Integrated Aquatic Vegetation Management Plan

Lake Desire

King County, Washington

Prepared by King County
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Executive Summary

Lake Desire is a small 72 acre lake located east of Renton in unincorporated King County, Washington. The lake is contained within the Peterson Creek subbasin of the Cedar River Watershed and is part of the Water Resource Inventory Area (WRIA) 8. King County owns 11% of the shoreline and the remaining 89% is divided up among 125 private parcels. About 70% of the shoreline is moderately developed residential and about 30% is undeveloped. The lake has public access, including a public boat ramp operated by Washington Department of Fish and Wildlife and a King County park, and is used for boating, fishing, swimming, wildlife viewing, and ecosystem processes.

Lake Desire contains two Class B noxious weed species (purple loosestrife (*Lythrum salicaria*) and Eurasian watermilfoil (*Myriophullum spicatum*)), one Class A noxious weed species (reed sweetgrass (*Glyceria maxima*)), and two Class C noxious weeds (fragrant water lily (*Nymphaea odorata*) and yellow flag iris (*Iris pseudacorus*)). To date, these infestations have been inadequately addressed at Lake Desire, making the lake a potential source of noxious weed infestations for many nearby lakes. At nearby Spring Lake (0.5 mile east of Lake Desire) the community has been working hard to reduce their purple loosestrife, fragrant water lily, yellow flag iris and Eurasian watermilfoil infestations. At Shady Lake (0.5 mile to the south of Lake Desire) local community efforts have been undertaken to control Eurasian watermilfoil. The close proximity of these lakes means that plants from Lake Desire can easily re-infest Spring and Shady Lakes by vectors such as: wind, animal, human, boat, and boat trailer movement. Eurasian watermilfoil, purple loosestrife, and fragrant water lily can greatly hinder recreational activities, and decrease habitat and water quality at Lake Desire. The outflow from Lake Desire flows south into the Cedar River by way of Peterson Creek and through the Peterson Lake Natural Area, both free of purple loosestrife.

Members of the Lake Desire community along with the King County Noxious Weed Control program realized the importance of controlling these noxious weeds at Lake Desire to prevent further spread and ameliorate the damage that has already been done. As a group they decided to apply for an Aquatic Weeds Management Fund grant through the Washington Department of Ecology (Ecology). If awarded, grant money, along with matching hours from King County employees and Lake Desire volunteers, will fund initial eradication efforts and several years of follow-up survey and control. Since eradication is very difficult to achieve and re-introduction is likely, the community is prepared for the long term effort that will be required.

This Integrated Aquatic Vegetation Management Plan (IAVMP) is a planning document developed to ensure that the applicant and community have considered the best available information about the waterbody and watershed prior initiating control efforts. Members of King County staff and the Lake Desire community worked in partnership to develop this IAVMP for Lake Desire. To address the task of generating community appreciation of and action towards this important ecological, aesthetic and recreational issue, a core group of residents, along with several King County Staff, formed an IAVMP Steering Committee. The Committee was able to educate the community about the problem, inspire to contribute feedback about different treatment options, and gather over 125 signatures and a commitment of over 800 annual volunteer hours towards the project.

In development of the IAVMP control goals were prioritized, focusing on the problems that could be achieved based on funding and other resource limitations. While yellow flag iris is prevalent at the lake, the plant is well established and its control is very resource intensive. Iris is therefore not a target of this management plan. Also, since its discovery and initial treatment, reed sweetgrass appears to have been eradicated where found at the Lake. The community ultimately agreed on an IAVMP plan which incorporates and integrated treatment strategy to address three target plants: purple loosestrife, fragrant water lily, and Eurasian watermilfoil. Control activities targeting these plants will combine an initial treatment of aquatic herbicide followed by manual control methods. These control activities will be done by a combination of hired contractors, Lake Desire community volunteers, and King County staff.

This IAVMP presents an overview of the aquatic weed problems, details about the community planning process, watershed and lake characteristics, a review of suitable control options, a management plan, budget and funding plans, and an implementation plan. There is also a large Appendix section that contains background and supporting documents.

Section 2 - Problem Statement

Lake Desire is a small 72 acre lake located east of Renton in unincorporated King County. The lake is contained within the Peterson Creek subbasin of the Cedar River Watershed and is part of the Water Resource Inventory Area (WRIA) 8. King County owns 11% of the shoreline and the remaining 89% is divided up among 125 private parcels. About 70% of the shoreline is moderately developed residential and about 30% is undeveloped. The lake has public access, including a public boat ramp operated by Washington Department of Fish and Wildlife and a King County park, and is used for boating, fishing, swimming, wildlife viewing, and ecosystem processes.

Lake Desire contains two Class B noxious weed species (purple loosestrife (*Lythrum salicaria*) and Eurasian watermilfoil (*Myriophullum spicatum*)), one Class A noxious weed species (reed sweetgrass (*Glyceria maxima*)), and two Class C noxious weeds (fragrant water lily (*Nymphaea odorata*) and yellow flag iris (*Iris pseudacorus*)). To date, these infestations have been inadequately addressed at Lake Desire, making the lake a potential source of noxious weed infestations for many nearby lakes. At nearby Spring Lake (0.5 mile east of Lake Desire) the community has been working hard to reduce their purple loosestrife, fragrant water lily, yellow flag iris and Eurasian watermilfoil infestations. At Shady Lake (0.5 mile to the south of Lake Desire) local community efforts have been undertaken to control Eurasian watermilfoil. The close proximity of these lakes means that plants from Lake Desire can easily re-infest Spring and Shady Lakes by vectors such as: wind, animal, human, boat, and boat trailer movement. Eurasian watermilfoil, purple loosestrife, and fragrant water lily can greatly hinder recreational activities, and decrease habitat and water quality at Lake Desire. The outflow from Lake Desire flows south into the Cedar River by way of Peterson Creek and through the Peterson Lake Natural Area, both free of purple loosestrife.

Eurasian watermilfoil (*Myriophyllum spicatum*) is a submersed aquatic noxious weed that proliferates to form dense mats of vegetation in the littoral zone of lakes and reservoirs. It reproduces by fragmentation, and those fragments can "hitch-hike" on boat trailers from one lake to another. This noxious weed can degrade the ecological integrity of a water body in a few growing seasons. Dense stands of milfoil crowd out native aquatic vegetation, which in turn alters predator-prey relationships among fish and other aquatic animals. *M. spicatum* can also reduce dissolved oxygen, first by inhibiting water circulation in areas where it grows, and second by oxygen consumption from bacteria decomposing dead plant material. The decomposition of *M. spicatum* also adds nutrients to the water that can contribute to increased algal growth connected with water quality problems. Further, dense mats of *M. spicatum* can increase water temperature by absorbing sunlight, create mosquito breeding areas, and negatively affect recreational activities such as swimming, fishing, and boating.

Purple loosestrife (*Lythrum salicaria*) is an emergent aquatic noxious weed that degrades native wetland plant communities. Purple loosestrife can quickly adapt to environmental changes and expand its range to replace native plants used for groundcover, food, or nesting material. This noxious weed species has colonized the shoreline of most of the lake, including Wetland 15 (at the north end of the lake) and threatens to disperse further into the wetland if not controlled. The plant threatens to lower plant diversity and can also alter hydrologic dynamics through sediment accretion along the shoreline. This emergent weed fails to provide the same forage and habitat for birds, mammals, and invertebrates as provided by

native plant communities. So far, purple loosestrife has not been observed one and a half miles downstream at the Peterson Lake Park Natural Area. The Natural Area is known to support five species of salmonids and there exists the potential for purple loosestrife infestations spreading from Lake Desire and infesting the Peterson Creek and Lake Natural area, causing salmon habitat to be degraded. Purple loosestrife produces a prolific number of seeds (up to two million seeds per mature plant) that could easily be transported downstream to pollute this valuable resource.

Reed sweetgrass (*Glyceria maxima*) is a tall aquatic grass that grows along the margins of lakes, rivers, and streams. In 2010, an area of reed sweetgrass was found along the north shoreline of Lake Desire. Native to Europe and Asia, reed sweetgrass is only known to occur in a few isolated locations in King and Snohomish Counties. Because of this limited distribution and great potential to cause ecological damage, reed sweetgrass is a Class A Noxious Weed in King County and is required to be eradicated. Growing to over 6 feet tall and ranging from the shore to water 6 feet deep, reed sweetgrass can completely dominate a wetland to the exclusion of all other vegetation once established. This grass is an inferior food and nesting source for waterfowl compared with the species it displaces and it also changes the macroinvertebrate community structure, which can impact the food chain for fish and wildlife.

Fragrant water lily (*Nymphaea odorata*) is also affecting the waterbody, and is quickly expanding its distribution in the lake. When uncontrolled, this species tends to form dense, monospecific stands that can persist until senescence in the fall. Mats of these floating leaves prevent wind mixing and extensive areas of low oxygen can develop under the water lily beds in the summer. Water lilies can restrict lakefront access and hinder swimming, boating, and other recreational activities. They may also limit the distribution of our native water lily (*Nuphar polysepala*) which occupies the same niche and provides food and habitat for a variety of animals and fish. The fragrant water lily is still expanding in patches on Lake Desire, and so its current impacts are somewhat less evident. As soon as these patches connect, recreational activities such as boating, fishing, and swimming will become more difficult. Even canoes can have great difficulty moving across dense floating mats of fragrant water lily, not to mention entanglement with propellers of electric motors.

Yellow flag iris (*Iris pseudacorus*) is an emergent aquatic noxious weed that grows in dense stands along the lake shoreline. The plant spreads through floating seeds and rhizomes, both of which spread by wind and wave action. Yellow flag iris, crowds out native species with impenetrable mats and is found in many areas along the Lake Desire shoreline. The plant is very difficult to effectively control.

As a group these invasive plants:

- Pose a safety hazard to swimmers and boaters by entanglement
- Snag fishing lines and hooks, eventually preventing shoreline fishing
- Crowd out native plants, creating monocultures lacking in biodiversity
- Significantly reduce fish and wildlife habitat, thereby weakening the local ecosystem and degrading the wildlife and wildlife viewing opportunities
- Pose a threat to adjoining ecosystems
- Reduce property value

While efforts to control some of these species have occurred (by individual land owners, King County Parks, and King County Noxious Weeds), they have not been able to meet the current challenge of controlling such widespread infestations or of preventing re-infestation. Immediate lake-wide action is necessary to control these invasive weeds and prevent further infestation. If left unchecked, the lake may soon become more infested with aquatic weeds, severely degrading the lake ecosystem and making eradication difficult. The community is in support of this plan and recognizes that after initial control efforts, opportunity for re-infestation must be prevented.

Section 3 - Management Goals

The overall management goal for this Integrated Aquatic Vegetation Management Plan (IAVMP) is to control noxious aquatic weeds at Lake Desire in a manner that allows sustainable native plant and animal communities to thrive, maintains acceptable water quality conditions, and facilitates recreational enjoyment (boating, fishing, and swimming) of the lake.

The following objectives will be pursued to ensure success in meeting this goal:

- Eradication and prevention of floating and submerged aquatic noxious weeds.
- Control of regulated shoreline noxious weeds to reduce existing populations below the level of significant impact and to prevent spread.
- Do everything possible to maintain safe conditions for native salmonids during treatment.
- Involve the Lake Desire community in planning and implementation of the IAVMP.

Section 4 - Public and Community Involvement

Community Commitment

Support for aquatic vegetation management at Lake Desire gradually grew over the IAVMP planning period as community members learned more about the issue of aquatic noxious weeds. Several Lake Desire residents have been monitoring aquatic weeds and water quality at Lake Desire for many years. These individuals, who are already active in controlling noxious weeds, have expressed interest in being involved in aquatic vegetation management at Lake Desire. Other community membersbecame active in the process through the Lake Desire Community Club. The Club and its network of community members proved crucial in the development of the plan.

Steering Committee, Outreach, and Education Process

November 2010: First meeting with Lake Desire Community Club

Work began in October of 2010 to contact and meet with members of the Lake Desire community about the opportunity to control aquatic noxious weeds at the lake through creation and implementation of an IAVMP. A notice about the proposed IAVMP presentation was posted in the " Lake Desire Update 11/3/10" (an email news letter produced by the Lake Desire Community Club that is sent out to Lake Desire residences several times a month). Two King County employees (Ben Peterson and Katie Messick) attended the November 15, 2010 Lake Desire community meeting. They gave a brief presentation about noxious weeds at Lake Desire and the potential to control them through the creation and implementation of an IAVMP. The meeting was attended by eight community members. The general idea of aquatic weed control was well received, and the meeting attendees asked questions about the plants of concern and control techniques. Several of those at the meeting expressed interest in serving on the IAVMP steering committee.

March 2011: Project planning begins; first meeting of IAVMP Steering Committee

Background research related to the Lake Desire IAVMP began in late February and early March. A date for the first meeting for the Steering Committee was set for March 17, 2011 at the Lake Desire Community Club. An email notice was sent out to all who had expressed interest in the project at and since the Nov. 15, 2010 meeting. A notice in the Lake Desire Update e-news letter advertising the first Steering Committee meeting was published on March 16. The meeting was attended by nine Lake Desire residents and four King County staff (including one King County Parks staff member). At this meeting a slide show was presented describing noxious weed issues at Lake Desire and the IAVMP process. Tasks were assigned and an IAVMP project timeline was laid out (see Appendix 1 *meeting notes attendance lists, public notices, and signature sheets*).

The steering committee consisted of two King County noxious weed staff, two King County science staff, one representative from the Lake Desire Community Club, and ten Lake Desire residents who are active and interested in weed control.

