7.0 SUMMARY AND CONCLUSIONS

7.1 SUMMARY

This report results from a Washington State Legislature grant to study the feasibility of storing additional water in Lake Wenatchee. The Legislature acted upon recommendations of the State's Water Storage Task Force to study the issue of water storage across the State. The focus on reviewing all potential solutions to shortfalls in instream flow and water supply was sharpened in the drought year of 2001, when streamflows dropped to historic lows in late summer and many water users across the state had their water supply interrupted as a result.

The Legislature appropriated funds for this study because of its location within the Wenatchee River Watershed, the history of past water storage studies and permits on Lake Wenatchee and ongoing efforts in Watershed Planning undertaken by the Wenatchee Watershed Planning Unit. The Wenatchee River Watershed is listed as one of the State's sixteen "critical basins" because of the presence of Endangered Species Act (ESA) listed species, development pressures and the potential for future water shortages. Previous studies and planning on water storage in Lake Wenatchee were performed by the Wenatchee Reclamation District and Chelan County PUD. The Wenatchee Reclamation District initiated a water storage project in 1930 in response to drought conditions in the Wenatchee River Watershed. They obtained permits to construct a low dam near the mouth of the Lake, which would impound water to the normal high water elevation. The project was not completed and Chelan County PUD acquired the permits from the District. The PUD envisioned a water storage project that was a component of a larger hydroelectric project. That project was dropped in the 1970's and the rights reassigned back to the District.

Chelan County Natural Resources Department is leading the Wenatchee Watershed Planning effort and assembled a project team to oversee the scope of the feasibility study and obtain public comment on the scope. The project team was assembled from a diverse group of public, local agency (city and county), irrigation, conservation, state, federal and tribal interests. Six public and project team meetings were held in the time period from September 2001 to June 2002. In four of these meetings there was discussion to obtain input on the scope. A final scope of work for the feasibility study was agreed to by the project team and is the basis for this study.

Five broad study areas were selected by the project team to cover the scope of the feasibility study. The study areas address the following issues:

- Water Needs
- Technical Feasibility
- Legal Feasibility
- Socioeconomic Impacts
- Environmental Impacts

The following paragraphs summarize those study areas.

7.1.1 Summary of Water Needs

The water stored in Lake Wenatchee could be used for several purposes; those being instream flow augmentation, water supply for future surface water users in the Wenatchee River Basin Watershed or as mitigation for future groundwater use either in the aquifers supplying the Wenatchee River or in tributaries to the Wenatchee River.

A review of potential population growth and growth in municipal, domestic, industrial and agricultural water use was made. From the perspective of population growth and growth in forecasted municipal demands, the estimated increase in water demands over the next 20 years is:

- 7.3 cfs on a peak daily basis and
- 1,868 acre-feet annually.

No growth in self-supplied industrial and commercial water use is forecast unless additional water is made available that would not be subject to interruption from low streamflow levels and minimum instream flows set by Chapter 173-545 WAC.

A review of agricultural water use was made and the following conclusions were made:

- Agricultural water use accounts for an estimate of 68,000 acre-feet of consumptive use (either water consumptively used by crops or exported outside the Wenatchee River Watershed)
- The area of irrigated agriculture appears to be stable and not declining.
- There is a substantial area of land that is currently zoned for residential use that can be converted from agricultural use.

Our opinion is that although annual water use may decline if that land is developed, peak water use may not change. The peak water demands are important as they have the most immediate effect on streamflow. A review of water right applications was made to compare to the predicted future water demands.

- The current applications are requesting 43 cfs from surface water and 10.9 cfs from ground water.
- The types of use requested on the applications are primarily municipal and domestic for surface water and irrigation for ground water.
- Most of the applications, if approved, would be subject to minimum instream flows and therefore interruptible during low streamflow periods.

Some of the applications, such as those contained in the Peshastin Creek basin, would not likely be approved as the basin is closed for further appropriation from June 15 to October 15. The difference between the forecast future water needs and the quantity applied for is mostly due to water right applications for irrigation. It appears those applications are primarily for landscape or lawn irrigation and not commercial agriculture. It was estimated the increase in irrigation demand from approval of those applications to be 8 cfs; the estimated effect on streamflow is a reduction of 5.6 cfs. The estimated increase in municipal and domestic demand is 7.3 cfs and the estimated effect on streamflow is a reduction of about 5 cfs.

