-FINAL-
August 30, 2018

American Lake IAVMP
Introduction

American Lake is located within the city of Lakewood and Joint Base Lewis-McChord in Pierce County, Washington. The American Lake Veterans Affairs facility and the Washington Military Department at Camp Murray also have lake front property. The lake provides a unique recreational opportunity to both the citizens of the region and those serving, or having served, our state or country while stationed at or visiting one of these installations. There is a robust fishery in the lake, anglers come from all over to go after cutthroat trout, largemouth bass, rainbow trout, rock bass, kokanee and yellow perch. There are several well used parks on the lake with swimming beaches that serve both the military and civilian populations. There is also a well-established lakefront community where residents have lived for generations enjoying the opportunity the lake provides to swim, boat and fish. Water quality in this lake is generally good. Transparency is often more than 4 meters, an indication that nutrient driven algae blooms are not often present.

In recent years however, residents and interested agencies have noted an expanding population of the state listed noxious aquatic weed, *Myriophyllum spicatum* or Eurasian Watermilfoil. This noxious weed has been present in the lakes along the I-5 corridor for decades and the spread of the plant from lake to lake is generally facilitated by boat movement. Lake Washington for example has had a significant problem with this noxious weed since the 1970's. A significant number of the smaller lakes along I-5 have developed similar problems over the years and American Lake is now experiencing this same trend. The primary mode of spread of this weed from lake to lake is plant fragments on boat trailers that are not cleaned properly. Once these fragments reach a new lake they grow root hairs and sink to the lake bottom and root. They then "auto fragment" each fall spreading the plant around the littoral (i.e., shallow) margins of the lake.

The Washington Department of Ecology (DOE) recognized the threat this and other noxious aquatic weed species pose to our water resources. In the 1990's the Legislature through the work of a Joint Select Committee of the House, Senate and interested parties developed a program to help communities develop management strategies and implement them.

This program is funded by collecting a tax on the registration of boat trailers as they are the primary vector for spread. These funds are used by DOE to administer this program and to provide grant funding for management planning and control activities. The first step in this

process for an infested water body is to build a stakeholder group and assist them in planning to target and control the invasive aquatic weed. This is done through the development of an Integrated Aquatic Vegetation Management Plan or IAVMP for short. Once this planning process is completed, the action plan that is developed can be implemented. The stakeholders can apply for DOE grant funds to help implement the plan.

In the case of American Lake, concerned citizens approached the City of Lakewood to sponsor a grant to create an IAVMP. The DOE grant program requires involvement of a public entity that can contract with the agency. The City decided that it has a role in the protection of the lake and submitted the necessary application to Ecology to be considered for a planning grant. In the fall of 2016 this application was accepted by DOE and in the spring of 2017 that agency determined that the Lakewood application ranked high enough to receive funding support. The City then contracted with DOE to begin the plan development.

This plan follows the guidelines established by the DOE. The plan will be reviewed by the various stakeholders and edited as necessary to meet the needs of the community and to solve the invasive aquatic weed problem in American Lake.

Problem Statement and Management Goals

The first step that the City of Lakewood undertook was to try and identify key stakeholders that should be part of the planning process. In many cases one jurisdiction or lake homeowner's association includes the primary stakeholder group. In this case there are both local, state and federal ownership of the lake shoreline, there are city parks, there is an extensive shoreline homeowner base and this lake is a destination for fishers from all over the Pacific Northwest because of the diversity of the fishery. American Lake is one of the few locations in the region to fish for Kokanee for example.

The City was able to identify and obtain participation in this process from the following groups:

- The City of Lakewood
- Representatives from the American Lake Improvement Club as well as the Tillicum neighborhood
- Environmental officials from the federal government representing Joint Base Lewis-McChord
- Representatives of the Department of Veterans Affairs facility on the lake
- Environmental officials from the Washington Military Department/Camp Murray

As a first key step in the planning process, this group of stakeholders discussed and developed the following Problem Statement and Management Goals to help focus the direction of the planning effort.

Problem Statement:

Eurasian Watermilfoil (EWM) has become a problem in American Lake the past few years. EWM, which is a state-listed noxious weed, has spread to numerous shorelines around the lake, forming dense stands out to approximately 15 feet deep. Swimming, boating, fishing and other recreational uses have been greatly impacted where EWM is present. Swimmer safety along the shorelines is a serious concern and should be given priority. Transfer of EWM to other lakes from boats or other watercraft using American Lake is also a major concern. A growing monoculture of EWM is adversely impacting the diversity of the native plant communities and impacting native fish and wildlife populations.

Management Goals:

- Maintain recreational and habitat uses of the lake by removing EWM.
- Keep swimming areas clear of EWM for safety reasons.
- Keep boating areas clear of EWM to minimize boat damage and transfer potential.
- Educate property owners and lake users about the negative impacts of EWM.
- Choose appropriate EWM control methods that are both effective and environmentally sensitive.
- Establish an agreement or memorandum of understanding among all lake front property owners and other interested parties to:
    - Determine equitable financing options for all lake front property owners to address ongoing control or eradication of EWM.
    - Determine maintenance responsibilities.
- Reduce overall costs by using volunteer labor when possible.

With this Problem Statement and these Management Goals providing direction, the balance of this document will go through DOE's IAVMP planning process to develop an action plan for the community.

Waterbody and Watershed Features

American Lake is the largest natural water body within Pierce County, Washington. The surface area of the lake is 446 hectares or 1,132 acres. The lake is located within the Chambers-Clover Creek Watershed. The sub-basin around American Lake is approximately 25 square miles.

The lake is made up of two primary basins:

The southwestern basin is small compared to the overall acreage of the lake and is approximately 78 acres in size. This area is relatively shallow compared to the main lake. The maximum depth is 39 feet and a considerable percentage of this basin is suitable for colonization of aquatic plant growth (littoral area). This area is connected to the main lake through a narrow channel.

The main lake is 1,054 acres in size and is a much deeper basin. The maximum depth is 87 feet. In most areas of this basin, the littoral area is limited to narrow bands along the shoreline. Moderate to steep slopes underwater comprised of gravel characterize the near shore areas of the lake.

A Washington DOE aquatic plant survey conducted in the 1990's indicated that aquatic plant species present included a variety of pondweeds (*Potamogeton sp.)*, the macro algae chara (*Chara sp.)*, American waterweed (*Elodea canadensis),* common naiad *(Najas flexis)* and water celery *(Vallisneria americana).*

One of the interesting observations of the DOE Survey at that point in time was that submersed aquatic vegetation covered no more than 10% of the littoral zone of the lake. With the introduction of EWM this is no longer the case.

Water flow into the lake is primarily from groundwater. There is some inflow through Murray Creek from the east and stormwater runoff. There is very limited outflow except during periods of high water. There is an overflow channel served by a box culvert at the south end of the lake that controls this flow.

Land use around the lake and throughout the watershed is considered to be urban. These land uses influence lake water quality. Ground water studies indicate that there are excessive nutrients present in the groundwater adjacent to the lake. Phosphorus and nitrates are present. A study by Kraemer Chin and Mayo in 1993 indicated that the lake was exhibiting tendencies toward increased eutrophy (i.e., nutrient rich).

American Lake receives a very high level of recreational use because of its location near Tacoma and JBLM. The City of Lakewood maintains two parks on the lake and very active public boat ramps. There are private marinas that rent boats and the military facilities include marinas and provide boating opportunities to that community. The lake also has several private beaches and swimming clubs. Several lakeshore owners base their float planes on the lake.

While good water quality can to some degree limit aquatic plant growth, Eurasian Watermilfoil has been known to thrive in lakes with pristine or oligotrophic conditions. Lake Tahoe is a good

example of this. The lake is considered one of the most pristine lakes in the United States and there is currently an expanding population of Eurasian Watermilfoil doing very well there.

Identify Beneficial Use Areas

The stakeholders discussed this at length and came up with the following beneficial use zones. These can be divided into shoreline and open water uses.

American Lake is unique in that there are several different types of ownership of the shoreline. Many lakes have a shoreline private property owner component. Most also have a public park and/or public access and boat ramp. American Lake also has a considerable amount of the shoreline in state and federal agency ownership.

