CITY OF RIVER FALLS

WATER MANAGEMENT PLAN

FOR THE

KINNICKINNIC RIVER AND

ITS TRIBUTARIES

APRIL 20, 1995

Prepared by Short Elliott Hendrickson Inc.
in cooperation with the City of River Falls, Wisconsin Department of Natural Resources, the University of Wisconsin-River Falls and Trout Unlimited.

River Falls Wisconsin

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Forward and Acknowledgments

The Watershed Management Plan for the Kinnickinnic River and it's tributaries is the culmination of a significant, multi-governmental effort. Beginning in 1991 with the City's receipt of a state grant, the project began with a single objective:

> *"to aid in preparation of an action plan to minimize adverse water quality impacts from existing and future storm water discharges to the Kinnickinnic River."*

The "action plan" is further defined by an implementation program. The implementation program includes:

- Recommended improvements and estimated project costs and quantities.
- Implementation schedule which conforms to the expected development pattern and maximizes hydraulic benefits and construction sequencing.
- Monitoring program schedule and estimated costs.
- Identification of responsible agencies and organizations.
- City policies and draft ordinances and permit procedures which are needed to assure implementation of the plan, especially in the area of construction site erosion and runoff control as they relate to water quality.

- Identify advantages and disadvantages of viable financing options to be used to offset the costs of the implementation plan.

- Future plan amendment process.

The 205j Plan, as presented, meets the contractual requirements of the Wisconsin DNR. However, it is clearly the intent of the contract and the scope that the plan would be implemented; to not implement some or all of the plan may greatly diminish the ability of the City to obtain future grants of this type.

The River Falls City Council adopted the plan on April 12, 1994 (Resolution No. 2414). Over the course of the preceding year, minor plan amendments were made consistent with said resolution. The changes result in a final, adopted document that will play a key role in the management of the Kinni for years to come.

Application to Corporate Units

Although the study area encompasses 64 square miles, including each of the surrounding four townships, this plan only applies to the City of River Falls and that area within the corporate units. The plan does not apply specifically to the surrounding townships, nor does the plan address agricultural runoff. While it is probably true that land stewardship has reduced runoff and sediment loadings which once existed, the current and future threats to the river are from the development of land, changing open space to subdivisions, and shopping centers.

The larger study area is now a candidate for the State Priority Watershed Program. If selected, the Kinni could receive millions of dollars into the area for water quality enhancement over a 10-year period.

Township Cooperation

River Falls Township is in full support of the plan. Kinnickinnic Township participated in the process from beginning to end. Clifton Township provided comments on the draft lannage which are reflected in the final document.

Troy Township did not actively participate, representing less than 25% of the study area. However, virtually no land use impacts within Troy (or Kinnickinnic) Townships are expected to take place outside of the extraterritorial zone (ETZ).

Working through the technical committee, a three-phased approach for accomplishing township cooperation was developed:

1) Township development of mirror ordinances, to be enforced by "the appropriate jurisdiction".

2) If mirror ordinances are not implemented, attempt to establish an intergovernmental cooperative agreement for watershed management.

3) If still ineffective, extend the ETZ to the full three mile limit.

The language, reflected in the plan, was agreed to be the participating Townships.

River Falls Township has decided to develop mirror ordinances; Clifton Township may also follow the City's lead. Mirror ordinances would have little or no impact on any of the Townships, since most of the development is already in the ETZ.

Implementation Program: *A Series of Checks & Balances*

A significant implementation program, both in scope and cost has been presented in the plan. The programs, projects and costs associated with the plan must be approved as individual items, as part of the City's Capital Improvement Program.

By adopting the plan, the City Council has not specifically committed to the elements of the implementation program. Each activity is still subject to action by the Common Council before it can be considered in the City's annual budget.

The dates in the implementation plan continue to reflect 1994 as the first year of the implementation program. Some activities have occurred over the last year, including the City's successful grant application for Lake George, nomination of the Kinnickinnic River for state priority watershed status by Pierce and St. Croix Counties, and application of plan guidelines for development of the City's new industrial park (Paulson property).

There will never be one-to-one correspondence between the proposed dates of the implementation plan and the current calendar. For that reason, all planning dates remain unchanged.

Significant Elements

The plan includes numerous recommendations for reducing storm water impacts. Some of the most significant elements include:

❑ Establishment of E.P.I. (effective percent impervious) guidelines, including zero impact level of 10-12% imperviousness.	pp 63, 84, 85, 243, 256 & Appendix

- ❑ Establishment of Conservancy Zoning (500 feet either side of the river). p. 256
- ❑ Pollutant loading equations p. 38
- ❑ Copper toxicity limits for storm water discharge. p. 46
- ❑ Recommended total suspended solids removal criteria at 85%. p. 46
- ❑ The Kinnickinnic River Land Trust p. 199

Acknowledgments

A multitude of individuals played a significant role in conceiving, discussing and reviewing this plan. Without their participation, the project could not have succeeded: The group included:

Marty Engle	WDNR
Dan Simonson	WDNR
Kent Johnson	Trout Unlimited
Robert Chambers	The Kinnickinnic River Land Trust, Clifton Twp.
Kelly Cain	River Falls Township
Dale Braun	U.W. River Falls
Mike Wharton	U.W. River Falls
Peter Dahm	City of River Falls
Darrin Beier	City of River Falls
Louis Campbell	River Falls Township
Jerry Larson	Kinnickinnic Township

The "205j program" goal is to deliver high quality of water to the river. The plan does not address habitat for trout or any other aquatic life. The plan considers management of the total resource. Proper management of the watershed will perpetuate the existing stream status as an outstanding resource water (WDNR designation).

It will most certainly be through the cooperative efforts of all parties that the goal will be achieved.

Respectfully submitted,

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Project Manager

River Falls Wisconsin

EXECUTIVE SUMMARY

River Falls is located in southern St. Croix and northern Pierce counties in western Wisconsin. The community, consisting of the City and adjacent townships, is undergoing rapid growth and development. The Kinnickinnic River and its tributaries are valuable trout streams representing a major natural amenity of the community. However, the effect of storm water from the City of River Falls and the surrounding towns has the potential to degrade the physical and biological characteristics of the Kinnickinnic River and its tributaries.

The City has long recognized a need to protect and enhance its water resources. The City has:

- Adopted Erosion Control Ordinances (1982)
- Developed and Enforced Floodplain Zoning
- Aggressively developed both retention and detention facilities
- Aggressively pursued acquisition of land for public purposes along the Kinnickinnic. In 1990 alone two acquisitions brought over 42 acres into public control at a total transaction value of close to $105,000.
- Undertaken strategic planning with the University of Wisconsin affecting the South Fork.
- Recognized the Town of River Falls as an important partner with a long history of

While much has been done, much remains to be undertaken and completed. The protection of the water quality of the Kinnickinnic is critical to the environmental and economic future of the community. Development along the Kinnickinnic needs to be carefully planned to protect the existing resource. Recent articles in fishing magazines (Humphrey 1989) have directly addressed this problem as it relates to the lower Kinnickinnic.

The City has an existing storm water system, much of which discharges directly into the Kinnickinnic. The existing system has seen some improvements, such as the new outfall and sediment basin for the St. Croix Street storm sewer and Industrial Park areas. However, more needs to be done to protect water quality and fisheries.

The future of Lake George and Lake Louise are topics of continuous debate. Severe sedimentation created by poor urban and agricultural practices has left the City with shallow lakes not conducive to the cold water fishery. These lakes provide a focus for the community; the problem facing them must be locally addressed. Sampling of bottom sediments from Lake George was conducted in 1989-90. An acceptable action plan has yet to be developed; more research is needed.

Trout are considered an indicator species of environmental quality. Therefore, trout habitat is a major issue in this urbanizing area. A plan to protect and enhance this resource must be developed, locally supported, adopted and implemented.

Because of the potential development trends, the City has joined forces with the Wisconsin Department of Natural Resources, Trout Unlimited and the University of Wisconsin-River Falls to finance this planning process. The community at large is concerned with and is addressing the following general issues:

- Surface and ground water quality
- Protection of the river corridor
- Improvement of the river corridor in the Central Business District
- Identification and protection of existing spring areas and recharge areas that sustain a cold-water fishery
- Tourism
- Prevention of ground water pollution
- Enhancement of the Fishery
- Maintenance and enhancement of rural character and community identity

These general concerns are minimally addressed in several planning documents including the City's 1987 Master Plan, the 1990 Community Plan for Downtown Improvement, and the five-year Recreation Capital Improvement Plan. However, to address the above-stated concerns, the City of River Falls and the adjacent towns of River Falls, Clifton, Troy and Kinnickinnic must act **together** to accommodate growth while addressing problems associated with increased runoff volumes, sedimentation, thermal influence of runoff, and transfer of toxic pollutants via storm water into the Kinnickinnic. With more impervious surfaces resulting from development, there is less opportunity for groundwater to infiltrate and recharge springs and cold water feeder streams. Without aggressive planning and implementation measures, the urbanization taking place will result in increased water temperatures which threaten high quality trout waters.

The Local Water Management Plan for the Kinnickinnic River and its tributaries is the first major step towards managing water resources in River Falls and in the Kinnickinnic River Watershed.

Plan Approach

The general strategy of the plan is to deliver good quality storm water runoff to the Kinnickinnic River at acceptable rates and volumes to reduce pollutant loading and stream bed/stream bank degradation, and maintain a river temperature suitable to support a cold water fishery. Area DNR fisheries managers will have primary responsibility for habitat management decisions.

The plan addresses the following:

- Thermal pollution
- Flooding as it relates to bank erosion and habitat degradation
- Sediment delivery
- Pollutant loading, including nutrients and heavy metals
- Ground water

Focus Areas

The plan focuses on several main topic areas:

Watershed Assessment. The Watershed Assessment includes a complete description of the physical environment.

Hydrologic Analysis. The basic philosophy of the hydrologic analysis is to maximize the use of existing natural storage areas and to encourage an approach to future development which promotes green space and infiltration. Detention of storm water will reduce the flood impacts on the River and tributary branches. Properly designed detention basins can also significantly reduce the suspended solids and nutrients entering the River. By controlling the rates of storm water discharge, stream bank and stream bed damage can be minimized.

Water Quality. The Water Quality approach focuses on best management practices designed to reduce the nutrient and suspended solids loading and the thermal impacts to the River from the storm drainage system. The water quality approach is closely tied to the results of the hydrologic analysis, assuring that future detention basins can include features to improve the quality of storm water discharging to the River.

Ground Water Management. The ground water program focuses on describing the geologic formations, assessing the connections between ground water and surface water, the impact of a new municipal well and identifying the threats to, and protection strategy for, surficial and deep well aquifers.

Plan Implementation

Action Plans for each of the seven minor watersheds are the backbone of plan implementation. In addition to goals and policies and the watershed-specific Action Plans, this document outlines a process for public involvement and the administrative procedures for implementing the plan, including an improvement program and financing options. Local regulations are also recommended.

Future Watershed Management

Through an integrated effort beginning at the community and local level, the resources of the Kinnickinnic River can best be protected.

These first comprehensive management efforts can be used to guide future development. The plan can also be the basis for establishment of a DNR priority watershed for the Kinnickinnic River Watershed. Such a designation would involve the study area and the City of River Falls and could be expanded to all 11 townships in the Kinnickinnic River Basin. The goal of the priority watershed program would be to protect the Kinnickinnic River and its tributaries. One of its major functions would be to review future land use practices in the overall River basin.

The Kinnickinnic River Priority Watershed would provide a mechanism that would address water quality issues as they relate to rational land use and stewardship.

River Falls Wisconsin

INTRODUCTION

Background

Location

The City of River Falls is located in the southern St. Croix and northern Pierce counties in western Wisconsin. River Falls lies about seven miles south of Interstate 94, along State Trunk Highway 65/35. The Kinnickinnic River bisects the community from the northeast to the southwest. The South Branch of the Kinnickinnic River splits the University of Wisconsin-River Falls (UWRF) campus, which is located in the southeast part of the City. The Kinnickinnic and its tributaries are valuable trout streams, representing a major natural amenity of the community.

Growth

The City and adjacent townships are undergoing rapid growth and development. The City experienced a 16 percent plus growth rate during the 1980s while the State grew at a rate of approximately 3 percent. State Trunk Highway Beltline (S.T.H.) 65/35 has been recently completed. A four-lane connector to the Interstate 94 system was approved by the Transportation Projects Commission on December 18, 1990. This project is planned for construction in 1996. Pierce and St. Croix counties are designated as part of the Twin Cities Metropolitan Planning Area.

The City is expected to grow from its current 1990 estimated population of 10,500 to an estimated 16,500 persons in the year 2010 (Ayres 1987). This population, given the planned highway improvements approved since the Master Plan was prepared in 1987, must be considered conservative. Furthermore, projected population figures do not include the extraterritorial zoning and surrounding townships which are rapidly converting from agricultural to rural residential uses.

Development Impacts

- *Anticipated major commercial development immediately north and west of the Kinnickinnic River*. State Trunk Highway 35/65 bridge and a 90-acre annexation in 1989 paved the way for freeway interchange related development within close proximity of the River corridor.

- *Secondary impacts associated with the planned beltline*. Residential development in ravine and bluff areas will increase the rate and volume of runoff, compounding the flooding problems and increasing the risk of increased erosion.

- *Existing and proposed landfills*. Proposals exist for ordinance amendments allowing demolition landfills in the southeast quadrant of the City which, while legitimate, pose great concern for surface and ground water quality. A rubble and stump/branch disposal area in the southwest part of the City is also of concern.

- *Major industrial development in the southeast quadrant of the community*. Significant development is anticipated in this part of the City which could have a significant effect on the storm water and ground water or ground water recharge. Plans for a future municipal well in this area must also be considered.

Planning Area

The planning area encompasses approximately 64 square miles. This is the major urbanized area associated with this River and includes two major tributaries. The first tributary, the South Fork of the Kinnickinnic, flows through the 185-acre University of Wisconsin-River Falls campus. The second is the Rocky Branch. The planning area is illustrated on page 9.

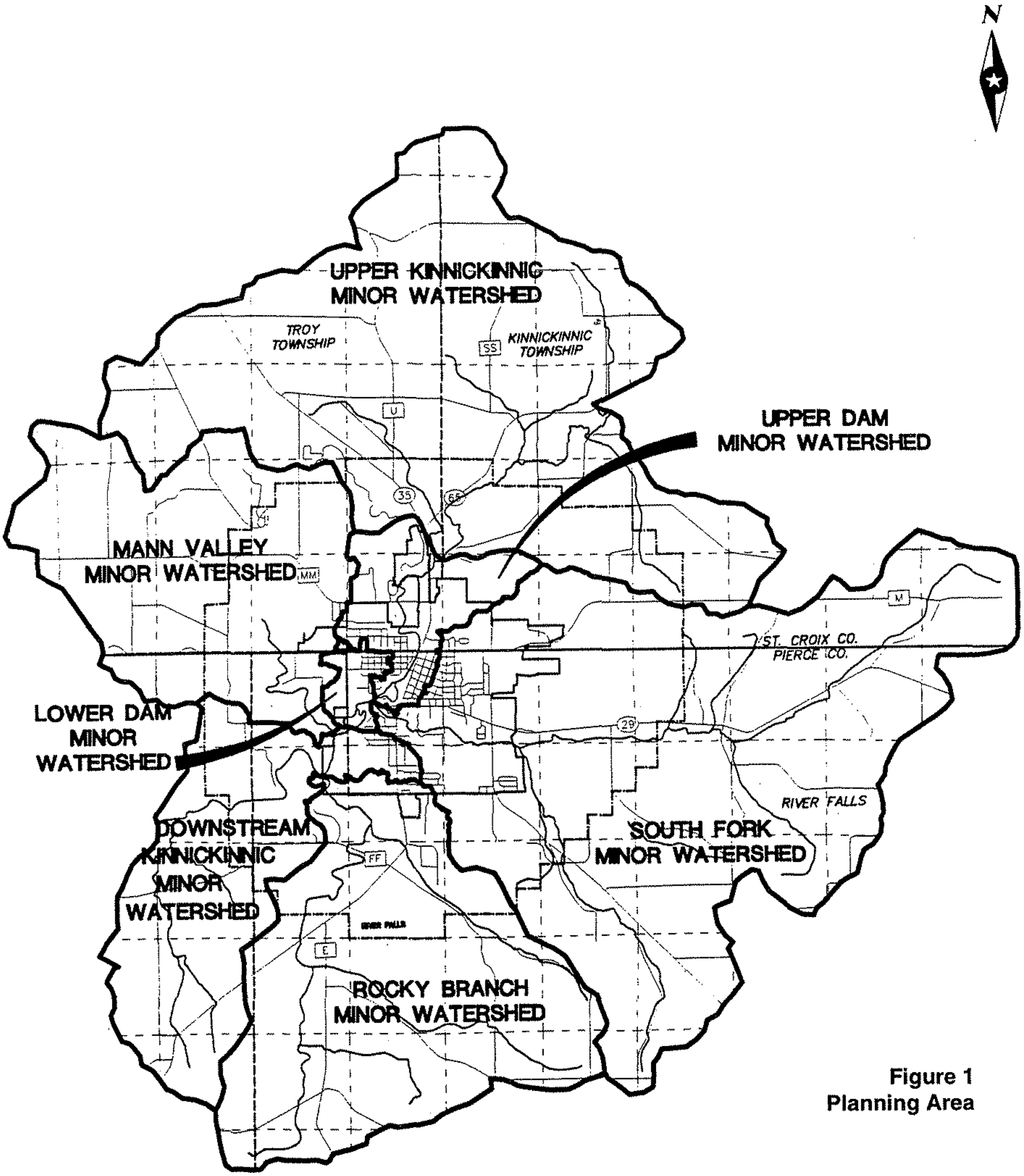


Figure 1
Planning Area

Planning Process

The planning process is illustrated on Figure 2 on page 11. Starting the planning process with the best available information assures a meaningful and useful final product. Use of the existing resources in the planning process has been maximized. Where necessary, new data have been generated.

During the period of data collection and analysis, representatives of the DNR, Trout Unlimited, University of Wisconsin-River Falls, adjacent townships and the City met regularly. Through this "committee" process, the Problem Statement and Mission Statement of the plan were formalized, the goals and policies of the program were agreed upon, the existing and new data were reviewed and discussed and an implementation plan was developed.

Planning Approach

The general approach of the study is to deliver good quality storm water runoff to the Kinnickinnic River at acceptable rates and volumes to reduce sediment loading and stream bed/stream bank degradation and maintain a suitable river temperature to support a cold-water fishery.

The study addresses the following:

- Thermal Pollution
- Flooding as it relates to bank erosion and habitat degradation
- Sediment delivery
- Pollutant loading including nutrients and heavy metals
- Ground Water

The Kinnickinnic River is three distinct reaches and can be described as:

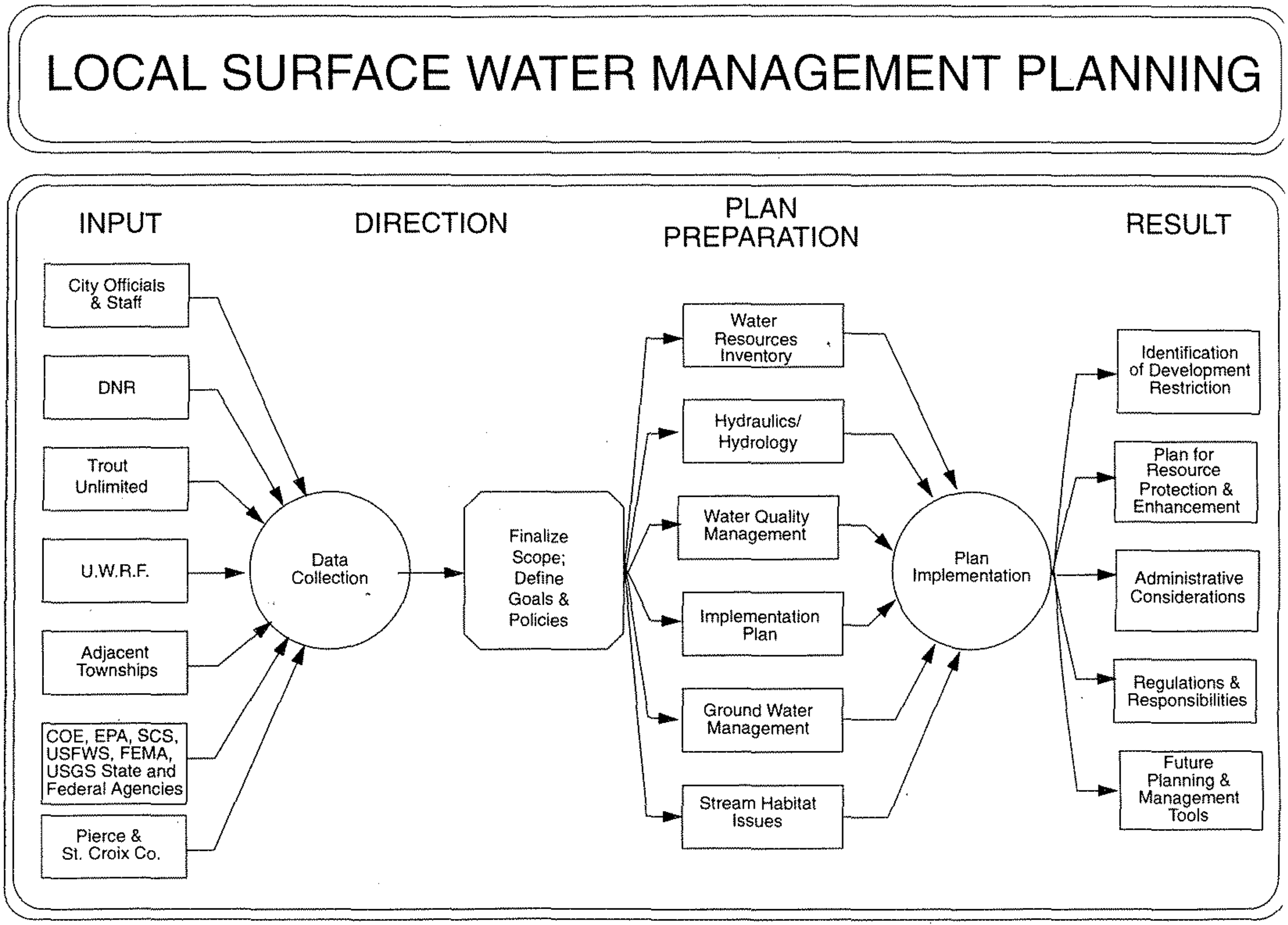

LOCAL SURFACE WATER MANAGEMENT PLANNING
INPUT
DIRECTION
PLAN PREPARATION
RESULT
City Officials & Staff
DNR
Trout Unlimited
U.W.R.F.
Adjacent Townships
COE, EPA, SCS, USFWS, FEMA, USGS State and Federal Agencies
Pierce & St. Croix Co.
Data Collection
Finalize Scope; Define Goals & Policies
Water Resources Inventory
Hydraulics/ Hydrology
Water Quality Management
Implementation Plan
Ground Water Management
Stream Habitat Issues
Plan Implementation
Identification of Development Restriction
Plan for Resource Protection & Enhancement
Administrative Considerations
Regulations & Responsibilities
Future Planning & Management Tools

Figure 2

Upper River

The upper 12 miles of the River, between the spring holes and the City are rated as Class I (top quality) trout waters. This rating is based in part on the high rate of natural reproduction and high density of native trout. Threats to this part of the River include agricultural nonpoint source runoff, increased sedimentation, and reduction of spring activity. According to the Basin Plan for this region of the State (Wisconsin Department of Natural Resources 1980), the Kinnickinnic Watershed has one of the highest average annual erosion rates of any watershed in the state. However, actual rate of sediment delivery to the River is lower than might be expected. The well-established riparian zone of vegetation currently filters sediment from runoff. Proper land management activities in the upper portions of the watershed will preserve the riparian vegetation resulting in high quality habitat and more effective management of the lower reaches.

Middle River

The middle reach of the River extends from the extraterritorial zoning area on the northeast to the lower impoundment to the southwest, including the entire urbanized section of the City. The management goal for this segment of the River differs from the inventory-nature of the upper river plan. This reach is divided into several minor watersheds for the establishment of overall plan objectives and management strategies.

The "urban" section of the River has been the recipient of storm sewer and other point discharges, as well as sediment from the upper watershed, for years. The shallow lakes behind each of the City-owned dams are evidence of the siltation that has occurred over the years.

This plan delineates the tributary area to this segment of the River and considers Best Management Practices (BMPs) to make practical and effective improvements to existing and future storm water discharges. Reduction of sediment and nutrient loading will be the primary purpose of the BMPs. However, flood control through detention of storm water is planned to reduce the frequency of overtopping either impoundment which is likely to resuspend the accumulated fine-grained sediments.

Deposition of these sediments downstream can have the negative effect of modifying trout habitat and reducing the success of natural reproduction. Any addition of eroded particles to a trout stream, other than those that are naturally eroded by action of the stream against its bank and bottom, can be considered harmful to the stream's trout-carrying capacity. Therefore, management on this segment of the River will focus on controlling discharges to the River and stabilizing the accumulated sediments behind the City-owned dams to reduce the likelihood of resuspension and deposition of sediment downstream. The thermal impact of dam discharges will also be considered as they impact the physical habitat of the lower River.

Lower River

The segment of the River, from the lower impoundment to the southwesterly boundary of the planning area, has two management strategies. First, management of discharges from the lower dam and impacts of major flood flows on the upper River are considered. Second, natural and man-made discharge points to the River are identified. Management plans for future discharge have been developed, including analysis of inflows from Bartosh Park, Rocky Branch, and Mann Valley.

The runoff management strategy for future river discharges is based on the projection of future land uses. The plan does **not** consider preservation of the lower River, which would, in effect, eliminate all discharges to the lower River. A drastic watershed change, as would be needed to isolate the lower River, is not practical or beneficial, as hydrology is a major component of the stream ecosystem. Rather, a protection strategy is proposed.

The protection strategy recommends a minimum number of discharge points to the River. Outfalls should include measures to reduce sediment loadings, velocity of discharge, and angle of discharge to the stream bank, introducing safe flows into the River without eroding the stream banks or stream bed and maintaining a suitable stream temperature to sustain a cold-water fishery. Development within the watershed will continue to discharge to the River, but in a planned, controlled manner, which will maximize infiltration and minimize stream bank and stream bed degradation temperature to sustain a cold-water fishery.

Thermal Management

Increasing temperatures on the lower reaches of the River are a major concern. A thermal profile throughout the study area illustrates existing and future problem areas (see *Monitoring Program*). Utilizing available temperature monitoring data, a protection plan developed to mitigate the effects of thermal pollution can be implemented.

Implementation Plan

The final step is where the community puts the plan into action. The implementation plan includes the following elements.

1. Identification of Development Restrictions
2. Plan for Resource Protection and Enhancement
3. Administrative Considerations
4. Regulations and Responsibilities
5. Future Planning and Management Tools

River Falls Wisconsin

Responsible Agencies

The City of River Falls is taking a lead role by undertaking and preparing an action plan to minimize adverse water quality impacts from existing and future storm water discharges to the Kinnickinnic River. The City continues to rely on the DNR to provide expertise in the area of instream habitat as DNR is recognized as having an intimate knowledge of the River ecosystem and the ultimate responsibility for management of the fishery.

The City of River Falls, through its Community Development Department, is the responsible agency for undertaking storm water planning in the extraterritorial zone. While the City has an active and ongoing planning process with each of the four townships of the extraterritorial zone, active participation of all townships at this stage of the planning process could be improved. Trout Unlimited and the University of Wisconsin-River Falls, however, play major roles in plan development, and implementation.

205j Grant

The initial water management program is being funded primarily by an Environmental Protection Agency (EPA) 205j Grant for water quality planning assistance. The grant, which is administered by WDNR is supplemented with additional funds and in-kind contributions from the City, Trout Unlimited and UWRF.

Plan Objective

The intent of the River Falls plan is to focus all basic information and planning data into a single document which describes existing conditions, specifies policies and standards, and recommends actions for the future enhancement of the communities' water resources. The plan is prepared in accordance with the Wisconsin Department of Natural Resources administered 205j grant program with input from UWRF, TU and the adjacent townships.

River Falls Wisconsin

INTRODUCTION

Proper use of water resources and water quality protection can be realized through strong policies and thoughtful program implementation. Implementation of such a program requires the cooperation of neighboring towns, both county, State and federal agencies and the WDNR.

Planning allows decisions to be made which provide for the enhancement of water quality, prevention of ground water degradation, reduction of local flooding, and improved development patterns relative to the environment.

River Falls Wisconsin

GOALS AND POLICIES

The goals and policies of the River Falls Water Management Plan provide for future development and growth while minimizing surface water problems and enhancing the environment. The goals and policies are consistent with the goals of the EPA's Section 205j of the Federal Clean Water Act and WDNR's Nonpoint Source Program while meeting the more specific and changing needs of the community.

Goal

A ***goal*** is a vision toward which water management efforts are directed. This section of the plan identifies ten goals for water resources planning and management functions.

Policy

Each goal has several corresponding policies. A ***policy*** is a governing principle that provides the means for achieving established goals.

Standards

Standards are an extension of the policies. The standards provide detailed guidance regarding water management practices. Specific standards are included in the Appendix A.

Thermal mitigation standards are found in Appendix B.

The goals, policies and standards are developed into specific action plans for each minor watershed in the study area.

Flood Control

Control flooding and minimize related public capital expenditures.

Policy 1.1: Natural storm water storage areas and constructed detention areas should be utilized to control flooding.

Policy 1.2: The storage capacity of the natural drainage system shall be utilized to control rates of runoff to undeveloped rates where practical.

Policy 1.3: The Community will take an active role in developing regional detention areas, as opposed to individual on-site detention, whenever practical.

Policy 1.4: All hydrologic studies shall be based on standard hydrologic criteria and ultimate development of the entire tributary drainage area.

Policy 1.5: Major storm water facilities (i.e., ponds, pond outlet systems, and major conveyance systems) shall be designed using a return period of 100 years.

Policy 1.6: All minor drainage system analyses and design (i.e., storm sewer) shall be based on a return period of 10 years unless otherwise specified.

Policy 1.7: Detention facility design shall include access for maintenance of the outlet structure and the facility in general.

Policy 1.8: The design of storm water facilities shall consider and identify location(s) of overflow(s) to drainage systems that may prevent damage to adjacent properties from extreme water levels.

Policy 1.9: Minimum building elevations (lowest slab) shall be above flood levels established in this report and/or the City flood insurance study.

Policy 1.10: Emergency overflows or outlets to drainage systems shall be provided to any landlocked area if the available storm water storage capacity is inadequate to prevent flooding of adjacent structures.

Water Quality

Achieve water quality standards in City lakes (impoundments) and the Kinnickinnic River and its tributaries, consistent with intended uses and classifications.

Policy 2.1: The appropriate jurisdiction(s) and WDNR shall manage intended uses and nondegradation standards of the Kinnickinnic River and its tributaries.

Policy 2.2: Sedimentation ponds shall be constructed prior to discharging runoff into the River and its tributaries.

Policy 2.3: All new development shall reduce total suspended solids loading to a drainage system, pond, or river in accordance with TSS removal standards of this plan.

Policy 2.4: The design of Best Management Practices (BMPs) must identify and mitigate the thermal impacts of a proposed development.

Policy 2.5: All construction plans developed for the maintenance and/or improvement of water quality shall include a detailed access and maintenance plan and shall require approval by the appropriate jurisdiction prior to initiating construction.

Policy 2.6: Water quality impacts of agricultural areas outside of the planning area will be regulated by the appropriate jurisdiction or the land conservation offices in Pierce and St. Croix counties.

Policy 2.7: The Community shall develop and the appropriate jurisdictions shall adopt and implement a thermal management plan for the River based on the effective percent impervious factor of subwatersheds.

Policy 2.8: A response plan to minimize the impact of hazardous spills on the River and its tributaries shall be developed by the Community.

Recreation, Fish and Wildlife

Protect and enhance water recreational facilities, fish and wildlife habitat.

Policy 3.1: The appropriate jurisdiction shall clearly mark and/or fence natural areas, wildlife habitat and wetlands to be protected during construction.

Policy 3.2: Buffer zones of natural vegetation shall be maintained around ponds, wetlands, and stream and river banks, to provide habitat for wildlife and to maintain a natural margin.

Policy 3.3: The water level fluctuation of a wetland, pond or stream shall be minimized to prevent adverse habitat changes.

Policy 3.4: Instream habitat improvements in the Kinnickinnic River and its tributaries shall be managed by WDNR (with assistance from Trout Unlimited [TU]) and shall focus on management of stream bank vegetation and erosion prevention in an effort to improve the stream productivity and thermal conditions.

Policy 3.5: Prior to modifying wetlands or streambanks, or constructing storm water facilities, existing habitat shall be fully described, both graphically and in writing by the owner or developer. Said habitat shall be maintained and enhanced, or new habitat shall be developed to replace lost habitat.

Policy 3.6: The Community shall support programs for improving fisheries habitat in conjunction with WDNR, TU, and University Wisconsin-River Falls.

Policy 3.7: The Utility Commission, on behalf of the City, shall operate the Lake George and Lake Louise Dams in a run-of-the-river fashion consistent with Federal Energy Regulatory Commission license requirements, as administered by WDNR.

Policy 3.8: Activities related to recreation, fish and wildlife shall be consistent with WDNR's St. Croix River Basin Plan.

Public Participation, Information and Education

Increase public participation and knowledge in management of the water resources of the Community.

Policy 4.1: The Community will utilize a variety of medias, including quarterly newsletter, radio and local cable television, to discuss water resource issues affecting the Community.

Policy 4.2: Citizen water quality monitoring is encouraged and supported by the Community.

Policy 4.3: The University of Wisconsin-River Falls, area schools, and resource agencies will be responsible for development and implementation of a community education program relating to preserving and improving water quality in the Community.

Ground Water

Promote ground water recharge, prevent contamination of the aquifers and protect spring areas.

Policy 5.1: A flow monitoring system shall be established to monitor flow along the Kinnickinnic River to establish the existing ground water contributions and losses along the stream.

Policy 5.2: Identified recharge areas shall be protected from adverse development and from potential contamination.

Policy 5.3: When practical, ponds shall be designed as "wet ponds" with storage volume below the outlet to promote infiltration/ground water recharge.

Policy 5.4: The use of grassed waterways shall be encouraged to maximize infiltration. Proper grades shall be maintained or underdrain systems installed as part of an overall site plan to insure positive drainage.

Policy 5.5: A response plan to prevent the spread of hazardous spills to the recharge areas shall be developed by the appropriate jurisdiction.

Policy 5.6: All spring areas shall be identified in the field, denoted on official maps of the City and township(s) and protected from development within the watershed.

Policy 5.7: The appropriate jurisdiction shall use both regulatory and non-regulatory tools to protect the land area within designated well head protection areas.

Wetlands

Maintain wetland acreage and increase the wetland values within the Planning Area.

Policy 6.1: A wetland management plan for wetlands in the planning area shall be established.

Policy 6.2: A wetland classification system will be developed to prioritize and manage wetlands.

Policy 6.3: Areas that can be used for wetland mitigation shall be identified by the appropriate jurisdiction.

Policy 6.4: Wetland mitigation criteria shall be established consistent with state and federal regulations, and the intent of this plan.

Policy 6.5: Alteration of wetlands is discouraged. Alteration may be allowed on an individual basis if the alteration can be properly mitigated, in accordance with federal and state regulatory programs.

Erosion Control

Prevent soil erosion.

Policy 7.1: Existing vegetation shall be preserved on all parcels to the maximum extent practical.

Policy 7.2: Erosion control plans shall be required for all land disturbance activities within the planning area.

Policy 7.3: All erosion and sediment control measures specified in the erosion control plan must be installed prior to obtaining a grading permit.

Policy 7.4: Soil erosion shall be prevented through the installation of erosion control practices consistent with state and locally recognized methods.

Policy 7.5: Topsoil stockpiled for reuse shall be protected with mulch to prevent erosion.

Policy 7.6: It shall be the responsibility of the developer/contractor to keep streets and property adjacent to construction areas free from sediment carried by construction traffic at site entrances and access points, and from site runoff and blowing dust.

Policy 7.7: Soil erosion from agriculture areas outside of the planning area will be regulated by the local land conservation offices in Pierce and St. Croix counties.

Policy 7.8: The appropriate jurisdictions shall establish and maintain riparian buffer zones and green areas along the Kinnickinnic River and its tributaries to minimize sediment input and stabilize stream banks.

Regulatory Responsibility

Assume responsibility for managing water resources within the planning area and recognize the regulatory authority of other local, state and federal entities.

Policy 8.1: This plan and all subsequent amendments shall be consistent with all other regulatory agencies.

Policy 8.2: The establishment and implementation of a local permitting program for water resources management shall be the responsibility of the appropriate jurisdiction.

Policy 8.3: The Wisconsin Department of Natural Resources and the U.S. Army Corps of Engineers have regulatory authority over protected waters and wetlands management.

Policy 8.4: The City, the adjacent townships, and Pierce and St. Croix counties, will actively and cooperatively pursue the establishment of development related agreements and consistent planning focused on protection of the Kinnickinnic River.

Policy 8.5: The appropriate jurisdictions shall establish and maintain riparian buffer zones and green areas along the Kinnickinnic River and its tributaries to minimize sediment input and stabilize stream banks.

Finance

Finance water resources projects by means that are equitable to all citizens.

Policy 9.1: All developments shall, to an extent determined by the appropriate jurisdictions, provide land, funding, or a combination of both for management of local water resources, which includes development of regional facilities and planning studies.

Policy 9.2: The appropriate jurisdictions will establish a common fee structure charged to developers for analyzing the impacts of the proposed development.

Policy 9.3: The appropriate jurisdictions will establish a fee structure charged to developers for constructing capital improvements (i.e., trunk conveyance systems, regional ponds, etc.).

Policy 9.4: Assessments may be used when a project benefits affected owners and benefits can be demonstrated.

Policy 9.5: The appropriate will actively pursue available grants to fund local projects and implementation of this plan.

Policy 9.6: The appropriate jurisdictions shall investigate the feasibility of alternative funding sources.

Policy 9.7: The community shall encourage donations and in-kind contributions of public and private organizations and the school systems for plan implementation.

Policy 9.8: The community shall encourage the formulation and implementation of a State priority watershed program for the Kinnickinnic River.

Policy 9.9: The community shall continue to utilize the State's land stewardship program and appropriate jurisdiction's budgets for acquiring lands along the river and its tributaries.

Records Management and Documentation

Preserve historical data, records, and files pertaining to the water resources of the planning area.

Policy 10.1: A classification system will be developed and recorded for each new detention area, including the basis for the classification.

Policy 10.2: Engineering calculations will be required in a standard format to ease record keeping.

Policy 10.3: Past studies will be documented and filed. If a study does not currently exist, it should be noted.

Policy 10.4: During extreme rainfall events, high water conditions should be noted and surveyed.

Policy 10.5: A history of flooding and water quality problems will be developed by noting past events and recording current floods.

Policy 10.6: Changes in water quality, such as increased aquatic vegetation, changing thermal conditions, increased sedimentation, reduced fish numbers, and fish kills will be recorded.

Policy 10.7: A condition survey of storm water facilities will be established and implemented by the appropriate jurisdiction for the purpose of water resource management.

Policy 10.8: Trout Unlimited will be responsible for managing all temperature related data collected for the Kinnickinnic and its tributaries.

Policy 10.9: The City shall continue to develop a computer based Geographic Information System related to water management and land development.

River Falls Wisconsin

WATERSHED ASSESSMENT

Introduction

The Kinnickinnic River Subbasin is part of the larger St. Croix River Basin in Northwestern Wisconsin (see Figure 3 on page 32). The Kinnickinnic Subbasin includes the Willow River Watershed to the north, and the Kinnickinnic River Watershed in the south (Figure 4 on page 33).

Study Area

The Kinnickinnic River Watershed is further divided into three smaller watersheds: the Upper Watershed, the Central or Middle Watershed; and the Lower Watershed (Figure 5 on page 34). The study area for this project encompasses the entire Central Watershed, or about 64 square miles (Figure 6 on page 35). The Central Watershed includes seven identifiable minor watersheds:

- Upper Kinnickinnic (north of STH 35/65)
- Upper Dam (above Powell Lake Dam)
- South Fork
- Mann Valley
- Lower Dam (above Lake Louise Dam)
- Rocky Branch
- Downstream Kinnickinnic

Each minor watershed is unique, having different land use, variable rates of development, natural resources, and potential threats to overall resources. Therefore, plan objectives are centered about each minor watershed in accordance with the overall planning objective. A separate action plan is developed for each minor watershed.

Mission Statement

The mission statement represents the Community's attitude towards water management efforts. To accomplish the goals and follow the policies and standards, the City must have a single, consistent approach. The mission statement focuses on what is to be accomplished and how it will be accomplished.

The most logical first step in any comprehensive planning process is to clearly define the limits of the project. One of the best ways to develop a consensus among all concerned parties regarding a project scope is to establish a problem statement and mission statement.

Problem Statement

The increase in urban and rural runoff, with its associated thermal and sediment-related pollution from present and future land uses in the planning area, will continue to have a detrimental impact on the cold-water fishery of the Kinnickinnic River and its major tributaries without proper management of surface and ground water.

Mission Statement

The City of River Falls, in cooperation with the Town of River Falls, adjacent towns, the Department of Natural Resources (DNR), Trout Unlimited, and the University of Wisconsin - River Falls, will implement a regional water quality plan which will accommodate anticipated community development and continued sustainable agricultural practices, while controlling the quality and quantity of storm water runoff and properly managing and protecting ground water resources as well as the physical habitat of the Kinnickinnic River and its tributaries.

Method of Analysis

The methods utilized in analyzing the minor watersheds are described in the following pages. Based on the monitoring results from this study, the *Monitoring Program* section of the report recommends future monitoring activities.

Discussion

Each of the minor watersheds are described in the following sections. The descriptions are organized as follows:

Minor Watershed Descriptions

General Watershed Characteristics

- Location
- Physical Environment
  - Land Use
  - Soils
  - Unique Features

Hydrologic Units

Water Quality

Action Plan

Implementation

Based on the recommended action plans, an overall implementation program is developed, including estimated costs, tentative schedules, and related funding sources.

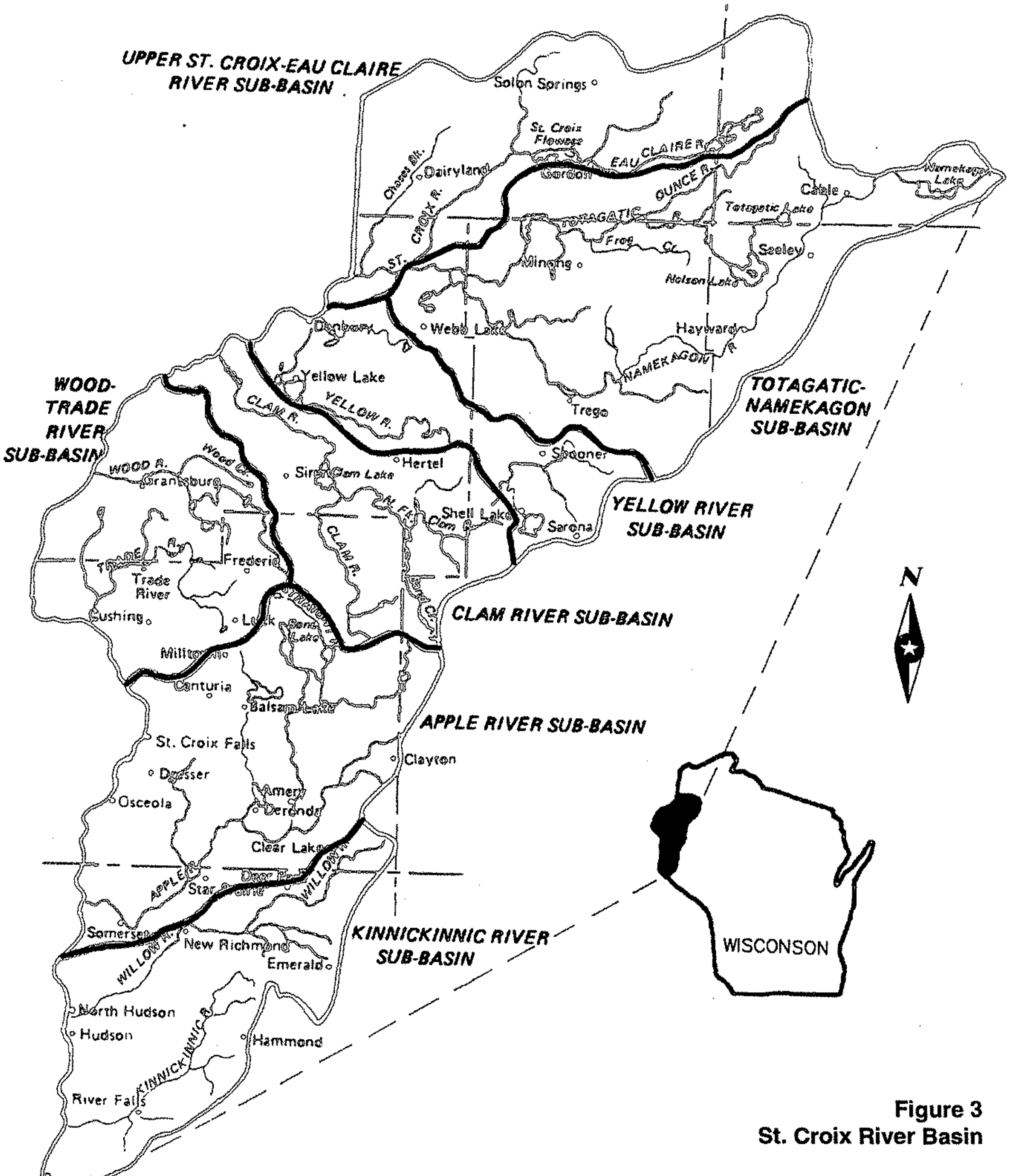


Figure 3
St. Croix River Basin

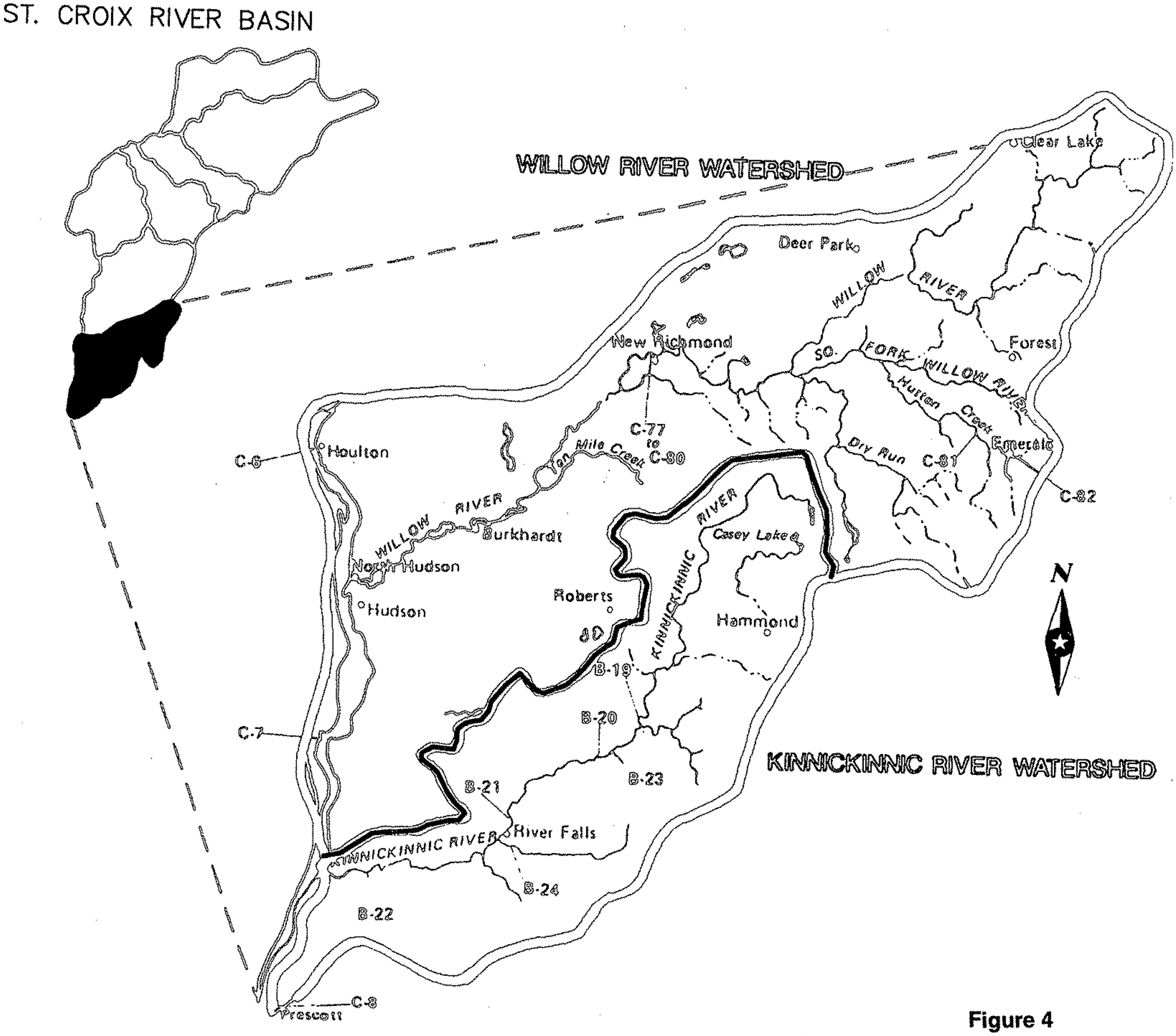


Figure 4
Kinnickinnic River Subbasin

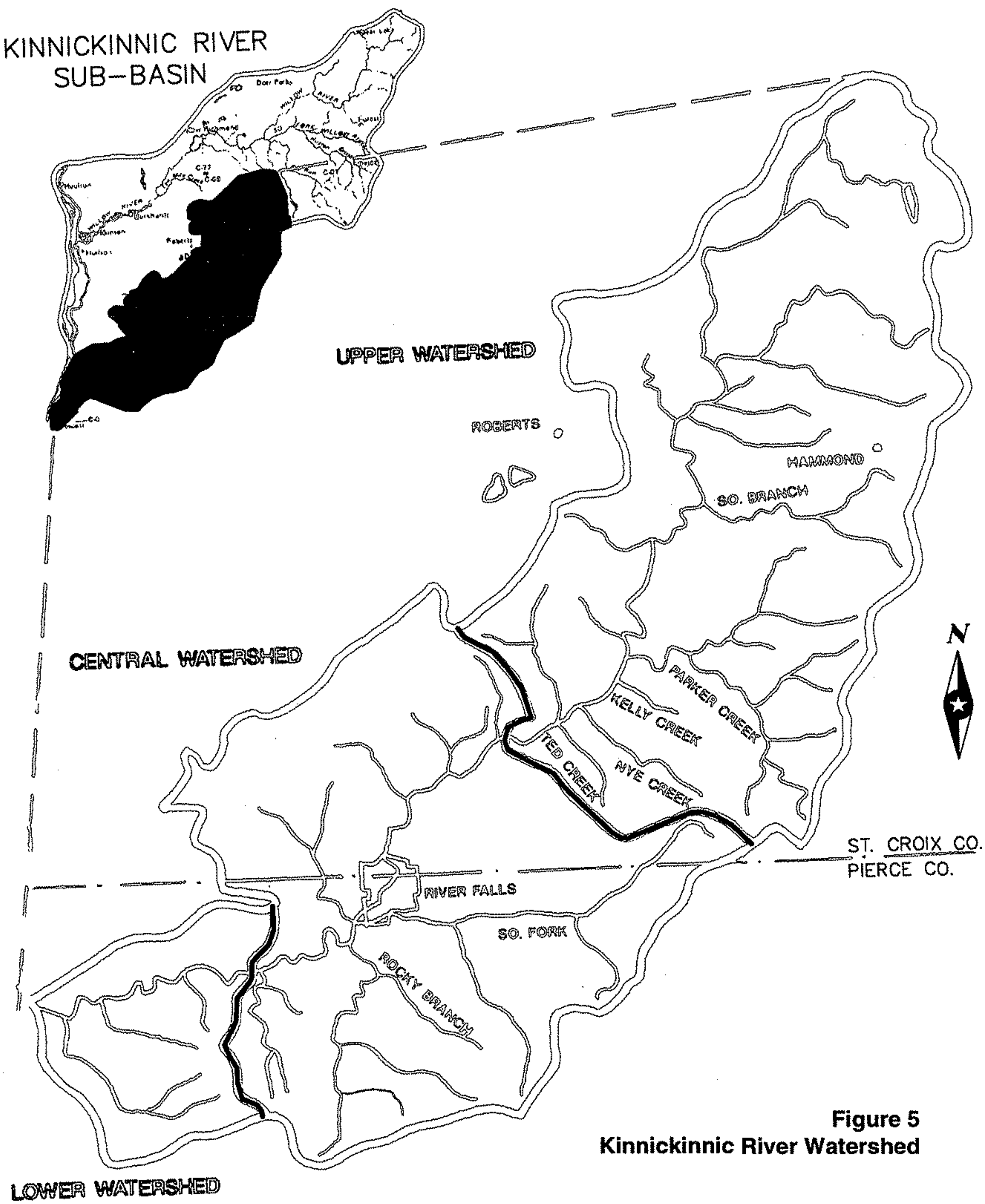


Figure 5
Kinnickinnic River Watershed

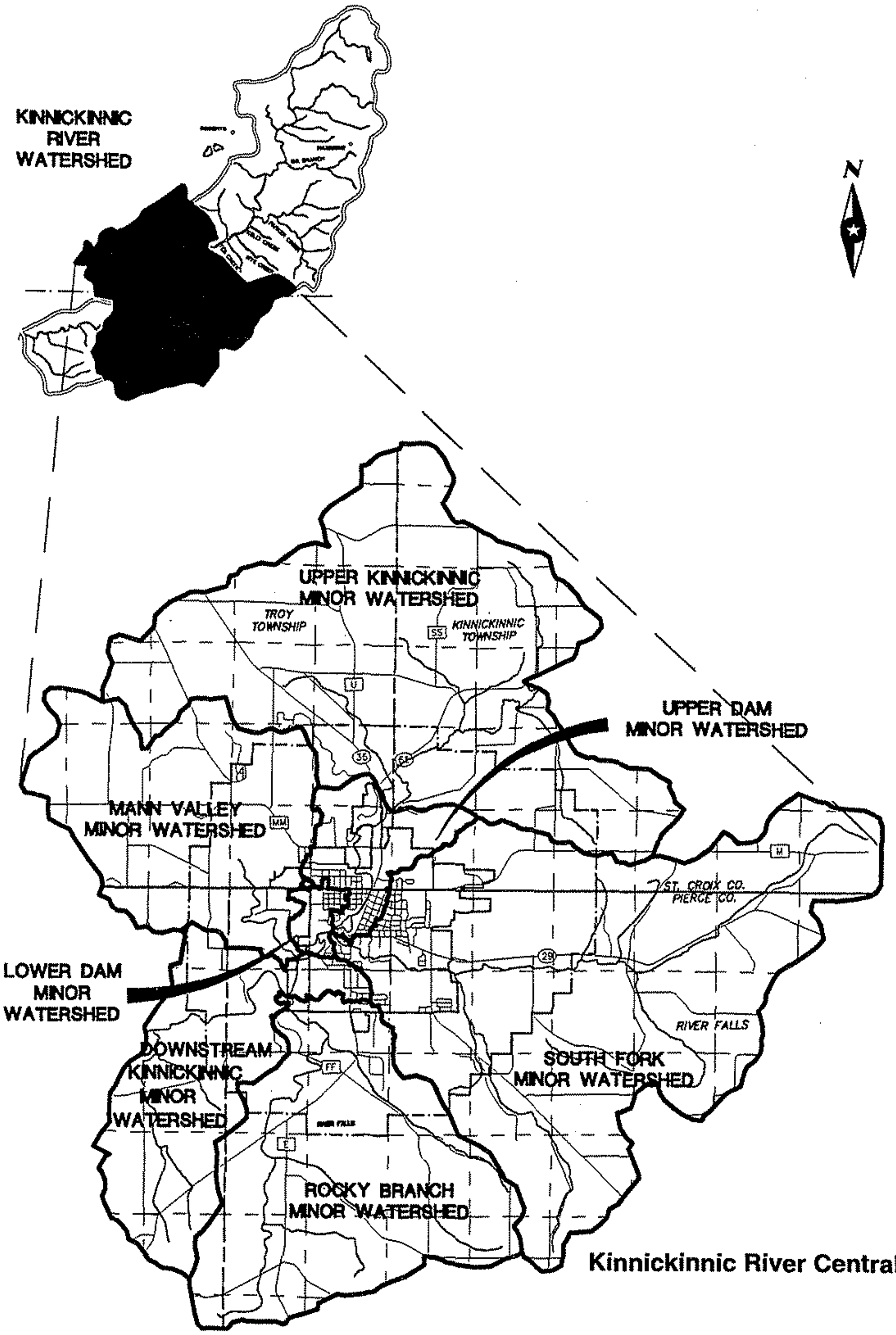


Figure 6
Kinnickinnic River Central Watershed

Water Quality Analysis

The primary focus of the water quality evaluation effort is to (1) provide a preliminary screening of the City's urban runoff pollutant characteristics, (2) provide a means to estimate total suspended solids (TSS) removal efficiency of existing storm water ponds and, (3) identify existing and future pollutant source areas.

Water Quality Overview

The water quality monitoring and modeling work to date is not intended to be a detailed water quality evaluation effort but rather a planning level screening. The time period considered for modeling is the growing season (April- October). The growing season is used because trout are most susceptible to degraded in-stream water quality during this period.

❑ **Runoff Water Quality Monitoring**

P8 Urban Catchment Model

Urban runoff water quality modeling was conducted using the P8 Urban Catchment Model Version 1.1 (IEP, 1990). Urban areas are defined as those areas with an impervious percentage greater than 10. The P8 model requires the input of the SCS curve number for pervious areas and the impervious fraction. The previous curve numbers and impervious fraction (%I) for each land use type used in the analysis are shown in Table 1 on page 37.

An area-weighted composite curve number and impervious fraction is generated for each subwatershed via a geographic information system (GIS) using existing and future land use and soils data. Information from as-built drawings and field inspections is used for each describing existing pond. The pollutant removal efficiency is determined for each pond under existing and future land use conditions.

Precipitation Data

Minneapolis-St. Paul airport hourly precipitation data for an average year is used. A statistically average year is the year in which the April-October monthly rainfall exhibited the smallest departure from long-term normal.

Table 1
P8 Inputs by Land Use Type

	SCS - Curve Number				
Land Use Type	**A-Soil**	**B-Soil**	**C-Soil**	**D-Soil**	**%I**
1 Family	39	61	74	80	0.30
2 Family	39	61	74	80	0.38
M Multifamily	39	61	74	80	0.65
Rural Residential	39	61	74	80	0.05
Open (Undeveloped)	39	61	74	80	0.02
Industrial	39	61	74	80	0.72
Commercial	39	61	74	80	0.85
Vacant	39	61	74	80	0
Public	39	61	74	80	0.50
Parks	39	61	74	80	0.10
Woods	39	61	74	80	0.02
Wetlands	85	85	85	85	0
Row	39	61	74	80	0.60
Agriculture	62	71	78	81	0.02

Parameters

The water quality parameters used in the modeling includes; Total Suspended Solids (TSS) Total Kjeldahl Nitrogen (TKN), Total Phosphorus (TP), Copper (Cu), Lead (Pb), Zinc (Zn) and Arsenic (AS).

Total Suspended Solids

The growing season TSS loading from the rural areas (impervious percentage <10) is estimated to be 45 lb./acre. The rural TSS loading is calculated using observed watershed sediment export information from USGS (1976). It is important to realize that the 45 lb./acre value is a basin scale value and is not at all applicable to a specific site.

The only water quality parameter reported from the modeling is the total suspended solids or TSS loading. The TSS concentration was deemed most appropriate for two reasons. First, total suspended solids loading plays a major role in impacts to trout habitat and second, the loading of the other pollutants can be calculated using TSS loading and the regression equations. The regression equations in Table 2 were developed using typical River Falls urban runoff characteristics. The equations are only applicable to urban areas (areas with greater than 10 percent imperviousness).

Table 2
Pollutant Loading Regression Equations

TSS (Lb.) = 12.159 x % I* x Acres	Rsq=0.99942
TP (Lb.) =0.00229 x TSS - 0.0129	Rsq=1
TKN (Lb.) =0.0115 x TSS - 0.1088	Rsq=1
Cu (Lb.) =0.000171 x TSS - 0.00637	Rsq=0.99998
Pb(Lb.) =0.000242 x TSS - 0.00114	Rsq=0.9999
Az (Lb.) =0.000621 x TSS - 0.00369	R=1

*Where I = percent impervious, for 75% impervious, Use I = 75.0)

❑ Sampling Site Descriptions

Residential Site

Figure 7 on page 40 illustrates the subwatersheds and sites monitored as part of this project. The sampling program involves three land use types; residential, commercial and industrial. The residential site is at the southwest quadrant of the intersection of Falls Street and Maple Street, one block upstream of the first site. The residential subwatershed has a tributary drainage area of 29.4 acres.

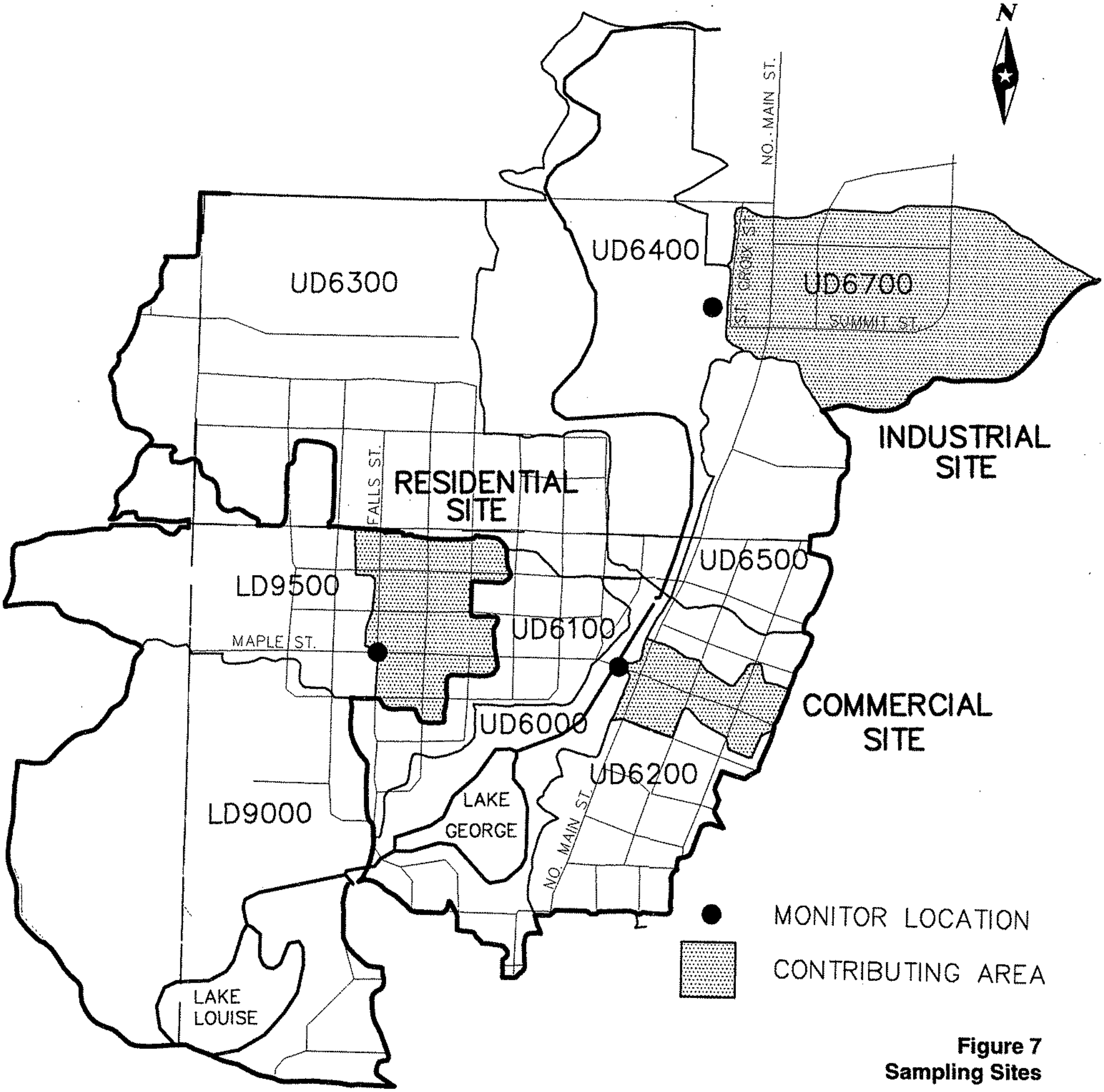


Figure 7
Sampling Sites

Commercial Site

The commercial subwatershed covers 13 acres. The sampling site is installed in a manhole located south of the easterly terminus of the Maple Street bridge. The land use is primarily commercial retail with a small single family residential area at the easterly edge. The commercial site also contained a thermistor which monitors the temperature of storm water runoff. The temperature monitoring equipment was installed and maintained by Trout Unlimited personnel.

Industrial Site

The industrial sampling site is located at the St. Croix Street storm sewer outfall. The sampling site is installed directly above the outfall pipe. The majority of the land use is industrial with a small amount of commercial along north Main Street. The sampling frequency for each site is summarized in Table 3. Due to the frequency of rainfall, only one storm sample was collected from this site.

Table 3
Storm Water Runoff Sampling Frequency

Residential	Commercial	Industrial
June 14, 1992	June 8, 1992	August 26, 1992
August 4, 1992	June 14, 1992	
August 10, 1992	June 14, 1992	

Monitoring

The American Sigma 800SL portable sampler with integral flow meter was used for sample collection. For manhole installation, the sampler was suspended from a platform bracket just below the manhole cover. A 3/8-inch vinyl intake tube connected a teflon strainer to the sampler pump. The intake strainer was attached to the bottom of the inflowing storm sewer pipe.

Sample Collection

The storm water flow rate was monitored continuously by the sampler's integral flow meter. Flow depth information was collected by a pressure transducer mounted in the bottom of the pipe. Flow data and samples were collected weekly, or as rain events dictated. Flow data was downloaded from the sampler to a laptop computer. The data was subsequently used for flow-compositing and analysis.

Discrete samples were collected for each rainfall event. A sampling frequency was established which was more frequent at the beginning of the storm event to better characterize the first flush. The sampling equipment setup was individually determined for each site based on watershed characteristics. All discrete samples were flow-composited prior to analysis.

❑ **Acceptable Storm Events**

Storm event selection for monitoring follows the EPA-NPDES storm water monitoring requirements to the greatest extent practical. In this way, the monitoring completed as part of this project can satisfy future federal requirements for the City.

Rainfall Characteristics

Samples were collected from runoff resulting from measurable storm events (greater than 0.1 inch) occurring at least 72 hours from the previously measurable storm event. Where feasible, the variance in the duration of the event and the total rainfall of the event did not exceed the average (median) rainfall event for the area by more than 50 percent. The median rainfall event for the area was determined using the Minneapolis-St. Paul synoptic rainfall data. Table 4 summarizes the rainfall characteristics used for event selection. Acceptable storm selection was made first on the basis of rainfall volume, then duration.

Table 4
Rainfall Characteristics Used for Storm Selection

	Mean Value	Upper Limit	Lower Limit
Rainfall Volume (In.)	0.31	0.46	0.15
Duration (Hr.)	6.8	10.2	3.4
Intensity (In./Hr.)	0.46	0.45	0.44

All samples collected were immediately iced. If the storm event was acceptable, the discrete samples were flow-composited and delivered to the laboratory for analysis. All samples were delivered to the laboratory within 48 hours of retrieval.

Large Event Fractions

For events larger than the specified upper limit, only a portion of the total sample was analyzed. That portion was equal to the sample collected within the first three hours, or during that period in which the first 0.46 inches of was reached. Rainfall amounts recorded by National Weather Service observation in River Falls (Mosher, 1992) were used for the study.

Results of the monitoring are included in Table 5.

Table 5
Runoff Monitoring Results

5A - Residential		
Parameter (mg/L)	**River Falls Median**	**NURP Median**
TSS	240.0	101.0
TKN	2.6	1.90
TP	0.75	0.38
Cu	0.030	0.033
Pb	0.015	0.144
Zn	0.110	0.135

5B - Commercial		
Parameter (mg/L)	**River Falls Median**	**NURP Median**
TSS	150.0	69.0
TKN	2.1	1.20
TP	0.50	0.20
Cu	0.30	0.029
Pb	0.080	0.104
Zn	0.190	0.226

Table 5 (Continued)
Runoff Monitoring Results

5C - Industrial	
Parameter (mg/L)	**River Falls Median[1, 2]**
TSS	250.0
TKN	2.5
TP	0.50
Cu	0.030
Pb	0.050
Zn	0.210

1. This data represents only one storm event.
2. No NURP data is available for direct comparison.

5D - All Sites		
Parameter (mg/L)	**River Falls Median**	**NURP Median**
TSS	200.0	100.0
TKN	2.6	1.5
TP	0.50	0.33
Cu	0.030	0.034
Pb	0.050	0.140[1]
Zn	0.140	0.160
As	Below Detection	-

1. NURP Monitoring was completed prior to the decrease in leaded gasoline use.

Interpretation of Monitoring and Modeling Results

The monitoring and modeling data presented represent a preliminary screening of storm water runoff quality and pollutant loadings from the study area. Without additional monitoring to verify storm event mean pollutant concentration values, estimated loadings can only be considered best available estimates. The most appropriate use of this data is for relative comparison between subwatersheds to locate pollutant source areas. This data can also be used to identify pollutant source areas under both existing and future land use conditions to most effectively target treatment measures.

Preliminary Screening Level

The estimated TSS values of each subwatershed are reported in the individual minor watershed descriptions. The TSS value can be entered into the appropriate regression equation in Table 2 on page 38 to obtain a growing season loading in pounds. The pollutant loading regressions apply only to the urban subwatersheds.

Recommended Storm Water Treatment Guidelines

The recommended level of treatment for urban storm water is always a difficult question to address. To help address this question, a methodology based on copper toxicity was developed. Using this approach, a recommended minimum TSS removal efficiency for urban storm water treatment has been determined specifically for River Falls.

Copper Toxicity

Toxicity research conducted as part of the Nationwide Urban Runoff Program (NURP)(EPA, 1983) identified copper as the element most commonly found in urban runoff which is most toxic to aquatic organisms. The toxicity of copper is linked closely to water hardness. Review of water quality data for the Kinnickinnic River indicates an average hardness of 220 parts per million (ppm). The chronic toxicity criteria or CTC is determined using the following formula from the Wisconsin Administrative Code-NR105 (105.06, Table 6).

$$CCT = e^{[V (Ln(Hardness) + LN (CCI1)]}$$

Where V = 0.9422
Ln(CCI) = -1.8956
Hardness = 220

The resulting chronic toxicity criteria level is 24 micrograms per liter (μg/l).

Recommended TSS Removal Efficiency

The P8 model (IEP, 1990) was used in conjunction with a prototype wet pond to evaluate the frequency of exceeding the 24 μg/l level for various storm water treatment levels. The analysis was run using River Falls runoff quality data and Minneapolis-St. Paul hourly precipitation data for a typical year, April-October. The 24 μg/l concentration was considered an end of the pipe discharge limit and a non exceedance frequency of 90 percent is applied to this level. Based on this discharge standard, the recommended minimum TSS removal efficiency for storm water treatment areas is estimated to be 85 percent.

Hydrologic Analysis

Objectives

The objective when dealing with urban hydrology is to provide flood control at all locations within the drainage system. The analytical problems that must be solved to address these objectives are the prediction of runoff peaks, volumes, and discharge versus time curves (hydrographs) anywhere in the drainage system (Bedient, Phillip B., and Wayne C. Huber, 1988).

Watershed Response

Urbanization changes a watershed's response to precipitation. The most common effects are reduced infiltration and decreased travel time, which significantly increase peak discharges and runoff. Runoff is determined primarily by the amount of precipitation and by infiltration characteristics related to soil type, soil moisture, antecedent rainfall, cover type, impervious surfaces, and surface retention. Travel time is determined primarily by slope, length of flow path, depth of flow, and roughness of flow surfaces. Peak discharges are based on the relationship of these parameters and on the total drainage area of the watershed, the location of the development, the effect of any flood control works or other natural or man-made storage, and the time distribution of rainfall during a given storm event (USDA Soil Conservation Services, 1986).

Modeling

The HydroCAD model is used for hydrologic analysis. HydroCAD utilizes SCS methodologies and includes features to allow more user interaction and quick system updates. Over sixty subwatersheds have been identified as part of the modeling. Stage/storage curves are based on available design data for basins. Modeling results have been compared to overall flow estimates previously prepared for the City-owned dams as part of FERC relicensing. The model is calibrated to flows included in the FERC documents, and to flow data records at the power plants.

The individual minor watershed descriptions address modeling results.

Rainfall

Several rainfall parameters are considered in using the SCS design methodology. The duration (how long it rains), rainfall depths (how much it rains), time distribution (how the total rainfall depth is distribution over the duration of the rainfall event), and recurrence interval (how probable it is that the rainfall event will recur in a given year) are important factors.

100-Year Event

The 5.9-inch rainfall in a 24-hour period is referred to as a "100-year event." The term "100-Year" is often called the return period or recurrence interval of a storm event. The return period is related to the probability of a given event being equal or exceeded. The probability that the "100-year event" will be exceeded in a given year is 0.01, or 1 percent.

Conventional wisdom holds that if a 100-year event occurs in one year, then it cannot occur for another 100 years. This belief is false because it implies that rainfall occurs deterministically rather than randomly. Because rainfall occurs randomly, there is a finite probability that the 100-year event could occur in two consecutive years. Thus, the exceedence probability concept is the best way to express rainfall events (McCuen, 1982).

Runoff Factors

To estimate runoff from rainfall, SCS uses the Runoff Curve Number (CN) method. Determination of CN depends on the watershed's soil and cover conditions, which the model represents as hydrologic soil group, cover type, treatment, and hydrologic condition (USDA-SCS, 1986).

The cover condition, or type of land use, is typically expressed by a percentage of impervious or hard surface area (roof tops, parking lots, etc.). The CN (or runoff coefficient) is directly related to runoff. The greater the impervious area, the higher the CN and the more rainfall that will drain off of a property rather than soak into the soil. For each of the two rainfall events, runoff volumes are then estimated.

Curve numbers and watershed impervious fractions were determined by first digitizing land use and soil maps. Using a GIS and database, the land use/soil intersections were tabulated to calculate a curve number and impervious percentage for each subwatershed. Both the curve number and impervious percentage are key model inputs.

Time Parameters

The initial time parameters used in SCS methodology are the time of concentration (T_c) and travel time (T_t). T_c is the time it takes for runoff to travel to a point of interest (usually the outlet or waterbody of a given watershed) from the hydraulically most distant point. T_t is the time it takes for runoff to travel in a given flow segment. T_c is the sum of T_t values for various consecutive flow segments.

Peak Discharge, Hydrographs, and Storages

The HydroCAD model estimates peak rates and volumes of runoff based on given rainfall data in the form of a hydrograph. The runoff is routed through the drainage system which includes ditches, storm sewers, and storage basins. The storage basins have specific elevation/storage/discharge relationships. These relationships are used for determining the resulting flood elevations. The program compares the rate of water entering a basin to the rate of the water leaving the basin. Excess volume is detained or temporarily stored until the rate of discharge is equal to or greater than the rate of inflow. The program determines the resulting high water elevations based on the elevation/storage relationship. Table 6 summarizes the hydrologic criteria used in this study.

Table 6
Summary of Hydrologic
Design Criteria

Method	• Soil Conservation Service (SCS) procedures and HydroCAD Model
Land Use	• City of River Falls Land Use and Zoning Maps, Field Reconnaissance and GIS Investigation
Watershed Boundaries and Datum	• April 6, 1981, Ortho-photo Topographic Maps, Storm Sewer As-builts and Field Reconnaissance
Design Storm	• 100-year recurrence interval • SCS Type II Distribution • 24-hour duration • Normal soil moisture (AMC-2) • 5.9-inch precipitation

Hydraulic Analysis

Hydraulic data for the main reach of the Kinnickinnic River and South Fork was obtained from FEMA (Dewberry and Davis, 1992). The data obtained included hydraulic printouts and contour maps showing the locations of each cross section. The original hydraulic analysis was done with a 1968 Soil Conservation Service computer program which calculates water surface profiles. The program has since been modified and the user's manual for the 1968 program is no longer available through the local SCS office. Without a manual to identify model inputs, available data was interpreted to develop new a new hydraulic model. The cross sectional information and reach information could easily be determined. Variables such as channel depth, roughness (n values) across the section, and bridge sections were not as clear. Interpretation of this information may include some inaccuracies.

The interpreted data was input into the BOSS Corporation HEC-2 Water Surface Profile program. Additional cross sections were taken from City contour maps to extend the profiling to the extent of current City limits. The revised program was run and the new water surface elevations were compared to the 1982 study. In most cases, the data matches very closely. The largest errors occurred at bridges. This may be due to difficulties in interpreting the previous computer printouts at the bridge locations.

Results

Table 7 on page 53 illustrates the results of the hydraulic profile analysis. Table 7 also includes profile information from the City's Flood Insurance Study (FEMA, 1982).

Table 7
Hydraulic Profiles

Kinnickinnic River 100-Year[1] Profile					South Fork 100-Year[1] Profile				
Station (Ft.)[2]	Location	Flow Rate (cfs)	Profile[3] SEH 1993	FIS (FEMA 1982)	Station (Ft.)[1]	Location	Flow Rate (cfs)	Profile[3] SEH 1993	FIS (FEMA 1982)
0	Section 50	14,200	807.0	N/A	0	Section 101		831.8	-
800	Section 1	14,200	808.9	N/A	100	Section 102	7,250	833.2	-
1320	Section 2	14,200	812.8	N/A	320	Section 103	7,250	834.6	-
1730	Section 3	14,200	812.5	N/A	440	Section 104	7,250	850.1	850.0
2140	Powell Dam	14,200	814.9	815.0	590	Section 105	7,250	855.4	855.5
3000	A	14,200	832.3	832.3	730	Section 106	7,250	860.4	859.5
3270	B	14,200	832.4	832.4	890	Section 107	7,250	862.1	861.7
3970	Section 7	14,200	832.5	832.6	1070	Section 108	7,250	863.2	863.2
4440	C	14,200	1	833.4	1250	Section 109	7,250	865.2	867.2
4600	Section 9	14,200	839.1	839.0	1440	B	7,250	872.8	872.8
4710	Jct Falls Dam	14,200	843.9	844.0	1620	Section 111	7,250	878.5	877.5
6420	D	12,300	874.9	875.0	1740	Section 112	7,250	880.1	878.2
6880	E	12,300	875.2	875.6	2160	Section 113	7,250	881.4	880.3
7340	Maple St.	12,300	876.2	876.2	3140	Section 114	7,250	882.2	880.9
7410	Maple St.	12,300	876.6	876.6	4040	Third St.	7,250	882.4	882.0
7810	F	12,300	1	877.8	4990	Section 116	6,900	882.8	882.3
8240	Cedar St.	12,300	879.7	879.8	5690	Section 117	6,900	883.7	883.9
8590	Division St.	12,300	880.6	881.0	5950	Section 118	6,900	884.4	884.6
9340	Section 19	12,300	883.2	883.0	6500	Section 119	6,900	885.5	886.0
9810	Section 20	12,300	884.3	884.0	7050	Section 120	6,900	888.0	887.9
11410	Section 21	12,300	885.4	884.3	8250	Section 121	6,900	890.7	890.5
11980	Section 22	12,300	885.7	N/A	8920	Section 122	5,250	892.2	892.0
12380	"MM"	12,300	886.9	N/A	9370	Section 123	5,250	892.7	892.3
13385	New	12,300	889.1	N/A	9500	Section 124	5,250	892.5	N/A
14355	New	12,300	890.0	N/A	10300	Section 126	5,250	896.3	N/A
15285	New	12,300	890.9	N/A	11210	Section 127	5,250	901.9	N/A
					13020	Section 128		909.0	N/A
					14970	Section 129	5,250	913.3	N/A
					16720	Section 130	5,250	917.9	N/A
					17840	Section 131	5,250	920.5	N/A
					18470	New	5,250	922.4	N/A
					18685	New	5,250	923.3	N/A
					19905	New	5,250	927.4	N/A

1. Existing program contains numerous conveyance errors.
2. Section locations based on FIS stationing, FEMA Work Maps (1972 Contour Base) and the original profile model (1974).
3. Conveyance errors of existing SCS program are included.
4. Locations Denoted by Letter Correspond with FIS (1982).

Need for FIS Amendment

As the community continues to grow, the need to establish regulatory floodplain elevations where none exist today will become immediate. The revised hydraulic profile illustrated by Table 7 is a first step. However, the new cross sectional data should only be used for planning purposes. To establish regulatory elevations would require a restudy of the City's Flood Insurance Study (FIS). Al Lulloff, Wisconsin DNR Floodplain Section Manager in Madison, cautions that a restudy could be lengthy and expensive. (Lulloff, 1993) According to Lulloff, WDNR has established a statewide project list for restudy. The projects are ranked for priority. DNR does some of the restudy work; FEMA does others.

According to Lulloff (1993) the City could initiate the restudy themselves. Using this approach, the City would have a better chance of getting the floodplain maps reprinted. If the City does the revision, the revised mapping could be used until FEMA does a reprinted panel, according to Lulloff. However, unless the changes are significant, FEMA may not reprint the panel which is currently used by lenders when determining flood insurance requirements of individual parcels.