June 2011: Second Steering Committee Meeting- Discussion of Treatment Options

During April, May, and June, treatment options for control of the target noxious weeds were researched. On June 7 a one-page mailer that advertised the June 23rd meeting was sent out to 191 Lake Desire property owners (Appendix 1). The mailer indicated that the meeting would entail a discussion of the IAVMP planning process and a discussion of what control methods would used to control the noxious weeds at the lake. Also on June 7 an email was sent to all who had been involved with the planning process (up to that point) notifying and inviting them to the June 23rd meeting. On June 23rd a meeting was held at the Lake Desire Clubhouse with 17 community members and four King County Staff in attendance (see Appendix 1). A slide show was presented that detailed all weed control methods that would be possible at Lake Desire. Discussion focused on plusses and minuses of the methods, including chemical control methods. Ultimately a weed control strategy that combined the use of manual and chemical methods was decided on.

July – September 2011: Weed Surveying; publicity about potential herbicide use

Following the June meeting, it was decided that more publicity needed to be done regarding the proposed use of aquatic herbicides as a tool in controlling the aquatic noxious weeds at Lake Desire. A one-page handout was developed by King County staff that described the pros and cons of the proposed aquatic herbicide use along with sources for more information on the subject and King County staff contact information (See Appendix 1). In mid-July these flyers were distributed door-to-door around Lake Desire by community volunteers as they spread the word about an up-coming community party. In August and September purple loosestrife and Eurasian watermilfoil were surveyed by canoe by King County staff. During these surveys, contact was made with several Lake Desire residents, and the IAVMP was discussed.

October 2011: Community/pubic meeting to discuss proposed IAVMP and collect final comments

On September 20, 2011, a postcard mailer was sent to 191 property owners at Lake Desire (Appendix 1). The mailer invited owner to "join your Lake Desire neighbors for community meeting on the Lake Desire IAVMP" on October 4. On September 19, 2011 an email was sent to all who had been involved with the planning process (up to that point) inviting them to the October 4 meeting.

The October 4 meeting was held at the Lake Desire Clubhouse with 24 community members and three King County Staff in attendance (see Appendix 1). Discussion at the meeting focused on control methods, project budget, and funding options. Comments and suggestions collected during the meeting have been incorporated into the text of the IAVMP.

There was also discussion about the distribution of a community letter of support for the plan. Community members agreed to go door-to-door in October and November and gather signatures from Lake Desire residents. During this signature gathering effort, a copy of the community letter of support, a

sign-up sheet, and a fact sheet that outlined the use of aquatic herbicides that are proposed in this IAVMP were presented to residents (Appendix 1).

November 2011: Continued IAVMP work and circulation of Letter of Support

King County staff and Steering Committee members continued to work on the IAVMP. Daft copies of the Plan were exchanged with and edited by Steering Committee members. Concurrently, Lake Desire residents continued to circulate the Letter of Support among their neighbors.

In total, over 125 residents of Lake Desire signed on to the Letter of Support. All these individuals live in properties surrounding Lake Desire and committed a combined total of over 800 volunteers hours per year (Appendix 1)

The Appendix 1 that is referred to contain "Community Involvement and Outreach Documents (Materials)":

- March 17 meeting attendance sheet
- March 17 meeting minutes
- June 23 meeting mailer notice
- June 23 meeting attendance sheet
- June 23 meeting minutes
- July herbicide info handout produced by King County NWCP
- October 4 meeting mailer notice
- October 4 meeting attendance sheet
- October 4 meeting minutes
- Herbicide info sheet produce by King County NWCP that outlines toxicity of herbicides that will likely be used in the project
- Community Letter of Support
- Copy of signature sheet (blank)
- Signed signature sheets

Section 5 - Waterbody and Watershed Characteristics

Watershed Characteristics

Location and Size of Watershed

The Lake Desire watershed is located in South-central King County, Washington in an unincorporated area, 3 miles east of the city limits of Renton and Kent (Figure 1a). This unincorporated part of King County is generally known as Fairwood. State resource agencies frequently use a system of Water Resource Inventory Areas (WRIA) to refer to the state's major watershed basins. Lake Desire is located in WIRA 8, which refers to the Cedar-Sammamish combination watershed and includes Lake Washington, Lake Sammamish, and most of the city of Seattle.

Figure 1a. Lake Desire Regional Map. Map showing the location of Lake Desire in relation to the cities of Seattle, Renton, and Kent, Washington state.

The Lake Desire watershed constitutes 862 acres (21%) of the Peterson Creek Sub-basin of the Lower Cedar River watershed (King County, 2011; King County, 2003). The 4043 acre Peterson Creek Sub-basin receives a mean annual rainfall of 44.4 inches, with a water yield of 47.5% (or 21.1 inches) (King County, 2003). The elevation of Lake Desire is 488 feet (USGS, 1965). The Lake Desire watershed receives drainage from the steeply sloping areas surrounding the lake to the east. There is one small peak

to the east of the lake, Echo Mountain, which rises to an elevation of 899 feet. The area between the Lake and Echo Mountain is considered a "Landslide Hazard" by King County (2008). More gently sloped terrain makes up the north and west sides of the Lake Desire basin.

Streams and Wetlands in the Watershed

The Lake Desire watershed contains two designated wetlands and one stream. Adjacent to the north end of Lake Desire lays a topographically flat 17-acre wetland, Wetland 15 (Figure 1b) (King County, 1993). Farther up, in the northeast part of the watershed resides a 43-acre fen wetland, Wetland 14 (Figure 1b) (1993). Both Wetland 14 and Wetland 15 are "Class 1 wetlands", the most valuable wetland classification, and contain habitat for WA State endangered or threatened species, 40-60% permanent open water, and uncommon plant associations (1993). Wetland 14 is a bog, most of which has been altered through peat mining. The slow draining acidic conditions of this specialized type of wetland feature leads to a unique assemblage of plants.

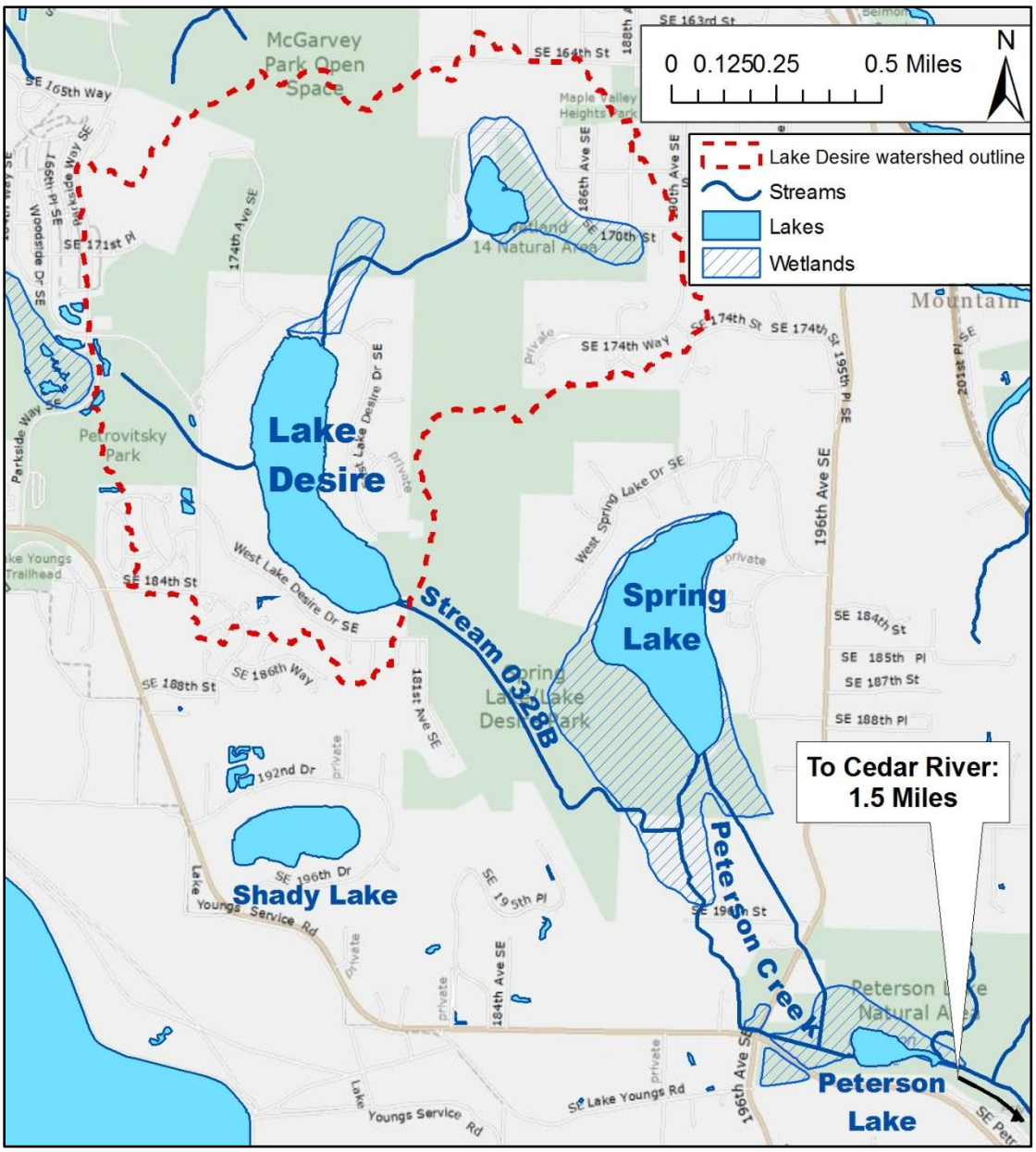

Figure 1b. Lake Desire Vicinity Map. Map showing water bodies and wetlands in the Lake Desire area.

Wetland 15 is fed by the stream that flows from Wetland 14 through the McGarvey Park Open Space. It contains many snags and fallen logs, large western hemlock trees growing on the Sphagnum mat, and areas of dense willow and cattail along the Lake Desire Shoreline (King County, 1993). East Lake Desire Road cuts through the wetland and tends to cause flooding to the low-lying areas to the north during times of high water runoff (T. Sieger, pers. comm., March 29, 2011; King County, 1993).

A small stream flows from Wetland 14 to Wetland 15 and Lake Desire (Figure 1b)(1993). A tributary of Peterson Creek, stream 0328B, flows south from Lake Desire and joins the main stem of Peterson creek about 1 mile down from the outlet (Figure 1b) (1993). Any other streams that flow into Lake Desire are small, un-named, seasonal drainages.

The Lake Desire watershed is located on a plateau above the Cedar River in an area of unusually high lake density. Within two miles of Lake Desire are Spring Lake (68 acres), Shady Lake (19 acres), and Peterson Lake (4 acres), which are all within the Peterson Creek Sub-basin (Figure 1b) (1993). Shadow Lake (56 acres) and Lake Youngs (685 acres) are close by to the south with-in 3 miles.

The Lake Desire watershed consists of five major soil types (Table 1) (USDA, 1973). The majority (82%) of the watershed consists of Alderwood gravelly sandy loam in slopes ranging from 0-6% (AgB), 6-15% (AgC), and 15-30% (AgD); it surrounds approximately 75% of the Lake Desire shoreline (Figure 2). All the Alderwood gravelly sandy loam soil types consist of moderately well drained glacial till over denser, very slowly drained material at a depth of 24 to 40 inches. Compaction or removal of these soils (AgB, AgC, & AgD) during the typical urban or suburban development can result in a commensurately large hydrologic effect, such as a high water table (King County, 1993). In these soils effluent from septic absorption fields can flow laterally above the less permeable layer and can seep at the bottom of slopes (King County, 1994). The Everett gravelly sandy loam (EvC) soil type, about 6% of the watershed, is concentrated around the north shore of Lake Desire (Figure 2). This soil type, while consisting of well drained glacial outwash, makes up much of the low lying wetland (Wetland 15) at the north edge of the lake. In the northeast part of the Lake Desire watershed occurs the Orcas peat soil type, (approximately 4% of the watershed) (Figure 2). This soil type, which nearly all coincides with Wetland 14, is a very deep, poorly drained peat soil made of decomposing organic material (USDA, 1973). This soil, which supports sphagnum moss, Labrador tea, and cranberry plants, is acidic and has a high water holding capacity (UADA, 1973; Mitsch & Gosselink, 1993).

Table 1 - Soil type

Soil Name	Soil map symbol	Acres in watershed	Percent of Watershed
Alderwood gravelly sandy loam, 0 to 6 percent slopes	AgB	87.3	9.8%
Alderwood gravelly sandy loam, 6 to 15 percent slopes	AgC	620.5	69.8%
Alderwood gravelly sandy loam, 15 to 30 percent slopes	AgD	21.6	2.4%
Everett gravelly loam, 5 to 15 percent slopes	EvC	53.3	6.0%
Orcas peat	Or	35.7	4.0%
Water	W	71.0	8.0%
Total for area of interest		889.3	100.0%

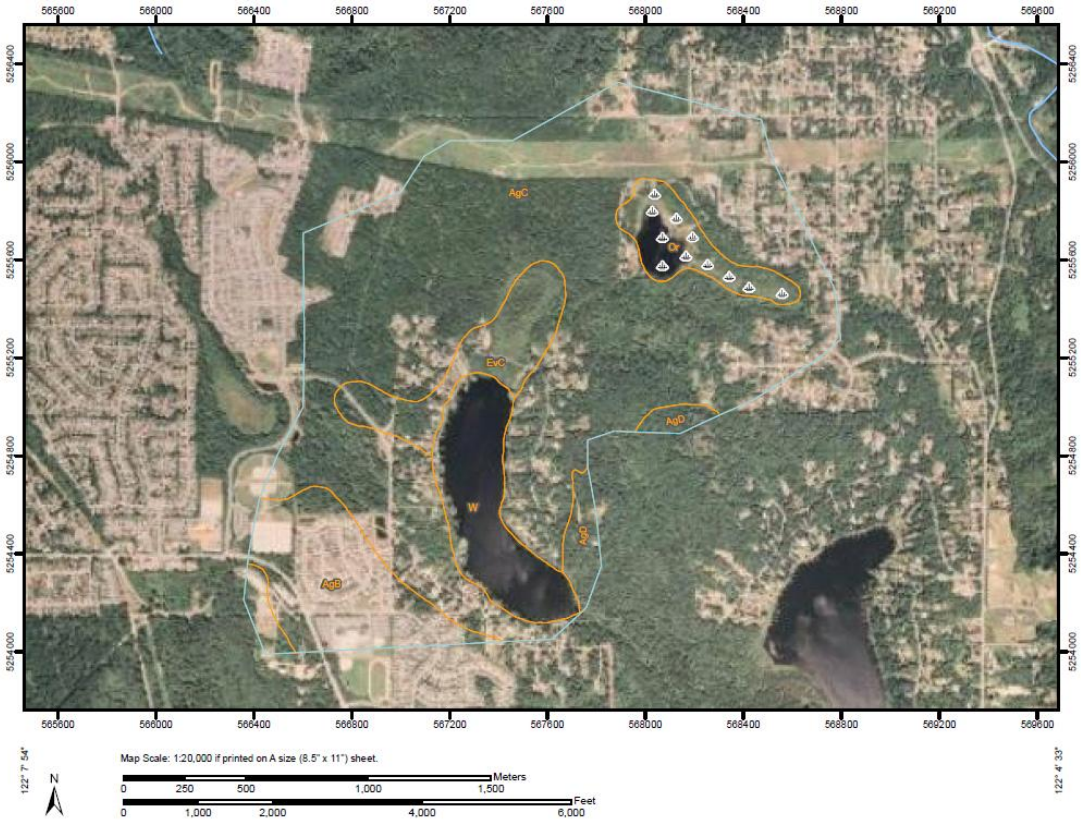

***Figure 2. Soil Map of Lake Desire Watershed*.** Map showing the five mapped soil types in the Lake Desire Watershed, King County, Washington, produced by USDA-NRCS.

