Integrated Aquatic Vegetation Management Plan

Cowlitz River Hydroelectric Project
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and
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1.0 Introduction

The purpose of the Integrated Aquatic Vegetation Management Plan (Plan) is to assist Tacoma Power (Tacoma) in meeting state water quality standards for protection of ecological, aesthetic, and recreational values for the Cowlitz River Hydroelectric Project (Project). As requested by the Washington State Department of Ecology (WDOE), the Plan was developed according to the approach outlined in the *Citizen's Manual for Developing Integrated Aquatic Vegetation Management Plans* (Gibbons et al. 1994). The Plan will be submitted to WDOE as part of Tacoma's application for water quality certification under Section 401 of the Clean Water Act.

The Plan will also enable Tacoma to meet the obligations of state law requiring landowners to control noxious weeds on their property (RCW 17.10.140). However, while the land surrounding the reservoirs is owned by Tacoma, much of it is managed by Washington Department of Fish and Wildlife (WDFW). For this reason, it is anticipated that will share the responsibility for implementing the Plan with other stakeholders, including WDFW, Lewis County Community Services Division of Parks and Recreation, Washington State Parks and Recreation Commission, private camp and resort owners, and homeowners associations. In addition, the participation of local residents, conservation and recreation groups who have first-hand knowledge of the Project's waterbodies and a personal concern for the health of these aquatic systems, will help to ensure the long-term viability of the Plan.

2.0 Project Description

Waterbodies addressed in this Plan include Riffe Lake, Mayfield Lake, the reach of the Cowlitz River between Riffe and Mayfield lakes, and Swofford Pond (Figure 1). This area corresponds to lands shown in Figure 1 as Tacoma's ownership within the FERC boundary.

Riffe Lake is the largest of the Cowlitz River Hydroelectric Project reservoirs. It measures 23 miles long, 2 miles wide, and covers approximately 11,800 acres, with about 52 miles of shoreline. Average water depth is 143 feet at full pool. Riffe Lake is operated for power generation and as a storage reservoir for flood control. The reservoir is drawn down approximately 60 feet during the winter to accommodate high winter and spring flows. Drawdown begins after Labor Day, and full-pool is usually reached by Memorial Day. Thus, during the growing season, water levels are approximately 20 feet below full pool in early May, at full pool by early June, and are again 20 feet below full pool by early October, a schedule that would vary somewhat from year to year, depending on weather and flow conditions. The major tributary to Riffe Lake is the Cowlitz River upstream of the Project. Smaller tributaries include Rainey, Frost, and Steffen creeks near Kosmos; Sand, Swigert, Shelton and Simmons creeks on the north shore, and Peterson and Landers creeks on the south shore. Water leaves Riffe Lake via the spillgates or the intake for the Mossyrock Powerhouse, which is 210 feet below the full pool elevation.

Mayfield Lake is 13.5 miles long, 0.7 miles wide and covers a maximum surface area of 2,250 acres, with 33.5 miles of shoreline. The average water depth is 61 feet at full pool. The reservoir is operated as run-of-the-river and drawdown seldom exceeds three feet. Major tributaries to Mayfield Lake include the Cowlitz River via Mossyrock Dam, the Tilton River, and Winston Creek. Smaller tributaries include Klickitat Creek on the southeast shore and Silver Creek on the northwest shore. Water discharged from the Mayfield Powerhouse is drafted through the intake, 36 feet below the full pool elevation.

Swofford Pond covers approximately 240 surface acres. The average depth is about 8 feet, and the maximum depth is about 20 feet. Swofford Pond was formed by the construction of a 30-foot-high, 800-foot-long embankment dam to retain inflow from Sulphur Creek and Mud Creek. The outlet is controlled by a hydraulic cylinder-operated flap gate between Swofford Pond and Riffe Lake.

3.0 Identification of the Problem

To date, Eurasian water milfoil (*Myriophyllum spicatum* L.) is the only aquatic nuisance species that has been reported in Cowlitz Project waters. The establishment of several other exotic nuisance plants, such as hydrilla (*Hydrilla verticillata*), Brazilian elodea (*Egeria densa*) and parrotfeather (*Myriophyllum aquaticum*), has been documented in other Washington lakes and streams, and could occur in the Project area. For example, swollen bladderwort (*Utricularia inflata*), a floating aquatic macrophyte, was recently observed growing in a pond approximately four miles from the Cowlitz Project (J. Tipping, WDFW, pers. comm., July 23, 1998). Although not listed on the Lewis County Noxious Weed List for 1999, swollen bladderwort is well-established in Lake Limerick, Mason County (WDOE 1998a), and until recenty, was also present in Silver Lake, Cowlitz County (WDOE 1999). Potential occurrence of this introduced bladderwort should be monitored in the Project area. The 1999 Lewis County Noxious Weed List, with definitions of weed classifications, is provided in Appendix 1.

In addition to weedy aquatic macrophytes, exotic species that affect wetlands are also covered in this Plan. To date, invasive wetland species documented in the Project area include purple loosestrife (*Lythrum salicaria*), reed canarygrass (*Phalaris arundinacea*), and Japanese knotweed (*Polygonum cuspidatum*). Annual review of the Lewis County Noxious Weed List will be used to help identify species that may represent future problems in the Project area.

Purple loosestrife is classified as a Class B noxious weed; control is mandatory, and prevention of spread is considered a high priority in Lewis County. Purple loosestrife was introduced into the eastern U.S. in the 1800's. It has gradually spread westward, and now represents a serious threat to native wetlands in several areas of western Washington. A small patch was recently observed growing along the south shore of Swofford Pond (B. Wamsley, Lewis County Weed Board, pers. comm., August 28, 1998). The plants were removed by hand-pulling, but this occurrence emphasizes the importance of monitoring potential habitat. Loosestrife typically occurs in emergent wetlands, protected lakeshores and backwaters of rivers and streams.

Reed canarygrass is designated a Class C noxious weed, a classification for which long-term suppression and control programs are optional. It is common in the Project area. It's tolerance of a broad range of environmental conditions makes it very difficult to eradicate and replace with more desirable native wetland species; however, reed canarygrass may provide an important groundcover at sites where more desirable plants cannot be established, such as the drawdown zone at the upper end of Riffe Lake.

Japanese knotweed is present in scattered locations in the Project area. This deciduous shrub is an aggressive plant that, like reed canarygrass, tolerates a wide variety of soil, light and hydrologic conditions. Giant knotweed (*P. sachalinense*) is very similar in appearance to Japanese knotweed, but has not been documented in the Project area. Both species are designated as Class C County Select noxious weeds in Lewis County.

In addition to exotic, invasive species, this Plan is designed to address the management of native aquatic plants. Depending on where they occur, dense beds or floating mats of native vegetation can adversely affect water quality, fisheries, wildlife, recreation, and aesthetic resources. For example, abundance of plants such as watershield (*Brasenia schreberi*) and floating-leaved pondweed (*Potamogeton natans*) can reduce dissolved oxygen levels in shallow water areas of ponds and lakes, and thus limit habitat quality for fish. Elodea (*Elodea canadensis*) is managed at Lake Mayfield County Park in order to maintain safe swimming conditions. Both the beneficial and potential adverse impacts of aquatic vegetation must be evaluated in determining how native and exotic species will be managed. These concerns are discussed in more detail in Sections 10 and 11. At this point in time, however, Eurasian milfoil represents the primary aquatic weed concern in the Cowlitz Project area.

Eurasian milfoil is classified as a Class B noxious weed by the Lewis County Noxious Weed Control Board, and control is mandatory. Milfoil is an aquatic macrophyte that was introduced into the United States from Europe and Asia. It was first documented in Washington in Lake Meridian, King County, in 1965. Although no milfoil was observed in Lake Scanewa, just upstream of Riffe Lake, during surveys conducted by the Lewis County Noxious Weed Control Board in 1995 (Wamsley 1995), milfoil has been documented in numerous other lakes in western Washington (WDOE 1998c).

Like native species of milfoil, such as *M. sibericum*, Eurasian milfoil grows in the shallow, slow-moving waters of lakes, ponds, and streams. Although it does provide nutrients, surface area for aquatic organisms, forage for some species of waterfowl, and hiding cover for several species of fish, Eurasian milfoil is regarded as a nuisance plant that complicates the management of water quality, recreation, and navigation.

Milfoil has been shown to spread rapidly by rhizomes and by the formation of adventitious roots, and fragments naturally as a means of reproduction. Fragmentation also occurs as a result of wave action, disturbance by boat propellers, or feeding activities of waterfowl. The broken pieces often root and produce new plants. Milfoil is easily spread, because it can be carried on boats and boat trailers if they are not thoroughly cleaned, and can then easily establish in any waterbody that provides suitable conditions.

As they expand and grow to the surface, dense stands of milfoil tend to form a canopy that shades out native aquatic macrophytes (Amundsen and Brenkert 1978). When diversity in the plant community is reduced in this way, changes may occur in the fish community as well. A review of changes in fish populations in the littoral zone of four Wisconsin lakes (Lyons 1989) showed that a diverse assemblage of fish species present from 1914 through the 1960's had been replaced over a short period of time by a single fish species, a shift which correlated with the invasion and spread of milfoil. The spread of milfoil can also affect the wildlife community, by preventing the growth of aquatic macrophytes that provide important forage for many species of waterfowl.

Dissolved oxygen was generally high (greater than 8 mg/L). The exceptions to this were measurements of DO in the Kosmos Flats in late August (6.8 to 8.0 mg/L) and near the bottom at the site near the Mossyrock Dam in November (5.6 mg/L).

Of the Project waterbodies, Riffe Lake values had the greatest range (6.7 to 8.4) of pH. Review of time series plots indicates that pH was fairly constant throughout the water column during December through April. During May, June, and July pH at the surface of Riffe Lake was considerably higher than in deeper water. Measurements made during the summer longitudinal study show that near the surface pH increases from 7.3 just downstream of the Cowlitz Falls Dam to 7.7 in the main body of Riffe Lake. Near the bottom pH decreased from about 7.2 to 6.7. Measurements of pH in the Kosmos Flats were considerably lower than at the same depth in the main body of the reservoir.

Water clarity as measured by Secchi depth ranged from 0.6 meter in February to 7.2 meters in August, and was relatively similar at each of the monitored sites during each month. The seasonal trend in water clarity was an increase from late winter to mid-summer (with the exception of July) and then a decrease from late summer until early winter.

Nitrogen available for primary production (nitrate, nitrite, and ammonia) was limited in surface waters of Riffe Lake during May through November. Cowlitz River inflow to Riffe Lake also had low concentrations of inorganic nitrogen during most of this period. Near-bottom nitrate plus nitrite concentrations were considerably higher than at the surface during this period.

Periodic measurements of total phosphorus (TP) ranged from less than the detectable limit of 0.005 mg/L to 0.032 mg/L. Ortho-phosphorus, the biologically available form of phosphorus, was typically less than 0.02 mg/L at most sites.

Phytoplankton densities were generally highest (about 1,000 to 1,800 cells per mL) during June and July, and lowest (less than 300 cells per mL) during August through October. Zooplankton densities were highest (about 45,000 organisms per cubic meter) during July and lowest (around 10,000 organisms per cubic meter) during late summer and autumn.

The Carlson Scale of Trophic Status combines measurements of Secchi depth, TP and chlorophyll-a, which may be indirectly estimated based on phytoplankton densities, to assess productivity (Carlson 1977). Using this scale, Riffe Lake is considered mesotrophic.

Based on measured Secchi depths of 7.2 meters (23.6 feet) during the 1997 growing season, warm water temperatures, and mesotrophic nutrient status, Riffe Lake would be considered potentially suitable for the establishment of Eurasian milfoil. Secchi depth (and consequently, area available for milfoil colonization) may change slightly from year to year, depending on factors such as turbidity and phytoplankton density, but would not be expected to exceed 9 meters (30 feet).

