

APPENDIX I

Lake Water Quality Management Plan

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INTRODUCTION

Pierce County is responsible for addressing surface water management issues in unincorporated areas within the County. These issues include drainage, flood hazard reduction, water quality, and fish and wildlife habitat in the floodplain. Pierce County does not currently have a formal program for addressing the unique water quality issues often found in lakes. The purpose of this memorandum is to evaluate lake water quality concerns, existing management activities related to lake water quality, and lake management gaps/needs. Based on the results of the gap analysis, a recommended lake program is provided. In addition, relevant policy questions are provided for Pierce County to consider as it evaluates the role it will play in lake management in the County.

PIERCE COUNTY GOALS FOR LAKE MANAGEMENT

Pierce County Public Works and Utilities, Surface Water Management Division (PCWP) has identified the need to provide a fully functioning lake management program. The goals for the lake management program are the same goals as for the Basin Plans, which are to:

- Reduce flood hazards
- Improve fish habitat
- Improve water quality

This document focuses on Pierce County's goals for improving and maintaining lake water quality, which in turn also supports goals related to improving habitat and reducing flood hazards.

BENEFICIAL USES AND ECONOMIC IMPORTANCE OF LAKES

There are approximately 57 lakes in unincorporated Pierce County. These lakes provide valuable functions including:

- Recreational opportunities such as swimming, motorized and non-motorized boating, and fishing
- Aesthetic qualities which contribute to property values
- Fish and wildlife habitat, surface water and groundwater flow regulation, and sediment and nutrient sinks
- Water supply

Several relevant studies have been conducted on the economic importance of lakes and the potential negative impacts of lake water quality problems. These studies indicate that recreational usage of lakes, which is often correlated with the quality of lakes, contributes to the local economies of areas around lakes. These studies also describe how the value of lakeside properties can depend on the quality of lakes, particularly if problems such as algae blooms or invasive aquatic plants significantly degrade the usability of a lake.

A study of Lake Delavan, a 2,000-acre lake in Wisconsin with extensive lakeshore development and recreational use, evaluated the economic value of water quality management activities based on property owner and recreational user surveys, input-output analysis, and a hedonic analysis of property values (University of Wisconsin-Whitewater 2005). The study was conducted in 2005, approximately 12 years after a \$7 million rehabilitation program was completed to enhance wetlands, eliminate carp, restock game fish, and reduce algae and phosphorus in the lake. The study evaluated the positive economic effects of the rehabilitative lake management activities as well as the potential negative effects of the lake water quality returning to the pre-rehabilitation conditions if future deterioration occurs.

The Lake Delavan study determined that households located near the lake due to the presence of the lake amenities (i.e., views and recreation) spend \$52.6 million/year in the local area (about \$24,000 per household). Visitors to the lake spend an additional \$9.4 million/year. Indirect spending as a result of the lake also contributed \$15 million/year, resulting in total direct and indirect spending related to the lake of approximately \$77 million annually. The study estimated that 812 jobs are generated from these expenditures. The study also found that the lake water quality improvements implemented resulted in the average lakeshore property appreciating in value by \$177,000 over a 16 period (beyond additional appreciation not related to the quality of the lake), an aggregate increase in valuation of over \$99 million for the 565 homes considered.

The Lake Delavan study found that degradation of water quality to pre-rehabilitation levels would reduce the amount of time property owners and visitors spend around the lake, resulting in a reduction of regional economic activity by 8% to 13% (\$5 to \$6 million/year). Conversely, the study found that maintaining existing water quality while providing additional improvements in the management of Eurasian water milfoil could increase economic activity by 8% to 11%.

Several studies have also recently been completed on the economic value of lakes in Maine (State of Maine DEP 2007, and EPA 2000). At a state-wide level, the studies found that lake-based expenditures by all users support over 50,000 jobs in Maine and generate an estimated \$1.8 billion in total direct expenditures for recreation. Recreation generates \$1.1 billion each year, other uses of lake water (such as drinking water, youth camps, and commercial uses) generate \$400 million each year, and lake front property owners contribute over \$300 million in investments in properties and taxes.

The Maine studies found that a 1 meter reduction of summertime minimum clarity (Secchi transparency) resulted in a reduction of 3 to 5% in the expected market price of a typical

lakefront property. The State of Maine estimated that the net benefit of avoiding measurable water quality degradation in lakes exceeds \$2 billion annually. The studies also evaluated the willingness of day access users to pay for water quality, and found users are estimated to be willing to pay \$2 to \$6 million annually to support water quality efforts.

The Maine studies also reported that water clarity, quality of swimming, and scenic beauty are important to most people when they choose which lake to visit or where to buy property. A noticeable gain in water quality could increase statewide lake use in Maine by up to 13% (1.6 million user days) each year, which would result in approximately a \$107 million increase in economic activity in the state. Conversely, the Maine studies found that a visible decrease in water quality would likely result in equivalent or greater losses in economic benefit from the lakes.

The studies on the economic value of lakes in Wisconsin and Maine indicate that lake water quality management activities can benefit regions surrounding lakes through increased economic activity associated with recreation and through increased property values. These studies also indicate that degradation of lake water quality can adversely affect the local economies.

LAKE WATER QUALITY CONCERNS

Lake water quality is important to the public for many reasons, including recreational usage, aesthetics, and habitat quality for fish and wildlife. Common lake water quality problems include:

- Excessive and/or invasive aquatic plant growth
- Excessive algal growth (typically due to elevated phosphorus inputs to the lake) and toxic algae (cyanobacteria) blooms
- Poor water clarity due to algal growth and/or soil eroded from the lake's watershed
- Pathogens from human and animal waste, which can increase health risks for people swimming or wading in the lake
- Low dissolved oxygen levels caused by excessive aquatic plant growth and/or discharges of oxygen-demanding materials into the lake
- Sediment build-up near surface water inlets
- Trash, oil and gasoline spills, and lake disturbance resulting from recreational activities.

Many lake water quality problems can be linked to excessive nutrient input, which accelerates eutrophication in lakes resulting in increased aquatic plant and algae growth and degraded water quality. Potential nutrient sources include land use activities (such as removal of native vegetation along lakeshores and tributary streams), point source discharges (such as wastewater treatment plant and industrial discharges), and non-point discharges (such as agricultural runoff,

stormwater, and septic systems). Soil erosion can contribute sediment, nutrients, and other pollutants to lakes. River management controls like dams can affect lake parameters such as temperature and suspended sediment.

Although recreational usage and aesthetic values of lakes can be impaired by excessive aquatic plant and algae growth, healthy lakes typically require some level of algae and aquatic plants. Algae are primary producers and serve as the food base for many lake organisms, including fish and benthic invertebrates. Aquatic plant communities provide oxygen for aquatic life; habitat and food for waterfowl, fish, amphibians, invertebrates, and insects; protection of the shoreline from erosive waves; and stabilization of bottom sediments from re-suspension (Cooke et al. 2005).

However, excessive algal and aquatic plant growth and its effects on water quality are the most common problems addressed in the management of shallow, eutrophic lakes (Cooke et al. 2005). Excessive algal blooms hinder lake recreation, are unsightly, and deplete lake oxygen levels during decomposition. Certain strains of blue-green algae (also known as cyanobacteria) can be toxic to people and animals if ingested; thus, algae-dominated lakes require close surveillance to ensure public safety. Aquatic plants, especially invasive species, can grow out of control in nutrient-rich lakes. Excessive aquatic plant growth similarly hinders lake recreation, is unsightly, and can negatively alter lake food webs.

The factors typically affecting the abundance and distribution of plants within lakes are nutrients, light availability, sediment characteristics, wind, and wave energy (Nichols, 2001). Algal growth is often limited by nutrient concentrations in the water column. The cycling of nutrients in lakes is complex and dependent upon a variety of physical, chemical, and biological factors. In aquatic systems, phosphorus (P) and nitrogen (N) are the most limiting nutrients for algal growth; generally, the addition of these nutrients to a lake will increase the rate and amount of algae production (Bachmann, 2001). However, lake size and depth control how nutrients affect algal growth. In deeper lakes, there is generally a continual loss of nutrients from the epilimnion to the hypolimnion as algae and particulate matter die and sink to the bottom of the lake. In contrast, the frequent mixing of shallow lakes typically results in a relatively rapid return of nutrients from most settled material into the water column.

Controlling nutrient inputs to lakes is a key component in maintaining or improving lake water quality. Septic systems and runoff from agricultural land are two potential sources for high nutrient inputs to lakes and contributing streams. Stormwater runoff can also contribute nutrients to lakes from fertilizers and eroded soil. In Pierce County, the Tacoma-Pierce County Health Department is responsible for septic system design, inspection, and repair. Pierce Conservation District addresses runoff from agricultural land through voluntary landowner participation in its conservation planning program. Surface Water Management addresses stormwater quality through its NPDES MS4 permit program and basin planning. The Washington State Department of Ecology (Ecology) also supports programs to address invasive aquatic weeds and toxic algae

in lakes. The control measures implemented by these agencies are described in greater detail in Section 6 below.

Once lake sediments are enriched with nutrients, addressing invasive or excessive aquatic vegetation generally requires controlling plant growth through physical, mechanical, chemical, or biological control methods. Examples of physical and mechanical control methods include hand pulling and harvesting with machines. Examples of chemical control methods include herbicides that target certain types of aquatic vegetation and alum to reduce concentrations of plant-available forms of P. Examples of biological control methods include herbivorous fish (such as sterilized grass carp), weevils that feed on target aquatic plants, and restoration of native aquatic plant communities. Ecology recommends that lake management groups and local governments collaborate in the development of integrated aquatic vegetation management (IAVM) plans for lakes with aquatic plant management issues. An IAVM plan evaluates the available control methods and selects the most appropriate methods for the lake conditions and management goals. Ecology generally will not issue permits for application of certain aquatic herbicides and other control techniques unless the applicant has completed an IAVM.

NISQUALLY BASIN LAKE SURVEY RESULTS

The Nisqually Basin planning area encompasses more than 16 lakes. The Nisqually Basin Characterization Report noted little information was available for some of these lakes. Therefore, in 2007, Pierce County sent questionnaires to about 1,800 owners of properties near these lakes. Technical Memorandum #5 describes the results of the questionnaire responses in detail. This section summarizes relevant information from the surveys related to potential management of the lakes by Pierce County.

Survey respondents were asked to rate the importance of lake issues, with 1 being the most important and 4 being the least important. The average results from 103 responses are listed in Table I-1. Water quality issues received the highest average ranking of importance and flooding issues in and around lakes received the lowest average ranking of importance.

Rank of Issue	Issue	Average Ranking*
1	Water Quality	1.3
2	Fish Health	1.6
3	Algae Blooms	1.7
4	Water Weeds	1.9
5	Septic System Use	1.9
6	Fertilizer Use	2.2
7	Lake Level	2.3
8	Flooding	2.8

*1 is most important and 4 is least important

These results provide a general overview of lake management concerns in the Nisqually Basin. Certain concerns are more prevalent for some lakes depending on the lake size, location, level of watershed development, and usage.

The questionnaire results indicate that most of the lakes in the Nisqually Basin have public access points, and most are used for boating, swimming and fishing. In addition, Clear Lake, Harts Lake, and Silver Lake provide water for irrigation.

Survey respondents were asked to describe problems concerning flooding, fish populations, algae blooms, aquatic weeds, and water quality. Problems identified by survey respondents for specific lakes are shown in Table I-2.

Lake	Problems				
	Flooding	Fish Kills	Algae Blooms	Aquatic Weeds	Water Quality
Alder Lake	x	x	x	x	
Clear Lake	x	x	x	x	x
Harts Lake	x	x	x	x	x
Lake Serene	x	x	x	x	x
Lake Twenty-Seven					
Ohop Lake	x	x	x	x	x
Rapjohn Lake					
Silver Lake	x	x	x		x
Tanwax Lake	x	x	x	x	x
Twin Lakes	x		x	x	x
Whitman Lake	x	x	x	x	x

* No responses were received for Cranberry Lake, Kregger Lake, Mud Lake, Trout Lake, and Tule Lake.

The questionnaires also asked respondents to describe their specific issues or concerns. Specific issues identified included:

- For Clear Lake, one respondent described concerns related to motor boat and jet ski usage and water quality; another respondent indicated there is an aquatic weed management program in place.
- For Harts Lake, there was one complaint regarding aquatic plants (milfoil) and one complaint regarding trash left in the lake by fishermen and hunters.
- Ohop Lake has a Lake Improvement Club that has been controlling aquatic weeds using an aquatic vegetation management plan approved by Ecology. Ohop Lake also limits

water ski and jet ski activity to the period from 11:00 AM to 3:30 PM, with a speed limit of 8 mph during other hours. Ohop Lake respondents expressed concerns about sediment buildup, failing septic systems, fireworks, motor boats, and excessive populations of cormorants reducing the fishery in the lake.

