TECHNICAL MEMORANDUM

Twin Lakes Area Habitat Assessment

Prepared for

Aspect Consulting

May 2010

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Prepared for

Aspect Consulting
179 Madrone Lane North
Bainbridge Island, WA 98110

Prepared by

Herrera Environmental Consultants
2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121
Telephone: 206.441.9080

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Executive Summary

A habitat assessment and lake water level fill scenario analysis was completed by Herrera Environmental Consultants (Herrera) for Aspect Consulting (Aspect) to assist them, Ecology, and the Twin Lakes Aquifer Coalition (TLAC) in their evaluation of options related to the raising of water levels in Barnsley Lake, Big Twin Lake, and Little Twin Lake near Winthrop, Washington. Herrera conducted a rapid field habitat characterization on November 12, 2009 that, in addition to other available sources of information, will support evaluation of potential impacts of Aspect's modeled lake level change scenarios on fish and wildlife habitat (i.e., WDFW, InfOnly, 300 acres feet per year [afy], and 400 afy; see Appendix A).

In general, based on this assessment and only considering effects within the Twin Lakes study area[1], implementation of any of the scenarios would result in benefits to fish and wildlife habitat in these lakes in the long term, although some adverse effects may result in the short term.

A summary of the findings of the four lake level fill scenarios and their associated benefits related to provision of habitat, reduction of invasive species, minimization periodic vegetation die-back (i.e., "reservoir effect"), and lake bank stability is provided in Table 1.

Of the scenarios evaluated, the 400 afy fill scenario (1) most quickly achieves the target water level elevation at Big Twin Lake and Little Twin Lake (however projected to create water levels that are even higher than the target level), and (2) provides the lowest risk of a wet-dry condition at the Barnsley Lake area.

[1] This assessment does not consider potential impacts to fish and wildlife habitat in the Methow River or its watershed, as such analysis was not included in the scope of the work performed by Herrera. These impacts should be considered in evaluating the various fill scenarios.

Table 1. Summary of the level of benefits associated with water level change scenarios at Big Twin, Little Twin, and Barnsley Lakes.

	Big and Little Twin Lakes			Barnsley Lake		
Scenarios / Lakes	Fish and wildlife habitat provision and reduction of reed canarygrass (i.e., achievement of target lake levels)	Minimization of reservoir effect and new invasive species establishment (i.e., minimization of lake level fluctuation)	Lake bank stability	Fish and wildlife habitat provision and reduction of reed canarygrass (i.e., achievement of target lake levels)	Minimization of reservoir effect and new invasive species establishment (i.e., minimizing lake level fluctuation)	Lake bank stability
WDFW	High	Low	Moderate	Low	High	High
InfOnly	Low	Moderate-High	Moderate	High	Low	High
300 afy	Moderate-High	High	Moderate	Low	Moderate-High	High
400 afy	High	Moderate-Low	Moderate	High	Moderate-Low	High

All scenarios simulate TLAC transfer of water from wells located in close proximity to the Methow River. For the WDFW, 300 afy, and 400 afy scenarios, well discharge is directed first to Big Twin Lake and upon reaching target elevation, is then directed to Barnsely Lake. After Barnsley Lake fills, discharge is directed to the infiltration galleries located between Big Twin and Barnsley Lakes. For the InfOnly scenario, water is directed only to the infiltration galleries. Withdrawals are as follows:

WDFW Scenario – Withdrawals are limited the DFW withdrawal window – April 1 to July 15 when flows at the Methow River at Winthrop gage station are between 800 and 6,000 cfs.

300 afy – Withdrawals evenly distributed between April 1 and September 30 (50 af/month)

400 afy – Withdrawals evenly distributed between April 1 and September 30 (67 af/month).

Inf Only – 400 afy – Withdrawals evenly distributed between April 1 and September 30 (67 af/month).

Introduction

This habitat assessment and lake water level fill scenario analysis and report was completed by Herrera Environmental Consultants (Herrera) to assist in evaluation of options related to the raising of water levels in Barnsley Lake, Big Twin Lake, and Little Twin Lake[2] (collectively also referred to in this report as the Twin Lakes study area) near Winthrop, Washington. Herrera conducted a rapid field habitat characterization on November 12, 2009 that, in addition to other available sources of information, will support evaluation of the potential impacts of modeled lake level change scenarios (see Appendix A) on fish and wildlife habitat.

Although target water levels and the projected equilibrium water levels for each of the lakes under each fill scenario has been determined, the mechanism by which these levels shall be achieved is not yet decided. The target water elevation for Big Twin Lake and Little Twin Lake is 1798.0 feet and the target level for Barnsley Lake is 1780.5 feet (Aspect Consulting 2009a).

This assessment also intends to provide a range of expected outcomes and considerations from the habitat perspective associated with the fill scenarios. This includes a discussion of the projected biological effects during lake level rise (as a product of anticipated biological effects of the anticipated lake level fill rates and fluctuations associated with the four fill scenarios) and the overall anticipated biological changes as a result of increased lake level and fluctuation once filled. In addition, this document qualitatively addresses lake bank stability associated with the fill scenarios.

This assessment does not consider potential impacts to fish and wildlife habitat in the Methow River or its watershed.

[2] Dibble Lake was also included in this assessment as a secondary consideration. Dibble Lake does not have a target water level elevation under this project, but it is expected to rise in conjunction with hydrologic inputs to the other lakes, as discussed in the Results section of this report.

Methods

The following section provides a description of the methods used to conduct the habitat assessment, which included a brief review of existing information and a rapid field characterization of habitat conditions at each lake. A qualitative visual assessment of lake bank substrate type and stability was also performed at each study area.

Analysis of Modeled Lake Level Change Scenarios

Lake level change scenarios and target water elevations provided to Herrera by Aspect Consulting were reviewed as part of this assessment. The predicted fluctuations in lake water levels were first interpreted, and then a discussion of their projected effects on habitat conditions was developed. This was prepared in concert with an exploration of overall biological effects during an increase in lake level and upon reaching target water levels, and the implications such effects might have for fish and wildlife habitat in the immediate Twin Lakes study area.

Review of Existing Information

The following background materials were reviewed to assist in the habitat assessment and the analysis of the lake water level change scenarios:

- Draft Memorandum: Preliminary Feasibility Assessment of Multipurpose Storage for the Twin Lakes Area (Aspect Consulting 2009a)
- High resolution aerial imagery (Aspect Consulting 2009b)
- Okanogan County Soil Survey (NRCS 2009)
- Twin Lakes Aquifer Recharge Project Final Interim Report (IRZ Consulting 2003[3])
- Geology of the Methow Valley (Barksdale 1975)

[3] It is understood that the Washington Department of Ecology has identified potential inaccuracies in this report, and therefore it was used only to provide general background information for the purposes of this assessment.

Habitat Assessment

As mentioned, field work was conducted to complete the habitat assessment of Barnsley Lake, Big Twin Lake, and Little Twin Lake. Habitat characteristics were assessed by walking the four study areas and documenting conditions with hand written and voice-recorded notes, photographs, and GPS points. Effort was made to carefully document the habitat lying within the zone that will be newly submerged and within the projected riparian zone following execution of the selected scenario or combination of scenarios and attainment of the target lake water levels.

