TECHNICAL MEMORANDUM

Date: September 26, 2014
To: Craig Gildroy, Planning Director
From: Sarah Sandstrom, Fisheries Biologist
Project Number: 071108.5
Project Name: City of Chelan SMP Update

Subject: Updated Review of Buffers and Scientific Literature Relevant to Lake Chelan

Background

This memorandum was prepared to 1) briefly compare the conclusions of the October 2012 City of Chelan Buffer Science Report and the City's proposed setbacks[1] with a recent review of buffer literature specific to semi-arid shorelines, 2) consider additional scientific literature relevant to ecological functions and shoreline development in Lake Chelan and 3) identify remaining data gaps relevant to shoreline development and ecological functions. WAC 173-26-201(2)(a) requires that SMPs be based on "the most current, accurate, and complete scientific and technical information." Although the body of scientific information concerning lake shorelines is extensive, far fewer studies have investigated the functions and ecological relationships specific to Lake Chelan. While the available scientific data may allow for inferences related to shoreline functions and the effects of development in Lake Chelan, it is recognized that there is some level of inherent uncertainty in those inferences and that data gaps remain. Explicit recognition of these gaps can help policy makers understand the range of possible outcomes from policy decisions.

Review of Shoreline Buffers

In 2013, in recognition of the unique characteristics and functions of riparian buffers on shorelines in semi-arid lands east of the Cascade Range, Ecology supported development of a review and analysis of buffer functions in semi-arid lands of nearby Grant County (Anchor QEA 2013). This memorandum evaluates how recommendations from the *Final Draft Semi-Arid Riparian Functions and Associated Regulatory Protections to Support Shoreline Master Program Updates* report (Anchor QEA 2013) (Semi-Arid Functions Report) compare with setback standards in the proposed City of Chelan SMP.

[1] The revised version of the SMP now refers to the shoreline buffers as shoreline setback to recognize that these are more accurately managed areas (consistent with SMA) rather than traditional critical area buffers.

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The Semi-Arid Functions Report (Anchor QEA 2013) focused on a review of literature specifically relevant to the Columbia Basin Plateau. Although the City of Chelan is located north of the Columbia Basin, in the North Cascades basin, based on the similar semi-arid climate and vegetative considerations, buffer functions in the Columbia Basin are expected to be generally similar to those found in Lake Chelan. The Semi-Arid Functions Report suggests that waterbodies with hydro-facility operations tend to have limited floodplain and associated riparian habitats in comparison to more natural systems (Anchor QEA 2013). The depth to the water table surrounding the lake generally fluctuates with lake levels. Because germination of riparian vegetation is generally dependent on moisture from groundwater in arid and semi-arid climates, lowered lake levels may limit riparian seedling recruitment (Braatne et al. 2007 cited in Anchor QEA 2013).

Based on a review of riparian functions specific to semi-arid climates, the Semi-Arid Functions Report identified recommended buffer widths for different types of waterbodies. For a lake with a narrow riparian corridor and a mix of developed shoreline with open space, the report notes that water quality protection would be expected to require the largest buffer (Anchor QEA 2013). In this scenario, the Semi-Arid Functions Report recommends a buffer width of 50 feet, with the opportunity to reduce width if additional surface water quality BMPs and treatment measures are employed and/or with habitat enhancements and demonstration of no net loss of ecological function (Anchor QEA 2013). The report does not specifically address the effect of water level fluctuations on effective buffer widths relative to water quality. The Semi-Arid Functions Report also suggests that a 40- to 50-foot buffer (depending on the hillslope) represents a conservative buffer width to effectively limit erosion (Anchor QEA 2013). For other functions (e.g., fish and wildlife, shade and cover, and organic input), the report recommends buffers that meet the “representative functional local condition.”

Consistent with the conclusions in the Semi-Arid Functions Report (Anchor QEA 2013), buffer functions related to water quality are expected to be most important for Lake Chelan. Lake Chelan is classified as ultraoligotrophic, with low nutrient input, low organic productivity, and high water transparency. As such, nutrient contributions to lake waters have the potential to substantially alter the aquatic ecosystem. A 1989 Department of Ecology assessment found that 10 to 25 percent of Lake Chelan’s phosphorus and nitrogen loading was the result of human activities, and total soluble nitrogen rates in orchard areas adjacent to the lake did not meet state drinking water standards (Montgomery Water Group et al. 1995). A TMDL for phosphorus was established in 1993 based on exceedances documented in 1987. Water quality sampling has been conducted in 1987, 1995, 1996, 1999, and 2007. Sampling since 1987 has indicated that total phosphorus concentrations meet the water quality standards, and a weak downward trend has been identified in total phosphorus concentrations over that time period (Newell and Coffin 2011). However, it is not clear whether the weak decreasing trend is a result of decreased phosphorus loading to the Lake, or whether it is related to different runoff and dilution characteristics (Newell and Coffin 2011). Sampling in 2007 confirmed that phosphorus is the limiting nutrient controlling growth of algal biomass in the Lake (Newell and Coffin 2011). Additionally, a TMDL and associated Water Quality Implementation Plan is in place to address DDT and PCBs in Lake Chelan (Anderson and Peterschmidt 2008). Anderson and

