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LAKE GEORGE  
PIERCE COUNTY  
*River Falls*

**FEASIBILITY STUDY RESULTS  
AND MANAGEMENT ALTERNATIVES**

Prepared for the  
Lake George Protection  
and Rehabilitation District  
under Chapter 33  
Wisconsin Statutes

by  
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## SUMMARY

Lake George was created as a millpond on the Kinnickinnic River in 1862. Today, the lake covers 18 acres and has an average depth of five feet. Located in the center of River Falls and surrounded by parks, Lake George is a scenic asset to the downtown area. The dam generates some of the city's hydroelectric power.

Erosion and sedimentation became serious problems during the agricultural development of the area. As a result, Lake George has filled in considerably. Sedimentation, however, has been slowed down greatly. The current problem with Lake George is caused by the thick layer of bottom sediment already deposited. Aquatic plants root in the nutrient rich lake bottom sediments and floating plants accumulate in quiescent areas. These sediments will support prolific aquatic plant growth for years to come which detracts from the beauty of the lake.

The sources of sediment, which include cropland and stream bank erosion and urban runoff, are well on their way to being controlled. Continued monitoring and correction of specific problem sites will effectively maintain the improvements that have been made and protect any investments that are made in management of the lake.

Several alternatives are available for control of aquatic plants. Aquatic plant harvesting is a relatively low-cost measure that may reduce floating plant accumulation. Repeated cutting is required but specific problem areas can be treated. Drawdown can be an inexpensive method to control aquatic plants. The cost of purchasing electrical power for a few weeks in the spring to allow a drawdown should be explored. Floating plants can also be treated chemically.

Dredging will provide vegetation control for a longer time but at greater expense. Near-shore areas would be immediately subject to regrowth. Increasing the lake volume through dredging will not warm the water enough to improve the panfishing or encourage additional swimming activity.

Changing economic conditions may alter the outlook for electric power production from Junction Falls (Upper Kinnickinnic Pond) dam. Dam removal or hydroelectric power redevelopment are alternative water resource uses that should be considered in a long-term lake management strategy.

If nothing is done, the lake will remain much as it is today for the foreseeable future. Without vigilance, sedimentation may potentially increase.

Lake district officials should consider the long-term use of the lake and the public financial commitment to lake management in choosing alternatives for managing Lake George.

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## INTRODUCTION

Physical, chemical, and biological data were collected on Lake George during 1980. Department of Natural Resources lake management staff analyzed the results of this study. This report discusses the feasibility study results and offers management alternatives. Background information is included to help lake district decision makers and future researchers.

## BACKGROUND

### Setting

Lake George is an impoundment of the Kinnickinnic River at River Falls, Pierce County, Wisconsin. Sometimes known as Upper Kinnickinnic Pond, Lake George is held by the Junction Falls dam. The South Fork of the Kinnickinnic joins the main stem just below Lake George. Both empty into the Lower Kinnickinnic Pond (held by the Powell Falls dam).

Physical characteristics of Lake George are found in Table 1 below and on the lake map in Figure 1.

TABLE 1.

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#### LAKE GEORGE, PIERCE CO.

Watershed area *	65,280 acres
Lake area	18 acres
Ratio, watershed to lake area	3627:1
Average outflow **	45 ft <sup>3</sup> /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

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\* as measured by U.S. Army Corps of Engineers

\*\* calculated from long-term average runoff as measured by U.S. Geological Survey, all other data measured in feasibility study.

### Physical Characteristics

River Falls is a city of 9,000 people located about 30 miles southeast of Minneapolis-St. Paul. The largest city in Pierce County, River Falls is home to a state university campus as well as being an agricultural service center.

The Kinnickinnic River watershed draining into the millpond is primarily agricultural land (60% crop; 35% pasture; 5% woodland).

