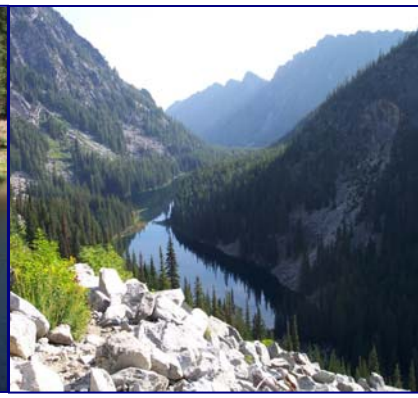
CHELAN COUNTY NATURAL RESOURCE PROGRAM

MULTI-PURPOSE WATER STORAGE ASSESSMENT IN THE WENATCHEE RIVER WATERSHED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Executive Summary

This Multi-Purpose Water Storage Assessment for the Wenatchee Watershed identifies and reviews a number of potential water storage strategies to improve streamflow and water supply conditions in WRIA 45. The first stage of the storage assessment (Step A) identifies potential water storage strategies and opportunities such as new surface water reservoirs, optimizing or enlarging the capacity of existing reservoirs or lakes, tapping existing lakes, storm water storage and groundwater recharge. The assessment also evaluates small scale storage strategies such as stream channel restoration and repair, enhancement of natural floodplain storage through channel migration zone and wetland protection projects, use of rain barrels at individual residences and providing small fire storage tanks. At the end of the first stage all of the opportunities were ranked according to the factors such as:

- The potential improvement in instream flow, water supply, water quality and habitat
- The opportunity's consistency with the Biological Strategy for the Wenatchee Watershed
- The opportunity or sub-watershed importance relative to other opportunities and subwatersheds

It was determined that small scale opportunities such as enhancement of natural floodplain storage through channel migration zone and wetland protection projects would proceed through funding by other grants. There are a number of habitat related storage opportunities that can be pursued, many of which include activities that help channels access their floodplains.

The Water Quantity Subcommittee recommended analysis of specific, larger scale opportunities as part of the second stage (Step B) of the Multi-purpose Storage Assessment. Eighteen opportunities were selected for a more detailed analysis; located primarily in the Mission, Icicle, Peshastin, Lower Wenatchee and Chumstick Sub-watersheds. Those sub-watersheds experience the greatest water supply and instream flow issues. A potential opportunity in the Nason Sub-watershed has since been added to the list. The results of the Step B Assessment include:

- Instream reservoirs would have the largest storage capacity and be the most cost-effective to construct (reservoirs analyzed cost approximately $4,900 to $8,000 per acre-foot of storage and supplemented flows by approximately 6-19 cfs for a month in late summer). Although the opportunities could greatly improve instream flow and water supply conditions in some basins, the permitting of these opportunities requires public participation and the process can be lengthy. Most opportunities are located on federal public land. Potential sites on federal public lands managed by the U.S. Forest Service (USFS) will require public analysis and disclosure before they may be approved as a storage project.
- Enlargement of existing reservoirs and lakes would provide storage at a cost of $15,000 to $25,000 per acre-foot while providing a small flow supplementation benefit of less than 1 cfs for a month. These opportunities would also be subject to extensive environmental review.
- An opportunity to transfer 3 cfs from the Chiwawa Basin to Little Chumstick Creek was identified in the Assessment. A water storage reservoir in the Chumstick subwatershed was analyzed in conjunction with a pumping station located on an irrigation ditch that diverts from the Chiwawa River. This alternative was estimated to cost $21,500 per acre foot of water stored. The ability to implement this project quickly may be more feasible as the footprint of the reservoir is on private land.
- The most costly opportunities reviewed in the Step B Assessment were off-channel reservoirs ($19,000 to $181,000 per acre-foot). Most of these opportunities would present fewer permitting issues as the sites for the reservoirs are located on private land and the footprint of the opportunity much smaller than other alternatives. However, the flow benefits of these opportunities are generally small. The exception in this category is the Campbell

Creek Reservoir. The Campbell Creek Reservoir opportunity would provide a significant storage and flow benefit (500 acre-feet, 7 cfs for 30 days). As a portion of the potential reservoir would be placed on federal public lands managed by the U.S. Forest Service, it will require public analysis and disclosure before it may be approved as a storage project.

- Overall the most cost-effective opportunity may be the optimization of high alpine lakes operated by the Leavenworth National Fish Hatchery and the Icicle and Peshastin Irrigation Districts. It is thought the cost of such an opportunity will be much less than other water storage opportunities because the reservoirs already exist and the opportunity will change only the operation of the reservoirs to provide more water in late summer. No cost estimates were prepared for this opportunity as it was determined that additional analyses would be performed with the next stage of water storage grants, starting in 2006.
- This Storage Assessment also provided the following programmatic recommendations for small scale storage opportunities:
    - Stream Channel Restoration and Repair.
    - Small Water Storage Tanks for Fire Protection.
    - Rainwater Capture.

This study of water storage opportunities in the Wenatchee Watershed should be viewed as a reconnaissance-level or preliminary study. Much more detailed information is required to adequately assess the feasibility of any of the projects. Information required to determine the technical feasibility of the potential projects includes:

- Subsurface explorations to determine geotechnical engineering issues
- Additional streamflow measurements and gaging at the site of the reservoirs to determine the yield of the basins
- Topographic information to determine the size of the project facilities
- Environmental reviews to assess wetland and fisheries impacts
- Hydrologic modeling of basins to determine the effect the reservoirs will have on streamflow, both when capturing flow during spring and when releasing during late summer
- Public participation and input into new water storage projects to determine public acceptability.
- Additional review of permitting requirements with USFS and other agencies. The opportunities that will be studied in the next phase of water storage assessments will likely be wholly or partially sited on land managed by the USFS. For a project to take place, a proponent would submit a proposal to the USFS. The USFS will follow agency regulations, including use of the NEPA process to evaluate the opportunities and alternatives to the proposed action.

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1.0 Introduction

The Wenatchee Multi-purpose Water Storage Assessment was prepared to identify the opportunities for developing water storage projects within the Wenatchee Watershed that would benefit multiple uses such as instream flow, water supply, instream and riparian habitat and water quality. The assessment was prepared under the direction of the Water Quantity Subcommittee of the Wenatchee Watershed Planning Unit. Funding for this assessment was provided by the Washington State Department of Ecology under Grant No. G0500130.

The subcommittee developed a two step process to investigate water storage opportunities, Step A and Step B. The Scope of Work for the Assessment is contained in Appendix A. The Step A assessment was designed to locate all sites in the Wenatchee Watershed that are physically capable of storing water and may be reasonable to implement. Screening criteria were then applied to the opportunities to identify opportunities that warranted more in-depth analysis in Step B. An abbreviated description of the work required for the Step A and Step B Assessments is summarized in the following paragraphs.

1.1 Description of Step A Assessment

The Step A Assessment involves analysis of a broad range of storage-related opportunities in WRIA 45. The assessment will identify a broad range of possible water storage options and provide the basis for the subcommittee to select top priority options for further evaluation. The assessment will:

- Consider the type of storage projects that would be useful in the watershed, given the current and future water supply and demand and instream flow considerations.
- Consider and scope reasonable and applicable storage alternatives and identify potential site locations for: off-channel storage, underground storage, and other alternatives (a conventional in-channel storage assessment was completed for the Wenatchee in 2003: the Lake Wenatchee Water Storage Feasibility Study, June 2003). Both large and small scale storage options will be considered, including but not limited to: use of wetlands in channel migration zones for storage and infiltration, infiltration of reclaimed water or stormwater and aquifer storage coupled with instream flow augmentation.
- Include an inventory and assessment of the water storage infrastructure needs including public and private water systems, where information is available. This inventory will ensure that small drinking water systems and fire safety needs are addressed.
- Consider how to balance the full range of potential uses for stored water (multipurpose).
- Identify potential environmental effects associated with the different storage alternatives.

1.2 Description of Step B Assessment

The Step B Assessment further develops and evaluates the high priority water storage opportunities derived from Step A. It includes:

- Provide a more detailed assessment of the natural resource elements of the selected (Step B) potential storage projects or areas.
- Consider general feasibility and engineering elements of the Step B storage projects.

- Address the environmental effects and associated regulatory elements of the Step B storage projects or areas.

- Prepare report that provides full development of the prioritized list of storage projects and assessment of the feasibility of those projects based on resource, environmental and engineering considerations. The findings of this report will also be provided as management strategies that will be integrated into the Phase III Watershed Management Plan for WRIA 45.

It should be noted that the decision of which projects to review in the Step B Assessment was made at the completion of the Step A Assessment. An emphasis was placed on surface water storage projects because of their greater potential benefit in terms of water supply for instream and out-of-stream uses compared to other storage projects such as groundwater storage. The scope of work that is included in Appendix A describes groundwater analyses that were not completed because of the focus on surface water projects.

1.3 Previous Water Storage Studies in Wenatchee Watershed

Three studies that reviewed water storage sites in the Wenatchee Watershed are summarized in the following paragraphs. Additional water storage studies may be available but were not identified during the course of this project.

1.3.1 Existing and Potential Reservoir Sites in the Methow-Okanogan and Chelan-Wenatchee-Entiat Basins

This study, completed in 1975 by the Washington Department of Ecology, identified potential water storage sites with a minimum of 1,000 acre-feet capacity. Nine sites in the Wenatchee Watershed were identified. The sites were located on Chiwawa River, Wenatchee River, Beaver Creek, Plain Creek and Icicle Creek. The only information provided for each site was a dot on a map showing the location. No discussion of hydrology, environmental resources or cost was provided. It is doubtful any of the sites are feasible because they are located on salmon-bearing streams. None of the sites identified were used in this study.

1.3.2 Lake Wenatchee Water Storage Feasibility Study

This study, completed in 2003 by MWH, reviewed the potential for increasing storage on Lake Wenatchee. The additional water storage would be achieved by constructing an inflatable rubber dam at the outlet from Lake Wenatchee. Two levels of increased storage were reviewed. The lower level would impound 6,750 acre-feet in excess of historic low water levels (up to El. 1870.3). The higher level would impound 12,300 acre-feet of water in excess of historic low water levels (up to El. 1872.4 ft).

The impoundment of additional water in Lake Wenatchee as studied would provide more than enough water to meet future municipal and domestic water needs in the watershed but could not provide enough water to substantially reduce the occurrence of Wenatchee River flows falling below instream flow levels set by state regulation.

For the lower level alternative, impacts to wetlands at the head of Lake Wenatchee may occur and juvenile Bull Trout migration time may be adversely impacted. Beach recreation and shoreline use would be impacted and easements for inundation of second class shorelines would be required. The costs of the easements were estimated to be between $1.4 and $3.5M. The construction cost, including permitting was estimated to be $5.4M. The unit cost of water was estimated to be $1165 per acre-foot which is reasonable and much less than costs for other water storage reservoirs in Washington State.

For the higher level alternative, impacts to wetlands at the head of Lake Wenatchee are likely and juvenile Bull Trout migration time may be adversely impacted. Beach recreation and shoreline use would be impacted much more than the lower level alternative. Easements for inundation of second class shorelines and flooding easements on private property would be required. The costs of the easements were estimated to be between $6.1 and $15.3M. In addition, mitigation costs to properties would be incurred such as rebuilding or reinforcing docks and bulkheads. Those costs were not estimated in the study. The construction cost, including permitting was estimated to be $5.8M. No unit cost of water was estimated because mitigation costs were not defined. The conclusion was made that the higher level alternative would be problematic to implement because of impacts to wetlands and waterfront property.

No action on the Lake Wenatchee project has occurred since the report was completed and no further study of the project was performed for this report.

1.3.3 Columbia River Mainstem Storage Options, Washington Off-Channel Storage Assessment Pre-Appraisal Report

This study, completed in 2005 for the Washington State Department of Ecology and U.S. Bureau of Reclamation, evaluated potential off-stream storage sites that could retain a minimum of 300,000 acre-feet of Columbia River water. The storage sites would receive water pumped from the Columbia River with release back to the river timed for instream flow benefit. Storage sites within 10 miles of the mainstem of the Columbia River were reviewed, including a site in the Mission Creek watershed. The Mission Creek site would be constructed across Mission Creek just downstream of the head of Tripp Canyon. It would impound approximately 470,000 acre-feet. The water supply for the reservoir would be pumped from the Columbia River, a distance of 7.7 miles from the reservoir. The total construction cost was estimated to be $1.23 to $1.39 billion which equates to $2960 per acre-foot.

This water storage project would be very difficult to implement because of environmental impacts to Mission Creek and the impoundment area along with the costs. This project was not reviewed by the Water Quantity Subcommittee and is not addressed in this report.

2.0 Existing Water Storage Facilities in Chelan County and Wenatchee Watershed

A list of existing water storage reservoirs in Chelan County was obtained from the Dam Safety Section (DSS) of the Washington State Department of Ecology and is summarized in Table 2-1. DSS regulates dams that have a storage capacity of greater than 10 acre-feet above natural ground level. The list contains reservoirs located in the Wenatchee Watershed and those located throughout Chelan County. The list does not contain very small ponds or reservoirs that also exist in the Wenatchee Watershed (they are below the DSS threshold). There are ten reservoirs in the Wenatchee Watershed that are regulated by DSS. They range from small reservoirs (the reservoir for Dryden Dam is the forebay for the dam and doesn't impound much water) to Klonaqua Lake, which impounds 1920 acre-feet. Seven of the dams are located in the Alpine Lakes Wilderness area in the Icicle subbasin. In the remainder of Chelan County, there are 39 dams regulated by DSS. A number of the reservoirs are small (less than 100 acre-feet) and located in the Stemilt and Wenatchee Heights area.

Table 2-1
List of Reservoirs in the Wenatchee Watershed and Chelan County
Compiled by Dam Safety Section of the Department of Ecology

Name of Dam/Reservoir	Dam Height, ft	Normal Storage, Acre-feet	Location			
			Section	Township	Range	
Reservoirs Located in Wenatchee Watershed						
Klonaqua Lake Dam	13	1920	3	24	14	E
Eightmile Lake Outlet Dam	19	1610	33	24	16	E
Colchuck Lake Saddle Dam	8	1240	10	23	16	E
Colchuck Lake Dam	15	1240	10	23	16	E
Square Lake Dam	7	500	22	25	13	E
Nada Lake Dam	9	150	9	23	17	E
Upper Snow Lake Dam	10	110	17	23	17	E
Tumwater Canyon Dam	15	17	33	25	17	E
Tree Top Wastewater Treatment Facility Dam	13	10	3	23	19	E
Dryden Diversion Dam	10	8	22	24	18	E
Reservoirs Located in Remainder of Chelan County						
Chelan Dam	33	676100	13	27	22	E
Rocky Reach	120	382000	35	23	20	E
Rock Island Dam	90	130000	5	21	22	E
Asamera-Cannon Mine Tailings Dam	340	2500	21	22	20	E
Wapato Lake Dam	20	2000	15	28	21	E
Antilon Lake Dam	65	1920	36	29	21	E
Antilon Saddle Dam No. 1	25	1240	36	29	21	E
Antilon Saddle Dam No. 2	15	1240	36	29	21	E
Upper Wheeler Dam	55	610	29	21	20	E
Three Lakes Reservoir Dam	8	600	29	22	21	E
Stemilt Main Dam	65	500	15	21	20	E
Spring Hill Dam	30	460	16	21	20	E

Name of Dam/Reservoir	Dam Height, ft	Normal Storage, Acre-feet	Location			
			Section	Township	Range	
Upper Wheeler Saddle Dam	15	370	29	21	20	E
Meadow Lake Dam	18	360	33	22	21	E
Spring Hill Saddle Dam	12	280	16	21	20	E
Beehive Dam	38	260	12	21	19	E
Beehive Saddle Dam	10	260	12	21	19	E
Lily Lake Dam	13	212	22	21	20	E
Stemilt Saddle Dam	9	100	15	21	20	E
3 Amigos Reservoir	23	100	10	21	20	E
Wenatchee Heights Reservoir No. 2	29	80	20	21	20	E
Wood Reservoir Dam No. 1	23	66	36	22	20	E
Clear Lake Dam	15	60	23	21	20	E
H & H Reservoir Dam No. 1	20	46	1	21	19	E
Clear Lake Saddle Dam	8	45	23	21	20	E
Great Depression Dam	22	30	4	21	20	E
Stemilt Equalizing Reservoir	24	28	12	21	20	E
Wood Reservoir Dam No. 2	17	28	36	22	20	E
Wenatchee Heights No. 1 Main Dam	32	21	29	21	20	E
Wenatchee Heights No. 1 Saddle	21	20	29	21	20	E
Steffen Brothers Reservoir Dam	15	20	28	21	20	E
Greenwood Reservoir No. 1 Dam	16	15	15	21	20	E
Milo Wood Pond Dam	14	15	28	21	20	E
McLaughlin Dam	20	15	7	21	21	E
Cammack Dam	12	12	14	21	20	E
Wenatchee Heights Stabiliz. Pond	13	11	10	21	20	E
Greenwood Reservoir No. 2 Dam	16	10	15	21	20	E
Zimmerman Pond Dam	11	7	4	21	20	E
Parkens & Stegeman Dam	11	4	20	25	19	E

A review of Department of Ecology water right records was performed to determine what reservoir permits are active and if there are any reservoir permit applications. Reservoir permits are required for any above-ground reservoirs that impound water to a depth greater than 10 feet or impound greater than 10 acre-feet, regardless of whether the water stored is used beneficially or not. Table 2-2 contains a list and description of existing and pending reservoir permits. There are currently three reservoir permits pending. The two largest (350 acre-feet total) by Johnson are located in Leavenworth in the Mountain Home Creek basin.

A reservoir permit for water storage in Lake Wenatchee was issued in 1934 but cancelled in 1976 (MWH, 2003).

Table 2-2
Existing and Pending Reservoir Permits

Document Number	Document Type	Pur-pose	Date Permit Issued	Last Name	Business Name	Priority Date	Acre Feet	Acres Irr.
R4-*01924 ACCWRIS	Certificate	IR·	10/20/1939		Icicle Irrigation District	8/2/1926	2000	
R4-*02752 CWRIS	Certificate	IR·	12/18/1931		Icicle Irrigation District	10/29/1929	1000	
R4-*05672 ABBCWRIS	Certificate	FS·	6/18/1942		US Bureau Reclamation	3/26/1942	16000	
R4-01220 CWRIS	Certificate	PO·	8/26/1958		Chelan Cnty PUD 1	1/9/1956	390000	
R4-28479	Permit	SR·	1/10/1985		Asamera Minerals (US) Inc	6/12/1984	1280	
R4-28593	Application	SR·		Waltar		1/4/1985	5	
R4-31677	Application	SR·		Johnson		1/29/1993	100	440
R4-32056	Application	IR·		Johnson		4/22/1994	250	75

3.0 Step A Water Storage Assessment

The Step A Assessment was performed by identifying potential locations for water storage through map analysis, publication review, discussion with the Water Quantity sub-committee members, and limited site reviews. The assessment was performed on a sub-watershed basis consistent with the Wenatchee Watershed Plan. Over 70 potential opportunities for water storage were identified in the Step A Assessment. Figure 1 shows the location of all the Step A Water Storage Projects identified within the Wenatchee Watershed.

The following sections describe the initial water storage opportunities identified, their potential beneficial effects and some of the potential negative effects. At the conclusion of the Step A Assessment the Water Quality Subcommittee identified a short list of opportunities that are recommended for more in-depth study and evaluation in the Step B Assessment. The recommended Step B projects are listed at the end of this chapter and are analyzed in the Step B Assessment contained in Chapter 4.

3.1 Lower Wenatchee Sub-Watershed

3.1.1 Issues and Recommended Actions from Watershed Plan

The following issues and recommended actions for the Lower Wenatchee Sub-Watershed are listed in the Wenatchee Watershed Plan. Two of the recommended actions, increase instream flow and provide water supply for future growth, could be addressed by providing additional water storage.

Issues:

a) Land development has reduced channel migration, woody debris recruitment, and gravel recruitment.
b) Stream temperatures often exceed standards.
c) Late summer instream flows are often critically low.
d) Floodplain function, riparian habitat, and channel complexity are reduced or degraded.
e) The Lower Wenatchee River contains important habitat for spring and summer chinook, steelhead, and bull trout.

Recommended Actions:

a) Protect remaining floodplain and riparian habitat.
b) Restore channel migration to resemble historical function.
c) If restoration is not possible, improve fish access to oxbows and historical side channels that have been cut off from main channel.
d) **Increase instream flow.**
e) **Provide water supply for future growth**.
f) Initiate public information efforts to discourage harassment of spawning summer chinook salmon.
g) Reduce nonpoint pollution from septic tanks and livestock.
h) Initiate public information efforts to encourage protection of riparian habitat.

3.1.2 List and Description of Potential Multi-purpose Water Storage Projects

Table 3-1 lists the opportunities for increased water storage identified in the Lower Wenatchee Sub-watershed. The potential volume of water stored is a preliminary estimate obtained by reviewing the area available for a reservoir. Water storage estimates were not prepared for CMZ projects as it was determined they would likely have very little storage. Figure 2 shows the locations of the potential projects.