Nearly half of the shoreline on American Lake is privately owned (26,581 feet). For the most part these lots are residential lakeside homes. The majority have docks, a swimming area and mooring for boats or water craft. The identified beneficial uses in these areas are primarily for the use of the individual property owners and they include swimming off their property, fishing from their shoreline or dock, mooring watercraft and other shoreline recreational opportunities. Significant portions of the southern shoreline in this category is heavily impacted by EWM growth interfering with all of these beneficial uses. The eastern end of the lake and portions of the northeast shoreline in this category have patchy localized Eurasian Watermilfoil colonies that have a local impact on use. These areas are also subject to colonization in the future and over time absent management these areas will probably resemble the heavily infested south shoreline. It has been well documented that Eurasian Watermilfoil growth at densities present on the south shoreline can impact lakefront property values and associated tax assessments in addition to the obvious impacts to swimming and boating.

The Department of Veteran Affairs (VA) owns approximately 8,769 feet of shoreline on the northern edge of the lake. This property has a couple of fishing docks and areas that resemble beach or swimming access sites. Representatives from the VA attending the stakeholder's meetings indicated that they don't operate a beach or shoreline recreational activities but there is some limited use. Portions of this property are also undeveloped and provide good undisturbed shoreline habitat. There are significant portions of the VA shoreline property impacted with EWM. The potential impact on beneficial uses are not as high as some of the private areas described above because of the limited use pattern, but this noxious weed does impact ecology and habitat. Ideally this plan would lead toward a goal of complete control of this noxious weed, so treatments should occur here to prevent the spread and recolonization of the rest of the lake from this source.

The Washington Military Department at Camp Murray owns approximately 8,592 feet of shoreline frontage on the south shore of the lake. A significant portion of this shoreline zone is undeveloped and natural undisturbed habitat. There is a beach available for members of the Washington National Guard, and the Camp Murray representative to the stakeholders group indicated the public could use this facility as well after passing through the security gate. There also are recreational vehicle camp sites at this facility. The beneficial uses of waterfront recreation, swimming and habitat are all impacted by Eurasian Watermilfoil along this frontage.

Joint Base Lewis-McChord is the second largest shoreline property owner on the lake. Their frontage is approximately 16,731 feet. While portions of the shoreline are undisturbed and provide good habitat, there is extensive recreational use that occurs in these areas. There is a park with beach and marina with slips for approximately 200 boats on the northern edge of this property. There are several smaller parks with beaches, fishing docks and facilities located throughout the complex. On the south shoreline there is an extensive campground with water access and recreational facilities that include shoreline cabins and fishing docks. Eurasian Watermilfoil is well distributed along this property and is extremely dense in some areas. All of these beneficial uses are impacted by this growth.

There is one private beach facility associated with the Tacoma Golf and Country Club on the eastern shoreline. This facility includes the traditional golf course and clubhouse facilities. In addition, their pool is adjacent to a private swimming beach that is controlled by life guards and well used. This area is starting to see expanding populations of Eurasian Watermilfoil, the extremely dense beds of this plant stop just short of this property, but fragments will move into this zone and expand in the coming year or two. The activities and beneficial uses are not heavily impacted at this point at this location, but over time expanding aquatic plant beds will interfere with swimming and water sports at this locale.

There are two public beach facilities associated with City of Lakewood parks on the lake in addition to the military facilities. Dense aquatic plant beds formed by Eurasian Watermilfoil and other species are a threat to swimmers. They have been attributed with causing drowning deaths in Washington State most summers in recent history. They also pose a problem for life guards and first responders where swimmers are in trouble. If swimmers go down in the dense vegetation they often are not as visible as they would be in open water and the time it takes to locate them often ensures a negative outcome.

Harry Todd Park on the south shore of the lake is a 17 acre park with a community beach facility. The Commencement Bay Rowing Club is based at the park and their boathouse houses their crew as well as college crews from Pacific Lutheran University and the University of Puget Sound. American Lake is considered to be one of the best rowing waters in the Pacific Northwest and they host regattas on a regular basis. This portion of the lake and the crew

docks are heavily impacted by dense growth of EWM as is the adjacent beach. This plant has a significant impact on these beneficial uses.

American Lake North Park is heavily used by the community in the summer months. The beach is at capacity most days during the warmer summer months. This area of the lake is starting to show some colonies of Eurasian Watermilfoil growing together. While there is not a heavy impact on the swimming facility at this point, within the next year or so it appears that there will be heavy growth in this location.

Lastly there are two major public access sites on the lake. The first is a large community boat ramp adjacent to American Lake North Park. This facility is equipped for multiple launch and retrieval of vessels. There is Eurasian Watermilfoil present in the boat ramp areas. These plants can easily be transported to other water bodies as infested boats leave the lake. The second is on the south shoreline on publicly accessible Camp Murray property and is managed by Washington Department of Fish and Wildlife (WDFW). This location is adjacent to some of the most well-established milfoil beds in the lake. Boaters will often fish on more than one lake in a day if production is slow on one waterbody. Clearing these boat ramps and access sites will both improve the beneficial use opportunities on American Lake and help stop movement of this noxious weed to other regional water bodies.

The majority of the surface acreage in American Lake is over deep water and these acres are not capable of supporting noxious aquatic weed growth for these reasons. Boating and waterskiing take place in this zone and on hot summer days this can be quite crowded. Seaplane operations take place on the open water expanses of the lake; there are a number of seaplanes based on the lake. The lake is within airspace controlled by both McChord Field and Fort Lewis's Gray Army Airfield. The deeper areas of the lake are heavily used by kokanee fishermen, the lake is one of the premier kokanee lakes in the western part of the state. The various rowing crews based at Harry Todd Park boathouse use the lake in this zone extensively for training and regattas. Lastly with Fort Lewis immediately adjacent to the lake, military training including water drops simulating insertion is regularly practiced at the lake. While none of these beneficial uses are directly impacted by EWM because of water depths, the majority of the people accessing this area have to contend with dense weed beds as they transition from the shoreline littoral areas to these deeper water portions of the lake.

Map Aquatic Plants

During the summer of 2017, Aquatechnex biologists conducted a mapping project on American Lake to support the development of the IAVMP.

Two technologies were used to perform this mapping effort.

The first step was to review bathymetry maps of the lake and determined where the team should focus mapping efforts.

Aquatic plants are limited by light and pressure with respect to the areas within a lake they can inhabit. Light is generally the limiting factor in most lake systems.

Aquatic plants, like their terrestrial relatives, need sunlight for photosynthesis, the processes all plants use to sustain themselves. With increasing depth, light can become extinct in water rapidly. With suspended material like algae or other turbidity, light penetration into the lake can be further degraded. As water clarity is generally uniform throughout an individual lake, the depth to which aquatic plants can grow is also generally uniform throughout the lake. In cases where water clarity is very good, aquatic plants then generally become limited by water pressure. Aquatic plants generally do not occur much below 28 feet because of water pressure and the impact on vascular processes within the plant. Some macroalgae can survive at deeper depths.

This area that can support aquatic plant growth is called the littoral zone of the lake. This is the area that would be the focus of the survey. A significant area in American Lake is too deep to support aquatic plant growth. With the identification of a potential littoral area using the 20 foot contour we identified areas of the lake that could be considered within the littoral area. That map was used to define survey areas for the mapping team.

The first mapping effort utilized a hydro-acoustic mapping technology to build shapes and boundary map for aquatic vegetation. This system uses a hydro-acoustic depth sounding system linked to Digital GPS (DGPS) equipment. The mapping vessel travels transects over the littoral areas of the lake and collects water depth, height of aquatic plants present and bottom composition data every second. This data file is then processed to build maps for these parameters. We use CiBioBase, a subscription based Cloud computing technology for aquatic environments. This technology uses algorithms developed for analysis of hydro-acoustic data for these parameters.

The aquatic vegetation map generated by this system provides a measure of aquatic plant biovolume. Biovolume is the percent of the water column under the mapping vessel that is filled with aquatic vegetation. This map does not show plants by species. The maps generated show with a color HEAT map the location, shape and density of aquatic plant growth in the lake. This information is used to further focus investigative efforts of the mapping team.

Armed with the aquatic plant coverage maps generated by CiBioBase, we deployed mapping vessels equipped with sampling rakes and Trimble submeter GPS data loggers and aquatic biologists to classify the species present in the lake. The team spent a few days investigating all areas where aquatic plant growth was present. They identified aquatic plants present and used

the Trimble systems to further define the location and shape of aquatic weed beds present in the lake.