- On Serene Lake, one respondent noted that thick weeds preclude fishing and swimming, and that past herbicide applications were not effective in controlling aquatic plant growth.
- For Whitman Lake, four respondents expressed concern that motor boats and jet skis are damaging the lake.

The Phase 1 Nisqually Basin Characterization Report identified potential flooding problems at the following lakes: Clear Lake, Cranberry Lake, Harts Lake, Ohop Lake, Rapjohn Lake, Tanwax Lake, and Whitman Lake. A variety of flooding problems were also described by respondents to the survey, ranging from minor nuisance flooding to flooding that affects roads and structures. Several respondents noted that beaver dams appear to contribute to the flooding problems. Flooding problems are being addressed through the basin planning process.

The results of the survey indicate that there are a number of water quality-related issues which could be addressed by Pierce County in a lake management program, including providing assistance related to water quality monitoring, nutrient reduction and aquatic plant control. In addition to water quality-related issues, there may be a role for Pierce County to play in addressing conflicts between various types of recreational lake uses. Existing activities related to lake management are described in Section 6 below.

CURRENT ORGANIZATIONAL ROLES AND RESPONSIBILITIES FOR LAKE MANAGEMENT IN PIERCE COUNTY

Pierce County addresses issues associated with lake management through Surface Water Management (PCWP) and Tacoma-Pierce County Health Department (TPCHD).

Surface Water Management

Surface Water Management (PCWP) is currently developing an Invasive Vegetation and Lakes Management project. The Invasive Vegetation project includes field surveys of 21 lakes in unincorporated Pierce County to obtain information on invasive aquatic plants (i.e., aquatic weeds). Invasive aquatic plants reduce recreational and aesthetic qualities of lakes and put lakes at risk for shifts in ecological functions and decreased habitat quality. The Invasive Vegetation project will provide baseline information on lakes and recommendations to address invasive plant issues in lakes. In addition, the results of this technical information memorandum describing existing lake management activities and gaps in a fully functioning lake management program are intended to be included in the overall Lakes Management Plan developed through the Invasive Vegetation project.

PCWP addresses water quality through its National Pollutant Discharge Elimination System (NPDES) stormwater permit and Stormwater Management Program as well as through the development and implementation of Basin Plans, Watershed Action Plans (focused on non-point source pollution), and the Salmon Recovery Plan. As a part of the Watershed Action Plans, Pierce County works collaboratively with local watershed councils and other groups to improve water quality.

The Stormwater Management Program describes actions taken by the County to comply with its stormwater NPDES permit and improve water quality. These actions include:

- Water quality monitoring
- Public education and outreach
- Operation and maintenance practices for roads and stormwater structures
- Illicit discharges detection and elimination
- Stormwater management and site development manual
- Inspection of businesses and industries
- Use of Best Management Practices to prevent stormwater pollution
- Capital Improvement Programs to build regional stormwater facilities

Tacoma-Pierce County Health Department

Tacoma-Pierce County Health Department (TPCHD) has 0.5 FTE performing lake water quality monitoring and limited public outreach. The work is often nearly full-time in the summer and then part-time the rest of the year. TPCHD also implements a septic system program that affects lake management. TPCHD has a new position (1 FTE) working on Green Landscaping issues such as composting and yard care. This position could provide assistance in the future related to lakefront property landscaping and nutrient reduction.

TPCHD monitors water quality at seven freshwater swimming beaches each summer. Water samples are collected from each swimming area at least once every other week and tested for E. coli bacteria. E. coli bacteria are found in the intestines of humans and warm-blooded wildlife species. High concentrations of E. coli in a surface water sample indicate that the water body is contaminated with fecal matter and may therefore pose a health risk for people swimming or wading in the water. If E. coli levels are high, an advisory sign is posted at the beach. TPCHD does some data management to track the monitoring information; however they lack staff time to do extensive data management and dissemination. The beaches monitored are:

- American Lake: North Park, Harry Todd Park
- Spanaway Lake: Main Beach, North Beach

- Lake Tapps: North Park, Allan York Park
- Wapato Lake: Main Beach

Funding for the freshwater swimming beach monitoring comes from the general “Health Pool” funding provided to TPCHD by the City of Tacoma and Pierce County. This funding source has been declining in recent years.

In addition to the beach monitoring program, TPCHD also monitors for toxic algae in lakes from public access points, identifies algae species in the lab and field, and posts caution signs at lakes with toxic algae levels of concern. Currently, they focus on taking samples where scum layers are observed near public access points. However, they may be missing some areas with algae problems that would only be accessible by boat and sites with algae dispersed through the water column by boat activity. Some algae problems are reported by volunteers involved in PCD’s monitoring program, and when invited by those volunteers to investigate further TPCHD field staff have the opportunity to go on private property and access other parts of lakes.

TPCHD received a Freshwater Algae Program grant from the Dept. of Ecology for about \$48,000. The grant will help fund an increased toxic algae project that will include additional public education and outreach (including mailings, workshops, and newspaper articles), purchase of additional sampling equipment to sample the density of algae blooms to better find dispersed algae problems, creating an Algae Watch Program using community volunteers to help identify algae problem areas, creating a database to better track algae program data and activities, making the database available to the public via the web, and enhancing the toxic algae public warning system.

In addition to monitoring and the planned Algae Program, TPCHD does some education and outreach when contacted by lakeside property owners with questions about lake water quality, including distributing flyers and brochures. TPCHD has done targeted mailings to waterfront property owners as well. TPCHD does some informal coordination with other agencies, primarily with Pierce Conservation District (PCD), but inter-agency coordination is limited.

The TPCHD Septic System Program addresses the permitting of new septic systems and assists homeowners with maintenance and repair of existing septic systems. The TPCHD Septic System Program, along with the Operation and Maintenance Program, works to ensure that septic systems are located and installed correctly and kept in good working condition. TPCHD does some limited education regarding septic systems, primarily in response to questions and for properties that are going through sale or transfer. TPCHD provides guidance to homeowners regarding how to keep septic systems in good condition; the guidance includes determining the location of the systems, inspecting the systems periodically (every three years), and maintaining the systems (pumping systems every three to five years). TPCHD provides as-built drawings to landowners when requested to assist landowners in determining the location of septic systems. TPCHD also provides homeowners with contact information for contractors who can assist with septic system inspection and maintenance.

Pierce Conservation District

PCD implements a volunteer monitoring program for water quality in streams called the Pierce Stream Team. There are 3.0 FTE staff in the Stream Team program who provide, among other things, watershed health education as well as monitoring, data management, training and equipment loan, and aquatic weed management advice. The Stream Team program is primarily focused on volunteer monitoring in streams and several lakes in and around incorporated cities. PCD estimates that program management for the lake-oriented aspects of Stream Team work currently requires approximately 0.3 FTE.

PCD coordinates volunteer lake monitoring for the cities of Lakewood (since 2000), Bonney Lake (since 2004), and previously for Tacoma (ending in 2005). The lakes monitored for these programs include American, Gravelly, Louise, Steilacoom and Carp (for Lakewood); and Bonney and Debrajane (for Bonney Lake). PCD coordination for the Lakewood and Bonney Lake monitoring programs includes training volunteers, delivery of samples collected by volunteers to laboratories for analysis, conducting lab testing of water samples and providing data management. Lab fees and lake kits for the Lakewood and Bonney Lake programs are paid for by the cities. Lakewood spends approximately \$11,000 per year monitoring five lakes and Bonney Lakes spends approximately \$4,500 per year monitoring two lakes.

To assist with volunteer monitoring in unincorporated Pierce County, PCD owns three lake kits for loan to individuals to conduct lake water quality monitoring of physical parameters. Each kit cost about \$1,770 and includes a dissolved oxygen and temperature meter and secchi disks for measuring water clarity. There are several lakeshore residents on Ohop Lake who regularly monitor the physical parameters of the lake using their own kits. Occasionally, residents on Harts Lake and Tule Lake also collect physical data on lakes. PCD has no funding available to collect and analyze water quality samples from volunteers monitoring these lakes.

PCD compiles lake water quality data and shares it with city staff and volunteer participants in the Lakewood and Bonney Lake programs. PCD also manages the data reported from individual lake homeowners monitoring their lakes. PCD shares data with TPCHD and communicates with Ecology regarding lake health issues and lake conditions.

PCD has a lake health brochure available for download at their website: piercecountycd.org. PCD provides support to lake homeowner groups for aquatic weed management in Lake Bonney and Lake Ohop, and answers questions on aquatic weeds from the public when contacted. PCD served on the Ohop Lake Improvement Club plant control advisory committee and assisted the Ohop Lake homeowners group with submitting an Integrated Aquatic Vegetation Management (IAVM) plan development grant application to Ecology. PCD served as the fiduciary agent for the implementation of the Ohop Lake IAVM plan grant.

Washington State Department of Ecology

Ecology has several programs and policies that affect lake management, including the Aquatic Plant Management Program, Freshwater Aquatic Weeds Account, NPDES permitting for aquatic herbicide application, and the Algae Control Program. Ecology also provides educational materials to citizens addressing lake management topics. Ecology has 7 employees whose work includes some aspects of lake management; however most of these employees work on other non-lake issues as well. It is estimated that Ecology has 3 to 4 FTE implementing lake management programs and policies.

From 1989-1999, Ecology ran a statewide lake water quality monitoring program. The statewide program was discontinued in 2000 due to lack of funds. However, Ecology still conducts water quality monitoring studies in lakes where needed to support development of Total Maximum Daily Loads (TMDLs).

Aquatic Plant Management Program

Ecology strongly encourages development of long-term, integrated aquatic vegetation management (IAVM) plans to address nuisance aquatic plants in lakes. IAVM plans may be required before certain aquatic plant control activities may be initiated or before permits are issued for the use of herbicides. Ecology follows federal court guidance by requiring National Pollutant Discharge Elimination System (NPDES) permits for the use of aquatic pesticides.

In 1991, the legislature established the Freshwater Aquatic Weeds Account to provide financial and technical support for addressing invasive aquatic plants at a statewide level. This Account provides funding for technical assistance, public education and grants to help prevent and/or control invasive, non-native aquatic plants. The budget for the Freshwater Aquatic Weeds Account program is approximately \$600,000 per year. Revenue for the Account comes from a \$3 contribution from annual license fees for boat trailers. The types of activities funded include planning, education, monitoring, implementation, pilot or demonstration projects, surveillance and mapping projects. The Account calls for completion of an IAVM Plan before projects can be considered for implementation grants.

Cities, counties, state agencies, tribes, and special purpose districts (excluding lake management districts) are eligible to receive grants. Lakes groups and other private organizations must work in conjunction with their local governments to receive funding for projects. For example, PCD received \$30,000 from the Account in 2005 to develop an IAVM plan for Ohop Lake. PCD applied for \$75,000 from the fund for an Ohop Lake submerged aquatic weed eradication project in 2006 and 2007, but did not receive funding. The Lake Ohop project proposes removing Brazilian elodea using a fluridone treatment combined with hand removal of weeds in problem areas.

Algae Control Program

In 2005, the legislature established funding for an algae control program and requested Ecology to develop the program. Ecology recognizes that reducing nutrient input to lakes is the only long-term solution to prevent algae blooms. However the amount of money available for this program (about \$250,000 per year) is not enough to fund comprehensive lake-wide and watershed-wide nutrient reduction projects. Instead the program focuses on providing local governments with the tools they need to manage algae problems. The program targets blue-green algae (also known as cyanobacteria) because these algae pose a health risk to humans, pets, and livestock. Ecology's algae program provides for:

- Algae identification
- Toxicity testing
- An on-line database to post the laboratory results
- Small grants (\$25,000 to \$50,000) for algae or nutrient management projects

Ecology began funding small grants to local governments in the fall of 2007. TPCHD received a grant from the Freshwater Algae Control program for approximately \$48,000 in 2007. For more information, see the Ecology website on the Algae Control Program at:

<http://www.ecy.wa.gov/Programs/wq/plants/algae/index.html>

Educational Resources

Ecology provides educational resources for landowners on lake functions and lake management at the following website: <http://www.ecy.wa.gov/Programs/wq/links/plants.html#management>

Information on the website includes the “Washington Lakes Book,” information about lake landscaping practices and forming a lake association, and “A Citizen’s Guide to Understanding and Monitoring Lakes and Streams.”