Table 3-1
Lower Wenatchee Sub-watershed
Description of Potential Multi-purpose Water Storage Projects

Project Name	Water Source	Description of Project	Potential Volume of Water Stored
CMZ Project 6	Wenatchee River	An oxbow/former channel has been isolated by the SR2 fill but still has good floodplain forest. Excellent candidate for reconnection via bridge or large culverts which would increase floodplain capacity.	n/a
CMZ Project 9	Wenatchee River	Cattail marsh in a farmed area was probably a former back channel and could be reconnected via an at-grade culvert through the railroad embankment. Reconnection could increase floodplain capacity.	n/a
CMZ Project 10	Wenatchee River	Native riparian forest, an open-water wetland and several former back channels coexist on this site. CMZ project would construct a surface connection to the river from the existing pond, increasing floodplain capacity.	n/a
CMZ Project 11	Wenatchee River	Floodplain hardwood forest between SR2 and the river. Currently floods during 2yr+ event. CMZ project would create additional open water/backchannel habitat, increasing floodplain capacity.	n/a
CMZ Project 15	Wenatchee River	Site has an open water wetland, but most of the site is former floodplain isolated by a levee. The levee could be pulled back or breached and back-channel access restored. There are also riparian planting opportunities. Such restoration could be designed so as to maintain recreational river access. PUD is currently pursuing construction.	n/a
Cashmere Wastewater Lagoon	Wenatchee River	The Cashmere Wastewater Lagoon may be replaced with a more compact wastewater treatment facility. The lagoon could be retrofitted into a stormwater holding pond and possibly incorporate groundwater recharge.	10 acre-feet

Project Name	Water Source	Description of Project	Potential Volume of Water Stored
Derby Canyon Off-channel Reservoir	Derby Canyon Creek	This project would entail construction of small off-channel reservoirs on private land where land is available in Derby Canyon. Water would be diverted into the reservoirs during winter or spring and released during summer.	1-20 acre-feet
Williams Canyon Off-channel Reservoir	Williams Canyon Creek	This project would entail construction of off-channel reservoirs on private land (where available) or on federal land managed by the U.S. Forest Service (USFS) in Williams Canyon. Water would be diverted into the reservoirs during winter or spring and released during summer.	1-50 acre-feet
Ollala Canyon Off-channel Reservoir	Ollala Canyon Creek	This water storage project would entail construction of off-channel reservoirs on private land (where available) or on land managed by the USFS in Ollala Canyon. Water would be diverted into the reservoirs during winter or spring and released during summer.	1-20 acre-feet
Nahahum Canyon Off-channel Reservoir	Nahahum Canyon Creek	This water storage project would entail construction of small off-channel reservoirs on private land where land is available in Nahahum Canyon. Water would be diverted into the reservoirs during winter or spring and released during summer.	1-20 acre-feet
Peshastin Recharge Basin	Lower Wenatchee	Construct recharge basin near Wenatchee River to augment groundwater supplies. Project would require diversion from Wenatchee River. A more detailed description of the project is provided in Appendix B.	n/a

3.1.3 Potential Benefits of Projects

The potential benefits of the water storage projects are qualitatively described in Table 3-2. Projects are described as having beneficial, neutral, or, negative effects on factors that address the issues and recommendations listed in the Watershed Plan for the Lower Wenatchee sub-watershed. The factors listed in Section 3.1.1 are water quantity (instream flow and water supply), water quality and habitat. Most of the opportunities for water storage reviewed for this analysis address water quantity issues and are not expected to significantly impact other factors such as water quality and habitat. An exception is a physical disturbance to habitat such as an instream storage reservoir which may impact fisheries habitat and fish migration.

The surface water storage opportunities listed in Table 3-1 would likely increase instream flow or water supply. However, the size of those potential storage projects are very small relative to the entire Lower Wenatchee sub-watershed, therefore the benefits would be very localized to the basin they are located (an example of a basin would be Ollalla Canyon). The CMZ opportunities listed are expected to improve habitat conditions but would have little or no benefit to instream flow or water supply during critical low flow periods. The Cashmere Wastewater Lagoon project is also small and would have no measurable benefit to instream flow or water supply in the Lower Wenatchee Sub-watershed.

Table 3-2
Potential Step A Water Storage Project Benefits
Within Lower Wenatchee Sub-watershed

Project Name	Improvement in Water Quality (reduce temp. or non-point pollution)	Improvement in instream flow in Wenatchee River or water supply	Improvement in habitat or fish passage
CMZ Project 6	◒	◒	○
CMZ Project 9	◒	◒	○
CMZ Project 10	◒	◒	○
CMZ Project 11	◒	◒	○
CMZ Project 15	◒	◒	○
Cashmere Wastewater Lagoon	◒	◒	◒
Derby Canyon Off-channel Reservoir	◒	○	◒
Williams Canyon Off-channel Reservoir	◒	○	◒
Ollala Canyon Off-channel Reservoir	◒	○	◒
Nahahum Canyon Off-channel Reservoir	◒	○	◒
Peshastin Recharge Basin	◒	○	◒

○ = Potential Benefit or Improvement ◒ = No Benefit or No Impact ● = Potential Impact or Reduction

3.1.4 Review of Potential Environmental Effects

Key natural resources elements and potential "fatal flaws" associated with each Step A water storage project were identified using data from Washington Department of Fish and Wildlife (WDFW). The Washington Department of Fish and Wildlife Priority Habitats and Species (PHS) data sets from 2005 were used as a simple tool to identify interactions with the environment. Each potential water storage project footprint on the landscape was overlain with the PHS data set. All PHS resources within 500 feet of the footprint of the storage project were identified. The distance of 500 feet was selected to represent potential direct interactions between priority habitat and species should construction and operation of a water storage facility take place. Indirect effects, such as noise generated during construction, and effects to water quantity and quality may extend beyond 500 feet and were not identified in this process.

Outcomes from this simple screening highlight some potential PHS resources that could be affected by the potential projects In order to determine feasibility (e.g. obtaining the appropriate permits), more detailed site analysis and public outreach is needed to identify public support, the extent of impacts, and sensitivity of the resource. Projects that are selected for the Step B Assessment undergo a more rigorous review of feasibility including potential environmental effects (see Section 4).

The GIS analysis identified eighteen separate PHS habitats associated with the various Step A projects in the Lower Wenatchee sub-Watershed. For the purposes of this analysis, the PHS data has been consolidated into four categories:

- Terrestrial Wildlife and Habitats,
- Endangered Species Act (ESA)-Listed Fish Habitat,
- Non-Listed Fish Habitat, and
- Streams and Wetlands.

All projects with terrestrial wildlife and habitats will require coordination with Federal Agencies and the WDFW Area Habitat Biologist to determine if project could be allowed to move forward, and if so, what would be appropriate mitigation. Should a project become feasible for development, typical mitigation measures include avoidance of sensitive areas (e.g. elk calving, areas containing snags and large down wood), and may also include seasonal restrictions for construction. Specific management requirements and recommendations exist for some species and habitat types and these would be incorporated within the NEPA analysis, project implementation, and project management.

In addition to Special Use screening and permitting required for all proposed projects on National Forest Lands, aquatic permits from county, state, and federal permitting agencies would be required for storage opportunities impacting fish-bearing waters, streams, and wetlands. Although this analysis does not differentiate between projects that require reservoirs placed within streams, and those placed off-channel, this distinction can be a significant factor in permitting feasibility. Potential reservoir projects that would require placement within ESA-listed fish habitat, thereby directly impacting spawning, rearing, or migration of listed salmonids, may not be feasible to implement under numerous federal agency policies and permitting processes, especially under Section 7 of the Endangered Species Act (ESA). Potential projects placed off-channel may also indirectly impact ESA-listed habitat, however permits may be obtained if laws could be met, and permitting agencies accept appropriate impact avoidance and minimization measures.

Table 3-3 presents the review of environmental factors for the Step A water storage projects in the Lower Wenatchee Sub-watershed.

Table 3-3
Review of Environmental Factors
Within Lower Wenatchee Sub-watershed

Project Name	PHS-Terrestrial Wildlife and Habitats	ESA-Listed Fish	Non-Listed Fish	Wetlands/ Streams
CMZ Project 6		√	√	√
CMZ Project 9		√	√	√
CMZ Project 10		√	√	√
CMZ Project 11		√	√	√
CMZ Project 15		√	√	√
Cashmere Wastewater Lagoon		√	√	√
Derby Canyon Off-channel Reservoir	√	√		√
Williams Canyon Off-channel Reservoir	√			√
Ollala Canyon Off-channel Reservoir	√			√
Nahahum Canyon Off-channel Reservoir	√			√
Peshastin Recharge Basin				

3.2 Upper Wenatchee and Chiwaukum Sub-Watershed

3.2.1 Issues and Recommended Actions from Watershed Plan

The following issues and recommended actions for the Upper Wenatchee and Chiwaukum Sub-Watersheds are listed in the Wenatchee Watershed Plan. Two of the recommended actions, increase instream flow and provide water supply for future growth, could be addressed by providing additional water storage.

Issue Summary:

a) Land development has reduced channel migration, woody debris recruitment, and gravel recruitment.
b) Fecal coliform and water temperatures are elevated.
c) The sub-watershed contains important habitat for spring and summer chinook, steelhead, and bull trout.

Recommended Actions:

a) Protect remaining floodplain and riparian habitat.
b) Restore channel migration to resemble historical function.
c) If restoration is not possible, improve fish access to oxbows and historical side channels that have been cut off from main channel.
d) Initiate public information efforts to discourage harassment of spawning summer chinook salmon.

e) ***Increase instream flow.***
f) ***Provide water supply for future growth.***
g) Reduce nonpoint pollution from septic tanks and livestock.
h) Initiate public information efforts to encourage protection of riparian habitat.

3.2.2 List and Description of Potential Multi-purpose Water Storage Projects

Table 3-4 lists the water storage projects identified in the Upper Wenatchee and Chiwaukum Sub-watershed. The potential volume of water stored is a preliminary estimate obtained by reviewing the area available for a reservoir. Figure 3 shows the locations of the projects.

Table 3-4
Upper Watershed
Description of Potential Multi-purpose Water Storage Projects

Project Name	Water Source	Description of Project	Potential Volume of Water Stored
Canyon Creek Off-Channel Reservoir	Canyon Creek, Chiwaukum Creek	Potential site for a reservoir that would store runoff from Chiwaukum and Canyon Creek. Site is located on federal land managed by the USFS. Would required stream diversions.	50-100 acre-feet
Lower Chiwaukum Creek Off-Channel Reservoir	Chiwaukum Creek	Potential site for an off-stream reservoir near the mouth of Chiwaukum Creek. Would required stream diversion. Site is located on private property.	100-200 acre-feet
Wenatchee River Off-Channel Reservoir	Wenatchee River	Potential site for an off-channel reservoir to store Wenatchee River flow. Site is located on federal land managed by the USFS. Would require stream diversion or pump from River.	100-200 acre-feet
Upper Wenatchee Recharge Basin	Wenatchee River	Potential site for a recharge basin near Plain. Site would be on private land. Would require diversion from Wenatchee River or enlarge Wenatchee- Chiwawa Irrigation ditch to convey water to basin. See Appendix B for more detailed description.	10-100 acre-feet

3.2.3 Potential Benefits of Projects

The potential benefits that the water storage projects could have on the main issues described for the Upper Watershed are qualitatively described in Table 3-5. The surface water storage opportunities would likely improve instream flow or water supply. Surface water storage that increases instream flow in the Chiwaukum River would also have the benefit of increasing instream flow for most of the length of the Wenatchee River.

Table 3-5
Potential Step A Water Storage Project Benefits
Within Upper Wenatchee and Chiwaukum Sub-watersheds

Project Name	Improvement in Water Quality (reduce temp. or non-point pollution)	Improvement in instream flow in Wenatchee River or water supply	Improvement in habitat or fish passage
Canyon Creek Off-Channel Reservoir	◒	○	◒
Lower Chiwaukum Creek Off-Channel Reservoir	◒	○	◒
Wenatchee River Off-Channel Reservoir	◒	○	◒
Upper Wenatchee Recharge Basin	◒	○	◒

○ = Potential Benefit or Improvement ◒ = No Benefit or No Impact ● = Potential Impact or Reduction

3.2.4 Review of Potential Environmental Effects

Table 3-6 presents the review of environmental factors for the Step A water storage projects in the Upper Watershed.

Table 3-6
Review of Environmental Factors
Within Upper Wenatchee and Chiwaukum Sub-watersheds

Project Name	PHS-Terrestrial Wildlife and Habitats	ESA-Listed Fish	Non-Listed Fish	Wetlands/ Streams
Canyon Creek Off-Channel Reservoir				√
Lower Chiwaukum Creek Of-Channel Reservoir		√		√
Wenatchee River Off-Channel Reservoir		√		
Upper Wenatchee Recharge Basin				

3.3 Mission Sub-Watershed

3.3.1 Issues and Recommended Actions from Watershed Plan

The following issues and recommended actions for the Mission Sub-Watershed are listed in the Wenatchee Watershed Plan. One of the recommended actions, increase instream flow, could be addressed by providing additional water storage.

Issues:

a) Low or non-existent flows with associated high instream temperatures in lower Mission Creek disrupt distribution and abundance of native species, particularly in summer.
b) Channelization of lower Mission, Brender and Yaksum creeks.
c) Degraded water quality and loss of riparian habitat, road construction, urban/residential and agricultural development, especially in the floodplains, grazing, and soil compaction have changed channel function, channel sinuosity, and floodplain function
d) Fish passage barriers (culverts) when flows are available.
e) The Mission Sub-watershed contains important habitat for spring chinook, and steelhead.
f) How to provide for out-of-stream water uses without degrading habitat

Recommended Actions in order of priority:

a) **Increase stream flow**.
b) Reduce nonpoint pollution from septic tanks and livestock.

3.3.2 List and Description of Potential Multi-purpose Water Storage Projects

Table 3-7 lists the projects identified in the Mission Sub-watershed. The potential volume of water stored is a preliminary estimate obtained by reviewing the area available for a reservoir. Figure 4 shows the locations of the projects.

Table 3-7
Mission Creek Subbasin
Description of Potential Multi-purpose Water Storage Projects

Project Name	Water Source	Description of Project	Potential Volume of Water Stored
East Fork Mission Creek Reservoir	E. Fk Mission Creek	Potential site for an off-channel reservoir in the upper reaches of the Mission Creek basin at about 4200 ft. Site is located on federal land managed by USFS in an existing depression. A diversion on the East Fork would be required.	50-100 acre-feet
Upper Reach Mission Creek Lake	Runoff from NW side of Mission Peak	Potential site for an off-channel reservoir near the very southern boundary of the Mission Creek basin at about elevation 6300 ft. Site is located on federal land managed by USFS at an existing lake.	10-50 acre-feet
Little Camas Creek Reservoir	Little Camas Creek	Potential site for an instream reservoir on Little Camas Creek at about elevation 4200 ft. Site is located on federal land managed by USFS.	500-1000 acre-feet
Stream Channel Restoration on Peavine Canyon, Poison Canyon, Sand Creek	Creeks that restoration is performed on.	Install check structures in creeks to increase bed level, thereby increasing bank storage along creek. Restore riparian area and improve habitat.	Very small
Cashmere Recharge Basin	Lower Wenatchee	Construct recharge basin in Lower Mission Creek to augment groundwater supplies. Project would require diversion on Mission Creek. Diversion would need to occur in winter or spring time when flow is sufficient. Project area is located on privately owned land. See Appendix B for a more detailed description.	n/a

3.3.3 Potential Benefits of Projects

The potential beneficial effects the water storage projects could have on the main issues described for the Mission Sub-watershed are qualitatively described in Table 3-8. The projects that will store water in surface reservoirs would likely have a measurable benefit to instream flow and/or water supply in the Mission Sub-watershed. They could also slightly improve water quality conditions by increasing flow in Mission Creek. Very little effect on fish habitat or fish passage would likely result other than benefits from increased instream flow which are covered in the instream flow and water supply criteria column. The stream channel restoration projects would not likely measurably improve instream flow or water quality conditions however they would have some benefits from sediment retention, riparian and habitat restoration and possibly low-flow maintenance if enough length of stream were restored. The recharge basin may improve water supply conditions but probably not to the extent a surface water reservoir would as a recharge basin is not as efficient in storing and releasing water on demand when compared to surface water reservoirs.

Table 3-8
Potential Step A Water Storage Project Benefits
Within Mission Sub-watershed

Project Name	Improvement in Water Quality (reduce temp. or non-point pollution)	Improvement in instream flow in Mission Creek or water supply	Improvement in habitat or fish passage
East Fork Mission Creek Reservoir	○	○	◒
Upper Reach Mission Creek Lake	○	○	◒
Little Camas Creek Reservoir	○	○	◒
Stream Channel Restoration on Peavine Canyon, Poison Canyon, Sand Creek	◒	◒	◒
Cashmere Recharge Basin	◒	○	◒

○ = Potential Benefit or Improvement ◒ = No Benefit or No Impact ● = Potential Impact or Reduction

3.3.4 Review of Potential Environmental Effects

Table 3-9 presents the identification of environmental factors for the Step A projects in the Mission Sub-watershed.

Table 3-9
Review of Environmental Factors
Within Mission Sub-watershed

Project	PHS-Terrestrial Wildlife and Habitats	ESA-Listed Fish	Non-Listed Fish	Wetlands/ Streams
East Fork Mission Creek Reservoir				√
Upper Reach Mission Creek Lake				√
Little Camas Creek Reservoir				√
Cashmere Recharge Basin				√

3.4 Peshastin Sub-Watershed

3.4.1 Issues and Recommended Actions from Watershed Plan

The following issues and recommended actions for the Peshastin Sub-Watershed are listed in the Wenatchee Watershed Plan. One of the recommended actions, increase instream flow, could be addressed by providing additional water storage.

Issues:

a) Land development, primarily the State Highway, has reduced channel migration, riparian habitat, floodplain function, stream sinuosity, and gravel recruitment.
b) Elevated stream temperature.
c) Late summer instream flows are often critically low and impede migration, reduce rearing habitat, and contribute to elevated water temperature.
d) The Peshastin Sub-watershed contains important habitat for spring and summer chinook, steelhead, and bull trout.

Recommended Actions:

a) Increase stream flow.
b) Increase stream sinuosity and floodplain function from Ingalls Creek to mouth.
c) **Restore flow from Camas Creek to mouth**.
d) Other projects should be delayed until stream sinuosity and flows are addressed.

3.4.2 List and Description of Potential Multi-purpose Water Storage Projects

Table 3-10 lists the projects identified in the Peshastin Sub-watershed. The potential volume of water stored is a preliminary estimate obtained by reviewing available topographic maps. Figure 5 shows the locations of the projects.

Table 3-10
Peshastin Creek Sub-watershed
Description of Potential Multi-purpose Water Storage Projects

Project Name	Water Source	Description of Project	Potential Volume of Water Stored
Upper Camas Creek Lakes	Camas Creek	Potential site for an off-channel reservoir in the upper reaches of the Camas Creek basin at about elevation 2960 ft. Site is located on private land at two small lakes. A diversion on Camas Creek would be required.	1-10 acre-feet
Camas Land Off-channel Reservoir	Camas Creek	Potential site for an off-channel reservoir on private land owned by a church camp at about elevation 2900 ft. A diversion on Camas Creek would be required.	1-10 acre-feet
Camas Land Groundwater Level Management	Camas Creek	Project would increase groundwater levels in Camas Prairie by removing or blocking drainage ditches or other methods to be determined. Camas Prairie is privately owned.	1-10 acre-feet
Campbell Off-channel Reservoir	Peshastin Creek	Potential site for an off-channel reservoir in a canyon on the west side of the Peshastin Creek valley. Water would be supplied by the Tandy pipeline, which runs just below the reservoir site. The Tandy pipeline is an existing diversion	250-500 acre-feet

Project Name	Water Source	Description of Project	Potential Volume of Water Stored
		from Peshastin Creek. Water would also be collected from the canyon. Site is on both private and federal land managed by the USFS.	
Hansel Lane Pond	Peshastin Creek	Expand existing pond to provide additional storage. Site is on privately owned land at about elevation 1640 ft. Diversion from Peshastin Creek would be required.	1-10 acre-feet
Hansel Creek Off-channel Reservoir	Hansel Creek/Peshastin Creek	Potential site for an off-channel reservoir that would require an diversion from Peshastin Creek or Hansel Creek. Site is on privately owned land at about elevation 1760 ft.	1-10 acre-feet
Ingalls Creek Off-channel Reservoir	Ingalls Creek	Potential site for an off-channel reservoir between Ingalls Creek and Peshastin Creek at about elevation 1840 ft. Site is located on privately owned land. A diversion from Ingalls Creek would be required.	100-300 acre-feet
Tronsen Creek Off-channel Reservoir	Tronsen Creek	Potential site for an off-channel reservoir next to Tronsen Creek at about elevation 4700 ft. Site is located on the west side of Hwy 97 at the upper end of the Tronsen Creek campground on federal land managed by USFS. A diversion from Tronsen Creek would be required.	100-300 acre-feet
Negro Creek Instream Reservoir	Negro Creek	Potential site for an instream reservoir on Negro Creek at about elevation 3800 ft. Site is located on federal land managed by USFS.	100-500 acre-feet
Stream Channel Restoration on Ruby Creek, Lower Camas Creek, Mill Creek, Larsen Creek	Creeks that restoration is performed on.	Install check structures in creeks to increase bed level, thereby increasing bank storage along creek. Restore riparian area and improve habitat.	n/a

3.4.3 Potential Benefits of Projects

The potential beneficial effects the water storage projects could have on the main issues described for the Peshastin Sub-watershed are qualitatively described in Table 3-11. Most of the water storage projects listed in Table 3-11 are surface water storage reservoirs which do not impact other factors such as water quality and habitat, except for the case of an instream reservoir on Negro Creek that may impact habitat or fish passage. The projects to repair headcuts would not likely increase water quantity but would have other benefits as described in the same projects in Mission Sub-watershed.

Table 3-11
Potential Step A Water Storage Project Benefits
Within Peshastin Sub-watershed

Project Name	Improvement in Water Quality (reduce temp.)	Improvement in instream flow in Peshastin Creek or water supply	Improvement in habitat or fish passage
Upper Camas Creek Lakes	◒	○	◒
Camas Land Off-channel Reservoir	◒	○	◒
Camas Land Groundwater Level Management	◒	○	◒
Campbell Off-channel Reservoir	◒	○	◒
Hansel Lane Pond	◒	○	◒
Hansel Creek Off-channel Reservoir	◒	○	◒
Ingalls Creek Off-channel Reservoir	◒	○	◒
Tronsen Creek Off-channel Reservoir	◒	○	◒
Negro Creek Instream Reservoir	◒	○	●
Stream Channel Restoration on Ruby Creek, Lower Camas Creek, Mill Creek, Larsen Creek	◒	◒	◒

○ = Potential Benefit or Improvement ◒ = No Benefit or No Impact ● = Potential Impact or Reduction

3.4.4 Review of Potential Environmental Effects

Table 3-12 presents the review of environmental factors for the Step A projects in the Peshastin Sub-watershed.

Table 3-12
Review of Environmental Factors
Within Peshastin Sub-watershed

Project	PHS-Terrestrial Wildlife and Habitats	ESA-Listed Fish	Non-Listed Fish	Wetlands/ Streams
Upper Camas Creek Lakes	√			√
Camas Land Off-channel Reservoir	√			√
Camas Land Groundwater Level Management	√			√
Campbell Off-channel Reservoir				√
Hansel Lane Pond		√	√	√
Hansel Creek Off-channel Reservoir		√	√	√
Ingalls Creek Off-channel Reservoir				√
Tronsen Creek Off-channel Reservoir	√			√
Negro Creek Instream Reservoir			√	√
Stream Channel Restoration on Ruby Creek, Lower Camas Creek, Mill Creek, Larsen Creek				√

3.5 Chumstick Sub-Watershed

3.5.1 Issues and Recommended Actions from Watershed Plan

The following issues and recommended actions for the Chumstick Sub-Watershed are listed in the Wenatchee Watershed Plan. One of the recommended actions, increase instream flow, could be addressed by providing additional water storage.

Issues:

a) Private land development and high road density affects sediment delivery.
b) Channel migration affected by state highway, the railroad, multiple water crossing structures, and private land development.
c) Fecal coliform and water temperature levels are elevated, mostly a result of livestock and improper septic tanks
d) Fish passage is impeded at the North Road and numerous smaller culverts upstream.
e) Riparian habitat has been degraded or lost from Little Chumstick Creek to mouth.
f) The Chumstick Sub-watershed contains important habitat for steelhead.