The area of the littoral zone above 9 meters (30 feet) at summer full pool, during the growing season, is estimated to be approximately 740 acres, based on pre-project USGS topography. Bathymetric mapping of the reservoir recently conducted by Tacoma will be used to refine this estimate and provide more current data. Sediment accumulation since construction of the Project may have increased the area of the littoral zone, especially at the Cowlitz delta and in the vicinity of Kosmos, resulting in additional acreage that could be colonized by milfoil.

As described in Section 2.0, above, annual drawdowns during the fall may help to prevent establishment of milfoil populations in Riffe Lake through desiccation and freezing of milfoil plants. However, this method of control is not reliable under conditions of high rainfall and relatively moderate winter temperatures (Gibbons et al. 1994). As much as 2,500 acres of the littoral zone may be above 9 meters (30 feet) as the reservoir is gradually drawn down during the fall to provide for flood storage, and gradually filled during the early spring.

6.2.2 Mayfield Lake

Water near the surface is considerably warmer than at depths of three meters or more during August and September. The only temperatures that exceeded 20°C were measured at depths of less than two meters in the Cowlitz and Tilton arms during early August. By late August, surface temperatures were reduced to less than 20°C throughout the reservoir.

Dissolved oxygen concentrations were typically greater than 8 mg/L in Mayfield Lake. The exceptions to this were early autumn measurements of DO for near the bottom of the site near the Mayfield Dam, and near bottom measurements made in late August in the Tilton arm at the head of the canyon and the mainstem of the reservoir downstream of the confluence of the Cowlitz and Tilton arms.

Mayfield Lake pH measurements ranged from 6.7 to 8.0. Values were highest in surface water and lowest near the bottom, particularly in the summer. Elevated near surface values were not measured until June, a month later than in Riffe Lake. Values greater than 7.5 were only observed in water at or above the thermocline. The site near the dam consistently had the lowest near bottom pH values.

During late August 1997, measurements of pH remained relatively similar throughout the water column from a short distance downstream of the Mossyrock powerhouse tailrace to the Harmony Bridge over the Cowlitz River arm of Mayfield Lake. Beyond this point pH increased rapidly about 0.5 units. Bottom pH remained relatively stable until the Cowlitz and Tilton arms joined then decreased as the depths increased. Tilton River inflow had a much higher pH than the Cowlitz River inflow (7.9 versus 7.0). The bottom pH in the canyon was 6.5, and remained below 7.0 down to the junction with the Cowlitz arm.

Secchi depths ranged from a low of 0.5 meters in November 1997 to a high of 5.2 meters in September. Both the lowest and highest values were measured at the site in the Cowlitz arm near the Mossyrock Hatchery. Mayfield lake water clarity was lowest during winter through early summer and highest in mid to late summer.

The availability of inorganic nitrogen for primary production was higher in surface waters of Mayfield Lake than in Riffe Lake. These higher levels were primarily in the form of nitrate and nitrite, and occurred through the winter, spring, and autumn. During the summer, the availability of nitrogen was comparable in surface waters throughout Riffe Lake and in Mayfield Lake near the dam. However, considerably more nitrogen was available for primary production in both the Cowlitz and Tilton arms of Mayfield Lake, particularly during July.

Periodic measurements of TP ranged from less than the detectable limit of 0.005 to 0.03 mg/L. Ortho-phosphorus was typically less than 0.02 mg/L.

Phytoplankton densities were generally highest (between about 500 and about 1,000 cells per mL) in June, and lowest (less than 100 cells per mL) in November. In October, the Tilton arm had a much higher phytoplankton density (about 1,500 versus less than 600 cells per mL) than either of the other two Mayfield Lake sites. Like Riffe Lake, Mayfield Lake would be considered mesotrophic in terms of nutrient status, based on Secchi depth, TP, and chlorophyll-a concentrations.

Zooplankton densities were typically less than 10,000 organisms per cubic meter. Densities of more than 20,000 organisms per cubic meter were measured for the Tilton and Cowlitz arms during August and September. The Tilton arm August sample, which had a zooplankton density of about 96,000 organisms per cubic meter, was the only one of these samples that had a density of more than 25,000 organisms per cubic meter.

Based on its mesotrophic status, appropriate water temperatures and Secchi depths during the growing season, Mayfield Lake should be considered to provide suitable conditions for establishment of Eurasian milfoil. The estimated area of littoral zone in Mayfield Lake above 5.2 meters (17.2 feet), which corresponds to the highest Secchi depth measured during the 1997 growing season, is approximately 450 acres, based on pre-project mapping completed in 1943. Bathymetric mapping conducted in 1998 will be used to refine this estimate.

6.2.3 Swofford Pond

No thermal stratification occurred in Swofford Pond, although temperatures exceeded 20°C in July, August, and September. A maximum temperature of 25°C was recorded during early August.

Summer dissolved oxygen concentrations in Swofford Pond were very low throughout much of the water column. The lowest concentrations were recorded in September when DO was only 6 mg/L at a depth of 1.5 meters, and all measurements from 2.5 meters to the bottom had concentrations of less than 2 mg/L. Dense colonization by Eurasian milfoil or native species currently present in the pond would be likely to further reduce night-time and early morning DO, with potentially harmful effects on aquatic resources.

Swofford Pond pH values ranged from 6.8 to 8.2. Measurements of pH in the upper two meters of Swofford Pond were 7.5 or higher during all monitoring events with the exception of November. Near surface pH increased as the summer progressed until August and then rapidly decreased in late summer. Near bottom pH values were considerably lower during June through September.

Periodic measurements of Swofford Pond Secchi depths ranged between a low of 1.2 meters in October to a high of 3.5 meters in July.

The amount of nitrogen available for primary production was much reduced in Swofford Pond during the summer. In September, ammonia concentrations were high, but nitrate plus nitrite concentrations remained low.

Phytoplankton densities ranged from a high of about 16,000 cells per mL in May to a low of less than 1,000 cells per mL in July. Blue-green algae made up over 40 percent of the phytoplankton during June through November, and was particularly abundant in October. Zooplankton densities steadily increased from a low of about 200,000 organisms per cubic meter in May to nearly 600,000 organisms per cubic meter in August. Swofford Pond would be considered eutrophic.

Waterfowl densities are highest on Swofford Pond and Mayfield Lake. Large numbers of coots (*Fulica americana*) are observed on Riffe Lake during the fall and winter. Use is highest in all three areas during the fall migration period, and lowest during the spring and summer. Relatively few ducks appear to winter in the area, but Canada geese and coots are present on Riffe and Mayfield lakes year-round. Wood ducks, mallards and common mergansers nest in the Project area.

Wading birds, such as great blue heron (*Ardea herodias*) and green-backed heron (*Butorides striatus*), forage along the shallow lake margins and in adjacent wetlands. The reservoirs and forested areas around them provide forage, perch and nesting habitat for bald eagles (*Haliaeetus leucocephalus*) and osprey (*Pandion haliaetus*).

In addition to birds, a variety of other wildlife species are associated with upland forests, wetlands, and riparian habitats adjacent to Project waterbodies. River otter (*Lutra canadensis*), raccoon (*Procyon lotor*), muskrat (*Ondatra zibethicus*), and beaver (*Castor canadensis*) are the most common furbearers. Big game species include black-tailed deer (*Odocoileus hemionus*) and Roosevelt elk (*Cervus elaphus*). Little is known about amphibian use, but it is expected that Pacific treefrog (*Pseudacris regilla*), red-legged frog (*Rana aurora*), and the introduced bullfrog (*Rana catesbeiana*), in addition to northwestern salamander (*Ambystoma gracile*), Pacific giant salamander (*Dicamptodon tenebrosus*), rough-skinned newt (*Taricha granulosa*), ensatina (*Ensatina eschscholtzii*), and western toad (*Bufo boreas*), would be present. Few reptile species are thought to occur in the Project area. Two turtle species (the slider, *Trachemys scripta*; and the painted turtle, *Chrysemys picta*) may have been introduced, and native garter snakes (*Thamnophis* species) are abundant.

7.3 Recreation Resources

As shown in *Washington Outdoors: Assessment and Policy Plan 1990-1995* (Interagency Committee for Outdoor Recreation 1990), the heavily populated 12-county planning region that includes Lewis County is the source of most of the state's recreation demand in all activity categories. With the exception of camping, this region also satisfies more of the recreation demand than any other region of the state. However, many households in the region recreate in other areas to satisfy their great demand. It is projected that the population of the Cowlitz Project region, and Lewis County in particular, will increase by nearly 20 percent between the years 1989 and 2000.

Recreation activities on Project lands include boating, fishing, relaxation, camping, wildlife-watching, photography, nature study, and the year-round viewing of scenery by visitors and passersby. To accommodate these types of recreation, a number of camping, fishing, boating, and picnic facilities have been developed on Cowlitz Project lands by Tacoma, the State of Washington, Lewis County and private organizations. These are located along the shores of Mayfield and Riffe lakes, Swofford Pond, and the Cowlitz River (Figure 3).

Glenoma Community Park is located near the east end of Riffe Lake on land owned by Tacoma and leased to Lewis County Community Services, Division of Parks and Recreation. Mossyrock Park is a year-round recreational facility, owned and operated by Tacoma on the southwest shore of Riffe Lake. The Mossyrock Dam Overlook is located on the north side of the dam. Here, a stairway leads from the parking lot and overlook to Riffe Lake. This site is a very popular fishing area. The Kosmos Boat Launch is located on the northeast shore of Riffe Lake. Taidnapam Park, a year-round recreational facility owned and operated by Tacoma, is also located on the northeast shore of Riffe

Lake. A parking lot and vault toilet at the Kosmos Flats serves a hang-glider landing area. This area is within the Cowlitz Wildlife Area.

Ike Kinswa State Park is situated on Mayfield Lake's Tilton Arm. Mayfield Lake County Park is a full-service recreational facility operated by Lewis County Community Services, Division of Parks and Recreation, on land leased from Tacoma along the east shore of the lake. Lake Mayfield Resort is a commercial operation located along the southwest shore of Mayfield Lake. Harmony Lakeside RV Park is a commercial RV park located on the north shore of Mayfield Lake. The 61-acre Mayfield Lake Youth Camp is located partially on private land and partially on land leased from Tacoma.

Swofford Pond provides a warm-water recreational fishery. Bank-fishing is especially popular. A boat launch is located at the east end of the pond, and while internal combustion engines are prohibited, electric motors are allowed.

8.0 Distribution and Abundance of Aquatic Vegetation

Figure 4 shows shallow areas in Swofford Pond, Mayfield Lake and Riffe Lake that could support milfoil and other aquatic plants, based on the relationship between contour elevations and water clarity, as measured by Secchi depth. These areas were roughly estimated from pre-project topography. They will be updated from bathymetric surveys recently conducted by Tacoma to map and quantify acreages of potential colonization.

Aquatic vegetation surveys conducted to date have focused primarily on milfoil in Swofford Pond. Information about species abundance and distribution in Mayfield and Riffe Lake has been based largely on incidental observations recorded during water quality sampling, fish hydroacoustic studies, and waterfowl counts. Tacoma contracted with Harza to conduct more systematic surveys during June and July, 1998 (Appendix 2). Although 100 percent coverage was not obtained due to the large size of the reservoirs and limited underwater visibility on several survey days, most shallow-water areas of the reservoirs were covered.

Due to the large seasonal drawdown of the reservoir and the steep bathymetry, it supports less aquatic vegetation than Mayfield Lake. In Mayfield, the most common and widely-distributed aquatic plants appear to be *Elodea* species. Several well-established patches of *Potamogeton* species are also present in the littoral zone. Canadian elodea (*Elodea canadensis*), clasping-leaved pondweed (*Potamogeton richardsonii*), horned pondweed (*Zannichellia palustris*) and *Chara* were observed in Mayfield Lake during a water weed survey in 1991 (Tacoma 1991) and again in 1998 (Appendix 2).