Statewide Lake Monitoring Program

Ecology has monitored rivers and streams since the 1950s. With the assistance of federal grants Ecology was able to implement an extensive statewide lake monitoring program from 1989 through 1999. During that period, Ecology typically monitored about 60 lakes annually with help from about 250 volunteers. Ecology staff visited each lake in the spring or early summer and again in late summer while volunteers collected data every two weeks. Ecology collected data from more than 180 lakes during the statewide lake monitoring program. Parameters sampled included temperature, pH, conductivity, and dissolved oxygen profiles, chlorophyll, total nitrogen and total phosphorus. At selected lakes Ecology also monitored hardness, turbidity, total suspended solids, and fecal coliform bacteria. Volunteers monitored surface temperature and Secchi disk depth and provided general information and observations about their lake including noting where Eurasian milfoil and zebra mussels were observed.

In 2000, Ecology was unable to obtain sufficient funding and had to discontinue the statewide lake monitoring program. Ecology still files data from volunteers who have chosen to continue monitoring lakes, but they no longer recruit new volunteers or meet with current volunteers, nor are they able to assess the data submitted. At present, there is no state-wide monitoring or assessment of lake water quality.

Washington State Department of Fish and Wildlife

The Washington State Department of Fish and Wildlife (WDFW) stocks certain lakes with fish and responds to fisheries issues in lakes. Nearly 4.1 million trout, 7 inches or larger, were scheduled to be stocked in 356 Washington lowland lakes in 2007. The following lakes in the Nisqually Basin were stocked with trout by WDFW: Clear Lake, Harts Lake, Ohop Lake, Rapjohn Lake, Tanwax Lake, and Whitman Lake. When recreational fisheries are degraded by an imbalance of predator fish or other issues, WDFW may propose rehabilitative actions such as treating a lake with rotenone to remove existing fish and restocking with a balanced population of game fish. WDFW also provides public education and outreach about fish and wildlife issues, such as a guidance video for boaters to avoid spreading zebra mussels.

Assessment Summary of Current Organization Roles and Responsibilities

Numerous local and state organizations play different roles in the management of lakes in Pierce County. Many of these roles and activities are focused on water quality in general at the local level. Projects that specifically address lake issues are typically added duties to other priorities. At the state level there are programs focused on lake management, however resources are spread throughout the state for these programs and they are not extensively funded. All sharing of information between governmental entities occurs as a result of informal arrangements. Data collection and information sharing with the public is generally reactive rather than preventive focused on water quality problems in lakes. Financial and technical assistance to property owners is sparse. There is no specific unifying local legislative framework in place.

LAKE MANAGEMENT GAPS/NEEDS

The components of a fully functional lake management program have been identified through research into similar programs and through stakeholder meetings and interviews. A fully functional lake management program includes the following components:

1. Monitoring and Source Identification
2. Volunteer Monitoring
3. Data Management and Dissemination
4. Education and Outreach
5. Community Technical Assistance

6. Inter-Agency Coordination and Information Sharing
7. Phased Implementation of the Aquatic Invasive Plant Program
8. Funding for Lake Projects
 - a. Lake Projects: Detailed lake studies
 - b. Lake Projects: In-lake control and management strategies
 - c. Lake Projects: Watershed strategies
 - d. Lake Projects: Provide funding for private projects
9. Enforcement
10. Legal Authority

Table I-3 summarizes the gaps in current activities related to these lake management program components and identifies resources that would be required to fill these gaps County-wide. Each of the lake management program components is also discussed below. An approach for implementing the lake management program in the Nisqually Basin is described in Section 8.

As discussed in Section 6, Surface Water Management is currently developing an Invasive Vegetation and Lakes Management Program. The results of this technical information memorandum describing existing lake management activities and gaps in a fully functioning lake management program are intended to be included in the overall Lakes Management Plan developed through the Invasive Vegetation project.

The gap analysis identified the need for approximately 6.0 FTE and an additional \$2,245,000 in supporting budget to implement a fully functional lake management program throughout unincorporated Pierce County. Specific lake projects are projected to require \$2,125,000 per year in funding and supporting program costs are projected to require \$120,000 per year in funding. Table I-4 provides an overview of the gap analysis.

Table I-3. Detailed Gap Analysis for Pierce County Lake Management Program

					Annual County-Wide Program Implementation Cost Estimates	
	Lake Management Component	Function	Current work	Gap/Need	FTE Resources	Additional supporting budget
1	Monitoring and Source Identification	Identify water quality problems (including aquatic weeds and toxic algae) and their sources or causes, track changes in water quality over time. Determine which lakes need further study or improvement.	TPCHD has 0.5 FTE to monitor 7 beaches at 4 lakes for fecal bacteria, and to respond to algae concerns on all lakes.	Limited water quality data is available for many lakes. TPCHD only reports lake water quality concerns, does not propose how to address concerns. Need additional info to organize lake management activities and determine which lakes need proposed projects for additional study and water quality improvement activities. Need to use a boat to conduct lake water quality monitoring at multiple sites in lakes (not just public access points).	2.0 FTE PCWP (includes 0.5 FTE for Data Management)	\$ 50,000
2	Volunteer Monitoring	Train volunteers in lake monitoring techniques, collect samples from volunteers, perform testing on samples, distribute data to public via website.	PCD Stream Team provides equipment loan of 3 lake kits to landowners.	Volunteer monitoring provides an opportunity for residents to take an active part in monitoring lake health, and provides economic and useful background data on lake functions and health. Volunteers can collect data at more frequent intervals than County staff.	1.0 FTE PCD	\$35,000 PCD
3	Data Management and Dissemination	Make monitoring data and other program information accessible to other organizations and to the public.	TPCHD grant will be used to provide algae data on the web. PCD shares data with TPCHD.	Monitoring data needs to be accessible to other organizations and to the public. If additional monitoring is conducted, data management and dissemination will be required as well.	0.5 FTE (included in 2.0 FTE for Monitoring)	\$ 2,000
4	Education and Outreach	Perform outreach and education regarding lake-friendly landscaping, on-site sewage treatment, lake health, etc.	TPCHD, PCD, WDFW, and Ecology perform limited outreach and education. PCD provides outreach and education on watershed health and nutrient management. PCD and TPCHD distribute lake management brochures.	Additional outreach and education activities are needed to inform the public about lake issues and motivate changes to improve lake health	1.0 FTE PCWP (includes 0.3 FTE for Community Assistance, and 0.1 FTE for Inter-Agency Coord)	\$ 10,000

5	Community Technical Assistance	Answer questions on lake health and functions. Help lakeshore owners obtain grants, form lake management districts, and determine appropriate fees or rates. Provide technical guidance on lake projects.	TPCHD and PCD provide limited technical assistance related to lakes. PCD provides aquatic weed management advice when requested.	Lakeshore property owners and recreational users often want to know more about lake health and address problems on lakes. Assistance for these stakeholders is needed.	0.3 FTE (included in 1.0 FTE for Education)	\$ 2,000
6	Inter-Agency Coordination and Information Sharing	Share information on lake management activities with other local and state agencies (e.g., TPCHD, PCD, Ecology).	Limited inter-agency coordination occurs. PCD shares data with TPCHD and communicates with Ecology.	Inter-agency coordination is needed to improve the efficiency and effectiveness of lake management activities.	0.1 FTE (included in 1.0 FTE for Education)	\$ 1,000
7	Aquatic Invasive Species Management	Implement activities recommended by PCWP Invasive Vegetation project such as education, lake monitoring and management activities.	PCWP is currently conducting an Invasive Vegetation project.	Invasive aquatic species reduce recreational and aesthetic qualities of lakes and put lakes at risk for shifts in ecological functions and decreased habitat quality.	1.0 FTE PCWP	\$ 20,000
8	Funding for lake projects	Provide funding to implement projects to improve lake health.	None.	As a result of the Aquatic Invasive Plant Program, monitoring information, public requests, and detailed lake studies, various capital lake projects are likely to be proposed. Funding to implement these projects will be needed.	1.0 FTE PCWP	\$ 2,125,000
	Lake Projects: Detailed lake studies	Perform detailed analysis of lake characteristics, functions, problems, and proposed projects to address problems.	None.	Costs could range from \$150,000 to \$400,000 or more per lake studied. There are five 1st Tier Lakes in the Nisqually Basin that could require detailed studies. Funding will be needed.		varies
	Lake Projects: In-lake control and management strategies	As a result of the Invasive Vegetation project and detailed lake studies, in-lake control and management strategies are likely to be proposed including aquatic plant harvesting or chemical control.	Ecology provides small grants for aquatic weed and algae management.	Costs could range from \$10,000 to \$8 million or more per lake studied and managed. Funding will be needed.		varies
	Lake Projects: Watershed strategies	As a result of the Invasive Vegetation project and detailed lake studies, watershed strategies such as stormwater treatment, agricultural runoff management, and forestry runoff management to reduce inputs of nutrients, bacteria, and other pollutants to lakes that receive stormwater runoff.	PCWP and PCD implement watershed improvements for stormwater and water quality enhancement.	Costs could range from \$10,000 to \$20 million or more per lake studied and managed. Funding will be needed.		varies

	<i>Lake Projects: Funding for private projects</i>	As a result of education, outreach, and monitoring, lakeshore owners may request assistance in retrofitting septic systems, funding in-lake treatment or management, etc.	Ecology provides small grants for aquatic weed and algae management.	Costs could range from \$10,000 to \$1 million or more per requested project. Funding will be needed.		<i>varies</i>
9	Enforcement	Enforcement options may be needed to address sources of water quality problems.	Limited to none. TPCHD has ability to obtain search warrant if they have evidence that a property is discharging untreated wastewater, but this option is rarely used.	The need for additional enforcement options will be evaluated as the lake management program is implemented. No FTE staff need is currently identified.		
10	Legal Authority	As a public agency, Pierce County requires legal authority to implement programs such as the lake management program.	Pierce County is responsible for addressing surface water quality under the NPDES MS4 program and the TMDL program.	To implement a lake management program, a County-wide ordinance may be needed to establish the program and the lake management function in Surface Water Management. This will not require on-going FTE support, however an initial investment of time by County staff may be needed.		

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Table I-4. Pierce County Lake Management Program Gap Analysis Summary

Program Elements	GAP-SWM		GAP-Others	
	FTEs	\$	FTEs	\$
Monitoring and Source Identification				
Surface Water Management	1.5	\$50,000		
TPCHD			1.0	(no cost)
PCD				
Volunteer Monitoring				
Surface Water Management				
TPCHD				
PCD			1.0	\$35,000
Data Management and Dissemination				
Surface Water Management	0.5	\$2,000		
TPCHD				
PCD				
Education and Outreach				
Surface Water Management	0.6	\$10,000		
TPCHD				
PCD				
Community Technical Assistance				
Surface Water Management	0.3	\$2,000		
TPCHD				
PCD				
Inter-Agency Coordination and Information Sharing				
Surface Water Management	0.1	\$1,000		
TPCHD				
PCD				
Aquatic Invasive Species Management				
Surface Water Management	1.0	\$20,000		
TPCHD				
PCD				
Funding for lake projects				
Surface Water Management	1.0	\$2,125,000		
TPCHD				
PCD				
Enforcement				
Surface Water Management				
TPCHD			1.0	(no cost)
PCD				
Legal Authority				
Surface Water Management				
TPCHD				
PCD				
Summary				
Surface Water Management	5.0	\$2,210,000		
TPCHD			2.0	(no cost)
PCD			1.0	\$35,000
TOTAL	5.0	\$2,210,000	3.0	\$35,000

Detailed Gap Analysis

1. Monitoring and Source Identification

Program Gaps

Monitoring and source identification is needed to identify water quality problems (including aquatic weeds and toxic algae) and their sources or causes as well as to track changes in water quality over time. Monitoring results are also required to determine which lakes need further study or improvement.

Water quality monitoring is currently performed by TPCHD to address human health concerns. TPCHD has 0.5 FTE to monitor 7 beaches at 4 lakes for fecal bacteria, and to respond to algae concerns on all lakes. There is significant travel time involved in reaching the lakes for monitoring. The 0.5 FTE is not adequate to meet the lake monitoring needs to monitor all lakes in Pierce County or to organize a volunteer monitoring program. The Department of Ecology is no longer running the volunteer lake monitoring program.

There is limited water quality data available for many lakes in Pierce County. Additional monitoring and source identification data is needed to organize lake management activities and determine which lakes need projects proposed for additional study and water quality improvement activities. There is a need to use a boat to conduct lake water quality monitoring at multiple sites in lakes to capture trends and conditions throughout lakes, not just at public access points. Data management and dissemination is a critical complementary component to the monitoring and source identification component. The volunteer monitoring program component will also provide complementary resources for monitoring lake conditions.

The recommended monitoring program component includes assessing lakes for water quality risks and sorting lakes into management level tiers. 1st Tier lakes would be at high risk for water quality problems and would require more frequent and extensive monitoring. 2nd and 3rd Tier lakes would be at moderate and lower risk for water quality problems, respectively, and would require less frequent monitoring. It is recommended that all lakes be monitored by County staff periodically, with additional monitoring data collected by volunteers in conjunction with the volunteer monitoring program component.