This data was processed and exported to ArcGIS mapping programs and final maps were created to support the IAVMP process. These maps consisted of a threat zone map and a coverage map showing the extent and shape of EWM colonies in the lake. The threat zone map shows those areas of the lake that are shallow enough to support EWM growth. This is important information for analysis of the maximum potential level of infestation the lake would support. The EWM maps show the current location and percent of the threat zone that are supporting this invasive weed during the summer of 2017.

The team also noted the presence of any other native aquatic plant species in the lake.

Characterize Aquatic Plants

As of the summer of 2017, EWM had formed dense monocultures throughout major portions of the littoral area of American Lake.

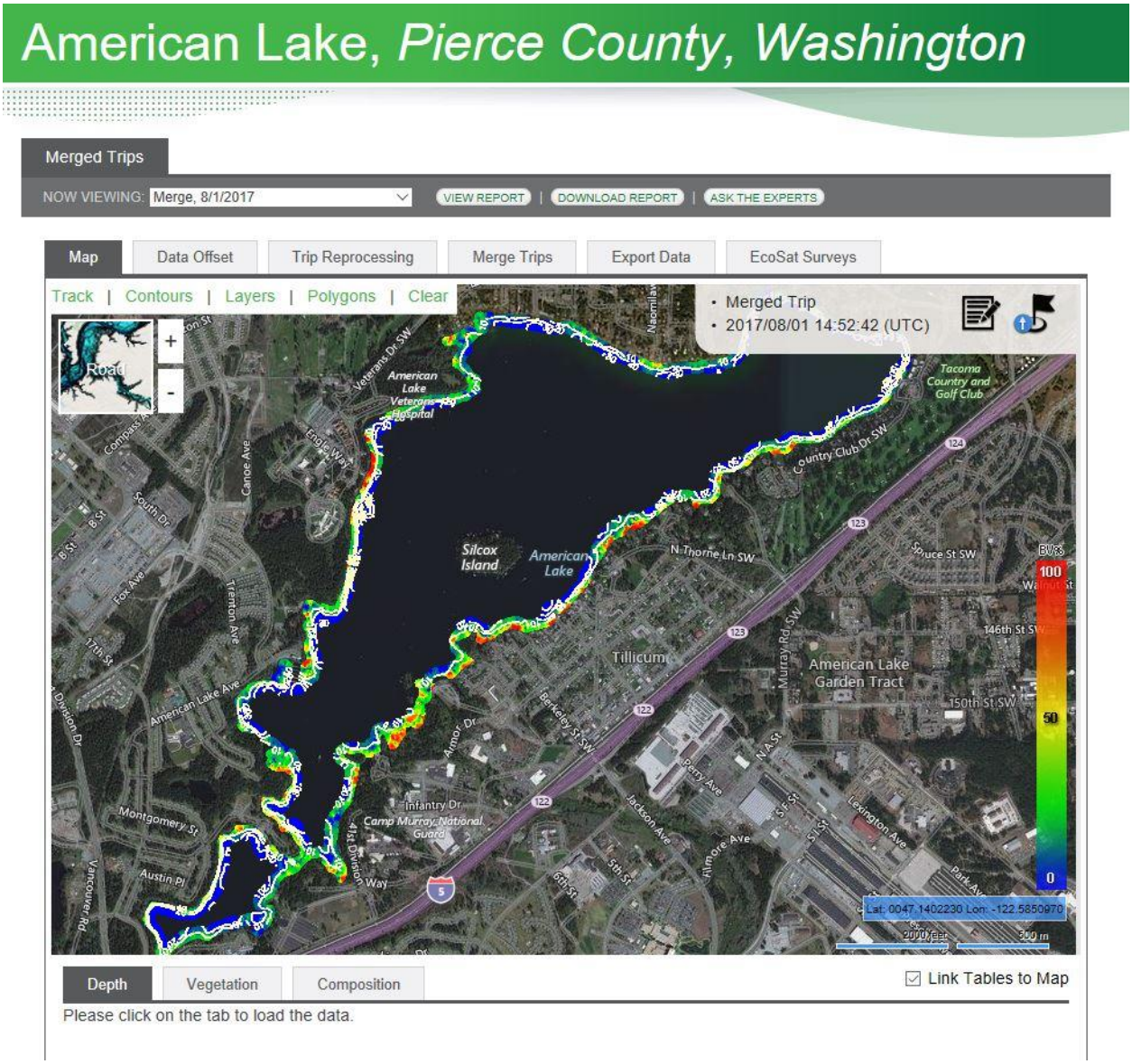
The first step in the mapping process was to obtain hydro-acoustic aquatic plant biovolume data for the littoral areas of the lake. This survey covered 109.88 ha or 271.53 acres of the lake. This was broken down into a few files or areas. In each area, several measurements are produced. The key measurements of interest to this project were:

- Area surveyed in hectares and acres
- Percent of the water body
- Percent Area Covered (PAC) refers to the overall area within this survey grid with submersed vegetation present and growing
- BVp refers to the percent of the water column taken up by vegetation where vegetation exists. Areas with no vegetation present are not taken into consideration for this calculation
- BVw refers to the average percent of the water column taken up by vegetation regardless of whether vegetation exists. In areas with no vegetation, a zero value is entered in to the calculation thus reducing the overall biovolume of the entire area covered by the survey

One of the few areas where native aquatic plant growth is dense and potentially impacting beneficial uses. Najas sp. is the dominant species present.

(We use italic to highlight picture descriptions and to differentiate from the actual text of the report.

Aquatic Plant biovolume survey



Area surveyed	109.88 ha or 271.53 acres
Percent of Water body	23.71 percent
PAC	64.9%
BVp	27.4%
BVw	17.8%

Once the hydroacoustic mapping work defined the aquatic plant biovolume in the lake by location and density, the team took those maps back to the field to identify species present in those communities. A number of methods were used to examine these zones.

A survey boat was equipped with the CiBioBase GIS files and these were used to navigate to all locations where aquatic plant biovolume had been detected. The boat was also equipped with a Trimble JUNO DGPS receiver and data logger to help the survey biologists map species presence. The Trimble unit has a data dictionary set up for the team to use in mapping the species present. Trimble Terrasync Professional software allows the team to view the location of the mapping vessel, the location of the GIS files for aquatic plant biovolume and the data dictionary allows the team to add the location and species/density attributes to the map. On return from the field, the Trimble Terrasync files are processed via differential correction to obtain submeter accuracy and exported as ESRI Shapefiles to be used in the analysis and creation of the final report.

The survey team traveled and reviewed all locations in the lake where aquatic plant biovolume had been detected. In cases where monocultures of plants were found, an attribute was assigned via a line feature along the outside edge of the aquatic plant bed. In cases where aquatic plant biovolume had been mapped at depth but not visible from the survey boat, a sampling rake was deployed and retrieved and plants collected were noted. The Trimble unit was used to map the location and the species attributes for conversion to Shapefiles.

Most of the areas where submerged aquatic plants were present were dense monocultures of *Myriophyllum spicatum* or Eurasian Watermilfoil. These zones were clearly identified via visual observation and the survey boat mapped the outside edge where the plant beds extended to the shoreline. Within these monocultures there were traces of other submerged plant species noted from time to time as an understory. They did not make up more than 5 percent of the density within these monocultures and these aquatic plant beds were mapped as *Myriophyllum spicatum* for purposes of management planning.

There were also areas of the lake where *Myriophyllum spicatum* monocultures were not yet established. In these areas the team used a combination of visual and underwater observation to locate aquatic plants. Where they were observable from the boat the Trimble unit was used to map location and species attributed for conversion to shapefile. Where the biovolume map showed low density of plant species present but water depth precludes visual observation and mapping, the sampling rake was deployed to sample the species present.