Milfoil surveys conducted by Resource Management, Inc. (RMI) in 1991, 1993, 1994 and 1995 indicate that *Elodea* and *Potamogeton* species were present in Swofford Pond. The macroalgaes *Nitella* and *Chara* species were abundant and widely distributed. Figure 5 shows milfoil and macroalgae observed by RMI in 1994. Coontail (*Ceratophyllum demersum*) and floating bladderworts (*Utricularia* species) were also observed by RMI. WDFW planted several species of aquatic plants in May of 1995, including 16,000 tubers of Sago pondweed (*P. pectinatus*), 11,000 tubers of water celery (*Vallisneria americana*), and 150 pounds each of coontail and elodea in shallow water along the west and southeast shore of Swofford Pond. Subsequent observations indicated that pondweed and elodea were growing and spreading (M. Cope, WDFW, February 23, the bottom with weights and are often punched with holes to let gas escape. Bottom barriers are relatively expensive, but if properly installed and covered with a thin layer of sand to shield from sunlight, are effective and may last up to 10 years.

Other physical control methods, such as water level management or the use of dyes, would be less feasible for application in Project waterbodies. Drawdown can kill plants through desiccation and/or freezing, but is likely to adversely affect other beneficial uses of the Project waterbodies, such as fisheries and recreation. Use of dyes to create shaded conditions that are not suitable for establishment of problem plants would not be feasible in Riffe or Mayfield lakes due to their large volume, and could complicate the management of fisheries and wildlife in Swofford Pond.

9.2 Mechanical Control Methods

Mechanical methods can also be employed to manage aquatic and terrestrial weeds. Mechanical methods include harvesting, rotovation (bottom tillage), or diver-operated suction dredging. Harvesting and rotovation are often used to control large areas of infestation and to create open-water areas in dense stands of aquatic vegetation at sites where hand-pulling would be too time-consuming and expensive. Disadvantages include fragmentation, considerable increases in turbidity as bottom sediments are stirred up, and incidental removal of desirable aquatic plants.

Diver-dredging represents a "mid-range" option between hand-pulling and harvesting. Although it is more expensive than hand-pulling, it is also faster than hand-pulling and involves less risk of fragmentation, turbidity, or loss of desirable plants. Diver-dredging could be an effective approach for treatment of noxious aquatic weeds in the Project area at sites that are too large for hand-pulling.

9.3 Biological Control Methods

Biological controls would include the use of pathogenic organisms, plant-eating fish or insects, or use of aquatic plants that would outcompete problem species. Biological controls can provide a "natural" alternative to chemicals or can be used in combination with chemicals, but in some cases, they have had undesired effects on non-target species. Biological controls are not proposed for the Cowlitz Project at this time. Depending on the outcome of studies now underway at the University of Washington and other research institutions, they may be considered in the future.

Stocking of sterile grass carp (*Ctenopharyngodon idella*) is currently approved as a milfoil treatment in Washington, but is not recommended (Gibbons et al. 1994). Although grass carp have been very effective at removing milfoil in some lakes, they appear to find native plants more palatable. The end result of stocking grass carp may be a lake that is devoid of all plants, including desirable native species (WDOE 1999). The U.S. Army Corps of Engineers and U.S. Department of Agriculture are investigating the potential efficiency of pathogenic fungi and stem-boring weevils in controlling milfoil (WDOE 1997a).

Biological control agents for purple loosestrife were investigated initially by the International Institute of Biological Control (IIBC), Europe. The IIBC was contracted by the U.S.A. to do the initial survey for biological control agents in Europe and to conduct the screening tests on candidate organisms. Biological control tests were also conducted in the United States for a number of years. Three species of beetles were approved for release in the United States on June 26, 1992. *Hylobius transversovittatus* is a root-infesting weevil, and *Galerucella calmariensis* and *G. pusilla* are leaf-feeding beetles. Feeding by these insects at high densities of attack resulted in defoliated mature

Observations of plants designated as Class C weeds (e.g., Japanese knotweed, reed canarygrass) will be included in Tacoma's Annual Report so that distribution can be monitored. Although presence of these species does not require implementation of control measures, suppression and prevention of spread is consistent with County priorities for noxious weed management.

11.3 Removal Methods

If the results of future monitoring indicate that milfoil and other noxious aquatic plants can be controlled by physical and/or mechanical methods, hand-pulling and diver-dredging (suction dredging) would be the most preferred. Based on the results of monitoring in 1998, these methods would be effective because 1) the total biomass of milfoil within the Project area is relatively low, enabling these relatively laborious methods to keep the spread of milfoil in check; 2) these methods best protect the other desirable aquatic species; and 3) complete removal of the plant, including the root mass, greatly increases the duration of effective control. Removal activities may be conducted at the same time as monitoring to increase efficiency.

11.3.1 Aquatic Plants

Hand-Pulling and Diver-Dredging: If plants are removed from water over 3-4 feet deep, hand-pulling will be conducted by divers equipped with snorkel or SCUBA gear. A narrow spade or long knife will be used to loosen the roots from the substrate. Plants will be bagged underwater or allowed to float to the surface, where they will be captured and bagged for transport. Fragments will be contained and captured using a fine net, such as a swimming pool skimmer. Tacoma will identify and use appropriate disposal sites.

Where plant densities are too high for efficient hand-pulling, diver-dredging will be considered. Diver-dredging requires specialized training and equipment, and must be professionally contracted. Milfoil densities in Swofford Pond are already high enough that hand-pulling may not be as efficient as diver-dredging. However, results of surveys planned for 1999 will be used to help determine which method would be most cost-effective.

Hand-Cutting: At this point in time, aquatic plant densities in Swofford Pond are below optimal levels, in terms of fish habitat. In the future, management of aquatic plants in Swofford Pond to achieve fisheries management objectives may require either hand-cutting or mechanized cutting to reduce cover. Also, some species of aquatic plants, such as water lilies, cannot be removed by hand-pulling. Depending on species to be controlled and the size of the area, a specially-constructed rake could be dragged through the water to remove a swath of vegetation at a selected depth. A boat-mounted mechanized cutter could be used to treat more resistant species and/or larger areas more efficiently. Selection of specific methods would be based on recommendations of fish and wildlife managers to the Steering Committee.

Bottom Barriers: At some sites, hand-pulling or diver-dredging could be followed by application of a bottom barrier to prevent re-growth of any aquatic vegetation. Bottom barriers are acceptable controls at beaches, docks and boat launches, where no aquatic vegetation is desired. Bottom barriers should be considered as an alternative to the annual Sonar® treatments that have been applied at Lake Mayfield County Park for several years.

Herbicide Application: Aquatic nuisance weeds have been successfully controlled in many lakes in western Washington through the use of herbicides (B. Wamsley, Lewis County Noxious Weed

Board, pers. comm., April 16, 1999). Herbicides may be used alone or in combination with other control methods to effectively meet a variety of management objectives. However, several factors must be evaluated before deciding whether or not to apply herbicides. The risk to beneficial uses (water quality, native plants, fish, wildlife, recreation) caused by the nuisance weeds if they are not controlled must be weighed against the risk to beneficial uses that could be caused by chemicals.

Concerns regarding the potential effects of chemicals on human health must also be addressed in determining whether or not to select an herbicide treatment. At a public meeting held in Salkum in April, 1999, some local residents urged Tacoma to emphasize prevention and monitoring and thoroughly investigate non-chemical methods of control. Tacoma agrees with this approach. At the time of this writing, herbicide treatment is not proposed. The use of non-specific herbicides in particular is discouraged, because of the potential impacts to non-target species. Repeated past applications of Sonar® in Swofford Pond failed to eliminate milfoil and also reduced the overall aquatic plant abundance to levels that were inadequate to meet fish and wildlife habitat objectives. Varying application methods for Sonar® were attempted, including low dose, long-term exposure (10 parts per million for 8 weeks). The herbicide applications initially eliminated milfoil, but re-infestation occurred, possibly from seed (which would be unusual, because milfoil rarely produces viable seeds) or brought in by a boater or some other carrier. Given the considerable loss of valuable native species and the persistence of milfoil in Swofford Pond, additional Sonar® applications are not endorsed at this time. However, Tacoma recognizes the situation may change in the future. New chemicals, new labels for existing chemicals, and new application methods may prove to be safe, effective, and economical choices for the kinds of problems that may be encountered.

11.3.2 Wetland Plants

Upon observation of purple loosestrife, the location and extent of infestation will be recorded, and removal will be conducted as follows:

1. Clip off flower spikes and place into plastic bags to avoid spreading seeds around while removing the rest of the plant,
2. Dig out stalks or cut them off as close to the ground surface as possible,
3. Bag the stalks,
4. Dispose the flower spikes into the trash or at a transfer station (ultimate destination of refuse from the project area is Arlington, Oregon),
5. Stalks my be disposed at an upland composting site, or put in the trash,
6. Mark/map the site, because seedlings will be produced that also require removal,
7. Monitor annually until no seedlings are observed (seeds can remain viable in the soils for many years).

If the extent of the loosestrife is so great as to rule out hand removal, then the Emergency Action Plan (Section 12.3) will be implemented.

11.4 Annual Report

Annual reports will be prepared by Tacoma Power to document weed control activities. Reports will be prepared by the end of February documenting the previous year's activities. These reports will be circulated to the Steering Committee (individuals listed in the Emergency Action Plan, Section 12.2). The reports will provide an annual opportunity to assess the suitability of new weed control strategies, such as biological controls or herbicides. The reports will contain (1) maps indicating locations where noxious weeds were located and where controlled; (2) description of control activities including acreage controlled and approximate pounds removed; (3) general status of project area vegetation as pertains to habitat and recreational quality; (4) description of new control methods that may be applicable; and (5) a proposed plan for the following year.

11.5 Steering Committee and Agency Coordination

The Steering Committee currently includes representatives from the Lewis County Weed Board, WDOE (Southwest Regional Office), the Cowlitz Tribe, WDFW, Mayfield Village, Harmony Lakeside RV Park, local residents, U.S. Fish and Wildlife Service, and Tacoma Power. The Steering Committee will be provided with the annual report in February, and will meet in March to review the report and plan activities for the upcoming year. The Steering Committee will be a valuable source of information, and members are anticipated to identify links with other control efforts in the state, provide reference materials (e.g., the Bio-Integral Resource Center's Directory of Least Toxic Methods and Controls, the Washington Department of Transportation's Integrated Vegetation Management Plan) and take an active role in development of education and public involvement activities.

In addition to the scheduled Steering Committee meeting, Tacoma will be responsible for annual contact with the Lewis County Weed Control Board representative and WDOE. The intent is to obtain the latest descriptive brochures, to learn of new threats and to discuss control options. Assistance for weed control, education and public involvement will be requested. Grant opportunities will be identified. In addition, Tacoma will annually contact managers at Lake Mayfield County Park and Ike Kinswsa State Park to discuss weed control efforts and problems, and encourage participation on the Steering Committee.

12.0 Action Plan

Sections below describe the schedule for implementation of various aspects of the integrated treatment scenario (Section 11 above); permitting required for different kinds of treatments; and a protocol for dealing with noxious weed sightings outside the regular monitoring schedule. A rough comparison of treatment costs is also provided.

12.1 Costs and Schedule

The proposed schedule and estimated cost for 1999-2000 activities for the Cowlitz Project are presented in Table 2, below. Treatment costs are based on the assumption that hand-pulling would provide adequate treatment in Swofford Pond this year. Treatment and permitting costs would be expected to vary from year to year, depending on the occurrence and concentration of nuisance weeds. Education and public involvement costs would also vary; it is expected that initial start-up costs would be high, but would decrease after the contacts have been made, materials have been compiled, and coordination mechanisms are in place.