Sediments within Lake Desire are generally loose and high in organic content (Sally Abella pers. comm., September 16, 2011), similar to other small lakes in the region.

Land Use Activities in the Watershed and Potential Nonpoint Nutrient Source Locations

The larger Peterson Creek Sub-basin tributaries drain approximately 6.3 mi^2, including Lake Desire and Spring Lake. Over half the area is classified as forested, with another quarter of the land use as low-density residential and 9% of the sub-basin classified as wetland (King County, 2003). While this sub-basin is among the largest in the Cedar River Basin, it is also one of the least developed (2003). In 1993, 48% of the Lake Desire Watershed was forested, 16% wetland, and 6% grass. Additionally, only 4% of the wastershed was in high density housing and 25% was in a one house per 20 acre designation (King County, 1994).

As of 2010 approximately 31% percent of the Lake Desire watershed is in urban development (King County, 2008). Approximately 50% of the Lake Desire watershed is included within the King County Urban Growth Boundary; including the area immediately around the lake (Figure 3) (King County 2008). The watershed has over six miles of paved roadway, plus an unknown amount of paved private driveways and parking areas. Eighty-seven residences surround Lake Desire, and there is potential for more development as many private parcels are undeveloped. Residential development in the Watershed over the past 40 years may have resulted in increase water flow, in the form of runoff into Lake Desire (T. Sieger, pers. comm., March 29, 2011). There is also anecdotal evidence of increased times of high water

at the Lake during winter, up to two feet above the summer low level (T. Sieger, pers. comm., March 29, 2011). This water level elevation raise is a concern because old residential septic systems may leak and contribute nutrients to the lake (King County, 1994; T. Sieger, pers. comm., March 29, 2011).

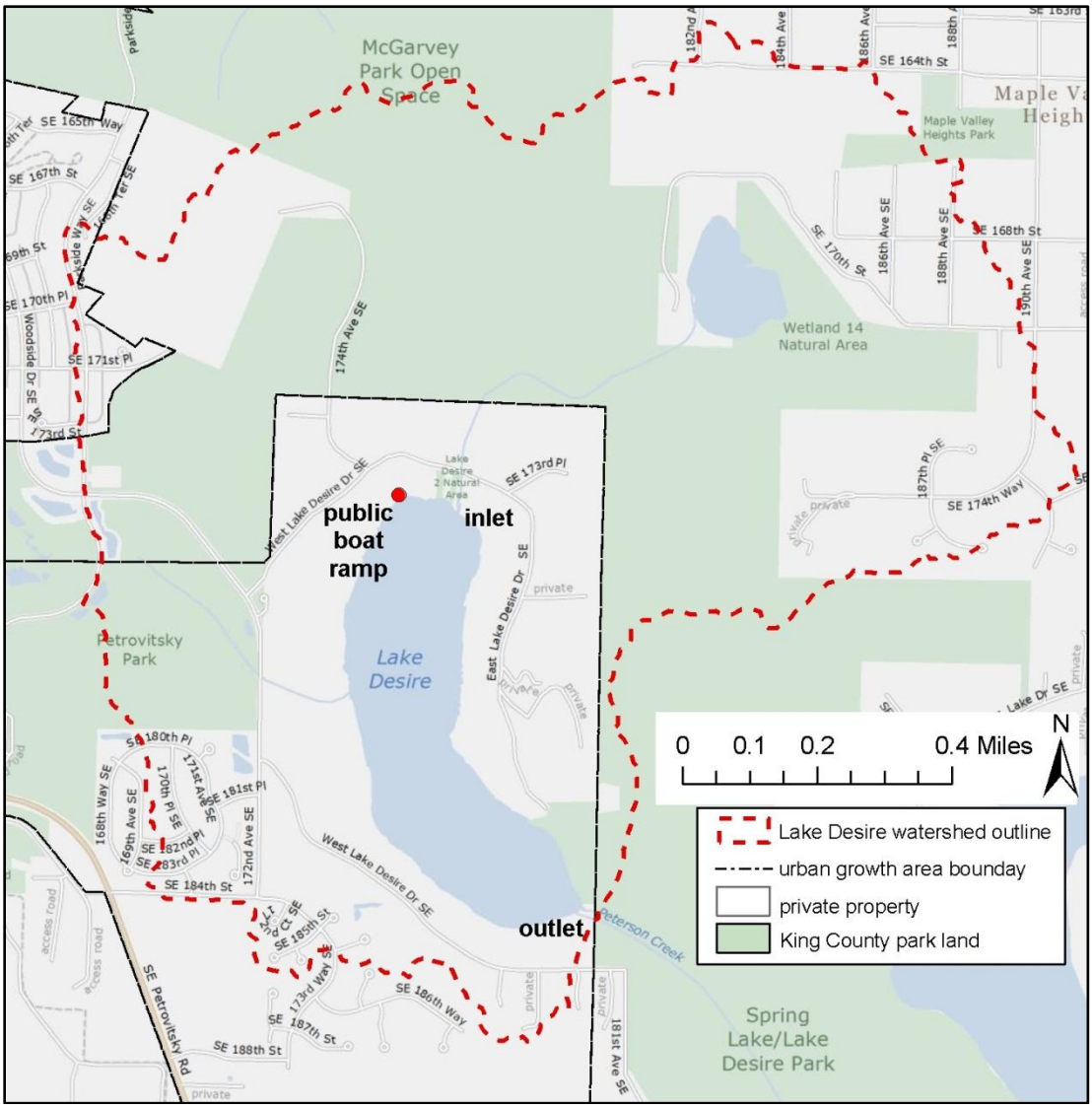

***Figure 3. Lake Desire Watershed Map*.** Map showing Lake Desire watershed, urban growth area boundary, boat ramp, inlet, outlet, public and private land.

Peat mining in Wetland 14 occurred up until the late 1980s (King County, 1993, Rigg, 1958). Of the 43 acres the wetland covers, 37 have been "significantly altered" by peat mining (King County, 1993). Historically the wetland has filtered contaminants from surface water runoff coming from higher up in the watershed before they entered the lake. The residential subdivision upstream of Wetland 14 has lead to an increase in runoff into the wetland (King County, 1993).

The north part of the Lake Desire watershed has had a history of coal mining activity. Located on the west side of Lake Desire in the Woodside area, the "Fire King" coal mine operated from 1935 to 1946 (Shertz, 2004). Coal mining occurred in the northwest part of the watershed at the King Coal Mine from

the 1950's through the 1980's (King County, 1994). In the McGarvey Park area, the New Black Diamond Mine operated between 1884 and 1939 (King County, 2010).

The original logging in the watershed occurred in the 1930s, just prior to the original land sub-divisions (T. Sieger, pers. comm., March 29, 2011). Prior to ownership by King County, the McGarvey Park Open Space was logged in the mid 1960s, and now very few mature conifers remain (King County 2010). Other than a 75-acre hardwood tree harvest planned for McGarvey Park Open Space, there are no know present logging operations occurring in the watershed (King County, 1993; 1994; 2010).

Traversing the north-central part of the Lake Desire Watershed is the Bonneville Power Administration's (BPA) power line corridor right-of-way (King County 2010). High-voltage transmission lines and towers run down this 500-foot wide corridor where trees and shrubs are kept cut short. This right-of-way also contains dirt access road.

Community History

The original parcel subdivision of shoreline around Lake Desire began in 1942 and the first tract/parcel map was published in 1943 (*Lake Desire Summer Homes Tracts*, 1943; T. Sieger, pers. comm., March 29, 2011). Originally the parcels at the lake were a site for summer cabins and campsites, allowing for recreational pastimes such as picnicking and fishing (Shertz, 2004). In the 1960s property owners began building permanent, year round homes around the lake (2004).

The original logging access road, SE Petrovitsky Rd., was an oiled dirt road until 1971 or 1972 when it was paved (T. Sieger, pers. comm., March 29, 2011). The majority of the houses around Lake Desire were built in the 1970s and 1980s with the most recent development occurring in the 1990s in the southwest part of the Lake Desire watershed west of 172nd Ave SE (Figure 3). It is likely water withdrawals for residential use do occur at Lake Desire but the extent in not known. Several individuals have water rights claims on the Lake.

King County owns 11% of the Lake Desire shoreline, and the remaining 89% is divided up among 125 private parcels. About 70% of the shoreline is moderately developed residential and about 30% is undeveloped (King County, 2008). Private residences, both directly along the shore of the lake and throughout the watershed, provide a potential source for nutrient input (in the form of septic tank failure and yard fertilizer runoff) (King County, 1993). The increase in impervious surface from the residences, roads and other paved areas in the watershed have resulted in increased volumes of runoff entering the lake (1993).

A 373-acre King County Park (Lake Desire/Spring Lake Park) occupies 800 feet of shoreline in the southeast part of Lake Desire (Figure 3). The land, originally purchased by a developer in 1964, had been slated for a development called the "Spring Lake Golf and Country Club" (Shertz, 2004). Eventually plans fell through and much of the land was purchased by King County in 1990 through the King County Open Space bond and state funding (2004). The Lake Desire/Spring Lake Park supports passive recreational uses on a small trail system through forest and near the wetland areas. Features of the park include regionally valuable habitats like the rare plant communities found on the rocky bald of Echo Mt. and the large fen with its Sphagnum plant communities adjacent to neighboring Spring Lake (King County 2003). McGarvey Park Open Space, also a King County property, occupies much of the Lake Desire watershed just north of the Lake (Figure 3). This open space park covers 400 acres and contains

5.5 miles of trails, which are open to both hikers and mountain bikers. These two parks make up the majority of the 862 acres of contiguous parcels owned by King County, much of which is preserved as open space. In light of the habitat fragmentation that has degraded forest and wetland resources in the region, these tracts are important as they provide regionally significant wildlife corridors and habitat (King County, 1993).

Waterbody Characteristics

Lake Desire is a 72 acre lake located in south central King County (T 23 N – R 5 E; Sec. 36-NE ¼) (Figure 4) (Wolcott, 1973). Lake Desire, also known as Echo Lake, has a depth of 21 feet and an estimated volume of 933 acre-feet (1973). A tributary of Peterson Creek, flows from Wetland 14 to Wetland 15 and into Lake Desire (Figure 1b)(1993). A smaller un-named seasonal stream flows into Lake Desire from the west (Figure 1b). The Peterson Creek tributary 0328B continues as an perennial outflow stream from the lake into the main stem of Peterson Creek (1 mile downstream of Lake Desire) (Figure 1b). Lake Desire flushes an estimated 339% of its volume annually. This number was derived by multiplying the average annual rainfall (3.67 ft) by the watershed area (862 acres), then dividing by the estimated lake volume (933 acre-feet). This value is an overestimate, as it does not account for water lost to evaporation from within the watershed.

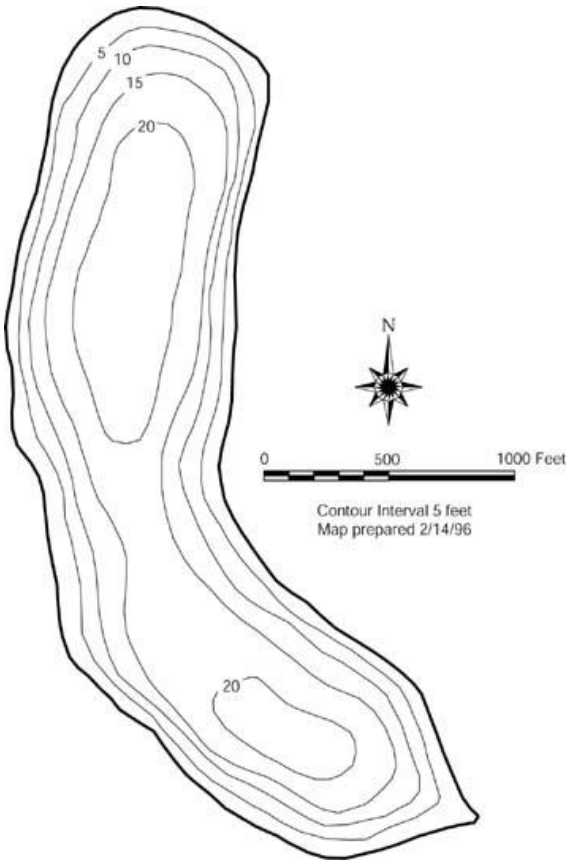

Figure 4. Lake Desire Bathymetirc Map.