A fourth lake, Dibble Lake, was also assessed during the field visit, but as a secondary consideration. Since this site was of secondary consideration and was not included in Herrera's scope of work, this assessment was more abbreviated and consisted of a brief field characterization and a less detailed discussion of potential biological effects.

A rapid field assessment of bank substrate composition and stability was also performed at each of the lakes. This was accomplished by walking along the banks of each lake and documenting general substrate type and soil texture, relative bank cohesion, and vegetation characteristics, and the presence of erosion features. The bank assessment was performed using the same approach described above and focusing on all areas in the vicinity of the existing ordinary high water mark to areas lying within proximal elevations to target water levels.

Results

Analysis of Modeled Lake Level Change Scenarios

As stated previously, the target water elevation for Big Twin Lake and Little Twin Lakes is 1798.0 feet and the target level for Barnsley Lake is 1780.5 feet. What follows is a description of the results from the interpretation of each of the four lake level change scenarios provided by Aspect (2009a): WDFW, InfOnly, 300 acres feet per year (afy), and 400 afy (see Appendix A). These interpretations have been integrated with the findings from the habitat assessment to develop the predictions of subsequent biological effects provided in the Discussion section of this report.

WDFW Scenario

Big and Little Twin Lakes

This scenario results in the most rapid achievement of target lake levels and also the highest fluctuation at Twin Lakes (slightly more than two feet upon reaching equilibrium). Although long-term average withdrawals are about 270 afy, the WDFW scenario achieves the target 1798.0 lake elevation more quickly than the 300 afy and 400 afy scenarios, due to the relatively greater water availability and higher withdrawal rates simulated for the first years of operation.

Barnsley Lake

This scenario does not facilitate achievement of the target water level for Barnsley Lake as provided by the model (ending 2027). However, the water level fluctuation is less than that associated with all the other scenarios, at approximately 0.75 feet upon reaching equilibrium.

InfOnly Scenario

Big and Little Twin Lakes

This scenario does not achieve target water levels at Twin Lakes; it results in the lowest overall levels here. However, this scenario does result in the second lowest degree of water level fluctuations at these lakes.

Barnsley Lake

Target water levels are achieved, and exceeded, most rapidly at Barnsley Lake under this scenario (approximately in 2012), but also exhibit the greatest fluctuations once equilibrium is reached (approximately two feet). This scenario also results in the highest overall annual water levels, at approximately 1781 feet.

300 afy Scenario

Big and Little Twin Lakes

Of the scenarios that achieve target water elevations at Twin Lakes, this scenario results in the longest required fill duration to reach those levels, which occurs in year 2017. However, once the target water elevation is reached, this scenario offers the least degree of fluctuation as compared to the other scenarios (approximately one foot).

Barnsley Lake

This scenario does not achieve the target water level for Barnsley Lake as provided by the model (ending in 2027). However, the water level fluctuation is the second lowest of all the scenarios, at approximately one foot upon reaching equilibrium.

400 afy Scenario

Big and Little Twin Lakes

This scenario most rapidly achieves target lake levels and exhibits the second highest fluctuation at Twin Lakes (slightly less than two feet upon reaching equilibrium). This scenario also produces the highest lake levels overall, at an annual average of 1799 feet once equilibrium is reached, which is one foot higher than the target level of 1798.

Barnsley Lake

This scenario results in the second most rapid achievement of target lake levels at Barnsley Lake, as well as the second greatest degree of fluctuations once equilibrium is reached. It also results in the second highest annual average water level elevations at this lake.

Habitat Assessment

Overview

The Twin Lakes area study area is located in the Methow Valley approximately 1-2 miles southwest of Winthrop, WA. The lakes are situated on a glacial outwash terrace, and the lake formations themselves are considered “glacial kettles” (Barksdale 1975). The climate of the central Methow Valley is semi-arid, with hot, dry summers, and cool winters.

Hydrology for the lakes is primarily driven by groundwater, stormwater runoff, and precipitation. Annual variation in lake levels is typical, with lake levels being highest in the summer during peak snowmelt, and lowest in the winter when precipitation falls mainly as snow.

Big Twin Lake, Little Twin Lake, and Dibble Lake are utilized by (triploid) rainbow trout (*Oncorhynchus mykiss*) and also by Lohantan trout (*Oncorhynchus clarki heshawi*), and these lakes are stocked annually by WDFW. No fish are present in Barnsley Lake due to the lack of year-round surface water.

Wildlife supported by the habitat within the study area include species that commonly utilize riparian habitats within the Methow Valley, such as mule deer (*Odocoileus hemionus*), coyote (*Canis latrans*), squirrels (*Spermophilus* spp.), common loon (*Gavia immer*), mallard (*Ana strepera*), Canada geese (*Branta canadensis*), great blue heron (*Ardea herodias*), red winged blackbird (*Agelaius phoeniceus*), songbirds (e.g., chickadees (*Poecile* spp.)), pileated woodpecker (*Dryocopus pileatus*), painted turtle (*Chrysemys picta*) and other amphibians, bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos)*, osprey (*Pandion haliaetus*), and red tailed hawks (*Buteo jamaicensis)*

Site Observations

During the field work conducted on November 12, 2009, weather conditions were clear and approximately 30ºF. Field activities included the habitat assessment methods described in the previous section, in addition to discussions with Aspect Consulting project team consisting of Erick Miller and Joseph Lubischer and TLAC members Dick Ewing, Robert Waltham, and Ben Johnson, Twin Lakes Campground owner, regarding current and historical site conditions and other site and project related information.

Because of the time of year[4] and recent cold weather, most on site vegetation in each of the study locations was in various stages of dormancy: deciduous woody trees and shrubs had lost many of their leaves and flowering/fruiting bodies, and many of the herbaceous species had senesced. Fortunately, dry weather had provided for the preservation of various vegetative and flowering characteristics of most species, which permitted positive plant identification to level of detail needed for this assessment.

In general, a sharp transition exists from riparian to upland vegetation along an elevation gradient associated with the lake banks due to the relatively exposed landscape and the dry climatic conditions during the growing season in the Methow Valley. Cattail (*Typha latifolia*), softstem bulrush (*Schoenoplectus tabernaemontani*), quaking aspen (*Populus tremuloides*), black cottonwood (*Populus trichocarpa*) serviceberry (*Amelanchier alnifolia*), bitter cherry (*Prunus emarginata*), black hawthorn *(Crataegus douglasii*), and willow (*Salix* spp.) rapidly transition to shrub-steppe vegetation, such as bitterbrush (*Purshia tridentata*), bluebunch wheatgrass (*Agropyron spicatum*), and wax currant (*Ribes cereum*) or dry open forest dominated by ponderosa pine (*Pinus ponderosa*).

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[4] Observations of on-site fish and wildlife habitat utilization during this time of year are likely to differ notably from those that may have been made earlier in the summer or fall, when diversity and availability of forage is higher. Therefore, in addition to the fact that on-site assessments of wildlife usage were extremely brief in duration, much of the information presented herein draws upon information gleaned from background materials or from anecdotal information provided by local residents and TLAC members.