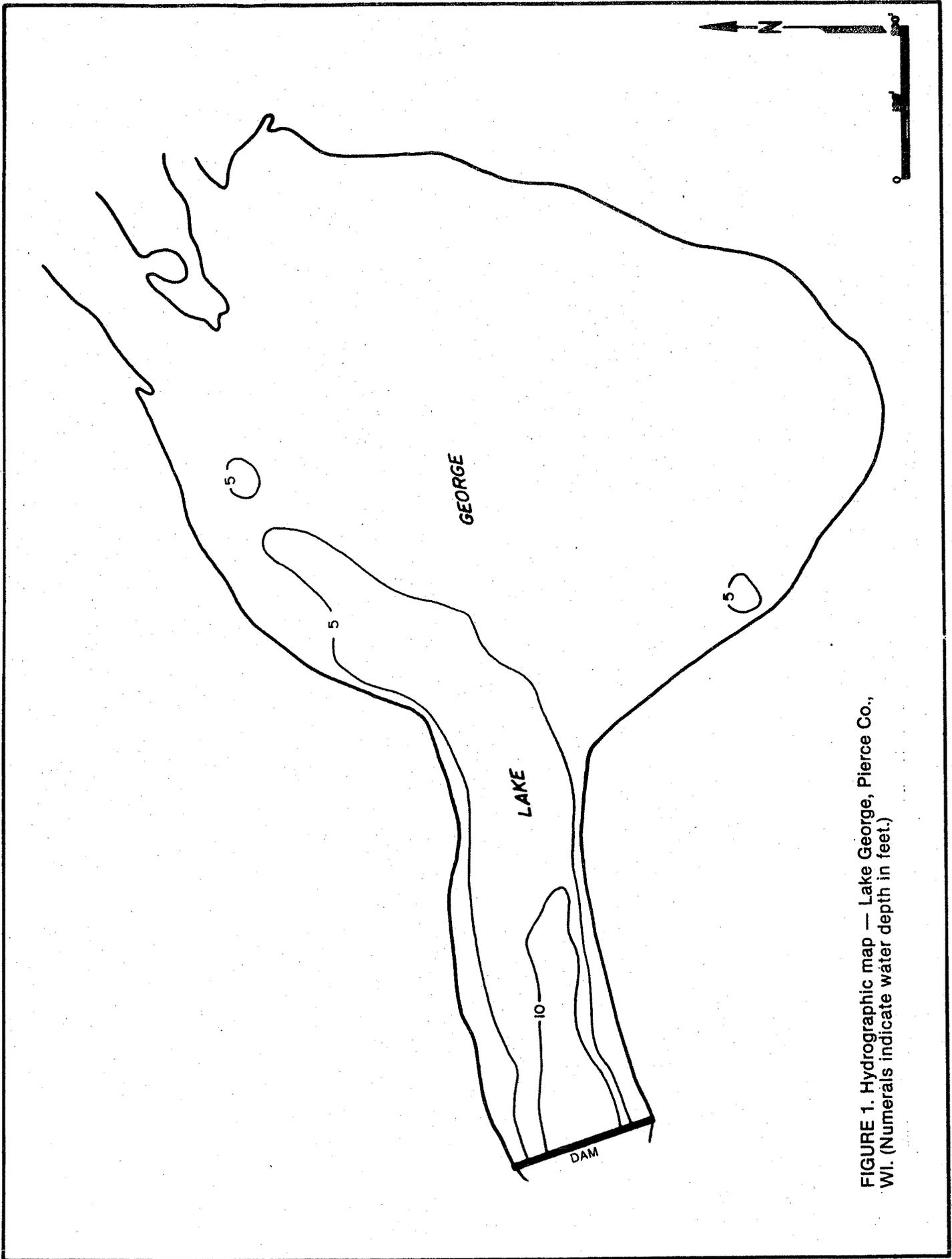


FIGURE 1. Hydrographic map -- Lake George, Pierce Co., WI. (Numerals indicate water depth in feet.)

## History

Much of what is now Pierce and St. Croix Counties was purchased from the Indians in 1837. Oak openings and prairie lands made for each planting so that by 1880 nearly three-fourths of the land area was devoted to growing wheat.

To grind the grain that was produced, several dams were built on the Kinnickinnic River. In 1861, Captain D. A. Andrews secured a permit to build a dam at the Junction Falls site. At that time, there were two other dams upstream within two miles of Junction Falls. A cloudburst in 1894 washed out those three dams. A timber crib dam was built in 1862. The City of River Falls acquired the Junction Falls dam site in 1900. By this time, the invasion of the cinch bug (a wheat pest) forced farmers to reduce their wheat acreage and turn to livestock and dairying. With the subsequent drop in demand for grist milling, the city outfitted the dam with hydroelectric generators. The old timber crib dam stood until the spring floods of 1920. Construction began on the present concrete dam the following summer.

The rapid period of cultivation in the Kinnickinnic watershed caused a serious erosion problem. The soil that washed off the land and into the streams was trapped behind the dams. Much of it remains in Lake George today, making the lake very shallow and promoting weed growth in the lake. The City of River Falls formed a lake district in 1979 to protect the lake's water quality and improve its appearance and recreational value.

## Current Management and Use

Today, Lake George is not very popular for boating or other water recreation. Lake improvements have been considered but management information and funds for implementation were not available.

Over three-fourths of the Lake George shoreline is zoned conservancy. Land use is by special permit only.

The city government and local volunteer organizations have created a walking trail along the lake's edge, complete with benches and interpretive signs. The park creators are working with developers of adjacent land to encircle the lake with the path. The lake area is fast becoming a focal point for natural area appreciation and outdoor relaxation in River Falls.

Stream bank erosion was once a serious problem, but much of the Kinnickinnic River above Lake George is now public fishing ground. Cattle are fenced out, stream banks have been stabilized, and strips of at least ten feet of buffering vegetation have been allowed to grow up. Decreased cultivated acreage in the watershed and improved soil and water conservation practices have decreased upland erosion as well.

## The Watershed

### Relief and Drainage

A lake is a product of its watershed. Water reaching a lake has fallen as rain or snow on the surrounding land area and has either run off the surface or percolated through the ground, picking up minerals, nutrients, or sediment along the way. Relief and drainage, climate, geology, soils, and land use are characteristics of the watershed that determine the composition of the lake water and, in turn, the features of the lake system. Figure 2 is a map of the Lake George watershed.