Beneficial and Recreational Uses

Lake Desire supports a variety of beneficial and recreational uses. While internal combustion engines are prohibited on the lake (KCC 12.44.330), a wide variety of boaters recreate on Lake Desire using electric, wind, and human propelled vessels. Nearly all developed lake-front properties have boats at the shore ready for use, and small docks from which to experience the water. In times of warmer weather, swimming is a popular activity, mainly from private docks and some private beaches. There is no swimming allowed at the boat ramp but there is an informal swimming access point in the King County Park land along the southeast shore. Residents and visitors also use the lake for bird watching and wildlife viewing. Lake Desire's one public boat ramp is located in the northwest part of the lake and managed by Washington Department of Fish and Wildlife (WDFW). Internal combustion engine motors have not been allowed on the lake since the mid-1980s (T. Sieger, pers. comm., March 29, 2011). The boat ramp exists largely to facilitate recreational fishing on the lake. Public access to the lake is confined to the boat ramp and small pier and King County's Spring Lake/Lake Desire Park on its southeast shore.

The lake is a popular local fishing destination and used by both visitors and lake residents. The busiest fishing time is in the spring, after the lake has been stocked by Department of Fish and Wildlife.

Lake Desire and watershed support a variety of recreational uses. Many who live within the watershed and those who come from elsewhere utilize its resources. Hiking, running, mountain biking, and birding are very popular in the King County Parks and other open space that make up the watershed.

Water Quality

Since 1985, King County residents have participated in a volunteer monitoring program, King County Lake Stewardship Program, which creates a long-term record of water quality for the region's small lakes. Volunteer monitoring began at Lake Desire before 1985 and continued through 2004, when monitoring of physical and chemical parameters the lake were discontinued due to budget cuts(King County, 2001). The data record for Lake Desire is largely complete with data missing for only one year, 1993.

The assessment of biological activity, or trophic state, results in the classification of lake water quality into three general categories: oligotrophic, mesotrophic, and eutrophic. Lakes with low biological activity are considered oligotrophic, lakes with high biological activity are considered eutrophic. Lakes whose quality ranges between eutrophic and oligotrophic are considered mesotrophic. One of the most common measures used to calculate a lake's water quality classification is the numerical trophic state index (TSI) developed by Robert Carlson (1977). This index allows comparison of lake water quality by rescaling water clarity, phosphorous, and chlorophyll *a* along a trophic continuum based on a scale of 0 to 100 related to algal biovolumes. Lakes may be naturally eutrophic, mesotrophic, or oligotrophic based on the inherent character and stability of the surrounding watershed. Eutrophication is a process that occurs naturally in some lakes and may be accelerated in others by human activities.

For Lake Desire, the data collected classify the lake as moderately high in primary productivity (threshold eutrophic) with fair water quality (King County, 1995). Increased productivity from human impacts was

verified in the lake management plan (1995). The lake was listed for phosphorus impairment on the EPA 303d list in 1996, but reduced to a category 1 (meets water quality standards) in 2008.

Data from the 16-year record from 1985 to 2000 are summarized in Table 2, taken from King County Lake Water Quality: A Trend Report on King County Small Lakes (November 2001).

Summary of water quality characteristics

- Water clarity (Secchi depth) ranged from 1.6 – 2.4 meters (May-October average)
- Total phosphorous ranged from 23 – 40 μg/L (May-October average)
- Chlorophyll *a* ranged from 4.8 – 15.0 μg/L (May-October average)
- TSI Secchi ranged from 48 – 54
- TSI Chl *a* ranged from 48 – 57
- TSI TP ranged from 49 – 54
- TSI annual average 48 – 56

Year	No. of Samples	Secchi (meter)	Chl *a** (µg/L)	TP* (µg/L)	TSI* Secchi	TSI* Chl *a*	TSI* TP	TSI* Average
1985	12	2.3	9.0	25	48	52	51	50
1986	11	2.4	6.0	23	48	48	49	48
1987	11	2.3	7.7	24	48	51	50	50
1988	10	2.1	9.8	26	49	53	51	51
1989	11	2.1	6.0	26	49	48	51	50
1990	12	1.7	9.6	23	53	53	49	52
1991	6	2.2	4.8	31	48	46	54	49
1992	8	1.6	10.7	27	54	54	52	53
1993	---	---	---	---	---	---	---	---
1994	10	2.3	8.6	31	48	52	53	51
1995	12	1.8	12.3	33	52	55	54	54
1996	12	1.6	14.4	40	53	57	57	56
1997	12	1.6	10.8	31	53	54	54	54
1998	12	2.1	8.2	25	49	51	51	50
1999	13	1.7	14.2	26	53	57	51	54
2000	13	1.8	15.0	24	51	57	50	53

*Chl *a*=chlorophyll *a*, TP=total phosphorus, and TSI=Trophic State Index

***Table 2. Average Values for Selected Trophic Parameters at Lake Desire*.**

Fish and Wildlife Communities

Lake Desire and the surrounding terrestrial habitat in the watershed support a variety of fish, birds, and animals by providing nesting, forage, and cover.

Fish

A detailed 1999 survey of Lake Desire found the resident fish species to include the warmwater fish: largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), pumpkinseed (*Lepomis*

gibbosus), yellow perch (*Perca flavescens*), and brown bullhead (*Ameiurus nebulosus*) (Downen & Muller, 2000). The most abundant salmonid found during that survey was rainbow trout (*Oncorhychus mykiss*); also found were cutthroat trout (*Oncorhychus clarki*) (one fish) and coho salmon (*Oncorhychus kisutch*) (three fish) (Downen & Muller, 2000).

Historically Lake Desire had been managed for recreational trout fishing. In 1955 fishermen on Lake Desire had a catch limit of seven fish per day (Spokesman-Review, 1955). In 1968 and 1972 the lake was treated with rotenone to remove warm water sport fish to improve trout fishing(Downen & Muller, 2000; O'Neal et al, 2001). In the mid 1980s five pound trout were caught at Lake Desire (T. Sieger, pers. comm., March 29, 2011). While coho salmon have been found in the stream leading out of Lake Desire as close as one mile from the lake, it is not known if the fish regularly make it all the way to the lake (King County, 2003).

Lake Desire is stocked with approximately 7,000 rainbow trout (8-12 inches long) in mid- to late-March, and provides a popular fishery until June (Region 4 Customer Service, Washington State Department of Fish and Wildlife, pers. comm., April 6, 2011). Lake Desire is open all year to recreational fishing but most of the visits likely occur during the spring, just after stocking occurs. Lake Desire falls under the General Statewide Regulations for limits and size restrictions set by Washington Department of Fish and Wildlife (WDFW).

Birds

Birds are attracted to Lake Desire due to the mix of forest, wetland, and open water habitats. The residents of Lake Desire have generated a list of 48 species of birds seen at the Lake in the past several years (Table 3). This list includes 7 species of regulatory significance including the great blue heron, bald eagle, osprey, common goldeneye, hooded merganser, pileated woodpecker, and bufflehead.

Table 3 -Lake Desire Bird List*

American Coot	Dark eyed junco	Mallard
American crow	Downy Woodpecker	Osprey
American Gold Finch	Evening grosbeak	Peregrines Falcon
American Robin	Fox sparrow	Pileated woodpecker
Bald Eagle	Flicker	Pine Siskin
Ban tailed pigeon	Fly catcher	Purple finch
Barn Swallow	Golden Kinglet	Red Breasted Nut Hatch
Barred owl	Great Blue Heron	Red tailed hawk
Black Capped Chickadee	Great horned owl	Red winged black bird
Black headed grosbeak	Gull	Sharp shinned hawk
Bufflehead	Hairy wood pecker	Snipe
Canadian Goose	Hooded Merganser	Spotted Towhee
Cedar Waxwing	House wren	Starling
Common Golden eye	House finch	Stellar Jay
Common Merganser	Humming birds	Varied Thrush
Cormorant	King Fisher	Western tanager

***Table compiled by Lake Desire resident Tammie Cooke, 2011

Mammals, Reptiles and Amphibians

A variety of mammals, reptiles and amphibians utilize the Lake Desire watershed during various times in their life cycle. A list compiled by local resident Kathy Shertz demonstrates the range of sightings from the past several years in the Lake Desire area (Table 4). The wildland-urban interface that exists in the watershed provides many opportunities for interaction with these animals, some welcome and some unwelcome by the human residents.

Table 4. Mammals, Reptiles and Amphibians seen in the Lake Desire area

Mammals	
bats	mice
beaver	mountain beaver
black bear	opossum
Black-tailed Deer	raccoon
Cottontail rabbit	river otter
coyote	shrew
Douglas squirrel	Townsend chipmunk
European grey squirrel	wood rat

Reptiles and amphibians	
bullfrogs	red-legged frog
Northwestern garder snake	spotted frog
northwestern salamder	toads
Pacific tree frog	western pond turtle

Information retrieved from Shertz, Kathy. 2004. Lake Desire, Spring Lake, Lake Youngs History and Information. Kathy Shertz, 18533 W Lake Desire Dr SE, Renton, WA.

Characterization of Aquatic Plants in Lake Desire

A very diverse population of plant species can be found in the Lake Desire watershed and includes bog-associated plants in the north, forest plants on Echo Mt. and horticultural plants at private residences. The water body hosts a wide range of plants from emergent species to submersed species. Aquatic vegetation serves a wide array of ecological functions such as supporting food chains, providing habitat for a variety of animal species, intercepting sediments at the upland/water interface, removing toxic compounds from runoff, and providing erosion control/bank stabilization.

The most recent comprehensive aquatic plant survey of Lake Desire occurred on July 24, 1995 as part of a plant-mapping project on 36 lakes carried out by King County's Lake Stewardship Program (King County, 1996). The surveys were conducted by boat using a two-person crew plus a volunteer (or volunteers) when available. Surveyors used GPS to establish shoreline sections between two fixed points. Each shoreline section was characterized by community type, species present, percent cover of community type, and relative species density within a community type. Community types were defined as

emergent, floating, or submergent (Figure 5). Since that survey Katie Messick and other King County staff have added to the list as new plants have been discovered, resulting in the current 23-species list (Table 5). However, the list of grasses, sedges, rushes and other emergent wetland or facultative species may not be complete.

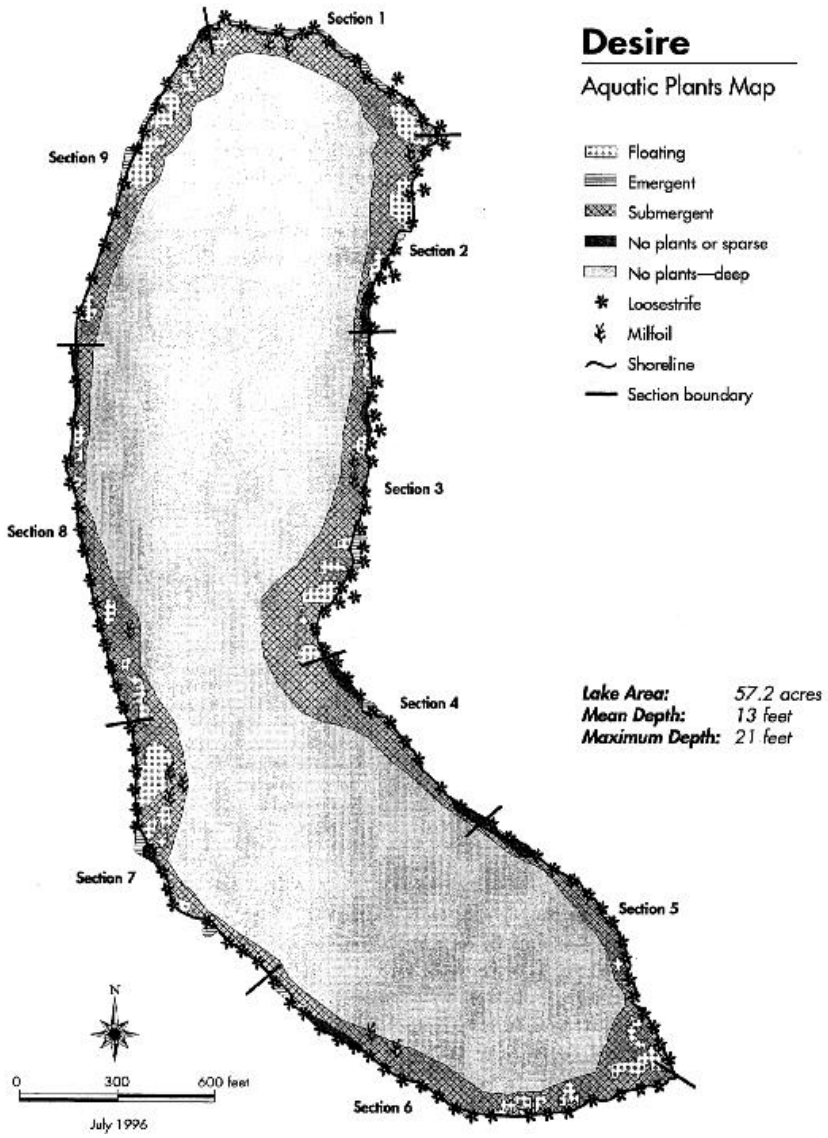

Figure 5. Aquatic Plants at Lake Desire.

Twenty-three plant species (Table 5) have been identified at Lake Desire, including eight emergent types, four floating types, and eleven submergent types:

- **Emergents** are plants that are rooted in the sediment at the water's edge but have stems and leaves which grow above the water surface.
- **Floating** rooted plants are rooted in the sediment and send leaves to the water's surface.
- **Submergent** plants are either freely-floating or are rooted in the lake bottom but grow within the water column.

*Table 5. Aquatic Plants found in Lake Desire 1995-2011**.