Due to the drop in lake water levels over the past decade, a gap between the shoreline emergent vegetation and relic riparian vegetation has developed. This intermediate zone, which is demarcated by the historic and existing water levels, is often occupied exclusively by reed canarygrass (*Phalaris arundinacea*), an aggressive invasive species common in disturbed riparian areas. Other invasive species observed within the upper elevations of this intermediate zone include knapweed (*Centaurea diffusa*), dalmatian toadflax (*Linaria dalmatica*), cheatgrass (*Bromus tectorum*), Russian thistle (*Salsola kali*), and bulbous bluegrass (*Poa bulbosa*).

In general, large woody debris (LWD) is virtually absent near the current lake level elevation, and it is much more common at the elevation of historic lake levels where relic riparian vegetation inhabits a narrow zone. Much of these trees and shrubs have exhibited die back or mortality once soil moisture decreased, resulting in significant amounts of downed wood. This wood will become available as habitat features to aquatic species once lake levels rise (including some logs 10+ inches in diameter). In addition, there is potential for revival (e.g., through root sprouting) of many of these trees and shrubs that have died back through renewed soil moisture levels associated with elevated lake levels.

Barnsley Lake

Barnsely Lake is approximately 10 acres in size and can be accessed from Twin Lakes Road, approximately 1.1 miles southwest of Winthrop, WA. Barnsley Lake is currently a seasonally inundated shallow depressional wetland characterized by palustrine emergent and palustrine scrub-shrub habitat. There was no surface water observed during the November 12, 2009 field visit. The deepest portion of the wetland is dominated by cattail, with softstem bulrush being a commonly observed subordinate species that occurs in monotypic stands in lower microtopographic areas. A dense stand of young (approximately 5-15 years old) quaking aspen and willow have established in the eastern portion of the wetland, likely following draw-down of water levels in the lake.

The area around periphery of the lake (upgradient from an abrupt cattail boundary) is dominated by reed canarygrass. In low gradient areas along the west and south shores, this reed canarygrass zone extends out into broad, shallow inlet topographic features. The southern periphery of the lake is characterized by a small stand of mature (30-60 year old) quaking aspen at the elevation of the historic lake shoreline, with some sporadic black hawthorn and ponderosa pine. Upgradient from the zone of reed canarygrass, habitat conditions become much drier quickly (as mentioned), transitioning from riparian vegetation or nonnative pasture grasses taking advantage of moist conditions to shrub steppe vegetation, such as bitterbrush and wax currant (Figures 1, 2, and 3).

Wildlife species listed above are known to utilize Barnsley Lake, and as mentioned, Barnsley Lake supported a large population of painted turtles when it was historically characterized by surface water (Ewing 2009).

An unnamed tarn that is located to the north of Barnsley Lake (and is projected to be affected by water level increases in Barnsley Lake) is characterized by heavily grazed pasture grasses and knapweed (Figure 4).

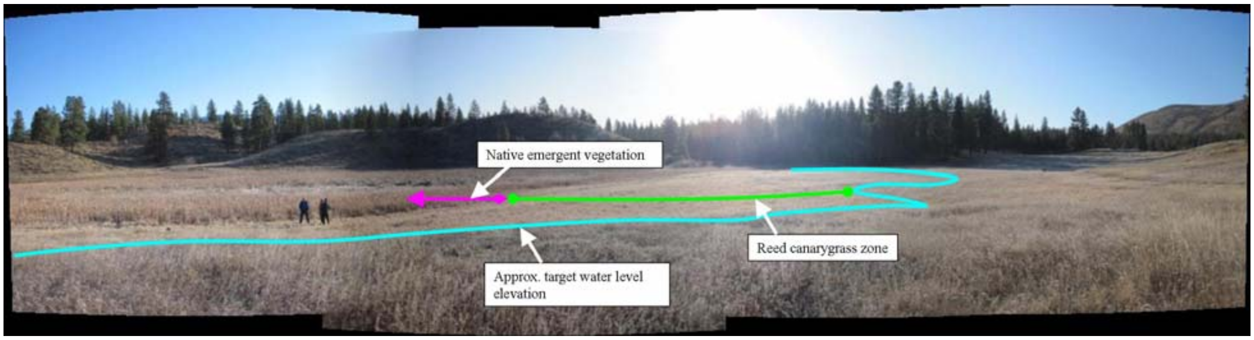

Figure 1. Panoramic photograph of Barnsley Lake (northwest shore) depicting target water level elevations and vegetation types.

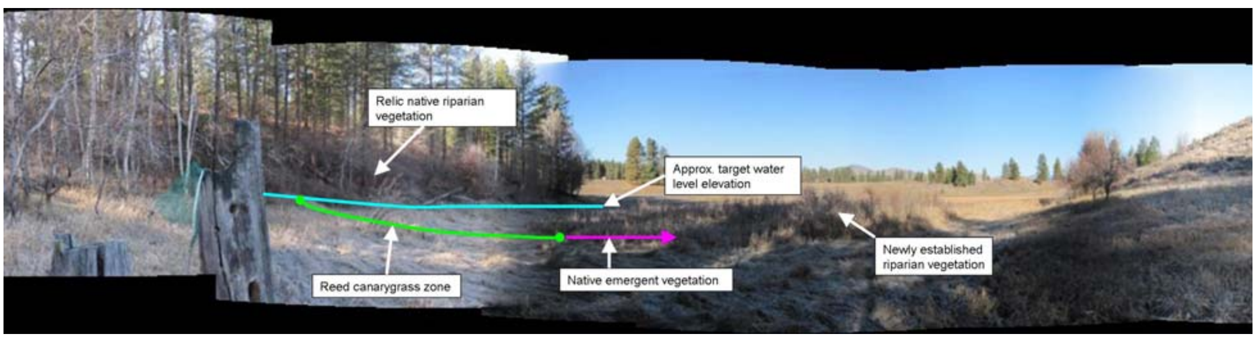

Figure 2. Panoramic photograph of Barnsley Lake (south shore) depicting target water level elevations and vegetation types.

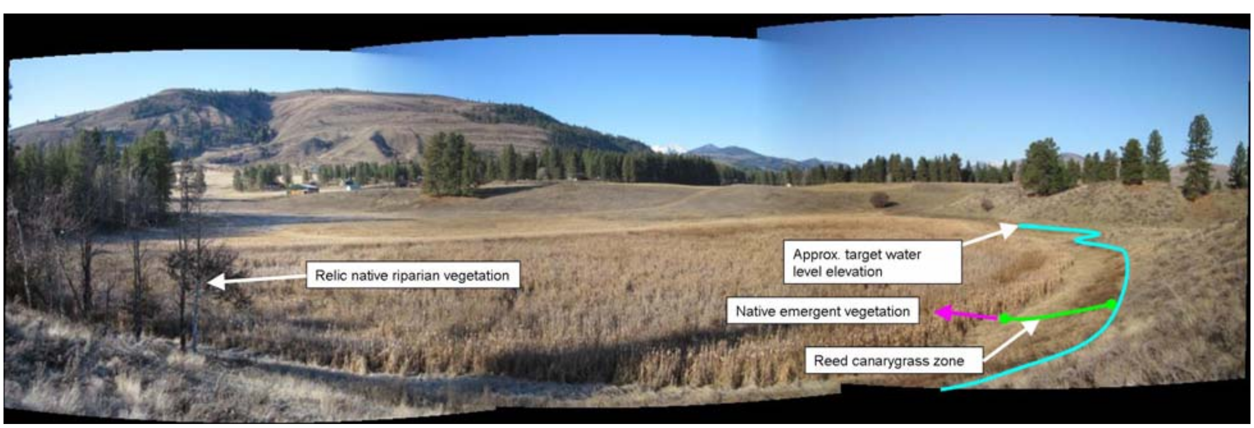

Figure 3. Panoramic photograph of Barnsley Lake (east shore) depicting target water level elevations and vegetation types.

