AVISTA

October 8, 2012

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street N.E.
Washington, DC 20426

Subject: Spokane River Hydroelectric Project, FERC Project No. 2545
Submittal of the Lake Spokane Dissolved Oxygen Water Quality Attainment Plan

Dear Secretary Bose:

In accordance with the Federal Energy Regulatory Commission's (FERC) June 18, 2009 Spokane River Hydroelectric Project (No. 2545) License, Appendix B, Section 5.6.C and FERC's July 9, 2010 Order Amending the License to Include the Revised Water Quality Certification and Requiring a Dissolved Oxygen Water Quality Attainment Plan, Avista completed the Lake Spokane Dissolved Oxygen Water Quality Attainment Plan (DO WQAP).

FERC's July 9, 2010 Order required Avista to file the DO WQAP with FERC within 30 days of receiving approval from the Washington Department of Ecology (Ecology) or by September 1, 2012, whichever was earlier. On August 8, 2012, Avista requested a 90-day extension to file the DO WQAP and on August 23, 2012, FERC issued an Order Granting an Extension of Time, which extended the FERC filing deadline to December 1, 2012.

Avista submitted the DO WQAP to Ecology for initial review and approval on May 25, 2012. Avista subsequently revised the DO WQAP to incorporate Ecology's edits and comments. On September 27, 2012, Ecology approved the DO WQAP. The consultation record with Ecology is included as Appendix E of the DO WQAP.

With this, Avista is filing the Ecology-approved DO WQAP with FERC and upon FERC's approval will begin implementing it. If you have any questions regarding this filing, please feel free to contact Meghan Lunney of our office at (509) 495-4643.

Sincerely,

Elvin "Speed" Fitzhugh
Spokane River License Manager

Enclosure

cc: Heather Campbell, FERC
Marcie Mangold, Ecology
David Moore, Ecology

AVISTA CORPORATION

LAKE SPOKANE DISSOLVED OXYGEN WATER QUALITY ATTAINMENT PLAN

Spokane River Hydroelectric Project
FERC Project No. 2545

Washington 401 Certification,
Section 5.6

Prepared By:

Avista

Golder Associates

October 5, 2012

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List of Acronyms and Abbreviations

%	Percent
°C	degrees Celsius
AUM	animal unit month
Avista	Avista Corporation
BMP	best management practice
BOD	biochemical oxygen demand
CE-QUAL-W2	CE-QUAL-W2 two-dimensional hydrodynamic and water quality model
Certification	Amended section 401 water quality certification
cfs	cubic feet per second
DNR	Washington State Department of Natural Resources
DO	dissolved oxygen
DO TMDL	Dissolved Oxygen Total Maximum Daily Load (report)
DO WQAP	Dissolved Oxygen Water Quality Attainment Plan
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
EPACT	Energy Protection Act
FERC	Federal Energy Regulatory Commission
ft	Feet
Golder	Golder Associates Inc.
gpm	gallons per minute
HED	hydroelectric development
kg	Kilograms
LA	load allocation
lbs	Pounds
m	meter(s)
mg/L	milligrams per liter
NPDES	Natural Pollutant Discharge Elimination System
OM	organic matter
OX	Oxygen
Project	Spokane River Hydroelectric Project
QAPP	Quality Assurance Project Plan
TP	total phosphorus
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WLA	wasteload allocation

EXECUTIVE SUMMARY

The Washington Department of Ecology (Ecology) has determined that the dissolved oxygen (DO) levels in certain portions of the Spokane River and Lake Spokane do not meet Washington's water quality standards. Consequently, those portions of the River and Lake are listed as impaired water bodies under Section 303d of the Clean Water Act. In response, Ecology developed the Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load Water Quality Improvement Report (DO TMDL), issued on February 12, 2010.

Reduced DO levels are largely due to the discharge of nutrients into the Spokane River and Lake Spokane. Nutrients are discharged into the Spokane River and Lake Spokane by point sources, such as waste water treatment facilities and industrial facilities, and from non-point sources, such as tributaries, groundwater, and stormwater runoff, relating largely to land-use practices.

Avista Corporation (Avista) owns the Spokane River Hydroelectric Project (Project), which consists of five dams on the Spokane River, including Long Lake Hydroelectric Development (HED) which creates Lake Spokane. Avista does not discharge nutrients into either the Spokane River or Lake Spokane. However, the impoundment creating Lake Spokane increases the residence time for water flowing down the Spokane River, and thereby influences the ability of nutrients contained in those waters to reduce DO levels.

Avista received a new, 50-year license for the Project from the Federal Energy Regulatory Commission (FERC) on June 18, 2009 (FERC 2009). The license incorporates a water quality certification (Certification) issued by Ecology under Section 401 of the Clean Water Act (Ecology 2009). The Certification (included as Appendix A) requires Avista submit this Lake Spokane Dissolved Oxygen Water Quality Attainment Plan (DO WQAP).

As required, this DO WQAP addresses Avista's proportional level of responsibility as determined in the DO TMDL. It identifies potentially reasonable and feasible measures to improve DO conditions in Lake Spokane, and incorporates an implementation schedule to analyze, evaluate and implement such measures. In addition, it contains benchmarks and reporting sufficient for Ecology to track Avista's progress toward implementing the plan within the ten-year compliance period.

The DO TMDL defines Avista's proportional responsibility for control measures by reference to Table 7 of that document (Appendix B). In Section 2.0 of this DO WQAP, Avista estimates that addressing Table 7 would require reductions within the range of 511 to 1,896 kilograms (kg) of phosphorous annually.

Avista has identified a number of potentially reasonable and feasible measures associated with Lake Spokane that have the potential to yield such reductions. Briefly, those include: 1) reducing carp populations, 2) aquatic weed management, 3) acquiring, restoring, and/or enhancing wetlands, 4) Hangman Creek load reduction, 5) education regarding septic system maintenance and improvements, 6) lawn area reduction and native vegetation buffers, 7) grazing land conversion, 8) maintaining a vegetative shoreline buffer on Avista owned property, and 9) modifying the intake of an agricultural irrigation system. These measures represent a significant load of nutrients that was not explicitly assigned as either a point source or non-point source load allocation in the DO TMDL.

Based on preliminary evaluations, Avista proposes to focus its initial efforts on two measures: reducing carp populations and aquatic weed management, which are expected to have the greatest potential for phosphorus reduction. Study plans to further evaluate these two measures are included in Appendices C and D.

When Avista implements such reasonable and feasible measures, fulfills Washington Administrative Code (WAC) 173-201A-510(5), and addresses the DO deficits referenced in the DO TMDL, it will have met the conditions of the Certification. The Certification states that in such an event, Ecology will consider changes to reduce reporting and monitoring requirements. If, on the other hand, the implementation of reasonable and feasible measures does not fully address Avista's proportional responsibility within 10 years, and no new reasonable and feasible measures are identified, the Certification states that Avista may pursue one or more of the alternative means of compliance specified in WAC 173-201A-510(5)(g)(ii).

As required in the Project FERC license, Avista will file this DO WQAP with FERC by December 1, 2012.[1]

[1] On August 23, 2012, FERC issued an Order Granting an Extension of Time, which extended the FERC filing deadline to December 1, 2012.

1.0 INTRODUCTION AND BACKGROUND

The Spokane River begins at the outlet of Lake Coeur d'Alene in Idaho, and flows 111 miles to the Columbia River. Sections of the Spokane River in Washington and Lake Spokane are listed[2] as impaired water bodies for dissolved oxygen under Section 303d of the Clean Water Act. In response, Ecology developed the Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load (DO TMDL), which was issued by Ecology on February 12, 2010, and approved by the United States Environmental Protection Agency (EPA) on May 21, 2010.

Avista Corporation (Avista) owns and operates the Spokane River Hydroelectric Project (Project), which consists of five Hydroelectric Developments (HEDs) on the Spokane River in northern Idaho and eastern Washington, in and near the City of Spokane (Figure 1-1). The Project operates under a license issued by the Federal Energy Regulatory Commission (FERC 2009) which incorporates a water quality certification (Certification) issued by Ecology under Section 401 of the Clean Water Act (Ecology 2009). As presented in Appendix A, the Certification requires Avista to develop a Lake Spokane Dissolved Oxygen Water Quality Attainment Plan (DO WQAP) that addresses its proportional level of responsibility, based on its contribution to the dissolved oxygen problem in Lake Spokane as determined in the DO TMDL (Ecology 2010a, 2010e).

Lake Spokane, the 5,060-acre reservoir created by the Long Lake HED, is approximately 23.5 miles long with a normal full-pool elevation of 1,536 feet (Figure 1-2). The reservoir transitions from a shallow riverine environment (generally less than 25 feet deep) in its upper reaches to a deeper lacustrine environment at the lower end of the reservoir. The maximum depth of the reservoir is approximately 202 feet (ft).

The DO TMDL relies on the CE-QUAL-W2 hydrodynamic and water quality modeling to assess the capacity of the Spokane River and Lake Spokane to assimilate oxygen-demanding pollutants (i.e., phosphorus, carbonaceous biological oxygen demand, and ammonia) under varying conditions (DO TMDL, page vi). The DO TMDL used the 2001 water year as the basis for the CE-QUAL-W2 modeling simulations. Ecology has stated that the 2001 water year best represents current low river flow conditions (DO TMDL, page 20). It should be noted however, that current minimum discharges for the Post Falls HED are 500 and 600 cubic feet per second (cfs), depending upon Coeur d'Alene Lake's elevation. This is in contrast to a minimum discharge of 300 cfs or calculated inflows (whichever was less), which was in effect in 2001. The current requirements[3] at Post Falls HED ensure that low flows downstream will not fall to the levels experienced in 2001.

[2] Spokane River and Lake Spokane Ecology 2008 303d Listing IDs for dissolved oxygen include: 40939, 15188, 17523, 15187, 11400.
[3] Section I of Appendix A of Avista's Spokane River Project FERC License.

The DO TMDL assigned each point source discharger to the Spokane River in Washington[4] a wasteload allocation (WLA) and a load allocation (LA) for each primary tributary to the Spokane River[5]. The WLAs and LAs are based on loads of total phosphorus (TP), ammonia, and carbonaceous biochemical oxygen demand. To incorporate an assessment of conditions at the Idaho/Washington boundary, Ecology worked with EPA to develop specific assumptions for the anticipated loads from wastewater treatment plants and stormwater in Idaho (Ecology 2010a).

Since Avista does not discharge nutrients to either the Spokane River or Lake Spokane it was not assigned a WLA or a LA. However, since the presence of the Long Lake HED increases the residence time (average amount of time it takes water to flow through Lake Spokane) the DO TMDL assigned Avista a “proportional level of responsibility” for depressed DO levels in Lake Spokane through a water quality modeling scenario. This responsibility is reflected in Table 7 of the DO TMDL, which was subsequently corrected (Ecology 2010e; Appendix B). Table 7 in the TMDL is based on a comparison of CE-QUAL-W2 model runs for the 2001 model year.

The DO TMDL indicates that Avista may satisfy its proportional level of responsibility for depressed DO in Lake Spokane through several nutrient-reduction methods. Specifically, the DO TMDL states that Avista may either increase the loading capacity of the reservoir by altering dam operations or implement nonpoint source phosphorus reductions (Ecology 2010a, page 69). The DO TMDL, however, further indicates a preference for reduction of nonpoint source loads to the lake through implementing best management practices (BMPs) and pollutant controls on adjacent lands that would otherwise directly contribute pollutants to the reservoir (Ecology 2010a, pages 69-70).

The goal of the water quality improvement measures described in this DO WQAP is to improve water quality in Lake Spokane. To achieve this goal, Avista will implement Ecology-approved reasonable and feasible water quality improvement measures that address its proportional responsibility reflected in Table 7 of the DO TMDL. If addressing the numeric element in Table 7 is not achievable, Avista will then seek to achieve the highest attainable level of improvement through reasonable and feasible measures. As Avista implements reasonable and feasible measures during the ten-year compliance window, ongoing reporting and monitoring will provide compliance assurance.

As stated by Ecology, and included in Appendix B, Section 5.6(C) of the License, “If, at any time during the ten year compliance period, the Licensee demonstrates to Ecology’s satisfaction that the Project is able to address and continue to address the Licensee’s proportional level of responsibility as determined in the DO TMDL consistent with the provisions of this Certification, Ecology may make appropriate changes to reduce or ease the burden of reporting and monitoring requirements.”

[4] City of Liberty Lake, Kaiser, Inland Empire Paper Company, City of Spokane and Spokane County.
[5] Hangman Creek, Coulee Creek, Little Spokane River, and groundwater inflow.

However, if at the end of the ten-year compliance period, after evaluating and implementing all reasonable and feasible alternatives, as approved by Ecology, Avista is unable to achieve compliance with water quality standards, it will work with Ecology in accordance with WAC173-201A-510(5)(g).

This DO WQAP acknowledges both the physical and regulatory complexities of this setting, including but not limited to, point and non-point source phosphorus reductions that will be taking place throughout the basin during the same compliance period. In addition, several parties, including Avista, will continue to refine the modeling in an effort to better represent conditions in the Spokane River and Lake Spokane. Finally, and because there are limited, if any, examples of implementing DO improvements on this scale, we recognize that utilizing an adaptive management approach may be essential as we implement the reasonable and feasible measures to be most effective.

2.0 ESTIMATES OF PHOSPHORUS REDUCTIONS DERIVED FROM TABLE 7

Avista's approach for improving DO levels in Lake Spokane involves sequential and prioritized measures that may reduce the availability of phosphorus in Lake Spokane. Avista has identified a number of reasonable and feasible measures that could be used to reduce phosphorus loading to the lake, with a primary focus on phosphorous.

The DO TMDL assigned Avista a DO responsibility based on DO deficits in milligrams per liter (mg/L) during different parts of the year, as shown in the shaded cells of Table 7 (Appendix B). To evaluate practical options for improving DO conditions, it is necessary to convert DO deficits into equivalent amounts of phosphorus that would account for the DO deficits. Translating DO deficits into terms of total phosphorus helps provide a means to assess the relative benefits of different potential measures. Table 2-1 expresses this deficit in terms of equivalent kg of phosphorus by converting the total mass of oxygen represented in the shaded cells of Table 7 in the DO TMDL to an equivalent phosphorous load. This was completed by applying a trading factor that relates DO to phosphorus. The trading factor was developed for the Brownlee Reservoir as part of a Section 401 Water Quality Certification Application for the Hells Canyon Complex, FERC No. 1971 (Idaho Power Company 2007), and was based on CE-QUAL-W2 modeling results and associated stoichiometry. The ratio of TP to oxygen (Ox) is related to organic matter (OM) stoichiometry and is based on the ratios of TP to OM (TP/OM = 0.01) and Ox to OM (Ox/OM = 1.5). Combining these ratios results in a TP to oxygen ratio of 0.67% (TP/Ox = 0.67%).

Though there are morphological and other water quality differences between Lake Spokane and Brownlee Reservoir, important similarities between the two water bodies do exist, including: a thermally stratified lacustrine zone during the summer months and low DO levels occurring in the transition and lacustrine zones during thermal stratification. The trading factor for Brownlee Reservoir was expressed in units of tons of DO per year, whereas the DO TMDL for Lake Spokane is based on incremental improvements of DO in milligrams per liter (mg/L) during different parts of the year. In order to apply the trading factor as an estimate of Avista's responsibility, it was necessary to convert Avista's DO responsibility defined in Table 7 from mg/L to tons of DO per year.

The conversion from mg/L to tons of DO was based on the DO responsibility in Table 7 of the DO TMDL (in mg/L) and a volume of water to which that responsibility applies. Multiplying the two (mg/L * L) calculates a total mass of DO. An exact calculation of total mass of DO is not possible using Table 7 because it aggregates and averages a complex time series of model results into a series of two-week time steps. Limiting assumptions were applied to estimate a minimum and maximum annual mass of DO represented by Table 7 in the TMDL. The smallest volume of water to which the Table 7 responsibility applies was estimated by calculating the cumulative static volume for all model segments and time steps that have a Table 7 DO responsibility. On the other extreme, the largest volume of water to which the Table 7 responsibility could apply is the cumulative static volume plus the estimated routed volume of water that flows through the model segments during the course of the semimonthly interval used in

Table 7. This calculation does not incorporate the DO concentration of water flowing from upstream segments. Using this approach, the total mass of DO associated with Avista's Table 7 responsibility is estimated to range from 84 to 312 tons DO/year or 76,204 to 283,042 kg DO/year.

Applying the Brownlee trading factor (0.67%) to the 76,204 to 283,042 kg DO/year results in an equivalent total phosphorus value of 511 to 1,896 kg/year (Table 2-1). This provides a reasonable estimate to frame the amount of phosphorus targeted for removal to meet the DO deficits assigned to Avista in Table 7.

Table 2-1: Equivalent Phosphorus Target

Avista's DO Responsibility	Low (Static Volume)	High (Dynamic Volume)
Tons DO/year[1]	84	312
Kg DO/year[2]	76,204	283,042
Kg TP/year[3]	511	1,896

Notes:
1. Source: Golder (2010).
2. Tons DO/year converted to kg DO/year using a conversion factor of 1 ton = 907.18474 kilograms (e.g., 76,204 = 84 x 907.18474).
3. kg DO/year converted to kg TP/year using a TP/Ox ratio of 0.0067, which was the proposed ratio in the Brownlee Reservoir Section 401 certification application (Idaho Power Company 2007); (e.g., 511 = 76,204 x 0.0067).

3.0 ANALYSIS OF POTENTIAL REASONABLE AND FEASIBLE MEASURES

This section outlines implementation activities to improve DO with regard to the potential phosphorus reduction measures with the overall goal of achieving the water quality standards in Lake Spokane as previously discussed in Section 1.

3.1 Potential Phosphorus Reduction Measures

Potential phosphorus reduction measures identified in this DO WQAP include: reducing carp populations; aquatic weed management; acquiring, restoring, and/or enhancing wetlands; Hangman Creek load reductions; education regarding septic system maintenance and improvements; reducing lawn area and installing native vegetation buffers; reducing grazing land; maintaining a vegetative shoreline buffer on Avista owned property; and modifying the intake of an irrigation system.

Avista submitted a letter to Ecology that outlined these potential reasonable and feasible measures to address Avista's proportional level of responsibility (Avista 2009). Ecology replied by stating that "Ecology believes the letter identifies promising potential reasonable and feasible DO improvement measures in advance of a fully developed DO WQAP" (Ecology 2010b). Avista subsequently identified reducing carp populations as an additional potential measure and Ecology verbally agreed it was practical to include as a potential measure.

Table 3-1 summarizes preliminary estimates of current TP loading from each potential measure. These are phosphorous loads that were not explicitly assigned as either a point or non-point load allocation in the TMDL. Avista will implement the reasonable and feasible measures with the goal of capturing the highest proportion of phosphorous following further evaluation and planning, as referenced in Appendices C and D. These measures are discussed in the sections that follow in order of their potential effectiveness in reducing total phosphorus load to Lake Spokane. Based on the estimated levels of potential total phosphorus reductions available through these measures, Avista anticipates that prioritized implementation of them will be effective in reducing phosphorus to meet its proportional level of responsibility.

Avista's evaluation of the relative reasonableness and feasibility of each measure is ongoing. As such, Avista intends to continue refining the estimates of phosphorus removal through the phased implementation process, and further refine the estimates of DO improvements through the monitoring and modeling program. Avista will adaptively select its phosphorus-control activities based on the results of the monitoring and modeling, as the results become available.

For the purposes of this DO WQAP, Avista anticipates being credited for implementing measures that improve DO in Lake Spokane. Avista will calculate the "credit" for each measure that it implements based upon the amount of phosphorus removed and the associated DO response in the lake. Credit will be used in this context for the remainder of this document.

Avista will work with Ecology, as appropriate, before implementing mitigation measures. This includes obtaining all necessary permits prior to implementation.

Table 3-1: Summary of Potential Measures and Estimated Existing Phosphorus Loads

Measure	Type	Basis of Loading Factor Calculation[1]	Estimated Lake Spokane Loading (kg TP/year)[1]
Reducing Carp Populations	Direct reduction in biomass from carp removal; subsequent reduction from reduced bioturbation and nutrient-pumping is not included.	125,000 carp x biomass/carp x TP proportion of carp biomass x proportion of population (25%)	1,594 – 2,625 kg/yr
Aquatic Weed Management	Reduction in biomass	Summation of invasive species-specific acres x mass TP/acre	481 – 3,852 kg/yr
Wetland Acquisition, Restoration, and/or Enhancement	Load reduction by increased P-uptake	42.51 acres x mass TP uptake/yr	310 – 3,100 kg/yr
Hangman Creek Load Reduction	Reduction in sediment phosphorous (March – October)	DO TMDL	DO TMDL Actions: 867 kg/yr
Improved Septic System Operation via Education	Reduction in Phosphorous discharge	410 households x wastewater TP concentration x wastewater volume/household x (1-soil TP retention factor)	188 – 1,077 kg/yr
Lawn Area Reduction	Reduction in Phosphorous run-off	74 acres x fertilizer application rate (kg TP/acre-year) x portion of applied TP that becomes runoff (6.2%)	72.5 kg/yr
Grazing Land Conversion	Reduction in Phosphorous runoff	Number of acres (200 to 230) x grazing period precipitation (3.65 inches) x mass TP/acre-inch of precipitation (0.02)	15 – 17 kg/yr
Vegetative Shoreline Buffer on Avista Owned Property	-	-	None at this time.
Targeted Irrigation Withdrawal	Remove irrigation water with higher phosphorus concentrations	TP concentration of water removed (mg TP/L) x volume of water removed (L/year)	5 kg/yr with the intake at 25 m below surface

Notes:
1 Source: Range of calculations in following subsections.

3.1.1 Reducing Carp Populations

Common carp (*Cyprinus carpio*), referred to in this document as carp, influence phosphorus loading and phosphorus bioavailability through three primary pathways:

1. Carp feeding mechanisms churn up sediments resulting in their resuspension and increased turbidity in the water column, referred to as bioturbation, which can influence water chemistry on a very large scale (Canfield and Farquhar 2009).
2. Carp act as "nutrient pumps" when they consume nutrient-rich benthic sediments and then excrete the previously sediment-bound nutrients into the water column in a form that is available to other organisms (Drenner et al. 1996, as cited by Chumchal 2002).
3. Carp feeding and growth accumulates phosphorus from their food sources into their bodies. Following their death, biological processes break down their carcasses and release phosphorus into the water column. This can result in phosphorus loading to the water body.

An estimate of phosphorus in Lake Spokane carp along with the potential TP load reduction is provided in Table 3-2. These are based on a rough order estimate of the carp population (125,000) and average weight of carp (4.2 kg) in the lake during Washington Department of Fish and Wildlife's (WDFW's) 2001 survey (Donley 2011) and literature values for phosphorus content in carp. So, assuming an average annual die-off and removal of 25 percent of the carp in the lake (31,250 carp), the TP load could be reduced by approximately 1,588 to 2,625 kg/year.

Table 3-2: Potential Total Phosphorus Load Reductions from Carp Carcass Removal

Variable	Non-Supplemented Diet [1]	Phosphorus Supplemented Diet [2]
Number of Carp in Lake Spokane [3]	125,000	
Lake Spokane Average Carp Mass (kg carp/carp)[3]	4.2	
TP Proportion of Carp (decimal)[4]	0.0121	0.0200
Total Lake Spokane Carp TP Content (kg TP) [5]	6,375	10,500
TP content for 25% Lake Spokane Carp Harvest (kg TP) [6]	1,594	2,625

Notes:
[1] Carp with uncontrolled diet.
[2] Carp with diet supplemented with 20 g TP / kg.
[3] Source: Donley 2011.
[4] Source: Nwanna et al. 2010a.
[5] Number of Lake Spokane Carp x Lake Spokane Average Carp Biomass x TP Proportion of Carp (e.g., 6,375 = 125,000 x 4.2 x 0.0121)
[6] Total Lake Spokane Carp TP Content multiplied by 25% (e.g., 1,594 = 6,375 x 0.25).

Reducing the carp population would also reduce carp "nutrient-pump" and bioturbation effects. However, estimating the associated phosphorous removal is difficult based on available literature. A recent study in Minnesota (Scott Watershed Management Organization 2011) evaluated the contribution of common carp and aquatic plants to water quality impairments in Cedar Lake. Data from years 2006 through 2008 were used to calibrate water quality models and determine the relative proportion of internal phosphorous loads from aquatic plants and carp. The calibrated model indicated that about 40% of Cedar Lake's internal phosphorous load to the lake originated from carp at a density of 400 pounds/acre (Scott Watershed Management Organization 2011)[6]. Applying the Cedar Lake carp loading rate to a surface area similar to the estimated area inhabited by carp in Lake Spokane 1,300 acres, which is equal to about 25% of Lake Spokane's total area) is equivalent to an internal phosphorous loading of approximately 4,183 kg/year.

Based on the amount of potential phosphorus reduction from carp removal, and the added benefits of carp control to fisheries management objectives in Lake Spokane (reductions in competition with desirable species and improvements in habitat conditions), this action is given a high priority in the overall phasing of phosphorus reduction actions. The loading factors and potential improvement from removing carp from the lake will be further refined through the study plan outlined in Appendix C.

Avista will work with WDFW during the analysis of this potential mitigation measure, including methods of capturing carp, and will obtain all required permits prior to implementation.

3.1.2 Aquatic Weed Management

Aquatic weeds influence DO levels in Lake Spokane through seasonal stages, beginning with uptake of phosphorus from sediments. This uptake increases overall weed growth. When aquatic weeds die, DO from the water column is consumed to break down the organic material. In addition, as the weeds decay, phosphorus is released back into the water column becoming available for further uptake. There are also diurnal fluctuations in DO levels that are primarily driven by photosynthesis producing oxygen during daylight and respiration consuming oxygen in the nighttime. Diurnal fluctuations primarily affect DO levels in the surface layer of the lake (i.e. upper 8 meters).

Controlling the growth of weeds and removing them before they die can help improve DO levels in the lake by reducing the diurnal fluctuations in DO levels during growth and reducing the biochemical oxygen demand (BOD) during decay. Removing aquatic weeds before they die also reduces the amount of phosphorus released into the lake and sediments from decomposition.

A summary of the acreage of aquatic weed species in Lake Spokane along with the relative TP content is provided in Table 3-3. Information was compiled by AquaTechnex (2007) with a focus on exotic weeds including Eurasian watermilfoil (*Myriophyllum spicatum*), yellow floating heart (*Nymphoides peltata*), and white lily (*Nymphaea odorata*). Native aquatic macrophytes provide food and cover for aquatic invertebrates, fish and waterfowl, so this measure focuses on selective reduction of non-native plants biomass prior to decomposition. Estimates of potential TP load reductions were based on a recent aquatic plant survey (AquaTechnex 2007), TP content of the invasive plant species, and harvesting efficiencies (Table 3-3). Harvesting aquatic plants is a technique typically employed during the growing season when submersed vegetation has grown to or near the water surface.

[6] Source: Table 3-6 in cited document.

Table 3-3: Total Phosphorus Loading and Acreage Coverage of Aquatic Weeds in Lake Spokane

Species	Loading Factor	Area (acres)	Estimated Lake Spokane Loading (kg TP/yr) [7]
Eurasian Watermilfoil [1,2,3]	0.42 - 3.4 kg TP/acre[6]	242.2	102 – 823
Yellow Floating Heart [1,2,4]	1.38 - 11.07 kg TP/acre[6]	196.2	271 – 2,172
Water Lily [1,2,5]	0.55 - 4.37 kg TP/acre[6]	196.2	108 - 857
Total	**--**	**634.7**	**481 – 3,852**

Notes:
1. AquaTechnex (2007) with assumption that yellow floating heart and water lily distributions were equal.
2. Low and high biomass harvest rates of 50 g/m^2 (202 kg/acre) and 400 g/m^2 (1619 kg/acre) were used for submergent species based on Cooke et al. (2005).
3. Eurasian milfoil total phosphorus content is 0.21% of the biomass based on Owens et al. (2007).
4. Yellow floating heart total phosphorus content is 0.684% of the biomass based on Marion and Paillisson (2003).
5. Water lily total phosphorus content is 0.27% of the biomass based on Cooke et al. (2005), assuming average for various macrophytes.
6. Loading factor ranges were calculated by multiplying each species' phosphorus content by the low and high biomass harvest rate (e.g. Eurasian Watermilfoil Low Loading Factor: 0.42 kg TP/acre = 0.0021 kg TP/kg biomass x 202 kg biomass/acre and High Loading Factor: 3.4 kg biomass/acre = 0.0021 kg TP/kg biomass x 1,619 kg biomass/acre).
7. Estimated Lake Spokane Loadings were calculated by multiplying loading factor by area (e.g., 823 = 3.4 x 242.2 for Eurasian milfoil high estimate), and summed to obtain the Total Estimated Lake Spokane Loading.

Figure 3-1 shows the distribution of exotic aquatic weeds from the 2007 aerial survey (AquaTechnex 2007). The TP estimates provided in Table 3-3 are based on a single year of aerial survey (2007) and on literature estimates of total biomass and phosphorous content. The practical "harvestable" phosphorous may be less than shown in Table 3-3 and will vary from year to year. Yellow floating heart appears to be the largest potential contributor of phosphorous of the plant species currently identified in Lake Spokane. If implemented, harvesting would not target milfoil since it spreads by fragmentation, and harvesting this species would likely cause further spread of the infestation. However, it should be noted there are areas where milfoil is present along the edge of large yellow floating heart. In such areas Avista would evaluate methods to avoid, or treat, the milfoil areas prior to harvesting to prevent the spread of milfoil.

Based on the amount of potential phosphorus reduction from this action, it is given a high priority in the overall phasing of phosphorus reduction actions. The total harvestable TP, optimum harvest methods, potential for nutrient pumping, harvest locations/frequencies, and other factors will be refined as outlined in Appendix D.

3.1.3 Acquiring, Restoring, and/or Enhancing Wetlands

Wetlands can be used to increase the deposition of sediments and their attached phosphorus along with increasing the uptake and retention of phosphorus by plants with the overall result of reducing the discharge of phosphorous to the lake from run-off and/or groundwater. Burgoon and others estimated the net annual phosphorus uptake by emergent wetland species as varying from 1.8 to 18 grams of phosphorus per meter^2 per year (7.3 to 73 kg/acre) (Burgoon et al. 1991), depending on plant species. Examples of typical phosphorus uptake values for emergent wetland plants that are typical of the area around Lake Spokane include: bulrush (16 pounds [lbs]/acre/year or 7.3 kg/acre/year), cattail (67 to 360 lbs/acre/year or 30 to 163 kg/acre/year), reed (31 lbs/acre/year or 14 kg/acre/year), and rush (100 lbs/acre/year or 45.4 kg/acre/year) (Kulzer 1990). Upon senescence and fall die-off of plants, the availability of phosphorus is cycled back to the wetland and to surrounding waters with hydraulic connectivity to the wetland. Even with this seasonal release of phosphorus, harvesting biomass to remove phosphorus and other nutrients from constructed wetlands has been limited to floating aquatic plants in the United States (EPA 2000). Avista will evaluate any harvesting of plants on a case-by-case basis, which includes considering the potential phosphorus load from plant die-off and hydraulic connectivity of the wetland to Lake Spokane. In accordance with its Lake Spokane Wetlands Plan, Avista is considering acquisition or permanent protection of approximately 43 acres of wetland area downstream of Nine Mile HED, in the vicinity Spokane River and the Little Spokane River confluence, as well as in the vicinity of the Spokane River and Hangman Creek confluence. Based on phosphorus loading rates for a range of wetland species (Burgoon et al. 1991), the 43 acres of wetland opportunities could help prevent up to 310 to 3,100 kg TP/yr (43 acres x 7.3 kg/acre/year and 43 acres x 73 kg/acre/year) from entering the lake. Because of the uncertainty in timing and lack of independent control, this measure is given a moderate priority in the overall phasing of phosphorus reduction actions. The phosphorus loading rate will be refined should any property be acquired or protected and a site-specific wetland plan completed for that property in accordance with Appendix B, Section 5.3(G) of the License. At the present time, Avista has pursued the two most likely candidate sites and has not been able to acquire either property.