Common Name	Scientific Name	Community	Status (and noxious weed class)	Sections Found
watershield	*Brasenia schreberi*	Floating	Native	2, 3, 4, 5, 8
coontail	*Ceratophyllum demersum*	Submersed	Native	1, 2, 5, 6, 7, 9
muskgrass	*Chara sp.*	Emergent	Native	not specified
spike rush	*Eleocharis sp.*	Emergent	Native	2, 3, 4, 7, 9
American waterweed	*Elodea canadensis*	Submersed	Native	1, 2, 4, 5, 6, 7, 8, 9
water moss	*Fontinalis sp.*	Submersed	Native	not specified
reed sweetgrass	*Glyceria maxima*	Emergent	Noxious (Class A)	9
yellow-flag iris	*Iris pseudacorus*	Emergent	Noxious (Class C non-designate)	2, 3, 7, 9
purple loosestrife	*Lythrum salicaria*	Emergent	Noxious (Class B designate)	1, 2, 3, 4, 5, 6, 7, 8, 9
northern watermilfoil	*Myriophyllum sibiricum*	Submersed	Native	not specified
Eurasian watermilfoil	*Myriophyllum spicatum*	Submersed	Noxious (Class B non-designate)	1, 2, 3, 6, 7, 8
naiad, slender water-nymph	*Najas flexilis*	Submersed	Native	5
nitella	*Nitella sp.*	Submersed	Native	1, 5
spatterdock	*Nuphar lutea*	Floating	Native	1, 2, 3, 4, 5, 7, 8, 9
fragrant waterlily	*Nymphaea odorata*	Floating	Noxious (Class C non-designate)	1, 2, 3, 4, 5, 6, 7, 8, 9
ribbon-leaf pondweed	*Potamogeton epihydrus*	Submersed	Native	not specified
floating-leaved pondweed	*Potamogeton natans*	Floating	Native	not specified
small pondweed	*Potamogeton pusillus*	Submersed	Native	1, 2, 3, 4, 6, 7, 8
flat-stem pondweed	*Potamogeton zosteriformis*	Submersed	Native	4, 5
marsh cinquefoil	*Potentilla palustris*	Emergent	Native	1, 2, 3, 4, 6, 7, 9
hardhack	*Spiraea douglasii*	Emergent	Native	1, 3, 4
cattail	*Typha latifolia*	Emergent	Native	1, 2, 3, 4, 5, 6, 7, 8, 9
common bladderwort	*Utricularia vulgaris*	Submersed	Native	not specified

*Plant list based on a July 1995 survey and added to up until summer 2011 by King County Staff.

Noxious Weeds at Lake Desire

Table 5 includes the 23 aquatic plant species found at Lake Desire within the past 16 years. Included in this table are the five listed noxious weed species: Eurasian watermilfoil (*Myriophullum spicatum*), purple loosestrife (*Lythrum salicaria*), reed sweetgrass (*Glyceria maxima*), fragrant water lily (*Nymphaea odorata*) and Yellow flag iris (*Iris pseudacorus*). These first four species will be the focus of the plant management efforts on Lake Desire. The term "noxious weed" refers to those non-native plants that are legally defined by Washington State's Noxious Weed Control Law (RCW 17.10) as "highly destructive, competitive, or difficult to control once established". Noxious weeds have usually been introduced accidentally as a contaminant, or as ornamentals. Non-native plants often do not have natural predators (i.e. herbivores, pathogens) or strong competitors to control their numbers as they may have had in their home range. The King County Noxious Weed Board has designated purple loosestrife (*Lythrum salicaria*) and reed sweetgrass (*Glyceria maxima*) as regulated noxious weeds, meaning their control and/or eradication is required. Eurasian watermilfoil (*Myriophullum spicatum*), fragrant water lily (*Nymphaea odorata*) and Yellow flag iris (*Iris pseudacorus*) are listed noxious weeds, however their control is not required by the King County Noxious Weed Board because they are already widespread in the county.

Surveys for noxious weeds specifically have occurred since the aquatic plant survey done by King County staff in 1995 (Table 4 and Figure 5). The King County Noxious Weed Control Program has been annually monitoring the distribution of *L. salicaria* at Lake Desire since 1996.

Recent surveys and mapping have documented the current location of the noxious weeds at Lake Desire (Figure 6). During the summer of 2011 Lake Desire was surveyed for *L. salicaria*, *G. maxima*, and *M. spicatum*. An aquatic survey of *L. salicaria* was conducted on August 2, 2011 by two King County Noxious Weed Staff, Ann Stevens and Ben Peterson. The survey was conducted by canoe using a Global Positioning System (GPS) receiver. Information gathered was then transferred to and compiled in the Geographic Information System (GIS) program ArcMap 9.3.1.

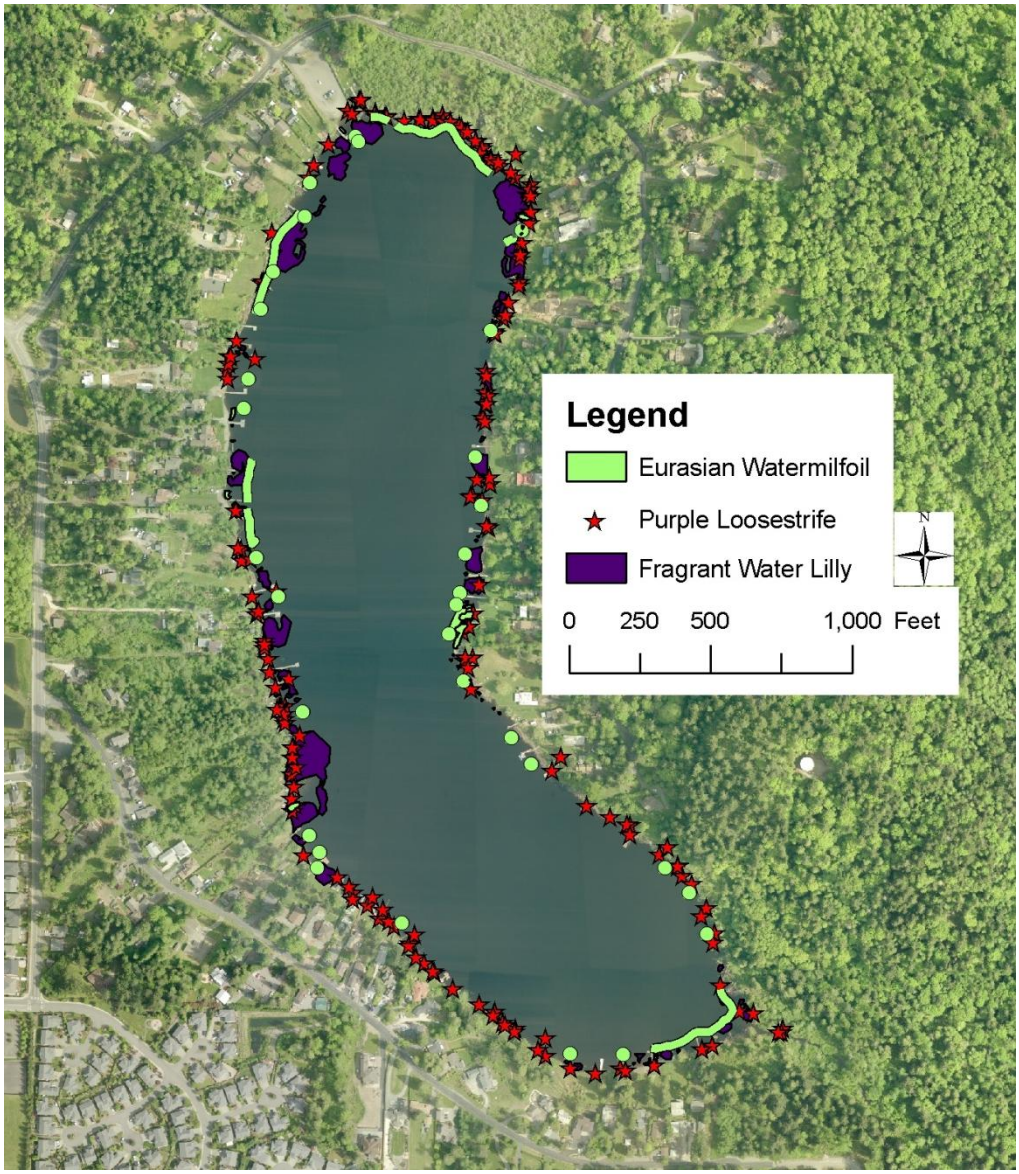

***Figure 6. Aquatic Noxious Weeds at Lake Desire 2011*.**

A survey of the location and density of *M. spicatum* was conducted on August 30, 2011 by Sally Abella, Lake Ecologist for King County, and Ben Peterson of King County Noxious Weeds. This survey was conducted by canoe using a Global Positioning System (GPS) receiver as well as hand mapping. Due to the changeable nature of the *M. spicatum* population the data from the 2011 survey has been combined with a survey done by King County staff in the summer of 2010. The location and amount of *N. odorata* has been mapped based on summer 2009 high resolution air photos taken of the lake. *I. pseudacorus* was not mapped because it is not a target of this management plan and *G. maxima* was not mapped because the infestation has been eradicated.

Eurasian watermilfoil

Eurasian watermilfoil (*Myriophyllum spicatum*) is a submersed aquatic noxious weed that proliferates to form dense mats of vegetation in the littoral zone of lakes. The plant was first found at Lake Desire in 1979 (King County 1996). It reproduces by fragmentation, and those fragments can "hitch-hike" on boat

trailers from one lake to another. This noxious weed can degrade the ecological integrity of a water body in a few growing seasons. Dense stands of milfoil crowd out native aquatic vegetation, which in turn alters predator-prey relationships among fish and other aquatic animals. *M. spicatum* can also reduce dissolved oxygen: first, by inhibiting water circulation in areas where it grows, and second, by oxygen consumption from bacteria decomposing dead plant material. The decomposition of *M. spicatum* also adds nutrients to the water that can contribute to increased algal growth connected with water quality problems. Further, dense mats of *M. spicatum* can increase water temperature by absorbing sunlight, create mosquito breeding areas, and negatively affect recreational activities such as swimming, fishing, and boating. Finally, *M. spicatum* presence in a lake has been found to significantly decrease property values (on average over $50,000 less) on lakefront homes in King County (Tamayo & Olden, 2010).

Purple loosestrife

Purple loosestrife (*Lythrum salicaria*) is an emergent aquatic noxious weed that degrades native wetland plant communities. Purple loosestrife can quickly adapt to environmental changes and expand its range to replace native plants used for ground cover, food, or nesting material. This noxious weed species has colonized the shoreline of most of the lake, including Wetland 15 (at the north end of the lake) and threatens to disperse further into the wetland if not controlled. The purple loosestrife infestation surrounding Lake Desire has been known to be extensive for years (King County 1996). The plant threatens to lower plant diversity and can also alter hydrologic dynamics through sediment accretion along the shoreline. This emergent weed fails to provide the same forage and habitat for birds, mammals, and invertebrates as provided by native plant communities. So far, purple loosestrife has not been observed one and a half miles downstream at the Peterson Lake Park Natural Area; however, the threat of infestation remains as long as the infestation at Lake Desire exists. Purple loosestrife produces prolific seed (up to two million seeds per mature plant) that could easily be transported downstream to pollute this valuable resource.

Reed sweetgrass

Reed sweetgrass (*Glyceria maxima*) is a tall aquatic grass that grows along the margins of lakes, rivers, and streams. Native to Europe and Asia, reed sweetgrass has only been known to occur in a few isolated locations in Washington, in King and Snohomish Counties. In 2010 a small area of reed sweetgrass was found at the north shoreline of Lake Desire. Because of this limited distribution and great potential to cause ecological damage, reed sweetgrass is a Class A Noxious Weed in King County and its eradication is required by law. Growing to over 6 feet tall and ranging from the shore to water 6 feet deep, reed sweetgrass can completely dominate a wetland to the exclusion of all other vegetation once established. This grass is an inferior food and nesting source for waterfowl compared with the species it displaces and it also changes the macroinvertabrate community structure, which can impact the food chain for fish and wildlife. Fortunately, *G. maxima* is fairly easy to kill, and herbicide applications in 2010 and 2011 may have eradicated it from Lake Desire. However, monitoring must continue to make sure it does not return.

Fragrant water lily

Fragrant water lily (*Nymphaea odorata*) is also affecting the waterbody, and is quickly expanding its distribution in the lake. When uncontrolled, this species tends to form dense monospecific stands that can persist until senescence in the fall. Mats of these floating leaves prevent wind mixing and extensive areas of low oxygen can develop under the water lily beds in the summer. Dense mats can also increase water temperature, and the warm, shallow stagnant water among them creates perfect mosquito breeding

habitat. Water lilies can restrict lakefront access and hinder swimming, boating, and other recreational activity. They may also limit the distribution of our native water lily (*Nuphar polysepala*) which occupies the same niche and provides food and habitat for a variety of animals and fish. The fragrant water lily is still expanding in patches on Lake Desire, and so its current impacts are somewhat less evident. As soon as these patches connect, recreational activities such as boating, fishing, and swimming will become more difficult. Even canoes can have great difficulty moving across dense floating mats of fragrant water lily, not to mention entanglement with propellers of electric motors.

Yellow flag iris

Yellow flag iris (*Iris pseudacorus*), native Europe and the Mediterranean region, (Washington State Noxious Weed Control Board, 2001a) was introduced as a garden ornamental and erosion control. The yellow flowers are a distinguishing characteristic, but when not flowering it may be confused with cattail (*Typha sp.*) or broad-fruited bur-reed (*Sparganium eurycarpum*). Yellow flag iris is considered an obligate wetland species (OBL), with a >99% probability of occurring in wetlands as opposed to upland areas (Reed, 1988). The plants produce large fruit capsules and corky seeds in the late summer. Yellow flag iris spreads by rhizomes and seeds. Yellow flag iris can spread by rhizome growth to form dense stands that can exclude even the toughest of our native wetland species, such as *Typha latifolia* (cattail). This noxious weed is well established at Lake Desire, growing in locations around the lake. In addition to threatening to lower plant diversity, yellow flag iris can also alter hydrologic dynamics through sediment accretion along the shoreline. Yellow flag iris has not yet been observed downstream at the Peterson Lake Park Natural Area (King County, 1999). This species produces prolific seed that could easily be transported downstream to invade this valuable resource area.