Recommended Actions:

a) Restore passage for anadromous and inland fish. This should be done in a comprehensive, coordinated strategy, rather than a piecemeal approach.

b) Protect remaining floodplain and riparian habitat
c) Increase stream flow.
d) Restore riparian habitat, primarily from Eagle Creek to Suntisch Canyon.
e) Reduce road densities.
f) Restore stream channel migration.
g) Reduce nonpoint pollution from septic tanks and livestock.
h) Reduce fine sediment input from roads and some land management activities.

3.5.2 List and Description of Potential Multi-purpose Water Storage Projects

Table 3-13 lists the projects identified in the Chumstick Sub-watershed. The potential volume of water stored is a preliminary estimate obtained by reviewing the area available for a reservoir. Figure 6 shows the locations of the projects.

Table 3-13
Chumstick Creek Sub-watershed
Description of Potential Multi-purpose Water Storage Projects

Project Name	Water Source	Description of Project	Potential Volume of Water Stored
Eagle Creek Tributary Lakes	Runoff from Chumstick Mountain	Potential site is at two small existing lakes or ponds at elevation 4000 ft (upper) and 3000 ft (lower). Photos of each are in Appendix C. Sites are on federal land managed by USFS.	50-100 acre-feet
Eagle Creek SW Tributary Lake	SW Tributary of Eagle Creek	Potential site is at two small existing lakes at about elevation 3320 ft. Photos of each are in Appendix C. Sites are on federal land managed by USFS.	10-50 acre-feet
East Van Creek Off-channel Reservoir	East Van Creek	Potential site is at two small existing lakes or ponds at elevation 4000 ft (upper) and 3000 ft (lower). Photos of each are in Appendix C. Sites are located on federal land managed by USFS.	50-100 acre-feet
Small off-channel reservoirs in Chumstick Creek, Little Chumstick Creek and Eagle Creek valleys	Adjacent Creeks	These projects would entail construction of reservoirs on private land where land is available near Chumstick Creek. Water would be diverted into the reservoirs during winter or spring and released during summer.	1-10 acre-feet each
CMZ Project 19 - Irwin Property	Wenatchee River	Undeveloped floodplain across from Leavenworth city park. Project would construct a backchannel and increase storage capacity in the floodplain.	Very little
CMZ Project 20	Wenatchee River	Particularly active portion of the floodplain has one active side channel. Project would provide additional backchannel habitat and increase floodplain storage.	Very little

Project Name	Water Source	Description of Project	Potential Volume of Water Stored
Ski Hill Wetlands/Stormwater Storage or recharge	Groundwater seepage, stormwater runoff	The City of Leavenworth would like to study a project that would help control runoff from the Ski Hill area, and store the water in constructed wetlands and recharge it where possible. Project would be located on city or currently privately owned land.	1-10 acre-feet
Pump from the Upper Wenatchee Sub-watershed	Wenatchee-Chiwawa Irrigation District or the Wenatchee River	Construct a pump station to pump water from the Wenatchee-Chiwawa Irrigation District ditch or Wenatchee River into a pipeline and over the hill to Little Chumstick Creek, where it would be allowed to recharge the creek valley. The project may require an upgrade of the irrigation ditch to deliver enough water. The project would be located on both private land and federal land managed by the USFS.	N/A, May be able to pump 3-5 cfs

3.5.3 Potential Benefits of Projects

The potential beneficial effects the water storage projects could have on the main issues described for the Chumstick Sub-watershed are qualitatively described in Table 3-14. The surface water storage projects listed in the table would likely improve instream flow or water supply; the CMZ projects listed would not likely increase the quantity of water available but would have some habitat benefits. The Ski Hill Wetlands project may improve water quality by treating and recharging stormwater runoff. The project is not likely to improve water quantity or provide fish habitat. The project to pump into the Chumstick Sub-watershed would improve instream flow or water supply by recharging the Little Chumstick Creek valley during dry times of the year. However the project would reduce flow in the Wenatchee River by the amount of water pumped into the Chumstick Sub-watershed.

Table 3-14
Potential Step A Water Storage Project Benefits
Within Chumstick Sub-watershed

Project Name	Improvement in Water Quality (reduce temp. or non-point pollution)	Improvement in instream flow in Chumstick Creek or water supply	Improvement in habitat or fish passage
Eagle Creek Tributary Lakes	◒	○	◒
Eagle Creek SW Tributary Lake	◒	○	◒
East Van Creek Off-channel Reservoir	◒	○	◒
Small off-channel reservoirs in Chumstick Creek, Little Chumstick Creek and Eagle Creek valleys	◒	○	◒
CMZ Project 19 - Irwin Property	◒	◒	○
CMZ Project 20	◒	◒	○
Ski Hill Wetlands/Stormwater Storage or recharge	○	◒	◒
Eagle Creek Tributary Lakes	◒	○	◒
Pump from Upper Wenatchee Sub-watershed	◒	○	◒

○ = Potential Benefit or Improvement ◒ = No Benefit or No Impact ● = Potential Impact or Reduction

3.5.4 Review of Potential Environmental Effects

Table 3-15 presents the review of environmental factors for the Step A projects in the Chumstick Sub-watershed.

Table 3-15
Review of Environmental Factors
Within Chumstick Sub-watershed

Project Name	PHS-Terrestrial Wildlife and Habitats	ESA-Listed Fish	Non-Listed Fish	Wetlands/ Streams
Eagle Creek Tributary Lakes	√			√
Eagle Creek SW Tributary Lake	√			√
East Van Creek Off-channel Reservoir	√			√
Small off-channel reservoirs in Chumstick Creek, Little Chumstick Creek and Eagle Creek valleys			√	√
CMZ Project 19 - Irwin Property				√
CMZ Project 20				√
Ski Hill Wetlands/Stormwater Storage or recharge				
Eagle Creek Tributary Lakes	√			√
Pump from Upper Wenatchee Sub-watershed				

3.6 Icicle Sub-Watershed

3.6.1 Issues and Recommended Actions from Watershed Plan

The following issues and recommended actions for the Icicle Sub-Watershed are listed in the Wenatchee Watershed Plan. One of the recommended actions, restore flow conditions on Icicle Creek downstream of Rat Creek, could be addressed by providing additional water storage.

Issues:

a) Land development downstream of Leavenworth Hatchery has affected stream channel migration, recruitment of large woody debris, and off channel habitat.
b) There are barriers to migration on Icicle Creek at Leavenworth Hatchery and possibly in the boulder field near Snow Creek
c) Water withdrawals in Icicle Creek (primarily between Rat Creek and the hatchery) likely contribute to low flows and high summer temperatures in lower Icicle Creek.
d) The Icicle Road upstream of Chatter Creek at places may confine the stream channel and affect floodplain function.
e) The 1994 Rat Creek fire caused increased sedimentation and water temperature in the middle and lower Icicle drainage.
f) The Icicle Sub-watershed contains important habitat for steelhead, bull trout, cutthroat trout, and redband trout.

Recommended Actions:

a) Protect remaining floodplain and riparian habitat downstream of Chatter Creek. Emphasis should be placed on habitat downstream of Leavenworth Hatchery.
b) Rectify human-made passage barriers.
c) Restore flow conditions on Icicle Creek downstream of Rat Creek.
d) Investigate the role of surface and well water withdrawals on instream flows and habitat use.
e) Develop strategies with water users to reduce effects, if any.
f) Initiate public information efforts to discourage harassment of spawning salmonids.
g) Manage recreation areas to reduce impacts to riparian cover.

3.6.2 List and Description of Potential Multi-purpose Water Storage Projects

Table 3-16 lists the projects identified in the Icicle Sub-watershed. The potential volume of water stored is a preliminary estimate obtained by reviewing water right records, drawings for new reservoirs planned by Johnson and geologic information. Figure 7 shows the locations of the projects.

Table 3-16
Icicle Creek Sub-watershed
Description of Potential Multi-purpose Water Storage Projects

Project Name	Water Source	Description of Project	Potential Volume of Water Stored
Alpine Lakes Optimization (review potential to draw down lakes more)	Various sources	Optimize use of water from high Alpine Lakes (Snow, Nada, Colchuck, Square, Klonaqua, Eightmile) by installing remote data collection and remote operational capability at each lake. Information would be telemetered by satellite to base station to control amount of water discharged and accurately determine remaining volume of water in reservoirs. Also review potential for increasing storage at existing lakes. Lakes are located within federally-designated wilderness area.	Total volume in lakes is approximately 5500 acre-feet (from Ecology records)
Icicle Creek Recharge Basin	Icicle Creek	Construct recharge basin in Icicle Creek valley to augment groundwater supplies. Project would require diversion on Icicle Creek or use of existing diversion. Diversion would need to occur in winter or spring time when flow is sufficient. Project would be located on land currently privately owned. See Appendix B for more detailed description.	10-50 acre-feet
Mtn Home Off-channel Reservoirs	Mtn. Home Creek	Potential site on privately owned land at approximately elevation 2600 ft. Property owner has identified two potential storage reservoir sites that may be constructed to provide water for a development.	350 acre-feet

3.6.3 Potential Benefits of Projects

The potential beneficial effects the water storage projects could have on the main issues described for the Icicle Sub-watershed are qualitatively described in Table 3-17. The Alpine Lakes Optimization and the Mtn. Home Reservoirs would provide measurable benefits to instream flow and water supply. The Icicle Creek Recharge basin would have a much smaller benefit. The projects would not have much effect on water quality or habitat.

Table 3-17
Potential Step A Water Storage Project Benefits
Within Icicle Sub-watershed

Project Name	Improvement in Water Quality (reduce temp. or non-point pollution)	Improvement in instream flow in Icicle Creek or Wenatchee River or water supply	Improvement in habitat or fish passage
Alpine Lakes Optimization	◒	○	◒
Icicle Creek Recharge Basin	◒	○	◒
Mtn Home Off-channel Reservoirs	◒	○	◒

○ = Potential Benefit or Improvement ◒ = No Benefit or No Impact ● = Potential Impact or Reduction

3.6.4 Review of Potential Environmental Effects

Table 3-18 presents the review of environmental factors for the Step A projects in the Icicle Sub-watershed.

Table 3-18
Review of Environmental Factors
Within Icicle Sub-watershed

Project	PHS-Terrestrial Wildlife and Habitats	ESA-Listed Fish	Non-Listed Fish	Wetlands/ Streams
Alpine Lakes Optimization	√		√	√
Icicle Creek Recharge Basin	√			√
Mtn Home Off-channel Reservoirs				√

3.7 Nason Sub-Watershed

3.7.1 Issues and Recommended Actions from Watershed Plan

The following issues and recommended actions for the Nason Sub-Watershed are listed in the Wenatchee Watershed Plan. One of the recommended actions, increase instream flow, could be addressed by providing additional water storage.

Issues:

a) The state highway, railroad, and private land development affect woody debris recruitment, channel migration, and gravel recruitment.
b) Lower Nason Creek is on the state 303(d) list for water temperature.
c) The Nason Creek Sub-watershed contains important habitat for spring chinook, steelhead, and bull trout.

Recommended Actions:

a) Protect remaining floodplain and riparian habitat.
b) Restore channel migration to historical function.
c) If restoration is not possible, improve fish access to oxbows and historical side channels.
d) Initiate public information efforts to discourage harassment of spawning salmonids.
e) Increase instream flow.

3.7.2 List and Description of Potential Multi-purpose Water Storage Projects

Table 3-19 lists the projects identified in the Nason Sub-watershed. The potential volume of water stored is a preliminary estimate obtained by reviewing the area available for a reservoir. Figure 8 shows the locations of the projects.

Table 3-19
Nason Creek Subbasin
Description of Potential Multi-purpose Water Storage Projects

Project Name	Water Source	Description of Project	Potential Volume of Water Stored
CMZ Project N1	Nason Creek	Oxbow located to the east of Hwy 207 has been cut off hydrologically from the main Nason Creek channel. The reconnection via culvert would provide high-flow off-channel habitat for juvenile salmonids and increase floodplain storage.	n/a
CMZ Project N2	Nason Creek	Oxbow located to the east of Hwy 207 has been cut-off to fish access from the main Nason Creek channel. N2 is connected via open water ponds and wetland to N3 to form a large wetland complex with old creek channels. Undersized and impassable culverts prevent proper hydrologic connectivity and fish passage to and from the main Nason Creek channel. The	n/a

Project Name	Water Source	Description of Project	Potential Volume of Water Stored
		reconnection to the mainstem via culvert would provide high-flow off-channel habitat for juvenile salmonids. A larger connection would increase floodplain storage.	
CMZ Project N3	Nason Creek	Remnant oxbow currently provides open water and palustrine scrub-shrub wetland habitat. Drains to the Nason Creek mainstem via 36" culvert at the downstream end. The culvert is perched and creates fish stranding at low flows. Likely not passable to fish during high flows due to high water velocities. The reconnection to the mainstem via the construction of a proper culvert would provide high-flow off-channel habitat for juvenile salmonids within the N3 and N2 wetland complex. A larger connection would increase floodplain storage.	n/a
CMZ Project N4	Nason Creek	Remnant oxbow maintains a perennial inundated cattail/willow wetland. No upstream culvert. Downstream culvert in improperly sized for fish passage and currently strands fish during low flows. Channel reconstruction on the west side of Hwy 207 would also be necessary for fish passage to and from the Nason Creek mainstem. The reconnection to the mainstem via the construction of a proper culvert would provide high-flow off-channel habitat for juvenile salmonids and increase floodplain storage.	n/a
Nason Creek Floodplain Storage	Nason Creek	Potential site is in floodplain wetland that is separated from Nason Creek by the railroad embankment. This project would review the feasibility of improving the connection between Nason Creek and the floodplain wetland or constructing water level control in the wetland to increase storage.	10-50 acre-feet
Coulter Creek Instream Reservoir	Coulter Creek	Potential site for instream reservoir is at elevation 3300 ft. Site is located on federal land managed by USFS.	10-50 acre-feet
Roaring Creek Tributary Off-channel Reservoir	Roaring Creek West Trib.	Potential site for off-channel reservoir at site of small existing lake at about elevation 5120 ft. on federal land managed by USFS.	1-10 acre-feet
Roaring Creek instream reservoir	Roaring Creek	Potential site for instream reservoir is at elevation 4400 ft. Site is located on federal land managed by USFS.	10-50 acre-feet

Project Name	Water Source	Description of Project	Potential Volume of Water Stored
Lanham Lake	Lanham Creek	Potential site is at small existing lake at about elevation 4140 ft. Site is located on federal land managed by USFS.	10-50 acre-feet
Nason Creek Off-channel Reservoir	Nason Creek	Potential off-channel reservoir near confluence of Whitepine Creek and Nason Creek. Site is on federal land managed by USFS at an elevation of about 2350 ft. A diversion from Nason Creek or Whitepine Creek would be required.	10-100 acre-feet
Rock Lake	Schilling Creek	Potential site is at small existing lake at about elevation 5900 ft. Site is located on federal land managed by USFS.	10-50 acre-feet
Cresent Lake	Cresent Creek	Potential site is at small existing lake at about elevation 5450 ft. Site is located on federal land managed by USFS.	10-50 acre-feet
Canaan Lake	Royal Creek	Potential site is at small existing lake at about elevation 5900 ft. Site is located on federal land managed by USFS.	10-50 acre-feet
Merritt Lake	Mahar Creek	Potential site is at small existing lake at about elevation 5000 ft. Site is located on federal land managed by USFS.	10-50 acre-feet
Mill Creek Instream Reservoir	Mill Creek	Potential site for a large instream reservoir on Mill Creek at about elevation 3300 ft. Site is federal land managed by USFS. Potential problem is railroad tunnel located 200-300 feet under reservoir site.	1000-1500 acre-feet
Upper Nason Creek Off-channel Reservoir	Nason Creek	Potential site for off-channel reservoir on north side of Hwy 2 at elevation 3200 ft. A diversion from Nason and/or Smith Brook Creek would be required.	50-100 acre-feet

3.7.3 Potential Benefits of Projects

The potential beneficial effects the water storage projects could have on the main issues described for the Nason Sub-watershed are qualitatively described in Table 3-20. The surface water storage projects would likely improve instream flow or water supply and with the exception of some potential instream reservoirs, have little or no effect on habitat and water quality. The CMZ projects listed could improve habitat but would have little or no benefit to instream flow or water supply. The projects that increase instream flow in Nason Creek would also have the benefit of increasing flow the entire length of the Wenatchee River.

Table 3-20
Potential Step A Water Storage Project Benefits
Within Nason Sub-watershed

Project Name	Improvement in Water Quality (reduce temp. or non-point pollution)	Improvement in instream flow in Nason Creek or Wenatchee River or water supply	Improvement in habitat or fish passage
CMZ Project N1	◒	◒	○
CMZ Project N2	◒	◒	○
CMZ Project N3	◒	◒	○
CMZ Project N4	◒	◒	○
Nason Creek Floodplain Storage	◒	◒	○
Coulter Creek Instream Reservoir	◒	○	●
Roaring Creek Tributary Off-channel Reservoir	◒	○	◒
Roaring Creek instream reservoir	◒	○	●
Lanham Lake	◒	○	◒
Nason Creek Off-channel Reservoir	◒	○	◒
Lake Susan Jane	◒	○	◒
Rock Lake	◒	○	◒
Cresent Lake	◒	○	◒
Canaan Lake	◒	○	◒
Merritt Lake	◒	○	◒
Mill Creek Instream Reservoir	◒	○	●
Upper Nason Creek Off-channel Reservoir	◒	○	◒

○ = Potential Benefit or Improvement ◒ = No Benefit or No Impact ● = Potential Impact or Reduction

3.7.4 Review of Potential Environmental Effects

Table 3-21 presents the review of environmental factors for the Step A projects in the Nason Sub-watershed.

Table 3-21
Review of Environmental Factors
Within Nason Sub-watershed

Project	PHS-Terrestrial Wildlife and Habitats	ESA-Listed Fish	Non-Listed Fish	Wetlands/ Streams
CMZ Project N1	√	√	√	√
CMZ Project N2	√	√	√	√
CMZ Project N3	√	√	√	√
CMZ Project N4	√	√	√	√
Nason Creek Floodplain Storage	√	√	√	√
Coulter Creek Instream Reservoir			√	√
Roaring Creek Tributary Off-channel Reservoir				
Roaring Creek instream reservoir			√	√
Lanham Lake			√	√
Nason Creek Off-channel Reservoir	√	√	√	√
Lake Susan Jane				
Rock Lake	√		√	√
Cresent Lake	√			√
Canaan Lake				
Merritt Lake	√			
Mill Creek Instream Reservoir	√		√	√
Upper Nason Creek Off-channel Reservoir	√		√	√

3.8 Chiwawa Sub-Watershed

3.8.1 Issues and Recommended Actions from Watershed Plan

The following issues and recommended actions for the Chiwawa Sub-Watershed are listed in the Wenatchee Watershed Plan. Although the recommended actions for the Sub-watershed do not include increasing streamflow or water supply, actions taken in the Chiwawa Sub-Watershed could improve streamflow and water supply conditions downstream along the Wenatchee River.

Issues:

a) Most of this watershed is in public ownership and protected as Wilderness Area or under the Northwest Forest Plan. Habitat within these areas is essentially pristine.
b) There is limited housing development in private parcels on the lower Chiwawa River. Loss of riparian vegetation in these reaches may influence water temperatures and hiding cover.
c) Water withdrawals in the lower Chiwawa River may affect rearing habitat in low flow years.

d) The Chiwawa Sub-watershed contains important habitat for spring chinook, steelhead, and bull trout.

Recommended Actions:

a) Protect remaining floodplain and riparian habitat, particularly around Chikamin Flats.
b) Investigate the role of surface and well water withdrawals on instream flows and habitat use. Develop strategies with water users to reduce effects, if any.
c) Initiate public information efforts to discourage harassment of spawning spring chinook salmon and bull trout.
d) Manage recreation areas to reduce or avoid impacts to riparian habitats.

3.8.2 List and Description of Potential Multi-purpose Water Storage Projects

Table 3-22 lists the projects identified in the Chiwawa Sub-watershed. The potential volume of water stored is a preliminary estimate obtained by reviewing the area available for a reservoir. Figure 9 shows the locations of the projects.

Table 3-22
Chiwawa Subbasin
Description of Potential Multi-purpose Water Storage Projects

Project Name	Water Source	Description of Project	Potential Volume of Water Stored
Marble Creek Instream Reservoir	Marble Creek	Potential site for an instream reservoir in the upper reaches of the Marble Creek basin at Marble Meadow, about elevation 5920 ft. Site is located on federal land managed by USFS.	50-100 acre-feet
Marble Creek off-channel Reservoir	Marble Creek	Potential site for an off-channel reservoir adjacent to Marble Creek at about elevation 2940 ft. Site is located on federal land managed by USFS. A diversion on Marble Creek would be required.	50-100 acre-feet
Gate Creek Off-channel Reservoir	Gate Creek, Marble Creek	Potential site for an off-channel reservoir between Gate Creek and Marble Creek at about elevation 2560 ft. Site is located on federal land managed by USFS. A small lake is present. A diversion on Gate Creek or Marble Creek would be required.	50-100 acre-feet
Minnow Creek Off-channel Reservoir	Minnow Creek	Potential site for an off-channel reservoir adjacent to Minnow Creek at about elevation 2860 ft. Site is located on federal land managed by USFS. A diversion on Minnow Creek would be required.	50-100 acre-feet

Project Name	Water Source	Description of Project	Potential Volume of Water Stored
Goose Creek North Tributary Reservoir	N. Trib. To Goose Creek	Potential site for an off-channel reservoir in a tributary valley north of Goose Creek at about elevation 2380 ft. Site is located on federal land managed by USFS. A small pond exists at the site. A diversion on Goose Creek would be required.	10-50 acre-feet
Deep Creek Instream Reservoir	Deep Creek	Potential site for an instream reservoir opposite Morrow Meadow at an elevation of about 2260 ft. Site is located on federal land managed by USFS.	10-50 acre-feet
Beaver Creek Off-channel Reservoir	Beaver Creek	Potential site for an off-channel reservoir adjacent to Beaver Creek at about elevation 2240 ft. Site is located on private land. A diversion on Beaver Creek would be required.	10-50 acre-feet
Connection to old oxbows and other floodplain storage areas	Chiwawa River	There are numerous areas in the Chiwawa River floodplain that may benefit from improving connection between the river and floodplain or constructing side channels or oxbows to increase water storage in the floodplain.	n/a

3.8.3 Potential Benefits of Projects

The potential beneficial effects the water storage projects could have on the main issues described for the Chiwawa Sub-watershed are qualitatively described in Table 3-23. The surface water storage projects would likely improve instream flow or water supply and with the exception of some potential instream reservoirs, have little or no effect on habitat and water quality. The project to connect old oxbows and other floodplain storage areas could improve habitat but would have little or no benefit to instream flow or water supply. The projects that increase instream flow in the Chiwawa River would also have the benefit of increasing flow for most of the length of the Wenatchee River.