To develop a monitoring program component like the former Ecology lake monitoring program, County staff would visit each lake at least as frequently as once in the spring or early summer and once again in late summer while volunteers collect data every two weeks. If volunteers are not available and additional information is needed, staff would be required to visit lakes more frequently. Staff would collect data on parameters such as temperature, pH, conductivity, and dissolved oxygen profiles, chlorophyll, total nitrogen, total phosphorus and dissolved phosphorus. At selected lakes staff would also monitor hardness, turbidity, total suspended solids, fecal coliform bacteria, invasive aquatic weeds, and toxic algae. Volunteers would monitor surface temperature and Secchi disk depth and provided general information and

observations about their lake including noting where algae and invasive aquatic weeds were observed. More highly trained volunteers could assist by collecting lake water samples, which would be picked up and analyzed by County staff as in the King County lake monitoring program.

Pollutant source identification monitoring work may also be required on lakes with observed water quality problems. The level of this work will be dependent upon future results from the monitoring program component, however for the purpose of estimating the current gap it is assumed that preliminary source identification monitoring would be performed through this program component and more detailed studies would be conducted under program component 8, funding for lake projects (detailed lake studies).

Estimated Need

A fully functioning program is estimated to require an additional 3.0 FTE to monitor lakes throughout Pierce County in addition to the 0.5 FTE currently monitoring lakes for TPCHD. This estimate includes 0.5 FTE for data management and dissemination, discussed below in program component 3. However, this estimate does not include the 1.0 FTE for volunteer monitoring described below in program component 2.

It is recommended that two of these staff positions be added to PCWP and one be added to TPCHD under its funding sources. The monitoring program staff will need to coordinate closely with the staff involved in the volunteer monitoring program at PCD and staff involved in water quality monitoring for TPCHD. It may increase efficiency to use laboratory facilities at TPCHD.

An additional \$50,000 per year in funding for the monitoring program will also be required to provide field equipment, travel costs, laboratory sample analysis, and other program components.

2. Volunteer Monitoring

Volunteer monitoring provides an opportunity for residents to take an active part in monitoring lake health, and provides economic and useful background data on lake functions and water quality. Volunteers can collect data at more frequent intervals and more locations than County staff. As noted above, the Department of Ecology is no longer running a volunteer lake monitoring program. Pierce Conservation District runs a volunteer stream monitoring program, but the program has a limited lake monitoring element in unincorporated Pierce County. PCD currently coordinates volunteer lake monitoring programs for the cities of Bonney Lake and Lakewood. PCD has three lake kits available to loan out to individual landowners interested in monitoring lakes in unincorporated Pierce County, however these kits only measure physical parameters such as temperature, dissolved oxygen, and water clarity. PCD does not currently have funding available to collect and test water samples from volunteers in unincorporated Pierce County. There may be an opportunity to coordinate volunteer monitoring activities with the Nisqually Tribe, which occasionally supports volunteer monitoring.

The lake management program in King County relies heavily on volunteer monitoring for water quality samples. King County staff are willing to provide Pierce County with program development information and volunteer training information to assist in the development of this program component.

There is a need to expand the volunteer monitoring of lakes performed in Pierce County. There is a need to recruit additional volunteers, train additional volunteers in lake monitoring techniques, collect and organize additional data from volunteers, collect samples from volunteers when appropriate, perform testing on samples, and work in conjunction with the staff in the monitoring program component to distribute the data to the public through a website. In addition, planning and implementation of volunteer outreach and volunteer appreciation activities will be needed.

Estimated Need

A fully functioning program is estimated to require an additional 1.0 FTE to plan and implement the volunteer monitoring component of the lake management program. It is recommended that this staff position be added to PCD, increasing program efficiency by adding to the existing volunteer monitoring program at PCD. An increase in PCD funds will be necessary to complete this work. The staff for the volunteer monitoring program will work closely with the staff added for program component 1, monitoring and source identification.

An additional \$35,000 per year in funding for the volunteer monitoring program will also be required to provide field equipment, travel costs, laboratory sample analysis, volunteer recruiting, volunteer appreciation, and other program elements. An increase in PCD funding for volunteer monitoring will be required to provide these supporting program costs.

3. Data Management and Dissemination

Monitoring data needs to be organized and made accessible to other organizations and to the public. If additional monitoring is conducted through program components 1 and 2, data management and dissemination will be required as well.

There is a need to organize and make monitoring data and other program information accessible to other organizations and to the public, preferably through the web similar to the King County program. TPCHD will use a portion of the grant from Ecology for the toxic algae program to provide algae data on the web, but otherwise there are no current resources available for organizing and disseminating lake water quality monitoring data.

Estimated Need

A fully functioning program is estimated to require an additional 0.5 FTE to provide data management and dissemination as a part of the monitoring and source identification program

component. This staff need is included in the 2.0 FTE described for program component 1, monitoring and source identification.

An additional \$2,000 per year in funding for the data management and dissemination program component will be required to make monitoring data and other program information available to the public and other organizations, primarily through electronic sources such as the web.

4. Education and Outreach

Outreach and education are needed to inform the public about lake issues and motivate changes to improve lake health. Lakes are affected significantly by the activities occurring in the lake watershed, and addressing lake water quality problems and preventing future problems requires extensive public involvement and education. Education of lakeshore property owners and lake users could help encourage lake-friendly landscaping, erosion/sediment control, pet waste disposal, care and maintenance of septic systems, sewage and trash disposal for recreational users, and other behaviors that would help reduce pollutant inputs to lakes. In addition, education programs could improve local support for lake management fees or assessments, and/or restrictions on shoreline land use.

TPCHD provides limited outreach and education regarding lake water quality issues including distribution of flyers and other information. TPCHD recently added 1.0 FTE to implement a Green Landscaping program. This position could provide assistance in the future related to lakefront property landscaping and nutrient reduction, however it is not currently focused in that area. PCD provides outreach and education on nutrient management to County residents however this outreach is not lake specific. PCD provides outreach and education primarily regarding general watershed health issues, with some focus on lake water quality issues including distribution of brochures on protecting lake water quality. WDFW provides public education and outreach about fish and wildlife issues, such as a guidance video for boaters to avoid spreading zebra mussels, however WDFW conducts these activities statewide with limited budget available.

There is a need to perform additional outreach and education regarding lake-friendly landscaping, erosion/sediment control, on-site sewage treatment system maintenance, proper boat maintenance to prevent lake pollution, invasive aquatic plants, lake health, and other issues. An outreach and education staff person could also provide community technical assistance and inter-agency coordination and information sharing to fulfill program components 5 and 6, respectively.

Estimated Need

A fully functioning program is estimated to require an additional 1.0 FTE to provide lake-focused education and outreach. This estimate includes 0.3 FTE for community technical assistance, discussed below in program component 5, and 0.1 FTE for inter-agency coordination

and information sharing, discussed below in program component 6. This staff position should be added to PCWP.

An additional \$10,000 per year in funding for the education and outreach program component will be required to provide resources to the public through printed materials, outreach events, educational activities, and other program elements.

5. Community Technical Assistance

Lakeshore property owners and lake recreational users often want to know more about lake health and want to address problems on lakes. TPCHD and PCD currently provide limited technical assistance related to lakes, answering questions when possible and directing landowners to additional resources if available. PCD provides aquatic weed management advice when requested. However, additional assistance for these stakeholders is needed.

There is a need to provide a County staff person to answer questions on lake health and functions from property owners and recreational users. There is also a need to provide technical assistance to help lakeshore owners obtain grants for lake management activities, form lake management districts, and determine appropriate fees or rates. There are a number of complaints each year to various County departments regarding beaver activity around lakes and streams. There is a need to provide information to landowners about beaver management options available. In addition, if lake management projects are being implemented by lakeshore landowners, there is a need to provide technical guidance on these projects to protect aquatic habitat and human health.

Estimated Need

A fully functioning program is estimated to require an additional 0.3 FTE to provide community technical assistance. This staff need is included in the 1.0 FTE described for program component 4, education and outreach.

An additional \$2,000 per year in funding for the community technical assistance program component will be required to provide resources to the public through printed materials, technical assistance events, and other program components.

6. Inter-Agency Coordination and Information Sharing

There is a need to share information on lake management activities performed by PCWP with other local and state agencies (e.g., TPCHD, PCD, and Ecology). There is currently very limited inter-agency coordination, and what occurs is performed informally. PCD shares lake water quality data with TPCHD, and communicates with Ecology about lake conditions. Additional inter-agency coordination is needed to improve the efficiency and effectiveness of lake management activities. There is a need to form a lake management task force or inter-agency committee to provide a regularly scheduled opportunity for stakeholders to meet and discuss lake management issues.

Estimated Need

A fully functioning program is estimated to require an additional 0.1 FTE to provide inter-agency coordination and information sharing. This staff need is included in the 1.0 FTE described for program component 4, education and outreach.

An additional \$1,000 per year in funding for the inter-agency coordination and information sharing program component will be required to provide resources fulfill the program component.

7. Aquatic Invasive Species Management

PCWP is currently implementing an Invasive Vegetation and Lakes Management Plan project. The Invasive Vegetation project includes field surveys of 21 lakes in unincorporated Pierce County to obtain information on invasive aquatic plants (i.e., aquatic weeds). Invasive aquatic plants reduce recreational and aesthetic qualities of lakes and put lakes at risk for shifts in ecological functions and decreased habitat quality. The Invasive Vegetation project will provide baseline information on invasive plants in lakes and recommendations to address these issues.

There is a need to provide resources to implement baseline activities recommended by Invasive Vegetation project such as lake monitoring and management activities focused on aquatic invasive plants and education and outreach focused on preventing the further dispersal of aquatic invasive species. More complex or extensive lake management projects recommended by the Invasive Vegetation project will require additional lake project funding under program component 8, funding for lake projects.

Estimated Need

A fully functioning program is estimated to require an additional 1.0 FTE to plan and implement the aquatic invasive plant component of the lake management program. This staff position should be added to PCWP.

It is estimated that an additional \$20,000 per year in funding for the aquatic invasive species program component will be required to provide resources fulfill the baseline program component such as field equipment, travel costs, laboratory sampling, education and outreach materials and other program elements specific to aquatic invasive species. The recommendations in the Invasive Vegetation project may call for more complex or extensive lake management projects to address aquatic invasive species. These projects would require additional funding under program component 8, funding for lake projects.

8. Funding for Lake Projects

The need for detailed lake studies and specific capital projects to address problems in lakes is not yet known. These needs will be identified as the Lake Management Program is implemented, monitoring data results are analyzed, and community requests for action are received. However, once these needs are identified there is limited funding available for conducting detailed lake

studies and implementing capital projects or programmatic actions to address problems in lakes. TPCHD was able to obtain lake study grants from the U.S. Environmental Protection Agency (EPA) in the early 1990's to study American Lake and Steilacoom Lake. The Nisqually Tribe also conducted a detailed study of Ohop Lake in 1997. The costs for these lake studies and the estimates of project costs developed in these studies can be used to develop a range of potential funding needs for lake projects.

There are a variety of types of lake projects that could be needed in Pierce County. These types of projects include:

- Detailed lake studies of lake characteristics, functions, problems and proposed projects to address problems.
- In-lake control and management strategies such as aquatic plant harvesting and chemical control implemented by County staff.
- Watershed strategies such as stormwater treatment, agricultural runoff management, forestry runoff management, and water treatment to reduce inputs of nutrients, bacteria and other pollutants to lakes.
- Funding for private projects such as retrofitting septic systems and funding in-lake treatment or management implemented by private landowners.

The scale of lake projects could vary dramatically, depending on what problems are identified and how complex the functions are in lakes that are identified as needing improvement. The Ohop Lake study completed by the Tribe in 1997 cost roughly \$150,000. Costs could be substantially higher for studies involving larger or more complex lakes. Studies of American Lake and Steilacoom Lake in the early 1990s cost \$330,000 and \$350,000, respectively. Therefore, costs are estimated to range from \$150,000 to \$400,000 or more per lake studied.

As discussed in program component 1, monitoring and source identification, Pierce County could organize lakes into management level tiers. 1st Tier lakes would be at high risk for water quality problems and would require more frequent and extensive monitoring, and would likely be candidates for additional detailed lake studies. 2nd and 3rd Tier lakes would be at moderate and lower risk for water quality problems, respectively, and would require less frequent monitoring and likely would not require additional detailed lake studies. In the Nisqually Basin, 5 out of 16 lakes have been identified as potential 1st Tier lakes.