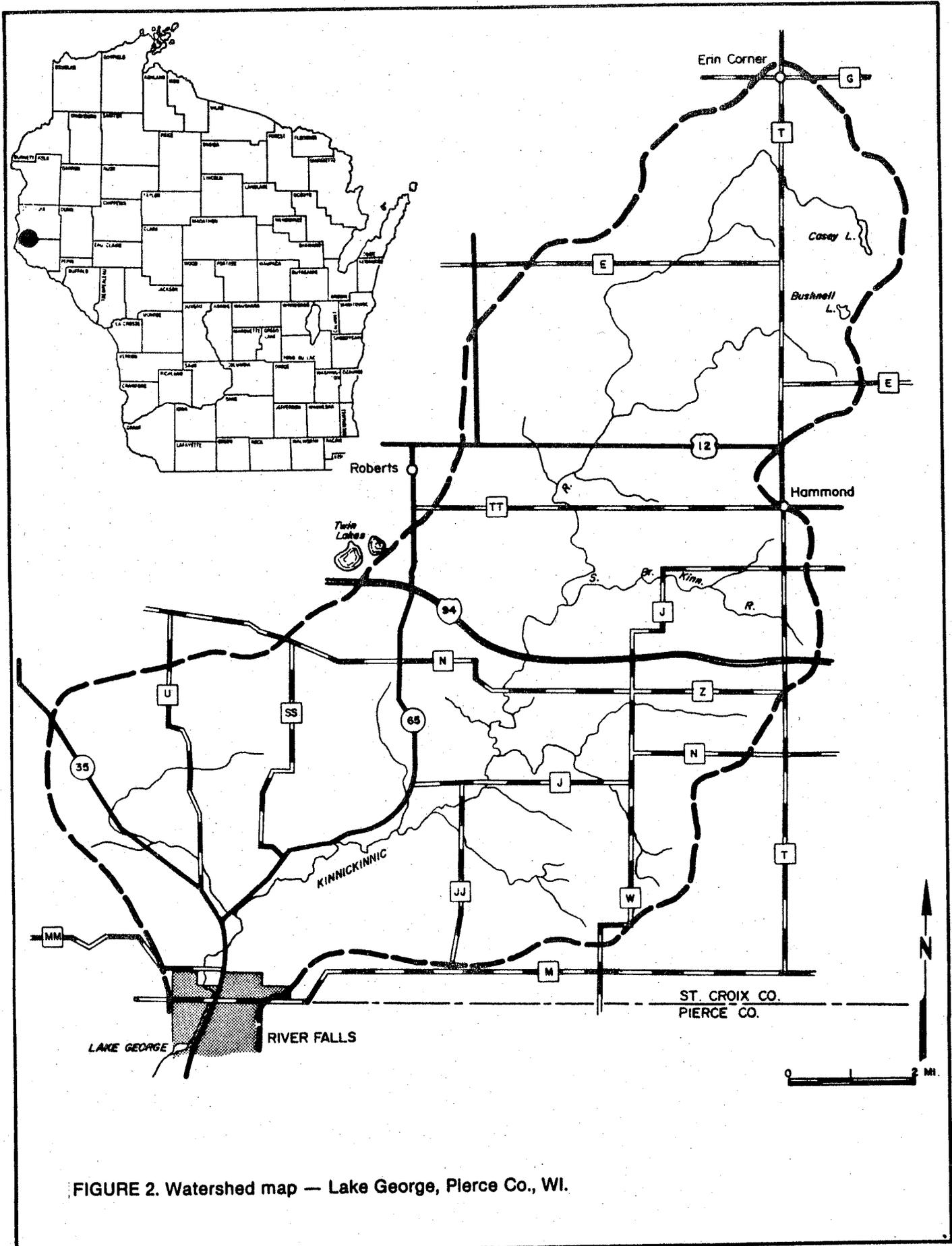


FIGURE 2. Watershed map — Lake George, Pierce Co., WI.

Above River Falls the Kinnickinnic River flows through a broad outwash plain bordered by steeply sloped uplands. The uplands are flat-topped limestone hills rising to heights of 200 feet above the valley floor.

There are fewer wetlands in the Kinnickinnic watershed than in the neighboring Willow and Apple River drainages. The wetlands are predominantly river bottom hardwood stands. As the steep slopes near streams indicate, the land is generally quite well drained.

#### Geology

The Upper Kinnickinnic watershed was smoothed by glaciers early in the last Ice Age. Some depressions were filled with glacial material to depths of 200-250 feet. In general, surface deposits of glacial materials, loess (wind-deposited soils) and water-carried sand and gravel are less than 100 feet deep. The lake itself is underlain by sand. Water flows very easily through this material. Most shallow wells tap this layer.

The glacial material is underlain by dolomite (Prairie du Chien group) and St. Peter sandstone. On the uplands much of the sandstone has been eroded away. At 300-500 feet below the surface, the bedrock becomes predominantly sandstones (Trempealeau, Franconia, and Dresbach).

#### Soils

The uplands in the watershed are covered by silts of varying depths. The southern portion and the valley bottom are covered by silt loams and loams underlain by sand. The dominant soil types are in general moderately to well drained. Erosion may be serious on some of the silts if not properly managed.

#### Land Use

About 60% of the watershed is cultivated, primarily for corn with some soybeans. About 35% is pastureland and 5% remains wooded. Urban area covers about 1% of the watershed area.

## FEASIBILITY STUDY RESULTS

### Water Flows

Regional measurements of rainfall, surface runoff, and groundwater were combined with watershed characteristics to generally describe the source and amount of water flowing through Lake George. The relative importance of water sources reflects the potential sources of sediment and nutrients. The amount and destination of flow determines whether these materials remain in the lake or get carried out.

Water enters the pond either from rainfall, surface runoff, or groundwater. Surface runoff, including direct runoff and stream flow, is the source of most of the millpond's water. Of this, over 99% is from stream flow.

The lake surface area is very small compared to the watershed area. Direct rainfall contributes a very small amount of water compared to the portion of the rainfall that runs off the entire watershed surface.

The groundwater contribution is also small relative to runoff. Lakes and valley bottoms are generally groundwater discharge areas so that some groundwater does flow directly into the lake. However, when a reservoir is constructed, water "piles up" near the dam so that water often flows from the lake into the groundwater system. In addition, the magnitude of the lake-groundwater interaction is limited by the thick layer of sediments.

Water leaves the lake by evaporation and surface flow, as well as flow to groundwater. Evaporation and groundwater flows are relatively small compared to surface flow.

Water flows rapidly through Lake George, flushing the lake about every 21 hours at average flows. Even during dry periods (at the once-in-ten-year low flow) the lake is flushed about every 44 hours.

### Water Chemistry

#### Nutrients

Phosphorus is one nutrient that limits or promotes plant growth in lakes. Runoff from the land surface, groundwater, and rainfall carry phosphorus to the lake. Runoff from the watershed delivers most of Lake George's water as well as its phosphorus (366,650 kilograms or 808,463 pounds per year, see appendix for calculation).

Water - and phosphorus - move through Lake George so rapidly (flushing every 21 hours) that current nutrient delivery to the lake is not a controlling factor for plant growth. In general, controlling phosphorus delivery is effective in reducing plant and algae problems at flushing rates of two weeks or more. Nutrient-rich sediment, deposited years ago, provides the medium for abundant rooted and attached plant growth in Lake George.

#### Oxygen

Sufficient oxygen dissolved in the lake water is essential to fish and plant life, as well as to the speedy decay of plant and animal debris in lakes. Winter fish kills, an indicator of oxygen shortage, have not been reported in Lake George. The rapid flow of water through the lake during the winter prevents low oxygen problems.

The oxygen content of the water decreased during retention in the lake (12.2 mg/l at inlet to 10.0 mg/l at the dam) in late April but increased (8.8 mg/l to 9.6 mg/l) in mid-August. (Data from West Central District, DNR, Basin Assessment Survey, collected 1981.) All of these values are well above the 5 mg/l standard for acceptable water quality.

#### Acid Rain Susceptibility

Acid rain, a result of air pollution, is being addressed daily in newspapers and magazines, as well as in research laboratories. The consequences of acid rain on a lake, including elimination of fish life, concern all lake users and managers.

The high alkalinity or "hardness" of Lake George's water (180 mg/l  $\text{CaCO}_3$  at pH 8.5, measured May 20, 1980) is a buffer against the effects of acid rain. Lakes are considered not to be sensitive to acid rain if alkalinity is higher than 30 mg/l. Since the geologic and soil conditions that create high alkalinity are constant, acid rain is unlikely to be a problem for Lake George in the foreseeable future.