Table 3-23
Potential Step A Water Storage Project Benefits
Within Chiwawa Sub-watershed

Project Name	Improvement in Water Quality (reduce temp. or non-point pollution)	Improvement in instream flow in Chiwawa River or Wenatchee River or water supply	Improvement in habitat or fish passage
Marble Creek Instream Reservoir	◒	○	●
Marble Creek off-channel Reservoir	◒	○	◒
Gate Creek Off-channel Reservoir	◒	○	◒
Minnow Creek Off-channel Reservoir	◒	○	◒
Goose Creek North Tributary Reservoir	◒	○	◒
Deep Creek Instream Reservoir	◒	○	●
Beaver Creek Off-channel Reservoir	◒	○	◒
Connection to old oxbows and other floodplain storage areas	◒	◒	○

○ = Potential Benefit or Improvement ◒ = No Benefit or No Impact ● = Potential Impact or Reduction

3.8.4 Review of Potential Environmental Effects

Table 3-24 presents the review of environmental factors for the Step A projects in the Chiwawa Sub-watershed.

Table 3-24
Review of Environmental Factors
Within Chiwawa Sub-watershed

Project Name	PHS-Terrestrial Wildlife and Habitats	ESA-Listed Fish	Non-Listed Fish	Wetlands/ Streams
Marble Creek Instream Reservoir	√			
Marble Creek off-channel Reservoir				√
Gate Creek Off-channel Reservoir				√
Minnow Creek Off-channel Reservoir				√
Goose Creek North Tributary Reservoir	√			
Deep Creek Instream Reservoir	√			
Beaver Creek Off-channel Reservoir	√	√	√	√
Connection to old oxbows and other floodplain storage areas		√	√	√

3.9 Upper Watershed (Lake Wenatchee, Little Wenatchee, White River)

3.9.1 Issues and Recommended Actions from Watershed Plan

The following issues and recommended actions for the Little Wenatchee and White River Sub-Watersheds are listed in the Wenatchee Watershed Plan. Although the recommended actions for the Upper Watershed do not include increasing streamflow or water supply, actions taken in the Upper Watershed could improve streamflow and water supply conditions downstream along the Wenatchee River.

Issues – Little Wenatchee:

a) Past riparian harvest and log drives below the waterfalls may have affected stream channel morphometry and function.
b) Habitat above the waterfalls is intact and relatively pristine: essentially need to protect and maintain stream channel and floodplain integrity.
c) The lower Little Wenatchee is on the state 303(d) list for water temperature.
d) The Little Wenatchee River contains important habitat for spring chinook, sockeye, steelhead, and bull trout.

Recommended Actions – Little Wenatchee:

a) Protect stream channel, riparian and floodplain function: focus on Little Wenatchee River falls downstream to mouth.
b) Address road impacts in the drainage, emphasis on Rainy Creek and Little Wenatchee between Hidden Creek and Fir Creek.
c) Restore wetland complexes that connect to stream channel.
d) Manage recreation areas to reduce impacts to riparian cover.
e) Initiate public information efforts to discourage harassment of spawning salmonids.

Issues - White River:

a) Past riparian harvest and log drives have altered woody debris accumulations and channel morphometry.
b) Habitat is intact and contiguous, but development pressures place a critical need to protect and maintain stream channel and floodplain integrity.
c) The White River contains important habitat for spring chinook, sockeye, steelhead, and bull trout.

Recommended Actions - White River:

a) Protect stream channel, riparian and floodplain function: focus on Panther Creek downstream to mouth.
b) Restore wetland complexes that connect to stream channel
c) Protect shorelines along Lake Wenatchee near White River mouth
d) Initiate public information efforts to discourage harassment of spawning spring chinook, sockeye salmon, and bull trout.
e) Manage recreation areas to reduce impacts to riparian cover.

3.9.2 List and Description of Potential Multi-purpose Water Storage Projects

Table 3-25 lists the projects identified in the Upper Watershed. The potential volume of water stored is a preliminary estimate obtained by reviewing the area available for a reservoir. Figure 10 shows the locations of the projects.

Table 3-25
Upper Watershed (Lake Wenatchee, White and Little Wenatchee)
Description of Potential Multi-purpose Water Storage Projects

Project Name	Water Source	Description of Project	Potential Volume of Water Stored
Connection to old oxbows and other floodplain storage areas	White River	There are numerous areas in the White River floodplain that may benefit from improving connection between the river and floodplain or constructing side channels or oxbows to increase water storage in the floodplain.	n/a
Lake Creek Instream Reservoir	Lake Creek	Potential site for an instream reservoir on Lake Creek, at about elevation 2600 ft. Site is located on federal land managed by USFS.	100-500 acre-feet
Fish Creek Instream Reservoir	Fish Creek	Potential site for an instream reservoir Fish Creek, at about elevation 2800 ft. Site is located on federal land managed by USFS.	100-500 acre-feet

3.9.3 Potential Benefits of Projects

The potential beneficial effects the water storage projects could have on the main issues described for the Upper Wenatchee Sub-watershed are qualitatively described in Table 3-26. The surface water storage projects would likely improve instream flow or water supply. Since both are instream reservoirs they may impact habitat through disturbance in the reservoir area. The oxbow and floodplain connection project listed could improve habitat but would have little or no benefit to instream flow or water supply

Table 3-26
Potential Step A Water Storage Project Benefits
Within Upper Wenatchee Sub-watershed

Project Name	Improvement in Water Quality (reduce temp. or non-point pollution)	Improvement in instream flow in Wenatchee River or water supply	Improvement in habitat or fish passage
Connection to old oxbows and other floodplain storage areas	◒	◒	◒
Lake Creek Instream Reservoir	◒	○	●
Fish Creek Instream Reservoir	◒	○	●

○ = Potential Benefit or Improvement ◒ = No Benefit or No Impact ● = Potential Impact or Reduction

3.9.4 Review of Potential Environmental Effects

Table 3-27 presents the review of environmental factors for the Step A projects in the Upper Watershed.

Table 3-27
Review of Environmental Factors
Within Upper Wenatchee Sub-watershed

Project Name	PHS-Terrestrial Wildlife and Habitats	ESA-Listed Fish	Non-Listed Fish	Wetlands/ Streams
Connection to old oxbows and other floodplain storage areas	√			√
Lake Creek Instream Reservoir			√	√
Fish Creek Instream Reservoir			√	√

3.10 Decision on Further Evaluation of Step A Projects

At a meeting held on November 15, 2005, the Water Quantity sub-committee reviewed the Step A projects and made recommendations for preferred projects based upon a number of factors, including:

- The criteria described in the tables in Sections 3.1 – 3.9
- The project's consistency with the Biological Strategy for the Wenatchee Watershed
- The project or sub-watershed importance relative to other projects and sub-watersheds

No quantitative ranking of preferred projects was made and the recommendation for which projects should be further analyzed in the Step B Assessment was based primarily on potential water quantity benefits and location within the Wenatchee Watershed. The projects are located primarily in the Mission, Icicle, Peshastin, Lower Wenatchee and Chumstick Sub-watersheds. A potential project in the Nason Sub-watershed was added to the list as the potential benefits to instream flow in Nason Creek and the Wenatchee River from a reservoir in that basin was desired to be reviewed.

The projects recommended for further study in the Step B Assessment are listed in Table 3-28.

Table 3-28
Recommended Step B Projects

Sub-Watershed	Project Name
Lower Wenatchee	Cashmere Wastewater Lagoon
	Derby Canyon Off-channel Reservoir
	Williams Canyon Off-channel Reservoir
	Ollala Canyon Off-channel Reservoir
	Nahahum Canyon Off-channel Reservoir
Mission	East Fork Mission Creek Reservoir
	Upper Reach Mission Creek Lake
	Little Camas Creek Reservoir
Peshastin	Campbell Off-channel Reservoir
	Ingalls Creek Off-channel Reservoir
	Tronsen Creek Off-channel Reservoir
	Negro Creek Instream Reservoir
Chumstick	Eagle Creek Tributary Lake
	Eagle Creek SW Tributary Lake
	East Van Creek Off-channel Reservoir
	Pump from Upper Wenatchee into Little Chumstick Creek
Icicle	Alpine Lakes Optimization (review potential to draw down lakes more)
	Mtn Home Off-channel Reservoirs
Nason	Mill Creek Instream Reservoir or Upper Nason Creek Off-channel Reservoir

A number of potential projects reviewed in the Step A Assessment do not provide much benefit in terms of water quantity improvement but could have substantial benefits to habitat. Those types of projects include the connection of old oxbows, floodplain connection and stream channel restoration on small tributaries. It was recommended in the November 2005 Water Quantity Subcommittee meeting that the oxbow and floodplain connection projects continue to be pursued through grant funding and programs targeting habitat improvement but not be further pursued as a water storage project. Stream channel restoration was recommended to be included in the Wenatchee Watershed Plan as a programmatic recommendation for all basins with eroding tributaries but not be further pursued as a water storage project.

4.0 PERMITTING REQUIREMENTS

This section provides an overview of applicable federal, state and local permits and other regulatory approvals necessary for the construction and operation of a Step B water storage project (*e.g.*, reservoir). Likely major permits, approvals and related conditions are described, including an estimate of permit timeframes, agency contacts, potential issues, project features submit to permits, potential approaches and mitigation requirements in the subsequent subsections.

4.1 List of Permits

A list summarizing the potential federal, state and local permits and regulatory approvals necessary for construction of water storage reservoir projects within the Wenatchee Watershed is provided in Table 4-1. This list of permits and approvals may not apply to all the recommended Step B projects. A discussion of each permit or approval follows the table.

Table 4-1
List of Potential Federal, State and Local Permits and Regulatory Approvals

Permit Type	Timeframe	When Applicable	Regulatory Agency
Federal – USDA Forest Service Special Use Permit	Occurs after other permits are obtained	Locating a project on federal land managed by USFS	USDA Forest Service
Federal - Corps of Engineers 404/Section 10	6 to 24 months for an individual permit, depending on completion of NEPA/SEPA process and Section 7 Consultation	Locating a structure, excavating, or discharging dredged or fill material in a Water of the U.S., including wetlands	U.S. Army Corps of Engineers Seattle, WA 98124 Regulatory Branch (206) 764-3495
Federal - Section 7 Consultation (Biological Assessment)	6 to 18 months, depending on complexity	Required for Corps 404 Permit or if federally listed threatened or endangered species may be affected	U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration Fisheries
Federal -NEPA	EIS process with public comment is usually 12 months, although appeals can stretch this out to 3 or more years	For projects with Federal nexus. Scoping of projects would likely determine EIS is required	Federal lead agency to be determined
State - Dam Safety Construction Permit	2 to 6 months, a larger or more complex project takes longer	Constructing, modifying, or repairing any dam or controlling works for storage of 10 or more acre-feet	Washington Department of Ecology Water Resources Program Dam Safety Section (360) 407-6600
State - Clean Water Act Section 401, Water Quality Certification	Concurrent with Corps 404 permit process. Ecology has up to 6 months after public notice to issue 401 cert.	Applying for a federal license or permit to conduct any activity that might result in a discharge of dredge or fill material into water or wetlands, or excavation in water or wetlands	Washington Department of Ecology Shorelands & Environmental Assistance Program (360) 407-6600
State -Water	Up to 24 months if	Constructing a barrier across	Washington Department of

Permit Type	Timeframe	When Applicable	Regulatory Agency
Reservoir Permit	expedited. Longer if not.	a stream, channel, or water course, if the barrier will create a reservoir to impound water	Ecology Water Resources Program (360) 407-6600
State – Water Right Permit	If expedited or a non-consumptive use with environmental benefit, up to 24 months.	When diverting water from a stream or using water from a reservoir.	Washington Department of Ecology Water Resources Program (360) 407-6600
State -Hydraulic Project Approval (JARPA)	2 to 3 months; concurrent with Corps 404 permit process	Work that uses, diverts, obstructs, or changes the natural flow or bed of state waters	Washington State Department of Fish and Wildlife Fish and Wildlife Habitat Program (360) 902-2534
State - Section 106 of the National Historic Preservation Act	3 to 6 months; Longer for complex projects	Federal or federally assisted projects	Washington State Office of Archaeology and Historic Preservation in coordination with Lead Agency (360) 586-3065
State - Aquatic Lease	6 – 12 months	May be required for impounding water onto State-owned lands	Washington Dept. of Natural Resources
State - NPDES	3 – 6 months	Construction sites > 5 acres	Washington Dept. of Ecology
State – Aquifer Storage and Recovery	6-12 months; longer for complex projects	Required for ASR Projects	Washington Dept. of Ecology
County - Shoreline Conditional Use / Substantial Development	3 – 6 months but likely same time frame as EIS	Projects valued at $2,500 or more located on the water or shoreline area	Chelan County Department of Building/Fire Safety and Planning (509) 667-6225
County -State Environmental Policy Act (SEPA)	EIS process with public comment is usually 12 months, although appeals can stretch this out to 3 or more years	Scoping of project inputs would likely determine EIS is required	Chelan County Department of Building/Fire Safety and Planning (509) 667-6225
County - Chelan Co. Critical Areas Ordinance	Same as Shoreline and SEPA	Applicable to projects within Critical Areas defined by Chelan County.	Chelan County Building, Fire Safety, Planning Department

4.1.1 USDA Forest Service

Before any permits from federal, state and local agencies could be issued for a storage project on National Forest Land, a Special Use Permit from the USDA Forest Service will be required.

Permitting water storage projects on federal land managed by the USFS is subject to all laws, regulation, and policy governing the management of National Forest System Lands. There is no precedent for building a new water storage project in congressionally designated Wilderness areas, or for physically increasing the size of a storage structure in Wilderness areas. Management of existing facilities is permitted; however, on-site study of existing structures would require a permit

The process of obtaining a permit to develop a water storage facility on land managed by the USFS is subject in part to the land allocation. Designation of Land Use Allocations were made by the Wenatchee Land and Resource Management Plan (1990) as amended by the Northwest Forest Plan (1994). Each type of Land Use Allocation has standards and guidelines specific to that allocation that define activities that are allowable on those lands.

All of the eleven Step B water storage projects that have been identified on National Forest System Lands would be classified as Developments. A list of Land Use Allocations follows:

Congressionally Reserved Areas (CRAs, i.e., Congressionally Designed Wilderness on the maps)
These lands includes lands with congressional designations that normally preclude timber harvest, as well as other federal lands including National Parks and Monuments, Wildernesses, Wild and Scenic Rivers, National Wildlife Refuges, and military reservations.

Administratively Withdrawn Areas (AWAs)
Administratively Withdrawn Areas (AWAs) are lands that are excluded from planned or scheduled timber harvest through current forest plans or draft plan preferred alternatives. Examples include recreation sites, areas that are visually sensitive, unstable, or have special habitat or sensitive species, area where reforestation cannot be ensured or other areas where management emphasis precludes scheduled timber harvest. Any timber harvested in these areas through salvage or other unscheduled harvest do not contribute to the allowable sale quantity.

Late Successional Reserves (LSRs)
Late Successional Reserves (LSRs) are intended to protect and enhance conditions of late successional and old-growth forest ecosystems, which serve as habitat for late successional and old growth related species including the northern spotted owl. In the case of Late Successional Reserves (LSR's), one of the more restrictive designations, development, is discouraged. On a case-by-case basis, development in LSR's may be permitted to go forward if the proposal address public needs or provide significant public benefits. Proposals would be reviewed on a case-by-case basis.

Managed Late Successional Areas (MLSAs)
Managed Late Successional Areas (MLSAs) are similar to LSRs but are identified for certain owl activity centers on the eastside of the Cascades where regular and frequent fire is a natural part of the ecosystem. Certain silvicultrual treatments and fire hazard reduction treatments are permitted to help prevent complete stand destruction from large catastrophic events such as high intensity, high severity fires; or disease or insect epidemics.

Matrix
The Matrix consists of those federal lands outside the six categories of designated areas (Congressionally Reserved Areas, Late-Successional Reserves, Adaptive Management Areas, Managed Late-Successional Areas, Administratively Withdrawn Areas, and Riparian Reserves). Most timber harvest and other silvicultural activities would be conducted in that portion of the matrix with suitable forest lands, according to standards and guidelines. Most scheduled timber harvest takes place in the matrix. The matrix includes non-forested areas, and forested areas that are technically unsuitable for timber production, and therefore do not contribute to the probable sale quantity (PSQ).
Riparian Reserves

As a general rule, standards and guidelines for Riparian Reserves prohibit or regulate activities in Riparian Reserves that retard or prevent attainment of the Aquatic Conservation Strategy objectives. Watershed analysis and appropriate NEPA compliance is required to change Riparian Reserve boundaries in all watersheds.

If construction of a reservoir impairs a designated function, it would be very hard to permit. The Wenatchee Land and Resource Management Plan as amended by the Northwest Forest Plan does provide for the consideration of certain types of projects in sensitive locations. Water storage projects located on lands designated as Late Successional Reserves and Managed Late Successional Areas, will require a proposal for a Special Use Permit, and if the proposal is accepted for analysis, extensive planning efforts would be required before a reservoir might be approved for construction. Based on analysis on a case-by-case basis, projects proposed in these two designations may not receive final approval for construction. Administratively Withdrawn Areas are also highly unlikely to receive approval for water storage, depending on the reason they were withdrawn. Congressionally Designated Wilderness, have no precedent nationally for the development of water storage.

The Wenatchee Land and Resource Management Plan (1990) as amended by the Northwest Forest Plan 1994) identifies three types of watershed categories; Tier 1 Key Watersheds, Tier 2 Key Watersheds, or non-Key Watersheds. The watershed designations place additional management requirements or emphasis on activities. Tier 1 Key Watersheds contribute directly to the conservation of at-risk anadromous salmonids, bull trout, and resident fish species and have a high potential for being restored as part of a watershed restoration program. Within the Wenatchee Watershed there are four Tier 1 Key Watersheds (Ingalls Creek, Mission Creek, Icicle Creek and the Upper Wenatchee River). Tier 2 Key Watersheds may not contain at-risk fish stocks, but they are important sources of high quality water. No Tier 2 Key Watersheds are designated within the Wenatchee Watershed.

A Watershed Analysis is required before management activities are performed and all watersheds in the Wenatchee Watershed have had Watershed Analyses completed. Water storage projects may be consistent with recommendations made in the Watershed Analyses as they could supplement instream flow, improve water quality and meet other identified uses.

4.1.2 Corps of Engineers 404/Section 10

The principal federal laws that regulate activities in navigable waters and wetlands are Sections 404 and 401 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. A Corps permit is required when locating a structure, excavating, or discharging dredged or fill material in waters of the United States, including wetlands, or transporting dredged material for the purpose of dumping it into marine waters. A Corps permit is required for the activity of constructing a dam or impoundment in the bed any stream, river, or wetland because it would require place fill material in a regulated water body. Any activity planned for waters in Chelan County are administered by the Central Washington field office, Chelan, WA, of the Seattle District, U.S. Army Corps of Engineers. The timeframe for processing a complete project such as this would likely be 6 to 12 months from the time of application, assuming the SEPA, NEPA, and ESA process is complete.

4.1.3 ESA Section 7 Consultation (Biological Assessment)

The Endangered Species Act (ESA) identifies plant and animal species considered to be in danger of extinction (endangered) or likely to become endangered (threatened). The law is administered by the U.S. Fish and Wildlife Service (USFWS) for terrestrial plants and animals, and listed fish that do not migrate to the ocean. The law is also administered by the National Oceanic and Atmospheric Administration (NOAA) Fisheries for marine animals and anadromous fish that migrate from rivers to the ocean. USFWS and NOAA are collectively referred to as “the Services” when ESA reviews are conducted.

Section 7 of the ESA is triggered when a Federal agency is involved. Federal involvement may take several forms, such as constructing a project, providing funds for project implementation, and/or having regulatory jurisdiction over a proposed action (i.e., issuing federal permits). Federal agencies with one or more areas of involvement on the project as described above (constructing, funding or issuing permits) are required to consider the impacts of the proposed project on threatened and endangered species found in the project area.

The responsible Federal agency, also called the Action Agency, is required to document the degree to which the proposed project will impact any threatened or endangered species found in the project area. The agency then makes a determination of "no effect," "not likely to adversely affect," or "likely to adversely affect." In the case of the proposed water storage reservoir projects within the Wenatchee Watershed, the responsible Federal agencies will likely include the US Corps of Engineers and the USDA Forest Service.

"No effect" Determinations

“No effect” determinations are made when listed species will not be affected by the proposed action. This determination is made when the project actions would have no direct, indirect, or cumulative effects on listed species. For example, habitat will not be altered or the species is not found in the area at the time of year when the proposed activity will occur. No effect determinations are documented by the federal action agencies in a memo format and are generally not circulated to USFWS or NOAA Fisheries.

Not Likely to Adversely Effect Determinations

“Not likely to adversely affect" determinations are made when potential effects of the proposed action will be insignificant or unlikely to occur. Federal agencies prepare documents to describe the proposed project, project impacts, conservation measures, and the effects determination, which are submitted to USFWS and NOAA Fisheries (the Services) for review.

The Corps of Engineers routinely prepares Biological Evaluations (BE) to explain its determination of "not likely to adversely affect" determination was made. The BE is circulated to USFWS and/or NOAA depending upon the species involved. USFWS and/or NOAA will then issue a letter of concurrence with the determination, or not concur. If a nonconcurrence letter is sent, then the Services advise the Corps of Engineers to request formal consultation.

Likely to Adversely Effect Determinations

If the action agency (in this case most likely the Corps of Engineers or the USDA Forest Service) determine a proposed project will result in significant environmental effects, a Likely to Adversely Effect determination is made. This determination requires that a biological assessment (BA) be prepared. A BA is also prepared when the action agency has determined that a project may adversely affect a protected species.

Under this scenario, the Corps of Engineers requests a formal consultation with USFWS and/or NOAA. In response to this request, the Services prepare a Biological Opinion (BO), which first determines whether the adverse effects would jeopardize the continued existence of any species. If a jeopardy determination is made, the Services identify reasonable and prudent alternatives (RPA) that are intended to avoid jeopardy to the species. The action agencies must implement these measures or appeal to higher authority. If jeopardy is not determined, then the Services identify reasonable and prudent measures (RPM), which the action agencies must implement to reduce impacts to listed species. Jeopardy determinations are rare.

The ESA specifically mandates that the Section 7 process is strictly between the Services and the action agency. However, either the action agency or the Services can request input from others. The typical timeline for ESA consultation can be as brief as a month for No Effect determinations, to four months and greater if the Services are required to prepare a BO as would be required under a Likely to Adversely Affect determination. The typical timeline for a Not Likely to Adversely Affect determination is two months.