Figure 4. Panoramic photograph of the unnamed tarn located to the north of Barnsely Lake.

Big Twin Lake

Big Twin Lake is approximately 79 acres in size, is located roughly two miles south of Winthrop, WA, and can be accessed via Big Twin Access Road (Figure 5). The water level elevation observed on the November 12, 2009 field visit was approximately1788.0 feet (Miller 2009). This lake is one of the largest lacustrine bodies of water in the Methow Valley, and it consequently attracts a host of wildlife species and also supports a productive trout fishery that has dwindled in recent years due to the lake drawdown. As stated before, the primary fish species in Big Twin Lake is rainbow trout that are stocked by WDFW to support the fishery.

Figure 5. Panoramic photograph of Big Twin Lake taken from the Big Twin Lakes Access Road.

The shoreline of Big Twin Lake is characterized by a concentric zonation of wetland plant species distributed along a soil moisture/inundation gradient associated with slope elevation (Figure 6). Shoreline vegetation mostly consists of herbaceous species, such as cattail and softstem bulrush, with some sporadic stands of young quaking aspen, black cottonwood, and shrubs, including serviceberry and willow along the southern end of the lake (Figure 7). In most locations, cattail occupies the deepest lacustrine emergent zone around the periphery of the lake, transitioning upgradient to softstem bulrush, toad rush (*Juncus bufonius*), Baltic rush (*Juncus balticus*), reed canarygrass, and nonnative grasses (e.g., cheatgrass). Some patches of woody vegetation, namely young quaking aspen, were observed near the current shoreline (some of these appear to have been planted), and older riparian trees, including black cottonwood and weeping willow (*Salix babylonica*), are found in the campground vicinity and at the southern end of the lake at the elevation of the historic shoreline (Figure 8). In the campground, regular watering allows for the presence/persistence of domestic turf grass; however the sharp transition to shrub steppe vegetation exists along the majority of the unmanaged shoreline. Some inlets and other broad, low gradient areas (e.g., lawn of campground) also occupy shoreline areas. Eurasian water milfoil (*Myriophyllum spicatum*) is common in Big Twin Lake.

Figure 6. Panoramic photograph of Big Twin Lake (from Twin Lakes Campground) depicting target water level elevations and vegetation types.

Figure 7. Panoramic photograph of Big Twin Lake (southern shoreline) depicting target water level elevations and vegetation types.

Figure 8. Relic riparian vegetation in the Twin Lakes campground.

Little Twin Lake

Little Twin Lake is approximately 23 acres in size, is located roughly two miles south of Winthrop, WA, adjacent to Big Twin Lake, and it can be accessed via Big Twin Access Road (Figure 9). The water level observed during the November 12, 2009 field visit was approximately 1787.5 feet (Miller 2009). This lake is characterized by habitat conditions and fish and wildlife utilization similar to Big Twin Lake. However, Little Twin Lake exhibits more woody debris and relic riparian vegetation at the elevation of the historic lake levels (just above the reed canarygrass zone) (Figure 10). Plant species occupying the riparian zone include serviceberry, mountain alder (*Alnus incana*), quaking aspen, bitter cherry, and Pacific willow (*Salix lucida ssp. lasiandra*), with considerable downed wood also found here. There are also many dead blue elderberry (*Sambucus cerulea*) in this area. Notable large, old, stressed Pacific willows occupy a portion of the historic shoreline elevation on the NW portion of the lake (Figure 11). High quality small snags suitable for wildlife as habitat were also observed near the proposed shoreline elevation (Figure 12). The northern shore of the lake is characterized by a large, low gradient inlet feature occupied primarily by reed canarygrass and other nonnative pasture grasses. Eurasian milfoil was also observed at Little Twin Lake.

Figure 9. Panoramic photograph of Little Twin Lake (northwest shoreline).