Because yellow flag iris is so prolific at the lake and so difficult to control, the plant is <u>not a target of this management plan</u>. However, individual homeowners are encouraged to take up control of yellow flag iris on their own. See appendix 5 for the Yellow-flag iris Best Management Practices document that describes the plant in-depth and reviews control techniques.

Noxious weed control history at Lake Desire

While noxious weeds have been an issue at Lake Desire for many years, a coordinated control effort has been slow to form. While no lake-wide efforts have targeted submersed or floating noxious weeds at Lake Desire, some individual land owners have targeted plants on their waterfront. Techniques employed by land owners have included cutting, raking and weedmats, all which can control submersed and floating plants but not eradicate them. See the Management Alternatives chapter later in this document for more details on these control methods.

The King County Noxious weed control program (KCNWCP) has been surveying the distribution of purple loosestrife at the lake since 1996. Annually, King County staff work with Lake Desire residents to ensure that all purple loosestrife plants are controlled. However due to varying levels of cooperation by land owners as well as the large extent of the purple loosestrife infestation, the overall extent of the plants distribution has not diminished.

In addition to working with individual property owners, the KCNWCP has on three occasions released *Galerucella* beetles, a species specific biological control agent for purple loosestrife (see the biocontrol

section later in this document for more details on *Galerucella* beetles) (Roy Brunskill, KCNWCP, pers. comm., September 22, 2011). *Galerucella* beetles were released at the Lake Desire boat launch in July of 2000 and 2001, as well as at King County property on the southeast side of the lake in August 2005. While the beetles are still present at the lake and can be found on purple loosestrife plants, they have produced inconsistent control of the plants. This lack of control could be due to patchy nature of the distribution of purple loosestrife plants at Lake Desire. Control using *Galerucella* beetles is most effective in large, dense, contiguous patches of the plant where remaining flower heads/seed heads are regularly removed.

Control and monitoring of reed sweetgrass at Lake Desire has been handled by the King County Noxious weed Control Program. The patch reed sweetgrass which is growing in the northwest corner of the lake has been treated with an aquatic approved version of glyphosate herbicide in the late summer of 2010 and 2011. In 2010 reed sweetgrass was estimated to cover 500 square feet. Following the 2010 herbicide treatment the area of reed sweetgrass had reduced to 10 square feet by the summer of 2011. The last 10 square feet of the grass was treated with glyphosate herbicide on September 19, 2011. The King County Noxious Weed Control Program will continue to monitor (and treat with herbicide as necessary) the reed sweetgrass at the lake.

Section 6 - Management Alternatives

A wide variety of control methods have been developed to address the general problem of aquatic noxious weeds. The suitability of control methods for specific plants, such as purple loosestrife or Eurasian watermilfoil, varies widely. All know control options (aquatic herbicide, manual control methods, mechanical control methods, environmental manipulation, biological control) have been considered and evaluated for each noxious weed species as it relates to the conditions at Lake Desire (table 6). This matrix separates potential control methods into those that warrant further investigation (either for whole-lake treatment or for small-scale temporary control) and those methods that are not applicable in Lake Desire.

A detailed description of all known control methods, advantages, disadvantages, costs, and suitability at Lake Desire can be found in Appendix 2 –Control Methods Options. From this document table 6 was created. The discussion below describes control methods that warrant further consideration, both at the large scale (whole lake treatment) or small scale (private property waterfront).

Table 6. Summary of Management Alternatives **–page 1.**

broad control method category	Specific method	compatible with Lake Desire water body characteristics	effectiveness for purple loosestrife	further consideration?	effectiveness for fragrant water lily	further consideration?	effectiveness for Eurasian watermilfoil	further consideration?
Manual and Environmental Manipulation Control Methods	Hand pulling	yes	effective in some situations, can be part of an IPM solution	**YES***	not practical for a large area, can be useful for individuals to maintain open water in small areas	no*	not practical, causes fragmentation	no*
	diver hand pulling	yes	not relevant	no	not relevant	no	not practical for initial control, but can be an important part of follow-up control in an IPM solution	**YES**
	raking	yes	not relevant	no	not relevant	no	not practical, causes fragmentation	no
	bottom barriers	area of infestation too large	can suppress growth in some situations, but will not eradicate.	no*	not practical for a large area, can be useful for individuals	no*	not practical for a large area, can be useful for individuals	no*
	water level drawdown	not possible	not relevant	no	not relevant	no	not relevant	no
Mechanical Control Methods	Cutting	yes	when cut at the base at flower-drop, will control the plant for the year. Will not eradicate. Can be part of an IPM solution	**YES***	effective for short term control of small areas, must be done frequently. Will not eradicate	no*	will not control, may spread infestation	no*
	Harvesting	can't be done around docks, logs and other in-water obstructions	not relevant	no	effective for short term control of large infestations. Expensive. Must be done frequently.	no	effective for short term control of large infestations. Will spread smaller infestations.	no
	Rotovation	Difficult around docks, logs and other in-water obstructions	not relevant	no	will fragment rhizomes and may spread infestation	no	will cause extensive fragmentation and spread infestation	no
	Diver dredging	yes	not relevant	no	not relevant	no	uses a suction dredge to remove plants from soil. Expensive. Can cause fragmentation and spread of infestation	no
	Sediment dredge	Difficult around in-water obstructions, causes water quality issues and fish habitat degradation	not relevant	no	can be effective. Causes severe short-term water quality disturbance. Requires extensive permits. Very expensive	no	will not control, may spread infestation	no
	Sediment agitation (weed rollers)	yes	not relevant	no	Useful around individual docks, but not relevant for larger infestation control	no*	Useful around individual docks, but not relevant for larger infestation control	no*
Biological Control Methods	grass carp	Not suitable for Lake Desire because the lake has an outlet through which the fish could escape.	not relevant	no	not relevant	no	Grass carp will eat Eurasian watermilfoil but only after they eat most of the other plants in the lake. Inefficient and environmentally costly.	no
	Galerucella beetles for purple loosestrife	yes	already on site. Not effectively reducing population. Must be combined with manual control of seeds.	**YES**	not relevant	no	not relevant	no

* starred methods can be employed by individual property owners for small-scale temporary control

Table 6. Summary of Management Alternatives –page 2.

broad control method category	Specific method	compatible with Lake Desire water body characteristics	effectiveness for purple loosestrife	further consideration?	effectiveness for fragrant water lily	further consideration?	effectiveness for Eurasian watermilfoil	further consideration?
Biological Control Methods	Other biocontrol agents for purple loosestrife: seed and root feeding weevils	yes	Not as easy to come by as Galerucella beetles. Not currently on site. Would take several years for populations to build up to controlling levels. Would have to be combined with manual control of seeds	**YES**	not relevant	no	not relevant	no
	milfoil weevils	Not suitable for Lake Desire due to presence of weevil predators (sunfish) in the lake.	not relevant	no	not relevant	no	may be effective if a reproducing population can be established. This requires proper shoreline habitat and a lack of predators	no
Chemical Control	Diaquat	not suitable because it does not kill plant roots	not relevant	no	not relevant	no	will kill plants but roots remain intact, able to re-re sprout. Does not eradicate the plant.	no
	Endothall	not suitable because it does not kill plant roots	not relevant	no	not relevant	no	will kill plants but roots remain intact, able to re-re sprout. Does not eradicate the plant.	no
	Fluridone	not suitable because it requires whole-late treatment	not relevant	no	not relevant	no	will control milfoil down to the roots however it controls large areas at a time and is not suitable for the spot treatment needed for the plants at Lake Desire	no
	Glyphosate		not desirable for purple loosestrife control; it is non-selective and monocots (cattails, grasses, and sedges) may be un-intentionally damaged in during spraying	no	Aquatic formulations can be very effective when applied by a skilled contractor. Can result in dead, floating root mats that may need to be dealt with.		not relevant	no
	Imasapyr	usable at Lake Desire but other herbicides are more cost effective and work just as well	not desirable for purple loosestrife control; it is non-selective and monocots (cattails, grasses, and sedges) may be un-intentionally damaged in during spraying	no	not relevant	no	not relevant	no
	Triclopyr	aquatic formulations are compatible for use	Very effective, if properly applied. Selective: won't harm monocots (cattails, grasses, and sedges)	**YES**	not relevant	no	The Triclopyr TEA formulation can be very effective if properly applied and concentrations are maintained for the required time period.	**YES**
	2,4-D	Some are compatible	not relevant	no	Very effective, if correct chemical is properly applied	**YES**	Very effective, if correct chemical is properly applied	**YES**

* starred methods can be employed by individual property owners for small-scale temporary control

A word about Integrated Pest Management

The preferred approach for weed control is Integrated Pest Management (IPM). IPM involves selecting from a range of possible control methods to match the management requirements of each specific site. The goal is to maximize effective control and to minimize negative environmental, economic and social impacts. IPM uses a multifaceted and adaptive approach. Control methods are selected that reflect the available time, funding, and labor of the participants, the land use goals, and the values of the community and landowners. Management of noxious weed problems will require dedication over a number of years, and should allow for flexibility in method as appropriate.

Reed sweetgrass (*Glyceria maxima*)

The tall aquatic grass reed sweetgrass has infested a small area of shoreline in the northwest corner of the lake. Reed sweetgrass responds well to glyphosate herbicide (*see Appendix 4 for herbicide label*). The patch at Lake Desire has been treated with an aquatic approved version of glyphosate herbicide in the late summer of 2010 and 2011. In 2010 reed sweetgrass was estimated to cover 500 square feet. Following the 2010 herbicide treatment the area of reed sweetgrass had reduced to 10 square feet by the summer of 2011. The last 10 square feet of the grass was treated with glyphosate herbicide on September 19, 2011. The King County Noxious Weed Control Program (KCNWCP) will continue to monitor, and treat with herbicide as necessary, the reed sweetgrass at the lake. Reed sweetgrass is well on its way to eradication at Lake Desire, therefore no further discussion of control methods is needed.

Purple loosestrife (*Lythrum salicaria*)

For more information on the following purple loosestrife control methods reference Appendix 2 -Control Method Options and Appendix 5 – Purple Loosestrife Best Management Practices document.

Hand Pulling (only suitable for small areas or used in combination with other methods)

Hand pulling or digging of purple loosestrife plants is possible in areas where plants are growing out of soft substrate and the root mass of the plants are reachable. The entire root mass must be removed, bagged, and disposed of. Plants that are growing in rock or riprap, in amongst large downed wood, or amongst woody vegetation may not be able to be completely removed using this method. Additionally, while hand pulling may be feasible in the small scale, using hand pulling and digging on the lake-wide scale would be prohibitively expensive. Using hand pulling and digging methods to control purple loosestrife may work at Lake Desire only if it is part of an IPM solution that incorporates several control tactics such as bio control, long-term persistent cutting, weed mats and selective herbicide use.

Bottom Barriers/Weed Mats (only suitable for small areas)

The use of thick cardboard or plastic, staked down, and covered by six inches of mulch to cover closely cut purple loosestrife plants can prevent seed spread but will not eradicate the plant. Weed mats are only an option where the terrain is flat soil and not interrupted by logs, other vegetation, or rock. Weed mats also need to be checked often because they can become damaged and will need to be repaired or re-installed. Using weed mats to control purple loosestrife may work at Lake Desire only if it is part of an IPM solution that incorporates several control tactics such as hand pulling, bio control, long-term persistent cutting, and selective herbicide use.

Cutting (used in combination with other methods)

Cutting plants at the base when in flower may prevent seeding, but cut plants may continue to produce flowers. Sites should be consistently and regularly monitored until frost to cut and remove any subsequent flowers. Cutting will not kill the plants, and they will need to be controlled every year. Care must also be taken to properly dispose of root and stem fragments to prevent the growing of new plants. Cut plant parts must not be left on site, because root and stem fragments can take root and form new plants. Using cutting to control purple loosestrife may work at Lake Desire only if it is part of an IPM solution that incorporates several control tactics such as hand pulling, bio control, weed mats, and selective herbicide use.

Biological Control (used in combination with other methods)

Purple loosestrife population density and the number of flowering plants can be reduced, but there will always be some plants remaining when using biological control agents. Releases should be made only at sites where loosestrife infestations are large and immediate eradication of the weed is not the primary objective. Biological control can take up to six years to have a significant impact on the infestation.

Galerucella beetles have been released at Lake Desire several times in the past (see Chapter 5 Watershed and Waterbody Characteristics: Noxious Weeds at Lake Desire). *Galerucella* beetles are already on site but have not been able to effectively reduce the purple loosestrife infestation. The use of *Galerucella* beetles needs to be combined with the removal and bagging of plant flowers.

Other biocontrol methods that target purple loosestrife, such as use of seed feeding weevils and root feeding weevils, are more difficult to obtain than *Galerucella* beetles. They have not yet been tried at Lake Desire. If released they would take several years to build up populations to levels that would result in a significant impact on the population. The use of seed feeding weevils and root feeding weevils for purple loosestrife control needs to be combined with the removal and bagging of plant flowers. By its nature, biocontrol methods will at best result in reduced infestation of the target plant but not result in eradication.

Chemical Control

For large infestations of purple loosestrife, herbicide use may be necessary for effective control. The application of herbicide to the emergent purple loosestrife is best conducted by manual spot applications. Control of purple loosestrife is most effectively achieved using a selective herbicide such as an aquatic approved version of triclopyr or 2,4-D (*see Appendix 4 for herbicide label*). Triclopyr-TEA in particular has been very effective in killing purple loosestrife plants and has the lowest human and ecological side effects. Selective herbicides also have the advantage of not harming monocot plants (cattails, grasses, sedges, etc). These aquatic herbicides must be used with a Washington State Department of Ecology approved aquatic surfactant.