For proposed water storage reservoir projects on National Forest Land, there may be adverse effects that require complex consultation and result in extensive terms and conditions to mitigate adverse effects. The timeframe described above assumes limited adverse effects. It should also be noted that consultation takes place late in the NEPA process for actions that would be proposed on National Forest Lands. Such consultation results could dramatically alter the proposal, greatly increase the timeframe required to obtain permits, or lead to a decision maker selecting the no action alternative.

4.1.4 National Environmental Policy Act (NEPA)

The National Environmental Policy Act (NEPA) applies to federal projects, any project requiring a federal permit, and projects receiving federal funding. NEPA requires the action agency to inform the public of potential environmental, social and economic effects, and to solicit and consider public comments. NEPA is used to clearly document potential environmental impacts of proposed alternatives so that environmental considerations are taken into account in project selection.

NEPA review is likely to be required when any action is proposed that requires a federal agency to implement, fund, or approve (e.g., issue federal permit) a proposed action. NEPA review will be required for any accepted proposal for a USDA FS Special Use Permit on National Forest Lands.

If a project is likely to have significant adverse impacts on the environment, an Environmental Impact Statement is required. The EIS is intended to help agency decision-makers, applicants, and the public understand how a proposal will affect the environment, by providing an objective discussion of significant environmental impacts, reasonable alternatives, and measures to avoid or minimize adverse impacts. NEPA review may identify issues that could lead to the selection of a no-action alternative.

Potential lead agencies for this project could be the USFS (because of federal land affected by a project that is managed by the USFS); Corps via 404; USFWS via Section 7; or, if applicable, any agency providing federal funding.

4.1.5 Washington Department of Ecology Dam Safety Construction Permit

A Dam Safety Construction Permit is required before constructing, modifying, or repairing any dam or controlling works for storage of 10 or more acre-feet of water. The proponent must submit plans and specifications to Ecology for review and approval. These must be prepared by a qualified professional engineer. Permit processing time averages from 6 to 8 weeks, but varies depending on project complexity. Ecology also inspects the construction of all dams to reasonably secure safety of life and property.

4.1.6 Water Quality Certification (401)

A water quality certification (certification) is required of any applicant for a federal license or permit to conduct any activity that may result in any discharge into surface waters. This includes discharge of dredge and fill material into water or wetlands. The federal agency is provided a certification from the state that the discharge complies with the discharge requirements of federal law and the aquatic protection requirements of state law. In the case of Corps permit applications (Section 404), timing of certification is tied to Corps permit applications. Public notice for a water quality certification may be piggy-backed with the Corps public notice.

4.1.7 National Pollutant Discharge Elimination System

As authorized by the Clean Water Act this permit issued by Ecology could be required if construction activities disturb threshold area (formerly set at 5 acres, now set at 1 acre under Phase II requirements.)

4.1.8 Aquatic Use Authorization (Aquatic Lease)

Washington Department of Natural Resources (DNR) typically requires DNR approval/authorization for activities that use state-owned aquatic lands, including beds of state navigable waters. Application time may vary from 6-12 months.

4.1.9 Hydraulic Project Approval/Joint Aquatic Resource Permit Application

Any form of work that uses, diverts, obstructs, or changes the natural flow or bed of any fresh water of the state, requires a hydraulic project approval from the Department of Fish and Wildlife. A complete application package for a Hydraulic Project Approval (HPA) must include a completed Joint Aquatic Resource Permit Application (JARPA) form, general plans for the overall project, and complete plans and specifications of the proposed work within waters of the state. JARPA can be used to apply for Hydraulic Project Approvals, Shoreline Management Permits, Water Quality Certifications, and U.S. Army Corps of Engineers Section 404 and Section 10 permits. The application also must include complete plans and specifications for the protection of fish life.

4.1.10 Aquifer Storage and Recovery Permit

The application process for an ASR project was streamlined in 2002 by HB 2993 by specifying that Ecology "may accept for processing a single application form covering both a proposed reservoir and a proposed secondary permit or permits for use of water from that reservoir." The basic steps involved in permitting an ASR project are:

- Prior to applying, assess potential issues and impacts to the hydrogeologic system and the environment. If the general setting and conditions cannot be described in sufficient detail for the application, then a more detailed feasibility study must be performed. The feasibility study should reduce uncertainty with respect to project issues and impacts, as well as better quantify the available storage within the aquifer.
- Schedule a pre-application meeting with Ecology to discuss the project plan and likely requirements for monitoring and mitigation.
- Submit an application for an ASR project that contains at a minimum:
  - Water rights for the source waters for the proposed ASR project.
  - A general description of the physical design of the hydrogeologic system prepared by an engineer or geologist registered in the state of Washington.
  - A general description of the operational design of the hydrogeologic system prepared by an engineer or geologist registered in the state of Washington.
  - A project plan.
  - A data monitoring plan.
  - An environmental assessment and analysis of any potential adverse conditions or potential impacts to the surrounding environment, limited to storage and subsequent use of stored water, that might result from the project.

4.1.11 County Shorelines Management Act Permit (Shoreline Conditional Use/Substantial Development Permit)

These permits are required for any development or activity valued at $2500 or more that is located on a state water or shoreline area. Waters of the state include lakes greater than 20 acres or streams with a mean annual flow of greater than 20 cfs. This requirement also applies to any use or activity that materially interferes with the normal public use of the water or shorelines of the state regardless of cost, for any activity listed as a conditional use in the local master program, and for any activity that requires a variance from the provisions of the local master program. At this time neither the Chelan County Code nor the Chelan County Shoreline Master Plan address dams as a permitted use. A Shoreline Conditional Use permit could be obtained, the County's code could be permanently amended to add dams as a permitted use, or a Variance from County Code could be obtained as described below.

Chelan County reviews proposed code amendments twice annually, in February and August. A proposed amendment is first brought before the County Planning Commission, which issues a recommendation to the County Commission. The County Commission then reviews the proposed amendment and makes a determination to adopt or reject the amendment. Amendments accepted in the February cycle go into effect in July. Amendments accepted in the August cycle go into effect in January of the next year. permit varies as does processing time. Generally, a public hearing is required. The local official will require an affidavit of public notice, a location map, a topographic map, and a site plan.

To obtain a variance from Chelan County, the proponent would need to complete a Variance Application form and submit it to the County's Building, Fire Safety and Planning Department. If a shoreline variance or conditional use permit is required, the Department of Ecology must also approve or deny the permit, or approve the permit with conditions.

Per WAC 173-27-040 several shoreline development exemptions may be applied to water storage projects. All exemptions are construed narrowly, and only those developments that meet the precise terms of one or more of the listed exemptions in the WAC may be granted exemption from the substantial development permit process. The burden of proof that a development or use is exempt from the permit process is on the applicant. A summary of exemptions that may be applicable to some of the water storage projects are provided below. Details of each exemption are provided at http://apps.leg.wa.gov/WAC/default.aspx?cite=173-27-040.

- WAC 173-27-040 (2)a: Any development of which the total cost or fair market value, whichever is higher, does not exceed two thousand five hundred dollars, if such development does not materially interfere with the normal public use of the water or shorelines of the state.
- WAC 173-27-040 (2)e: Construction and practices normal or necessary for farming, irrigation, and ranching activities, including agricultural service roads and utilities on shorelands, construction of a barn or similar agricultural structure, and the construction and maintenance of irrigation structures including but not limited to head gates, pumping facilities, and irrigation channels: Provided, That a feedlot of any size, all processing plants, other activities of a commercial nature, alteration of the contour of the shorelands by leveling or filling other than that which results from normal cultivation, shall not be considered normal or necessary farming or ranching activities.
- WAC 173-27-040 (2)i: Operation, maintenance, or construction of canals, waterways, drains, reservoirs, or other facilities that now exist or are hereafter created or developed as a part of an irrigation system for the primary purpose of making use of system waters, including return flow and artificially stored ground water from the irrigation of lands Operation and maintenance of any system of dikes, ditches, drains, or other facilities existing on June 4, 1975, which were created, developed or utilized primarily as a part of an agricultural drainage or diking system

The exemptions exist for farming and irrigation which may not be the primary purpose of the water storage projects.

4.1.12 Water Reservoir Permit

A reservoir permit issued by the Washington Department of Ecology is required before constructing any barrier across a stream, channel, or water course, if the barrier will create a reservoir. A reservoir is defined as a dam or dike that will store water to a depth of 10 or more feet at its deepest point, or one that will retain 10 or more acre-feet of water.

Reservoir permit applications require information on the use and capacity of the reservoir, and a legal description of the location of the structure. Processing time varies depending on project complexity. The process requires publication of a legal notice for two succeeding weeks.

Normally, a reservoir permit application is accompanied by an application for a permit to use water. This application describes the intended beneficial uses of water that will be withdrawn from the reservoir. Unless otherwise specified, a reservoir permit will allow the permittee to fill the reservoir once a year. The permit specifically states the period during which the reservoir is filled. Any entity proposing to use water stored in a reservoir must file for a permit to use water, which must refer to the reservoir as its source of water. For these projects, the use of water may be for instream purposes or to provide water to meet future water needs. The allocation of water for each would need to be determined and water right applications filed for those water needs. However, if the water stored is used exclusively for instream flow supplementation, some protection of those needs is afforded by Chapter 173 – 545 WAC, the IRPP for the Wenatchee River Basin. The State's Trust Water Program may also be used to set-aside water for instream flow purposes.

A dam or other obstruction across or in a stream must be equipped with a durable and efficient fishway approved by Fish and Wildlife.

4.1.13 State Environmental Policy Act (SEPA)

The State Environmental Policy Act (SEPA) was enacted by the Washington State Legislature to ensure that state and local agencies consider likely environmental consequences of all government decisions or "actions". These may include issuing permits, adopting regulations, policies or plans on private lands, constructing public facilities on private state, or local municipal lands.

If a project is likely to have significant adverse impacts on the environment, an Environmental Impact Statement is required. The EIS is intended to help agency decision-makers, applicants, and the public understand how a proposal will affect the environment, by providing an objective discussion of significant environmental impacts, reasonable alternatives, and measures to avoid or minimize adverse impacts.

In 2003 the Department of Ecology (Ecology) published a Final Environmental Impact Statement for Watershed Planning under 90.82 RCW (Watershed Planning EIS). The Watershed Planning EIS was developed by Ecology to provide coverage under SEPA for as many local watershed plans as possible. The Watershed Planning EIS identifies a range of alternatives that are intended to represent the recommended actions that the Wenatchee Watershed Planning Unit may decide to include in its Watershed Plan.

Ecology addressed six potential water storage alternatives in its Watershed Planning EIS for watershed planning, as described below:

> **Alternative WP 19**: Construct and operate new on-channel storage facilities.
> Under this alternative, a water storage facility would be created by impounding a river or stream. On-channel storage facilities could include large reservoirs on the mainstream of major rivers as well as small reservoirs on tributary streams. Construction could involve creation of an earthen dam or a concrete dam.

Alternative WP 20: Raise and continue to operate existing on-channel storage facilities. Under this alternative the capacity of an existing on-channel reservoir would be increased by raising or enlarging the impoundment structure.

Alternative WP 21: Construct and operate new off-channel storage facilities. Under this alternative, an impoundment structure, either earthen or concrete, would be created in an upland location. Water would be diverted, or more likely pumped, from a river to an off-channel location for storage. Off-channel facilities could have a wide range of capacities.

Alternative WP 22: Raise and continue to operate existing off-channel storage facilities. Under this alternative the capacity of an existing off-channel reservoir would be increased by raising or enlarging the impoundment structure.

Alternative WP 23: Extend use of existing storage facilities to additional beneficial uses. Operation of a storage facility constructed to provide water for one specific beneficial use or group of uses could be modified to provide water for additional beneficial uses. For example, use of a storage facility originally constructed for municipal water supply could be expanded to supply water for irrigation or to provide additional flows for fish during critical life stages.

Alternative WP 24: Construct and operate artificial recharge/aquifer storage projects. Aquifer storage and recovery involves introducing water, usually surface water from rivers, into an aquifer through injection wells or through surface spreading and infiltration. The introduced water is stored in the aquifer until needed and then withdrawn from the aquifer through wells for beneficial use. Water to be stored in an aquifer must meet the state’s ground water quality standards, Chapter 173-200 WAC. Aquifer storage and recovery does not include operational losses of water during irrigation of land; to water artificially stored due to construction, operation, or maintenance of an irrigation system; or to projects involving recharge of reclaimed water (RCW 90.03.370).

The Watershed Planning EIS evaluates the impacts of and identifies mitigation measures for each of the alternatives listed above. The Watershed Planning EIS is used as a tool to evaluate the recommended strategies and high priority water storage projects or areas identified in this multipurpose water storage assessment. For those projects that are not located on federal lands, additional SEPA compliance may be needed for the implementation of specific recommendations and individual projects. Such compliance might include completion of a SEPA checklist for small projects, or for larger project a project EIS may be necessary. For proposed projects located on federally owned lands (USDA FS), the NEPA review process will be required.

Upon selection of high priority water storage projects (Step B), all of the high priority storage options can then be compared with the alternatives analysis in the Watershed Planning EIS. This evaluation will provide an assessment of the high priority projects consistency with the Watershed Planning EIS and whether additional SEPA (or NEPA, if located on federal lands) compliance is needed.

4.1.14 Section 106 of the National Historic Preservation Act

Section 106 of the National Historic Preservation Act requires Federal agencies to take into account the effects of their undertakings on cultural resources (e.g., archaeological sites, historic buildings, and traditional cultural properties) and afford the Advisory Council of Historic Preservation (ACHP) a reasonable opportunity to comment on such undertakings. The section 106 process seeks to accommodate historic preservation concerns with the needs of Federal undertakings through consultation among the agency official and other parties with an interest in the effects of the undertaking on historic properties, commencing at the early stages of project planning. The goal of consultation is to identify historic properties potentially affected by the undertaking, assess its effect and seek ways to avoid, minimize or mitigate any adverse effects on historic properties.

Furthermore, cultural resources located on federal property and on other lands involved in projects relying on federal funding or permits are protected by both federal and state law. State law protects archaeological sites and other cultural resources on private and state lands in Washington. Washington cultural resource law (RCW 27.53) states that no known archaeological site or resource can knowingly be damaged without first obtaining a certified permit.

Depending upon the location of a proposed water storage reservoir project, multiple state and federal jurisdictions could be participants in the section 106 consultation process. Such participants might include USDA Forest Service, Washington State Parks, Colville Confederated Tribes, Yakama Nation, and the Washington State Office of Archaeology and Historic Preservation or others. Duration of the Section 106 process could be 3 to 6 months, but could be longer for more complex projects.

4.1.15 Local Chelan County Critical Areas Ordinance

Any activities occurring on land within county jurisdiction would require compliance with local CAO regulations associated with wetlands, fish/wildlife conservation areas, floodplains, and aquifer recharge areas.

4.2 Required Easements and Land Acquisition

Besides permits from agencies to construct and operate a reservoir, the project proponent will need to obtain ownership of the land where the dam and reservoir are located as well as easements to access the sites. Typically, a temporary construction easement would be needed for equipment to access the work site and for a staging area to construct the reservoir if the project owner does not have ownership of sufficient land to accommodate access and construction needs. A permanent easement or right of entry would also be needed for equipment to occasionally access and maintain the facilities.

5.0 Step B Water Storage Assessment

The purpose of the Step B Water Storage Assessment is to identify project features, the potential water supply that would become available if the project was implemented, the potential environmental effects of the project, the estimated construction costs, the difficulty of obtaining permits and other issues that may affect the ability to implement the water storage project.

To perform this assessment, a preliminary layout of a reservoir was applied to each site using the best available topography which was USGS 7.5 minute quadrangle maps in most cases. Dam embankments were preliminary designed using 2.5:1 (horizontal:vertical) slopes on the reservoir side of the embankment and 2:1 on the outside embankment. An outlet and spillway was sized based upon experience with similar reservoirs. In most locations, the reservoir and embankments were sized to store the maximum amount of water that was physically possible but reasonable from a hydrologic or water availability basis. Other project features were identified, such as stream diversions or pump stations along with supply pipelines to the reservoirs. A review of site geology was made using available geologic maps to assess dam foundation and construction issues and whether a liner to prevent seepage is likely needed. A review of baseline environmental resources at each site was made using the PHS database. An estimate of costs to construct and operate the reservoirs was made. A summary of issues that would affect the viability of the project was also prepared.

The following sections contain a summary of the Step B water storage projects by subwatershed. Appendices D and E contain more detailed information of hydrology at each site and cost to construct each potential project.

5.1 Lower Wenatchee Sub-Watershed

Four water storage sites in the Lower Wenatchee Sub-watershed were identified in the tributaries and canyons located on the north side of the Wenatchee River. The reservoirs located in this Sub-watershed will be limited by the space available to site a reservoir and the amount of water that can be diverted from streams. The reservoirs described in this section are configured to maximize the water storage potential at each site. As it may not be feasible to construct the reservoirs as shown because of property ownership constraints, a generic configuration of a small reservoir (5 acre-feet) is also described to provide a unit cost for reservoirs that may be constructed on other parcels of land.

5.1.1 Derby Canyon Off-Channel Reservoir

5.1.1.1 Description of Project

A preliminary location for a potential reservoir site is shown in Figure 5-1. The site was selected without consideration of property ownership or availability and siting a reservoir where shown may not be feasible because of those issues. The reservoir was located with the toe of the embankments set back 100 feet from Derby Canyon Creek. The setback reduces the potential size of the reservoir and increases the cost as it is located in a narrow valley with sloping side walls to the creek. The reservoir shown has a footprint of 3.0 acres and a potential impoundment volume of 17 acre-feet. A diversion structure on Derby Canyon Creek would be required, as well as a pipeline to deliver the water by gravity to the reservoir. An alternative would be to construct a small pump station on the banks of Derby Creek and a pressure pipeline to the reservoir. Less pipe would be required for that alternative however annual power costs would be incurred.

The reservoir would require an inlet, outlet and emergency spillway. The water from the reservoir would likely be released directly back to the stream via a pipeline from the reservoir.

5.1.1.2 Potential Water Yield and Use of Water

Appendix D contains estimates of flow for Derby Creek. Assuming 1 cfs of the late winter and early spring flow in Derby Canyon Creek could be diverted and stored in the reservoir, the reservoir would fill in approximately 9 days. The water stored in the reservoir could be released in summer and fall to augment streamflow and groundwater supplies in Derby Canyon. The estimated flow augmentation is 0.2 cfs for 30 days and 0.1 cfs for 60 days, which accounts for evaporation from the reservoir during the summertime. Although the flow in Derby Canyon should be adequate to support that level of diversion, no assessment of instream resources or water rights was made to determine if the flow would be allowed to be diverted. The proposed maximum water allocations for the Wenatchee Watershed do not specify maximum allocations for Derby Canyon but do specify them for the Wenatchee River at Monitor control point. The maximum allocations at that control point includes tributaries such as Derby Canyon. The maximum allocations range from 148 cfs in February to 360 cfs in April. Diversions from Derby Creek would be well under those allocations.

5.1.1.3 Baseline Environmental Resources and Potential Impacts

The Derby Canyon off-channel reservoir site is located directly adjacent to Derby Creek within known mule deer habitat (PHS 2005). While the reservoir would not be located within known wetland or stream resources, the project would require a water intake from Derby Creek and a discharge into Derby Creek. Both locations potentially have riparian wetlands and instream habitats. Derby Creek supports summer steelhead (ESA-listed) and resident fish species.

The construction of the reservoir would require the clearing of 3 acres of forested habitat used by mule deer during severe winter browsing and spring fawning. Noise during construction also has the potential to disturb mule deer; however construction could be timed to avoid disturbing spring fawning periods (May 1 – June 30). Potential impacts to aquatic habitats and wetlands could occur in association with the construction of the water intake and discharge locations. Water intake and discharge structures would require fish-friendly design.

5.1.1.4 Geotechnical Considerations

The reservoir site is located on alluvium overlaying Chumstick sandstone formation. The alluvium consists of sediments ranging from gravel to clay size. The depth to sandstone is not known but is likely shallow. The issues relating to the project include the depth to sandstone which affects how the embankments would be constructed and the requirement for a liner in the reservoir if insufficient fine grain material or rock is present to hold water. The cost estimate was prepared assuming a fill only embankment with material imported to the site. The costs shown in the following section could be reduced if the reservoir could be constructed with cuts balancing fills thereby reducing the volume and cost of material imported to the site and also reducing the volume of embankment fill required.

5.1.1.5 Costs

The configuration of the reservoir was analyzed to estimate the quantity of materials and work required to construct the reservoir. Unit costs obtained from similar projects were applied to the quantities estimated and an estimate of costs to construct the reservoir prepared. A contingency of 30% was applied to the construction cost estimate to account for uncertainties in the design and constructability of the reservoir. That level of contingency is commonly used at a preliminary level of cost estimating. Allowances for engineering, permitting and construction management (20%), sales tax (7.7%) and land acquisition or lease costs were also added to the construction cost to estimate the total costs of implementation. Table 5-1 summarizes the estimated costs of implementing the project. Appendix E contains spreadsheets with more detailed information on quantities and costs estimated for the potential project.

Table 5-1
Estimated Implementation Cost
Derby Canyon Water Storage Reservoir

Item	Cost
Estimated Construction Cost	$1,135,000
Contingency (30%)	$340,500
Engineering, permitting, construction mgmt (20%)	$227,000
Sales Tax (7.7%)	$87,395
Estimated Land Acquisition or Lease Costs	$33,600
Estimated Total Implementation Cost	**$1,824,000**

The costs of implementing this project are estimated to be $1.8M, or approximately $107,000 per acre-foot. The reservoir configuration shown in Figure 5-1 did not attempt to balance cut and fills on-site, primarily because of the potential for rock to be present at shallow depths. If a location could be found where the reservoir embankments could be constructed with material excavated from the reservoir, construction costs would be much less.

The estimated Operations & Maintenance cost for the project is listed in Table 5-2. That cost would include the annual costs of operating the project (staff time) and maintaining the project facilities (including maintenance such as mowing, cleaning, repairs etc.). The O&M costs would also provide a reserve fund for replacement of parts of the project as they wear out or get damaged. The cost was estimated by multiplying the construction cost by 1%. The construction cost used is the estimated construction cost plus the 30% contingency. The O&M costs presented in this report should be viewed as being approximate and order of magnitude costs. Some owners spend very little on operations and maintenance, especially for small projects. No power costs would be incurred if a gravity diversion is maintained. Because of the small size of the project, it may be easier to install a pump in the creek closer to the reservoir. If the project proceeds, then an analysis of the cost difference between a gravity and pump diversion should be performed.