The effect on streamflow from future municipal and domestic demand and from approval of pending water right applications for irrigation is an estimated reduction of about 10.6 cfs.

The largest potential water need is for instream flow. Chapter 173-545 WAC has set minimum flows for the Wenatchee River and some tributaries. Hydrologic analyses have determined the average shortfall between Wenatchee River streamflow (measured at Plain) and the minimum flows is 17,500 acre-feet per year. In 2001, the shortfall was 50,400 acre-feet for the time period of July to October.

While there should be continual updates of the information contained in this chapter there were no additional areas of water needs analysis that were identified for further study.

7.1.2 Summary of Technical Feasibility

To enable seasonal storage and release of water from Lake Wenatchee, an inflatable rubber dam was identified as the most suitable type of structure for the site. The rubber dam would be located on the Wenatchee River approximately 1,600 feet downstream of the mouth of the lake where the river is narrowest. The site is the location of a previous bridge crossing that was demolished, however the concrete bridge pilings still exist.

Two operating water levels were selected for analysis of benefits and impacts. The first water level is the Ordinary High Water (OHW). This water level is important as it is the demarcation between private property and State-owned shorelands, except those second-class shorelands sold to property owners. The OHW level was field surveyed and estimated to be El. 1870.3 above mean sea level. The second water level selected for analysis is El. 1872.4 above mean sea level, which corresponds to the spring high water level that occurs nine out of ten years.

A hydrologic model of Lake Wenatchee was prepared using historic streamflow and lake level data. The model was prepared to determine the existing water level regime of the lake and the effect of operating the lake as a storage reservoir. Five potential operating alternatives were analyzed with the model. The alternatives are:

Alternative 1 – Maximum lake level controlled by the rubber dam = El. 1872.4. The dam would start storing water July 1 and releasing water August 23. Lake outflow would ramp up to 100 cfs in excess of historic outflows on September 1 and water released until storage is exhausted.

Alternative 2 – Maximum lake level controlled by the rubber dam = El. 1872.4. The dam would start storing water July 1 and releasing water August 23. Lake outflow would ramp up to 200 cfs in excess of historic outflows on September 1 and water released until storage is exhausted.

Alternative 3 – Maximum lake level controlled by the rubber dam = El. 1872.4. The dam would start storing water June 1 and releasing water July 1. Pulse flows would be released at a rate of 100 cfs for 4 hours per day until August 15. Lake outflow would be augmented by 100 cfs in excess of historic outflows starting August 16 and water released until storage is exhausted.

Alternative 4 – Maximum lake level controlled by the rubber dam = El. 1870.3. The dam would start storing water July 1 and releasing water August 23. Lake outflow would ramp up to 50 cfs in excess of historic outflows on September 1 and water released until storage is exhausted.

Alternative 5 – Maximum lake level controlled by the rubber dam = El. 1870.3. The dam would start storing water July 1 and releasing water August 23. Lake outflow would ramp up to 100 cfs in excess of historic outflows on September 1 and water released until storage is exhausted.

The results of the model indicate Alternative 2 provides the greatest flow augmentation, but for a shorter time period than Alternative 1, which can augment flow through much of October if needed. Alternative 3 has less water to store and release because it has different storage and release seasons in comparison to Alternatives 1 and 2. Alternatives 1 and 2 were found to provide a maximum storage (in excess of minimum historic water levels) of 12,300 acre-feet in late August. The maximum increase in lake levels from historic levels is about 2.7 feet in July, 3.9 feet in August and 2.6 feet in September from Alternatives 1-3.

Alternative 5 can reliably provide a flow augmentation of 75 cfs in September. Alternative 4 can provide 50 cfs in September and for about one-half of October. The increase in lake levels from historic for the two alternatives is about 0.6 feet in July, 2.0 feet in August and 1.0 feet in September.

The rubber dam requires construction of a concrete structure to support the 10-feet high (maximum) by 200-feet long black rubber bladder. The concrete structure would be mostly submerged and hidden from view except at the sides of the channel where sloping walls would be visible. When deflated (for most of the year) the rubber dam will be submerged and not visible. A fish ladder is required and would likely sit on the north side of the river adjacent to the state park. The fish ladder would be a concrete structure with 15-feet wide weirs and a total rise of 5 feet. Rubber dams have been found to be very rugged and resistant to vandalism, debris and other damage.