3.1.4 Hangman Creek Load Reduction

Hangman Creek is a major tributary to the Spokane River, and a significant contributor of sediment and associated phosphorus loading (Ecology 2011a, 2011b). Hangman Creek joins the river about 1.5 miles downstream of Monroe Street HED (Figure 1-1) and contributes an annual average of about 200 cubic feet per second (cfs) to the Spokane River, although it has peaked at greater than 20,000 cfs during extreme runoff conditions (USGS 2012).

Naturally occurring erosion of stream banks and soils has been exacerbated by road building, agriculture, and other land use practices that do not incorporate current BMPs. Land use from agricultural, range land, placement of roads and railroads, urban development, and timber activity has influenced water quality. In addition, physical stream channel and floodplain modifications that have led to unstable stream banks and increased erosion (Ecology 2011a).

The Spokane River and Lake Spokane DO TMDL estimated phosphorous loads for the mouth of Hangman Creek (Ecology 2010a). As shown on Table 3-4, and based upon the 2001 flow conditions, the DO TMDL indicates that the vast majority of phosphorous load entering from Hangman Creek occurs between March and May. Under the 2001 conditions, TP loads were estimated to be over 72 kg /day, which is more than 2.5-times greater than the CE-QUAL-W2 modeled "natural condition". The DO TMDL did not estimate loading or provide load reductions in Hangman Creek for November through February, as this time period was not identified as the critical season of DO impairment in the river or lake. It should be noted, during the November through February time period, Hangman Creek often has some of its biggest flows. While these flows are infrequent and weather dependent, they often result in a large pulse of sediment loading from Hangman Creek into the Spokane River. That being said, these pulse loading events were not accounted for in the DO TMDL and could therefore not be incorporated into our analysis.

On an annualized basis, the TP reduction from Hangman Creek prescribed under the DO TMDL is approximately 800 kg/yr (Table 3-4). An additional 3,317 kg/year of TP could potentially be removed over and above what is already prescribed in the DO TMDL.

Table 3-4: Phosphorus Load in Hangman Creek

Month	Natural Load	2001 Load	Load Reduction Prescribed under the DO TMDL
Mar – May (kg TP/day)	28.2	72.4	8.8
June (kg TP/day)	1.8	4.5	1.1
Jul-Oct (kg TP/day)	0.5	0.8	0.2
Nov-Feb (kg TP/day)	Not Reported		
Annualized Total Load (kg TP/yr) [2]	2,709.9	6,894.2	867.2

Notes:
1. Table adapted from the Spokane River and Lake Spokane DO TMDL (Ecology 2010a, Table 6b).
2. Annualized Total Load calculated as sum of mass for all periods with reported values (e.g., Natural Load of 2,709.9 = (28.2 kg/day x 92 days) + (1.8 kg/day x 30 days) + (0.5 kg/day x 123 days).

Although the amount of potential phosphorus reduction from sediment management in Hangman Creek is large, it was given a moderate to low priority in the overall phasing of phosphorus reduction actions because of uncertainty for counting total phosphorus reductions in Hangman Creek. Avista will more thoroughly evaluate total phosphorus reduction opportunities in Hangman Creek as further clarity emerges on how such reductions would be counted within the larger context of expected nutrient reductions from tributary loadings as discussed in the DO TMDL toward meeting water quality standards.

3.1.5 Education Regarding Septic System Maintenance and Improvements

Inadequate, failing, or poorly maintained septic systems can contribute dissolved nitrogen and phosphorus to nearby surface waters. While nitrate loads typically match the concentrations from the septic system sources, phosphorus can be adsorbed onto soil particles, which can reduce the amount of phosphorous entering a water body relative to the source levels.

The potential phosphorus loading from septic systems to Lake Spokane was estimated based on the number of septic systems within 300 feet of the shoreline extending from the Little Spokane River confluence to Long Lake Dam (Table 3-5). Estimated loading to groundwater from septic systems ranges from 625 kg TP/year to 2,153 kg TP/year (Table 3-5, EPA 2002). A portion of the TP loading to groundwater is absorbed by subsoils. HDR (2007) estimated that the TP retention factor for groundwater ranges from 50% to 70% based on aquifer characteristics in Spokane County. Using these assumptions, the loading to the lake from septic systems could range from 188 to 1,077 kg TP/year (Table 3-5). This analysis is supported by a site-specific analysis conducted for just the Suncrest area (HDR 2011) that estimated a surface water phosphorus loading of 0.7 kg/day (255 kg/year), which is 1.7 kg/yr/household and within the range of loading factors estimated in Table 3-5. Homeowner education to improve septic tank/drain field efficiencies is the primary means of addressing this source of phosphorus. Based on the amount of potential phosphorus reduction from this action, and its relative complexity, this action will be given a low priority in the overall phasing of phosphorus reduction actions.

Table 3-5: Estimated Total Phosphorus Loading from Septic Systems

Variable	Units	Houses without EPACT-efficient fixtures		Houses with EPACT-efficient fixtures	
		Minimum	Maximum	Minimum	Maximum
Phosphorus Concentration in Domestic Septic Tank Effluent[1]	Mg TP/L	11	22	11	22
Daily Residential Wastewater Flows[1]	L water/person-day	189	265	151	227
Per Person TP Loading from Domestic Septic Tank Effluent [2]	Kg TP/person-year	0.76	2.1	0.61	1.8
Number of residents/ household[3]	people/ household	2.5	2.5	2.5	2.5
Number of Households[4]	Households	410	410	410	410
Loading to Groundwater from Residential Septic Systems [5]	Kg TP/year	779	2,153	625	1,845
Loading to Surface Water from Residential Septic Systems – retention factor of 0.7[6]	**Kg TP/year**	**234**	**646**	**188**	**554**
Loading to Surface Water from Residential Septic Systems – retention factor of 0.5[6]	**Kg TP/year**	**390**	**1,077**	**313**	**923**

Notes:

1. Range of typical phosphorus concentrations in residential wastewater and a range of typical residential wastewater flows. Houses built pre-1994 that have not been retrofitted with U.S. Energy Policy Act (EPACT)-efficient fixtures would typically have higher wastewater flows than houses built post-1994 or houses built pre-1994 which were not retrofitted with EPACT-efficient fixtures (EPA 2002).
2. TP concentration x flow x days (e.g., 1.8 kg/person-year = 22 mg/L x 227 L/person-day x 365 days x 0.000001 kg/mg).
3. U.S. Census Bureau (2008) – average of the average household size for Spokane County (2.43 people/household) and Stevens County (2.65 people/household).
4. The number of residences was estimated by using Google Earth and counting each lot with some type of structure present as a residence. Each parcel was only counted once regardless of how many houses, sheds, and/or guest houses appeared to be present. Based on this analysis, there are 410 residences within 300 feet of the shoreline (Lunney 2009a).
5. TP load per person x people per house x households (e.g., 1,845 kg/year = 1.8 kg/person-year x 2.5 persons/household x 410 households).
6. Groundwater retention rate of 0.5 to 0.7 estimated for the Spokane County area in HDR (2007). Loading calculated as Loading to Groundwater x retention factor (e.g., 554 kg/year = 1,845 kg/year x (1-0.7)).

3.1.6 Lawn Area Reduction and Native Vegetation Buffers

Phosphorus loading from manicured lawns can occur through runoff of excess fertilizer that contains phosphorus and through leaching of phosphorus to the groundwater. The amount of phosphorus loading depends on a number of factors including the amount of fertilizer that is applied to the lawn, the phosphorus content of the fertilizer that is used, and the frequency and intensity of storm events that produce runoff. This evaluation of phosphorus loadings from manicured lawns is limited to surface runoff.

Table 3-6 presents the estimated Lake Spokane TP loading from manicured lawns, which is based on the known lawn area within 200 feet of the lake's shoreline. The 74 acres of manicured lawn identified within 200 feet of the lake's shoreline results in approximately 73 kg TP/yr of phosphorus loading (Garn 2002) to the lake.

Table 3-6: Estimated Total Phosphorus Loading from Fertilized Lawns

Variable	Unit	Value
Total Area of manicured lawns within 200 feet of the shoreline[1]	Acres	74
TP Application Rate[2]	kg/acre/year	15.8
Portion of TP applied that reaches the surface water[3]	n/a	0.062
Phosphorus Loading from Fertilizer use on Manicured Lawns[4]	kg/year	72.5

Notes:
1. Lunney (2009b)
2. HDR (2007)
3. King et al (2007). The phosphorus loading factor of 0.062 means that only 6.2 percent of the phosphorus that is applied to manicured lawns becomes runoff and enters the lake (HDR 2007).
4. This estimate of 72.5 kg TP/year = 74 acres x 15.8 kg TP/acre/year x 0.062. It assumes that lawns do not significantly contribute to total phosphorus loading from October through April, since they are not actively growing and therefore not fertilized during this period. In addition, the estimate did not account for the existing total phosphorus loading associated with poor management of lawn clippings that would allow the clippings to enter the lake, decay, and release total phosphorus into the lake.

Homeowner education on proper fertilization methods and related landscape care is the primary means of addressing this source of phosphorus and the actual reduction in phosphorous loading will most likely be less than 73 kg TP/year. Avista assumes a limited amount of phosphorus reduction to Lake Spokane will be achieved from this action, so this measure is given a low priority in the overall phasing of phosphorus reduction actions. It is important to note that Avista partnered with others to support passage of a Washington law[7], effective January 2013, limiting the use of phosphorus (except for certain circumstances) in residential lawn fertilizers, which includes those adjacent to Lake Spokane in all three counties. Although the new law legally restricts use of fertilizer containing phosphorus, homeowner education will be important in actually reducing phosphorus loads to the lake.

In addition, Avista has partnered with Ecology, the Spokane County Conservation District, and the Stevens County Conservation District through an Ecology grant to identify two to five Lake Spokane homeowners and encourage them to change to more naturalized shorelines. Progress to date includes identifying two Lake Spokane homeowner parcels and initiating designs for them to replace bulkheads with a more naturalized shoreline. These two parcels will be used as prototypes to demonstrate the benefits of naturalized shorelines, including native vegetation buffers

[7] Engrossed Substitute House Bill 1489, Water Quality - - Fertilizer Restrictions, Approved by Governor Christine Gregoire April 14, 2011 with the exception of Section 4 which is vetoed. Effective Date January 1, 2013. http://apps.leg.wa.gov/billinfo/summary.aspx?bill=1489&year=2011

3.1.7 Grazing Land Conversion

Grazing, particularly when livestock access the water's edge, can lead to direct and indirect nutrient loading. Limiting grazing, or improving grazing practices, can reduce phosphorus and ammonia loadings as well as erosion.

Avista has identified approximately 215 acres of land that is currently used for grazing under lease from Washington State Department of Natural Resources (DNR). This land is located within the south half of Section 16 in Township 27 North, Range 40 E.W.M. in Stevens County. Currently the 215 acres of land are being used for grazing with a livestock density of 15 animal unit months (AUM)[8], which is less than one animal per acre (15 AUM/200 acres). The total estimated loading from grazing on the 215 acres of land ranges from 15 to 17 kg TP/year (Table 3-7). Avista is pursuing leasing the 215 acres of land from DNR with the intent of placing the land in conservation use, and thereby eliminating grazing activities for the term of its FERC License.

Based on the limited amount of phosphorus reduction from this action, it is given a lower priority in the overall phasing of phosphorus reduction actions. However, there is interest in eliminating grazing on land adjacent to Lake Spokane to promote open space and recreational use. Additionally, Avista may pursue similar actions on the Little Spokane River and Hangman Creek that would restrict grazing along those shorelines. Should Avista move forward to eliminate grazing in these areas, Avista would pursue an appropriate phosphorus reduction credit.

Table 3-7: Estimated Total Phosphorus Loading from Grazing Lands

Variable	Unit	Value	
Total Area of Grazing Lands[1]	acres	200	230
TP Loading from Grazing[2]	Kg TP/acre-inch of precipitation	0.02	0.02
Total Precipitation during Grazing[3,4]	inches	3.65	3.65
Total TP Loading from Grazing Lands[5]	Kg TP/year	15	17

Notes:
1. Lunney (2010). This land is along the shore of Lake Spokane in T27N R40E S16 and currently used for grazing activities. The DNR campground will continue to be operated as a campground and is not included in this evaluation.
2. Heathwaite and Johnes (1996). Based on grazing at a density of less than 8 animals per hectare (or 3.2 animals per acre).
3. WRCC (2009). Based on grazing 3 to 4 months per year.
4. Based on May to August (123 days) when runoff from grazing is assumed to occur.
5. Grazing land area x TP load per inch precipitation x inches precipitation (e.g., 17 = 230 acres x 0.02 kg TP/acre-in x 3.65 in).

3.1.8 Vegetative Shoreline Buffer on Avista Owned Property

Avista owns several parcels of land, totaling approximately 350 acres, which are located within 200 feet of the Lake Spokane shoreline in Spokane, Stevens, and Lincoln counties. These parcels are currently

[8] An AUM is the amount of forage required by one animal unit for one month. An Animal Unit (AU) is generally one mature cow of approximately 1,000 pounds and a calf as old as six months, or their equivalent.

undeveloped. Avista is interested in identifying the potential phosphorus loads that could be avoided by maintaining a 200-foot buffer along the lake's shoreline for the land that it owns. The lands within the 200-foot buffer are managed and protected as conservation and public recreation lands in accordance with Avista's Spokane River Project Land Use Management Plan. Conservation lands are managed primarily to protect or enhance identified wildlife, botanical, cultural, aesthetic, or other natural resource values, while still providing for low-to-moderate levels of public use and enjoyment (e.g., hiking, bank fishing, etc.) where compatible with site-specific resource protection and safety needs.

This 200-foot buffer should create similar sediment-filtering effects as those described in the wetland/restoration enhancement section. Avista has already begun implementing this measure and will work with Ecology in obtaining the appropriate credit related to phosphorus reduction.

3.1.9 Irrigation Water Pumping System Modification

A community of Hutterian Brethren operates a pump site located on the south shore of Lake Spokane at approximately 47° 49' 25" N, 117° 46' 32" W within the southwest and northwest quadrants of Section 21, Township 27N, Range 40E (Fitzhugh 2009). The pump drafts water from an approximate depth of 8 feet (2.4 meters) below the lake's full pool elevation (Fitzhugh 2009). Avista evaluated the possibility of lowering the pump intakes to target either higher phosphorus concentrations and/or lower DO concentrations. A rough estimate of the amount of TP and DO that would be withdrawn from the lake under different assumed depths of the pump system intake indicated that modifying the pump system to withdraw water from deeper in the lake and continuing to use the current pumping regime would remove between 23 and 29 kg TP per year (Table 3-8).

Initial discussions with the landowner on this option have not been favorable (primarily in regard to pumping cold water on the crops) and based on the limited amount of phosphorus reduction from this action, it will not be considered further.

Table 3-8: Total Phosphorus Benefit for June-October at Current Pump Depth and Five Alternative Depths[1]

Semi-monthly Period	Total Phosphorus Removed (kg TP)[2]					
	3 m (Current)	7 m	10 m	15 m	20 m	25 m
Jun 1-15	1	1	1	1	1	1
Jun 16-30	1	1	1	1	1	1
Jul 1-15	5	5	5	4	4	5
Jul 16-31	5	5	5	5	5	5
Aug 1-15	4	4	4	4	5	5
Aug 16-31	4	4	4	4	5	6
Sep 1-15	2	2	2	2	3	3
Sep 16-30	2	2	2	2	2	3
Oct 1-15	0	0	0	0	0	0
Oct 16-31	0	0	0	0	0	0
Total (kg TP/yr)	**24**	**24**	**24**	**23**	**26**	**29**
Total Change (kg TP/yr)[3]	**0**	**0**	**0**	**-1**	**2**	**5**

Notes:
1. The pump system includes four pumps each of which have a pumping capacity of approximately 2,500 gallons per minute. It is our understanding that two or three of these pumps are currently in active use (Fitzhugh 2009). The location of the pumps corresponds to Lake Spokane model segment 31 (Washington model segment 183) of the Portland State University (PSU) Spokane River CE-QUAL-W2 numerical model domain.
2. Loads were calculated by multiplying estimates of the total volume of water withdrawn by the corresponding TP concentrations for each semi-monthly period. TP concentrations used for the current pump configuration are based on output from a CE-QUAL-W2 TMDL1 model scenario run by Golder Associates Inc. (Golder) on November 30, 2009. This CE-QUAL-W2 TMDL1 model scenario run is not reflective of the output presented in the Revised DO TMDL (Ecology 2010a). The average pumping rates for each month were estimated assuming full use of the allowable 2,700 acre-feet under water right S3-30241 to irrigate potatoes per the irrigation requirement identified in the Washington Irrigation Guide (USDA 1997). Based on this analysis, the average pumping rates used in the analysis were 1,360 gallons per minute (gpm) in June, 6,740 gpm in July, 7,360 gpm in August, 4,270 gpm in September, and 160 gpm in October.
3. A negative Total Change indicates less TP removed than under existing pump configuration.

3.2 Study Plan Process and Implementation

As described above, the phosphorus reduction measures evaluated by Avista could target reduction of a significant amount of total phosphorous that was not explicitly assigned as either a point source WLA or non-point source LA reduction strategy in the DO TMDL. By pursuing prioritized reductions, Avista currently believes it can fulfill its “proportional responsibility” defined in the DO TMDL. These resulting phosphorus reductions are expected to be either long-, short-term, or both in nature, and Avista anticipates being credited for them accordingly. For example, Avista would be granted credit for the removal of 125,000 carp, in an ongoing basis, for as long as the removal effectively reduces phosphorus loading to the lake when compared to its baseline[9] state, as determined through modeling and supporting studies. Similarly, Avista would receive long-term credit for removing and replacing a large acreage of invasive/nuisance aquatic weed species which contributes a high phosphorus loading and replacing it

[9] Baseline conditions would be consistent with the basis of the DO TMDL 2001 model.

with plant species creating a lower phosphorus load. Some actions may achieve short-term benefits, and would be evaluated and credited in that context. Other actions may also achieve longer-term benefits, and would be evaluated and credited in that context.

Each of these measures has been individually assessed, based upon several criteria (Figure 3-2). The overall prioritization of evaluating the reasonableness and feasibility of these measures was based on numerous factors, including Avista's ability to control implementation, potential TP load reductions, perceived assurance of obtaining credit, and potential secondary effects. Avista's evaluations of the specific criteria used to prioritize these measures are identified in Figure 3-2. Based on the results of this assessment, each measure has been prioritized as follows for phased implementation:

1. Reducing Carp populations – High priority
1. Aquatic weed management – High priority
2. Acquiring, restoring and/or enhancing wetlands – Moderate priority
3. Hangman Creek load reduction – Moderate-Low priority
4. Education regarding septic system maintenance and improvements – Low priority
5. Reducing lawn area and installing native vegetation buffers – Low priority
6. Conversion of grazing lands to open space – Low priority
7. Vegetative shoreline buffer on Avista-owned property – Priority not established
8. Irrigation water pumping system modification – Eliminated from further consideration

The implementation schedule as presented in Figure 3-3 will be carried out following agency approval. Adaptive management has been incorporated into this schedule to allow for iterative improvements in approach based on data or modeling results as well as other forms of new information. Annual reports will embody an adaptive management approach by assessing, as appropriate, newly-available information, new technologies, factors impacting schedule, and similar items. Finally, Avista interprets that the ten-year compliance period begins upon Ecology and FERC approval of this DO WQAP.

4.0 DO WQAP IMPLEMENTATION AND SUCCESS

The success of improving dissolved oxygen levels in Lake Spokane is not simply dependent on Avista's implementation of this DO WQAP, but is also highly dependent on the effectiveness of reducing nutrient loads from point and non-point sources throughout the Spokane River Basin. The DO TMDL recognized this by assigning WLAs for point sources in Washington, LAs for non-point sources in Washington, and working with EPA to address point source loads in Idaho.

Efforts to improve DO levels in the Spokane River and Lake Spokane will occur over many years. The major nutrient reductions, as discussed in the DO TMDL, will be due to improvements at wastewater treatment plants, most of which will not be completed until at least 2016. In addition, the specific actions that will achieve compliance for non-point discharges have yet to be defined, and have a wider range of uncertainty. Avista's proportional responsibility is relatively small compared to these major sources. Adding complexity are the year-to-year variations in weather, river flow, groundwater discharge, land use, and population growth, along with other variables. As a result, even as Avista implements the DO WQAP and further improves water quality, DO monitoring alone is unlikely to document the incremental benefits of these measures.

Avista's proportional responsibility is defined in the DO TMDL using water quality modeling results (based on 2001 data) that have an implied level of accuracy and precision. In other words, the model can calculate very small expected changes in water quality in thousands of different portions of the lake. However, it is impossible to match this level of implied accuracy with actual monitoring data. Moreover, manipulation of output from the model is necessary to consolidate the simulated nutrient dynamics in the lake in the form of management or compliance metrics. Finally, it is extremely unlikely that the conditions of the 2001 modeled year will be reproduced during the 10-year compliance period, particularly since Avista is implementing new minimum discharge requirements upstream at Post Falls so that the low streamflows observed in 2001 are not produced again in the future. These factors and others create a gap in expectations between the model results and actual results based on monitoring data. All that can be clearly demonstrated are the actions Avista takes, along with a reasonable calculation of phosphorus reductions (both long term and short term) that result.

For these reasons, Avista will demonstrate ongoing compliance by documenting actions outlined in this DO WQAP; calculating phosphorus reductions resulting from those actions; monitoring efforts related to phosphorus reduction; and monitoring and modeling of water quality and aquatic habitat (since the goal of DO standards is to support designated uses including habitat). The schedule, is discussed in Section 7 of this DO WQAP. Avista knows of no other exactly comparable situation nationally wherein a utility is carrying out this work within the context of a FERC license/Certification in support of TMDL goals. Avista expects to learn from and improve on its efforts during the implementation, in concert with Ecology and others. This approach reflects an adaptive strategy, with the intent of addressing Avista's proportional responsibility through reasonable and feasible water quality improvement measures, all in the overall context of protecting and improving water quality to sustain designated uses.

With these limitations in mind, Avista will implement several approaches to assess the effectiveness of implementation. The following components are discussed in detail in Sections 5 and 6 of this document:

1. **Specific Phosphorus Reduction Monitoring.** The structure and phasing of Avista's phosphorus reduction actions and annual reporting will allow active interaction with Ecology and collaborative decision-making on the progress and value of the phosphorus reduction measures undertaken by Avista.

2. **Baseline Nutrient Monitoring.** The monitoring program will provide a consistent framework for a variety of analytical approaches to interpret the data collected in Lake Spokane over the past several decades.[10]

3. **Modeling.** The modeling program will use the capability of the CE-QUAL-W2 model to portray the effects of management actions on water quality and aquatic habitat over a longer time frame, which will address issues related to model accuracy and natural variability over a multi-year time period.

4. **Habitat Evaluation.** The modeling will include a better representation of habitat for species protected under the core summer salmonid spawning designated aquatic life use. This information will help us understand the water quality standards in relation to protecting designated uses.

Avista plans to implement the DO WQAP over a ten-year time period in accordance with the schedule shown in Figure 3-3. The adaptive process will allow newly obtained information to guide and refine the proposed reduction measures, insure to Avista and Ecology that they are reasonable and feasible, and measure their overall effectiveness in terms of DO improvements, with the goal of achieving water quality standards in the lake (Figure 4-1).

4.1 Adaptive Management

As Avista implements the DO WQAP, it will utilize an ongoing adaptive management approach using new information as it becomes available in order to implement the most effective mitigation measures. This approach was used as Avista identified, evaluated, and prioritized the nine potential control measures in Table 3-1 so as to facilitate implementing measures that are expected to remove the greatest amount of phosphorus in the shortest timeframe.

Avista intends to continue refining the estimates of phosphorus load reductions through the DO WQAP implementation process, and further refine the estimates of DO improvements through the associated monitoring and modeling. As such, Avista will adaptively incorporate new information obtained from results of the monitoring and modeling data. The results of the monitoring and modeling may indicate a control action is not as effective as the literature values suggested. If this is the case, the management

[10] Historic data includes, but not limited to, the 1999-2001 Spokane River BOD TMDL study and ongoing Lake Spokane Nutrient Monitoring study, which started in May 2010 (Ecology 2012a).

strategy and schedule will be revised to propose more effective mitigation measures. On the other hand, the monitoring results and modeling may indicate an implementation measure has a greater effectiveness at reducing TP loads and improving DO than initially thought. If this is the case, the management strategy and schedule may be revised to place greater emphasis on implementation of that particular measure. Both these situations illustrate that Avista will adapt its implementation activities based upon results of the monitoring and modeling.

Finally, Avista will submit annual reports that will embody an adaptive management approach by assessing, as appropriate, newly-available information, new technologies, factors impacting schedule, and similar items. Greater detail regarding the contents of the annual reports is included in Section 7.1.

5.0 DATA COLLECTION AND MANAGEMENT PLAN

Data collection will include baseline lake monitoring and phosphorus reduction monitoring for the specific measures, as well as CE-QUAL-W2 modeling (described in Section 6).

5.1 Baseline Lake Monitoring

In 2010, Avista teamed with Ecology to implement a two-year nutrient monitoring program for Lake Spokane to support the DO TMDL effort. The program included conducting one sampling event in May and October, and two sampling events per month from June through September. The sampling was conducted at six lake monitoring stations in Lake Spokane and two upstream river stations. These six lake monitoring stations were included in previous Lake Spokane sampling studies, including Ecology's Spokane River and Lake Spokane (Long Lake) Pollutant Loading Assessment for Protecting Dissolved Oxygen (Cusimano 2004). All sampling was completed in accordance with the Quality Assurance Project Plan (QAPP) developed by Ecology (Ecology 2010d). Avista will continue water quality monitoring at the six stations in Lake Spokane until 2016. Avista anticipates Ecology will provide the water quality data from the two upstream river stations, monitored by Ecology, and a river station downstream of Long Lake Dam (54A070 Spokane River at Long Lake). In 2016, Avista will evaluate the results and success of monitoring baseline nutrient conditions in Lake Spokane and will work with Ecology to define future monitoring goals for the lake. This may include assessing whether the monitoring parameters, locations, duration, and frequency should be modified.

5.1.1 Monitoring Sites and Sampling Schedule

Avista will continue monitoring water quality at the six lake monitoring stations that have been monitored since 2010 (Table 5-1).

Table 5-1: Water Quality Sampling Stations

Site ID	Description	RM	Longitude	Latitude
LL0	Lake Spokane @ Station 0 (near Long Lake dam)	32.66	-117.83381	47.83400
LL1	Lake Spokane @ Station 1	37.62	-117.76001	47.83060
LL2	Lake Spokane @ Station 2	42.06	-117.70030	47.86374
LL3	Lake Spokane @ Station 3	46.42	-117.66569	47.86416
LL4	Lake Spokane @ Station 4	51.47	-117.60955	47.81382
LL5	Lake Spokane @ Station 5	54.20	-117.56812	47.79866

Notes:
1. Source: Ecology (2010d).

Water samples will be sent to an accredited lab for analysis of nitrate plus nitrite, total persulfate nitrogen, orthophosphorus, total phosphorus, and chlorophyll a. At each lake sampling station, samples will be collected from discrete depths as described in the QAPP Addendum (Avista 2012b).

Field staff will measure water temperature, DO, pH, and conductivity *in situ* by lowering a Hydrolab® or similar multi-parameter water quality meter from a boat and recording values at predetermined intervals through the water column. The water quality meter will be calibrated according to the manufacturer's directions and following standard measurement procedures (APHA et al. 1992).

5.2 Site-Specific Phosphorus Reduction Monitoring

Avista will monitor site-specific phosphorus reduction to confirm the effectiveness of reasonable and feasible measures. Monitoring activities will vary depending on the goals of the specific phosphorus reduction measure. The study plans for the two high priority measures, Reducing Carp Populations and Aquatic Weed Management, are included as Appendices C and D, respectively.

5.3 Monitoring Quality Assurance Project Plan

Avista's baseline nutrient monitoring will be conducted under Ecology's 2010 QAPP for Lake Spokane Nutrient Monitoring, Avista's 2012 Addendum to this QAPP (submitted to Ecology in May 2012, approved July 2012), and any future revisions or addendums, as appropriate. Site-specific phosphorus reduction monitoring will also be conducted in accordance with appropriate applicable procedures identified in this QAPP and any future revisions or addendums.

Key components of this QAPP include *insitu* monitoring of water temperature, DO, pH, and specific conductivity; collection of water samples; use of an accredited laboratory to analyze water samples; collection/monitoring duplicates; and the measurement quality objectives in Table 5-2.

Table 5-2: Summary of Measurement Quality Objectives for Field and Laboratory Samples

Analysis	Method	Expected Range of Values	Duplicate Samples RSD	Method Reporting Limits and/or Resolution
Field				
Water Temperature	Hydrolab MiniSonde®[1]	1.0 - 30° C	**+/- 0.1° C[1]**	0.01° C
Specific Conductivity	Hydrolab MiniSonde®[1]	50 – 500 µmhos/cm	+/- 0.5%[2]	0.1 umhos/cm
pH	Hydrolab MiniSonde®[1]	6.0 – 9.0 SU	0.05 SU[3]	1 to 14 SU
Dissolved Oxygen	Hydrolab MiniSonde®[1]	1.0 – 12 mg/L	5% RSD	0.1 - 15 mg/L
Laboratory				
Dissolved Oxygen	SM 4500OC	1.0 – 12 mg/L	+/- 0.1 mg/L[1]	0.01 mg/L
Dissolved Nitrate/Nitrite	4500-NOI[3]	<0.01 – 30 mg/L	10% RSD	0.01 mg/L
Total Persulfate Nitrogen	SM 4500-NOB[3]	0.5 – 50 mg/L	10% RSD	0.025 mg/L
Dissolved Orthophosphate	SM 4500-P G	0.01 – 5.0 mg/L	10% RSD	0.003 mg/L
Total Phosphorous	SM 4500-P F	0.01 – 10 mg/L	10% RSD	0.005 mg/L
Chlorophyll *a*	SM 10300	1 – 1,000 mg/m^2	25% RSD	2 mg/L

Notes:
EPA: EPA Method Code.
SM: Standard Methods for the Examination of Water and Wastewater, 20th Edition (APHA et al., 1998).
RSD: Relative standard deviation.
[1] Same for both the MiniSonde and DataSonde style of meters.
[2] As percentage of reading, not RSD.
[3] As units of measurement, not percentages.

As additional needs for site-specific monitoring become evident, Avista will prepare QAPP addendum(s) and submit them to Ecology for approval.

5.4 Data Analysis

Analysis of water quality data collected as part of the monitoring effort will include simple presentation of the monitoring data, as well as more comprehensive analysis using statistical methods and graphical display. The specific analytical approaches for data reduction and analysis are not being proposed at this stage. However, a variety of methods will be considered, such as graphical time series, “box & whiskers” plots, frequency histograms, cumulative frequency plots, and the Seasonal Kendall Test (Helsel 2005). The goal is to effectively depict relationships between observed water quality and benchmarking criteria or modeling results.

6.0 CE-QUAL-W2 MODELING PLAN

The Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load (DO TMDL) assessed Avista's contribution to depressed dissolved oxygen (DO) in Lake Spokane by comparing CE-QUAL-W2 model outputs for TMDL Scenario #1 and the No Source scenario (Ecology 2010a, 2010b). The DO TMDL (Ecology 2010a) indicates that this comparison will serve as a basis for evaluating the adequacy of Avista's DO WQAP in meeting its responsibilities, and notes that the comparison may be further refined in development of the DO WQAP.

This section describes refinements to the application of the CE-QUAL-W2 model, such as those developed for the recently developed habitat module, that are planned as part of this DO WQAP. The goals of these refinements are to use the model as a tool to understand the aquatic systems within Lake Spokane and their complex relationships, as well as a tool to evaluate whether the lake meets water quality objectives set in the DO TMDL and Washington state water quality standards (WAC 173-201A).