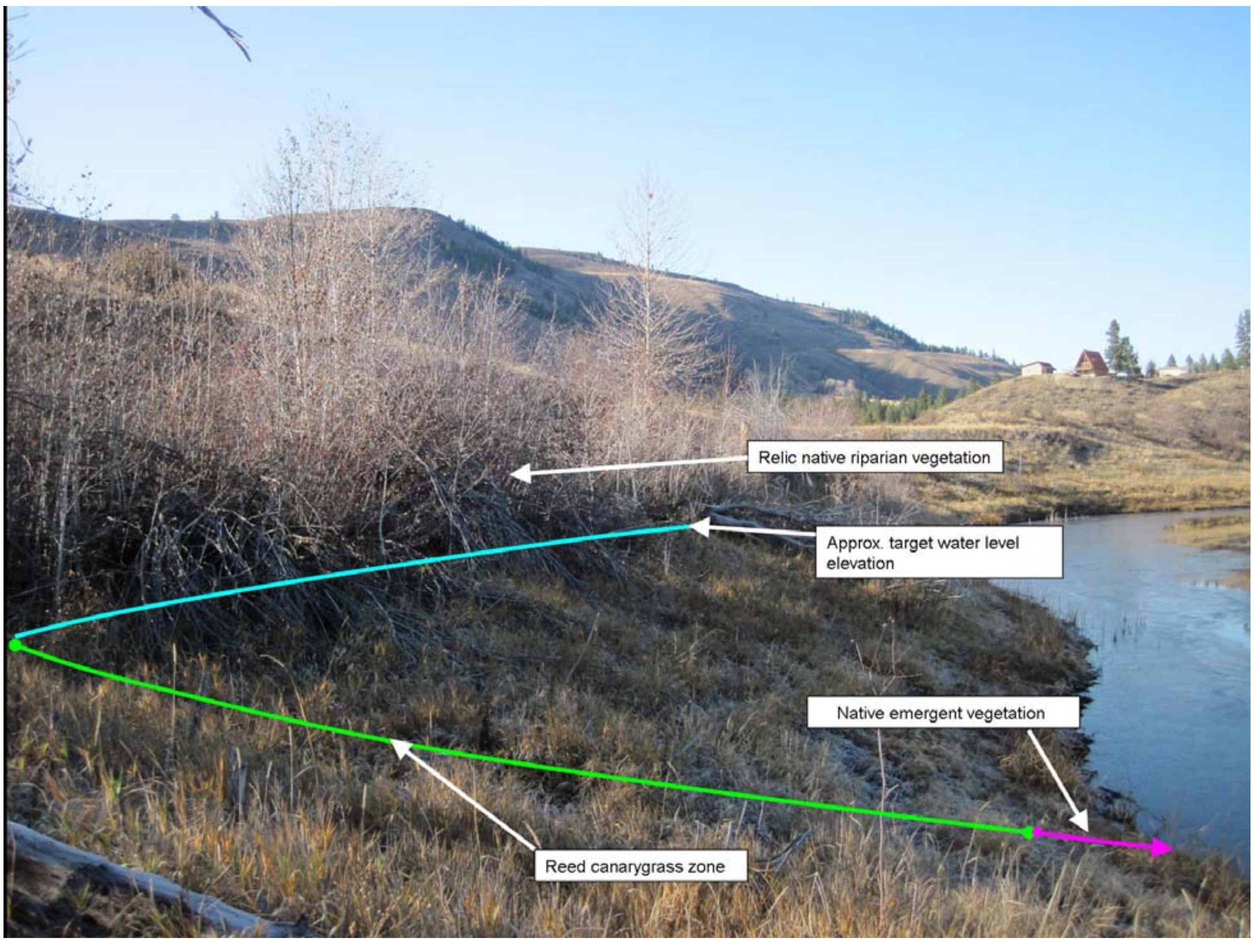

Figure 10. Panoramic photograph of Little Twin Lake (northwest shoreline) depicting target water level elevations and vegetation types.

Figure 11. Photograph of large, stressed Pacific Willow along northern shoreline on Little Twin Lake.

Figure 12. Photograph of snag observed on northwest shore of Little Twin Lake.

Dibble Lake

Dibble Lake is approximately 4.7 acres in size, is located roughly three miles south of Winthrop and is accessed via Wandling Road. As previously stated, Dibble Lake was included in the assessment as a secondary consideration (not included in Herrera's scope of work), and these results represent brief summary of limited observations made during the field visit.

Dibble Lake exhibits the steepest shoreline of all of the lakes in this study, and is characterized by the greatest amount and diversity of shoreline vegetation. The concentric zonation of plant communities characterizing the other lakes within the study area also occurs at Dibble Lake (Figure 13). Mature quaking aspen (40-60 years old) and a notable amount of downed wood occupy the majority of the historic shoreline area, but similar to the other lakes, the riparian vegetation is separated from the existing water line by a band of reed canarygrass. On the west and southern flank of the lake, a dense nootka rose (*Rosa nutkana*) thicket and serviceberry with an overstory of ponderosa pine occupy the historic lake level shoreline. Cattails are the dominant species lacustrine emergent zone. Wildlife utilization is similar to the Twin Lakes, however, songbirds are much more prominent here than waterfowl, which is a contrast to Twin Lakes.

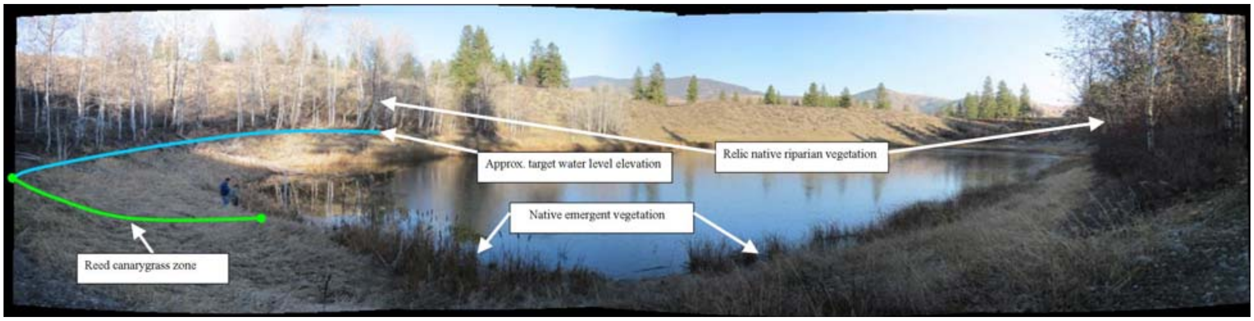

Figure 13. Panoramic photograph of Dibble Lake (west shoreline) depicting target water level elevations and vegetation types.

Lake Bank Substrate Characterization and Stability Assessment

Review of the Okanogan Soil Survey (NRCS 2009) revealed that soils in the study area were characterized mainly by the Owhi ashy fine sandy loam, 25 to 45 percent slopes, extremely stony soil mapping unit. This Owhi soil series consists of deep, well drained soils underlain by very gravelly coarse sand. These nearly level to steep soils are on terraces and terrace escarpments, and they formed in glacial outwash. Large gravels and cobbles is surface soil layers are common in the Owhi map unit characterizing the study area. Runoff is rapid and the hazard of erosion is high due to the steep grade.

Haley ashy fine sandy loam, 8 to 25 percent slopes was a subordinate soil map unit found in the study area, occupying the northwest shore of Barnsley Lake and the entirety of the unnamed tarn to the north of Barnsley Lake (NRCS 2009). The Haley soil series consists of deep, well-drained soils underlain by sand. Like the Owhi series, these nearly level to steep soils are also on terraces and terrace escarpments and were formed in glacial outwash. Runoff is medium, and the hazard of erosion and soil blowing is moderate (NRCS 2009).

Observation of shoreline bank conditions within the study area during the field visit agreed with the information provided in the soil survey. Soil texture field tests determined the presence of cobbly and gravelly fine sandy loams in most areas. Evidence of previous erosion of lakeshore areas was observed, with some limited areas of exposed soil, namely at Big and Little Twin Lakes (Figure 14 and 15). Most often, erosion was evidenced by a thick layer of cobbles and large gravels, indicating the likely removal of the sandy loam matrix over time through both stormwater runoff, precipitation, and lake level fluctuations. However, most lakeshore areas (at current and target lake levels) are vegetated at between 60 and 100% cover by herbaceous and/or woody plant species: this high vegetation coverage minimizes soil loss.

Figure 14. Photograph of substrate conditions at Big Twin Lake.

Figure 15. Photograph of substrate conditions at Little Twin Lake.

Discussion

The following discussion addresses the likely (1) biological effects on the existing fish and wildlife habitat, and (2) lake bank stability effects associated with increasing water levels at Big Twin Lake, Little Twin Lake, and Barnsley Lake. As previously stated, this discussion is based on review of existing information and a rapid (one-day) field assessment. Extensive monitoring of biological communities may be necessary to determine actual impacts to fish and wildlife habitat arising from changes in lake levels under any of the proposed scenarios.

The subsection that addresses biological effects is organized as a time-series discussion with two project stages: (1) during lake water level rise, and (2) following achievement of target or equilibrium lake water levels. The portion of the section that addresses effects during lake water level rise includes both a general discussion of biological effects associated with this stage and an analysis of the various effects associated with each of the four model fill scenarios in terms of the anticipated rate of water level rise and fluctuation.

The subsection that addresses lake bank stability effects of scenario implementation discusses physical and biological site characteristics that contribute to bank stability, including, but not limited to, slope, substrate, and vegetation.