The estimated costs of designing, permitting and constructing the rubber dam to impound water to El. 1872.4 are $5.8M. Those costs do not include financing, legal, interest during construction, project mitigation, land purchase or easement, and other costs not directly related to construction of the rubber dam structure. Some of these costs are identified in Chapter 5 and 6 and summaries of all costs both estimated and not are shown at the end of this chapter. The estimated costs to construct a rubber dam to impound water to El. 1870.3 are $5.4M.

A review of the potential increase in wind and wave-driven shoreline erosion was made for an example site on Lake Wenatchee on the south shore near the State Park. Lake Wenatchee is prone to high winds from a north/northwest direction during summer. The wind analysis shows a large potential increase in wave energy directed at the site if water levels are maintained at El. 1872.4 and a much smaller increase if water levels are maintained at El. 1870.3. It is out opinion that very little or no additional shoreline erosion would occur if water levels are maintained at the lower elevation.

Areas that the team identified for additional study in Technical Feasibility are further specific analysis of the wind and wave erosion potential. The scope of work for this study only asked for an approximation of the potential change in erosion by calculating the change in the wave energy from existing conditions. The effect on actual soil conditions of the surrounding beaches and banks as well as on water front structures was beyond the scope of this study. Further specific analysis of those areas should be made to more fully address erosion issues.

7.1.3 Summary of Legal and Permitting Issues

A review of the status of a reservoir permit issued to Wenatchee Reclamation District (WRD) was performed and it is concluded the permit was cancelled and would need to be reapplied for. The WRD purchased an easement in 1944 from the State of Washington for the right to inundate second-class shorelands and that easement still applies to all second-class shorelands purchased from the State after that date. Second-class shorelands extend up to the line of OHW. It was found that private property owners with a total of 10,950 and Washington Parks and Recreation Department with 9,430 front feet of waterfront own second-class shorelands that were purchased prior to the issuance of the overflow easement. An easement would need to be purchased from those property owners to maintain water levels at the OHW level. A total of 70,000 feet of shoreline exists around Lake Wenatchee and overflow easements from all property owners on the lake would need to be obtained to maintain water levels at El. 1872.4.

A review of the potential impact on Tribal fisheries was performed and the conclusion reached that the project would have a negligible effect on Tribal fisheries in the Wenatchee River Watershed.

A review of permitting issues was performed and the types of permits that would be required from Federal, State and local agencies described. The typical timeframe for acquisition of those permits was also described. The project would likely be subject to the NEPA process and would require a Corps of Engineers permit, bringing in the need for consultation under ESA. One to three years was the estimated timeframe for application and acquisition of the necessary permits. Approaches to permitting and additional information needed for the permitting process are provided.

7.1.4 Summary of Socioeconomic Impacts

Impacts of the Lake Wenatchee Water Storage Project on property values, property improvements and the cost of easements would vary with each alternative.

The assessed value of the property on Lake Wenatchee based on literature review and discussions with the Chelan County Assessors Office regarding the property values, relates only to linear frontage of shoreline as opposed to total square footage of shoreline area.

For the El. 1870.3 (OHW) Alternatives, storage to the OHW elevation would directly impact only those landowners holding unrestricted rights to second class shorelands. However, this taking may also impact individual owners' sense of value because of restricted access to seasonal beaches in the public domain. The cost of easement to inundate the second class shorelands where that right does not presently exist is estimate at between $1.4 and $3.5 million.

The analysis concluded that it is likely that there would be little or no impact to property improvements in the OHW alternatives.

For the El 1872.4 Alternatives, there would be a substantial loss of beach and shallow water shoreline on much of the lake. There would likely be increased shoreline erosion and vegetation mortality associated with the higher lake levels. There would likely slow the rate at which adjacent properties would increase in value. The cost of easements to inundate the second class shorelands where that right does not presently exist and compensation to landowners for lands that would be inundated between the OHW and El. 1872.4 is estimated at between $6.1 and $15.3 million.

A range of mitigation cost for improvements on the properties that may be affected by higher water levels. However, no overall cost of mitigation for these individual lot improvements can be made until a detailed, lot by lot inventory of the improvements and their elevations can be made.

The findings from the cultural resource analysis identified a component of a previously recorded Headwaters archaeological site (45CH208) along the north bank of the Wenatchee River. The 1990 floods experienced in the upper Wenatchee River watershed exposed and destroyed a large portion of the site.

It is likely that there would be some impact on the Headwater site in all Alternatives and consultation with all affected Native American Tribes, USFS/Wenatchee National Forest, Lake Wenatchee State Parks, and Washington State Office of Archaeology and Historic Preservation is recommended in the event this project moves forward. A Memorandum of Agreement between the state, tribes and federal agencies would need to be entered into to mitigate for effects to site 45CH208 and other potential resources.