An experienced and licensed aquatic herbicide applicator can selectively target individual emergent weed species and limit collateral damage to other species to a minimum. This is especially true when infestations are small so that large areas with a diverse plant distribution don't have to be treated. Since the emergent noxious weed infestations at Lake Desire are still confined largely to the shoreline, it should be relatively simple for the applicator to avoid significant collateral damage and preserve the native plant community.

Treatment of purple loosestrife will likely have to occur twice during the growing season in order to ensure that no plants were missed as the vegetative part of the plants can be hard to spot among other vegetation. In sensitive areas or areas prone to erosion, careful spot-spraying will create fewer disturbances than manual or mechanical control. For several years following treatment, areas should be monitored for new plants germinating from the seed bank. In some cases several years of treatment may be necessary.

Fragrant water lily (*Nymphaea odorata*)

For more information on the following fragrant water lily control methods reference Appendix 2 -Control Method Options and Appendix 5 – Fragrant Water Lily Best Management Practices document.

Hand Pulling and cutting (only suitable for small areas)

Hand pulling and cutting can be used to temporarily control fragrant water lily in a small area, such as around a dock, if repeated on a regular basis. Hand pulling will likely not eradicate the plant from a water body and *is impractical for large infestations*. While cuttings won't increase the spread of fragrant water

lily, all pulled or cut plants and plant parts must be removed from the water, and an HPA pamphlet permit required. Several years of monitoring are needed for signs of plants growing from root fragments and from the seed bank. Fragrant water lily can be composted on dry land or placed in yard waste bins.

Bottom Barriers (only suitable for small areas)

An opaque bottom barrier can be used to suppress water lily growth in small, areas such as boat launch or around a swimming area. Barriers need to be regularly cleaned and maintained because plants will root in the sediment that accumulates on top of them. Bottom barriers are not practical for large-scale infestations such as the whole of Lake Desire.

Sediment Agitation (Weed Rolling) (*only suitable for small areas*)

Weed rolling is a suitable way to temporarily control, *not eradicate*, water lily in a small discrete area such as at the end of a dock but is not suitable for any larger area. Weed rolling involves the use of a commercially available, low voltage power unit that drives an up-to-30-foot long roller set on the lake bottom through an adjustable arc of up to 270 degrees. A reversing action built into the drive automatically brings the roller back to complete the cycle. Fins on the rollers detach some plants from the soil, while the rollers force other plants flat, gradually inhibiting growth. *Detached plants should be removed from the water with a rake or gathered by hand.* Once plants are cleared from the area, the device can be used as little as once per week or less to keep plants from re-colonizing the area. Weed rolling is not applicable to lake wide infestation.

Chemical Control

Chemical methods used to control fragrant water lily can be very effective and are appropriate for whole-lake treatments. The most effective herbicide and environmentally low toxic herbicide suitable is an aquatic version of glyphosate (*see Appendix 4 for herbicide label*). This aquatic herbicide must be used with a Washington State Department of Ecology approved aquatic surfactant. Glyphosate is applied directly to the floating leaves through precise foliar spraying by an approved aquatic herbicide contractor. Foliar application of the herbicide reduces the chance that the herbicide will come in contact with and affect non-target plants. Glyphosate also has the advantage of working through translocation whereby the chemical gets moved through the plant and kills the plant to the roots.

Spraying of plants will need to occur twice during the growing season to ensure that no plants were missed. It is expected that herbicide treatment will occur over a two year period. The control effectiveness of fragrant water lily is easy to measure through visual surveys due to the floating leaves.

A drawback of using herbicide to control water lily is the potential for "uplifting" of mats of decomposing water lily roots that can form floating islands in the lake after the plants have died. Most of the water lilies at Lake Desire are in small, discrete circular patches as opposed to large monospecific stands. These smaller areas may not generate floating sediment mats because of their size, but there are several places in Lake Desire with a larger area covered with fragrant water lily. Note that natural decay of fragrant water lily patches can also often create these floating mats. Removal of these mats from the lake is possible using manual or mechanical means (generally involving towing the mats to a take-out point and cutting them up with hand tools or larger machinery). At minimum, a Hydraulic Project Approval (HPA) permit from the Washington Department of Fish and Wildlife will be required to remove the mats. Other permits may also be required.

Eurasian watermilfoil (*Myriophyllum spicatum*)

For more information on the following Eurasian watermilfoil control methods reference Appendix 2 - Control Method Options and Appendix 5 – Eurasian Watermilfoil Best Management Practices document.

Hand Pulling and cutting (only suitable for small areas)

Hand pulling can be used to temporarily control Eurasian watermilfoil in a small area if repeated on a regular basis. Hand pulling will likely not eradicate the plant from a water body and *is impractical for large infestations*. All pulled plant parts must be removed from the water, and an HPA pamphlet permit required. Several years of monitoring are needed for signs of plants growing from root fragments and from the seed bank. Milfoil can be composted on dry land or placed in yard waste bins. Cutting of milfoil is not recommended as it will likely increase the infestation through fragmentation.

Diver Hand Pulling (suitable for small areas or follow-up control)

Diver hand pulling involves the use of divers to carefully pull and bag entire milfoil plants. Divers are able to target just milfoil plants and carefully search the area for missed plants. This method, while likely too expensive for whole lake initial control of milfoil, can be used in smaller areas. Diver hand pulling is also an excellent follow-up to chemical control as a way to get missed plants after a year or two of treatment.

Bottom Barriers (only suitable for small areas)

An opaque bottom barrier can be used to suppress milfoil growth in small, discrete areas like at a boat launch or around a swimming area. Barriers need to be regularly cleaned because plants will root in the

sediment that accumulates on top of them. Bottom barriers are not practical for large-scale infestations such as the whole of Lake Desire.

Sediment Agitation (Weed Rolling) (*only suitable for small areas*)

Weed rolling is a suitable way to temporarily control, *not eradicate*, milfoil in a small discrete areas such as a dock end but is not suitable for any larger area. Weed rolling involves the use of a commercially available, low voltage power unit that drives an up-to-30-foot long roller set on the lake bottom through an adjustable arc of up to 270 degrees. A reversing action built into the drive automatically brings the roller back to complete the cycle. Fins on the rollers detach some plants from the soil, while the rollers force other plants flat, gradually inhibiting growth. *Detached plants should be removed from the water with a rake or gathered by hand.* Once plants are cleared from the area, the device can be used as little as once per week or less to keep plants from re-colonizing the area. Weed rolling is not applicable to lake wide infestation.

Chemical Control

The use of a formulation of 2,4-D DMA or triclopyr-TEA can provide excellent initial control of the Eurasian watermilfoil (*see Appendix 4 for herbicide label*). Use of these herbicides, while applied to the water column, can be applied in the specific areas where the milfoil plants are growing, thus targeting only those plants and leaving the surrounding native submerged plants largely undisturbed. An expensive and riskier (to non-target plants) lake-wide treatment with fluridone for control of Eurasian watermilfoil is un-necessary because of the scattered nature of the infestation.

The loose sediments in Lake Desire are high in organic content and are flocculent around much of the lake's littoral zone. There is some concern that the granular formulations of 2,4-D BEE may settle by gravity into these sediments, which could inhibit the release of the 2,4-D to the water column. If this was the case, the predicted level of control of Eurasian watermilfoil would not be achieved because the concentrations released to the water column may not be high enough to kill the plants. Determination of which form of the herbicides is used (liquid, pellet, or granular) will be most effective at Lake Desire can be made on the recommendation of experienced and licensed aquatic herbicide applicators.

Triclopyr-TEA use for submerged plant situations requires careful monitoring of herbicide concentration levels over an extended time period to make sure that the concentration is high enough to kill the targeted plants but not so high as to cause adverse side effects. Two treatments may be required to keep the herbicide concentration at the appropriate level for the desired time period.

Regardless of what chemical is used, it is expected that herbicide treatment will occur over a two year period. The control effectiveness of Eurasian watermilfoil requires careful surveying and will need to be done following each herbicide treatment.

Section 7 – Integrated Treatment Plan

Lake Desire and its associated shoreline contain four listed noxious weed species whose presence has diminished the quality of Lake Desire as an ecological and human resource. The goal of the treatment plan is to halt and reverse the degradation caused by the targeted plants. The three wide spread target species, Eurasian watermilfoil (*Myriophyllum spicatum*), fragrant water lily (*Nymphaea odorata*) and purple loosestrife (*Lythrum salicaria*), each require different treatment and monitoring techniques. Reed sweetgrass (*Glyceria maxima*) is well on its way to eradication at Lake Desire, therefore no further discussion of control methods is needed (see: SECTION 6 - MANAGEMENT ALTERNATIVES). Although all these four species at Lake Desire are highly aggressive and are difficult to control and eradicate, the goal of eradication is reasonable for all of them and may be achieved within the 6-year timeframe of the project. All methods suggested combine to form an Integrated Pest Management (IPM)strategy that is a balance between target weed eradication and environmental protection.

Permits

Most aquatic weed control activities require permits. Many manual and mechanical control methods are covered under the "Aquatic Plants and Fish" pamphlet, a Hydraulic Project Approval (HPA) from the Washington Department of Fish and Wildlife that is free of charge and expedites the removal aquatic of noxious weeds. This HPA pamphlet permit applies only to use by individual land owners, not the whole lake, and only applies to aquatic noxious weeds, not "beneficial plants" or native plants that may be seen as weeds. A National Pollutant Discharge Elimination System (NPDES) permit must be obtained before aquatic herbicides can be applied to natural water bodies in Washington State (including Lake Desire). The Washington Department of Agriculture holds an NPDES permit for the management of noxious weeds growing in wet areas such as lake shores, freshwater wetlands, river banks, and estuaries. Licensed applicators can obtain coverage under this permit free of charge. For herbicide treatment of in-lake plants (floating or submersed weeds) the project will need an Aquatic Plant and Algae Management NPDES permit from the Washington Department of Ecology. This permit must be held by the herbicide applicator or the legal entity hiring the applicator, it must be applied for at least sixty days before the herbicide application, and a permit fee applies. In 2011 the permit fee was $415.

The schedule laid out below is tentative and will be reassessed each year depending on the density and distribution of milfoil plants found during surveys. Large or dense milfoil beds will generally be treated using herbicide, but when surveys indicate sparse milfoil coverage, diver pulling will be employed.

purple loosestrife (*Lythrum salicaria*)

Initial control (year 1)

A pre-treatment survey of purple loosestrife will occur in late July or early August. The survey will be conducted by King County staff from a small boat and all plants will be mapped.

Initial control of purple loosestrife will be accomplished using a selective aquatic herbicide formulation of triclopyr (e.g.: Renovate3 ™) (*see **Appendix 4** for herbicide label*). The herbicide will be applied by a licensed aquatic herbicide contractor using boat mounted spot spraying equipment or a backpack sprayer. Treatment of purple loosestrife plants will occur in mid August, once most of the plants have flowered. A contractor will be able to accurately spot spray purple loosestrife plants on shore, avoiding non-target plants.

In early September the entire lake shore will be surveyed again for purple loosestrife to determine the thoroughness of the herbicide treatment.

As necessary, a second spot treatment of purple loosestrife using herbicide will be scheduled for mid September. Additionally, hand removal of any remaining purple loosestrife flowers or seed heads will be conducted by Lake Desire community volunteers or individual property owners by mid September.

Follow-up control (year 2- 4)

Purple loosestrife control in years two, three, and four will use a combination of herbicide treatment and hand pulling follow-up. Pre-treatment surveys of purple loosestrife will occur in late July or early August. The survey will be conducted by King County staff from a small boat and all plants will be mapped.

Spot herbicide treatment of persisting purple loosestrife plants will be conducted by a contractor in mid-August. In early September the entire lake shore will be surveyed again for purple loosestrife to determine the thoroughness of the herbicide treatment.

Based on the September survey and mapping, hand removal of any remaining purple loosestrife flowers or seed heads will be conducted by Lake Desire community volunteers or individual property owners by mid September.

Follow-up control (year 5 and 6)

Purple loosestrife will continue to be surveyed and mapped in early August and early September by King County staff. Based on the September survey and mapping, hand removal of any remaining purple loosestrife flowers or seed heads will be conducted by Lake Desire community volunteers or individual property owners by mid September.

fragrant water lily (*Nymphaea odorata*)

Initial control (year 1)

Pre-treatment survey of fragrant water lily is not necessary because the distribution of the plants has been consistent from year to year, and the expected distribution can be based on the past year's summer air photo.

Initial control of fragrant water lily will be accomplished using a broad-spectrum aquatic herbicide formulation of glyphosate (*see **Appendix 4** for herbicide label*). Suitable formulations include, but are not limited to: Rodeo®, AquaMaster®, and AquaPro®. The herbicide will be applied by a licensed aquatic herbicide contractor, on a calm, dry day to ensure good herbicide contact with the plants. Treatment of water lily will occur in June once the water lily plants have fully surfaced for the year but before treatment of milfoil occurs. Once the water lily has been cleared the milfoil plants will be easier to survey and treat.

As necessary, a second spot treatment of water lily will be scheduled for August. A final survey of remaining water lily plants will be conducted during the late summer watermilfoil survey and mapping in early September.

Follow-up control (years 2-6)

Year two and three water lily treatment will consist of spot herbicide treatments in August if needed. A final survey of remaining water lily plants will be conducted during the late summer watermilfoil survey and mapping in early September. It is unlikely that annual herbicide treatment will be necessary after year three, but one more year of spot treatment may be necessary to complete eradication before the end of the project. After several years of herbicide the populations of lily become smaller and cutting may become viable option for the few stubborn patches that remain.

Floating mud mats

When water lilies die, often their root masses will swell with gas and rise to the surface, bringing up all the muck from the bottom of the lake around them. This is a natural process and will occur at the end of the life cycle of a water lily patch whether it died naturally or was controlled using herbicide. Occasionally these mats will sink again on their own, but just as often they will persist and become floating islands of vegetation. Many lake communities choose to leave them in place, but they can also be removed mechanically if desired. This plan provides for the removal of any mud mats that may form during the second and fifth years. If they do form as a result of the water lily control, the community can assess their effect on the lake and decide at that point whether to remove them or leave them in place.