Table 2. 1999-2000 schedule of aquatic vegetation management activities.

Activity	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Est. Cost*
Education/Public Involvement				■	■				■	■			$4,500
Aquatic Monitoring													$4,000[1]
Mayfield Lake boat launches, swim beaches, 1/3 littoral zone						■	■						
Swofford Pond, entire						■	■						
Riffe Lake boat launches, swim beaches, 1/5 littoral zone									■	■			
Riffe Lake outlet from Swofford Pond									■	■			
Wetland Monitoring								■	■				$2,500
Hand-pulling in Swofford Pond, Mayfield Lake, and Riffe Lake outlet from Swofford Pond						■	■		■	■			$16,000[2]
Annual Report		■	■										$3,000
Steering Committee and Management Coordination			■	■									$2,500
Permit Preparation/Processing				■	■	■							$800

[1]Cost for monitoring only, with no treatment.

[2]Cost includes monitoring and hand-pulling during the same field effort.

The cost of hand-pulling to control aquatic weeds in shallow water would be relatively low, covering labor and possibly boat rental and the purchase of spades. WDOE estimates $130 for hiring a commercial puller to remove weeds for "the average waterfront lot" (WDOE 1998b). For deep-water situations where SCUBA gear is required, the cost per day for contract divers ranges from $500 to $2,400 (Gibbons et al. 1994).

Costs of hand-cutting would be roughly equivalent to hand-pulling. However, purchase of a battery-operated hand-held cutter ($150-$1,300) or a portable boat-mounted cutter ($400-$3,000) would represent capital costs in addition to labor (WDOE 1998b). Rental of harvesting equipment for larger areas is estimated at about $600/day (Gibbons et al. 1994).

The cost of suction-dredging can range from $1,100 to over $2,000 per day, depending on plant density and other factors (Gibbons et al. 1994). In 1993, the cost of diver-dredging considered as a follow-up treatment to Sonar® applications to Swofford Pond was estimated at $35,000.

The cost of bottom barriers ranges from approximately $0.55 to $0.85 per square foot for materials and installation (Gibbons et al. 1994). Costs of installation vary, depending on the material selected and the specific site requirements.

Herbicide application ranges in cost from about $200 per acre (Rodeo®) to $1,000 an acre (Sonar®) in 1994 dollars (Gibbons et al. 1994). A bill now awaiting approval in the Washington State Legislature House Ways and Means Committee would provide state funding through WDOE for government entities (e.g., cities, counties, and state agencies) to apply 2-4, D to milfoil in certain situations. The program is intended to address lakes where 1) milfoil infestation is recently documented or remains after other measures have been implemented; and 2) milfoil infests no more than 20 percent of the littoral zone. Priority funding under this program would be given to lakes with public access, where the applicant is ready to proceed with treatment as soon as funding is granted.

12.2 Permit Requirements

For any plant management activity, including hand-pulling, hand-cutting, or mechanical cutting, an Hydraulic Project Approval (HPA) must be obtained from WDFW. Diver-dredging requires an HPA, a WDOE Short Term Modification of Water Quality Standards permit, an Army Corps of Engineers Section 404 Permit, and in some cases, a Shorelines Permit. A letter of approval may also be needed from the Washington Department of Natural Resources.

If bottom barriers are to be installed, a Shorelines permit from Lewis County is required and an HPA may be required from WDFW as a function of the scale of the installation.

Herbicide application would require a Short Term Modification of Water Quality Standards permit from WDOE. Herbicides must be applied by a state-licensed applicator.

12.3 Emergency Action Plan

In addition to planned monitoring and control activities, an emergency action plan is needed to provide for quick response to sightings of exotic species previously unknown in the Project area. Noxious weeds may be identified and confirmed during annual monitoring activities. Within one week of such a report, Tacoma will notify the following agencies to discuss management options:

- Lewis County Weed Board (360) 740-1215
- WDOE Southwest Regional Office (360) 407-6274
- WDFW (Wildlife) (360) 469-6223
- WDFW (Fisheries) (360) 978-4962

Exotic species or new locations of documented species may also be reported as casual observations (i.e., by boaters, anglers, Project operations staff, WDFW field crews), outside the regular monitoring protocol. Within two weeks of such a report, Tacoma will conduct a field visit to identify and locate the reported plant(s), and if necessary, will contact a qualified aquatic plant specialist to confirm the sighting. Following confirmation, Tacoma will contact the individuals listed above.

Telephone conversation and/or meeting records will be maintained and a control strategy will be determined. Appropriate permits and funding will be obtained.

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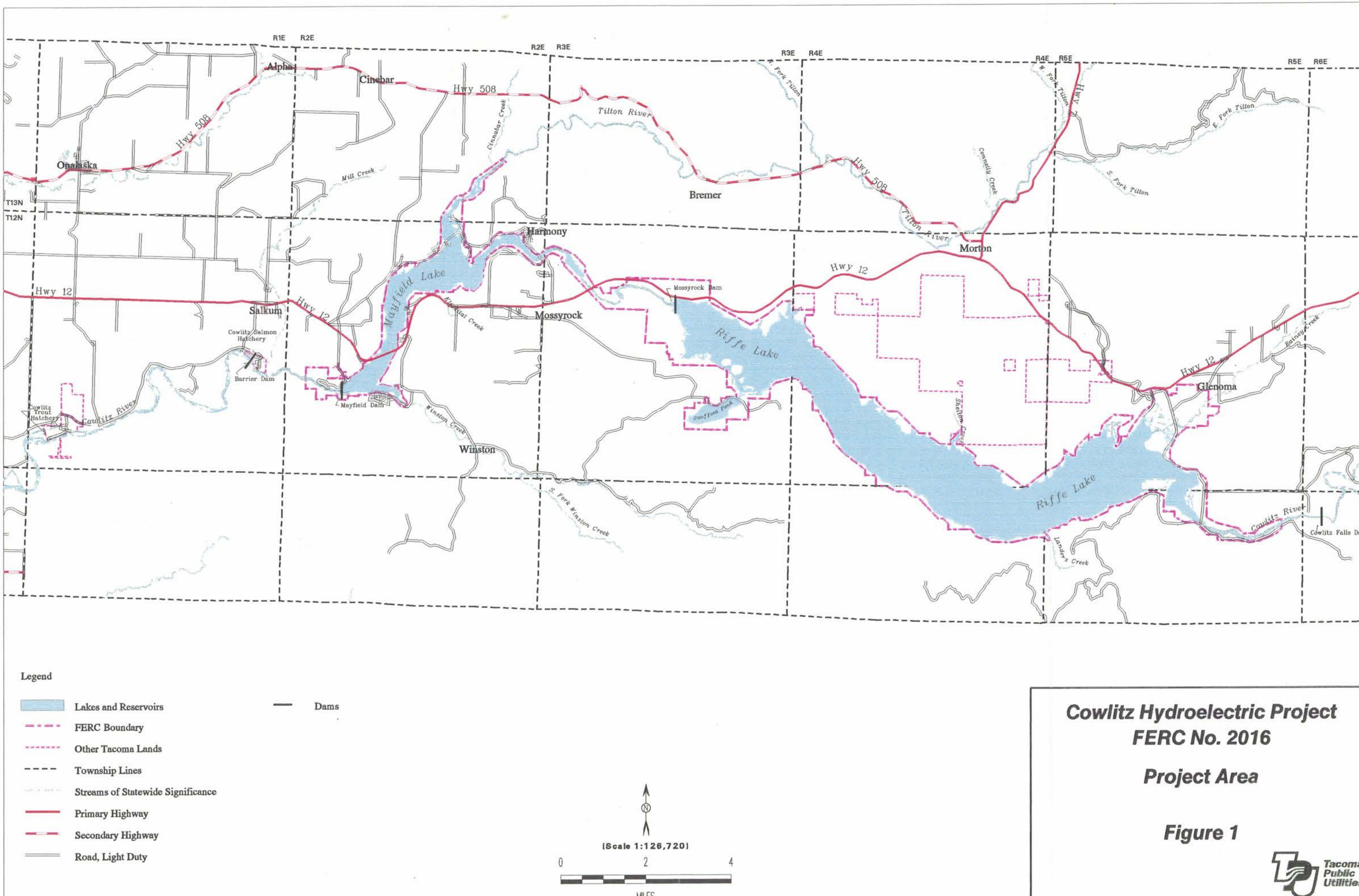
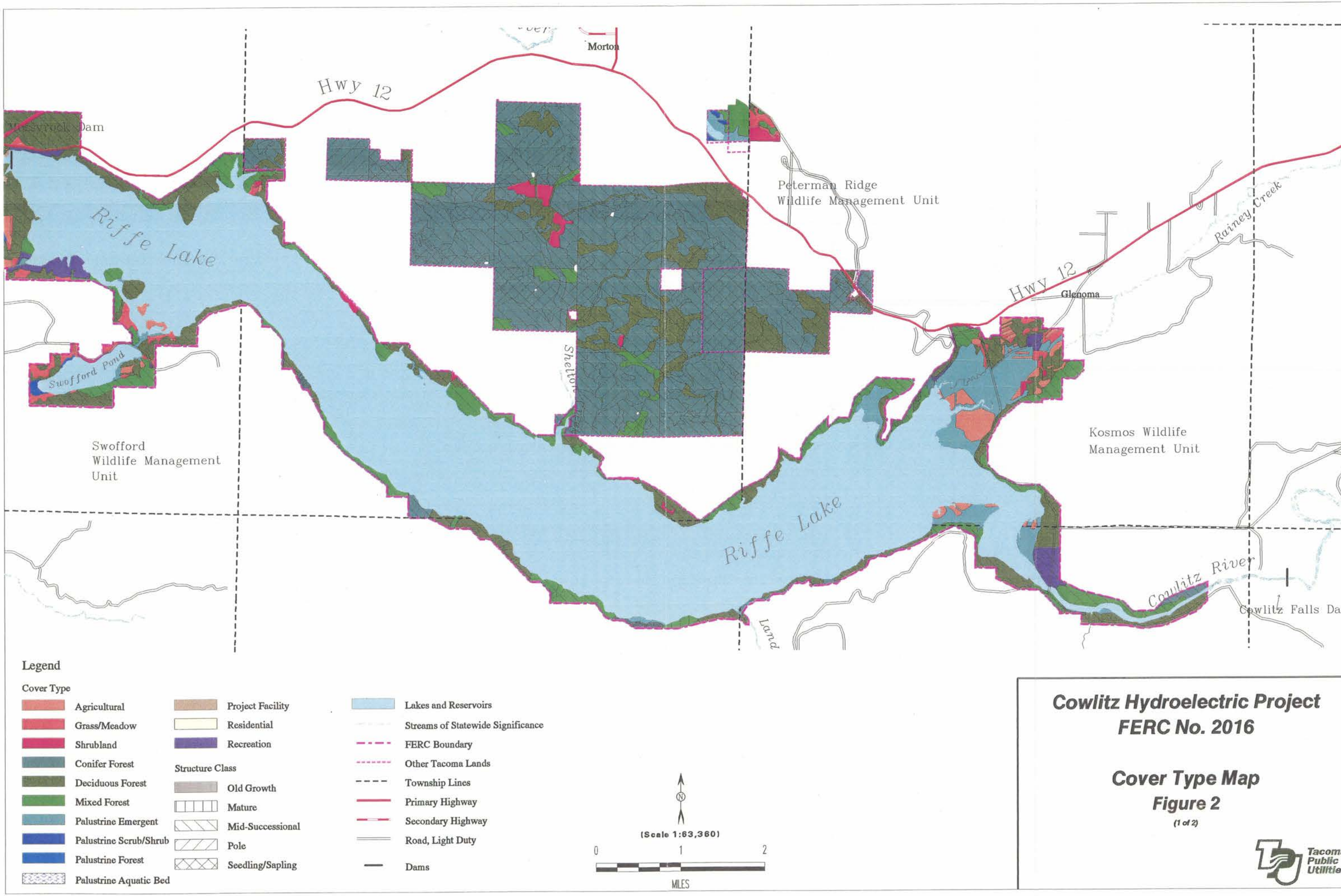