Lake Spokane has a number of relatively distinct physical and habitat components, many of which are determined by its longitudinal and vertical structure. The CE-QUAL-W2 water quality model used for the DO TMDL is capable of simulating each of these two dimensions and their interactions with each other along with resulting water quality conditions. A habitat module has also recently been developed for the CE-QUAL-W2 model, which enables it to also quantify certain water-quality aspects of aquatic habitat in the lake. This provides the capability to calculate the area, volume, and locations of "suitable habitat" within a model result based on user-defined criteria, which include temperature and DO.

A synopsis of the conceptual elements of Lake Spokane is provided in the following section, followed by a summary of the modeling approach and timeline.

6.1 Conceptual Model

6.1.1 Longitudinal Structure

In a longitudinal direction (from upstream to downstream), three zones are present in Lake Spokane, as in many reservoirs (Figure 6-1 and 6-2)[11]:

- The riverine zone is river-like and is farthest upstream. This zone of the lake has the shallowest depths and greatest water velocities. The riverine zone is approximately 2 miles long extending from near Nine Mile Dam to CE-QUAL-W2 model segment 155 during the summer low flow period.

[11] The delineation of riverine, transition, and lacustrine zones is based on the CE-QUAL-W2 modeled thermal stratification for the low inflow summer period. At higher flows (e.g., spring and early summer), the riverine zone extends further downstream to about segment 162.

- The transition zone is approximately 9 miles long and includes CE-QUAL-W2 model segments 156 through 169. This zone is characterized by transitional water depths, water velocities, and widths, as the lake transitions from riverine to lake-like conditions. The deepest part of the channel (thalweg) increases from approximately 11 feet to 72 feet between segments 156 and 169, respectively. As depths and cross-sectional area increase, velocity slows and the capacity to transport sediments decreases. The transition zone is also an important location for macrophyte beds and shoreline habitat.
- The lacustrine zone is the largest zone by length, area, and volume. It is approximately 13 river miles long extending from CE-QUAL-W2 model segment 170 to Long Lake Dam (model segment 188). The lacustrine zone is generally deep (up to 202 feet), has a large cross-sectional area, and low water velocity in which fine sediments may become deposited.

The longitudinal structure of Lake Spokane is defined in the current CE-QUAL-W2 model, to a level of accuracy defined by the number of segments in the model and the bathymetric data incorporated (Figure 6-1). Longitudinal depictions of Lake Spokane's average cross-sectional velocities and maximum depths are displayed in Figure 6-2.

6.1.2 Vertical Structure

The vertical structure of Lake Spokane is set up by thermal stratification, which is largely determined by the lake's inflow rates and temperature, change in lake storage, climate, and location of the powerhouse intake. Within Lake Spokane's lacustrine zone, thermal stratification creates three layers that are generally present between late spring and early fall (Figure 6-3). The thermal and longitudinal structure of Lake Spokane influences productivity and nutrient cycling as discussed below.

- The epilimnion is the uppermost layer; it is the warmest layer due to solar radiation. Temperature in Lake Spokane's epilimnion typically reaches temperatures exceeding 20 °C each summer and extends to a depth of about 5 meters in August (Avista 2012a).
- The metalimnion contains the thermocline, a layer of water in which temperature declines rapidly with depth, typically defined as >1°C per meter of depth. Temperature in Lake Spokane's metalimnion is typically cooler than 20°C with a thermocline at about 5 to 7 meters during August (Avista 2012). The metalimnion provides a barrier for some materials and properties. For example, photosynthetic organisms may grow in the epilimnion and affect oxygen or nutrient levels there, but not in deeper layers, When these organisms die they settle by gravity into the hypolimnion, carrying nutrients with them and affecting water quality there, but not in the epilimnion.
- The hypolimnion is the deepest layer of the lake and is present throughout the lacustrine zone of the lake. Temperature in Lake Spokane's hypolimnion typically remains cooler than 18°C and is at depths below 10 meters in August (Avista 2012). When the metalimnion is established, the hypolimnion no longer has a significant source of oxygen, either from exchange at the surface or as a result of photosynthesis. But animals and bacteria live in these lower waters and consume oxygen. If enough organic matter rains down to the hypolimnion, bacterial decay may consume all the oxygen, making this zone inhospitable for fish and other aerobes.

6.1.3 Updated Bathymetry

Avista commissioned a bathymetric survey of Lake Spokane that was conducted by Northwest Hydro Inc, from Skamania WA. The survey was conducted in 2009 and final map sheets were approved by Avista in 2011. Soundings were collected using a single-beam and multi-beam sonar and was collected in accordance with the United States Army Corps of Engineers Hydrographic Survey Manual EM-112-02-1003 (USACE 2002). Average water surface elevation at the time of the survey was 1,538 (NAVD88) feet. The final survey included a depiction of upland Lidar data provided by Avista, so there is now a complete depiction of both the deep and near-shore bathymetry as well as lakeshore topography around Lake Spokane. Figures 6-4 through 6-6 show the bathymetry of Lake Spokane based on GIS data provided by Avista.

6.1.4 Aquatic Habitat

The biotic communities of lakes and reservoirs are commonly divided into three distinct biotic zones, which interact with one another (Figure 6-7). The interaction between lake biotic zones requires a holistic view of lake and watershed processes for successful lake management (Cooke et al. 2005; Mitchell 2011). Lake Spokane's three biotic zones are as follows:

- The littoral zone, which is located along the margin of the lake, extends out to the limit of sunlight penetration to the substrate. Littoral zones are characterized by high plant and animal species diversity, and are common locations for fish reproduction and development (Cooke et al. 2005).
- The limnetic zone includes the open-water areas where light can penetrate, biota is dominated by macro- and microplankton, and fish are dominated by invertebrate grazers (Cooke et al. 2005). Lake Spokane's limnetic zone is defined by light penetration generally to a depth of approximately 15 to 50 feet depending on the season and location (Ecology 2012a, 2012b). Aquatic vegetation in this zone is floating on the lake surface. Vegetation and algae that die in this zone fall to the lake bottom (the profundal zone) where they decay.
- The profundal zone includes the open water and substrate areas below the depth that light can penetrate (i.e., below the limnetic zone). The decomposition of vegetation and algae consumes DO in this zone, and DO has limited mixing with the rest of the lake because of thermal stratification as described above.

The biotic zones of Lake Spokane are not explicitly defined in the current CE-QUAL-W2 model, but the recent addition of a habitat module will facilitate evaluation of biotic zones with the model. Appropriate temperature and DO criteria for usable habitat conditions for various species, along with delineation of the littoral, limnetic, and profundal zones, will be used with the habitat module to generate habitat assessments with the CE-QUAL-W2 model.

6.2 Modeling Approach

The modeling approach described below is intended to provide the ability to evaluate Avista's proposed management actions relative to the DO TMDL baseline and determine relative improvements in water quality over a variety of time frames, including the 2001 model year responsibilities defined in the DO TMDL. This approach will:

- Focus the modeling effort specifically on Lake Spokane, thus reducing modeling times and complexities with incorporating the upstream river segments of the model, for which Avista has no responsibility.
- Incorporate the most recent bathymetric data on Lake Spokane, from which habitat and water quality conditions can be evaluated.
- Add the capability to simulate water quality effects from Avista's proposed actions, specifically aquatic weed and carp harvesting.
- Add the capability to simulate year-over-year water quality and year-over-year effects from Avista's proposed actions.
- Preserve the capability to evaluate Avista's actions in relation to the 2001 model year used in the DO TMDL, but also present Avista's actions in relation to expected longer term conditions in Lake Spokane.

The proposed approach is shown in Figure 6-8.

6.2.1 Update Model Configuration

The 2001 CE-QUAL-W2 model will be modified by making it smaller (focusing on the Lake only), incorporating the new bathymetry data collected by Avista, and adding the capability to simulate macrophyte and carp harvesting. To ensure that the changes to the model create model results that are consistent with the 2001 model run, the modifications will be made in steps and aided by a nonlinear parameter estimation methodology. Parameter estimation techniques will allow the model to be effectively updated and compared to the 2001 model used for the DO TMDL. The process will allow the reconfiguration to occur in an automated fashion under the control of a computer, as opposed to a manual approach. In addition to the time-saving advantages of this approach, it will generate estimates of the uncertainties accompanying various parameters as part of the process.

In addition to maintaining consistency amongst state variables and direct model outputs, the DO output from the model will be compared with model output used for the DO TMDL using the same volume-weighted calculation which include:

- Use 4-hour modeled DO
- Exclude upper 8 m
- Compute volume-weighted 4-hour DO by segment
- Select minimum volume-weighted 4-hour DO for each day to represent the daily DO for that segment
- Average the daily minimum DO within each semi-monthly period

Differences between the modified model output and the DO TMDL model output will be tracked and summarized for each step, along with sensitivity analysis generated by the parameter estimation process. The individual steps of model modification are described below.

Step 1: The model domain will be reduced to focus specifically on Lake Spokane and will not include the Spokane River upstream of Nine Mile HED. The first step of the model update will be to set boundary conditions at Nine Mile HED. Flows and water quality concentrations from the 2001 model for Nine Mile HED will be used as the boundary condition. A comparison to the 2001 model will be made after this step, and flow balances and model outputs will be checked.

Step 2: The second step will be to incorporate the lake bathymetry data recently collected by Avista into the model. The current segmentation in the model will not be changed from the model used for the DO TMDL, layer thicknesses will be modified if warranted based on the new bathymetry. Another comparison to the 2001 model will be made after this step, and flow balances and model outputs will be checked.

Step 3: Although aquatic plants (macrophytes) can be simulated in CE-QUAL-W2, they are not explicitly incorporated in the current model. CE-QUAL-W2's handling of aquatic plants is described in Figure 6-9. Aquatic plant growth and decay will be incorporated into the revised model so that effects of harvesting can be evaluated.

Step 4: There is no explicit function to model carp removal in CE-QUAL-W2, but the dynamics of carp populations (growth, decay, and bioturbation) can be simulated using an analogy to macrophyte processes. However, some modification to the macrophyte module may be necessary to incorporate specific growth and decay functions, and to simulate sediment nutrient release from bioturbation. Consultation with the developers of CE-QUAL-W2 will be conducted before any code modifications are attempted.

The individual (Steps 1 through 4) and cumulative differences between the modified model output and the TMDL model output will be summarized, along with sensitivity analysis generated by the parameter estimation process. The goal is to incorporate the modifications described and generate model results at each step that are consistent with the results of the TMDL model run. As a starting point, a target of less than 5% difference in simulated DO concentration between the TMDL run and the modified run will be set. Any changes to state variables in the CE-QUAL-W2 model that are required to achieve this target will be documented and justified based on the sensitivity analysis.

6.2.2 Multi-Year Baseline and Model Output Structures

Once the model modifications have been made to the 2001 model year, a multi-year baseline will be established. The objective of developing a multi-year baseline simulation is to provide a basis for comparison that can be used for Avista's proposed management actions to determine relative improvements in water quality over a variety of time frames. Avista's proposed management actions (aquatic weed harvesting and carp reduction) will have "carry-over" effects, where the results of the action may not be realized until season(s)/year(s) following when they have been conducted. This type of analysis is not currently possible with the existing CE-QUAL-W2 model. The multi-year baseline simulation will be developed to simulate year-over-year water quality conditions in Lake Spokane assuming that all point and non-point load reductions prescribed in the DO TMDL are implemented. The proposed multi-year time frame is 2001-2011, and will include the 2001 model year.

The baseline simulation will incorporate available data relevant to setting state variables in CE-QUAL-W2, such as temperature, solar radiation, wind speed, inflow/outflow, and internal cycling processes. In many cases, the variables used (stoichiometric ratios for example) will not change from year to year, while other variables (inflow/outflow and solar radiation for example) will change from year to year. The baseline run will **not** be a calibrated simulation over the multi-year period since it will be based on nutrient loading conditions prescribed in the DO TMDL (which were not in existence during the simulation period). However, it is expected that the baseline run will produce a representative simulation of lake conditions had the TMDL load allocations been in place over the 2001-2011 time frame. Since the ultimate goal is to evaluate the effect of Avista's actions on water quality in Lake Spokane, this baseline-setting approach is valid, as long as the baseline results are representative of the system and capture significant year-to-year variability; and as long as the driving boundary conditions for the model (hydrology and climate) are not changed between comparative simulations.

Water quality output from the baseline model will be presented in time series and statistical formats to depict how water quality varies as a function of time (seasonally and year-over-year) and location (riverine/transition/lacustrine, epilimnion/metalimnion/hypolimnion, and littoral/limnetic/profundal). Specific locations for model output will include, at a minimum, each of the core long-term monitoring stations for Lake Spokane (LL0-LL5). Output will also be produced in study areas selected for assessment of carp harvesting and aquatic weed management (Appendix C and D of DO WQAP), as well as other measures implemented by Avista. If a water quality trading framework is implemented for the Spokane River, there may be a need to develop model output that can be used to guide that process and characterize water quality improvements from upstream trading between wasteload generators. The needs of this group will be considered when developing output approaches.

The habitat structure of Lake Spokane is not explicitly incorporated in the current CE-QUAL-W2 model. The release of CE-QUAL-W2 v3.7 included a new habitat module. One output of the habitat module is a computation of fish habitat volumes based on temperature and DO targets. The habitat module allows the user to evaluate multiple fish species and set parameters for minimum temperature (°C), maximum temperature (°C), and minimum DO (mg/L) associated with a given species. The habitat module outputs percent volume of habitat (%) for the water body and volume of habitat (m^3) for each time step specified in the time series frequency input file. The default output from the habitat module provides the user with a percent volume of habitat for the water body without regard to the spatial location and distribution of the habitat. However, model output can be manipulated to depict habitat time series for selected segments and depths in the lake. This will be the approach used for Lake Spokane, so that habitat can be characterized for specific species in specific areas, in addition to the lake as a whole. A range of usable habitat criteria (e.g., preferred temperature, DO, depth) will be established for rainbow trout (salmonid species) based on available literature values.

6.2.3 Avista Actions Simulations

Avista Actions simulations will be prepared prior to finalizing implementation commitments on Avista's proposed actions. The simulations will show year-over-year water quality conditions in Lake Spokane (from 2001-2011) assuming full implementation of all point and non-point load reductions prescribed in the DO TMDL. Avista's measures, as described in Section 3 of the DO WQAP and refined through the adaptive management process, will be evaluated in part based on the model results. Output from the model, including usable habitat, will be presented using the same format as the baseline simulation.

6.3 Model Quality Assurance Project Plan

A detailed Quality Assurance Project Plan (QAPP) for model development will be prepared and submitted to Washington Department of Ecology (Ecology) for review and approval. The Model QAPP will include the following:

1. **Project Management Overview**: The level of participation from Ecology technical staff on model development will need to be defined. We recommend that Ecology assign a staff-level technical representative capable of interacting with the modeling team and participating in the formulation of modeling strategies and interpretation of output.

2. **Technical Advisory Group and Model Review**: Avista will confer with outside experts and Ecology team members familiar with limnology and the CE-QUAL-W2 model during development of the model.

3. **Task organization, description and schedule**: The schedule is not necessarily tied to the field studies or modeling conducted by other stakeholders. However, some interaction between Avista's team and other teams addressing Spokane River Basin DO issues would increase overall efficiencies and aid in reaching the overall goal of improving DO in Lake Spokane.

4. **Data Quality Objectives for Model Application**: Data quality objectives (DQOs) in the context of this modeling strategy address the inputs and outputs to the model. While actual measured data will be used to derive the model inputs and to assess the model outputs, a distinction needs to be made between model "data", and observed "data". More rigorous statistical treatment can often be applied to model "data" and the comparison between model data sets, and the approach will need to be outlined in the DQOs for the model.

5. **Assumptions and Methods for Developing Model Inputs**: Model inputs for the multi-year simulation will be in the form of "continuous" time series for climatic, hydrologic, and water quality information, with the assumption that all DO TMDL load allocations had been in place. Measured "continuous" data for this condition does not exist, so assumptions and estimating methods will be necessary to fill various data gaps. We recommend that, where possible, simple seasonal relationships for nutrient concentrations at the model boundary or biological growth rates within the lake are applied over the entire simulation period. The year-to-year-variability will therefore be driven primarily by differences in hydrology and climate (which are well defined and measured), and the fundamental process interactions defined in CE-QUAL-W2 (which are theoretically sound).

6. **Version, Model Set Up, and Sensitivity Analysis Protocols**: Version control for the model code and the input/output files used for model runs will need to be managed using a prescribed file naming structure. The types of sensitivity analysis and how those analyses are conducted will also need to be developed. We recommend considering using a parameter optimization software PEST (Doherty 2010) for the parameter estimation. This software has recently been successfully applied by the USGS to a CE-QUAL-W2 model (Sullivan and others 2011).

7. **Data Management**: This will encompass the organization, display, and reporting of actual data and model data used and associated with the model. We recommend a centralized data management structure that provides a concise set of standardized reports, graphs, and tables related to the modeling effort to facilitate comparisons.

7.0 REPORTING AND COMPLIANCE SCHEDULE

Several study plans and reports will be prepared during the ten-year compliance period. This section discusses the goal(s) and approach for each report. The schedule for these products along with other DO WQAP actions is presented in Figure 3-3.

7.1 Annual Summary Report

Annual summary reports, which will also be embedded in the five-, eight-, and ten-year reports, will be prepared to provide a summary of each year's baseline monitoring, implementation activities, effectiveness of the implementation activities, and proposed actions for the upcoming year. Specifically, these reports will include:

1. **Baseline Water Quality Monitoring Results.** The results of the baseline water quality monitoring will be used to communicate water quality conditions in Lake Spokane and its primary inflows and outflow[12] for the previous May through October. Each report will provide tables of the water quality data collected for the DO WQAP and provide a description of general hydrologic and climatic conditions for perspective. The report format will be standardized to facilitate comparison between years.

2. **Results of Study Plans.** Based on preliminary evaluations, Avista proposes to focus its initial efforts on two measures: reducing carp populations and aquatic weed management. These two measures are expected to have the greatest potential for phosphorus reduction. Study plans to further evaluate these two measures are included in Appendices C and D. The findings of these two studies will determine whether it is reasonable and feasible to implement these two measures.

3. **Implemented Control Measures.** This section will provide a list of control actions that are implemented by Avista in the previous year(s), along with the status for each. A summary of the effectiveness of phosphorus reduction for the implemented measure will also be provided. This section will also provide a recommendation on whether the implemented mitigation measure should be continued or modified.

4. **Proposed New Mitigation Measures.** The proposed mitigation measure(s), along with targeted phosphorus reduction estimate(s) will be presented in each annual report. This section will also discuss monitoring or other approaches to evaluate the phosphorus reduction occurring from the implementation of the measure(s).

5. **Ongoing Habitat Evaluation.** Avista will pursue an analysis of Lake Spokane's aquatic habitat specific to Washington's designated aquatic life use, core summer salmonid habitat. This will be completed by utilizing the CE-QUAL-W2 habitat module and analyzing temperature and dissolved oxygen profiles at key habitat locations identified for rainbow trout (*Oncorhynchus mykiss*). Avista will utilize applicable data (e.g., bathymetry) which may become available from other fishery efforts (e.g., triploid rainbow trout stocking or reducing carp populations) for Lake Spokane.

Avista will consult with and seek Ecology approval on the potential actions. With Ecology's approval, Avista will finalize its recommendations for the upcoming year. The consultation process will start as early as January, beginning with an informal meeting to summarize the previous year's activities. The

[12] Avista anticipates that Ecology will provide the water quality data for the inflow and outflow stations.

annual reports will be provided to Ecology by February 1 of each year for a 30-day review and approval period. Avista will post the approved annual reports on its website and will notify the DO TMDL implementation committee of these actions.

7.2 Five-, Eight-, and Ten-Year Reports

In addition to the information contained in the normal annual reports, the five-, eight-, and ten-year reports will broadly assess the progress made towards improving Lake Spokane's water quality through the implementation of the selected reasonable and feasible measures.

These reports will provide an evaluation of Lake Spokane water quality, will summarize the control actions implemented by Avista, and describe reasonable and feasible measure(s) that Avista plans to continue or start implementing. The Lake Spokane water quality evaluation will include both monitoring and modeling results, and will address year-over-year variability and trend analyses. The reports will also summarize as applicable, Lake Spokane's water quality based on the results of the annual baseline water quality evaluation; monitoring associated with each implementation action; modeling results; and an analysis of the lake's aquatic habitat.

The goal for the Ten-Year Report will be to document progress toward addressing Avista's proportional responsibility to improve dissolved oxygen in Lake Spokane. This report will contain information consistent with prior reports and assess overall progress toward attaining water quality goals. If the actions implemented to date have not achieved appropriate phosphorus reduction or dissolved oxygen improvement, Avista would evaluate new reasonable and feasible technologies. If new reasonable and feasible technologies exist, then Avista would complete a new compliance schedule to evaluate and incorporate the new technology. If no new reasonable and feasible improvements have been identified Avista will propose an alternative to achieve compliance with the standard, such as a site specific criteria, a use attainability analysis, or a water quality offset.[13] Avista will meet with Ecology to discuss the report's conclusions, including any proposals for meeting water quality standards. Following this meeting, Avista will submit the report to Ecology for a 30-day review and approval. Avista will file the Ecology-approved report with FERC.

[13] Potential alternative actions allowed under WAC 173-201A-510)5)(g) include new reasonable and feasible technologies along with a new compliance schedule, site specific criteria (WAC 173-201A-430), a use attainability analysis (WAC 173-201A-440), or a water quality offset (WAC 173-201A-450).

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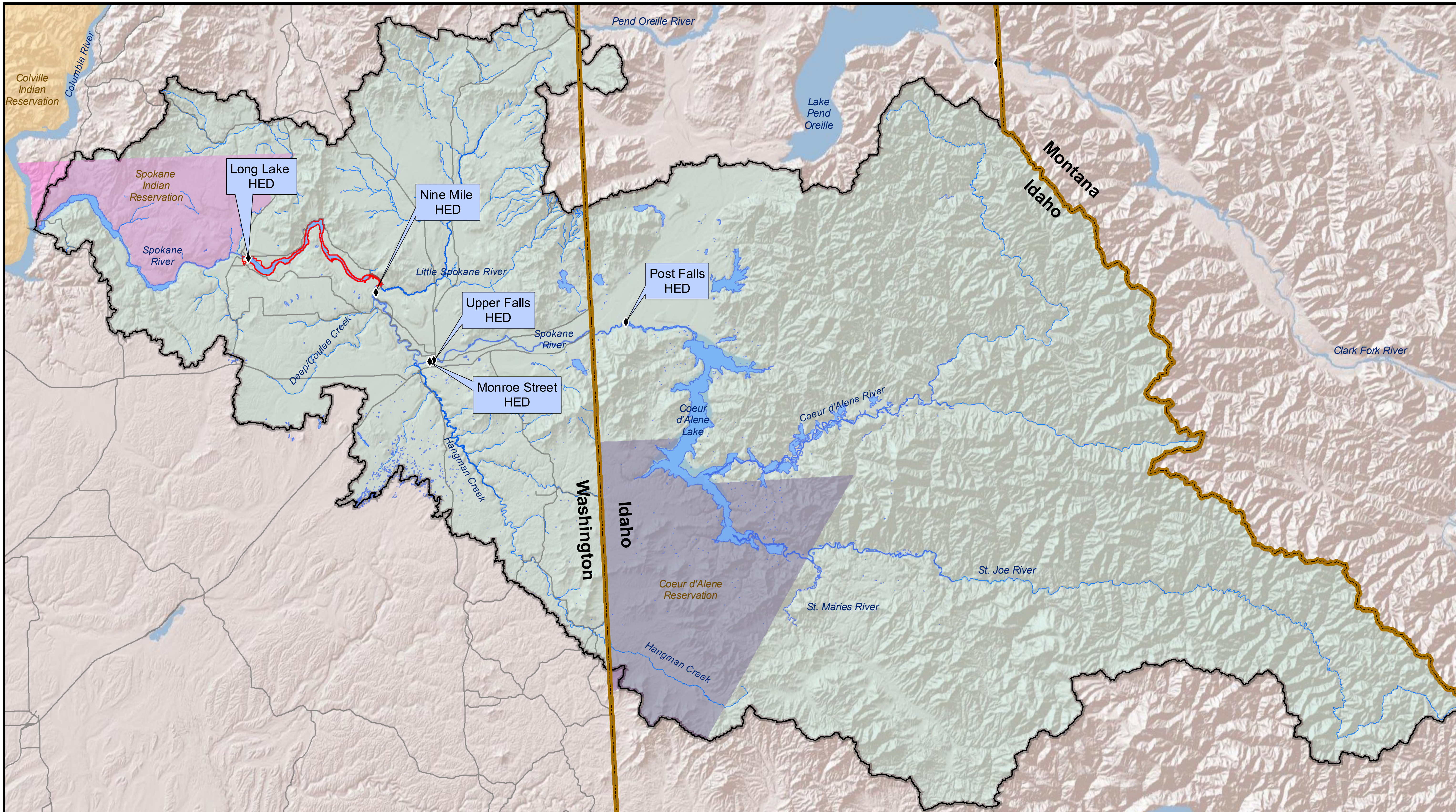
FIGURES



LEGEND

- ♦ Avista HED
- Long Lake Project Boundary
- Spokane River Basin
- State
- Major Highway

0 5 10 20 30 Miles

1 in = 10 miles

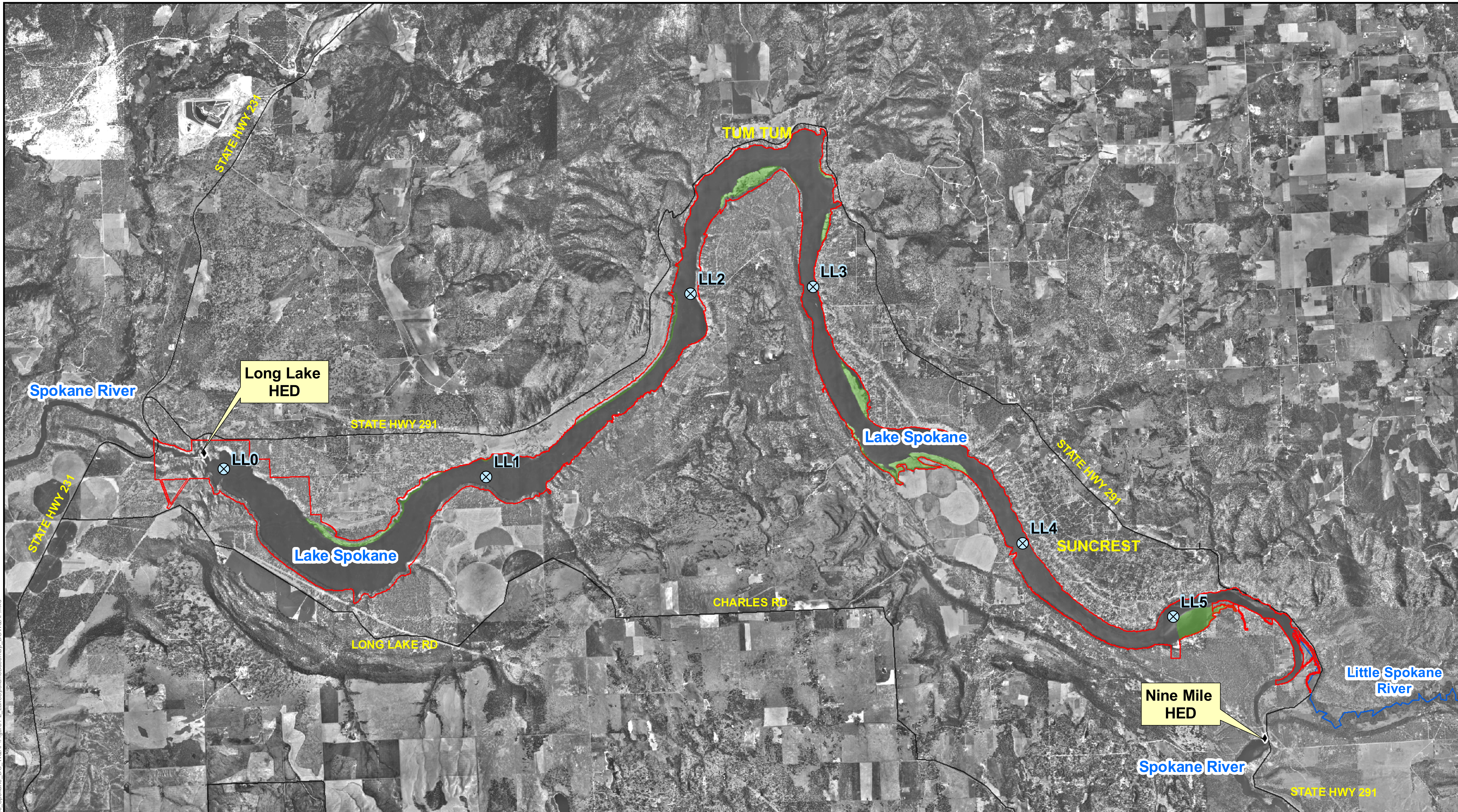
Map Projection:
NAD 1983 HARN State Plane Washington
South FIPS 4602 Feet

N W E S

FIGURE **1-1**

SPOKANE RIVER BASIN BASEMAP

AVISTA LAKE SPOKANE DO WQAP



LEGEND

- ⊗ Baseline Monitoring Stations
- ♦ Avista HED
- Long Lake HED Project Boundary
- Major Highway

1 0.5 0 1 2 3 Miles

1 in = 1 miles

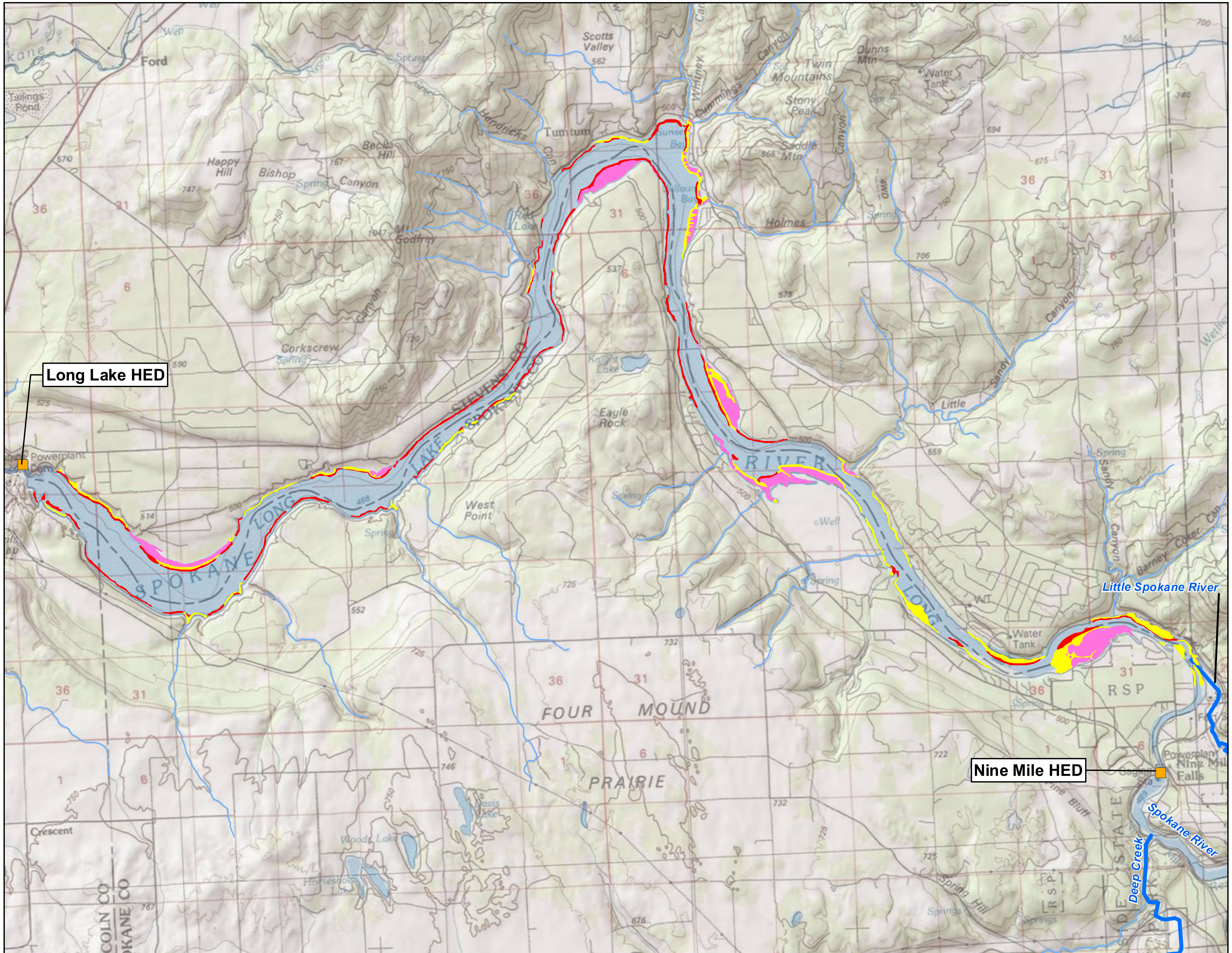
Map Projection:
NAD 1983 HARN State Plane Washington
South FIPS 4602 Feet

N W E S

FIGURE **1-2**

LAKE SPOKANE BASEMAP

AVISTA LAKE SPOKANE DO WQAP



LEGEND

- Long Lake HED
- Long Lake Primary Tributaries

Aquatic Noxious Weeds

- Eurasian watermilfoil
- Yellow floatingheart and white lily
- Native and introduced pondweed

Golder Associates

N

0 1.5

Sacle in Miles

Map Projection:
Washington State Plane
North Zone NAD 1983

Source:
Aquatechnex (2007), ESRI, USGS (quadrangle 24k),
Golder Associates Inc.