The team observed the following submerged, floating leaf and emergent species present and adjacent to in American Lake:

Scientific Name	Common Name	Classification	Habitat	Percent Cover
Myriophyllum Spicatum	Eurasian Watermilfoil	State Class B Noxious Weed	Submerged	85
Elodea canadensis	Common Elodea	Native species	Submerged	5
Potamogeton richardsonii	Richardson's Pondweed	Native species	Submerged	trace
Potamogeton gramineus	Thin-leafed Pondweed	Native species	Submerged	trace
Stuckenia pectinata	Sago Pondweed	Native species	Submerged	trace
Potamogeton crispus	Curly Leaf Pondweed	State Class C Noxious Weed	Submerged	trace
Potamogeton zosteriformis	Flat Stemmed Pondweed	Native Species	Submerged	trace
Vallisneria americana	Water Celery	Native species	Submerged	trace
Chara sp.	Muskgrass	Native Marco Algae	Submerged	Dominant in deeper water beyond macrophyte depth
Nymphaea odorata	Fragrant Waterlily	State Class C Noxious Weed	Floating leaf	n/a
Lythrum salicaria	Purple Loosestrife	State Class B Noxious Weed	Emergent	n/a
Iris pseudacorus	Yellow Flag Iris	State Class C Noxious Weed	Emergent	n/a

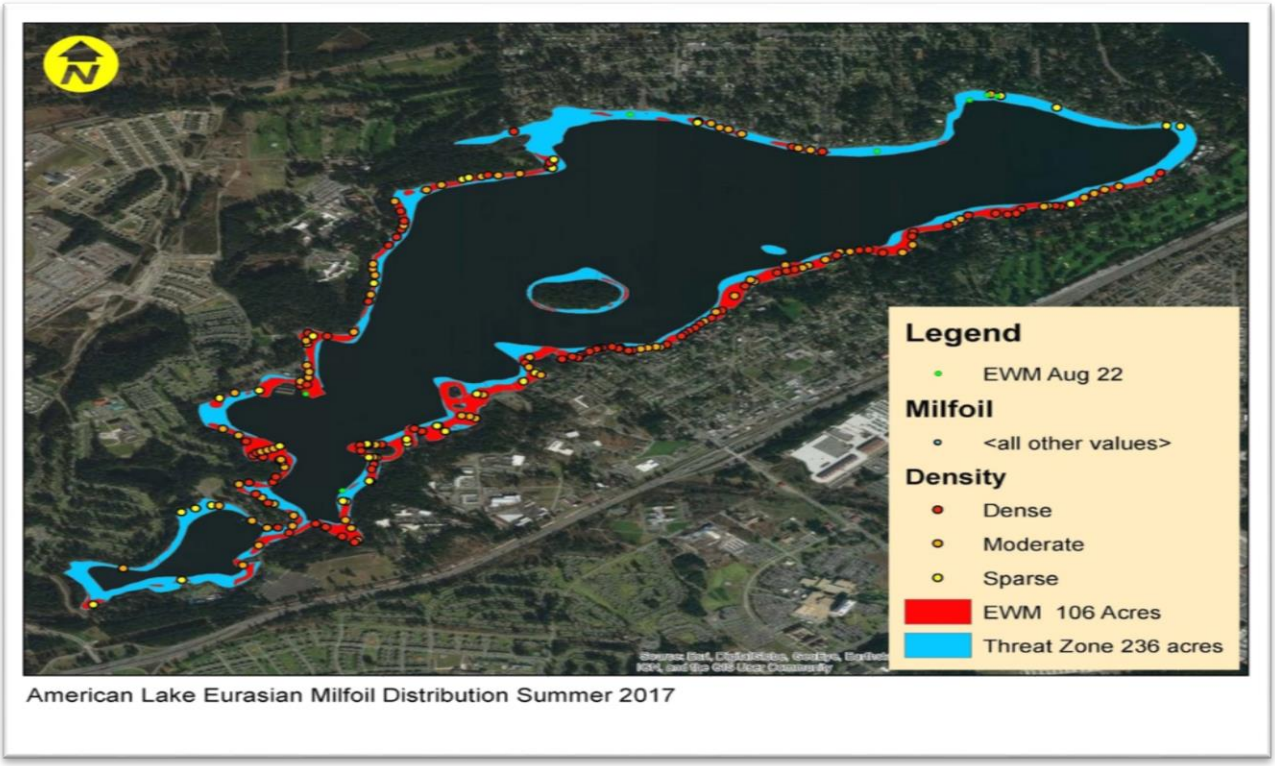
As noted above, in earlier studies the aquatic plant communities inhabited less than 10% of the littoral areas of the lake due to the gravel substrates. These conditions generally hold true to date in areas of the lake where EWM has not yet become established to any great degree. The native plants are distributed in scattered clumps throughout the littoral area with large areas of open space between them. The northern and eastern shorelines of the lake are populated in this fashion for the most part.

Large portions of the littoral area of the lake are currently heavily impacted by Eurasian Watermilfoil growth.

Myriophyllum spicatum growth in the southwestern portion of the lake

The acres in the water with the potential to become infested with invasive species is known as the "threat zone." The water clarity in American Lake is such that plants can survive down to at the least the 20 foot depth contour. This contour was digitized in ArcMap GIS to map this region of the lake. This area, approximately 236 acres in total, is the entire littoral area of the system, and classified as the threat zone for American Lake. Virtually all aquatic plant management operations are priced on a per acre basis. Therefore, it is important to know the size of the threat zone.

Currently, the areas of the lake within the threat zone that are populated with dense beds of Eurasian Watermilfoil is determined to be 106 acres. The EWM beds are particularly thick and well established along the southern shoreline of the lake. There are also dense patches adjacent to the VA and Fort Lewis facilities on the western and southwestern areas of the lake as shown on this map. (The map is also available for viewing at http://arcg.is/0fX1WC).



American Lake Eurasian Milfoil Distribution Summer 2017

There are also scattered establishing colonies of EWM throughout the balance of the littoral areas of the lake. It should be assumed that there will be some expansion of the milfoil beds in the lake into 2018 and a second mapping effort should be performed prior to the implementation of control activities.

Investigate Control Alternatives

Integrated aquatic plant management involves an understanding of the tools available to apply to a given situation and selecting the correct mix of technologies to deal with the problem as presented. It is also critical to understand that over time the correct mix of control strategies may change. Normally at the start of a major invasive species treatment program the problem is large in terms of acres covered or the percent of the littoral zone infested. The correct procedure is to implement the selected treatment strategy, evaluate the results of those treatments, review post treatment maps and again consider tools available and select the correct mix of technologies. These programs are generally ongoing in nature, it is rare that eradication occurs after the first applications. In many cases eradication never occurs but the target invasive weed populations can be reduced to the point of not interfering with beneficial uses. The IAVMP process should be ongoing with a regular evaluation and reexamination of the tools available.

The tool box for aquatic plant control includes physical, mechanical, biological and chemical control technologies.

An examination of each is presented here.

No Action Alternative

The No Action alternative is available to lake managers. This alternative leaves in place all the negative impacts caused by this noxious aquatic weed infestation. While there are no direct costs for management, costs to the community can include depressed property values, reduced tax collections, threats to the potable water supply, degradation of water quality and potential loss of life.

At this point approximately 106 acres of the 236 acre littoral area is heavily infested with EWM. Delaying action to target and control this growth, the assumption can be made that in future years, the remaining areas of the littoral zone will become colonized. An example of the impact of no action at this point would be: If the current cost of a treatment program would be $1,000.00 per acre, the cost for addressing this now would be $106,000.00. If left unaddressed until expansion is complete the cost to recover the littoral zone at today's dollars would be $236,000.00 at some future time. This does not consider cost increases for control activities that may occur over time.

Prevention

It is too late for the prevention alternative to be utilized in this case. EWM was introduced some time ago and it is widely distributed in American Lake. The infestations in American Lake do however pose a threat to other water bodies in the region. Fishers could be transporting EWM fragments to un-infested waters.

A prevention program would potentially halt the introduction of other noxious aquatic weeds from nearby lakes. In addition, there are threats from Zebra and Quagga Mussels on the horizon as they continue to move west. At this point these mussels have not been detected west of the Rocky Mountains, but the probability is that they will.

It is recommended that consideration be given to developing a prevention program for American Lake that involves public education. As mussels and other threats move closer to Western Washington the need for controlling access for boats and inspecting them prior to launch may need to be implemented.

Hand Pulling Alternative

Hand removal of submerged vegetation by digging or pulling is labor-intensive. Hand pulling is useful as a maintenance tool when the infestation is minimal and/or when small scale management

is an option. The entire plant must be removed, collected in a storage bag, and transported to shore for proper disposal. Water depth greater than three feet typically requires the use of SCUBA divers. The cost and management effectiveness of plant removal depends on: water clarity, sediment type, plant species, spread of plant fragments and density of vegetation being removed. When herbicide treatments are applied to eliminate the bulk of an invasive weed, divers can do periodic inspections to determine effectiveness of the treatment and at the same time carefully hand pull any remaining plants.