The projects that are developed as proposed solutions to lake problems can also vary significantly in scale and cost. For instance, the results of the Ohop Lake study conducted by the Nisqually Tribe found that the lake functions are controlled primarily by natural system conditions. Thus, the recommended actions from that study focused on educating landowners about the natural conditions and functions of the lake. In contrast, the Steilacoom Lake Phase I Restoration Study recommended alum treatment of inflow to the lake, with an approximate capital cost of roughly \$4 to \$8 million and annual costs of roughly \$300,000 (KCM 1996). The

American Lake study recommended watershed strategies to improve water quality in the lake requiring over \$20 million in capital costs.

As a result of these uncertainties, the costs for funding lake restoration projects cannot not be accurately predicted in this early phase of planning the Lakes Management Program. However, funding will be required and a budget need can be developed based on the costs of other lake studies and projects. There is a need for a staff person to plan and implement the lake project funding component of the lake management plan. This staff person would work closely with monitoring and education staff to identify lakes with problems, determine the studies or capital projects needed for lakes, manage funding and project budgets for lake projects, and oversee lake studies.

Estimated Need

A fully functioning program is estimated to require an additional 1.0 FTE to plan and implement the lake project funding component of the lake management program. This staff position should be added to PCWP.

The recommended Lake Management Program includes annual budget requests identified in the lake management program. It is estimated that the need for additional funds to implement lake projects is \$2,125,000 per year County-wide. The recommended lake management program includes annual budget requests to implement specific projects once the needs for the projects are known. It is estimated that the cost of specific lakes projects could range from \$200,000 to \$1,000,000.

9. Enforcement

Enforcement options may be needed to address sources of water quality problems. TPCHD has ability to obtain a search warrant if they have evidence that a property is discharging untreated wastewater, but this option is rarely used, in part because of limited resources. The need for additional enforcement options will be evaluated as the lake management program is implemented.

Estimated Need

A fully-functioning lake management program will require one FTE of enforcement staff at TPCHD, funded under their agency's funding sources. Additional FTE staff or resources may be required in the future as the lake management program is implemented and needs are identified.

10. Legal Authority

Pierce County is responsible for addressing surface water quality under the NPDES MS4 program and the TMDL program. As a public agency, Pierce County requires legal authority to implement programs such as the lake management program. To facilitate a County-wide lake

management program, and ordinance may be desirable to clarify the program and the lake management function in PCWP.

Estimated Need

A fully functioning program may require an initial investment of time by existing County staff to develop a County-wide ordinance to facilitate the lake management program and clarify the lake management function in Surface Water Management.

Lake Management Program Summary

Current Conditions

At this time, in total between them, PCWP, PCD, and TPCHD have approximately 0.8 FTE and \$48,000 (grant-funded) dedicated to lake management activities. TPCHD has 0.5 FTE to monitor 7 beaches at 4 lakes for fecal bacteria and to respond to algae concerns on all lakes, and a \$48,000 grant from the state Freshwater Algae Program to provide additional services addressing toxic algae. PCD dedicates approximately 0.3 FTE to volunteer monitoring and other activities which affect lake management.

Program Gaps

The analysis has identified program gaps related to monitoring, data management, education and outreach, community technical assistance, inter-agency coordination, phased implementation of the aquatic invasive plant program, funding for lake projects, enforcement and legal authority. These gaps are described in Table I-3 and summarized in Table I-4. In total, there is a need for an additional 6.0 FTE and \$2,245,000 annually to support a fully functioning lake management program. To be effective over time, resources for lake management need a long term, stable commitment that is funded out of each agency's respective budget.

To begin the phased implementation of the lake management program in other basins, all of the activities that took place in the Nisqually Basin Planning process related to lake management will need to be conducted during other Basin Plan updates, including gathering information from lakeshore landowners, inventorying lakes, and conducting the tiering process described in Section 8.0. Based on a tiering system, Pierce County Public Works and Utilities Surface Water Management Division will move into a lake management program. Rough (stand alone) monetary estimates will be developed to address the management of the highest tiered lakes. In addition, staff will be assigned to each of the high tiered lakes to work on management issues.

Estimated Needs – Fully Funded Program Costs

The estimated needs for a fully functioning lake management program are described in detail in Table I-3 and summarized in Table I-4. Pierce County Public Works and Utilities Surface Water Management Division will require an additional 5.0 FTE and \$2,210,000 in supporting program budget per year. Pierce Conservation District will require an additional 1.0 FTE and \$35,000 in

supporting budget per year. When combined, the total annual FTE and supporting program budget for Pierce County Public Works and Utilities Surface Water Management Division will be \$2,710,000. Over 10 years (without inflation), the total lake management program cost for Pierce County is projected to be \$27,100,000. The total annual FTE and supporting program budget for Pierce Conservation District will be \$135,000. Over 10 years (without inflation), the total lake management program cost for Pierce Conservation District is projected to be \$1,350,000.

RECOMMENDED PROGRAM FOR THE NISQUALLY BASIN

As discussed in Section 6, Pierce County Surface Water Management is currently implementing an Invasive Vegetation and Lakes Management Program. The results of this technical information memorandum describing existing lake management activities and gaps in a fully functioning lake management program are intended to be included in the overall lake management program developed through the Invasive Vegetation project. This section describes the recommended phased implementation of the lake management program for the Nisqually Basin specifically.

To begin the phased implementation of the lake management program in other basins, all of the activities that took place in the Nisqually Basin Planning process related to lake management will need to be conducted during other Basin Plan updates, including gathering information from lakeshore landowners, inventorying lakes, and conducting the tiering process.

The gap analysis identified the need for approximately 6.0 FTE and an additional \$120,000 in supporting funding (aside from specific lake project funding needs) to implement a fully functional lake management program throughout unincorporated Pierce County. Specific lake projects are projected to require an additional \$2,125,000 per year in funding. These resources would be required to implement the following program components.

1. Monitoring and Source Identification
2. Volunteer Monitoring
3. Data Management and Dissemination
4. Education and Outreach
5. Community Technical Assistance
6. Inter-Agency Coordination and Information Sharing
7. Phased Implementation of the Aquatic Invasive Plant Program
8. Funding for Lake Projects
 - a. Lake Projects: Detailed lake studies
 - b. Lake Projects: In-lake control and management strategies

- c. Lake Projects: Watershed strategies
- d. Lake Projects: Provide funding for private projects

9. Enforcement

10. Legal Authority

To implement these program components in just the Nisqually Basin, fewer resources would be required than for the County-wide program. It is estimated that 1.5 FTE and \$25,000 in supporting funding could be used to start up the lake management program in the Nisqually Basin.

As discussed in program components 1 and 8, Pierce County could organize lakes into management level tiers. 1st Tier lakes would be at high risk for water quality problems and would require more frequent and extensive monitoring, and would likely be candidates for additional detailed lake studies. 2nd and 3rd Tier lakes would be at moderate and lower risk for water quality problems, respectively, and would require less frequent monitoring and likely would not require additional detailed lake studies.

The lakes in the Nisqually Basin were organized in lake management tiers according to the criteria in Table I-5. When performing the tiering process, it may be necessary for staff to use best professional judgment regarding the protection of public health, safety and welfare to determine the appropriate tier for lakes. This may result in tier decisions that override certain quantified, documented, and/or undocumented conclusions, including information from questionnaires.

Table I-5. Lake Management Tier Criteria	
Tier 1	Significant Pierce County responsibility for stormwater and drainage near the lake Public access Heavy public use Higher risk of developing or increasing water quality or invasive plant problems Heavily developed lakeshore 303(d) listing or other significant water quality problems reported in surveys Septic system failures contributing to poor lake quality
Tier 2	Some Pierce County responsibility for stormwater and drainage near the lake Some public use and access Some risk of developing water quality or invasive plant problems based on lakeshore development levels and water quality information provided in public surveys
Tier 3	Low Pierce County responsibility for stormwater and drainage near the lake Low public access and use Less risk of developing water quality or invasive plant problems based on lakeshore development levels and water quality information provided in public surveys

To conduct the lake management tier organization process for the Nisqually Basin, an analysis of data available for each lake was performed. The results of the lakeshore resident surveys were analyzed along with water quality information such as 303(d) listings of impaired waterbodies. The relative level of development around the lake, stormwater outfalls to the lake, public access points, and other key data were evaluated using Geographic Information System (GIS) software. Maps of each lake from the GIS analysis are provided in Figures 1 – 14. These maps illustrate the density of lakeshore tax parcels, public drainage pipes and outfalls, and public roads around lakes.

The results of the lake management tier organization process are summarized in Table I-6. In the Nisqually Basin, 5 out of 16 lakes were identified as potential 1st Tier lakes. These 1st Tier lakes, Clear, Whitman, Tanwax, Ohop, and Silver Lakes, appear to be at higher risk of developing or increasing water quality or invasive plant problems based on level of lakeshore development and reported water quality problems. They are also of higher concern to Pierce County because of higher levels of public access, and in the case of Ohop Lake, because Pierce County has a greater responsibility for public stormwater drainage entering the lake. The 2nd Tier lakes include Alder, Harts, Serene, Twin, Rapjohn, and Trout Lakes. Mud, Cranberry, Twenty-Seven, Tule, and Kreger Lakes were identified as 3rd Tier lakes due to lower levels of lakeshore development, fewer reported water quality problems, lower public use, and lower Pierce County responsibility for public stormwater drainage entering the lakes.

The lake management tiers for each Basin may be updated and reorganized periodically as new information becomes available or new issues emerge. The results of the Invasive Vegetation and Lakes Management project may provide new insights into lakes requiring more detailed analysis or a higher level of management. In addition, new information regarding toxic algae blooms, septic system failures, and other lake water quality issues may also be collected, resulting in updated tier analyses.

The results of the tier analysis illustrate that a lake management program in the Nisqually Basin can be scaled to meet the general needs of each tier of lakes. The focus of the lake management program components will likely be directed primarily to the 1st Tier lakes, with resources directed to the 2nd and 3rd Tier lakes as appropriate to meet the needs of those lakes. It is anticipated that the 1st Tier lakes will require more monitoring and source identification, volunteer monitoring, education and outreach, community technical assistance, and funding for lake projects. 2nd and 3rd Tier lakes will likely require a lower level of monitoring and source identification, volunteer monitoring, education and outreach, community technical assistance, and funding for lake projects. However, the specific needs associated with each lake will develop over time as the lake management program is implemented.

Based on the tiering organization process, Pierce County Public Works and Utilities Surface Water Management Division will move into a lake management program. Rough (stand alone) monetary estimates will be developed to address the management of the highest tiered lakes. In addition, staff will be assigned to each of the high tiered lakes to work on management issues.

To support the phased implementation of the lake management program in the Nisqually Basin, it is recommended that 1.5 FTE and \$25,000 in annual supporting funding be allocated through a programmatic measure to implement all components of the lake management program including monitoring and source identification, volunteer monitoring, education and outreach, and community technical assistance. Additional capital funding will be required to implement specific lake projects such as detailed lake studies, in-lake management activities, watershed strategies for improving lake water quality, and private projects such as septic system retrofits. It is projected that approximately \$200,000 per lake will be required to address the five 1st Tier lakes in the Nisqually Basin over a ten year period. Therefore, it is recommended that an additional \$1,000,000 of the capital project budget for the Nisqually Basin Plan be used to provide funding for implementing specific lake projects and studies. Providing funding for implementing the lake management program in the Nisqually Basin will contribute significantly to the overall quality of watershed health in the basin and to meeting to goals of Pierce County for lake management.