This figure was originally produced in color. Reproduction in black and white may result in a loss of information.

FIGURE **3-1**
LAKE SPOKANE AQUATIC NOXIOUS WEED INFESTATIONS
AVISTA LAKE SPOKANE DO WQAP

Path: S:\GIS\Projects\10393119_AvistaAquaticWeeds\MXD\LakeSpokaneAquaticNoxiousWeeds_WQAP_Fig3-1.mxdGLEHMAN

Golder Associates

Measure	Can Reductions Currently be Quantified	Potential Load Reduction (kg TP/yr)	Avista's Ability to Control Implementation	Is Implementation Practical	Frequency of Implementation	Likely Implementation Success	Lake Spokane DO Improvement Response Time	Longevity of Each Implementation Event's Load Reduction	Assurance of Obtaining Credit	Potential Secondary Positive and Negative Effects	Overall Prioritization
Reducing Carp Populations	Yes for biomass reduction, but we need additional information to quantify bioturbation and nutrient-pumping effects	1,594 - 2,625 for biomass only	High	We believe yes, but will confirm by collecting additional information on carp congregation location(s), densities, and timing	Periodic, based on removal rates and carp population	High	Moderate - Fast	Long Term	High	Improve fishery, water quality (turbidity), and aesthetics	High
Aquatic Weed Management	Yes	481 - 3,852	High	Yes but need additional information to determine need for a support boat, efficiency of harvester, etc.	Periodic, based on removal rates	High, but dependent on species, location, weed density harvested, and technology used	Moderate	Moderate	High	Improve fishery, boating accessibility, and wildlife / fish habitat	High
Wetland Acquisition, Restoration, and/or Enhancement	Yes for order of magnitude, but need location and extent of restoration / enhancement to refine	310 - 3,100	Moderate, may need cooperation from land owners	Yes, but site dependent	One time	Moderate - High	Slow and dependent on distance from Lake Spokane	Long Term	Moderate, depending on location	Improve wildlife habitat and water quality	Moderate
Hangman Creek Load Reduction	Yes for order of magnitude, need specific measure to refine estimate	867	Moderate, need cooperation from land owners	Possible, need to identify specific options	Dependent on specific measure(s), landowner cooperation, and credits	High, although extreme precipitation / hydrologic events could substantially reduce long-term benefits	Slow and dependent on distance from Lake Spokane	Long Term	Low, because of lack of formal trading framework and established loading ratios	Improve water quality (total suspended solids, turbidity, and temperature), shoreline stability, sediment management, and riparian / wildlife / fish habitat	Moderate - Low
Improved Septic System Operation via Education	Only on an order of magnitude	188 - 1,077	Moderate	Yes for education	Ongoing	Low - Moderate	Slow - Moderate	Long Term	Low	Improve water quality (pathogen and nitrogen)	Low
Lawn Area Reduction	Yes	72.5	Moderate, dependent upon easements being followed	Yes	Progressing dependent on new shoreline partners	Moderate	Moderate	Long Term	Moderate	Improve water quality (nitrogen and pathogens), shoreline stability, and riparian / wildlife / fish habitat	Low
Grazing Land Conversion	Yes	15 - 17	High, have partner	Yes	Periodic, grazing lease renewal may be required	High	Fast	Long Term	High	Improve water quality (pathogens, turbidity, and temperature), shoreline stability, and riparian / wildlife / fish habitat	Low
Vegetative Shoreline Buffer on Avista owned Property	Need additional information to determine	To be determined	High	Yes	One time with ongoing long-term support	Moderate	Moderate - Fast	Long Term	To be determined	Improve / retain shoreline stability, and riparian / wildlife / fish habitat	Not Established
Targeted Irrigation Withdrawal	Yes	5	None, due to adverse effects on crop production	No	None	None	None	None	Not applicable, due to lack of implementation	Degrade crop production	Eliminate

Note:
Overall prioritization was developed by balancing Avista's ability to control implementation, potential TP reductions, perceived assurance of obtaining credit, and secondary effects.

FIGURE **3-2**
CRITERIA USED TO PRIORITIZE NINE POTENTIAL MITIGATION MEASURES
AVISTA LAKE SPOKANE DO WQAP

	Activity	Implementation Year[1]																																											
						Year 1				Year 2				Year 3				Year 4				Year 5				Year 6				Year 7				Year 8				Year 9				Year 10			
		2012				2013				2014				2015				2016				2017				2018				2019				2020				2021				2022			
		Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall
DO WQAP Submittal	Submit DO WQAP to Ecology		x																																										
	Receive approval from Ecology*			x																																									
	Submit DO WQAP to FERC*			x																																									
	Receive approval from FERC*				x																																								
Carp	Phase I Analysis: Identify location and population of carp							x	x	x	x	x																																	
	Summarize Phase I findings[2]*									x				x																															
	Phase II Analysis: Evaluate harvest technology									x	x	x	x																																
	Select carp removal method(s)												x																																
	Summarize Phase II findings[2], consult and discuss with Ecology													x																															
	Determine with Ecology whether carp population reduction is reasonable and feasible to implement in Lake Spokane*														x																														
	If determined reasonable and feasible, implement measure; if not, revise implementation strategy, monitoring, and schedule*															x	x	x	x	x	x																								
	If implemented, monitor for nutrient reductions															x	x			x	x			x	x			x	x			x	x			x	x			x	x				
Aquatic Weed Management	Phase I Analysis: Evaluate feasibility of mechanical harvesting						x	x	x																																				
	Nutrient reduction evaluation							x	x																																				
	Summarize findings[2], consult and discuss with Ecology*									x																																			
	Determine with Ecology whether aquatic weed harvesting is reasonable and feasible to implement in Lake Spokane*										x																																		
	If determined reasonable and feasible, implement measure; if not, revise implementation strategy, monitoring, and schedule*											x	x			x	x			x	x			x	x			x	x			x	x			x	x			x	x				
	If implemented, monitor for nutrient reductions											x	x			x	x			x	x			x	x			x	x			x	x			x	x			x	x				
	Implement yearly aquatic weed controls through separate program[3]											x	x			x	x			x	x			x	x			x	x			x	x			x	x			x	x				
Other Measures	Evaluate & implement additional measures, as appropriate																					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
Monitoring & Modeling	Baseline Monitoring[4]		x	x	x		x	x	x		x	x	x		x	x	x		x	x	x																								
	Ongoing Habitat Analysis[5]										x	x			x	x			x	x			x	x			x	x			x	x			x	x			x	x					
	Site Specific Nutrient Reduction Analysis[6]																																												
	CE-QUAL Modeling																				x	x											x	x						x	x	x			
Compliance Reporting	DO WQAP Annual Summary Report*									x				x				x								x				x								x							
	Five, Eight, and Ten-Year Reports*																					x												x								x			

Notes:

*Benchmarks

(1) = Implementation Year dependent upon date of FERC approval.

(2) = Findings will be summarized in the DO WQAP Annual Summary/ Report, which will be submitted to Ecology for review and approval.

(3) = Annual aquatic weed control activities implemented under the Lake Spokane and Nine Mile Reservoir Aquatic Weed Management Program.

(4) = Avista and Ecology will re-evaluate baseline nutrient monitoring program following the completeing of the 2016 season.

(5) = Ongoing in nature with periodic reporting to Ecology.

(6) = Dependent upon outcome of carp population reduction and aquatic weed management phased analyses.

FIGURE **3-3**

DO WQAP IMPLEMENTATION SCHEDULE

AVISTA LAKE SPOKANE DO WQAP

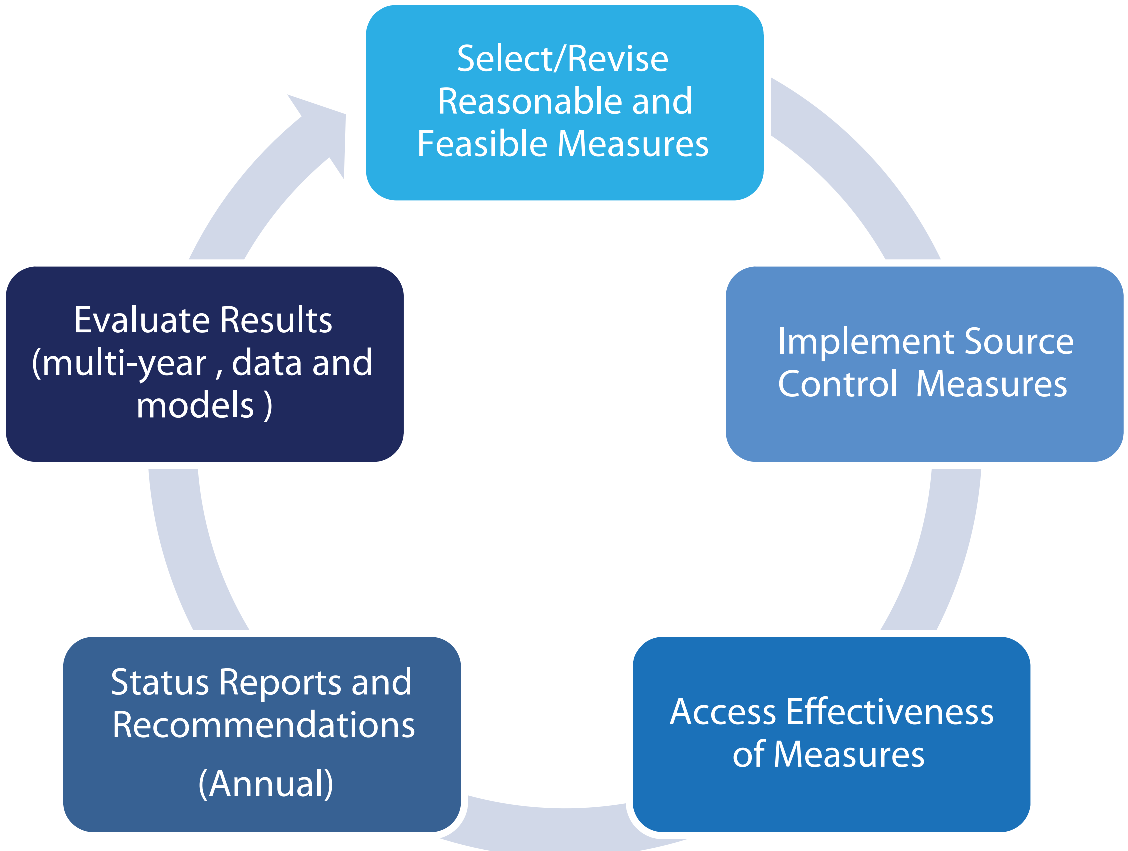


FIGURE **4-1**

ADAPTIVE PROCESS FOR SELECTING REASONABLE AND FEASIBLE MEASURES AND MEASURING SUCCESS

AVISTA LAKE SPOKANE DO WQAP

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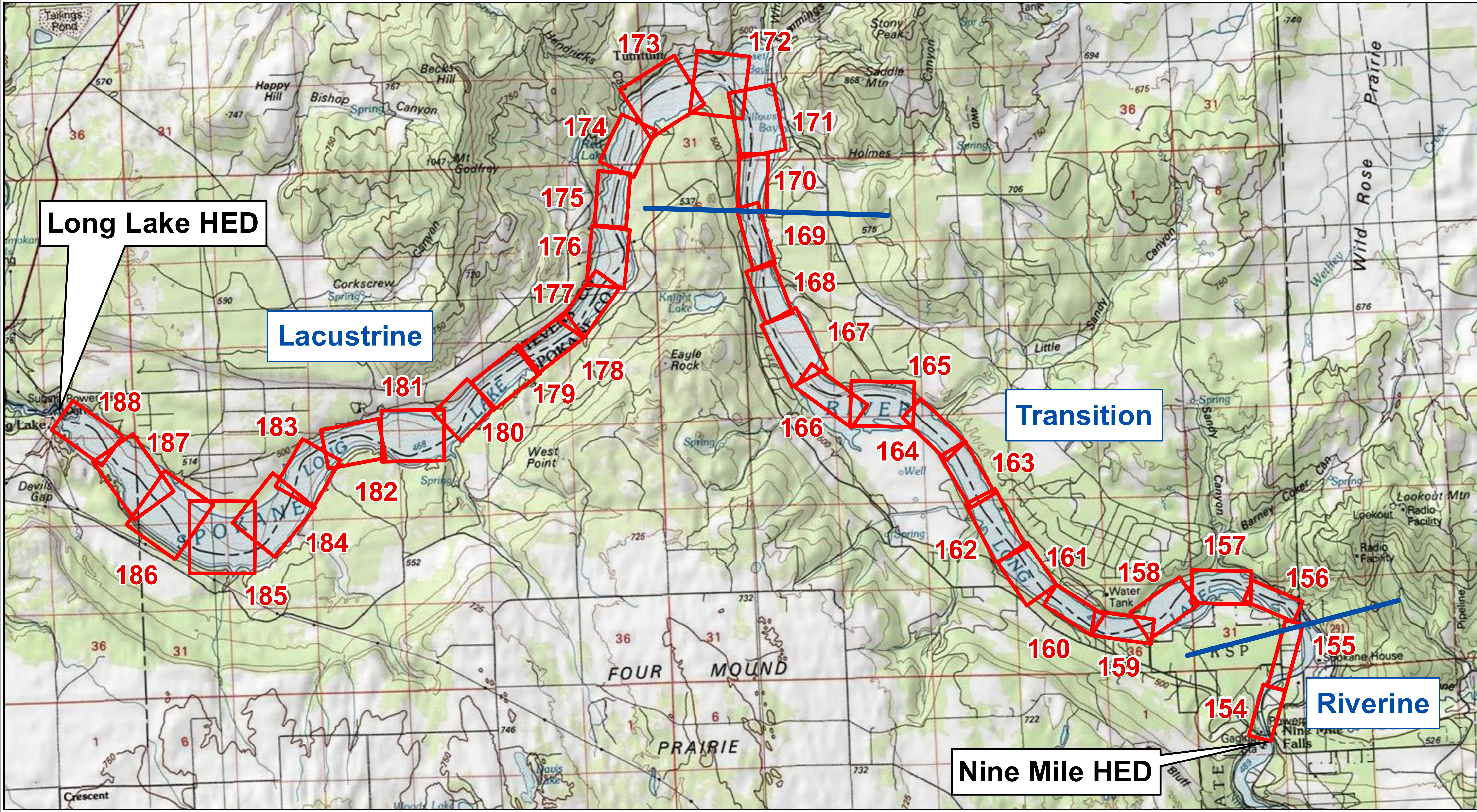
Golder Associates



LEGEND

CE-QUAL-W2 Model Segment

Lake Zone Break Line

0 2
Scale in Miles

Map Projection:
NAD 1983 HARN StatePlane
Washington South FIPS 4602 Feet
Source:
Golder Associates, Inc.(Model Segments, Lake Zones),
USGS (Topographic Map)

N

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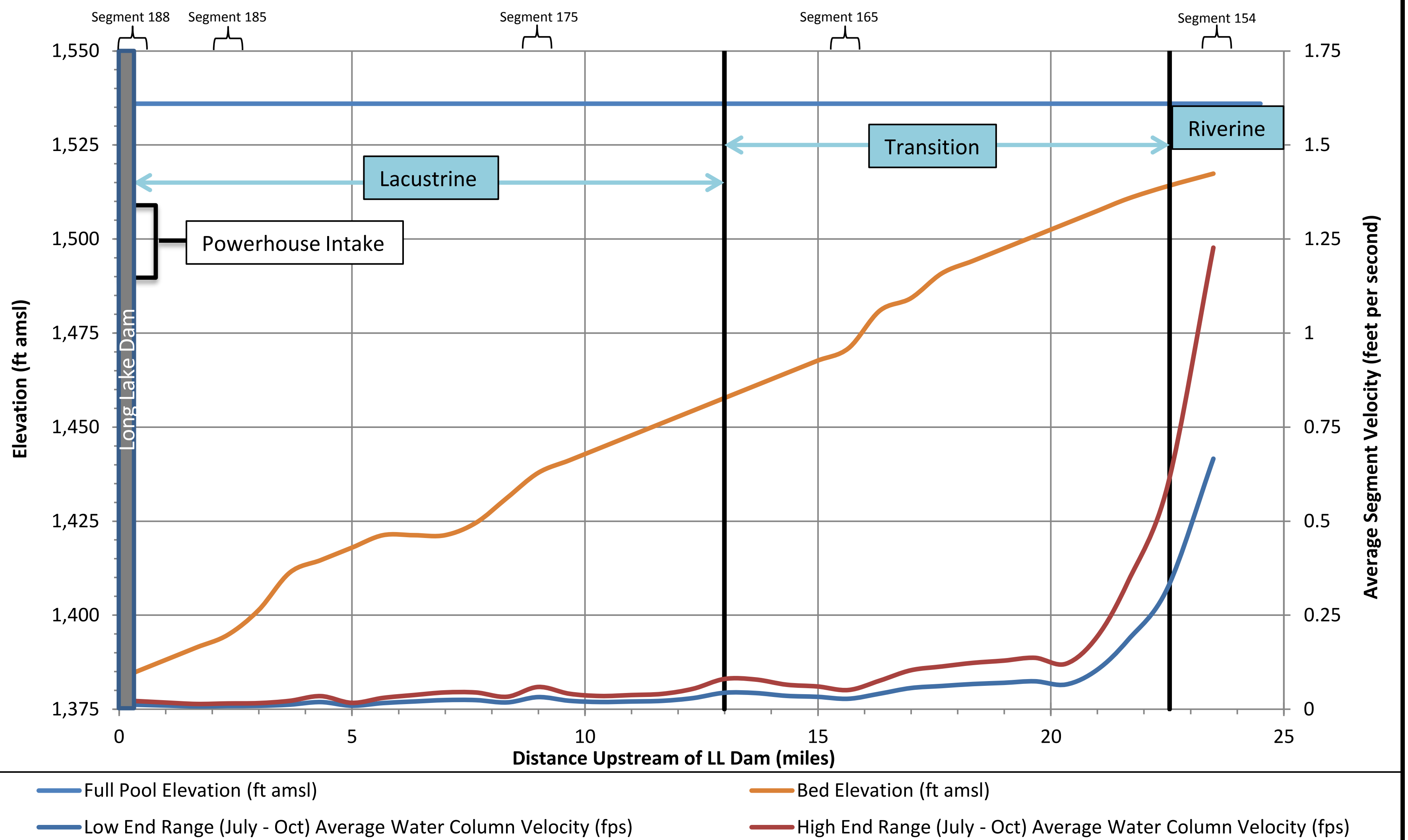
FIGURE **6-1**

LAKE SPOKANE LONGITUDINAL STRUCTURE, LAKE ZONES, AND CE-QUAL-W2 MODEL SEGMENTS

AVISTA LAKE SPOKANE DO WQAP

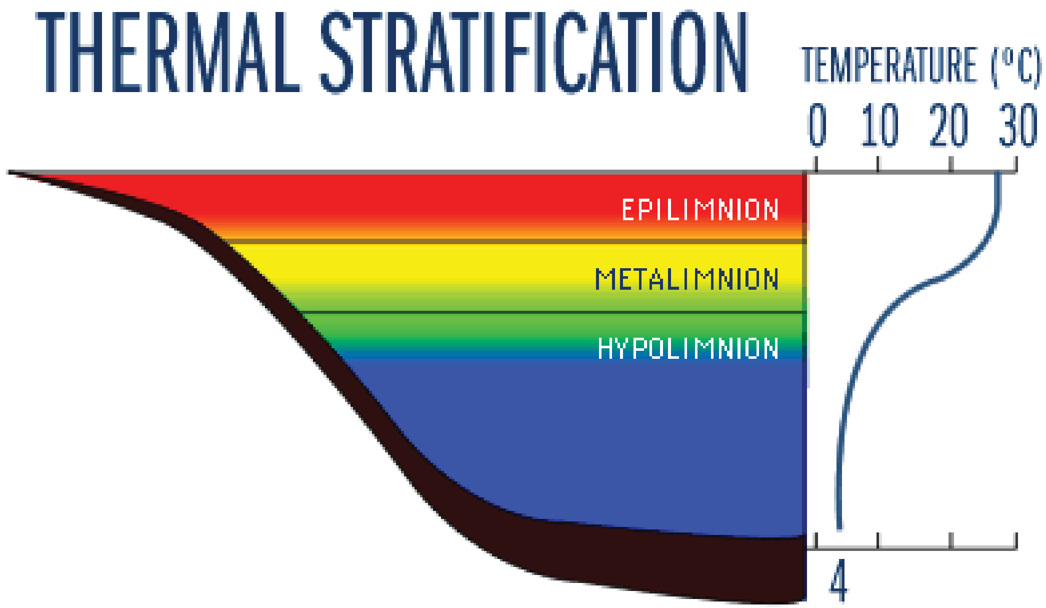
Path: S:\GIS\Projects\10393119_AvistaAquaticWeeds\MXD\LakeSpokaneModelSegs_and_Zones_fig6_1.mxd

Golder Associates



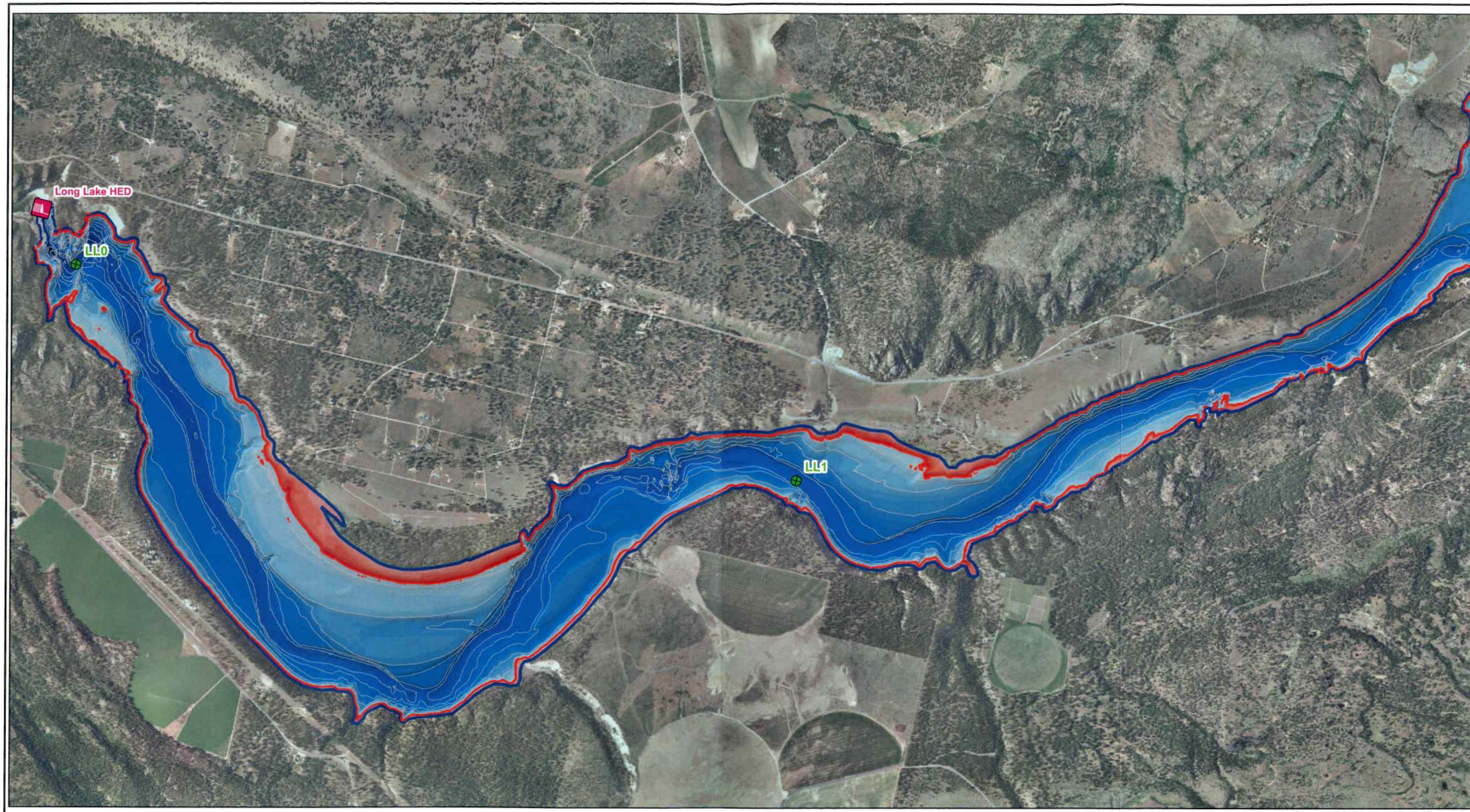
Golder Associates	Title: Lake Spokane Bed Elevation, Average Segment Velocity, and Longitudinal Zones Based upon CE-QUAL-W2 Inputs		
	Project Name: DO WQAP	Project No.: 073-93081-02.310	FIGURE 6-2
	Client Name: Avista	Date: May 23, 2012	

\\uspws.golder.com@SSL\DavWWWRoot\07393081401CertificationSupportAndDocumentation_1\Phases and Tasks\2011 Plus\02 Phase 310 Lake Spokane DO WQAP\Water Quality Attainment Plan\Final\Figures\Tables_and_Excel_Figures.xlsx



Source: University of Minnesota-Duluth 2004:
Water on the Web (http://WaterOntheWeb.org).

FIGURE **6-3**
A CROSS-SECTIONAL VIEW OF VERTICAL LAYERS THERMALLY STRATIFYING THE LACUSTRINE ZONE
AVISTA LAKE SPOKANE DO WQAP



LEGEND

- Avista HED
- Sampling Location
- Lake Spokane Boundary*
- Drawdown Limit (1524 ft)
- Contour (20ft)

Elevations Affected by Drawdown

1524 - 1526, 1526 - 1528, 1528 - 1530, 1530 - 1532, 1532 - 1534, 1534 - 1536, 1536 - 1538

*Lake Spokane Boundary created using aerial imagery and extent of bathymetry survey

0 0.25 0.5
Miles

Map Projection:
NAD 1983 StatePlane Washington
North FIPS 4601 Feet
NAVD 1988
Source:
ESRI (Aerial Imagery),Avista (Avista HED)
Golder Associates (Lake Spokane Boundary, Sampling Locations, Contours, Bathymetry Shade, Draw Down Data)

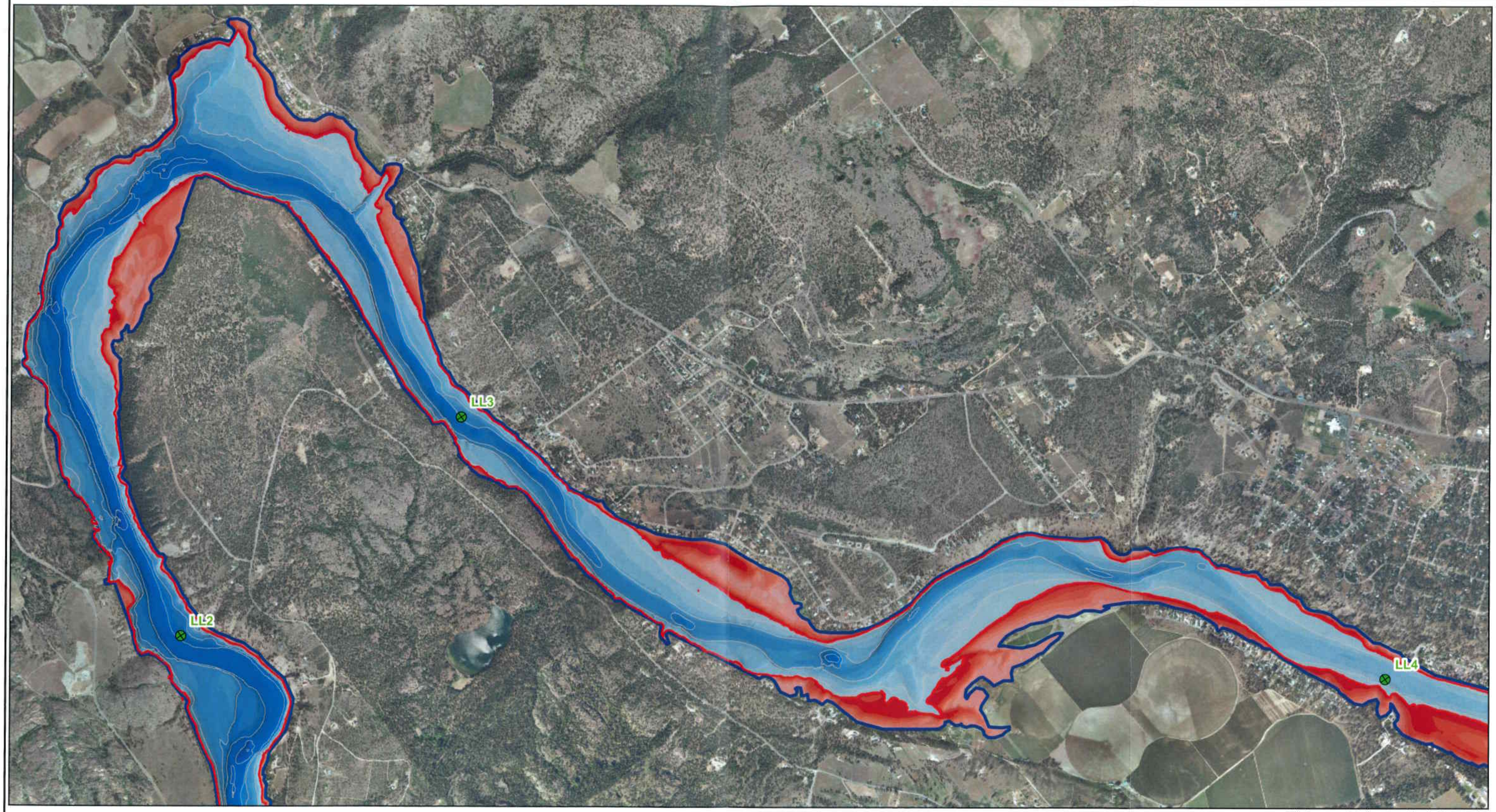
N

This figure was originally produced in color. Reproduction in black and white may result in a loss of information.