Advantages

- Species specific
- Site specific
- Minimum impact on native plants
- Useful near underwater obstructions
- Immediate improvement as plants don't need to wait to die
- No cost if performed by trained volunteers

Disadvantages

- Water visibility may restrict effectiveness
- Can be costly
- Slow, labor intensive
- Fragments may be generated
- Short-term increase in turbidity
- $800-$1,600 per day for two divers with a support boat and operator, typical coverage ranges from 400 to 2,000 square feet per day

Appropriateness for American Lake

Professional diver hand pulling to remove the bulk of Eurasian Watermilfoil for American Lake would be cost prohibitive and labor intensive given the current amount of infestation. Hand pulling is not an effective control method when EWM is widespread in the lake but may be useful once the weed mass is reduced. Divers employed to survey the lake for effectiveness of weed control can also use the opportunity to hand pull in some areas and is therefore included in the plan.

Diver Assisted Suction Harvesting Alternative (DASH)

Diver Assisted Suction Harvesting is a method whereby SCUBA divers use hoses attached to small boats with small pumps aboard to hand harvest and suck plant material to the surface. The purpose of this method is to remove all parts of the plant including the roots. A good operator can accurately remove target plants while leaving native species untouched. The suction hose pumps the plant material and some sediments to the surface where they are deposited into a porous bag (onion bag). The water and sediment are returned back to the water column (if the permit allows this) and the plant material is retained. Turbid water is generally reduced by trained divers, as the divers hand pull plants from the sediment and direct the plant into the suction intake. Turbid water can be discharged to an area curtained off from the rest of the lake by a silt curtain, however, placement of sediment curtains is time consuming and costly and are usually unnecessary. The plants are disposed of on shore. Removal rates vary from approximately 0.25 acres per day to one acre per day depending on plant density, sediment type, and diver efficiency. DASH is more

effective where softer sediment allows easy removal of the entire plant, although water turbidity is increased with softer sediments. Harder sediment may require the use of a knife or tool to help loosen sediment from around the roots. In very hard sediments, Eurasian Watermilfoil plants tend to break off leaving the roots behind and defeating the purpose of this method.

Advantages

- DASH provides site-specific and species selective control
- Divers can remove plants around docks and in other difficult to reach areas
- DASH can be used in situations where herbicide use is not an option for aquatic plant management
- Use of suction results in reduced release of plant fragments
- Effective in large areas with light plant growth
- Low possibility for fish to be affected or harmed as they usually vacate the area while it is being harvested

Disadvantages

- Labor intensive and costly
- Suction harvesting stirs up deep sediments if the suction head contacts the lake bed. This may lead to the release of nutrients or long-buried toxic materials into the water column. However, a good operator can nearly eliminate this problem in low sediment laden lakes such as American Lake.
- The tops of plants growing in rocky or hard sediments may be removed, leaving a viable root crown behind to initiate growth
- Not appropriate for large, densely infested areas
- Entire plant removal difficult in rocky/gravel areas
- Potential short-term increased turbidity
- Invertebrates attached to the plants can be sucked up with plants and be destroyed

Costs of Diver Assisted Suction Harvesting:
$1,500 a day for two divers and support boat. A budget of $10,000 per year, would allow two divers to provide around 6 days of suction harvesting, covering .25 to 1.0 acres per day depending on plant density.

Appropriateness for American Lake:
DASH is appropriate for American Lake and is included in the IAVMP. It is recommended following herbicide treatment when plant density is reduced and in areas with low infestation where chemical treatment would be less cost effective. (Since herbicide application must maintain a required concentration in water for a specific exposure time around target plants, scattered individual plants require a larger area of application. This insures plants get enough exposure for the herbicide to be effective). On-going DASH can be used during yearly surveys for locating new infestations and monitoring effectiveness of herbicide applications.

Bottom Screens or Benthic Barriers Alternative

A bottom screen or benthic barrier covers the sediment like a blanket, compressing aquatic plants while reducing or blocking light. An ideal bottom screen should be durable, heavier than water, reduce or block light, prevent plants from growing into and under the fabric, be easy to install and maintain, and should readily allow gases produced by rotting weeds to escape without "ballooning" the fabric upwards. Even the most porous materials, such as window screen, will billow due to gas buildup. Therefore, it is best to remove as much plant material as possible (such as via suction harvesting) to reduce the gassing of the decomposing plants. Materials such as burlap, plastics and woven synthetics can all be used for bottom screens. It is important to anchor the bottom barrier securely to the bottom to keep wave action or ballooning from dislodging the barriers. Unsecured screens can create navigation hazards and are dangerous to swimmers. Anchors must be effective at keeping the material down and must be regularly checked. Natural materials such as rocks or sandbags are preferred as anchors.

The duration of weed control depends on the rate that weeds can grow through or on top of the bottom screen, the rate that new sediment is deposited on the barrier, and the durability and longevity of the material. For example, burlap left in place may rot and tear within two years; in one season plants can grow through window screening material, or on top of felt-like fabric. Regular maintenance is essential to extend the life of most bottom barriers. Barriers should be removed annually at the end of the growing season so they do not become new rooting habitat for unwanted plants.

In addition to controlling nuisance weeds around docks and in swimming beaches, bottom screening has become an important tool to help eradicate and contain early or small infestations of noxious weeds. Divers should recheck screens every few weeks to make sure that all targeted plants remain covered and that no new fragments have taken root nearby.

Advantages

- Not toxic
- Installation of a bottom screen creates an immediate open area of water
- Bottom screens are easily installed around docks and in swimming areas
- Properly installed bottom screens can control up to 100 percent of aquatic plants
- Screen materials are readily available and can be installed by divers
- Barriers can be moved, removed, cleaned and used in other water bodies or used repeatedly in one location for many years.

Disadvantages

- Because bottom screens reduce habitat by covering the sediment, they are suitable only for very localized control. According to the DOE, only 50% of the length of a shoreline area may be covered by bottom barriers at any one time.
- For safety and performance reasons, bottom screens must be regularly inspected and maintained, adding to initial cost.

- Boat anchors, fishing gear, or paddles may damage or dislodge bottom screens.
- Improperly anchored bottom screens may create safety hazards for boaters and swimmers.
- Some bottom screens are difficult to anchor on deep muck sediments.
- Bottom screens can interfere with fish spawning and bottom-dwelling animals.
- Without regular maintenance, aquatic plants may quickly colonize bottom screens.

Costs of Bottom Barriers:

- $0.35 to $0.85 per square foot for geotextile or burlap material
- $0.35 to $0.60 per square foot for labor to install barriers
- $0.30 to $0.50 per square foot for removal costs

Appropriateness for American Lake:
It is appropriate to install bottom screens under existing docks and in areas that may be difficult to reach with herbicide treatments and/or mechanical means. Bottom screens will be used on a limited and "as needed" basis as identified during diver surveys of the lake after herbicide, suction or hand harvesting treatments. Areas possibly requiring bottom barriers are: swimming areas at Harry Todd Park and American Lake Park. Bottom barriers will be checked on a regular basis during diver hand-pulling to assure they are properly anchored and plants have not colonized on top of the screen. Screens will be removed at the end of each growing season.

Mechanical Control

There are two primary methods of mechanical control of submersed aquatic weed growth.

Aquatic Plant Harvesting

The primary methodology is aquatic plant harvesting. These machines have a cutter head that cuts and captures most of the aquatic plant growth during a pass and convey the plant mass onto the deck of the harvester. When the harvester storage area is filled, the machine travels to a shore unloading site and offloads the aquatic plant biomass. The shore team then disposes of the aquatic plant growth, generally at a land fill or composting facility.

The key to an effective aquatic plant harvesting operation is having the right mix of equipment and minimizing transport distances to shoreline unloading sites. All aquatic plant harvesting programs have two components; the harvester(s) work on the water to cut and collect target vegetation, and a shoreline site needs to receive the harvesters, unload the cut weed growth and transport it to a disposal site. Developed lakes often have very limited shoreline access for this type of activity forcing the harvesters to travel some distances. While they are moving back and forth to unload, no harvesting occurs. Generally, one mid-sized aquatic plant harvesting system can clear from 0.25 to 0.50 acres per day in open water when working within a quarter mile of the shore unloading site.

Rotovation

The second mechanical option for aquatic plant control is rotovation. Rotovation tills the lake bottom disrupting aquatic plant biomass and root crowns thereby providing relief. Rotovation has not been widely used in Washington State because of the excessive turbidity it causes and the fact that it dislodges plants and root crowns from the lake substrate, where they then drift around the lake to recolonize.