The project should result in no adverse effect on whitewater boating and rafting because changes in flows would be small and flows would still accommodate a wide range of boating activities. The operation of the project is not expected to result in either a beneficial or adverse effect on the regional economy because use associated with river flows is not expected to change.

Constructing the dam at the outlet of Lake Wenatchee would disrupt boating access to the upper reach of the Wenatchee River. Because Wenatchee State Park is the only suitable launch site to the upper reach of the river, the dam would act a barrier to access to large segment of the reach of the river between Lake Wenatchee and Plain.

To ensure access to the river is maintained, the project sponsors should ensure the dam includes a portage or a replacement launch facility is constructed downstream of the dam. Because a portage facility would require boaters to exit the river soon after launching from the existing State Park boat ramp, a new launch ramp would better facilitate access to the river. Site visits indicated a replacement launch ramp could be constructed on state property located on the south side of the river just downstream of the dam site. To reduce costs, this facility could utilize access roads and staging areas that will be needed to facilitate construction of the dam. An order of magnitude cost estimate for constructing a launch for rafts, kayaks, and other non-motorized t was conducted. Elements of the launch ramp facility would include constructing an access road, parking lot, boat launch, rest room, and signage. Construction costs were estimated to total $165,000.

A study of market value as opposed to assessed value should be conducted with a representative sample of buyers, sellers and owners around the lake. A lot-by-lot survey of property improvements and their elevations to establish the number and cost of the mitigation that would need to take place particularly at the El. 1872.4 elevation.

7.1.5 Summary of Environmental Effects and Recommended Additional Studies

Several populations of economically and culturally important fish species are found in the Wenatchee River system. Four species of anadromous (ocean-rearing) fish are present in the basin: chinook, sockeye, steelhead, and Pacific lamprey. While historically abundant, native coho have been extinct from the basin since the early 1900s. Reintroduction efforts were begun in 1997. Other important salmonid species in the Wenatchee basin are bull trout, kokanee, westslope cutthroat trout, and rainbow trout. Three fish species in the Wenatchee River basin are protected under the federal Endangered Species Act (ESA). Steelhead and spring chinook in the Wenatchee River basin are listed as endangered under the ESA. Bull trout in the Wenatchee River basin are listed as threatened under the ESA.

The operation of the rubber dam to augment flows in the mainstem Wenatchee River during late-summer/early-fall could provide some benefit to the upstream migration and holding of adult steelhead, chinook, and to a lesser degree coho salmon. The degree of potential benefit would be related to the amount and timing of flow available and hence alternative 3 and 2 would likely have the greatest and alternative 4 the lowest potential benefit. The largest benefits to migration and holding would likely be to steelhead and summer chinook during the lowest flow years, since these species spawn in the mainstem Wenatchee, and they would likely spend some time holding in the river prior to spawning. The pulse flow operational alternative (Alternative 3) specifically targets adult passage for spring chinook and sockeye during low flow conditions that may occur in July.

Supplemental water released to the mainstem Wenatchee River during late-summer/early-fall may potentially enhance to varying degrees the amount of spawning habitat available to chinook in the mainstem Wenatchee River. The timing of the flow releases associated with alternative 3 and the limited amount of supplemental flow under alternative 4 suggest the benefits to chinook spawning habitat in the mainstem would be small compared to the other alternatives. If the fall rains coincide with the end of the period of supplemental water and water levels are not subsequently reduced during incubation, the increased spawning habitat could benefit spring and summer/fall chinook. Negative impacts to incubating chinook embryos could occur if areas used for spawning are subsequently dewatered during the period between flow augmentation from the Lake Wenatchee Water Storage project and the onset of the fall rains. The only other salmonid species that spawn in the mainstem are steelhead. Steelhead spawning will not be affected by project operations, because steelhead spawn in the spring.

Operation of the rubber dam will not affect high-flow rearing habitat in the mainstem Wenatchee River. The release of water stored in Lake Wenatchee during late-summer/early-fall may temporally increase the amount of low-flow refuge habitat and may afford some benefit to juvenile salmon species rearing in the river, with Alternative 4 providing the least benefit. The effects of extending the period of high water levels in Lake Wenatchee during the summer on juvenile fish rearing in the lake and at the mouths of the Little Wenatchee and White rivers are unknown. Higher water levels throughout the summer could benefit juvenile fish rearing in the wetland complex on the western end of the lake if the higher water levels help maintain open water and transportation corridors between ponded areas and the main lake. However, baseline information on the habitat condition, use and productivity of this wetland area is not available.