FIGURE **6-4**
LAKE SPOKANE BATHYMETRY AND DRAWDOWN MAP #1
AVISTA LAKE SPOKANE DO WQAP

Path: S:\GIS\Projects\10393119_AvistaAquaticWeeds\MXD\LakeSpokaneBathymetryAndDrawdown_map1.mxdGLEHMAN

Golder Associates



LEGEND

- Avista HED
- Sampling Location
- Lake Spokane Boundary*
- Drawdown Limit (1524 ft)
- Contour (20ft)

Elevations Affected by Drawdown

1524 - 1526, 1526 - 1528, 1528 - 1530, 1530 - 1532, 1532 - 1534, 1534 - 1536, 1536 - 1538

*Lake Spokane Boundary created using aerial imagery and extent of bathymetry survey

0 0.25 0.5
Miles

Map Projection:
NAD 1983 StatePlane Washington
North FIPS 4601 Feet
NAVD 1988
Source:
ESRI (Aerial Imagery),Avista (Avista HED)
Golder Associates (Lake Spokane Boundary, Sampling Locations, Contours, Bathymetry Shade, Draw Down Data)

N

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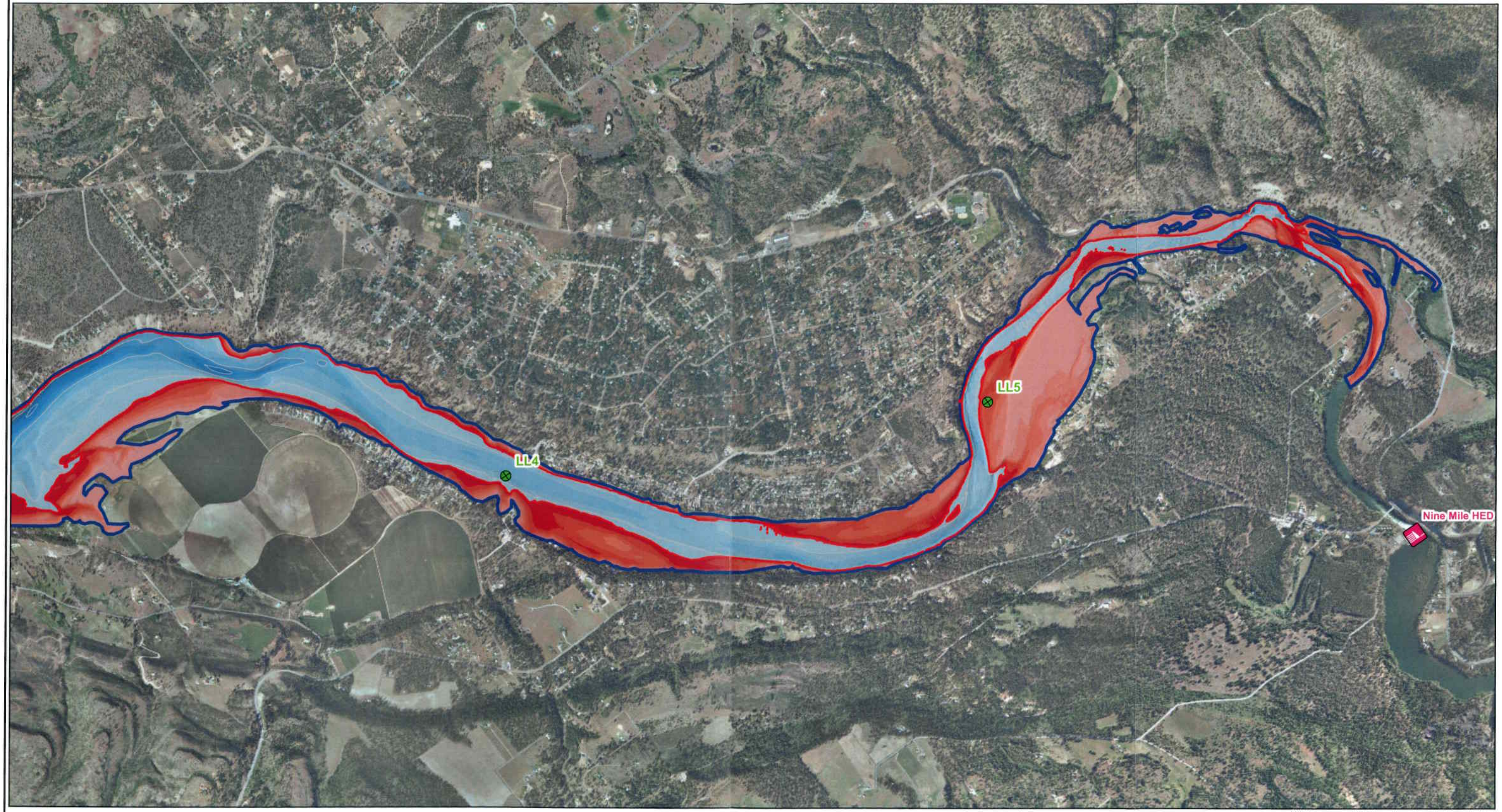
FIGURE **6-5**

LAKE SPOKANE BATHYMETRY AND DRAWDOWN MAP #2

AVISTA LAKE SPOKANE DO WQAP

Path: S:\GIS\Projects\10393119_AvistaAquaticWeeds\MXD\LakeSpokaneBathymetryAndDrawdown_map2.mxdGLEHMAN

Golder Associates



LEGEND

- Avista HED
- Sampling Location
- Lake Spokane Boundary*
- Drawdown Limit (1524 ft)
- Contour (20ft)

Elevations Affected by Drawdown

1524 - 1526, 1526 - 1528, 1528 - 1530, 1530 - 1532, 1532 - 1534, 1534 - 1536, 1536 - 1538

*Lake Spokane Boundary created using aerial imagery and extent of bathymetry survey

0 0.25 0.5
Miles

Map Projection:
NAD 1983 StatePlane Washington
North FIPS 4601 Feet
NAVD 1988
Source:
ESRI (Aerial Imagery),Avista (Avista HED)
Golder Associates (Lake Spokane Boundary, Sampling Locations, Contours, Bathymetry Shade, Draw Down Data)

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This figure was originally produced in color. Reproduction in black and white may result in a loss of information.

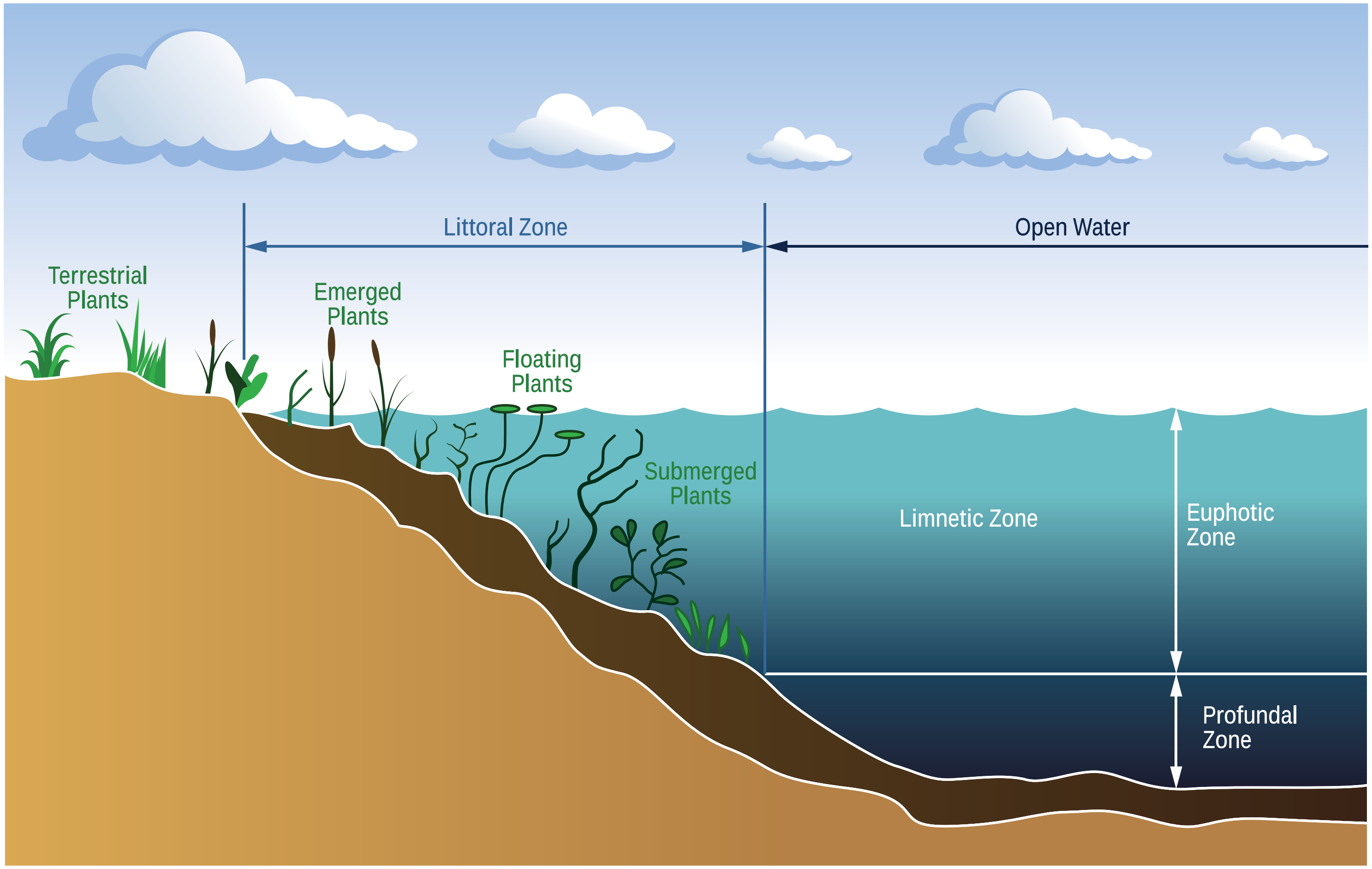
FIGURE **6-6**

LAKE SPOKANE BATHYMETRY AND DRAWDOWN MAP 3

AVISTA LAKE SPOKANE DO WQAP

Path: S:\GIS\Projects\10393119_AvistaAquaticWeeds\MXD\LakeSpokaneBathymetryAndDrawdown_map3.mxdGLEHMAN

Golder Associates



Source: University of Minnesota, General College 2006.

FIGURE **6-7**
A CROSS-SECTIONAL VIEW OF AQUATIC HABITAT ZONES
AVISTA LAKE SPOKANE DO WQAP

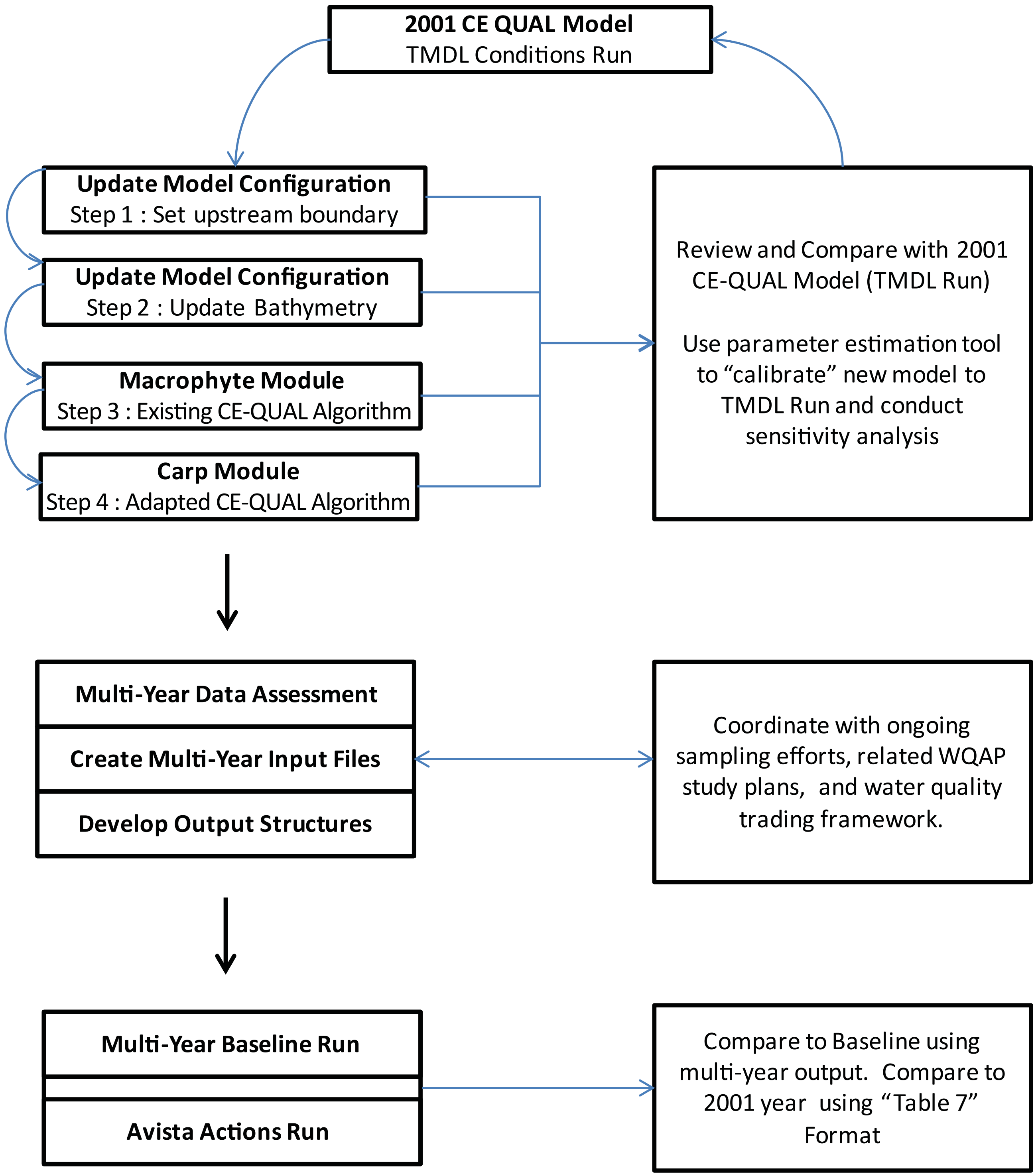
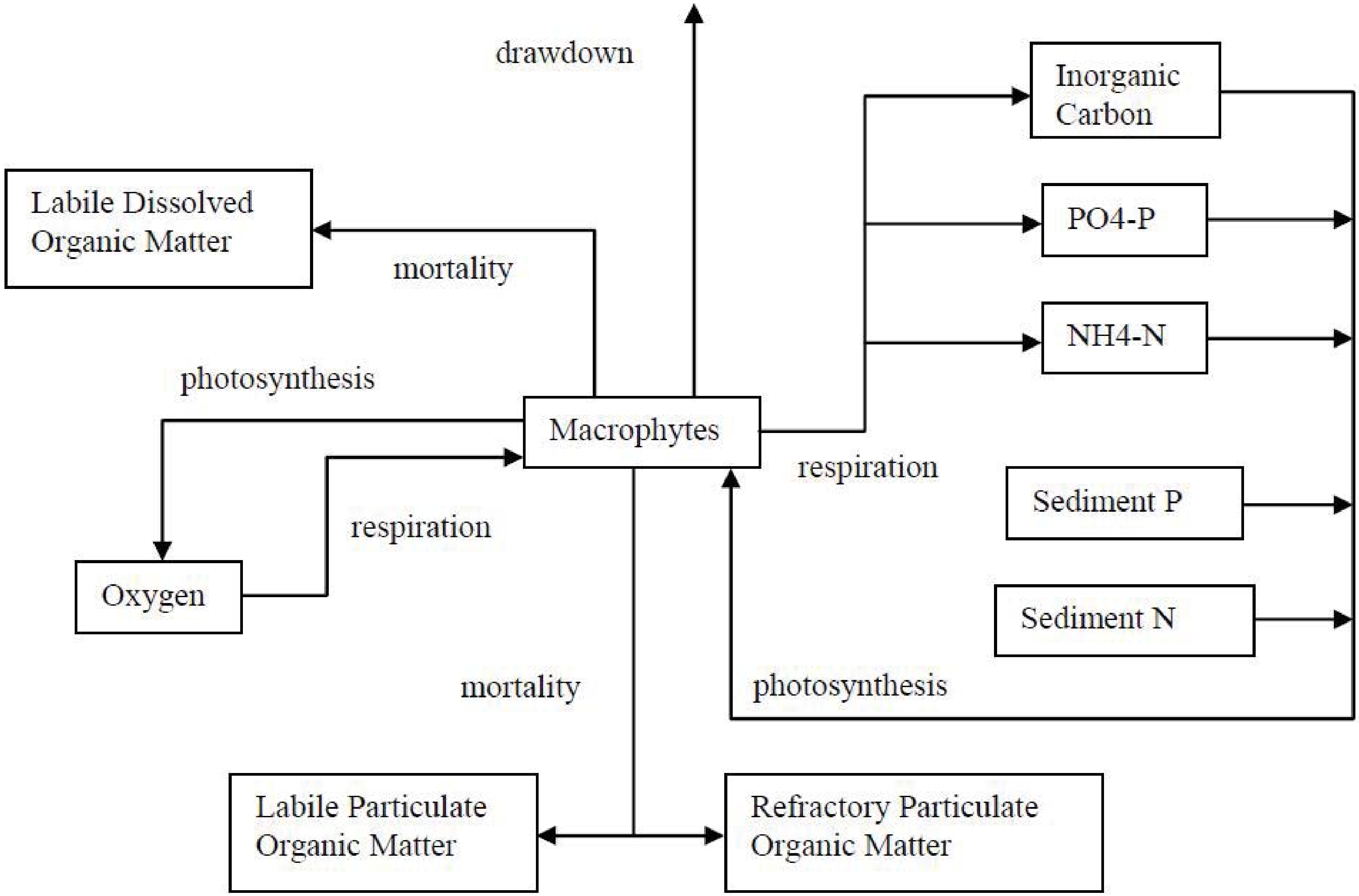


FIGURE **6-8**

APPROACH TO LAKE SPOKANE CE-QUAL MODEL REFINEMENTS

AVISTA LAKE SPOKANE DO WQAP



Source: Cole and Wells 2011

FIGURE **6-9**
NUTRIENT FLUXES FOR THE MACROPHYTE COMPARTMENT IN CE-QUAL-W2
AVISTA LAKE SPOKANE DO WQAP

APPENDIX A

SECTION 5.6 DISSOLVED OXYGEN
OF ECOLOGY ORDER NO. 7792 AMENDING
WATER QUALITY CERTIFICATION (ECOLOGY 2010C)

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

IN THE MATTER OF GRANTING A WATER QUALITY CERTIFICATION to Avista Corporation in accordance with 33 U.S.C. §1341 FWPCA § 401, RCW 90.48.260 and WAC 173.201A	) Order No. 7792) Amending Section 401 Certification) For Relicensing of the Spokane River) Hydroelectric Project (FERC No.2545)) issued under Order No. 6702

To: Mr. Elvin Fitzhugh, License Manager
Avista Corporation
P.O. Box 3727
Spokane, WA 99220-3727

The following changes to Order No. 6702 (section 401 certification for the relicensing of the Spokane River Project), were made as a result of the approval of the Total Maximium Daily Load (TMDL) for Dissolved Oxygen (D.O.) on the Spokane River according to section 5.1.M.(iv) and section 5.6.C. of the 401 certification.

Section 5.6 Dissolved Oxygen A. General Conditions and C. Lake Spokane: page 46 and 54of Order No. 6702 dated May 8, 2009 are hereby amended:

5.6 Dissolved Oxygen

A. General Conditions

The primary purpose of the following conditions is to achieve water quality numeric criteria for DO, in order to protect beneficial uses. The Project shall comply with the standards found in WAC 173-201A, as further described in this Certification.

Upon completion of the ten year compliance period, the Licensee shall operate the Project in full compliance with the state water quality standards.

Ecology has developed a Total Maximum Daily Load for Dissolved Oxygen in the Spokane River (DO TMDL). As part of that process, Ecology has determined the Project's contribution to the DO problem in the Spokane River, and the Licensee's proportional level of responsibility for control measures. The Project's dissolved oxygen responsibility for Lake Spokane can be found in the Spokane River/Lake Spokane Dissolved Oxygen Water Quality Improvement Report, www.ecy.wa.gov/biblio/0710073.html.

C. Lake Spokane

Within two years of the effective date of this amendment, the Licensee shall develop a DO WQAP for review and approval by Ecology, in accordance with WAC 173-201A-510(5).

The DO WQAP will provide a detailed strategy to address the Licensee's proportional level of responsibility, based on its contribution to the dissolved oxygen problem in Lake Spokane as determined in the DO TMDL.

No other conditions or requirements of Order No. 6702 are changed by this amendment.

The entire text of Amended Order No. 7792 is contained in the enclosure. All changes made under this Order are shown in strikethrough and/or underlined. If any discrepancy exists between the above description of the text of this order and the enclosure, the text of Order No. 7792 shall prevail.

Right to appeal these amendments

These amendments to the original order (not the original order) may be appealed. Your appeal must be filed within thirty days of the date of issuance of the amended Order. The appeal must be sent to the Washington Pollution Control Hearings Board, Post Office Box 40903, Olympia, Washington 98504-0903. At the same time, a copy of the appeal must be sent to the Department of Ecology, Fiscal Office, P.O. Box 47615, Olympia, Washington 98504-7915. In addition, send a copy to Marcie Mangold, Department of Ecology, 4601 N. Monroe Street, Spokane, Washington 99205. The notice of appeal shall contain a copy of the amended Order. Your appeal alone will not stay the effectiveness of this amended Order. Stay requests must be submitted in accordance with RCW 43.21B.320. These procedures are consistent with Chapter 43.21B RCW.

DATED this 27th day of May 2010 at Spokane, Washington.

James M. Bellatty
Water Quality Section Manager
Eastern Regional Office

APPENDIX B

ERRATUM SPOKANE RIVER AND LAKE SPOKANE DISSOLVED OXYGEN TOTAL MAXIMUM DAILY LOAD WATER QUALITY IMPROVEMENT PROJECT (ECOLOGY 2010E)

To ask about available formats for the visually impaired call 360-407-7472. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

Publication No. 07-10-073b

Erratum Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load Water Quality Improvement Project

Table 7

Table 7 in the Spokane River and Lake Spokane Dissolved Oxygen TMDL Water Quality Improvement Project (page 49) requires a minor correction.

The table provides the numeric dissolved oxygen (DO) responsibility for Avista by taking the difference in the natural DO condition and the TMDL condition (full attainment of wasteload and load allocations).

What was missing from the document was the subtraction of the 0.2 mg/L water quality standard from this difference.

This Erratum identifies an error only in the cited table. **This error was corrected in the online version of the document, www.ecy.wa.gov/biblio/0710073.html.**

The error does not affect the conclusions and recommendations of the TMDL water quality improvement report.

Table 7. TMDL Scenario #1 dissolved oxygen concentrations (*italics) are compared with No Source scenario concentrations (bold) for June 1 through September 15. Avista's responsibility (mg/L DO) for each segment is quantified in the shaded cells.*

Segment	June 1-15			June 15-30			July 1-15			July 16-31			Aug 1-15			Aug 16-31			Sept 1-15		
157	9.23	9.40	_	9.44	9.66	_	8.94	9.46	_	8.93	9.43	_	9.06	9.55	_	9.22	9.93	_	9.40	9.96	_
158	9.42	9.66	_	9.42	9.79	_	9.06	9.49	_	9.11	9.60	_	9.14	9.65	_	9.31	9.84	_	9.46	9.99	_
159	9.54	9.84	_	9.46	9.86	_	9.13	9.53	_	9.19	9.62	_	9.19	9.63	_	9.32	9.78	_	9.47	9.93	_
160	9.57	9.88	_	9.45	9.85	_	9.12	9.47	_	9.19	9.58	_	9.18	9.56	_	9.30	9.70	_	9.44	9.87	_
161	9.56	9.87	_	9.51	9.94	_	9.16	9.52	_	9.19	9.57	_	9.19	9.55	_	9.30	9.68	_	9.45	9.84	_
162	9.56	9.89	_	9.55	10.01	_	9.16	9.53	_	9.18	9.59	_	9.18	9.53	_	9.26	9.61	_	9.41	9.79	_
163	9.58	9.96	_	9.59	10.06	_	9.18	9.56	_	9.17	9.63	_	9.17	9.53	_	9.18	9.52	_	9.31	9.73	_
164	9.61	10.03	_	9.58	10.08	_	9.15	9.52	_	9.14	9.62	_	9.13	9.47	_	9.10	9.37	_	9.20	9.62	_
165	9.62	10.05	_	9.57	10.10	_	9.06	9.38	_	9.09	9.53	_	9.07	9.36	_	8.96	9.12	_	9.11	9.50	_
166	9.59	10.03	_	9.51	10.03	_	8.87	9.07	_	8.98	9.30	_	8.97	9.15	_	8.82	8.85	_	9.07	9.38	_
167	9.59	10.03	_	9.48	9.98	_	8.73	8.87	_	8.84	9.07	_	8.87	8.97	_	8.69	8.63	_	9.01	9.27	_
168	9.61	10.10	_	9.43	9.91	_	8.52	8.58	_	8.55	8.63	_	8.66	8.57	_	8.44	8.20	0.0	8.95	9.11	_
169	9.62	10.16	_	9.37	9.82	_	8.41	8.41	_	8.36	8.37	_	8.47	8.31	_	8.25	7.92	0.1	8.85	8.91	_
170	9.60	10.18	_	9.28	9.72	_	8.37	8.36	_	8.27	8.23	_	8.37	8.17	_	8.13	7.71	0.2	8.69	8.66	_
171	9.58	10.17	_	9.23	9.66	_	8.40	8.39	_	8.23	8.17	_	8.31	8.07	0.0	8.04	7.55	0.3	8.57	8.43	_
172	9.50	10.08	_	9.08	9.46	_	8.23	8.17	_	7.96	7.80	_	7.98	7.63	0.2	7.70	7.07	0.4	8.35	8.06	0.1
173	9.40	9.96	_	8.96	9.31	_	8.12	8.00	_	7.80	7.55	0.0	7.80	7.36	0.2	7.51	6.78	0.5	8.15	7.75	0.2
174	9.29	9.80	_	8.81	9.12	_	7.96	7.79	_	7.59	7.27	0.1	7.56	7.05	0.3	7.26	6.42	0.6	7.85	7.34	0.3
175	9.20	9.68	_	8.69	8.99	_	7.86	7.66	_	7.46	7.09	0.2	7.40	6.84	0.4	7.09	6.21	0.7	7.62	7.04	0.4
176	9.12	9.59	_	8.63	8.91	_	7.83	7.60	0.0	7.41	6.99	0.2	7.39	6.79	0.4	7.06	6.13	0.7	7.55	6.91	0.4
177	8.93	9.31	_	8.35	8.54	_	7.50	7.19	0.1	6.99	6.46	0.3	6.92	6.22	0.5	6.56	5.54	0.8	7.01	6.24	0.6
178	8.85	9.21	_	8.27	8.42	_	7.44	7.10	0.1	6.92	6.34	0.4	6.88	6.15	0.5	6.51	5.47	0.8	6.89	6.06	0.6
179	8.79	9.14	_	8.24	8.37	_	7.42	7.07	0.1	6.88	6.27	0.4	6.86	6.11	0.6	6.51	5.44	0.9	6.81	5.92	0.7
180	8.73	9.05	_	8.19	8.30	_	7.38	7.02	0.2	6.83	6.19	0.4	6.81	6.03	0.6	6.49	5.42	0.9	6.67	5.75	0.7
181	8.66	8.95	_	8.15	8.21	_	7.36	6.97	0.2	6.78	6.08	0.5	6.74	5.89	0.6	6.47	5.36	0.9	6.52	5.53	0.8
182	8.67	8.95	_	8.16	8.21	_	7.41	7.01	0.2	6.84	6.13	0.5	6.78	5.92	0.7	6.56	5.46	0.9	6.53	5.52	0.8
183	8.55	8.78	_	8.00	7.98	_	7.26	6.85	0.2	6.70	5.97	0.5	6.58	5.69	0.7	6.37	5.29	0.9	6.29	5.27	0.8
184	8.54	8.75	_	7.98	7.94	_	7.30	6.88	0.2	6.77	6.01	0.6	6.63	5.71	0.7	6.43	5.33	0.9	6.30	5.34	0.8
185	8.47	8.63	_	7.94	7.87	_	7.29	6.88	0.2	6.78	6.00	0.6	6.58	5.64	0.7	6.42	5.29	0.9	6.23	5.27	0.8
186	8.34	8.44	_	7.84	7.74	_	7.18	6.76	0.2	6.63	5.84	0.6	6.37	5.41	0.8	6.24	5.08	1.0	5.96	4.93	0.8
187	8.31	8.40	_	7.85	7.75	_	7.23	6.79	0.2	6.66	5.83	0.6	6.36	5.35	0.8	6.27	5.05	1.0	5.96	4.90	0.9
188	8.20	8.25		7.67	7.56	_	7.10	6.65	0.2	6.53	5.71	0.6	6.15	5.17	0.8	6.07	4.88	1.0	5.73	4.68	0.8

Table 7. (cont'd)