#### Lake Biology

##### Aquatic Plants

Aquatic plants (called macrophytes) play important roles in lake systems. Fish and wildlife inhabit plant zones near the shore. The aquatic insects that live in macrophyte beds are an important source of fish food. Aquatic plant root systems help prevent erosion of near-shore sediments. Aquatic plants also cause problems. Excessive macrophyte growth is unsightly. It can interfere with fishing, swimming, boating, and other lake uses. A mass of dead and decaying plant material on the lake bottom takes up oxygen needed by fish and releases additional nutrients for algae growth. Figure 3 shows the major aquatic plant beds in Lake George, identifies the plants, and indicates their relative abundance.

The major nuisance aquatic plant in Lake George is duckweed. This tiny, bright green, floating plant forms large mats in areas of the lake where the flow of water is slow. Duckweed thrives in the moderately hard, alkaline and nutrient-rich waters of Lake George.

Storm sewer drains are also shown on the map. The location of the plant beds near the storm water drains suggest that nutrient-rich water and sediment from urban areas may have promoted localized plant growth. Overall, storm water contributes only a small proportion of the sediment and nutrients delivered to the lake. As previously discussed, current nutrient delivery is not a controlling factor in Lake George. Control of urban runoff will probably not reduce plant growth, but is important in protecting future investments in lake management.

##### Fishery

Trout, carp, suckers, and a variety of panfish inhabit Lake George. Some trout are always present in the lake but most enter the lake in the winter, seeking deeper water. Rough fish such as carp are not a problem in Lake George. Cold water temperatures limit their reproduction and prevent them from invading the upstream trout waters. Cold water also limits the panfish populations and prevents popular fish such as bass from being established.

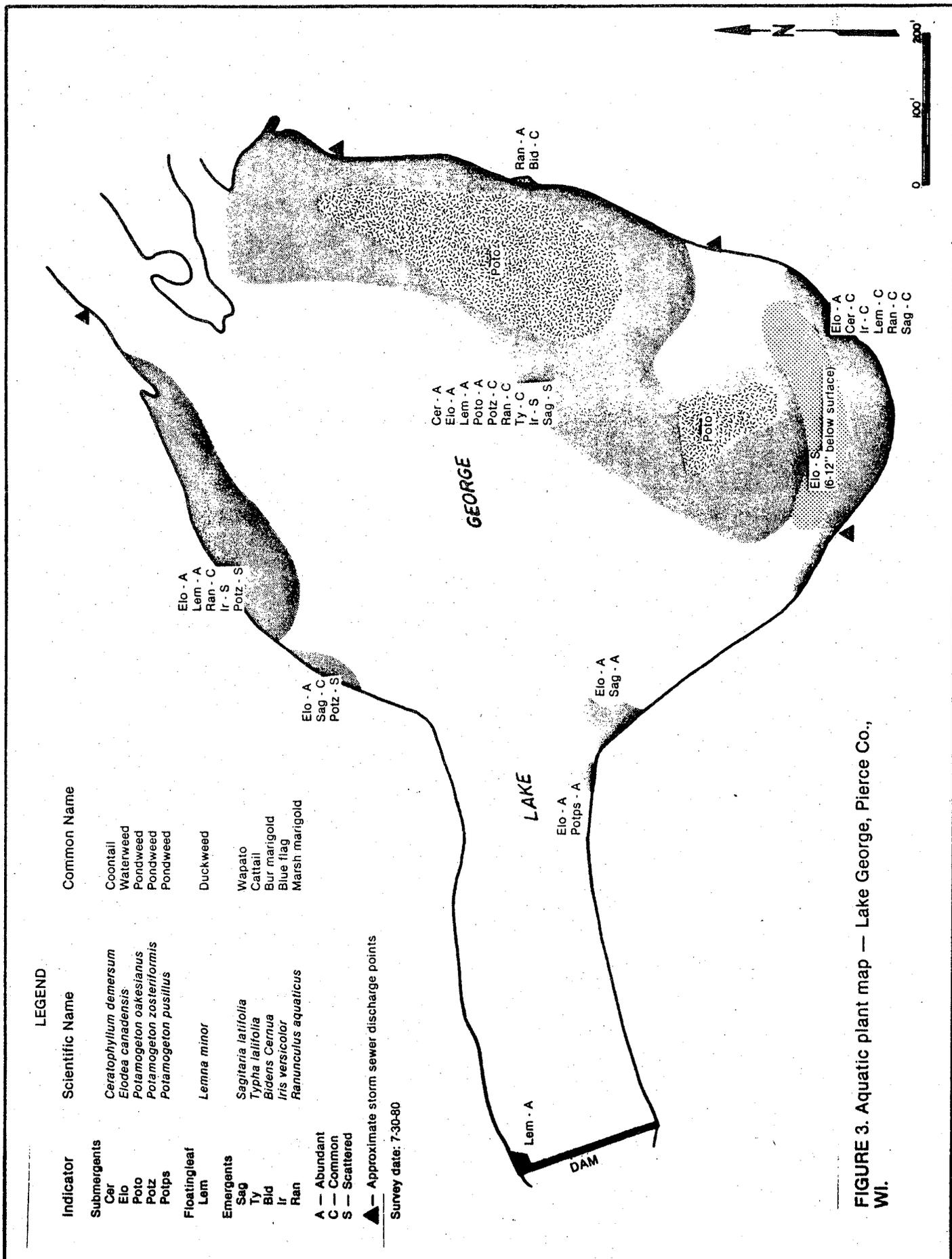


FIGURE 3. Aquatic plant map — Lake George, Pierce Co., WI.

The large flow through Lake George keeps water temperatures uniform throughout. Even on hot, sunny, and calm days the temperature difference from top to bottom is only 4°C. Temperatures are near the warm end of the range generally suitable for cold water fisheries (8-20°C; Lake George is 15-23°C). Complete results of the temperature survey are included in the appendix.

### Sedimentation

Sedimentation or infilling is an insidious problem of lakes and flowages. In the natural aging process, silt and dead organisms accumulate on lake bottoms. This process is greatly accelerated by runoff from lands bared for cultivation and construction. Lakes become very shallow and aquatic plants grow profusely in the nutrient-rich sediments. Even in lakes where the water quality is good, sedimentation can cause serious plant growth problems.

Sediment ranges from zero to eight feet thick on the bottom of Lake George, generally deeper near the dam. The total volume of soft sediment is 64,012 cubic yards (measured in 1980). The material is predominantly fine sand, silt, and clay eroded from the uplands. Figure 4 shows the depth of the soft sediments in Lake George.