Table I-6. Nisqually Basin Lake Management Tier Analysis

Lake	Tier	Size	Lake Access			Water Quality							Pierce County Drainage			Development Level		Survey	
			Public Beach/Park	Public Boat Launch	Private Access ¹	303(d) listed ² 0=None 1-Past 2-Current	Algae Blooms (TPCHD) ³ 0=none 1=observed 2=health concern	Algae Blooms Reported ⁴	Aquatic Weeds Reported ⁴	Fish Kills Reported ⁴	Water Quality Problems Reported (General) ⁴	Reported Septic System Problems ⁵	Number of public stormwater outfalls into lake ⁶	Roads near lake 0=No 1=Yes	Flooding Reported in Surveys	Number of lakeshore tax parcels (in Pierce County)	Visual review of GIS data 1=low density 2=med density 3=high density	# of surveys sent out	Number of survey respondents
Clear Lake	1	155	0	1	1	1	2	15	5	5	8	0	0	1	6	130	3	111	15
Whitman Lake	1	29	0	1	0	0	1	8	8	3	5	0	1	1	7	79	3	77	8
Tanwax Lake	1	172	1	1	2	0	2	8	12	6	5	0	0	1	3	115	3	87	13
Ohop Lake	1	235	0	1	0	2	2	24	4	9	14	0	16	1	22	230	2	199	27
Silver Lake	1	138	1	1	1	0	2	3	0	1	1	0	0	1	2	64	2	52	5
Harts Lake	2	109	1	1	0	2	2	3	3	3	2	0	0	1	2	45	2	38	6
Alder Lake ⁷	2	3065	1	2	0	0	0	1	1	1	0	0	37	1	1	59	2	61	7
Lake Serene	2	8	0	0	0	0	0	3	3	2	3	0	0	1	1	28	1	48	3
Twin Lakes ⁸	2	26	0	0	0	0	0	3	3	0	1	0	0	1	3	23	1	22	6
Rapjohn Lake	2	56	0	1	0	0	1	0	0	0	0	0	0	1	0	16	1	14	1
Trout Lake ⁹	2	7	0	0	1	0	0	0	0	0	0	0	0	0	0	3	1	9	0
Mud Lake ⁹	3	20	0	0	0	0	0	0	0	0	0	0	0	1	0	3	1	11	0
Cranberry Lake ⁹	3	34	0	0	0	0	0	0	0	0	0	0	0	1	0	5	1	12	0
Lake Twenty-Seven	3	21	0	0	0	0	0	0	0	0	0	0	0	1	0	9	1	11	2
Tule Lake ⁹	3	34	0	0	0	0	1	0	0	0	0	0	0	1	0	11	1	18	0
Kreger Lake ⁹	3	40	0	0	0	0	0	0	0	0	0	0	0	1	0	22	1	12	0

Notes

- ¹ Includes camps and resorts, only represents those known to BC through survey results or notification from stakeholders
- ² Water Quality criteria based on Dept. of Ecology 303(d) listings, all 303(d) listings are for Phosphorus
- ³ Water Quality criteria based on Tacoma-Pierce Co. Health Dept. reports on algae; with 1 = potentially toxic algae observed but not in significant amount to cause health concern, 2 = have posted lakes with "caution" signs due to significant amount of pote
- ⁴ Water Quality criteria based on # of responses received from public surveys sent to lakeshore and lake floodplain residents.
- ⁵ Reported septic system problems based on the County's Service Response System (SRS) database.
- ⁶ Based on GIS analysis of "drainage pipes" layer, identifies public pipes where "DISCHARGE_DE = LAKE"
- ⁷ Alder Lake is also partially in Thurston County and Lewis County
- ⁸ Camp Arnold is located at Twin Lakes
- ⁹ No survey responses were received for Cranberry Lake, Kreger Lake, Mud Lake, Trout Lake, and Tule Lake.

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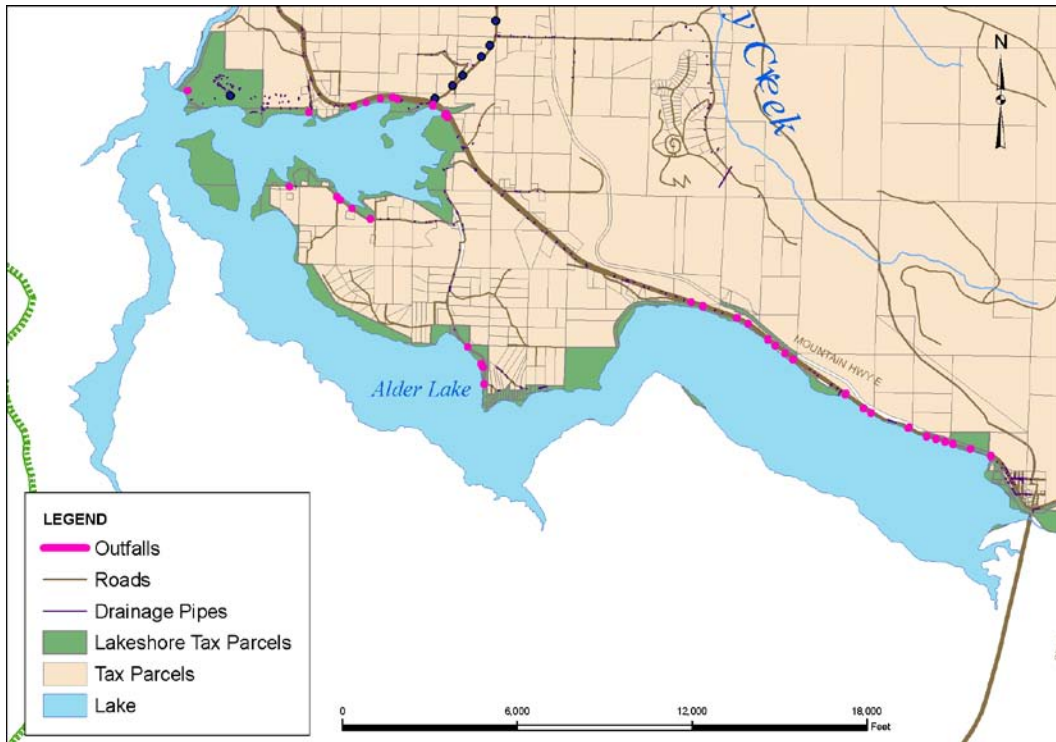