Table 5-2
Operation & Maintenance Costs
Derby Canyon Water Storage Reservoir

Item	Cost
Annual Operations & Maintenance Cost	$14,800
Power Cost	$0
Totals	**$14,800**

5.1.1.6 Implementation Issues

The primary issue relating to implementation of this project is the cost. At a cost of $107,000 per acre-foot, the feasibility of this project is marginal as configured. If further review of this site is desired, additional investigation is needed to determine the geotechnical suitability of the site, the volume of water that is available for diversion and to optimize the design of the reservoir based upon the geotechnical conditions found. It is possible that other sites in Derby Canyon exist where it would be less expensive to construct a reservoir. In addition, smaller reservoirs might also cost less to implement on a per acre-foot basis as it would be easier to site a small reservoir than a larger reservoir in the narrow canyon. Section 5.1.5 describes the costs of a smaller reservoir that may be more feasible than this configuration.

The Derby Canyon storage project would be constructed outside of the main stream channel resulting in only minor impacts to aquatic habitat from construction and operation of the water intake and outlet locations. Aquatic permits would require seasonal construction restrictions to protect ESA-listed fish, and additional BMPs to protect habitats during construction. Impacts resulting in greater than 0.10 acre of direct fill or flooding of wetlands would require an individual permit from the Corps, as opposed to the streamlined Nationwide Permit.

Obtaining aquatic permits for the Derby Canyon storage project is feasible. The project site is not located within federal lands, and would not require a permit from the USFS. The feasibility of obtaining Section 404/401 and HPA permits would depend on the quantity of impacts to aquatic habitats. This project would likely qualify for a Nationwide Permit due to the minimal impacts to streams and wetlands expected to occur. An HPA would also likely be granted by WDFW as no impact to fish migration would occur. Section 7 ESA-consultation would be feasible as no impact to fish migration would result from the project.

5.1.2 Williams Canyon Off-Channel Reservoir

5.1.2.1 Description of Project

A preliminary location for a potential reservoir site is shown in Figure 5-2. The site was selected without consideration of property ownership or availability and siting a reservoir where shown may not be feasible because of those issues. The reservoir shown has a footprint of 6.5 acres and a potential impoundment volume of 68 acre-feet. A diversion structure on Williams Canyon Creek would be required, as well as a pipeline to deliver the water to the reservoir. The reservoir would require an inlet, outlet and emergency spillway. The water from the reservoir would likely be released directly back to the stream via a pipeline from the reservoir.

5.1.2.2 Potential Water Yield and Use of Water

Appendix D contains estimates of flow for Williams Canyon Creek. Assuming 0.3 cfs of the late winter and early spring flow in Williams Canyon Creek could be diverted and stored in the reservoir, the reservoir would take most of the winter and early spring to fill (3-4 months). The water stored in the reservoir could be released in summer and fall to augment streamflow and groundwater supplies in Williams Canyon. The estimated flow augmentation is 0.9 cfs for 30 days and 0.4 cfs for 60 days, which accounts for evaporation from the reservoir during the summertime. The flow in Williams Canyon may not be adequate to support that level of diversion in every year and the reservoir may only partially fill in dry years. No assessment of instream resources or water rights was made to determine if that quantity of flow would be allowed to be diverted. The proposed maximum water allocations for the Wenatchee Watershed do not specify maximum allocations for Willisams Canyon but do specify them for the Wenatchee River at Monitor control point. The maximum allocations at that control point includes tributaries such as Williams Canyon. The maximum allocations range from 148 cfs in February to 360 cfs in April. Diversions from Williams Canyon Creek for this reservoir are well under those allocations.

5.1.2.3 Baseline Environmental Resources and Potential Impacts

The proposed reservoir site is located directly adjacent to Williams Creek within known mule deer habitat (PHS 2005). While the reservoir would not be located within known wetland or stream resources, the project would require a water intake from Williams Creek and a discharge into Williams Creek. Both locations potentially have riparian wetlands and instream habitats. Williams Creek does not support any fish species.

The construction of the reservoir would require the clearing of 6.5 acres of forested habitat used by mule deer during severe winter browsing and spring fawning. Noise during construction also has the potential to disturb mule deer, however construction could be timed to avoid disturbing spring fawning periods (May 1 – June 30). Potential impacts to aquatic habitats and wetlands could occur in association with the construction of the water intake and discharge locations.

5.1.2.4 Geology

The reservoir and embankment site is located on fine-grained (sand to clay) deposits overlaying the Chumstick sandstone formation. The depth to sandstone is not know but is likely shallow. The issues relating to the project include the depth to sandstone which affects how the embankments would be constructed and the requirement for a liner in the reservoir if insufficient fine grain material or rock is present to hold water. The cost estimate was prepared assuming a fill only embankment with material imported to the site. The costs shown in the following section could be reduced if the reservoir could be constructed with cuts balancing fills thereby reducing the volume and cost of material imported to the site and also reducing the volume of embankment fill required.

5.1.2.5 Costs

Table 5-3 summarizes the estimated costs of implementing the water storage project. Appendix E contains spreadsheets with more detailed information on quantities and costs estimated for the potential project.

Table 5-3
Estimated Implementation Cost
Williams Canyon Water Storage Reservoir

Item	Cost
Estimated Construction Cost	$3,112,000
Contingency (30%)	$933,600
Engineering, permitting, construction mgmt (20%)	$622,400
Sales Tax (7.7%)	$239,624
Estimated Land Acquisition or Lease Costs	$72,450
Estimated Total Implementation Cost	**$4,980,000**

The costs of implementing this project are estimated to be $4.98M, or approximately $73,200 per acre-foot. The reservoir configuration shown in Figure 5-2 did not attempt to balance cut and fills on-site, primarily because of the potential for rock to be present at shallow depths. If a location could be found where the reservoir embankments could be constructed with material excavated from the reservoir, construction costs would be much less.

The estimated Operations & Maintenance cost for the project is listed in Table 5-4. No power costs would be incurred if a gravity diversion is maintained. Because of the small size of the project, it may be easier to install a pump in the creek closer to the reservoir. If the project proceeds, then an analysis of the cost difference between a gravity and pump diversion should be performed.

Table 5-4
Operation & Maintenance Costs
Williams Canyon Water Storage Reservoir

Item	Cost
Annual Operations & Maintenance Cost	$40,500
Power Cost	$0
Totals	**$40,500**

5.1.2.6 Implementation Issues

The primary issues relating to implementation of this project are the cost and land ownership. At a cost of $73,200 per acre-foot, the feasibility of this project is marginal as configured. If further review of this site is desired, additional investigation is needed to determine the geotechnical suitability of the site, the volume of water that is available for diversion and to optimize the design of the reservoir based upon the geotechnical conditions found. It is possible that other sites in Williams Canyon exist where it would be less expensive to construct a reservoir. In addition, smaller reservoirs might also cost less to implement on a per acre-foot basis as it would be easier to site a small reservoir than a larger reservoir in the narrow canyon.

The Williams Canyon storage project would be constructed outside of the main stream channel resulting in only minor impacts to aquatic habitat from construction and operation of the water intake and outlet locations. Aquatic permits would require BMPs to protect habitats during construction. Impacts resulting in greater than 0.10 acre of direct fill or flooding of wetlands would require an individual permit from the Corps, as opposed to the streamlined Nationwide Permit.

Obtaining aquatic permits for the Williams Canyon storage project is feasible. The project site is not located within federal lands, and would not require a permit from the USFS. The feasibility of obtaining Section 404/401 and HPA permits would depend on the quantity of impacts to aquatic habitats. This project would likely qualify for a Nationwide Permit due to the minimal impacts to streams and wetlands expected to occur. An HPA would also likely be granted by WDFW as no impact to fish migration would occur. Section 7 ESA-consultation would be feasible as no ESA-listed fish species are present.

5.1.3 Ollala Canyon Off-Channel Reservoir

5.1.3.1 Description of Project

A preliminary location for a potential reservoir site is shown in Figure 5-3. The site was selected without consideration of property ownership or availability and siting a reservoir where shown may not be feasible because of those issues. The reservoir shown has a reservoir footprint of 2.9 acres and a potential impoundment volume of 9 acre-feet. A diversion structure on Ollala Canyon Creek would be required, as well as a pipeline to deliver the water to the reservoir. The reservoir would require an inlet, outlet and emergency spillway. A small pump station on the banks of Ollala Canyon Creek may also be feasible. The water from the reservoir would likely be released directly back to the stream via a pipeline from the reservoir.

5.1.3.2 Potential Water Yield and Use of Water

Appendix D contains estimates of flow present in Ollala Canyon Creek. Since the reservoir is small, it was assumed that only 0.5 cfs would be needed to divert in late winter and early spring flow to store in the reservoir. At that rate of diversion, the reservoir would fill in approximately 9 days. The water stored in the reservoir could be released in summer and fall to augment streamflow and groundwater supplies in Ollala Canyon. The flow augmentation would be 0.1 cfs for 30 days and 0.05 cfs for 60 days, which accounts for evaporation from the reservoir during summer. Although the flow in Ollala Canyon should be adequate to support 0.5 cfs diversion, no assessment of instream resources or water rights was made to determine if the flow would be allowed to be diverted. The proposed maximum water allocations for the Wenatchee Watershed do not specify maximum allocations for Ollala Canyon but do specify them for the Wenatchee River at Monitor control point. The maximum allocations at that control point includes tributaries such as Ollala Canyon. The maximum allocations range from 148 cfs in February to 360 cfs in April. Diversions from Ollala Canyon Creek for this reservoir are well under those allocations.

5.1.3.3 Baseline Environmental Resources and Potential Impacts

The proposed Ollala Canyon off-channel reservoir site is located directly adjacent to Ollala Creek within known mule deer habitat (PHS 2005). While the reservoir would not be located within known wetland or stream resources, the project would require a water intake from Ollala Creek and a discharge into Ollala Creek. Both locations potentially have riparian wetlands and instream habitats. Ollala Creek does not support any fish species.

The construction of the reservoir would require the clearing of 2.9 acres of forested habitat used by mule deer during severe winter browsing and spring fawning. Noise during construction also has the potential to disturb mule deer, however construction could be timed to avoid disturbing spring fawning periods (May 1 – June 30). Potential impacts to aquatic habitats and wetlands could occur in association with the construction of the water intake and discharge locations.

5.1.3.4 Geology

The reservoir and embankment site is located on alluvium deposits (from gravel to clay) overlaying the Swakane Gneiss formation. The depth to rock is not know but is likely shallow. The issues relating to the project include the depth to rock which affects how the embankments would be constructed and the requirement for a liner in the reservoir if insufficient fine grain material or rock is present to hold water. The project is also located adjacent to a fault line, however with the short embankments required the project would still be feasible to construct. The cost estimate was prepared assuming a fill only embankment with material imported to the site. The costs shown in the following section could be reduced if the reservoir could be constructed with cuts balancing fills thereby reducing the volume and cost of material imported to the site and also reducing the volume of embankment fill required.

5.1.3.5 Costs

Table 5-5 summarizes the estimated costs of implementing the water storage project. Appendix E contains spreadsheets with more detailed information on quantities and costs estimated for the potential project.

Table 5-5
Estimated Implementation Cost
Ollala Canyon Water Storage Reservoir

Item	Cost
Estimated Construction Cost	$1,004,000
Contingency (30%)	$301,200
Engineering, permitting, construction mgmt (20%)	$200,800
Sales Tax (7.7%)	$77,308
Estimated Land Acquisition or Lease Costs	$30,450
Estimated Total Implementation Cost	**$1,614,000**

The estimated implementation costs are $1.61M, or $179,300 per acre-foot of storage. The reservoir configuration shown in Figure 5-3 did not attempt to balance cut and fills on-site, primarily because of the potential for rock to be present at shallow depths. If a location could be found where the reservoir embankments could be constructed with material excavated from the reservoir, construction costs would be much less.

The estimated Operations & Maintenance cost for the project is listed in Table 5-6. No power costs would be incurred if a gravity diversion is maintained. Because of the small size of the project, it may be easier to install a pump in the creek closer to the reservoir. If the project proceeds, then an analysis of the cost difference between a gravity and pump diversion should be performed.

Table 5-6
Operation & Maintenance Costs
Ollala Canyon Water Storage Reservoir

Item	Cost
Annual Operations & Maintenance Cost	$13,100
Power Cost	$0
Totals	**$13,100**

5.1.3.6 Implementation Issues

The primary issues relating to implementation of this project are the cost and land ownership. At a cost of $179,300 per acre-foot, the feasibility of this project is marginal as configured. If further review of this site is desired, additional investigation is needed to determine the geotechnical suitability of the site, the volume of water that is available for diversion and to optimize the design of the reservoir based upon the geotechnical conditions found. It is possible that other sites in Ollala Canyon exist where it would be less expensive to construct a reservoir. In addition, smaller reservoirs might also cost less to implement on a per acre-foot basis as it would be easier to site a small reservoir than a larger reservoir in the narrow canyon.

The Ollala Canyon storage project would be constructed outside of the main stream channel resulting in only minor impacts to aquatic habitat from construction and operation of the water intake and outlet locations. Aquatic permits would require BMPs to protect habitats during construction. Impacts resulting in greater than 0.10 acre of direct fill or flooding of wetlands would require an individual permit from the Corps, as opposed to the streamlined Nationwide Permit.

Obtaining aquatic permits for the Ollala Canyon storage project is feasible. The project site is not located within federal lands, and would not require a permit from the USFS. The feasibility of obtaining Section 404/401 and HPA permits would depend on the quantity of impacts to aquatic habitats. This project would likely qualify for a Nationwide Permit due to the minimal impacts to streams and wetlands expected to occur. An HPA would also likely be granted by WDFW as no impact to fish migration would occur. Section 7 ESA-consultation would be feasible as no ESA-listed fish species are present.

5.1.4 Nahahum Canyon Off-Channel Reservoir

5.1.4.1 Description of Project

A preliminary location for a potential reservoir site is shown in Figure 5-4. The site was selected without consideration of property ownership or availability and siting a reservoir where shown may not be feasible because of those issues. The reservoir shown has a reservoir footprint of 9.1 acres and a potential impoundment volume of 165 acre-feet. A diversion structure on Nahahum Canyon Creek would be required, as well as a pipeline to deliver the water to the reservoir. The reservoir would require an inlet, outlet and emergency spillway. The water from the reservoir would likely be released directly back to the stream via a pipeline from the reservoir.

5.1.4.2 Potential Water Yield and Use of Water

Appendix D contains estimates of streamflow present in Nahahum Canyon Creek. Assuming 1-2 cfs of the late winter and early spring flow could be diverted and stored in the reservoir, the reservoir would take approximately 6-12 weeks to fill. The reservoir may not fill in some years as the yield from Nahahum Canyon is very small. If the reservoir is filled, the water stored could be released in summer and fall to augment streamflow and groundwater supplies in Nahahum Canyon. The flow augmentation would be 2.3 cfs for 30 days and 1.1 cfs for 60 days, accounting for evaporation from the reservoir in summer. Although the flow in Nahahum Canyon should be adequate to support that 1-2 cfs diversion, no assessment of instream resources or water rights was made to determine if the flow would be allowed to be diverted. The proposed maximum water allocations for the Wenatchee Watershed do not specify maximum allocations for Nahahum Canyon but do specify them for the Wenatchee River at Monitor control point. The maximum allocations at that control point includes tributaries such as Nahahum Canyon. The maximum allocations range from 148 cfs in February to 360 cfs in April. Diversions from Nahahum Canyon Creek for this reservoir would be well under those allocations.

5.1.4.3 Geology

The reservoir and embankment site is located on alluvium deposits (from gravel to clay) overlaying the Chumstick formation. The depth to rock is not know but is likely shallow. The issues relating to the project include the depth to rock which affects how the embankments would be constructed and the requirement for a liner in the reservoir if insufficient fine grain material or rock is present to hold water. The cost estimate was prepared assuming a fill only embankment with material imported to the site. The costs shown in the following section could be reduced if the reservoir could be constructed with cuts balancing fills thereby reducing the volume and cost of material imported to the site and also reducing the volume of embankment fill required.

5.1.4.4 Baseline Environmental Resources

The proposed Nahahum Canyon off-channel reservoir site is located directly adjacent to Nahahum Creek within known mule deer habitat (PHS 2005). While the reservoir would not be located within known wetland or stream resources, the project would require a water intake from Nahahum Creek and a discharge into Nahahum Creek. Both locations potentially have riparian wetlands and instream habitats. Nahahum Creek does not support any fish species.

5.1.4.5 Potential Impacts

The construction of the reservoir would require the clearing of 9.1 acres of forested habitat used by mule deer during severe winter browsing and spring fawning. Noise during construction also has the potential to disturb mule deer, however construction could be timed to avoid disturbing spring fawning periods (May 1 – June 30). Potential impacts to aquatic habitats and wetlands could occur in association with the construction of the water intake and discharge locations.

5.1.4.6 Costs

Table 5-7 summarizes the estimated costs of implementing the water storage project. Appendix E contains spreadsheets with more detailed information on quantities and costs estimated for the potential project.

Table 5-7
Estimated Implementation Cost
Nahahum Canyon Water Storage Reservoir

Item	Cost
Estimated Construction Cost	$2,616,000
Contingency (30%)	$784,800
Engineering, permitting, construction mgmt (20%)	$523,200
Sales Tax (7.7%)	$201,432
Estimated Land Acquisition or Lease Costs	$100,800
Estimated Total Implementation Cost	**$4,226,000**

The estimated implementation costs are $4.2M, or $25,600 per acre-foot. The reservoir configuration shown in Figure 5-4 did not attempt to balance cut and fills on-site, primarily because of the potential for rock to be present at shallow depths. If a location could be found where the reservoir embankments could be constructed with material excavated from the reservoir, construction costs would be much less.
The estimated Operations & Maintenance cost for the project is listed in Table 5-8. No power costs would be incurred if a gravity diversion is maintained. Because of the small size of the project, it may be easier to install a pump in the creek closer to the reservoir. If the project proceeds, then an analysis of the cost difference between a gravity and pump diversion should be performed.

Table 5-8
Operation & Maintenance Costs
Nahahum Canyon Water Storage Reservoir

Item	Cost
Annual Operations & Maintenance Cost	$34,000
Power Cost	$0
Totals	**$34,000**

5.1.4.7 Implementation Issues

The primary issues relating to implementation of this project are the cost and land ownership. At a cost of $4.2M and $25,600 per acre-foot, the feasibility of this project is marginal as configured. If further review of this site is desired, additional investigation is needed to determine the geotechnical suitability of the site, the volume of water that is available for diversion and to optimize the design of the reservoir based upon the geotechnical conditions found. It is possible that other sites in Nahahum Canyon exist where it would be less expensive to construct a reservoir. In addition, smaller reservoirs might also cost less to implement on a per acre-foot basis as it would be easier to site a small reservoir than a larger reservoir in the narrow canyon

The Nahahum Canyon storage project would be constructed outside of the main stream channel resulting in only minor impacts to aquatic habitat from construction and operation of the water intake and outlet locations. Aquatic permits would require BMPs to protect habitats during construction. Impacts resulting in greater than 0.10 acre of direct fill or flooding of wetlands would require an individual permit from the Corps, as opposed to the streamlined Nationwide Permit.

Obtaining aquatic permits for the Nahahum Canyon storage project is feasible. The project site is not located within federal lands, and would not require a permit from the USFS. The feasibility of obtaining

Section 404/401 and HPA permits would depend on the quantity of impacts to aquatic habitats. This project would likely qualify for a Nationwide Permit due to the minimal impacts to streams and wetlands expected to occur. An HPA would also likely be granted by WDFW as no impact to fish migration would occur. 7 ESA-consultation would be feasible as no ESA-listed fish species are present.

5.1.5 Other Reservoir Sizes To Consider

An estimate of costs to construct a smaller reservoir was also prepared with the idea that a smaller reservoir may be easier to implement because of property ownership issues and cost. A generic configuration was studied that would result in 5 acre-feet of storage. The reservoir footprint would be approximately 2.5 acres. It was assumed that the reservoir would be excavated and the material from the excavation used for the embankments. A liner would be needed to prevent seepage. Since the reservoir is small, it was assumed a small pump station would be constructed on a nearby creek. A 225 gallon per minute (0.5 cfs) pump would fill a 5 acre-foot reservoir in 5 days. Water could be released from the reservoir at a rate of 0.07 cfs (37 gpm) for 30 days or 0.03 cfs (18 gpm) for 60 days in late summer, accounting for evaporation from the reservoir during summer.

Table 5-9 summarizes the estimated costs of implementing a 5 acre-foot water storage project. Appendix E contains spreadsheets with more detailed information on quantities and costs estimated for the potential project.

Table 5-9
Estimated Implementation Cost
Five Acre-foot Water Storage Reservoir

Item	Cost
Estimated Construction Cost	$385,000
Contingency (30%)	$115,500
Engineering, permitting, construction mgmt (20%)	$77,000
Sales Tax (7.7%)	$29,645
Estimated Land Acquisition or Lease Costs	$25,200
Estimated Total Implementation Cost	**$633,000**

The estimated implementation costs are $0.63M, or $126,600 per acre-foot. The costs are conservative as smaller projects won't incur as much engineering and permitting costs as larger projects. The estimated Operations & Maintenance cost for the project is listed in Table 5-10.

Table 5-10
Operation & Maintenance Costs
Five Acre-foot Water Storage Reservoir

Item	Cost
Annual Operations & Maintenance Cost	$5,000
Power Cost	$310
Totals	**$5,310**

The primary issues relating to implementation of a 5 acre-foot water storage project are the cost and land ownership. The construction costs are still high (up to $0.63M and $126,600 per acre-foot).

5.1.6 Permits Required for Each Reservoir Site

The permits requirements described in Section 4 were reviewed and those permits required for each of the reservoir sites in the Lower Wenatchee Sub-watershed identified. Table 5-11 provides a list of the permits required.

5.2 Mission Sub-Watershed

5.2.1 East Fork Mission Creek Reservoir

5.2.1.1 Description of Project

A preliminary location for a potential off-channel reservoir site near East Fork Mission Creek is shown in Figure 5-5. The reservoir shown has a potential impoundment volume of 95 acre-feet and would require an embankment approximately 50 feet high. The reservoir and dam footprint is approximately 11.5 acres. The drainage area to the reservoir is 100 acres, which could deliver most of the runoff to the lake. However, a diversion structure on East Fork Mission Creek is required to ensure the reservoir fills. The reservoir would require an outlet and emergency spillway. The water from the reservoir would be released directly back to the stream via a pipeline from the reservoir.