Monitoring

The NPDES permit requires monitoring of herbicide levels in the lake after treatment. Independent samples will be collected at the time of the application and again five days post treatment.

A baseline sample will also be taken before the application, since Water Quality experts at Ecology report heightened levels of herbicides in the lake surface water due to runoff after heavy storm events. One sample is taken from within the treatment area, and one from outside. All samples will be sent to an independent, Ecology-accredited laboratory for the analysis. Samples will continue to be collected and sent for laboratory analysis until the herbicide levels drop below a pre-determined threshold. This procedure will be performed each year an application of herbicide for water lily control is conducted. Surveys after the initial application are essential to determining the success of the effort, and will be used to determine what measures need to be implemented to complete the water lily control for Year 1 (and subsequent years).

Eurasian watermilfoil (*Myriophyllum spicatum*)

Initial control (year 1)

Pre-treatment survey of Eurasian watermilfoil will occur in early to mid-July. The survey will be conducted by King County staff from a small boat using a view tube to survey submerged plants. Plant locations will be recorded using a combination of GPS and sketched marks on detailed aerial photos and later transferred to a GIS file).

Initial control of Eurasian watermilfoil will be accomplished using a selective aquatic herbicide formulation of 2,4-D DMA and/or triclopyr-TEA (*see **Appendix 4** for herbicide label*). Suitable formulations include, but are not limited to: Renovate® OTF (granular triclopyr-TEA), Navigate® (granular 2,4-D) or Renovate ® MAX G (granular triclopyr-TEA + 2,4-D). The herbicide will be applied by a licensed aquatic herbicide applicator at the label-recommended rate.

Initial treatment will occur in mid-July, after the initial treatment of water lily has taken effect and milfoil plants have become visible in the water. Locations to be treated will be based on survey maps, GPS coordinates, and new visual observations of plants seen as the treatment occurs. A record of which areas were treated and amount of herbicide applied will be kept for 7 years, in addition to all other required herbicide application records. A record of herbicide application will also be entered into the Secure Access database through the State of Washington as part of the NPDES permit.

First year follow-up spot treatment will occur in mid-August to early September to control any plants that were missed during the July treatment. The second treatment will occur before milfoil plants are expected to fragment, usually early September.

In September the entire lake will be surveyed for milfoil again to determine the thoroughness of the two rounds of herbicide treatment. The survey will be conducted by King County staff from a small boat

using a view tube to see submerged plants. Any plants found will be mapped. If necessary, plants may be pulled by a dive team or residents from their properties.

Follow-up control (years 2-6)

Each year following the initial treatment will begin with a boat survey of milfoil in early to mid-July. If conditions warrant, one to two rounds of herbicide spot treatment will be scheduled for mid-July and mid to late August. If the milfoil population is small and/or sparse enough so that it can be pulled by divers in one day, contracted divers will hand-pull and carefully bag all milfoil found. A follow-up survey will be done in September regardless of the control method(s) used.

Monitoring

The NPDES permit requires monitoring of herbicide levels in the lake after treatment. Samples will be collected at the time of the application and again five days post treatment. A baseline sample will also be taken before the application, since water quality experts at Ecology report heightened levels of herbicides in the lake surface water due to runoff after heavy storm events. One sample is taken from within the treatment area, and one from outside. These samples will be sent to an independent, Ecology-accredited laboratory for analysis. Sampling and analysis will continue until the herbicide levels drop below a pre-determined threshold. This procedure will be performed each year an application of herbicide for milfoil is conducted.

Surveys after the initial application are essential to determining the success of the effort, and will be used to determine what measures need to be implemented to complete the milfoil control each year.

Plan Elements, Costs, and Funding

Implementation of the Lake Desire IAVMP is scheduled to span six years, at a total estimated cost of $100,248. Table 7 outlines the tasks and estimated costs of implementation on an annual basis. The budget is broken into two three-year segments. This partitioning will allow for more definitive budget strategizing in the short term and adaptive management in the later years of the project. The majority of the costs accrue in the first three years, the period of most aggressive treatment. As the project progresses, more funds are dedicated at detecting and controlling reintroduction of aquatic noxious weed species.

Costs of the Plan

Planning Costs

Many of the planning costs have already been incurred through the creation of this IAVMP. Approximately 75% of the cost of researching, planning for and writing this management plan came in the form of a grant from the Washington State Department of Ecology's Aquatic Weeds Management Fund. The remaining costs came in form of salary match from King County Water and Land Resources Division staff. Additionally several Lake Desire residents contributed their time publicizing the IAVMP process, collecting signatures of support, and reviewing the written document. Total planning costs are estimated at around $20,000.00.

Capital Costs

There are no capital costs associated with this IAVMP. It is not anticipated that any equipment will needed to be purchased.

Operational and Maintenance Costs

The majority of expenses associated with implementation of the Lake Desire IAVMP are operational and maintenance costs. These costs include hiring of herbicide contractors, mapping and surveying, follow-up weed removal, community outreach, and project administration & management (**Table 7**).

Table 7 -Lake Desire IAVMP Budget.

	Task	Year 1	Year 2	Year 3	Year 1-3 total	Year 4	Year 5	Year 6	Year 4-6 total	Total (for 6 years)
Noxious Weed Control	Herbicide Application-Eurasian watermilfoil	$2,000	$1,200		$3,200	$1,400		$1,600	$3,000	$6,200
	Diver and snorkel hand pulling of milfoil		$5,000	$5,300	$10,300		$6,000		$6,000	$16,300
	Herbicide Application - fragrant water lily	$3,000	$1,300		$4,300	$1,500			$1,500	$5,800
	Water lily mat cleanup		$2,400		$2,400		$2,400		$2,400	$4,800
	Herbicide Application - purple loosestrife	$6,000	$3,100	$3,200	$12,300	$3,500			$3,500	$15,800
	aquatic herbicide related water quality testing	$1,200	$1,300		$2,500	$1,000		$1,200	$2,200	$4,700
	Purple Loosestrife follow-up	$1,350	$1,350	$1,350	$4,050	$1,350	$1,350	$1,350	$4,050	$8,100
	Contractor management	$2,300	$1,950	$1,600	$5,850	$1,950		$1,600	$3,550	$9,400
Weed surveys		$1,488	$1,488	$1,488	$4,464	$1,488	$1,488	$1,488	$4,464	$8,928
Education & Outreach	Education and Outreach (volunteers)	$900	$900	$900	$2,700	$900	$900	$900	$2,700	$5,400
	Education and Outreach (King County staff)	$1,060	$1,060	$1,060	$3,180	$1,060	$1,060	$1,060	$3,180	$6,360
Project Administration and Report Writing		$1,760	$1,410	$1,410	$4,580	$1,060	$1,060	$1,760	$3,880	$8,460
	sub totals	$21,058	$22,458	$16,308	$59,824	$15,208	$14,258	$10,958	$40,424	$100,248
			Year 1-3 total		$59,824		**Year 4-6 total**		$40,424	$100,248 **Project Total**

	= hired contractor
	= King County staff
	= Lake Desire community volunteers

Sources of Funding

Funding for implementation of the Lake Desire IAVMP will come from a combination of sources that will change as the project progresses. Potential sources of funding such as grants, formation of a Lake Managment District, and self funding were all considered by the Steering Committee. Focusing on grant funding was chosen by the Committee. This funding option depends on a blend of contributed funds, matching cash funds, and matching in-kind volunteer hours.

Grants

The program has applied for a grant from Washington State Department of Ecology's Aquatic Weeds Management Fund (AWMF). If received, this funding, along with the required match, should be enough to fund the first three years of the Plan. This IAVMP has been developed to be consistent with all AWMF guidelines and requirements. Given the lake-wide extent of the infestations, potential for infestation of neighboring habitat (wetlands, Spring Lake, Peterson Creek, and the Cedar River), and the support of the Lake Desire community (Appendix 1), it is expected that AWMF grant will be awarded. In signing onto the Community Letter of Support, 130 Lake Desire residents have pledged a combined total of over 800 volunteer hours annually towards the weed control effort at the lake (Appendix 1).

Matching Funds

Awarding of the Ecology's AWMF grant requires matching funds. Requiring matching funds distributes the responsibility of funding between the state agency (Ecology) and the local stakeholders (Lake Desire residences and the King County Noxious Weed Control Program) (Tables 8a, 8b, 8c). Both cash match and in-kind match are proposed to be used to fulfill this requirement. Cash matching funds are proposed to come from staff hours of King County Noxious Weed Control Program employees. King County staff hours value include the total hourly cost of that employee's time. These total costs include: hourly rate, benefits, paid time off, and overhead. The weighted average cost of King County employee's staff time was calculated based on amount of time employees of particular pay levels were expected to work on the project. This weighted average cost came out to be $44/hour. In-kind matching funds are proposed to come from volunteer labor and supplies provided by Lake Desire residents. Volunteer hours are estimated at a rate of $15/hour.

Long Term Sustainability

The long term sustainability of this project is dependent on the commitment of Lake Desire Community of residents to follow-up weed control and the ability of the staff of the King County Noxious Weed Control Program to communicate weed control techniques, strategies and priorities. In the absence of the AWMF grant funding options will be re-evaluated by the Steering Committee.

Through their participation in the development of this IAVMP as well as the show of support and commitment volunteer hours (Appendix 1), the Lake Desire Community has demonstrated their desire to support this plan for the long term. KCNWCP staff will be able to provide specific weed control strategies for situations as they arise in the future. Ideas that have been brought up by community members for long term maintenance of the project's control efforts include:

- members of the Community acquiring and using an aquatic herbicide applicators license
- community weed pulling work days
- a new dedication by property owners to control noxious weeds on their property

Table 8a - Matching funds for total 6-year project

		Budgeted	% of Total		Budgeted	% of Total
Match	In-kind Match *(volunteer hours)*	$13,500.00	13.6%	}	$46,648.00	46.8%
	Cash Match *(King County Staff hours)*	$33,148.00	33.3%			
Grant funds after match					$53,600.00	53.2%
Total Project Cost =					$99,617.06	100%

Table 8b - Matching funds for Year 1-3 of project

		Budgeted	% of Total		Budgeted	% of Total
Match	In-kind Match *(volunteer hours)*	$6,750.00	11.41%	}	$24,824.00	41.97%
	Cash Match *(King County Staff hours)*	$18,074.00	30.56%			
Grant funds after match					$35,000.00	58.03%
Year 1-3 Project Cost =					$59,146.84	100.00%

Table 8c - Matching funds for Year 4-6 of project

		Budgeted	% of Total		Budgeted	% of Total
Match	In-kind Match *(volunteer hours)*	$6,750.00	16.68%	}	$21,824.00	53.93%
	Cash Match *(King County Staff hours)*	$15,074.00	37.25%			
Grant funds after match					$18,600.00	46.07%
Year 4-6 Project Cost =					$40,470.23	100.00%

Section 9 – Monitoring, Evaluation, and Implementation

Monitoring

Yearly surveying and monitoring of emergent, floating and submerged aquatic noxious weeds will be conducted at Lake Desire. These surveys will help guide noxious weed control efforts and provide a year-to-year baseline for progress towards weed eradication. The surveys will be done by King County staff, and possibly volunteers, using small boats. During the surveys, mapping of the aquatic noxious weeds will be done using aerial photos and/or GPS data loggers. Collected data will then be transferred to GIS.

Evaluation of the Plan

The effectiveness of the plan will be evaluated yearly by King County staff and other members of the Implementation Committee (see below). Adaptive changes will be made as needed. Year-to-year comparisons of the monitoring data will be used to evaluate trends in specific target species abundance and distribution. The results of these comparisons will guide control efforts and may result in a change in future control strategies. Success of the plan will be measured by the reduction of the target noxious weed species.

Implementation

The implementation of the plan will follow the process outlined below:

Convene a project Implementation Committee. This group will consist of King County staff and interested members of the Lake Desire community, likely members of the IAVMP Steering Committee. They will control how the plan in implemented.

Identify Funding Sources. The most likely source for funds to support the implementation of the IAVMP is the Washington State Department of Ecology Aquatic Weeds Management Fund (AWMF). Other local and regional grants will be pursued. The AWMF grant which requires matching funds and time from the local agency and community and could fund the first three to four years of the project. This grant requires the local community work in conjunction with a local government agency; in this case that agency is King County Department of Natural Resources and Parks Noxious Weed Control Program. During the final year of the grant's funding, the need for future funding will be assessed by the Implementation Committee.

Select an Herbicide Contractor. An applicator will be selected for treatment of each of the three target weeds outlined in the IAVMP. The treatments will be done either "in house" by experienced King County DNRP employees or by a competent contractor. Contractors will be hired according to the King County process. The Request for Proposals will go out in March 2012 if the grant is funded. Contract proposals will include permit application and cost, herbicide application, and notification and postings required by the permits.

Application of Herbicide. Application of herbicides will be completed as prescribed in the IAVMP, unless consultation with the community, Ecology and/or the applicator leads to defensible changes in the plan.

Public Education and Communication. The residents of Lake Desire will be notified about up-coming herbicide applications as determined by the NPDES permit, the results of yearly monitoring efforts, and any major changes made to the plan via the emailed Lake Desire News. Much of this communication will be done by active members of the Lake Desire community who are involved with the Implementation Committee. The Committee will take into account public feedback when making decisions about the plan.

Monitoring Surveys. Surveys will be done yearly by King County staff with the help of Lake Desire residents. Surveys will be done at the same time each year in order to get a comparable measure of the plants distribution and density.

Manual follow-up. Each year in late summer, a few weeks after herbicide treatment occurs, community members will manually remove the reproductive parts of plants that were not treated. This will include removal of purple loosestrife flower heads, gathering of any nuisance dead water lily mats, and milfoil fragments.

Long Term Monitoring and Maintenance. This will be done by the Lake Desire community after the satisfactory completion of the implementation plan.

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