Segment	Sept 16-30			Oct 1-15			Oct 16-31			Nov 1-15			Nov 16-30			Dec 1-15			Dec 16-31		
157	9.58	9.90	_	9.81	10.07	_	10.40	10.49	_	10.59	10.83	_	10.82	10.79	_	11.41	11.50	_			_
158	9.63	9.91	_	9.99	10.08	_	10.49	10.55	_	10.67	10.85	_	10.80	10.80	_	11.43	11.49	_	11.50	11.54	_
159	9.62	9.85	_	10.01	10.09	_	10.51	10.56	_	10.70	10.89	_	10.83	10.81	_	11.43	11.49	_	11.51	11.58	_
160	9.60	9.79	_	10.01	10.10	_	10.52	10.56	_	10.69	10.90	_	10.82	10.78	_	11.43	11.48	_	11.50	11.59	_
161	9.60	9.77	_	10.02	10.10	_	10.52	10.54	_	10.69	10.88	_	10.83	10.77	_	11.43	11.48	_	11.49	11.57	_
162	9.58	9.74	_	10.04	10.12	_	10.55	10.57	_	10.67	10.83	_	10.82	10.73	_	11.43	11.46	_	11.49	11.57	_
163	9.52	9.72	_	10.01	10.12	_	10.57	10.60	_	10.66	10.80	_	10.81	10.70	_	11.42	11.45	_	11.49	11.56	_
164	9.41	9.66	_	9.91	10.06	_	10.55	10.60	_	10.65	10.79	_	10.80	10.66	_	11.40	11.41	_	11.48	11.54	_
165	9.30	9.59	_	9.77	10.00	_	10.47	10.54	_	10.65	10.79	_	10.81	10.64	_	11.39	11.38	_	11.47	11.53	_
166	9.26	9.47	_	9.70	9.91	_	10.42	10.48	_	10.60	10.70	_	10.78	10.59	_	11.37	11.33	_	11.45	11.49	_
167	9.20	9.36	_	9.63	9.85	_	10.37	10.42	_	10.59	10.67	_	10.79	10.58	_	11.36	11.30	_	11.43	11.48	_
168	9.15	9.23	_	9.56	9.78	_	10.28	10.36	_	10.59	10.64	_	10.80	10.57	_	11.34	11.27	_	11.43	11.47	_
169	9.10	9.13	_	9.49	9.70	_	10.17	10.28	_	10.61	10.66	_	10.79	10.55	_	11.27	11.11	_	11.41	11.43	_
170	9.03	9.01	_	9.40	9.60	_	10.04	10.17	_	10.56	10.63	_	10.79	10.51	_	11.20	10.92	_	11.38	11.37	_
171	8.96	8.86	_	9.31	9.48	_	9.91	10.06	_	10.48	10.54	_	10.75	10.44	_	11.20	10.92	_	11.36	11.31	_
172	8.86	8.65	0.0	9.26	9.40	_	9.82	9.99	_	10.37	10.41	_	10.72	10.40	_	11.29	11.06	_	11.43	11.39	_
173	8.75	8.46	0.1	9.21	9.31	_	9.77	9.91	_	10.29	10.29	_	10.68	10.35	_	11.29	11.03	_	11.46	11.41	_
174	8.56	8.16	0.2	9.17	9.18	_	9.75	9.85	_	10.27	10.24	_	10.66	10.33	_	11.27	10.97	_	11.45	11.38	_
175	8.37	7.92	0.3	9.09	9.06	_	9.73	9.80	_	10.24	10.19	_	10.64	10.32	_	11.26	10.95	_	11.46	11.37	_
176	8.27	7.77	0.3	8.95	8.87	_	9.67	9.72	_	10.16	10.08	_	10.60	10.30	_	11.24	10.90	_	11.50	11.39	_
177	7.79	7.15	0.4	8.66	8.46	0.0	9.69	9.70	_	10.15	10.05	_	10.58	10.29	_	11.21	10.86	_	11.50	11.37	_
178	7.60	6.88	0.5	8.50	8.23	0.1	9.68	9.67	_	10.12	10.00	_	10.55	10.27	_	11.19	10.83	_	11.52	11.37	_
179	7.53	6.75	0.6	8.44	8.13	0.1	9.65	9.63	_	10.08	9.93	_	10.52	10.25	_	11.18	10.80	_	11.58	11.40	_
180	7.36	6.51	0.7	8.30	7.92	0.2	9.62	9.57	_	10.06	9.88	_	10.50	10.23	_	11.17	10.78	_	11.61	11.40	_
181	7.18	6.24	0.7	8.12	7.64	0.3	9.54	9.43	_	10.04	9.84	_	10.48	10.20	_	11.16	10.76	_	11.59	11.35	_
182	7.03	6.04	0.8	7.97	7.47	0.3	9.41	9.25	_	10.04	9.83	_	10.48	10.19	_	11.15	10.74	_	11.56	11.31	_
183	6.66	5.63	0.8	7.59	7.01	0.4	9.28	9.09	_	10.02	9.79	_	10.47	10.17	_	11.15	10.74	_	11.59	11.30	_
184	6.50	5.50	0.8	7.29	6.69	0.4	9.14	8.88	0.1	10.01	9.76	_	10.46	10.16	_	11.14	10.73	_	11.59	11.29	_
185	6.31	5.29	0.8	7.02	6.35	0.5	8.90	8.56	0.1	10.00	9.74	_	10.46	10.16	_	11.13	10.71	_	11.59	11.26	_
186	5.94	4.89	0.8	6.66	5.82	0.6	8.64	8.26	0.2	9.96	9.68	_	10.46	10.15	_	11.11	10.67	_	11.55	11.21	_
187	5.88	4.81	0.9	6.39	5.52	0.7	8.51	8.14	0.2	9.94	9.63	_	10.44	10.12	_	11.09	10.64	_	11.52	11.18	_
188	5.57	4.52	0.8	5.88	5.12	0.6	7.96	7.52	0.2	9.91	9.52	_	10.40	10.08	_	11.07	10.61	_	11.55	11.19	_

APPENDIX C

STUDY PLAN – CARP POPULATION REDUCTION

AVISTA CORPORATION

STUDY PLAN FOR PHOSPHORUS REDUCTION BY CARP POPULATION REDUCTION

A component of Avista's Lake Spokane Dissolved Oxygen Water Quality Attainment Plan

Prepared By:

Avista

Golder Associates

Revised August 16, 2012

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List of Acronyms and Abbreviations

Avista	Avista Corporation
carp	common carp (*Cyprinus carpio*)
CPUE	catch per unit effort
DO TMDL	Dissolved Oxygen Total Maximum Daily Load (report)
DO WQAP	Dissolved Oxygen Water Quality Attainment Plan
Ecology	Washington State Department of Ecology
FERC	Federal Energy Regulatory Commission
g	gram(s)
Golder	Golder Associates Inc.
ISSG	International Union for Conservation of Nature, Invasive Species Specialist Group
kg	kilogram(s)
mm	millimeter(s)
TP	total phosphorus
WDFW	Washington Department of Fish and Wildlife
WPUE	weight per unit effort

1.0 INTRODUCTION

Common carp (*Cyprinus carpio*), referred to in this document as carp, influence phosphorus loading and phosphorus bioavailability in Lake Spokane. Carp transfer phosphorus from lake sediment into the water column through feeding and excretion, and also cause phosphorus loadings during die-offs. In addition, carp can negatively affect native aquatic vegetation, native fauna, and popular warmwater fish like bass and panfish (crappie, perch, and sunfish) that are targeted by anglers. This study plan evaluates the potential for reducing phosphorus releases by reducing the lake's carp population and is a component of the Lake Spokane Dissolved Oxygen Water Quality Attainment Plan (DO WQAP) developed by Avista Corporation (Avista) to address its proportional level of responsibility as determined in the Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load (DO TMDL).

1.1 Purpose

This study plan focuses on carp population reduction as a way to reduce phosphorus loads and concentrations in Lake Spokane.

1.2 Background

This section describes carp biology and common effects on the ecosystem as well as historic Lake Spokane fish diversity and relative abundance.

1.2.1 Carp Biology

Carp are included on the list of "100 of the World's Worst Invasive Alien Species", based on their serious impact on biological diversity and human activities, and their illustration of important issues of biological invasion (Lowe et al. 2000). Carp have extremely flexible life-cycle requirements; they are tolerant of low dissolved oxygen concentrations, warm water, and high turbidity, and their omnivorous feeding habits allow them to shift to available food resources. They are keystone ecosystem engineers that alter aquatic habitats and negatively affect native aquatic flora and fauna (ISSG 2010).

Carp typically live for 13 to 20 years in the wild, and commonly become sexually mature at three to four years of age (ISSG 2010). Adult carp congregate in shallow areas for spawning during spring and summer, typically in water temperatures of 18 to 23°C (Sigler 1958, Swee and McCrimmon 1966, Bardach et al. 1972, and Jester 1974 as cited by Edwards and Towney 1982). Males externally fertilize eggs and females spread the adhesive eggs over macrophytes. Egg production is dependent on the size of the female carp (100,000 to 300,000 eggs per kilogram) with a single female producing as many as 360,000 to 599,000 eggs in one season (ISSG 2010). The eggs hatch quickly (2 days at 25°C), and larval growth is very rapid.

Carp are omnivores; their diet varies seasonally and between locations depending on food availability (ISSG 2010). Food sources also vary by life stage. Fry initially feed on zooplankton, but shift to phytoplankton when zooplankton density is low (Alikunhi 1958, Vaas and Vaas-van Oven 1959, and

Panov et al. 1973 as cited by Edwards and Towney 1982). As they get larger, feeding shifts to littoral fauna and later to benthic macroinvertebrates and other bottom fauna, macrophytes, algae, and detritus (Vaas and Vaas-van Oven 1959 as cited by Edwards and Towney 1982). Adults also feed on benthic macroinvertebrates, detritus and occasionally plant matter.

Adult feeding in sediments consists of sucking up mud from the bottom to a depth of about 12 centimeters (about 5 inches), ejecting it, and selectively consuming items while they are suspended (Chumchal 2002; Driver et al. 2005 and Saikia & Das 2009 as cited in ISSG 2010). This feeding mechanism churns up the sediments, resuspends sediments, and increases turbidity in the water column, and is a form of bioturbation[1]. Bioturbation aids in the decomposition of organic matter within the sediment and can influence water chemistry on a very large scale (Canfield and Farquhar 2009). Phosphorus that was bound in bottom sediments is made more bioavailable through two pathways: 1) carp acting as "nutrient pumps" when they consume nutrient-rich benthic sediments and then excrete those nutrients back into the water column in a form that is available to other organisms (Drenner et al. 1996, as cited by Chumchal 2002) and 2) bioturbation resulting in resuspension of sediments and their associated nutrients. The significance of phosphorus release through these pathways is dependent on both the abundance and distribution of carp within Lake Spokane, how much sediment is consumed and disturbed on an annual basis, and the bioavailability of resuspended phosphorus once sediments are disturbed.

As described above, when carp are alive, they can increase phosphorous loading via excretion and bioturbation. Dead carp carcasses are a second mechanism for phosphorous release. As carp feed and grow they accumulate phosphorus from their food sources into their bodies. Following their death, biological processes break down their carcasses and release phosphorus into the water column.

Reduction in zooplankton caused by adult and/or juvenile feeding by carp could lead to less zooplankton predation on phytoplankton (also referred to as algae) and stimulate algal blooms (Pinto et al. 2005). Adult feeding activity can also make waterbodies unattractive due to high turbidity and can render the water unsuitable for swimming or for drinking by livestock (NIWA 2003 as cited in ISSG 2010).

1.2.2 Lake Spokane Historical Information

Lake Spokane is managed by Washington Department of Fish and Wildlife (WDFW) as a mixed species fishery. Between 1974 and 2001, WDFW stocked Lake Spokane with over 1.6 million trout (Osborne et al 2003). Few fisheries investigations have been conducted on Lake Spokane in the last 30 years.

On June 18-22, 2001, WDFW conducted a standardized warmwater survey of Lake Spokane, which included use of boat electrofishers, gill nets, and fyke nets for inshore habitat and gill nets for offshore habitat. Sampling locations were randomly selected in seven sections of Lake Spokane (Figure 1). Each

[1] Bioturbation is defined as the stirring or mixing of sediment or soil by organisms, especially burrowing, boring or by ingestion (The American Heritage Science Dictionary 2002).

fish was identified to species and weighed, and the total length was measured. These analyses did not include fish less than one year old (i.e., young-of-the-year).

Table 1 provides the overall inshore and offshore fish composition and the range of total lengths of the fish captured during the 2001 survey. Carp were the second most prevalent species for inshore habitat, based on weight. Excluding young-of-year, total lengths of carp ranged from 77 to 975 millimeters (3 to 38 inches). Chris Donley (2011) reported the mean carp weight as 4.2 kilograms (kg) or 9.24 pounds. Donley (2011) also reported that carp densities were greater in the shallower areas in the lake's upper end and embayments.

Table 1: Lake Spokane Fish Species Composition by Percentage Weight and Length and Range of Total Lengths Collected with Inshore and Offshore Sampling Gear

Fish Species	Native (Yes/No)	Inshore			Offshore		
		% by Weight	% by Number	Total Length	% by Weight	% by Number	Total Length
Largescale Sucker *Catostomus macrocheilus*	Yes	49.5	32.4	72-570	8.1	2.1	435-513
Common Carp *Cyprinus carpio*	No	13.7	1.6	77-975	---	---	---
Northern Pikeminnow *Mylocheliyus caurinus*	Yes	9.7	13.5	54-612	63.7	49.3	170-530
Tench *Tinca tinca*	No	9.3	4.0	398-518	---	---	---
Yellow Perch *Perca flavescens*	No	5.2	23.4	87-335	17.0	39.4	102-279
Largemouth Bass *Micropterus salmoides*	No	4.9	2.3	220-550	---	---	---
Smallmouth Bass *Micropterus dolomieui*	No	2.5	8.4	91-505	---	---	---
Black Crappie *Pomoxis nigromaculatus*	No	1.6	5.3	118-325	0.5	0.7	206-220
Brown Bullhead *Ictalurus nebulosus*	No	1.4	2.1	131-338	1.1	0.7	284-316
Yellow Bullhead *Ictalurus natalis*	No	0.7	2.0	110-318	---	---	---
Mountain Whitefish *Prosopium williamsoni*	Yes	0.4	1.3	80-355	2.5	2.5	315-363
Bridgelip Sucker *Catostomus columbianus*	Yes	0.3	0.7	86-502	---	---	---
Channel Catfish *Ictalurus punctatus*	No	0.2	0.0	725-725	---	---	---
Brown Trout *Salmo trutta*	No	0.2	0.3	90-584	2.7	1.8	255-397

Fish Species	Native (Yes/No)	Inshore			Offshore		
		% by Weight	% by Number	Total Length	% by Weight	% by Number	Total Length
Chiselmouth *Acrohceilus alutaceus*	Yes	0.2	1.8	129-300	0.1	0.4	220
Longnose Sucker *Catostomus catostomus*	Yes	0.1	0.5	130-278	---	---	---
Pumpkinseed *Lepomis gibbosus*	No	0.0	0.2	53-160	---	---	---
Rainbow Trout *Oncorhynchus mykiss*	No	0.0	0.0	112-310	0.5	0.4	310-310
Sculpin *Cottus spp.*	Yes	0.0	0.1	78-91	---	---	---
Kokanee *Oncorhynchus nerka*	No	---	---	---	3.1	2.5	224-339
Chinook salmon *Oncorhynchus tshawytscha*	No	---	---	---	0.6	0.4	323-220

Notes: Analysis does not include young-of-year fish; total lengths reported as range in millimeters (mm); --- indicates no values reported.
Source: Osborne et al. 2003

In July 2010, Lake Spokane experienced a carp die-off primarily of large (approximately two-foot-long) carp that had been spawning in the shallow aquatic weed beds along the upper and middle portion of the lake (Fry 2010). Shoreline residents estimated more than a couple of hundred dead carp. WDFW and the Washington Department of Ecology (Ecology) indicated the fish kill was related to a carp-specific virus brought on by either pre-or post-spawning stress combined with the relatively rapid increasing water temperatures experienced during early summer of 2010 (Fry 2010).

Donley (2011) developed a rough proportional estimate of 125,000 carp in Lake Spokane. This estimate was based on a comparison of WDFW's standardized warmwater survey catch per unit effort using boat electrofishing conducted in Lake Spokane in 2001 and Sprague Lake in 2003, along with a rough population estimate for Sprague Lake in 2007 when a rotenone treatment killed an estimated 500,000 carp in Sprague Lake. At a mean weight of 4.2 kg per carp, this is approximately 525,000 kg (579 tons) in Lake Spokane. Donley (2011) estimated that the majority of carp inhabit approximately 600 to 800 hectacres (approximately 1,483 to 1,977 acres) in the upper portion of Lake Spokane. Using this population estimate, 525,000 kg of carp in 800 surface hectacres yields a density of 656 kg of carp/hectare (265 kg/acre). Research has documented that carp densities of greater than 100 kg/hectare (40 kg/acre) in shallow lakes can adversely affect water quality (Bajer et al. 2009).

2.0 POTENTIAL PHOSPHORUS LOAD REDUCTION ESTIMATE

Carp influence phosphorus loading and phosphorus bioavailability through three primary pathways:

- Carp feeding mechanisms churn up sediments resulting in sediment resuspension and increased turbidity in the water column referred to as bioturbation, which can influence water chemistry on a very large scale (Canfield and Farquhar 2009).
- Carp act as "nutrient pumps" when they consume nutrient-rich benthic sediments and then excrete the previously sediment-bound nutrients into the water column in a form that is available to other organisms (Drenner et al. 1996 as cited by Chumchal 2002).
- Carp feeding and growth accumulates phosphorus from their food sources into their bodies. Following their death, biological processes break down their carcasses and release phosphorus into the water column.

2.1 Phosphorus Effects of Carp Feeding and Excreting

Reducing the carp population would reduce carp “nutrient-pump” and bioturbation effects, although available information on this topic is limited and therefore estimating the associated phosphorous removal is difficult. A recent study in Minnesota (Scott Watershed Management Organization 2011) evaluated the contribution of common carp and aquatic plants to water quality impairments in Cedar Lake. Data from years 2006 through 2008 were used to calibrate water quality model and determine the relative proportion of internal phosphorous loads from aquatic plants and carp. The calibrated model indicated that about 40% of the internal phosphorous load to Cedar Lake originated from carp. This modeling indicated that carp feeding activity (bioturbation and nutrient pumping) over an estimated habitat area of 1,300 acres (equal to about 25% of Lake Spokane’s total area) was equivalent to an internal phosphorous loading of approximately 4,608 kg/year. A detailed evaluation of total phosphorus (TP) loads from “nutrient pump” excretions and carp-caused bioturbation has not yet been conducted, although these loads may be substantial. Section 3.0 describes how this will be addressed during the Phase I Analysis.

2.2 Phosphorus Accumulation in Live Carp

The extent of accumulation of TP in live carp tissue was estimated using literature values for phosphorus concentrations in carp dry matter and the ratio of dry matter to wet weight along with the average carp weight (4.2 kg) for Lake Spokane (Table 2). A study of characteristics of carp fed different diets (Nwanna et al. 2010) provides information for whole-body phosphorus contents. For each kg of wet weight of carp, the mass of TP ranged from 12.15 g TP for carp fed a diet without phosphorus supplementation to 20.01 g TP for carp fed a diet supplemented with 20 g TP per kg of feed. Applying these rates to WDFW’s 2001 Lake Spokane warmwater fisheries survey, the average carp size of 4.2 kg indicates that on average Lake Spokane carp contain between 51 g (0.051 kg) and 84 g (0.084 kg) of TP. Further application of these rates with Donley’s (2011) rough estimate of Lake Spokane carp numbers and biomass indicates approximately 6,379 to 10,506 kg TP may be accumulated in Lake Spokane carp (Table 3). Assuming an average annual die-off and removal of 25 percent of the carp in the lake, the current TP load from carp carcasses is approximately 1,600 to 2,600 kg/year.

Table 2: Estimated Average Carp Biomass and Phosphorus Content

Description	Non-Supplemented Diet [1]	Phosphorus Supplemented Diet [2]	Source
Ratio of Carp Dry Matter : Carp Wet Weight	0.300	0.264	Nwanna et al. 2010
g TP / kg Carp Dry Matter	40.5	75.8	Nwanna et al. 2010
g TP / kg Carp Wet Weight	12.15	20.01	calculated
Lake Spokane Average Carp Mass[3] (kg)	4.2	4.2	Donley 2011
Lake Spokane Average g TP / Carp	51.	84.	calculated
Lake Spokane Average kg TP / Carp	0.051	0.084	calculated

Notes:
[1] Carp in Lake Spokane with uncontrolled diet.
[2] Carp with diet supplemented with 20 g TP / kg.
[3] Source: Donley (2011).

Table 3: Rough Estimates of Lake Spokane Carp Biomass and Total Phosphorus Content

Description	Non-Supplemented Diet[1]	Phosphorus Supplemented Diet[2]	Source
Estimated Number of Carp in Lake Spokane	125,000		Donley 2011
Lake Spokane Average kg TP / Carp	0.051	0.084	calculated (See Table 2)
TP Content of Carp in Lake Spokane (kg TP)	6,375	10,500	calculated
TP Content for 25% Lake Spokane Carp Harvest (kg TP)	1,594	2,625	calculated

Notes:
[1] Carp in Lake Spokane with uncontrolled diet.
[2] Carp with diet supplemented with 20 g TP / kg.

2.3 Phosphorus Releases Upon Carp Die-Off Events

As discussed above, a Lake Spokane carp die-off and clean-up effort occurred in July 2010. We know these types of events occur naturally and as a result we have no control or management over them. However, if a mass die-off of Lake Spokane carp occurs during the implementation of the Lake Spokane Dissolved Oxygen Water Quality Attainment Plan (DO WQAP), Avista will coordinate an effort to remove the carp carcasses in order to minimize an associated phosphorus release into Lake Spokane. The amount of TP removed will be calculated using the ratios or a refinement of the ratios presented in Table 2.

3.0 NUTRIENT REDUCTION EVALUATION

Avista will pursue a series of phased analyses with following overall goals: reduce uncertainty associated with the current estimate of TP loading from carp (both within carcasses and from excretion/bioturbation); evaluate the feasibility of removing carp from Lake Spokane[2]; and identify monitoring and reporting needs to demonstrate the extent of phosphorus reduction from carp management. The phased analyses are described below.

3.1 Phase I Analysis

Avista will complete a Phase I analysis to obtain a better understanding of carp abundance, biological measures, seasonal behavior, and whole-body phosphorus concentrations as described in detail below. Given the results of WDFW's 2001 warmwater fisheries survey (Osborne et al 2003; Donley 2011), which suggest carp use shallow water and primarily concentrate in the upper end of the lake, the study area will consist of Lake Spokane inshore habitat generally less than 30 feet deep.

3.1.1 Phase I Components

The Phase I analysis will include at least the following five items, the first three of which were recommended by Donley (2011).

1. **Quantify Carp Abundance**. A mark and recapture study will be completed to estimate the number of carp greater than 330 mm (12 inches) long using Lake Spokane's inshore habitat when carp distribution is more widespread (after spawning, but before over-wintering). This study will be conducted in the summer of the first full year following agency approval of the DO WQAP.

2. **Investigate Basic Carp Biological Measures**. A study consistent with WDFW's Warmwater Survey protocol will be completed to determine basic biological measures, including catch per unit effort (CPUE); weight per unit effort (WPUE); distribution of length, weight, age class, condition factor, growth, and size at maturity; along with an estimate of natural mortality. This study will be conducted in the summer of the first full year following agency approval of the DO WQAP.

3. **Identify Carp Seasonal Behavior (movement and congregation).** A telemetry study will be developed to gain an understanding of macro-scale seasonal carp movements. This study may start before the mark-recapture study in order to gain information for the carp spawning season, which occurs in early summer. Results of this study will indicate where and when carp congregate, and will be used to evaluate the feasibility of specific carp capture and removal technologies. This study will be conducted in the first and second full year following agency approval of the DO WQAP.

4. **Test Whole-Body Carp Phosphorus Concentration.** Carp will be collected and whole-body homogenized samples will be analyzed to document phosphorus content (g TP/kg carp wet weight). This ratio will be used to translate carp removal to TP load removed. This study will be conducted in the summer of the first full year following agency approval of the DO WQAP.

[2] This analysis will focus on removing, not eliminating, carp from Lake Spokane.

5. **Estimate Loads from Carp Excretions and Bioturbation.** A literature review will be used to determine a range of TP loadings from carp nutrient-pump excretions and bioturbation, and factors found to control these. Results deemed representative of Lake Spokane conditions will be used in combination with Lake Spokane carp abundance, biological measures, and seasonal behavior to estimate TP loads caused by carp nutrient-pump excretions and bioturbation.

3.1.2 Phase I Quality Assurance Project Plan

The methods and procedures employed during Phase I monitoring and analysis will be managed for quality control by implementing commonly-accepted procedures for capture, measurement, and analysis of fish-tissue samples. As part of this process, Avista will work with WDFW and Ecology and obtain all required permits before sampling fish.

3.1.3 Phase I Coordination and Reporting

Avista will summarize the findings in the WQAP annual report submitted to Ecology on February 1 for review and approval.

3.2 Phase II Analysis

For Phase II, Avista will evaluate the feasibility of carp harvesting technologies using information reasonably available, including the results of the Phase I analysis. As recommended by Donley (2011), harvesting technologies evaluated will include, but are not limited to, seining, gill netting, using rotenone in cove(s), baiting and trapping, and archery. The recent interest in obtaining carp for local and global markets and development of a carp processing plant in Minnesota (by K&C Fisheries) may provide additional insight into carp harvesting techniques and potential markets. Avista will explore these opportunities. This evaluation will include the potential for carp harvest by each method, technical and economical practicality for each removal method, and the expected reduction in phosphorus mass.

Avista will summarize the Phase II analysis in the WQAP annual report submitted to Ecology on February 1. The report will include the results of the evaluation and recommendations for a carp removal method(s) to implement, if reasonable and feasible. The Phase II findings and recommendations will be presented to Ecology for discussion of which method, if any, should be implemented under the WQAP. Upon receiving approval from Ecology, Avista will begin implementing the selected reasonable and feasible carp removal method(s).

Avista will work with WDFW during the analysis of this potential mitigation measure, including methods of capturing carp, and will obtain all required permits prior to implementation.

4.0 SCHEDULE

The schedule for the Phase I and II analyses is synchronized with other milestones and assessments for the DO WQAP. Figure 2 displays the schedule for preparing the Phase I and II Analyses, annual reporting, and the potential implementation schedule. Results of the Phase I and II analyses will be used to determine the implementation actions for years after 2016. Avista will amend the implementation schedule accordingly if it is deemed necessary.

The implementation schedule, as presented in Figure 2, incorporates several benchmarks identifying key interactions and decision points important in evaluating whether carp population reduction is a reasonable and feasible measure to implement under this DO WQAP. These benchmarks are presented in Table 4.

Table 4: Carp Population Reduction Benchmarks

Timeframe	Benchmark
Spring 2012	Submit DO WQAP to Ecology
Summer 2012	Submit DO WQAP to FERC
Fall 2012	Receive FERC approval to begin implementation
Winter 2014 & Winter 2015	Summarize Phase I Analysis findings in Annual Summary Report and submit to Ecology for review and approval
Winter 2015	Summarize Phase II Analysis findings in Annual Summary Report and submit to Ecology for review and approval
Winter 2015	Work with and discuss findings with Ecology
Spring 2015	Determine with Ecology, whether carp population reduction is reasonable and feasible to implement in Lake Spokane
Begin Summer 2015[1]	If determined reasonable and feasible, implement measure; if not, revise implementation strategy, monitoring, and schedule

Notes:
1. Adaptive management will be used to determine whether it is reasonable and feasible to continue implementation and if it is appropriate to revise the schedule.

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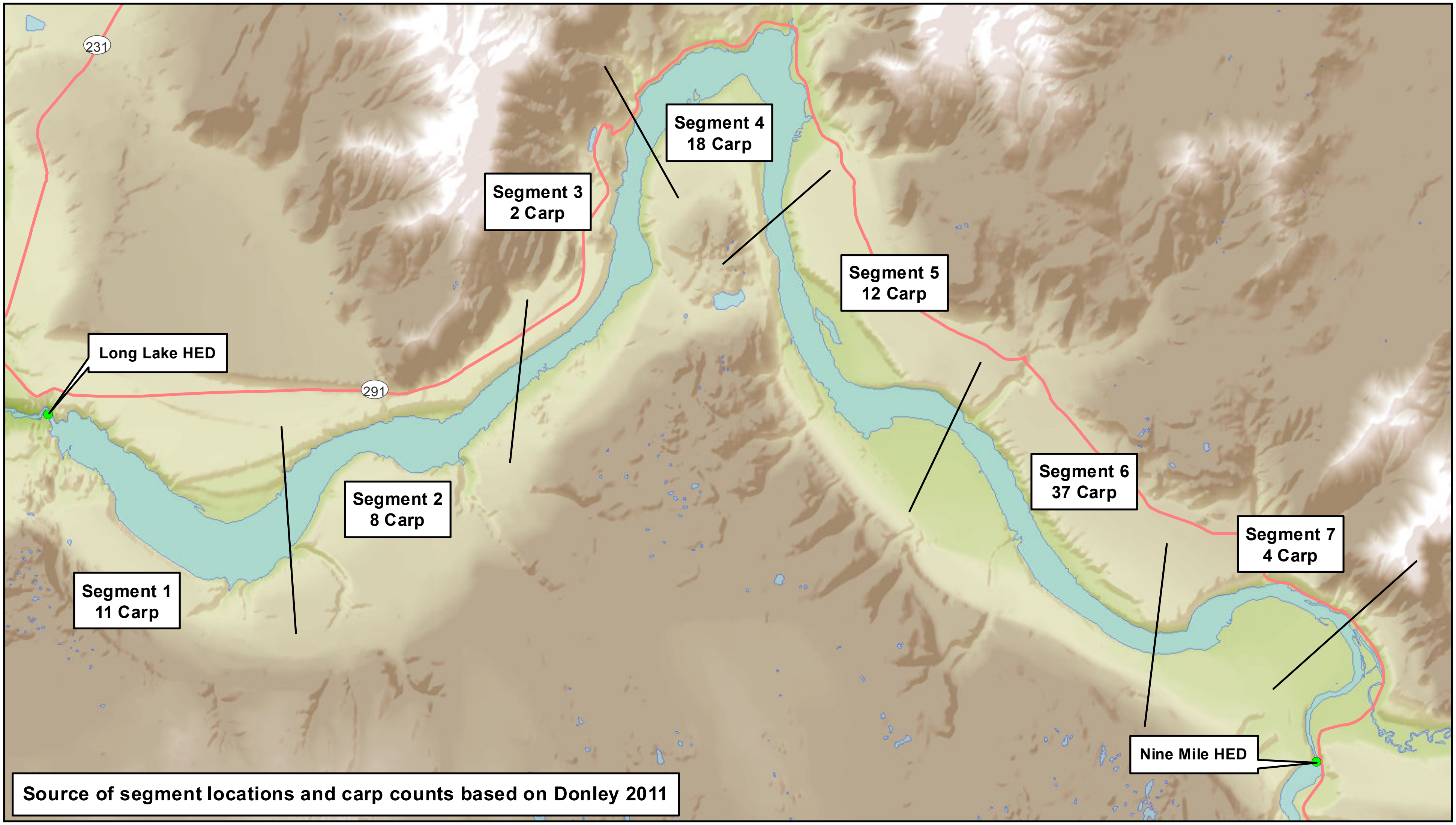
FIGURES



LEGEND

Water Body
Major River
Major Highway

0 2
Scale in Miles

Map Projection:
NAD 1983 HARN StatePlane Washington
South FIPS 4602 Feet

Source:
Segment Locations and Carp Counts Based on Donley 2011,
NHD (Waterbody, Major River, Dam),
ESRI (Major Highways, Topo Map)

N

This figure was originally produced in color. Reproduction in black and white may result in a loss of information.

FIGURE 1

MAP OF LAKE SPOKANE DEPICTING PRIMARY 2001 FISH SAMPLING SECTIONS

AVISTA LAKE SPOKANE DO WQAP APPENDIX C

Path: S:\GIS\Projects\10393119_AvistaAquaticWeeds\MXD\LakeSpokaneCarpSampling_8x11.mxdGLEHMAN

Golder Associates

						Year 1				Year 2				Year 3				Year 4			
Activity		2012				2013				2014				2015				2016			
		Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall
Report Writing	Submit DO WQAP to Ecology*		x																		
	Submit DO WQAP to FERC*			x																	
	Receive FERC approval to begin implementation*				x																
Phase I Analysis	Quantify carp abundance							x													
	Investigate biological measures							x													
	Identify seasonal behavior							x	x	x	x	x									
	Test whole-body phosphorus concentration							x													
	Estimate loads from carp excretions and biotrubation									x											
	Summarize findings in Annual Summary Report to Ecology*									x				x							
Phase II Analysis	Evaluate carp harvesting technologies									x	x	x	x								
	Select carp removal method(s)												x	x							
	Summarize findings in Annual Summary Report to Ecology*													x							
	Consult and discuss findings with Ecology*													x							
	Determine with Ecology whether carp population reduction is reasonable and feasible to implement in Lake Spokane*														x						
Implement?	If determined reasonable and feasible, implement measure; if not, revise implementation strategy, monitoring, and schedule*															x	x	x	x	x	x
	If implemented, measure nutrient reduction															x	x			x	x

Notes:
*Benchmarks

FIGURE 2
CARP POPULATION REDUCTION PLANNING AND IMPLEMENTATION SCHEDULE
AVISTA LAKE SPOKANE DO WQAP APPENDIX C

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Golder Associates

APPENDIX D

STUDY PLAN – AQUATIC WEED MANAGEMENT

AVISTA CORPORATION

STUDY PLAN FOR PHOSPHORUS REDUCTION BY AQUATIC WEED MANAGEMENT

A component of Avista's Lake Spokane
Dissolved Oxygen Water Quality Attainment Plan

Prepared By:

Revised August 16, 2012

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List of Acronyms and Abbreviations

Avista	Avista Corporation
BOD	biochemical oxygen demand
DO	dissolved oxygen
DO TMDL	Dissolved Oxygen Total Maximum Daily Load (report)
DO WQAP	Dissolved Oxygen Water Quality Attainment Plan
Ecology	Washington State Department of Ecology
FERC	Federal Energy Regulatory Commission
g	gram(s)
Golder	Golder Associates Inc.
IAPMP	Lake Spokane Integrated Aquatic Plant Management Plan
IWPCC	Inland Water Pest Control and Consulting
kg	kilogram(s)
m^2	square meter(s)
Program	Spokane and Nine Mile Reservoir Aquatic Weed Management Program
TP	total phosphorus
WDFW	Washington Department of Fish and Wildlife

1.0 INTRODUCTION

Aquatic plants influence phosphorus loading and phosphorus bioavailability in Lake Spokane, which is impounded by Long Lake Hydroelectric Development. Exotic species can negatively affect native aquatic vegetation, native fauna, and warmwater fish popular with anglers. This study plan is a component of the Lake Spokane Dissolved Oxygen Water Quality Attainment Plan (DO WQAP) developed by Avista Corporation (Avista) to address its proportional level of responsibility as determined in the Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load (DO TMDL).