The project operation is not anticipated to affect juvenile outmigration in the tributaries or in Lake Wenatchee, provided suitable fish passage facilities are integrated into the dam design.

The release of water stored in Lake Wenatchee during late-summer/early-fall could coincide with the peak of sockeye spawning in late September. Although it is unknown if sockeye spawn along the shoreline of Lake Wenatchee, the species is known to use this type of habitat in other lakes. Reduced lake levels during the period of sockeye spawning could result in redds being built in areas that would subsequently become dewatered as the stored water is released to the mainstem Wenatchee River. Thus, there is some potential negative impacts to lake-shore spawning (if it occurs) related to all of the alternatives.

Release of water stored in Lake Wenatchee to supplement late-summer/early-fall flows in the mainstem Wenatchee River will result in the lowering of the lake levels and potential stranding of juvenile fish rearing in the littoral areas. However, because the shoreline of Lake Wenatchee is generally steep, shallow littoral areas where stranding could occur are limited to the wetland area in the vicinity of the confluence with the Little Wenatchee and White rivers, at the western end of the lake. It is believed that trapping and stranding effects would be minimal in this area because of the complex morphology occurring within the wetland habitat, and the generally low temperatures expected during the summer because of vegetative shading and connection with groundwater.

The operation of the rubber dam will temporally increase the mainstem river minimum instream flows during the late-summer/early fall period and may help maintain or restore connections with off-channel habitats that could otherwise become dewatered or isolated from the main channel. The effects of this would likely be relatively small due to the comparatively low amount of water that would be supplemented to the lower river compared to natural flows. The operation of the rubber dam will not affect side-channel habitat in the tributaries, upstream of the lake influence. However, higher water levels throughout the summer in Lake Wenatchee could result in increased open water and transportation corridors between off channel areas in the wetland complex on the western end of the lake, including the lower portions of the tributaries, and the main lake.

At the western end of the lake there is an extensive complex of wetlands associated with the outlets of the Little Wenatchee and White rivers. These delta wetlands include littoral wetlands along the lake shore, floodplain wetlands including abandoned oxbow channels, and beaver ponds. Based on the extent and magnitude of hydroperiod changes predicted under the five alternative operational scenarios, Alternatives 1, 2 and 3 have a high probability of altering wetland vegetation in the delta wetlands of Lake Wenatchee. Alternatives 4 and 5 have a moderate probability of affecting wetland community structure in at least the lower elevation wetland zone (i.e., El. 1870 to 1871). Changes in wetland vegetation resulting from these scenarios (assuming they would be maintained and not varied year-to-year) would likely consist of a movement up slope of plant communities presently occurring in the wetlands, but could also involve changes within plant communities. Under all alternatives, more flood tolerant species such as spikerush and bur-reed may displace sedges and rushes, with the OHW (the interface between bare substrate and emergent vegetation) also moving up in elevation.

High water temperatures are a limiting factor for salmonids in the mainstem Wenatchee River during the summer and potentially for salmonids near the mouth of the Little Wenatchee River. The operation of the rubber dam may provide little if any temperature benefits however additional studies, including temperature modeling is required.

Although specific field studies were not conducted that would help to define incremental benefits in terms of fish habitat relative to different streamflows, it can be surmised that such benefits in terms of supplementation of 50-100 cfs, would be relatively small when considering the channel dimensions of the Wenatchee River. River widths in the range of 150-200 ft. are not uncommon, especially in wide riffle habitats, and even under extremely low flows (e.g. 300 cfs at Plain) the additional 50 to 100 cfs for a short period of time (one month) would likely result in relatively small changes in water depth (» 1-2 inches). How these changes in water depth translate into changes in fish habitat is not known. However, extremely low flows that occur during warm summer months can create especially stressful conditions to fish. During such periods, the provision of even relatively small amounts of flow may temporally and spatially benefit fish populations. Clearly, the potential environmental impacts and benefits of the Lake Wenatchee Water Storage Project warrant further consideration.