With City-revised mapping, property owners could provide the new information to a lender. Lenders would be requested to waive the flood insurance requirements in favor of the new maps. According to Lulloff, the lender would send information to FEMA. FEMA would then provide a letter of agreement accepting the revised floodplain requirements for the individual parcel.

Lulloff indicated that Pierce County has recently updated their FIS. Any City map revisions should incorporate the new County information.

Thermal Profile Analysis

As important as biological water quality and flooding issues are to the Kinnickinnic River, the thermal impact of urbanization represents the most serious threat to the River. Although the community and the resource agencies recognize the problem, very little hard data exists to quantify the magnitude of the problem.

Ideal Temperatures

A cold water fishery capable of sustaining a healthy trout population requires a stable thermal regime. Several studies which have been completed on the topic of the influence of water temperature on fish survival and growth are listed in the Literature Review. Table 8 illustrates preferred temperature ranges for trout.

Table 8
Preferred Temperatures[1]

Species	Lower Avoidance	Optimum	Upper Avoidance
Brown Trout	46°F	57°F(13.9°C)	62°F
Brook Trout	44°F	59°F(15.0°C)	64°F

1. Source: *Fishing World.*

Lake George Temperatures

The first recent thermal monitoring data was completed by the DNR as part of a management planning study for Lake George (Moe, 1981). Table 9 on page 56 illustrates temperature data from Lake George.

Table 9
Lake George Water Temperature Profile, 1980[1]

Water Temperature (°F)															
Date	**7/31**	**8/1**	**8/2**	**8/3**	**8/4**	**8/5**	**8/6**	**8/7**	**8/8**	**8/9**	**8/10**	**8/11**	**8/12**	**8/13**	**Avg.**
Inlet	66.6	64.8	65.7	62.6	-	64.2	66.7	66.0	67.8	66.9	59.0	60.8	64.2	59.9	64.2
Surface	69.6	70.2	68.9	73.4	63.5	64.2	73.6	68.9	68.4	69.3	70.0	66.2	67.6	61.7	68.3
1'	66.6	68.4	68.4	66.7	63.5	64.0	69.8	63.7	68.0	68.0	63.7	63.0	66.2	61.0	65.8
2'	66.2	67.8	66.0	64.9	63.0	63.3	67.3	66.2	68.0	67.8	61.7	61.7	65.3	60.8	65.0
3'	65.8	66.9	64.9	63.9	62.6	62.8	66.2	65.1	67.8	67.5	60.8	59.9	64.4	60.4	64.2
4'	64.6	66.0	64.2	63.0	62.2	62.6	64.8	64.6	67.6	67.6	60.6	59.4	63.5	59.9	63.6
5'	64.0	65.3	63.9	62.4	62.1	62.6	64.4	64.4	67.5	67.5	60.4	59.0	62.6	59.4	63.3
6'	64.0	64.4	63.3	62.1	61.9	62.4	64.0	64.4	67.1	67.5	59.9	59.0	62.6	59.2	63.0
7'	63.3	63.7	63.1	61.7	61.7	62.1	63.1	64.4	66.9	67.5	59.7	59.0	62.4	59.2	62.7
8'	63.0	63.1	62.8	61.5	61.7	61.9	62.6	64.4	66.7	67.3	59.7	58.8	61.9	59.2	62.4
9'	62.6	63.0	62.8	61.2	61.7	61.9	62.6	64.4	66.7	67.1	59.7	58.8	60.8	59.2	62.3
10'	61.9	62.4	62.8	61.0	61.5	61.9	62.6	64.4	66.7	67.1	59.7	58.8	60.8	59.2	62.2
11'	61.3	62.4	62.8	61.0	61.5	61.7	62.6	64.2	66.7	66.9	59.7	58.8	60.8	59.2	62.1
12'	61.0	67.6	62.8	61.0	61.5	61.7	62.6	64.2	66.7	66.9	59.7	58.8	60.8	59.2	62.5
Bottom (13)	60.8	62.6	62.6	61.0	61.5	61.7	62.6	64.2	66.6	66.9	59.7	58.8	60.8	59.2	62.1
Outlet	-	-	-	-	-	-	65.1	65.5	67.5	67.8	60.8	60.8	63.7	59.4	63.8
Air Temp(°F)		94	83	-	77	78	94	92	92	75	73	74	76	72	81.7
Weather	Part Sun	Sun	Part Sun	Sun	Rain	Sun	Part Sun	Cldy	Part Sun	Rain	Cldy	Sun	Part Sun	Rain	

1. Source: Gary Moe, WDNR, 1981.

DNR Temperature Profiles

In 1992, the Wisconsin Department of Natural Resources conducted extensive minimum/maximum temperature monitoring, according to Brad Matson (1992).

The thermal study conducted on the Kinnickinnic River from August 24 to August 30 was designed to monitor thermal influences on that stretch of the river from Quarry Road downstream to County Road F. Matson expected warming influences to come from several sources, including storm sewer runoff, flow stagnation and river widening due to two dams in River Falls, runoff from construction on the Highway 35 bypass, and the River Falls Wastewater Treatment Facility outflow. Matson expected cooling influences to come from feeder streams that included the South Fork River, Rocky Branch, and any unnamed creeks flowing into the Kinnickinnic, as well as springs and natural transpiration/evaporation processes.

According to Matson (1992), maximum/minimum thermometers were installed in 35 locations on the Kinnickinnic and South Fork rivers, as well as in the feeder streams. Figure 8 on page 58 illustrates the monitoring locations. Matson assumed the uppermost station on the Kinnickinnic, located at the Quarry Road Bridge to represent average thermal activity as past surveys have shown the river to have consistent temperatures in the stretch from I-94 downstream to the Highway 35 bridge. Other stations were chosen in areas where thermal influences were perceived to be greatest and could be monitored for changes at the point of maximum impact.

Matson originally hoped to complete the study during a time when typical summer weather was occurring in the area. Unfortunately, the summer of 1992 has been much cooler than normal. According to Matson, during the week of the study, air temperatures ranged from nighttime lows of 50°F to

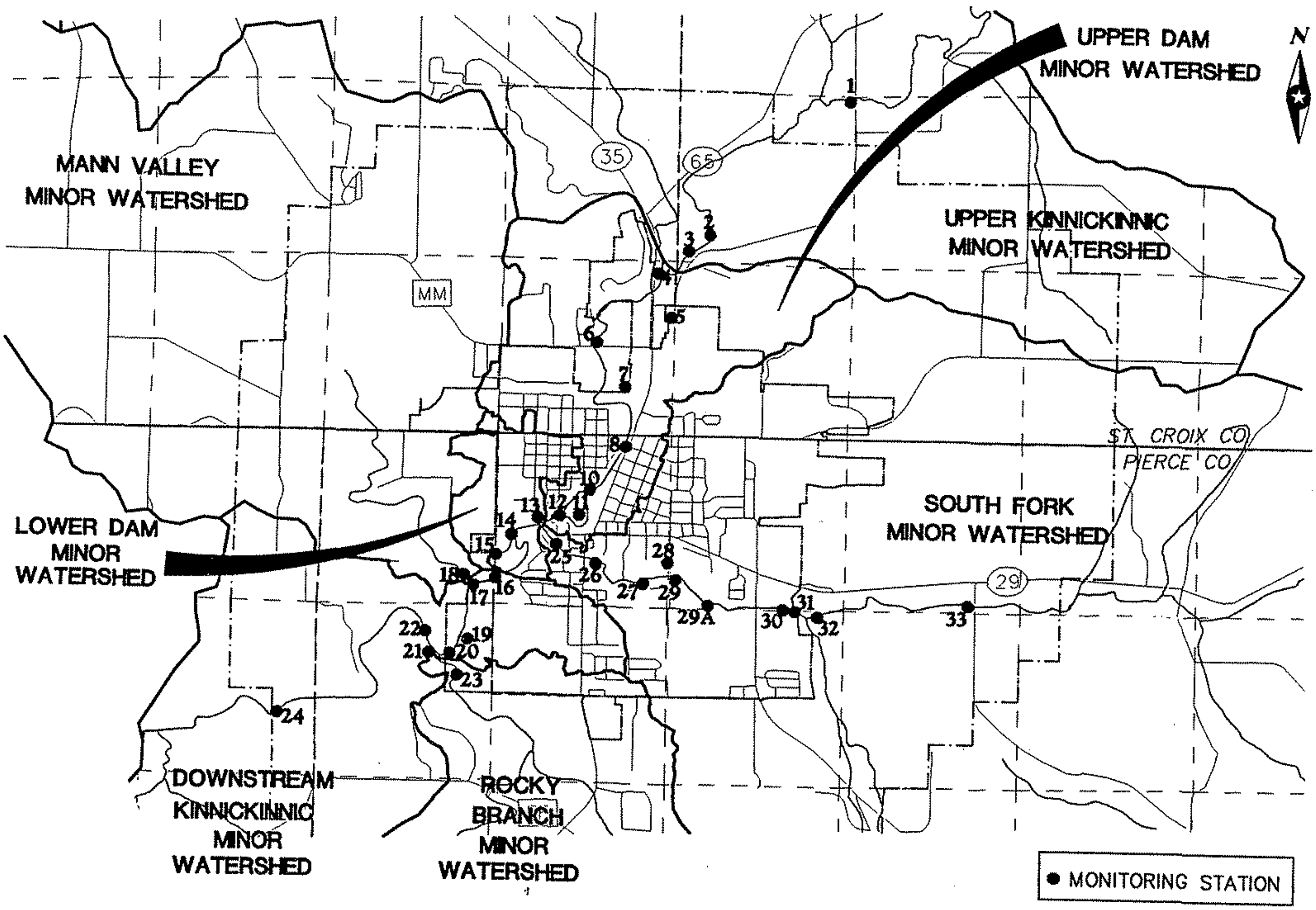


Figure 8
Monitoring Stations

daytime highs of 78°F, 10° to 20° below average late August temperatures. A rain event did occur during the study, with 1.25 inches falling on the second day. Matson found that the rainfall showed the influence of storm runoff and other sources of periodic thermal influence.

According to Matson, none of the influences were found to have profound thermal impact. However, many sites showed obvious influence in the cooling or warming of the river. In many cases, Matson believes that these influences would be much more pronounced if studied during a period of normal weather patterns and average temperatures. Matson found that during and immediately after the rain event, temperatures in all cases increased by some amount and many of the warming influences showed significant increases. In the days following the rain event, weather patterns became consistent and river thermal patterns became more evident. Daily maximum temperatures seemed to stabilize and slightly reflect air temperature and sunlight conditions. Daily minimum river temperatures reflected nighttime air temperature lows, but also seemed to decrease daily as river flow normalized and allowed cooling influences to maximize their effect. This finding is similar to that of Stephan (1993) who found that measured water temperatures follow the air temperatures closely with some lag time.

Table 10 on page 60 illustrates the 1992 thermal monitoring results.

Table 10
Minimum/Maximum Water Temperatures
Kinnickinnic River[1]

	Date											
	8/25/92		8/26/92		8/27/92		8/28/92		8/29/92		Avg.	
Site	Min	Max	Min	Ma	Min	Ma	Min	Ma	Min	Ma	Min	Ma
Air Temp.	58	78	52	60	50	68	56	68	56	70	54.4	68.8
1	56	62	54	57	53	57	53	56	52	57	53.6	57.8
2	56	62	54	59	53	57	52	56	52	58	53.4	58.4
3	56	64	54	58	52	58	52	56	51	59	53.6	59.0
4	57	66	54	58	54	58	54	58	53	59	54.4	59.8
5	-	-	60	68	59	79	60	76	58	82	59.3	76.3
6	57	66	54	59	54	58	54	59	52	59	54.2	60.2
7	-	-	59	70	58	77	58	76	60	81	58.8	76.0
8[2]	58	65	54	59	55	60	55	60	52	59	54.8	60.6
10	59	67	54	60	54	61	56	62	54	61	55.4	62.2
11	63	72	56	64	55	66	54	65	57	63	57.0	66.0
12	59	66	56	60	54	60	54	59	-	-	55.8	61.3
13	58	64	57	60	54	59	54	59	54	60	55.4	60.4
14	61	72	62	72	59	71	60	70	58	70	60.0	71.0
15	63	68	62	69	60	68	61	68	59	68	61.0	68.2
16	60	66	57	61	57	61	56	61	56	62	57.2	62.2
17	60	66	56	61	57	62	56	61	56	61	57.0	62.2
18	55	55	53	55	54	55	53	55	52	55	53.4	55.0
19	68	80	54	70	56	74	53	70	54	71	57.0	73.0
20	59	67	54	60	54	60	54	60	53	60	54.8	61.4
21	55	60	52	56	52	57	52	56	51	57	52.4	57.2
22	59	68	56	60	56	61	55	61	54	59	56.0	61.8
23	58	68	57	62	56	63	56	62	56	60	56.6	63.0
24	60	66	57	63	56	62	54	61	55	60	56.4	62.4
25	60	62	56	60	56	60	55	60	54	62	56.2	60.8
26	59	61	56	60	54	61	54	60	54	61	55.4	60.6
27	58	62	55	62	54	61	54	62	54	62	55.0	61.8
28	58	68	60	66	60	62	60	64	59	65	59.4	65.0
29	58	60	54	58	55	60	53	61	53	61	54.6	60.0
29A	57	60	54	57	54	60	53	60	53	61	54.2	59.6
30	56	58	52	56	53	60	52	60	54	62	53.4	59.2
31	56	59	52	57	52	59	52	59	52	62	52.8	59.2
32	55	58	52	56	52	59	51	59	50	60	52.0	58.4
33	54	58	52	56	51	60	51	59	50	60	51.6	58.6

1. Source: Marty Engel, WNDR, 1962
2. Site 9 not used.
3. Station Numbers correspond to Figure 8, Page 58.

The 1992 data followed previous DNR monitoring efforts. Table 11 illustrates 1991 monitoring data at 10 locations. The resulting profile is Figure 9 on page 64.

Table 11
1991 Thermal Monitoring Results[1]

		Date									
		8/30/91		8/31/91		9/1/91		9/2/91		9/3/91	
Location	No.	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Air Temp.		87	65	75	58	73	51	83	56	73	57
STH 35	1	66	60	67	62	63	55	60	56	63	59
Cedar Str.	3	68	60	67	63	64	55	62	56	64	59
L. George	4	82	72	81	70	74	61	68	61	70	62
Above Jct. F	5	69	61	70	60	66	57	65	57	66	60
Below Jct. F	6	70	66	70	62	66	59	65	59	66	58
S. Fk (mouth)	7F	70	67	72	62	66	58	67	55	68	58
S. Fk (UWRF)	7D	71	64	72	60	67	57	66	56	73	57
Above Powell	8	80	66	78	64	72	62	73	65	74	62
Below Powell	9	76	62	78	60	76	57	76	58	74	56
Below Ret. B11	10	75	65	73	63	74	60	75	59	70	54

1. Source: Marty Engel, WNDR, 1992.

Table 12 illustrates the thermal influences of two City detention basins and the warming effect on the river.

Table 12
Thermal Influences[3]

		Water Temperature					
Location	**Air Temp.**	**In-basin**	**Inflow**	**Outflow**	**Above[1] Confl.**	**Confl.**	**Below[2] Confl.**
Glen Park	78	72		72	64[1]	72	66[2]
Industrial Park	78	78	74			64	

1. Water Temperature recorded 50 yards upstream of confluence.
2. Water Temperature recorded 50 yards downstream of confluence.
3. Source: Marty Engel, WDNR, 1992.

Continuous Temperature Monitoring

In 1990, the DNR completed continuous monitoring upstream of River Falls to begin to establish baseflow conditions. Figure 10 on page 65 illustrates the 1990 results. The fluctuation in part is due to daily air temperature variation.

In 1992, Trout Unlimited installed four continuous recording devices (see Figure 8 on page 58). Figure 11 on page 66 depicts a typical installation of a thermistor station. The temperature units are set to record at 10-minute intervals. As more data becomes available, TU intends to combine the stream temperature data with ambient air temperature and rainfall data. Figure 12 on page 67 illustrates a typical monthly printout. The printout illustrates a similar daily fluctuation in temperatures similar to the DNR's 1990 data (Figure 10).

Average air temperatures and days with rainfall are also plotted to illustrate two factors which influence stream temperatures. A third factor, the impervious percentage of the contributing watershed, will be investigated as part of a future monitoring program.

In addition to the stream temperature monitoring, one thermistor unit was combined with a storm water sampling unit in the commercial manhole.

Long term continuous temperature monitoring will provide base line data to compare with future thermal conditions. More importantly, the monitoring will provide calibration for a thermal stream model which can be used to assess the impacts of individual storm sewer discharges and the limiting percentage of watershed imperviousness which can occur without causing adverse temperature conditions in the stream.

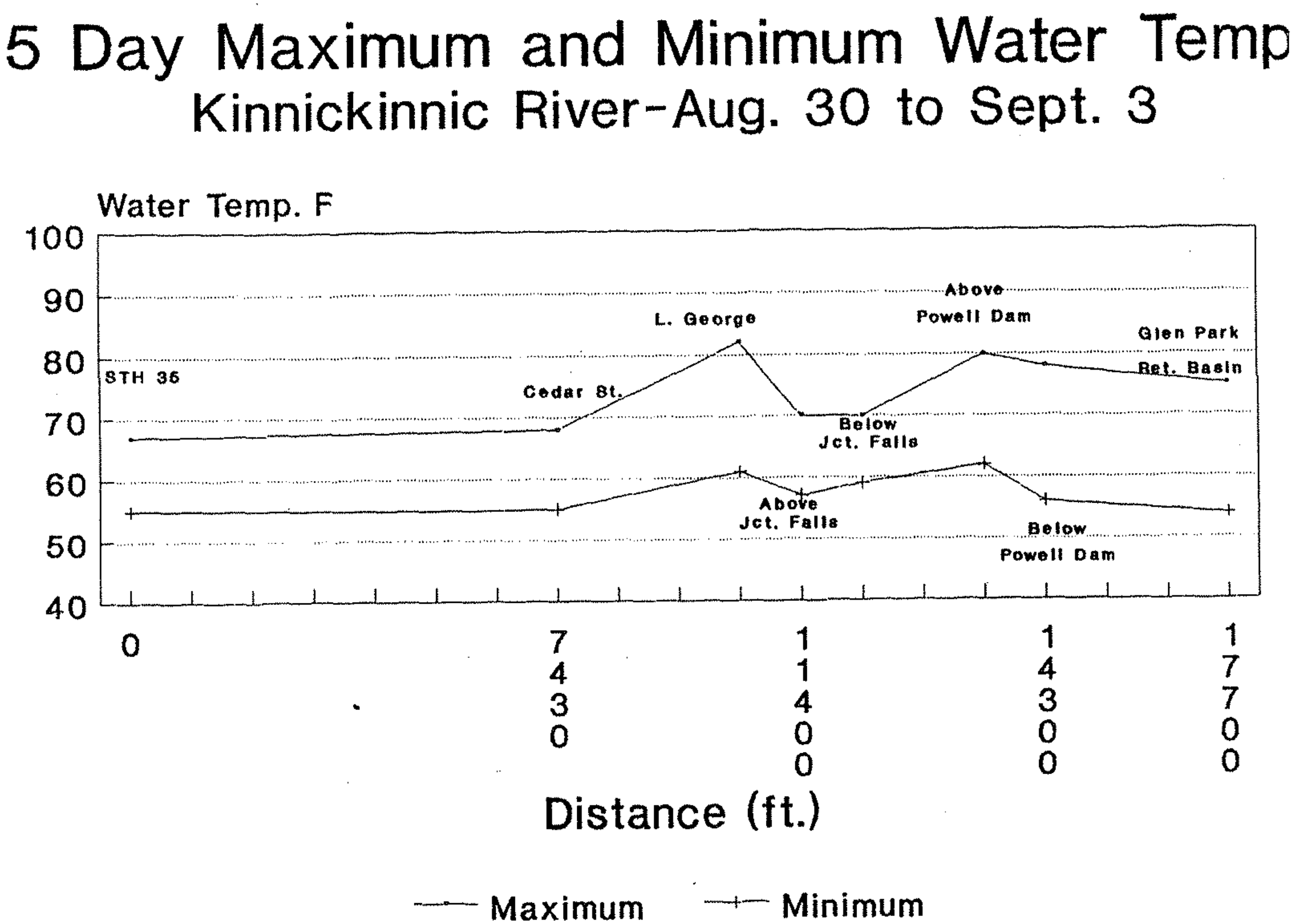
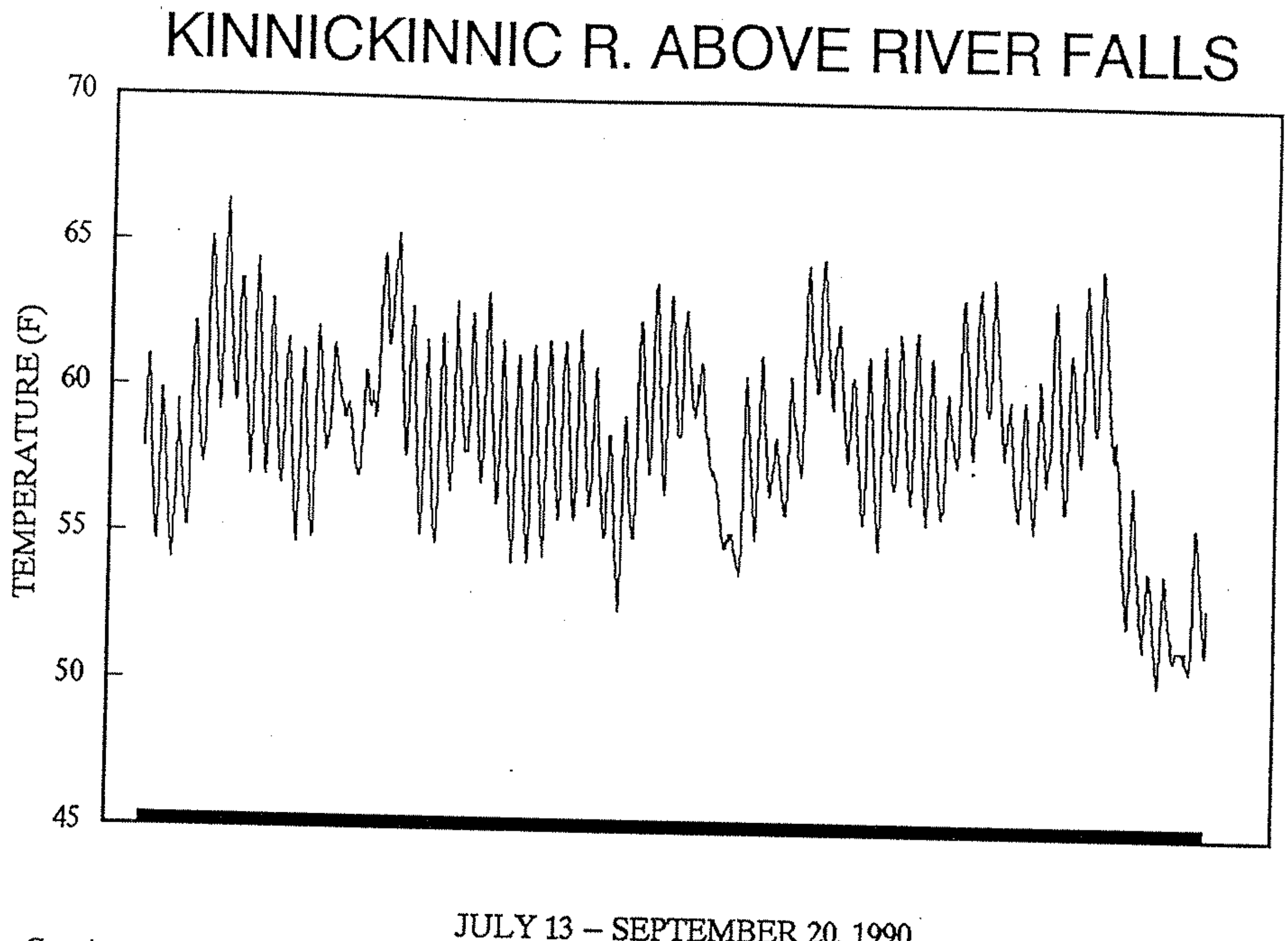


Figure 9
1991 Temperature Profile (WDNR)



Continuous temperature – 30 min. interval

Source: Ken Schreiber, WDNR
Location: Above old Hwy. 35 Bridge

Figure 10
WNDR 1990 Thermal Monitoring Results

THERMOGRAPH THERMOMETER SAMPLING CONFIGURATION

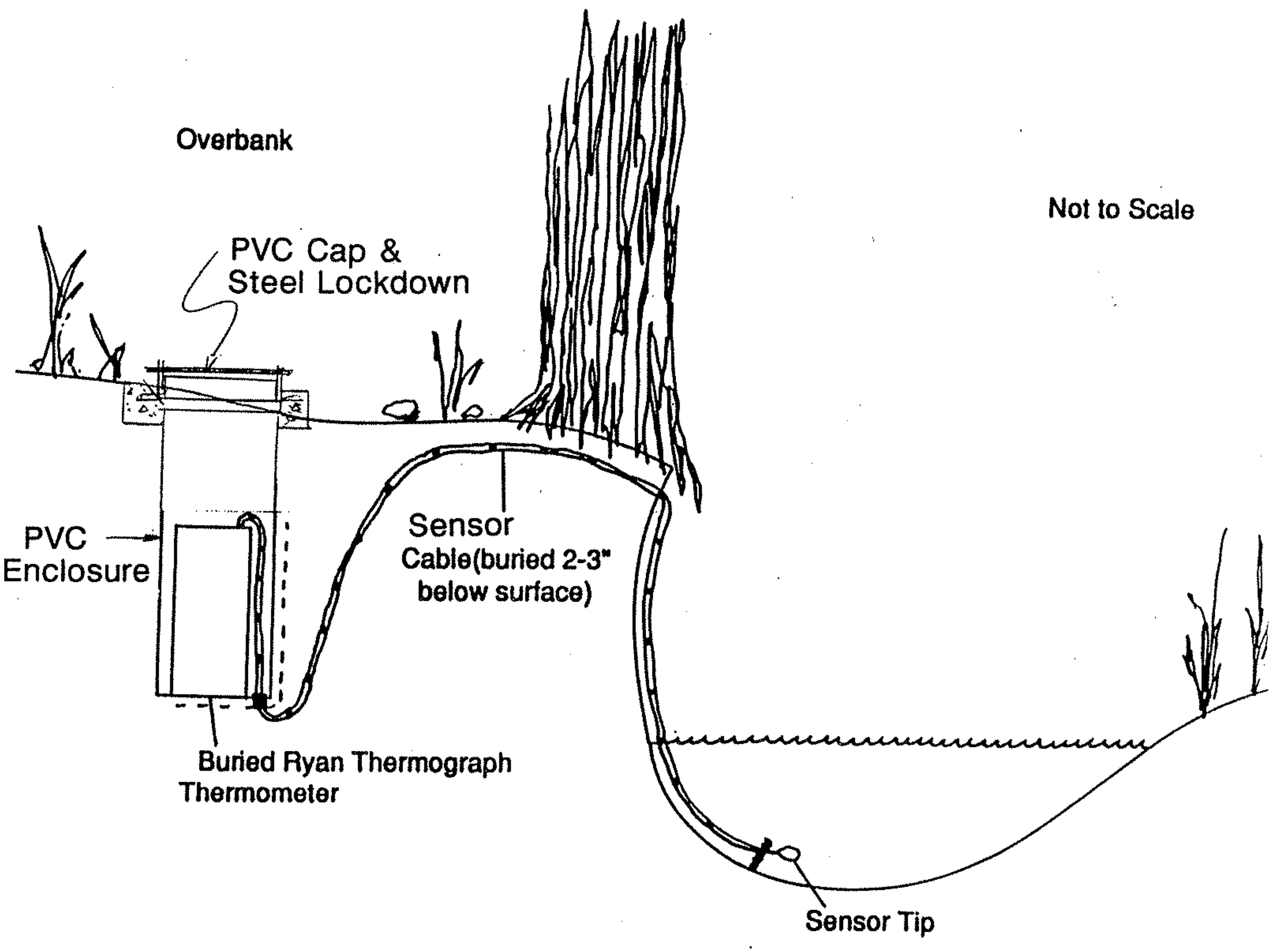


Figure 11
Thermograph Thermometer Sampling Configuration

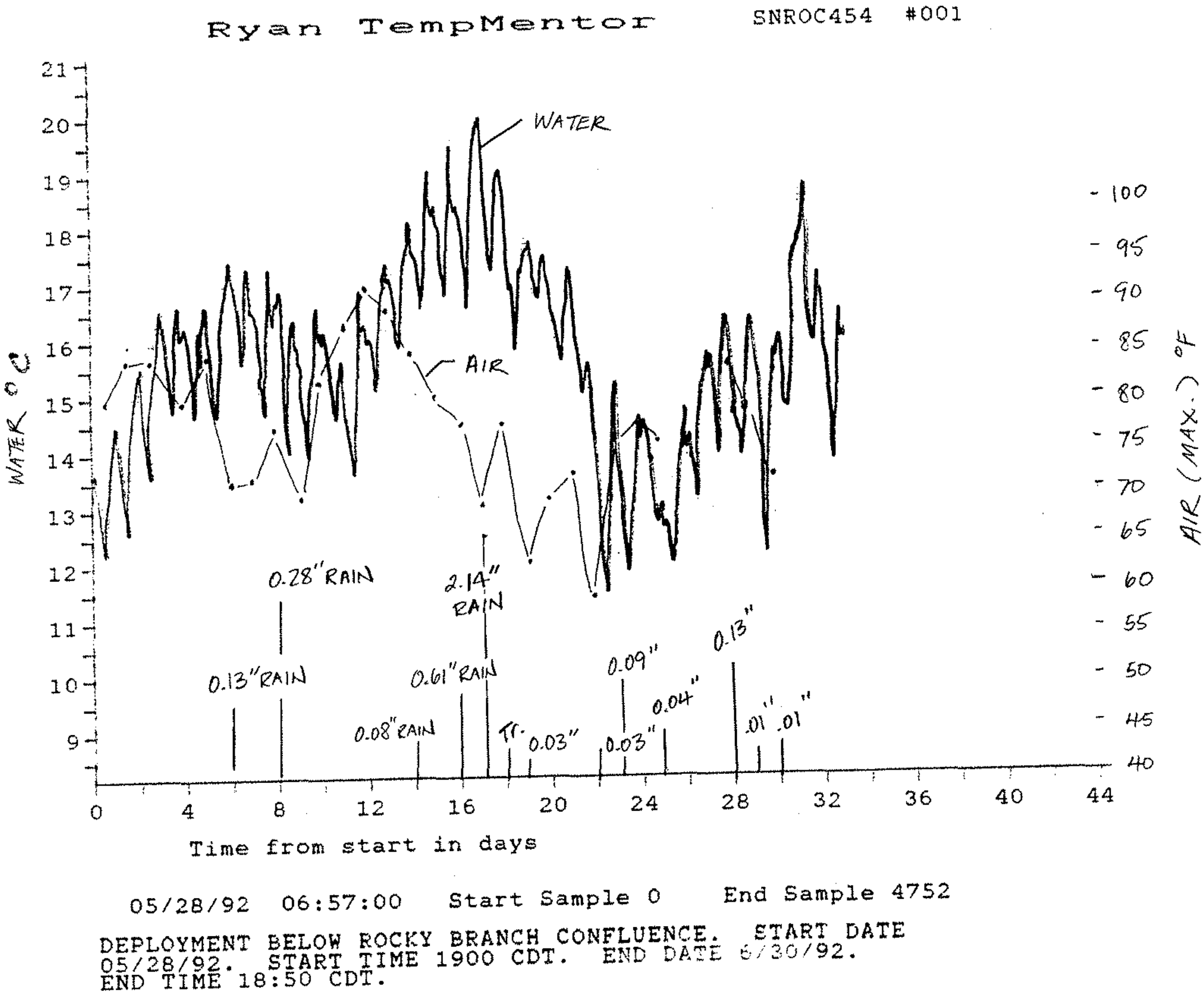


Figure 12
Trout Unlimited Typical Monthly Printout

Instream Water Quality Monitoring

Two early water quality studies were completed as part of undergraduate research projects at UW River Falls, the first in 1979 (Ayres, et. al, 1979), the second in 1989 (Lewandowski, 1989). Both efforts were short term in nature but present some of the only historic water quality data on the River.

In conjunction with the STH 35 River Falls Bypass, University of Wisconsin-River Falls' Dr. Robert Baker began to monitor contributions of a spring area near the highway for WDOT. According to Baker (1992), two monitoring stations were established in April 1990 on Sumner Brook, a tributary to the Kinnickinnic River in NE 1/4, NE 1/4, Section 36, T29N, R19W. Station S is 60 feet north of the confluence of Sumner Brook and the Kinnickinnic River. Section N is about 250 feet north of Station S.

Baker made measurements beginning on April 30, 1990, and is continuing through 1992. Measurements were made monthly from mid-September through June. From the first week in July through the second week in September, measurements were made weekly. Baker sampled for eight physical and chemical parameters at each station.

In May 1992, construction activities for the River Falls Bypass were begun in the watershed for Sumner Brook. These activities included significant filling, grading, blacktopping, and bridge construction. All data collected during months 25 through 30 were affected by Bypass construction.

❑ Discharge

According to Baker (1992), velocity was measured at each station at five to six locations. Average discharge was calculated to be about 0.68 cfs-almost double that of the summer of 1990. Baker attributes unusually high discharge values are most likely related to the effect of highway construction in the Sumner Brook

Watershed. This has the effect of reducing infiltration and increasing runoff, which could easily account for the high discharge.

❑ **Temperature**
Baker (1992) has found water temperatures to gradually increase from March through July and early August. Baker found this type of water temperature increase to parallel changes in the mean daily air temperature which vary in response to the gradual increase in the length of the day noting that gradual increase in water temperature is what is normally expected in this area. Baker found that the mean daily temperature rose by 14°C (24°F) between April and September and dropped about 16°C (28°F) from early September through mid-October. Specifically, the average air temperature for the week ending May 16 was 9°C (49°F) and was 23°C (73°F) for the week ending September 2. Since early September, Baker recorded a steady drop such that the average temperature for the week ending October 14 was 7°C (45°F).

❑ **Chloride**
Baker (1992) found chloride levels to be quite high. According to Baker, the high values in April are undoubtedly related to runoff from agriculture land due to snowmelt and above average precipitation in the spring. Baker indicates that Sumner Brook has a drainage area of 12.3 square miles and includes land cultivated with alfalfa, corn, and soybeans, as well as pasture land and a number of residential lawns. Potassium chloride (KCL) is a widely used agricultural fertilizer and could easily account for the high chloride level in April at a result of spring runoff according to Baker. Likewise, Baker attributes the high levels in early August to runoff of fertilizers added to fields under cultivation with alfalfa after the second cutting in late July. According to Baker, USDA recommends application of 300 to 400 lbs./acre of

KCL after each cutting of alfalfa. Baker observed high chloride levels are observed after the first and second cutting. Baker found chlorides from road salt and from agricultural fertilizers are relatively immobile over the winter months, only entering Sumner Brook through runoff after heavy precipitation events of about 2 inches or more. The removal of vegetation and disturbance of the soil that accompanied the inception of highway construction, undoubtedly mobilized chlorides to such a degree that runoff events of virtually any magnitude transported significant quantities of chloride ions to the stream, according to Baker.

❑ pH

Baker indicates that Sumner Brook is a basic stream with an average pH of 7.7. Such a high pH is to be expected because the stream is spring fed and only carries runoff after precipitation events, according to Baker. The bedrock underlying Sumner Brook is the Prairie du Chien dolostone, a carbonate unit over 60 m (200 feet) thick. Baker found that during periods of lower precipitation, flow is dominated by calcium carbonate-rich ground water which would result in higher pH values. Baker's higher readings detected during the summer were preceded by weeks with minimal precipitation. The very high pH detected in early spring may be related to runoff of agricultural lime during spring runoff, according to Baker.

Bypass construction is one of the primary causes of higher pH values. Truckloads of limestone aggregate are hauled in for road base. The introduction of limestone aggregate to the watershed, when coupled with the increased runoff mentioned earlier, undoubtedly caused the observed rapid rise in pH, according to Baker. Baker indicates that the application of asphalt to this limestone probably created a reasonably impermeable cover and caused the decrease in pH to near normal levels.

❑ **Conductivity**
Small variations in conductivity are probably related to precipitation/runoff events, according to Baker. Baker found low conductivity to occur during weeks with larger precipitation. Because conductivity is a measure of water hardness, the addition of surface runoff should be expected to lower the conductance, according to Baker.

❑ **Total Dissolved Solids**
Like conductivity, total dissolved solids (TDS) is increased dramatically in the latter part of the summer. Initially Baker (1992) found that TDS values decreased during intervals when Sumner Brook carried greater quantities of surface runoff and increased during periods of base flow. However, Baker found high TDS values occurred during the interval of construction-related, above-normal surface runoff. Baker believes the majority of inorganic ions were contributed by runoff from areas covered with limestone aggregate rather than through base flow.

❑ **Dissolved Oxygen**
Baker (1992) found the dissolved oxygen (DO) content of Sumner Brook decreased in the spring and then increased through the remainder of the summer and fall. This type of DO cycling is probably a response to variations in water temperatures, according to Baker. Baker indicates that cooler water temperatures result in lower biochemical oxygen demand (BOD) and a currently occurring high DO value. Conversely, warmer water temperatures often generate higher BOD and result in lower DO values, according to Baker. Baker believes the high values observed during the summer may be related to increased biological productivity due to higher than normal nutrients brought into Sumner Brook through runoff from disturbed soil.

Baker's monitoring will result in an assessment of the impact that the Bypass construction has on Sumner Brook. The data can be extrapolated for application on other watersheds.

Instream Fishery

Stream Survey Data from the DNR illustrates a productive trout population. Table 13 illustrates brown trout populations for three locations above River Falls.

Table 13
Brown Trout in Three Treatment Zones[1]

Treatment Zone	1973	1974	1975	1976	1977	1978	1979	1985
J.H. Fuller Parcel, NW Sec. 22, T28H, R18W, Kinnickinnic Township								
Total No./Mile	3025	3654	4046	4425	-	-	6963	9188
Trout/Mile <6 Inches	1575	1363	1925	1504	-	-	3663	3954
Trout/Mile ≥ 6 Inches	1450	2292	2121	2921	-	-	3300	5233
Trout/Mile ≥ 10 Inches	396	383	471	1100	-	-	879	1208
No./Acre	885	1069	1184	1295	-	-	2037	2506
Lbs./Mile	461	700	739	1125	-	-	1188	1443
Lbs./Acre	135	205	216	329	-	-	348	394
James Purfeers Parcel, NE Sec. 20, T28N, R18W, Kinnickinnic Township								
Total No./Mile	-	-	7242	5925	8958	5817	-	6867
Trout/Mile < 6 Inches	-	-	4958	2142	5646	2700	-	3292
Trout/Mile ≥ 6 Inches	-	-	2283	3783	3317	3117	-	3575
Trout/Mile ≥ 10 Inches	-	-	542	858	1133	800	-	375
No./Acre	-	-	1848	1512	2287	1485	-	1681
Lbs./Mile	-	-	742	1121	1309	1192	-	828
Lbs./Acre	-	-	189	286	334	304	-	203
Gibson Parcel, SE Sec. 20, T28N, R18W, Kinnickinnic Township								
Total No./Mile	-	3916	4980	4912	6324	4440	-	6764
Trout/Mile < 6 Inches	-	1964	2888	2216	3472	1220	-	3732
Trout/Mile ≥ 6 Inches	-	1952	2092	2696	2852	3220	-	3032
Trout/Mile ≥ 10 Inches	-	460	552	424	956	620	-	484
No./Acre	-	1165	1461	1482	1882	1320	-	1818
Lbs./Mile	-	555	763	806	1093	927	-	790
Lbs./Acre	-	165	227	240	325	276	-	212

1. Source: Marty Engel, WDNR

A summary of the results of a more recent stream survey completed on May 1 and 2, 1989, is shown in Table 14.

Table 14
Stream Survey (May 1989)

Location	Distance	Trout Brown Fish/Mile
1320 feet downstream from Hwy. 35 Bridge	832	7219
456 feet upstream from Hwy. 35	920	8534

Table 15 depicts brown trout populations for 1990 and 1992 in two locations below River Falls.

Table 15
Kinnickinnic River Brown Trout Populations
(1990-1992)

	Glen Park[1]		Ericksons[2]	
Size	**April 90**	**April 92**	**April 90**	**April 92**
5	81	1583	11	712
6	125	948	44	375
7	113	774	8	173
8	628	144	119	10
9	922	31	606	1
10	426	166	671	41
11	104	303	298	63
12	28	221	74	114
13	1	74	13	129
14	0	15	1	74
15	1	0	1	22
16	0	0	0	1
Total	**2429**	**4259**	**1946**	**1715**
12-16	30	310	89	340

1. N ½ Sec. 11, T27N, R19W, River Falls Township
2. SW Sec. 10 and SE Sec. 9, T27N, R19W, Clifton Township

From the stream surveys, several generalizations can be made. Trout numbers have been increasing in the Kinnickinnic River, especially in that area above the City. Some age (size) classes have experienced declines which could be attributed to numerous factors not necessarily related to urbanization. Trout densities are significantly less below the City than above the City; however, the fish are generally larger below River Falls.

One obvious fact is that the Kinnickinnic River is a significant ***native*** trout fishery which deserves significant efforts to protect it. If a proactive approach is taken, the protection can be accomplished in concert with anticipated development without creating a financial burden for the appropriate jurisdictions and without creating a hardship for property owners and developers.

River Falls
Wisconsin

The *Monitoring Program* has been adapted from the Minnesota Water Monitoring Plan (EQB 1992).

MONITORING PROGRAM

Introduction

The purpose of the Monitoring Program is to establish a coordinated monitoring system. It must support the water management activities of the community. It must produce the data needed to manage water in a coordinated, comprehensive way. Finally, it must make sure that people can find and compare easily all the data they need to make good decision.

Program Objectives

The Water Monitoring Program has seven objectives. The plan's objectives are to:

1. Adopt a comprehensive approach to monitoring;

2. Expand ambient monitoring;

3. Recognize trend analysis as an essential component of water management and routinely incorporate it as a key state and local government duty;

4. Help policy makers, policy developers, and citizens recognize the importance of good information and good analysis;

5. Support data exchange and analysis across agency and disciplinary borders and levels of government through integrated information management systems.

The *Monitoring Program* has been adapted from the Minnesota Water Monitoring Plan (EQB 1992).

6. Encourage and expand citizen and local government participation in the monitoring of water resources;

7. Provide the basis for a coordinated and integrated water monitoring system.

Principles for Monitoring

The Water Management Plan calls for a ***focus on the resource and integrated water resources management.*** Both are prerequisites for sustaining the high quality of the Kinnickinnic River. This plan identifies the monitoring elements necessary to support this new approach.

The other principles of the plan driving monitoring needs are:

- Manage water's interconnections;
- Focus on the resource;
- Manage hydrologic units;
- Make partnerships work for water;
- Make prevention the focus;
- Put public health and safety first;
- Let citizens make a difference;
- Educate people to change behavior;
- Understand the importance of research;
- Think long term.

Taken together, these principles point to the need for a comprehensive, coordinated system of water resources monitoring.

History of Monitoring

The *Watershed Assessment* section of this report summarizes the monitoring data. Historic monitoring includes water quality, water temperatures, sediment, aquatic vegetation, and fish populations.

The *Monitoring Program* has been adapted from the Minnesota Water Monitoring Plan (EQB 1992).

Additionally, ground water quality monitoring began in the area of the River Falls landfill in 1986. Initial monitoring for VOCs was limited to monitoring wells at the landfill and three private wells in the Birch Cliff Addition of Clifton Township. Recently monitoring was expanded to all 35 homes in the subdivision.

Types of Monitoring

Water resources monitoring is not a one-dimensional activity. Monitoring takes different forms and has different characteristics, depending on its purpose and intended uses. Typically, three general types of monitoring are conducted. These are: 1) ambient; 2) compliance; and 3) special research or study monitoring.

Ambient

Ambient monitoring focuses on describing baseline conditions and possible trends in water quality or quantity. Ambient monitoring provides "early warnings" of problems or resources needing particular attention. Ambient monitoring also gives the information needed to evaluate the effectiveness of management programs and projects.

Compliance

Compliance monitoring is usually done in response to a specific statute, ordinance, or rule. Depending on the regulatory program, this monitoring may be conducted either by the regulated community or the regulatory agency. Monitoring results generally are used to decide if the regulated community is complying with established standards and permits. Compliance samples typically must be analyzed by a certified laboratory, and samples must be collected, transported, analyzed, and reported according to established standards and procedures. This type of monitoring data is the most plentiful. It is most useful for evaluating contaminant source controls. It is probably the least useful for determining water quality baselines and trends.

The *Monitoring Program* has been adapted from the Minnesota Water Monitoring Plan (EQB 1992).

Special Research and Study

Special research and study monitoring is conducted to develop basic information about a specific issue, concern, or theme where such information is missing or incomplete. Study methods and results are usually reported and well-documented. Research projects usually follow rigorous scientific protocols and are commonly reviewed by peers. But, the monitoring timeframe often may be limited to two to four years, and sometimes even shorter periods, and monitoring commonly does not continue beyond or outside the research project. Special research and study monitoring often is limited in spatial or temporal distribution. So, monitoring results must be used carefully to make broad-based conclusions. Still, when compliance and special research and project monitoring data are properly integrated with ambient data, more complete analysis of ambient conditions or trends will result.

Roles and Responsibilities

On the Kinnickinnic River, monitoring has been limited to the DNR and Trout Unlimited (TU) as described in the *Watershed Assessment* section of this report. Private interests also do a significant amount of monitoring, either because of regulatory requirements, or simply an interest to understand the resource better.

DNR monitors the quality (and temperature) of the River to manage habitat for fish and wildlife effectively. TU is monitoring temperatures to establish baseline information from which trend analysis can be developed.

Data Compatibility

It is clear that water monitoring programs are dispersed among several entities. Data collected to support these management programs are similarly spread out. In the past, data was not always collected or reported in a consistent manner. These factors have

The *Monitoring Program* has been adapted from the Minnesota Water Monitoring Plan (EQB 1992).

made it a challenge to create information systems that bring together data across program and agency lines. To make this easier, a plan which begins to require compatibility and integration of data by those collecting it is necessary.

Water-related data compatibility guidelines have been vague in the past and mandatory only for selected programs and areas. As conventions, the guidelines have been voluntarily, but loosely and selectively followed by agencies automating water data. All jurisdictions and the DNR, with assistance from TU should consider how best to coordinate these efforts.

Data compatibility has the following five components:

Standard Geographic Locators

The use of standard geographic locators ensures that information collected for a program can be retrieved by area, or mapped and analyzed with other information within a geographic information system. Examples of standard locators include the Public Land Survey grid system and degrees of latitude/longitude. The City's GIS could be a repository for this information.

Standard Mapping and Automation Procedures

As more agencies get involved in keeping data inventories and GIS development, it is important that they keep information on base maps and use consistent data automation techniques. The USGS 1:24,000 (7-1/2-minute quadrangle) sheet is an appropriate base map for many water-related data inventory activities. The City's GIS may provide additional accuracy.

Standard for Data Identification and Classification

Standard identifiers are essential for constructing state data bases for ground water, streams, and lakes. Use of standard identifiers allow all information collected about a certain water feature to be correlated

The *Monitoring Program* has been adapted from the Minnesota Water Monitoring Plan (EQB 1992).

automatically. Inconsistent coding is a barrier to data sharing.

Designated Data Repositories

Certain data bases are designated as the ultimate repository for a select type of data (e.g., lake levels, surface water quality, temperature). This allows a user to retrieve all data of a particular type from one source despite the agency of origin. This is a way of consolidating for all users' information originating in different state and local agencies.

Widespread use of the "designated data repository" idea will help aggregate information on ground water quality, surface water quality, lake levels, and flow. Agencies and local governments must load small and once-in-time data collection into a designated data repository to make this possible. This will bring information from many sources into one. University of Wisconsin-River Falls could potentially serve in this role.

Integrated Retrieval Systems

Integrated systems offer the capability to pull together many types of data to compare, tabulate, map, and analyze information across agency lines and data type. They also enhance the ability to analyze tabular information in a GIS format with common GIS data layers.

Geographic Information Systems as Integrators of Data

Use of Geographic Information systems is expanding dramatically. GIS technology is emerging as a framework for integrating data. GIS references tie information to a point or area on the earth's surface, and allow the spatial integration of that data with other information. Most water-related monitoring information can be assigned a GIS reference. Therefore, data compatibility guidelines must assure

The *Monitoring Program* has been adapted from the Minnesota Water Monitoring Plan (EQB 1992).

that the large body of water-related data is accessible as GIS data.

Local Data Collection

The future contribution of local governments to water data collection must be recognized, encouraged, and developed. The state must also find a way to integrate locally collected data into state repositories and integrated systems.

Water Quality and System Components

Surface Water Quantity System Needs:
Stream Gage Networks are the principal tool used to measure surface water supplies. Stream gages, especially to those that agencies monitor continuously, give current information about the water in streams and rivers. Agencies also get important low flow and high flow information at partial record stations. One must have this kind of information to understand flow conditions and manage water use.

The only long-term flow records for the Kinnickinnic are for the dam discharges. A flow monitoring network should be established. Flow monitoring would help in estimating ground water interconnections and in establishing thermal river models.

Surface Water Quality System Needs:
Monitoring should identify and characterize specific water quality problems and allow an accurate evaluation of the state's water protection programs. Water quality monitoring includes:

- Chemical, physical, and biological characteristics (including thermal)
- Storm Water Monitoring
- Lake Assessment and Monitoring

The *Monitoring Program* has been adapted from the Minnesota Water Monitoring Plan (EQB 1992).

- Biological and Toxic Substances (fish tissue monitoring)
- Compliance Monitoring (monitoring occurs near discharges of facilities, such as wastewater treatment systems

Storm water monitoring, as summarized in the *Watershed Assessment* section of this report, represents a preliminary screening of runoff quality. Additional monitoring is needed to establish storm event mean pollutant concentrations. A better pollutant loading assessment can be developed, resulting in the design of more effective BMPs.

Instream monitoring should be a priority to establish baseline conditions from which a trends analysis can be developed. Such an approach will allow for more proactive watershed management.

Ground Water Quality System Needs:
Ground water quality monitoring should include representative coverage of aquifers. It should measure whether and how changes in point source controls, land use, and land management may affect ground water quality. It is an essential element of any state strategy to protect ground water in sensitive areas. As with surface waters, monitoring must cover a broad range of parameters, including degradation products of man-made chemicals, like pesticides.

A sampling protocol should be developed to supplement current City municipal well data and ground water monitoring around the old River Falls landfill.

The *Monitoring Program* has been adapted from the Minnesota Water Monitoring Plan (EQB 1992).

Climate Monitoring System Needs:

Hourly rainfall and temperature data are vitally important when developing trend analysis, especially for thermal impacts.

University of Wisconsin-River Falls has some weather data collection capabilities. Daily rainfall is recorded by a private individual.

University of Wisconsin-River Falls has tried to establish a first-order weather station through several grant programs. The University should continue to work towards this goal, as well as being the repository for all climate data in the area.

Interconnections of System Components

An important part of the monitoring framework relates to understanding the interconnections between air, land and water, and between ground and surface water. There is a need to measure how ground water quality and quantity affect surface water and vice versa. Monitoring of interconnections should address the range from conventional to toxic pollutants, point to nonpoint sources of pollution, to concerns with habitat alteration. It should use a variety of tools, from water column chemistry to sediment, tissue, and biological monitoring.

System Needs:

The thermal impacts of storm water runoff represent the major threat to the resource. The relative temperatures of storm water are known. Baseline temperature data of the river are being established. What is yet to be determined is a direct correlation between land cover (i.e., percent impervious) and impacts to the river.

The first step is to monitor the temperature of runoff from several urban watersheds of variable land cover.

The *Monitoring Program* has been adapted from the Minnesota Water Monitoring Plan (EQB 1992).

From this data, a correlation between land cover and temperature of runoff can be verified for the River Falls area. The correlation will be not only a function of land cover, but also ambient air temperatures and rainfall.

The next step would be to closely monitor stream temperature response to storm water discharge points. Once the stream response to watershed development is established, the appropriate jurisdiction can develop regulatory controls for allowable land use cover and require thermal mitigation. The effective percent impervious (EPI) index resulting in zero thermal impact could be established for all future development.

Information System Characteristics

Access

Information must be accessible to all interested users. This is true whether the users are inside or outside the program collecting the data. It is true whether they are from state agencies or local government, or are simply interested citizens.

Data Usefulness

All water-related data must be collected and analyzed to make sure it is reliable and useful. Still, different collections may have different purposes and meet different standards.

Integrated Analysis

Information management systems, like the ground water and stream information systems now under development, must make integrated analysis of water-related information across agencies and issues easy. The interested party should be able to examine the relationship of land use to water quality and quantity for both surface and ground water resources. They should be able to access the importance of interconnections between ground and surface water,

The *Monitoring Program* has been adapted from the Minnesota Water Monitoring Plan (EQB 1992).

and between quantity and quality. GIS will aid in this analysis.

Compatibility and Automation

Water, water-related, and related land use data with management value must be prepared properly for data entry. It must be automated and entered into the system. Those who collect the data should do this as part of the cost of its collection.

Repositories

Data repositories should be designated and maintained to merge small and temporary data collections of a like nature into a common pool. Agencies given responsibility for housing a "data repository" need to ensure the entry and control the quality of data entered from outside agencies. Examples would include the entry of local water quality data into a water quality data base at University of Wisconsin-River Falls or DNR offices.

Central Access Point

University of Wisconsin-River Falls should provide a central access point and menu interface to outside users for ground and surface water data. Subject to data privacy constraints, it would have "read only" access to the data.

Mapping

Mapping, like tabular reports, should be a standard part of water-related analyses. University of Wisconsin-River Falls could manage mapping features through its GIS curriculum.

Uniform Assurance and Quality Control

Uniform quality assurance and quality control practices should take place in data collection and analysis. This can be done by requiring use of certified laboratories and standard procedures for collecting water samples. Practices may vary by program type/objective (e.g., they would be more stringent for litigation than research projects).

The *Monitoring Program* has been adapted from the Minnesota Water Monitoring Plan (EQB 1992).

Related Characteristics

Monitoring must, as a matter of course, include the routine collection of the related characteristics important to the interpretation and analysis of water data.

Criteria and Procedures for Establishing and Conducting Monitoring Programs

All monitoring programs and projects should be accompanied by a written design document or plan, detailing what is to be done, why, and how. These plans should be analyzed routinely and informationally adjusted. They should also be formally reviewed at specific time intervals to evaluate results against objectives and the need for modifications. The design document or plan should include:

- **Objective or purpose** - A clear statement of the reasons for monitoring, or questions to be answered through the project, and intended use or uses of the results.

- **Program or project description** - A detailed description of the monitoring network, sampling frequency, media to be sampled, and parameters to be analyzed.

- **Quality control and assurance plan** - Specific procedures to be used in collecting and managing samples.

- **Cooperation and consultation efforts** - Specific listing of other agencies and units of government to keep involved in the program or project.

- **Data compatibility and user access** - A statement of how the entity proposing to collect data will make that data compatible

The *Monitoring Program* has been adapted from the Minnesota Water Monitoring Plan (EQB 1992).

with the state information system, and how access by interested users will be ensured (e.g., by automation and entry into the state system).

Monitoring programs and projects conducted by state agencies, or with state funding, should be coordinated with other agencies and units of government at the program design or planning stage. Specifically, entities conducting monitoring should:

- **Contact appropriate parties** - Agencies should contact local governments when planning or executing monitoring in their area. The state should list the entities monitoring water resources in the appropriate monitoring index. To avoid duplication, these entities should check with others from the index before starting related monitoring.

- **Submit monitoring proposal for technical review** - Monitoring proposals for new programs or projects that use state funds should include a thorough interdisciplinary review through by the WDNR. Review would cover technical soundness, consistency with the state monitoring plan, and coordination among monitoring efforts.

River Falls Wisconsin

Action Plan - River Falls Monitoring Program	4/20/95
Subject: River Falls Water Monitoring Plan	
Purpose: To make sure people can easily find and compare all the data they need to make good decisions, whether they come from local government, state agencies, the legislature, or the general public.	
Goal: To adopt and implement a comprehensive approach to trends—oriented resource monitoring with the ability to recognize changes that may be occurring in the water environment and provide the basis for rationally deciding what should be done.	
Applicable Goals and Policies:	

Problems (Probable Obstacles)	**Solutions** (Obstacle Avoidance)
1. Lack of long-term baseline monitoring data.	1. Expand ambient monitoring substantially.
2. Reacting to single monitoring efforts without seeing the "whole picture".	2. Recognize trend analysis as an essential component of water management and routinely incorporate it as a key state and local government duty.
3. Lack of available funding to support a long-term monitoring program.	3. Help policy-makers, policy developers, and citizens recognize the importance of good information and analysis. Encourage and expand citizen and local government participation in the monitoring of water resources.
4. Multiple monitoring efforts occurring simultaneously without coordination in methods of collection and reporting.	4. Support data exchange and analysis through shared information management systems.
5. No single repository exists for data which is collected.	5. Provide the basis for a coordinated and integrated water monitoring system. a. Establish a single entity charged with the responsibiliity of collecting and maintaining all monitoring data. b. Prepare a monitoring plan based on identified system needs. c. Identify monitoring process and protocol.
6. Mistrust among various jurisdictions.	

Table 16
River Falls Monitoring Program
Action Plan
Summary

Revised 4/20/95

Activity Steps	Resources	Measurement	Completion Date
1. Prepare Monitoring Plan			
a. Establish overall direction to require compatibility and automation of surface water-related data collected by state and local government and private groups.	• Water Management Plan • Previous monitoring records • Proposed activities in previous and proposed City and UWRF grants • Ongoing data collection	Monitoring Task Force established "Policy Paper" preparation and approval by Task Force	Dec. 1994 Feb. 1995
b. Define City, County, State, TU and UWRF's contributions to the statewide information system.	• Past and current activities • Financial obligations	Responsibilities matrix	March 1995
c. Develop information systems that make integration of data easier.	• City GIS • TU, DNR, and UWRF data • Existing State/national examples	Publish identified process for data integration and information retrieval	July 1995
d. Develop criteria and procedures for conducting and coordinating monitoring programs.	• DNR, UWRF protocol • Federal, (i.e., EPA) guidelines • Task Force	Publish data collecting and reporting standards.	Oct. 1995
e. Establish data repositories at UWRF.	• Responsible departments, curriculums • Budgetary implications	University Regent's approval	Dec. 1995
f. Build a comprehensive system of "leading environmental indicators" based on an inter-governmental environmental quality monitoring network.	• Toxicity guidelines • Trout suitability indices • Effective Percent Impervious (EPI) guidelines	Publish standards	Feb. 1996
g. Complete plan	• Steps A-F	Publish Report	May 1996

River Falls
Wisconsin

Table 16
River Falls Monitoring Program
Action Plan
Summary

Revised 4/20/95

Activity Steps	Resources	Measurement	Completion Date
2. Increase funding for water data base development.	• Grants • State funding • City/County/Township/Private	City-dedicated account set aside for monitoring budget	Jan. 1996
3. Carry out groundwater quality monitoring in well-head protection areas.	• Observation wells • Funding resources • Labor resources	Observation well installation Observation well readings and laboratory analysis	Jan. 1996 July 1996
4. Establish river flow monitoring network; Develop stream temperature model.	• TU thermal monitoring stations • Public/private funding • Public/private/volunteer labor	Installation of flow records Data recording begins Stream temp. - Model	 March 1996 March 1996
5. Provide additional storm water monitoring.	• EPA NPDES guidelines and protocol • Target watersheds	Monitoring Begins Monitoring Complete	May 1996 Aug. 1996
6. Expand the monitoring of precipitation.	• UWRF programs • Financial resources	Installation: data recording begins	July 1996
7. Intensity storm water assessments from both a thermal and pollutant loading standpoint.	• Thermal export from watershed • Stream temperature response modeling • Land use control	Percent Impervious correlation Stream response correlation Final EPI Criteria	Oct. 1996 Oct. 1996 Jan. 1997
8. Develop pesticide monitoring in rural areas.	• St. Croix and Pierce Co. Initiative • Township programs • DNR priority watershed program	Start up of monitoring	April 1997

Upper Kinnickinnic Minor Watershed

General Watershed Characteristics

Location

The Upper Kinnickinnic (UK) Minor Watershed in southern St. Croix County is illustrated on Figure 13 on page 93. This minor watershed is located in the northernmost portion of the study area. The UK Minor Watershed includes area in Troy and Kinnickinnic Townships. Portions of the UK Minor Watershed are within the City's extraterritorial zoning district.

The Kinnickinnic River flows southwesterly through the central part of the UK Minor Watershed. Two major transportation corridors, STH 35 and STH 65, split the minor watershed into three pieces.

This minor watershed covers 11,051 acres. Six subwatersheds have been identified. Flood flows in the UK Minor watershed are dominated by the 80 S.M. watershed to the north (FEMA, 1982).

Physical Environment

❑ **Land Use**

Existing land use is illustrated on Figure 14 on page 94. The highway corridors represent much of anticipated commercial development, especially directly adjacent to STH 35 (River Falls, 1991). The Paulson property, in the northwest corner of Section 25, T28N, R19W, represents a future industrial development site (Ayres, 1987). For the most part, however, land use will remain in agricultural use. About 74 percent of the minor watershed will be agricultural, compared to about 75.5 percent today. Figure 15 on page 95 illustrates the areas and intensity of anticipated land use changes.

River Falls Wisconsin

UPPER KINNICKINNIC MINOR WATERSHED

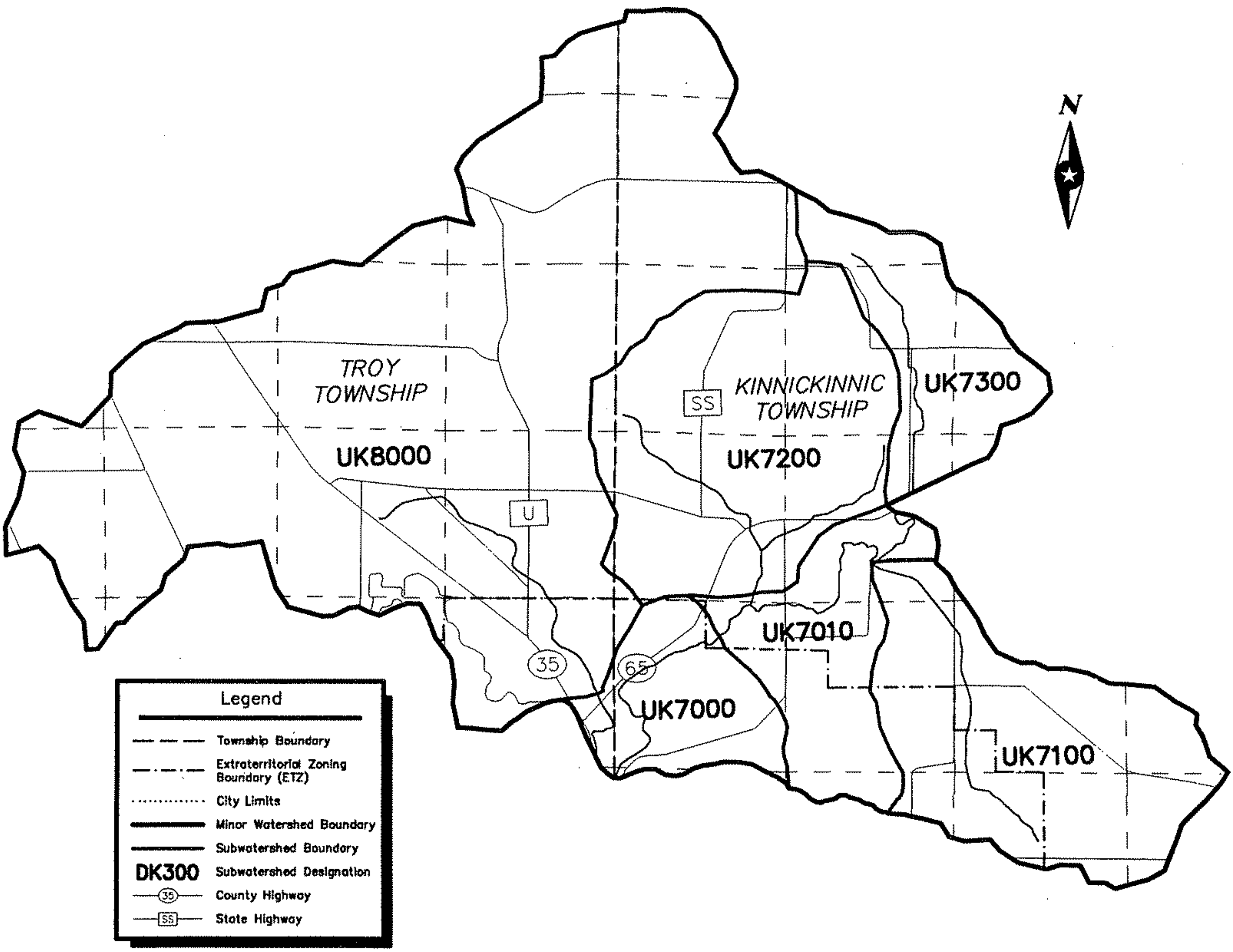


Figure 13
Upper Kinnickinnic Minor Watershed

River Falls Wisconsin

UPPER KINNICKINNIC MINOR WATERSHED

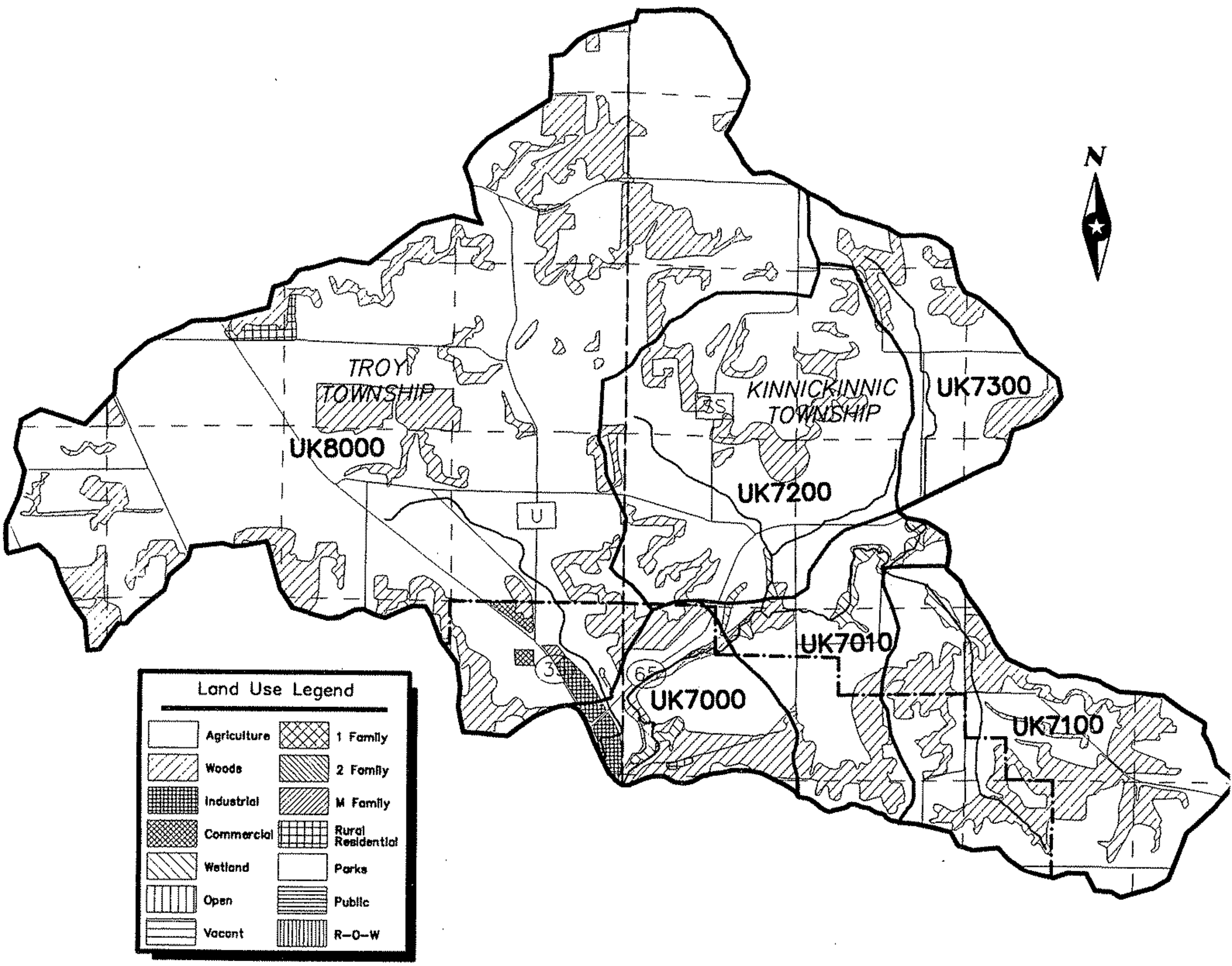


Figure 14
Upper Kinnickinnic - Existing Land Use

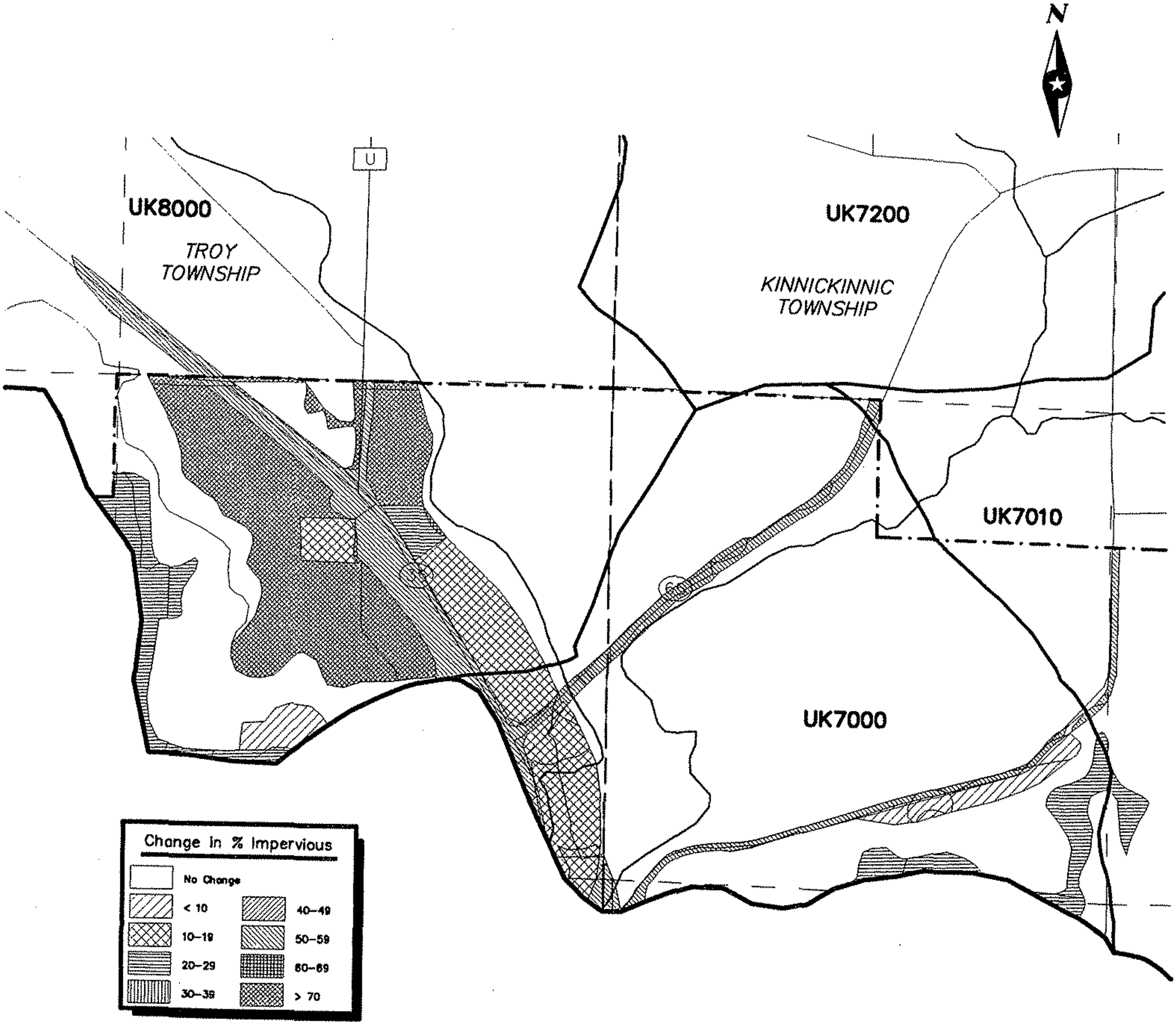


Figure 15
Upper Kinnickinnic - Land Use Changes

❑ Soils

The soils are comprised of four primary associations (USDA 1978).

- Sattre-Pillot-Antigo association
- Plainfield-Boone association
- Santiago-Otterholt-Arland association
- Ritchey-Derinda-Whalan association

A description of these associations are found in Appendix C.

Soils with moderate to very rapid permeability include the Sattre-Pillot-Antigo and Plainfield-Boone series. Soils having moderate to slow permeability include the Santiago-Otterholt-Arland and Ritchey-Derinda-Whalan. The soils are generally in hydrologic Group B, having moderate infiltration rates; i.e., low to moderate runoff potential.

❑ Unique Features

The UK Minor Watershed includes the highest quality portion of the Kinnickinnic River within the study area. This part of the river is considered to be a Class I trout fishery. The thermal regime (cold water condition) is very stable since it has not been impacted by urban runoff. There are an indeterminate number of springs which feed into the river. One such spring area, along the east side of STH 35, south of STH 65, has been monitored closely by the Wisconsin Department of Transportation (WDOT) during the 1991-1993 construction of the River Falls bypass (Baker).

According to J. R. Humphrey (1989), many 20-year easements were acquired along the Upper Kinnickinnic by the DNR in the 1950s, and more than 30 miles of fencing were installed. Humphrey (1989) indicates that many of the easements were renewed in the 1970s and that others have been added. According to Humphrey (1989), about 75 percent of the upper Kinnickinnic is fenced and open to anglers. Humphreys (1989) also notes that since 1987, the DNR has utilized trout stamp funds to purchase a number of stream side parcels.

Trout Unlimited's (TU) Kiap-Tu-Wish and Twin City chapters have been active in streambank improvement projects. In January of 1991, both sides of a 200-yard segment of the Upper Kinnickinnic were cleared of standing timber (Trout Unlimited, March 1991). Similar projects have been done in 1992 to improve habitat and fishing access.

TU has installed a permanent temperature monitoring station just off of Quarry Road about one half mile upstream of the STH 35 bridge. The thermistor unit is one of four permanent recording stations installed, maintained and monitored by TU specifically for this project. The *Watershed Assessment* section of the report includes a summary of existing thermal monitoring data. A more in-depth discussion of future monitoring activities can be found in the *Monitoring Program* Section of this report.

Hydrologic Units

The Upper Kinnickinnic Minor Watershed has been divided into six smaller subwatersheds as illustrated in Figure 13 on page 93. The hydrologic characteristics are listed in Table 17.

Table 17
Hydrologic Units of the
Upper Kinnickinnic Minor Watershed

Subwatershed Designation	Area	Curve Number[1]	Time of Concentration (Minutes	Percent Impervious[2]
UK7000	584.5	70	50.4	<10
UK7010	755.8	69	66.6	<10
UK7100	1,466.0	65	113.2	<10
UK7200	1,733.4	70	104.7	<10
UK7300	712.1	69	86.8	<10
UK8000	5,819.3	70	366.8	<10
Total	**11,051.0**	**69**		

1. Based on future land use conditions.
2. For rural areas, and areas with an impervious percentage of less than 10 percent, percent impervious estimates by subwatershed are not specifically reported.

There are no identifiable detention basins in the UK Minor Watershed. The effect of natural depressions has not been accounted for when computing storm flows. The 100-year discharge rates to the river are shown in Table 18.

Table 18
100-year Flow Rates for the
Upper Kinnickinnic River Minor Watershed

Subwatershed Designation	Direct Flow Rate [1 2] (cfs)
UK7000	910 cfs
UK7010	950 cfs
UK7100	1,030 cfs
UK7200	1,610 cfs
UK7300	730 cfs
UK8000	2,050 cfs

1. Based on future land use
2. Runoff rate is generated from subwatershed only; it is not a cumulative rate.

Water Quality

The water quality of the Kinnickinnic River in the UK Minor Watershed is the best of any river segment in the study area. Free of any concentrations of urban runoff, the largest water quality threats are related to agricultural land use practices, sanding/salting practices on highways, soil erosion, and potential spills of hazardous materials transported along either highway corridor.

Total Suspended Solids Loading

Excessive sediment loading to the Kinnickinnic can have a detrimental impact on trout spawning habitat.

In addition, the TSS loading can be a measure of other pollutant export.

The growing season total suspended solids (TSS) loading from the UK Minor Watershed is reported in Table 19.

Table 19
Growing Season Total Suspended Solids (TSS) Loading for the Upper Kinnickinnic River Minor Watershed

Subwatershed Designation	TSS Loading (lbs./ac.)[1,2]	Net Loading (lbs.)[2]
UK7000	45	25,400
UK7010	45	34,000
UK7100	45	65,100
UK7200	45	78,000
UK7300	45	32,000
UK8000	45	262,000
Total		**497,000**

1. For rural areas and areas which an impervious percentage less than 10, a minimum 45 lb./ac. TSS loading is assumed.
2. Future land use conditions

Based on anticipated future land use, the net TSS loading to the Kinnickinnic River is not expected to change significantly.

Because the TSS loading remains relatively constant, this segment of the river should be able to maintain itself. However, a strategy for addressing site-specific land use changes will be needed to prevent degradation of the river.

River Falls Wisconsin

UPPER KINNICKINNIC MINOR WATERSHED

Action Plan - Upper Kinnickinnic Minor Watershed	4/20/95
Subject:	Upper Kinnickinnic Minor Watershed Water Quality
Purpose:	To Achieve the highest level of river water quality protection
Goal:	The City, in cooperation with Troy and Kinnickinnic Townships, shall achieve a nondegradation standard which applies to all new development to those rates which exist at the adoption of this plan and water quality control after development to quality levels that exist in the Kinnickinnic River at the adoption of this plan.

Problems (Probable Obstacles) ➤	**Solutions** (Obstacle Avoidance)
1. Lack of consistency between the Townships and the City, in the area of water resources management. ➤	1. Develop a consistent approach to erosion control, development standards and surface water management by first developing mirror ordinance; if ineffective, then establishing an intergovernmental cooperative agreement for watershed management; if still ineffective, extending the ETZ.
2. Difficulty in reducing temperatures of storm water discharges to river temperatures. ➤	2. Utilize thermal best management practices to achieve the maximum thermal mitigation possible given the constraints of each available situation. (Refer to Appendix B for Thermal Mitigation Techniques.)
3. Maintenance of detention basins to ensure proper rate control and total suspended solids (TSS) reduction. ➤	3. Prior to completion of development, assign maintenance responsibilities for each facility to the appropriate jurisdiction.
4. Balancing the economic implications of on-site detention basins against property acquisition for regional detention ponds prior to development occurring. ➤	4. Adopt an on-site detention policy for all non-single family home sites, while requiring individual developers to dedicate existing low lands and depressions for use as regional basins during the preliminary plat stage. The dedication should be a permanent easement, but could also be fee title to the local unit of government.
5. Protecting spring areas with current land use regulations. ➤	5. Identify existing spring areas based on past observation and wintertime aerial observations.
6. Preventing hazardous spills along STH 35 and STH 65 and leaking underground storage tanks from contaminating the river and ground water responses. •	6. Develop environmental overlay zone of 500 feet either side of river centerline and spring areas prohibiting the above or below ground storage or fuel or other hazardous materials and identify the response process to a spill in the area.

Table 20
Upper Kinnickinnic Minor Watershed
Action Plan
Summary

Revised: 4/20/95

Activity Steps	Resources	Measurement	Completion Date
1. Develop consistent approach to watershed management. Adopt, interpret and enforce mirror ordinances based on an intergovernmental cooperative agreement.	• Identified & recognized State ETZ process • City Council • Troy & Kinnickinnic town boards • Objectives of this plan (natural resource implications) • Agency & Council support. • Public involvement and public information hearings.	Intergovernmental cooperative agreements. Adopted Mirror Ordinances	Jan 1, 1995 July 1, 1995
2. Identify Spring Areas	• DNR and TU records • University records • Land owners • Winter aerial photography	Completed map denoting spring areas	April 1995
3. Adopt Environmental Overlay Zoning	• Wellhead and spring protection zoning format	Council Approval	Jan. 1, 1995
4. Establish Development Review Criteria and enforcement standards for use by appropriate jurisdictions	• On-site and regional basin policy • Land dedication policy • Maintenance responsibilities • Quality, quantity (flow) and thermal standards • Hazardous materials identification • Public information program • Public hearing • Inspection/Enforcement • Permits • Erosion Control • Building Permit Process • Developer Agreements • Agricultural Land Conservation Programs	Written Plan	April 1995

UPPER DAM MINOR WATERSHED

General Watershed Characteristics

Location

The Upper Dam (UD) Minor Watershed, illustrated on Figure 16 on page 104, is centered about old STH 35 (through downtown River Falls), encompassing a tributary area extending from the old STH 35 bridge to the Lake George Dam. The upper two-thirds of the UD Minor Watershed is in St. Croix County. The remainder of the minor watershed is in Pierce County.

This minor watershed covers 1,300 acres. Seventeen subwatersheds have been identified. Seven existing detention basins provide primarily rate control benefits.