Cowlitz Hydroelectric Project
FERC No. 2016

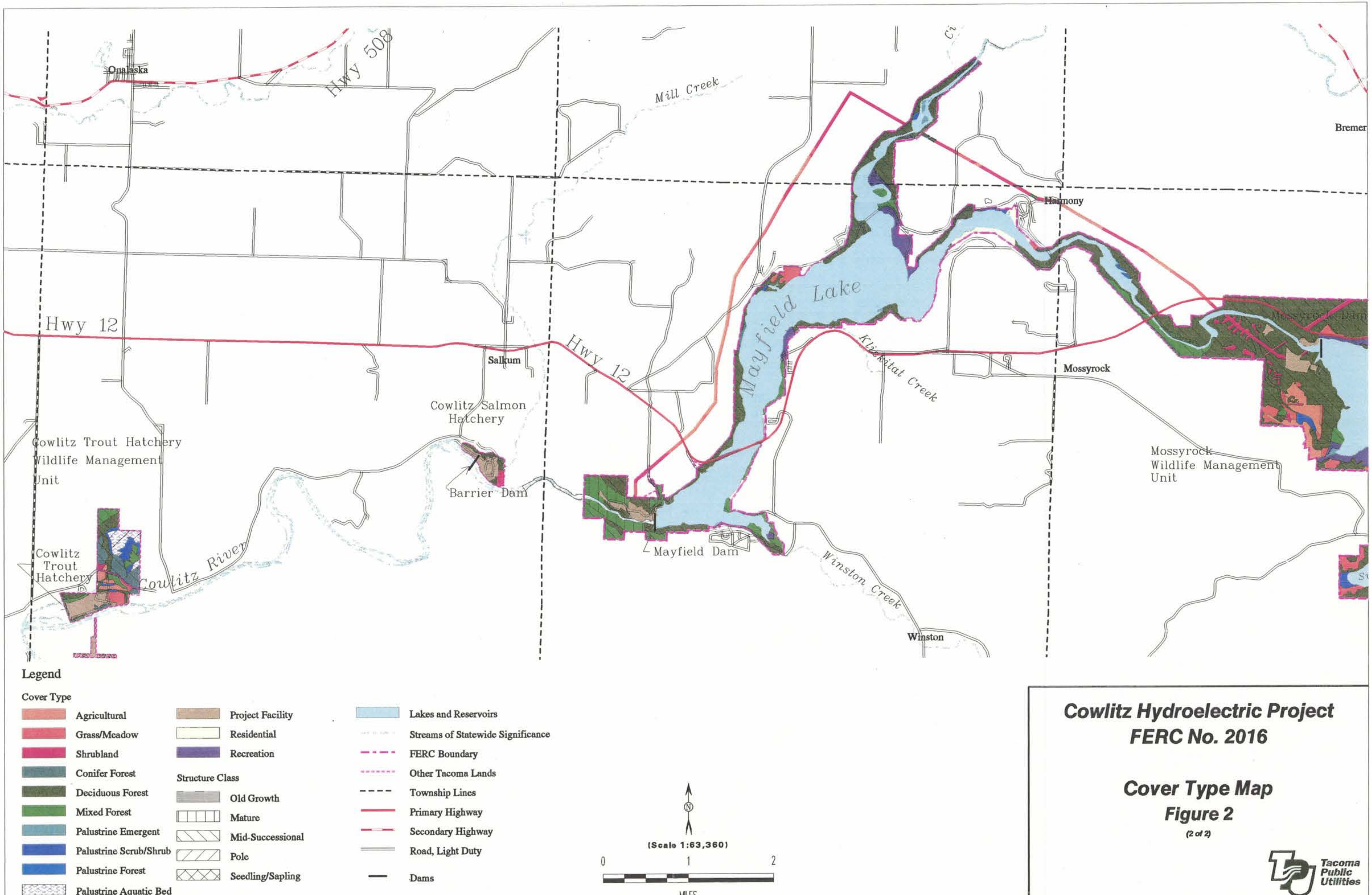
Project Area

Figure 1



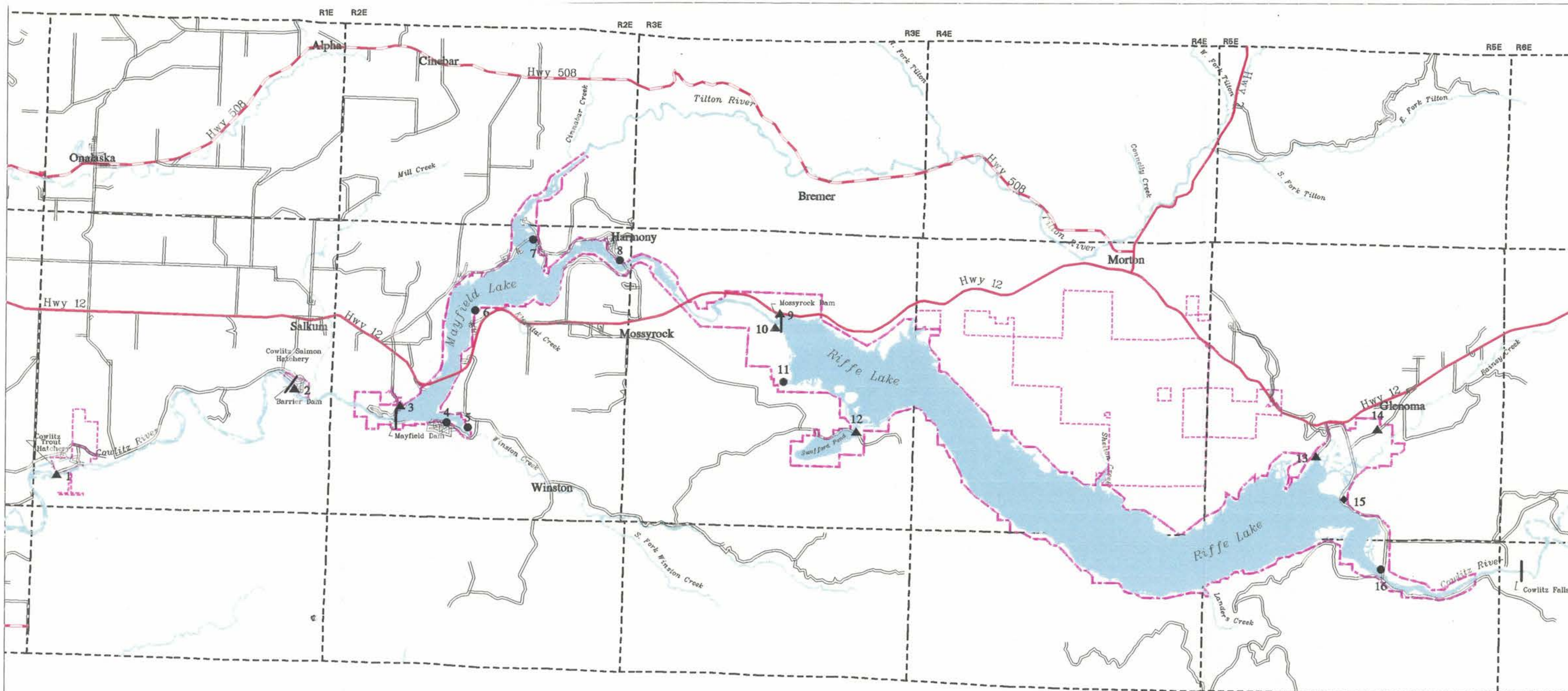
Cowlitz Hydroelectric Project
FERC No. 2016

Cover Type Map
Figure 2
(1 of 2)



Cowlitz Hydroelectric Project
FERC No. 2016

Cover Type Map
Figure 2
(2 of 2)



Legend

- Lakes and Reservoirs
- FERC Boundary
- Other Tacoma Lands
- Township Lines
- Streams of Statewide Significance
- Primary Highway
- Secondary Highway
- Road, Light Duty
- Dams
- Developed Day Use Facilities
- Developed Day Use & Overnight Facilities
- Undeveloped Day Use Area

N

(Scale 1:126,720)