Biological Effects

During Lake Level Rise

Overview

Wetland hydrology is described in terms of hydroperiod, which is the seasonal occurrence of flooding and/or soil saturation characterizing a given site. Different species of wetland plants are adapted to different hydroperiods and exhibit various mechanisms for tolerating the anoxia associated with hydric soils. Facultative wetland plant species are equally likely to occur in wetlands as in nonwetlands, whereas obligate wetland plant species almost always occur in wetlands under natural conditions. Although many of the existing native emergent plants that will become submerged under any of the scenarios are obligate wetland species (e.g., cattail, softstem bulrush) the extent of this water level rise (greater than 11 feet in some cases) will be more than what can be tolerated by even these species. An increase in water levels to the extent proposed in this project will result in vegetation loss in newly submerged areas – sudden flooding induces shock-level anoxic conditions to riparian vegetation, aerobic respiration ceases in root systems, eventually resulting in plant mortality. With the submergence of a significant amount of herbaceous vegetation, the potential exists for a temporary decrease in dissolved oxygen levels and production of methane as the plant material breaks down in the anoxic underwater environment through anaerobic decomposition.

Effects in the Transition Zone

As mentioned before, reed canarygrass currently dominates the transition zone between shoreline emergent vegetation and relic riparian vegetation. An explanation for the dominance of reed canarygrass in this area may be attributed to the change of hydrologic conditions associated with lake level decline. The relatively rapid drop in lake levels likely resulted in the exposure of significant areas of bare soil, which were likely quickly colonized by the emergent vegetation already present on site. Some areas were undoubtedly quickly invaded by reed canarygrass, a common and aggressive riparian invasive species tolerant of inundation, but some areas were likely able to maintain native characteristics due to the ability of some of the more aggressive native emergent species (e.g., cattail and bulrush) to spread rapidly through vegetative propagation.

One potential explanation for this observed condition is that this native emergent vegetation that historically occupied shoreline areas adjacent to riparian woody vegetation crept downslope with retreating lake levels: these species are tolerant of a higher degree of inundation than reed canarygrass (therefore outcompeting it), but they were likely unable to compete with reed canarygrass in higher elevation, drier areas. Following, a starkly obvious and ever-widening zone of monotypic reed canarygrass may have established for this reason around all of the lakes in soil moisture regimes where these other emergent species cannot compete.

The target lake levels have been set at the historic ordinary high water mark, which is an elevation that coincides with the upslope extent of the reed canarygrass zone and the downslope extent of the existing relic riparian vegetation. Since maximizing interaction between the existing riparian vegetation (and associated habitat features) and the aquatic environment will provide substantial benefit to fish and wildlife (i.e., will increase habitat surface area and volume and provide habitat partitioning and complexity), it is desirable to select the scenario or combination of scenarios that achieves this goal. Also, setting target lake levels here will have the added benefit of submerging the reed canarygrass, which has been shown to be a somewhat effective control technique if frequency and duration are sufficient (Jenkins et al. 2008).

Given the presence of the reed canarygrass zone, the benefits provided at water level increases intermediate between existing and target levels likely are only related to increased **quantity** (surface area/volume) of habitat. Once target levels are reached, however, there is a significant jump in the **quality** of habitat conditions in areas characterized by notable amounts of relic riparian vegetation, especially at Little Twin Lake and Dibble Lake.

Effects on Habitat Availability: Quantity and Quality

An increase in water volume in the lakes will translate to an increase in surface area available for aquatic species utilization at a greater range of depths. The amount and quality of newly available habitat will vary based on the bank slopes, bathymetry of lakes, and habitat features present. An increase in volume in broad shallow areas along the banks will make available much more habitat area (shallow water habitat) than in steep gradient shorelines. An increase in volume that submerges previously unavailable habitat features (e.g., downed wood) will provide greater functional lift (i.e., increased partitioning and complexity) than a volume increase that does not. These effects may counterbalance themselves within the study area due to the fact that most of the opportunities within the study area for large increases in habitat surface area are not characterized by notable amounts of habitat features. For example, most of the broad, shallow inlets mentioned previously are covered by reed canarygrass and other nonnative pasture grasses, which provide little habitat benefit to aquatic species. An increase in lake water levels here will significantly increase the quantity of available underwater surface area, but this habitat is not high in quality because it is characterized almost exclusively by monotypic, reed canarygrass stands and few habitat features (e.g., northern inlet of Little Twin Lake). In contrast, an increase in water levels in some cases (e.g., Dibble Lake) may not substantially increase the quantity of habitat available to aquatic species, but may facilitate the access to habitat features and the provision of associated functions (e.g., overhanging riparian vegetation), thereby significantly increasing the quality of habitat.

Barnsley Lake (including inlets at west and south shores of the lake), the unnamed tarn, and the inlet at the north end of Little Twin Lakes will exhibit the largest changes in surface area covered by water with lake level increases. Dibble Lake, with its steep banks, in contrast will change very little in terms of newly accessible surface area. At Little Twin Lake, there is the potential for an area approximately 1/3 the size of the lake to become new aquatic habitat. This area is currently dominated by reed canarygrass, and will likely be submerged if target levels are reached. Similarly at Big Twin Lake, inlets and broad, shallow areas (e.g., lawn of campground) just above the existing lake levels will then become newly inundated and available aquatic habitat, although not high in quality.

The potential exists for significant changes in fish prey resources (invertebrate and insect populations) and food web dynamics as the waterline shifts upslope and in closer proximity to the more diverse, relic native riparian vegetation instead of reed canarygrass. These trees and shrubs will transition from providing little influence to aquatic conditions, to playing a significant role in water quality, nutrient cycles, and aquatic habitat. For example, their increased proximity to the shoreline will facilitate a greater input of associated invertebrates and insects directly into the water, and the shade they provide will moderate water temperatures during the hot summer months, particularly in shallow areas.

"Reservoir Effect"

In general, greater fluctuations of lake levels will result in a wider zone of affected habitat, creating a periodic or seasonal die-back in vegetation, or "reservoir effect", around the perimeter of the lake. The changes within this fluctuation zone will likely include loss of vegetation and potential encroachment by opportunistic species (both native and nonnative) during periods of low water. This effect will be more pronounced in areas when lake banks have a low slope angle (such as the inlet at Little Twin Lake and at Barnsley Lake) rather than a high slope angle (such as at Dibble Lake) because the surface area of vegetation affected will be much greater for a given change in water volume. Greater lake level fluctuations will likely result in the preclusion of establishment by woody riparian species in this zone, which are unable to tolerate such variation in soil moisture regimes.

Attractive Nuisance Risk

Based on this assessment, this risk only appears to be an issue at Barnsley Lake, where currently no surface water exists; careful consideration of the different fill scenarios with respect to their implications for the development of an "attractive nuisance" for local wildlife is required. Given the rapid die-off of the painted turtle population that reportedly resided in Barnsley Lake following receding water levels (Ewing 2009), care must be taken to select a fill scenario that minimizes fluctuation here so that wildlife are not "tricked" into expecting high, year-round surface water when the fill scenario oscillates between surface water and ground-water only conditions. This statement is also reflective of the consideration that must be given to projected changes in hydrology characterizing the unnamed tarn located to the north of Barnsley Lake.