5.2.1.2 Potential Water Yield and Use of Water

Appendix D contains estimates of streamflow present in East Fork Mission Creek. Assuming 1 cfs of the late winter and early spring flow could be diverted and stored in the reservoir, the reservoir would take approximately 6-7 weeks to fill. The water stored could be released in summer and fall to augment streamflow and groundwater supplies in the East Fork Mission Creek and along the mainstem Mission Creek. The flow augmentation would be 1.2 cfs for 30 days and 0.6 cfs for 60 days, accounting for evaporation from the reservoir in summer. The proposed maximum water allocations for the Wenatchee Watershed specify maximum allocations for Mission Creek and the diversion for this reservoir would likely be less than the maximum allocation. However no assessment of instream resources or water rights was made to determine if the flow would be allowed to be diverted.

5.2.1.3 Geology

The potential reservoir site is located in a large landslide area overlying the Chumstick sandstone formation. There are several reservoirs located in similar areas in the Squilchuck-Stemilt watershed so the presence of the landslide would not preclude constructing a reservoir. The reservoir would need lining to prevent seepage which would reduce the stability of the existing slide.

5.2.1.4 Baseline Environmental Resources and Potential Impacts

Environmental resources associated with the East Fork Mission Creek Off-Channel Reservoir project site include the East Fork Mission Creek, adjacent wetlands and riparian habitat. Although East Fork Mission Creek is a tributary to Mission Creek, no ESA-Listed fish species or resident fish currently use this reach of the creek. The project would require a water discharge into the East Fork Mission Creek. The discharge location and pipeline alignment may contain riparian wetlands and/or instream habitats. No known sensitive terrestrial habitats are associated with this project.

This project would require the construction of an impoundment near East Fork Mission Creek. The impoundment footprint would cover approximately 6.2 acres, while the reservoir would an additional 5.3 acres for a total footprint of 11.5 acres. The dam and reservoir would inundate adjacent wetlands and riparian habitat. Existing vegetation within the reservoir area would be inundated and killed.

Table 5-11
Permits Required for Lower Wenatchee Sub-Watershed Water Storage Projects

Federal Permits/Approvals					State Permits/Approvals							Chelan County		
Project Name	**Forest Service Special Use Permit**	**COE 404/ Sec. 10**	**Sec. 7 Consult. (BA)**	**NEPA**	**Dam Safety Permit**	**Sec. 401 Water Quality Cert.**	**Res. & Water Right Permits**	**HPA / JARPA**	**Sec. 106 Nat'l Historic Pres. Act**	**Aquatic Lease**	**NPDES**	**Shore-line Permits**	**SEPA**	**Critical Areas Ord.**
Derby Canyon.		√	√		√	√	√	√	√		√		√	√
Williams Canyon.		√	√		√	√	√	√	√		√		√	√
Ollala Canyon.		√	√			√	√	√	√				√	√
Nahahum Canyon.		√	√		√	√	√	√	√		√		√	√
5 Acre-foot Reservoir		√	√			√	√	√	√				√	√

5.2.1.5 Costs

Table 5-12 summarizes the estimated costs of implementing the water storage project. Appendix E contains spreadsheets with more detailed information on quantities and costs estimated for the potential project.

Table 5-12
Estimated Implementation Cost
East Fork Mission Creek Water Storage Reservoir

Item	Cost
Estimated Construction Cost	$3,403,000
Contingency (30%)	$1,020,900
Engineering, permitting, construction mgmt (20%)	$680,600
Sales Tax (7.7%)	$262,031
Estimated Land Acquisition or Lease Costs	$127,050
Estimated Total Implementation Cost	**$5,494,000**

The estimated implementation costs are $5.5M, or $57,800 per acre-foot. The reservoir configuration shown in Figure 5-5 did not attempt to balance cut and fills on-site and optimization of cuts and fills may result in a different configuration and volume of reservoir and reduced cost. However the reservoir would likely be smaller as the amount of excavation that can be performed at the site is limited because of limited area available for construction.

The estimated Operations & Maintenance cost for the project is listed in Table 5-13. No power costs would be incurred with a gravity diversion.

Table 5-13
Operation & Maintenance Costs
East Fork Mission Creek Water Storage Reservoir

Item	Cost
Annual Operations & Maintenance Cost	$44,200
Power Cost	$0
Totals	**$44,200**

5.2.1.6 Implementation Issues

The East Fork Mission Creek reservoir storage project would be constructed outside of the main stream channel resulting in only minor impacts to instream habitat from construction and operation of the water intake and outlet locations. Additional impacts to riparian wetlands located within the floodplain may require mitigation compensation through the Section 404 permitting mechanism. The extent of wetland impacts would drive the feasibility of the Section 404 permitting. Impacts resulting in greater than 0.10 acre of direct fill or flooding of wetlands would require an individual permit from the Corps, as opposed to the streamlined Nationwide Permit. Aquatic permits would also require BMPs to protect habitats during construction.

The project site is located within National Forest Land allocated as Late Successional Reserve. Development, such as the construction of a reservoir is discouraged within this designation. Development in LSR's may be permitted to go forward if the proposal address public needs or provide significant public benefits. Proposals would be reviewed by the USFS on a case-by-case basis.

Obtaining aquatic permits for the East Fork Mission Creek reservoir storage project is feasible, but would require rigorous coordination with the USFS to obtain their permit. Although this reservoir project would provide for the public benefit, obtaining a permit to develop a water storage facility on USFS-designated LSR lands may not be feasible. The feasibility of obtaining Section 404/401 and HPA permits would depend on the quantity of impacts to aquatic habitats. This project would likely qualify for a Nationwide Permit due to the minimal impacts to streams and wetlands expected to occur. An HPA would also likely be granted by WDFW as no impact to fish migration would occur. Section 7 ESA-consultation would be feasible as no ESA-listed fish species are present.

The other important implementation issue is the high cost of the project ($5.5M) given the small volume of water supplied (95 acre-feet).

5.2.2 Upper Reach Mission Creek Lakes

5.2.2.1 Description of Project

Figure 5-6 shows the location of potential off-channel reservoir sites that would enlarge the storage capacity of existing lakes. The reservoirs shown have a potential impoundment volume of 51 acre-feet and would require embankments approximately 20 feet high. The increase in water levels at the lakes would be 10-15 feet from existing lake levels. The reservoir and dam footprint for both sites is approximately 7.6 acres. The drainage area to the reservoirs is 31 acres and no stream is available to divert from. The reservoirs would each require an outlet and emergency spillway. The water from the reservoirs would be released to a small stream via the outlet pipelines.

5.2.2.2 Potential Water Yield and Use of Water

Appendix D contains estimates of the yield of the drainage basins tributary to the lakes. The reservoirs should be able to be filled with snowmelt and runoff from their tributary basin. The water stored could be released in summer and fall to augment streamflow in Mission Creek. The flow augmentation would be 0.5 cfs for 30 days and 0.3 cfs for 60 days, accounting for evaporation from the reservoir in summer. The proposed maximum water allocations for the Wenatchee Watershed specify maximum allocations for Mission Creek and the diversion for this reservoir would likely be less than the maximum allocation. However no assessment of instream resources or water rights downstream of the reservoir was made to determine if runoff would be allowed to be stored.

5.2.2.3 Geology

These lakes are also located in a large landslide area and have similar requirements as the East Fork Mission Creek reservoir.

5.2.2.4 Baseline Environmental Resources and Potential Impacts

Both of the Upper Reach Mission Creek Lake reservoir projects are located outside of the main creek channel, at existing lakes. Associated with each lake is deepwater aquatic habitat, and fringe wetlands. Anadromous fish distribution is limited to the mainstem Mission Creek 4 miles below the project sites. No sensitive terrestrial habitats are located adjacent to the two lake project sites (PHS 2005).

Both of the Upper Reach Mission Creek Lake reservoir projects would require the construction of an impoundment at the lake outlet, resulting in raised water levels. The impoundment structures would be placed across wetland and outlet streams. The footprint of these impoundments would total 1.2 acres, and would include wetland and stream impact. The reservoirs would subsequently inundate another 6.4 acres, subsequently raising lake levels, inundating adjacent wetlands, and terrestrial riparian habitat. Existing wetland and riparian vegetation within the reservoir area would be inundated and killed. As there are no known fish within these lakes, and no instream impoundment structures would be required, no impacts to resident fish are expected.

5.2.2.5 Costs

Table 5-14 summarizes the estimated costs of implementing the water storage project. Appendix E contains spreadsheets with more detailed information on quantities and costs estimated for the potential project.

Table 5-14
Estimated Implementation Cost
Upper Reach Mission Creek Lakes

Item	Cost
Estimated Construction Cost	$745,000
Contingency (30%)	$223,500
Engineering, permitting, construction mgmt (20%)	$149,000
Sales Tax (7.7%)	$57,365
Estimated Land Acquisition or Lease Costs	$84,000
Estimated Total Implementation Cost	**$1,259,000**

The estimated costs of the reservoir projects are $1.26M, or $24,700 per acre-foot of storage.

The estimated Operations & Maintenance cost for the project is listed in Table 5-14. No power costs would be incurred.

Table 5-14
Operation & Maintenance Costs
Upper Reach Mission Creek Lakes

Item	Cost
Annual Operations & Maintenance Cost	$9,700
Power Cost	$0
Totals	**$9,700**

5.2.2.6 Implementation Issues

The Upper Reach Mission Creek Lakes reservoir storage project would raise current lake levels at two locations resulting in impacts to existing riparian and lakeshore wetland communities. Impacts to wetlands through flooding may require mitigation compensation through the Section 404 permitting mechanism. The extent of wetland impacts would drive the feasibility of the Section 404 permitting. Impacts resulting in greater than 0.10 acre of direct fill or flooding of wetlands would require an individual permit from the Corps, as opposed to the streamlined Nationwide Permit. Aquatic permits would also require BMPs to protect habitats during construction.

The project site is located within National Forest Land allocated as Matrix (Active Harvest). The Matrix consists of those federal lands outside the six categories of designated areas. Development, such as the construction of a reservoir is feasible within these lands.

Obtaining aquatic permits for the Upper Reach Mission Creek Lake reservoir storage project is feasible, but would require rigorous coordination with the USFS to obtain their permit. The feasibility of obtaining Section 404/401 and HPA permits would depend on the quantity of impacts to aquatic habitats. A project of this size would likely require an individual Section 404 permit thus requiring longer permitting timeline and mitigation for impacts. Section 7 ESA-consultation would be feasible as no ESA-listed fish species currently utilize Mission Creek Lake. As no resident fish currently use these lakes, no impact to fish migration is expected and no fishway would likely be required by WDFW.

The other important implementation issue is the high cost of the project ($1.26M) given the small volume of water supplied (51 acre-feet).

5.2.3 Little Camas Creek Reservoir

5.2.3.1 Description of Project

Figure 5-7 shows a potential location of an instream reservoir on Little Camas Creek. The reservoir shown has a potential impoundment volume of 926 acre-feet and would require an embankment approximately 75 feet high. The reservoir and dam footprint is approximately 33.1 acres. The drainage area to the reservoir is 1040 acres, which could deliver most of the runoff to the lake on an annual basis. The reservoir would require a low-level outlet and emergency spillway. The water from the reservoir would be released directly back to Little Camas Crek via the outlet.

5.2.3.2 Potential Water Yield and Use of Water

Appendix D contains an estimate of the runoff from the area tributary to the reservoir. The reservoir could fill but it would severely reduce stream flow below the reservoir. An estimate of the reservoir yield was made assuming the reservoir is full at the beginning of April and the same rate of outflow as inflow is maintained from April 1 to late summer until the reservoir is drawn down. The potential yield in late summer is estimated to be 12.9 cfs for 30 days and 6.4 cfs for 60 days. Additional study of the reservoir yield is needed because of the potential to reduce instream flows downstream of the reservoir. The proposed maximum water allocations for the Wenatchee Watershed specify allocations for Mission Creek. The maximum annual allocations total approximately 700 acre-feet, less than the size of this potential reservoir. A smaller reservoir may need to be studied if this project receives further consideration.

5.2.3.3 Geology

This reservoir and embankment site is located on the Swauk Formation, which is very similar to the Chumstick Formation. The formation would provide an adequate foundation for a dam and a reservoir liner would probably not be needed.

5.2.3.4 Baseline Environmental Resources and Potential Impacts

Environmental resources associated with the Little Camas Creek Instream Reservoir project site include Little Camas Creek, adjacent wetlands, and riparian habitat. Although Little Camas Creek is a tributary to Mission Creek, fish use is limited to resident fish as no ESA-Listed fish currently use the upper reaches of this creek. No known sensitive terrestrial habitats are associated with this project.

This project would require the construction of an instream impoundment resulting in a reservoir backwater within the creek channel and adjacent lands. The impoundment footprint would cover approximately 5.4 acres, and be placed across the existing creek channel and adjacent wetlands. The reservoir would cover another 27.7 acres, subsequently inundating the creek channel, adjacent wetlands, and floodplain/riparian habitat. Existing riparian and floodplain vegetation within the reservoir area would be inundated and killed.

Although no ESA-listed fish utilize this reach of Little Camas Creek, per state RCW 77.57.030, fish passage must be provided for resident fish. This would be a requirement of the HPA permitting through WDFW.

5.2.3.5 Costs

Table 5-15 summarizes the estimated costs of implementing the water storage project. Appendix E contains spreadsheets with more detailed information on quantities and costs estimated for the potential project.

Table 5-15
Estimated Implementation Cost
Little Camas Creek Water Storage Reservoir

Item	Cost
Estimated Construction Cost	$4,488,000
Contingency (30%)	$1,346,400
Engineering, permitting, construction mgmt (20%)	$897,600
Sales Tax (7.7%)	$345,576
Estimated Land Acquisition or Lease Costs	$365,400
Estimated Total Implementation Cost	**$7,443,000**

The total cost to implement the project is $7.4M or $8,000 per acre-foot. The costs of a fish ladder to allow upstream migration of resident trout was not specifically estimated but should be covered in the contingency amount.

The estimated Operations & Maintenance cost for the project is listed in Table 5-16. No power costs would be incurred.

Table 5-16
Operation & Maintenance Costs
Little Camas Creek Water Storage Reservoir

Item	Cost
Annual Operations & Maintenance Cost	$58,300
Power Cost	$0
Totals	**$58,300**

5.2.3.6 Implementation Issues

The Little Camas Creek Instream Reservoir storage project would impound Little Camas Creek resulting in impacts to wetlands and stream habitats. Impacts to wetlands through fill or flooding may require mitigation compensation through the Section 404 permitting mechanism. The extent of wetland impacts would drive the feasibility of the Section 404 permitting. Impacts resulting in greater than 0.10 acre of direct fill or flooding of wetlands would require an individual permit from the Corps, as opposed to the streamlined Nationwide Permit. Aquatic permits would also require BMPs to protect habitats during construction. Although no ESA-listed fish utilize this reach of Little Camas Creek, per state RCW

77.57.030, fish passage must be provided for resident fish. This would be a requirement of the HPA permitting through WDFW. Constructing a fish ladder for upstream passage would be problematic because of the large fluctuation in water levels in the reservoir. A reduction in that fluctuation would reduce the amount of storage that could be released.

The project site is located within National Forest Land allocated as Matrix (Active Harvest). The Matrix consists of those federal lands outside the six categories of designated areas. Development, such as the construction of a reservoir is feasible within these lands.

Obtaining aquatic permits for the Little Camas Creek Instream Reservoir storage project is feasible, but would require rigorous coordination with the USFS to obtain their permit. The feasibility of obtaining Section 404/401 and HPA permits would depend on the quantity of impacts to aquatic habitats and the impacts to resident fish migration. A project of this size would likely require an individual Section 404 permit thus requiring longer permitting timeline and mitigation for impacts. Section 7 ESA-consultation would be feasible as no ESA-listed fish species currently utilize this reach of Little Camas Creek.

The other important implementation issues are the high cost of the project ($7.4M) and the potential limit on how much water can be diverted and stored in the reservoir given the proposed maximum allocations for Mission Creek and the potential effect from reduced flows in Little Camas Creek when the reservoir is filling.

5.2.4 Permits Required for Each Reservoir Site

The permits requirements described in Section 4 were reviewed and those permits required for each of the reservoir sites in the Mission Sub-watershed identified. Table 5-17 provides a list of the permits required.

Table 5-17
Permits Required for Mission Sub-Watershed Water Storage Projects

	Federal Permits/Approvals				State Permits/Approvals							Chelan County		
Project Name	**Forest Service Special Use Permit**	**COE 404/ Sec. 10**	**Sec. 7 Consult. (BA)**	**NEPA**	**Dam Safety Permit**	**Sec. 401 Water Quality Cert.**	**Res. & Water Right Permit**	**HPA / JARPA**	**Sec. 106 Nat'l Historic Pres. Act**	**Aquatic Lease**	**NPDES**	**Shore-line Permits**	**SEPA**	**Critical Areas Ord.**
East Fork Mission Creek	√	√	√	√	√	√	√	√	√		√		√	√
Upper Reach Mission Creek Lake	√	√	√	√	√	√	√	√	√		√		√	√
Little Camas Creek	√	√	√	√	√	√	√	√	√		√		√	√

5.3 Peshastin Sub-Watershed

5.3.1 Campbell Off-Channel Reservoir

5.3.1.1 Description of Project

The location and potential configuration of the Campbell Creek reservoir is shown in Figure 5-8. The reservoir would store water that runs off from Campbell Creek and also water that is diverted from Peshastin Creek by a pipeline serving the Tandy Irrigation Company. The reservoir would require a dam with a maximum height of about 115 feet and would store 500 acre-feet. The site is on privately-owned land and USFS land. The reservoir and embankment footprint is approximately 17.7 acres. Project facilities would include the dam, a low-level outlet to Campbell Creek, a spillway and possibly another low-level outlet that would be used to supply water back to the Tandy ditch.

Water would be discharged either through a low-level outlet to Campbell Creek to augment Peshastin Creek flows during the late summer or would be discharged to the Tandy pipeline. The use of the water would need to be negotiated and would likely depend on the source of funding for the project and the permitting requirements of agencies involved in the project.

5.3.1.2 Potential Water Yield and Use of Water

The sources of water for the reservoir would be Campbell Creek and Tandy Ditch. The Tandy ditch (now enclosed in a pipeline) diverts water from Peshastin Creek and conveys it past the base of the proposed reservoir. The pipeline capacity is 8 cfs. The Tandy pipeline could be used to fill the reservoir prior to irrigation season. During the irrigation season (starting April 15) part of the pipeline capacity may be available for filling the reservoir but since flow in the pipeline may be allocated towards irrigation the reliability of filling the reservoir may be low. The proposed maximum allocation for Peshastin Creek is 6-7 cfs prior to April and 16 cfs in April. At a filling rate of 6-8 cfs, the reservoir would fill in about 5-6 weeks.

Flow from Campbell Creek would also contribute to filling the reservoir and would supplement flow later in the summer when no water is being pumped from the Tandy pipeline. Appendix D contains hydrologic calculations of the runoff from the Campbell Creek basin. The reservoir could supply 7 cfs to Peshastin Creek and Tandy Ditch Company water users for 30 days or 3.5 cfs for 60 days in late summer, not counting natural inflow during that time period.

5.3.1.3 Geology

The dam and reservoir site is located in a canyon containing alluvium overlying Chumstick Formation sandstone. The depth of the alluvium in the base of the canyon is not known but sandstone is very shallow on the side hills. The alluvium will need to be removed from the foundation area of the dam so its depth will have a large effect on the cost of constructing an embankment dam. The sandstone base of the reservoir site will likely restrict seepage and a liner probably won't be needed.

5.3.1.4 Baseline Environmental Resources and Potential Impacts

Environmental resources associated with the Campbell Creek Off-Channel Reservoir project site include Campbell Creek, adjacent wetlands and riparian habitat. Although Campbell Creek is a tributary to Peshastin Creek, no ESA-Listed fish species or resident fish currently use this creek. No known sensitive terrestrial habitats are associated with this project.

This project would require the construction of an instream impoundment resulting in a reservoir backwater within the creek channel and adjacent lands. The impoundment would cover approximately

5.1 acres, and be placed across the existing creek channel and adjacent wetlands. The reservoir would cover another 12.6 acres, subsequently inundating the creek channel, adjacent wetlands, and floodplain/riparian habitat. Existing riparian and floodplain vegetation within the reservoir area would be inundated and killed.

5.3.1.5 Costs

Table 5-18 summarizes the estimated costs of implementing the water storage project. Appendix E contains spreadsheets with more detailed information on quantities and costs estimated for the potential project.

Table 5-18
Estimated Implementation Cost
Campbell Creek Water Storage Reservoir

Item	Cost
Estimated Construction Cost	$6,091,000
Contingency (30%)	$1,827,300
Engineering, permitting, construction mgmt (20%)	$1,218,200
Sales Tax (7.7%)	$469,007
Estimated Land Acquisition or Lease Costs	$194,250
Estimated Total Implementation Cost	**$9,800,000**

The total estimated costs of implementing the project are $9.8M and $19,500 per acre-foot. The cost of the project is high as it is assumed that most all of the dam embankment would be constructed with imported fill materials, not materials within or adjacent to the reservoir If the dam embankments could be constructed with material excavated from the reservoir, construction costs would be much less. Another option would be a roller-compacted concrete (RCC) dam. This might be a less expensive option because steeper embankments can be constructed reducing the embankment volume.

The estimated Operations & Maintenance cost for the project is listed in Table 5-19. Power costs would be incurred with the pump station used to fill the reservoir.

Table 5-19
Operation & Maintenance Costs
Campbell Creek Water Storage Reservoir

Item	Cost
Annual Operations & Maintenance Cost	$79,200
Power Cost	$2,800
Totals	**$82,000**

5.3.1.6 Implementation Issues

The primary issue that may affect the ability to construct the reservoir is the cost of $9.8M. Other significant issues include the question of what purpose the water will be used for and environmental effects and permitting hurdles.

The Campbell Creek water storage project would impound Campbell Creek resulting in impacts to wetlands and stream habitats. Impacts to wetlands through fill or flooding may require mitigation compensation through the Section 404 permitting mechanism. The extent of wetland impacts would drive the feasibility of the Section 404 permitting. Impacts resulting in greater than 0.10 acre of direct fill or flooding of wetlands would require an individual permit from the Corps, as opposed to the streamlined Nationwide Permit. Aquatic permits would also require BMPs to protect habitats during construction. As no ESA-listed fish or resident fish utilize this reach of Campbell Creek, a fishway may not be required by WDFW.

The project site is located within National Forest Land allocated as Late Successional Reserve. Development, such as the construction of a reservoir is discouraged within this designation, however, development in LSR's may be permitted to go forward if the proposal address public needs or provide significant public benefits. Proposals would be reviewed on a case-by-case basis.

Obtaining aquatic permits for the Campbell Creek water storage project is feasible, but would require rigorous coordination with the USFS to obtain their permit. The feasibility of obtaining Section 404/401 and HPA permits would depend on the quantity of impacts to aquatic habitats. This project would likely qualify for a Nationwide Permit due to the minimal impacts to streams and wetlands expected to occur. An HPA would also likely be granted by WDFW as no impact to fish migration would occur. Section 7 ESA-consultation would be feasible as no ESA-listed fish species are present. As this reservoir project is located within USFS-designated LSR obtaining a permit to develop a water storage facility would require rigorous coordination with the USFS.