This study plan evaluates the potential for aquatic plant management to reduce phosphorus loadings from decomposing aquatic plants. The plan also describes the specific analyses that would be used to monitor the effectiveness of phosphorus reduction, should plant management be determined to be a reasonable and feasible method of reducing the lake's phosphorus loading. In addition to phosphorus reductions that are the focus of this plan, other associated benefits may include better control of invasive aquatic weeds, increased biodiversity of both aquatic plants and biota, and improvements to recreation and aesthetics.

1.1 Purpose

This study plan focuses on harvesting aquatic plants to improve water quality by reducing phosphorus loads and concentrations in Lake Spokane.

1.2 Background

This section describes aquatic plant biology and common effects on the ecosystem as well as the historic Lake Spokane aquatic plant diversity and relative abundance.

1.2.1 Aquatic Plant Biology

Growth and establishment of aquatic plants is dependent on numerous factors, including availability of light, sediments for rooting, and an appropriate balance of nutrients. Availability of light limits rooting aquatic plants to the littoral zone along the margin of the lake, and floating plants to the littoral zone and limnetic zone that extends across deep areas of the lake. The major nutrients necessary for aquatic plant growth are phosphorus, nitrogen, and carbon. When light is available, aquatic plants generally take up nutrients in the proportion that their cells require. Excess nutrients cannot be used by the plants for growth, although they may be stored for later use. The nutrient in shortest supply relative to the plants' needs may limit the production of the plants. In Lake Spokane, as is common for freshwater systems, phosphorus is identified as the limiting nutrient for aquatic plant growth (Ecology 2010a) and is therefore used as a management tool in the DO TMDL (Ecology 2010b).

Aquatic macrophytes take in nutrients from both sediments and the water column during their growth period. The proportion of nutrients provided from each of these sources varies by species, although sediments generally supply a substantial proportion of macrophyte nutrient demands through root uptake (Cooke et al. 2005). For instance, several studies have demonstrated that Eurasian watermilfoil

(*Myriophyllum spicatum)* generally assimilates phosphorus from the sediments through their roots rather than from the water column by their shoots (Smith and Adams 1986; Madsen 1998). Smith and Adams (1986) reported that Eurasian watermilfoil (milfoil) "is a potentially important vector in the movement of [phosphorus] from the sediments to the water."

Under phosphorus-limited conditions as in Lake Spokane, dissolved phosphorus, which is readily available for uptake by plants, is usually found only in low concentrations during the growing season (MDEP and MDCR 2004). Therefore, most of the phosphorus is either adsorbed to particles such as fine soil or clay or in living or dead plant or animal cells. Death and decay of organisms begin the process of releasing the phosphorus in dissolved form where it will almost instantly be taken up by other organisms (MDEP and MDCR 2004).

Aquatic plant growth contributes to diurnal dissolved oxygen (DO) fluctuations as the plants produce oxygen through photosynthesis during daylight and consume oxygen through respiration during the night. Aquatic plants also contribute to seasonal fluctuations in DO. During plant die-offs and subsequent decomposition in late summer and fall (the senescence period), DO in the water column and in detritus is used to breakdown the plants' organic material. During this decay, aquatic plants also release nutrients, including phosphorus, into the water. Controlling the growth of aquatic weeds and other plants along with removing them before they die can improve DO levels in the lake by reducing the biochemical oxygen demand (BOD) during decay and reducing the diurnal fluctuations in DO during growth. Removing aquatic plants before senescence also reduces the amount of phosphorus in the lake available for primary production such as algae growth.

1.2.2 Lake Spokane Aquatic Weeds

Lake Spokane was surveyed for aquatic weeds in 2000, and again in 2007. The survey conducted in 2000 (TetraTech 2001) documented 11 aquatic plants, five of which were noxious weeds. Mapping in 2000 indicated a total of 715 acres of introduced aquatic weeds, and mapping in 2007 showed 634 acres of introduced aquatic weeds (Table 1). The same aquatic plant species were documented in the 2000 and 2007 surveys, along with one additional native aquatic plant noted in 2007 (tape grass, *Vallisneria americana*). Figure 1 presents the distribution of noxious aquatic weeds in Lake Spokane.

Table 1: Species of Aquatic Plants Reported Present in Lake Spokane[1]

Common Name	Scientific Name	Noxious Weed Status[2]	2001 Survey Acreage	2007 Survey Acreage
Eurasian watermilfoil	*Myriophyllum spicatum*	Class B	230	242
White lily	*Nymphaea odorata*	Class C	15	--
Yellow floating heart	*Nymphoides peltata*	Class B	470	392[3]
Pondweeds, waterweed and other natives	-	-	380	308
Approximate area of aquatic noxious weeds			715	634
Total acres of aquatic vegetation			1,095	942

Notes:
1. In 2010, Washington State Department of Ecology (Ecology) identified flowering rush (*Butomus umbellatus*) in Lake Spokane, although an overall aquatic plant survey was not conducted.
2. Based on 2011 Washington State Noxious Weed List.
3. Area for yellow floating heart in 2007 includes areas of white lily.
Sources: TetraTech 2001, AquaTechnex 2007a.

Aquatic weeds within Lake Spokane exhibit a consistent growth pattern. Native and introduced pondweeds (*Potamogeton spp.*) such as curly-leaf pondweed (*Potamogeton crispus*) form beds where water is relatively shallow (less than 6 feet deep). In deeper water adjacent to these beds, milfoil is the dominant aquatic plant. These two bands of aquatic vegetation are present along roughly 40 percent of the shoreline. Another 30 percent of the shoreline is occupied by either native and introduced pondweeds, or milfoil. In these cases, milfoil appears to have colonized littoral habitats where shorelines drop off rapidly, and pondweeds are found where shallows are more extensive. Large beds of yellow floating heart and white lily are established in shallow bays and along shorelines with a slow current (AquaTechnex 2007a, 2007b; TetraTech 2001).

In addition, in late summer of 2010, flowering rush (*Butomus umbellatus*) was found in Lake Spokane. A surface survey conducted by the Washington State Department of Ecology (Ecology) identified and mapped approximately 100 locations with flowering rush in Lake Spokane (Figure 2), and two patches of flowering rush downstream of Long Lake Dam, in the Little Falls Reservoir (Avista 2012).

1.2.3 Aquatic Plant Management in Lake Spokane

Public concern over increasing infestations of milfoil and other aquatic weeds prompted development of the Lake Spokane Integrated Aquatic Plant Management Plan (IAPMP) in 2001 (TetraTech 2001) through a grant from Ecology. While a lack of available funding limited implementing actions recommended in the IAPMP, lakeshore residents have contracted with Inland Water Pest Control and Consulting (IWPCC) for localized aquatic herbicide treatment since 2007 (Wimpy 2010). According to IWPCC, since 2007 these treatments have totaled 130 acres and were applied to submerged and floating plants in the littoral region within the upper portion of Lake Spokane. These treatments primarily targeted areas of boater access from the shoreline into the main channel of the lake.

In 2010, Avista prepared the Lake Spokane and Nine Mile Reservoir Aquatic Weed Management Program (Program) (Avista 2010) as part of implementing the Spokane River Hydroelectric Project's new license issued by the Federal Energy Regulatory Commission on June 18, 2009 (FERC 2009). The goals of this Program are to (1) reduce the cover of invasive aquatic weeds at public and community boat access points, (2) maintain a moderate level of ongoing control of aquatic weeds in areas from 0 to 14 feet in depth through the use of weed-control reservoir drawdowns, and (3) support weed control and facilitate coordination among the entities involved in aquatic weed control on Lake Spokane. Avista coordinates these activities with entities currently involved in aquatic weed management (i.e., home owner associations, local conservation districts and weed control boards, Ecology, the Washington Department of Fish and Game [WDFW], and the Washington State Department of Natural Resources) through the development of an annual prioritized list of site-specific aquatic weed control and monitoring tasks.

Implementation of the Program began during the summer of 2011. Avista completed aquatic weed herbicide treatments on approximately 15 acres of Lake Spokane, including one public boat access location (Nine Mile Recreation Area and its boater access lane) and at five community boat access locations (Lake Ridge Park, Suncrest Park, West Shore, Willow Bay, and Lakeshore Estates), as shown in Figure 2. The purpose of these herbicide treatments was to reduce aquatic weed cover at recreation access points on the lake and as such targeted both noxious and invasive aquatic weeds. Monitoring results of pre- and post-treatment surveys indicate an overall efficacy of 85 percent reduction in weed cover for the 15 acres (Avista 2012).

Also in the summer of 2011, Avista, in cooperation with Ecology, completed a treatment of flowering rush in the lake. The treatment measures consisted of covering one patch with a bottom barrier and hand pulling approximately 200 individual flowering rush plants, via diver suction, from 28 locations.

Avista completed a Winter Drawdown of Lake Spokane during the 2011/2012 winter. The drawdown spanned January 20 through March 16 (57 days), and lowered the lake level 10.4 to 13.9 feet below the full pool elevation of 1,536 feet. The goal of the Winter Drawdown is to reduce aquatic weed populations along the margin of the lake by freezing the plants' root systems. The success of the drawdown will be evaluated by comparing pre- and post-drawdown monitoring results, which consist of water level, air temperature, soil temperature, and snow cover during drawdown; and aerial surveys and mapping for weeds in the exposed areas. The post-drawdown monitoring will take place during the peak of the growing season, most likely July or August of 2012, and Avista anticipates completing an aerial and mapping survey of the lake in either 2012 or 2013. In accordance with its Lake Spokane and Nine Mile Aquatic Weed Management Program, Avista will complete a Winter Drawdown at least once per four-year period. The frequency and duration of drawdowns may be modified (in consultation with Ecology and WDFW), based on the results of monitoring the effectiveness of drawdown at controlling aquatic weeds.

2.0 POTENTIAL PHOSPHORUS LOAD REDUCTION ESTIMATE

Aquatic plants influence Lake Spokane phosphorus loads in two primary ways:

1. Phosphorus accumulation in aquatic plant biomass
2. Phosphorus pulse releases upon seasonal senescence (the period when plants naturally die and decay)

2.1 Phosphorus Accumulation in Live Plants

Species-specific low-to-high ranges of biomass and total phosphorus (TP) content per acre are provided in Table 2. Information was compiled with a focus on exotic weeds including milfoil, yellow floating heart, white lily, and curly-leaf pondweed. These values were subsequently applied to the areas with aquatic weeds in Lake Spokane to estimate the relative TP content (Table 2).

Table 2: Aquatic Weed Biomass and Total Phosphorus (TP) Content[1]

Species	Biomass Weight (kg/acre)[2]		TP Content by Dry Weight (%)[3]	TP Content per Acre (kg TP/acre)	
	Low	High		Low	High
Eurasian watermilfoil	202	1,619	0.21	0.42	3.40
Yellow floating heart			0.684	1.38	11.07
White lily			0.27	0.55	4.37
Curly-leaf pondweed			0.24	0.48	3.89

Notes:
1. Although this analysis does not include flowering rush, Avista may elect to pursue evaluating control of flowering rush and associated phosphorus credits in the future.
2. Low and high biomass harvest rates of 50 g/m^2 (202 kg/acre) and 400 g/m^2 (1,619 kg/acre) were used for submergent species based on Cooke et al. (2005).
3. TP content by dry weight for milfoil from Owens et al. (2007); for yellow floating heart from Marion and Paillisson (2003); for white lily from Cooke et al. (2005); and or curly-leaf pondweed from Owens et al. (2007).

2.2 Phosphorus Pulse Releases Upon Seasonal Senescence

Aquatic weeds release nutrients, which they have accumulated throughout the growing season, during the senescence period. This annual introduction of nutrients through decomposition is considered a cause of depressed DO levels during summer and fall months. The release of nutrients also provides a source of nutrients for algae production.

Reducing this pulse of phosphorus loadings could be accomplished by removing aquatic weeds before senescence or preventing or reducing their growth and subsequent nutrient release. This analysis focuses on potential phosphorus load reductions that could be accomplished through harvesting and biomass removal of macrophytes in the late summer to fall, prior to their senescence. Although measures to control aquatic plant growth (e.g., bottom barriers) have not been included in this analysis, they also may result in substantial phosphorus load reductions which should be credited to Avista. Estimates of potential phosphorus load reductions were developed based on a recent aquatic plant survey (AquaTechnex 2007a, 2007b), TP content of the invasive plant species, and harvesting efficiencies

(Table 3). These estimates assume an equal distribution of yellow floating heart and white lily. Harvesting aquatic plants is a technique typically employed during the growing season when submersed vegetation has grown to or near the water surface. Cooke et al. (2005) reports that while maximum harvesting efficiency can reach 900 grams (g) of dry weight/m^2 per year, the likely range for the northern United States is between 50 to 400 g of dry weight/m^2 per year. Therefore, we used 50 and 400 g/m^2 (202 and 1,619 kg/acre) as minimum and maximum harvest rates in estimating the potential phosphorus load reductions in Table 3.

Table 3: Total Phosphorus Loading and Acres of Aquatic Plants in Lake Spokane

Species	Loading Factor	Area (acres)	Estimated Lake Spokane Loading (kg/yr)
Eurasian Watermilfoil [1,2,3]	0.42 - 3.4 kg/acre	242.2	102 – 823
Yellow Floating Heart [1,2,4]	1.38 - 11.07 kg/acre	196.2	271 – 2,172
Water Lily [1,2,5]	0.55 - 4.37 kg/acre	196.2	108 - 857
Total	**--**	**634.7**	**481 – 3,852**

Notes:
1. AquaTechnex (2007) with assumption that yellow floating heart and water lily distributions were equal.
2. Low and high biomass harvest rates of 50 g/m^2 and 400 g/m^2 were used for submergent species based on Cooke et al. (2005).
3. Total phosphorus content of 0.21% of the biomass for Eurasian Milfoil based on Owens et al. (2007).
4. Total phosphorus content of 0.684% of the biomass for Yellow Floating Heart based on Marion and Paillisson (2003).
5. Total phosphorus content of 0.27% of the biomass for Water Lily based on Cooke et al. (2005), assuming average for various macrophytes.

3.0 PHASE I ANALYSIS

Avista will complete an analysis to determine whether aquatic weed harvesting is a reasonable and feasible control method to reduce phosphorus in Lake Spokane. As described above, harvesting aquatic plants is typically done before senescence, with maximum harvesting efficiency reaching 900 grams (g) of dry weight/m2 per year and varying substantially (Cooke et al. 2005). There are a number of variables that Avista will evaluate including the following:

- Availability and operational requirements of an appropriate harvester
- Efficiency of harvester, given Lake Spokane's boat access limitations
- Effective harvest depth of yellow floating heart and water lily
- Impacts to fish and aquatic invertebrates
- Locations and limitations for disposal of harvested weeds
- Potential for nutrient pumping

If mechanical harvesting is determined to be reasonable and feasible, Avista anticipates targeting large acreages of yellow floating heart and water lily during the initial harvesting activities. In our review of loading factors, yellow floating heart was identified as having the highest phosphorus loading factor (1.38 to 11.07 kg TP/acre). Mechanical harvesting will not target milfoil-dominated areas, because milfoil spreads by fragmentation (Ecology 2011) and mechanical harvesting would likely cause further spread of milfoil. However, there are areas where milfoil is present along the edge of large patches of yellow floating heart and water lily. In such areas, Avista will evaluate methods to avoid or treat milfoil before harvesting in order to prevent the spread of milfoil.

Avista will summarize the findings of the feasibility analysis in the annual summary report completed under the DO WQAP, including recommendations of whether to implement mechanical harvesting in Lake Spokane. The annual summary report will be submitted to Ecology for review and approval, and the findings and recommendations will be presented to Ecology for discussion. Based on the findings, Ecology and Avista will determine whether aquatic weed harvesting is reasonable and feasible for implementation in Lake Spokane. Upon receiving agency approval, Avista will begin implementation of the mechanical harvesting of targeted aquatic weeds, if it is determined to be a feasible option.

If mechanical harvesting is deemed reasonable and feasible, Avista will ensure that all necessary permits and approvals are obtained before implementation and coordinate the harvesting with the aquatic weed control methods implemented under its Lake Spokane and Nine Mile Aquatic Weed Management Program.

4.0 NUTRIENT REDUCTION EVALUATION

Avista will collect data to refine phosphorus concentration data for relevant weed species as well as quantify the potential phosphorus load reduction for selected control method(s). This will be done through collection and analysis of harvested plant samples to refine phosphorus concentration data, and using phosphorus concentration data along with the plant biomass removed to quantify phosphorus load reduction from harvesting. Avista may also use information available from relevant sources to refine the quantification of phosphorus load reductions. The Nutrient Reduction Evaluation will be summarized in the applicable annual report submitted under the DO WQAP.

4.1 Refine Phosphorus Concentration Data for Relevant Weed Species

Avista will refine phosphorus concentrations for selected aquatic weed species through sampling during the growing season and analyzing for species-specific dry weight to wet weight ratios and TP concentrations in three to five biomass samples of each relevant species.

4.1.1 Quality Assurance Project Plan

The following methods and procedures will be used during the sampling of the selected weed species.

- All weed samples will be collected in accordance with Avista's Aquatic Weed Program for Lake Spokane (Avista 2010)
- Three to five samples will be collected for each species analyzed
- Each biomass sample obtained will be placed into a nylon mesh bag and spun to remove excess water, then weighed to the nearest 0.1 kg[1]
- After measuring wet weight, each sample will be placed in a Ziploc bag and sealed to maintain water content
- Samples will be delivered to an accredited laboratory for analysis of total phosphorus

The analytical results, including the variation between the TP content for samples of the same species, will be summarized in an Annual Summary Report and as indicated above. Avista may also use information available from relevant sources to refine the quantification of phosphorus concentrations in plant biomass. This may include, but is not limited to, using literature values for flowering rush and/or other weed species that become established in Lake Spokane.

4.2 Quantify Phosphorus Load Reduction for Selected Control Method(s)

Avista will quantify the phosphorus load reduction associated with selected aquatic weed control method(s) implemented in Lake Spokane. For each relevant control method (e.g., harvesting, winter drawdown, and herbicide application), phosphorus load reductions to Lake Spokane will be determined, and will include, at a minimum:

[1] No attempt will be made to rinse epiphytic algae from the plants; therefore, all biomass estimates should be considered to be an assemblage of both macrophytes and epiphytes.

1. Plant biomass removed will be quantified during implementation of the selected control method
2. Phosphorus to plant biomass ratios will be multiplied by the corresponding plant biomass removed resulting in the phosphorus load removed

5.0 SCHEDULE

The schedule for implementation of the Phase I analysis along with the Nutrient Reduction Evaluation will be synchronized with other milestones and assessments for the DO WQAP. Figure 3 displays the schedule for completing the Phase I analysis, Nutrient Reduction Evaluation, summary reporting, and implementation activities. Results of the Phase I analysis and Nutrient Reduction Evaluation will be used to determine the implementation actions for years after 2016. Avista will amend the implementation schedule accordingly if it is determined necessary.

The implementation schedule, as presented in Figure 3, incorporates several benchmarks identifying key interactions and decision points important in evaluating whether aquatic weed harvesting is a reasonable and feasible measure to implement under this DO WQAP. These benchmarks are presented in Table 4.

Table 4: Aquatic Weed Management Benchmarks

Timeframe	Benchmark
Spring 2012	Submit DO WQAP to Ecology
Summer 2012	Submit DO WQAP to FERC
Fall 2012	Receive FERC approval to begin implementation
Winter 2014	Summarize findings of Phase I Analysis and Nutrient Reduction Evaluation
Winter 2014	Submit DO WQAP Annual Summary Report to Ecology for review and approval
Winter 2014	Work with and discuss findings with Ecology
Spring 2014	Determine with Ecology, whether aquatic weed harvesting is reasonable and feasible to implement in Lake Spokane
Begin Summer 2014[1]	If determined reasonable and feasible, implement measure; if not, revise implementation strategy, monitoring, and schedule

Notes:
1. Adaptive management will be used to determine whether it is reasonable and feasible to continue implementation and if it is appropriate to revise the schedule.

6.0 REFERENCES

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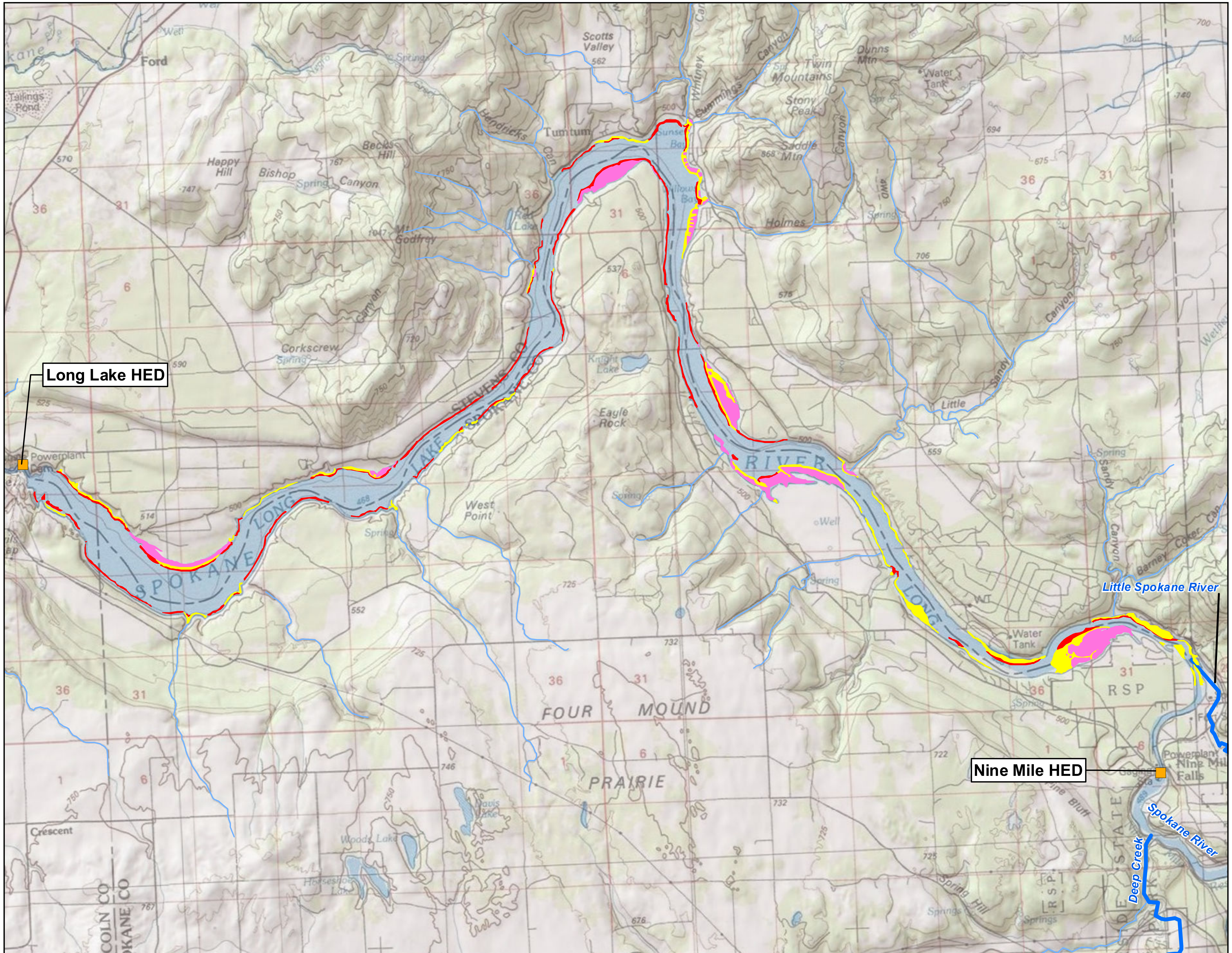
FIGURES



LEGEND

- Long Lake HED
- Long Lake Primary Tributaries

Aquatic Noxious Weeds

- Eurasian watermilfoil
- Yellow floatingheart and white lily
- Native and introduced pondweed

N

0 1.5
Sacle in Miles

Map Projection:
Washington State Plane
North Zone NAD 1983

Source:
Aquatechnex (2007), ESRI, USGS (quadrangle 24k),
Golder Associates Inc.

This figure was originally produced in color. Reproduction in black and white may result in a loss of information.

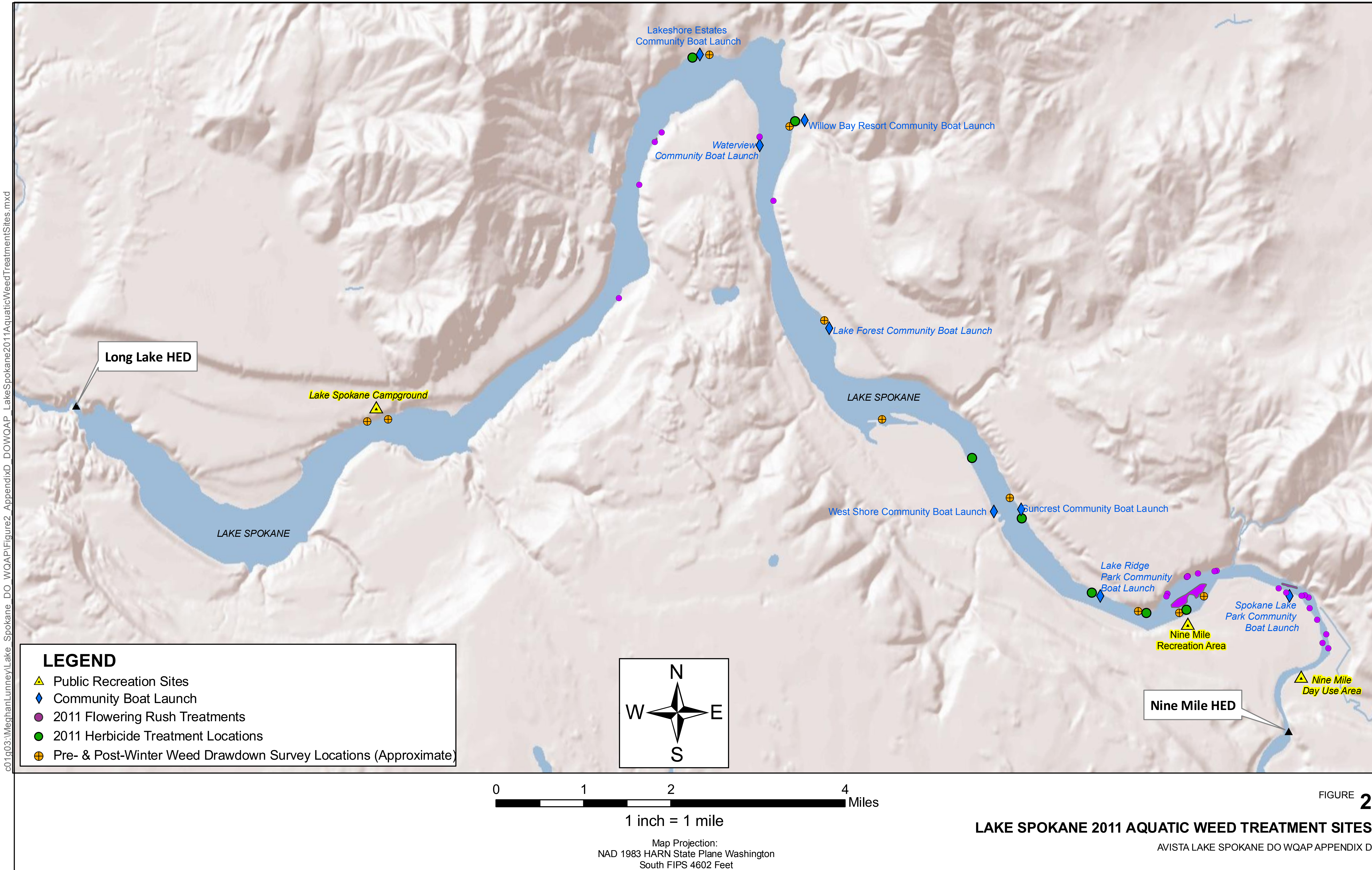
FIGURE 1

LAKE SPOKANE AQUATIC NOXIOUS WEED INFESTATIONS

AVISTA LAKE SPOKANE DO WQAP APPENDIX D

Path: S:\GIS\Projects\10393119_AvistaAquaticWeeds\MXD\LakeSpokaneAquaticNoxiousWeeds_WQAP_AppD_Fig1.mxdGLEHMAN

Golder Associates



Map Projection:
NAD 1983 HARN State Plane Washington
South FIPS 4602 Feet

FIGURE 2

LAKE SPOKANE 2011 AQUATIC WEED TREATMENT SITES

AVISTA LAKE SPOKANE DO WQAP APPENDIX D

						Year 1				Year 2				Year 3				Year 4			
Activity		2012				2013				2014				2015				2016			
		Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall
DO WQAP	Submit DO WQAP to Ecology*		x																		
	Submit DO WQAP to FERC*			x																	
	Receive FERC approval to begin implementation*				x																
Phase I Analysis	Evaluate Feasibility of Mechanical Harvesting						x	x	x												
Nutrient Reduction Evaluation	Refine TP Concentrations of Relevant Aquatic Weed Species							x	x												
	Quantify TP Load Reduction of Selected Control Method(s)							x	x												
Findings	Summarize Findings of Phase I Analysis & Nutrient Reduction Evaluation*									x											
	Submit DO WQAP Annual Summary Report to Ecology for review and approval*									x					x				x		
	Consult and discuss findings with Ecology*									x											
	Determine with Ecology whether aquatic weed harvesting is reasonable and feasible to implement in Lake Spokane*										x										
Implement?	If determined reasonable and feasible, implement measure. If not, revise implementation strategy, monitoring, and schedule*											x	x			x	x			x	x
	If implemented, measure nutrient reduction											x	x			x	x			x	x
	Implement annual aquatic weed controls through Lake Spokane and Nine Mile Aquatic Weed Management Program			x	x			x	x			x	x			x	x			x	x

Notes:
*Benchmarks

FIGURE 3
AQUATIC WEED MANAGEMENT PLANNING AND IMPLEMENTATION SCHEDULE
AVISTA LAKE SPOKANE DO WQAP APPENDIX D

APPENDIX E

CONSULTATION RECORD

May 25, 2012

Marcie Mangold, Water Quality Program
Washington Department of Ecology
Eastern Region Office
4601 N Monroe Street
Spokane, WA 99205-1295

Subject: Spokane River Hydroelectric Project, FERC Project No. 2545
Lake Spokane Dissolved Oxygen Water Quality Attainment Plan

Dear Ms. Mangold:

I have enclosed the Lake Spokane Dissolved Oxygen Water Quality Attainment Plan (DO WQAP) for your review and approval. The DO WQAP was completed in accordance with the Federal Regulatory Commission (FERC) Spokane River Project License (License) Appendix B, Section 5.6.C of the Washington Department of Ecology (Ecology) Section 401 Water Quality Certification, as amended May 27, 2010.