Physical Environment

❑ **Land Use**
Existing land use is illustrated on Figure 17 on page 105. The STH 35 corridor represents intensive existing development. The southernmost tip of the watershed includes the River Falls central business district. Further north, industrial development, including an industrial park, is interspersed with service industry and commercial development. The minor watershed currently has the highest level of development of any watershed within the study area. With anticipated growth along the STH 35 corridor and full occupancy of the industrial park, an overall increase in the intensity of development is expected, especially in the St. Croix County (northerly) portion of the UD Minor Watershed. Anticipated land use includes 8 percent industrial, 9 percent commercial, and 34 percent residential development. The UD Minor Watershed will ultimately have an overall impervious fraction of 36.4 percent. Figure 18 on page 106 illustrates areas and intensity of anticipated land use changes.

River Falls Wisconsin

UPPER DAM MINOR WATERSHED

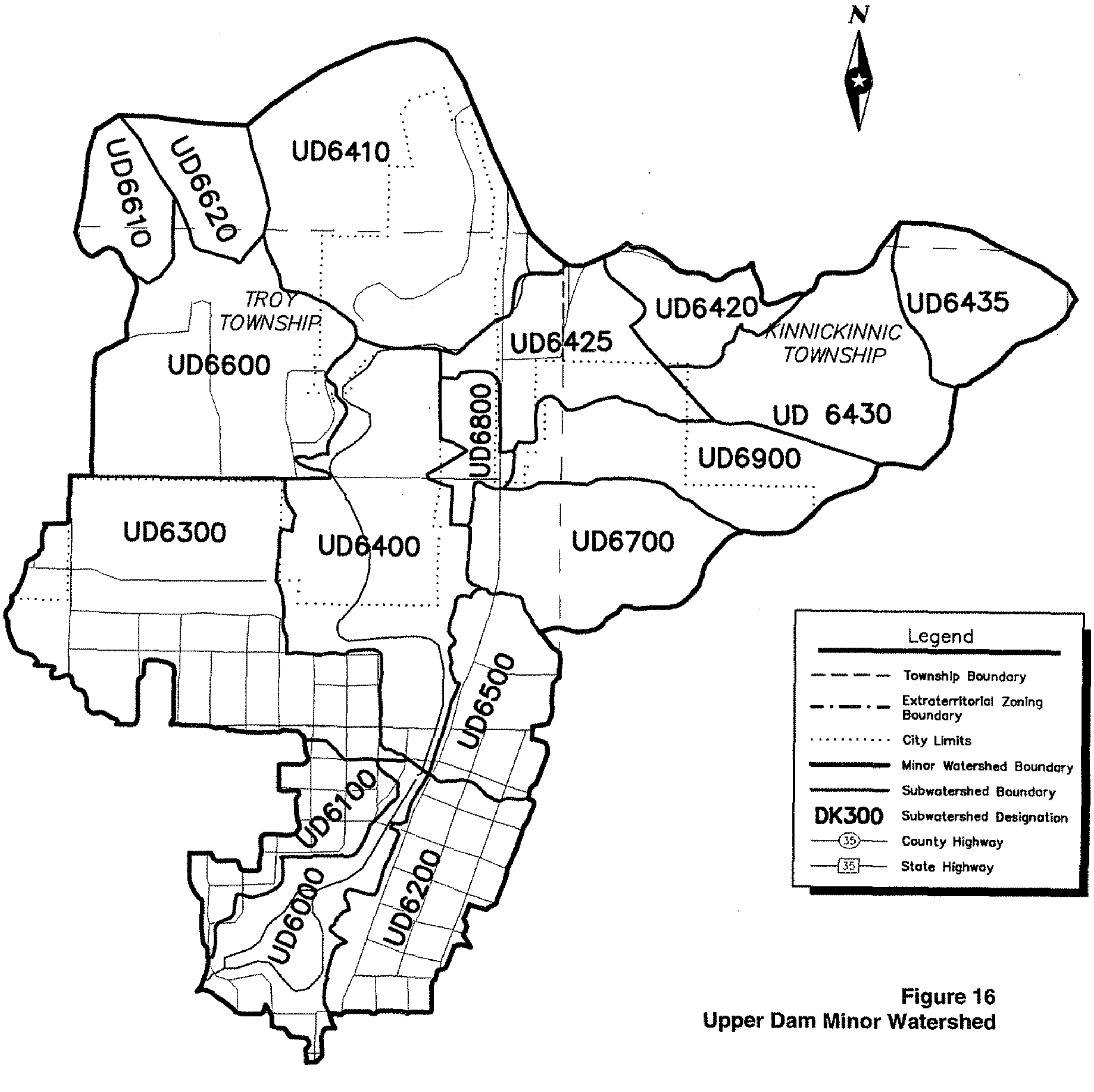


Figure 16
Upper Dam Minor Watershed

River Falls Wisconsin

UPPER DAM
MINOR WATERSHED

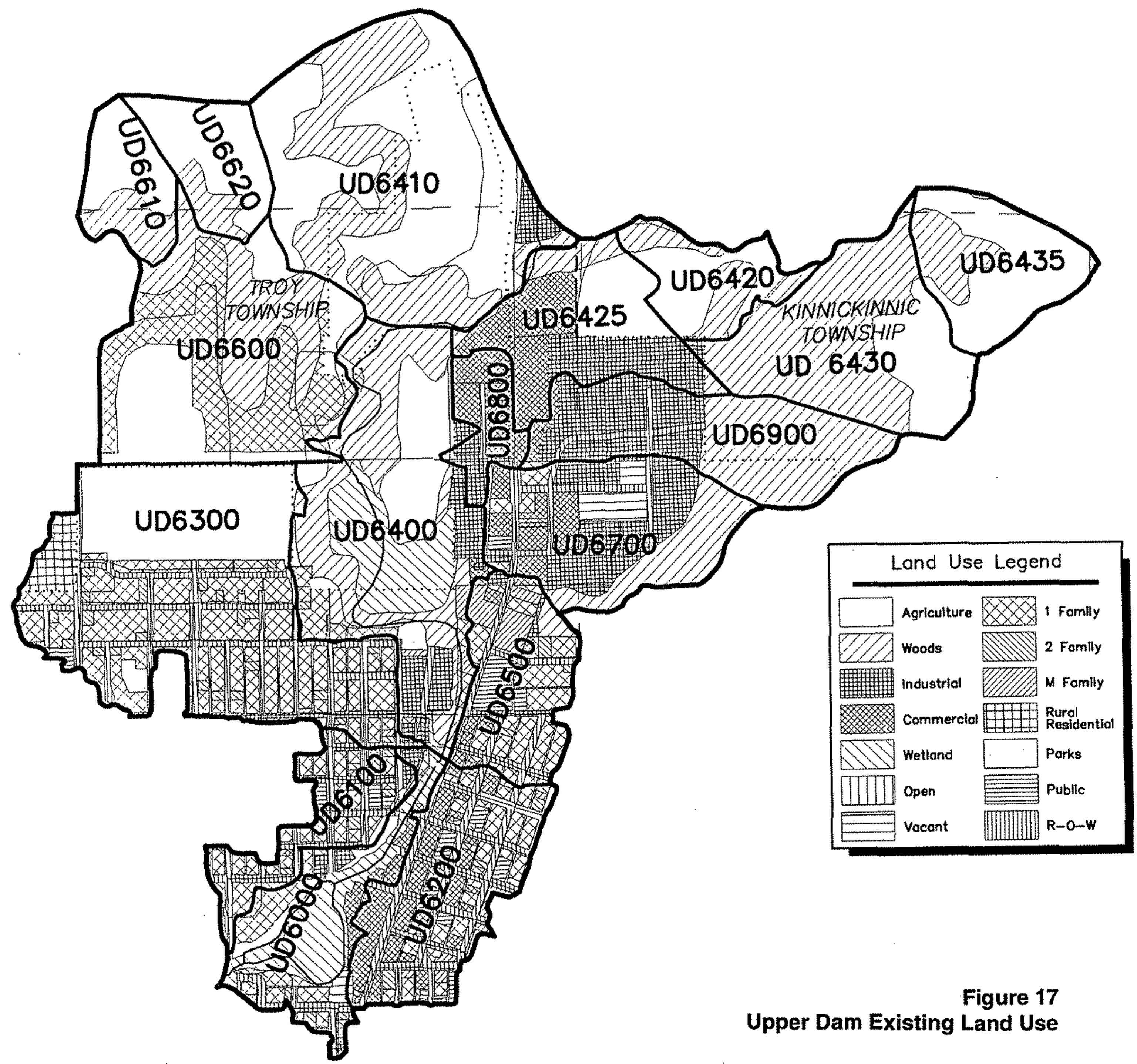


Figure 17
Upper Dam Existing Land Use

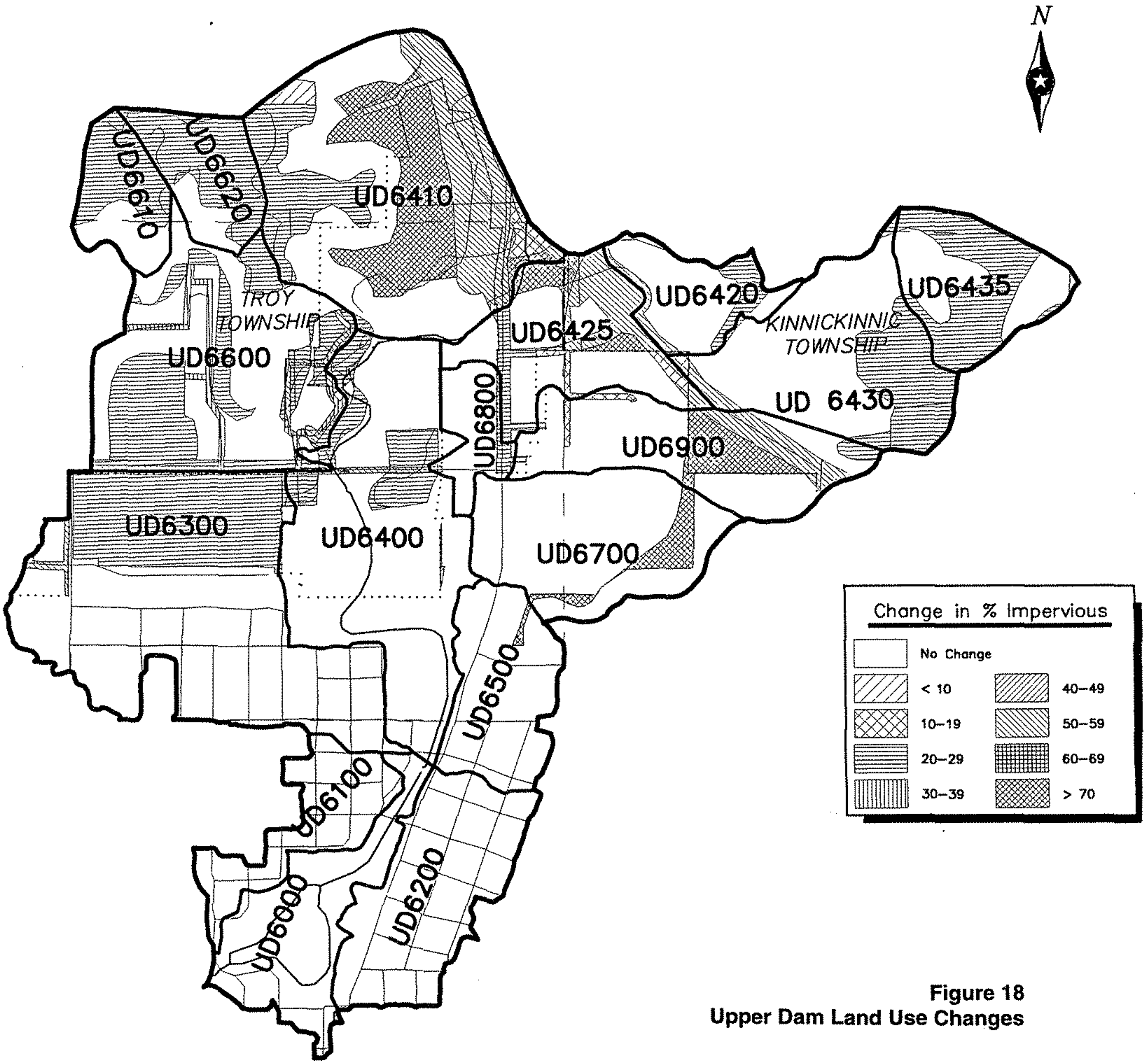


Figure 18
Upper Dam Land Use Changes

❑ Soils

The soil associations found in this minor watershed are:

- Sattre-Pillot-Antigo association
- Ritchey-Derinda-Whalan association
- Dakota-Waukegan association
- Santiago-Otterholt-Arland association (USDA, 1968)
- Derinda-Schapville association (USDA, 1968)

A description of these soils associations is found in Appendix C.

Soils with moderate to rapid permeability include the Sattre-Pillot-Antigo and the Ritchey-Derinda-Whalan (St. Croix County)/Dakota-Waukegan (Pierce County Associations). Soils with moderate to slow permeability include the Santiago-Otterholt-Arland (St. Croix County) and Derinda-Schapville association (Pierce County).

The soils are generally hydrologic group B, having moderate infiltration rates; i.e., low to moderate runoff potential.

❑ Unique Features

The UD Minor Watershed includes Lake George, the pool formed above the upper dam, as well as intensive hard surface areas related to commercial and industrial properties and the central business district. Although there are seven existing detention basins with the minor watershed, most of the storm runoff discharges directly to the River via one of the numerous storm sewer outfalls.

A Wisconsin Department of Natural Resources study initiated in 1980 identified physical characteristics of Lake George as shown inTable 21 (Moe, 1981).

Table 21
Lake George, Pierce County

Watershed Area[1]	65,280 acres
Lake Area	18 acres
Ratio, Watershed to Lake Area	3627:1
Average Outflow[2]	45 $ft.^3$/sec.
Annual Outflow	32,579 acre-feet/year
Lake Volume	94 acre-feet
Maximum Depth	13 feet
Mean Depth (volume/acre)	5 feet
Average Water Residence Time	21 hours

1. As measured by U.S. Army Corps of Engineers
2. Calculated from long-term average runoff as measured by U.S. Geological Survey, all other data measured in feasibility study.

Aquatic Plants

According to Moe (1981) , the major nuisance aquatic plant in Lake George is duckweed. Duckweed is a floating plant which forms large mats in areas where the flow of water is slow. Duckweed thrives in the moderately hard, alkaline and nutrient-rich waters of Lake George.

Moe (1981) documented the location of the plant beds near the storm water outfalls suggesting that nutrient-rich water and sediment from urban areas may have promoted localized plant growth. According to Moe, overall storm water contributes only a small proportion of the sediment and nutrients delivered to the lake. Moe (1981), found that current nutrient delivery is not a controlling factor in Lake George; rather, the nutrient-rich sediments, deposited years ago, provide the medium for abundant plant growth in Lake George.

According to Moe (1981), water and phosphorus move through Lake George so rapidly (flushing every 21 hours), that current nutrient delivery to the lake is not the controlling factor.

Fishery

Brown trout, carp, suckers, and a variety of panfish inhabit Lake George, seeking deeper water. Rough fish such as carp are not a problem in Lake George, according to Moe (1981). Cold water temperatures apparently limit rough fish, panfish, and bass populations from being established.

Sedimentation

According to Moe (1981), sediment ranges from 0 to 8 feet thick on the bottom of Lake George, generally deeper near the dam. The total volume of soft sediment measured in the 1981 study, is 64,012 cubic yards. Moe indicates that the material is predominantly fine sand, silt, and clay eroded from the uplands.

The historic rate of sedimentation in Lake George has been quite high starting with the period of intense cultivation during the late 1800s. According to Moe (1981), in the 1950s sediment was accumulating in Lake George at the rate of over 2,500 cubic yards per year. Moe estimates that improved upland soil conservation practices, including extensive stream bank protection, have reduced erosion and the resulting sedimentation, predicts that today sediment is being deposited in Lake George at a rate of less than 500 cubic yards per year (0.2 inches/year). Moe estimates the lake's life expectancy of over 300 years. Based on this rate, Moe's 1981 study showed that the top layer of sediments, where aquatic plants root, to be rich in phosphorus. Even without further inflows of phosphorus or sediment, the lake will continue to support abundant plant growth according.

Table 22 illustrates sediment initial sampling results on Lake George.

Table 22
Lake George Sediments
(Sampled May 20, 1980)

Constituent and Units	Sample[1]					
	I Top	I Bottom	II Top	II Bottom	III Top	III Bottom
% Solids	60	49	21	41	44	50
% Organic	5.3	3.9	0.5	3.5	4.0	4.6
Total Kjeldahl Nitrogen (mg N/g dry wt.)	3.83	2.53	0.39	2.21	2.60	2.70
Total Phosphorus (mg P/g dry wt.	1.87	0.80	0.17	0.90	0.82	0.61
Cadmium (mg/kg dry wt.)	25	20	7	23	20	29
Chromium (mg/kg dry wt.)	25	20	7	23	20	29
Total Organic Carbon (mg/kg dry wt.)	54,000	24,000	6,700	41,000	44,000	44,000
pH	6.7	7.3	6.8	6.5	6.7	6.6

1. Top samples are the upper 1 foot of each core.
Bottom samples are the second and third feet of each core.

In response to a proposal to dredge an area of Lake George for the construction of a fish habitat and a fishing pier, the Wisconsin Department of Natural Resources (DNR) requested additional testing of the bottom sediments of this area to determine if there are contaminants which would be released by the dredging.

GME Consultants, Inc., completed the sediment sampling and testing of the Lake George Sediments for the proposed fish habitat dredge area in River Falls. GME's investigation included driving four sample tubes into the lake sediments, and analytical testing of selected sediment samples.

According to GME (1990), about 3.8 to 6.4 feet of dark brown lake bottom sediments existed at the boring locations. GME's 1990 report found the sediments consisted of organic silty sand, organic silt with clay, fine sand with a trace of organics, and sand with silt and a trace of organics. According to GME (1990), this material constitutes lake bottom sediments deposited after the construction of the dam.

GME (1990) found brown and orange fine to medium sand underlying the recent sediments. This material constitutes naturally occurring fluvial soils according to GME.

Dense underlying granular soils or the bedrock surface was encountered at depths ranging from 5.0 to 7.3 feet below original grade.

The Wisconsin DNR requested particle size distribution and tests for total organic carbon, cadmium, chromium, copper, lead, and mercury content be completed (GME, 1990). Table 23 illustrates the results of GME's sediment sampling.

Table 23
Lake George 1990

Parameter	Range of Results (mg/kg)
Total Organic Carbon	380 to >16,000
Cadmium	<0.25 to 0.35
Chromium	<2.5 to 11.0
Copper	<0.25 to 6.4
Lead	<2.5 to 15
Mercury	<0.02

Note: These values appear to be well below levels which would be considered as hazardous levels.

Inflow Monitoring

During the summer of 1992, storm water runoff from a commercial watershed was monitored prior to its discharge to the river. The *Watershed Assessment-Method of Analysis: Water Quality* section describes the site and the characterization of the water quality. In addition, the thermal condition was also monitored (TU, 1992). The results of the 1992 monitoring are found on Figure 12 on page 67. TU's thermal monitoring results are found in the *Watershed Assessment* section of this study.

Thermal Impacts

Monitoring of lake temperatures on Lake George date back to 1980. As part of the Lake George Study, Moe (1981) reported the thermal conditions in the range of 59°F to 73°F July 31 through August 13, 1981. (Cold water fisheries are generally in the range of 44°F to 64°F (Fishing World)).

Lake George Management Alternatives

Moe's 1981 study reported a list of management alternatives, including:

- Protection of the Lake through Watershed Management (Sediment Reduction)
- Aquatic Plant Control
- Harvesting (Removal)
- Drawdown (Drying/Freezing)
- Chemical Control (Herbicide Application)
- Dredging
- Fish and Wildlife Habitat Improvement
- Return to Stream Conditions.

According to Moe (1981), returning the lake to a stream habitat may be a long-term money saver as well as an aesthetic advantage for River Falls. The lake temperatures are too cool to support a quality warm water fishery. But, the thermal conditions may be too warm for a quality cold water fishery. Therefore, the stream could be reestablished as quality trout habitat.

Hydroelectric Facilities

The benefits of the City's hydroelectric generating facilities at the Junction Falls Dam are questionable. According to an article in the *River Falls Area Guide* (1991), the 32-foot-high, 140-foot-long Junction Falls Dam generates 240 KW, accounting for about two-thirds of the River Falls Municipal Utilities generating capacity and about 2 percent of the total generating capacity of 13.4 MW. (The remaining capacity is diesel engine based which are not used). The dam was recently rehabilitated (HDR Techserv, 1987, 1988). However, the benefits of power generation, which results in about $77,000 of annual avoided power cost, should be weighed against the cost to maintain and operate the facility and the thermal impact of the shallow reservoir on the cold water fishery downstream.

Past thermal monitoring records show that temperatures on Lake George often exceed 70°F. Temperatures over 80°F were recorded in 1991 (Engel). These temperatures not only affect the cold water fishery in Lake George, but also the thermal regime of the lower river.

Downtown and River Front Study

The master plan for the Business Improvement District links the City center to the river corridor and utilizes this feature to give a unique flavor to the shopping district. The river's edge is planned as public open space throughout the central city with the provision of pedestrian walking paths and boardwalks exploring and linking the river's edge from north to south. On the south, the paths would provide a vital link to the University community and residential areas at Cascade and a future connection to the dam on the west. On the north, connections are projected to north park and adjacent residential areas. A new fishing dock and a pedestrian bridge on the old railroad trestle supports will provide for increased access to the river along these paths.

Commercial development has a close relationship to the river where east-west streets have been terminated and special features and overlooks will be provided. Key in these developments is the linking of Ash Park to the river by opening up the vista to the river and terracing the west end of the park to create a direct link to the existing pedestrian bridge. A new water feature and information kiosk would provide special focus to Ash Park.

A multipurpose park shelter and event structure is proposed to terminate this corridor on the west bank of the river. The addition of special paving and trees to the corridor will help link the river to Ostness Park on the east and provide the needed special identity to this key area of the City.

On the land adjacent to Lake George at the south entrance to the downtown area, a new commercial facility would be developed which maximizes views to the lake and maintains a public pathway connection in a park setting to Cascade. This development must not only effectively link the commercial core to the University, but also provide a quality entry to the downtown area from the south. New commercial facilities along Locust and Walnut Streets would help provide the needed expansion space for commercial activities in the core area.

The development south of Walnut would help provide the needed link of commercial activity to the river. A new overlook and pedestrian boardwalk at the terminus of Walnut at the river would provide a focus for the street and draw people to the river.

Stream/Lake Restoration Concept

One concept for stream/lake restoration is shown on Figure 19 on page 116.

River Falls Wisconsin

UPPER DAM
MINOR WATERSHED

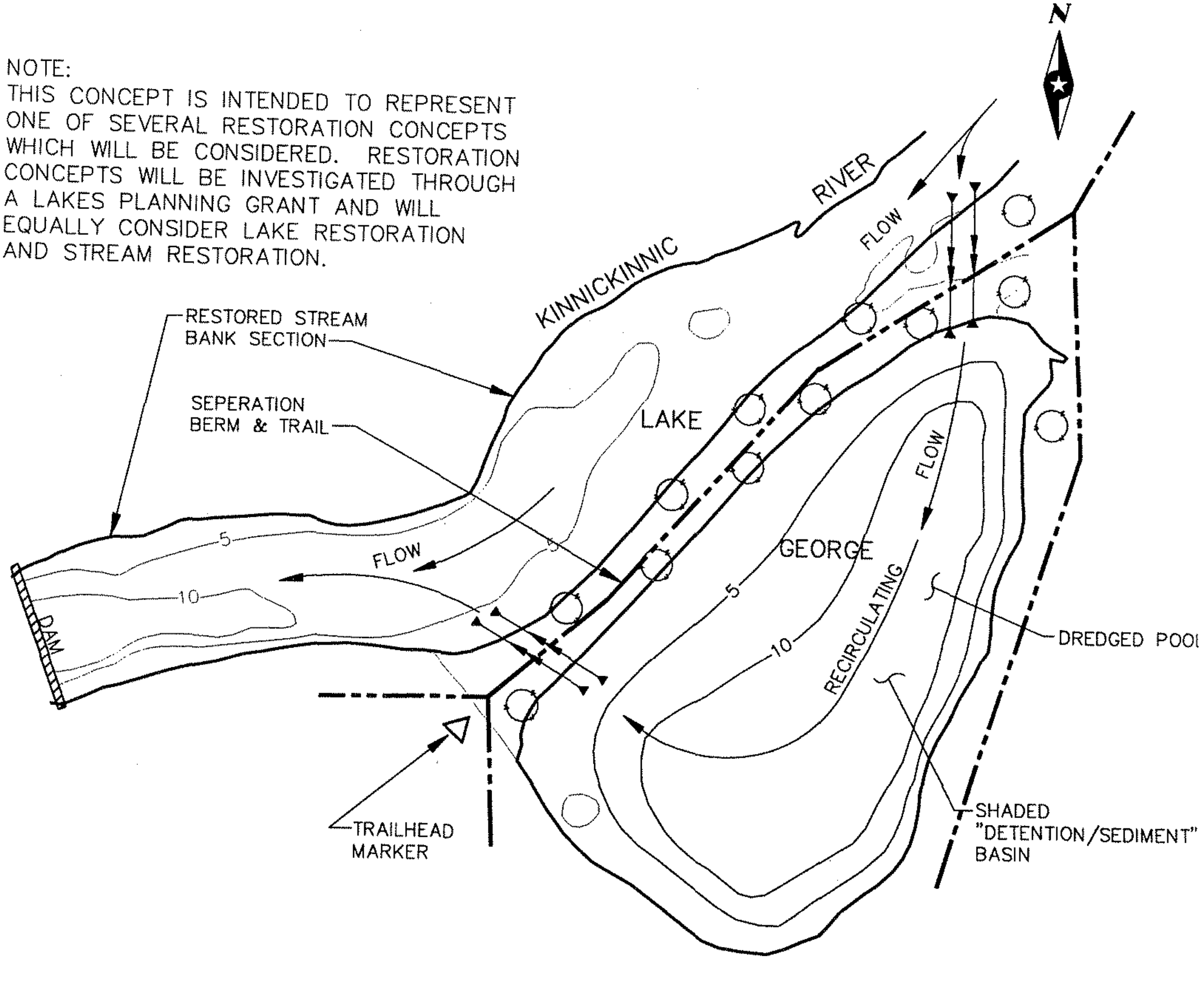


Figure 19
Lake George Restoration Concept

Hydrologic Units

The Upper Dam (UD) Minor Watershed has been divided into 17 smaller watersheds as illustrated on Figure 16 on page 104. The hydrologic characteristics of the subwatershed are listed in Table 24.

Table 24
Upper Dam Hydrologic Units

Subwatershed Designation	Area (Acres)	Curve Number[1]	Time of Concentration (Minutes)	Percent Impervious[2]
UD6000	57	73	25	44
UD6100	37	78	38	45
UD6200	71	82	36	58
UD6300	176	75	91	35
UD6400	130	66	82	24
UD6410	170	77	24	41
UD6420	33	65	21	11
UD6425	63	86	25	67
UD6430	101	67	34	13
UD6435	50	69	26	18
UD6500	52	78	43	45
UD6600	129	71	34	27
UD6610	29	68	12	19
UD6620	33	76	29	24
UD6700	80	79	53	49
UD6800	20	89	5	75
UD6900	62	82	30	55
Total	**1,300**	**75**	-	-

1. Based on future land use conditions.
2. For rural areas, and areas with an impervious percentage of less than 10 percent, percent impervious by subwatershed is not reported.

There are seven identifiable detention basins in the UD Minor Watershed. The detention basin data is illustrated in Table 25.

Table 25
Upper Dam Minor Watershed
Detention Basins

		Normal		100-Year Storm		
Designation	Location	Water Level	Surface Area	Water Level	Surface Area	Overflow Elevation
UD6000	Lake George	865.5	16.5	869.1	21.2	
UD6430		929.0	0.0	932.3	1.0	
UD6435		980.0	0.0	1,002.5	0.7	
UD6610		982.0	0.07	989.4	0.5	
UD6620		984.0	0.22	993.3	0.7	
UD6800	Super 8	887.0	0.20	893.1	1.3	893
UD6900	Industrial Park	898.0	0.44	903.7	1.7	903
UD6700	St. Croix St.	880.0	0.21	-	-	886.6

Designation	Available Storage (ac. ft.)	Inflow Rate (cfs)	Outflow Rate (cfs)	Peak Flow Reduction	Recommended First Floor Elevation
UD6000	685.5	3,705	3,695	0%	See FIS
UD6430	1.4	190	175	8%	934.3
UD6435	5.4	110	12	89%	1,004.5
UD6610	2.2	75	40	47%	991.4
UD6620	4.1	80	30	63%	995.3
UD6800	3.0	115	75	35%	895.1
UD6900	7.5	340	(1)	(1)	(1)
UD6700	2.2	163	-	-	887.6

1. Pond overtopping occurs. Future pond expansion recommended.

The UD Minor Watershed's collective 100-year peak runoff rate is about 2,700 cfs (2 cfs/ac.) as compared to 7,300 cfs (0.66 cfs/ac.) from UK Minor Watershed just upstream, which is almost 10 times larger than the UD Minor Watershed. The increased rate of runoff illustrates the impact of urbanization.

The individual 100-year peak runoff rates are illustrated in Table 26.

Table 26
Upper Dam 100-year Runoff Rates

Subwatershed Designation	Direct Flow Rate[1 2] (cfs)
UD6000	266
UD6100	92
UD6200	200
UD6300	218
UD6400	133
UD6410	523
UD6420	71
UD6425	239
UD6430	179
UD6435	109
UD6500	117
UD6600	266
UD6610	74
UD6620	82
UD6700	163
UD6800	112
UD6900	180

1. Based on future land use.
2. Runoff rate is generated from subwatershed only; it is not a cumulative rate.

❑ **Industrial Park**
The Industrial Park Pond appears to be undersized based on the existing and future contributing watershed (Miller, 1989). Historically, the pond has overtopped. The discharge has been an identified source of sediments to the river.

Modifications to the Industrial Park Pond should include expansion of the available storage. The outlet structure should be modified to enhance the sediment retention capabilities of the basin. Shading through extensive landscaping of the basin should also be prioritized. Lastly, a formalized conveyance system from the STH 35-River Falls Bypass to the pond should be developed to reduce the amount of channel erosion which occurs today.

❑ **St. Croix Street Outfall**
The St. Croix Street Outfall Pond (Hovde Basin) serves as the UD6700 subwatershed. The basin was modeled for water quality removal but not for hydrologic performance. The basin has a large overflow capacity (i.e., the hydraulic capacity is adequate). However, several modifications could be made to enhance the water quality benefits of the basin.

Water Quality

The water quality of the Kinnickinnic River in the UD Minor Watershed, including Lake George, is impacted greatly from urban runoff.

Nutrient Impact

The impact of nutrient inflow is minimized due to the relatively short retention time in Lake George and the river. Biological productivity (plant growth) is not considered to threaten the resource (Engel, 1991). However, total suspended solids (TSS) loading, or sedimentation, is a continuing problem. The TSS loading for the UD Minor Watershed, expressed in pounds per acre, is currently the highest of any of the seven minor watersheds in the study area. Under "ultimate" development, only the South Fork Minor Watershed is expected to have a higher TSS loading.

TSS Loading

The TSS loading has a direct relationship to the impervious fraction of the contributing watershed. The intense development within the UD Minor Watershed relates to a continued TSS loading unless expensive retrofitting of the existing drainage system, to provide sediment removal at many of the direct storm sewer outfalls to this section of the river, is undertaken. End-of-pipe treatment is not only costly, but many times ineffective. The hydraulics of the system often flush collected sediment from a basin into the river.

The growing season total suspended solids (TSS) loading from the UD Minor Watershed is reported in Table 27 on page 122.

The TSS loading can be expected to increase by 60 percent due to future development. Careful planning, which includes sediment basins, is required to maintain river water quality. These basins can be used either on each developing site or planned for a regional facility which serves multiple developments. As important as sediment removal is, the basins must also address the issue of thermal pollution.

Table 27
Upper Dam Growing Season
Total Suspended Solids (TSS) Loading

Subwatershed Designation	TSS Loading (lbs./ac)[1]	Pond Removal	Net Loading (lbs.)[1 2]
UD6000	535	-	30,600
UD6100	550	-	20,400
UD6200	701	-	49,900
UD6300	415	-	73,100
UD6400	292	-	40,500
UD6410	499	-	84,500
UD6420	134	-	4,400
UD6425	810	-	51,200
UD6430	127	41%	7,500
UD6435	220	86%	1,600
UD6500	547	-	27,700
UD6600	330	-	42,400
UD6610	231	67%	2,200
UD6620	294	78%	2,100
UD6700	596	-	47,600
UD6800	909	84%	2,900
UD6900	668	86%	5,900

1. Future land use conditions.
2. Shaded data illustrates priority subwatersheds. Subwatersheds UD6200, UD6300, UD6410 and UD6425 represent over 52 percent of the total loading. Applying the recommended TSS removal goal of 85 percent (see *Watershed Assessment - Water Quality*) to this subwatershed would result in over 44 percent reduction in net loading to this river segment.

Downstream Impacts

In addition to identifying impacts to this section of the river, the Upper Dam Minor Watershed represents a major source of pollutants to the lower river. The pool behind the dam often reaches temperatures in excess of 70°F in the summer. Temperatures of over 80°F have been recorded (Engel, 1991).

Warm water discharges downstream through routine dam operation. Though the dam discharge mixes with the cooler South Fork waters, the impact is noticeable downstream and has a building effect on temperatures in Lake Louise, behind the lower dam.

The warm water, in turn, affects the lower river. Although the Lake George discharge does not directly impact the lower river, the stability of its thermal regime remains a concern for the cold water fishery.

During storm events, the upper dam has been observed to overtop, discharging "....a chocolate-brown color" (Bauman, 1991). The sediment buildup behind the dam becomes resuspended and then is washed downstream. Some sediment is trapped in Lake Louise; however, a good share of fine sediment is likely washed downstream into the lower river where it covers spawning habitat and affects the direction of stream flow.

❑ **Storm Water Characterization**

Sampling of storm water runoff was completed from June through August, 1992. Six storms were sampled (see *Watershed Assessment - Water Quality* for monitoring details). The UD Minor Watershed sampling sites are representative of commercial and industrial watersheds. Watershed characteristics and sampling results are illustrated in Table 28.

Table 28
Upper Dam Storm Water Characterization

Parameter (μg/l)	Commercial Watershed	Industrial Watershed
TSS	150	250
TKN	2.1	2.5
TP	0.50	0.50
Cu	0.30	0.03
Pb	0.080	0.05
Zn	0.190	0.21
Location	Maple St. Bridge	St. Croix St. Outfall
Area	13 Acres	80 Acres
Curve No.	92	77
% Impervious Frac.	85	60

❑ **Industrial Park**
The industrial park pond provides 86 percent TSS solids removals. However, pond modification is required due to hydraulic inadequacies. Suggested modifications are illustrated in Figure 20.

❑ **St. Croix Street Outfall**
The St. Croix Street outfall (Hovde Basin) should be modified to increase the total suspended solids removal from 78 to to 85%. The modifications should include more sediment storage capacity and should include elements to provide thermal mitigation Figure 20 illustrates concepts for ultimate pond modifications.

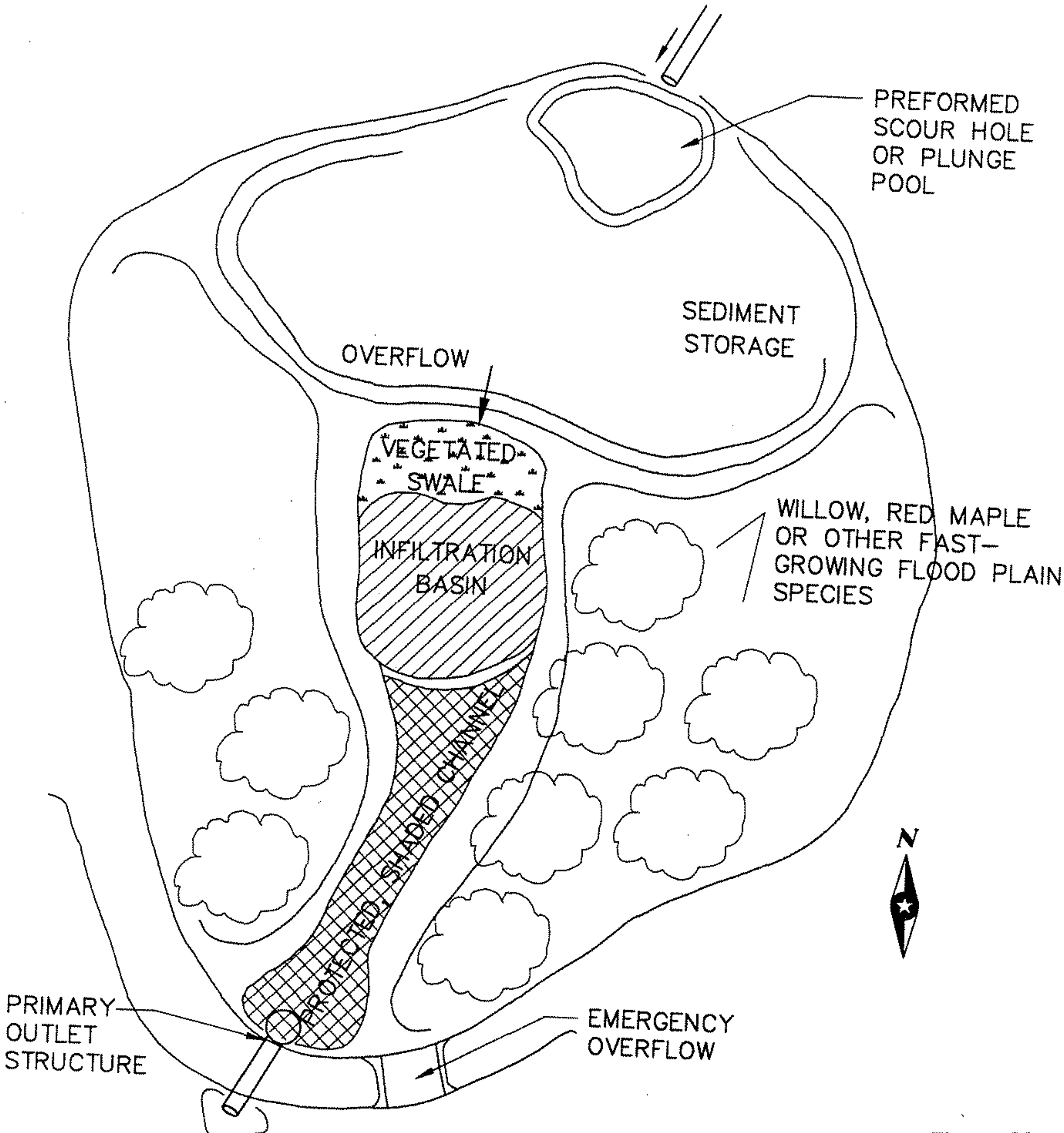


Figure 20
St. Croix Street Outfall and Industrial Park Pond Modification Concepts

Action Plan - Upper Dam Minor Watershed — 4/20/95

Subject: Upper Dam Minor Watershed Water Quality

Purpose: To minimize the impact of TSS loading and thermal pollution caused by existing and anticipated development.

Goal: The City shall develop a comprehensive sediment reduction program by addressing three main issues: 1) existing sources of sedimentation; 2) bottom sediments in Lake George; 3) existing and future drainage system sediment reduction.

Applicable Goals and Policies:

Problems (Probable Obstacles)	➤	**Solutions** (Obstacle Avoidance)
1. Difficulty in obtaining agreement among DNR, City Council, River Falls utilities, citizens and environmental groups on a management strategy for Lake George.	➤	1. Obtain WDNR's Lake Planning Grant and involve task force, including DNR, citizens, environmental groups, utility representatives and the City in the development of a lake management strategy.
2. Difficulty in obtaining existing developed properties to use for constructing end-of-pipe treatment for storm sewer outfalls.	➤	2. Identify specific properties that would be particularly well suited for sediment reduction and/or end-of-pipe treatment.
3. Difficulty in obtaining funding for lake management and drainage system retrofits.	➤	3. Develop city budget (property taxes) and other sources which will be available for the purchase of specific properties.
4. Maintenance of detention basins to ensure proper rate control and total suspended solids (TSS) reduction.	➤	4. The City will assume maintenance responsibilities for all detention basins and sediment removal structures within City limits.
5. Balancing the economic implications of on-site detention basins against acquiring property for regional detention ponds prior to development occurring.	➤	5. Adopt an on-site detention policy for all non-single family homesites, while requiring individual developers to dedicate existing low lands and depressions for use as regional basins during the preliminary plat stage. The dedication should be a permanent easement, but could also be fee title to the local unit of government.
6. Preventing hazardous spills along STH 35 and STH 65 and leaking underground storage tanks from contaminating the river and ground water resources.	➤	6. Develop environmental overlay zone of 500 feet either side of river centerline and spring areas prohibiting the above or below ground storage of fuel or other hazardous materials and identify the response process to a spill in the area.

Table 29
Upper Dam Minor Watershed
Action Plan
Summary

Revised 4/20/95

Activity Steps	Resources	Measurement	Completion Date
1. Obtain lake planning grant for Lake George.	• Task Force • Previous sediment studies • Additional water quality monitoring • New sediment studies • Dam operational characteristics	Grant Application Grant Approval Report Complete	Feb. 1994 Mar. 1994 Jan. 1995
2. Implement a sediment reduction strategy to reduce the use of road sand and increase street sweeping, especially in areas adjacent to the river.	• Street sweeping equipment • Public Works Sanding strategy and past records • Public information process to alert residents to road maintenance activities.	1. Completed written strategy for street sweeping priorities and frequencies, minimizing sanding activities in downtown area and installing signage to denote minimum road sand areas. 2. Increased sweeping	Jan. 1995 1994 Budget
3. Adopt Environmental overlay Zoning	• Wellhead and spring protection zoning format.	Council Approval	Jan. 1995
4. Establish Development Review Criteria and enforcement standards for use by appropriate jurisdictions.	• On-site and regional basin policy • Land dedication policy • Maintenance responsibilities • Quality, quantity (flow) and thermal standards • Hazardous materials identification • Public information program • Public hearing	Written Plan	April 1995
5. Retrofit existing drainage system for sediment and thermal reduction facilities.	• Map of applicable project areas • Area construction projects • Property purchase • Funding for construction	Completed map Construction Agreement Fee title or easement Facility constructed	Jan. 1994 Jan. 1995 As available As available
6. Modify Industrial Park Basin (page 116)	• TSS loading data • Development pressure	Completed feasibility Completed construction	1995 1996
7. Modify St. Croix Street Outfall Pond (page 120)	• Monitoring data • Land Availability	Completed feasibility Completed construction	1996 1997
8. Implement Lake George Management Plan	• Lake George Restoration Concept Plan • Previous lake monitoring data • Lake planning report (1995) • Feasibility Study results (1997)	Completed feasibility Completed project	1997 2000

SOUTH FORK MINOR WATERSHED

General Watershed Characteristics

The South Fork (SF) Minor Watershed in Pierce and St. Croix Counties, is illustrated on Figure 21 on page 129. This minor watershed is located in the central portion of the study area. The largest of the seven minor watersheds identified in this study, the SF Minor Watershed covers approximately 12,430 acres, including River Falls and Kinnickinnic Townships, and substantial area within the City's extraterritorial zoning district.

Location

The South Fork of the Kinnickinnic River flows westerly down the center of the SF Minor Watershed. The South Fork follows STH 29 and flows through the University of Wisconsin-River Falls campus where it discharges to the Kinnickinnic River below the Lake George Dam. The River Falls STH 35 Bypass crosses the South Fork within the lower third of the watershed. At the lowest end of the watershed, Old STH 35/STH 29, south of River Falls, crosses the river. There are several other minor river crossings throughout this minor watershed.

The SF Minor Watershed has been divided into 35 identifiable subwatersheds.

River Falls Wisconsin

SOUTH FORK
MINOR WATERSHED

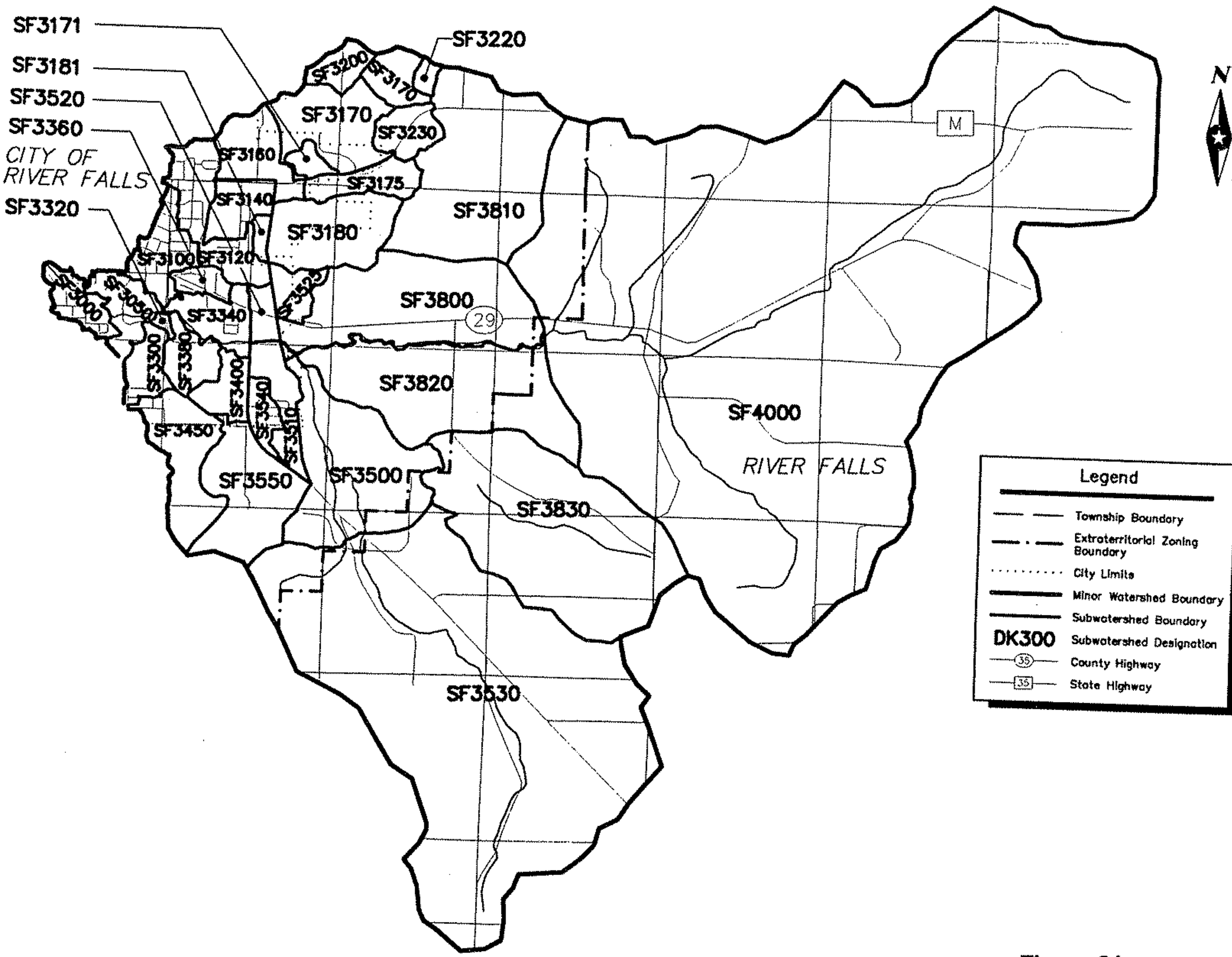


Figure 21
South Fork Minor Watershed

Physical Environment

❑ Land Use
Existing land use is illustrated on Figure 22 on page 131. The highway corridors represent most of the future anticipated commercial development, especially directly adjacent to the STH 35 River Falls Bypass. In the southwest quadrant of the intersection of the River Falls Bypass and STH 29, potential industrial growth represents the most intensive land use within this minor watershed. Continued growth and expansion of the River Falls campus is also anticipated. Figure 23 on page 132 illustrates areas and intensities of anticipated development.

The land use in much of the remaining South Fork Minor Watershed is expected to stay similar to what it is today. Agriculture today covers 71 percent of the minor watershed compared to 62 percent coverage in the future.

❑ Soils
Soils are comprised of six primary soil associations (USDA 1968).

Soils having moderate to rapid permeability include the Antigo-Onamia association and the Derinda-Schapville association. Soils having a moderate to slow permeability include the Derinda, Acid Variant-gale, Thin Solum Variant association, and the Renova-Vlasaty association.

These soils are generally in hydrologic group B, having moderate infiltration rates; i.e., low to moderate runoff potential.

A description of these associations is found in Appendix C.

❑ Unique Features
The SF Minor Watershed includes a widely varying stream ecosystem. The easterly portions of the South Fork of the Kinnickinnic River represent a stable, cold

River Falls Wisconsin

SOUTH FORK
MINOR WATERSHED

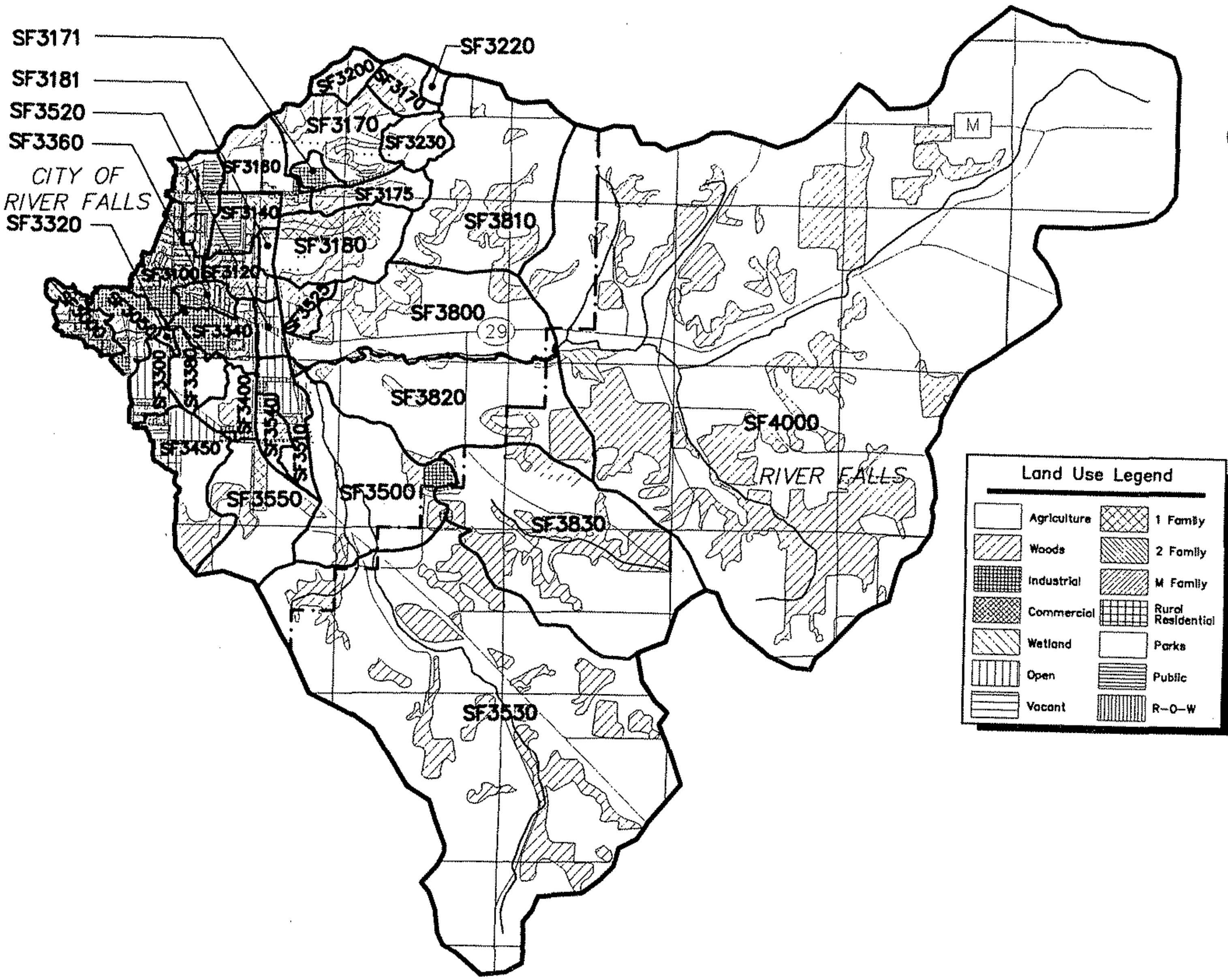


Figure 22
South Fork Land Use

River Falls Wisconsin

SOUTH FORK
MINOR WATERSHED

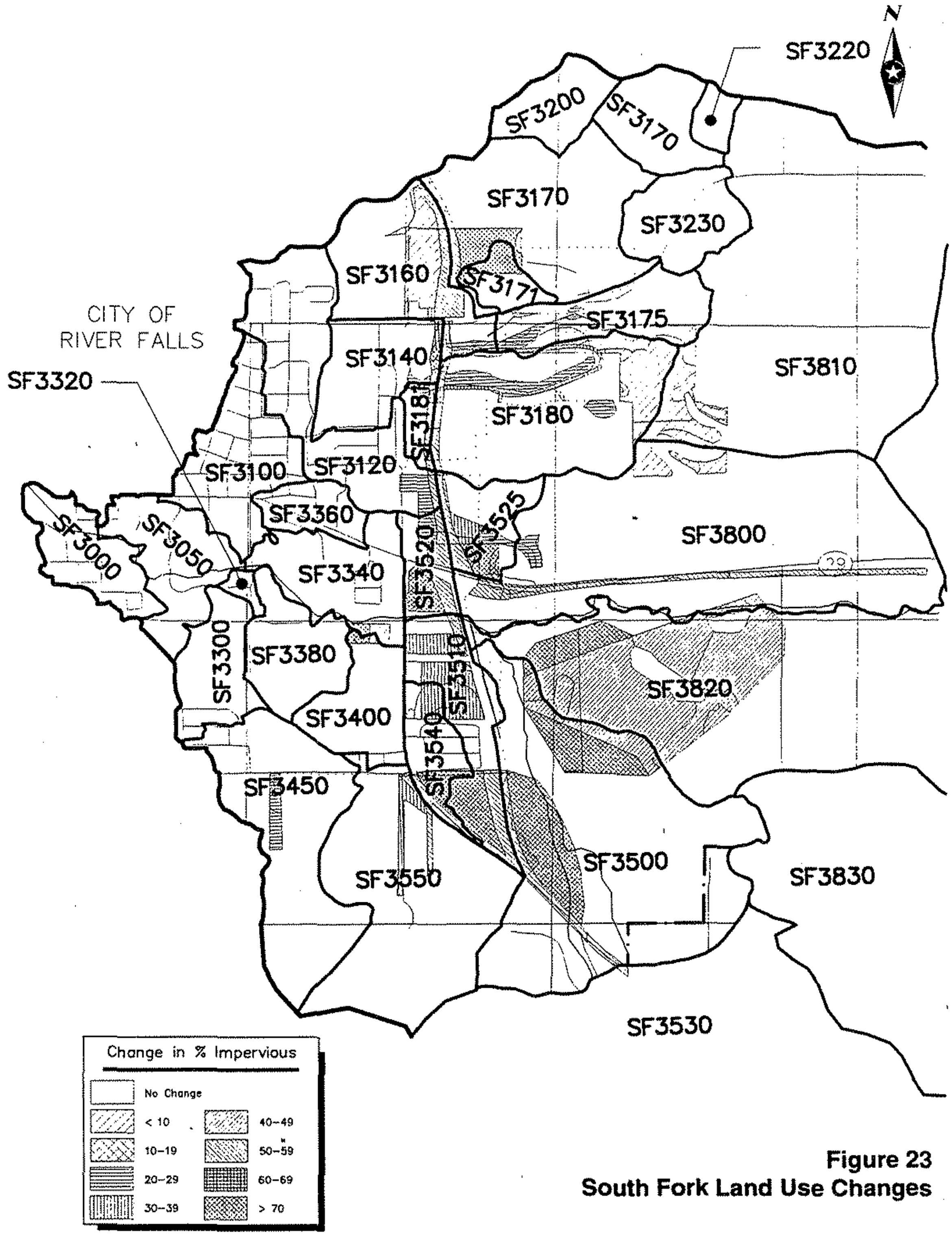


Figure 23
South Fork Land Use Changes

water regime and available brook trout spawning habitat. A natural threat to this portion of the river is an active beaver population. A number of dams constructed in the upper portions of the South Fork and the many feeder streams have created pools which are subject to thermal warming, threatening the overall thermal regime of the South Fork. The downstream, or westerly portion of the South Fork, has been impacted immensely by urbanization. The evidence of the impact of urbanization is most evident on the University of Wisconsin-River Falls campus.

South Fork Restoration Plan

A 1990 long-range development plan for restoration of the South Fork is represented in "Collaboration Across Campus" (CAC), a proposal from the University of Wisconsin-River Falls to the Department of Education in Washington, D.C., (Braun 1992). The plan includes stabilizing streambanks, removing non-native trees, controling beaver population, and constructing suitable trout habitat and holding structures. The objective is to resucitate the South Fork so that it is a Class I trout stream and so that it provides an attractive and usable campus resource.

Braun (1992) indicates the South Fork plan involves several phases. Preplanning (April 1993-April 1994) utilizes faculty, students, DNR personnel, City staff, and representatives from other interested groups with focus on environmental concerns and the effects of urbanization on the resource. Stream management data, including flow rate, water temperature, photographic records, and water quality analysis will be collected.

According to Braun, Phase 2 (September 1993-April 1994) focuses on planning. An integrated environmental education curriculum, with the South Fork as the centerpiece, will be developed through the River Falls school district and local education agencies. UW River Falls plans to increase environmental awareness and education throughout the region using the South Fork as a living laboratory.

In Phase 3 (April 1994 to October 1994), according to Braun (1992), students will assist actual construction work along side facility management and DNR workers. Braun says that Phase 4 - Evaluation (April 1993-December 1994) will monitor the pre- and post-project conditions.

Environmental Grant Programs

A second federal grant application is in the process of being funded. The grant application, entitled *Hook, Line and Thinkers* (Standiford, 1992), is a K through 5 curriculum based on a plan that involves community participation focused on the South Fork.

According to Dr. Standiford (1992), this plan is designed to integrate environmental education and emerging information technologies into the local school curriculums.

EPA's Environmental Education Grants

A third grant proposal, this one to the Environmental Protection Agency (EPA) focuses on environmental education. The program includes weather and stream monitoring, as well as community involvement and environmental curriculum. Although UW River Falls' 1992 proposal was unsuccessful, the EPA Environmental Grant Program still represents a potential source of funding for future monitoring and community involvement.

Through such grant programs, the South Fork can become the centerpiece of environmental education. In addition, the overall awareness of the general public in and around the River Falls area will be heightened as to the current status of the resource and the importance of resource protection activities.

Multi-objective Management

The South Fork restoration project raises a multi-objective management issue between the enhancement of trout habitat, focused on brook trout management as an indicator species of overall water quality, versus the native beaver population throughout campus-owned property. To maximize trout habitat, speed up the flow, and deepen the channel through the impacted areas of the South Fork, the beaver and the impacts of the many small dams along the South Fork and the feeder streams, must be eliminated, according to Marty Engel (1992). By eliminating box elders and other woody plants along the stream banks, Engel feels that the beaver habitat will no longer support a population that would have a detrimental effect on trout habitat.

Figure 24 on page 136 illustrates the South Fork restoration area. Examples of stream bank habitat structures are included in Appendix E.

Unnamed Tributary

The Unnamed Tributary No. 1, illustrated on Figure 25 on page 137, begins in the ridgelands and Section 32, Town of Kinnickinnic in Section 5 Town of River Falls. This tributary drains in a southwesterly direction, crossing Division Street at Greenwood Cemetery. It continues downstream through a constructed waterway on public school property. At the south edge of the school, it is joined by a small tributary from the east before entering a conduit at Ninth Street and Hazel Street. The length of the waterway from Division Street to Ninth Street is about 2,560 feet. The conduit then continues to Spring Street where, again, it becomes an open channel. The length of the conduit is about 1,060. The open channel joins the South Fork about 1,300 feet downstream from Cascade Street on the UW River Falls campus.

Unnamed Tributary Ogden's Study

In his report, *Eastside Drainage Project* (1976), Frank Ogden identified the inadequacies in the current ditch

River Falls Wisconsin

SOUTH FORK MINOR WATERSHED

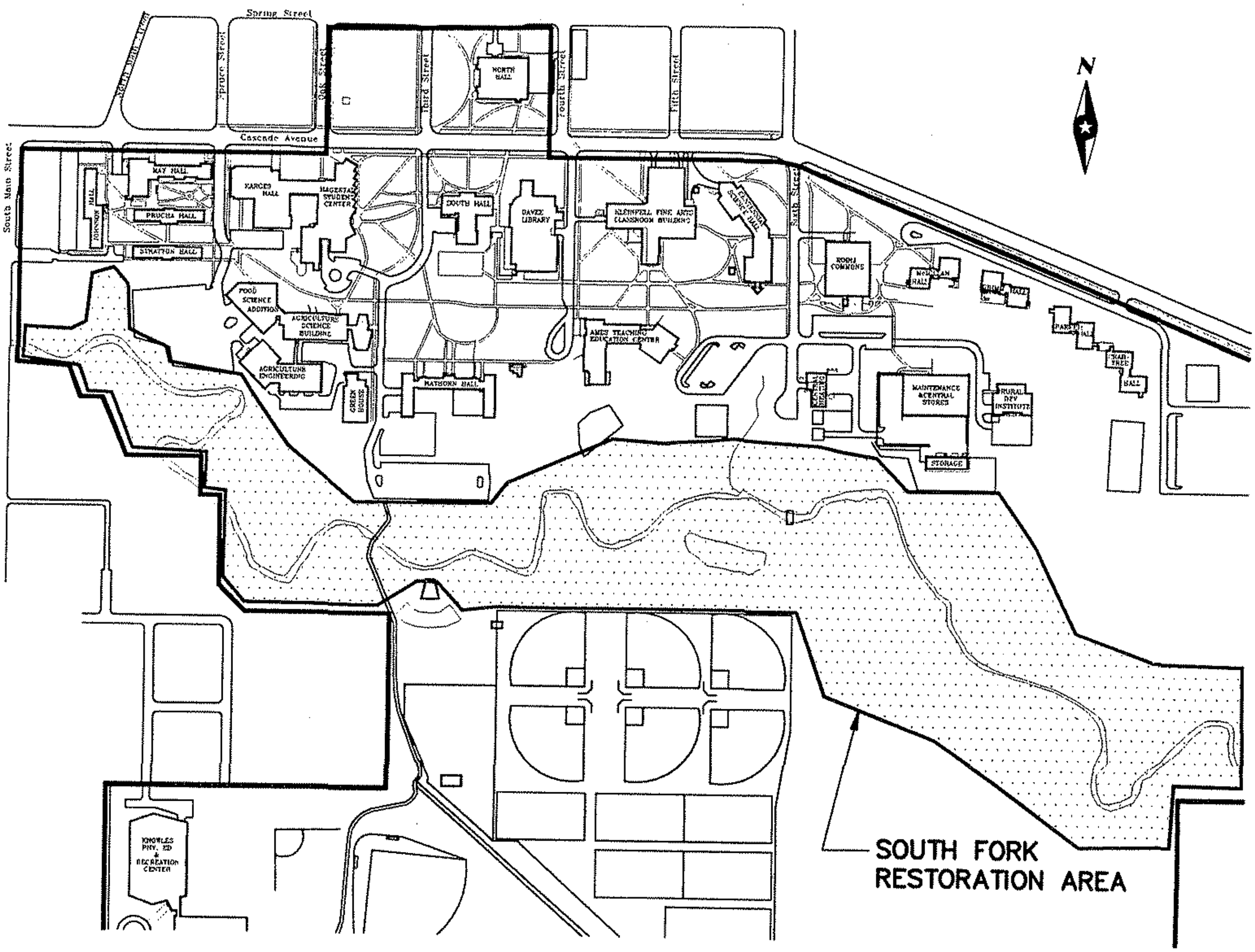


Figure 24
South Fork Restoration Area

River Falls Wisconsin

SOUTH FORK
MINOR WATERSHED

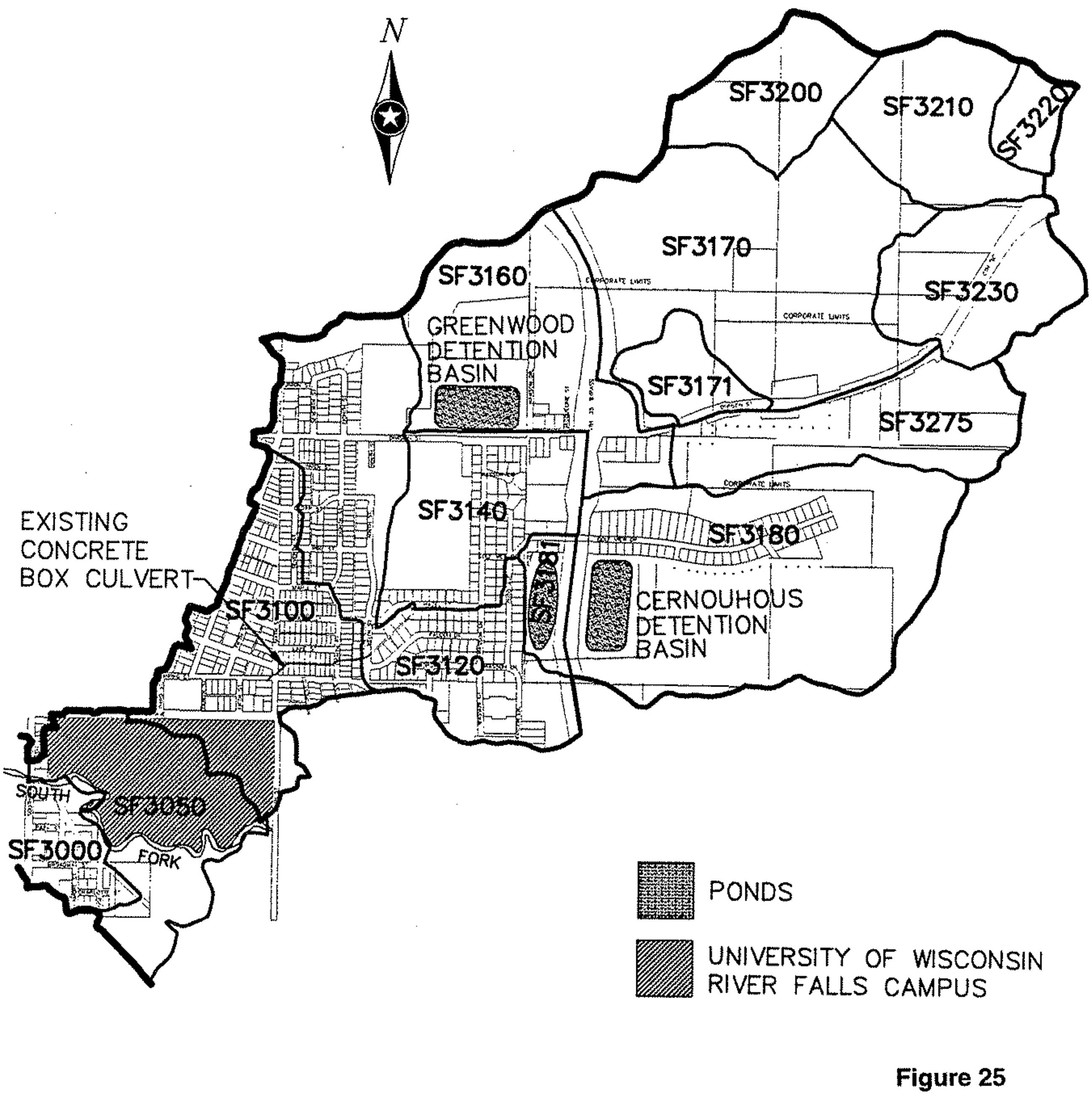


Figure 25
Unnamed Tributary

and culvert system between Cascade Avenue and Ninth Street. Ogden (1976) identified the box culvert between Spring Street and Ninth Street as the bottleneck in the system. Ogden (1976) proposed to construct two storm water detention basins adequate in size to eliminate the need for enlarging the box culvert between Spring Street and Ninth Street. The first basin, the Cernohous detention basin would serve an area of 225 acres and have a peak outflow of 40 cubic feet per second (the Cernohous detention basin is directly adjacent to the recently constructed River Falls Bypass. The second basin, directly north of Division Street and east of Greenwood Cemetery, would have a tributary area of 610 acres and a peak outflow of 50 cfs. Ogden's plan (1976) also called for replacement of the first 65 feet of box culvert, which measured 2 feet 8 inches high by 8 feet wide, to accommodate a peak flow rate of 170 cubic feet per second. (Both detention basins were ultimately developed; the box culvert was not replaced.)

Unnamed Tributary Flood Insurance Study

The City's Flood Insurance Study (FIS), (U. S. Department of Agriculture, 1977), identified the area of most serious potential flooding to be along the Unnamed Tributary. The USDA (1977) attributed the problem to inadequate storm sewer design.

According to USDA (1977), following a flood in 1966, the Pierce County Soil and Water Conservation District (SWCD) initiated a feasibility study as a potential Public Law 566 project for watershed protection and flood prevention. The project was turned down by the State Soil and Water Conservation Board on March 26, 1968, because of lack of floodplain regulation and implementation of earlier improvements. A Public Law 566 project was feasible, however, in the tributary area of the South Fork where increased residential building had occurred. Solutions, including an outlet channel, two flood water retarding structures, or a diversion conduit system were proposed.

The results of the 1977 Flood Insurance Study established the initial floodplain elevations for the Unnamed Tributary.

Unnamed Tributary Ayres Analysis

In 1981, the City contracted with Owen Ayres and Associates to perform a hydrologic and hydraulic analysis of the Unnamed Tributary to remove lands along this tributary from the zoning designation of floodplain lands. The study focused on the required detention and allowable release rates at the Division Street basin to prevent downstream areas from being flooded. In a letter to the City (Ayres, March 24, 1981), 172 structures were identified as being flooded for a 100-year event, including 141 houses, 29 garages, and 2 accessory structures. The analysis identified discrepancies or inaccuracies with the 1977 flood insurance study. Ayres (1981) summarized that eliminating flooding would depend on the feasibility of increasing the size of the Ninth Street box culvert and upstream channel capacities.

Uncontrolled Runoff Would Result in Damage

In other words, the previous construction of the Cernouhous & Greenwood detention basins did not completely control flooding. In an April 14, 1981, report to the City, Ayres noted that the local, uncontrolled runoff between Division Street and Hazel Street is 431 cfs, adding that this runoff would result in damage without any flow contributing from areas north of Division Street.

Ayres (1981) considered several alternatives for reconstructing the outlet pipe, including a 4-foot by 8-foot box culvert and pipe sizes ranging from 48 inches to 84 inches. Ayres (1981) concluded that, although development of the Greenwood Acres detention area (north of Division Street) would

Unnamed Tributary Ayres Analysis (Continued)

provide substantial benefits to a number of structures flooded, it would not solve the total flooding problem. Elimination of flooding would require major improvements to channel sections downstream of Division Street, including a new structure at Hazel Street and new culverts between Ninth and Spring Streets. The report recommended additional analysis to size the Division Street detention basin, define water surface profile between Division Street and the South Fork, update the existing FIS report, (USDA, 1977) and recommend downstream conveyance system improvements be undertaken.

On August 14, 1981, Ayres transmitted to the City of River Falls its report entitled *Detention Basins Design and Floodplain Analysis*. The report summarized the analysis and design of the Greenwood Acres detention area north of Division Street, and a hydraulic evaluation of Unnamed Tributary. The two main structures in the Unnamed Tributary are a 790-foot-long corrugated metal pipe arch through the University property, and a 1,280-foot-long box culvert from Spring Street to Ninth Street. Portions of the 100-year profile, reported in the August 14, 1981, report (Ayres), are significantly higher than previous profiles due to the installation of the corrugated metal pipe arch through the University property. This culvert increases the flood profile from Cascade Avenue to Spring Street. Upstream of Spring Street, the impact is insignificant. The report (Ayres, August 14, 1981), recommended that the City construct Greenwood Acres detention basin and necessary channel revisions between Division Street and Ninth Street.

The report (Ayres, 1981) further recommended that development upstream of Greenwood Acres detention area be controlled to reflect low density residential development assumed under future land use conditions in the report. Identified improvements include installation of a new box culvert from Spring

Street to Ninth Street. The report indicates that a correctly designed structure (4.8-foot by 12-foot reinforced concrete box culvert) could eliminate all flooding from the Unnamed Tributary. Without the culvert improvements, the report predicts that 34 houses and 11 garages will remain in the 100-year floodplain.

On October 5, 1981, the detention and floodplain analysis was revised (Ayres, October 5, 1981). The revision was based on new topographic mapping and actual construction of the Greenwood Acres detention basin. The revisions changed to the 100-year profiles by less than one foot throughout the cross section.

Unnamed Tributary Flood Insurance Study Revision

In 1982, the City's final Flood Insurance Study (FIS) was published (USDA, 1982). The 1982 FIS included the revised hydraulic profile analysis performed by Ayres (1981). The FIS also included the newly constructed Greenwood Acres detention basin north of Division Street, which was reported to be capable of containing the 100-year frequency flood.

The FIS included the Cernohous detention basin on Unnamed Tributary No. 2, which was constructed for flood protection of a residential area located in the eastern portion of the City. The report indicates that the basin is capable of containing the 100-year frequency flood (the basin is now bisected by State Trunk Highway 35-River Falls Bypass).

Ninth Street Conveyance System

Although deficiencies in the conveyance system between Ninth Street and Cascade Avenue have been identified, no detailed feasibility studies for correcting the situation have been completed. In 1990, the City of River Falls staff investigated sizing of various types of conveyance systems to accommodate the flows identified in the Ayres report (1981).

Conveyance Alternatives Considered

Three alternatives were evaluated; 72-inch by 115-inch concrete arch pipe at a cost of approximately $250 per lineal foot, 96-inch by 120-inch concrete box at approximately $225 per lineal foot, and an open ditch section. The City's study recommended the use of a 72-inch by 115-inch concrete arch pipe to pass 495 cfs. The cost for just the pipe installation would be over $250,000. Restoration would add significant cost. The pipe would be designed to eliminate all flooding of the affected area and remove the area from the floodplain. Figure 26 on page 143 illustrates the City's proposed box culvert replacement project.

In considering the ultimate replacement of the existing box culvert, the following elements should be investigated.

- Enhancement of hydraulic and water quality features of Cernohous Detention Basin.
- Enhancement of hydraulic and water quality features of Greenwood Detention Basin.
- Alternative outfall locations in addition to the existing campus outfall.

CITY	COUNTY	NO. OF SHEETS	SHEET NO.
RIVER FALLS	PIERCE	1	1

CITY OF RIVER FALLS

1990 WISCONSIN DEVELOPMENT FUND
PUBLIC FACILITIES, GRANT APPLICATION
STORM SEWER PLAN AND PROFILE

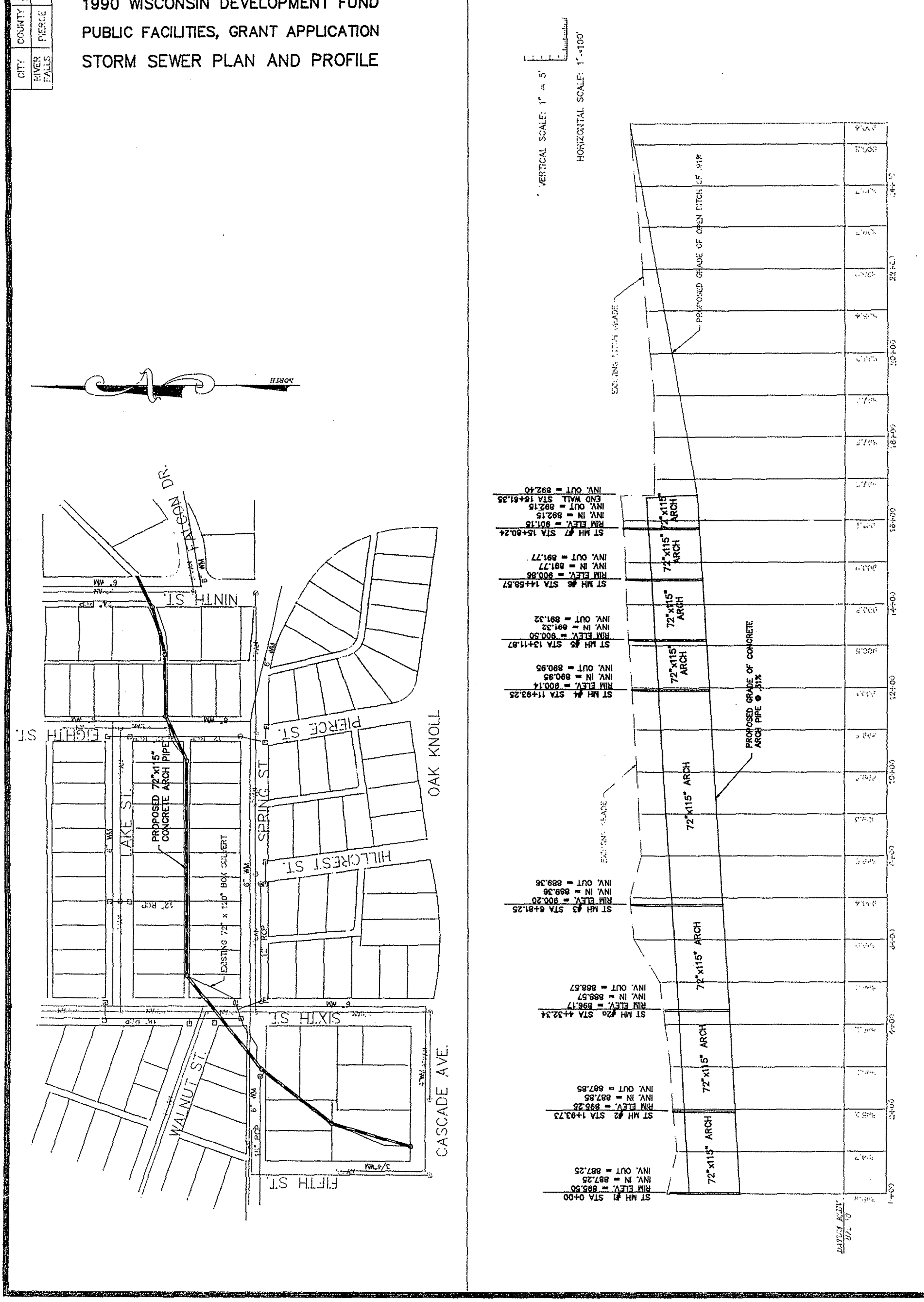


FIGURE 26

Hydrologic Units

The South Fork Minor Watershed has been divided into 35 smaller subwatersheds as illustrated on Figure 21 on page 129. The hydrologic characteristics of the subwatersheds are listed in Table 30 below.

Table 30
South Fork Hydrologic Units

Subwatershed Designation	Area (Acres)	Curve Number[1]	Time of Concentration (Minutes)	Percent Impervious[2]
SF3000	64	68	26.3	32
SF3050	82	71	43.1	33
SF3100	100	79	69.9	44
SF3120	149	76	43.4	39
SF3140	78	81	47.4	41
SF3160	115	68	25.4	19
SF3170	184	69	33.7	19
SF3171	25	86	26.0	65
SF3175	77	73	49.4	11
SF3180	203	71	30.9	18
SF3181	16	70	22.5	23
SF3200	50	71	20.1	11
SF3210	63	69	27.8	<10
SF3220	17	72	22.6	<10
SF3230	68	73	28.0	<10

1. Based on future land use conditions
2. For rural areas, and areas with an impervious percentage of less than 10 percent, percent impervious by subwatershed is not reported.

*Continued on page 145

Table 30 (Continued)
South Fork Hydrologic Units

Subwatershed Designation	Area (Acres)	Curve Number[1]	Time of Concentration (Minutes)	Percent Impervious[2]
SF3300	32	63	37.7	13
SF3320	7	71	30.0	<10
SF3340	89	66	45.5	30
SF3360	35	71	17.4	42
SF3380	72	65	44.9	<10
SF3400	65	73	42.9	15
SF3450	180	67	6.6	12
SF3500	403	64	60.3	19
SF3510	87	77	58.1	52
SF3520	36	77	29.6	60
SF3525	52	74	29.4	32
SF3530	2,166	68	116.5	<10
SF3540	43	80	37.7	60
SF3550	235	68	37.0	13
SF3800	457	65	57.0	<10
SF3810	540	70	48.2	<10
SF3820	504	70	100.9	17
SF3830	786	69	104.8	<10
SF4000	3,223	68	110.9	<10
SF4500	2,089	70	100.7	<10

1. Based on future land use conditions.
2. For rural areas, and areas with an impervious percentage of less than 10 percent, percent impervious by subwatershed is not reported.

There are nine identifiable detention basins within the SF Minor Watershed. The detention basin data is illustrated in Table 31 on page 147.

The two major detention structures, Greenwood Acres (SF 3160) and the Cernohous detention basin (SF 3180) provide the primary detention within the SF Minor Watershed. The Greenwood Acres detention basin reduces peak flow rates by almost 80 percent from 625 cfs peak flow rate coming in to 145 cfs peak flow rate leaving the basin. The Cernohous structure is even more effective, reducing the peak inflow of 425 cfs to 29 cfs discharge (93 percent attenuation).