One of the primary problems with both mechanical control techniques when targeting EWM is they have the potential to make the problem worse. From Smith and Barko J. Aquatic Plant Management 28: 55-64 (see attached)

"*Since Eurasian Milfoil appears to respond positively to disturbance, some control techniques may actually promote expansion of plant populations or delay declines. For example, Carpenter reported that frequently harvested areas in Lake Wingra continued to support robust plant growth after the species had declined in other parts of the lake. Techniques such as derooting, shallow dredging and drawdowns and others that create favorable Eurasian Milfoil habitat may perpetuate high Eurasian Milfoil populations. The two locations where Eurasian Milfoil populations are reported to have persisted for more than 10 to 15 years are more intensely managed (with mechanical control technologies) than locations where the plant has declined."* In addition, while aquatic plant harvesting is generally thought to be compatible with the environment, studies have documented severe negative impacts on fisheries and invertebrate communities from aquatic weed harvesting operations.

Sandy Engel with the Wisconsin DNR studied harvesting operations on lakes with invasive aquatic species present. He concluded that:

"Harvesting both removed and dislodged plant dwelling macroinvertebrates. Patches of displaced snails, caddisfly larva and chironomids drifted about the lake and onto shorelines after harvesting. Each harvest in 1980 removed about 3 million macroinvertebrates amounting in 22% in June and 11% in July of all plant dwelling macroinvertebrates in the lake. Insects alone accounted for one half of all macroinvertebrates harvested"

Further:
"Harvesting removed about 21,000 fish in 1980 and 31,000 in 1981. This constituted about one fourth of all fry in the lake based on electrofishing data. Over 90 percent were young of the year."

In addition, a considerable amount of EWM present in American Lake is not accessible by mechanical equipment. The potential treatment areas along the southern shoreline are not

accessible to aquatic plant harvesting equipment because of docks and floats attached to the shoreline. EWM is growing in and under these structures and the spaces are too tight for a harvesting head to access in many cases.

If harvesting were to be selected, there are two ways to proceed. An entity like the City of Lakewood can purchase and operate this equipment or a contractor can be hired.

Equipment purchase for a mid-sized aquatic plant harvester, a trailer and shore conveyor are currently in the $175,000.00-200,000.00 price range. One such system has the capacity to harvest between 0.25 and 0.5 acres per day. The capital cost of the system would have to be considered and factored into a cost per acre assumption. In addition, a large truck is required to support the transport of cut vegetation on the shore side of the operation. Other costs associated with operation are daily labor costs for at least three persons: a shore side driver to transport vegetation for disposal, an assistance to support docking and transfer of cut vegetation, and the harvester operator. This can involve prevailing wage rates if the operations are for a municipality, however the Washington Department of Labor and Industries in recent years had determined that managing and controlling EWM is not considered a "public work" and as such is not subject to these costs. Storage of the equipment on the water (marina dock space), fuel, plant disposal fees and other associated costs also have to be considered.

The second option is contract harvesting. There are four or five companies that do this work in the western United States. They generally bill on a daily rate model with $1,500.00 per day being a recent average cost. This cost can go higher depending on the size of equipment and the cost of disposal of cut vegetation. The production limitations of shore access affect them as well and production costs would probably be in the same range as quoted above. At a 0.25 acre per day production rate and $1,500.00 per day cost, a per acre estimate might be $6,000.00.

Lastly, harvesting operations do not kill the plant, they mow the top 5 feet off. As the harvester moves on to the next area, the milfoil will start to grow again. Areas harvested can be "topped out" again in 5- to 6 weeks.

Biological Control

There is only one biological control method that is considered operational for the management of submerged aquatic weed growth.

Triploid Grass Carp

Triploid grass carp have been used in this role for years throughout the United States. This fish is native to northern Asia and consumes freshwater aquatic plant growth. Grass carp in general

have not been allowed for stocking prior to the development of the triploid strain. State and Federal regulators have not wanted to have a reproducing population of these fish introduced to US waters because if left unchecked they could consume all the vegetation in a water body and dramatically alter the habitat within the system. In the 1990's fisheries biologists developed technologies to insure a sterile triploid fish. These fish can be used for aquatic plant management operations under permit in many states.

Grass carp are a poor choice for aquatic plant management where Eurasian Watermilfoil is the primary target and focus however. These fish have feeding preferences and EWM is among the lowest option they will select if given choices. Grass carp when introduced initially consume the remaining native aquatic plants further impacting those populations. They can, with much higher stocking densities, bring EWM under control in states where permits allow their use and allow stocking at rates that will accomplish control of EWM. However, this also impacts restoration and recovery of native aquatic plant communities.

In Washington State, triploid grass carp use is regulated by the Washington Department of Fish and Wildlife. Their permit program generally does not allow stocking of a public lake like American Lake and as such this approach would not be viable.

Milfoil Weevil

There have been decades of attempted development of a control process for EWM by the "milfoil weevil". This insect was observed in the 1980's feeding on EWM in Vermont lakes by their Department of Environmental Conservation. Through the 1990's that Department funded research on breeding and utilizing these weevils to target EWM. An Ohio company attempted to commercialize the use of this biocontrol technology for a number of years and recently issued a notice to discontinue milfoil weevil services (http://enviroscienceinc.com/es-discontinue-milfoil-solution-services/) A number of stories can be located regarding the effectiveness of this tool (example: http://www.cbc.ca/news/canada/sudbury/weevils-milfoil-sudbury-1.3685225).
As there are no legal and effective biological control agents for this target species, this option should not be considered for implementation.

Chemical Control

Aquatic herbicides are an effective method of aquatic plant control. These products are reviewed by the US Environmental Protection Agency (EPA) and if they meet the Agency's requirement for efficacy and protection of the environment, they are approved for use nationally. Each state can then address any additional concerns they may have about products.

In Washington State the Department of Agriculture (WSDA) has regulatory authority to register aquatic herbicides for use and license applicators. This program ensures that those utilizing these products have the training necessary to make applications and protect the environment. The WSDA has the ability to classify products as general use and restricted use. Restricted use herbicides can only be sold to applicators licensed by the department in the category that the applicator is licensed in. WSDA has classified all aquatic herbicides as restricted use in Washington State.

Permit Requirements for Aquatic Herbicides

The other regulatory oversight for use of these products comes from the Washington DOE. This agency regulates treatment to specific waterbodies through a general National Pollution Discharge Elimination System (NPDES) permit to make applications to "waters of the State". The DOE program is supported by a number of Risk Assessments they have performed or commissioned on each product that is available under their permit program.

The herbicides that are available and effective on *Myriophyllum spicatum or* Eurasian Watermilfoil are as follows:

- Diquat is a broad spectrum contact herbicide. It controls most aquatic plant species including EWM. Contact herbicides generally do not translocate within the plant, they kill the portions of the plant they come in contact with. Diquat is a fast acting product and comes as a liquid formulation. It is used in milfoil control projects when rapid removal of vegetation in the water column is necessary. It can also be used later in the summer to clear vegetation that might otherwise auto-fragment and lead to further dispersal in the lake.
- Endothall is a broad spectrum contact herbicide. It is also very effective on milfoil species and would be used much in the same way as diquat would be. Endothall is a bit more restrictive in terms of use of treated water than diquat.
- 2,4-D is a systemic herbicide that has activity on plants in the broadleaf family. There are two basic families of plants, those in the grass family and those in the broadleaf family. Most native aquatic plants are in the grass family. Eurasian Watermilfoil is in the broadleaf family so this class of herbicide is selective for milfoil. A systemic herbicide is one that will translocate within the plant so that complete control of the plant is possible. EWM has a root crown in the lake sediment that is a key survival structure. Systemic herbicides will kill both the vegetation in the water column and the root crowns and associated plant parts.
- Triclopyr is another systemic herbicide that has activity on plants in the broadleaf family. It can be used to selectively target milfoil and performs a bit better than 2,4-D in this role.