The historic rate of sedimentation in Lake George has been quite high starting with the period of intense cultivation during the late 1800's. Up to the mid-1950's sediment was accumulating in Lake George at the rate of over 2500 cubic yards per year. If runoff and erosion had not been reduced, the lake would have filled in about ten years ago.

Improved upland soil conservation practices, including extensive stream bank protection, have reduced erosion and the resulting sedimentation. Today, sediment is being deposited in Lake George at a rate of less than 500 cubic yards per year (0.2 inches/year). At this rate, the lake has a life expectancy of over 300 years.

The top layer of sediments, where aquatic plants root, is rich in phosphorus. Even without further inflows of phosphorus or sediment, the lake can support abundant plant growth. A complete chemical and physical analysis of the sediments, along with sediment volume and infilling calculations, are provided in the appendix.

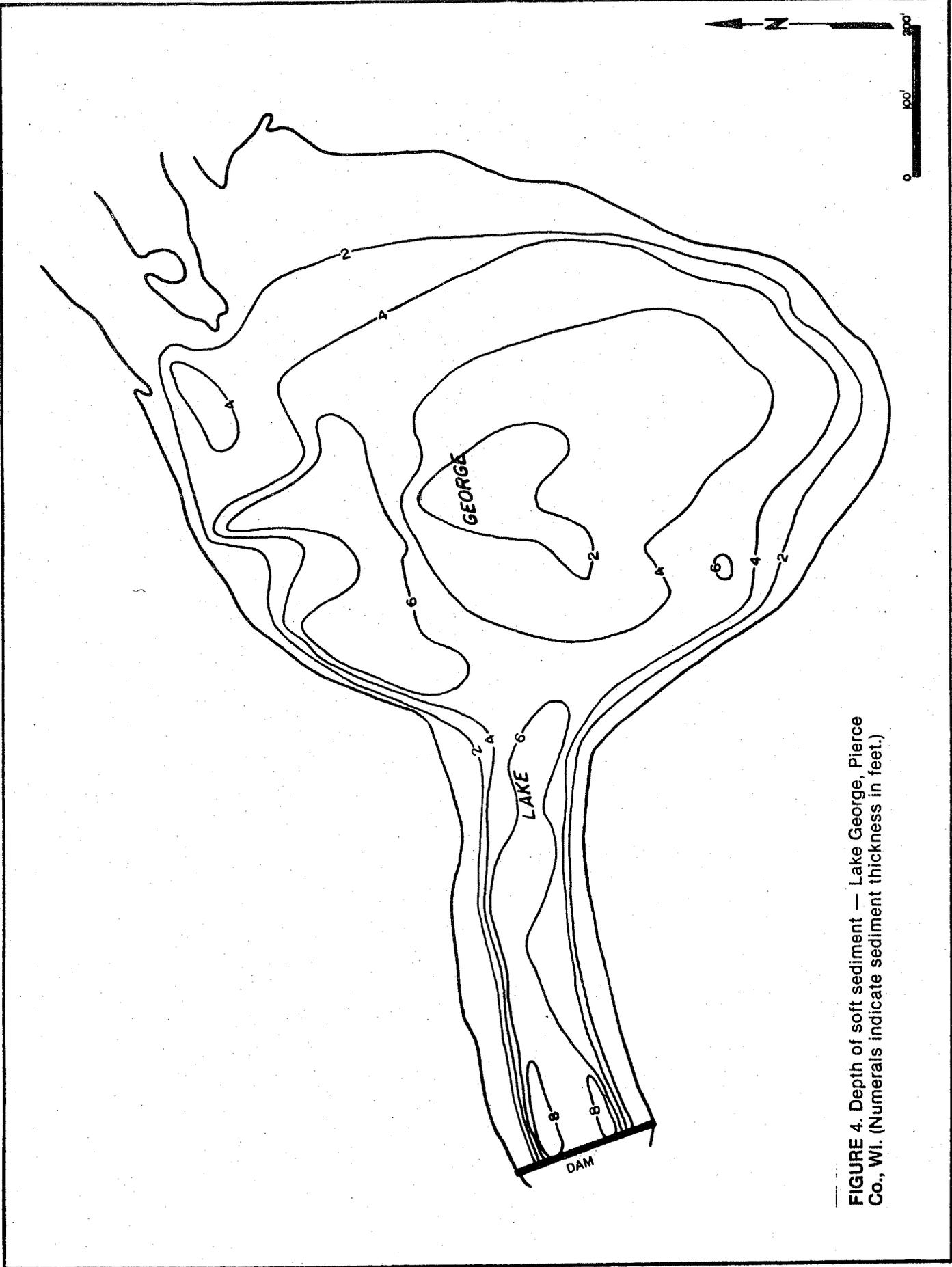


FIGURE 4. Depth of soft sediment — Lake George, Pierce Co., WI. (Numerals indicate sediment thickness in feet.)

## MANAGEMENT ALTERNATIVES

The presentation of alternatives is designed to provide the lake district decision-makers with ideas and factors to consider in planning their management efforts. The alternatives suggest ways of meeting the city's main objective, improving the lake's appearance, as well as options for enhanced long-term use of the water resource. Included are other benefits or side effects of the alternatives that decision-makers should consider.

This list of alternatives is not all-inclusive nor are the suggestions mutually exclusive. Some individual actions can begin immediately at little cost; others require technical and financial planning. Lake George District officials should consider the current and long-term use of the lake and its surroundings, as well as the public financial commitment to management when selecting one or more management actions.

### Protection of the Lake Through Watershed Management

The combination of improved agricultural practices in the watershed and stream bank protection along the upper Kinnickinnic River have reduced the sedimentation rate in Lake George by over 90%. The City of River Falls has erosion control and clean-up programs which reduce the potential for urban runoff and sedimentation problems.

Continued monitoring to identify problem sites in both urban and rural areas and cooperation with the county governments, Land Conservation Committees, and Department of Natural Resources water, fish, and wildlife managers to address any remaining problem sites will protect the improvements that have been made.

### Aquatic Plant Control

Controlling aquatic plant growth would improve the appearance of Lake George. Duckweed is the major visible plant. Unfortunately, duckweed can be very difficult to control. It has a waxy coat, giving it some resistance to herbicides. Because it floats, harvesting and collection is difficult. Its rapid growth rate makes duckweed a continual problem in areas of slow water movement.