0 2 4

MILES

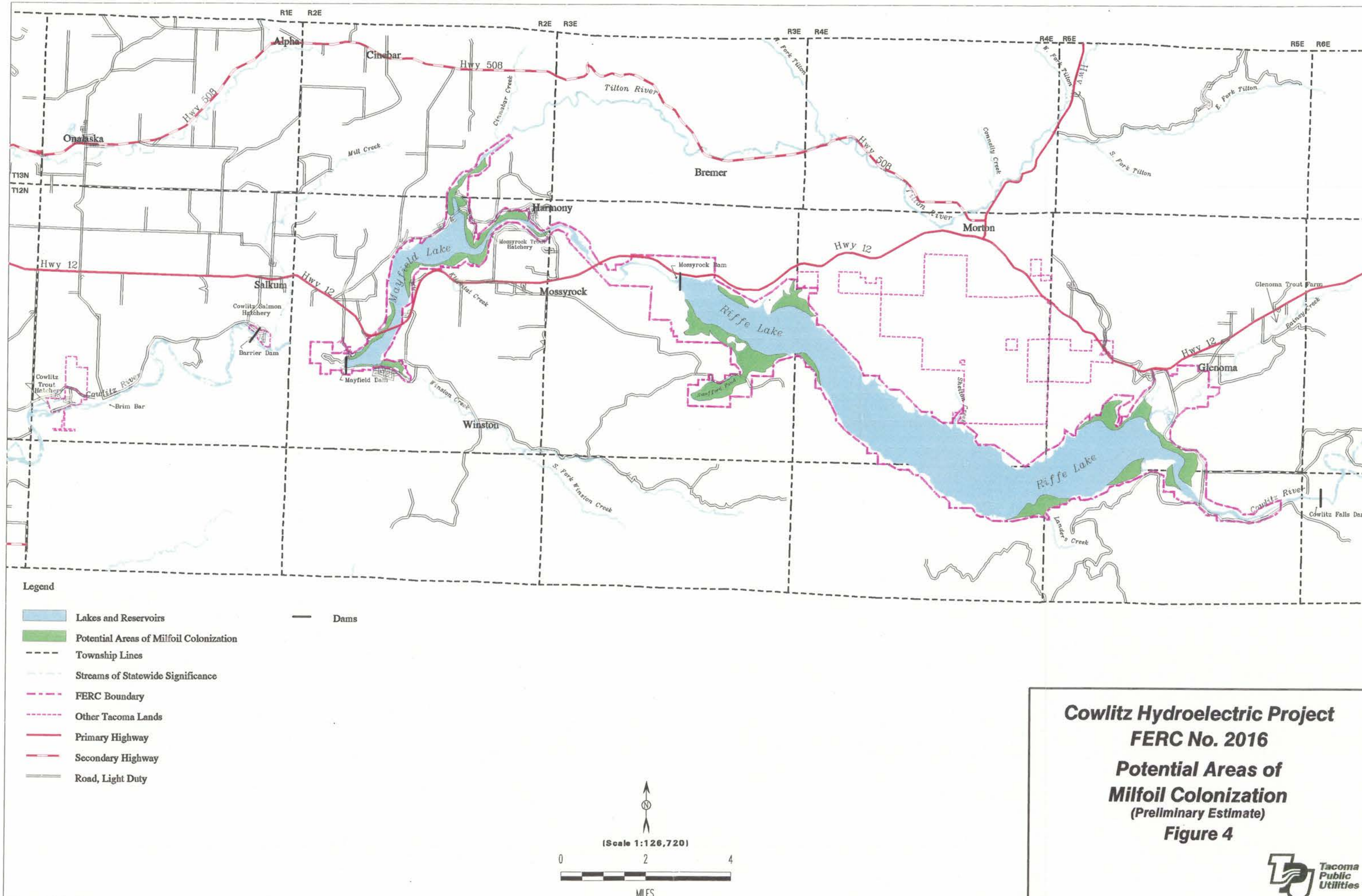
Existing Recreation

Site	Name	Size (Ac)	Activities
1.	Cowlitz Trout Hatchery	-	Boating, Interpretation, Fishing
2.	Cowlitz Salmon Hatchery	-	Boating, Interpretation, Fishing
3.	Mayfield Dam Overlook	2	Observation
4.	Lake Mayfield Resort	7	Boating, Picnicking, Camping
5.	Mayfield Lake Youth Camp	57	Organizational Group Camping
6.	Mayfield Lake County Park	27	Boating, Swimming, Picknicking, Camping
7.	Ike Kinswa State Park	454	Boating, Swimming, Picknicking, Camping
8.	Harmony Lakeside RV Park	-	Boating, Camping
9.	Mossyrock Dam Overlook	2	Observation, Interpretation, Fishing
10.	Hydrovista Visitors Center	-	Observation, Interpretation, Fishing, Picknicking
11.	Mossyrock Park	273	Boating, Picknicking, Minuture Golf, Camping
12.	Swofford Pond	44	Boating, Fishing
13.	Kosmos Boat Launch	16	Boating
14.	Glenoma Community Park	50	Baseball, Soccer, Picknicking
15.	Kosmos Flats	-	Hangliding, Windsurfing
16.	Taidnapam Park	124	Boating, Picknicking, Fishing, Camping

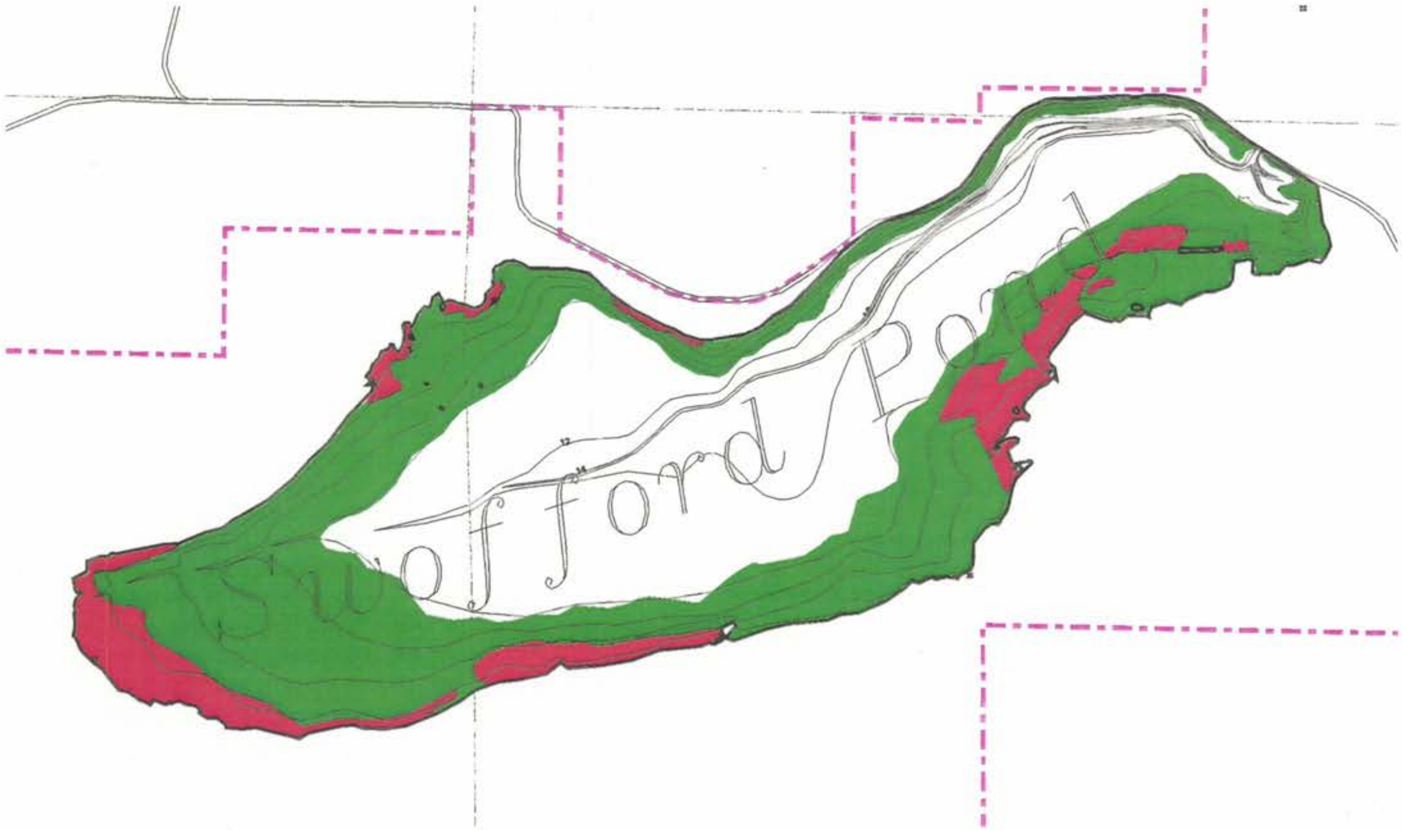
Cowlitz Hydroelectric Project FERC No. 2016

Existing Project Area Recreation Figure 3

Tacoma Public Utilities



R1E R2E
R2E R3E
R3E R4E
R4E R5E
R5E R6E
T13N
T12N
Alpha
Cinebar
Hwy 508
Onalaska
Tilton River
Cinnabar Creek
Mill Creek
Bremer
Connelly Creek
E. Fork Tilton
S. Fork Tilton
W. Fork Tilton
Hwy 7
Harmony
Morton
Mayfield Lake
Mossyrock Trout Hatchery
Hwy 12
Salkum
Klickitat Creek
Mossyrock
Mossyrock Dam
Riffe Lake
Cowlitz Salmon Hatchery
Barrier Dam
Mayfield Dam
Cowlitz Trout Hatchery
Cowlitz River
Brim Bar
Winston Creek
Winston
S. Fork Winston Creek
Stanford Pond
Shelton Creek
Glenoma Trout Farm
Rainey Creek
Glenoma
Landers Creek
Cowlitz Falls Dam
Legend
Lakes and Reservoirs
Potential Areas of Milfoil Colonization
Township Lines
Streams of Statewide Significance
FERC Boundary
Other Tacoma Lands
Primary Highway
Secondary Highway
Road, Light Duty
Dams
N
(Scale 1:126,720)
0 2 4
MILES
Cowlitz Hydroelectric Project
FERC No. 2016
Potential Areas of
Milfoil Colonization
(Preliminary Estimate)
Figure 4
Tacoma Public Utilities



Legend

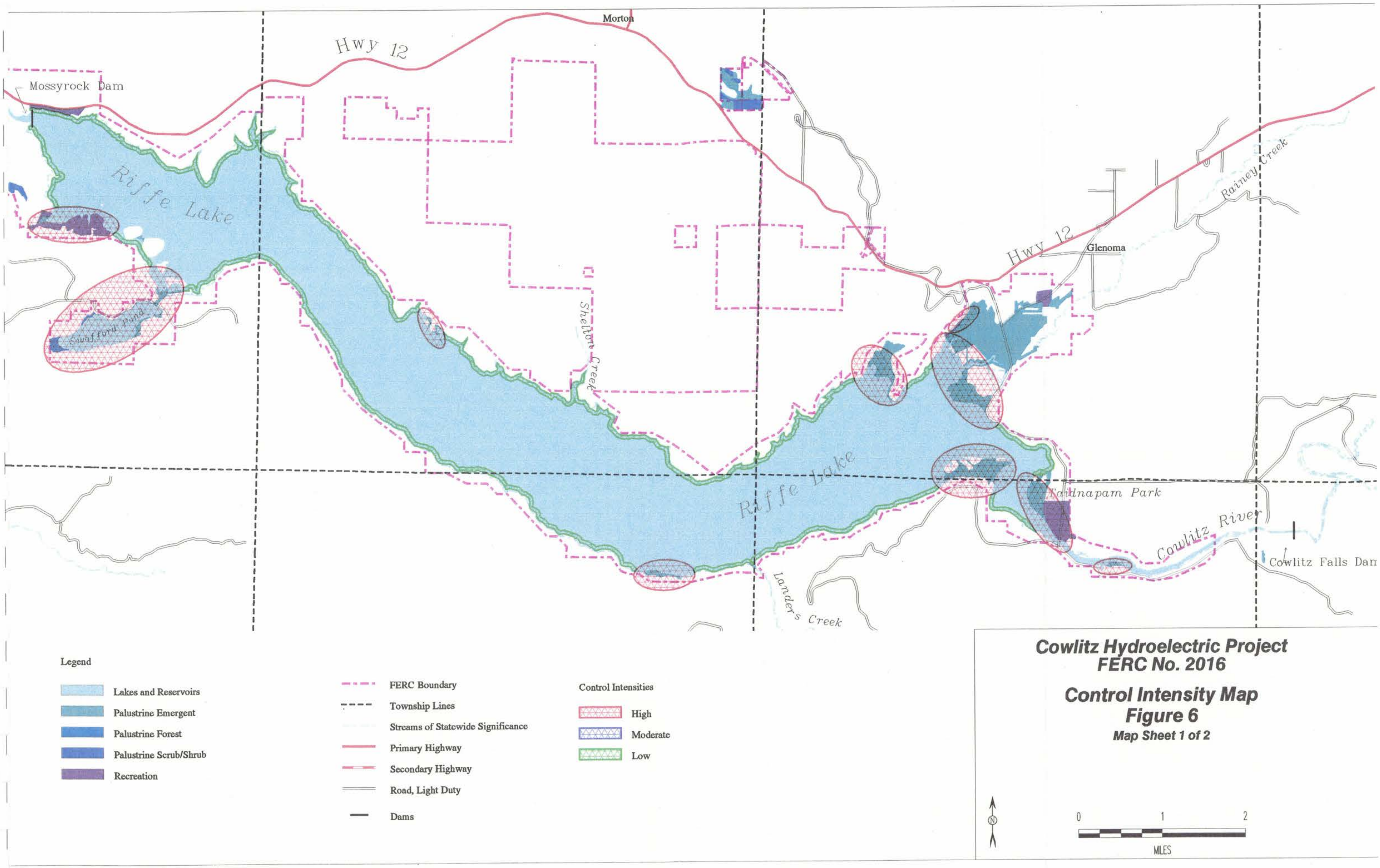
- Areas Dominated by Macroalgae in 1994
- Areas of Eurasian Milfoil observed in 1994
- Bathymetric Contours (2ft intervals)
- Swofford Pond Shoreline
- FERC Boundary
- Section Line
- Road, Light Duty