All of the fill scenarios provided in this analysis project year-round surface water conditions at Barnsley Lake (Aspect Consulting 2009a). However, there is greater chance that the lake could become dry during a drought year under the WDFW and 300 afy scenarios, because these scenarios would result in a lower overall equilibrium water level. Since, the oscillation between wet and dry conditions could have significant repercussions for wildlife, selection of a fill scenario (or combination of scenarios) that decreases the risk of creating an attractive nuisance at Barnsley Lake would have less impact on resident wildlife.

Analysis of Lake Level Fill Scenarios

A relatively complicated analysis is required to address the biological implications associated with the lake level fill scenarios given that the effects of each scenario at each lake need to be assessed in tandem (i.e., lake effects related to fill scenarios are not independent from each other). Projected effects, including some of the benefits and drawbacks of the various scenarios to affected habitat, are provided herein. However it is recommended that thorough consideration be given to the convoluted interaction effects[5] intrinsic to each scenario, including how they are manifested in terms of community priorities[6] – which is a task that is out of Herrera's scope of work.

This qualitative assessment provides a platform for initiating these discussions, but it is by no means a comprehensive analysis. Without a quantitative assessment of biological effects, it is difficult to determine with certainty which option will result in the least impact to habitat and lake quality for all lakes due to these complicated interaction effects. Monitoring habitat changes during lake level fluctuations will provide an indication of which sites may be more resilient to such changes, which may enable the TLAC to fine-tune their approach through an adaptive management framework.

[5] For example, using the 300 afy scenario: low fluctuation at Big Twin is desirable, but a failure to meet target levels at Barnsley Lake is undesirable.

[6] For example, the question of whether the prevention of an obvious reservoir effect at Big Twin Lake is more important to the community than achieving target water levels at Barnsley Lake.

What follows is a synopsis of predicted biological effects associated with the various fill scenarios based on the Analysis of Lake Level Change Scenarios portion of the Results section presented earlier in this report:

WDFW Scenario

Under the WDFW scenario, interaction between the existing relic riparian vegetation and the aquatic environment will occur the soonest out of any of the scenarios at Big and Little Twin Lakes, but the reservoir effect here will also be the highest of all the scenarios. This scenario does not allow for the achievement of target lake levels at Barnsley Lake, and therefore precludes significant interaction between existing relic vegetation and the aquatic environment here. In addition, there is a greater risk of oscillation between surface water presence and absence during drought years as compared to the 400 afy and InfOnly scenarios (Aspect Consulting 2009a). The WDFW scenario would have the lowest overall reservoir effect at Barnsley Lake due to the low projected fluctuation in water levels.

InfOnly Scenario

Under the InfOnly scenario, only minimal interaction between existing relic riparian vegetation and the aquatic environmental will occur at Big and Little Twin Lakes because target water levels will not be reached. The reservoir effect at Big and Little Twin Lakes will be relatively low, while it is the highest of all the scenarios at Barnsley Lake. This will have significant effects on the broad shallow areas adjacent to the northwest shore of Barnsley Lake. Target water levels will be achieved most rapidly (and exceeded) at Barnsley Lake under this scenario.

300 afy Scenario

The 300 afy scenario requires the longest duration to achieve target lake levels at Big and Little Twin Lakes, and therefore interaction between the existing relic riparian vegetation and the aquatic environment is delayed compared to the other two scenarios that achieve target levels at these lakes. However, this scenario results in the smallest potential reservoir effect at Big and Little Twin Lakes due to lower water level fluctuations. At Barnsley Lake, this scenario does not achieve target water levels and therefore does not facilitate significant interaction between the small amount of existing relic riparian vegetation and the aquatic environment. In addition, there is a greater risk of oscillation between surface water presence and absence during drought years as compared to the 400 afy and InfOnly scenarios (Aspect Consulting 2009a). The reservoir effect at Barnsley Lake under this scenario would be the second lowest of all the scenarios.

400 afy Scenario

Under the 400 afy scenario, water levels are achieved quickly at all lakes, maximizing the potential for interaction between the aquatic environment and existing relic riparian vegetation. However, this scenario results in the second highest water level fluctuations, and therefore relatively high potential reservoir effect at all lakes within the study area.

Summary

In general, based on this assessment and only considering effects within the Twin Lakes study area[7], implementation of any of the scenarios would result in benefits to fish and wildlife habitat in these lakes in the long term, although some adverse effects may result in the short term.

It is most desirable from the habitat perspective to consider implementation of the scenario or combination of scenarios that (1) most closely and most rapidly achieves target water levels at Big Twin and Little Twin Lake (and consequently Dibble Lake) to maximize the interaction between the aquatic environment and existing relic vegetation (with an added benefit of flood-shocking the reed canarygrass), (2) minimizes the reservoir effect and the potential for invasive species establishment in the fluctuation zone created by drawdowns during the summer months, and (3) minimizes the risk of oscillation between surface water presence and absence to prevent the development of an attractive nuisance to wildlife.

The 400 afy scenario is the fill scenario that both (1) most quickly achieves the target water level elevation at Big Twin Lake and Little Twin Lake (however projected to create water levels that are even higher than the target level), and (2) provides the lowest risk of a wet-dry condition at the Barnsley Lake area.

However, if dry conditions at Barnsley Lake during the winter are not of particular concern (due to limitations on wildlife usage while the water is frozen), the 300 afy scenario may prove more appealing due to the fact that fluctuations at Big Twin Lake would be approximately half that of the other scenarios, thereby minimizing the reservoir effect at this location.

A summary of the findings of the four lake level fill scenarios and their associated benefits related to provision of habitat, reduction of invasive species, minimization periodic vegetation die-back (i.e., “reservoir effect”), and lake bank stability is provided in Table 1.

Following Achievement of Target or Equilibrium Lake Levels

Overview

Once equilibrium of lake water levels is reached, a new riparian zone (the vegetation community within close proximity to the shoreline) will develop, comprising species best adapted to the new shoreline conditions and hydroperiod. This adaptation will be a product of natural plant establishment via competition among species for the water resources associated with these unique lacustrine features in this water-limited landscape. Functions associated with habitat features, such as downed wood and snags, will vary according to the characteristics of the existing shoreline and the water level elevation at which equilibrium is reached.

[7] This assessment does not consider potential impacts to fish and wildlife habitat in the Methow River or its watershed.

As described earlier, the potential exists for loss of native emergent vegetation upon relatively rapid lake level rise all of the scenarios; although a significant seed bank is likely present for these species, the proposed new shoreline is already occupied by well-established, dense reed canarygrass stands, which would create significant hurdles to establishment of other emergent species. For this reason, control of reed canarygrass and enhancement of native vegetation establishment (e.g., via planting) upon achievement of lake level equilibrium is encouraged. Monitoring will be an essential component of any strategy to ensure that adaptive management is targeted in such a way that successfully minimizes negative habitat effects. Given the significant deer populations in the vicinity, and the evidence of browse in the study area, browsing protection will be essential for the survival of any installed plant material.