Peterschmidt (2008) note that the current loading of PCBs may be from soil erosion, storm water transport, and air deposition.

The standard setback proposed for shoreline residential development in the City of Chelan SMP is 25 feet. The proposed SMP also requires treatment and either onsite infiltration or detention of stormwater for any new development or redevelopment. These measures substantially minimize potential impacts to water quality from future development activities, and infiltration and detention standards are also expected to substantially limit impacts to Lake Chelan that would result in soil erosion. Additionally, as noted in the 2012 City of Chelan Buffer Science Report, the lake level drawdown in the winter is expected to allow for additional space for infiltration and sub-surface nutrient retention in winter months when runoff is most likely. Therefore, setbacks that are narrower than the 50 feet recommended in the Semi-Arid Functions Report may be adequate, consistent with the Report's finding that a buffer less than 50 feet is appropriate if additional surface water quality BMPs and treatment measures are employed and/or with habitat enhancements and demonstration of no net loss of ecological function.

A small portion of the City's residential shoreline is undeveloped, and the proposed SMP identifies wider setbacks for this area (Tier 1-Residential) compared to the remaining developed residential shoreline area (Tier 2-Residential). Parcels in the proposed Tier 1- Residential setback area have steep slopes, and the soil is characterized by bedrock and predominantly shallow soils. These characteristics limit the effective infiltration of runoff within the setback. As such, a wider vegetated area is recommended to help maintain water quality conditions. Any setback less than 50 feet would not be warranted in this area.

Proposed SMP standards that require replanting of any vegetation that contributes to shoreline ecological function and is adversely impacted during development or redevelopment are expected to help maintain the "representative functional local condition."

Data Gaps

While the available scientific data may allow for inferences related to shoreline functions and the effects of development in Lake Chelan, it is recognized that there is some level of inherent uncertainty in those inferences and that data gaps remain. Literature specific to arid and semi-arid climates and other dam-regulated waterbodies helps explain the functions of buffers and setbacks on Lake Chelan; however, the following questions identify remaining data gaps. General recommendations are provided for programs to address these data gaps. Specific sponsors and funding sources would need to be identified in order to implement these programs. They might be eligible for federal or State grant funding, or they could be sponsored by non-profit, local, regional, State or federal entities.

- Are water quality trends related to changes in shoreline practices or inter-annual variation?
    - Recommendation: Conduct regular water quality monitoring as part of the Long Term Monitoring Plan (LTMP) for phosphorous, DDT and

PCBs. Monitor and manage potential effects from rural septic systems and irrigation return flows (RH2 Engineering 2012).

- How effectively does the lake level drawdown limit nutrients and contaminants from affecting water quality in Lake Chelan on a long-term basis? Similarly, do organic inputs from shoreline vegetation at low lake levels have a measurable effect on primary and secondary productivity in Lake Chelan?
    - Recommendation: Conduct research to evaluate nutrient sources, transport, and fate in relation to seasonal water levels. In light of uncertainty and potential sensitivity of Lake Chelan to elevated nutrients, consider conservative regulatory standards to help limit the potential for inadvertently surpassing the thresholds for nutrient loading that maintain the water quality conditions of Lake Chelan.

Shoreline Ecological Functions and Development in Lake Chelan

The natural condition of Lake Chelan has been substantially altered by anthropogenic influences. These changes include shoreline development, docks, shoreline stabilization, lake level management, and introduction of non-native species. The Lake drawdown prevents the establishment of aquatic vegetation above the low water elevation. The fish community has been altered as a result of species introductions for sport fisheries. Native species include: westslope cutthroat trout, bull trout (thought to be extinct), mountain whitefish, pygmy whitefish, burbot, largescale sucker, longnose sucker, bridgelip sucker, northern pikeminnow, peamouth, redside shiner, and three-spine stickleback. Introduced fish species include: rainbow trout, kokanee, landlocked Chinook salmon, lake trout, smallmouth bass, largemouth bass, and eastern brook trout. Additionally, *Mysis* were introduced historically to support kokanee.