Several methods are suggested for trial in Lake George. They include harvesting or drawdown to control submergent plants (in case they are physically promoting duckweed accumulation) and chemical control to eradicate the plant itself.

#### Harvesting

No methods of directly harvesting duckweed have been commercially developed. The duckweed mats in Lake George appear patchy, suggesting that the floating plants are caught in the tops of submergent plants at the water surface in the "bulge" of the lake. Water movement may be too slow there to dislodge the duckweed. If the submergent plants were harvested below the surface, normal water flow might prevent some of the duckweed accumulation.

While duckweed is not directly harvested, harvesting submergent plants has the advantage of removing some plant material from the lake system. The amount of material deposited as organic sediment is also reduced. The area, depth and time of harvesting can be varied to protect fish and fowl spawning or nesting areas and food sources.

All plants that are cut must be removed from the water. Application of the plant material to cropland or gardens is a popular option for disposal. The costs of harvesting can vary considerably. A range of harvesting equipment can be purchased or harvesting services can be contracted. Plant density and the degree of control desired will also affect the cost.

Small harvesters operate in water six inches or deeper and cut macrophytes down to 4-5 feet. The cutting rate is normally 2-4 acres per day. Harvester costs are roughly \$13,000-\$16,000. Large harvesters are used for the deeper, offshore locations. These machines require at least 12 inches of water and will cut down to 4-8 feet. The cutting rate is about 4-8 acres per day, depending on plant density. Costs will be approximately \$60,000 and up. Intermediate sized harvesters are often best where both near and offshore sites are in need of harvesting. Additional major operating needs include:

1. Manpower -- At least two people are needed to harvest and dispose of the plants;
2. Conveyor system -- Some mechanism is needed to take the plant from the harvester;
3. Transportation -- Trucks may be required to take the plants to a disposal site;
4. Disposal -- First, consider application to cropland or gardens.

A few private companies advertise macrophyte harvesting services. Prices vary between companies and will be influenced by lake location and macrophyte density. Anticipated costs are \$200-\$300 per acre. Disposal of the macrophytes is usually, but not always, included in the service available. The best strategy is to contract for harvesting services to test the effectiveness of harvesting. If it produces the desired results, then a decision on equipment investment can be made based on experience.

#### Drawdown

Depending on the cost of purchasing additional electric power, drawdown may be a low cost method of keeping submergent plants from growing to the surface. Drawdown can be done over winter or in the spring. In early spring, once submergent plants have begun growing, the lake would be drawn down. The water level must be reduced five to six feet to ensure that all areas normally in the photic (or lighted) zone where plants grow are sufficiently exposed. After about two weeks of exposure, the new plant shoots should be killed or stunted by drying or freezing. The desired result is that submergent plants do not grow to the surface during the summer. Submergent plants would still grow below the surface and more emergent plants might grow along the shore. Winter drawdown could potentially give greater control over emergents. The lake would refill with water in slightly more than a day (25 hours at 45 cfs).

The major environmental concern with drawdown is the effect of sediment that is carried downstream with increased flow from the lake. Drawdown must be done very slowly to prevent damage to downstream fisheries. Drawdown should also be timed to avoid critical fish spawning periods. The DNR's local fish manager can give advice on the necessary protection. The water management specialist in Eau Claire should be contacted for necessary approvals.

The dam plans show that a 5-6 foot drawdown would put water level at or below the water intake, precluding power generation. If the power plant generates about \$40,000 worth of electricity per year, the power cost of a two-week drawdown would be just over \$1,500 per year; a winter drawdown (November-March) would cost \$17,000 per year. How much reducing rooted aquatic plant growth would reduce duckweed accumulation is difficult to estimate. Harvesting and drawdown are suggested because of their relatively low cost and their flexibility. DNR's water, fish, and wildlife managers can provide sound advice for making a comparison of the two methods. Harvesting is not regulated (except that cut plants must be collected). Permission (not a formal permit) is required for drawdown.

#### Chemical Control

Several herbicides can control duckweed although complete eradication is very difficult. The plant's rapid growth potential necessitates vigilant application. Chemical treatment requires a permit. The DNR's aquatic nuisance control supervisor in Eau Claire can advise on the specifics of this requirement.

#### Dredging

Aquatic plants can root in water up to ten feet deep in Lake George. A complete restoration project would involve deepening the entire lake to about 12 feet. Dredging to 12 feet would ensure the maximum plant-free area. The zone near the shore must slope gently enough to prevent erosion and personal safety hazards. Figure 4 shows the plant-free area that could be created. The areas that are shallower than 10 feet would still maintain plant growth as would any areas that fill in to less than 10 feet due to shifting sediments and new deposition. Floating plants would remain in slow water areas.

Dredging the outlined area to 12 feet involves removing over 400,000 cubic yards of material, including excavating some of the original lake bottom (see appendix for calculation). The lake volume would be approximately quadrupled.

For Lake George, plant control is the major advantage of dredging. The near-shore areas would still support some plant growth, including duckweed. Even with the larger volume, the flushing rate is still rapid (four days at average flow) so that the water would not warm up enough to support a significant warm water fishery. While the water is clean, most people would probably consider it too chilly for swimming on all but the hottest days (65°F at 3' deep between July 31 - August 13).

Disposal may be the most difficult part of any dredging proposition. Since the lake is in the city, there is no adjacent disposal site that could accommodate large amounts of material. Hauling the sediment to the disposal site may be a major cost consideration. The large volume of sediment may make finding a disposal site difficult or may necessitate more than one site.

Large volumes of dredged materials must be disposed of carefully to avoid contaminating groundwater. Disposal requirements depend on the amount of material, the dredging method and the makeup of the sediments. DNR solid waste specialists can help evaluate the disposal needs or recommend further testing for specific dredging proposals. The results of sediment chemical analysis are included in the appendix for future use.

If the sediments are not contaminated, they could be sold for soil conditioning material or fill. The sediment is silty and the organic content low so the material's conditioning value may be limited. Establishing a site for storage of dredged material, re-used or not, requires a solid waste license (or waiver of license) from the Department of Natural Resources.