- Fluridone is a systemic herbicide that is extremely effective on EWM. This technology has to be used over a 6 to 8 week period however and in large lake systems like this, dilution often makes this approach cost prohibitive. This product may have a role in the smaller basins of the lake.
- Procellacor is a new class of selective systemic herbicide that received full US EPA registration in February of 2018... This product is one of the most effective herbicides against Eurasian and hybrid milfoils. It is unique in that it can be used at very low rates and has a much shorter contact exposure time requirement than the other broadleaf products. In order to be used in "Waters of the State" in Washington, the NPDES permit for aquatic herbicide application has to be amended by the Washington Department of Ecology. The Department has indicated that they expect to have the draft amendments completed by September of 2018 and hold public hearings in October of 2018. The Department has stated that the objective is to have the permit amended in time for use during the 2019 treatment season, so Procellacor should be a viable option for control in that time frame.

The costs associated with treatment activities in Washington State projected for 2018 would be as follows.

The Washington Department of Ecology Permit application is the first step needed to move this forward. This process takes about 60 days to complete so if treatments are proposed for the summer of 2019, this application work should happen in the winter of 2019.

A Notice of Intent to obtain coverage under the Statewide General NPDES permit for aquatic herbicides is the first step in this process. This filing can be done online by an applicator or other registered user of the site like the City. An applicator and a sponsor need to be identified (the applicator can be named later if there is a purchasing process that needs to occur and has not as of the time of filing). There is also a requirement to publish two legal notices in a local paper and deliver notification to shoreline property owners. And when the permit is issued there is an annual fee. The cost of filing the NOI is generally about $300-500.00 for the time involved. The cost of the two legal notices depends on the paper used, which in this case would most likely be The News Tribune. The mailing to shoreline residents is dependent on number of homes and includes development, printing and postage. The last fee is the annual ecology permit fee, this year it is $585.00 and it has been going up about $20-30.00 annually. So the permitting process can cost between $1,000-2,000.00 depending on legal notice and mailing costs.

There are also some public notice requirements just prior to treatment. All lakeshore properties must receive notification 10 days prior to any treatment work performed. This notice gives the schedule, the products to be used and any water use restrictions that might be

in place based on the application. On the day of treatment, there is also a posting requirement where shoreline properties receive signage so that people know the work is going to occur that day. These two steps cost approximately $2.000.00 for a lake treatment of this size.

The last cost is the application. The various products and costs per acre are estimated as follows (these are considered for budgetary purposes, costs may be lower and they should not be higher).

- Diquat, $350.00 per treated acre
- Endothall, $700.00 per treated acre
- 2,4-D liquid applications, $295.00 per treated acres
- 2,4-D granular application, controlled release pellet, $550.00 per treated acre
- Triclopyr granular, controlled release pellet, $990.00-1,100.00 per treated acre
- Fluridone granular, need to determine treatment area to price
- Procellacor, costs should range from $500.00 to $800.00 per acre based on water depth and plant densities. Under certain conditions the manufacturer is providing a three treatment season warranty for control.

Specify control intensity

The control intensity should be driven by the Problem Statement and management goals. They are:

Problem Statement:

Eurasian Watermilfoil (EWM) has become a problem in American Lake the past few years. EWM, which is a state-listed noxious weed, has spread to numerous shorelines around the lake, forming dense stands out to approximately 15 feet deep. Swimming, boating, fishing and other recreational uses have been greatly impacted where EWM is present. Swimmer safety along the shorelines is a serious concern and should be given priority. Transfer of EWM to other lakes from boats or other watercraft using American Lake is also a major concern. A growing monoculture of EWM is adversely impacting the diversity of the native plant communities and impacting native fish and wildlife populations.

Management Goals:

- *Maintain recreational and habitat uses of the lake by removing EWM.*
- *Keep swimming areas clear of EWM for safety reasons.*
- *Keep boating areas clear of EWM to minimize boat damage and transfer potential.*
- *Educate property owners and lake users about the negative impacts of EWM.*

- *Choose appropriate EWM control methods that are both effective and environmentally sensitive.*
- *Establish an agreement or memorandum of understanding among all lake front property owners and other interested parties to:*
    - *Determine equitable financing options for all lake front property owners to address ongoing control or eradication of milfoil.*
    - *Determine maintenance responsibilities.*
- *Reduce overall costs by using volunteer labor when possible.*

Based on the stated management goals, the objective of this project initially should be to remove Eurasian Watermilfoil in American Lake as economics allow.

Choose Integrated Treatment Scenario

The stakeholders group has reviewed the mapped conditions present, the uses and patterns present in the lake, the available technologies to control Eurasian Watermilfoil and determined that a two-phase approach will best meet the management goals outlined above. Phase One would be the initial effort directed at the major EWM populations currently in the lake. Phase Two would involve ongoing survey and response to conditions as found in the out years of the program.

Based on the current infestation in the lake system, a strategy of using selective systemic herbicides in combination with physical removal of smaller patches would best meet the goals of Phase One.

There are three herbicide technologies that are selective for Eurasian Watermilfoil.

2,4-D herbicides have been used for decades to selectively control milfoil infestations nationally. This is a systemic herbicide and will translocate into the root system and provide complete control of the plant. There are however a number of stakeholders around the lake including the US Veterans Administration. The VA representative indicated that their agency has a policy against using 2,4-D on their properties so that should be noted at least with respect to milfoil treatments in those zones 2,4-D herbicides come in both a liquid and controlled release granular formulation.

Triclopyr aquatic herbicides are also a tool that provides selective control of milfoil species. Like 2,4-D, Triclopyr herbicides are systemic and translocate to the root systems providing complete control of the plant. Triclopyr's activity on Eurasian Watermilfoil is a bit better that 2,4-D in terms of mode of action.

A third and superior option will be available sometime in the spring of 2019. Procellacor is a new herbicide that is completing the registration process at the US EPA and will be on the Washington Department of Ecology permit and available for in the spring of 2019. Procellacor was registered by the US EPA in their new reduced risk class of pesticides. Reduced Risk products are registered by EPA as replacements for older pesticide technologies because EPA feels they are better alternatives for the environment... Procellacor is thought by federal researchers to be the best milfoil herbicide ever developed and registered with the EPA. The product is labeled for application to potable water reservoirs and there no water use restrictions in treated areas except a short irrigation precaution. This product is systemic and will control Eurasian Watermilfoil at very low rates (in the low parts per billion) and very short contact exposure time requirements.

Fluridone herbicides have been used effectively to eradicate Eurasian Watermilfoil from Washington Lakes, but this herbicide mode of action is such that it must remain in the water at low rates for six to eight weeks. In a lake the size of American Lake, the herbicide budget for that process would exceed $600,000.00 and it probably would not be cost effective. If there continues to be expansion in the isolated bay on the southwest corner of the lake, however, this could be an excellent option for that area and should be considered.

With these 3-4 tools available, there are effective technologies to deal with the large infestations of milfoil in American Lake. There are also tools available to target and treat smaller patches in the largely un-infested portions of the lake.

There are significant areas of the lake along the north and northeast shoreline that have not been colonized to any large extent as of the summer of 2017. There are however pioneering colonies of milfoil plants lodging in this zone and over time will begin to fill the littoral zone here as well. This condition is also present to some degree around the island and in the southwest corner of the lake.

Diver survey and removal was recommended by the stakeholders for these zones. Divers supported by a mapping survey vessel should navigate these areas and map occurrences of milfoil plants. If the plants are few in number, they should be removed by the divers and bagged. Divers should be careful to remove the root crowns from the lake sediments as well. Where larger scattered patches that are too small to effectively treat with an herbicide, bottom barrier placement or Diver Assisted Suction Harvesting should be used to clear these zones.

A major treatment and diver survey effort should be undertaken in year one of the program as Phase One. At the completion of the year, follow up survey work should be used to assess control and identify any areas requiring touch up or further action. The systemic herbicides selected by the stakeholders will provide very close to 100% control where they are applied

effectively. There can be some limited regrowth in areas that require touch up in year two, but generally this is well less than 10%.

The stakeholders recognize that an ongoing effort needs to be in place after the Phase One treatment process to protect that investment and insure that the problem does not again expand to the point where this significant an investment is required.

Phase Two of the program will be ongoing. There will be a need for annual littoral zone survey work. This survey should be performed during the growing season and the objective would be to detect and map any surviving or re-introduced milfoil (or other noxious aquatic weeds). This information would be used by the group to target this growth with either diver removal or herbicides. The permit should be maintained with Ecology to insure treatment options are available.