Cowlitz Hydroelectric Project
FERC No. 2016

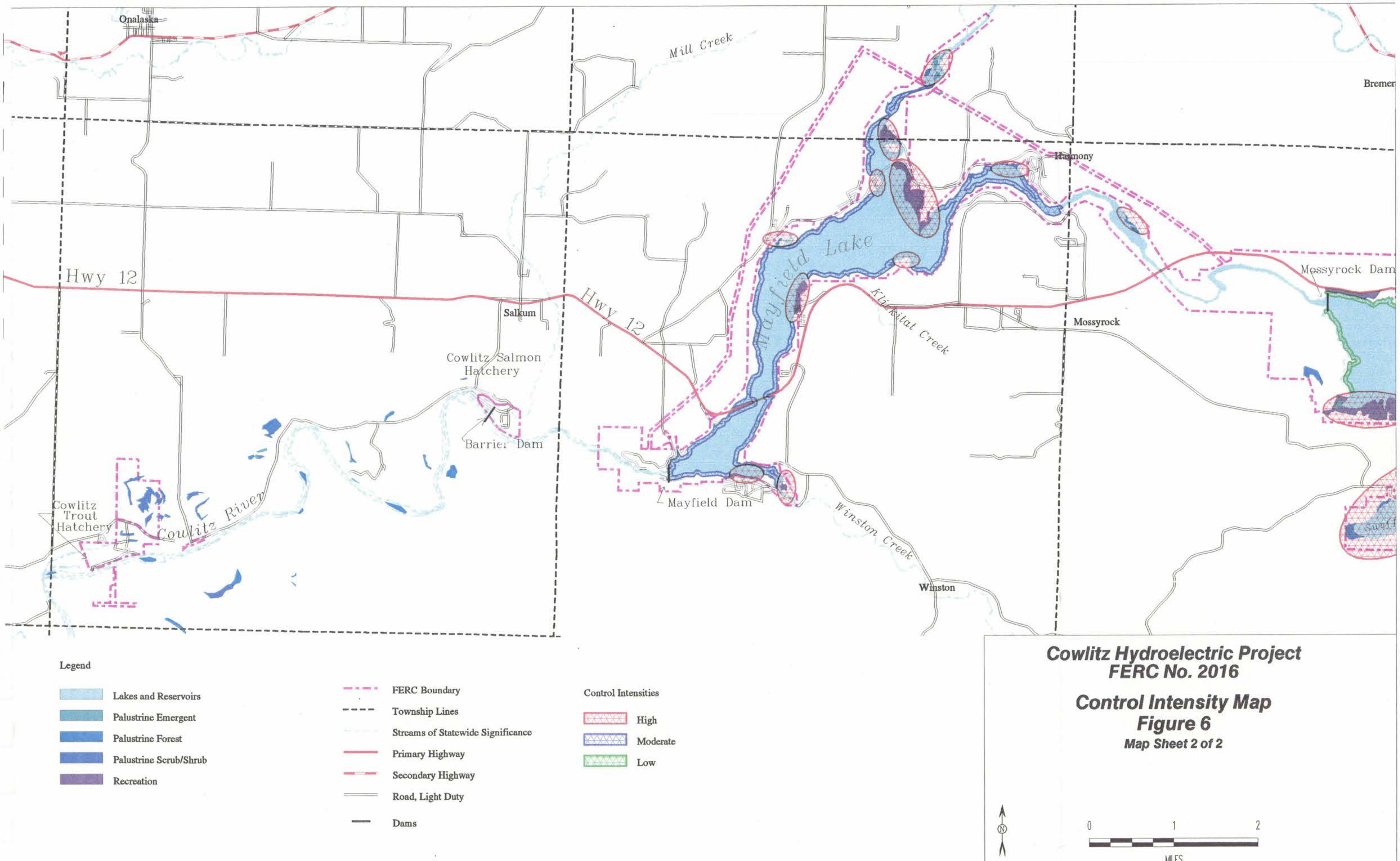
Swofford Pond 1994
Aquatic Plant Surveys

Figure 5

Tacoma Public Utilities



Map prepared by Harza, February 02, 1999 Copyright (c) Tacoma City Light



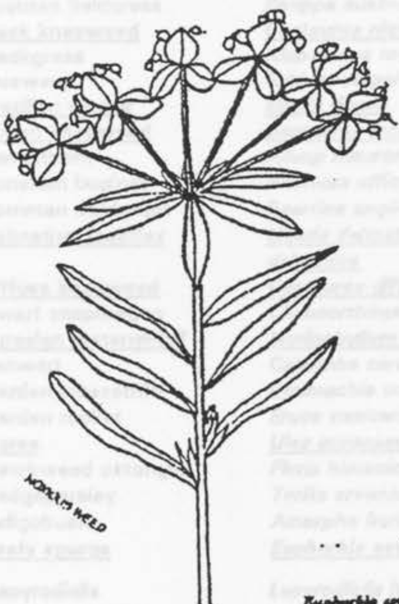
Cowlitz Hydroelectric Project
FERC No. 2016

Control Intensity Map
Figure 6
Map Sheet 2 of 2

1999 Lewis County Noxious Weed List

Appendix 1

Lewis County Noxious Weed List 1999



Euphorbia esula
Leafy Spurge

Noxious weeds are non-native plants that have been introduced to Washington through human actions. Because of their aggressive growth and lack of natural enemies in the state, these species can be highly destructive, competitive or difficult to control. These exotic species can reduce crop yields, destroy native plant and animal habitat, damage recreational opportunities, clog waterways, lower land values, and poison humans and livestock.

To help protect the state's resources, the Washington State Noxious Weed Control Board adopts a State Noxious Weed List each year. The list categorizes weeds into three major classes: A, B, and C according to the seriousness of the threat they pose to the state or a region of the state.

The Lewis County Noxious Weed List is made up of all Class A weeds, Class B designates and any selections by the County Board from the Class B or Class C weed list.

1999 Lewis County Weed List

Class A Weeds

Class A weeds are non-native species with a limited distribution in Washington. Preventing new infestations and eradicating existing infestations is the highest priority. Eradication of these species is required by law.

Common Name	Scientific Name
Bighead knapweed	*Centaurea macrocephala*
Buffalobur	*Solanum rostratum*
Clary sage	*Salvia sclarea*
Common crupina	*Crupina vulgaris*
Dyers woad	*Isatis tinctoria*
Eggleaf spurge	*Euphorbia oblongata*
Giant hogweed	*Heracleum mantegazzianum*
Hydrilla	*Hydrilla verticillata*
Italian thistle	*Cardus pycnocephalus*
Johnsongrass	*Sorghum halepense*
Lawnweed	*Soliva sessilis*
Meadow clary	*Salvia pratensis*
Mediterranean sage	*Salvia aethiopis*
Milk thistle	*Silybum marianum*
Peganum	*Peganum harmala*
Purple starthistle	*Centaurea calcitrapa*
Saltcedar	*Tamarix ramosissima*
Salt meadow cordgrass	*Spartina patens*
Silverleaf nightshade	*Solanum elaeagnifolium*
Slenderflower thistle	*Cardus tenuiflorus*
Spanish broom	*Spartium junceum*
Spurge flax	*Thymelaea passerina*
Syrian bean-caper	*Zygophyllum fabago*
Texas blueweed	*Helianthus ciliaris*
Velvetleaf	*Abutilon theophrasti*
Vochin knapweed	*Centaurea nigrescens*
Wild four o'clock	*Mirabilis nyctaginea*
Yellow devil hawkweed	*Hieracium floribundum*

Lewis County Noxious Weed Control Board (360) 740-1215

The Weed List also includes four "County Select" weeds that were chosen by the Lewis County Noxious Weed Control Board. They include Tansy ragwort, Scotch broom, Giant Knotweed and Japanese knotweed. These four weeds require landowner control under the described conditions:

Tansy ragwort, Senecio jacobaea:

1. Action level requiring landowner control: Identification and dominance level of 4 and 5.
2. Other considerations. Livestock present, neighboring livestock and forage production operations, landowners complaints.
3. The presence of biological agents on a property does not relieve a landowner of control responsibilities.

Scotch broom, Cytisus scoparius

1. Action level requiring landowner control: Identification and dominance at any level along described public right of way corridors.
2. Other considerations.
    - Public right of way corridors: St. Hwy. 123 from the intersection of Hwy. 123 and St. Hwy. 12 (T14N, Rge.10E, Sec. 20) extending north along Hwy. 123 to the Pierce County Line.
    - Public right of way corridors: St. Hwy. 12 from the intersection of Hwy. 12 and St. Hwy. 123 (T14N, Rge.10E, Sec. 20) extending east along St. Hwy. 12 to the Yakima County Line.

Giant Knotweed, Polygonom sachalinense
Japanese Knotweed, Polygonom cuspidatum

1. Action level requiring landowner control: Identification and dominance at any level along described river riparian corridor.
2. Other considerations.
    - River riparian corridor: Cowlitz River from the confluence of Clear Fork of the Cowlitz River and the Muddy Fork of the Cowlitz River (approx. river mile 132) downstream to the confluence with the Cispus River (approx. river mile 90). Extending 250 feet out from the mean high water mark and including any side channels.

Prevention of seed production required.

Weeds identified in this category may be widely distributed in other areas of Lewis County making prevention of all seed production within a single season difficult and not always practical. Nonetheless, the weed species in this group are noxious and landowners are encouraged to contain them. Prevention of seed spread to areas where listed as "Class B Designate" or Class B or C select is the goal.

"Dominance ratings" is a measure of plant density of the target noxious weed. It is an estimate based on a 0 (zero) to 5 scale where:

0 = not present
1 = target species is present, but not obvious in the surrounding plant community.
2 = target species is present, but not obvious. On a close examination multiple plants are present.
3 = target species is present and obvious in the surrounding plant community. The target species is not an obvious dominant within the plant community.
4 = target species is present and obvious in the surrounding plant community. The target species is a co-dominate in the plant community.
5 = target species is present and dominates the surrounding plant community.

1998 Aquatic Plant Survey Report

Appendix 2

1998 AQUATIC PLANT SURVEY REPORT

Introduction

Boat, snorkel and SCUBA surveys of aquatic plants were conducted in Swofford Pond, Riffe Lake and Mayfield Lake during the summer and early fall of 1998. The surveys were intended to provide baseline information needed for development of the Integrated Aquatic Vegetation Management Plan (Plan) for the Cowlitz River Hydroelectric Project (Project). Information regarding the abundance and distribution of both native species and noxious aquatic weeds will be used to help determine appropriate control intensities and control methods, and to help design a long-term monitoring program.

Methods

Preliminary aquatic plant surveys were conducted on June 8-9 and July 6, 1998, coinciding with the periodic water quality monitoring program. The preliminary surveys provided an overview of the distribution of aquatic plants in Swofford Pond, Mayfield Lake, and Riffe Lake. Systematic surveys were conducted on July 14 and 15 to develop a more complete inventory of species encountered in each waterbody, identify specific locations of invasive weeds, and map the locations of aquatic plant beds that may be important in terms of lake health (primary productivity, fish habitat, ecological diversity).

Surveys were conducted by boat, using a monoscope viewer to observe submersed plants. Snorkel and SCUBA gear were employed to survey depths that could not be viewed with the monoscope.

During the July 14 and 15 visits, aquatic biologists surveyed shallow-water areas of Mayfield and Riffe reservoirs and all vegetated areas of Swofford Pond. Surveys in Mayfield focused on evaluation of milfoil observations at three locations reported by WDFW (J. Tipping, WDFW, pers. comm., July 23, 1998), the vicinity of Lake Mayfield County Park, and shallow-water areas in the Cowlitz and Tilton arms of the reservoir. Surveys were conducted upstream in the Cowlitz River as far as the Harmony Bridge. Surveys in Riffe Lake were conducted at the Swofford Pond outlet into Riffe Lake and shallow areas nearby and along the south shore in the vicinity of Mossyrock Park. Surveys in Riffe Lake were terminated early, due to weather conditions (wind and wave action) and poor underwater visibility. Consequently, the shallow areas at the east end of Riffe Lake in the vicinity of the Kosmos Boat Launch, Kosmos Flats, Taidnapam Park, and Cowlitz River, have not been surveyed.