Even with the peak flow reduction capabilities of the Greenwood Acres and Cernohous detention basins, the peak flow rates to the box culvert entrance at Ninth Street between Hazel and Falcon Streets exceeds available capacity as noted in numerous previous studies of the unnamed tributary (Ayres, 1981). Uncontrolled runoff from the area which contributes storm water directly to the Ninth Street inlet accounts for about 500 cfs. Because the peak discharge rates from the Greenwood and Cernohous detention basins are delayed significantly through detention, an increase of detention to achieve further reduction and flow rates from those two basins would have no impact on the capacity problems of the Spring Street/Ninth Street conveyance system capacity problems.

Table 31
South Fork Detention Basins

		Normal		100-Year Storm		
Designation	Location	Water Level	Surface Area	Water Level	Surface Area	Overflow Elevation
SF3160	Greenwood	904.0	0.06	912.2	10.2	-
SF3170	-	930.5	0.0	935.7	2.1	-
SF3171	-	931.6	0.0	937.1	0.8	-
SF3180	Cernouhous	920.0	0.03	929.9	6.6	-
SF3181	-	907.3	0.0	913.6	2.6	-
SF3200	-	1,012.0	0.35	10,019.3	1.0	-
SF3210	-	1,022.0	0.53	1,029.3	1.1	-
SF3220	-	1,094.0	0.06	1,099.0	0.6	-
SF3230	-	1,014.0	0.19	1,023.5	1.1	-

Designation	Available Storage	Inflow Rate	Outflow Rate	Peak Flow Reduction	Recommended First Floor Elevation
SF3160	56.3	625	145	77%	914.2
SF3170	3.1	530	470	11%	937.7
SF3171	3.0	90	31	65	939.1
SF3180	26.9	425	29	93%	931.9
SF3181	4.0	65	30	55%	915.6
SF3200	5.0	140	72	48%	1,021.3
SF3210	6.0	135	68	49%	1,031.3
SF3220	1.7	44	11	75%	1,101.0
SF3230	6.1	160	157	3%	1,025.5

The individual 100-year runoff rates of the South Fork subwatersheds are illustrated in Table 32.

Table 32
South Fork 100-year Runoff Rates

Subwatershed Designation	Flow Rate[1,2] (cfs)
SF3000	133
SF3050	151
SF3100	169
SF3120	322
SF3140	182
SF3160	244
SF3170	354
SF3171	91
SF3175	134
SF3180	426
SF3181	41
SF3200	139
SF3210	130
SF3220	44
SF3230	161
SF3300	46
SF3320	15
SF3340	129

1. Based on future land use, 100-year event
2. Runoff rate is generated from subwatershed only; it is not a cumulative rate.

*Continued on Page 149

Table 32 (Continued)
South Fork 100-Yer Runoff Rates

Subwatershed Designation	Flow Rate[1,2] (cfs)
SF3360	103
SF3380	100
SF3400	128
SF3450	454
SF3500	439
SF3510	158
SF3520	91
SF3525	122
SF3530	1,710
SF3540	114
SF3550	420
SF3800	540
SF3810	880
SF3820	480
SF3830	700
SF4000	2,660
SF4500	2,010

1. Based on future land use, 100-year event.
2. Runoff rate is generated from subwatershed only; it is not a cumulative rate.

Unnamed Tributary Revised Flood Profile

❑ Revised Hydraulic Analysis

The original hydraulic profile for the Unnamed Tributary was to be reanalyzed based on the original Ayres study (1981). The revised analysis was to include redefined cross sections to provide additional detail in the modeling analysis in hopes of shrinking the extent of the floodplain. Detailed analysis of the existing study showed that a more detailed description of the cross sections would likely reduce the computed flood profile.

Box Culvert Options

The downstream box culvert requires reconstruction due to structural inadequacies, regardless of its required hydraulic capacity. As indicated previously, a number of box culvert options have been considered. Figure 26 on page 143 illustrates the City's current thoughts on culvert replacement.

The two major related issues with the proposed culvert are the size and cost. Previous designs have used the total flow rate at the culvert entrance as a design flow rate (about 500 cfs). Under this condition, the current system should experience significant flooding at the inlet at Ninth and Hazel. The only problem is that nobody is getting flooded. Apparently, the water does not reach the box culvert inlet as efficiently as previous models have predicted.

Recommended Action

Before a new culvert is built to convey the City-predicted 495 cfs (1990), a detailed storm sewer system analysis in the areas between the Greenwood and Cernohous detention basins and the Ninth/Hazel box culvert entrance should be undertaken. The goal of the study would be to develop a calibrated model of the direct contributing tributary area. Based on observed flooding in the area, the lack of structural damage and local precipitation records, the model could account for the errors in the current modeling which are apparently over-predicting the magnitude of downstream flooding and peak flow rates. With a calibrated model in place, a final design for downsizing the box culvert can be developed. Figure 27 on page 152 illustrates the proposed study area.

Once the design flow rate for the box culvert is computed, final profile revisions with new cross sections can be made, based on the recommended culvert replacement option.

FIS Amendment

Finally, the Flood Insurance Study could be amended based on the detailed model. However, if a sufficient period of record of rainfall events and corresponding lack of flooding exists, then a case for amending the FIS could be made to DNR officials and FEMA without the modeling.

Demonstrating the lack of historic flood damages may not be adequate for FEMA, but it is a good, first, low-cost alternative. A detailed model which may account for minor backyard storage and surcharging storm sewer inlets may, in fact, place additional development restrictions on existing developed and vacant properties. The benefit of reducing the floodplain and reducing the size of the conveyance system should be weighed against the cost of additional regulatory restrictions for watershed development outside of the Unnamed Tributary Floodplain.

River Falls Wisconsin

SOUTH FORK MINOR WATERSHED

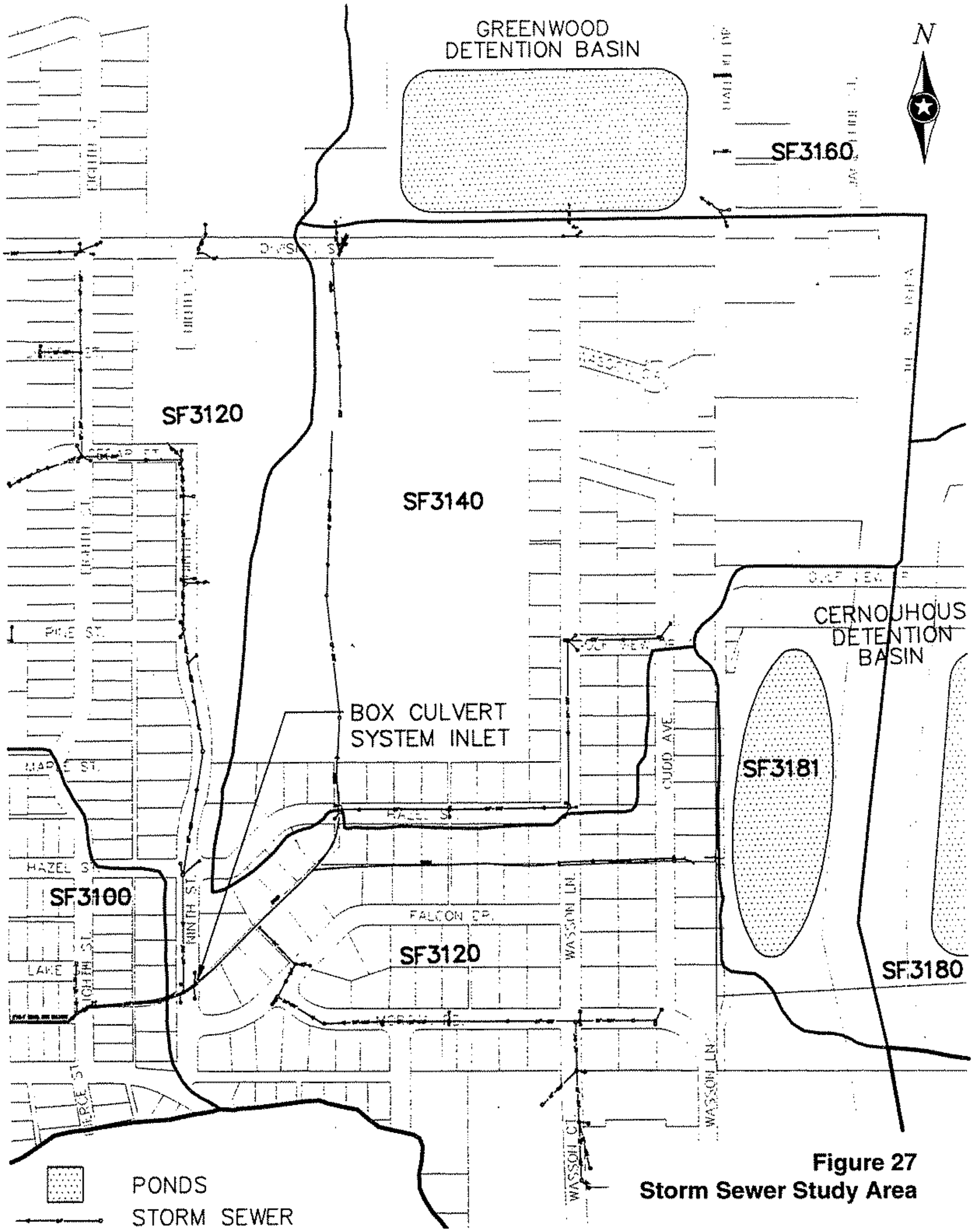


Figure 27
Storm Sewer Study Area

Water Quality

Water quality of the South Fork of the Kinnickinnic River in the SF Minor Watershed is extremely variable. Water quality varies from a highly impacted reach extending from the confluence of the South Fork and the Kinnickinnic River upstream through the UW River Falls campus, to a more natural condition in the rural areas east of the City. While the upper portions of the river have a more stable cold water regime, the influence of numerous beaver ponds threatens the thermal water quality of this reach.

Both the Greenwood Acres and Cernohous detention basins provide excellent total suspended solid removal. The Greenwood detention basin has a removal efficiency of 89 percent, while the Cernohous detention basin has a removal efficiency of about 72 percent. However, the area which lies downstream of the detention basins contributes runoff, TSS, and associated pollutants in an uncontrolled fashion. The Unnamed Tributary's outfall is the largest capacity and probably the worst single contributor to the problems of the lower reach.

Total suspended solids loading from agricultural areas in the upper reach continue to be a problem. In particular, subwatershed SF 3820, which lies south of the South Fork and directly east of the River Falls Bypass, is expected to experience a 360 percent increase in total suspended solids loading due to anticipated industrial development.

Areas east of the City limits are expected to experience only minor land use changes. Therefore, the suspended solids loading should remain at current levels.

West of the River Falls Bypass and continuing through the urbanized area of the City and the River Falls campus, individual storm sewer outfalls are the largest threat to the river. Sediment and pollutant delivery, as well as an overall flow volume and velocity can be damaging to the stream.

The growing season total suspended solids (TSS) loading from the SF Minor Watershed is reported in Table 33.

Table 33
South Fork Growing Season
Total Suspended Solids (TSS) Loading
(Continued on Page 155)

Subwatershed Designation	TSS Loading (lbs./ac.)[1,2]	Pond Removal	Net Loading (lbs.)[2]
SF3000	388	-	24,900
SF3050	401	-	32,900
SF3100	528	-	53,000
SF3120	474	-	70,600
SF3140	499	-	38,700
SF3160	231	89%	3,000
SF3170	233	28%	30,800
SF3171	792	62%	7,500
SF3175	135	-	10,400
SF3180	218	72%	12,500
SF3181	280	82%	800
SF3200	134	86%	900
SF3210	45	89%	300
SF3220	45	77%	200
SF3230	45	88%	600

1. Based on future land use conditions.
2. For rural areas, and areas with an impervious percentage of less than 10 percent, percent imprevious estimates by subwatershed are not specifically reported.

Table 33 (Continued)
South Fork Growing Season
Total Suspended Solids (TSS) Loading

Subwatershed Designation	TSS Loading (lbs./ac.)[1,2]	Pond Removal	Net Loading (lbs.)[2]
SF3300	154	-	9,500
SF3320	45	-	300
SF3340	364	-	32,400
SF3360	504	-	17,800
SF3380	45	-	3,200
SF3400	181	-	11,700
SF3450	145	-	26,100
SF3500	231	-	93,000
SF3510	632	-	54,800
SF3520	728	-	26,000
SF3525	392	-	20,500
SF3530	45	-	97,500
SF3540	730	-	31,600
SF3550	158	-	37,300
SF3800	45	-	20,600
SF3810	45	-	24,300
SF3820	207	-	104,600
SF3830	45	-	35,400
SF4000	45	-	145,100
SF4500	45	-	94,000

1. Based on future land use conditions
2. For rural areas, and areas with an impervious percentage of less than 10 percent, percent impervious estimates by subwatershed are not specifically reported.

Based on anticipated future land use, the net total suspended solids loading within the South Fork minor watershed is expected to increase approximately 43 percent. In addition to the impacts that excessive sediment loading has on trout spawning habitat, TSS loading can be an indicator of other pollutant exports (see *Watershed Assessment*).

Sediment removal at key locations in the watershed must be prioritized if the University of Wisconsin River Falls master plan for the reestablishment of the South Fork as a Class I trout fishery is to be realized. As important as these sediment removal devices are, their design should not ignore impacts to the cold water regime of the river; i.e., sediment basins minimize reliance on permanent pool design which would be subject to solar heating and ultimate discharge of warm water (±80°F) to the river.

End of pipe solutions to remove sediment are not the only options. In particular, the hydraulics of the outfall from Cascade Avenue and the Spring Street/Ninth Street box culvert system may flush any end-of-pipe sediment basin. An alternative strategy involves controlling construction site erosion during development of those areas around the River Falls Bypass and developing areas to the east and south of the City.

Currently, only 7 percent of the total suspended solids loading is removed through existing ponding facilities. Although a number of the subwatersheds will experience large increases in pounds per acre of total suspended solids loading, the focus should be on reducing the net loading in pounds to the river.

Of the non-rural subwatersheds (TSS loading greater than 45 lb./acre), the subwatersheds, illustrated on Table 34 on page 157 exhibit the highest individual net loadings and should receive initial focus for TSS load reduction.

Table 34
South Fork TSS Removal
Priority Watersheds

Subwatershed Designation	Net Loading lb./acre	Percent of Total SF Load
SF3820	104,600	8.9%
SF3500	93,000	7.9%
SF3120	70,600	6.0%
SF3510	54,800	4.7%
SF3100	53,000	4.5%
	376,000	**32.1%**

Applying the recommended TSS removal goal of 85 percent (see *Watershed Assessment - Water Quality*) on these subwatersheds would result in over 25 percent reduction in net loading to the South Fork.

Action Plan - South Fork Minor Watershed	**4/20/95**
Subject: South Fork of the Kinnickinnic River	
Purpose: To restore the South Fork to Class I - Brook Trout Status	
Goal: The City, River Falls Township and University of Wisconsin - River Falls shall work together to reduce the total suspended solids loading to the South Fork, mitigate the thermal impacts of future development, and increase public involvement in the South Fork restoration through an active community environmental education curriculum.	
Applicable Goals and Policies:	

Problems (Probable Obstacles) ➤	**Solutions** (Obstacle Avoidance)
1. Impacts related to increased development pressure adjacent to STH 35-River Falls Bypass and future industrial development. ➤	1. Implement "Effective Percent Impervious" (EPI) requirement for all development along the South Fork and its tributaries.
2. Campus expansion and parking lot development needs. ➤	2. Prepare Feasibility Study jointly with campus planning to identify future land use needs.
3. Control of warm roof top runoff from campus buildings ➤	3. Where feasible, disconnect rooftop drainage from underground systems and connect to over land drainageways to enhance infiltration. Direct drainage to new water features. (ponds, infiltration basins, etc.)
4. Control of runoff from maintenance facilities storage materials. ➤	4. Complete spill containment plan for any areas where hazardous material may be stored.
5. Unnamed Tributary Flooding (upstream) and flood/sediment damage (downstream). ➤	5. Complete detailed hydraulic system analysis to properly size upstream and downstream facilities.
6. Difficulty in developing concensu with resource agencies on stream improvement concepts. ➤	6. Establish "South Fork Restoration" "Task Force", including DNR, citizens, environmental groups, and the City in the development of a stream management strategy.
7. Difficulty in obtaining existing developed properties to use for constructing storm water treatment facilities. ➤	7. Coordinate identification of specific properties that would be particularly well suited for sediment reduction and storm water treatment with Campus Planning.
8. Difficulty in obtaining funding for lake management and drainage system retrofits. ➤	8. Develop City, Townships, County and University system budgets and other sources which will be available for projects.
9. Maintenance of detention basins to ensure proper rate control and total suspended solids (TSS) reduction. ➤	9. The City will assume maintenance responsibilities for all detention basins, environmental overlay, and sediment removal structures within City limits including those on campus.
10. Preventing hazaroud spills along STH 35 and Cascade and leaking underground storage tanks from contaminating the river and ground water resources. ➤	10. Develop environmental overlay zone of 500 feet either side of river centerline and spring areas prohibiting the above or below ground storage of fuel or other hazardous materials and identify the response process to a spill in the area. 10B. Implement Wellhead Protection Zoning (see *Ground Water*) section.

Table 35
South Fork Minor Watershed
Action Plan
Summary

Revised 4/20/95

Activity Steps	Resources	Measurement	Completion Date
1. Construct temporary sediment basin at Unnamed Tributary Outfall	• TSS loading data • Available campus lands • Hydrologic analysis • Campus planning	Completed construction on campus	July 1995
2. Prepare detailed study of uncontrolled runoff area contributing to Unnamed Tributary	• Previous studies • Storm sewer as-builts • Hydraulic Profile Analysis • Neighborhood meetings • Campus Planning	Completed City Feasibility Study	August 1995
3. Reconstruct Unnamed Tributary conveyance system	• Feasibility Study • Appropriate funding • Neighborhood meetings	Complete construction project	October 15, 1998
4. Establish Effective Percent Impervious (EPI) requirements for Bypass related development and South Fork Minor Watershed	• TSS loading results and recommended removal efficiencies • Thermal BMP guidelines • River Model	Area-specific developer's guidelines	Jan. 1997
5. Establish South Fork Restoration Task Force	• Campus planning • DNR/TU • Pierce County • City • River Falls Township • Index of Biotic Integrity (DNR)	Task force established. Meetins	Jan. 1994 Ongoing
6. Prepare South Fork Restoration Feasibility Study	• Appropriate Jurisdictions • Stream survey data • Thermal and flow data on stream	Completed and agency-approved plan	Jan. 1995
7. Develop mitigation basin, wetland complex at Unnamed Tributary outfall	• Restoration Feasibility Study • Monitoring of temporary sediment basin • Thermal BMP guidelines	Constructed project	1998
8. Implement specific habitat and water quality features recommended in South Fork Restoration Feasibility Study	• Appropriate Jurisdictions • Campus planning • DNR involvement • TU volunteers • Feasibility Study	Water quality features complete Habitat projects complete (Appendix E)	1966 1998
9. Amend Flood Insurance Study	• Climate Data • Unnamed Tributary Study • Existing FIS	Revised Insurance Rate Map (FIRM)	1997

River Falls Wisconsin

MANN VALLEY MINOR WATERSHED

General Watershed Characteristics

Location

The Mann Valley (MV) Minor Watershed, illustrated on Figure 28 on page 161, lies within the northwest of the River Falls central basins district. Centered about County Road MM, the MV Minor Watershed drains southeasterly to an outfall 2,000 feet below the lower dam. Approximately 80 percent of the watershed is in St. Croix County's Troy Township. The remaining area in Pierce County is within Clifton Township.

The MV Minor Watershed covers 5,100 acres. Four subwatersheds have been identified.

Physical Environment

❑ **Land Use**
Existing land use is illustrated on Figure 29 on page 162. Those areas closest to the city limits represent most of the future developments with the MV Minor Watershed. Residential-suburban development, or large-lot residential, comprises most of the development expected in this area. Extending further out to the north and west, today's agricultural land use is expected to remain unchanged. Figure 30 on page 163 illustrates areas and intensity of anticipated land use changes.

❑ **Soils**
Soils in the MV Minor Watershed, having moderate to very rapid permeability, include the Sattre-Pillot-Antigo association in St. Croix County. In Pierce County, the Dakota-Waukegan Association covers the MV Minor Watershed.

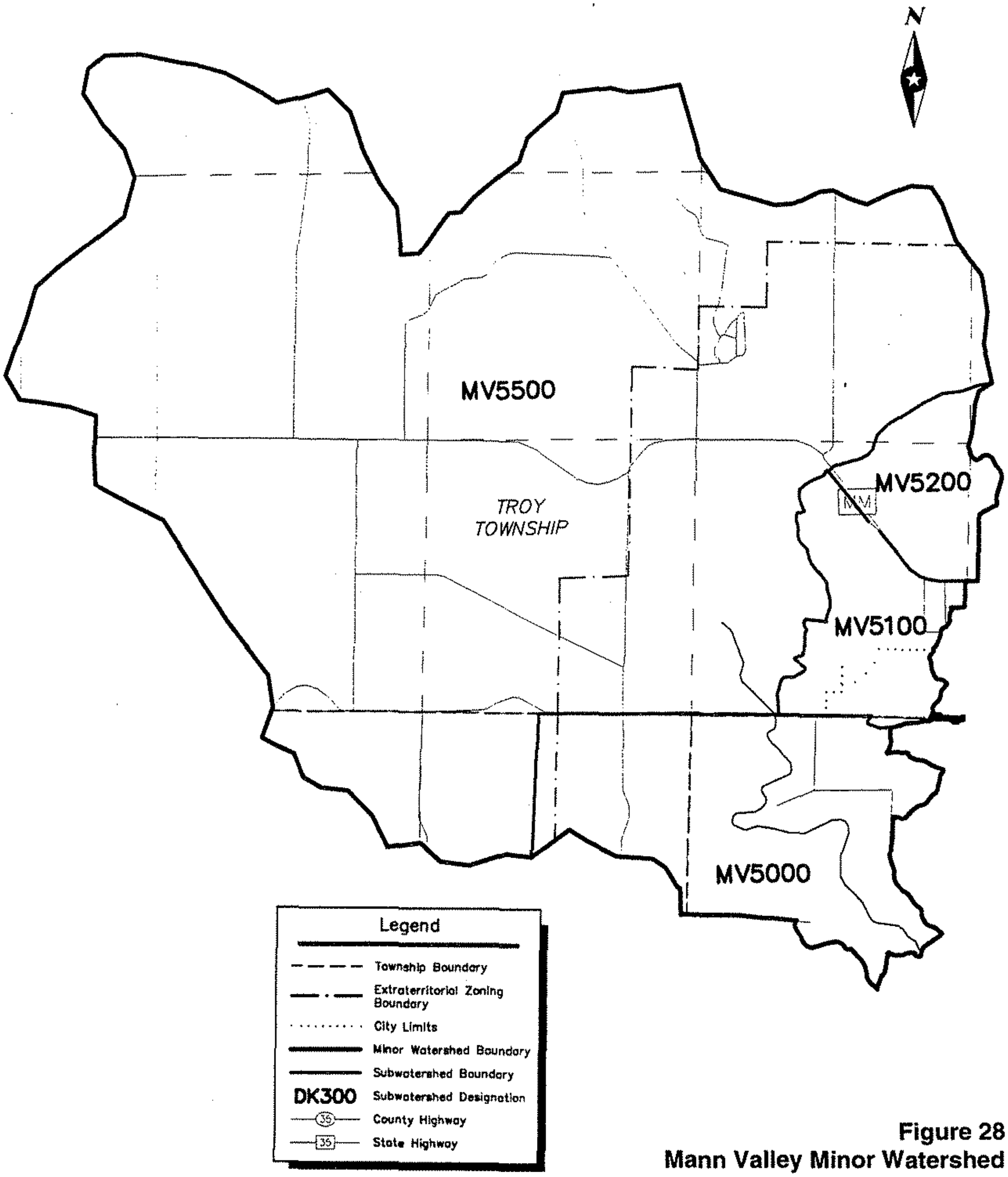


Figure 28
Mann Valley Minor Watershed

River Falls Wisconsin

MANN VALLEY MINOR WATERSHED

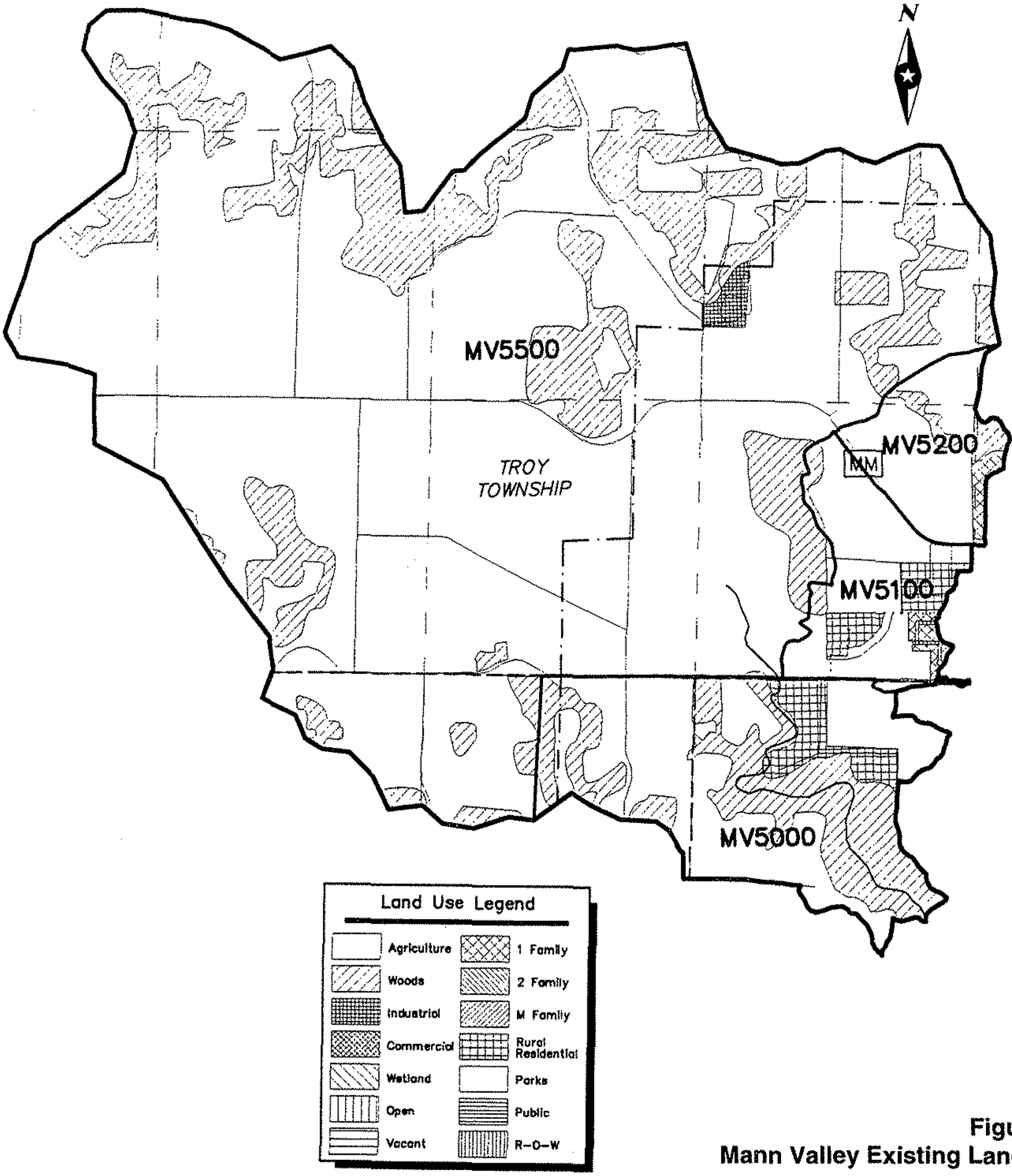


Figure 29
Mann Valley Existing Land Use

River Falls Wisconsin

MANN VALLEY
MINOR WATERSHED

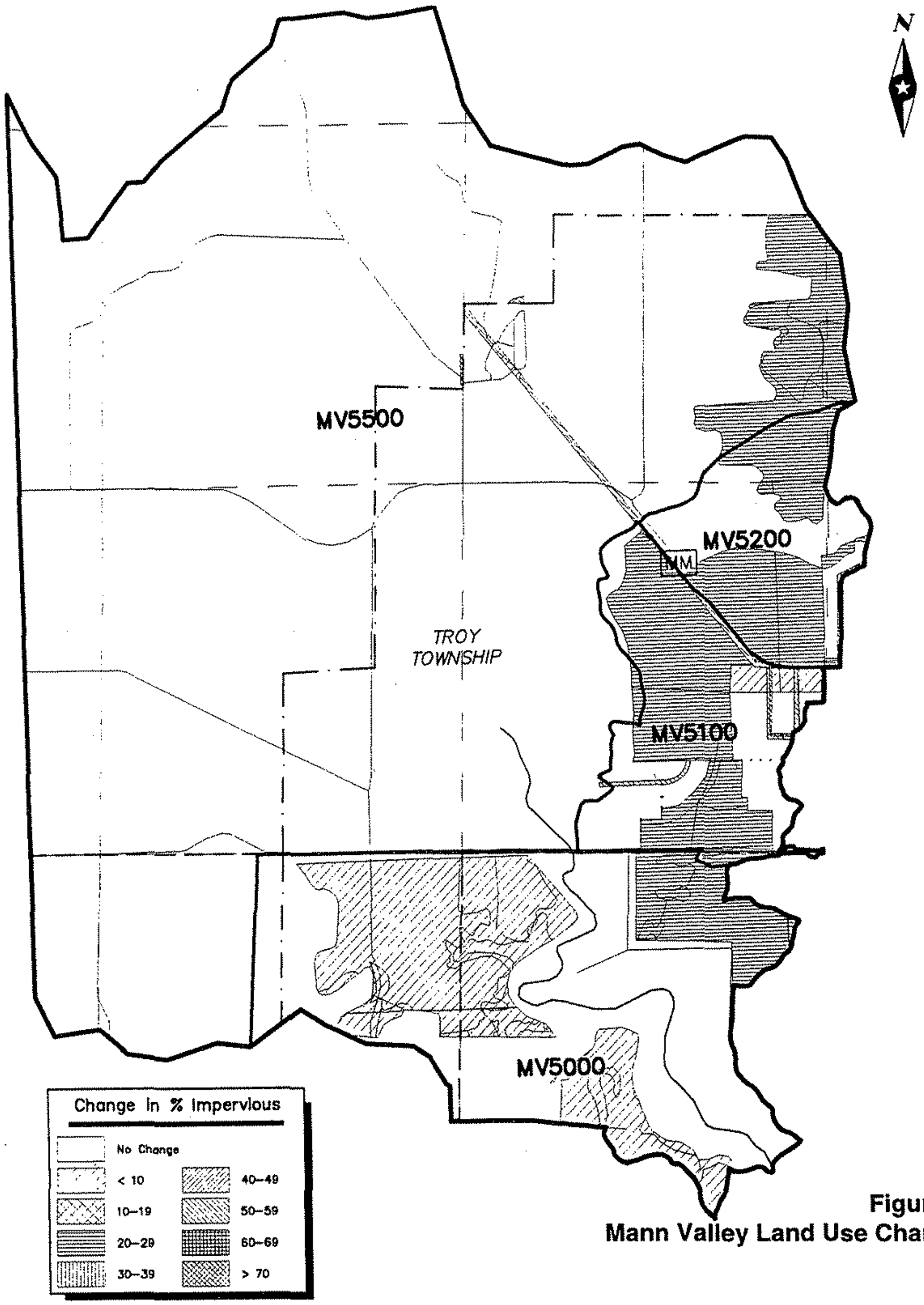


Figure 30
Mann Valley Land Use Changes

The soils are generally within hydrologic group B, having moderate infiltration rates; i.e., low to moderate runoff potential.

Descriptions of the soil associations found within the MV Minor Watershed can be found in Appendix C.

❑ Unique Features

The MV Minor Watershed's outfall is one of several cold water contributors to the lower river. Measured for the first time in 1992 (Engel, 1992), temperatures discharging into the Kinnickinnic River from the Mann Valley tributary were among the coldest found within the entire study area (Engel, 1992). Constant temperatures of 55°F were recorded. As a comparison, the most upstream station monitored on the Kinnickinnic had an average temperature reading of 68.8°F (Engel, 1992).

Although the flow rate in this tributary is very small in comparison to the flow in the Kinnickinnic River itself, the tributary's thermal regime is important in balancing the temperatures of the lower river.

At present, there are no identified detention basins within the watershed. Runoff that does eventually reach the Mann Valley drainageway combines with ground water influence, accounting for the cold temperatures (Engel, 1992). To maintain the thermal characteristics of this tributary, future development within the MV Minor Watershed will need to consider future discharges of storm water as well as identification and protection of spring areas, where ground water discharges to the drainageway.

Hydrologic Units

The Mann Valley Minor Watershed has been divided into four smaller subwatersheds, as illustrated on Figure 28 on page 161. Hydrologic characteristics and 100-year runoff rates are listed in Table 36.

Table 36
Mann Valley Hydrologic Units

Subwatershed Designation	Area	Curve Number[1]	Time of Concentration (Minutes)	Percent Impervious[2]	Runoff Rate[3,4] (cfs)
MV5000	610	60	13.1	<10%	94
MV5100	233	71	12.6	23%	55
MV5200	169	71	12.2	20%	40
MV5500	4,088	69	14.3	<10%	900
Total	**5,100**	-	-	-	-

1. Based on future land use conditions.
2. For rural areas, and areas with an impervious percentage of less than 10 percent, percent impervious by subwatershed is not reported.
3. Based on 100-year event.
4. Runoff rate is generated from subwatershed only; it is not a cumulative rate.

Water Quality

The MV Minor Watershed is the only minor watershed identified in the study area which does not have a significant stream or river segment running through it. However, the low temperatures of the base flow discharge of the Mann Valley tributary are significant to the ecosystem of the lower river. Water quality strategies for the MV Minor Watershed should focus on maintaining both the base flow rate and temperature of the Mann Valley tributary.

❑ **Total Suspended Solids**

The growing season total suspended solids loading (TSS) from the MV Minor Watershed is reported in Table 37.

Table 37
Mann Valley Growing Season
Total Suspended Solids (TSS)

Subwatershed Designation	TSS Loading (lbs./ac.)[1]	Net Loading (lbs.)[1 2]
MV5000	485	27,500
MV5100	281	65,500
MV5200	243	41,000
MV5500	45	184,000
Total	**1,054**	318,000

1. Future Land Use Conditions
2. Shaded data illustrates priority subwatersheds. Subwatershed 5100 represents almost 50 percent of the total loading. Applying the recommended TSS removal goal of 85 percent (see *Watershed Assessment - Water Quality*) on this subwatershed would result in over 41 percent reduction in net loading.

Based on anticipated future land use, a slight increase in net total suspended solids loading to the Kinnickinnic River is expected. The anticipated land use changes relate mostly to growth of residential-suburban or large lot residential development. The opportunity for constructing Best Management Practices for addressing total suspended solids removal, rate control storm water runoff, and thermal mitigation, should be pursued even before development reaches the preliminary platting stage.

Action Plan - Mann Valley Minor Watershed — 4/20/95

Subject: Mann Valley Minor Watershed Water Quality

Purpose: To prevent degradation of the cold water feeder stream which drains the Mann Valley to the Lower Kinnickinnic River.

Goal: The City, in cooperation with Troy and Clifton Townships, shall achieve a nondegradation standard which applies to all new development in the MV Minor Watershed, requiring rate control after development to rates which exist at the adoption of this plan, water quality control after development to remove total suspended solids, and infiltration to enhance and improve ground water contributions to the mann Valley tributary and to mitigate the thermal effects of urban storm water runoff.

Applicable Goals and Policies:

Problems (Probable Obstacles)	**Solutions** (Obstacle Avoidance)
1. Lack of consistency between the townships and the city, in the area of water resources management.	1. Develop a consistent approach to erosion control, development standards and surface water management by first developing mirror ordinance; if ineffective, then establishing an intergovernmental cooperative agreement for watershed management; or if still ineffective, extending the ETZ.
2. Maintenance of detention basins to ensure proper rate control and total suspended solids (TSS) reduction.	2. Prior to completion of development, assign maintenance responsibilities for each facility to appropriate jurisdiction.
3. Balancing the economic implications of on-site detention basins against property acquisition for regional detention ponds prior to development occurring.	3. Adopt an on-site detention policy for all non-single family home sites, while requiring individual developers to dedicate existing low lands and depressions for use as regional basins during the preliminary plat stage. The dedication should be a permanent easement, but could also be fee title to the local unit of government.
4. Protecting spring areas with current land use regulations.	4. Identify existing spring areas based on past observation and wintertime aerial observations.
5. Preventing the migration of hazardous materials stored or applied above or below gound from contaminating the river.	5. Develop environmental overlay zone of 500 feet either side of the main drainageway and spring areas prohibiting the above or below ground storage of fuel or other hazardous materials.
6. Difficulty in reducing temperatures of storm water discharges to match river temperature.	6. Utilize thermal Best Management Practices to achieve the maximum thermal mitigation possible given the constraints of each available situation. (Refer to Appendix B for thermal mitigation techniques.)

Table 38
Mann Valley Minor Watershed
Action Plan
Summary

Revised 4/20/95

Activity Steps	Resources	Measurement	Completion Date
1. Develop consistent approach to watershed management. Adopt, interpret and enforce mirror ordinances based on an inter-governmental cooperative agreement.	• Identified & recognized state process • City Council • Troy & Clifton town boards • Objectives of this plan (natural resource implications) • Agency & County support • Public involvement and public information hearings.	Intergovernmental cooperative agreements Adopted Mirror Ordinance	Jan 1, 1995 July 1, 1995
2. Identify Spring Areas	• DNR records • University records • Land owners • Winter aerial photography	Map denoting spring areas	April 1995
3. Adopt Environmental Overlay Zoning	• Wellhead and spring protection zoning format.	Council Approval	Jan. 1995
4. Establish Development Review Criteria and enforcement standards for use by appropriate jurisdictions.	• On-site and regional basin policy • Land dedication policy • Maintenance responsibilities • Water quality, quantity (flow) and thermal standards • Hazardous materials identification • Public information program • Public hearing • Inspection/Enforcement • Permits • Erosion Control • Building Permit Process • Developer Agreements • Agriculture land Conservation Programs	Written Plan	April 1995
5. Identify low areas, particularly well suited for future BMPs.	• Topographic maps • Property ownership data • City and/or state land stewardship funds.	Highlight properties on map Property Purchase	Dec. 1995 As properties and fund become available

LOWER DAM MINOR WATERSHED

General Watershed Characteristics

The Lower Dam (LD) Minor Watershed is the smallest of the seven watersheds analyzed as part of this study. Covering just under 290 acres, the minor watershed in Pierce County includes the area tributary to the Lower Dam. The impoundment behind the Lower Dam, called Lake Louise, receives the warm water discharge from Lake George above the Upper Dam, the cold water influences of the South Fork and the point discharge for the River Falls wastewater treatment plant.

Location

The Lower Dam (LD) Minor Watershed is illustrated on Figure 31 on page 170. The LD Minor Watershed has been divided into two subwatersheds.

Physical Environment

❑ **Land Use**
Existing land use is illustrated on Figure 32 on page 171. Future land use within the Lower Dam Minor Watershed is expected to intensify in the future. The Master Plan Report for the City of River Falls (Ayres, 1987), indicates expansion of industrial land use in the area bounded to the west by city corporate limits and to the south and east by the Kinnickinnic River and Lake Louise. Directly to the north and west of this area, continued expansion of single-family residential development is also anticipated. Figure 33 on page 172 illustrates areas and intensity of anticipated development.

River Falls Wisconsin

LOWER DAM
MINOR WATERSHED

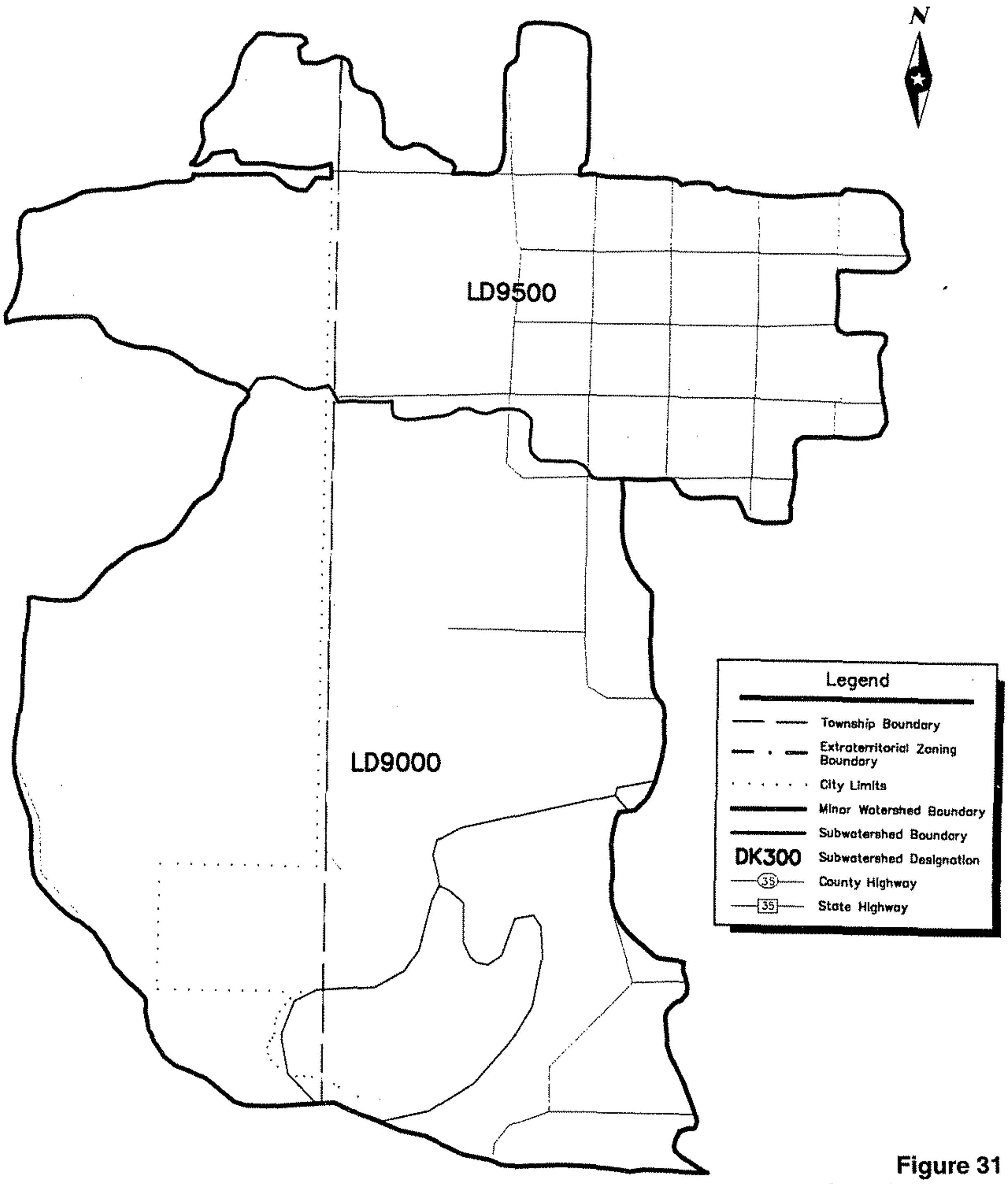


Figure 31
Lower Dam Minor Watershed

River Falls Wisconsin

LOWER DAM
MINOR WATERSHED

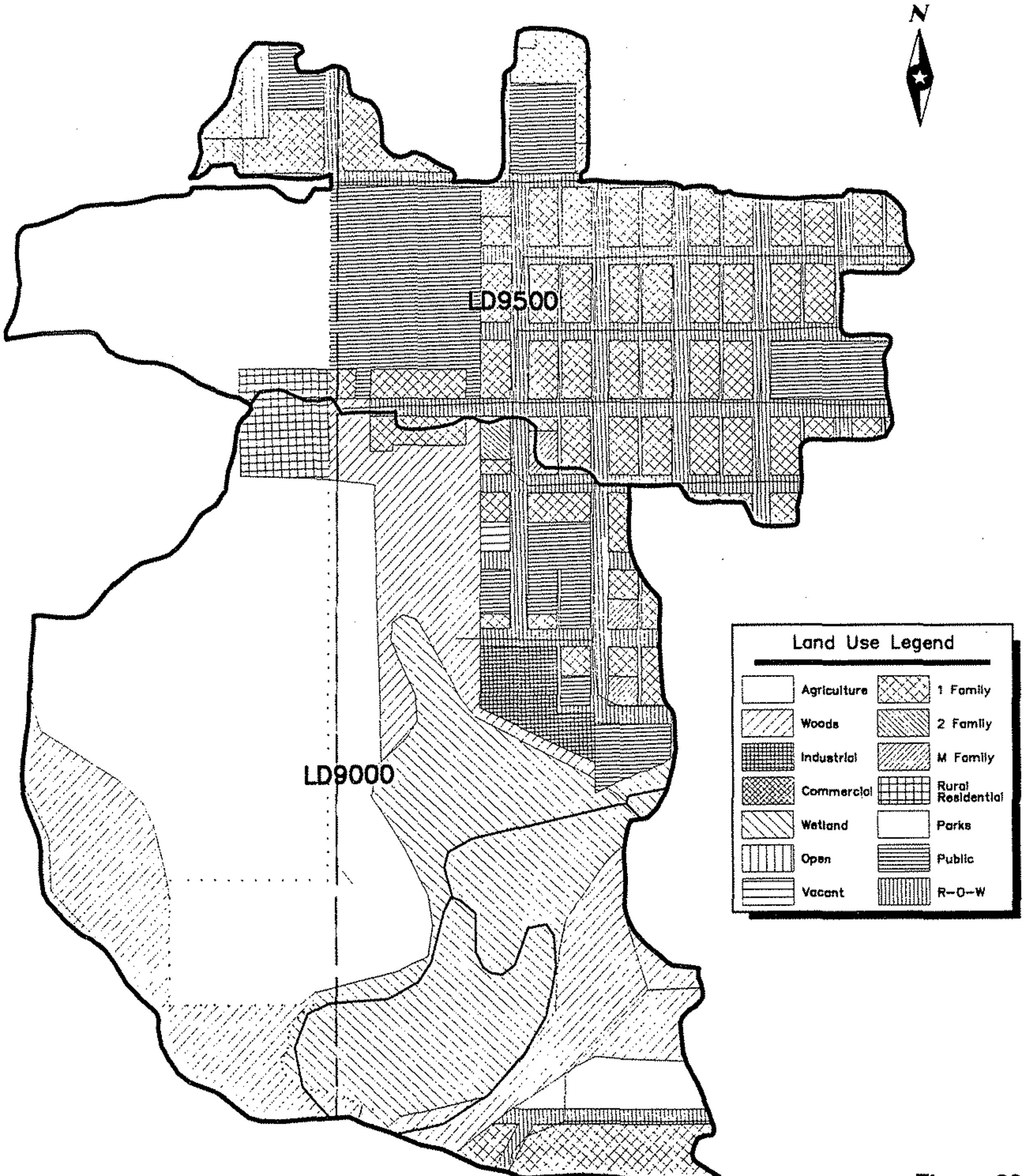


Figure 32
Lower Dam Existing Land Use

River Falls Wisconsin

LOWER DAM
MINOR WATERSHED

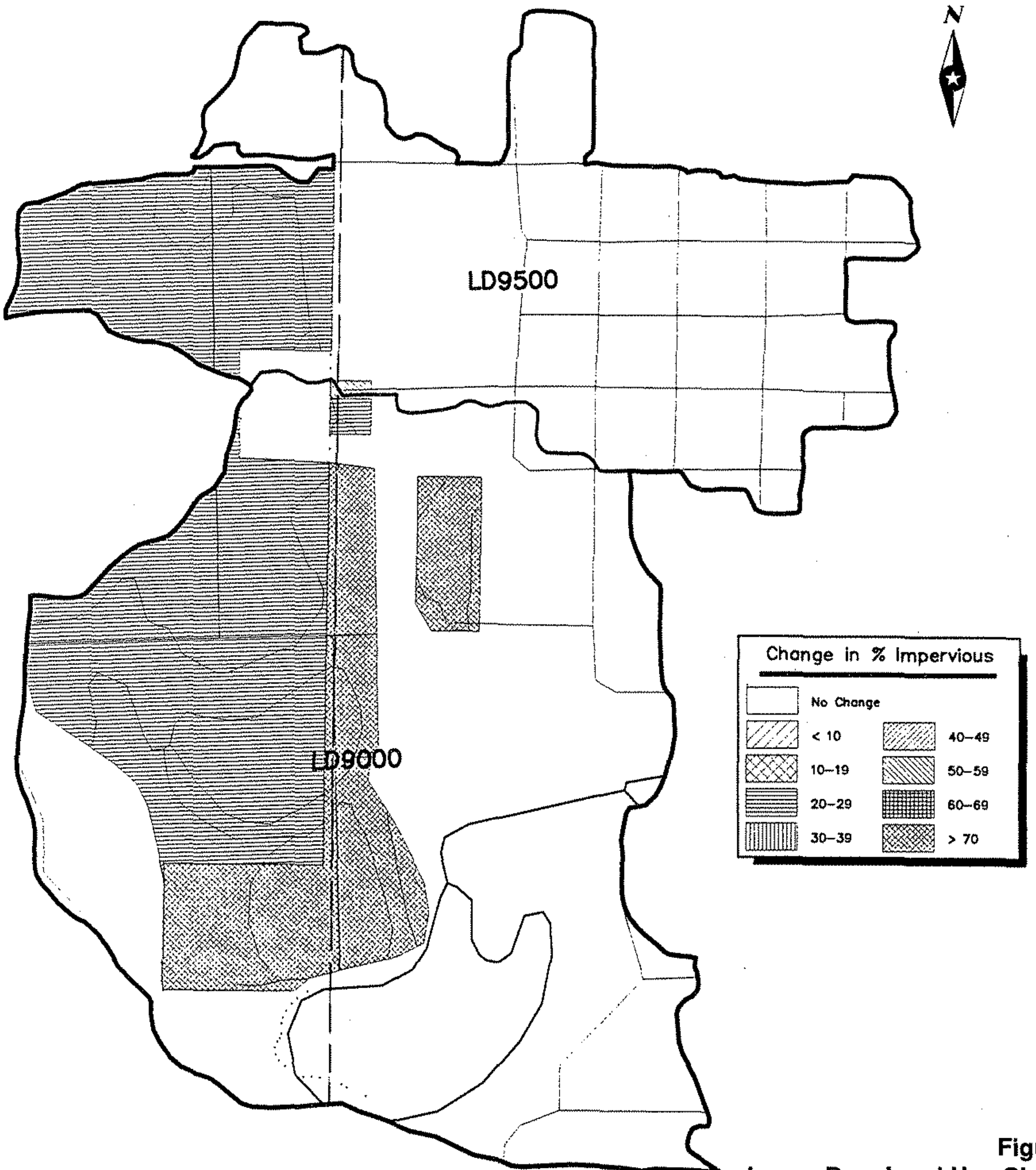


Figure 33
Lower Dam Land Use Changes

❑ **Soils**

The soils are comprised of two soil associations (USDA, 1978, 1968). In Pierce County, the Dakota-Waukegan association dominates the Lower Dam Minor Watershed. That portion of the LD Minor Watershed in St. Croix County is comprised of the Sattre-Pillot-Antigo association. A description of these associations is found in Appendix C.

The soils are generally included in hydrologic group B, having moderate infiltration rates; i.e., low to moderate runoff potential.

❑ **Unique Features**

The LD Minor Watershed includes the largest single water body, Lake Louise, within the study area. The lake, in fact, is an extremely shallow reservoir created by the 16-foot-high Lower Dam (HDR, 1987). At an average depth of 2 feet, Lake Louise is probably the highest impacted resource within the study area (HDR, 1987). Lake Louise receives warm discharge from Lake George and a significant total suspended solids from the upper reservoir during major storm events. The lake also receives the City-owned wastewater treatment plan effluent, and runoff from an industrial and residential watershed to the north and west.

The lake is buffered along a portion of the southern and western shores by natural, undeveloped areas, adding to the aesthetic appeal of the reservoir. A large wetland complex to the north represents the largest single wetland resource within the study area. Urban runoff from industrial and residential properties to the north and west are generally directed through this wetland complex prior to discharging to the lake. The wetland buffers the reservoir from pollutants and suspended solids being carried by storm water runoff. However, the thermal effects related to urban runoff remain unchecked. For this reason, and, because of the shallow nature of the reservoir itself, temperatures as high as 80°F have been recorded in Lake Louise (Engel, 1991).

Discharge of these warm waters in the run-of-the-river operating condition of the lower dam contribute to an overall thermal impact to the Lower Kinnickinnic River. The thermal impact carries downstream a considerable distance.

The Lower Dam was rehabilitated in 1992 to make structural repairs. The Lower Dam generates approximately 125 kilowatts of electricity (*River Falls Journal*, 1991), or approximately 1.0 percent of the total available generating capacity of River Falls public utilities. (Hydropower is complimented by diesel engine powered generating units; these units are currently not in use). The Lower Dam's hydro hydrogenerator output provides an annual avoided purchase power cost of $40,000 per year to the River Falls Municipal Utility (Hanson, 1993). The future benefits of dam operation and hydroelectric generation must be weighed against the negative influence the warm water has on the cold water regime and trout habitat of the Lower Kinnickinnic River.

A secondary issue in evaluating the future of Lake Louise Reservoir is the River Falls wastewater treatment plant. According to the St. Croix River Basin Plan (DNR, 1976), by the year 2003 the total wastewater treatment plant flows will be 1.82 million gallons per day. The Basin Plan (DNR, 1976) includes no thermal data for the existing or future discharges from the wastewater treatment plant. However, the DNR implements its nondegradation stream standards (Simonson, 1992), it is likely that future effluent requirements for the treatment plant will include thermal discharge requirements.

Along the south side of Lake Louise, passive and active recreation opportunities abound. A trail system in the City park system includes Lake Louise as a backdrop. While the lake certainly presents aesthetic qualities, the only active recreation is shoreline fishing. Although an occasional trout may be found in this reach of the river, the warm water regime is more likely to produce bass and pan fish.

Hydrologic Units

The Lower Dam Minor Watershed has been divided into two smaller subwatersheds as illustrated on Figure 31 on page 170. The hydrologic characteristics are listed in Table 39 below.

Table 39
Lower Dam Hydrologic Units

Subwatershed Designation	Area	Curve Number[1]	Time of Concentration (Minutes)	Percent Impervious[2]	Runoff Rate[3,4] (cfs)
LD9000	180	71	12.5	34%	42
LD9500	108	77	12.6	40%	31
Total	**288**	-	-	-	-

1. Based on future land use conditions.
2. For rural areas, and areas with an impervious percentage of less than 10 percent, percent impervious by subwatershed is not reported.
3. 100-year event.
4. Runoff rate is generated from subwatershed only; it is not a cumulative rate.

There are no identifiable detention basins in the LD Minor Watershed. The effect of natural depressions has not been accounted for when computing storm water flows.

Water Quality

The quality of storm water runoff discharging from the Lower Dam Minor Watershed to Lake Louise, expressed in terms of total suspended solids loading, is expected to experience an increase significantly. Based on anticipated land use changes, a net decrease in overall water quality is expected.

❑ **Total Suspended Solids Loading**
The growing season total suspended solids (TSS) loading from the LD Minor Watershed is reported in Table 40.

Table 40
Lower Dam Growing Season
Total Suspended Solids (TSS) Loading

Subwatershed Designation	TSS Loading (lbs./ac.)[1 2]	Net Loading (lbs.)
LD9000	413	74,500
LD9500	486	52,700
Total	**441**	**127,200**

1. Future land use conditions.
2. Applying the recommended TSS removal goal of 85 percent (See *Watershed Assessment - Water Quality*) would result in 108,000 lbs. of TSS removal.

Because the TSS loading is expected to increase significantly between current land use conditions and ultimate developed land use conditions, specific strategies for controlling sediment loading should be implemented within the contributing watershed.

❑ **Storm Runoff Characterization**
Sampling of storm water runoff was completed from June 14, 1992, to August 10, 1992. Three storms were sampled (see *Method of Analysis* for monitoring details). The LD Minor Watershed sampling site, located at the intersection of Falls Street and Maple

Street, is representative of a residential watershed. Watershed characteristics and sampling results are illustrated in Table 41.

Table 41
Lower Dam Storm Water Characterization

Parameter	Concentration (mg/l)
TSS	240.0
TKN	2.6
TP	0.75
Cu	0.030
Pb	0.015
Zn	0.110
Location	Falls St. & Maple St.
Area	29.4 Ac.
Curve No.	75
% Impervious	38

River Falls Wisconsin

LOWER DAM MINOR WATERSHED

Action Plan - Lower Dam Minor Watershed **4/20/95**

Subject: Lower Dam Minor Watershed Water Quality

Purpose: To minimize the impact of TSS loading and thermal pollution caused by runoff from existing and anticipated development.

Goal: The City shall develop a comprehensive sediment reduction program by addressing three main issues: 1) existing sources of sedimentation; 2) bottom sediments in Lake Louise; 3) existing and future drainage system for the reduction features.

Applicable Goals and Policies:

Problems (Probable Obstacles)	**Solutions** (Obstacle Avoidance)
1. Difficulty in altering the operational characteristics of the lower reservoir and wastewater treatment plant.	1. Prepare lake "restoration" and dam operational plan jointly with River Falls Public Utiities and Department of Natural Resources.
2. Difficulty in obtaining existing properties to use for constructing end of pipe treatment for storm sewer outfall.	2. Prior to completion of development, assign maintenance responsibilities for each facility to the appropriate jurisdiction.
3. Obtaining funding for lake management and retrofits.	3. Apply for WDNR's lake planning grant.
4. Maintenance of detention basins to ensure proper rate control and total suspended solids (TSS reduction).	4. Assign responsibility for facility maintenance prior to completion of construction.
5. Meeting DNR's nondegradation standards for the Kinnickinnic River and the River Falls wastewater treatment plant.	5. Modify plant or receiving waters to reduce the temperatures of wastewater treatment plant effluent.
6. Balancing the economic implications of on-site detention basins against acquiring property for regional retention ponds prior to development occurring.	6. Adopt an on-site treatment policy for all non-single family home sites, while encouraging individual developers to dedicate existing low lands and depressions for uses as regional basins during the preliminary plat stage. The dedication should be a permanent easement, but could also be fee title to the local unit of government.

Table 42
Lower Dam Minor Watershed
Action Plan
Summary

Revised 4/20/95

Activity Steps	Resources	Measurement	Completion Date
1. Apply for WDNR's Lake Planning Grant for Lake Louise	• City staff • DNR staff • WWTP and dam records • Lake George Grant Application	Grant Application	Feb. 1994
2. Establish a multidisciplined committee to address lake management options.	• River Falls Public Utilities • Resource agencies • City staff • University	Formation of Group Mission Established	April 1994 June 1994
3. Develop a plan for address of thermal discharges of WWTP effluence.	• Operational records • TU/DNR Data	Completed Thermal Management Report	August 1996
4. Implement thermal-abatement project at WWTP	• Thermal management report	Completed Project(s)	October 1997
5. Implement a sediment reduction strategy to reduce the use of road sand and increase street sweeping, especially in areas adjacent to the river.	• Street sweeping equipment • Public Works Sanding strategy and past records. • Public information process to alert residents to road maintenance activities.	Completed within strategy for street sweeping priorities and frequencies, minimizing sanding activities in downtown area as compared to other years and installing signage to denote minimum orad sand areas. Increased sweeping	August 1994 1995 Budget
6. Retrofit existing drainage system for sediment and thermal reduction facilities.	• Map of applicable properties. • Property purchase. • Funding for construction.	Completed map Fee title or easement Facility constructed	Jan. 1994 As available As available
7. Investigate stream restoration options.	• Lake George Concept Plan • Existing wetland extents • Lake depth mapping	Complete Lake's Planning Report Implementation Project	Mar. 1997 Oct. 1998

River Falls Wisconsin

ROCKY BRANCH MINOR WATERSHED

General Watershed Characteristics

Location

The Rocky Branch (RB) Minor Watershed, illustrated on Figure 34 on page 181, covers the south central part of the study area. Encompassing a little over 6,500 acres, the RB Minor Watershed is the Kinnickinnic River's second largest tributary, the Rocky Branch.

The RB Minor Watershed has been divided into four smaller subwatersheds. One detention basin has been identified. The basin is designed along SCS standards, including a standpipe outlet which provides rate control and moderate total suspended solids removal capabilities.

Physical Environment

❑ **Land Use**
Existing land use is illustrated on Figure 35 on page 182. A moderate change in land use from existing conditions is expected in the area of the STH 29 corridor which runs southwesterly through the northern one-third of the RB Minor Watershed. Figure 36 on page 183 illustrates anticipated land use changes.

Anticipated development of single-family residential parcels is expected within the RB Minor Watershed lying wholly within River Falls Township of Pierce County. However, the intensity of the expected development is insignificant when expressed in terms of future runoff and pollutant loadings to this important tributary. As with the Upper Kinnickinnic Minor Watershed, agricultural land use practices will continue to represent the largest threats to this portion of the study area.

River Falls Wisconsin

ROCKY BRANCH
MINOR WATERSHED

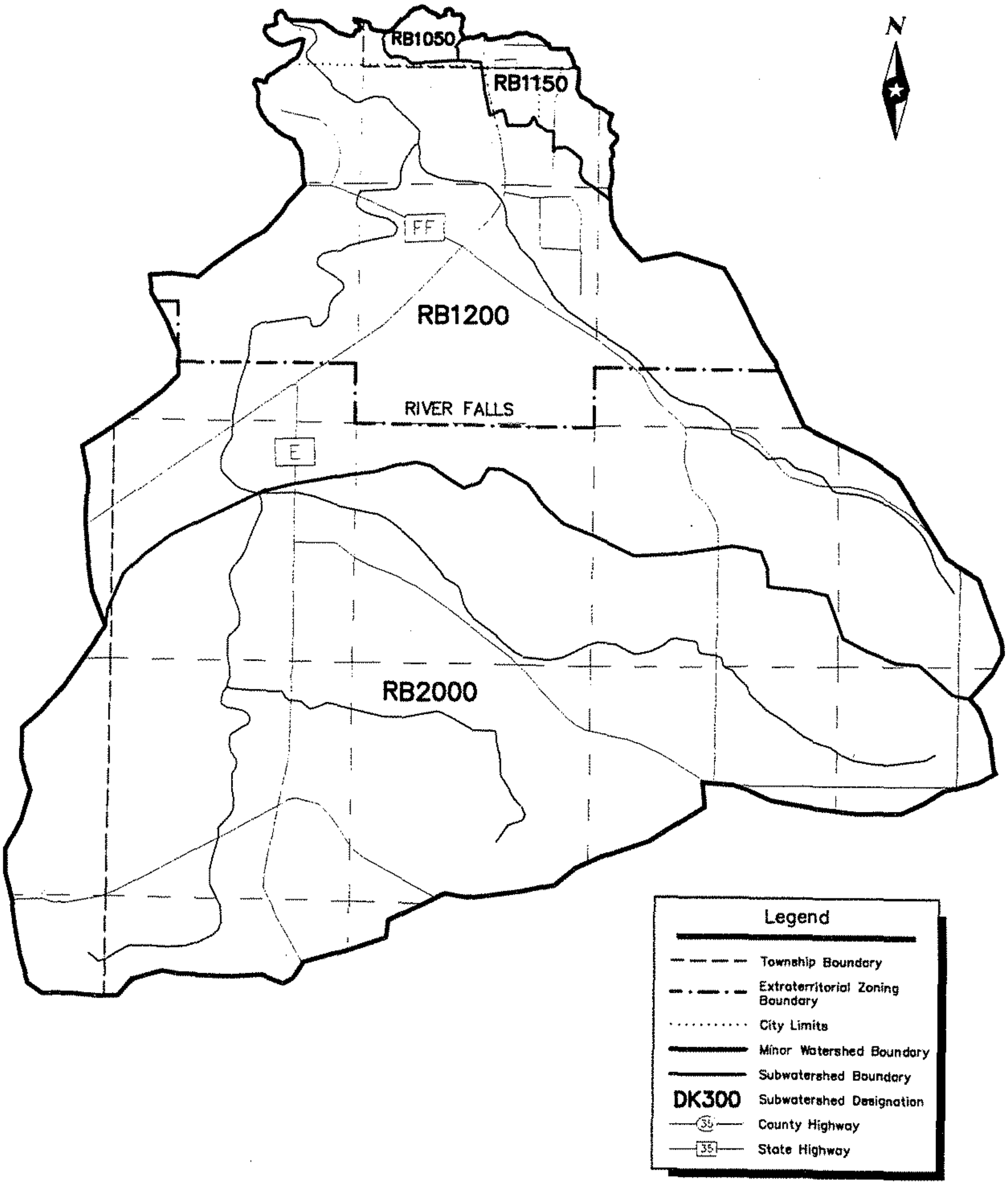


Figure 34
Rocky Branch Minor Watershed

River Falls
Wisconsin

ROCKY BRANCH
MINOR WATERSHED

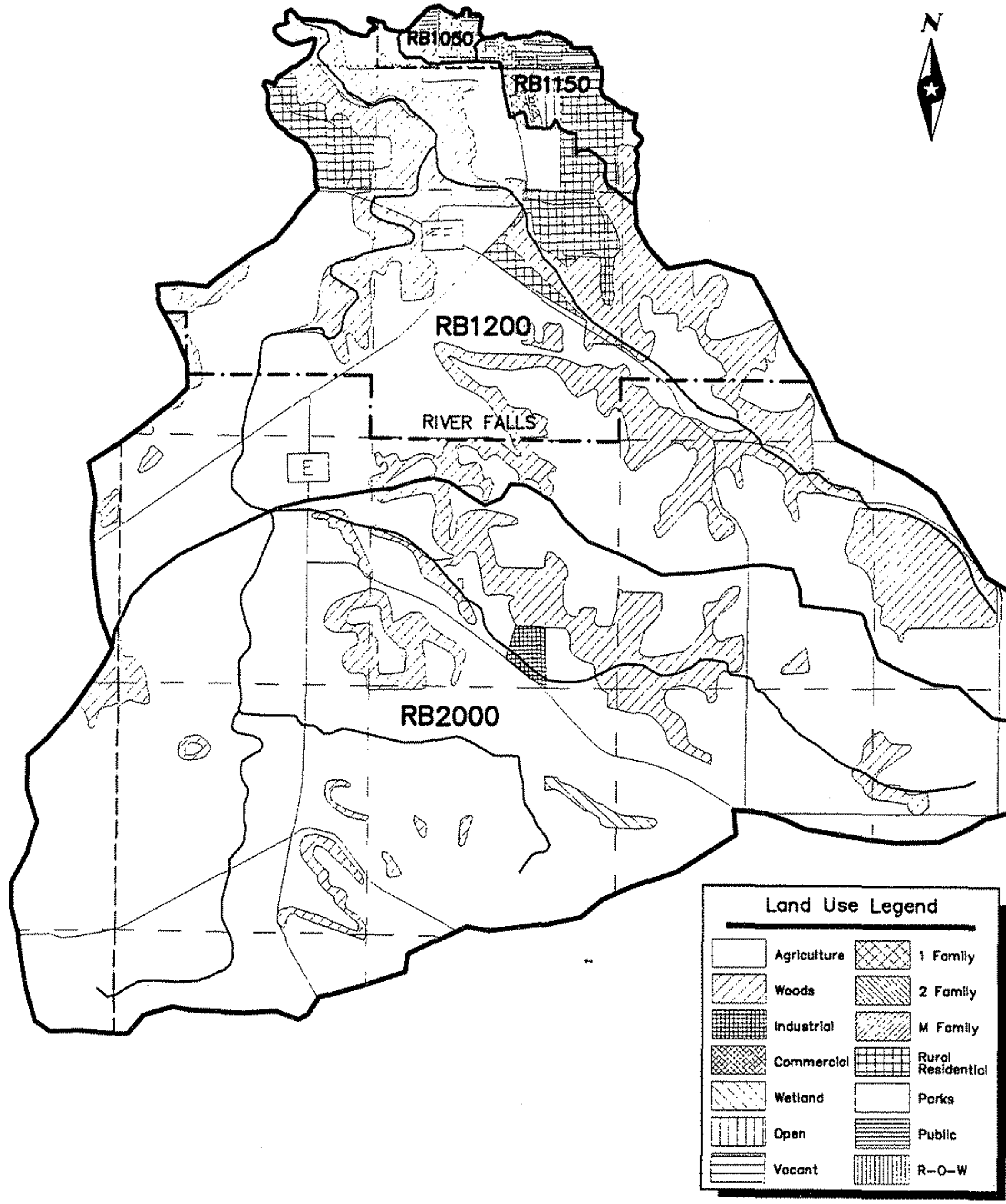


Figure 35
Rocky Branch Existing Land Use

River Falls Wisconsin

ROCKY BRANCH
MINOR WATERSHED

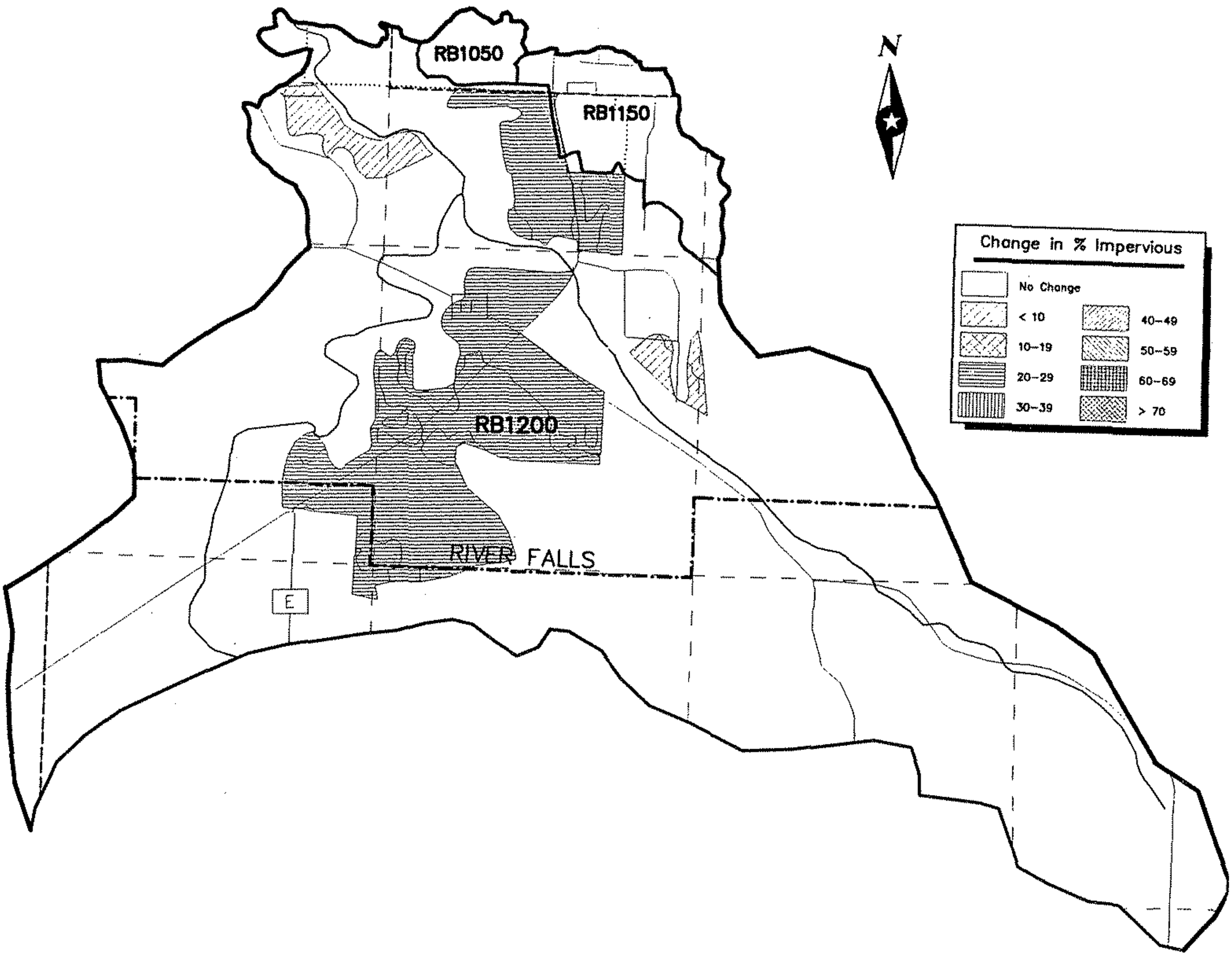


Figure 36
Rocky Branch Land Use Changes

❑ **Soils**
Soils are comprised of two primary soil associations (USDA, 1968).

Soils having moderate to rapid permeability include Dakota-Waukegan and the Renova-Vlasty associations. The Dakota-Waukegan soils are generally found occupying broad stream terraces while the Renova-Vlasty soils consist of gently rolling to steep upland ridges, very steep bluffs, narow valleys, sandstone hills and broad valleys. These soils are generally in hydrologic group B, having moderate infiltration rates; i.e., low to moderate runoff potential.

A description of these associations is found in Appendix C.

❑ **Unique Features**
The Rocky Branch Valley is among the more significant and scenic portions of the study area. In addition to its cold water conditions, the valley itself is comprised of a lushly vegetated floodplain flanked by steep bluffs. These bluffs offer numerous rock outcroppings as evidence of the area's geologic conditions.

According to Marty Engel, DNR area fisheries manager (1992), the Rocky Branch represents significant spawning habitat for the natural reproducing brown trout population of the lower Kinnickinnic River. Although the Rocky Branch has experienced only minor development impacts; a single-family subdivision located on the north side of County Road FF and along the south bluff line of the Rocky Branch is evidence that development encroachment on the Rocky Branch Valley has potential for creating future impacts on the river.

As is the case with the other minor watersheds, the transportation corridors which crisscross the RB Minor Watershed also pose potential threat to the high quality conditions of this tributary. The RB Minor Watershed is also home to the City's old sanitary landfill:

Sanitary Landfill

The sanitary landfill located south of County Road FF, just opposite of the Birch Cliff subdivision has been an area of recent concern. The City has monitored several ground water wells downgradient of the landfill in an effort to identify the mobility of potential contaminants. In 1993, the City initiated a remediation plan for the site.

Hydrologic Units

The Rocky Branch Minor Watershed has been divided into four smaller subwatersheds as illustrated on Figure 34 on page 181. The hydrologic characteristics are listed in Table 43.

Table 43
Hydrologic Units of the
Rocky Branch Minor Watershed

Subwatershed Designation	Area	Curve Number[1]	Time of Concentration (Minutes)	Percent Impervious[2]	Runoff Rate[3,4] (cfs)
RB1050	38	73	24.7	30%	100
RB1150	130	67	80.6	16%	132
RB1200	2,841	64	105.5	<10%	2,028
RB2000	3,542	70	98.1	<10%	3,478
Total	**6,552**	-	-	-	

1. Based on future land use conditions.
2. For rural areas, and areas with an impervious percentage of less than 10 percent impervious by subwatershed is not reported.
3. 100-year event.
4. Runoff rate is generated by subwatershed only; it is not a cumulative rate.

There is one identifiable detention basin in the RB Minor Watershed. The detention basin data is illustrated in Table 44.

Table 44
Rocky Branch Minor Watershed
Detention Basin

		Normal		100-Year Storm		
Designation	Location	Water Level	Surface Area	Water Level	Surface Area	Overflow Elevation
RB1050	School	888.0	0.17	899.0	0.69	

Designation	Available Storage	Inflow Rate	Outflow Rate	Peak Flow Reduction	Recommended First Floor Elevation
RB1050	4.4	100	41	58	901.0

Water Quality

Water quality of the Rocky Branch is very good. The cold water regime is stable at present. The tributary is also relatively free of urbanized impacts. However, total suspended solids remains a long-term problem, especially as it relates to agricultural land use controls within Clifton Township.

❑ **Total Suspended Solids Loading**
Growing season total suspended solids (TSS) loading for the RB Minor Watershed is recorded in Table 45.

Table 45
Growing Season Total Suspended Solids (TSS) Loading for the Rocky Branch Minor Watershed

Subwatershed Designation	TSS Loading (lbs./ac.)[1,2]	Net Loading (lbs.)[1]
RB1050	363	1,100
RB1150	194	25,300
RB1200	45	127,900
RB2000	45	159,400
Total	**50**	**313,717**

1. Future land use conditions.
2. For rural areas, and areas with an impervious percentage of less than 10 percent, percent impervious estimates by subwatershed are not specifically reported.

Based on anticipated future land use, the net total suspended solids loading to the Rocky Branch is not expected to change significantly. Because the TSS loading remains relatively constant, this tributary should be able to maintain itself. However, strategy for addressing site-specific land use changes will be needed to prevent further degradation of the river.

Additionally, the aesthetics of the stream valley should be preserved. Special riparian zoning will not only protect the water quality of the Rocky Branch, but will also preserve the unique natural conditions of the Rocky Branch Valley.

Pond RB1050 currently provides 92% Total Suspended Solids Removal, exceeding the recommended 85% removal criteria.

Action Plan - Rocky Branch Minor Watershed

4/20/95

Subject: Rocky Branch Minor Watershed Water Quality

Purpose: To preserve and protect water quality in the Kinnickinnic River tributary.

Goal: The City, in cooperation with Clifton and River Falls Township, shall achieve a nondegradation standard which applies to all new development in the RB Minor Watershed, requiring rate control after development to those rates which exist at the adoption of this plan and water quality control after development to quality levels that exist in the Rocky Branch at the adoption of this plan.

Applicable Goals and Policies:

Problems (Probable Obstacles)	**Solutions** (Obstacle Avoidance)
1. Lack of consistency between the Townships and the City, in the area of water resources management.	1. Develop a consistent approach to erosion control, developoment standards and surface water management by first developing mirror ordinance; if ineffective, then establishing an intergovernmental cooperative agreement for watershed management; if still ineffective, extending the ETZ.
2. Difficulty in reducing temperatures of storm water discharges to match river temperatures.	2. Utilize thermal best management practices to achieve the maximum thermal mitigation possible given the constraints of each available situation. (Refer to Appendix B for Thermal Mitigation Techniques).
3. Maintenance of detention basins to ensure proper rate control and total suspended solids (TSS).	3. Prior to completion of development, assign maintenance responsibilities for each facility to the appropriate jurisdiction.
4. Balancing the economic implications of on-site detention basins against acquiring property for regional detention ponds to development occurring.	4. Adopt an on-site treatment policy for all non-single family home sites, while requiring individual developers to dedicate existing low lands and depressions for use as regional basins during the preliminary plat stage. The dedication should be a permanent easement, but could also be fee title to the local unit of government.
5. Protecting spring areas with current land use regulations.	5. Identify existing spring areas based on past observation and wintertime aerial observations and prepare protection zoning which limits development impacts.
6. Preventing hazardous spills along Highway corridors and leaking underground storage tanks from contaminating the river.	6. Develop environmental overlay zone either side of river centerline and spring areas prohibiting the above or below ground storage of fuel or other hazardous materials and identify the response process to a spill in the area.
7. Reducing the potential for contamination from landfill impact on area groundwater.	7. Continue to monitor observation wells and develop action plan for the sanitary landfill.

Table 46
Rocky Branch Minor Watershed
Action Plan
Summary

Revised 4/20/95

Activity Steps	Resources	Measurement	Completion Date
1. Develop consistent approach to watershed management. Adopt, interpret and enforce mirror ordinances based on an inter-governmental cooperative agreement.	• Identified & recognized State process • City Council • Clifton & Kinnickinnic town boards • Objectives of this plan (natural resource duplications) • Agency & County support. • Public involvement and public information hearings	Adopted Mirror Ordinance	Jan. 1, 1995 July 1, 1995
2. Identify Spring Areas	• DNR records • University records • Land owners • Winter aerial photography	Map denoting spring areas	April 1995 1994 Budget
3. Adopt Protection Zoning	• Wellhead and spring protection zoning format.	Council Approval	Jan. 1995
4. Establish Development Review Criteria and enforcement standards for use by appropriate jurisdictions.	• On-site and regional basin policy • Land dedication policy • Maintenance responsibilities • Quality, quantity (flow) and thermal standards • Hazardous materials identification • Public information program • Public hearing • Inspection/Enforcement • Permits • Erosion Control • Building Permit Process • Developer Agreements • Agriculture Land Conservation Programs	Written Plan	April 1995
5. Address Landfill Issues	• Observation well data • Consent Order	-	Unknown

DOWNSTREAM KINNICKINNIC MINOR WATERSHED

General Watershed Characteristics

Location

The Downstream Kinnickinnic (DK) Minor Watershed in Pierce County, is illustrated on Figure 37 on page 192. This minor watershed is located at the southwesterly edge of the study area. The Minor Watershed covers approximately 3,870 acres in Clifton and River Falls Townships. The DK Minor Watershed has a relatively short stream segment which flows through the northerly third of the minor watershed in an east to west fashion. The majority of the tributary area lies to the south of the Kinnickinnic River.

The district is crossed by STH 29/65, County Road FF, and Angel Hill Drive along the western edge. The lower two-thirds of the minor watershed is drained by two primary feeder streams which meet just north of County Trunk Highway FF before discharging to the Kinnickinnic River. The DK Minor Watershed is split into six smaller subwatershed units.

Physical Environment

❑ **Land Use**

Existing land use in the Downstream Kinnickinnic Minor Watershed is illustrated on Figure 38 on page 193, The DK Minor Watershed has a diverse mixture of land use which is dominated by agriculture and wooded areas adjacent to the river. The DK Minor Watershed also includes a significant area of residential development within the City of River Falls corporate limits. Based on future land use projections, land use in the Downstream Kinnickinnic Minor Watershed is at its highest use today. Land use changes in the DK Minor Watershed are illustrated on Figure 39 on page 194.