While the initial focus of this program is to address the submerged aquatic weed *Myriophyllum spicatum,* there are localized patches of floating leaf and emergent noxious aquatic plants present in and adjacent to the lake. Individual Counties through their noxious weed program identify targets for control and eradication based on conditions in each County. The Pierce County Noxious Weed Board does not classify any of the floating leaf and emergent state listed noxious weeds as designated for control and eradication in the County.

These species should be a focus of concern for the American Lake Stakeholders even though control is not required. If allowed to expand they could cause alteration of the habitat and interfere with beneficial uses.

The ongoing monitoring program should map the location and extent of these three primary species ((*Nymphea odorata* (i.e., Fragrant Waterlily). *Lythrum salicaria* (i.e., Purple Loosestrife) and *Iris pseudacorus* (i.e., Yellow Flag Iris)).

There are control options available for these species.

Nymphea odorata at lower densities can be removed by diver hand collection or Diver Assisted Suction Harvesting (DASH). Conventional aquatic weed harvesters can also be deployed to collect these plants. There are a number of herbicide options available under the same NPDES permit that is used to target milfoil species present in the lake. Glyphosate herbicide with an aquatic surfactant is an extremely effective systemic treatment for this species. Imazamox with an aquatic surfactant is also an excellent control technology. Neither of these herbicide restrict water uses.

Lythrum salicaria and Iris pseudacorus occur on the margins of the lake. There are limited options available for targeting these plant mechanically. Manual removal works extremely well

where populations are low. There are biocontrol tools available for Lythrum salicaria. Two primary insect species have been shown to provide control where densities are high enough to support the biocontrol populations. Glyphosate and Imazamox herbicides with an aquatic surfactant also work extremely well on these species. Both of these plants can be targeted under the NPDES permit that governs submerged aquatic weed control, or a separate permit available from Ecology designed for emergent noxious weed control can be used where granted. The emergent noxious weed permit is a bit less restrictive in terms of conditions of notification that must be performed prior to application.

As this plan is implemented and the milfoil problem is addressed, a focus on these remaining noxious weeds should come into play. There is potential to use grant programs to support this work and the Stakeholders will review those and use that avenue where appropriate in the Phase Two efforts.

Develop Action Plan

The first step identified by the stakeholders is to develop a budget that can be used as guidance for implementation of this plan. This budget assumes that work would begin in 2019 because of the work involved in funding the program. Portions of it could move forward in 2018 if monies were available. For example, a permit could be obtained and individual private lot owners could contract for treatments; or funding from the partners might materialize in a shorter time frame.

The budget should have the following components:

Task	Timeline	Estimated Cost
Survey summer of 2019	June/July 2019	$2,500.00
Obtain necessary permits, aquatic herbicide permit from Washington Department of Ecology and HPA from WDFW Pamphlet.	Spring of 2019 if interested in starting work in 2019 or prior to summer of 2020	$1,750.00
Herbicide application to 130 acres of littoral area. This assumes treatment in 2019 and some expansion of milfoil colonies in the lake through 2018 and spring of 2019. This assumes budget of $1,000.00 per treated acre for application,	May-June 2019 is target.	$130,000.00

materials and public notification/permit condition compliance.		
Survey and diver removal targeting low density shoreline areas of the lake	Summer of 2019 unless funding available earlier	$30,000.00
Post Treatment evaluation survey, mapping and report	Late summer of treatment year	$2,500.00
Public meetings/web site/community involvement	Ongoing throughout the mission	$4,000.00
Year of treatment debriefing. Review of treatment, post treatment survey, what worked, lessons learned, develop action plan for following year based on conditions	Fall or winter after Phase One Treatments	$1,500.00
Optional equipment purchase for volunteer monitoring, Trimble GPS, software, training to develop data to present to City GIS for map creation	Any time through the mission and possibly for Phase Two ongoing mission	$7,500.00
Total Estimated funds necessary for Phase One and optional equipment noted above		$179,750.00

There are several potential funding sources for all or portions of this Phase One process. Some of them for consideration are:

- Stakeholder contributions; funding from VA, JBLM, State of Washington, Lakewood, and American Lake Improvement Club.
- Stakeholder contributions of materials such as herbicide if they have a budget or purchasing mechanism for that.
- Washington Department of Ecology IAVMP implementation grant, up to $75,000.00 can be requested.
- Lake Management District (LMD) or Special Purpose District set up for the entire lake, or private property owners on the lake. There are approximately 61,715 shoreline front feet around the entire lake. There are approximately 26,580 shoreline front feet adjacent to private properties on the lake. LMD's are generally set up based on front

feet. An $180,000.00 budget divided by the entire shoreline front footage would be $2.92 per front foot. Individual private properties on the lake average 50 feet so individuals yearly cost under this scenario would be about $146.00. The larger land owners would pay more if they were included in the LMD. There would also be some administrative costs for the entity that managed the LMD that would need to be added to this figure.

- Organize private funding of milfoil control for affected properties. Applicators could contract with individual property owners to perform control work and operate under the permit secured for this lake either before large scale funding is secured or if an LMD or similar funding set up is not realized.

Before any work can be performed, the process of identifying funding sources, collecting funds and working out any interagency agreements would be necessary.

Step One, Obtain Permits for use in 2019

Apply for the Washington Department of Ecology Aquatic Pesticide Permit for the lake. This involves filing a notice of intent (NOI) with Ecology to obtain coverage under their general NPDES permit. When the notice is filed, generally by the applicator, a mailing to all shoreline property owners is required as well as the publication of a public legal notice in the local paper. There is also a DOE annual permit fee. The permit fee is prorated during the year issued, for example if issued in May, prorated until end of fiscal year. After that, the permittee is billed each year for coverage from July 1 through the following June 30th. This permit should be maintained annually so that treatments can occur after Phase One work is completed if necessary.

Step Two, Obtain current conditions in the lake for 2019

A survey should be performed in the spring of 2019. The focus of this survey should be to confirm the current understanding of the infestation in the lake, and to review areas where light or no concentration of the invasive weed were present in 2017. As milfoil spreads primarily through fragmentation, there could be considerable new growth in these areas prior to implementation of the treatment program.

There should be a public awareness component to the program. This is especially true if the funding mechanism involves building a Lake Management District or similar taxing authority. This work should be ongoing.

Step Three, Contract for Control Work

Contracts for control work need to be developed, advertised and contractors retained. Aquatic herbicide applications need to be performed by licensed applicators. Diver assisted harvesting companies are present in the state and the region. Generally, a Request for Proposal format works best for selecting qualified firms to perform this work.

Step Four, Perform Aquatic Herbicide Treatment and Diver Assisted Removal

The herbicide treatment areas should be defined, the contractor should help with the selection of the appropriate products based on conditions present in the lake. Selective systemic herbicides that impact Eurasian Watermilfoil should be used. Procellacor would probably be the preferred product if treatments fall into the 2019 time frame. Renovate OTF granular (a Triclopyr product) would be the fall back systemic product if work is funded in 2018 before Procellacor reaches the DOE updated permit.

Diver survey and removal should focus on areas defined in the 2017 and 2018 surveys as little or no density of milfoil present.

Step Five, Perform Post Treatment Evaluation of Control

It is critical in these programs to have a post treatment evaluation. Aquatic plant management in this case is targeting an aggressive invasive plant. While the herbicide and diver removal technologies are extremely effective, we are dealing with biology and there can be factors that allow a few plants here and there to survive. There must be a process that reviews the sites treated with either technology and assess effectiveness.

Most effective programs have a debrief event near the end of the year or after a post treatment evaluation is performed. This allows stakeholders to discuss what worked well, what maybe didn't work well, lessons learned that would lead to future improvements to the program and development of action steps for the coming growing season.

The stakeholders group should then develop Phase Two or ongoing work efforts to protect the investment by finding and targeting new growth in the lake before it reaches problematic levels.

Moving Forward

The Stakeholders will endeavor to reach a memorandum of understanding during 2018 to define the role of each and to fund the program. During the fall of 2018, the Stakeholders will explore other funding sources including the Washington Department of Ecology Freshwater

Aquatic Weed Grant Program. During the late fall and early winter of 2019 the Stakeholders will determine what funding is available and implement the first phase of this plan based on budget available. Contracts for outside assistance will be advertised and awarded in the spring of 2019. The focus in the summer of 2019 will be control of Eurasian Milfoil in the lake via identified control methods. Evaluation of the control achieved will be used post season for planning future needs and activities. An active public awareness campaign has been and will continue to be utilized throughout the life of this project to keep lake residents and stakeholders informed and engaged.