At the edge of each aquatic macrophyte bed encountered, observers recorded the location, site number, weather conditions, visibility, and water depth. Secchi depth was recorded at selected sites. Beds were sketched on aerial photos and Project base maps, with delineations of individual beds being determined by 1) relative density of plants; and 2) relative dominance of plant species encountered. Within each bed, dominant and subdominant species were noted, abundance was estimated as low, moderate or high for each species, distribution was described as sparse, patchy, or carpeting; and the depth range of each species was estimated. When possible, substrate was also described (e.g., silt/clay, sand, gravel, cobble, boulder).

During each visit, plants that could not be identified in the field were collected, labeled with a number, location, and date, placed in plastic bags, and then returned to the office in a cooler. Plants

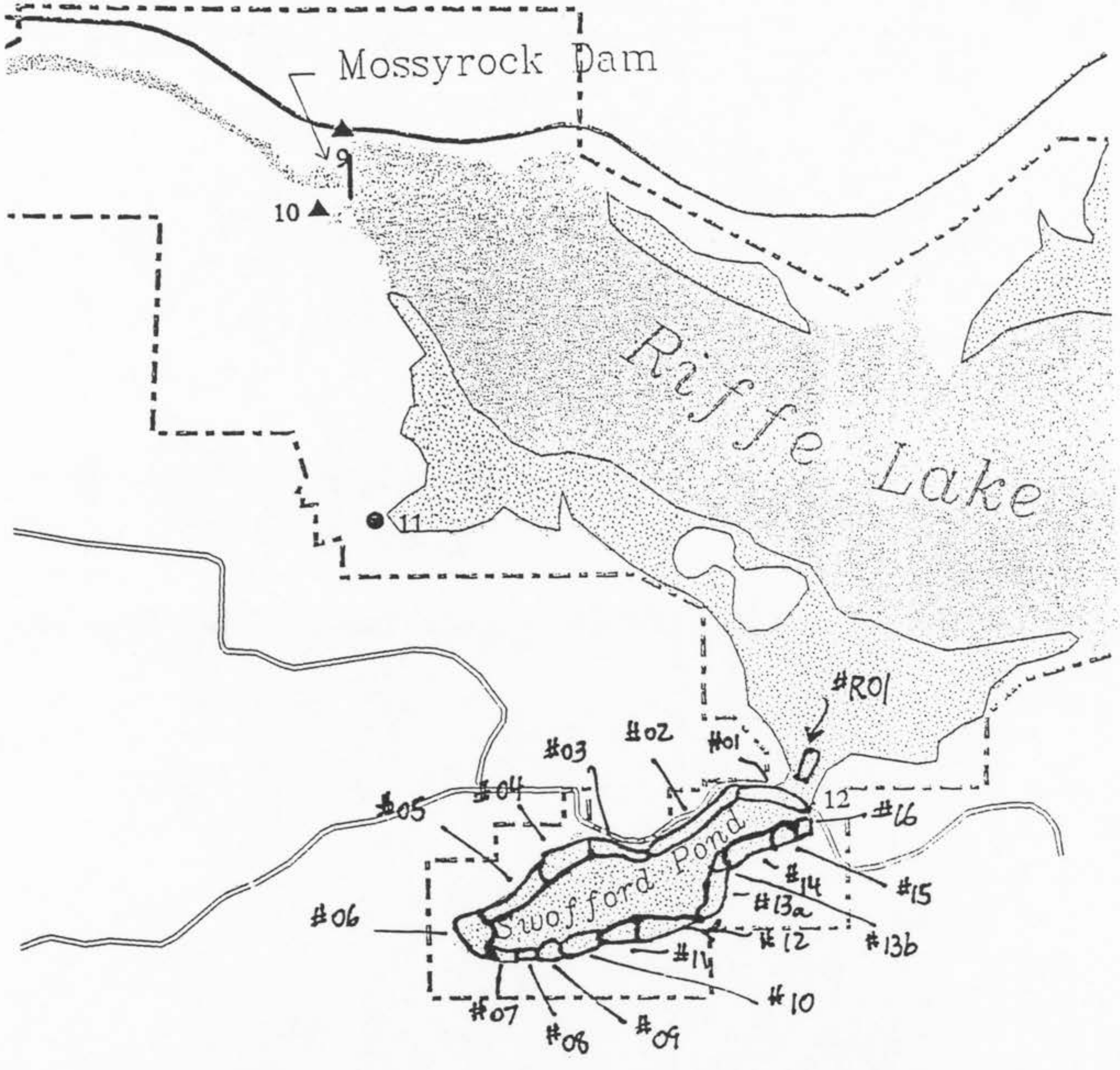
Riffe Lake

Invasive exotic species: Due to wind and wave action, visibility was poor during the survey of Riffe Lake, except in the more protected water at the outlet of Swofford Pond. SCUBA divers observed 5-6 well-established milfoil plants growing in approximately 6-8 feet of water, about 50 feet downstream of the outlet structure. No other colonies or individuals were noted, and no fragments were observed on the water surface.

Native aquatic plants: Aquatic vegetation is sparse in Riffe Lake. Small patches were observed in shallow water near the swimming beach at Mossyrock Park, near the old boat launch, and around the island just downstream from the main boat launch. The most common species observed were elodea, leafy pondweed, and floating-leaf pondweed.

Table 1. Macroalgaes, aquatic and emergent plants observed in or adjacent to Swofford Pond (S), Mayfield Lake (M), and Riffe Lake (R).

Scientific Name	Common Name	RMI	Harza
Brasenia schreberi	Watershield		S
Callatriche spp.	Water starwort		S
Ceratophyllum demersum	Coontail	S	S, M
Chara		S	S, M
Eleocharis palustris	Creeping spike rush		S
Elodea canadensis	Elodea		S, M, R
Iris pseudacorus	Yellow water-flag		S
Juncus effusus	Soft rush		S
Myriophyllum spicatum	Eurasian milfoil	S	S, M, R
Najas guadalupensis	Water naiad	S	S
Nitella		S	S, M
Phalaris arundinacea	Reed canarygrass		S
Polygonum amphibium	Water smartweed		S
Potamogeton amplifolius	Large-leaved pondweed	S	S
Potamogeton crispus	Curly pondweed		S
Potamogeton epihydrus	Ribbon-leaf pondweed		S, M
Potamogeton foliosus	Leafy pondweed	S	S, M
Potamogeton illinoensis	Illinois pondweed	S	S, M
Potamogeton natans	Floating-leaved pondweed		S, M
Potamogeton pectinatus	Sago pondweed		S
Potamogeton richardsonii	Richardson's pondweed		S, M
	Thin-leaved pondweed	S	
Ranunculus aquatilis	Aquatic buttercup		M
Ruppia maritima	Wigeon grass	S	
Sagittaria spp.			M
Scirpus spp.	Bulrush species		S
Sparganium emersum	Simple-stem burreed		S
Sparganium spp.	Burreed species		S
Typha angustifolia			S
Utricularia spp.	Bladderwort species	S	S
Utricularia vulgaris	Common bladderwort		S
Vallisneria americana	Water celery		S
Zanichellia palustris	Horned pondweed		S, M



Scattered milfoil observed in Cells #04, #05, #06, #07, #09, #10, #11
Milfoil concentrations observed in Cells #R01, #06, #15 and #16
Single individual observed in Cell #03

Figure 2. Swofford Pond Aquatic Plant Surveys, July 15, 1998 and Riffe Lake Surveys, July 16, 1998

Conclusions and Recommendations

Almost all of Swofford Pond appears to provide suitable habitat for aquatic macrophytes, and approximately 40 percent of the pond currently supports aquatic vegetation, either as scattered plants or well-established beds. Species diversity and abundance are greater in Swofford Pond than in Mayfield, and greater in Mayfield than in Riffe Lake.

Compared to Swofford Pond, the littoral zones of Mayfield and Riffe lakes account for a much smaller percentage of each waterbodies' surface area. The littoral zone of Mayfield Lake has been estimated at about 450 acres, or 20 percent of the surface area. Aquatic vegetation covers approximately 50 percent of the littoral zone. In Riffe Lake, the littoral zone is estimated to cover approximately 700 acres, or about 6 percent of the surface area at full pool. Of this area, only about 5 percent currently supports rooted aquatic macrophytes.

Eurasian milfoil is the only noxious aquatic weed that was observed during the surveys. Milfoil is sparsely scattered over approximately 20 acres in Swofford Pond. Milfoil was also observed in Mayfield Reservoir, in two dense colonies totaling about 600 square feet, and appeared sparse at a third site. Several (5-10) milfoil plants were observed in Riffe Lake at the outlet from Swofford Pond.

The Steering Committee for the Integrated Aquatic Vegetation Management Plan met on July 28, 1998 to discuss the objectives of the Plan. Based on discussions during the meeting and feedback following the meeting, management of aquatic plants for the Cowlitz Project will require a balance between measures that will 1) meet Tacoma's legal requirements to eradicate or control noxious weeds; 2) protect water quality; 3) maintain habitat suitability for fish; 4) protect native plant communities; 5) maintain recreation opportunity and human safety; and 6) protect downstream waters. The Committee also discussed control priorities and treatment options, including physical, mechanical, biological and chemical control methods.

During the meeting, Harza staff presented the preliminary findings discussed in this report, and informed the Committee of the status of native aquatic plants and noxious weeds. The Steering Committee identified what could be considered an "interim objective", since the Plan has not yet been finalized. The Committee recommended that known concentrations of noxious weeds should be treated as soon as they are identified, using physical methods, rather than waiting until the Plan is finalized and submitted to the Washington State Department of Ecology (DOE), which could delay treatment of noxious weeds until next year. Hand-pulling was identified as a method that would meet the objectives of the Plan, would not restrict future options for treatment, would not require permitting, and would be relatively economical. Based on these considerations, Tacoma requested that known concentrations of milfoil be removed from Riffe Lake and Mayfield Lake by hand-pulling as early as the task could be integrated into the water quality sampling program already underway in the Project waterbodies.

Removal of milfoil in Swofford Pond was not attempted. The extent of the colonization that has already occurred required a more intensive treatment than hand-pulling. Diver-dredging and/or application of herbicide are under consideration, and will be more carefully defined in the Plan.

Removal of milfoil from Riffe Lake at the outlet from Swofford Pond was simple, since the surface elevation had dropped about 15 feet below full pool. On September 10, 1998, two biologists waded into the outlet channel and pulled up the live plants, including the root material. Dessicated individuals that had been exposed by the drawdown were also removed. The wet weight of all plants removed from the site totaled 4.7 lbs.

On September 17, two biologists equipped with SCUBA gear removed milfoil from previously-identified sites in the Winston arm of Mayfield Lake. Milfoil plants were removed by hand-pulling. Soil was removed from the root mass by gently shaking the plants, allowing them to float to the surface. At the surface, the milfoil plants and any fragmented portions of plants were captured by a third biologist in a canoe. The plants were placed in plastic garbage bags. The crew returned on September 18 with snorkel gear to complete the milfoil removal.

The total wet weight of vegetation removed from Mayfield Lake was 210 lbs. However, milfoil at these sites grew densely with elodea, and although divers attempted to carefully avoid pulling it, elodea is estimated to account for approximately 20 percent of the total wet weight of vegetation removed. Removal of desirable native plants can be minimized in the future by conducting hand-pulling early in the year. Milfoil tends to grow earlier and faster than elodea, and the height difference between milfoil and elodea in May or early June would make the plants easier to separate.

Measures employed this year will help to prevent the spread of milfoil which would otherwise occur as a result of autofragmentation this fall. Sparsely-populated areas of Mayfield that were not treated continue to represent a risk of spread. These areas should be surveyed in May or June of 1999 to determine whether the populations are expanding. Areas treated by hand-pulling should also be surveyed, to determine whether re-growth has occurred. Surveys of all areas included in the monitoring program ("high control intensity") should be conducted early in the summer, when visibility is likely to allow for better coverage.