Two kinds of equipment can be used for dredging. In hydraulic dredging a cutterhead and pump are used to remove sediments. Because much water is pumped with the sediments, construction of one or more large holding ponds is usually necessary to settle the dredged material. The water can then be returned to the lake or disposed of in some other manner. Spray irrigation of the carriage water has been successful in some situations. The lake could be drawn down before dredging begins to eliminate some of the water to allow inspection of the dam and for removal of any large obstructions.

Standard earth moving equipment can also be used for dredging. The lake must be drawn down long enough to allow the sediments to dry, which may take months to complete. During this period power normally generated would need to be purchased. If the plant generates \$40,000 worth of electricity per year, a drying period lasting three months would add about \$10,000 in power costs to this project cost.

Many factors influence dredging costs including project site, method of removal, type of material to be dredged, distance to disposal sites, and availability of contractors. Unit costs on current dredging projects range from \$1.25 to \$2.50 per cubic yard of material removed.

Dredging and disposal require approvals from the Department of Natural Resources (DNR) District Headquarters at Eau Claire, and perhaps approval by the U.S. Army Corps of Engineers. Local government and property owners would also have to be contacted for permission to use a particular area for sediment disposal. Dredging permits generally require that any water returned to the lake or other surface or groundwater meets certain water quality standards. This means that if the dredging alternative is selected, further investigation will be necessary. Quite frequently a consulting firm is retained for project design, preparation of plans and specifications, and for project management. Some of the required information includes:

1. Location and volume of sediment to be removed.
2. More accurate determination of depth of soft sediment in the specific location of planned removal.
3. Location of the dredge disposal areas.

4. Specific plans for the containment facility.
5. Determination of additional sediment chemical and physical characteristics, if any.
6. Anticipated environmental effects of the dredging project.

The Lake District should contact the DNR District Headquarters in Eau Claire early in the planning stages of a dredging project.

#### Fish and Wildlife Habitat Improvement

Reports of Canada geese nesting near the inlet to Lake George or improved trout fishing in the lake might arouse even greater community interest in the lake area. Any of the management alternatives suggested have the potential for both positive and negative impacts on fish and wildlife habitat.

An example of lake management for an improved fishery is to place devices in the lake that are attractive to fish. Improving the area for songbirds and waterfowl use might involve canary grass control and food plant seeding for sedimentation islands and in shoreline areas. DNR's fish and game managers can help assess the wildlife potential of the area and suggest specific management techniques. These measures should be considered along with the total management plan to make sure that all activities are compatible.

#### Return to Stream Conditions

By returning the lake back to a stream habitat, it may be a long-term money saver as well as an aesthetic advantage for River Falls. The lake cannot support a quality warm water fishery. Therefore, the stream could be re-established as quality trout habitat.

Hydroelectric power no longer meets most of River Falls electricity needs. In the future, maintaining a large scale hydroelectric power installation may be too costly even for high return, peak load power generation. At the time that costs exceed returns, the lake management strategy should be reconsidered. The lake district might consider whether the benefits of the lake outweigh the costs of maintaining the dam plus managing the lake.

Some communities have turned weedy lakes into attractive streamside parks. Reedsburg, Wisconsin (Salk County) is a prime example, incorporating the same uses and features around a stream that are being encouraged around Lake George today (nature enjoyment and relaxation with paths and interpretive signs). River Falls has the added advantage that the Kinnickinnic River is a trout stream as well as one of the most diverse river ecosystems in the midwest.

Dismantling a 46-foot dam would be no small project. Because of the special features of the stream, care must be taken to keep Lake George's sediments from causing downstream pollution problems during dam removal. Dam removal requires a DNR permit. Contact the DNR District Headquarters in Eau Claire if dam removal is being considered.

## Hydroelectric Power Re-Development

Recently, private companies have become interested in developing small-scale hydroelectric power at existing dam sites. Advances in turbine materials and construction may make power generation at Junction Falls dam more efficient and less costly.

Hydroelectric power development could affect lake management by changing water levels or water temperature. These changes could have positive or negative impacts on Lake George. Power redevelopment must be undertaken with care. Dam modification, water level changes, and other associated actions require state permits. A list of some DNR publications that might be helpful in assessing River Falls hydroelectric potential is included in the appendix.

## Do Nothing

If no controls or management plans are implemented, what is the future of Lake George? The answer is that the lake would change little from its present state unless stream channel or watershed conditions are allowed to deteriorate. The lake's water quality is dominated by its physical characteristics and watershed. The lake is filling very slowly now, but the nutrient-rich sediments already deposited will sustain abundant plant growth for years to come. Whether or not the lake in its present condition is desirable and should be left alone is a decision for the lake district.

## The Next Steps

Before choosing any alternatives, lake district members should look at the present and potential use of the lake and its watershed. They should evaluate improvements needed to maintain these uses and assess the public support and financial commitment to lake management.

DNR resource managers are available to discuss the results and the options presented in this report. Knowing the major cause of lake problems, the lake district can decide on a management strategy to meet its goals. More detailed specifications can be drawn up from the basic plan when specific actions are considered. A lake management plan can unite people in working on lake issues and help ensure that individual actions are compatible with agreed-upon goals.

The question of financing should be kept in mind from the beginning. Although the current legislature has discontinued funding for inland lake renewal, some technical assistance is still available. Individual management activities and long-range planning should continue as far as possible. Some improvements could be made at no appreciable cost, e.g., cooperation with county government on runoff and erosion control projects and volunteer projects such as those already underway. What improvements would lake district residents be willing to tax themselves for? Are there any possible outside funding sources - public or private? Could some aspects of lake district activities be built into other local efforts, e.g., floodplain/shore land or other local and regional planning programs, a tax-incremental financing (TIF) district, park or road construction projects? River Falls has already demonstrated ingenuity in this type of effort. Public access or public benefit must be shown to warrant use of public funds. A plan is a useful tool for persuasion in trying any of the options above.

In some instances a management alternative selected by the lake district that requires a Department of Natural Resources permit and/or more than \$30,000 of state project grants must be evaluated in an Environmental Impact Assessment (EIA). The EIA provides an opportunity for public review and comment on its findings and determines whether an Environmental Impact Statement (EIS) is needed. If the EIA demonstrates that the selected management alternative will significantly affect the quality of the human environment, the Department will prepare an EIS prior to project approval.