Schoen and Beauchamp (2010) recently conducted an analysis of the food web dynamics in Lake Chelan, concluding that lake trout are the predominant piscivorous fish within the lake (Schoen and Beauchamp 2010). Juvenile lake trout feed predominantly on *Mysis*, and transition to piscivory once they reach a larger size (over approximately 50 cm) (Schoen and Beauchamp 2010). Schoen et al. (2012) found that the consumption of kokanee by lake trout exceeded kokanee production in Lake Chelan between 2005 and 2009. In a comparable lake in Montana, the introduction of *Mysis* facilitated the population growth of the introduced lake trout population there; the rise in the lake trout population corresponded with the extirpation of kokanee and the reduction in native bull trout and cutthroat trout populations (Ellis et al. 2011). Similarly, targeted reductions of Lake Trout in Lake Pend Oreille since 2006 have corresponded with an increase in kokanee population numbers in Lake Pend Oreille, Idaho (Wahl et al. 2013). However, Schoen et al. (2012) projected that predation pressure on kokanee would continue to increase in Lake Chelan in the short term even if the numbers of harvestable lake trout were reduced. Increased predation pressure would result from the young cohorts of lake trout growing to reach piscivorous size. Given the existing food web dynamics in Lake Chelan and the empirical example of large scale trophic cascade in Montana, the fish community in Lake Chelan could potentially change significantly in future years.

Based on the understanding that the fish community consists of several introduced species, that community dynamics may be in a state of flux, and that the influence of shoreline development is likely to vary with lake levels, a question has been raised regarding the relative importance of nearshore and littoral changes to the aquatic habitat of Lake Chelan. In the absence of specific studies of shoreline habitat changes in Lake Chelan, the understanding of the effects of shoreline development rely on available inferences from other waterbodies (e.g., Beauchamp et al. 1994, review by Kahler et al. 2000, review by Carrasquero 2001, Francis and Schindler 2006). One study of another deep, oligotrophic lake in Washington, Lake Crescent, concluded shallow nearshore areas of the lake are disproportionately responsible for foraging and breeding habitats for the whole-lake food web (Hampton et al. 2011). The same study found that residential development is associated with highly localized impacts to nearshore algae, phytoplankton, and invertebrate communities that may not be measurable through offshore sampling methodology (Hampton et al. 2011). Another recent study in Lake Tahoe, another deep, oligotrophic lake, found that elevated nearshore turbidity was directly correlated with wind, boat use, and lake currents (Alexander and Wigart 2013).

In Lake Chelan, managers have hypothesized that the relative influence of overwater structures and shoreline development is reduced because shoreline development is located 10s to 100s of feet away from the water's edge for much of the year as a result of the managed water levels in the Lake. It stands to reason that the exposed lake bed can help to limit effects of development on the aquatic ecosystem; however, the role of the water level fluctuation in mediating the effects of shoreline development has not been specifically investigated. In conclusion, additional research is warranted to better understand the role of the shoreline conditions and shallow littoral areas of the lake for foraging, rearing, and breeding of both native and introduced species. In the interim, policy makers will be charged with developing shoreline development standards based on the known conditions specific to Lake Chelan, and inferences from known ecological relationships in other lake systems.

Data Gaps

As noted above, additional research is needed to fully understand the effects of shoreline development on the Lake Chelan ecosystem. Questions that remain as data gaps and recommendations to address these data gaps are identified below. General recommendations are provided to address these data gaps. Specific sponsors and funding sources would need to be identified to implement the recommendations. In the past, the Chelan Public Utility District (PUD) sponsored studies of the food web dynamics of the Lake. State and federal agencies, as well as the PUD are engaged in long-term monitoring of the fish community in Lake Chelan.

- How do the effects of shoreline development interact with the lake food web? What is the relative importance of physical changes to the shoreline in relation to biotic communities and functions in Lake Chelan? How do the fluctuating lake levels affect the relative importance of shoreline development?

    - Recommendation: Conduct studies of littoral habitat usage in Lake Chelan, specifically in relation to overwater structures, shoreline stabilization, and natural cover on a seasonal basis.
- Is the existing species composition and food web of Lake Chelan sustainable?
    - Recommendation: Continue long-term research on species composition and diets. The Washington Department of Fish and Wildlife, National Park Service, National Forest Service, and Chelan (PUD) have developed long-term fisheries monitoring plans (National Park Service et al. 2013).

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