River Falls Wisconsin

DOWNSTREAM KINNICKINNIC
MINOR WATERSHED

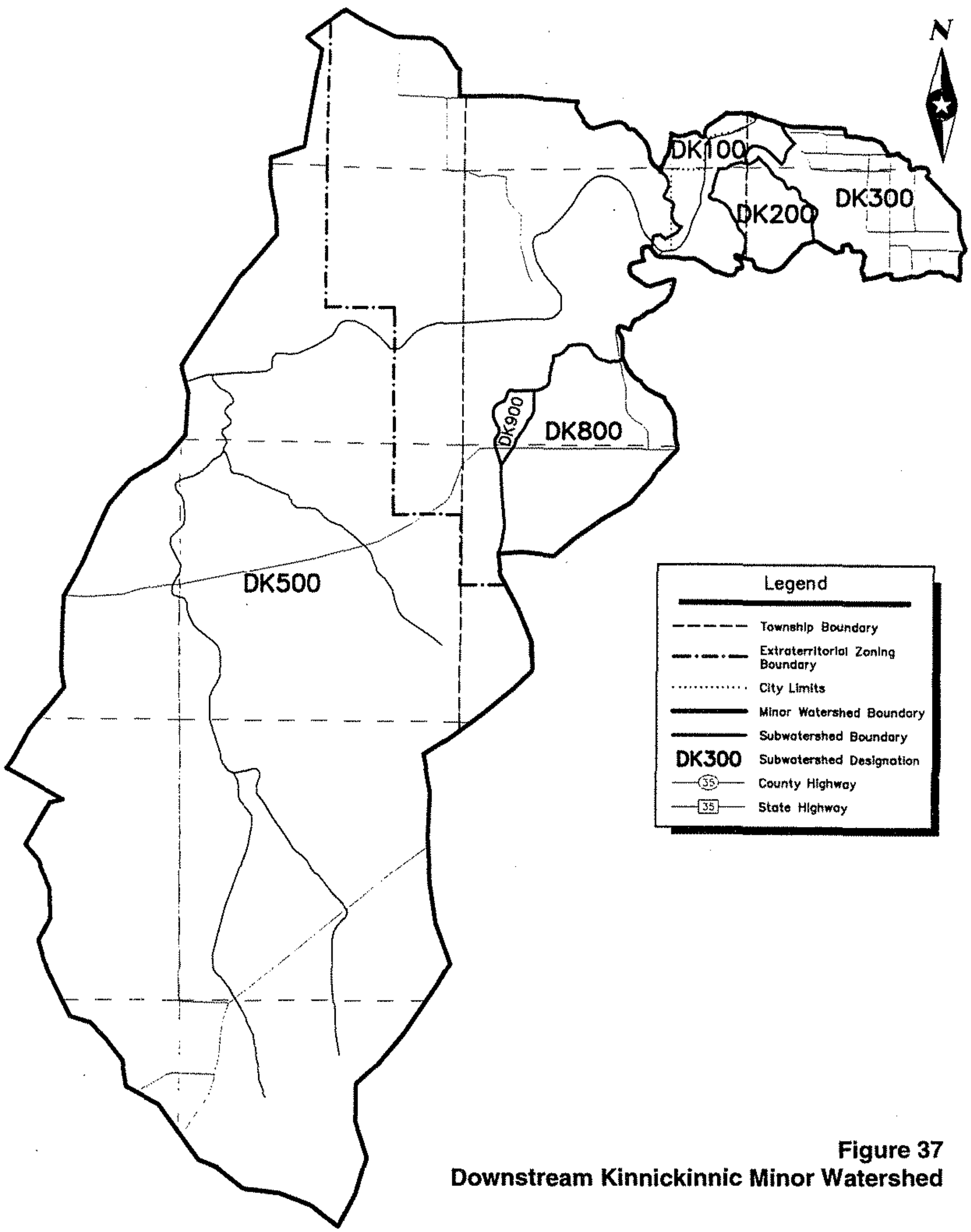


Figure 37
Downstream Kinnickinnic Minor Watershed

River Falls Wisconsin

DOWNSTREAM KINNICKINNIC MINOR WATERSHED

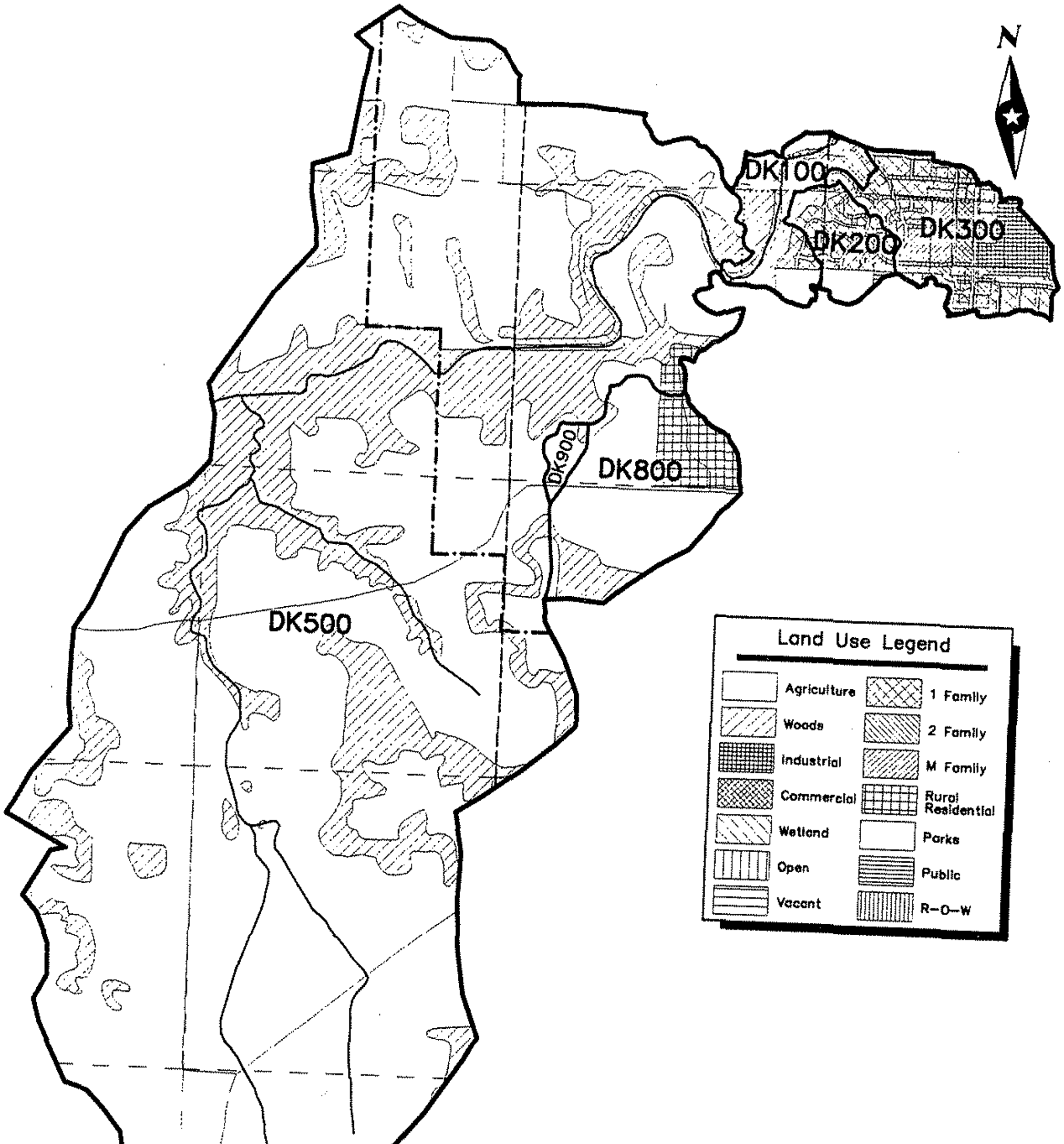


Figure 38
Downstream Kinnickinnic Existing Land Use

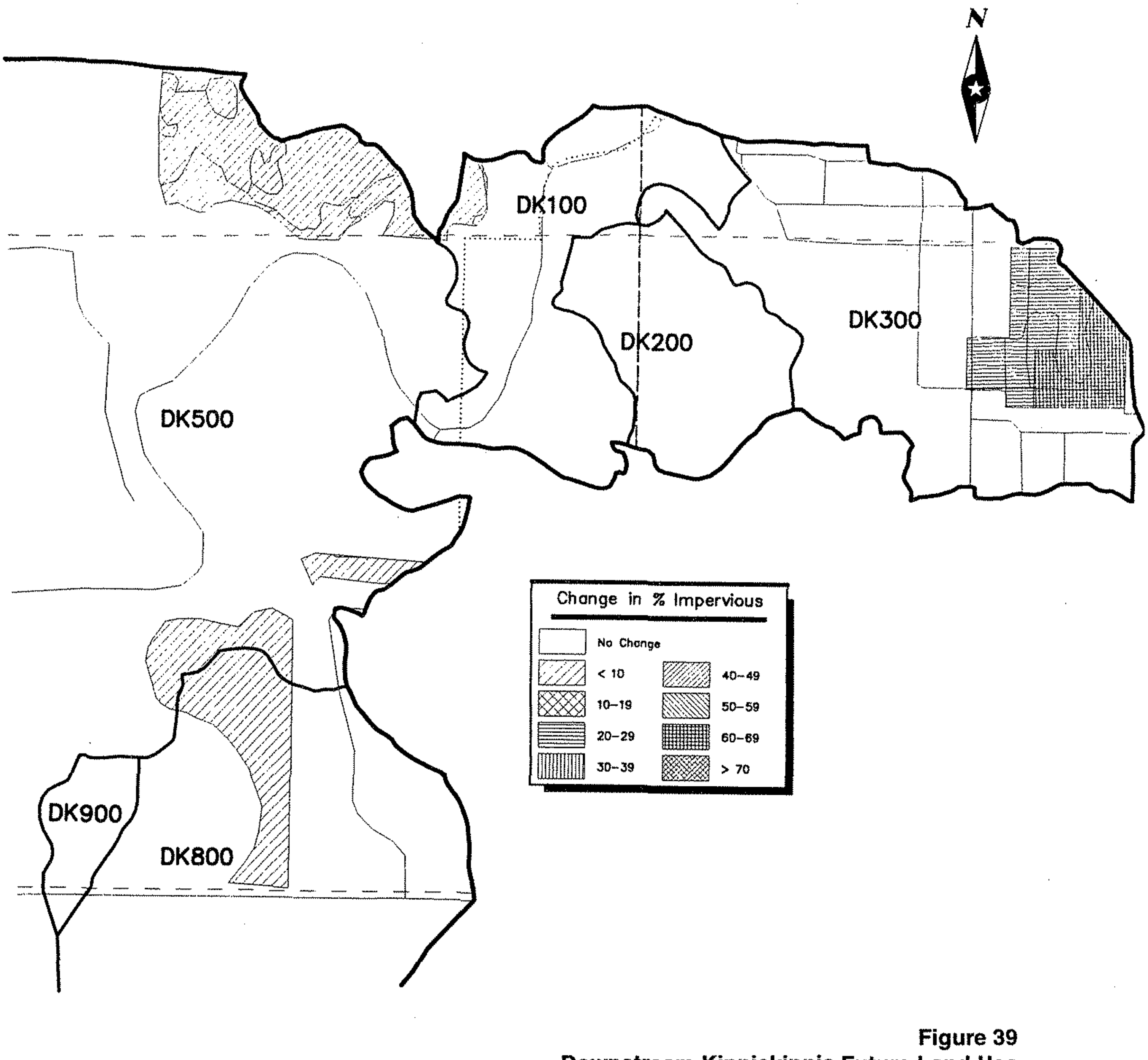


Figure 39
Downstream Kinnickinnic Future Land Use

❑ **Soils**
The DK Minor Watershed is comprised of three primary soil associations (USDA, 1968). The Antigo-Onamia association follows the river bed. Directly adjacent to the river bed, is the Dakota-Waukegan association which comprises the upland areas adjacent to the river. In the southernmost portion of the minor watershed, the Renova-Vlasaty association is found. Descriptions of these soil associations are found in Appendix C.

Fishery

❑ **Unique Features**
In his 1989 article, J. R. Humphrey identifies this lower reach of the Kinnickinnic as area which "must have been created by a master fly fisher". This reach is broader (on average about 40 feet wide) and shallower (one to two feet deep) than the upper river. The broken structure of the stream bed provide habitat for a variety of forage for larger front up to 18 inches in size.

The DNR's own fish survey results illustrated recent changes in the fisheries (see *Watershed Assessment*, pages 73 to 74.) Since 1990, the 12-16" size class has seen a significant increase in numbers while the 8-10" size class has seen a decline. Some of this change can be attributed to slot-size fishery regulations which limits the number of larger fish (over 16") that can be kept. There may be other limiting stream factors such as temperature, stream invertebrates, sedimentation, or flow which can all have a negative effect on the survival of juvenile trout.

Temperature Monitoring

Stream temperatures are monitored continuously by Trout Unlimited at a station just upstream of the Mann Valley tributary. The DNR has also monitored temperatures along the reach (see Figure 8, page 58).

In general, based on the DNR's monitoring data, temperatures in the Downstream Kinnickinnic are about average 2-3 degrees warmer than the upper river of the South Fork, reflecting the "heat island" effect of the upstream urbanized area and the two reservoirs.

Bartosh Canyon

Bartosh Canyon is a steep, eroding drainageway located within DK300 at Bartosh Park. It starts near Foster Street and continues in a northwesterly direction for nearly 1,400 feet to the confluence of the Kinnickinnic River (SCS, 1981). According to the SCS report, *"Bartosh Park Drainageway - Critical Area Treatment Preliminary Report"* (1981), the "canyon" drops about 75 feet from Foster Street to the river. The valley side slopes are steep and unstable. Vegetation is limited to mature oak/mixed hardwoods and underbrush.

The damage which has occurred over the years includes a 20-foot-deep scour hole below the CMP discharge, eroding valley slopes, and deposition of sediment and gravel to the river below the lower dam. The lower end of the drainageway provides a stable outlet, over bedrock, prior to discharging to the river. The large sand bar evident below the dam has resulted from only about two years of erosion; the City recently removed a similar sandbar to improve the tailwater conditions below the lower dam.

The Powell Dam hydroelectric generating plant just upstream has a normal generating capacity of 90-100 kw (SCS, 1981). Due to the build up in debris and sediment (prior to 1981), the SCS estimates a 50 percent loss in capacity due to lower operating head conditions. Some of the original objectives for restoring the area included reducing channel and streambank erosion, reducing flooding, and improving upstream flood storage (SCS, 1981). The SCS study presented five alternatives ranging from construction storm sewer to detention on UWRF parking facilities.

In November of 1988, the SCS published *"Preliminary Engineering Report - Bartosh Park Critical Area Treatment Measures"* and later revised the document in April 1989. The design flows identified in the study are as follows:

Frequency	CFS
10-year frequency	130
25-year frequency	169
50-year frequency	209
100-year frequency	251

The 1989 study (SCS, 1989) had two objectives:

1. Provide a stable outlet for runoff waters from storm sewer outlets;

2. Reduce channel erosion occurring in the drainageway, thus reducing sediment and debris from being carried to the Kinnickinnic River. This will protect the quality of the existing water.

Four alternatives were presented with installation costs ranging from $133,320 to $162,645. The alternatives considered construction of a 48-inch CMP drop inlet with a rock-lined waterway and building a pipeline from the top of the ravine to the bottom. The pipe sizes varied from 36 inches to 48 inches in diameter.

The River Country Resource Conservation and Development Council (RC RC&D), Pierce County, and River Falls agreed to cost-share on the project. RC RC&D's share is approximately $10,000 towards the preparation of plans and specifications.

A proposal for stabilizing the ravine was presented by SCS (1988) to RC RC&D. The proposal focused on two primary water quality goals—reduction of total suspended solids, and thermal impacts of storm water discharging to the river. The proposal identified the merits of the previous concepts; pipe option and rock-lined channel.

The installation of a pipe system and resulting overfill would reduce the erosive forces in the area and stabilize the eroded banks. This option would effectively address the total suspended solids issue (TSS). However, the pipe option does nothing in the way of thermal mitigation. Storm water is efficiently discharged to the river with no opportunity for cooling through infiltration or shading.

The preliminary engineering reports identify a stable channel cross section for the anticipated design flows. With a rock-lined channel, there is opportunity for infiltration of lower flows. However, for design flows, the contact time is very short, therefore, the cooling effect of a shaded area is not a factor.

The rock-lined channel would likely follow the existing profile. Such an alignment provides little opportunity for restoring the badly eroded slopes. (Such restoration requires flattening of the slopes and revegetation.) In the fall of 1993, the City and RCRC&D moved ahead with the pipe option.

Brush and Rubble Dump

A brush and rubble dump exists in a ravine area about 1-1/2 miles west of Highway 29, just north of FF (adjacent to DK 900). Over the years, tree stumps, limbs, concrete and bituminous have been pushed into the ravine. Although no monitoring has occured at the site, DNR officials have suggested that the City find a method of controlling runoff from the area. A likely solution would be to construct an impervious clay "dam" across the ravine below the dump area. Once the dam is in place, the existing material could be covered with additional soil.

Future plans for handling brush and rubble could include a chipper to reduce trees and limbs into useful mulch for area residents and crushing of bituminous and concrete rubble for reuse as roadway base material.

Kinnickinnic Valley Landowner's Association

The Kinnickinnic Valley Landowners Assocaition (KVLA) was formed four years ago as a private, non-profit, grass-roots organization of people who own property along the Kinnickinnic River downstream from River Falls. The majority of landowners along this area are members.

KVLA members prefer the Kinnickinnic Valley the way it is and are taking steps to ensure that the River's scenic and natural quantities are preserved in their present state. The Valley's natural community has many interesting, and some rate features: wildlife and birds, weeping cliffs, goat prairies, pine relics, and spring ponds. The trout fishing resource must be maintained and enhanced.

Kinnickinnic River Land Trust

Because both the natural and farming communities would be threatened by development and over use, the KVLA sought to guarantee the future well being of the Kinnickinnic through public and private conservation techniques.

Concerned landowners and friends of the river created the Kinnickinnic River Land Trust to protect the watershed. It is a non-profit, tax exempt corporation operated by a volunteer board of directors. Their mission is to conserve the natural resources and scenic beauty of the Kinnickinnic River Watershed.

The Land Trust has five areas of focus: (1) Involve the community in conservation. (2) Identify and protect natural resources and scenic areas. (3) Enhance wild trout resources. (4) Improve water quality. (5) Obtain funds to accomplish construction, education and stewardship.

The member supported conservation organization works to protect land through conservation easements from landowners and through direct acquisition, thereby protected land from inappropriate development that might otherwise be detrimental to the river.

Hydrologic Units

The Downstream Kinnickinnic Minor Watershed has been divided into six smaller watersheds as illustrated on Figure 37 on page 192. The hydrologic characteristics are listed in Table 47.

Table 47
Downstream Kinnickinnic Minor Watershed
Hydrologic Units

Subwatershed Designation	Area (Acres)	Curve Number[1]	Time of Concentration (Minutes)	Percent Impervious[2]	Runoff Rate[3,4] (cfs)
DK100	87.7	70	17.6	<10%	247
DK200	57.1	76	24.6	27%	166
DK300	151.7	79	35.6	45%	396
DK500	3,355.5	68	91.1	<10%	3197
DK800	198.8	66	30.6	<10%	345
DK900	15.1	71	17.5	<10%	44
Total	**3,865.90**	-	-	-	-

1. Based on future land use conditions.
2. For rural areas, and areas with an impervious percentage of less than 10 percent, percent impervious by subwatershed is not reported.
3. 100-year event.
4. Runoff rate is generated from subwatershed only; it is not a cumulative rate.

There are three identifiable detention basins within the Downstream Kinnickinnic Minor Watershed. The detention basin data is illustrated in Table 48 on page 202.

Table 48
Downstream Kinnickinnic Minor Watershed
Detention Basins

		Normal		100-Year Storm		
Designation	Location	Water Level	Surface Area	Water Level	Surface Area	Overflow Elevation
DK200	River Hills	914.0	0.0	922.2	2.96	924
DK800	N of FF	874.0	0.50	885.6	5.05	887
DK900	N of FF	874.0	0.01	882.3	0.76	883

Designation	Available Storage	Inflow Rate	Outflow Rate	Peak Flow Reduction	Recommended First Floor Elevation
DK200	3.0	165	154	7%	924.2
DK800	28.3	345	11	97%	887.6
DK900	1.2	44	9	79%	884.3

DK 200, located west of River Ridge Road, is too small to provide any significant benefit. The basin receives a very high rate of runoff and provides only seven percent peak flow reduction. This pond could be modified to improve its detention capabilities.

Conversely, DK 800, located north of FF, west of the Birch Cliff Subdivision, provides excellent peak flow reduction (97%). DK 800 has almost ten times more available storage than DK 200.

DK900 (directly west of DK 800) also provides significant peak reduction for its smaller (15.1 acres) tributary area.

Water Quality

Water quality of the Kinnickinnic River downstream of River Falls is the lowest of almost every portion of the study area with the possible exception of the downstream portions of the South Fork. The water quality problems are not a symptom of the direct contributing watershed, but rather a result of the upstream reaches of the river which include the City's wastewater treatment plant, the urbanized area of River Falls, and the two impoundments. However, the direct watershed still contributes to the overall water quality impacts to this reach.

The growing season total suspended solids (TSS) loading from the DK Minor Watershed is shown in Table 49.

Table 49
Downstream Kinnickinnic Growing Season
Total Suspended Solids (TSS) Loading

Subwatershed Designation	TSS Loading (lbs./ac.)[1,2]	Pond Removal	Net Loading (lbs.)[1]
DK100	45	N/A	4,000
DK200	329	76%	4,600
DK300	547	N/A	83,000
DK500	45	N/A	151,000
DK800	45	0	8,900
DK900	45	o	7,000
Total	**65**		**252,000**

1. Future land use conditions.
2. Shaded data illustrates priority subwatersheds. Subwatershed DK300 represent over 33% of the total loading. Applying the recommended TSS removal goal of 85 percent (see *Watershed Assessment - Water Quality*) on this subwatershed would result to almost 28% reduction in net loading from this river segment from this river segment.

Based on anticipated future land use, the net total suspended solids loading within the Downstream Kinnickinnic Minor Watershed is expected to remain near existing levels.

The largest single area of concern is DK 300-Bartosh Canyon (see page 192 for discussion). DK 300 has the highest loading (lbs/acre) of any area within this minor watershed. Improvements to this area should be prioritized.

River Falls Wisconsin

DOWNSTREAM KINNICKINNIC MINOR WATERSHED

Action Plan - Downstream Kinnickinnic Minor Watershed 4/20/95

Subject: Downstream Kinnickinnic Minor Watershed Water Quality

Purpose: To protect the lower river from the influence of urbanization.

Goal: The City, in cooperation with Clifton and River Falls Townships, shall achieve a nondegradation standard which applies to all new development in the DL Minor Watershed, requiring rate control after development of rates which exist at the adoption of this plan and water quality control after development to quality levels that exist in the Kinnickinnic River at the adoption of this plan.

Applicable Goals and Policies:

Problems (Probable Obstacles)	➤	**Solutions** (Obstacle Avoidance)
1. Lack of consistency between the Townships and the City, in the area of water resources management.	➤	1. Develop a consistent approach to erosion control, development standards and surface water management by first developing minor ordinance; if ineffective, then establishing an intergovernmental cooperative agreement for watershed management; if still ineffective, extending the ETZ.
2. Difficulty in reducing temperatures of storm water discharges to river temperatures.	➤	2. Utilize thermal best management practices to achieve the maximum thermal mitigation possible given the constraints of each available situation. (Refer to Appendix B for Thermal Mitigation Techniques).
3. Maintenance of detention basins to ensure proper rate control and total suspended solids (TSS).	➤	3. Prior to completion of development, assign maintenance responsibilities for each facility to the applicable local government unit in accordance with ETZ.
4. Balancing the economic implications of on-site detention basins against acquiring property for regional detention ponds to development occurring.	➤	4. Adopt an on-site treatment policy for all non-single family home sites, while encouraging individual developers to dedicate existing low lands and depressions for use as regional basins during the preliminary plat stage. The dedication should be a permanent easement, but could also be fee title to the local unit of government.
5. Protecting spring areas with current land use regulations.	➤	5. Identify existing spring areas based on past observation and wintertime aerial observations and prepare protection zoning which limits development impacts.
6. Preventing hazardous spills along STH 35 and STH 65 and leaking underground storage tanks from contaminating the river.	➤	6. Develop environmental overlay zone either side of river centerline and spring areas prohibiting the above or below ground storage of fuel or other hazardous materials and identify the response process to a spill in the area.
7. Existing and proposed landfills contaminating surface and ground water.	➤	7. Implement inplace land use controls and monitoring programs.

Table 50
Downstream Kinnickinnic Minor Watershed
Action Plan
Summary

Revised 4/20/95

Activity Steps	Resources	Measurement	Completion Date
1. Develop consistent approach to watershed management. Adopt, interpret and enforce mirror ordinances based on an inter-governmental cooperative agreement.	• Identified & recognized State process • City Council • Clifton & River Falls town boards • Objectives of this plan (natural resource duplication) • Agency & County support • Public involvement and public information hearings.	Intergovernmental Cooperative Agreement Adopted Mirror Ordinance	Jan 1, 1995 July 1, 1995
2. Identify Spring Areas	• DNR records • University records • Land owners • Winter aerial photography	Map denoting spring areas	April 1995
3. Adopt Environmental Overlay Zoning	• Wellhead and spring protection zoning format.	Council Approval	Jan. 1995
4. Establish ETZ Review Criteria	• On-site and regional basin policy • Land dedication policy • Maintenance responsibilities • Quality, quantity (flow) and thermal standards • Hazardous materials identification • Public information program • Public hearing	Written Plan	April 1995
5. Bartosh Canyon Study Plans	• Pierce County • Soil Conservation Service • River Country RC & D • City of River Falls	Completed surveys Completed Bidding Documents	Nov. 1993 March 1994
6. Bartosh Canyon Construction	• Construction Plans	Completed Construction w/Restoration	Oct. 1994
7. Rehabilitate DK200 - River Hills Pond	• Original Construction Plans • BMP Standards	Feasibility Study Construction	Oct. 1995 Nov. 1996

GROUND WATER PROTECTION

Background

River Falls currently obtains its water supply from four municipal wells drilled into the Jordan Sandstone Formation. Information about the four wells, Nos. 2, 3, 4 and 5, is shown in Table 51, *Existing Well Information*. The golf course well is also shown on this table.

Table 51
Existing Well Information

Well No.	Date Drilled	Depth (ft.)	Formation	Static Water	Test Pumped (GPM)	Drawdown (Ft.)
2	1948	401'	Jordan	21'	1000	50'
Specific Capacity = 20 gpm/ft. **Driller:** Keys Well Drilling Co.						
3	1953	379'	Jordan	39'	1060	51'
Specific Capacity = 20.8 gpm/ft. **Driller:** McCarthy Well Co.						
4	1967	415'	Jordan	49'	1560	98'
Specific Capacity = 15.9 gpm/ft. **Driller:** McCarthy Well Co.						
5	1979	440'*	Jordan	79'	1509	151'
* Backfilled with cement from 440' to 400' due to caving sandstone. **Specific Capacity** = 10 gpm/ft. **Driller:** Alan Lang Well & Pump, Inc.						
Golf Course Well	-	451'	25' into sandstone		757	25'-4"
Specific Capacity = 30 gpm/ft. (A very good well)						

Potential Well Site

The City is interested in drilling another well to augment its system. Of concern is the proper location for another well with 1,500 GPM (gallons per minute) capacity. It must not interfere with the other four wells or the golf course well, and it must not have an impact on the Kinnickinnic River, in particular the South Fork.

Location

From preliminary information, one desired location for a future well is south or southeast of the City. The South Fork of the Kinnickinnic River flows through this area. Also, there is an experimental farm and feed lot in this quadrant. However, there is ample location to site a well in this area without any impact on the well from the feed lot or the well affecting the river. (A second site north of the City is also being considered)

A new well would be drilled into the Jordan Sandstone formation, approximately 400 feet to 450 feet deep. This sandstone aquifer is a copious water producer as described by the Geological Survey and verified by the specific capacity of the existing wells. To prevent any possible communication of piezometric levels, the dolomite should be cased off above the sandstone. This is similar to the construction of Well No. 4 near the elevated tower at Sycamore and Charlotte. A discharge capacity of 1,500 GPM should be attainable.

Drawdown

At 1,500 gpm, the drawdown would be 100 feet to 150 feet. With an assumed static water level of 50 feet, the pumping level would be approximately 200 feet below ground. The anticipated ground level is in the 920 to 950 MSL (Mean Sea Level) range.

Specific Capacity

The specific capacity of the well, which is the rate of flow per unit of drawdown, is expected to be in the 10 to 20 gpm/ft. range. With this type of specific capacity, the major radius of influence for the drawdown curve would be approximately 200 feet, which would encompass an area of 2.88 acres.

These values represent a conservative approach to a new well design. If the new location produced water similar to Well Nos. 2 or 4 or the golf course well, the drawdown figures would not be as high.

Recommendation

A new well should be located 500 to 1,000 feet away from the Kinnickinnic River to ensure there would be no impact on the river flow. At this distance, if the well is cased off down to the sandstone formation, the Geological Survey and other local well drillers agree that there would be no impact on the river. Well No. 4 is located approximately 500 feet from the South Fork of the Kinnickinnic River and has been operating since it was installed in 1967 without any discernible impacts on the river flow.

Wellhead Protection Overview

Wellhead protection (WHP) for public wells is mandated by the 1986 Amendments to the federal Safe Drinking Water Act (SDWA). The primary goal of wellhead protection is to prevent contaminants that may have adverse effects on human health from entering public water supply wells. A wellhead protection plan should be designed to protect the land area that recharges the ground water which supplies the municipal well or well field.

Control measures are used as a wellhead protection plan for managing potential contaminant sources. The control measures take into consideration: 1) the local hydrogeologic and pumping conditions; 2) the vulnerability of the public well or well field to a potential contaminant source; 3) the amount and toxicity of the potential contaminant; 4) the distance from the potential contaminant source to the well or well field; and 5) the effectiveness of the measures that are already being employed by the source owner.

River Falls Wisconsin

A wellhead protection area (WHPA) should be delineated for each well or well field. This portion of the plan includes a preliminary WHPA based on the hydrogeology of the southeast quadrant of the City of River Falls. The scope of the analysis does not include a wellhead protection plan. However, a preliminary investigation has been conducted to delineate a wellhead protection area in the southeast quadrant of the City. (See Figure 40 on page 211 for proposed well field location.)

Generally, WHPAs consist of two or three zones, each of which have different degrees of WHP measures based on proximity to well, aquifer sensitivity, etc. For the purpose of this report, three time-of-travel (TOT) zones are defined based on capture zones of 5, 10, and 25 years.

❑ Geology

The bedrock in the River Falls area consists of Ordovician dolomites and sandstones. Depth to bedrock is 0 to 50 feet. The uppermost unit is the Galena Dolomite, Decorah Formation, and Platteville Formation, which are mostly dolomite and range in thickness from 0 to 115 feet. The next unit is the St. Peter Sandstone which is 0 to 200 feet thick. Under the St. Peter Sandstone is the Prairie du Chien Group, which includes undifferentiated Shakopee Dolomite, New Richmond Sandstone, and Oneota Dolomite. This unit, which serves as the major aquifer for River Falls, is approximately 340 feet thick and is underlain by the St. Lawrence confining bed.

The surficial geology in and around River Falls consists mostly of Quaternary ground moraine deposits. The till consists of unstratified clay, silt, sand, gravel and boulders. The thickness varies from 0 to 50 feet.

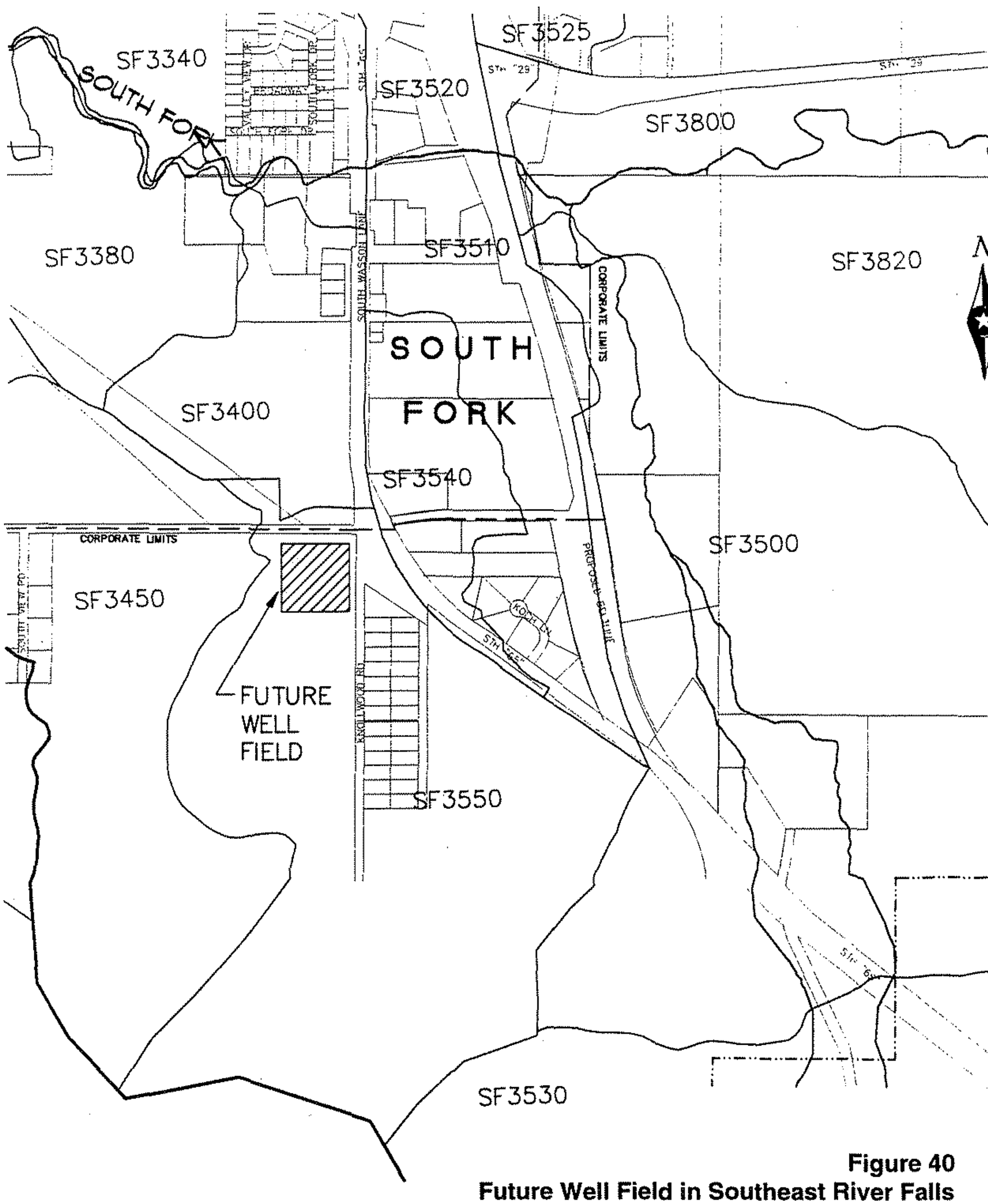


Figure 40
Future Well Field in Southeast River Falls

In the area of the proposed well field, the drift is unsaturated and approximately 15 to 20 feet thick. Static water is reported to be approximately 40 feet below the surface in the Prairie du Chien Formation.

Figure 41 on page 213 illustrates the area geology.

❑ **Soils**

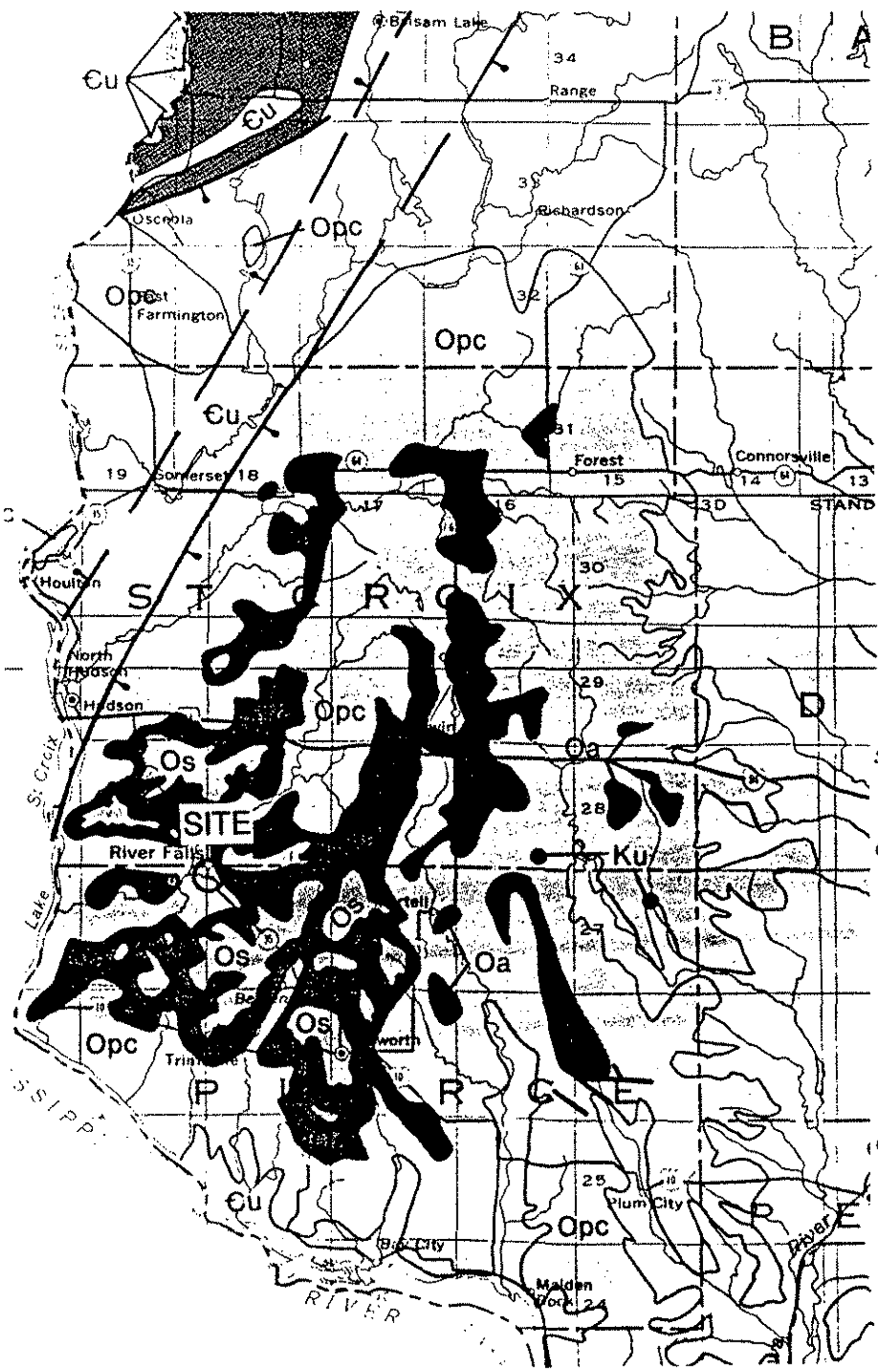
The soil type at the proposed wellhead location is variable. The soil varies from sand to clay. Soil permeability ranges from 0.05 to 0.02 inches/hour just south of the proposed wellhead location, to 2.5 to 5.0 inches/hour in sandy areas at the proposed well field. A description of the soils associations can be found in the South Fork Minor Watershed discussion and in Appendix C.

❑ **Ground Water Surface Water Relationships**

Ground water and surface water are intimately and directly related in all phases of their movement within the St. Croix River Basin, which includes the River Falls area. Both seasonal and long-term increases or decreases in precipitation cause corresponding increases or decreases in groundwater levels, stream flow, and lake stages. Similarly, natural or man-made changes in ground water levels, stream flow or lake stage cause corresponding changes in the others (H. L. Young and S. M. Hindall, 1973).

❑ **Well Head Protection Area Delineation**

One of the major elements of wellhead protection is the determination of zones within which contaminant source assessment and management will be addressed. The zones, denoted as Wellhead Protection Areas (WHPAs), are defined in the Safe Drinking Water Act as "the surface and subsurface area surrounding a water well or well field, supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or well field."



ROCK DESCRIPTIONS

Silurian System

Su — Dolomite, undivided; includes Cayugan, Niagaran and Alexandrian series

Ordovician System

Om — Maquoketa Formation–shale, dolomitic shale and dolomite; includes overlying Neda Formation (age uncertain) consisting of oolitic iron oxides and shale

Os — Sinnipee Group–dolomite with some limestone and shale; includes Galena, Decorah and Platteville Formations

Oa — Ancell Group–orthoquartzitic sandstone with minor limestone, shale and conglomerate; includes Glenwood and St. Peter Formations

Opc — Prairie du Chien Group–dolomite with some sandstone and shale; includes Shakopee and Oneota Formations

Cambrian System

Cu — Sandstone with some dolomite and shale, undivided; includes Trempealeau, Tunnel City and Elk Mound Groups.

Figure 41
Area Geology

The U.S. Environmental Protection Agency (EPA) identified six methods for delineating WHPAs. In order of increasing technical sophistication, these methods are:

1. Arbitrary Fixed Radius;
2. Calculated Fixed Radius;
3. Simplified Variable Shape;
4. Analytical Methods
5. Hydrogeologic Mapping
6. Numerical Flow/Transport Models

Generally, the more sophisticated the method, the more accurate the results. For the purpose of this report, a preliminary Numerical Flow/Transport Model has been performed. It should be noted that in order to construct an accurate model, hydrogeologic data needs to be collected throughout the potential WHPA to characterize spatial variations and hydraulic stresses. Much of this input data was inferred using literature, existing well logs, well construction reports, and site visits. To verify the results, additional field investigations should be completed.

The EPA "WHPA - Wellhead Protection Area Delineation Code" software version 2.01, by T. N. Blandford and P. S. Huyakorn, has been selected to delineate the WHPA for this report.

The program "WHPA" is a modular, semi-analytical ground water flow model designed to assist in delineating Wellhead Protection Areas. The model consists of four independent computational modules. In evaluating the data available and the hydrogeology of the area, it was determined that the Multiple Well

Capture Zone Module (MWCAP) was best suited to most accurately delineate the River Falls proposed well field.

MWCAP is designed to provide efficient delineation of steady-state, time-related and hybrid-capture zones for one or more pumping wells in homogeneous aquifers. MWCAP requires that stream or barrier boundaries, if used, be represented by straight lines in plan view.

Capture zones delineated using MWCAP are valid for fully penetrating pumping wells screened in aquifers that are essentially homogeneous. Ground water flow must be two-dimensional in the areal x-y plane, and, therefore, the aquifer may be confined or unconfined if the drawdown-to-initial saturated thickness ratio is small (less than about 0.1). A steady-state ground water flow field is assumed.

The drawdown-to-initial saturated thickness ratio at the proposed well field location may be greater than the MWCAP's assumption of less than 0.1. Data obtained from nearby wells indicate the ratio may be approximately 0.3. A larger ratio will tend to increase the WHPA. The WHPAs delineated in this report make many assumptions and are not intended to be used as final boundaries. Additional investigations and hydrogeologic evaluation is necessary to delineate accurate and appropriate WHPAs.

If a stream or barrier boundary is present, the boundary is assumed to be linear and fully penetrating.

The input requirements for the MWCAP module are outlined in Table 52 on page 216.

Table 52
Input Requirements for MWCAP Module

Program Variable	Description
For each problem:	
IUNIT:	Default units of input parameters (feet and days or meters and days)
NWELL:	Number of pumping wells for which capture zones are to be delineated.
XMIN:	Minimum x–coordinate of study area (ft or m)
XMAX:	Maximum x–coordinate of study area (ft or m)
YMIN:	Minimum y–coordinate of study area (ft or m)
YMAX:	Maximum y–coordinate of study area (ft or m)
DLMAX:	Largest allowable step length, dl
For each well (I=1, NWELL):	
XWELL(I):	x–coordinate of well (ft or m)
YWELL(I):	y–coordinate of well (ft or m)
QPWELL(I):	Well recharge rate [a/] (ft^3/d or m^3/d)
TRAN(I):	Transmissivity of the aquifer (ft^2/d or m^2/d)
GRAD(I):	Regional hydraulic gradient (ft/ft or m/m)
ANGLE(I):	Angle of ambient ground water flow (0-360°)
POR(I):	Aquifer porosity (dimensionless)
THICK(I):	Aquifer saturated thickness (ft or m)
IBOUND(I):	Associated boundary type (no boundary, stream boundary, or barrier boundary)
DSW(I):	Perpendicular distance from stream or barrier boundary to the well (ft or m)
THETA(I):	Orientation of stream or barrier boundary (0-360°)
ICZTYP(I):	Capture zone type option (steady-state, time–related, or hybrid)
TMCZ(I):	Time value associated with capture zone (days); time–related and hybrid capture zones only.
NSTLIN(I):	Number of pathlines to be computed for the well in addition to pathlines delineated automatically by the code
ICZPLT(I):	Flag indicating if capture zone boundary is to be plotted

[a/] The sign (+,-) of the discharge or recharge rate need not be specified.

Capture Zone

Literature indicates the transmissivity of the Prairie du Chien aquifer varies from 6,000 ft.^{2}/day to 13,000 ft.^{2}/day. As expected, the lower transmissivity value resulted in the largest capture zone. Figure 42 on page 218 shows the capture zone for 5, 10, and 25 years at an assumed transmissivity of 6,000 ft.^{2}/day. Figure 43 on page 219 and Figure 44 on page 220 show the same time-interval capture zones for 10,000 ft.^{2}/day and 13,000 ft. /day transmissivities, respectively.

The hydraulic gradient and ground water flow direction was determined from the Generalized Water Table Elevation Map of Pierce County, Wisconsin, published by the Wisconsin Geological and Natural History Survey. The well discharge rate was determined as the average of the daily discharge rates from the four existing municipal wells. The wellhead location can be adjusted in the model once it is further defined. Moving the wellhead location will change the boundaries of the WHPA. If the site is used as a future well field, further evaluation will be necessary to more accurately define the piezometric surface.

Table 53 on page 221 shows the input data used for this preliminary model.

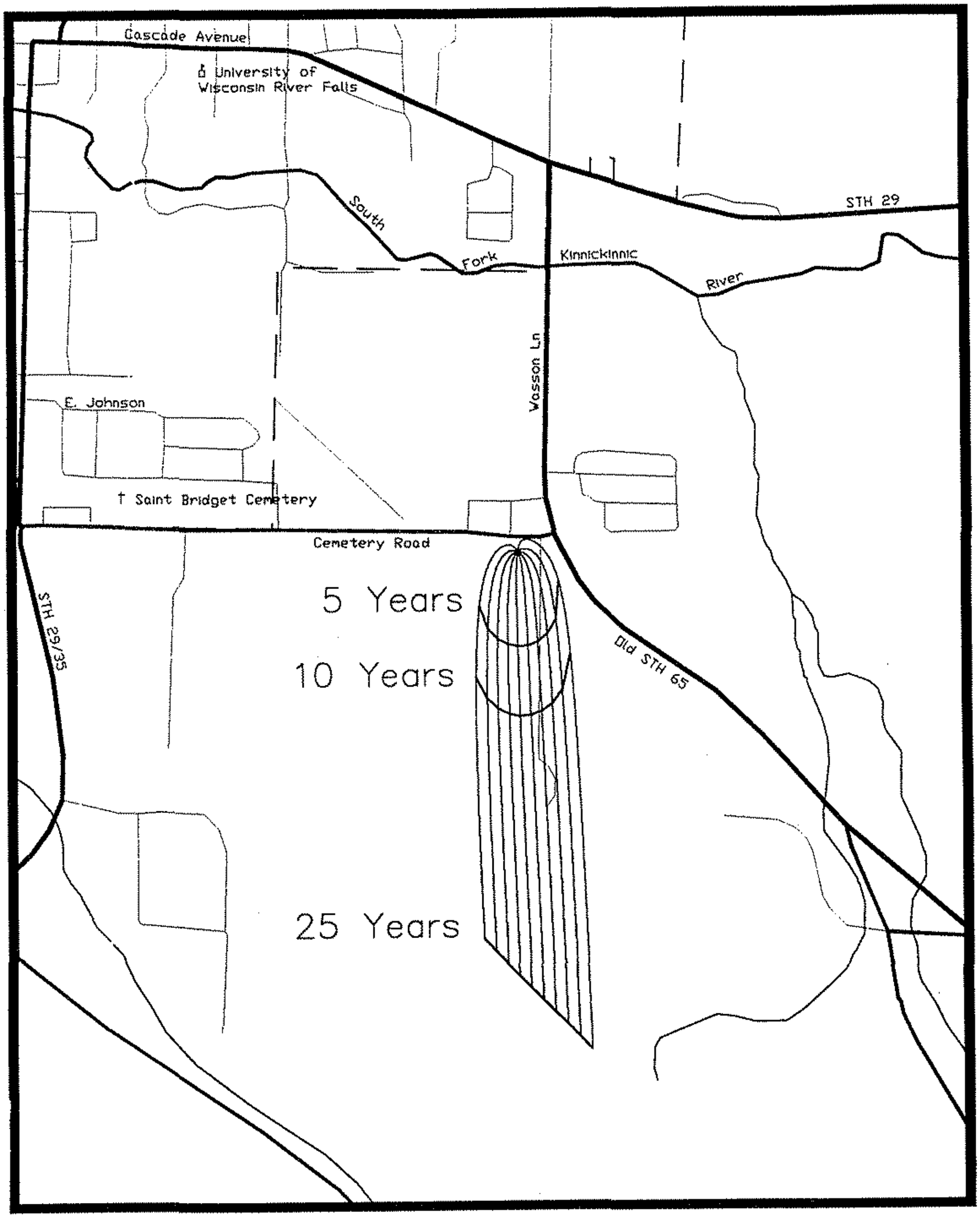


Figure 42
Capture Zone
5, 10, 25 Years
6,000 ft^2/day Transmissivity

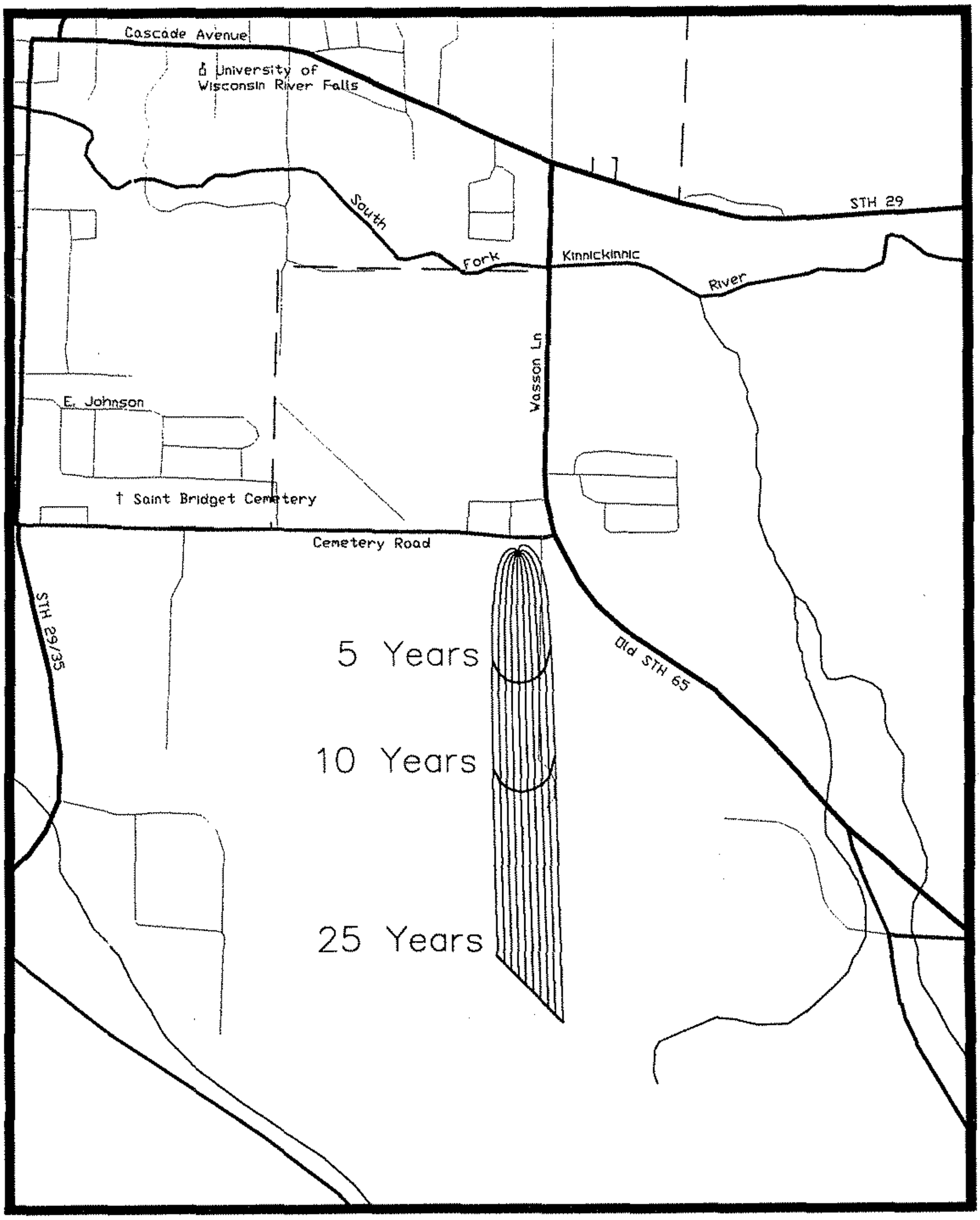


Figure 43
Capture Zone
10,000 Sq. Ft./Day Transmissivity
5, 10 and 25 Years

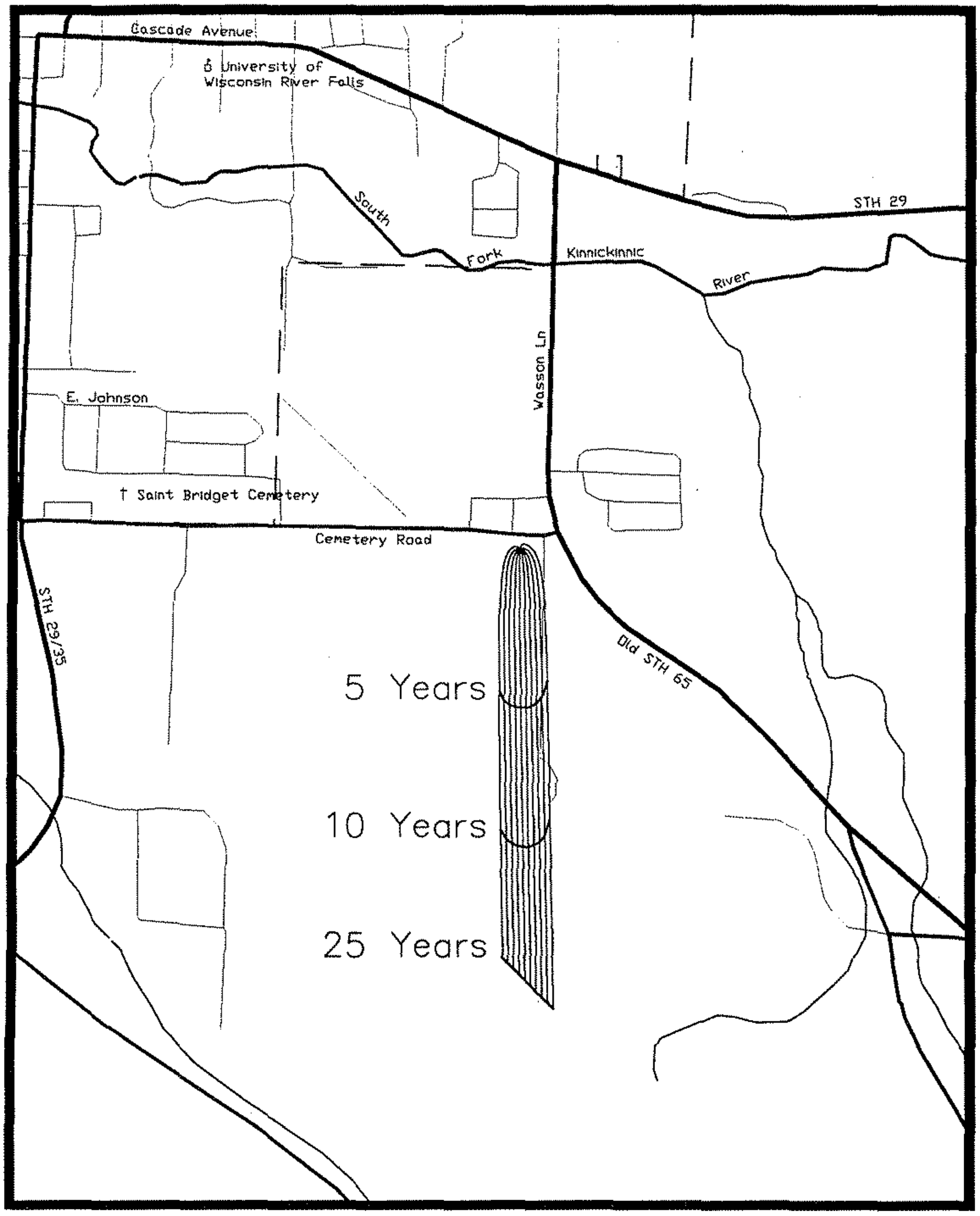


Figure 44
Capture Zone
13,000 Sq. Ft./Day Transmissivity
5, 10, and 25 Years

Table 53
Proposed Well Input Data
MWCAP

Program Variable	Program Value
Number of Wells:	1
Minimum X–Coordinate:	0 feet
Maximum X–Coordinate:	12,000 feet
Minimum Y–Coordinate:	0 feet
Maximum Y–Coordinate:	12,000 feet
Maximum Spatial Step Length:	20 feet
X–Coordinate:	6,000 feet
Y–Coordinate:	10,000 feet
Well Discharge Rate:	35,000 $ft.^3$/day
Transmissivity:	6,000, 10,000 and 13,000 $ft.^2$/day
Hydraulic Gradient:	0.0048 (dimensionless)
Angle of Ambient Flow:	90 degrees
Aquifer Porosity:	0.25 (dimensionless)
Aquifer Thickness:	340 feet
Boundary Type:	Barrier
Distance to Boundary:	3,000 feet
Boundary Orientation:	45 degrees
Capture Zone Type:	Time–related
Time Values:	5, 10 and 25 years
Pathlines Computed:	20
Pathlines Plotted:	10

Potential Contaminant Sources

A review of potential contaminant sources should be conducted within the zone of contribution (ZOC). The review should include both potential and existing contaminant sources. Point as well as nonpoint sources need to be evaluated.

Potential point contaminant sources include fuel storage tanks, fuel handling and transport facilities; waste disposal areas, such as landfills and dumps; chemical storage, handling and transport facilities; material stockpiles; industrial and commercial facilities. Potential nonpoint contaminant sources include the application of agricultural chemicals and on-site sewage treatment and disposal systems, highway salt and cemeteries. A review of "light industry" should not be overlooked while conducting this review. Small amounts of hazardous material can contaminate large areas of ground water. Below is a list of light industry sectors which have been identified by the EPA as potentially significant sources of ground water contamination.

- Agricultural Products and Services
- Mining and Quarrying
- Highway Deicing
- Textile and Apparel Products
- Lumber and Wood Preserving
- Printing and Publishing
- Chemical Product Blending
- Leather Products
- Mineral Products: Glass and Cement
- Metal Products
- Machine Shops
- Electronics and Electronic Equipment
- Transportation Maintenance
- Scrap Trade and Metal Container Recyclers

- Chemical and Petroleum Storage and Sales
- Automotive Repair, Services, and Parking
- Personal Services: Laundry, Pest Control and Photofinishing
- Repair Services: Furniture, Welding, and Septage Services
- Amusement and Recreation
- Educational, Medical and Engineering Laboratories

Management Approaches

Management approaches for wellhead protection should use a combination of regulatory and non-regulatory tools to protect the land area within the wellhead protection area (WHPA).

Regulatory Rules

The regulatory tools include:

1. **Municipal Zoning**
   Zoning is a tool for regulating new land use. Three approaches that can be used separately or in combination are:

   - **Revise Existing Zoning Ordinance**
     Review and revise zoning district boundaries to make sure the wells and wellhead protection areas are within districts compatible with ground water protection.

   - **Enact Overlay Zoning**
     Overlay zoning districts place additional requirements over those of the underlying districts. This approach allows municipalities to avoid overly broad regulations by limiting the most restrictive controls to the areas with the greatest need for protection.

2. **Conditional Uses**
   Conditional uses are certain uses which are still allowed as long as they meet specifically defined requirements.

   A major limitation with zoning is that uses in existence before the adoption of new zoning regulations are permitted to continue as nonconforming uses.

3. **Municipal Extraterritorial Zoning**
   This type of zoning is used when a municipal well or its zone of contribution is beyond municipal boundaries. Extraterritorial authority for a first, second or third class city extends up to three miles beyond city limits. River Falls currently uses extraterritorial zoning.

   Interim zoning can be adopted by the city for a maximum of two years without the consent of the affected town. For extraterritorial zoning to become permanent after two years, it must be approved by a majority vote of a six-member committee composed of three town and three city representatives.

   Extraterritorial zoning enables cities to take emergency action to control land uses affecting their water quality.

4. **Municipal Subdivision Ordinances**
   These ordinances regulate how larger tracts of land are subdivided for sale or development. Subdivision regulation can apply to residential, commercial and industrial development.

   State subdivision regulations are described in Chapter 236, Wisconsin Statutes, but cities with a planning agency may adopt subdivision ordinances which are more restrictive than the statutory requirements.

5. **Municipal Extraterritorial Subdivision Ordinances**
Extraterritorial authority is the same as for extraterritorial zoning.

6. **Municipal Hazardous Substance Ordinance**
This type of ordinance could do some or all of the following: Identify hazardous substance, require reporting by new and existing businesses, establish standards for storage and handling, require contingency plans in case of spills and provide for inspection and enforcement. Automobile salvage yards could be regulated under this ordinance or under separate ordinance authorized by Section 175.25, Wisconsin Statutes.

   The limitations of this ordinance are: self-reporting by existing facilities may be ineffective and identifying substances to be regulated, setting storage and handling requirements and inspection all require technical expertise that can be expensive.

7. **Municipal Underground Storage Tank (USTS) Ordinance**
This ordinance would supplement nontechnical aspects of the Department of Industry, Labor and Human Relations (DILHR) regulations.

8. **Municipal Hazardous Waste Ordinance**
This ordinance would regulate small quantity generators not covered by state and federal regulations.

9. **County Zoning**
This zoning covers all areas of a county except for those municipalities which have enacted their

own zoning ordinances. The county could use overlay zoning to protect the ground water in the wellhead protection area.

10. **County Subdivision Ordinance**
    This ordinance would be similar to that described for municipalities.

11. **County Well Code Ordinance**
    Counties may adopt and enforce a county well code which must conform to DNR rules in Chapter NR112, Wisconsin Administrative Code.

    Two limitations of this ordinance are: Inspection may require additional staff and special training and the ordinance must be applied countywide. Cities and towns cannot adopt well codes.

12. **County Septage Ordinance**
    This ordinance would allow the county to regulate the land disposal of septage. Site criteria and disposal procedures must be identical to DNR rules in Chapter NR113, Wisconsin Administrative Code. If the county does not adopt a septage ordinance, cities and towns may do so.

13. **County Animal Waste Storage Facility Ordinance**
    Counties may adopt an ordinance that requires all earthen animal waste storage facilities to meet minimum design and siting criteria. Standards for land application of animal waste could also be specified.

14. **County Hazardous Substance Ordinance**
    This ordinance would be similar to that described for municipalities. The county could regulate automobile salvage yards under this ordinance or

under a separate ordinance authorized by Section 59.07 (38) Wisconsin Statutes.

The non-regulatory tools include:

Non-Regulatory Rules

1. **Administrative Programs**

   - Hazardous waste collection from homeowners.
   - Groundwater monitoring.
   - Reduction of salt used on roads.
   - Inventory of storage tanks, above and underground.
   - Incentive programs for sealing abandoned wells and removing underground storage tanks.

2. **Education Programs**

   - Septic tank maintenance; dangers of dumping hazardous materials into septic systems.
   - Proper storage, handling and disposal of hazardous wastes by household and businesses.
   - Leaking underground storage tanks, how they pollute and methods of leak prevention.
   - Proper abandonment of wells.
   - Best agriculture management practices and proper storage and handling of pesticides and fertilizers.

- Proper use and application of pesticides and lawn fertilizers.

- Drinking water quality as determined by areawide water testing programs.

In Wisconsin, the Town of Rib Mountain and City of Mosinee have enacted overlay zones surrounding their City well fields. Marathon and Portage Counties have written county ground water plans with specific recommendations for ground water protection and management. An example Well Head Protection Zoning Ordinance is included in Appendix D. (Schilling, 1993)

River Falls Wisconsin

Action Plan - Ground Water Protection 4/20/95

Subject: Protection of Regional Ground Water Resources

Purpose: To develop a proactive approach to identifying and protect sensitive ground water resources and addressing contaminants already present.

Goal: The City and adjoining townships shall develop and implement a wellhead protection program based on both regulatory and non-regulatory tools.

Applicable Goals and Policies:

Problems (Probable Obstacles)	**Solutions** (Obstacle Avoidance)
1. Overlapping authorities between City, townships and DNR regarding wells, landfills, on-site septic systems, zoning and other issues that address potential threats to ground water.	1. Develop cooperative agreement between all units of local government to develop and implement plan.
2. Areas of existing contamination.	2A. Identify location and extent of existing contamination. 2B. Develop action plan for proposed clean-up.
3. Public Awareness as to the importance of protecting ground water resources.	3. Undertake education effort to raise public awareness.
4. Inadequate piezometric data (observation wells)	4. Install observation wells and designate responsibility for data collection.
5. Available funding.	5. Seek available local, state and federal assistance.
6. Uncapped abandoned well.	6. Develop regional facilities inventory and program for compliance.
7. Failed septic systems.	7. Develop regional facilities inventory and program for compliance.

Table 54
Ground Water Protection
Summary

Revised 4/20/95

Activity Steps	Resources	Measurement	Completion Date
1. Obtain consensus among local units of government regarding need for developing regional strategy.	• Water Quality Plan (1993) • State & Federal Programs and Requirements • Similar Statewide Programs	Signed Cooperative Agreement	July, 1994
2. Prepare regional ground water protection strategy plan.	• Water Quality Plan • Similar Regional Plans • State/Federal guidance	• 1995 Budget Item(s) • Completed Plan	Jan. 1, 1995 Aug. 1995
3. Implement recommended strategies.	• Ground Water Protection Plan • Cooperative Agreement • Funding	• Install Observation Wells • Develop Consistent Zoning • Undertake Well Abandonment Program	June 1996 Dec. 1996 Jan. 1997

River Falls Wisconsin

PUBLIC INVOLVEMENT

Introduction

❑ What is Public Involvement?
Public involvement is a strategy which recognizes people want to be involved in decisions which affect any facet of their life. It creates and implements opportunities for the public to participate in the processes which lead to decision-making.

❑ Why Prioritize Public Involvement?
People desire to be spoken to honestly and to be listened to personally regarding issues of interest to them. They will not tolerate being ignored, manipulated or circumvented. People have become sophisticated and skilled in "activism" techniques. They have the ability to stop, stall, or redirect initiatives. Ultimately, the degree to which we achieve success on any initiative (both in our professional and personal lives) is in direct proportion to the quality of the public involvement plan we implement.

❑ Who Can Benefit from Public Involvement?
Any individual or group whose actions affect other people, even to the smallest degree, can benefit from public involvement. Examples include:

- Architects, Engineers, Planners
- Managers, Coordinators, Chairpeople
- Governmental Agencies/Departments
- Business Owners
- Employees
- Public Officials
- Policy-making Bodies
- Parents, Spouses/SI's

Additionally, any individual or group who is affected by the action of others can benefit. Examples of this second group include:

- Tax Payers
- Business Owners
- Special Interest Groups
- Employees, Coworkers
- Landowners
- Consumers
- User Groups
- Families

❑ **What are the Benefits to Public Involvement?**
Use of a well-constructed public involvement plan will serve to establish the legitimacy of this plan as the initiative for protecting the Kinnickinnic River. By providing a planned public involvement process, delays can be avoided and money can be saved. Additionally, mediations, lawsuits, and/or mitigations can be eliminated, politicking can be minimized, and creative solutions can be forthcoming which can enhance the initiative. Lastly, a competitive edge can be earned by individuals/groups who develop a reputation for successful public involvement.

❑ **Six Actions to Successful Plan Involvement**

1. **Prioritize communications.** Commitment to truly involving the public requires allocation of resources to provide the development and utilization of effective communication skills, i.e., public speaking and conflict management.

2. **Acquire knowledge and skill to effectively work with the public.** Achieving public involvement is dependent upon the application of the most appropriate methodology which will facilitate maximum participation of the people affected. Different methods are effective with different groups depending on the circumstances. Thus, holding a meeting and/or mailing a newsletter may be insufficient.

3. **Accurately identify all segments of the public.** Promote the self-identification of "potentially affected individuals."

4. **Accurately identify all segments of the public.** Analyze the motivations, fears, concerns and desires of the people affected. Such awareness allows for the responsive structuring of information and helps determine which public involvement techniques will be most productive.

5. **Involve the public in the process.** Conduct the initiative/project in full view of the public. Educate people to the process the project will follow. Actively provide people opportunities to participate in that process and give their input.

6. **Share consideration which determine the course of action.** Following a recap of the goals and desired outcomes of the project and communicate the considerations which determine the recommended course of action. It is essential the public witness that the issues raised from their participation are reflected in these considerations and have received thoughtful and respectful analysis.

❑ **Training For A Successful Public Involvement Agenda.**

Successful public involvement can only be achieved within an atmosphere which is committed to the concept and prioritizes the allocation of appropriate resources.

A key resource is training. Most technical and financial professions do not require adequate course work in communications. And, even for "people oriented" professions such as personnel, marketing and management, training which includes all aspects of public involvement are rare. Consequently, every professional can benefit from further communication and involvement training.

Recommended training components include:

- Introduction to the concept;
- Understanding the process;
- Public speaking;
- Conflict management/resolution;
- Presentations and interviews;
- Daily communication techniques (letters, memos, telephone);
- Meetings - types/applications, "user friendliness";
- Support Tools: graphics, newsletters, mailings, etc.

Public Involvement Strategy

Effective Decision-Making Evolves from Building a Participatory Team

❑ **Effective Decision-making Evolves From Building a Participatory Team**

Decision-makers face the dilemmas of modern government within the scrutiny of an unusually well-educated, easily mobilized, and politically active public. The "public" consists of elected and appointed officials, area residents, adjacent property owners, regulatory and non-regulatory agencies, civic and community groups, governmental employees, and special interest groups. Such a public requires (and, on many occasions, demands) a participatory role in decisions they perceive as affecting their quality of life. Thus, the design and management of a productive public involvement campaign is imperative to the fulfillment of the goals of this plan.

Effective decision-making evolves from the building of a participatory team which integrates the public and the responsible governmental entities. It is this approach which should permeate the implementation.

❑ **Systematic Development of Informed Consent (SDIC)**

The underlying principles of SDIC technique are:

- Individuals (as well as other interests) generally are **NOT** able to accept someone else's conclusions-if those conclusions are very painful ones.

- But, those **SAME** individuals (and other interested parties) usually **ARE** able to come to those painful conclusions themselves-provided the supporting information is available to them in an understandable, manageable format.

From an understanding of this principle and the supporting public involvement techniques, the community can launch a successful public involvement/communication plan. The anticipated outcome will be to obtain the willingness of opponents to "go along" with a course of action to which they may be initially opposed.

The advantages of utilizing the SDIC model include:

- Effective enhancement of the project goals.
- Achievement of the action plans and accomplishment of the mission.
- Surmounting of opposition.
- Minimization of polarization within the required region.
- Retention of respect and credibility for the program.

❑ **Public Involvement/Communication**
Identification of the communication needs of the public first requires audience analysis. Audience analysis identifies the following groups:

- The general public
- City of River Falls officials
- River Falls public utilities
- Adjacent township officials and residents
- Agricultural community
- Developers/contractors
- Potentially affected individuals (PAIs)
- The media (local and region)
- County elected and appointed officials
- Regulatory and nonregulatory agencies (ex: DNR, TU)
- Civic groups/organizations
- School district & University of Wisconsin - River Falls
- Kinnickinnic Valley Homeowners Group and Kinnickinnic River Land Trust

Next, an issues matrix will be developed. The resulting needs identified will involve varying intensities of informational methodologies including:

- Public informational meetings
- Visual aids
- Printed materials
- Education curriculum
- Media releases
- Presentations (speaking engagements)
- Meetings

Five distinct strategies are involved within the proposed public involvement program. These are:

1. **Preparation**

- Prepare informational handouts.
- Identify local officials, individuals, and groups for possible supportive involvement in public education activities.
- Further identify public education/awareness opportunities within the community. One option is to stencil onto existing storm sewers the location of the outfall to make people more aware of the ultimate location of storm water discharges and the impacts on the river.

2. **Media**

- Prepare and distribute media packets (including goals, issues, future projects, etc.).
- Meet with editorial boards of the local newspaper, regional newspaper, and television and radio stations (including Cable TV - Channel 12) serving the area. To increase their awareness of the issues, seek their support via news coverage and special features, and determine how the City might facilitate their support (public calendar deadlines, talk show opportunities, submission of feature articles, and

guest editorials authored through local individuals, etc.).

- Facilitate media assistance, as determined above.

3. **Events (potential opportunities available for consideration):**

- Sponsor a community-wide "poster contest." Offer a prize. Involve local officials and/or notables on the judging panel. Hold an art show of the entries. Possibly print copies of the poster and distribute during *Kinnie Falls Days* and/or *River Falls Days* (either free with cost underwritten by a business or sold with proceeds going into the river protection fund).
- Involve local youth/seniors/community service organizations and businesses in a project to call attention to the river. Perhaps, tree planting, flower garden, handicapped access, fishing pier, trails, benches, gazebo building, etc.
- Develop, with community involvement, a display of river history/significance for permanent residence in the local historical society or City building. A traveling version of the display could be used as a part of the education curriculum being developed through University of Wisconsin - River Falls and the school district.
- Publish a small paperback book of reminiscences from local residents about the river. Include historic photos, local artists' drawings, and written history. Distribute free with underwriting of local business/foundations or sell with proceeds going to the river protection fund.
- Public informational brochure/flyer for distribution in any of the following ways:
    - Existing *River Falls Newsletter*
    - Insert in local paper or "shopper"
    - Handout at local events

  - Direct mailing to residents
  - Video, slides, etc.
- Develop a presentation and market/deliver it among civic organizations (Chamber of Commerce, Jaycee, Rotary, etc.)

4. **Organizations**

- Establish a "Friends of the Kinnickinnic River" or similar foundation to accept on a non-profit basis, grants, gifts, and donations. With limited funding abilities, the future growth of this foundation may help to foster cooperation between the cities, townships, and counties and make the plan a reality.
- Encourage the continued involvement of existing groups like Trout Unlimited. Make the involvement of such groups well known.

5. **Curriculum Design**

- Support the numerous environmental education grant programs and initiatives of University of Wisconsin - River Falls and area schools to develop and implement curriculum focused on the South Fork and the entire watershed.

Action Plan - Public Involvement — 4/20/95

Subject: Public's role in protecting the Kinnickinnic River's Water Quality

Purpose: To increase the public awareness of the need to protect the river and to make the public an active particpant in river protection strategies.

Goal: The community shall establish, undertake, and maintain an aggressive public involvement program to increase citizen awareness and regional cooperation, build consensus regarding river protection strategies, initiate environmental education in the community and achieve the goals of this plan through active community participation.

Applicable Goals and Policies:

Problems (Probable Obstacles)		**Solutions** (Obstacle Avoidance)
1. Lack of cooperation between the townships and the city, especially outside of the Extraterritorial Zoning Area.	➤	1. Target specific techniques designed to inform and build a consensus.
2. Overlapping and conflicting jurisdictions and responsibilities for land use controls and river/resource use and protection.	➤	2. Establish mirror ordinances and/or an intergovernmental cooperative agreement to define the rules with each of the entities involved with land use and river/resource use and protection to function as the central clearing house for education, interpretation and management responsibility regarding land use controls.
3. Available funding to initiate and continue the public involvement program.	➤	3. Develop a five year budget which includes projected expenses, available grants, and other funding alternatives.
4. Lacking understanding of city strategies, DNR programs and UWRF/school district curriculums.	➤	4. Identify key players to design a multi-focus, single purpose curriculum for K-12 university level programs and community education.

Table 55
Public Involvement
Action Plan

Revised 4/20/95

Activity Steps	Resources	Measurement	Completion Date
1. Develop series of articles regarding the plan for the local newspaper and city newsletter.	• River Falls Community Development Office • River Falls Journal • St. Paul Pioneer Press • UWRF *Student Voice* • UWRF News Bureau	• Published Articles	Winter 1994/95
2. Conduct a series of public meetings to discuss the report and address issues of indivuals.	• UWRF, WDNR, television, Townships, City of River Falls • Public Meeting Announcements	• Completed meetings • List of Issues raised and addressed • List of interested volunteers	Spring 1993 and Ongoing Summer 1994 Fall 1994
3. Recognize public involvement activities of Kinnickinnic River Land Trust and other non-profit environmental organizations.	• Public Meetings • Newspaper • City Community Development Office • Water Management Plan • Interested & Motivated Contributions • Mission and Purpose Statements	• List of organizations and responsibilities for public education/public involvement • Formation of intergovernmental cooperative agreement for public involvement/education	June, 1994 Jan. 1995
4. Develop a river awareness/protection element for City celebrations (*Kinnie Falls Days and River Falls Days*)	• City celebration organization committee • Non-profit organizations • Local Businesses • UWRF • Agencies	• Water quality/ environmental focus events conducted	July/August 1994

Table 55 (Cont'd)

Activity Steps	Resources	Measurement	Completion Date
5. Establish budget process for public involvement program.	• Non-profit organizations • Water Quality Plan • Community Development Staff • City, County, Township Budget Process	• Adopted city budget item for public involvement	Jan. 1, 1995
6. Education Grant Applications	• List of available grants and application requirements - UWRF	• Completed grant applications	Ongoing
7. Develop a presentation video/ program for civic groups and professional organizations.	• UWRF • Video Production Consultant • Public Access TV	• Completed Video • List of groups to which presentation has been made	May, 1994 Ongoing
8. Poster contest and non-profit organization membership drive.	• River Falls Days and *Kinnie Falls Days*	• Membership List and fund raiser results	Jan. 1995
9. Complete a Kinnickinic River history book as a fund raiser.	• Local residents • Non-profit organizations • UWRF	• Completed Document • Book Orders	May, 1996 Ongoing

IMPLEMENTATION

The Implementation Section is intended to provide guidance in carrying out the plan objectives. This section outlines the administrative process and recommends changes and additions to be made to existing community ordinances. The implementation program summarizes the schedule for and cost of recommended actions. Financing options are also discussed, followed by procedures for amending the plan. Lastly, standards for the plan implementation are included in Appendices A & B.

Permitting

City Authority

The major task of administering this plan will be in the permitting process. The City assumes the role of permitting for all land alteration within the city limits, thereby enforcing the policies and standards of this plan.

Permit Amendment

The City's existing permit procedures shall be amended to include water management aspects outlined in this plan. The permit for surface water management would be acquired at the same time all other permits are applied for. An approved permit would be required with any submitted preliminary plat. The building permit will be modified to regulate individual pond and drainage system impacts which are not covered by platting regulations. The permit shall require the applicant to meet the development standards of this plan (Appendix A & B). A City inspector shall be responsible for enforcement of the requirements in the permit.

To ensure conformance to this plan, the City's preliminary and final platting process shall require more detailed information. Thermal mitigation, development intensity (total percent impervious cover) erosion control and information regarding local plan standards are amount the items that should be addressed.

Local Government's Role

The City, townships, St. Croix and Pierce counties and WDNR will continue review and comment on any proposed land alteration within the ETZ. These units of government can appeal approval of a particular development if the project is considered to be inconsistent with this management plan. Outside of the ETZ, the responsibility is currently with the townships and/or county.