Figure 1: Alder Lake

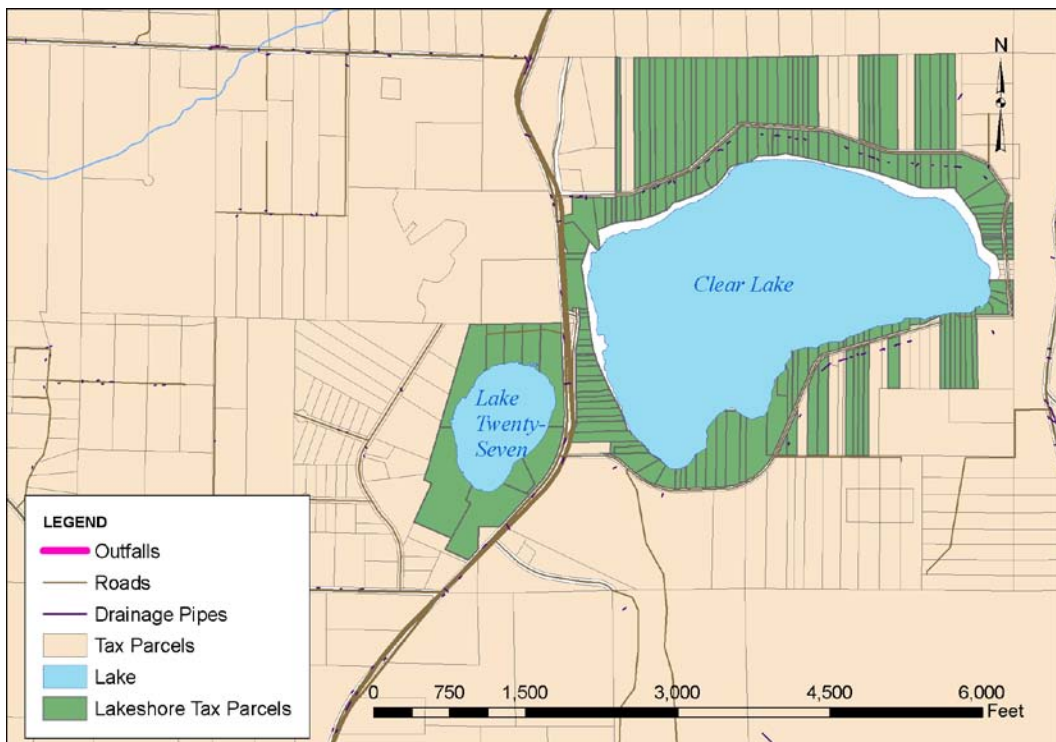


Figure 2: Clear Lake and Lake Twenty-Seven

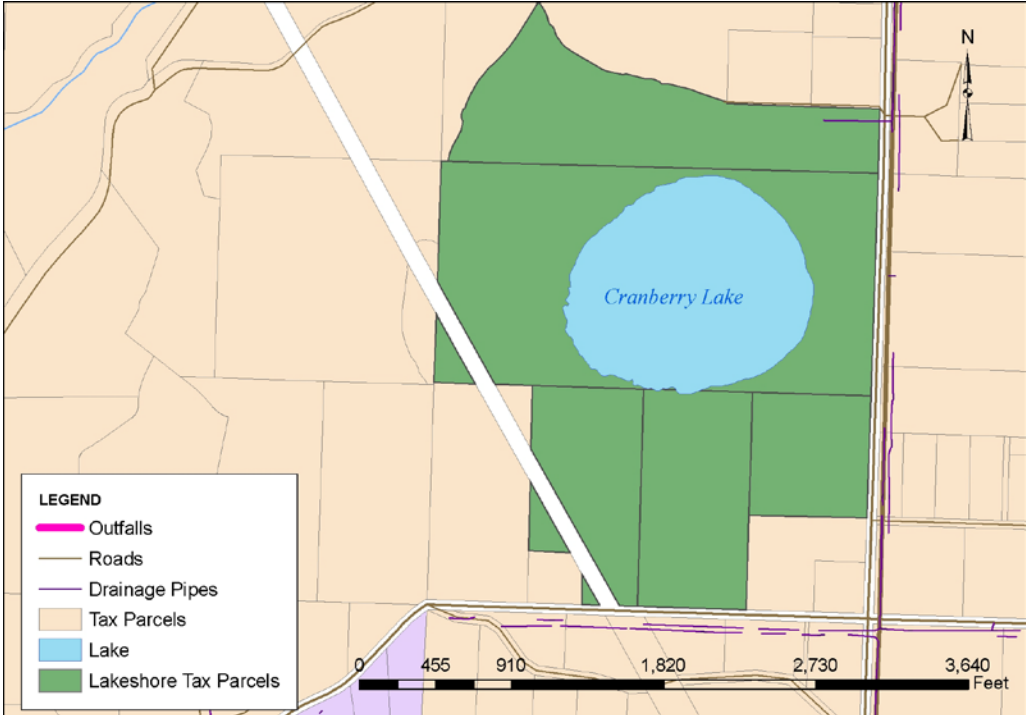


Figure 3: Cranberry Lake

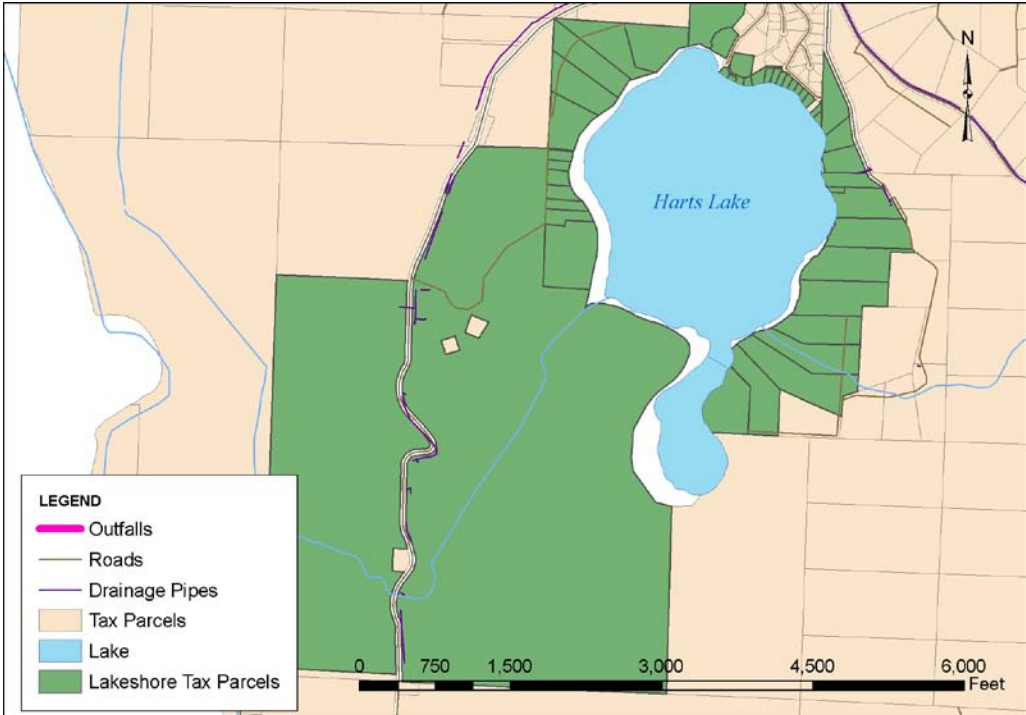


Figure 4: Harts Lake

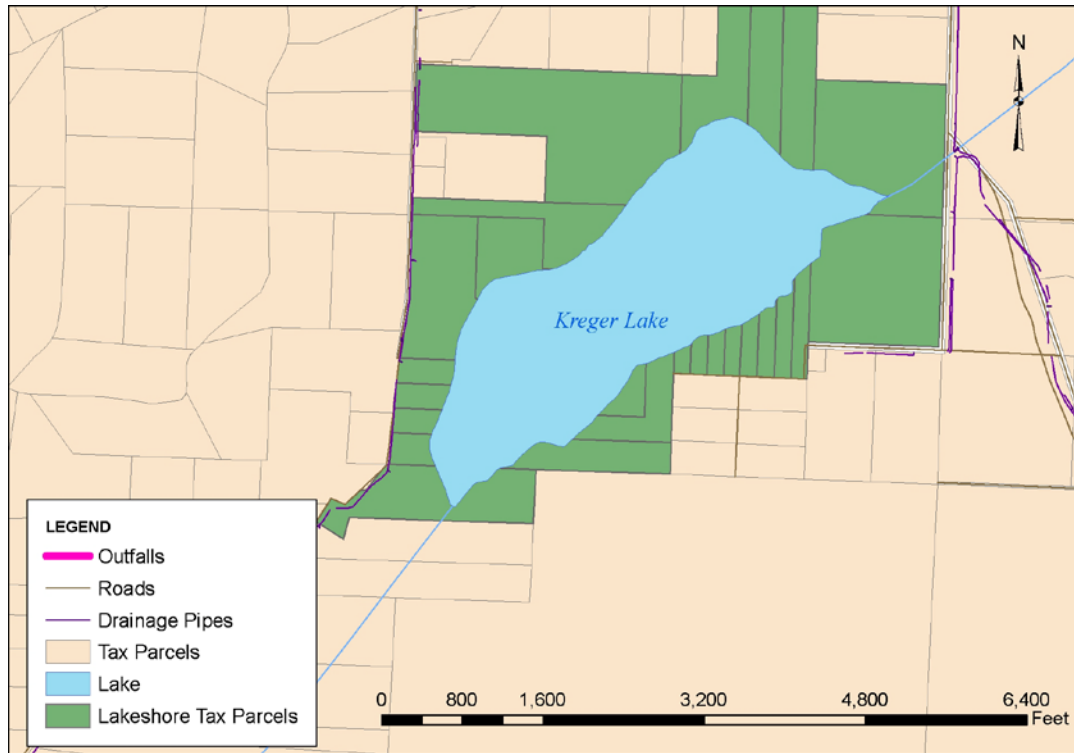


Figure 5: Kreger Lake

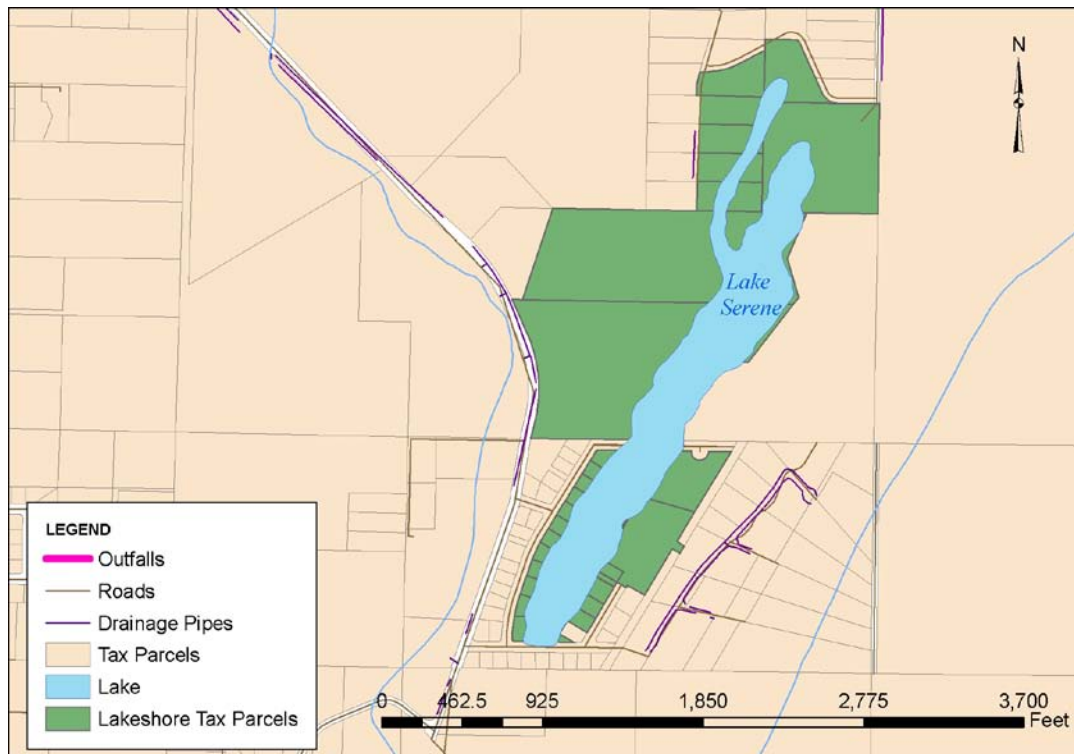


Figure 6: Lake Serene

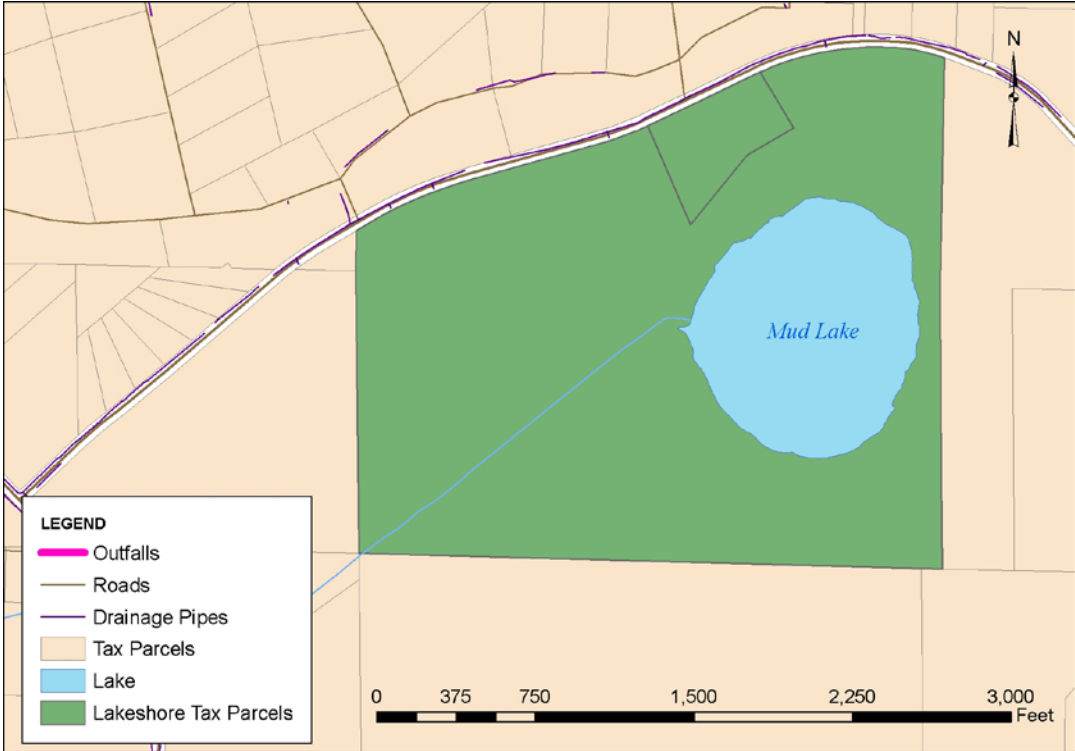


Figure 7: Mud Lake

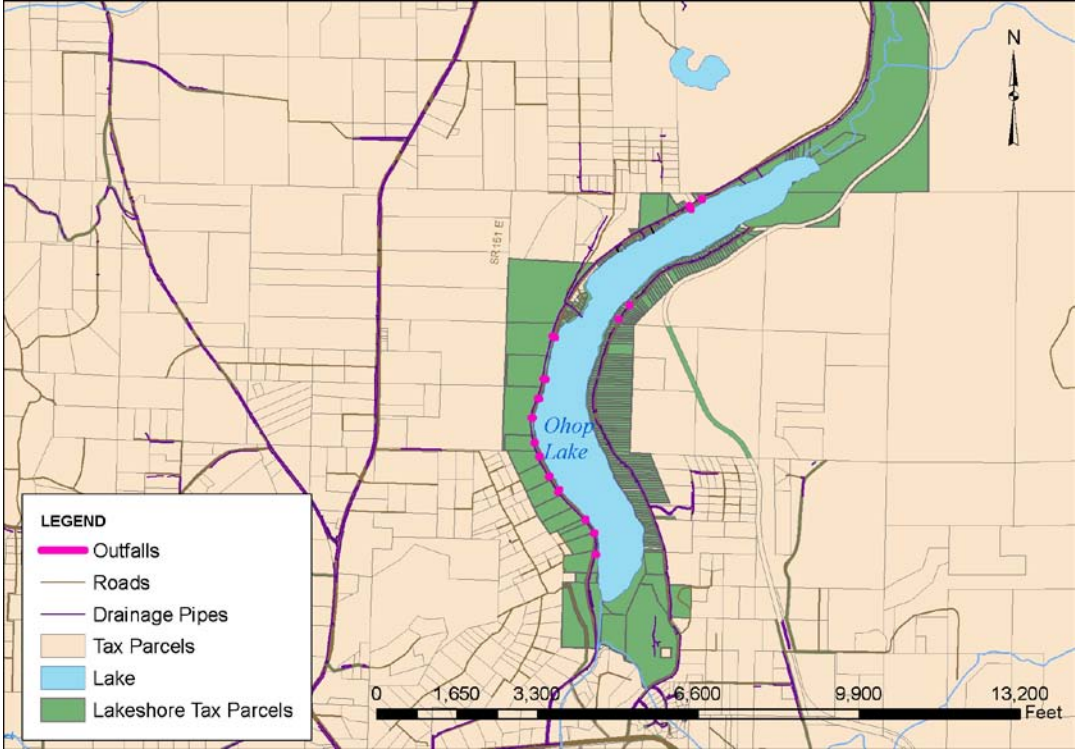