Effects associated with water level fluctuation once filled

As stated in the During Lake Level Rise section with the discussion of the various scenarios, lake level fluctuations will result in stress to the vegetation community within the fluctuation zone. The greater the fluctuation, the more pronounced an undesirable reservoir effect will result. In addition to having a positive effect on lake aesthetics, selection of the scenario, or combination of scenarios, that minimizes this effect will also (1) minimize effects to fish and wildlife by maximizing the interaction between the aquatic environment and the existing relic riparian vegetation occupying target lake level elevations, and (2) minimize the opportunity for invasive species establishment in unvegetated areas during drawdowns.

Lake Bank Stability

Lake Bank stability (i.e., the ability to counteract erosion or gravity forces) is a combined product of slope, substrate, and vegetation, and the interaction between these three variables. The greater the slope angle, in general, the higher the risk of erosion due to precipitation and stormwater runoff and subsequent sheer forces. Substrate characteristics, including soil texture, structure (e.g., compaction), and degree of alteration, affects slope stability in a myriad of ways. Vegetation, particularly native species, significantly affects slope stability through functions such as root cohesion, abatement of precipitation impacts via interception, and provision of roughness to reduce erosion.

Interaction effects among the three variables are innumerable: alteration of substrate properties or vegetation conditions will have substantial effects on lake bank stability, and results will vary depending on bank slope. For example, soil texture will influence vegetation type (e.g., more compacted soils often result in greater difficulty of vegetation establishment), effects of vegetation alteration on bank stability will depend on substrate type (e.g., less consolidated soils are at higher risk of erosion upon removal of vegetation than more compacted soils, in general), and slope angle influences the importance of either of these factors in maintaining slope stability (e.g., root cohesion plays a highly significant role on steeper slopes).

Significant fluctuations in water levels, and subsequent dieback and/or denuding of vegetation, may have impacts on slope stability due to a loss of root cohesion. Since most of the vegetation surrounding the lakes is herbaceous, which provides less soil-binding functions than shrubs and trees, these impacts will likely be limited to the upper soil horizon. This type of erosion, in which the upper layer loamy sand matrix is removed, leaving behind a dense layer of cobbles and gravel, was observed in a few locations around Big Twin Lake and Little Twin Lake. This effect is a potential result of (1) historically fluctuating water levels and associated erosive forces, (2) aeolic (wind) erosion given the high winds common in the area, (3) stormwater runoff, (4) and impacts to vegetation due to trampling and human use.

Since substantial historic water level fluctuations have been common at all of the lakes within the study area, it is unlikely that any of these scenarios (which don’t result in water level fluctuations beyond the boundaries of previous water level extents) will have a significant impact on lake bank stability. Analysis of potential indirect effects – such as an increase in water levels leading to an improved trout fishery, which results in higher visitor use and therefore greater erosion due to human impacts – is beyond the scope of this assessment, but should be considered in developing long-term management strategies.

Given the stabilizing effects of vegetation, especially native trees and shrubs adapted to the climate of the Twin Lakes area (in addition to their habitat value), enhancement of riparian vegetation on lake banks through planting of appropriate species is highly recommended. As mentioned, this treatment should only be undertaken once water levels have stabilized, to ensure appropriate species selection, installation methods, and planting schemes for the resulting shoreline and riparian conditions (including soil texture, soil moisture regime, etc.)

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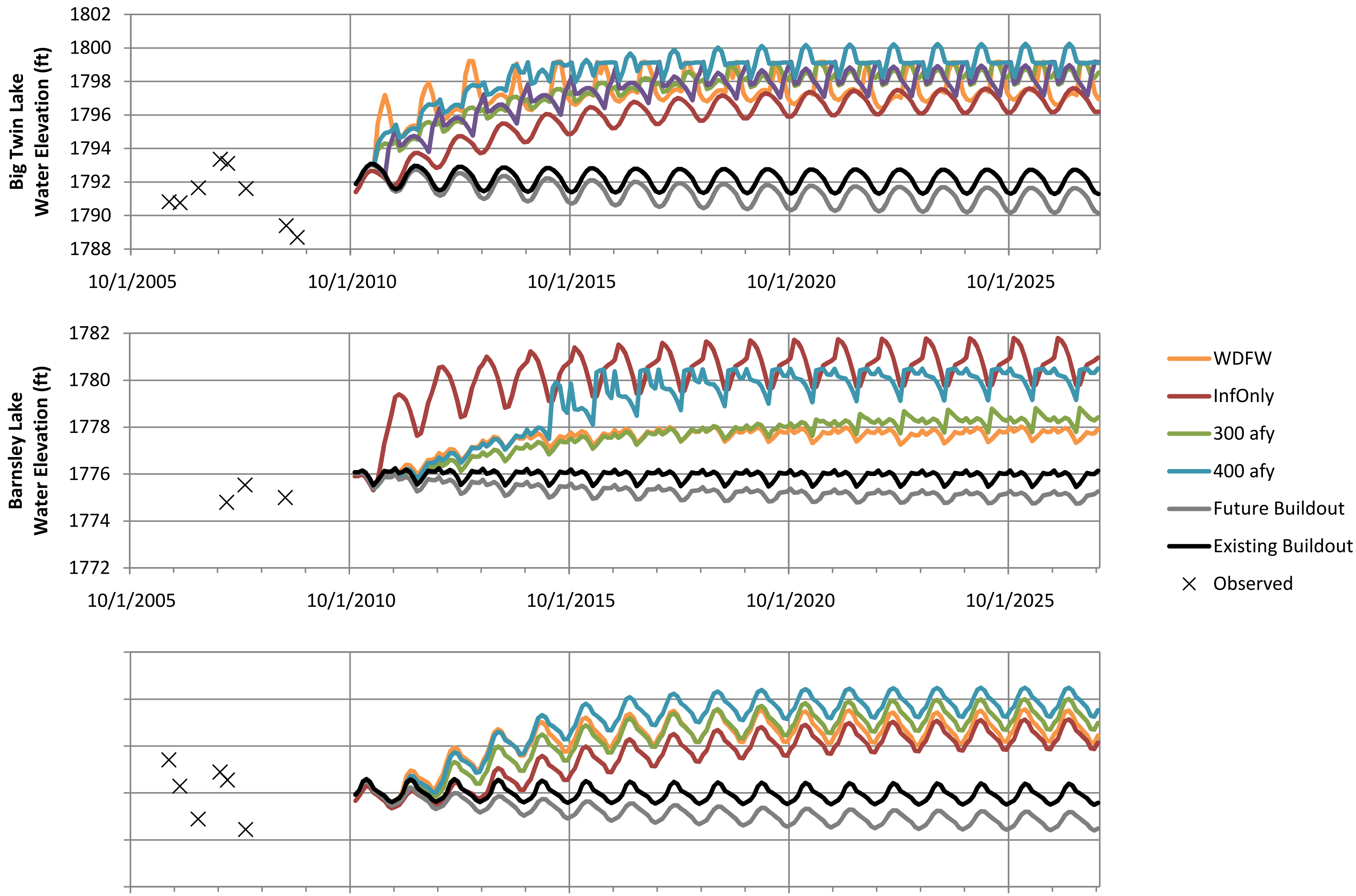
APPENDIX A

Lake Level Fill Scenario Graphs from Aspect Consulting



Aspect Consulting, LLC
8/19/2009
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Observed and Calculated Lake Levels

TLAC Water Right Application
Winthrop, Washington