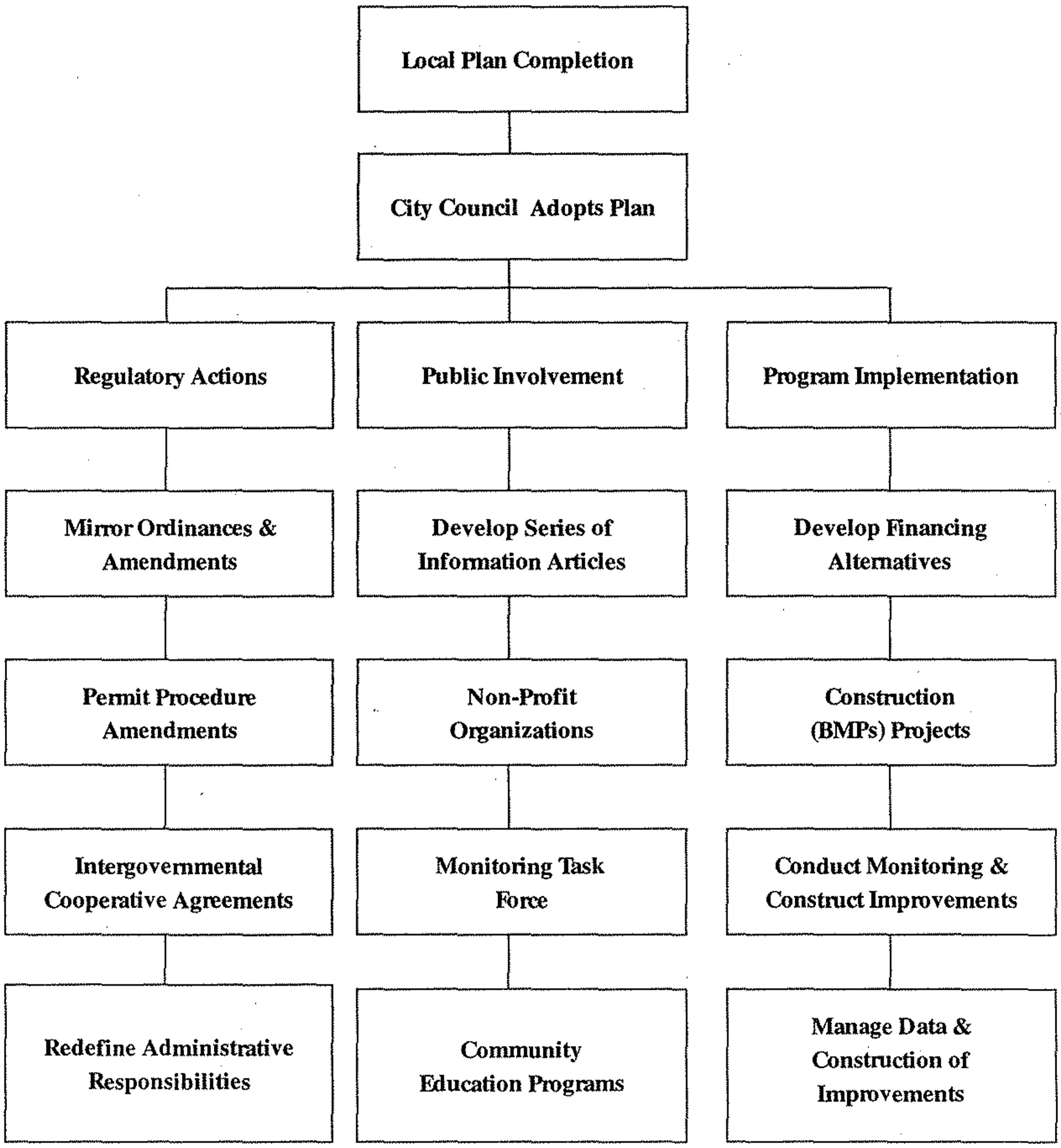
Administrative Process

The flow chart on page 245 illustrates the administrative process related to plan implementation. The administrative responsibilities of the City, and other related agencies follow:

A significant implementation program, both in scope and cost has been presented in the plan. The programs, projects and costs associated with the plan must be approved as individual items as part of the City's Capital Improvement Program.

By adopting the plan, the City Council has not specifically adopted the implementation program. Each activity is still subject to action by the common council before it can be considered in the City's annual budget.

Administrative Process



Administrative Responsibilities

Several entities will have administrative responsibilities within the planning area. For a local water management effort to be successful, each entities commitment and role must be clearly understood. Those currently having some level of administration responsibility include the City, UW River Falls, Trout Unlimited, WDNR, Pierce and St. Croix counties and the townships.

Following is a description of administrative responsibilities:

City's Role

The City's administrative responsibilities within City limits (and in the ETZ to the extent the authority exists) include, but are not limited to the following:

- Land use regulation
- Sediment and erosion control (ordinance)
- Permits (expansion of current program to cover drainage and erosion control)
- Capital improvements
- Conveyance system pond maintenance
- Participation and cooperation with the programs of the UWRF, WDNR and TU
- Local plat review and amendments
- Groundwater - wells
- Flow regulation - dam operation
- Individual septic systems records maintenance
- Ordinance review and amendment
- Comprehensive plan update(s)

- Financing Alternatives
- Hydrologic model update with land use/zoning changes
- Flood insurance study amendments

Federal, State and Local Agencies

Federal, state, and local agencies will continue to have certain overlapping administrative responsibilities. Several of these include, but are not limited to:

- Land use regulation and wetland alteration
    - Department of National Resources for all issues relating to state protected waters and wetland
    - U.S. Army Corps of Engineers, U.S. EPA, and U.S. Fish and Wildlife for all issues related to all wetland are not under the jurisdiction of the DNR
- Ground Water Issues
- Individual septic systems
- Hazardous waste/spill response

UW River Falls

UW River Falls management responsibilities include:

- Community education programs
- Development/maintenance of campus water quality features
- Restoration and maintenance of physical stream habitat of the South Fork within campus

- Repository for all monitoring data.

Trout Unlimited

TU's role includes:

- Coordination of volunteer efforts for TU-sponsored habitat projects and thermal monitoring.

Townships

Township responsibilities include:

- Adoption of ordinances that mirror City ordinances regarding watershed management.

Proposed Inter-governmental Cooperative Agreement

The long term success of the water management effort hinges on cooperation between the townships and the City. Cooperation means consistent policies for pond design, erosion control, land use practices, development intensity, groundwater protection, recreational opportunities and beyond.. Mirror ordinances can accomplish this goal.

Establishment

However, if mirror ordinances prove ineffective, a short term strategy that has met with much resistance is the extension of the ETZ to a full 3 mile radius. Although this action may accomplish consistency in land use policies, it lacks the regional cooperation necessary for the long term success of the program.

A viable, yet not well established alternative to ETZ extension would be to establish an intergovernmental cooperative agreement for the Kinnickinnic River. Figure 45 on page 253 illustrates the entire Kinnickinnic River basin which encompasses the 64 square mile study are and area in both St. Croix and Pierce Counties.

The watershed-based initiative is not a new concept for Wisconsin. The conference proceedings from the First Annual Wisconsin Water Law Conference (University of Wisconsin Law School, 1993) identified the need for watershed-based management (Sheffy, 1993).

Wisconsin Statutes 66.30 provides for an inter-municipal contract or cooperative agreement. (Kuhlmann, 1993). A Cooperative Agreement between local units of government would help achieve the purposes of this plan by:

A. assessing existing water quantity and quality problems;

B. assessing potential water problems and opportunities for natural resources enhancement in view of projected watershed development; and

C. formulating practical strategies to correct existing problems, to prevent potential problems, and to take advantage of opportunities to enhance water-related natural resources.

The State Priority Watershed Program is the catalyst for watershed-based management. Through the program, local government will have the opportunity to participate in the following activities:

- Assess existing watershed problems.
- Assess potential watershed problems and possible solutions.
- Formulate corrective strategies.
- Develop policies with the purpose of managing water resources on a watershed basis.
- Develop Watershed Management Plans.
- Utilize state funds to resolve any water management problems within the watershed.
- Monitor the implementation of plans and projects.
- Notify, inform, and solicit comments from citizens as appropriate.
- Interact with DNR and other water management agencies to insure consistency in the application of federal, state and local initiatives.

- Evaluate the condition of all water courses and conduct necessary repairs, improvement and maintenance.
- Resolve inter-community water management issues.
- Take lead role in the area of water quality, including monitoring and modeling.

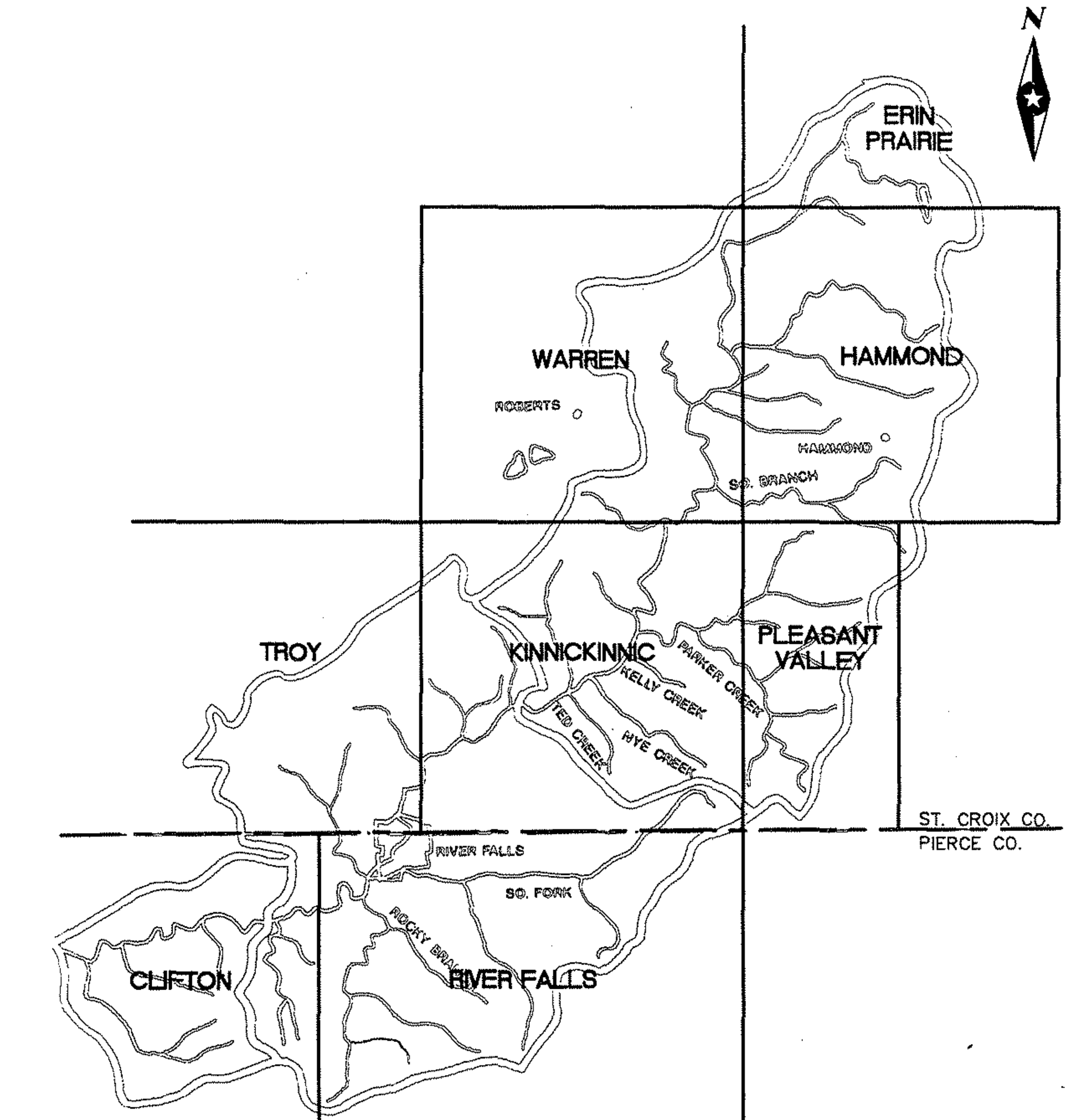


Figure 45
Kinnickinnic River Basin

Ordinances

The City of River Falls has several codes and ordinances that relate to surface water management. Table 56 depicts ordinances that will help the City realize the goals of this plan. The table also indicates the current status of each ordinance.

Consistency in water management will follow if the surrounding townships will adopt and enforce mirror ordinances.

Table 56
Regulation Status

Ordinance	Specifically Covered by Existing Code or Ordinance	Not Clearly Distinguished in Existing Code or Ordinance	Modifications Required
Shoreland Mgmt.	Chapter 22.17(2)		
Flood Plain Mgmt.	Chapter 22		
Wetland Protection	Chapter 22.20		X
Erosion Control	Chapter 19		X
Public Utilities		X	
Environmental Protection		X	
Storm Water Management	Chapter 18.07(2)	(d)	X
Groundwater (Wellhead) Protection		X	
Land Development Density		X	

Shoreland Management

City Ordinance references Pierce and St. Croix Co. Regulations.

Floodplain Management

City Ordinance is very comprehensive in the area of floodplain management.

Wetland Protection

River Falls demonstrated its interest in natural resource protection by adopting a wetland protection ordinance as part of the floodplain zoning ordinance in 1990. These modifications are suggested: (1) the ordinance should be consistent with federal sequencing (avoid, minimize, compensate). (2) identification of existing wetland should address land areas having a predominance of hydric soils that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that normally do support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions. An on-site field investigation should be required prior to all development, not just referring to existing WDNR mapping. (3) the ordinance should stand alone from floodplain zoning to place more emphasis on ordinance adherence.

Erosion Control

The City's erosion control ordinance is a very effective tool against reducing total suspended solids loading if properly implemented and enforced. Suggested modifications include

1. Referencing the Wisconsin Construction Site Best Management Practice Handbook (WDNR, 1989).

2. Include specifics for implementation of erosion control elements in lieu of phrases like "smallest practical area" or "as short a duration of time as is possible".

3. Consider modifying all references to storm water management by (a) referring to this document

(Appendix A) or (B) by creating an independent chapter "Storm Water Management" combining existing storm water related references.

4. Establishing fees for inspection which cover actual costs.

5. Require performance bonds for erosion control implementation.

6. Offer developer educational materials to enhance conformance.

Public Utilities

Availability of and requirement for connection to public utilities (sanitary sewer and potable water systems) should be specifically addressed. The ordinance should discuss provision of mandatory connection immediately upon availability, abandonment of private on-site septic systems, and well capping.

Environmental Protection

This ordinance would focus on the major elements of this study; total suspended solids and thermal load reduction as a means to improving water quality in the Kinnickinnic River. The ordinance would establish an environmental overlay district at least 500 feet either side of the river and tributaries, specify effective percent impervious (EPI) goals for proposed development, address fertilizer and chemical controls (both urban and rural applications) disposal of leaves and lawn clippings in a regional composting program, vegetation management in ditches, wetlands and stream banks, weeds and noxious growth, hazardous materials identification and control, hazardous waste disposal and a spill response program.

[The possibility of combining this ordinance with groundwater protection exists.]

Storm Water Management

The Storm Water Management Ordinance would include excerpts from existing ordinances provisions, as well as references to this plan in an effort to establish consistency in managing storm water runoff. This plan would become part of the City's Comprehensive Plan (adopted by reference). A uniform regional storm water management ordinance could be the first task for a newly formed water management organization.

Land Development Density

A land development density provision could be added to existing zoning. The environmental protection ordinance specifies effective percent impervious goals. This section of the code would specify minimum green space requirements, connected impervious areas, landscaping for shading, etc.

Groundwater (Wellhead) Protection

The groundwater protection ordinance would establish overlay districts of wellhead protection areas and spring areas. It would also address permitted uses in the various protection zones and could be further developed to address abandonment of wells. An example ordinance is provided in Appendix D.

Provisions for inspections and maintenance of on-site facilities (sanitary) should be developed. The first step would be to develop an inventory on on-site systems. The ordinance would require demonstration of bi-annual maintenance records to prevent environmental impacts from individual septic systems. The second step involves the identification of all existing private wells, an abandonment of all non-essential facilities.

[Elements of this ordinance could be combined with the environmental protection ordinance.]

Implementation Plan

Note: The plan was first reviewed formally by City Council in 1994. The five year plan, starting in 1994, is illustrated in the following stages. For simplicity, the years in the Implementation Plan have not been changed to match the final date of this document.

The implementation plan includes identification and prioritization of capital improvements, administration, inspections, permitting, plan amendments, financing alternatives, public involvement and monitoring programs.

Projects have been divided into three categories; Reactive, Enhancement and Proactive. Reactive projects involve the rehabilitation of existing problem areas. Enhancement projects involve the modification of existing facilities to improve flood control, water quality or thermal mitigation aspects. Proactive projects include non-structural, regulatory elements.

Planning-level estimates of capital expenditures have been made. Future anticipated projects are also listed. The Implementation Plan, Table 57 through Table 62, summarizes anticipated expenditures. Expenditures are also anticipated for such items as performing drainage system inspections, review and development of ordinances, amendment proceedings and maintenance.

The Implementation Plan is not a hard and fast commitment to complete each and every activity in the timeframe suggested. Rather, it is a suggested course of action that will accomplish the major goal of this plan, to accommodate growth in the community while protecting the environment.

The Implementation Plan should be reviewed on an annual basis. At that time, each proposed improvement is to be reconsidered, City budgets adjusted, and additional improvements added to the program

Figures No. 46 and 47 on pages 283 & 284 illustrate the implementation plan.

TABLE 57
CAPITAL EXPENDITURES SUMMARY
(1994 DOLLARS)

1994	$241,500
1995	$225,000
1996	$228,400
1997	$542,000
1998	$1,660,000
1999-2003	$2,325,000
TOTAL	**$5,221,900**
Average Annualized Cost	$522,190
Reactive Projects	$1,918,000
Enhancement Projects	$2,681,000
Proactive Projects	$622,900

***Potential Funding Sources:**

DNR Lakes Planning Grant	$20,000
RC RC&D/Pierce County	$10,000
DNR Fisheries Management	$84,000
UW River Falls (In Kind)	$10,000
Trout Unlimited (In Kind)	$12,000
Section 319 Program	$1,610,000
Wisconsin Development Fund	$250,000
DNR Priority Watershed	$80,000
Wallop-Breaux Funds	$500,000
TOTAL	**$2,576,000**

*These figures in no way represent a commitment on the part of the agency or entity. However, based on knowledge of funding programs, the figures represent sources of funding to be investigated.

Table 58
Implementation Plan

Revised 4/20/95

1994 Implementation Plan

No.	Item	Action Plan Reference	Cost	Complete	Responsible Units	Code
94-01	Establish Monitoring Task Force	Monitoring Plan 1a1	$1,000	August	City, Township, University, DNR, TU	P
94-02	Develop Mirror Ordinances for Watershed Mgmt.	UK1, MV1, RB1, DK1	$10,000	November	City, Township, County	P
94-03	Environmental Overlay Ordinance	UK3, UD3, MV3, RB3, DK3	$3,000	November	City, Township, County	P
94-04	Lake George Lake Planning Grant Application	Upper Dam 3a	$2,000	February	City	E
94-05	Lake George Lake Planning Grant Report	Upper Dam 3b	$15,000	December	Municipal Utilities, City, DNR, TU	E
94-06	Map of Potential System Retrofit Locations	UD5, LD6	$3,500	December	City	P
94-07	South Fork Effective Percent Impervious Std.	South Fork 4	$2,000	December	City, University, River Falls Township, DNR, TU	P
94-08	South Fork Restoration Task Force	South Fork 5	$2,000	Ongoing	City, University, River Falls Township, DNR, TU	R
94-09	South Fork Restoration Studies/Projects	South Fork 6	$4,000	Ongoing	City, University, River Falls Township, DNR, TU	R
94-10	Mann Valley BMP Location Mapping	Mann Valley	$4,000	December	City	P
94-11	Bartosh Canyon Restoration Plans/Specifications	Downstream Kinnickinnic 5b	$15,000	April	City, Pierce Co. RC, RC&D, SCS	R

Table 58 (Continued)

94-12	Bartosh Canyon Restoration Construction	Downstream Kinnickinnic 5c	$175,000	October	City, Pierce Co. RC RC&D, SCS	R
94-13	Apply for Priority Watershed Status	Implementation Plan - Financing	$2,000	March-June	City, DNR, County Land Conservation	P
94-14	Apply to Section 319 Financing	Implementation Plan - Financing	$3,000	March-May	City, DNR, County Land Conservation	P
	1994 Total		**$241,500**			

Reactive (R)	$196,000	(81.2%)
Enhancement(E)	$17,000	(7.0%)
Proactive(P)	$28,500	(11.8%)

Potential Revenue Sources:

DNR Lakes Planning Grant (94-05)	$10,000
RC RC&D/Pierce Co. (94-11)	$10,000
DNR Fisheries Management (94-09)	$4,000

Table 59
Implementation Plan

Revised 4/20/95

1995 Implementation Plan

No.	Item	Action Plan Reference	Cost	Complete	Responsible Units	Code
95-01	Monitoring Policy Paper	Monitoring Plan 1a1	$3,000	March	City, Township, UWRF, DNR, Counties, TU	P
95-02	Monitoring Contributions by Local Government	Monitoring Plan 1b	$5,000	May	City, Township, UWRF, DNR, Counties, TU	P
95-03	Monitoring Information System	Monitoring Plan 1c	$4,000	August	City, Township, UWRF, DNR, Counties, TU	P
95-04	Monitoring Criteria	Monitoring Plan 1d	$4,000	October	City, Township, UWRF, DNR, Counties, TU	P
95-05	UWRF Monitoring Data Center	Monitoring Plan 1e	$6,000	December	City, Township, UWRF, DNR, Counties, TU	P
95-06	Identify Spring Areas	UK2, MV2, LD2, RB2, DK4	$8,000	May	City, Township, UWRF, DNR, Counties, TU	P
95-07	Establish Developer Criteria	UK4, UD4, MV4, RB4, DK4	$3,000	March	City, Township, UWRF, DNR, Counties, TU	P
95-08	Sediment Reduction-Equipment	Upper Dam 2, Lower Dam 5	$55,000	December	City	P
95-09	Industrial Park Pond Study	Upper Dam 2a	$10,000	September	City	E
95-10	Unnamed Tributary Temporary Sediment Trap	South Fork 1	$65,000	November	City, UWRF, DNR	R
95-11	Unnamed Tributary Uncontrolled Runoff Study	South Fork 2	$15,000	September	City	R

Table 59 (Continued)

95-12	South Fork Restoration Task Force	South Fork 5	$2,000	Ongoing	City, University, River Falls Township, DNR, TU	R
95-13	South Fork Restoration Project Implementation	South Fork 6	$30,000	November	City, University, River Falls Township, DNR, TU	R
95-14	Lake Louise Lake Planning Grant	Lower Dam 1	$2,000	August	City	E
95-15	Lake Louise Planning Committee	Lower Dam 2	$5,000	December	Municipal Utilities, City, DNR, TU	E
95-16	River Hills Pond Modification Study	Downstream Kinnie 6a	$8,000	October	City	E
	1995 Total		**$225,000 (1994 Dollars)**			

Reactive (R)	$112,000	(49.8%)
Enhancement(E)	$25,000	(11.1%)
Proactive(P)	$88,000	(39.1%)

Potential Revenue Sources:

DNR Lakes Planning Grant (95-13) $30,000

Table 60
Implementation Plan

Revised 4/20/95

1996 Implementation Plan

No.	Item	Action Plan Reference	Cost	Complete	Responsible Units	Code
96-01	Monitoring Standards	Monitoring Plan 1f	$4,000	February	City, Township, UWRF, DNR, Counties, TU	P
96-02	Monitoring Plan Written	Monitoring Plan 1g	$4,000	April	City, Township, UWRF, DNR, Counties, TU	P
96-03	Seek Monitoring Funds	Monitoring Plan 2	$2,400	October	City, Township, UWRF, DNR, Counties, TU	P
96-04	River Flow Monitoring Installation	Monitoring Plan 4a	$6,000	April	TU	P
96-05	River Flow Monitoring Data Recording	Monitoring Plan 4b	$1,000	Ongoing	TU	P
96-06	Additional Precipitation Monitoring	Monitoring Plan 6	$5,000	October	UWRF	P
96-07	Sediment Reduction Strategy - Labor	UD2, LD5	$16,000	December	City	P
96-08	Industrial Park Pond Const.	Upper Dam 6	$70,000	November	City	E
96-09	St. Croix St. Outfall Study	Upper Dam 7	$10,000	October	City	E
96-10	South Fork Habitat Features	South Fork 8	$30,000	November	DNR, UWRF	R

Table 60 (Continued)

96-11	WWTP Thermal Abatement Study	Lower Dam 3a	$10,000	October	City, Municipal Utilities	E
96-12	River Hills Pond - Construction Modifications	Downstream Kinnie 6b	$70,000	November	City	E
	1996 Total		**$228,400 (1994 Dollars)**			

Reactive (R)	$30,000	(13.1%)
Enhancement(E)	$160,000	(70.1%
Proactive(P)	$38,400	(16.8%)

Potential Revenue Sources:

DNR Fisheries (96-10)		$30,000
UWRF (96-06)	$5,000	
Trout Unlimited (96-04, 96-05)	$7,000	

Table 61
Implementation Plan **Revised 4/20/95**

1997 Implementation Plan

No.	Item	Action Plan Reference	Cost	Complete	Responsible Units	Code
97-01	Ground Water Monitoring Wells Installed	Monitoring Plan 3a	$30,000	October	City, Municipal Utilities	P
97-02	Stream Temperature Model	Monitoring Plan 4c	$20,000	October	City, TU, DNR	P
97-03	Storm Water Monitoring	Monitoring Plan 5	$15,000	September	City, UWRF	P
97-04	Percent Impervious Correlation	Monitoring Plan 7a	$12,000	December	City, TU, DNR	P
97-05	Stream Response Correlation	Monitoring Plan 7b	$6,000	December	City, TU, DNR	P
97-06	Final EPI Criteria	Monitoring Plan 7c	$4,000	December	City, TU, DNR	P
97-07	Sed. Reduction Strategy - Labor	UD2, LD5	$16,000	December	City	P
97-08	St. Croix St. Outfall Construction	UD7	$70,000	November	City	E
97-09	Lake George Feasibility Study	UD8	$40,000	November	City, DNR, TU	E
97-10	Unnamed Trib. Box Culvert Feasibility	South Fork 3a	$40,000	November	City	R
97-11	Unnamed Trib. Wetland Mitigation Plan	South Fork 7a	$4,000	November	City, DNR, UWRF	E
97-12	South Fork Habitat Features	South Fork 8	$20,000	November	DNR, UWRF	R
97-13	WWTP Thermal Abatement Project	Lower Dam 4b	$250,000	97-98 Const.	Municipal Utilities, City	E
97-14	Lake Louise Stream Restoration Study	Lower Dam 5	$150,000	December	City, DNR, TU, Municipal Utilities	E
	1997 Total		**$542,000 (1994 Dollars)**			

Reactive (R)	$60,000	(11.1%)
Enhancement (E)	$379,000	(69.9%)
Proactive (P)	$103,000	(19.0%)

Potential Revenue Sources:

DNR Fisheries (97-12)	$20,000
Lake Planning Grant (97-14)	$10,000
Section 319 Program (97-08 & 97-10)	$110,000
Wisconsin Development Fund (97-13)	$250,000

Table 62
Implementation Plan

Revised 4/20/95

1998 Implementation Plan

No.	Item	Action Plan Reference	Cost	Complete	Responsible Units	Code
98-01	Ground Water Well Monitoring	Monitoring Plan 3b	$10,000	Annual Task	Municipal Utilities, City	PP
98-02	Pesticide Monitoring - Ag. Areas	Monitoring Plan 8	$30,000	March-Nov.	Townships, County, DNR	P
98-03	Unnamed Tributary Box Culvert Replacement	South Fork 3b	$1,500,000	May, 1999	City	R
98-04	Unnamed Tributary Wetland Construction	South Fork 7a	$100,000	October	City, DNR, UWRF	E
98-05	Republish Unnamed Tributary Flood Insurance Study	South Fork 9	$20,000	December	City, DNR	R
	1998 Total		**$1,660,000 (1994 Dollars)**			

Reactive (R)	$1,520,000	(91.6%)
Enhancement (E)	$100,000	(6%)
Proactive (P)	$40,000	(2.4%)

Potential Revenue Sources:

DNR Priority Watershed (98-02)	$30,000
Section 319 Program (98-03, 98-04)	$1,000,000

Table 63
Implementation Plan

Revised 4/20/95

Future Projects (1999-2003)

No.	Item	Action Plan Reference	Cost	Complete	Responsible Units	Code
F-01	Ground Water Well Monitoring	Monitoring Plan 3b	$50,000	$10,000 Annual Funding	Municipal Utilities, City	P
F-02	River Temp. & Flow Monitoring	Monitoring Plan 4b	$5,000	$1,000 Annual Funding	TU	P
F-03	Precipitation Monitoring	Monitoring Plan 6	$5,000	$1,000 Annual Funding	UWRF	P
F-04	Monitoring Plan Implementation	Monitoring Plan 1g, 8	$10,000	$1,000 Annual Funding	City, DNR, UWRF, TU	P
F-05	Lake George Restoration - Plan Implementation	Upper Dam 8	$1,000,000	As funds are available	City, DNR, TU, Counties	E
F-06	Lake Louise Restoration - Plan Implementation	Lower Dam 7b	$1,000,000	As funds are available	City, DR, TU, Counties	E
F-07	Old Sanitary Landfill	Rocky Branch	-	Based on Remediation Plan	City	R
F-08	Sediment Reduction Strategy - Labor	UD2, LD5	$90,000	$16,000 Annual Funding	City	P
F-09	Detention Pond Maintenance, Permits, Inspections, Enforcements	-	$125,000	$25,000 Annual Funding	City	P
F-10	Ordinance Review & Revision	-	$10,000	2003	City, Townships, County	P
F-11	Watershed Plan Amendment	-	$30,000	2003	City, Townships, County	P
	Future Projects Total		**$2,325,000**			

Reactive (R)	--	
Enhancement (E)	$2,000,000	(86%)
Proactive (P)	$325,000	(24%)

Potential Revenue Sources:

DNR Priority Watershed (F-01)	$50,000
Wallop-Breaux Funds (F-05, F-06)	$1,000,000
Section 319 Program (F-05, F-06)	$500,000
Trout Unlimited (F-02)	$5,000
UWRF (F-08)	$5,000

Financing

Paying for water management projects has become more complex in recent years. In the past, special assessments against benefited properties financed most of the necessary improvements. However, the financial options have broadened considerably. The question is, which method(s) best suit the needs of the City.

The major categories of funding sources are (1) Ad Valorem Taxes; (2) Special Assessments; (3) Impact Charges (Building Permits, Land Development Fees and Land Exaction); (4) User charges; (5) Tax Increment Financing; and (6) Grants. Following is a description and financing principles used with each of these financing mechanisms.

Table 63 on page 279 illustrates the advantages and disadvantages of the different financing methods.

Ad Valorem

A. General Taxes
General taxation is the most common revenue source used to finance government services including minor maintenance measures for drainage and water quality facilities. Using property tax has the effect of spreading the cost over the entire tax base of a community.

B. Special Tax District
The tax district is similar to the administrative structure under general taxation except that all or part of the community may be placed in the tax district. The principle is to better correlate improvement costs to benefited or contributing properties.

Special Assessments

Municipalities are familiar with the use of special assessments to finance special services from maintenance to construction of capital improvements. The assessments are levied against properties benefiting from the special services. The philosophy of this method is that the benefited properties pay in relation to benefits received. The benefit is the increase in the market value of the properties.

Impact Charges

As land is developed or built upon, surface 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 can require dedication of land for ponding or drainage purposes. The land, however, must be from the parcel being developed.

User Charges

User charges are a mechanism by which a city can generate funds through billings similar to water and sewer billings. The principle is to charge for services rendered to properties without consideration to an increase in market value of the property.

Tax Increment Financing

The City could establish a TIF district and utilize the funds for capital improvement and retrofits of the drainage system. TIF funds however, must be spent within the district.

Grants

State grants are available for surface water management and nonpoint source pollution. However, it is generally not a good financial practice to rely 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. Examples of some available grants include:

State of Wisconsin

A. Wisconsin Department of Natural Resources (WDNR)

- Lakes Planning Grant

The Lakes Planning Grant is offered twice annually (February and August). The grant amount (usually $10,000) is typically supplemented with $3,000 to $5,000 in local dollars. Diagnostic evaluations and water quality analysis are typically funded activities. Participation in the Lakes Planning Grant Program is a prerequisite for participation in the Federal Clean Lakes Program. The grant is available on an every-other-year basis.

- Priority Watershed Program

In late April or early May of each year, DNR district offices contact the Land Conservation Offices of each County to solicit interest in the state's priority watershed program. If a County expresses interest prior to the July 1 deadline, the proposed priority watershed is placed on a state consideration list.

If granted, the priority watershed program represents the single largest state funding source. Typically, the program begins with a one to two year planning process and continues on into funding demonstration best management practices and implementation of projects in both the urban and rural setting. The program relies on County support and voluntary participation by property owners.

- State Land Stewardship Program

This voluntary program includes a streambank 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.

- State Revolving Loan Fund Program

  Typically used for wastewater treatment and collection systems, state dollars could potentially be used in watershed or non-point source control. DNR has not been contacted in this regard.

- Wisconsin Development Fund

  The City has previously applied for funding assistance from WDF for the unnamed tributary box culvert project, without success. Dollars are typically applied to construction activities.

- Lake Protection Grants - Another Tool for Lake Organizations

  With assistance from this new grant program, lake management organizations can obtain up to $100,000 in matching funds to purchase wetlands and other lands critical to lake ecosystems. They will also be able to develop local regulations or restore wetlands.

  All counties, cities, towns, villages, tribes, town sanitary districts, public inland lake protection and rehabilitation districts, and qualified lake associations are eligible to participate in this grant program.

  Activities that are acceptable for funding include purchasing property or easements which contribute to the protection or improvement of the natural ecosystem 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 and the educational activities necessary for these regulations to be implemented.

The state will contribute 50% of the cost of a project or property purchase, up to $100,000. The Department of Natural Resources will provide applications and technical guidance for the Protection Grants Program. Grants will be awarded annually and a priority project list will be prepared each year on a state-wide basis. The first grant deadline is November 1, 1993.

B. River Country Resource Conservation and Development Area.

RC RC & D

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.

Misecellaneous

C. Other potential sources of grant monies include:

- Environmental Protection Agency (EPA)

  - 604b - Urban Water Quality Grant

    The EPA's 604b Grant Program is targeted at water quality improvements in urban areas. The grant is not a cost share program, but does require local participation. The grant is generally administered through the state. A 604b grant (previous 205j) funded over 80 percent of this study.

- Underground Injection Control Program

  The U. S. Environmental Protection Agency's Underground Injection Control (UIC) program involves inventories of ground water protection areas in the City to address abandoned drainage or domestic disposal wells which are potentially harmful to underground sources of drinking water. The results of the questionnaire can provide a great deal of information on the degree of risk to the City's underground sources of drinking water. The EPA has provided funding and training for volunteers to implement the UIC program at the local level.

- Environmental Education Grant

  The EPA's Environmental Education Grant, enacted in 1991, is targeted at cities or organizations in the amount of $25,000 or less. The Environmental Education Grant is intended to finance local education initiatives related to the nature environment. Grants are awarded on a 50/50 cost share basis.

- Clean Lakes Grant

  The federal Clean Lakes Grant is the next step in lake restoration following the State Lake Planning Grant Program. The program includes significantly more funding than the state program and can be used for development and implementation of lake restoration plans.

- Section 319 - Clear 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 includes a spring application period (May to June). The program is significant in that it funds implementation (i.e., construction) rather than funding planning efforts or studies. The funds are available for either full or matching funds.

• U.S. Army Corps of Engineers

  - Section 22 Planning Assistance to States Programs

    Funds are a 50/50 cost share. The program is administered through state planning (WNDR-Madison). Eligible projects are given to COE to prepare a cost estimate for preliminary design. The estimate 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.

- Mississippi River Coordinating Commission (National Park Service)

    The Commission prepared a plan in 1988 to preserve and restore the natural and historical nature of a 50,000 acre river corridor called the Mississippi National River and Recreation Area.

    Availability of funds to states or local units is unknown at this time. The earliest funds would be available until FY 95 (October 1994). The ability to tie the project to park/trail issues could be important. Funds would be up to a 50/50 cost share. However, getting funds for application on the St. Croix Basin may be difficult.

D. Private

- Upper Mississippi River Basin Association

    - Environmental Management Program (EMP)

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

    - McKnight Foundation

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

McKnight Foundation, stretching dollars to cover the Kinnickinnic River is unlikely.

- Minnesota-Wisconsin Boundary Area Commission

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

- Kinnickinnic River Land Trust

  This non-profit organization can receive state and federal funding for obtaining conservation easements or development rights over properties along the river.

• Wallop-Breaux Funds

  The program is called Wallop-Breaux, referring 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 sportfishing 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 an activity are strictly reinvested back into the activity's maintenance.

  The Internal Revenue Service collects the money and gives it to the U. S. Fish and Wildlife Service. After taking 6 percent off the top for administration, the service gives money to each state based on its relative size and the number of resident fishermen. No state receives more than 5 percent of the total, less than 1 percent.

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 percent went to surveys and research. About half of the 6 percent the service takes pays for the staff that administers the funds. The rest of the $12 million a year in administrative money is used for various special projects.

Table 64
Advantages and Disadvantages of Different Financing Mechanisms

	Ad Valorem Tax	Special Assessments	Fee Impacts	User Charges	Grants
Advantages	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. Only benefited properties pay. 2. Revenues from assessment are applied to a specific project cost. No competition with general services. 3. Benefits directly related to cost for service. 4. Assessment can be deferred in hardship cases.	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. 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 services 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. Reduce cost burden to residents in the community.
Disadvantages	1. No incentive to reduce runoff or pollution. 2. No relationship to level of benefits received. 3. Discontinuous source of revenue. 4. Limitations on amount of expenditures due to budget constraints. 5. Competition with other City services (i.e., police, fire).	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.	1. Only addresses problems within the vicinity of the new development, not usually existing developments. 2. Only addresses prevention not correction of major problems. 3. Limited usefulness as a financing mechanism.	1. Some initial costs in development of rate formula and philosophy. 2. May require an expanded administrative structure.	1. Undependable source of revenue. 2. Increase 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 considerable lead time from application to receiving funds.

Wallop-Breaux is supposed to be new money for new fishery improvements. But some of the money is being used to replace state funding from licenses and the general treasury. The U. S. Fish and Wildlife Service views itself as simply a conduit of dollars to the states.

- Pittman-Robertson - Federal Aid in Wildlife Restoration Act

  Funded by an excise tax on angling and hunting equipment, this program helps raise the revenue necessary to fund specific restoration projects by state fish and wildlife agencies.

- Sport Fish Restoration Act

  States receive federal aid monies for fisheries management, administered by the U. S. Fish and Wildlife Service on a 75 percent (federal) and 25 percent (state) basis. The federal share is from excise taxes and the state share is mainly from sportfishing licenses.

Amendment Procedures

The River Falls Local Water Management Plan is intended to extend through the year 1998. For the plan to remain dynamic, an avenue must be available to implement new information, ideas, methods, standards and management practices. Amendment proposals can be requested any time by any person or persons either residing or having business within the City.

Request for Amendment

Written requests for plan amendment is submitted to the City staff. The request shall outline the need for the amendment as well as additional materials that the City will need to consider before making its decision.

Staff Review

A decision is made as to the validity of the request. Three options exist; 1) reject the amendment 2) accept the amendment as a minor issue, with minor issues collectively added to the plan at a later date 3) accept the amendment as a major issue, with major issues requiring an immediate amendment. In acting on an amendment request, staff shall recommend to City council whether or not a public hearing is warranted.

Council Consideration

The amendment and the need for a public hearing shall be considered at a regular or special Council meeting. Staff recommendations should also be considered before decisions on appropriate action(s) are made.

Public Hearing

This step allows the public input based on the public sentiment. Council shall determine when the public hearing should occur in the process.

Council Adoption

Final action on an amendment is Council adoption. However, prior to the adoption, an additional public hearing should be held.

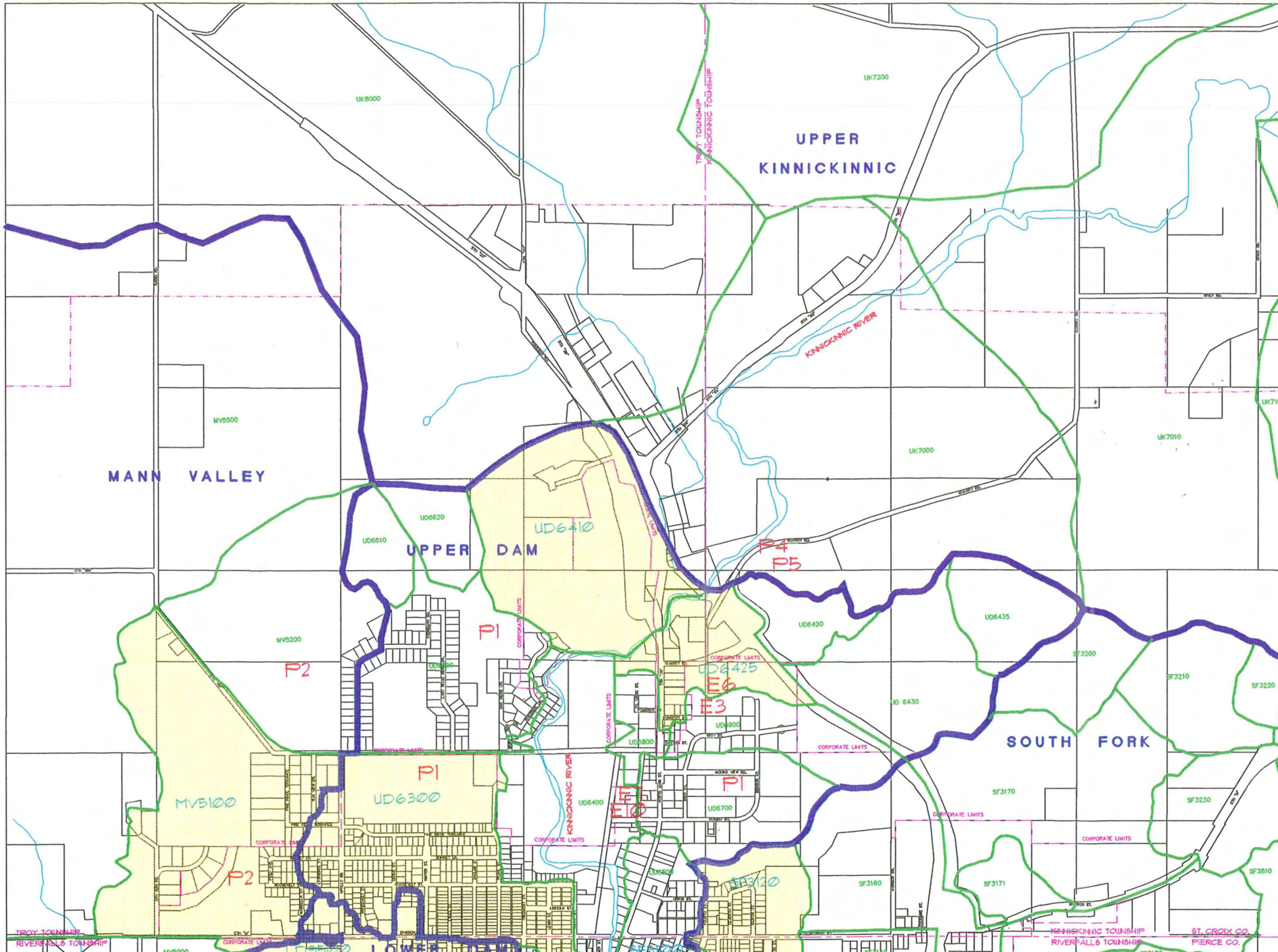
Plan Review

A brief annual Report should be made by City Planning and Engineering staff summarizing development changes, capital improvements and other water management-related issues that have occurred over the past year. The review should also include an update on available funding sources for water resource issues. Grant programs are especially important to review since they may change annually. These changes do not necessarily require individual amendments. The reports can, however, be considered when the plan is brought up to date. The report should be completed by September 1 to allow implementation items to be considered in the normal budget process. Copies of the report should be filed with the counties, townships, UWRF and DNR.

Plan Update

The plan will remain in effect through 1998. The plan should then be reviewed for consistency with current water resources management methods. At this time, all annual reports and past amendments can be added to the document. Depending on the significance of changes, a new printing of the plan may be appropriate. At a minimum, the Capital Improvement Program must be amended every five years.

The annual update can also serve as an important public information tool.



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LEGEND

EXTRA-TERRITORIAL ZONING (ETZ) LIMITS

MINOR WATERSHED LIMITS

UPPER DAM — MINOR WATERSHED DESIGNATION

SUB-WATERSHED LIMITS

UK7010 — SUB-WATERSHED DESIGNATION

TOTAL SUSPENDED SOLIDS REMOVAL PRIORITY SUB-WATERSHEDS

E3 — PROJECT IDENTIFICATION

94-01 — PROJECT NO.- SEE IMPLEMENTATION PLAN

E — ENHANCEMANT PROJECT

E3 96-08	INDUSTRIAL PARK POND STUDY
E6 96-08	INDUSTRIAL PARK POND CONSTR.
E7 96-09	ST. CROIX ST. CUTFALL STUDY
E10 97-08	ST. CROIX ST. CUTFALL CONSTR.

P — PRO-ACTIVE PROJECT

P1 94-06	MAP POTENTIAL STORM SEWER RETROFIT LOCATIONS
P2 94-10	MAP POTENTIAL BMP LOCATIONS
P4 96-04	RIVER FLOW MONITORING INSTALLATION
P5 96-05	RIVER FLOW DATA COLLECTION

NOTE:
NON-STRUCTURAL PROJECTS ARE TYPICALLY NOT LISTED.

WATER MANAGEMENT PLAN FOR THE KINNICKINNIC RIVER AND IT'S TRIBUTARIES

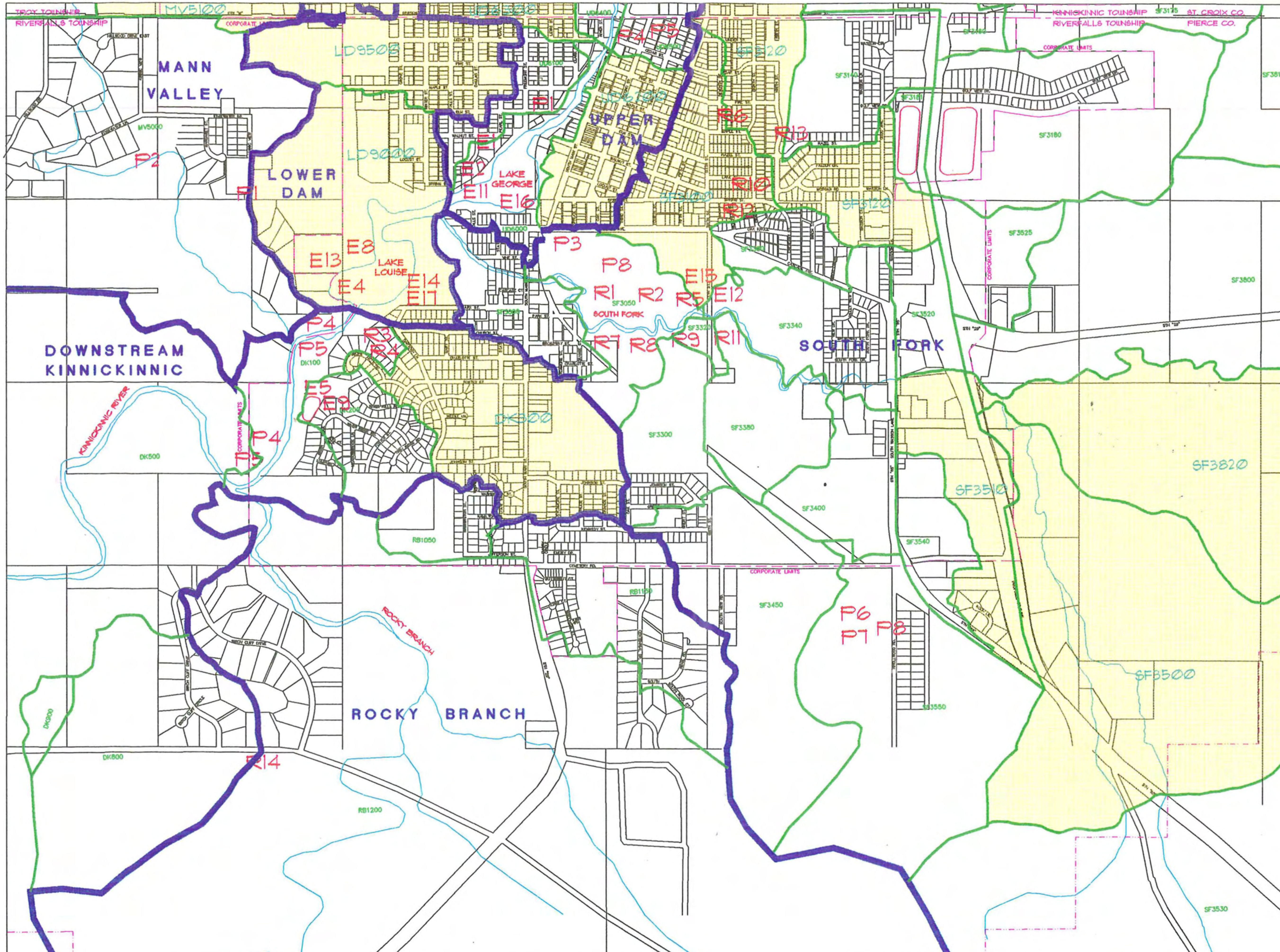
RIVER FALLS, WISCONSIN

FIG. NO. 46
IMPLEMENTATION PLAN
ST. CROIX COUNTY

DECEMBER 31, 1993
FILE NO. RIVER1271.00

SEH RF1271S1.DWG RF1271H1.DWG

1 OF 2



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LEGEND

EXTRA-TERRITORIAL ZONING (ETZ) LIMITS

MINOR WATERSHED LIMITS

UPPER DAM — MINOR WATERSHED DESIGNATION

SUB-WATERSHED LIMITS

UK7010 — SUB-WATERSHED DESIGNATION

TOTAL SUSPENDED SOLIDS REMOVAL PRIORITY SUB-WATERSHEDS

R5 — PRJECT IDENTIFICATION

94-01 — PROJECT NO. SEE IMPLEMENTATION PLAN

R	**REACTIVE PROJECT**
R1 94-08	SO. FORK RESTORATION TASK FORCE
R2 94-09	SO. FORK RESTORATION STUDY/PROJECTS
R3 94-11	BARTOSH CANYON PLANS & SPECS.
R4 94-12	BARTOSH CANYON CONSTRUCTION
R5 95-10	UNNAMED TRIBUTARY SEDIMENT TRAP
R6 95-11	UNNAMED TRIBUTARY UNCONTROLLED RUNOFF STUDY
R7 95-12	SO. FORK RESTORATION TASK FORCE
R8 95-13	SO. FORK RESTORATION PROJECT IMPLEMENTATION
R9 96-10	SO. FORK HABITAT FEATURES
R10 97-10	UNNAMED TRIBUTARY BOX CULVERT FEASIBILITY STUDY
R11 97-12	SO. FORK HABITAT FEATURES
R12 98-03	UNNAMED TRIBUTARY BOX CULVERT RECONSTRUCTION
R13 98-05	RE-PUBLISH FLOOD INSURANCE STUDY
R14 F-07	OLD SANITARY LANDFILL
E	**ENHANCEMANT PROJECT**
E1 94-04	LAKE GEORGE PLANNING GRANT
E2 94-05	LAKE GEORGE RESTORATION REPORT
E4 95-14	LAKE LOUISE PLANNING GRANT
E5 95-16	RIVER HILLS POND MODIFICATION STUDY
E8 96-11	WWTP THERMAL ABATEMENT STUDY
E9 96-12	RIVER HILLS POND RECONSTRUCTION
E11 97-09	LAKE GEORGE RESTORATION FEASIBILITY STUDY
E12 97-11	UNNAMED TRIBUTARY OUTFALL WETLAND MITIGATION PLAN
E13 97-13	WWTP THERMAL ABATEMENT PROJECT IMPLEMENTATION
E14 97-14	LAKE LOUISE RESTORATION FEASIBILITY STUDY
E15 98-04	UNNAMED TRIBUTARY WETLAND CONSTRUCTION
E16 F-05	LAKE GEORGE RESTORATION IMPLEMENTATION
E17 F-06	LAKE LOUISE RESTORATION IMPLEMENTATION
P	**PRO-ACTIVE PROJECT**
P1 94-06	MAP POTENTIAL STORM SEWER RETROFIT LOCATIONS
P2 94-10	MAP POTENTIAL BMP LOCATIONS
P3 95-05	WWTP MONITORING DATA CENTER
P4 96-04	RIVER FLOW MONITORING INSTALLATION
P5 96-05	RIVER FLOW DATA COLLECTION
P6 97-01 F-02	GROUND WATER MONITORING WELLS INSTALLED
P7 98-01 F-01	GROUND WATER WELL MONITORING
P8 F-03	HOURLY PRECIPITATION MONITORING

NOTE:
NON-STRUCTURAL PROJECTS ARE TYPICALLY NOT LISTED.

WATER MANAGEMENT PLAN FOR THE KINNICKINNIC RIVER AND IT'S TRIBUTARIES

RIVER FALLS, WISCONSIN

FIG. NO. 47
IMPLEMENTATION PLAN
PIERCE COUNTY

DECEMBER 31, 1993
FILE NO. RIVER1271.00

SEH RF1271B2.DWG RF1271H2.DWG

River Falls Wisconsin

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River Falls
Wisconsin

APPENDIX A

Standards

Design Elements

Design Standards provide consistency throughout the area when developing storm water facilities. These standards are to be used as a guide when designing any storm water facility within the study area. Any variance from these Standards requires approval from the appropriate jurisdiction.

Hydrology Major Facilities (i.e., Detention Ponds)

The U.S.D.A. Soil Conservation Services (SCS) method shall be the basis for all hydrologic studies.

Storm Distribution

Major storm water facility design shall be based on the U.S.D.A. (SCS) method. The Design Storm (DS), 100-year return period, 24-hour duration, Type II distribution with average soil moisture conditions (AMC-2).

Rainfall

Rainfall amounts for hydrologic analysis shall be based on Hershfield, D. M., 1961, Rainfall Frequency Atlas of the United States for Durations of 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years, Technical Publication No. 40 (TP-40).

Landlocked Areas

Available storage volume of landlocked areas shall be established by estimating the normal or initial water surface elevation at the beginning of a rainfall event and the additional runoff volume resulting from a 100-year/10-day runoff (7.2 inches) and saturated or frozen soil conditions (CN=100).

Flow Rate Criteria

Peak storm water discharge rates and storage volumes from any watershed, subwatershed, detention basin, wetland or conveyor shall be consistent with the values shown in the plan. Variances will be allowed if computations can be provided that demonstrate that no adverse downstream effects will result from the proposed system. If the methodology used to calculate is inconsistent with the standards of this plan, and the results are significantly different from this plan, then the results in this plan shall control.

Inter-Community Flow Rates

Where a flow rate variance involves inter-community issues or significant water bodies, the appropriate jurisdiction shall have a review role. Any variances shall be reflected in subsequent plan amendments.

Hydrology - Minor Facilities (i.e., Storm Sewer, Ditches, Culverts)

Rational Method shall be the preferred methodology for the design of minor systems.

Local Collection System

The minor drainage system shall be analyzed and designed using a 10-year frequency rainfall, and shall be evaluated for the 100-year frequency rainfall. A local Intensity/Duration/Frequency Curve shall be used to determine the peak flow rates for the 10-year event. Full pipe flow analysis shall be used unless special conditions can be demonstrated to support the consideration of pressure flow.

County or State Systems

Culvert crossings or storm sewer systems in County or State right-of-way may have a design frequency which differs from the 10-year. Each agency/unit of government shall be contacted to determine the appropriate design frequency.

Hydraulics

Culverts shall be analyzed using methodology consistent with Federal Highway Administration's Hydraulic Design of Highway Culverts - Hydraulic Design Series 5.

1-Year Storm Outlet Structure

Outlet structures intended to control peak discharge rates to those rates shown in the plan should evaluate the retardation of discharge for a 1-year storm as well as the 100 year storm. Consideration as to the required maintenance and operation of these types of structures.

Emergency Overflows

Existing, natural occurring or man-made emergency overflows from detention areas shall be analyzed as part of the design of the structure.

Antiseepage Collars

Anti-seepage collars shall be used on culverts under public streets under the following conditions:

- All water and ponding structures with a pool depth of 2 feet and a two-day duration.
- 250-acre watershed or more.
- Design head of 10 feet or more.

The collars shall be installed so as to increase the creep distance or seepage line along conduit by 15 percent.

Minimum Building Elevation

The minimum building elevation is defined as the lowest slab elevation for a home or building, including basements and crawl spaces. The minimum building elevation for structures shall be the greatest of the following:

1. An elevation 2 feet above the design storm elevation; or

2. An elevation our feet above the water table; or

3. An elevation determined by the City's Flood Insurance Study (1982)

Thermal Mitigation Required

When the impervious percentage of the contributing watershed to a pond or discharge point exceeds 15%, thermal mitigation elements shall be required to work towards an effective percentage impervious value (after discharge) of 15%. Refer to developer packet and Appendix B.

Pond Construction Criteria (Above Normal Water Elevation)

The following criteria will be followed for pond construction above the normal water elevation. This area of the pond will more than likely be the pond area flooded during a storm up to a 100-year duration.

- Maximum 3Horizontal:1Vertical side slopes.
- Proper allowance for access and maintenance easements.
- Detention time of 6 to 12 hours (ref. pB-18).
- North/south orientation.
- Landscaping to provide shading of basin and outflow channel.
- Emergency overflow above the 100-year design storm high water elevation.
- Erosion control elements to prevent filling during adjacent grading activities (see erosion control standard).
- Restoration (see restoration standard).

Size

Pond volume shall be such to prevent flooding of existing structures, maintain the outlet flow rate identified in the plan, and handle all future development proposed in the watershed. In areas identified as critical to maintain fish & wildlife habitat, the bounce of the pond shall be limited to protect the habitat.

Pond Construction Criteria (Sediment Retention)

Newly constructed detention basins shall provide additional storage volume below the outlet (dead storage) to allow for reasonable accumulation of sediment. Where thermal mitigation is required, dead storage should be minimized. Where sedimentation is considered to be a continuous problem, access to the area to allow for sediment removal is required.

Criteria

The following general criteria should be used when designing the sediment pond.

- For basins not required to have thermal mitigation, a minimum 4 feet of standing water (dead storage depth) should be provided.
- Maximize the separation between inlet points and outlets to prevent short-circuiting of storm flows.
- A 10:1 slope for the first 15 feet from shore, then 3:1 maximum slope.

Size

Detention ponds will be designed to achieve 85% total suspended solids removal. Stormwater treatment can be provided via a single pond which meets the design and treatment criteria or an on-site network of interconnected ponds. If an on-site pond network is used, the overall pollutant removal efficiency for the network must meet the criteria. The recommended pond design criteria in order of importance are as follows:

(1) The permanent pool is important because it provides storage and treatment of runoff during and between storm events. Permanent pool volume should be greater than or equal to the volume required to achieve the 85% suspended solids (TSS) removal standard.

(2) To promote settling and provide space for sediment accumulation, the mean depth of the permanent pool (volume/surface area) should be greater than or equal to 4 feet (unless thermal mitigation is required; then dead storage should be minimized). This constraint may be infeasible for small ponds (< approx. 3 acre-feet in volume or less. In such cases, depths of 3-4 feet may be used.

(3) To promote plug flow behavior, the ratio of maximum length to maximum width (L_c/W_c) should be greater than or equal to 3. Expected performance is less sensitive to the length/width ratio than to volume or depth. This constraint may not be feasible for some sits or small ponds. In such situations, baffles may be installed to isolate the inflow area from the remainder of the pond. A desirable alternative (for all pond sizes) is to construct two or more separate ponds in series with a total volume equal to that specified above Item (1).

(4) For safety purposes and to provide suitable habitat for rooted aquatic plants, the bench width (minimum distance horizontal and below at the normal water level should be at least 15 feet and the bench slope should not be steeper than 10:1 (horizontal vertical).

(5) To provide stability, the side slopes above the bench slope should not be steeper than 3 feet horizontal to 1 foot vertical. Shallower slopes may be appropriate, depending upon soil properties. Shallower slopes are more feasible for larger ponds.

Pond Skimmers

During the review, the City may determine that a pond skimming device would be required. Pond skimming devices should be designed to remove oils and floatable materials up to a one-year frequency event. The skimmer should be set 4 inches below the normal surface water elevation and should control the discharge velocity to 0.5 fps.

Erosion Control

The City's erosion control ordinance shall govern all erosion control issues in the ETZ. The County Land Consevation Offices shall be responsible for erosion control outside of the ETZ.

Erosion control elements such as silt fence, bale checks, rock construction site entrances, etc. shall be installed prior to starting any grading activities. All disturbed areas and exposed soils shall be stabilized and/or restored within 14 days of suspension of grading activities. The Wisconsin Construction Site Best Management Practice Handbook (DNR, 1990).

Restoration

Above Normal Water Elevation

Areas that currently have wetland vegetation will be stripped prior to grading. The soil will be stockpiled and redistributed on site after the pond is constructed to encourage the reestablishment of wetland vegetation.

All disturbed or constructed wetland areas will be restored using City-approved vegetation which is consistent with surrounding wetland vegetation. All other areas will be seeded immediately after pond construction with a mixture containing fast germinating seed mixture (i.e.,, annual rye, oats, barley) and permanent grasses. Areas may be sodded instead of seeded.

Below Normal Water Elevation

Restoration below the normal water elevation will be done **if** ground water does not maintain the normal water level. When restoration is required, all areas of the 10:1 shelf above the ground water and below normal elevation will be restored with annual fast-germinating seed (i.e., annual rye, oats, barley). The pond may need to be pumped down to do the restoration.

Wildlife Pond Construction

During construction of ponds for wildlife enhancement, the following items should be considered:

- Preservation of existing natural vegetation
- Restoration compatible with surrounding vegetation
- 200 to 300 square feet of island(s) or floating rafts for waterfowl nesting habitat
- Provision of open water for habitat diversity
- Variable bottom contours to provide deeper holes and flat shallow benches, providing habitat for diversity of plants and wetland inhabitants
- Water level fluctuation be minimized so as to prevent the loss of wildlife habitat, especially during nesting.

DEVELOPER PACKET

The River Falls community developed a Water Management Plan to analyze the impacts of existing and future development. To have consistent data throughout the watershed, all hydrologic and hydraulic submittals will be in a common format.

Enclosed in this information packet is the required submittal forms for each project. It is recognized that various methods are available for analysis; however, to be consistent with the watershed plan data is to be submitted which will allow for easy review. The base data forms are included in this packet.

A submittal checklist is also included. The checklist will be used to verify if the information is accurate. If information is not included, no approval action will occur until **all** data is completed. If approval is not required, please provide supporting documentation.

KEY POINTS

When preparing your engineering calculation, please remember these key points:

- Rate control is not required **IF** downstream system is adequate to handle flow and the design flow rates meet the rates shown in this plan.
- Water quality improvements are required for all developments. Regional sediment ponds may be available for some developments.
- Thermal mitigation will be required for all developments exceeding the established effective percent impervious guideline.
- All data submitted to the City will be reviewed using SCS methodology; i.e., TR-20 or HydroCAD.
- Hydraulics will be reviewed using FHWA HY-8 computer program and hydraulic text books such as Brater and King.
- Water quality improvements reviewed by P8 model. (IEP, Inc.)
- A predesign meeting with the appropriate jurisdiction(s) is required before any data will be accepted. The purpose of this meeting is to discuss regional ponding, trunk sewer systems, and regional water quality needs.

River Falls Wisconsin

DEVELOPMENT NAME ______________________

____

DEVELOPER'S NAME ______________________

ENGINEERING FIRM ______________________

CONTACT PERSON ______________________

SUBMITTAL CHECKLIST

(used by city to verify all information is submitted)

	Submitted	Approved
• Drainage map	______	______
• Land use map using SCS classification	______	______
• Soils map from County with drainage areas shown	______	______
• Soils map with SCS hydrologic soils classification	______	______
• Erosion control plan	______	______
• Erosion control checklist	______	______
• DNR permit applied for*	______	______
• DNR permit approved*	______	______
• COE wetland permit applied for*	______	______
• COE wetland permit approved*	______	______
• Local permit applied for*	______	______
• Local permit approved*	______	______

*Enclose copy of permit application and final approved permit.

NOTES:

RECEIVED ______________________

REVIEWED BY ______________________

DATE ______________________

ENGINEER APPROVAL ______________________

PROJECT FINAL APPROVAL ______________________

CONSULTANT FILE NO. ______________________

CITY FILE NO. ______________________

River Falls Wisconsin

ENGINEERING FIRM ______________________

CONTACT PERSON ______________________

DEVELOPMENT NAME ______________________

____

DEVELOPER'S NAME ______________________

NOTES:

EROSION CONTROL CHECKLIST

When developing a plan, you **must** satisfy all the following criteria. If a criterion does not apply, you **must** demonstrate why it does not apply.

Check if applicable:	(1)	(2)	(3)
1. **Stabilize all exposed soils and soil stockpiles.**			
A. All exposed soils must be stabilized from the erosive forces of rain, wind and flowing water within 14 calendar days of grading activities.	____	____	____
B. All soil stockpiles must have an adequate sediment trapping system surrounding them, or, if it is planned that a stockpile is to remain undisturbed for more than one year, it must be stabilized.	____	____	____
2. **Establish permanent vegetation** on all exposed soils not otherwise permanently stabilized.	____	____	____
3. **Prevent sediment damage to adjacent properties and other designated areas.**	____	____	____
4. **Schedule erosion and sediment control practices.** Requires a detailed schedule of the timing of erosion and sediment control measures and the phasing of land disturbance activities.	____	____	____
5. **Use temporary sedimentation basins** for all runoff from disturbed soil areas greater than 5 acres.	____	____	____
6. **Engineer the construction of steep slopes** in a manner which will minimize erosion potential and maintain stability. Considerations include slope length, gradient, drainage area, ground water conditions, and the inherent shear angle for the soil material.	____	____	____
7. **Control the storm water leaving a site.**			
A. All properties and watercourses downstream of land disturbance activities shall be protected from the increased volume, velocity and peak flow rates resulting from development.	____	____	____
B. Concentrated storm water runoff leaving a development site must be discharged directly into a stable, well-defined natural or man-made off-site receiving channel, or pipe.	____	____	____
8. **Stabilize all waterways and outlets** so that storm water will be conveyed and discharged without erosion.	____	____	____

(1) Item addressed on plans or specifications.
(2) Field verification, implementation, installation.
(3) Were erosion control measures removed or permanently established?

River Falls
Wisconsin

ENGINEERING FIRM ____________

CONTACT PERSON ____________

DEVELOPMENT NAME ____________

DEVELOPER'S NAME ____________

EROSION CONTROL CHECKLIST (Continued)

Check if applicable:	(1)	(2)	(3)
1. **Protect storm sewers from the entrance of sediment.** All functional storm sewer inlets shall be fitted with an appropriate sediment-trapping device. This criterion may be waived, in the judgment of the permitting authority, if the drainage area is adequately stabilized.	____	____	____
2. **When working in or crossing water bodies**, take precautions to contain sediment, stabilize the work area during construction to minimize erosion, and restabilize the work area within seven calendar days of completion.	____	____	____
3. **Restabilize utility construction areas as soon as possible.** If dewatering is necessary during utility construction, adjacent properties shall not be flooded and/or eroded by the dewatering activity.	____	____	____
4. **Protect paved roads from sediment and mud brought in from access routes.** If sediment is transported to a paved surface, the surface shall be cleaned daily by shoveling or sweeping, **not** street washing.	____	____	____
5. **Dispose of temporary erosion and sediment control measures** within 30 calendar days of permanent soil stabilization or as directed by the permitting authority.	____	____	____
6. **Maintain all temporary and permanent erosion and sediment control practices** to assure their continued performance.	____	____	____

Source: Ramsey SWCD

(1) Item addressed on plans or specifications.
(2) Field verification, implementation, installation.
(3) Were erosion control measures removed or permanently established?

NOTES:

RECEIVED ____________
REVIEWED BY ____________
DATE ____________
ENGINEER APPROVAL ____________
PROJECT FINAL APPROVAL ____________
CONSULTANT FILE NO. ____________
CITY FILE NO. ____________

12/31/93

River Falls Wisconsin

ENGINEERING FIRM ______________________

CONTACT PERSON ______________________

DEVELOPMENT NAME ______________________

DEVELOPER'S NAME ______________________

DRAINAGE AREA I.D. ______________________

DRAINS TO (POND I.D.) ______________________

MAJOR WATERSHED ______________________

HYDROLOGIC AND HYDRAULIC COMPUTATION SHEETS CHECKLIST

Pond I.D.		Hydrologic Summary Sheet	Hydrologic Curve No.	Time of Concentration	Stage Discharge	Stage Storage	Wetland Mitigation	Water Quality
☐	Submitted	☐	☐	☐	☐	☐	☐	☐
	Approved	☐	☐	☐	☐	☐	☐	☐
☐	Submitted	☐	☐	☐	☐	☐	☐	☐
	Approved	☐	☐	☐	☐	☐	☐	☐
☐	Submitted	☐	☐	☐	☐	☐	☐	☐
	Approved	☐	☐	☐	☐	☐	☐	☐
☐	Submitted	☐	☐	☐	☐	☐	☐	☐
	Approved	☐	☐	☐	☐	☐	☐	☐
☐	Submitted	☐	☐	☐	☐	☐	☐	☐
	Approved	☐	☐	☐	☐	☐	☐	☐
☐	Submitted	☐	☐	☐	☐	☐	☐	☐
	Approved	☐	☐	☐	☐	☐	☐	☐

NOTES:

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REVIEWED BY ______________________

DATE ______________________

CITY ENGINEER APPROVAL ______________________

FINAL PROJECT APPROVAL ______________________

CONSULTANT FILE NO. ______________________

CITY FILE NO. ______________________

River Falls Wisconsin

ENGINEERING FIRM ______________________

CALCULATION BY__________________ DATE________

REVIEWED BY __________________ DATE________

DEVELOPMENT NAME ______________________

____

DEVELOPER'S NAME ______________________

DRAINAGE AREA I.D. ______________________

DRAINS TO (POND I.D.)______________________

MAJOR WATERSHED ______________________

HYDROLOGIC SUMMARY SHEET

Water Quantity	Developer Submitted	Plan Check	Final As-built
Normal Water Elevation (feet)	________	________	________
High water elevation (feet) for:			
100-year SCS Type II Storm Distribution, AMC II	________	________	________
100-year, 10-day runoff (snow melt)	________	________	________
Detention Time (hours)			
Overflow Elevation (feet)	________	________	________
Minimum Building Elevation (feet)	________	________	________

Water Quality

Total Suspended Solids Removal (percent)	________	________	________
Impervious Percentage of Total Contributory Subwatershed (percent)	________	________	________
Thermal Mitigation - Infiltration (yes/no)	________	________	________
Thermal Mitigation Shading (yes/no)	________	________	________

Downstream Trunk Storm Sewer Trace

Downstream Major Water Body ______________________

Description of where water travels from the pond to the downstream major water body.

____

____

NOTES:

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REVIEWED BY ______________________

DATE ______________________

ENGINEER APPROVAL ______________________

FINAL PROJECT APPROVAL ______________________

CONSULTANT FILE NO. ______________________

CITY FILE NO. ______________________

River Falls Wisconsin

PROJECT NAME ____________________

____

OWNER'S NAME ____________________

DRAINAGE AREA I.D. ____________________

DRAINS TO (POND I.D.) ____________________

MAJOR WATERSHED ____________________

ENGINEERING FIRM ____________________

CALCULATION BY ____________________ DATE __________

REVIEWED BY ____________________ DATE __________

HYDROLOGIC CURVE NUMBER COMPUTATION SHEET

LAND USE FOR ULTIMATE DEVELOPMENT	SOIL GROUP	CN	ACRE PER PRACTICE	PRODUCT (CNxACRES)
		TOTAL		

OWNER/ENGINEER COMMENTS:

WEIGHTED CN

$\frac{\text{TOTAL PRODUCT}}{\text{TOTAL ACRES}} =$

NOTES:

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REVIEWED BY ____________________

DATE ____________________

ENGINEER APPROVAL ____________________

CONSULTANT FILE NO. ____________________

CITY FILE NO. ____________________

River Falls Wisconsin

ENGINEERING FIRM ______	DEVELOPMENT NAME ______
CALCULATION BY ______ DATE ______	DEVELOPER'S NAME ______
REVIEWED BY ______ DATE ______	DRAINAGE AREA I.D. ______
	DRAINS TO (POND I.D.) ______
	MAJOR WATERSHED ______

TIME OF CONCENTRATION COMPUTATION SHEET

FLOW PATH	SURFACE ID	SURFACE N or VEL.	FLOW LENGTH (FEET) (L)	HIGH ELEV. (FEET)	LOW ELEV. (FEET)	DROP FEET	SLOPE (FT/FT) (S)	TRAVEL TIME (SEC)
ATTACH SKETCH SHOWING FLOW PATH							TOTAL	SEC
							CUML. TRAVEL TIME (MIN)	MIN
							CUML. TRAVEL TIME (HOURS)	HR

NOTES:

RECEIVED ______

REVIEWED BY ______

DATE ______

ENGINEER APPROVAL ______

CONSULTANT FILE NO. ______

CITY FILE NO. ______

River Falls Wisconsin

ENGINEERING FIRM ____________

CALCULATION BY ____________ DATE ______

REVIEWED BY ____________ DATE ______

DEVELOPMENT NAME ____________

DEVELOPER'S NAME ____________

DRAINAGE AREA I.D. ____________

DRAINS TO (POND I.D.) ____________

MAJOR WATERSHED ____________

STAGE—DISCHARGE INFORMATION SHEET

☐ NEW CONSTRUCTION

☐ EXISTING CONTROL STRUCTURE

SOURCE OF DATA i.e., as-builts, plats, survey

____

____

POND OVERFLOW HYDRAULICS

WEIR LENGTH ____________

C ____________

If something other than a weir is assumed, attach additional calculations.

OUTLET DESCRIPTION

PIPE SIZE ____________

PIPE TYPE ____________

INLET TYPE (1) ____________

INLET INVERT ____________

OUTLET INVERT ____________

SLOPE ____________

LENGTH ____________

(1) Based on FHWA - HDS-5

TAILWATER DESCRIPTION (Ditch, Culvert, Pond)

PERFORATED STANDPIPE ☐ YES ☐ NO

Attach Stage-Discharge Calculations & GRAPH

DESCRIPTION OR SKETCH OF CONTROL STRUCTURE IF IT IS NOT A CULVERT OR STORM SEWER OUTFALL.

Attach all additional hydraulic calculations.

NOTES:

RECEIVED ____________

REVIEWED BY ____________

DATE ____________

SENGINEER APPROVAL ____________

OUTLET AS-BUILT APPROVED ____________

CONSULTANT FILE NO. ____________

CITY FILE NO. ____________

River Falls Wisconsin

ENGINEERING FIRM ____________________

CALCULATION BY____________________ DATE__________

REVIEWED BY ____________________ DATE__________

DEVELOPMENT NAME ____________________

____

DEVELOPER'S NAME ____________________

DRAINAGE AREA I.D. ____________________

DRAINS TO (POND I.D.)____________________

MAJOR WATERSHED ____________________

STAGE—STORAGE INFORMATION SHEET

STAGE	AREA (AC.)	ELEV. DIFF. (FT.)	AVERAGE AREA (AC.)	STORAGE (AC-FT)	CUML. STORAGE
					0

Table should be used for all contours including those below outlet (normal water elevation). Cumulative storage below the outlet and above the outlet should be computed separately. Last elevation should be 2 feet above the emergency overflow elevation.

NOTES:

RECEIVED ____________________

REVIEWED BY ____________________

DATE ____________________

ENGINEER APPROVAL ____________________

POND AS-BUILT APPROVED ____________________

CONSULTANT FILE NO.____________________

CITY FILE NO. ____________________

River Falls
Wisconsin

ENGINEERING FIRM ____________________

CALCULATION BY____________________ DATE__________

REVIEWED BY ____________________ DATE__________

DEVELOPMENT NAME ____________________

____

DEVELOPER'S NAME ____________________

DRAINAGE AREA I.D. ____________________

DRAINS TO (POND I.D.) ____________________

MAJOR WATERSHED ____________________

WETLAND MITIGATION SHEET

DESCRIBE SEQUENCING PROCESS (AVOIDANCE, MINIMIZATION & MITIGATION). SPECIFY AREA AND VOLUME OF FILL MATERIAL. ATTACH COPIES OF FEDERAL, STATE OR LOCAL PERMITS.

FILL AREA (ACRES) __________

FILL VOLUME (ACRE-FT) __________

FEDERAL PERMIT ☐ STATUS ____________________

STATE PERMIT ☐ STATUS ____________________

LOCAL PERMIT ☐ STATUS ____________________

SEQUENCING PROCESS:

*** add additional sheets as necessary to describe all activities**

NOTES:

RECEIVED ____________________

REVIEWED BY ____________________

DATE ____________________

CITY ENGINEER APPROVAL ____________________

CONSULTANT FILE NO. ____________________

CITY FILE NO. ____________________

River Falls
Wisconsin

ENGINEERING FIRM ______________

CALCULATION BY ______________ DATE ________

REVIEWED BY ______________ DATE ________

DEVELOPMENT NAME ______________

DEVELOPER'S NAME ______________

DRAINAGE AREA I.D. ______________

DRAINS TO (POND I.D.) ______________

MAJOR WATERSHED ______________

WATER QUALITY SHEET

PERCENT IMPERVIOUS (FROM CURVE NO. SHEET) ________% = "I"

TOTAL SUSPENDED SOLIDS (TSS) LOADING ________ LBS/AC
(TSS = 12.15914 X "I"; FOR 50 PERCENT IMPERVIOUS," I" - 50)

TSS REMOVAL STANDARD - 85%

ATTACH SUPPORTING DOCUMENTATION TO ILLUSTRATE TSS REMOVAL FEATURES WHILE MINIMIZING PERMANENT POOL VOLUME.

EFFECTIVE PERCENT IMPERVIOUS STANDARD - 15%

IF PERCENT IMPERVIOUS OF CONTRITING SUBWATERSHED EXCEEDS 15 PERCENT, DEVELOP THERMAL MITIGATION FEATURES. OPTIONS INCLUDE:

- ☐ 1. UPSTREAM SEDIMENT TRAPPING AREA
- ☐ 2. VEGETATED SWALE(S)
- ☐ 3. ON-LINE INFILTRATION TRENCH
- ☐ 4. OFF-LINE INFILTRATION
- ☐ 5. NORTH-SOUTH ORIENTATION
- ☐ 6. LANDSCAPING-SHADED STORAGE/ SHADED DISCHARGE SCHANNEL
- ☐ 7. OTHER

✻ add additional sheets and sketch to describe all ponds

NOTES:

RECEIVED ______________

REVIEWED BY ______________

DATE ______________

CITY ENGINEER APPROVAL ______________

CONSULTANT FILE NO. ______________

CITY FILE NO. ______________

River Falls
Wisconsin

APPENDIX B

Thermal Mitigation Techniques and Example Best Management Practices

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

Background

One of the most recent and comprehensive works on thermal pollution is the report entitled ***"Thermal Impacts Associated with Urbanization and Storm Water Management Best Management Practices"*** (Galli, 1990). In studying six headwater urban streams and four storm water BMP sites in the Piedmont portion of Maryland's Anacostia River Basin, Galli (1990) analyzed a full range of watershed development. Galli (1990) evaluated the effectiveness of four BMPs; an infiltration facility, artificial wetland, extended detention—dry pond, and a wet pond.

Flow rates in the watersheds studied by Galli (1990) are less than those in the Kinnickinnic and South Fork. However, the Maryland study (Galli, 1990) can be extrapolated to develop recommended BMPs for River Falls. By developing the first BMPs as pilot projects with adequate monitoring, the effectiveness of thermal mitigation on the Kinnickinnic and the South Fork can be maximized.

Effects of Meteorological and Watershed Land Use Conditions on Free-flowing Stream Temperatures

Galli (1990) identified four interrelated factors which impact the thermal regime of free-flowing streams:

- Watershed Imperviousness - largest influence
- Riparian Canopy Coverage - key influence
- Air Temperature - larger influence than storm flow
- Stream Order/Size

Watershed Imperviousness

According to Galli (1990), Imperviousness, together with local meteorological conditions, has the largest influence on urban stream temperatures. Average water temperature of the urban streams increased in a linear fashion with increasing levels of watershed imperviousness. Results indicated that

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

the average rate of increase was 0.14° per one percent increase in imperviousness.

Galli (1990) found stream temperatures in an undeveloped watershed responded to storm events by becoming slightly cooler. This was largely due to the drop in air temperatures which accompanied most rainfall events. While this was also generally true of urban streams, as the level of watershed imperviousness increased the streams became progressively more responsive to inputs of storm water runoff.

With increasing imperviousness, the storm size needed to produce large, stream temperature fluctuations decreased, according to Galli. At a 12 percent watershed imperviousness level, over 0.7 inches of rainfall was generally required to produce temperature fluctuation. In contrast, at a 60 percent imperviousness level, less than 0.2 inches of precipitation was needed to produce a comparable temperature change.

Galli noted that storm water inflow generally increases stream temperatures. In addition, the potential thermal impact of storm water runoff on receiving streams increased as the runoff to receiving stream flow ratio increased. The smaller the base flow in the stream, the larger the thermal impact of runoff will be.

Galli found that even at the relatively low 12 percent watershed imperviousness level, neither Maryland Class III (68.0°F) or IV (75.0°F) temperature standards could be met 100 percent of the time. Both the frequency and magnitude of temperature standards violations increased with increasing levels of watershed imperviousness.

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

Riparian Canopy Coverage

Riparian vegetation plays a key role in insulating small streams from the warming effect of solar radiation. Other studies have shown that the removal of riparian vegetation can raise the summer water temperature of small streams by 11 – 20°F, and can lower winter water temperatures by 5 – 7°F (Gal;li, 1990). Galli (1990) found an average positive stream temperature increase of 1.5°F per 100 feet of flow through either open or poorly shaded reaches.

Air Temperature

Galli (1990) reported that ninety to ninety-five percent of the time air temperature had a greater influence on stream temperature than did storm flow. The potential for major stream temperature increases grew dramatically when air temperatures remained at or above 80°F for long periods of time.

The amount and intensity of precipitation was an important, though somewhat smaller factor according to Galli. Small storms which produced little or no runoff generally had little effect on receiving stream temperatures. Sharp, rapid increases in stream temperature were not observed under steady, light precipitation conditions. Stream temperature increases were, however, closely associated with warm air conditions which included heavy shower activity.

According to Stefan (1993), large rivers are more exposed to solar radiation than smaller, shaded streams. Stefan reported that shading has had a major effect on the water temperature of small, headwater streams. According to Stefan, removal of forest cover has resulted in average monthly stream temperature increases of as much as 4.4°C, especially during the summer.