Figure 8: Ohop Lake

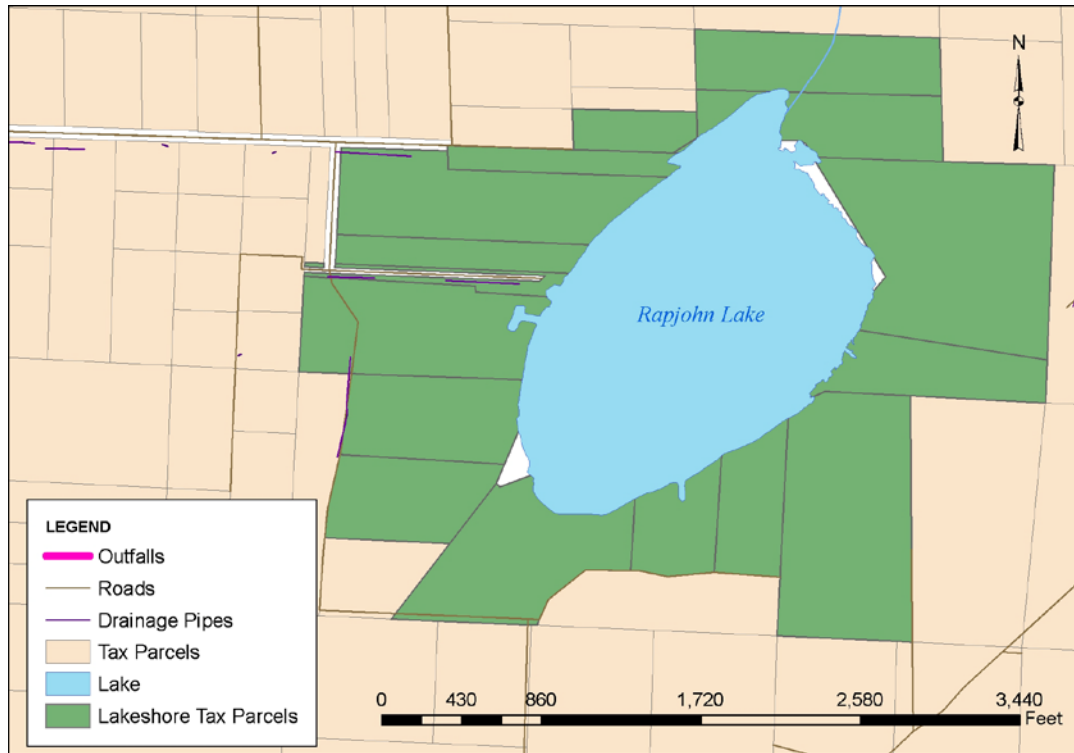


Figure 9: Rapjohn Lake

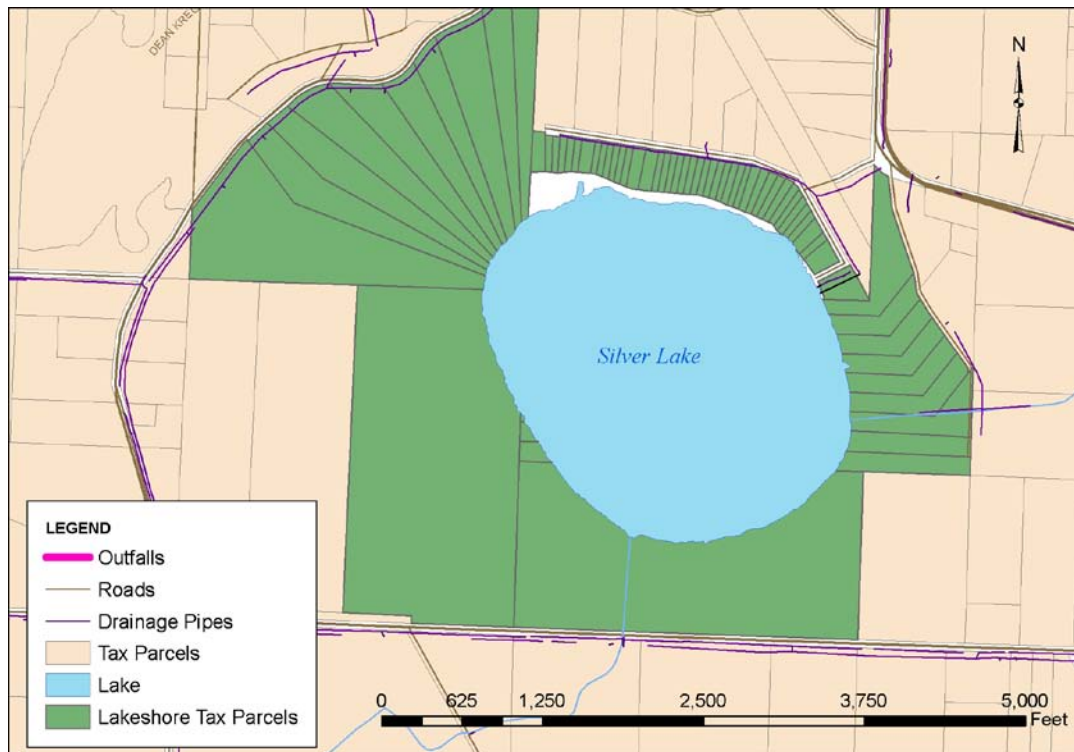


Figure 10: Silver Lake

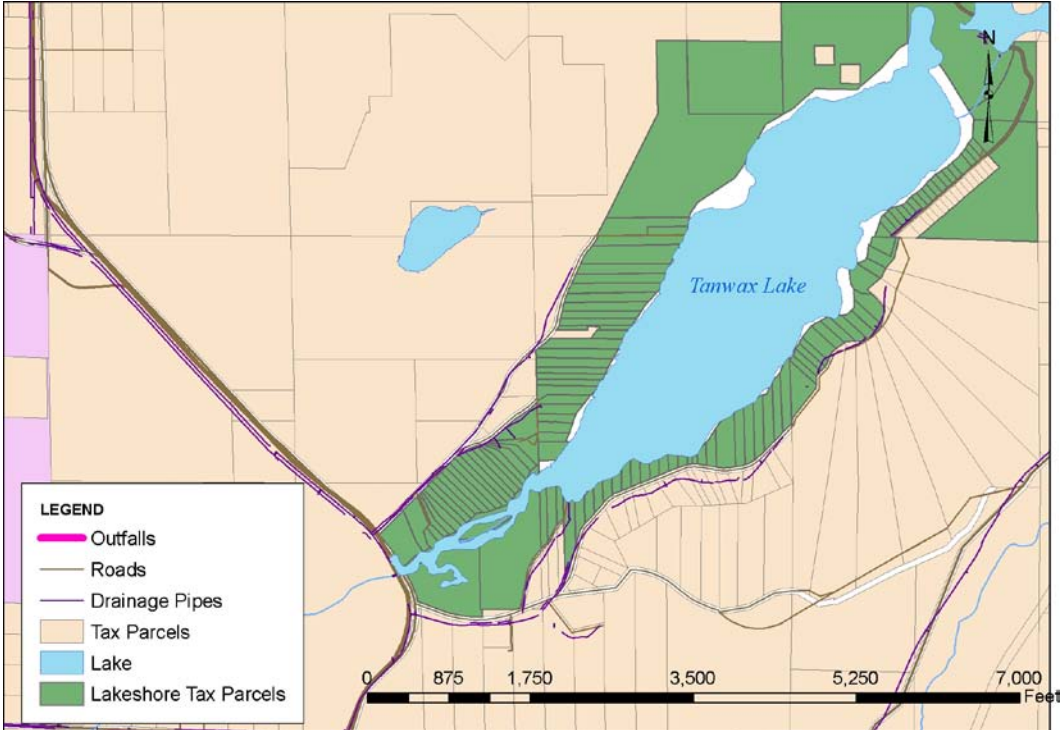


Figure 11: Tanwax Lake

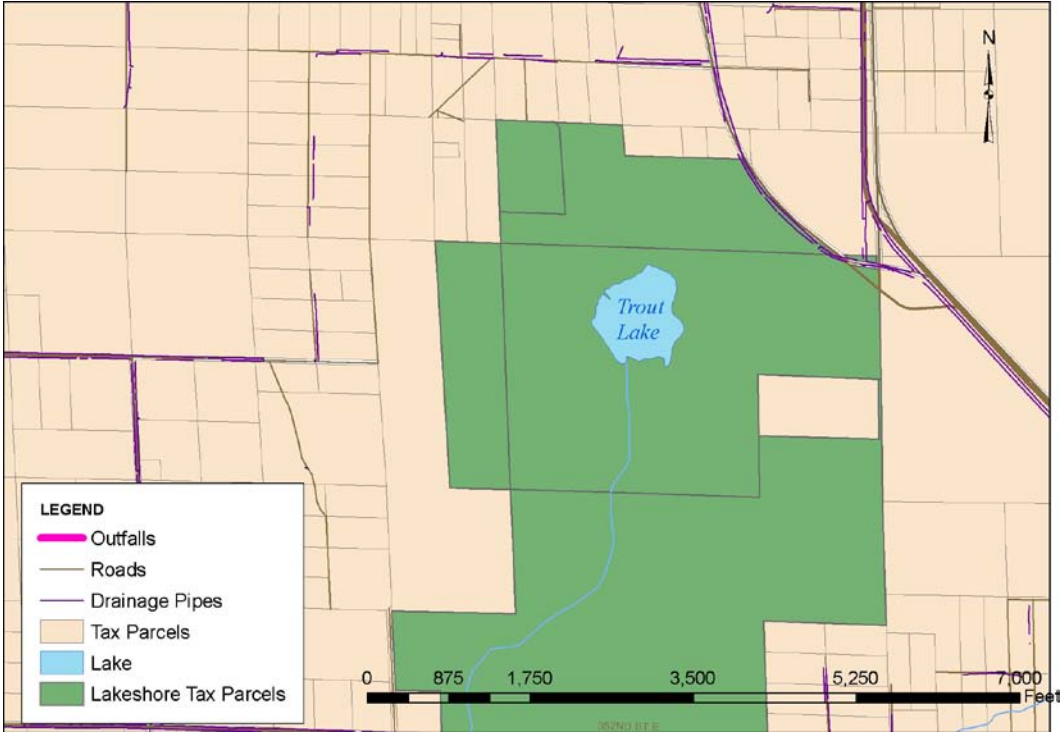


Figure 12: Trout Lake

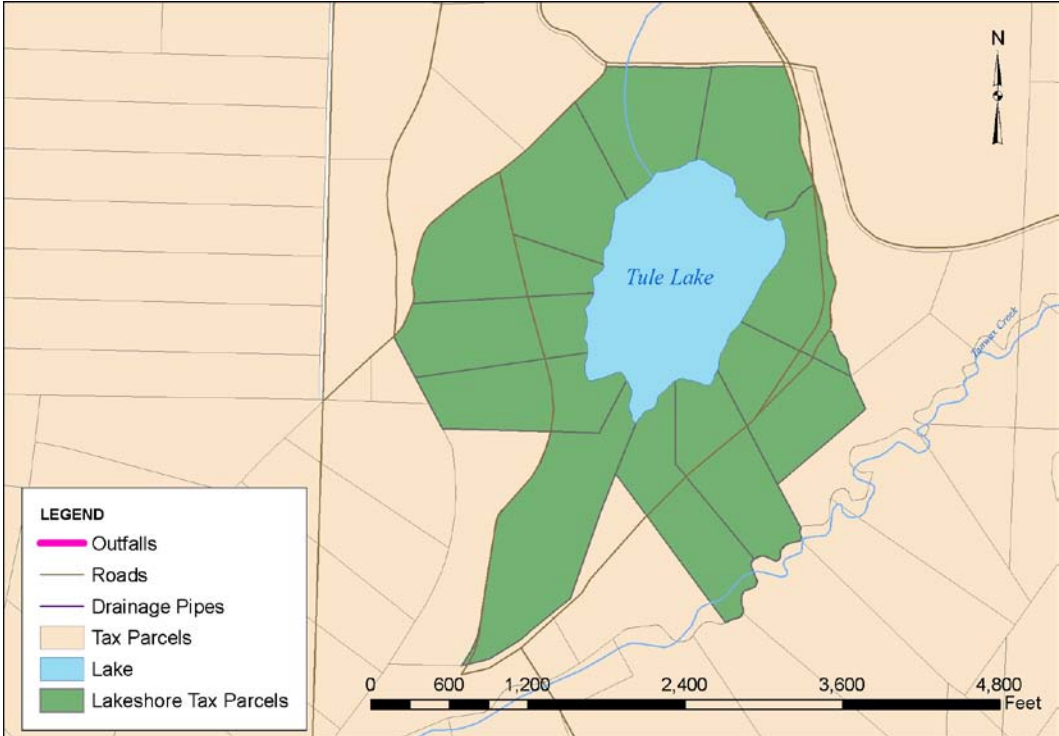


Figure 13: Tule Lake

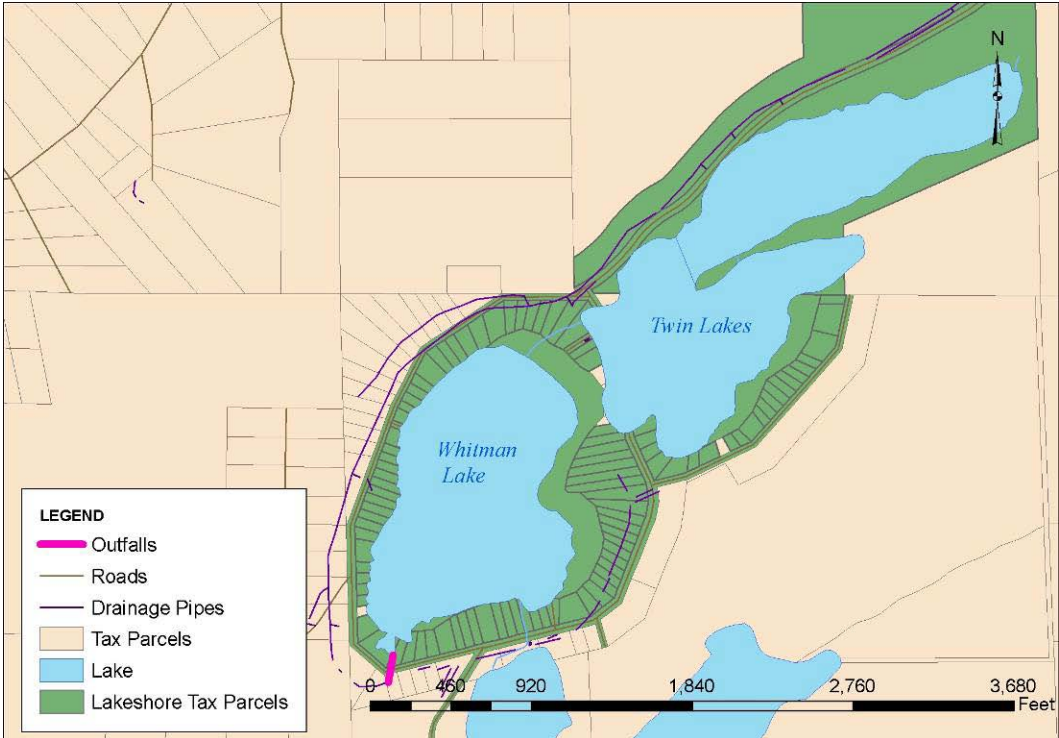


Figure 14: Whitman and Twin Lakes

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