APPENDICES

LAKE GEORGE  
PIERCE COUNTY

- . Estimated Phosphorus Loading
- . Sediment Chemical Analysis
- . Sedimentation Rates
- . Sediment Volume Calculation
- . Water Temperature
- . Publications on Assessing Hydropower Potential

APPENDIX:

LAKE GEORGE, PIERCE COUNTY  
ESTIMATED PHOSPHORUS LOADING

Land Use

59% cropland  
row, (corn, soybeans) 50% contoured  
35% pasture  
5% woodland  
1% urban

P Loading = (Acres in use) (Export Coefficient for land use)

<u>Use</u>	<u>Acres</u>	(kg/ac/yr) <u>Export</u> <u>Coefficient</u>	(kg/yr) <u>P</u> <u>Delivered</u>
Row crops	38,515	7.6 (average of values for straight and contoured cropping)	292,716
Pasture	22,848	0.4	9,139
Woodland	3,264	0.3	979
Urban	<u>653</u>	1.9	<u>1.240</u>
Total	65,280		304,070 (4 kg/acre) (670,474 lbs)

APPENDIX: SEDIMENT CHEMICAL ANALYSIS

Lake George Sediments (sampled May 20, 1980)

Constituent and Units	SAMPLE #					
	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.)	2.0	1.2	0.5	1.1	1.0	1.6
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

\* Top samples are the upper one foot of each core.  
Bottom samples are the second and third feet of each core.

APPENDIX: SEDIMENTATION RATES  
LAKE GEORGE, RIVER FALLS, WI

<u>Year</u>	<u>Site I</u>	<u>RATE (cm/yr)</u>		<u>Site III</u>
			<u>Site II</u>	
1954-58	1.0			5.0
59-64	6.7	2.3		2.5
65-71	1.4	0.9		2.9
72-81	0.6			0.6

## APPENDIX:

## SEDIMENTATION VOLUME CALCULATION

Material to be Removed in Deepening to 12'  
Lake George, River Falls, WI

<u>STATION</u>	<u>AREA (ft<sup>2</sup>)</u>	<u>AVERAGE AREA (ft<sup>2</sup>)</u>	<u>LENGTH (ft)</u>	<u>VOLUME (ft<sup>3</sup>)</u>
0+00				
0+50	31	16	50	802
1+00	47	39	50	1,954
1+50	94	71	50	3,557
2+00	163	129	50	6,463
2+50	178	171	50	8,567
3+00	340	259	50	12,976
3+50	340	340	50	17,034
4+00	503	422	50	21,142
4+50	534	519	50	26,002
5+00	1,466	1,000	50	50,100
5+50	2,953	2,210	50	110,721
6+00	3,654	3,304	50	165,530
6+50	5,570	4,612	50	231,061
7+00	5,989	5,780	50	289,578
7+50	7,873	6,931	50	3,472,431
8+00	8,303	8,088	50	4,052,088
8+50	14,951	11,627	50	582,513
9+00	6,235	10,593	50	530,709
9+50	7,271	6,753	50	338,325
10+00	5,779	6,525	50	326,903
10+50	4,486	10,265	50	514,277
11+00	4,633	4,560	50	288,456
11+50	3,146	3,890	50	194,889
12+00	2,549	2,848	50	142,685
12+50	686	1,618	50	<u>81,062</u>
				11,409,825 ft <sup>3</sup>
				422,620 yd <sup>3</sup>

APPENDIX:

WATER TEMPERATURE (°C)

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
Inlet	19.2	18.2	18.7	17.0		17.9	19.3	18.9	19.9	19.4	15.0	16.0	17.9	15.5
Surface	20.9	21.2	20.5	23	17.5	17.9	23.1	20.5	20.2	20.7	21.1	19.0	19.8	16.5
1'	19.2	20.2	20.2	19.3	17.5	17.8	21.0	17.6	20.0	20.0	17.6	17.2	19.0	16.1
2'	19.0	19.9	18.9	18.3	17.2	17.4	19.6	19.0	20.0	19.9	16.5	16.5	18.5	16.0
3'	18.8	19.4	18.3	17.7	17.0	17.1	19.0	18.4	19.9	19.7	16.0	15.5	18.0	15.8
4'	18.1	18.9	17.9	17.2	16.8	17.0	18.2	18.1	19.8	19.8	15.9	15.2	17.5	15.5
5'	17.8	18.5	17.7	16.9	16.7	17.0	18.0	18.0	19.8	19.7	15.8	15.0	17.0	15.2
6'	17.8	18.0	17.4	16.7	16.6	16.9	17.8	18.0	19.7	19.7	15.5	15.0	17.0	15.1
7'	17.4	17.6	17.3	16.5	16.5	16.7	17.3	18.0	19.5	19.7	15.4	15.0	16.9	15.1
8'	17.2	17.3	17.1	16.4	16.5	16.6	17.0	18.0	19.4	19.6	15.4	14.9	16.6	15.1
9'	17.0	17.2	17.1	16.2	16.5	16.6	17.0	18.0	19.3	19.5	15.4	14.9	16.0	15.1
10'	16.6	16.9	17.1	16.1	16.4	16.6	17.0	18.0	19.3	19.5	15.4	14.9	16.0	15.1
11'	16.3	16.9	17.1	16.1	16.4	16.5	17.0	17.9	19.3	19.4	15.4	14.9	16.0	15.1
12'	16.1	17.0	17.1	16.1	16.4	16.5	17.0	17.9	19.2	19.4	15.4	14.9	16.0	15.1
Bottom(13)	16.0	17.0	17.0	16.1	16.4	16.5	17.0	17.9	19.2	19.4	15.4	14.9	16.0	15.1
Outlet							18.4	18.6	19.7	19.9	16.0	15.6	17.6	15.2
Air Temp(°F)	94	83			77	78	94	92	92	75	73	74	76	72
Weather	Part Sun	Part Sun	Part Sun	Sun	Rain	Sun	Part Sun	Cl'dy	Part Sun	Rain	Cl'dy	Sun	Part Sun	Rain

Publications on Assessing Hydropower Potential

Alward, Ron, Sherry Eisenhart and John Volkman. "Micro-Hydro Power, Reviewing an Old Concept." U.S. Department of Energy, Idaho Operations Office. January, 1979.

Reisner, Marc. "Power, Profit, and Preservation, The Invasion of Small-Scale Hydropower." Wilderness. 1984.

"Small-Scale Hydropower and the Environment: How Much Harm?" Water Resources Program, National Wildlife Federation. May, 1983.

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