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

Stefan (1993) found that water temperature responds directly to air temperatures with a time lag, ranging from four hours for shallow rivers less than 2 feet deep, up to seven days for rivers 15 feet deep. Stefan was able to establish daily and weekly linear relationships between air and stream temperatures.

Stefan suggested the following equations:

Daily	$Tw(t) = 5.0 + 0.75\, Ta\,(t-\delta)$
Where δ	h/α
Weekly	$Tw(t) = 2.9 + 0.86\, Ta(t)$

$Tw(t)$	Stream temperature at time t
$Ta(t)$	Air temperature at time t
δ	Time lag between air and water temperature in days;
t	Time in days
h	Average depth of the river as measured over the width and length of a investigated reach.
α	Thermal diffusitivity coefficient
α	$\frac{K}{\rho cp}$
ρ	Density of water
cp	Specific heat of water
K	Bulk surface heat exchange coefficient

Stefan (1993) indicates that better results are obtained for shallow streams which are more responsive to air temperature because they have smaller thermal inertia. The

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

results of Stefan's Study (1993) are adequate to obtain rough estimates of stream water temperatures.

Stream Order/Size

It is well known that stream temperature naturally increases in a downstream direction with increasing stream order/ distance from the source. According to Galli (1990), a variety of anthropogenic factors, such as the removal of riparian vegetation, micro-climate changes, and reduction of ground water inflow, add to the so-called "watershed Delta-T" effect of an urban stream. Monitoring results (Galli,1990) indicated that the watershed Delta-T effect for an 18 percent impervious-urban third order stream system, is on the order of 1 – 2°F per stream mile. In addition, smaller, lower-order urban streams are more responsive to this background watershed effect.

Effect of Urban Storm Water Management on BMP's in Water Temperature

Galli (1990) found that none of the four BMPs monitored were thermally neutral. All four BMP types had positive average total Delta-T's and each violated Maryland temperature standards some of the time. Temperature standards violations occurred under both base flow and storm flow conditions. According to Galli (1990), wet, long detention periods, and poorly shaded channels contributed greatly to the problem. Specific findings for each BMP type are described below and are additionally summarized in Table B-1.

1. Infiltration - Dry Pond (Most Effective)

Of the four BMPs, this hybrid facility (which had average and maximum positive BMP Delta-T's of 2.5 and 7.6°F) produced the smallest Delta-T increases (i.e., was the most effective). The infiltration trench portion of the BMP, designed for 0.25 inches of street runoff, worked well during small storms.

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

However, large storm events (i.e., ≥ 1.0 inches precipitation) and/or 2 – 3 consecutive days of moderate rainfall generally overtaxed the capacity of the infiltration trench system. This often resulted in the ponding of several feet of runoff in the dry pond area. The facility's defacto extended detention control combined with high incoming solar radiation on the unshaded riprap pilot channel, storage pool, and outfall area, produced a 4.0°F Delta-T increase.

From a water temperature standards perspective, this BMP had the lowest frequency of Maryland Class III (68.0°F) and IV (75.0°F) violations. Standards violations were more frequently associated with storm flow conditions. Under storm flow conditions, Class III temperature standards were exceeded 18 percent of the time. The BMP's single Class IV violation was a product of a large storm and 53 hours of extended detention.

2. Extended Detention - Artificial Wetland

The average and maximum BMP Delta-T's associated with the wetland were 3.2 and 8.7°F, respectively. Delta-T storm flow temperatures at the wetland were typically lower than base flow Delta-T temperatures. However, approximately two-thirds of the time the difference between base flow and storm flow Delta-T's was relatively small (i.e., ≤ 3.0°F).

The shallow depth (mean depth is approximately 18 inches) and small permanent pool volume, relative to the 140-acre contributory watershed, made the wetland and its outflow station very responsive to air temperature fluctuations. The wetland's small permanent pool did, however, give it a limited ability to moderate outflow temperatures during certain small storm events. In addition, because the wetland's extended detention capability was extremely limited, it had little influence on outflow station temperature behavior.

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

Under base flow conditions, wetland outflow station temperatures exceeded Maryland Class III and IV temperature standards 60 and 15 percent of the time, respectively. In contrast, the same standards were violated approximately 57 and 5 percent of the time, respectively, under storm flow conditions. Outflow stations were higher than inflow station temperatures 95 percent of the time.

3. Extended Detention - Dry Pond

The average and maximum BMP Delta-T's associated with the extended detention dry pond were 5.3 and 11.2°F, respectively. The maximum Delta-T produced by this BMP was slightly higher under storm flow conditions (11.2°F) than under base flow conditions (9.7°F). The higher storm flow Delta-T's were the product of: a) the influx of relatively warm storm water runoff into the facility; b) the partially shaded pilot channel's heat contribution; and c) additional heating of detained waters via solar radiation. In addition, the highest Delta-T's were noted during hot weather. This BMP's 500-foot-long pilot channel produced an average positive stream Delta-T of 3.7°F.

Under storm flow conditions, the extended detention dry pond violated Class III and IV temperature standards 48 and 15 percent of the time, respectively.

4. Wet Pond (Least Effective)

The wet pond's large permanent pool served as an effective heat regulator. In general, the pond had a major warming effect on base flow temperature. However, during most storm events, both pond and outflow station temperatures were depressed. The relatively large permanent pool volume resulted in the pond slowly storing and releasing solar radiation/heat; thus making it slow to respond to air

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

temperature fluctuations. Average summer pond surface water temperatures remained generally over 77°F. Pond waters were noticeably slow to cool down in late summer/ early fall.

Of the four BMPs, the wet pond had the highest recorded maximum Delta-T (15.1°F). Delta-T base flow temperatures at the wet pond were higher than storm flow Delta-T's 99 percent of the time. The average base flow Delta-T (9.7°F) was slightly higher than the average storm flow Delta-T (8.5°F). The pond's riprap outflow channel produced an average positive Delta-T increase of 2.0°F.

From a water temperature standards perspective, this BMP had the highest frequency of Class III and IV temperature standards violations. Under base flow conditions, Class III and IV standards were exceeded 77 and 35 percent of the time, respectively. In contrast, under storm flow conditions, the same standards were violated 64 and 25 percent of the time, respectively.

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

Table 1
Summary: BMP Temperature Performance[1]

Galli (1990)

Parameter		BMP Type			
		Infiltration-Dry Pond	Extended Detention Wetland	Extended Detention Dry Pond	Wet Pond
Average Base Flow Delta-T (°F) Maximum Base Flow Delta-T (°F)		2.6 7.6	3.9 8.7	5.5 9.7	9.7 15.1
Average Storm Flow Delta-T (°F) Maximum Storm Flow Delta-T (°F)		2.3 5.0	2.4 7.8	5.2 11.2	8.5 14.0
Average Total Delta-T (°F) Maximum Total Delta-T (°F)		2.5 7.6	3.2 8.7	5.3 10.9	1.1 9.1
Percent Base Flow Violation of MDE Temperature Stds.	Class III (68°F) Class IV (75°F) Class I (90°F)	8 1[2] 0	60 15 0	50 10 0	77 35 0
Percent Storm Flow Violation of MDE Temperature Stds.	Class III (68°F) Class IV (75°F) Class I (90°F)	18 0 0	57 5 0	48 15 0	64 25 0
Maximum observed outflow water Temp (°F)		77.7	80.8	81.9	82.6

1. Total Delta-T values shown represent combined base flow and storm flow temperatures (i.e., all flow conditions).
2. Class IV violation result of defacto extended-detention control.
Note: These results are specific for the Maryland Study area (Galli, 1990).

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

Biological Implications

Galli (1990) used literature review information together with results from the water temperature monitoring portion of the study, to identify the potential biological impacts associated with temperature regime modification. Major findings are presented starting at the bottom of the food chain with algae, and progressing sequentially to fish. In addition, to facilitate reader understanding, results have been graphically summarized in Figure B-2.

1. Algae

Water temperature monitoring results (Galli, 1990) suggest that subtle shifts in the attached algae community species composition would have been expected to have occurred in some of the urban streams studied. At all developed watershed and BMP sites, diatoms would have continued to remain the dominant overall algal group. However, certain coldwater and/or light sensitive species may have either declined in numbers and/or been replaced by other, more temperature- or light-tolerant species. The scenario would have occurred most likely in stream reaches where considerable thermal enrichment and/or removal of riparian vegetation took place (e.g., wet pond outflow, extended detention (ED) wetland outflow, highly developed urban stream site, and ED dry pond outflow station). In addition, it is probable that green and blue-green algal species would have been represented in greater numbers in the warmer, open-lit sections of these streams.

While some temperature-related shifts in algal community species composition undoubtedly occurred, it is unlikely that they would have in themselves had a major affect on either the resident macroinvertebrate or fish communities of these urban streams.

Summary: General Impacts of Human Activities on Stream Temperature and Biota

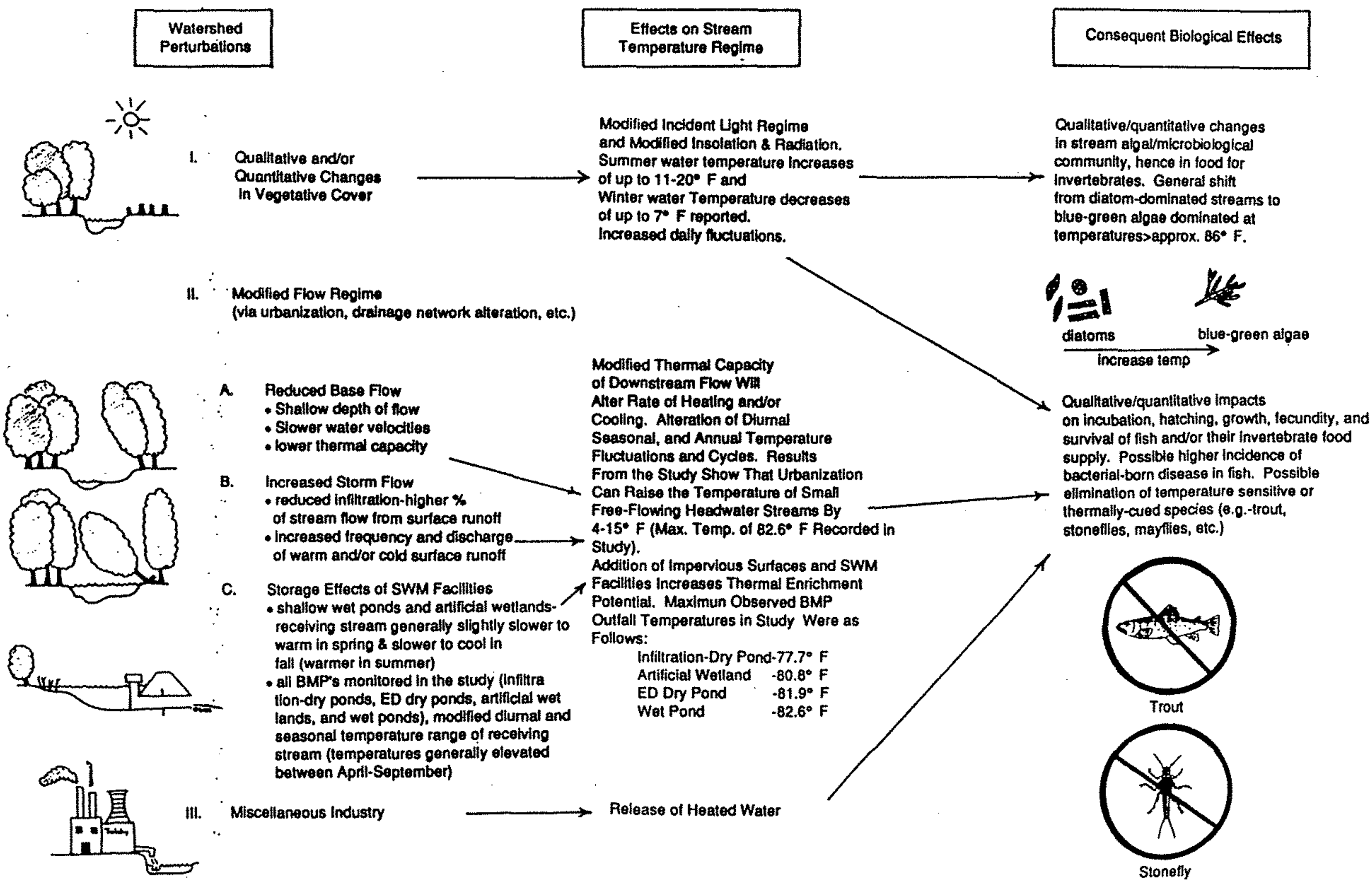

FIGURE B2 (GALLI, 1990)

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

2. Macroinvertebrates - Aquatic Insects.

Results of Galli's Maryland Stream Studies (1990) indicate that the thermal enrichment effects produced, either through urbanization and/or associated BMPs, would severely affect coldwater aquatic insects. It is most likely that sensitive groups, such as stoneflies, would either be eliminated or severely restricted (for much of the year) at temperature levels comparable to those observed at the moderately and highly developed watershed sites and at the wet pond, ED wetland, and ED dry pond outflow stations. While collectively more temperature tolerant, many mayfly and caddisfly species would similarly be eliminated, severely restricted, and/or stressed at the preceding temperature levels.

Restructuring of the macroinvertebrate community would also occur according to Galli, with intolerant species and/or groups of insects being replaced by thermally-tolerant ones. It would be expected that tolerant groups such as Diptera (flies and midges) would gain greater dominance in these stream systems. In addition, noninsect species would probably become more abundant. The preceding changes could, if particularly extensive, have a negative impact on the resident fish community according to Galli.

3. Fish

Results (Galli, 1990) show that the vast majority of resident fish species would not be affected by the temperature increases produced either through urbanization and/or construction of BMPs. However, coldwater species, such as trout, would not be expected to survive at temperature levels observed at either the moderately or highly developed watershed sites or at any of the four BMP outfall locations.

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

The findings from Galli's 1990 study underscore the point that moderate levels of watershed imperviousness and/or the improper introduction of associated BMPs can have a devastating impact on sensitive coldwater streams and the fish communities which they support.

Trout Species and Thermal Stress

All trout species are extremely sensitive to thermal pollution/ stress. Sustained elevated water temperatures over 70°F are generally considered to be stressful, while those at or above 77°F are usually lethal. Galli (1990) water temperature monitoring results from the 12 percent impervious Gum Springs tributary indicate that base flow water temperatures remain safely below levels considered to be stressful to trout. However, under storm flow conditions, water temperature exceed 70°F.

Galli (1990) found the frequency and magnitude of these stress-producing episodes were more severe in Lower Gum Springs, where the temperature regime is negatively affected by the storm water discharge from the Oak Springs ED wetland.

Land Use Control Program Implications

Through the process of urbanization, vegetation is removed from watersheds; formerly pervious surfaces are converted to hard, impermeable ones, such as rooftops, streets, and parking lots; and natural drainage networks are modified to convey runoff more efficiently. These processes act together to alter the thermal regime of urban, headwater streams.

According to Galli (1990), among the more enlightening results of the Maryland Study was the finding that the level of watershed development represents the single, greatest man-caused influence on the temperature regime of urban, headwater streams.

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

Program implications, are briefly described as follows:

1. Watershed Imperviousness Factor

Galli (1990) found that for urban headwater streams, the level of watershed imperviousness largely determines the magnitude of change from the predevelopment thermal regime. As previously noted, results from this study show that mean, summer stream temperatures increase linearly with increasing watershed imperviousness. Importantly, watershed imperviousness has a negative influence on stream temperatures under both base flow and storm flow conditions.

Galli found the frequency of Maryland temperature standards violations generally increases with increasing levels of imperviousness as illustrated in the following table. This phenomenon occurs regardless of whether watershed storm water management controls are present or absent. Reduction of ground water flows, the urban heat island effect, removal of riparian vegetation, and drainage network alteration are primary causes of the problem according to Galli (1990).

Table 2
Summary: Maryland Water Temperature Standards Violations Versus Watershed Imperviousness **(Galli, 1990)**

Watershed Development Level	Percent Imperviousness (%)	Percent of time MDE Temperature Std. Violated (%)			
		Class III (68°F)		Class IV (75°F)	
		Base Flow	Storm Flow	Base Flow	Storm Flow
Light	12.0	10	5	0	1
Moderate	30.0	25	1	25	1
High	60.0	67	57	12	10

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

2. Conflicting Stream Protection and Watershed Development Goals

Emphasis on Land Use Control

Galli (1990) identified that all too often the goal of stream protection conflicts with land use development. Many of the environmental problems caused by urbanization, stream warming for one, cannot be completely mitigated by engineering means. Thus, far greater emphasis on land use control measures is required in sensitive streams.

Results from Galli's 1990 study show that stream temperature regime changes occur at relatively low levels of watershed imperviousness (i.e., $\leq$ 12 percent). The study (Galli, 1990) also strongly suggests that trout and other coldwater animal and plant life will most likely be lost when watershed imperviousness exceeds 12 – 15 percent.

3. Thermal Regime Protection Strategy

Galli (1990) suggests that the long-term protection of thermally sensitive streams requires a holistic watershed management approach which includes, at a minimum, the following water temperature protection elements:

- Land use controls (which govern type, density, and location of development within a watershed);
- Riparian/stream buffer requirements;
- Employment of temperature-sensitive BMPs and storm water conveyance systems;
- Long-term water temperature and biological monitoring at strategic stream locations within the watershed; and
- Routine long-term maintenance of BMPs and other associated infrastructure.

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

Galli (1990) concluded that extraordinary land use, riparian management, and storm water management controls are needed to properly protect the resident aquatic life of cold water. Galli (1990) notes that this stream protection strategy requires that many difficult, and potentially costly, land use decisions be made.

Implications for Storm Water Management Programs

Aquatic community species composition and activity in freshwater stream systems are largely regulated by water temperature. Galli (1990) reports that in urban streams, the composition and structure of the aquatic community is generally affected by thermal regime modification, as well as by flow regime, water quality, and physical/structural habitat changes.

The results of (Galli, 1990) water temperature monitoring study have several major implications with regard to current storm water management practice selection, design, and policy. These implications are outlined below.

1. Storm Water Management Practice Selection

Infiltration is the best BMP choise in thermally sensitive watersheds

The four BMPs tested (Galli, 1990) were, in ranked order of both Delta-T and outflow temperatures standards performance: 1) infiltration-dry pond; 2) artificial wetland; 3) extended detention dry pond; and 4) wet pond. Schuler (1991) noted that wet ponds are preferred over straight discharges.

By a wide margin, the infiltration facility outperformed all other BMP types. Clearly, infiltration generally remains the best BMP choice in thermally sensitive watershed areas.

However, according to Schuler (1991) the clogging potential and high degree of maintenance associated as the infiltration basins make this BMP somewhat impractical if not used in

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

association with other treatment measures such as an upstream sediment trap and a downstream wetland facility.

Galli (1990) found that at low levels of watershed imperviousness, improper BMP selection can have a major negative effect on the water temperature regime of small, headwater streams. This is particularly the case in cold water stream systems where the selection of conventional wet and/or extended detention BMPs could conceivably eliminate temperature-sensitive species such as trout.

Galli's 1990 study also shows that at moderate levels of watershed imperviousness, the potentially negative influence of BMPs on the receiving stream's temperature regimes is reduced. This is due to the fact that the temperature regimes of these streams have been (or will be) modified by the background level of urbanization. Consequently, temperature-sensitive biota will, even in the absence of BMPs, most likely be reduced and/or eliminated from these streams according to Galli (1990).

At high levels of watershed imperviousness, the general impact of BMPs on the receiving stream temperature regime is minimal. In these streams, the need for providing high levels of water quality and stream channel erosion control may outweigh temperature concerns. Galli found that in MDE Class III (68°F) watershed areas, both extraordinary land use and storm water management controls are necessary to protect resident stream biota. Galli notes that the absence of water temperature and biological data, together with the lack of rapid assessment guidelines, often makes the BMP selection process difficult in these areas.

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

2. BMP Design Feature Considerations

Infiltration Design

Galli indicates that the thermal performance of the infiltration-dry pond could have been improved had its infiltration design treatment capacity been sized to handle more than 0.25 inches of runoff from roadway areas. Although infiltration systems which are to be located in thermally sensitive watersheds should, as a general rule, be intentionally oversized, there is a finite storm-size which can be treated in this manner. Because of the high probability of large storms and/or several consecutive days of precipitation overtaxing infiltration system design capacity, it is extremely unlikely that 100 percent compliance with MDE Class III (68°F) standards can be achieved.

Schuler (1991) recommends using a sediment upstream of the infiltration basin to reduce the clogging potential and high maintenance costs. A wetland facility below the infiltration feature can provide additional polishing of storm water.

Shading would Improve BMP Performance

Results from Galli's 1990 stream study revealed that unshaded (and/or poorly shaded) pilot and riprap outflow channels produced maximum positive Delta-T's of 8.5°F. Shading of these structures via landscaping or other means would have improved the overall performance of every BMP type tested in the study according to Galli (1990). In addition, results further indicated that the practice of employing long, wide riprap outflow channels should be seriously reexamined. Whenever possible, outflow channels should be heavily shaded. They should also include a deep, narrow base flow channel to quickly return this water back to the natural stream channel.

One of the more revealing findings of Galli's analysis was that long periods of extended detention control can produce BMP Delta-T increases on the order of 4 – 12°F. For this reason, the

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

6-12 Hour Detention Periods are Recommended

use of extended detention BMPs in thermally sensitive areas should be carefully evaluated. Galli further recommends that a 6- to 12-hour detention period limit be established for these areas and that shading of the storage pool area be required.

3. Future Research Needs

Galli identifies a strong need to develop holistic guidelines and stream assessment procedures for defining appropriate storm water management options within any watershed area.

Water temperature monitoring of parallel pipe and base flow diversion systems, multiple-port release wet ponds, sand filters, and other promising thermally sensitive conveyance/ storm water management practices is urgently needed, according to Galli (1990).

Mitigation Strategy - BMPs

The nature, severity, and reversibility of environmental impacts in urban watersheds is typically a direct function of imperviousness (Schuler, 1990). Therefore, the mitigation strategy for the Kinnickinnic River Watershed involves balancing the effects of future development through the implementation of Best Management Practices which result in an effective percent impervious (EPI) factor which is within the threshold for protecting sensitive streams.

EPI Concept

According to Schuler (1990),sensitive trout streams in the mid-Atlantic region cannot persist when watershed imperviousness exceeds 15 percent. Two potential strategies present themselves; 1) allow no future development which would exceed 15 percent impervious surface, or 2) implement Best Management Practices (BMPs) to reduce the Delta-T's on the receiving water to a level similar to uncontrolled runoff from a 15 percent impervious watershed. This second approach illustrates the 15 percent EPI concept.

Appendix B *Thermal Mitigation Techniques* has been adapted from *Thermal Impacts Associated with Urbanization & Storm Water Management Best Management Practices* (Galli, 1990).

BMP Selection

A BMP system approach is recommended. A BMP system is defined as a combination of structural and nonstructural measures to attenuate, convey, pre-treat, treat, and polish urban storm water runoff (Schuler, 1990). A BMP system is designed to achieve an overall watershed target. For the Kinnickinnic River and its tributaries, the "target" is to maintain these sensitive trout waters and prevent further degradation from development.

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Components of an Effective Urban BMP System

RUNOFF ATTENUATION		Reduce site imperviousness. Reduce disturbed area. Disconnect Impervious areas. Designate stream buffers. Protect non-tidal wetlands. Protect site tree cover. Utilize cluster development and site fingerprinting. Source control.
RUNOFF CONVEYANCE		Use of vegetated swales w/checkdams. Flow splitters. Install parallel pipes to protect sensitive streams. Level spreaders to un-concentrate runoff. Reduce stream enclosure by storm drains. Storm drain infiltration/outfall protection.
RUNOFF PRETREATMENT		Use of sediment fore bays (R) or settling Basins (I) to remove grit before entry into BMP. Design for frequent/rapid removal. Use of grass filter strips and/or Water Quality separators for infiltration facilities. Micropools in Extended Detention Ponds.
RUNOFF TREATMENT	Pollutant Removal	-Retention/Detention or infiltration of 75% to 90% of all storms.
	Frequent Floods	-Detention or infiltration for up to 24 hours for 0.5 to 1.0 WINCH volume.
	Frequent Floods	-Detention of 2, 10 and/or 100 yr frequency storm event.
SYSTEM MAINTENANCE		Inspection to approve/accept the structure. Sediment disposal plan. Strict specifications on BMP materials for longevity. Native landscaping and moving plans. Easy access to, around and in the BMP. Two year check-up. Infiltration replacement. Flexibility in design.
SECONDARY IMPACT MITIGATION		Evaluation of Downstream Delta T. Outfall protection. Safe conveyance of the safety storm. Mixing of runoff to keep O_2 levels high and carbon slime down. Reestablish canopy closure downstream. Downstream wetland protection.

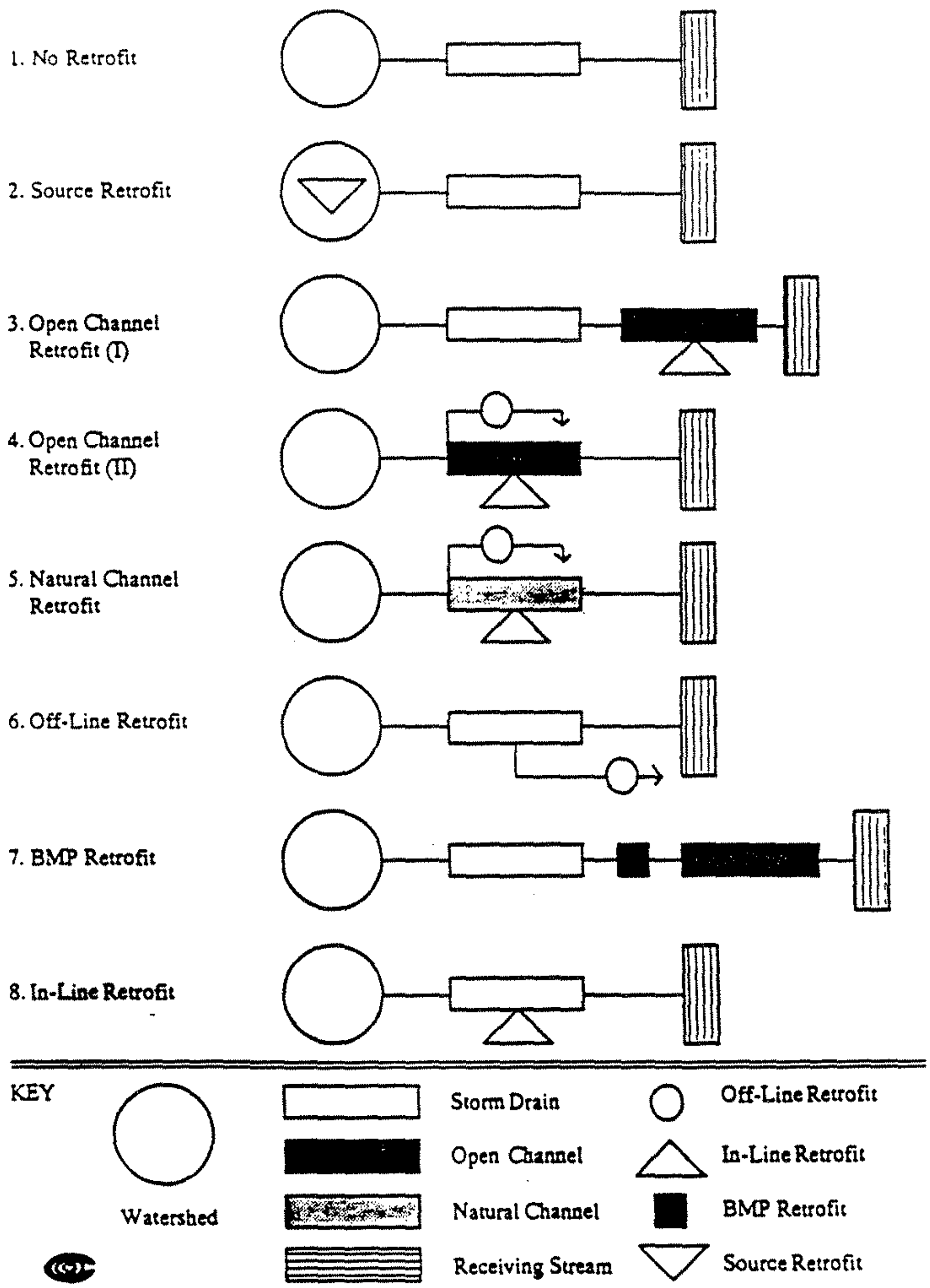
BMP/Design	Suspended Sediment	Total Phosphorus	Total Nitrogen	Oxygen Demand	Trace Metals	Bacteria	Overall Removal Capability
Extended Detention Pond							
Design 1	60 to 80%	20 to 40%	20 to 40%	20 to 40%	40 to 60%	Insufficient Knowledge	Moderate
Design 2	80 to 100%	40 to 60%	20 to 40%	40 to 60%	60 to 80%	Insufficient Knowledge	Moderate
Design 3	80 to 100%	60 to 80%	Insufficient Knowledge	40 to 60%	60 to 80%	Insufficient Knowledge	High
Wet Pond							
Design 4	60 to 80%	40 to 60%	20 to 40%	20 to 40%	20 to 40%	Insufficient Knowledge	Moderate
Design 5	60 to 80%	40 to 60%	20 to 40%	20 to 40%	60 to 80%	Insufficient Knowledge	Moderate
Design 6	80 to 100%	60 to 80%	40 to 60%	40 to 60%	60 to 80%	Insufficient Knowledge	High
Infiltration Trench							
Design 7	60 to 80%	40 to 60%	40 to 60%	60 to 80%	60 to 80%	60 to 80%	Moderate
Design 8	80 to 100%	40 to 60%	40 to 60%	60 to 80%	80 to 100%	60 to 80%	High
Design 9	80 to 100%	60 to 80%	60 to 80%	80 to 100%	80 to 100%	80 to 100%	High
Infiltration Basin							
Design 7	60 to 80%	40 to 60%	40 to 60%	60 to 80%	40 to 60%	60 to 80%	Moderate
Design 8	80 to 100%	40 to 60%	40 to 60%	60 to 80%	80 to 100%	60 to 80%	High
Design 9	80 to 100%	60 to 80%	60 to 80%	80 to 100%	80 to 100%	80 to 100%	High
Porous Pavement							
Design 7	40 to 60%	60 to 80%	40 to 60%	60 to 80%	40 to 60%	60 to 80%	Moderate
Design 8	80 to 100%	60 to 80%	60 to 80%	60 to 80%	80 to 100%	80 to 100%	High
Design 9	80 to 100%	60 to 80%	60 to 80%	80 to 100%	80 to 100%	80 to 100%	High
Water Quality Inlet							
Design 10	0 to 20%	Insufficient Knowledge	Insufficient Knowledge	Insufficient Knowledge	Insufficient Knowledge	Insufficient Knowledge	Low
Filter Strip							
Design 11	20 to 40%	0 to 20%	0 to 20%	0 to 20%	20 to 40%	Insufficient Knowledge	Low
Design 12	80 to 100%	40 to 60%	40 to 60%	60 to 80%	80 to 100%	Insufficient Knowledge	Moderate
Grassed Swale							
Design 13	0 to 20%	0 to 20%	0 to 20%	0 to 20%	0 to 20%	Insufficient Knowledge	Low
Design 14	20 to 40%	20 to 40%	20 to 40%	20 to 40%	0 to 20%	Insufficient Knowledge	Low

Key
- 0 to 20% Removal
- 20 to 40% Removal
- 40 to 60% Removal
- 60 to 80% Removal
- 80 to 100% Removal
- Insufficient Knowledge

Design 1: First-flush runoff volume detained for 6-12 hours.
Design 2: Runoff volume produced by 1.0 inch, detained 24 hours.
Design 3: As in Design 2, but with shallow marsh in bottom stage.
Design 4: Permanent pool equal to 0.5 inch storage per imercious acre.
Design 5: Permanent pool equal to 2.5 (Vr); where Vr = mean storm runoff.
Design 6: Permanent pool equal to 4.0 (Vr); approx. 2 weeks retention.
Design 7: Facility exfitrates first-flush; 0.5 inch runoff/impervious acre.
Design 8: Facility exfiltrates one inch runoff volume per impervious acre.
Design 9: Facility exfiltrates all runoff, up to the 2 year design storm.
Design 10: 400 cubic feet wet storage per impervious acre.
Design 11: 20 foot wide turf strip.
Design 12: 100 foot wide forested strip, with level spreader.
Design 13: High slope swales, with no check dams.
Design 14: Low gradient swales with check dams.

Figure 16: Comparative Pollutant Removal Of Urban BMP Designs
Source: Thomas R. Schueler, *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*, (Metropolitan Washington Council of Governments, July, 1987) p. 26.

FIGURE 7
Urban Stormwater Retrofit Techniques



Benefit Provided

POND SYSTEMS	Channel Protection	Particulate Removal	Solute Removal	Wetland Habitat	Clog-free	Low Hazard	Community Acceptance	Small Delta-T	Fingerprinting Capability	Reduced Mowing	Land Requirement	Use in Permeable Soils	Wildlife Habitat
Design No.1 Dry Ed Pond	High	High	Low	Medium	Low	High	Low	Medium	Low	Low	High	High	Medium
Design No.2 Micropool Dry Ed Pond	High	High	Medium	Low	High	Medium	Medium	Medium	High	Medium	High	Medium	Medium
Design No.3 Shallow Marsh Ed Pond	High	High	High	High	High	Medium	Medium	Medium	Low	High	Medium	Low	High
Design No. 4 Wet Ed Pond	High	High	High	Medium	High	Low	Medium	Low	Low	High	Medium	Low	Medium
Design No.5 Wet Pond	Medium	High	High	Medium	High	Low	High	Low	Medium	High	Medium	Low	Medium
Design No.6 Shallow Marsh	Medium	High	High	High	Low	Medium	Medium	Low	Low	High	High	Low	High
Design No.7	Medium	High	Medium	Low	Low	High	Medium	High	Medium	Low	Medium	High	Low

Key → Low Benefit ○ Medium Benefit ◐ High Benefit ●

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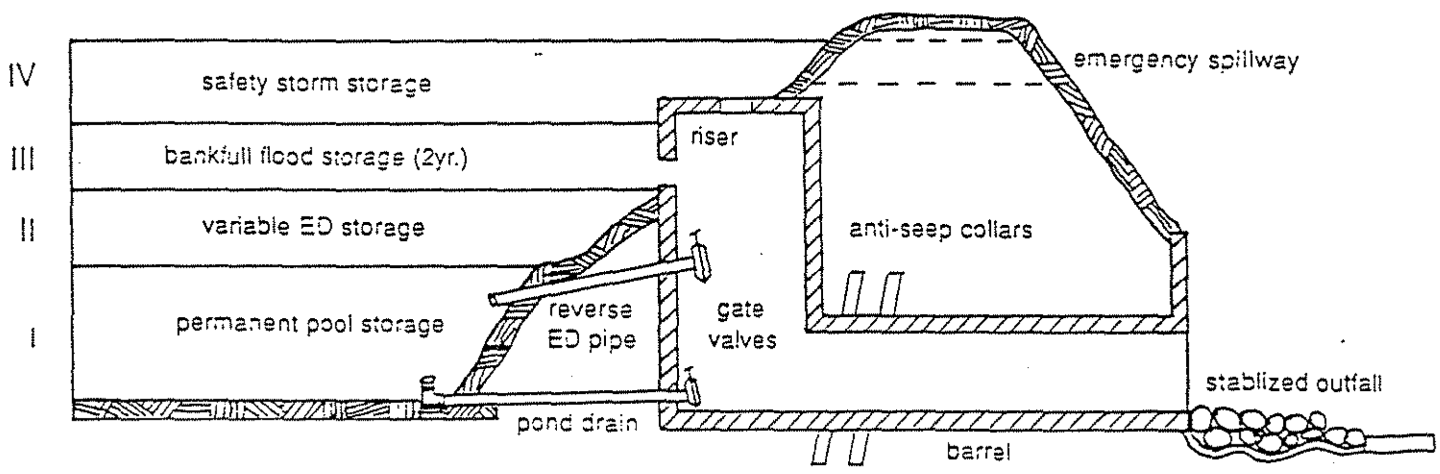
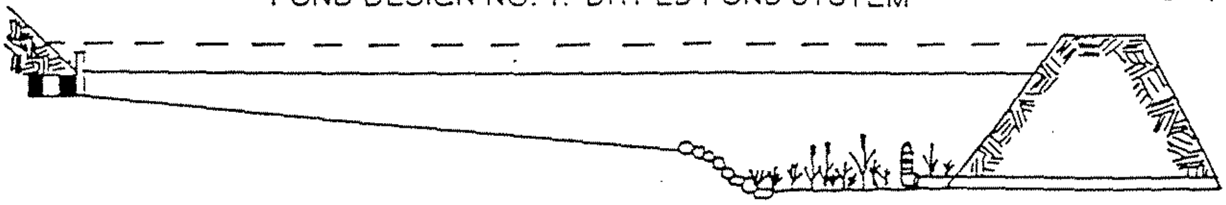
Fig 4.1

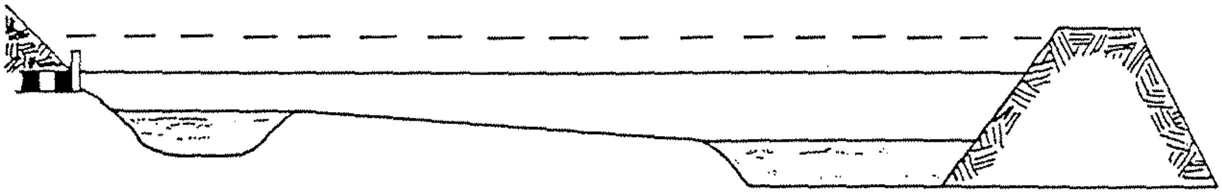
STANDARD POND SYSTEM DESIGN
CROSS-SECTION VIEW



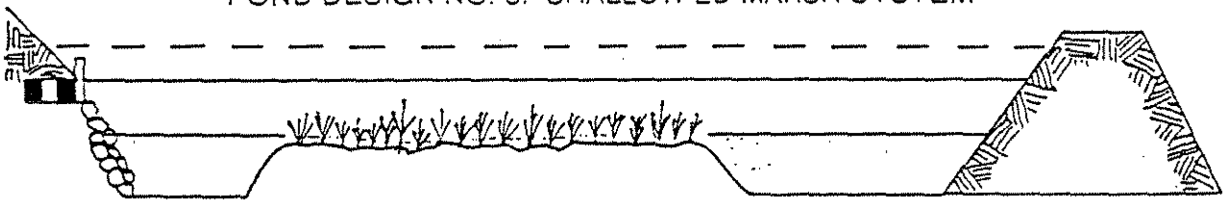
POND DESIGN NO. 1: DRY ED POND SYSTEM



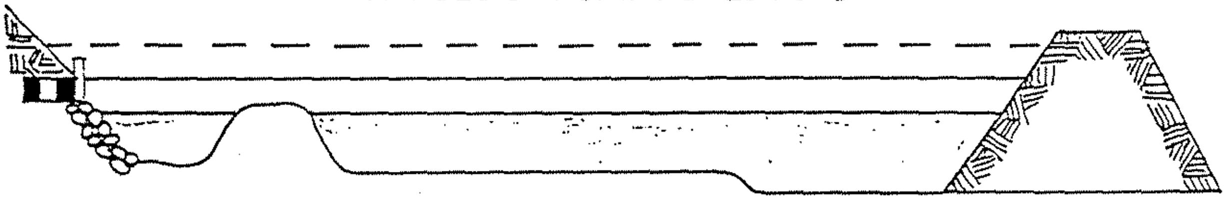
POND DESIGN NO. 2: ED MICROPOOL SYSTEM



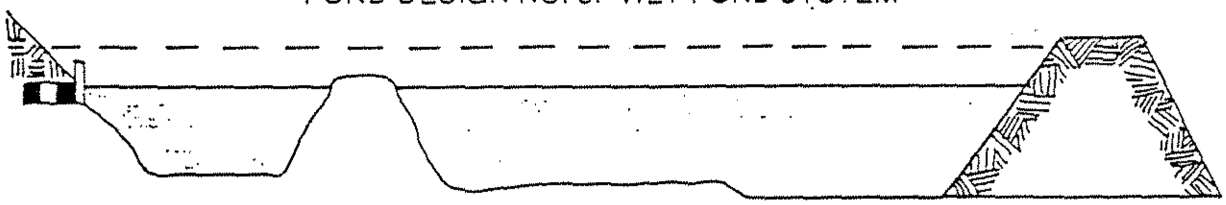
POND DESIGN NO. 3: SHALLOW ED MARSH SYSTEM



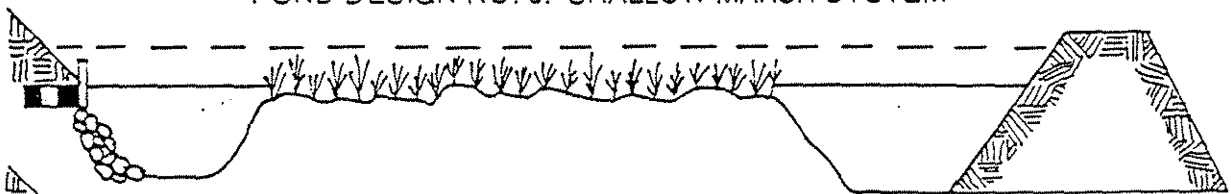
POND DESIGN NO. 4: WET ED POND



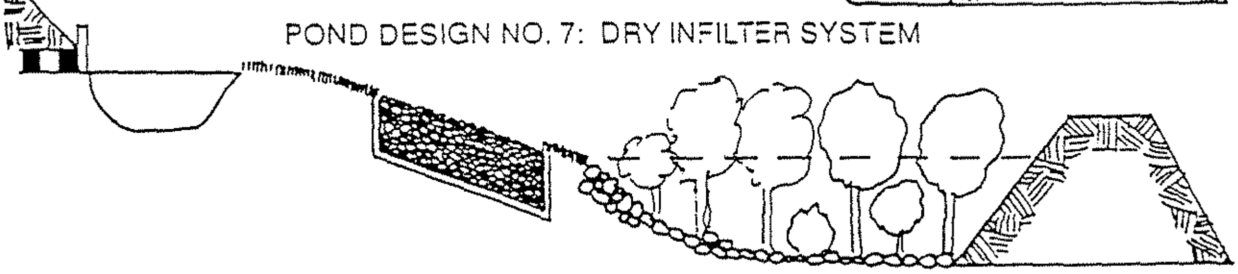
POND DESIGN NO. 5: WET POND SYSTEM



POND DESIGN NO. 6: SHALLOW MARSH SYSTEM



POND DESIGN NO. 7: DRY INFILTER SYSTEM



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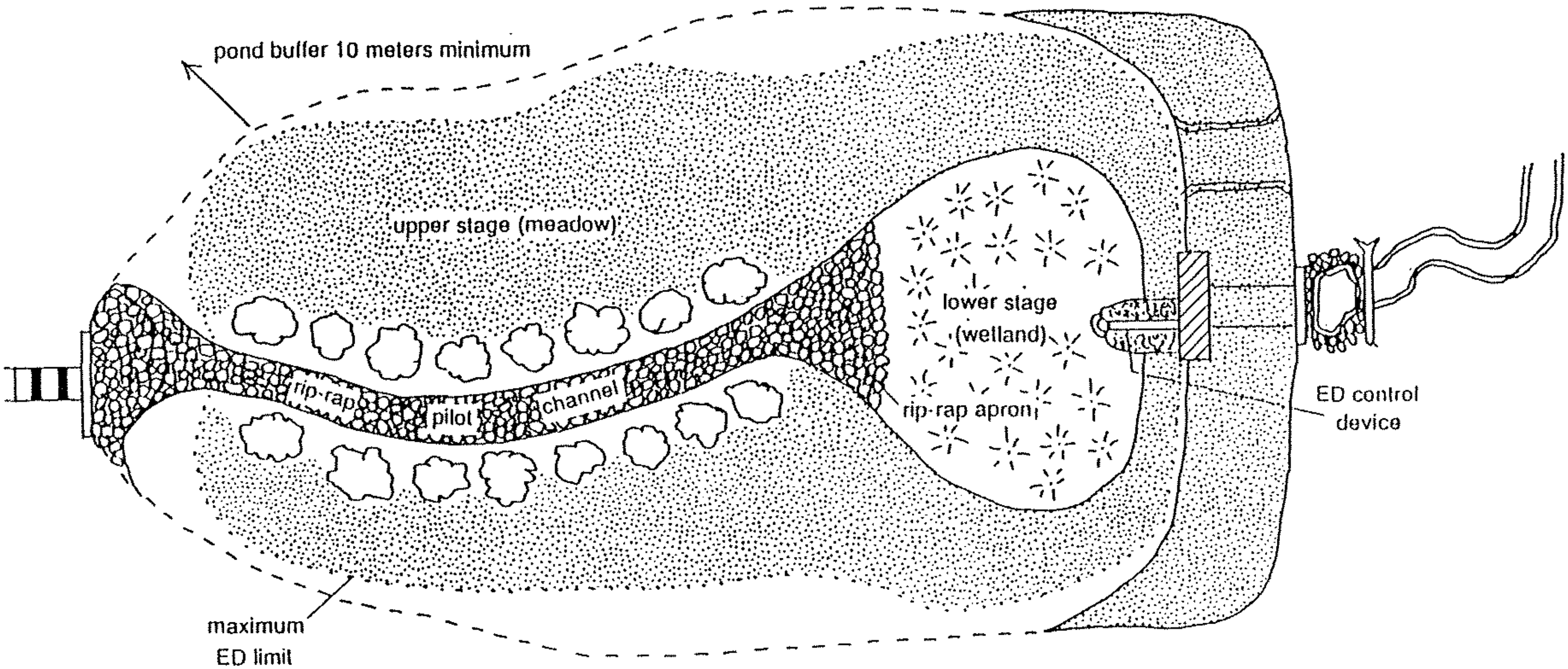
POND DESIGN NO. 1: DRY ED POND SYSTEM



STORAGE ALLOCATION:

ED storage (24 hours) = 75 mm/impha
upper stage = 45 mm/impha
lower stage = 30 mm/impha

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POND DESIGN NO. 2: ED MICROPOOL SYSTEM

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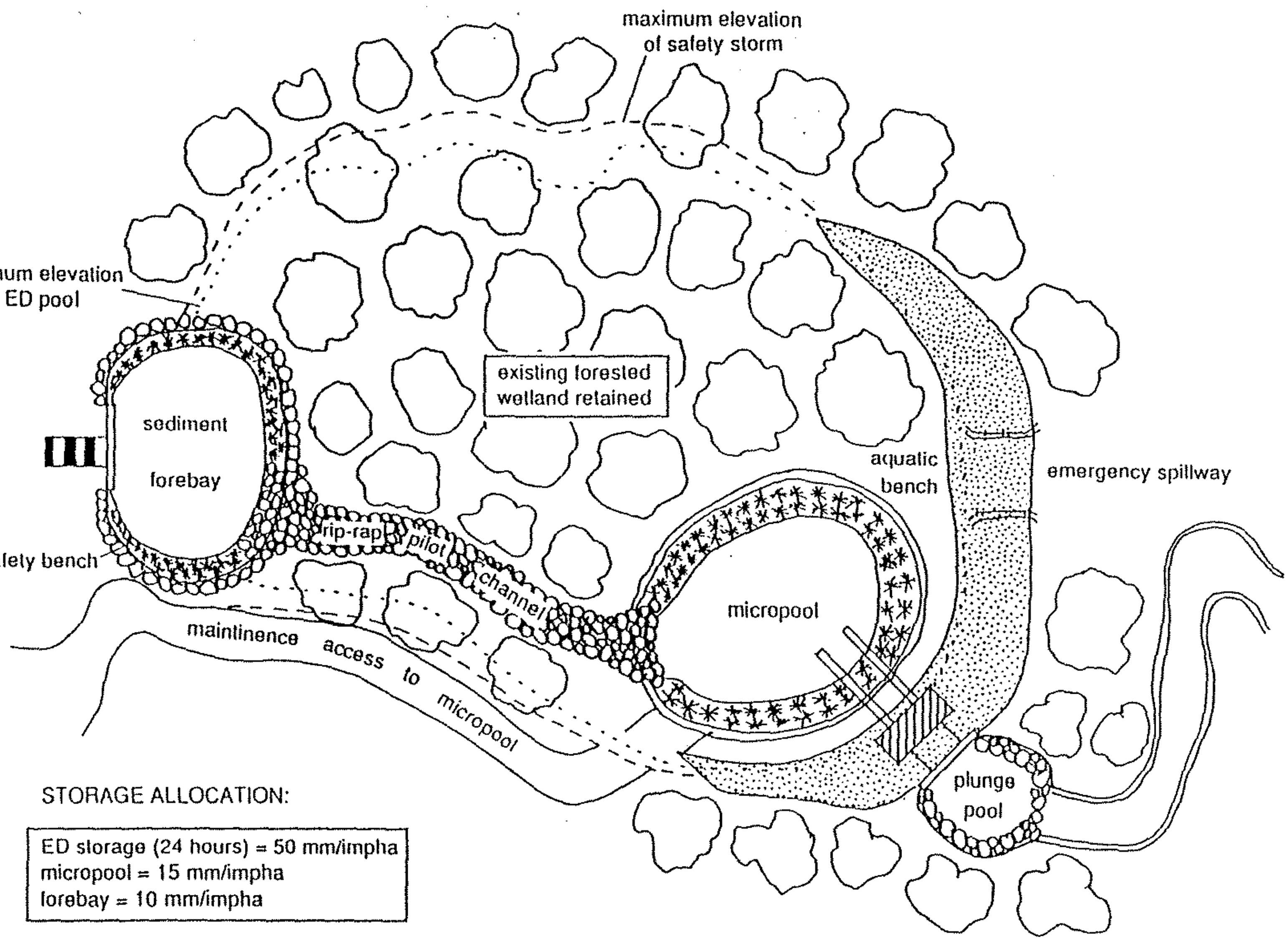

STORAGE ALLOCATION:

ED storage (24 hours) = 50 mm/impha
micropool = 15 mm/impha
forebay = 10 mm/impha

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POND DESIGN NO. 3: SHALLOW ED MARSH SYSTEM

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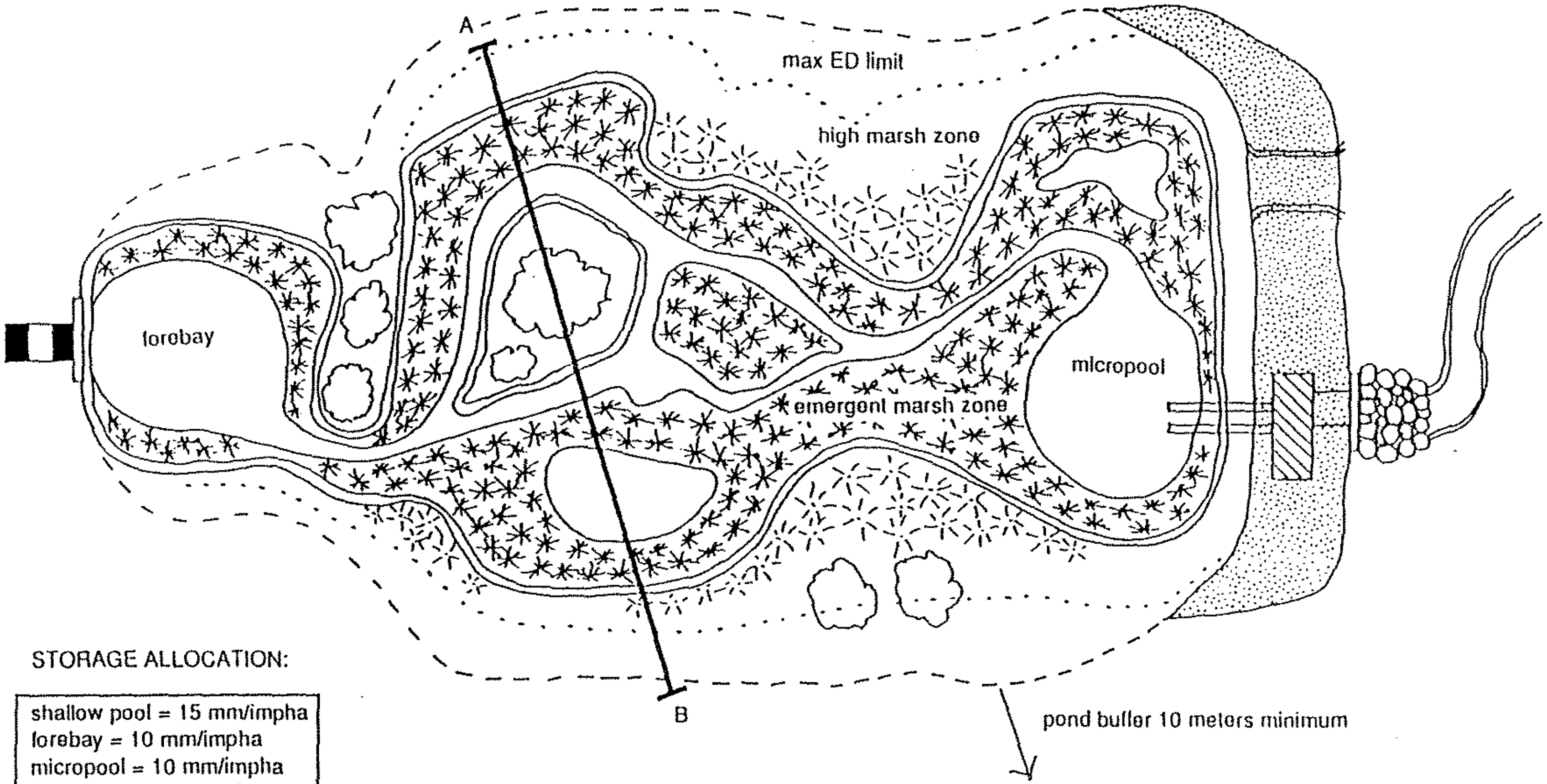
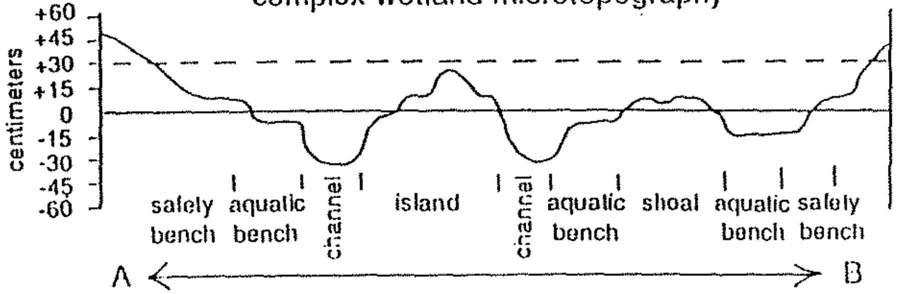


STORAGE ALLOCATION:

shallow pool = 15 mm/impha
forebay = 10 mm/impha
micropool = 10 mm/impha
24 ED pool = 40 mm/impha

complex wetland microtopography



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POND DESIGN NO. 4: WET ED POND

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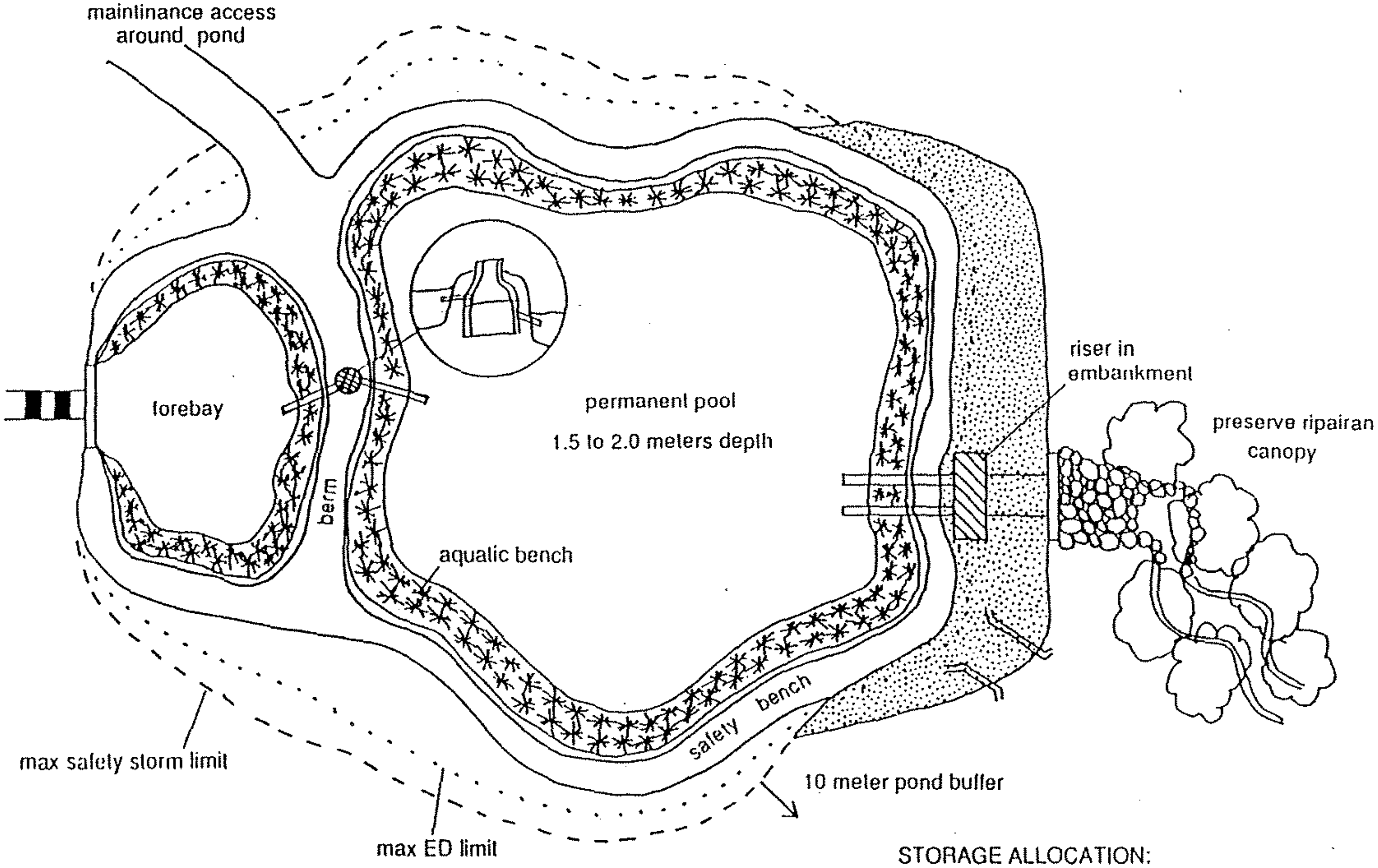
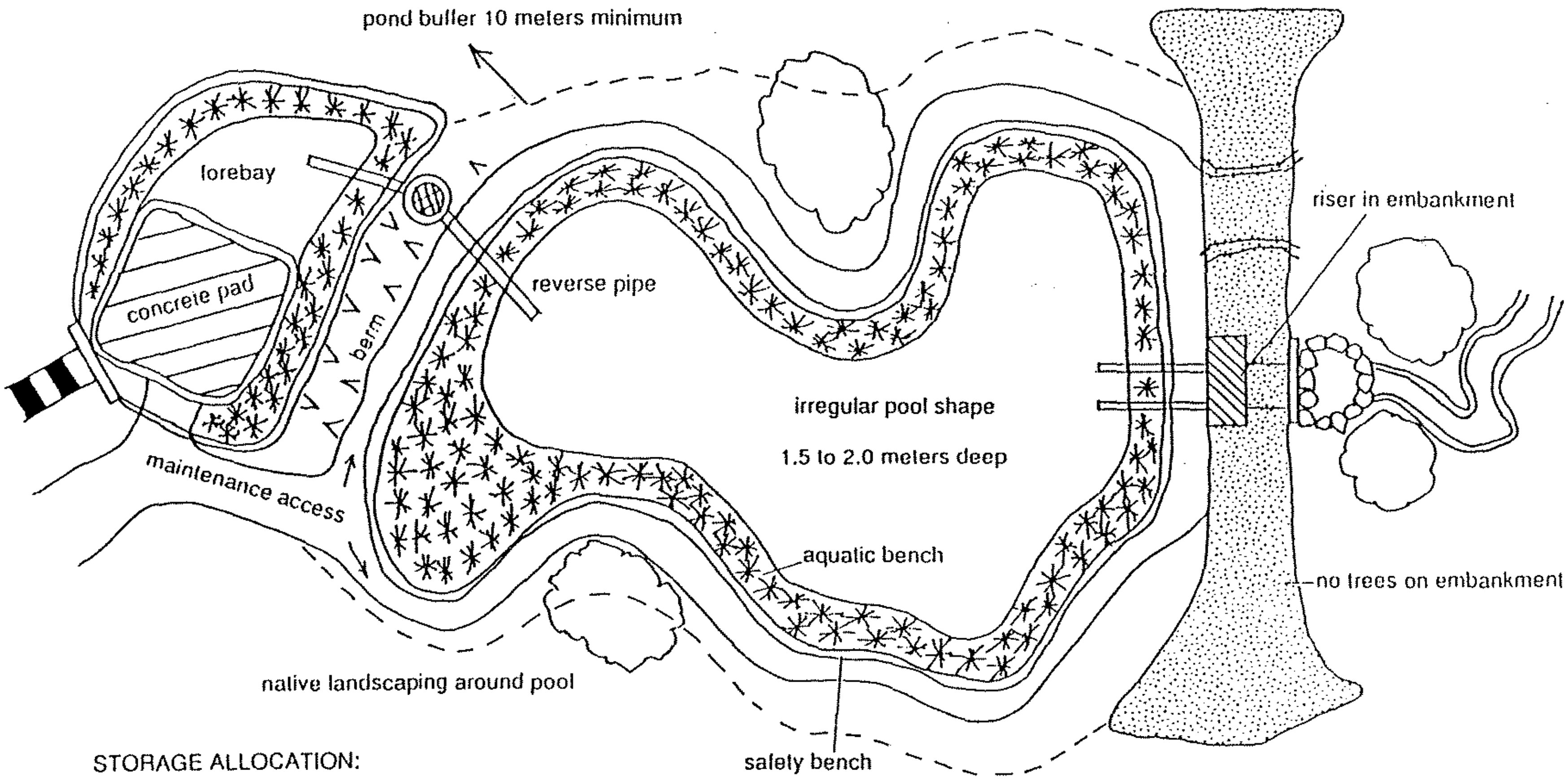


STORAGE ALLOCATION:

forebay = 10 mm/impha
permanent pool = 30 mm/impha
ED storage = 35 mm/impha

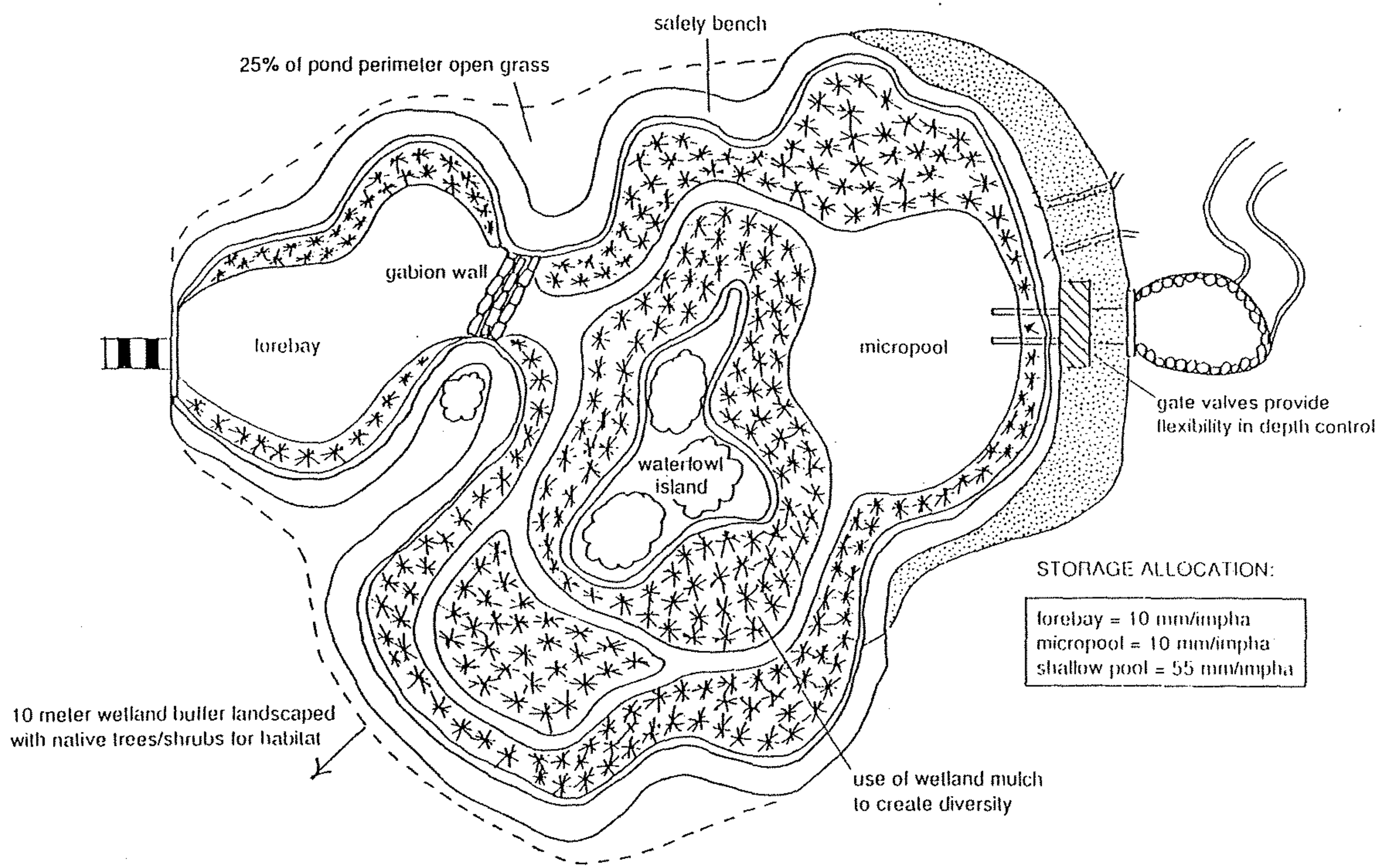
POND DESIGN NO. 5: WET POND SYSTEM



STORAGE ALLOCATION:

forebay = 15 mm/impha
pool = 60 mm/impha

POND DESIGN NO. 6: SHALLOW MARSH SYSTEM



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POND DESIGN NO. 7: ...Y INFILTER SYSTEM

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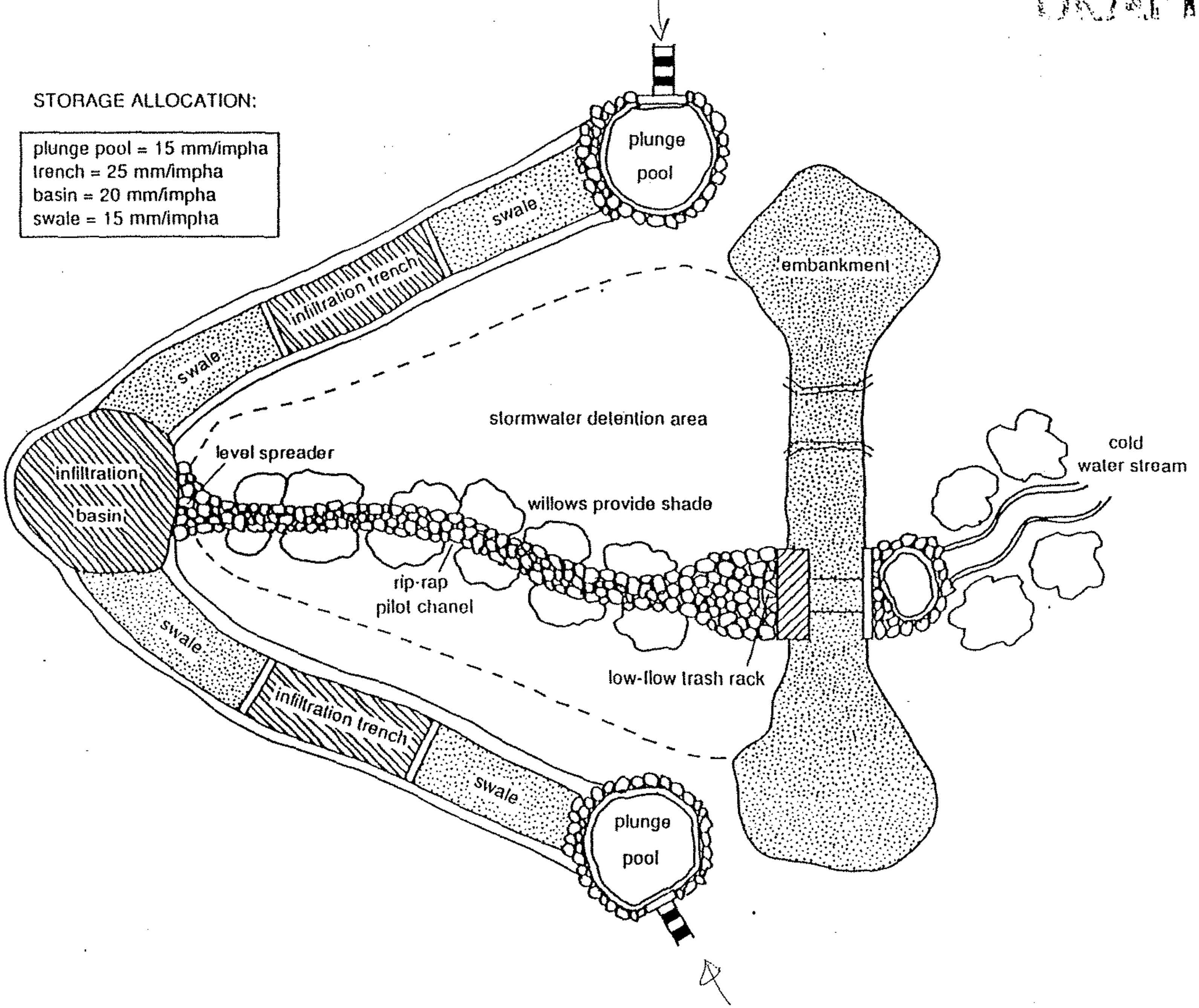


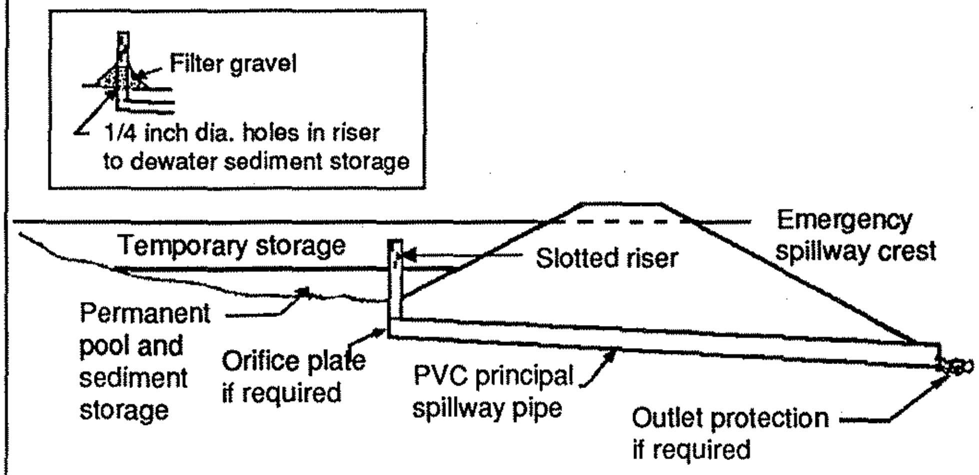
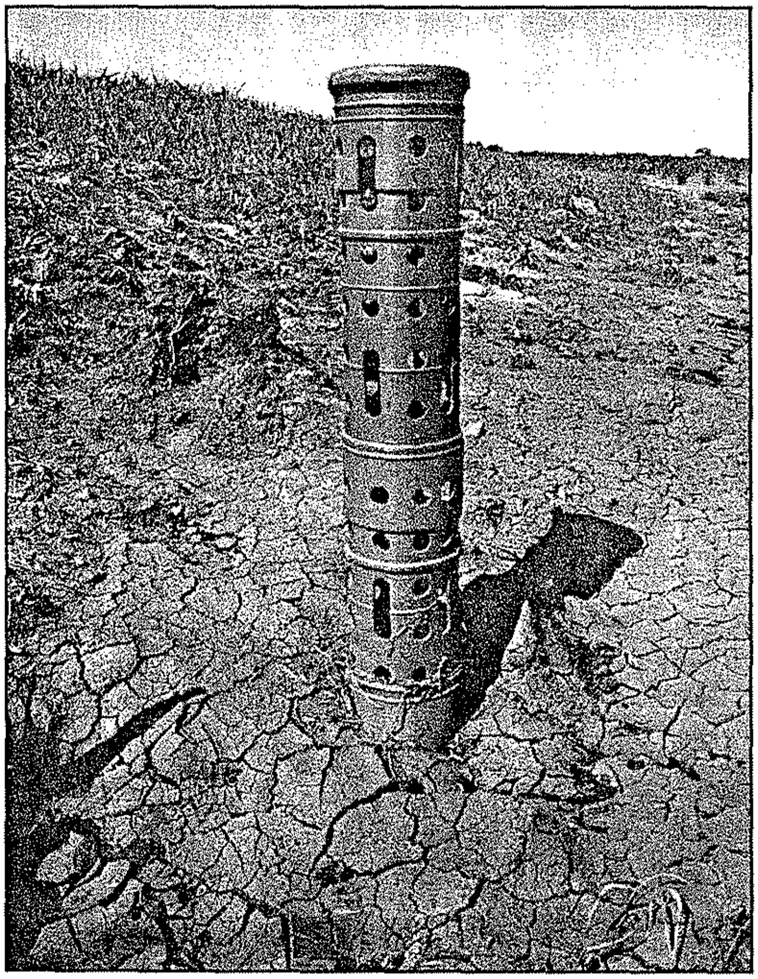
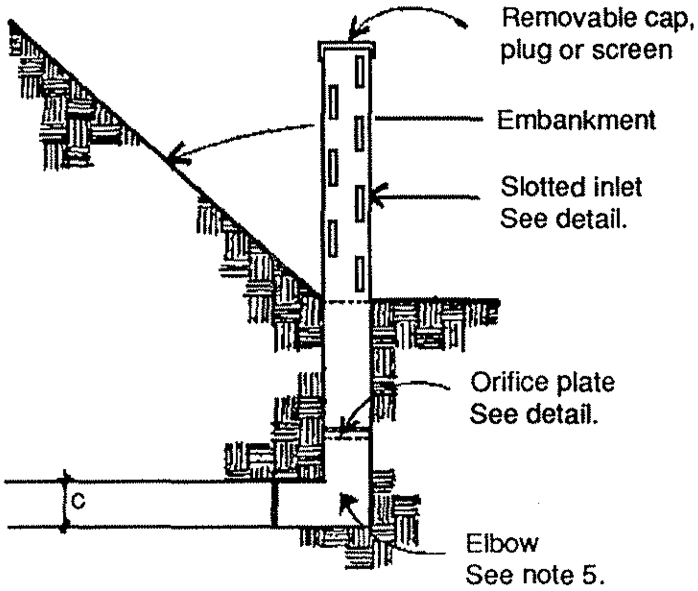
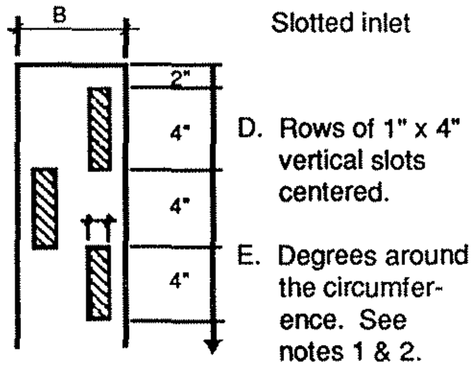


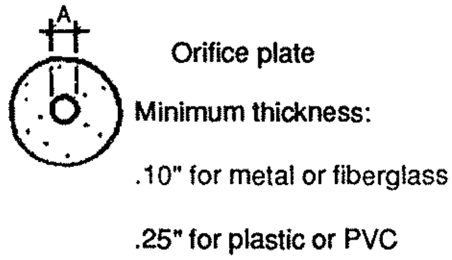
Figure 6.1-6: Slotted riser with PVC pipe

Prefabricated slotted riser









Principal spillway pipe with slotted riser

Standard DimensionsTable

A in.	B in.	C in. min.	D rows	E degr.	Slot area ft²/ft.	Minimum wall thickness corrugated metal base	smooth steel in.	PVC in.
1.50-3.50	6	4	4	90	.167	16	.10	.15
3.75-5.50	8	6	6	60	.250	16	.10	.20
5.75-6.00	10	8	8	45	.383	16	.13	.25

Notes and Comments

1. Slotted inlets shall be fabricated from corrugated metal, smooth steel or PVC plastic pipe. Materials shall have at least the minimum wall thickness given in the standard dimensions table.

2. Slots shall be cut cleanly and deburred. Ends of slots may be round or square.

3. Orifice plate, cap and all fittings shall be snug and securely fastened. Orifice plate shall be cleanly cut and free of burrs with care taken not to round the edges. It should be a minimum of 2.0 feet below grade for proper functioning.

4. The portion of the inlet below grade may be perforated with a gravel filter for additional dewatering of basin.

5. Fabricated or standard elbow, fabricated or standard tee with main tile line or plug in upstream end, or standard tee with one end embedded in concrete.

6. The height if inlet is above the sediment pool level shall be such that the velocity of flow through the slots is less than 2.0 feet per second.

7. Head on the orifice, if placed as suggested, may be figured by adding 0.7 times the maximum depth of impounded water plus the depth of the orifice below grade. Has a relatively constant rate of change.