Additional studies and information needed to fully evaluate potential project impacts include:

- Temperature modeling in the mainstem river to assess the potential impacts/benefits of increased flow released from Lake Wenatchee.
- Instream flow channel study to determine potential benefits to habitat in the Wenatchee River from increased flow released from Lake Wenatchee.
- Instream flow fish passage study to identify areas for which flow related migration delays may occur.
- Fish passage details and impact analysis.
- Survey of the lake shoreline and of the Little Wenatchee and White rivers to identify potential spawning habitat that could be affected as a result of changed lake levels.
- Topographic survey to determine elevational range of plant communities and accessibility of off-channel fish habitat at specific lake levels.
- Wetland studies to better assess impacts.

7.2 CONCLUSIONS

We offer the following conclusions for the Lake Wenatchee Storage Project:

7.2.1 If Water Is Stored To El. 1870.3 Ft (Alternatives 4 and 5)

The storage project would impound an estimated 6,750 acre-feet in excess of historic low water levels for. The average difference in lake water levels in August would be 2 feet; in September 1 feet. The project could reliably supply between 50 cfs and 75 cfs for the month of September and early October. That water would be used to augment instream flow in the mainstem Wenatchee River and/or to offset future water needs in the Wenatchee River Watershed. The project would supply more than enough water to meet future municipal and domestic water needs in the Watershed. The project could not provide enough water to substantially reduce the occurrence of Wenatchee River flows falling below instream flows set by Chapter 173-545 WAC.

Some potential environmental impacts exist for storage of water to El. 1870.3, there is a moderate probability of affecting wetlands in at least the lower wetland zone. Juvenile Bull trout upstream migration time may be adversely impacted.

Maintaining water levels higher than historic would affect beach recreation by reducing beach area but few other socio-economic impacts were identified. Costs of mitigation for damage to property improvements is unlikely. Cost for easement for inundation of second class shorelands (20,380 feet) in these alternatives is estimated to be between $1.4 and $3.5 million.

The construction cost, including permitting costs is estimated to be $5.4M.

On a unit cost of storage basis, the project construction and easement cost would be $1165 per acre-feet That cost is reasonable and much less than storage costs for other storage projects under consideration in Washington State. For example a review of potential storage projects under consideration in the Yakima River Watershed (EES, MWG 2002) found storage costs ranging from $1,200 to $8,100 per acre-feet of water supplied by the project during dry years. Unit costs from the *Water Storage Task Force Report to the Legislature* (Ecology, 2001) for projects constructed or proposed in Washington State range from $1,695 to $13,280 per acre-feet. The highest unit costs were for smaller projects or projects that required pumping to a reservoir and therefore more facility costs and long-term power costs.

This scenario of maintaining water levels at El. 1870.3 appears to be feasible and cost-effective and warrants additional study if a demand for the water exists and the potential impacts from implementation are less than alternative instream flow augmentation or water supply projects.

7.2.2 If Water is Stored To El. 1872.4 Ft (Alternative 1, 2 and 3)

The storage project would impound an estimated 12,300 acre-feet in excess of historic low water levels. The average difference in lake water levels in August would be 3.9 feet; in September 2.6 feet. The project could reliably supply between 100 cfs and 200 cfs for the month of September and early October. That water would be used to augment instream flow in the mainstem Wenatchee River and/or to offset future water needs in the Wenatchee River Watershed. The project would supply more than enough water to meet future municipal and domestic water needs in the Watershed. The project could not provide enough water to substantially reduce the occurrence of Wenatchee River flows falling below instream flows set by Chapter 173-545 WAC.

Environmental impacts are likely for storage of water to 1872.4 feet, including potential impacts to wetlands at the head of the lake and plant communities around the shoreline of the lake. The costs of mitigation are not identified. There would be increased flow benefits for mainstream Chinook salmon for passage spawning and rearing. Length of time for juvenile Bull trout's upstream migration could be affected adversely.

Socio-economic impacts would also be greater with this storage scenario. Storage to this water level would cause considerable loss of beach and would require purchase of flooding easements around the entire lake (70,000 feet) as well as inundation easements for some of the second class shorelands. Cost for these easement are estimated to be between $6.1 and $15.3 million.

Property improvements would likely be impacted, but costs of mitigation for damage to these property improvements cannot be known until a lot-by-lot inventory is done.

The construction cost, including permitting costs is estimated to be $5.8M.

Since large portions of the potential costs for these alternatives are not known the unit cost for storage at El. 1872.4 cannot be calculated.

It is our opinion storage to El. 1872.4 is problematic and would be difficult to implement because of impacts to wetlands and to waterfront property.