This DO WQAP addresses Avista's proportional level of responsibility as determined in the Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load. It includes the Ecology-approved potential reasonable and feasible measures to improve dissolved oxygen conditions in Lake Spokane, and incorporates an implementation schedule to analyze, evaluate and implement such measures. In addition, the DO WQAP contains benchmarks and reporting requirements sufficient for Ecology to track Avista's progress toward implementing the plan within the ten-year compliance period, which Avista understands begins upon Ecology and FERC approval of the DO WQAP.

We believe it would be helpful to meet and walk through the Plan with you and other Ecology staff, after you've had a chance to read through it. Please give me a call at (509) 495-4643, and we can schedule a time that would be best. Finally, we would appreciate your comments by July 16, 2012, which will allow us to meet our FERC filing requirements in a timely manner.

Again, thank you for your help to date and please feel free to call me if you have any questions or wish to discuss the DO WQAP.

Sincerely,

Meghan Lunney
Aquatic Resource Specialist

Enclosure

cc: Chad Brown, Ecology
David Moore, Ecology
Adriane Borgias, Ecology

Lunney, Meghan

From: Mangold, Marcie (ECY) [DMAN461@ECY.WA.GOV]
Sent: Tuesday, June 26, 2012 7:04 AM
To: Lunney, Meghan
Cc: Moore, David (ECY)
Subject: Draft DO WQAP
Attachments: DRAFT_Avista's Lake Spokane Dissolved Oxygen WQAP borgias.docx

Hello again Meghan,

I have incorporated Adriane's comments in this version. Sorry for the confusion. Again, please call if you have any questions.

Thank you,

D. Marcie Mangold
Department of Ecology
Water Quality Program
phone (509) 329 3450
fax (509) 329 3570

Lunney, Meghan

From:	Lunney, Meghan
Sent:	Friday, August 17, 2012 12:08 PM
To:	Marcie Mangold
Cc:	Fitzhugh, Speed (Elvin); Goloborodko, Yelena; David Moore (dmoo461@ecy.wa.gov)
Subject:	Revised Lake Spokane Dissolved Oxygen Water Quality Attainment Plan - FOR YOUR REVIEW & APPROVAL
Attachments:	Avista_Revised Lake Spokane DO WQAP_8-17-12_REDLINED.pdf; Avista_Comments & Responses_Revised Lake Spokane DO WQAP_8-17-12.pdf
Importance:	High

Marcie,
We have revised the Lake Spokane Dissolved Oxygen Water Quality Attainment Plan (Revised DO WQAP) to address and incorporate your June 26, 2012 comments. Attached you will find the following:

- Link to our ftp site where a clean pdf version of the Revised DO WQAP is posted. If you have any troubles accessing the ftp site, please let me know. ftp://198.181.21.179/Usr/mll6521a/Avista_Revised Lake Spokane DO WQAP_8-17-12.pdf
- A pdf version of the Revised DO WQAP, which shows all track-changes to the document (please note Section 6, CE-QUAL-W2 Modeling Plan, was rewritten without tracking revisions to incorporate Tony Whiley's comments).
- A pdf summarizing Ecology's comments and Avista's responses.

I'll also hand deliver a hard copy of each of these documents to your office. As we discussed, I will send out a doodle poll, so that we can have another meeting like the last one to go over the Revised DO WQAP.

Hopefully, we have addressed everyone's comments and Ecology can approve it so that we can send it to FERC by September 1st. Thanks again for everyone's help, we greatly appreciate it!

Thanks,

Meghan Lunney
Aquatic Resource Specialist
Avista Utilities
(509) 495-4643

The contents of this message may be privileged and confidential. Therefore, if this message has been received in error, please delete it without reading it. Your receipt of this message is not intended to waive any applicable privilege. Please do not disseminate this message without the permission of the author.

ECOLOGY COMMENTS ON

DRAFT LAKE SPOKANE DISSOLVED OXYGEN WATER QUALITY ATTAINMENT PLAN

Comment CB1: This sentence is awkward… maybe the author meant to say "increasing".

Avista Response: The influence of increased residence time can have both negative and positive effects on the influence of nutrients on DO levels. Therefore, we have revised the text to clarify this.

Comment DM2: It would be good to reference where this is discussed and reference the calculations say in an appendix?

Avista Response: The text has been revised to indicate that Section 2, including Table 2-1, is where the calculations are discussed.

Comment AB3: It would be helpful to summarize the criteria used to identify/prioritize potential measures (to the extent known), as in could it be accomplished, can the reductions be quantified, what are the "on the ground" reductions, what are the benefits? These are just examples, perhaps there are others that were considered (ability of Avista to implement or have control over for the long term). Addressing DM's comment below would probably address this comment too.

Avista Response: The criteria used to prioritize these measures are identified in a new figure (Figure 3-2).

Comment DM4: What does reasonable and feasible mean to Avista here? How was this determined? WAC 173-201A-510(5)(b)(iv) specifies that WQAP's must include analytical methods that were/will be used to evaluate all reasonable and feasible improvements.

Avista Response: Avista completed an initial literature analysis of phosphorus loading to Lake Spokane from nine potential mitigation measures. Our overall prioritization of further evaluating the reasonableness and feasibility of these measures was based on numerous factors, including Avista's ability to control implementation, potential TP load reductions, perceived assurance of obtaining credit, and potential secondary effects. The specific criteria used to prioritize these measures are identified in Figure 3-2, which has been added to the DO WQAP. Further, Avista will identify analytical methods that will be used to evaluate whether measure(s) are reasonable and feasible prior to obtaining Ecology approval and implementing them.

Comment DM5: WAC 173-201A-510(5) includes more steps than just implementing the reasonable and feasible measures ie monitoring, compliance schedule, methods that were/will be used to evaluate all reasonable and feasible improvements, water quality monitoring, and benchmarks and reporting.

Avista Response: We agree and have revised the text to clarify the sentence. Additionally, we note that Criteria used to evaluate reasonable and feasible measures are in Section 3.2, Water Quality Monitoring is in Section 5.0, and Reporting is in Section 7.0.

Comment DM6: These need to be any **new** reasonable and feasible technologies according to WAC 173-201A-510(5)(g)(i)

Avista Response: We agree and have revised the text to incorporate the revision.

Comment DM7: Are you referring to the FERC license? Please reference if you are.

Avista Response: Yes, this is a reference to the FERC License, and a footnote has been added to provide the correct reference.

Comment AB8: A minor point, but p 69 says that Avista 'may either increase the loading capacity of the reservoir by altering dam operations or implementing nonpoint source phosphorus reductions."

And on p 69-70

"The preferred method of pollutant reduction is to reduce nonpoint source contributions to the reservoir by implementing BMPs and pollution controls on lands . . . "

Avista Response: The text has been revised to address this comment.

Comment DM9: Please discuss this in greater detail in the body of the document. How will this be done?

Avista Response: Section 4.1 Adaptive Management has been added to the text to address this comment.

Comment DJM10: Need review by Tony Whiley and other sections that deal with modeling and TP / DO trading factor.

Avista Response: No response, this is Ecology's internal comment.

Comment DJM11: Same comment as djm2, need review by Tony Whiley.

Avista Response: No response, this is Ecology's internal comment.

Comment DM12: The purpose of a WQAP is to, WAC 173-201(A)(5)(c) and (d) ensure compliance with all applicable water quality criteria, not to just improve DO.

Avista Response: The text has been revised to address this comment.

Comment DM13: And adaptively manage or adapt to results of the data. This may be a good place to discuss Adaptive Management?

Avista Response: Section 4.1 has been added to the text to address this comment.

Comment AB14: There are a number of problems with the way information is expressed in this table. One should be able to read across the table columns and understand how the numbers are derived (or else footnote the calculations below the table or describe elsewhere in the document). Here are some generic comments to consider:

1) Units should be included on everything. Like (kg P) or (kg biomass) or (acres biomass). Otherwise it is difficult to see what the calculations are.
2) Is this table supposed to represent the relationships used to derive loading? Like Column 3 (loading factor) x Column 4 (number and units) equals loading (kg P/year)?
3) Time factors need to be included in Columns 3 and 4 in order to calculate annual loading.
4) Habitat calculations for carp are in acres (area). Would a volume calculation represent actual habitat?

Avista Response: The table was revised to clarify the basis of loading calculations and reference the detailed calculations provided in following subsections of the DO WQAP. All estimated loadings are presented as kg TP/year. Revisions to the table were not tracked, because MS Word is incapable of tracking deletion of columns and we believe attempting to track other substantial revisions would likely lead to confusion.

Comment AB15: Per table 3-3 this should be 481-3852?

Avista Response: Values were revised from rounding to exact match of detailed loading estimate to maintain consistency.

Comment AB16: Should be footnote 3?

Avista Response: The table has been revised to note the correct citation, although the number is not 3, because notes were added to clarify calculations.

Comment DM17: Can you explain the difference or the reasoning behind using wet weight vs dry weight?

Avista Response: Although it is possible to obtain "dry weight" fish mass, it requires both killing and desiccating the fish, and is therefore not practical in most cases. Instead, fish mass is nearly always done on a "wet weight" basis, which can be done by simply weighing live fish or their carcasses. Therefore, calculations for potential phosphorus load reductions from carp removal are based on "wet weight" carp mass. Table 3-2 was revised to clarify use of wet weight and method of calculations. This method of calculating phosphorus load reductions can be used in the future based on either the number of carp removed or the total "wet weight" mass of carp removed.

Comment DM18: How was this estimate calculated? Modeling? What method will Avista use to confirm this in the Carp Plan?

Avista Response: The text has been revised to clarify the direct results of the Cedar Lake model estimates and extrapolation to Lake Spokane.

These estimates were provided to merely show the loading from bioturbation. At the present time, we are unable to estimate credit for reducing carp bioturbation and nutrient-pumping phosphorus loadings through carp removal. As such, Avista will work with Ecology to determine the appropriate credit and method for confirming these load reductions.

Comment AB19: Same comment as before about acres vs. volume for carp habitat. Do the acres refer to the acres of area disturbed by the carp feeding? If so, then the volume comment on the previous table is irrelevant.

Avista Response: The 1,300 acres is for Lake Spokane and is based on Donely (2011) who reported "The majority of [Lake Spokane] carp inhabit the upper portion of the reservoir or approximately 600 to 800 surface hectares [1,000 to 2,000 acres] of area." Since bioturbation is directly associated with the substrate area, not water volume, use of area is appropriate for this analysis.

Comment DM20: Please include consultation with WDFW regarding permits and methods of capturing carp either in this document or the Carp Plan.

Avista Response: The text has been revised to address this comment.

Comment AB21: ensure compliance with applicable water quality criteria.

Avista Response: controlling the growth of aquatic weeds and removing them before they die is only one measure amongst many that will be needed to improve DO. No one measure, by itself, will ensure compliance with the water quality standards. The cumulative effectiveness of all measures will be used to help ensure compliance with the applicable water quality standards, including the numeric criteria.

Comment DM22: These calculations are confusing. Is this the content in .21% of Eurasion milfoil? Please explain where these percents came from and why they are being used.

Avista Response: Table notes were added to clarify calculation methods and provide examples of them. The phosphorus content of Eurasian milfoil is 0.21% by mass (i.e., 0.0021 kg TP/kg biomass). An example of its use is multiplying this phosphorus content (0.0021 kg TP/kg biomass) by the low biomass harvest rate used for submergent plants (202 kg/acre) resulting in the low-end loading factor for Eurasian Watermilfoil of 0.42 kg TP/acre.

Comment DM23: POPUD has done some studies regarding fragmentation and fish loss due to mechanical harvesting that may be helpful.

Avista Response: Thank you for this reference. We have called the Pend Oreille Public Utility District (POPUD) contact you provided and requested the studies that you referenced.

Comment DM24: I believe that this is a great thing, but can more detail be put into discussing, die off of plants in wetlands, and how the P will be contained within the wetland?

Avista Response: We have added a discussion of potential phosphorus loading from plant die-off along with effects of hydraulic connectivity of the wetlands to Lake Spokane.

Comment DM25: Is there a citation or reference for this statement, not that I don't believe it?

Avista Response: Citations have been added.

Comment AB26: Units = kg P/day

Avista Response: We revised the table so that with exception of Annualized Total Load, units are kg TP/day.

Comment DJM27: For this and other tables, unclear how the number is derived. It would be helpful to have work shown in appendix.

Avista Response: Notes were added for tables to clarify calculation methods and provide examples of them.

Comment DM28: How will/would you make the connection between education and implementation or removal of failing septic systems? Surveys?

Avista Response: Stevens County Conservation District and the Lake Spokane Association have been monitoring approximately 20 shoreline sites in the upper portion of Lake Spokane for fecal coliform and optical brighteners (dye added to laundry detergents), with the goal of determining whether leachate from septic systems is present in the lake. This monitoring was conducted in April, May, and June of 2012 and is scheduled to be completed monthly from August 2012 through January 2013. Results from this type of monitoring , combined with the results from the baseline nutrient monitoring, may be used to evaluate whether septic systems are in fact contributing nutrients to the lake, and could contribute to evaluating the likelihood of these septic system education efforts reducing TP loads and improving DO in the Lake.

Comment AB29: The units are mass/person/year. So flow is irrelevant and therefore the efficiency of the fixtures are irrelevant. A low flow unit will have a higher concentration P and a high flow unit will have a lower concentration of P but in the end the mass of P remains the same. This is assuming that 100 percent of the P that is in the septic effluent is transferred to the lake.

The efficiencies of the fixtures may have an impact on the rate of phosphorus exchange, which would also be affected by geology and attenuation in the soil. Over time, one would assume a quasi steady state system where low flow P is entering the system at a higher concentration but slower rate than a high flow system (which would have a lower concentrations). Again, with a permeable geology one would think this sort of averages things out.

Since I didn't study the references, perhaps this table considers all of that but it wasn't immediately clear.

Avista Response: Although flow is irrelevant for calculating TP load to the groundwater, it can influence groundwater flow rates to surface waters and thereby influence TP loadings to surface waters (i.e., Lake Spokane). To maintain consistency with TP retention factors used, we included flow rates in our calculations presented in the table.

Comment DJM30: Should mention Avista effort at partnering with Ecology and Stevens to address fertilizer use and buffer education.

Avista Response: The text has been revised to address this comment.

Comment DM31: What is being proposed in this section? It is somewhat confusing. Will the 215 acres be taken out of grazing? How will this be done? How will the properties be secure from grazing and for how long?

Avista Response: The text has been revised to address this comment.

Comment DJM32: Should clarify how this term is used throughout report; i.e., as a DO/TP ratio, not for point source trading.

Avista Response: Section 3.1 has been revised to clarify Avista's use of the term "credit" within the DO WQAP.

Comment DM33: This is a great idea, but there are many variables that make some areas more valuable that others for instance continuous property vs smaller checkerboard pieces. If we had a model to calculate (which I think there is one) this may prove to be a great project!

Avista Response: We agree and will keep pursuing a way to calculate phosphorus load reductions resulting from Avista keeping a vegetative buffer along its Lake Spokane shoreline property.

Comment DM34: Please clarify or edit as discussed during our meeting on 6/8/2012

Avista Response: Section 3.1 has been revised to clarify Avista's use of the term "credit" within the DO WQAP.

Comment DM35: Was P monitored within the water column? It isn't real clear to me how these numbers are calculated. I may be missing something.

Avista Response: Potential TP removal was based on TMDL1 scenario Lake Spokane model segment 31 (Washington model segment 183) model results for the layer corresponding to the depth column as described in table note 2, not TP measurements. For example, for August 16-31 at a depth of 25 m, 6 kg TP removed = August pumping rate (7,360 gpm, 27,858 Liters per minute) x minutes in time period (23,040 minutes) x modeled concentration for that depth layer (0.009 mg/L) x kg:mg ratio (0.000001).

We also added a row to the table to show the total change in TP removed (kg/yr) compared to the current pump configuration, which is directly consistent with the value in the summary table (Table 3-1).

Comment DM36: Please see previous comment.

Avista Response: With regard to the text that you highlighted, Section 3.1 has been revised to clarify Avista's use of the term "credit" within the DO WQAP.

Comment DM37: Term of license?

Avista Response: Possibly, but this will depend on the effectiveness of the measure being addressed. We anticipate being awarded credit for implementing measures as long as each one is effectively reducing phosphorus loads to the lake.

Comment DJM38: As discussed, should clarify how priorities were determined; not through level of importance but in terms of reasonable and feasible (I believe this is what it was based on).

Avista Response: A new figure (Figure 3-2) was added to clarify the criteria used to prioritize these measures.

Comment DM39: As referenced before, what does reasonable and feasible mean to Avista here? How was this determined? WAC 173-201A-510(5)(b)(iv) specifies that WQAP's **must** include analytical methods that were/will be used to evaluate all reasonable and feasible improvements. Please explain how/what/why these were ranked in terms of reasonable and feasible.

Avista Response: Please see response to Comment DM4, located in the Executive Summary.

Comment DM40: Specifically how will this approach work? Will you attend conferences, look for updated information on the web?

Avista Response: Avista personnel regularly attend annual conferences and will continue to do so during the implementation of the DO WQAP.

Comment DM41: How will this be done? Will it be developed later? Monitoring is a critical an essential required part of WQAP's (WAC 173-201A-510(5)(v). Please explain you monitoring plans and schedules. These may be referenced here but need to be in your weed and carp plan as a separate section.

Avista Response: Avista monitoring will consist of baseline nutrient monitoring and site-specific phosphorus reduction monitoring. The data collection and management, along with the monitoring schedules are discussed in greater detail in Section 5.0.

With regard to monitoring plans and schedules for the potential measures identified in Appendices C and D, results of the Phased analyses will have a major influence on implementation actions for years after 2016, and Avista will amend the implementation schedule, accordingly.

Comment AB42: Would prefer the wording: "The modeling program will use the capability of CE-QUAL-W2 model to portray the effects of management actions over a longer time frame …"

Avista Response: Revised text to clarify Avista's modeling approach and incorporated suggested revision.

Comment DM43: Ecology determines this according to your 401 Certification 5.1.W. general requirements

Avista Response: The text has been revised to address this comment.

Comment DM44: Again, standards must be met, not just improvement. The plan must ensure compliance with water quality standards.

Avista Response: The text has been revised to address this comment. Again, please refer to Section 1, which identifies the goal of this DO WQAP.

Comment DJM45: Should mention these are consistent with stations used in previous studies (Cusimano 2004 for one).

Avista Response: The text has been revised to indicate the referenced six monitoring stations were included in previous studies, including Cusimano (2004).

Comment AB46: Marcie, Dave: seems like I saw a document dated June from Jim Ross. Also, there is the issue of one of the sampling points being removed that needs to be looked at9.

Avista Response: No response, this is an Ecology internal comment.

Comment DM47: These have to be identified in specific study plans, whether they are a replication of what is here or something new, as well as a QAPP for items that aren't already covered under the existing QAPP.

Avista Response: In this referenced sentence, we were attempting to communicate Avista's plan to identify any appropriate additional sampling sites and protocols for studies other than the baseline lake monitoring. Since this sentence in the Baseline Lake Monitoring section, was not addressing baseline nutrient monitoring, we have deleted it to avoid confusion. Avista is committed to provide sampling sites and protocols on a timeline that is based on decisions to proceed with specific actions, many of which are dependent on results of studies that have not yet been conducted.

Comment DM48: How long will this monitoring take place?

Avista Response: This monitoring will continue until 2016, at which time Avista will evaluate the results and success of monitoring baseline nutrient conditions in Lake Spokane and will work with Ecology to define future monitoring goals for the lake, including sampling station locations.

Comment DM49: How? There are no monitoring discussions within the plans. Please be more specific here. We are certifying that you will comply with DO water quality standards and we need assurance on how you will achieve this. A QAPP component here would be helpful.

Avista Response: We have added a section that addresses the monitoring QAPP to the DO WQAP, Carp Population Reduction Plan, and the Aquatic Weed Management Plan.

Comment AB50: Be more specific here. As in, "A recently developed habitat module will implemented with the CE-QUAL-W2 model in order to evaluate aquatic habitat in Lake Spokane."

Avista Response: The text has been revised to address this comment.

Comment DJM51: Will a reference species be used and if so, which one? Or will it be reference conditions? This should be clarified here.

Avista Response: CE-QUAL-W2's habitat module will be used for rainbow trout and potentially other selected fish species or guilds. We have clarified this with text revisions.

Comment DJM52: Need Tony Whiley review on this. Approach should also include development, review and approval of modeling QAPP.

Avista Response: We have added a description of the components of a modeling QAPP.

Comment DM53: Please be specific here on how this expansion will occur.

Avista Response: The modeling approach has been described in more detail, including addition of Figure 6-8, which shows the proposed modeling workflow.

Comment DM54: These comments are from Tony Whiley.

[DM54a] • Changes to water quality as a consequence of the proposed modifications to the original model (adjusting Lake Spokane bathymetry and setting the upstream boundary to Nine-Mile Dam) should be examined prior to running other model scenarios. It is important that a water quality baseline is established before further model adjustments are made. The comparison should be made applying the same dissolved oxygen and temperature assessment methods used in the TMDL analysis. The assessment should be made sequentially; first examining potential water quality changes resulting from the upstream boundary adjustment, prior to adjusting bathymetry. Then, once confirmation has been made that no significant changes have occurred, then the bathymetry should be adjusted and examined for its potential influence.

Avista Response: We have clarified the sequence of activity and reinforced the fact that the changes to the model will be essentially "calibrated" to the 2001 CE-QUAL model TMDL Run, which now forms the regulatory baseline from which Avista's actions are undertaken.

Comment [DM54b] • The draft proposal does not specify how management actions – macrophyte harvesting, carp reduction – will be examined within the CE-QUAL W2 model framework. What elements of the model will be adjusted to affect these activities?

Avista Response: Once the macrophyte/carp module is incorporated into the model, harvesting scenarios can be run by changing the growth and die-off dynamics. The same will be conducted relative to carp harvesting. Also, Figure 6-8 has been added to the DO WQAP for clarification as to how macrophyte harvesting and carp population reduction will be examined in the CE-QUAL-W2 model framework.

Comment [DM54c] •Although it is proposed that the model results will be compared to those observed at water quality monitoring stations (LL0 – LL5), all assessments should include the same model layers and segments applied in the TMDL used to examine hypolimnetic dissolved oxygen.

Avista Response: Yes, this is what will occur. When we get outside of the 2001 model year, we will have to rely on available data in addition to the 2001 model results.

Comment [DM54d] • What model variables will be adjusted? Where will the meteorological data used to run the model beyond 2001 come from? Will the inclusion of data beyond the TMDL period (2001) require model recalibration? What's the proposed modeling workflow in terms of examining potential water quality changes resulting from adjustments to the original TMDL model? Will tribal fishery interests be properly addressed by examining solely the habitat requirement of rainbow trout? How will the habitat data be presented? Will the analysis of model output be consistent with those applied in the original TMDL? There is mention of presenting time series plots and performing statistical analyses but no mention of what statistical analysis will be used, for what parameters, at what frequency etc. We need this level of detail. It shows that AVISTA, and consultant - Golder Associates, have done their "homework" and really thought through the proposed work making it more transparent so that it can be properly reviewed and adjusted, if necessary. It makes the whole process more efficient. Also, as a side note, future reporting should stick with one unit system, preferably SI (metric).

Avista Response: Regarding model variables, the PEST algorithm will facilitate evaluating parameter sensitivity, and assist with determining which parameters are viable for adjustment and how to adjust them.

Regarding meteorological data, the Spokane Airport is the most likely station to provide most meteorologic data , as this is a long-term monitoring station and was the station used to calibrate the 2001 TMDL model scenario. Availability and representativeness of other meteorological data (e.g., wind, which was found not to be representative of Lake Spokane) will be evaluated and if determined appropriate will be incorporated into the input files.

Regarding whether inclusion of data beyond the TMDL period (2001) will require model recalibration, no. Revisions have been made to further explain development of the multi-year "baseline" and comparable multiyear Avista Action simulations.

Figure 6-8 has been added to the DO WQAP to show the proposed modeling workflow.

Avista is working with the Spokane Tribe to address tribal fishery and water quality concerns on the Reservation through a separate Settlement Agreement. In addition, Avista aerates the waters released from Long Lake Dam to increase dissolved oxygen levels, when they drop near 8 mg/L in the tailrace below the dam. This is in compliance with a separate section of the Washington 401 Water Quality Certification.

The results of the habitat module will most likely be presented in a graphical format that displays the time series for the percent of total lake volume within user-defined water quality criteria, or "usable habitat". The useable habitat criteria output will either be defined as survival thresholds or as optimal habitat thresholds for one or multiple species. We envision Ecology will be engaged in the decision for the format to present the results.

With regard to model output consistent to those applied in the original TMDL, yes, there will be a "Table 7" format in addition to the multi-year formats.

The focus of the analyses will be dissolved oxygen, Section 5.4[1] describes some of the options under consideration, but we will need to start working with the model before finalizing an approach. Year-to-year and seasonal variations are likely to be of most interest. The seasonal Kendall test is the most likely statistical method that will be employed.

With regard to sticking to a one unit system, we also prefer using metric as an International System of Units (SI), however, to be consistent with the DO TMDL, in some instances we will

[1] Section 5.3 in the Draft DO WQAP.

need to provide both metric and U.S. based units (i.e. pounds is used consistently in the DO TMDL and acres will be used for areal calculations).

Comment DJM55: Ecology will do this as well as most current modeling inputs and outputs that lead to modified permits (IEP for example with extended season modeling).

Avista Response: We appreciate Ecology's commitment to maintaining the 2001 model and the associated input files along with managing any changes to the input and output files leading to modified permits (e.g., Inland Empire Paper extended season modeling).

Comment DM56: Each of the reports contained within need a consultation, review and approval from Ecology.

Avista Response: The text has been revised to address this comment.

Comment DM57: More than consultation needs to occur.

Avista Response: The text has been revised to address this comment.

Comment DJM58: Would like to add that Avista will include final reports on its websites and will notify DO TMDL implementation committee when reports are posted.

Avista Response: The text has been revised to address this comment.

Comment AB59: There was also a discussion about a 30 day review and approval period as well as a consideration about submitting the report prior to March 1 due to workload considerations.

Avista Response: We recognize a review and approval period is at least a 30-day period and have revised the text to indicate the annual summary report will be submitted to Ecology by February 1 for review and approval.

Comment DM60: This will require the completion of another WQAP (compliance schedule) WAC 173-201A-510(g)(i) and (ii)

Avista Response: The text has been revised to better reflect how Avista will satisfy WAC 173-201A-510(5)(g).

Comment DM61: Upon Ecology consultation, review and approval they will be submitted to FERC.

Avista Response: The text has been revised to address this comment.

Comment DJM62: On Figure 3-2, tenth row should say "carp harvesting."

Avista Response: The referenced figure has been revised to address this comment.

Comment DM63: Include Ecology consult, review and approval.

Avista Response: The DO WQAP schedule (Figure 3-2 in the draft and Figure 3-3 in the revised) has been revised to address this comment.

Comment DM64: Are values on page 6 based on dry weight or wet weight? Please include consultation with WDFW regarding appropriate methods for collecting carp and necessary permits.

Page 7 and 8, Ecology needs to approve the Phases/stages.

Page 8, 3.1.2, submit to Ecology for review and approval.

Page 9, there is no monitoring or check in's (benchmarks). How will success be measured?

Avista Response: Lake Spokane Average Carp Mass presented in Table 2 are wet weight, as based on field measurements.

The text has been revised to incorporate Avista's working with WDFW, and Avista obtaining all necessary permits.

Avista recognizes that Ecology will review and approve the various phases of implementing this DO WQAP.

Pertaining to the comment regarding Ecology approval of the results of the Phase I Analysis, the text has been revised to clarify the Phase I findings, which will be incorporated in an annual summary report and submitted to Ecology for review and approval.

Pertaining to the monitoring/benchmark comment, benchmarks have been added to the text in Section 4.0.

Comment DM65: Page 5, 2.2, 3rd sentence, the use of "significant" usually means statistical analysis. Did this occur? What reference is there for significant?

Page 7, second paragraph, reasonable and feasible is determined by Ecology, please make sure that how this determination will occur in the Phase I analysis that Avista will consult with Ecology as well as review and approval.

There are no methods described for monitoring, modeling or checkin/benchmarks for this project. This is a must in WQPP's according to WAC 173-201A-510(v) and (vi). In figure 3, please include consultation, review and approval with Ecology.

Avista Response: The referenced statement is not based on studies specific to Lake Spokane. Therefore, we have changed the text from "significant" to "substantial" to alleviate any implication of statistical significance within Lake Spokane.

The text has been revised to indicate that the Phase I report will be submitted to Ecology for review and approval along with how determination of reasonable and feasible will be made.

Section 5.0 text has been revised to include benchmarks and Figure 3 has been revised to incorporate this comment.

Comment AB66: Figure 3, typo on 1st line of Implement section, should read "reasonable"

Avista Response: The referenced figure has been revised.

Memorandum
Environmental Affairs

DATE: September 4, 2012, 15:37

TO: File

FROM: Meghan Lunney

SUBJECT: **Lake Spokane DO WQAP**

Received an e-mail message from Avista's e-mail system indicating the message sent from Marcie Mangold containing Ecology's red-lined Lake Spokane DO WQAP was too large for the Avista server to receive. Meghan Lunney went to Ecology and picked up an electronic version of the red-lined version from Marcie Mangold containing Ecology's comments.

Lunney, Meghan

From: Lunney, Meghan
Sent: Friday, September 14, 2012 3:49 PM
To: Marcie Mangold (dman461@ecy.wa.gov)
Cc: David Moore (dmoo461@ecy.wa.gov); Fitzhugh, Speed (Elvin); Goloborodko, Yelena
Subject: Revised Lake Spokane DO WQAP - For Your Approval

Importance: High

Revised_Lake
›okane DO WQAP_T

Marcie,
Attached for your approval is the Revised Lake Spokane Dissolved Oxygen Water Quality Attainment Plan (DO WQAP), dated September 12, 2012. The plan incorporates the comments Ecology provided on September 4, 2012, which include three grammatical edits along with a request to clarify Table 3-4. Due to file size, the attached pdf only includes the text of the document. The full plan (including figures and appendices) is available for download at the following ftp site.
ftp://198.181.21.179/Usr/mll6521a/Lake Spokane/Ortho/Revised_Lake Spokane DO WQAP_9-12-12.pdf

If you have any questions please contact me at 509-495-4643. As soon as we have an Ecology-approved DO WQAP, we will submit it to the Federal Energy Regulatory Commission.

Thanks for all your help!!!

Meghan Lunney
Aquatic Resource Specialist
Avista Utilities
(509) 495-4643

The contents of this message may be privileged and confidential. Therefore, if this message has been received in error, please delete it without reading it. Your receipt of this message is not intended to waive any applicable privilege. Please do not disseminate this message without the permission of the author.

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
4601 N Monroe Street • Spokane, Washington 99205-1295 • (509)329-3400

September 27, 2012

Mr. Elvin "Speed" Fitzhugh
Spokane River License Manager
Avista Corporation
1411 East Mission Ave., MSC-1
Spokane, WA 99220-3727

RE: Request for Approval – Spokane River Hydroelectric Project No. 2545
Dissolved Oxygen Water Quality Attainment Plan
Washington 401 Certification, Section 5.6.C

Dear Mr. Fitzhugh:

We have reviewed the Dissolved Oxygen Water Quality Attainment Plan (WQAP) that was emailed to the Department of Ecology (Ecology) on September 14, 2012. We thank you for answering our questions and incorporating our comments into the final document.

Ecology approves the Dissolved Oxygen Water Quality Attainment Plan.

Please feel free to contact me at (509) 329-3450 or by email at dman461@ecy.wa.gov if you have any further questions regarding this matter.

Sincerely,

D. Marcie Mangold

D. Marcie Mangold
Water Quality Program

DMM:dw
cc: Graham Simon, WDFW
Brian Crossley, Spokane Tribe of Indians
David Knight, Ecology/WQP