Figure 6.1-7: Slotted riser standard dimensions

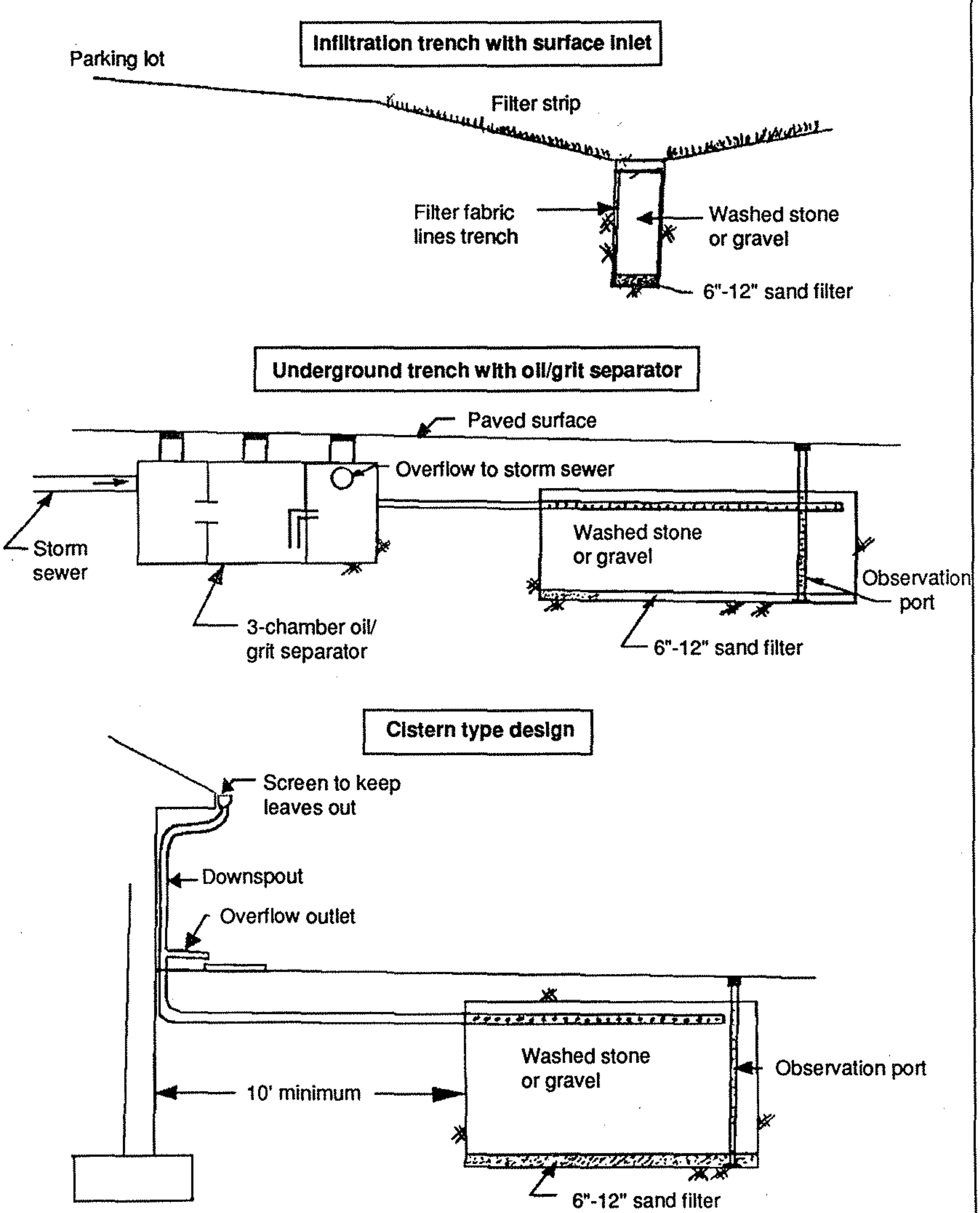
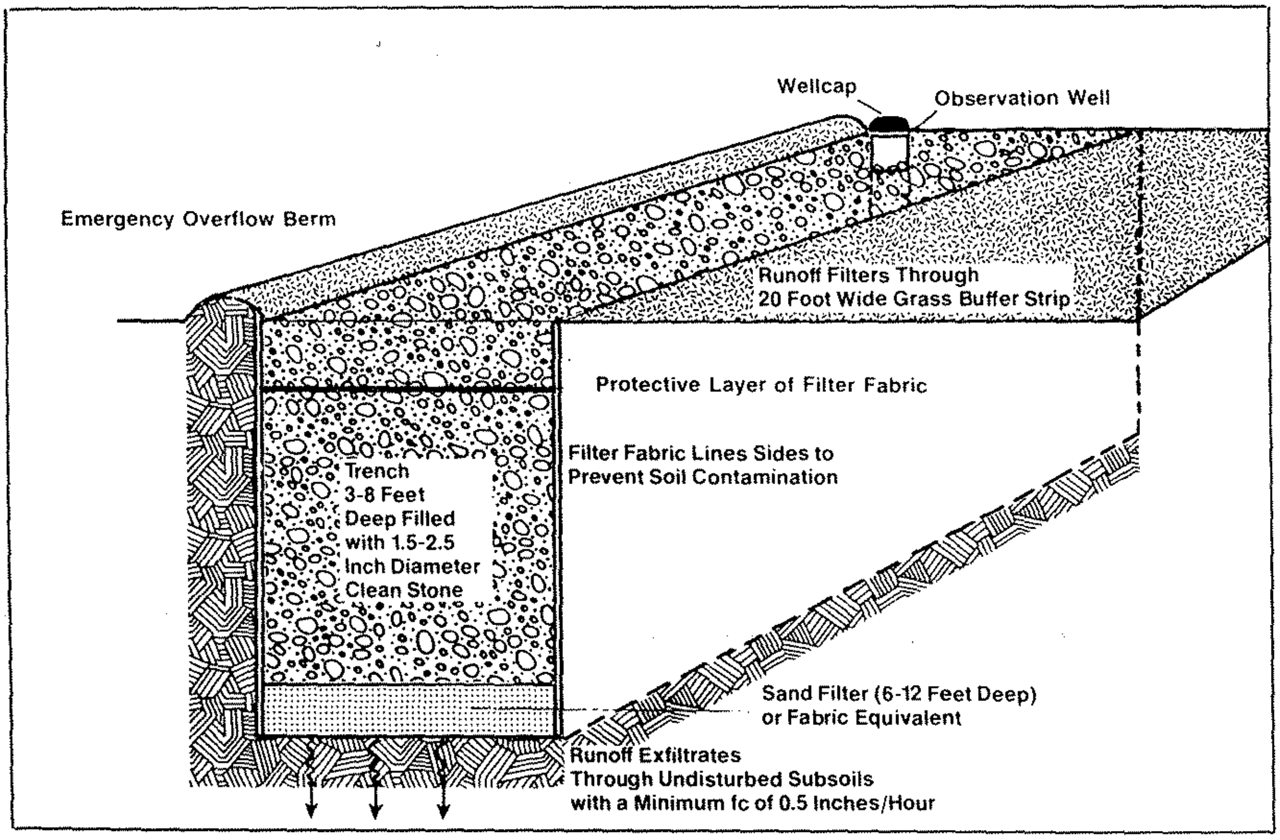


Figure 4.4-1: Typical infiltration trench use

CHAPTER 5: INFILTRATION TRENCHES

Infiltration trenches are an adaptable BMP that effectively remove both soluble and particulate pollutants. As with other infiltration systems, trenches are not intended to trap coarse sediments. Grass buffers (for surface trenches) or special inlets (for underground trenches) must be installed to capture sediment before it enters the trench. Depending on the degree of storage/exfiltration achieved, trenches can provide groundwater recharge, low flow augmentation and localized streambank erosion control. Individual trenches are primarily an on-site control, and are seldom practical or economical on sites larger than 5 or 10 acres. Trenches are only feasible when soils are permeable and the water table and bedrock are situated well below the bottom of the trench. Aside from regular inspections and more rigorous sediment and erosion control, trenches have limited routine maintenance requirements. However, trenches will prematurely clog if sediment is not kept out before, during and after construction of a site. If a trench does become severely clogged, partial or complete replacement of the structure may be required.

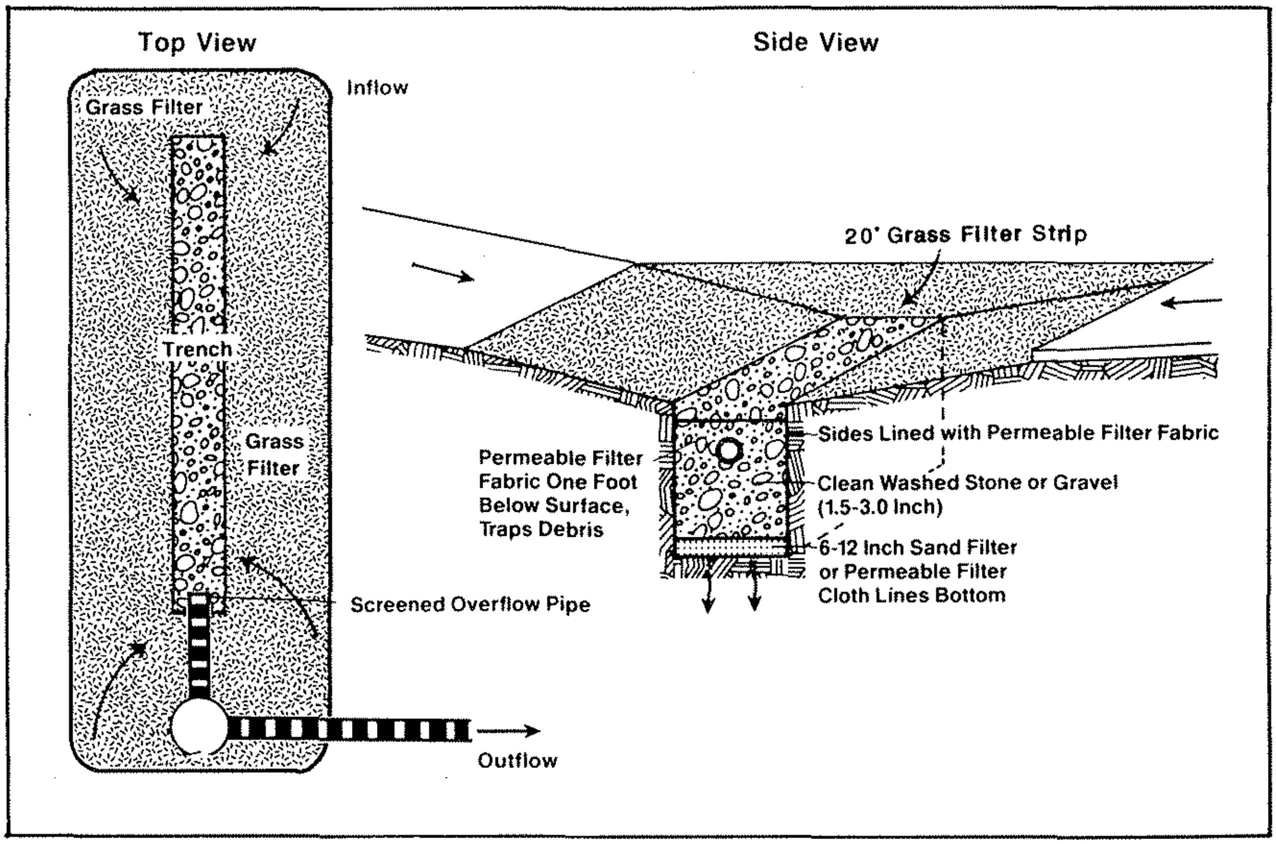
Figure 5.1: Schematic of an Infiltration Trench



DESIGN 1:

Median Strip Design (Figure 5.2). This design is frequently used for highway median strips and parking lot "islands" (depressions in between two lots or adjacent sides of one lot). Sheet flow is accepted from both sides of the trench, and is filtered through a 20 foot wide grassed buffer strip. The strip is an integral part of the trench, and should be graded to have a uniform slope not greater than 5%, and should directly abut the contributing impervious area. Berms located on each side of the strip form a shallow depression that temporarily stores runoff before it enters the trench. An overflow pipe is used to pass excess runoff.

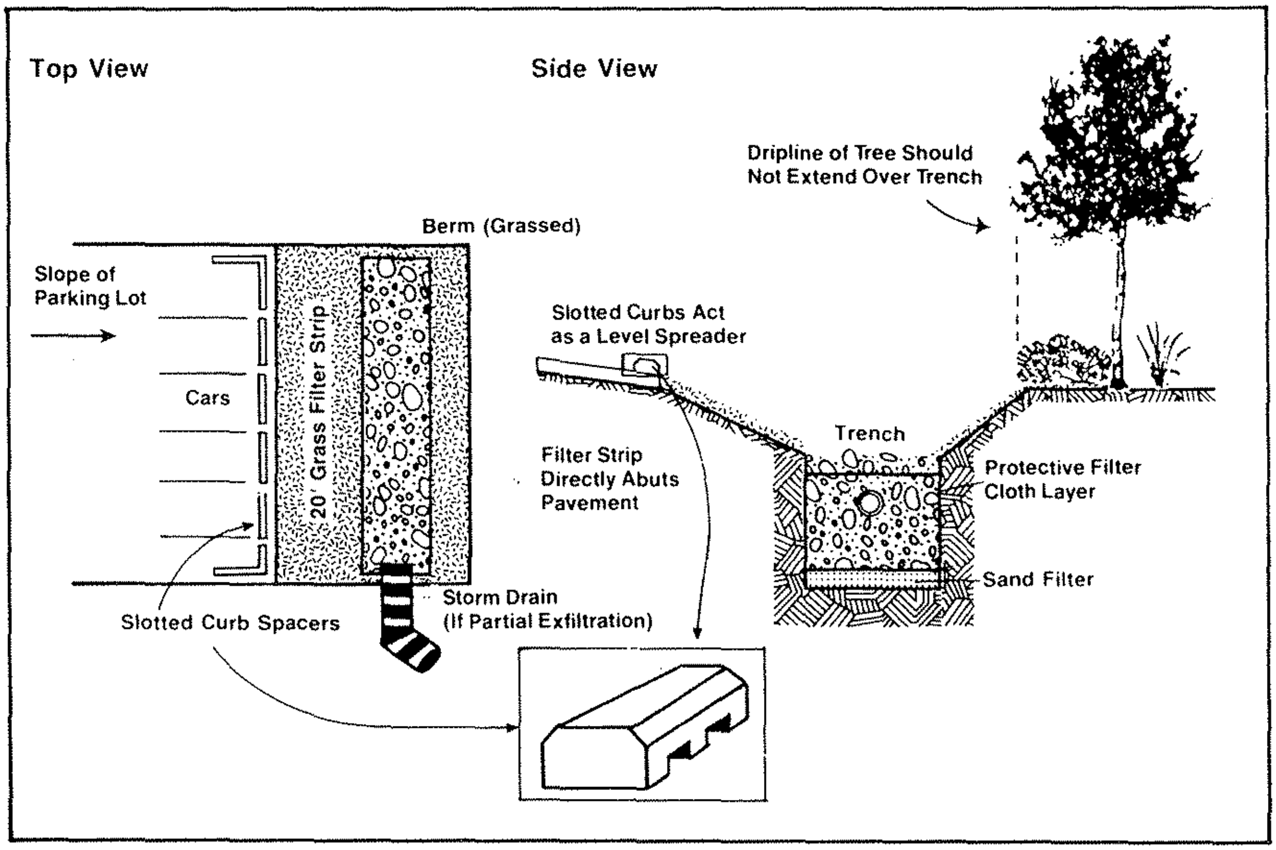
Figure 5.2: Median Strip Trench Design



DESIGN 2:

Parking Lot Perimeter (Figure 5.3). This design accepts sheet flow from the lower end of a parking lot. Slotted curb spacers are used as level spreaders to route sheet flow from the parking lot over the 20 foot wide filter strip (and also keep cars from damaging the strip). After being filtered over the grass strip, runoff enters the surface of the trench. A shallow berm is installed at the far end of the trench to ensure that runoff does not escape. The trench should have an overflow to pass large design storms, such as a PVC pipe with holes drilled on its underside, set near the top of the trench (Figure 5.3).

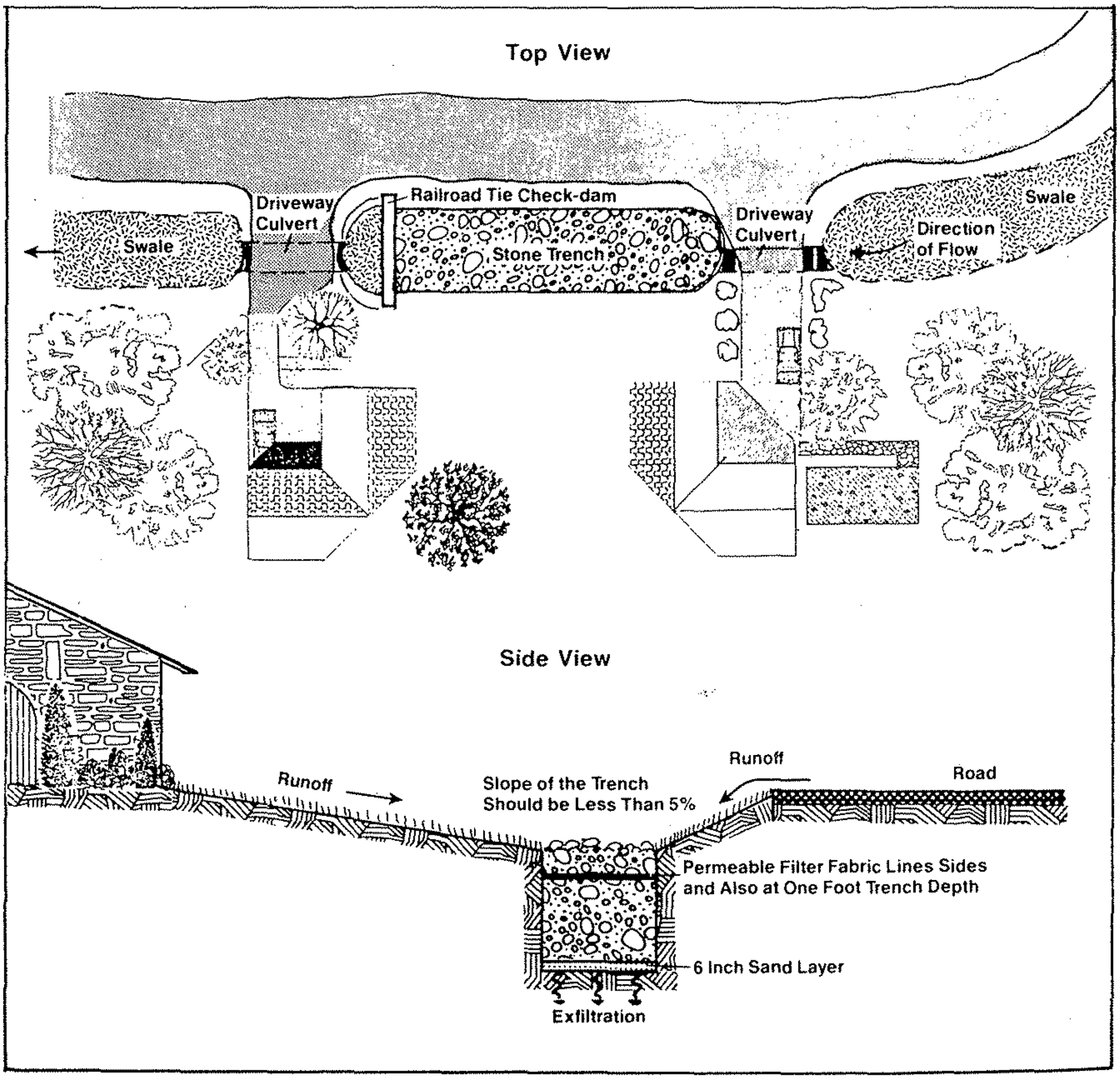
Figure 5.3: Parking Lot Perimeter Trench Design



DESIGN 3:

Swale Designs (Figure 5.4). Low density residential runoff (5-15% impervious) can be treated through a series of surface trenches located in swale drainage systems. The major design requirement is that the longitudinal slope of the swale collection system should never exceed 5%. Otherwise, concentrated flows will develop that might erode the swales and contaminate the trench. In addition, concentrated flows may pass around or over the surface of the trench and never infiltrate. An earthen check dam or railroad tie placed perpendicularly to the flow path, on the downstream side of the trench, can prevent "short-circuiting" and increase the volume of runoff exfiltrated by the trench. The slope of the trench should be as close to zero as feasible, and should have sideslopes of 5:1 (h:v) or less.

Figure 5.4: Swale/Trench Design



CHAPTER 6: INFILTRATION BASINS

Infiltration basins are effective in removing both soluble and fine particulate pollutants borne in urban runoff. Coarse-grained pollutants should generally be removed before they enter a basin. Unlike other infiltration systems, basins can be easily adapted to provide full control of peak discharges for large design storms. Also, basins can serve relatively large drainage areas (up to 50 acres). Depending on the degree of storage/exfiltration achieved in the basin, significant groundwater recharge, low flow augmentation and localized streambank erosion control can be achieved.

Figure 6.1: Schematic of an Infiltration Basin

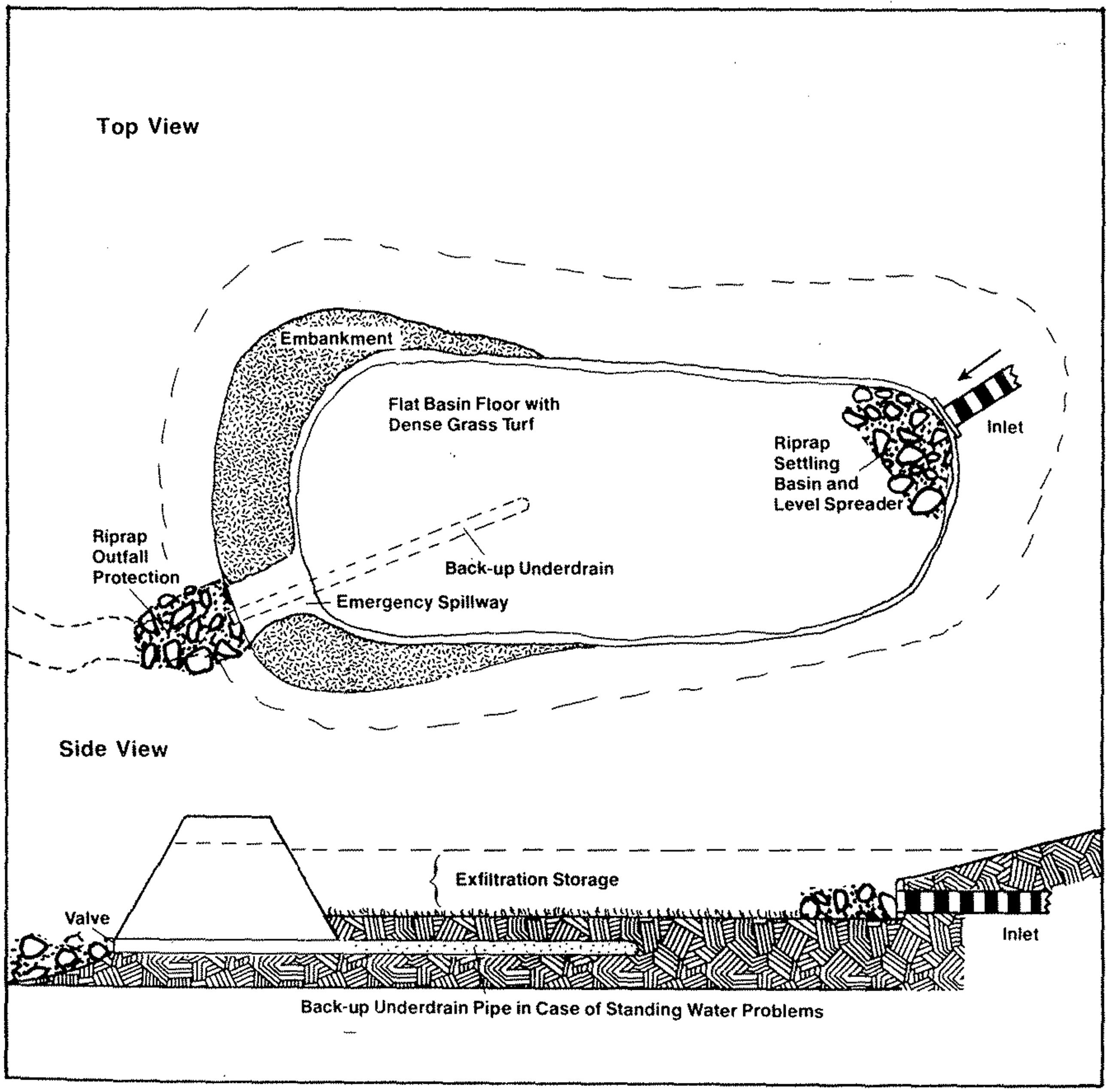
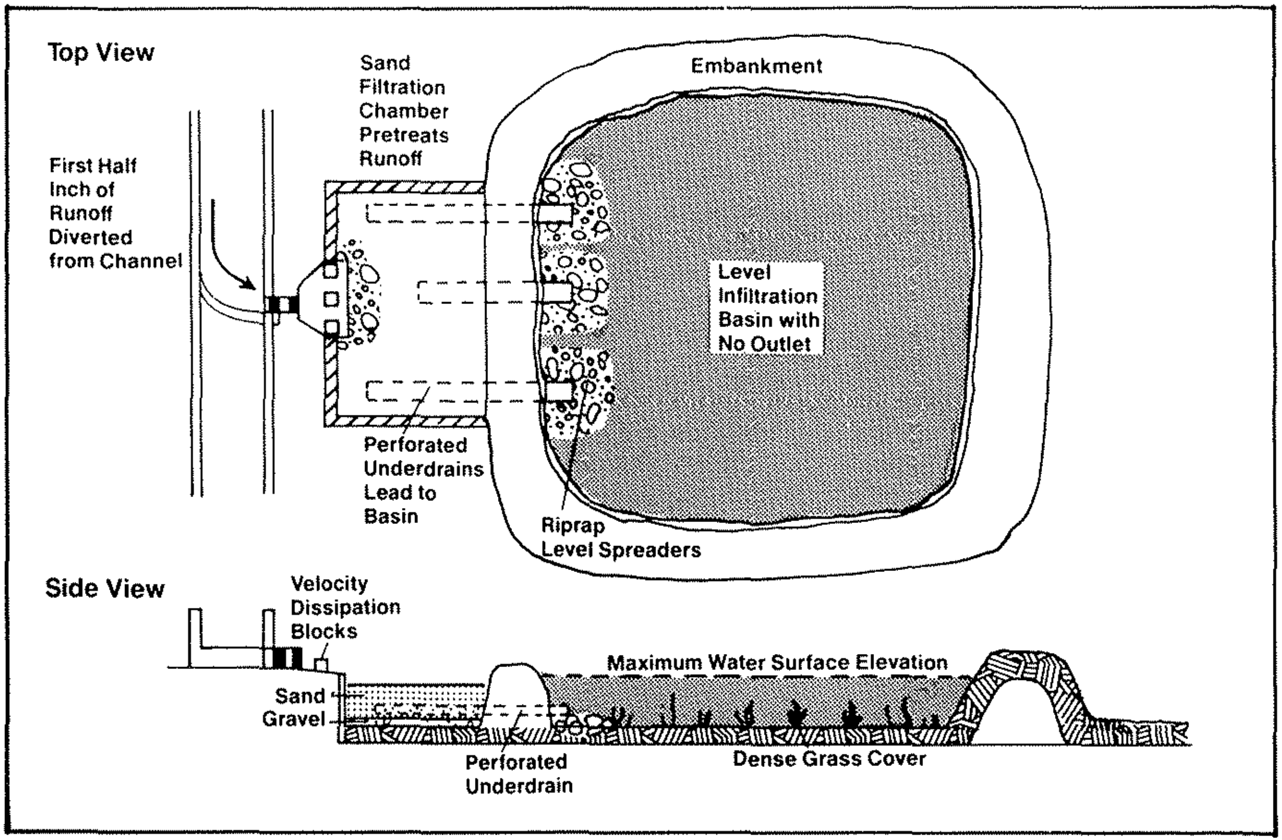


Figure 6.4: Off-line Infiltration Basin Design



Depth to Seasonally High Water Table

A minimum of two to four feet of clearance is needed between the floor of the basin and the seasonally high water table. This depth can be readily determined from soil borings taken during wet weather. High water tables often present a major obstacle to the use of infiltration basins, since basins are usually located in depressions at the low end of a watershed where local water tables are located near the the ground surface.

Proximity to Wells and Foundations

Basins should be located at least 100 feet away from drinking water wells to minimize the possibility of groundwater contamination, and should be situated at least 10 feet down-gradient and 100 feet up-gradient from building foundations to avoid potential seepage problems.

Maximum Depth of Reservoir

To insure that the basin completely drains within 72 hours, it may be necessary to limit the depth of the basin if underlying soils have relatively low exfiltration rates. Recommended depth limits for basins are shown for various soil textures in Table 6.2.

Watershed Size

Md WRA (1983b) suggests that basins can be applied to sites ranging from 5 to 50 acres in size. Other BMPs, such as extended detention ponds and wet ponds, are better candidates on larger sites as they are more capable of handling sustained baseflow.

Table 6.2: Soil Limitations For Infiltration Basins

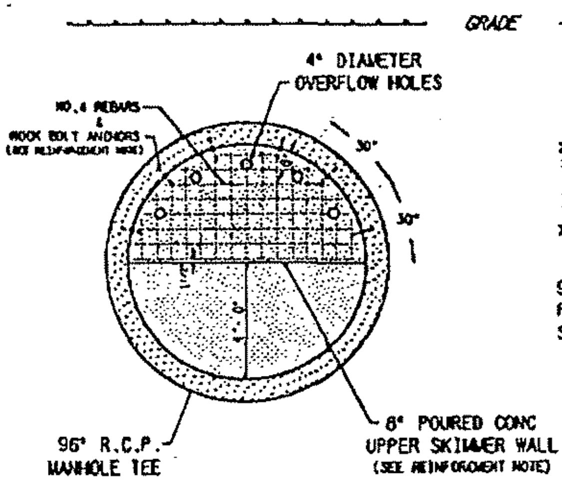
SOIL TYPE	MINIMUM INFILTRATION RATE (fc--inches/hr)	SCS SOIL[1] GROUP	MAXIMUM DEPTH OF[2] STORAGE (inches) 48 hrs	72 hrs
Sand	8.27	A	397	595
Loamy Sand	2.41	A	116	174
Sandy Loam	1.02	B	49	73
Loam	0.52	B	25	37
Silt Loam	0.27	C	13	19

[1] Sandy Clay Loams, Clay Loams, Silty Clay Loams, Sandy Clay, Silty Clay,and Clay Soils are not included as these soil types are all NOT FEASIBLE for infiltration basins.

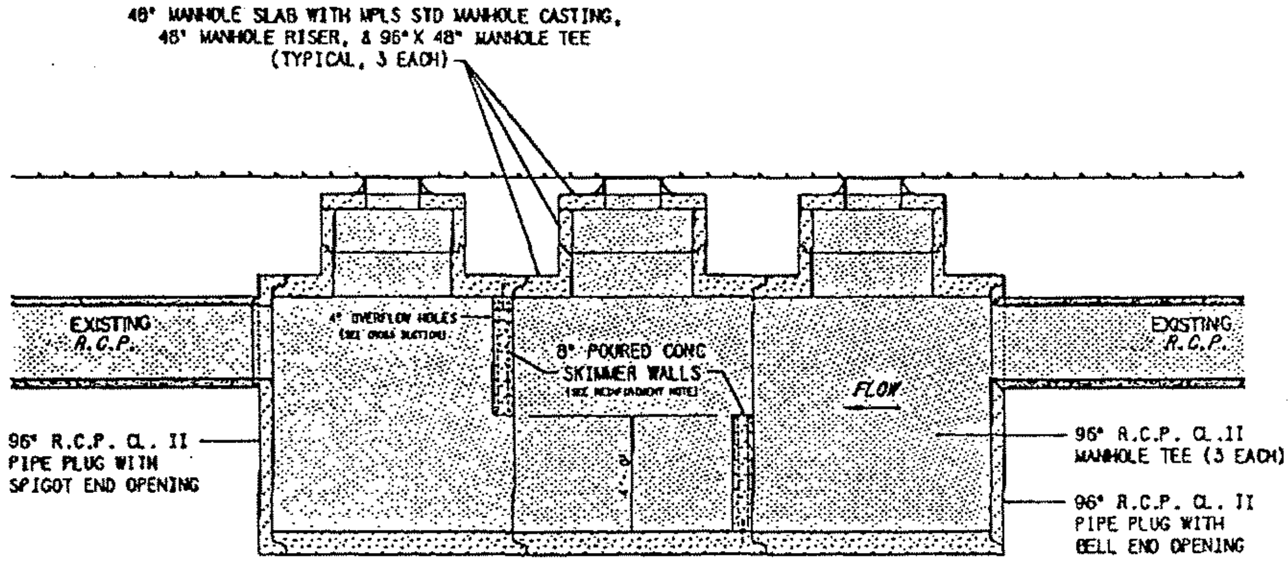
[2] Maximum Depth in the Basin that can drain completely within 48 or 72 hours after a storm, given the soil infiltration rate.

96" DIAMETER GRIT CHAMBER

STORM DRAIN



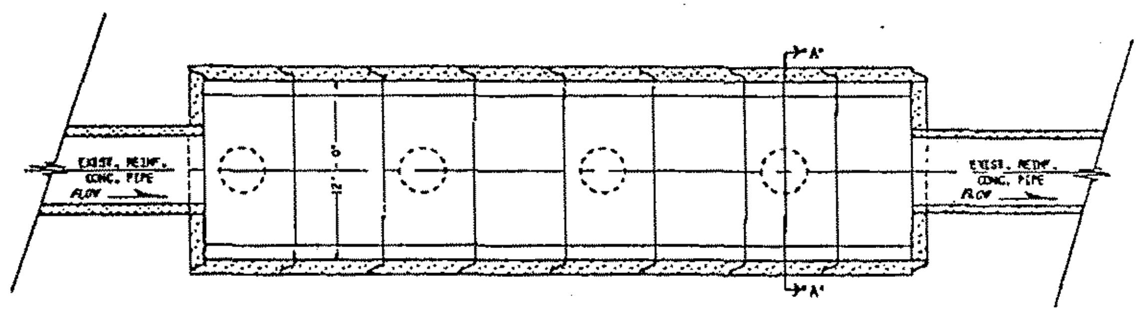
CROSS SECTION DETAIL



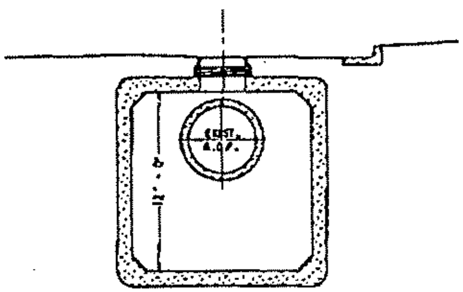
SKIMMER WALL REINFORCEMENT
2 ROWS - NO. 4 REBARS 6" O.C. (EACH WAY)
6 - 8" LONG, NO. 4 EPOXY ROCK BOLT ANCHORS

LONGITUDINAL SECTION DETAIL

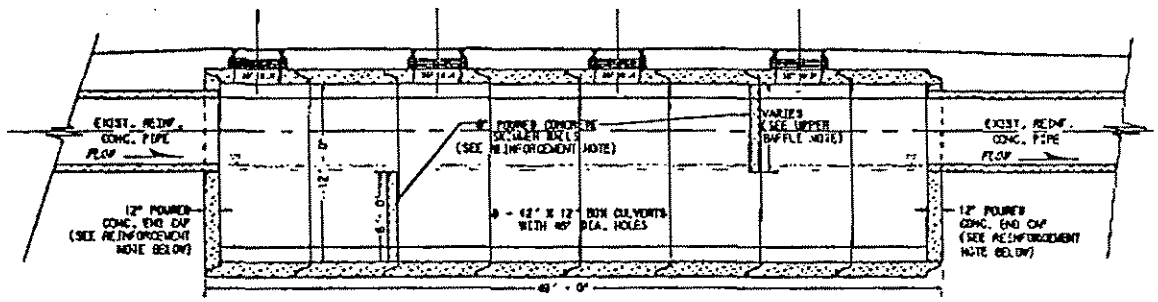
GRIT CHAMBER DETAIL



PLAN VIEW SECTION



SECTION "A - A"



END CAP & SKIMMER WALL REINFORCEMENT NOTE
1 ROW - NO. 4 REBARS, 6" O.C. (EACH WAY)
6 - 8" LONG, NO. 4 EPOXY ROCK BOLT ANCHORS

PROFILE VIEW SECTION

UPPER BAFFLE NOTE
BAFFLE TO EXTEND BELOW ELEVATION OF OUTLET.
CROSS-SECTIONAL AREA BELOW BAFFLE SHALL BE GREATER THAN OR EQUAL TO CROSS-SECTIONAL AREA OF OUTLET PIPE.

APPENDIX C

Soil Association Descriptions

Soil Survey

Sattre-Pillot-Antiago association

This association consists of soils on stream terrace and outwash plains. It is about 30 percent Sattre soils, 20 percent Pillot soils, 15 percent Antiago soils, and 35 percent minor soils.

Sattre and Pillot soils are on stream terraces and outwash plains. They are nearly level to sloping and are well drained. The substratum, to a depth of 60 inches, is yellowish brown sand and gravel.

Antigo soils are also on stream terraces and outwash plains. They are nearly level to sloping and are well drained. The substratum, to a depth of 60 inches, is strong brown sand and gravel.

This association is well suited or moderately well suited to corn, oats, and alfalfa. Sattre and Antigo soils have medium natural fertility and moderate available water capacity. Pillot soils have high natural fertility and moderate available water capacity. Controlling erosion and maintaining good soil tilth and fertility are the main concerns of good management.

The main enterprises are dairying and feeding beef cattle. Such cash crops as corn, soybeans, peas and beans for canning are also frequently grown. Where slopes are less than 6 percent, Sattre, Pillot, and Antigo soils have slight limitations for homesites and septic tank absorption fields. Where slopes are less than 6 percent, Sattre soils have slight limitations and Pillot and Antigo soils have moderate limitations for local roads and streets. All the major soils in this association have severe limitations for trency-type sanitary landfill and sewage lagoons.

Plainfield-Boone association

This association consists of solids on outwash plains, stream terraces, and sandstone uplands. It is about 60 percent Plainfield soils, 15 percent Boone soils, and 25 percent minor soils.

Plainfield soils are on outwash plains and stream terraces. They are gently sloping to moderately steep and are excessively drained. The substratum, to a depth of 60 inches, is strong brown sand.

Boone soils are on foot slopes, knolls, and ridges of sandstone uplands. They are gently sloping to moderately steep and are excessively drained. The substratum, to a depth of 50 inches, is light yellowish brown fine sand and sandstone fragments. Below this, it is white, weakly cemented sandstone.

This association is suited mainly to permanent pasture or pine tree plantations, but some areas are cultivated and used for growing limited amounts of corn, oats, and hay. Plainfield and Boone soils are subject to soil blowing. They have low natural fertility and low available water capacity. A few extensive areas of gently sloping Plainfield soils are suitable for irrigation and for growing such crops as benas, peas, potatoes, and strawberries. Controlling soil blowing and maintaining organic matter content are the main concerns of management.

The main enterprises are feeding beef cattle and some dairying, but land use is changing to pine tree plantations or recreational and urban uses. Where slopes are less than 6 percent, Plainfield and Boone soils have slight or moderate limitations for septic tank absorption fields and local roads and streets. Where slopes are less than 6 percent, Plainfield soils have slight limitations for homesites and Boone soils have moderate limitations for homesites. Both soils have severe limitations for trench type sanitary landfill and sewage lagoons.

Santiago-Otterholt-Arland association

This association consists of soils on sandstone and limestone uplands that are covered in most places by a thin mantle of glacial drift or a thick mantle of windblown silt loam. It is about 25 percent Santiago soils, 20 percent Otterholt soils, 20 percent Arland soils, and 35 percent minor soils.

Santiabo soils are on ridges of till plains. They are gently sloping to steep and are well drained.

Otterholt soils are on ridges and valleys of till plains and uplands where the mantle of windblown silt loam is thick. They are gently sloping to moderately steep and are well drained.

Arland soils are on ridges, foot slopes, and valleys of uplands that are covered by a thin mantle of glacial drift and are underlain by sandstone at a relatively shallow depth. They are gently sloping to very steep and are well drained. The substratum, to a depth of 60 inches, is very pale brown, weakly cemented sandstone.

Most of the gently sloping and sloping soils in this association are cultivated. They are well suited or suited to corn, oats, and alfalfa. Most of the steeper soils are used for alfalfa, permanent pasture, or trees. Otterholt soils have high natural fertility and very high available water capacity. Santiago soils have medium natural fertility and high available water capacity. Arland silt loam has medium natural fertility, and Arland sandy loam has low natural fertility. Arland soils have moderate available water capacity. Controlling erosion and maintaining soil tilth and fertility are important factors of good management.

Where slopes are less than 6 percent, the major soils in this association have mostly slight or moderate limitations for homesites, septic tank absorption fields, local roads and streets, trench type sanitary landfill, and sewage lagoons. Otterholt soils have severe limitations for local roads and streets and Arland soils have severe limitations for trench type sanitary landfill and sewage lagoons.

Ritchey-Derinda-Whalan association

This association consists of soils on limestone and shale uplands. It is about 30 percent Ritchey soils, 16 percent Derinda soils, 15 percent Whalan soils, and 39 percent minor soils.

Ritchey soils are on ridges and knolls of uplands in areas where limestone is at a relatively shallow depth. They are gently sloping to very steep and are well drained. Dolomitic limestone is at a depth of about 18 inches.

Derinda soils are on ridge tops of shale uplands. They are gently sloping and sloping and are moderately well drained. The substratum, to a depth of 60 inches, is olive clay shale interbedded with fragmented dolomitic limestone.

Whalan soils are on ridges and knolls and in valleys in areas where limestone is at a relatively shallow depth. They are gently sloping to steep and are well drained. Dolomitic limestone is at a depth of about 34 inches.

Many soils in this association have a shallow root zone and are moderately steep or steep. These soils are suited to hay, permanent pasture, or trees. Some gently sloping and sloping soils are suited to corn, oats and alfalfa. Ritchey, Derinda, and Whalan soils have medium natural fertility. Ritchey soils have low available water capacity, and Derinda and Whalan soils have moderate available water capacity. Ritchey soils have moderate permeability, Derinda soils have slow permeability, and Whalan soiils have moderately slow permeability. Controlling erosion, maintaining soil tilth, and removing ponded water in some areas are important factors of good management.

Some areas in this association are used for growing corn, oats, and hay, but many areas are in permanent pasture and trees. Dairying and feed beef cattle are the main enterprises. The major soils in this association have mostly severe limitations for homesites, septic tank absorption fields, local roads and streets, trench type sanitary landfill, and sewage lagoons. Where slopes are less than 6 percent, Derinda soils have moderate limitations for sewate laboons and Whalan soils have moderate limitations for local roads and streets.

Dakota-Waukegan association

This soil association occupies broad stream terraces in the northwestern corner of Pierce County.

The principal soils are those of the Dakota and Waukegan series. Those soils are moderately deep loams and silt loams underlain by sandy material. For the most part, they are gently sloping. The Dakota and Waukegan soils formed under a cover of prairie grasses and scattered oaks, and they are dark colored. The Waukegan soils are more silty than the Dakota.

Less extensive in this association are the dark-colored Rockton and Hesch soils. The Rockton soils occur where limestone bedrock is near the surface. The Hesch soils occupy the lower slopes of the sandstone hills that rise above the terraces. They are gently sloping to steep and formed in material weathered from sandstone.

Many of the soils of this association have layers of loamy material within their substratum of loose, sandy material. They are especially prevalent in the soils near hills and ridges capped with limestone.

The Dakota and Waukegan soils, and others in this association, are well suited to crops. Yields are generally good if enough rainfall is received, and if the rainfall is well distributed. Many of the soils, however, are somewhat droughty, and some are susceptible to wind erosion.

Derinda-Schapville association (USDA, 1968)

This association is characterized by gently sloping to steep ridgetops—some broad, some narrow—and by narrow, steep-walled valleys. All of the ridgetops are capped with shale. The shale, in turn, is covered by a layer of glacial till and by windblown silty material (loess).

A major part of this association consists of Derinda, Schapville, Renova, and Vlasaty soils. In many places, Derinda soils and their dark-colored associates, the Schapville soils, occur toward the outer edges of the ridgetops. In those areas the layer of glacial till is thin or absent and the mantle of silty material directly overlies the shale. Wet subsoil variants of the Schapville series occur in the less sloping parts of the association, where the cover of windblown material is thin and a perched water table is near the surface.

In the wet subsoil variants of the Schapville series, percolating water collects above the layer of slowly permeable shale or clay that underlies the blanket of silty material. The water moves laterally along the top of the slowly permeable layer until it reaches an outlet along the marginal breaks. Here, along the fringe of the perched water table, moisture passes upward by capillary action into the overburden of soil material. The additional moisture favors more luxuriant growth of plants, which, in turn, contribute more organic matter to the soils.

The Renova are well-drained soils on the central and highest parts of ridges, generally on the steeper convex slopes. The Vlasaty soils are in areas marginal to those occupied by the Renova soils, at a slightly lower elevation, and mainly on gentle, concave slopes.

In this association, the Seaton, Renova, and Vlasaty soils are the best for farming. They are suited to all the crops commonly grown in the area. The Wykoff soils are slightly less suitable for crops because they are generally steeper and are slightly more droughty than the Seaton, Renova, and Vlasaty soils. The Derinda and Schapville soils have limited depth, and as a result, are not well suited to deep-rooted crops. The sargeant soils and the wet subsoil variants of the Schapville series generalloy have slopes that are more gentle than those of the other soils. Excess water is a hazard in the less sloping areas of those soils.

Most of the soils of this association are used for crops. Where the soils are too steep for cultivation, however, they are used mainly for meadow, permanent pasture, or trees, and a small acreage is idle. The native forest in the wooded areas consists of upland hardwoods. See Figure 14 on page 59

Antigo-Onamia association

This association occupies the terrace of the Kinnickinnic River and also makes up part of Mann Valley. The terrace consists of a shelf of bedrock cut by a gorge threough which flows the Kinnickinnic River. On this terrace have been deposited various thicknesses of outwash and loess that overlie the bedrock. Moderately deep Antigo and Onamia soils are predominate in this association illustrated in Figure19. They are silty or loamy and are underlain by sand and gravel. For the most part, they are nearly level or gently sloping parts of the terrace in the western part of the association. The soils of this association that formed an outwash—the Meridian Intell, for example, and to a lesser extent, the Antigo and Onamia—have layers of loamy material within their substratum of loose, sandy and gravely material.

The major soils of this association, and some of the minor soils, are suitable for crops. Soils are slightly droughty during extended periods of dry weather, but the ones that have loamy material within the substratum are less droughty than others. .

Derinda Acid Variant Gale, Thin Solum Variant association

This association consists of sloping to steep soils in a valley located in the upper reaches of the watershed and includes soils on ridgetops that surround the valley. Typical of the landscape in this association are rounded hills covered by silty material. Soils are underlain by acid shale or by siltstone and sandstone bedrock. This association is unique in Pierce County, for where the extremely acid shale is near the surface, the soils are acid. This acid reaction has a marked influence on the management of soils and crops. The association is also unique in the fact that in the geologic past, the area that now makes up this association, was thye site of a disturbance that caused a vertical displacement of the bedrock. The fault line caused by this displacement extends southeast/northwest across the southern part of the association. Along the fault line in some parts of the association, the bedrock on one side of the hill is of an extremely different kind than that on the other side, although both kinds of bedrock are at the same elevation.

Renova-Vlasaty association

This soil association consists of gently rolling to upland ridges, very steep bluffs, narrow valleys, stone hills and broad valleys. The southernmost portion of the association are underlain by a layer of yellowish-brown glacial till which caps the bedrock or limestone. The till is most common on hills and ridgetops and also extends into the valleys. Most of the soils form partly in the till, partly in windblown silty material, loess that formed a mantle over the till. Throughout most of this association are light-colored soils formed under cover of trees in the exteme western part, howeever, some dark-colored soils are intermingled with light-colored ones. The dark-colored soils have formed in areas, called oak openings, with a cover consisting partly of grass and trees.

A major part of this association is occupied by the Renova and Vlasaty soils. Those well drained or moderately well drained soils occur at the highest elkevations on ridgetops and the uplands.

Cultivated crops are grown in the soils of most of the ridgetops and valleys. The steep sideslopes of the ridge and hills are mainly in trees, but some of these steep areas are pasture. The cover of trees is sparse in the western part of the association. Where the deep, silty soils are properly farmed, the yield of crops is generally good. The moderately deep soils are only slightly less productive than the deep soils, but the shallow soils have been more adversely affected by erosion. Droughtiness is not a major problem in this association.

Appendix D

Model Ground Water Protection Ordinance

Section 1

Model Ground Water Protection Ordinance

A. Purpose and Authority

The residents of the Kinnickinnic River Valley depend exclusively on ground water from the surficial aquifer for a safe drinking water supply. Certain land use practices and activities may seriously threaten or degrade this ground water supply. The purpose of this Ground Water Protection Ordinance is to institute land use regulations, restrictions, and guidelines to protect the ground water and to promote the public health, safety and general welfare of the residents of the community.

B. Definitions

(1) **Aquifer** means a saturated, permeable geologic unit that can transmit and yield economic quantities of water under ordinary hydraulic gradients.

(2) **Best Management Practices (BMP) Plan** means a plan which incorporates practicable voluntary methods that are capable of preventing and minimizing degradation of ground water, considering economic factors, availability, technical feasibility, implementability, effectiveness, and environmental effects. Best management practices apply to schedules of activities; design and operation standards; restrictions of practices; maintenance procedures; waste and hazardous waste management plans; practices to prevent site releases; spillage, or leaks; application and use of chemicals; drainage from raw materials storage; operating procedures; treatment requirements; and other activities causing ground water degradation.

(5) **Manicured Lawn** means an area which has been sodded or seeded with turf species (e.g. bluegrass, perennial rye, etc.) and is maintained with regular

mowing operations and periodic applications of fertilizer and/or pesticide.

6) **Moderate Potential Ground Water Risk Area** means a geographic area defined by natural features where the estimated time of travel may range from several years to decades for water-borne surface contaminants from activities conducted at or near the land surface resulting in ground water degradation to the surficial aquifer.

(7) **Natural Vegetative Cover** means the preservation or establishment of ground covers, flower beds, shrubs, or trees, not requiring the use of fertilizers or pesticides after initial planting. Natural vegetative covers are encouraged as an alternative to the manicured lawn.

(8) **Surficial Aquifer** means an unconfined saturated, permeable geologic unit near the ground surface. Often known as the water-table or upper most aquifer.

(9) **Very High to High Potential Ground Water Risk Area** means a geographic area defined by natural features where the estimated time of travel may range from either hours to months or weeks to years for water-borne surface contaminants from activities conducted at or near the land surface resulting in ground water degradation to the surficial aquifer.

Section 2

Ground Water Protection Overlay District A

A. District A - Boundary

The Ground Water Protection Overlay District A is a Very High to High Potential Ground Water Risk Area extending from ______________________________ ______________________________ as shown on the attached map. This area is subject to the most stringent land use and development restrictions.

B. Permitted Uses

The following are permitted uses within the Ground Water Protection Overlay District A. Uses not listed here or in (C) below are to considered prohibited uses.

(1) Parks and playgrounds, provided there are no on-site waste disposal or fuel storage tanks facilities.

(2) Wildlife areas.

(3) Nonmotorized trails, such as biking, skiing, nature and fitness trails.

(4) Sewered residential developments subject to the conditions in Section 4.A.(1).

(5) Unsewered (single family) residential development subject to the conditions in Section 4.A.(2).

(6) Agricultural activities which have demonstrated or documented the implementation of best management practices for fertilizer and pesticide uses.

C. Special Uses

The following may be allowed as special uses within the Ground Water Protection Overlay District A. Uses not listed here or in B. above are to be considered prohibited uses.

(1) Commercial and industrial uses served by municipal sanitary sewer except those listed as prohibited in **D.** below.

(2) Commercial and industrial uses in unsewered areas with an approved Best Management Practices plan.

D. Prohibited Uses

The following are prohibited uses within the Ground Water Protection Overlay District A. These uses are prohibited based on the very high to high potential ground water risk that activities routinely associated with these uses (storage, use and handling of potential pollutants) will cause contamination. Uses not listed are not considered permitted uses.

(1) Animal feedlots unless constructed and operated in accordance with current standards

(2) Bulk fertilizer and/or pesticide facilities without a contingency plan

(3) Hazardous waste storage or treatment facilities

(4) Junk yards or auto salvage yards

(5) Landfills

(6) New cemeteries

(7) Nurseries for ornamental plants, greenhouses, and pesticide and fertilizer storage and use associated with retail sales outlets which do not possess a chemigation permit, or a contingency plan if required by current standards

(8) Salt storage in uncovered facilities

(9) Underground storage tanks of any size unless compliance with current standards can be demonstrated

(10) Unlicensed vehicle repair establishments

(11) Wastewater spray irrigation facilities

E. Existing Facilities

Where any of the uses listed in **D.** above exist within the Ground Water Protection Overlay District A on the effective date of this ordinance, owners of these facilities will be required to complete an approved BMP plan and upgrade the facilities to prevent ground water degradation within five (5) years from the date of the ordinance enactment. The BMP plan and the plans for the proposed upgrade must be approved, and the appropriate approval or permit issued by the City/Town, prior to any work being initiated. Expansion of the prohibited use will not be allowed unless there is a concurrent BMP plan preparation and upgrade of the facilities.

Section 3

Ground Water Protection Overlay District B

A. District B - Boundary

The Ground Water Protection Overlay District B is a Moderate Potential Ground Water Risk Area extending from ____ ________________, as shown on the attached map. Land use restrictions within the Ground Water Protection Overlay District B are less restrictive than in Overlay District A.

B. Permitted Uses

The following uses are permitted within Ground Water Protection Overlay District B.

(1) All uses listed as permitted uses in Ground Water Protection Overlay District A.

(2) All uses not prohibited or special uses in this section.

C. Special Uses

The following uses may be permitted on a case-by-case basis, providing that adequate ground water protection or monitoring measures are instituted.

(1) Animal feedlots unless constructed and operated in accordance with current standards.

(2) Bulk fertilizer and/or pesticide facilities without a contingency plan prepared in accordance with current standards.

(3) New cemeteries

(4) Nurseries for ornamental plants, greenhouses, and pesticide and fertilizer storage and use associated with retail sales outlets which do not possess a chemigation permit, if required by current standards.

(5) Recycling facilities

D. Prohibited Uses

The following uses are prohibited uses within the Ground Water Protection Overlay District B. These uses are prohibited based on the high probability that activities associated with these uses (storage, use, and handling of potential pollutants) will cause ground water contamination.

(1) Hazardous waste storage or treatment facilities

(2) Junk yards or auto salvage yards

(3) Landfills

(4) Salt storage in uncovered facilities

(5) Wastewater spray irrigation facilities

(6) Underground storage tanks of any size unless compliance with current standards can be demonstrated

(7) Unlicensed vehicle repair establishments

E. Existing Facilities

Where any of the uses listed in D. above exist within the Ground Water Protection Overlay District B on the effective date of this ordinance, owners of these facilities will be required to complete an approved BMP plan and upgrade the facilities to prevent ground water degradation within five (5) years from the date of the ordinance enactment. The BMP plan and the plans for the proposed upgrade must be approved. and the appropriate approval or permit issued by the City/Town, prior to any work being initiated. Expansion of the prohibited use will not be allowed unless there is a concurrent BMP plan preparation and upgrade of the facilities.

Section 4 Best Management Practices -

The following standards and guidelines shall apply to all uses permitted within Ground Water Overlay Districts A and B.

A. Residential - Lawn Standard

(1) Single-family residential uses served by a municipal sewer are allowed to maintain up to a maximum of thirty-five percent (35%) of the lot area as a manicured lawn. The remaining portion of the lot exclusive of impervious areas and the manicured lawn shall be maintained in natural vegetative cover.

(2) Single-family residential uses in unsewered areas are allowed to maintain up to a maximum of ten percent (10%) of lot areas from one-quarter (0.25) to two and one-half (2.5) acres as a manicured lawn. Single-family residential uses in unsewered areas are allowed to maintain up to a maximum of twenty percent (20%) of lot areas from greater than two and one-half (2.5) acres to five (5) acres as a manicured lawn. The remaining portion of the lot exclusive of impervious areas and the manicured lawn shall be maintained in natural vegetative cover.

(3) Multifamily residential uses in sewered or unsewered areas are allowed to maintain up to a maximum of fifty percent (50%) of the entire site as a manicured lawn. The remaining portion of the site exclusive of impervious areas and the manicured lawn shall be maintained in natural vegetative cover.

B. Commercial / Industrial - Lawn Standard

(1) All commercial and industrial uses are allowed to maintain up to a maximum of thirty percent (30%) of the site area as a manicured lawn. The remaining

portion of the site exclusive of impervious areas and the manicured lawn shall be maintained in natural vegetative cover.

C. Fertilizer Type and Application Guidelines (Manicured Lawns)

(1) Fertilizer usually contains nitrogen, phosphate and potash. Nitrogen is the most important lawn nutrient but it can contaminate ground water with nitrate. The numbers on a fertilizer bag indicate the percentage of these three plant nutrients. For example, a fertilizer labeled 10-1-4 contains 10% nitrogen, 1% phosphate and 4% potash.

(2) Choose a fertilizer high in Water Insoluble Nitrogen (WIN). WIN is released slowly, helps prevent "lawn burn" and ground water contamination.

(3) Apply the amount of fertilizer shown in the chart below around May and the same amount around September 15. If lawn watering is not practiced, apply half the amount of fertilizer shown.

Pounds of Fertilizer to Apply[1]

	% Nitrogen in Purchased Fertilizer						
	5	10	15	20	25	30	45
Lawn Area (square feet)							
1,000 sq. ft.	20	10	7	5	4	3	2
2,000 sq. ft.	40	20	13	10	8	6	4
3,000 sq. ft.	60	30	20	15	12	10	7
4,000 sq. ft.	80	40	27	20	16	13	9
5,000 sq. ft.	100	50	33	25	20	17	11
10,000 sq. ft.	200	100	66	50	40	35	23
20,000 sq. ft.	400	200	133	100	80	70	47

1. For example, on a 3,000 square foot lawn and a 10-1-4 fertilizer (10% nitrogen), use 30 pounds of fertilizer in May and 30 pounds after September 15. If lawn watering is not practiced, use 15 pounds each time. Set the lawn spreader at half the setting suggested of the fertilizer bag. Place the amount of fertilizer needed for 1,000 square feet (see above chart) into the spreader. Apply the fertilizer to a 1,000 sq. ft. area. If the spreader empties before you finish, decrease the setting; if you have excess fertilizer, increase the setting. Write down the setting and use the same one each fertilizing period.

TABLE 4.4
INVENTORY MEASUREMENTS

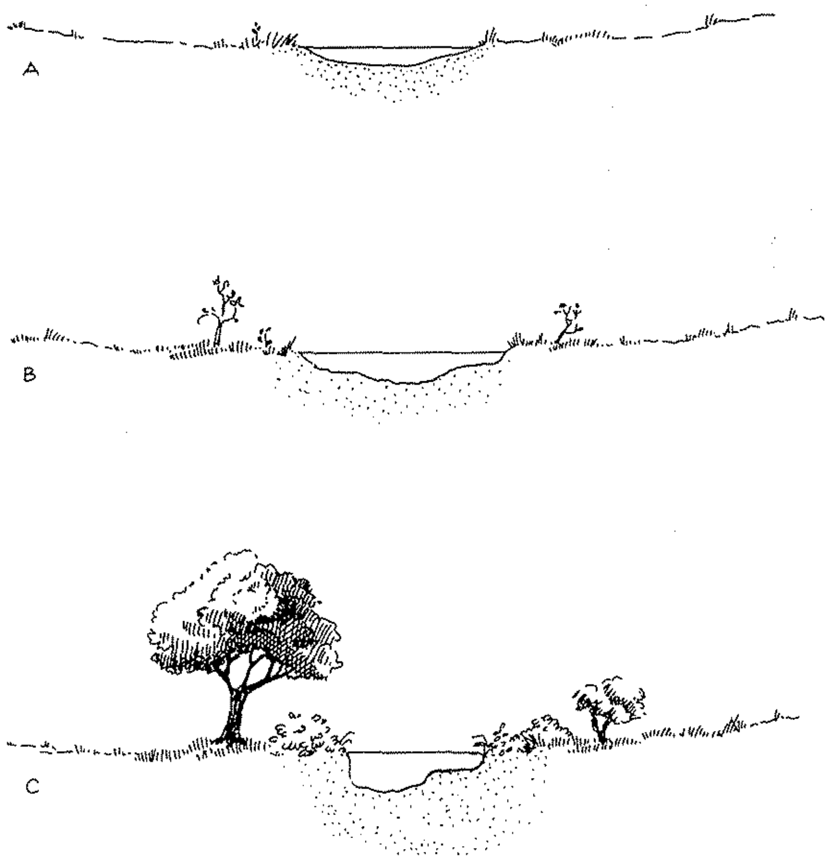
Habitat Attributes	*Excellent*	*Good–Fair*	*Poor*
..iparian vegetation			
Streamside habitat type	Brush/sod	Boulder/rubble tree, root, brush	Bare soil
Vegetation overhang* (less than 1 ft. from water surface)	Greater than 1 ft. on 50% of bank	Greater than 1 ft. on 30%–45% of bank	Greater than 1 ft. on less than 20% of bank
Shading	40%–60%	Less than 25% Greater than 75%	Less than 10% Greater than 90%
Bank stability	80% stable	30%–60% stable	Less than 30% stable
Channel characteristics			
Bank angle*	50% of bank less than 90 degrees	30%–45% of bank less than 90 degrees	Less than 20% of bank less than 90 degrees
Bank height	Ave. less than 1 ft.	Ave. 1–3 ft.	Ave. greater than 3 ft.
Bank undercut*	Greater than 6 in. on 50% of bank	Less than 6 in. on 20%–45% of bank	Less than 6 in. on less than 20% of bank
Water width:depth ratio†	5:1	20:1	40:1
Substrate composition	Gravel/rubble boulder	Gravel/rubble and/or sand/silt	Sand, silt, boulder (in any combination)
Embeddedness	Less than 20%	20%–40%	Greater than 40%
In-stream habitat			
Pool/riffle ratio	.5:1–1.5:1		Less than .5:1 Greater than 1.5:1
In-stream aquatic vegetation	Abundant		Not present
Woody debris	Abundant		Not present
Summer high temperature	58°–64° F	55°–70° F	Less than 50° F Greater than 72° F
Biology			
Aquatic insects	Many species abundant	Many species	Few species
Periphyton	Many species abundant	Many species	Few species
Fish			
Species‡	1–trout 2–whitefish 3–sculpins	1–trout 2–sculpin/whitefish 3–sucker 4–dace	1–sucker 2–dace 3–trout
Age distribution	Each age class has at least 10% as many fish as previous age class	All age classes represented, some consistently poorly represented	–No adults –1 or more age classes not represented
Numbers§	More than 250 in 1,000 sq. ft. of stream surface	Range from 200 to 50 in 1,000 sq. ft. of stream surface	Less than 50 in 1,000 sq. ft. of stream surface

* Based upon idea that thalweg will be adjacent to any bank a maximum of 50% of the reach length as a result of meandering. Thalweg must be adjacent to bank to form undercut banks with overhanging vegetation.

† Based upon 20-ft. wide stream:
Average 2 ft. depth—excellent;
Average 1 ft. depth—good–fair;
Average 0.5 ft. depth—poor.

‡ Numbers indicate relative abundance.

§ Includes all age classes of trout.

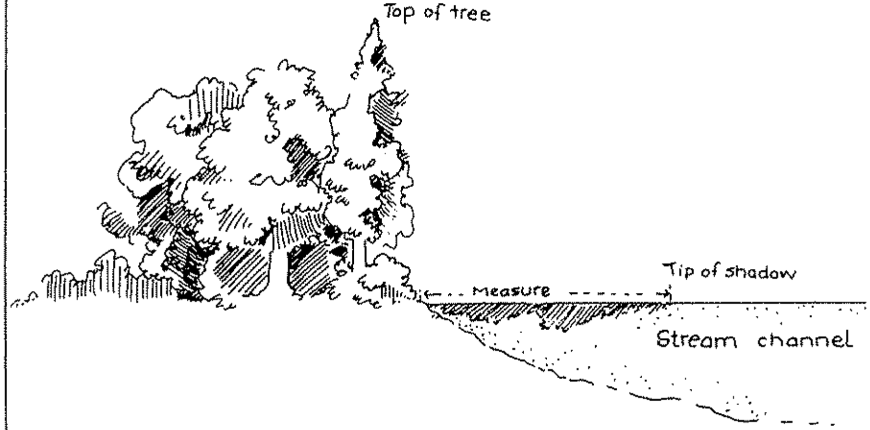


A - Riparian vegetation is severely depleted, the channel is wide and shallow

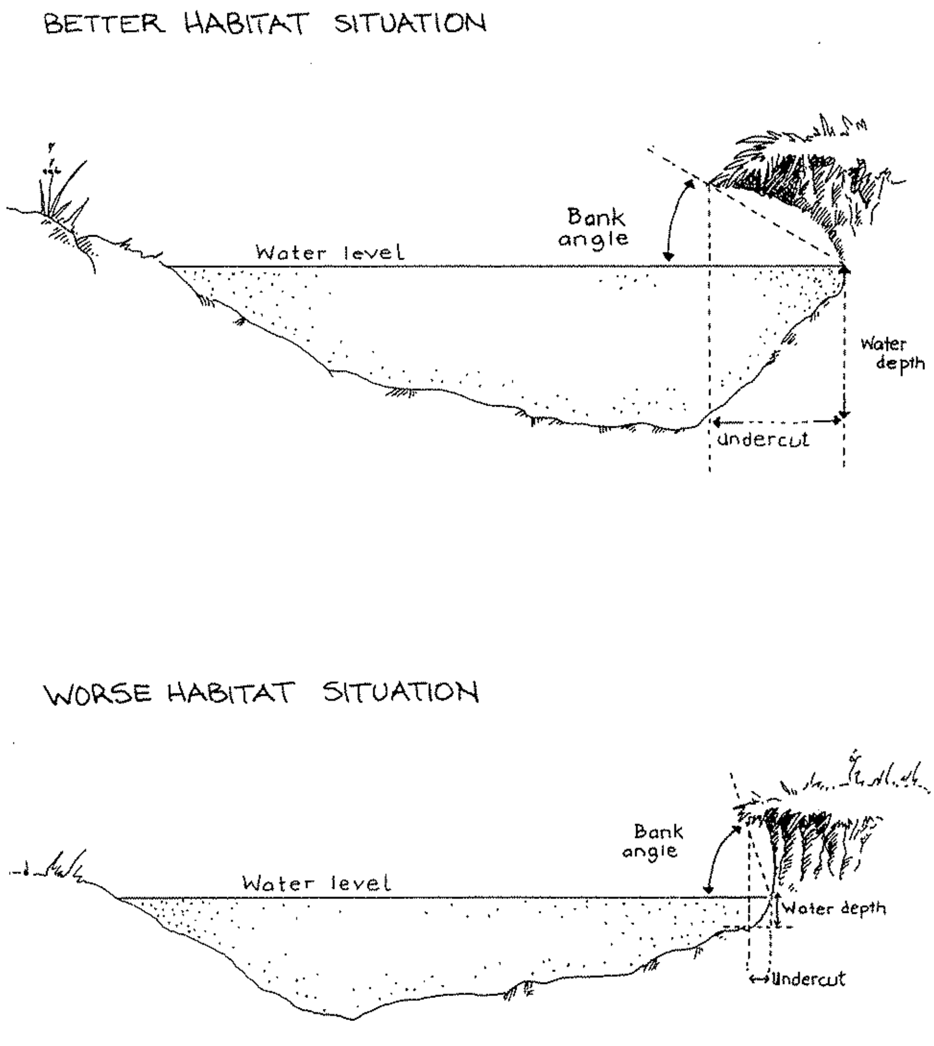
B - Riparian vegetation begins to recover, the channel becomes more narrow and deep

C - Healthy riparian vegetation and narrow, deep channel

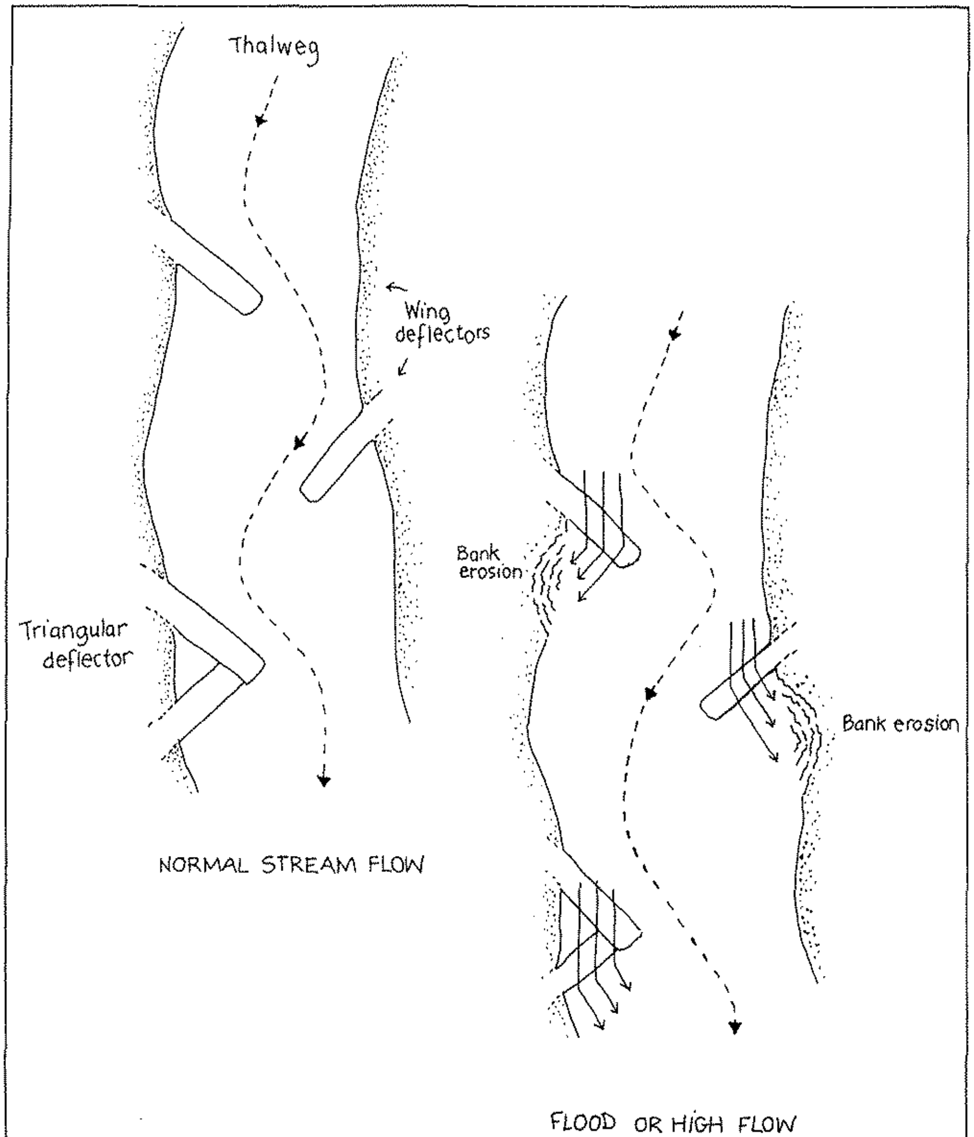
3.10 Recovery of a laterally unstable stream channel.



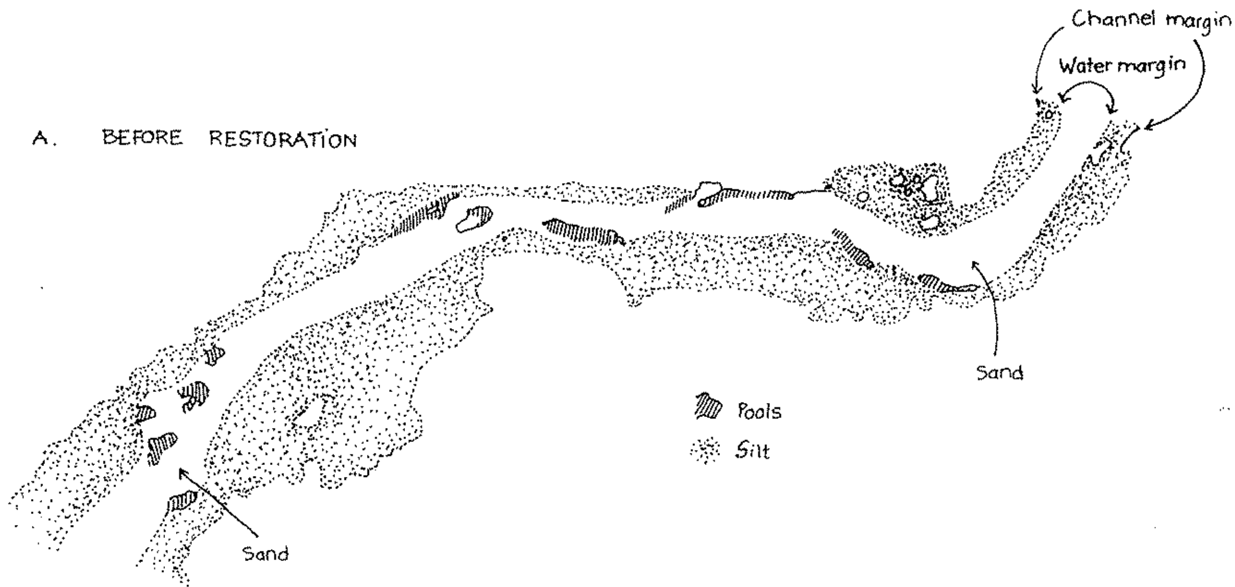
4.4 Measurement of stream shaded areas. *Measurement of the shaded area of a stream along a transect.*

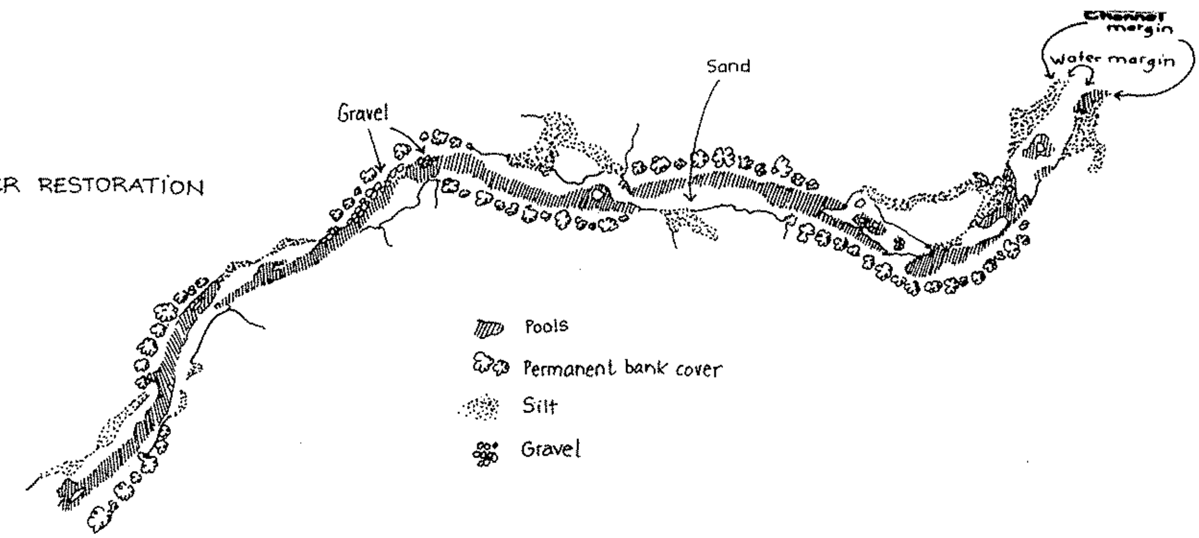


4.5 Measurement of bank angle and undercut. *Note the condition of the bank.*

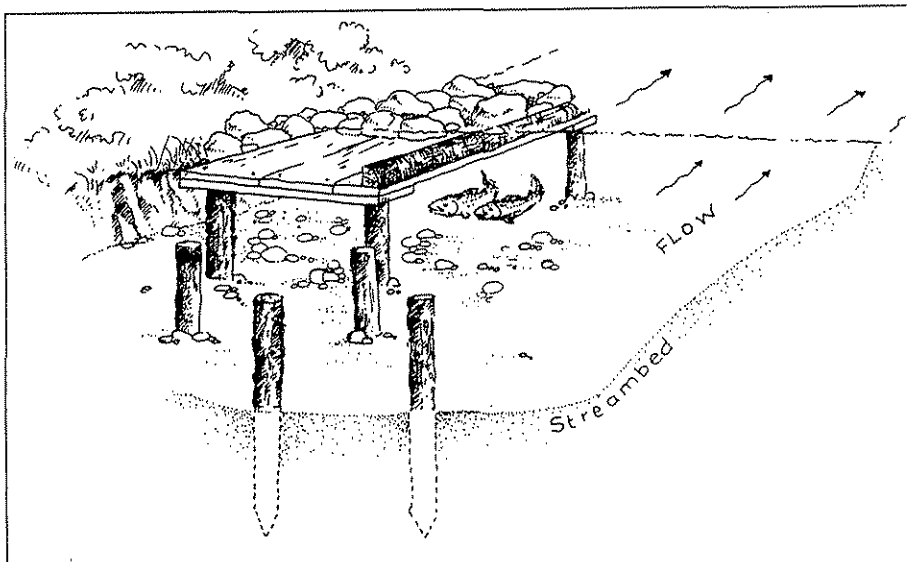


6.1 Wing deflectors cause bank erosion. *Wing deflectors, which appear to function as well as triangular deflectors during normal flows, can cause bank erosion during flood or high flows, as shown on the right side of the drawing. This is because when water flows over an obstruction, it leaves the object flowing at a right angle to it.*

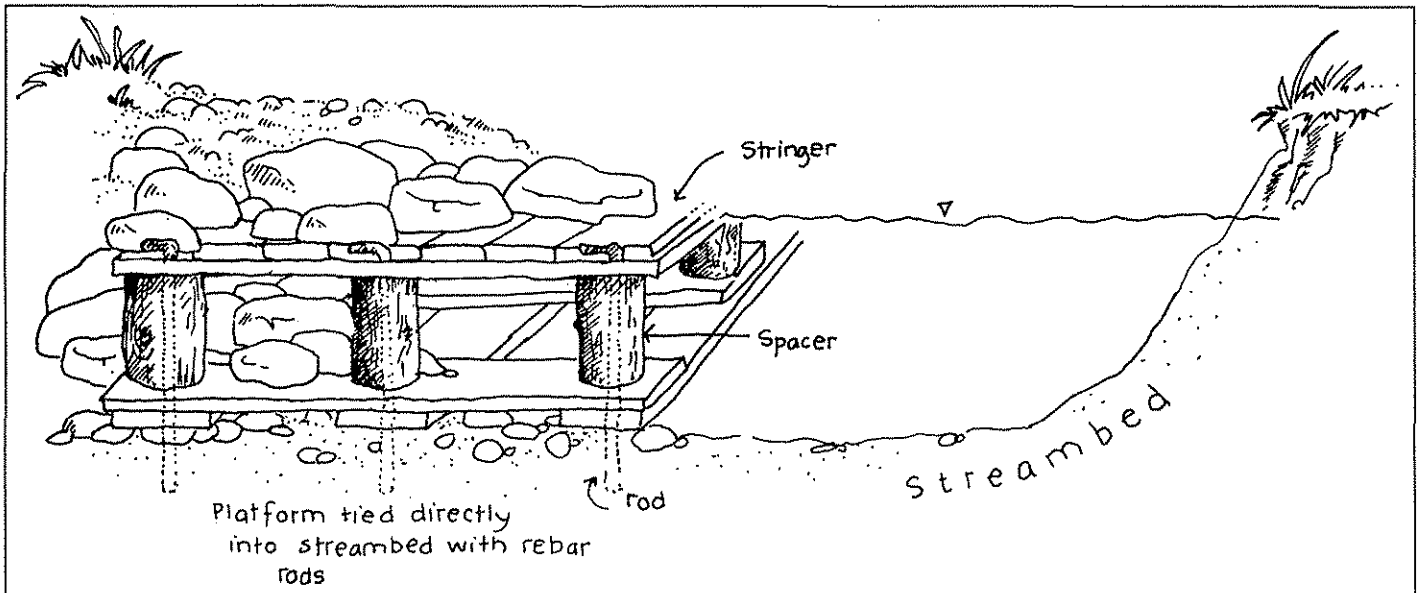




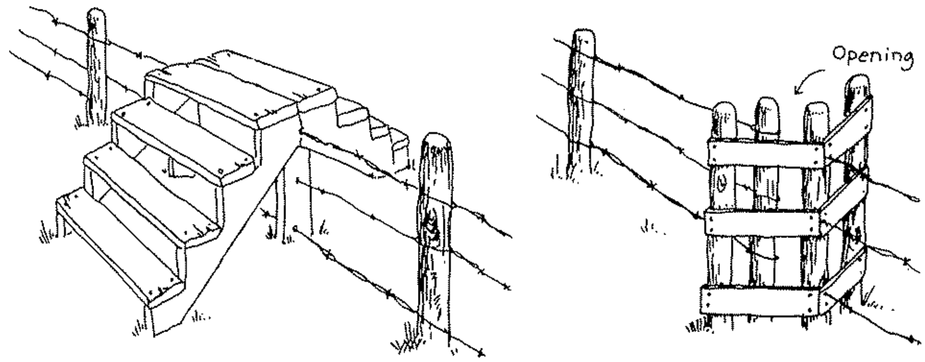
7.4 Lawrence Creek, Wisconsin; habitat maps. *These two maps show the same reach of Lawrence Creek before (A) and after (B) restoration. Following restoration, the channel and water width are greatly reduced, as is the amount of sand and silt found in the channel. The permanent bank cover, pools, and gravel is much increased following construction. Notice that the pools and permanent bank cover are found together on the outside bank of meander bends where the cover/deflector structures were placed.*



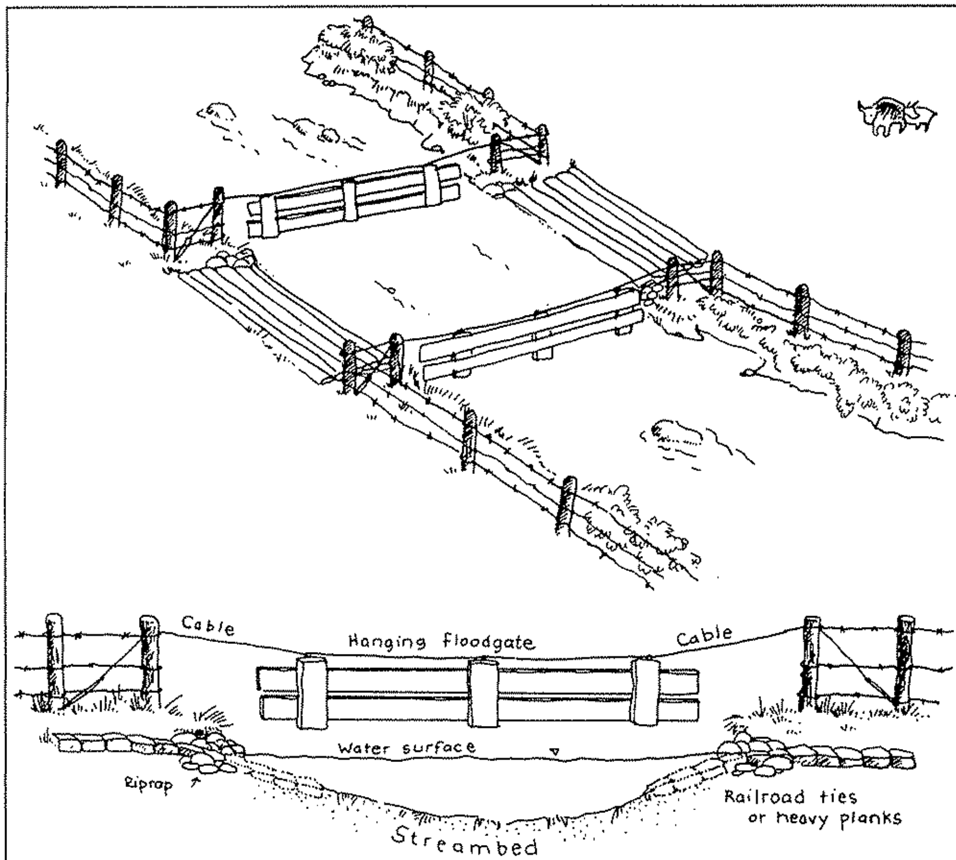
7.5 Cover/deflector structure construction. *Cover/deflector structure showing the various stages of construction prior to placement of sod.*



7.11 LUNKERS structure. *A LUNKERS structure placed in the stream. The next step will be placement of sod on top of the rock.*



6.3 Angler access to fenced streams. *Two different methods of affording anglers access to a fenced section of stream.*



6.2 Livestock stream crossing. *Aerial and cross-section views of a livestock stream crossing and watering point. The planking protects stream banks and bed. The hanging gates prevent livestock access to the rest of the stream. The rock riprap protects the planking from washing out.*