5.3.2 Ingalls Creek Off-Channel Reservoir

5.3.2.1 Description of Project

A location for a potential reservoir site adjacent to Ingalls Creek is shown in Figure 5-9. The site is located on private land near the confluence of Ingalls Creek and Peshastin Creek. A diversion dam on Ingalls Creek would be required as well as a pipeline from the dam to the reservoir. The reservoir would be an off-channel reservoir with approximately 260 acre-feet of storage. The reservoir would be constructed by excavating the reservoir area and building embankments. Additional fill for the embankments would need to be imported to construct the project. The highest embankment would be 80 feet high. The footprint of the reservoir and embankment would be 15.2 acres. Water would be discharged through a low-level outlet to Ingalls Creek to augment creek flows during the late summer.

5.3.2.2 Potential Water Yield and Use of Water

Appendix D contains an estimate of the runoff from Ingalls Creek. Ingalls Creek is the largest tributary to Peshastin Creek and could fill the reservoir in less than a month at a diversion rate of 5 cfs. The diversion is less than the proposed maximum allocation for Peshastin Creek. However no assessment of instream resources or water rights was made to determine if the flow would be allowed to be diverted.

An estimate of the reservoir yield was made assuming the reservoir is full at the beginning of April and water is released in late summer. The potential yield in late summer is estimated to be 3.5 cfs for 30 days and 1.7 cfs for 60 days, accounting for evaporation during summer. The releases would increase instream flow in Peshastin Creek from Ingalls Creek to its mouth.

5.3.2.3 Geology

The reservoir and embankment site is located primarily on till material which has formed a flat-topped mass at the mouth of the Ingalls Creek. The issues relating to the project include the depth to rock which affects how the embankments would be constructed and the requirement for a liner in the reservoir if insufficient fine grain material is present to hold water. The cost estimate was prepared assuming that most of the material used for the embankment would come from the cut needed to construct the reservoir. Material for the embankment foundation would be imported.

5.3.2.4 Baseline Environmental Resources and Potential Impacts

No known sensitive environmental resources are located at the proposed Ingalls Creek off-channel reservoir site. However, the project would require a water intake from Ingalls Creek and a discharge into Ingalls Creek. Both locations potentially have riparian wetlands and instream habitats. Ingalls Creek supports ESA-listed fish species and resident fish.

No impacts to sensitive environmental resources would occur in association with the off-channel reservoir site. The reservoir site would permanently impact approximately 15.2 acres of non-sensitive terrestrial habitats. Potential impacts to aquatic habitats and wetlands could occur in association with the construction of the water intake and discharge locations. Water intake and discharge structures would require fish-friendly design.

5.3.2.5 Costs

Table 5-20 summarizes the estimated costs of implementing the water storage project. Appendix E contains spreadsheets with more detailed information on quantities and costs estimated for the potential project.

Table 5-20
Estimated Implementation Cost
Ingalls Creek Off-Channel Reservoir

Item	Cost
Estimated Construction Cost	$4,107,000
Contingency (30%)	$1,232,100
Engineering, permitting, construction mgmt (20%)	$821,400
Sales Tax (7.7%)	$316,239
Estimated Land Acquisition or Lease Costs	$168,000
Estimated Total Implementation Cost	**$6,645,000**

The estimated costs of implementation are $6.6M or $25,600 per acre-foot. The reservoir configuration shown in Figure 5-9 did not attempt to balance cut and fills on-site, primarily because of the potential for rock to be present at shallow depths. Additional analyses using better topography and geotechnical information may result in a more efficient configuration and reduced cost.

The estimated Operations & Maintenance cost for the project is listed in Table 5-21. No power costs would be incurred.

Table 5-21
Operation & Maintenance Costs
Ingalls Creek Off-Channel Reservoir

Item	Cost
Annual Operations & Maintenance Cost	$53,400
Power Cost	$0
Totals	**$53,400**

5.3.2.6 Implementation Issues

The primary issues this project would have are its cost of $6.6M and that the property is privately owned and is currently in use.

The project would be constructed outside of the main stream channel resulting in only minor impacts to aquatic habitat from construction and operation of the water intake and outlet locations. Aquatic permits would require seasonal construction restrictions to protect ESA-listed and resident fish, and additional BMPs to protect habitats during construction. Impacts resulting in greater than 0.10 acre of direct fill or flooding of wetlands would require an individual permit from the Corps, as opposed to the streamlined Nationwide Permit.

Obtaining aquatic permits for the Ingalls Creek off-channel storage project is feasible. The project site is not located within federal lands, and would not require a permit from the USFS. The feasibility of obtaining Section 404/401 and HPA permits would depend on the quantity of impacts to aquatic habitats. This project would likely qualify for a Nationwide Permit due to the minimal impacts to streams expected to occur. Successful Section 7 ESA-consultation and WDFW HPA permitting would be feasible as no impact to fish migration would result from the project, and construction timing restrictions and BMPs would minimize potential direct impacts to aquatic habitats.

5.3.3 Tronsen Creek Off-Channel Reservoir

5.3.3.1 Description of Project

A location for a potential reservoir site adjacent to Tronsen Creek is shown in Figure 5-10. The site is located on USFS land just north of Hwy 97 and below the summit of Blewett Pass at the Tronsen Campground. A diversion dam on Tronsen Creek would be required as well as a pipeline from the dam to the reservoir. The reservoir would be an off-channel reservoir with approximately 175 acre-feet of storage. The reservoir would be constructed by excavating the reservoir area and building embankments. Additional fill for the embankments would need to be imported to construct the project. The footprint of the reservoir and embankments would be 12.3 acres. The highest embankment would be 55 feet high. Water would be discharged through a low-level outlet to Tronsen Creek to augment creek flows during the late summer.

5.3.3.2 Potential Water Yield and Use of Water

Appendix D contains an estimate of the runoff from Tronsen Creek. The reservoir could be filled by diverting 4 cfs from Tronsen Creek for about 3 weeks. The diversion is less than the proposed maximum allocation for Peshastin Creek. However no assessment of instream resources or water rights was made to determine if the flow would be allowed to be diverted. An estimate of the reservoir yield was made assuming the reservoir is full at the beginning of April and water is released in late summer. The potential yield in late summer is estimated to be 2.4 cfs for 30 days and 1.2 cfs for 60 days, accounting for evaporation during summer. The releases would increase instream flow in Tronsen Creek and Peshastin Creek to its mouth.

5.3.3.3 Geology

This reservoir and embankment site is located on Swauk Formation sandstone. The rock will provide a good foundation for an embankment however most of the embankment material must be imported because there likely won't be sufficient material available on-site.

5.3.3.4 Baseline Environmental Resources and Potential Impacts

The proposed Tronsen Creek off-channel reservoir site is located directly adjacent to Tronsen Creek within known elk habitat (PHS 2005). The elk habitat is identified as a transitional area between winter and summer habitats, as well as summer habitat. The reservoir site is not located within known stream or wetland resources, however the project would require a water intake from Tronsen Creek and a discharge into Tronsen Creek. Both locations potentially have riparian wetlands and instream habitats. No ESA-listed or resident fish are known to occur within this reach of Tronsen Creek.

The construction of the reservoir would require the clearing of 12.3 acres of forested habitat used by elk. Noise during construction also has the potential to disturb elk, however construction would occur during summer months and would not disturb winter elk migration, and likely can be conducted outside of the spring elk calving season (May 1 – June 30).

Potential impacts to aquatic habitats and wetlands could occur in association with the construction of the water intake and discharge locations.

5.3.3.5 Costs

Table 5-22 summarizes the estimated costs of implementing the water storage project. Appendix E contains spreadsheets with more detailed information on quantities and costs estimated for the potential project.

Table 5-22
Estimated Implementation Cost
Tronsen Creek Water Storage Reservoir

Item	Cost
Estimated Construction Cost	$5,386,000
Contingency (30%)	$1,615,800
Engineering, permitting, construction mgmt (20%)	$1,077,200
Sales Tax (7.7%)	$414,722
Estimated Land Acquisition or Lease Costs	$135,450
Estimated Total Implementation Cost	**$8,629,000**

The total implementation costs are estimated to be $8.6M or $49,300 per acre-foot. The reservoir configuration shown in Figure 12 did not attempt to balance cut and fills on-site, primarily because of the potential for rock to be present at shallow depths. If a location could be found where the reservoir embankments could be constructed with material excavated from the reservoir, construction costs would be less.

The estimated Operations & Maintenance cost for the project is listed in Table 5-23. No power costs would be incurred.

Table 5-23
Operation & Maintenance Costs
Tronsen Creek Water Storage Reservoir

Item	Cost
Annual Operations & Maintenance Cost	$70,000
Power Cost	$0
Totals	**$70,000**

5.3.3.6 Implementation Issues

The Tronson Creek off-channel storage project would be constructed outside of the main stream channel resulting in only minor impacts to aquatic habitat from construction and operation of the water intake and outlet locations. Aquatic permits would require seasonal construction restrictions to protect resident fish, and additional BMPs to protect habitats during construction. Impacts resulting in greater than 0.10 acre of direct fill or flooding of wetlands would require an individual permit from the Corps, as opposed to the streamlined Nationwide Permit.

The project site is located within National Forest Land allocated as Matrix (Active Harvest). The Matrix consists of those federal lands outside the six categories of designated areas. Development, such as the construction of a reservoir is feasible within these lands. However since the site is located within an active recreation area (Tronsen Campground) the site may not be acceptable to the USFS.

Obtaining aquatic permits for the Tronson Creek off-channel storage project is feasible, but would require rigorous coordination with the USFS to obtain their permit. The feasibility of obtaining Section 404/401 and HPA permits would depend on the quantity of impacts to aquatic habitats. This project would likely qualify for a Nationwide Permit due to the minimal impacts to streams and wetlands expected to occur. An HPA would also likely be granted by WDFW as no impact to fish migration would occur. Section 7 ESA-consultation would be feasible as no ESA-listed fish species currently utilize Tronson Creek.

Another issue for implementation will be the cost of $8.6M and $49,300 per acre-foot. Those costs are very high for water storage projects and it would not be among the most cost effective alternatives.

5.3.4 Negro Creek Instream Reservoir

5.3.4.1 Description of Project

The location and potential configuration of the Negro Creek reservoir is shown in Figure 5-11. The site is located on USFS land in the upper Peshastin Sub-watershed. A dam would be constructed to impound Negro Creek; water would be discharged through a low-level outlet to augment creek flows during the late summer. The dam would be about 70 feet high and impound 440 acre-feet. The footprint of the reservoir and embankments would be 21 acres. Other project facilities required would be a spillway to discharge high flows and a fishway to provide upstream and downstream passage of resident fish and bull trout.

5.3.4.2 Potential Water Yield and Use of Water

Appendix D contains an estimate of flow in Negro Creek. The reservoir could be filled by retaining 5-10 cfs of streamflow for 3-6 weeks. That would represent about 25% of the streamflow in Negro Creek in early spring. The proposed maximum allocation for Peshastin Creek is 6-7 cfs in November through March, 16 cfs in April, 38 cfs in May and 44 cfs in June. The diversion would likely be less than the maximum allocations for Peshastin Creek. However no assessment of instream resources or water rights was made to determine if the flow would be allowed to be diverted. An estimate of the reservoir yield was made assuming the reservoir is full at the beginning of April and water is released in late summer. The potential yield in late summer is estimated to be 6 cfs for 30 days and 3 cfs for 60 days, accounting for evaporation during summer. The releases would increase instream flow in Negro Creek and Peshastin Creek to its mouth and slightly increase flow in the Wenatchee River.

5.3.4.3 Geology

The reservoir and embankment site is located on alluvial deposits overlaying the Ingalls Tectonic Complex rock formation (Amphibolite). The depth to rock is not known. The issues relating to the project include the depth to rock which affects how the embankments would be constructed and the availability of material on-site to construct the embankment and the requirement for a liner in the reservoir if insufficient fine grain material or rock is present to hold water. The cost estimate was prepared assuming a fill only embankment with material imported to the site. The costs shown in the following section could be reduced if the reservoir could be constructed with cuts balancing fills thereby reducing the volume and cost of material imported to the site and also reducing the volume of embankment fill required.

5.3.4.4 Baseline Environmental Resources and Potential Impacts

Environmental resources associated with the Negro Creek Instream Reservoir project site include Negro Creek, adjacent wetlands, riparian habitat, and non-listed resident fish. Negro Creek is a tributary to Peshastin Creek and currently supports bull trout and resident salmonids. No known sensitive terrestrial habitats are associated with this project.

This project would require the construction of an instream impoundment resulting in a reservoir backwater within the creek channel and adjacent lands. The dam footprint would cover approximately 2.5 acres, and be placed across the existing creek channel and adjacent wetlands. The reservoir would cover another 18.5 acres, subsequently inundating the creek channel, adjacent wetlands, and floodplain/riparian habitat. Existing riparian and floodplain vegetation within the reservoir area would be inundated and killed. A fishway would be required to allow passage of bull tout and resident fish species, however due to the steep gradient of the creek at the proposed impoundment site the effectiveness of this fishway may be limited.

5.3.4.5 Costs

Table 5-24 summarizes the estimated costs of implementing the water storage project. Appendix E contains spreadsheets with more detailed information on quantities and costs estimated for the potential project.

Table 5-24
Estimated Implementation Cost
Negro Creek Water Storage Reservoir

Item	Cost
Estimated Construction Cost	$2,054,000
Contingency (30%)	$616,200
Engineering, permitting, construction mgmt (20%)	$410,800
Sales Tax (7.7%)	$158,158
Estimated Land Acquisition or Lease Costs	$232,050
Estimated Total Implementation Cost	**$3,471,000**

The estimated cost of implementing the project is $3.5M, or $7,900 per acre-foot. The cost of the project is high as it is assumed that most all of the dam embankment would be constructed with imported fill materials, not materials within or adjacent to the reservoir If the dam embankments could be constructed with material excavated from the reservoir, construction costs would be much less.

The estimated Operations & Maintenance cost for the project is listed in Table 5-25. No power costs would be incurred.

Table 5-25
Operation & Maintenance Costs
Negro Creek Water Storage Reservoir

Item	Cost
Annual Operations & Maintenance Cost	$26,700
Power Cost	$0
Totals	**$26,700**

5.3.4.6 Implementation Issues

The Negro Creek Instream Reservoir storage project would impound Negro Creek resulting in impacts to wetlands and stream habitats. Impacts to wetlands through fill or flooding may require mitigation compensation through the Section 404 permitting mechanism. The extent of wetland impacts would drive the feasibility of the Section 404 permitting. Impacts resulting in greater than 0.10 acre of direct fill or flooding of wetlands would require an individual permit from the Corps, as opposed to the streamlined Nationwide Permit. Aquatic permits would also require BMPs to protect habitats during construction. Bull trout and resident fish use this reach of Negro Creek, and per state RCW 77.57.030 fish passage must be provided. This would be a requirement of the HPA permitting through WDFW, and as part of Section 7 ESA consultation with the Services.

The project site is located within National Forest Land allocated as Administratively Withdrawn Areas. These areas are lands that are excluded from planned or scheduled timber harvest through current forest plans or draft plan preferred alternatives. Development, such as the construction of a reservoir is unlikely to be allowed within these lands.

Obtaining aquatic permits for the Negro Creek Instream Reservoir storage project would be difficult. The feasibility of obtaining Section 404/401 permits would depend on the quantity of impacts to aquatic habitats and the impacts to resident and ESA-listed fish migration. As such, this project would likely require an individual Section 404 permit. Section 7 ESA-consultation and the HPA permit process would be problematic as the feasibility of constructing an effective fishway for bull trout and resident fish is reduced by the steep gradient of the project site and the fluctuating water levels in the reservoir. As this reservoir project is located within USFS-designated Administratively Withdrawn Ares, obtaining a permit to develop a water storage facility would require rigorous coordination with the USFS.

Other implementation issues are the cost ($3.5M) and the potential effects on Negro Creek and Peshastin Creek during the time the reservoir fills.

5.3.5 Permits Required for Each Reservoir Site

The permits requirements described in Section 4 were reviewed and those permits required for each of the reservoir sites in the Peshastin Sub-watershed identified. Table 5-26 provides a list of the permits required.

Table 5-26
Permits Required for Peshastin Sub-Watershed Water Storage Projects

Federal Permits/Approvals					State Permits/Approvals							Chelan County		
Project Name	**Forest Service Special Use Permit**	**COE 404/ Sec. 10**	**Sec. 7 Consult. (BA)**	**NEPA**	**Dam Safety Permit**	**Sec. 401 Water Quality Cert.**	**Res. & Water Right Permit**	**HPA / JARPA**	**Sec. 106 Nat'l Historic Pres. Act**	**Aquatic Lease**	**NPDES**	**Shore-line Permits**	**SEPA**	**Critical Areas Ord.**
Campbell Off-channel Res.	√	√	√	√	√	√	√	√	√		√		√	√
Ingalls Creek Off-channel Res.		√	√		√	√	√	√	√		√	√	√	√
Tronsen Creek Off-channel Res.	√	√	√	√	√	√	√	√	√		√		√	√
Negro Creek Instream Res.	√	√	√	√	√	√	√	√	√		√		√	√

5.4 Chumstick Sub-Watershed

5.4.1 Eagle Creek Tributary Lakes

5.4.1.1 Description of Project

Figure 5-12 shows the location of potential off-channel reservoir sites that would enlarge the storage capacity of existing lakes. The reservoirs shown have a potential impoundment volume of 79 acre-feet and would require embankments approximately 20 feet high. The increase in water levels at the lakes would be 10-15 feet from existing lake levels. The reservoir and dam footprint for both sites is approximately 6.3 acres. The drainage area to the reservoirs is 31 acres and no stream is available to divert from. The reservoirs would each require an outlet and emergency spillway. The water from the reservoirs would be released to a tributary of Eagle Creek via the outlet pipelines.

5.4.1.2 Potential Water Yield and Use of Water

Appendix D contains estimates of the yield of the drainage basins tributary to the lakes. The reservoirs should be able to be filled with snowmelt and runoff from their tributary basin. There are no maximum allocations for the Chumstick subwatershed however an instream flow control point exists on the Wenatchee River at Peshastin, which is located downstream from where the Chumstick flows into the Wenatchee River. The proposed maximum allocation for all projects located upstream of the Peshastin control point (including the Chumstick subwatershed) ranges from 111 cfs in February to 335 cfs in April. As long as there is sufficient streamflow available in the Chumstick subwatershed the maximum allocation proposed in the Watershed Plan would not limit diversions into the potential reservoirs. However no assessment of instream resources or water rights was made to determine if the flow would be allowed to be diverted. The water stored could be released in summer and fall to augment streamflow in Eagle Creek. The flow augmentation would be 1.0 cfs for 30 days and 0.5 cfs for 60 days, accounting for evaporation from the reservoir in summer.

5.4.1.3 Geology

The Eagle Creek Tributary Lakes are located on or near a series of sandstone and metamorphic rock formations near the Entiat Fault. The west lake is located within the Chumstick Formation. The east lake is located over a metamorphic rock formation near the edge of a large landslide. The depth to rock is not known for either lake, but is likely shallow. The issues relating to the project include the depth to rock which affects how the embankments would be constructed and the requirement for a liner in the reservoir if insufficient fine grain material or rock is present to hold water. The cost estimate was prepared assuming a fill only embankment with material imported to the site. The costs shown in the following section could be reduced if the reservoir could be constructed with cuts balancing fills thereby reducing the volume and cost of material imported to the site and also reducing the volume of embankment fill required.

5.4.1.4 Baseline Environmental Resources and Potential Impacts

The Eagle Creek Tributary Lake reservoir projects are located outside of the main creek channel, at existing lakes. Associated with each lake is deepwater aquatic habitat, and fringe wetlands. Summer steelhead distribution is isolated to the lower 2-miles of Eagle Creek, well below the project areas. All of the projects are located in spring and summer bighorn sheep habitat (PHS 2005).

Each Eagle Creek Tributary Lake project would require the construction of an impoundment at the lake outlet, resulting in raised water levels. The impoundment structures would be placed across wetland and outlet streams. The footprint of these impoundments will total 1.4 acres, and would include wetland and stream impact. The reservoirs would cover another 4.9 acres, subsequently raising lake levels, inundating adjacent wetlands, and terrestrial riparian habitat. Existing wetland and riparian vegetation within the reservoir area would be inundated and killed. As there are no known fish within these lakes, and no instream impoundment structures would be required, no impacts to resident fish are expected.

The construction of the impoundments associated with these projects would require the clearing of forested habitat used by bighorn sheep and the inundation of potential foraging habitat at the lake fringes. Noise during construction also has the potential to disturb bighorn sheep during spring lambing and summer foraging. Construction timing to avoid spring lambing is appropriate to avoid animal disturbance during this sensitive period.

5.4.1.5 Costs

Table 5-27 summarizes the estimated costs of implementing the water storage project. Appendix E contains spreadsheets with more detailed information on quantities and costs estimated for the potential project.

Table 5-27
Estimated Implementation Cost
Eagle Creek Tributary Lakes Water Storage Reservoirs

Item	Cost
Estimated Construction Cost	$757,000
Contingency (30%)	$227,100
Engineering, permitting, construction mgmt (20%)	$151,400
Sales Tax (7.7%)	$58,289
Estimated Land Acquisition or Lease Costs	$69,000
Estimated Total Implementation Cost	**$1,263,000**

The estimated cost of implementing the project is $1.3M, or $16,000 per acre-foot. The cost of the project is high as it is assumed that most all of the dam embankment would be constructed with imported fill materials, not materials within or adjacent to the reservoir If the dam embankments could be constructed with material excavated from the reservoir, construction costs would be much less.

The estimated Operations & Maintenance cost for the project is listed in Table 5-28. No power costs would be incurred.

Table 5-28
Operation & Maintenance Costs
Eagle Creek Tributary Lakes Water Storage Reservoirs

Item	Cost
Annual Operations & Maintenance Cost	$9,800
Power Cost	$0
Totals	**$9,800**

5.4.1.6 Implementation Issues

The Eagle Creek Tributary Lake storage projects would raise current lake levels resulting in impacts to existing riparian and lakeshore wetland communities. Impacts to wetlands through flooding may require mitigation compensation through the Section 404 permitting mechanism. The extent of wetland impacts would drive the feasibility of the Section 404 permitting. Impacts resulting in greater than 0.10 acre of direct fill or flooding of wetlands would require an individual permit from the Corps, as opposed to the streamlined Nationwide Permit. Aquatic permits would also require BMPs to protect habitats during construction.

The project sites are located within National Forest Land allocated as Matrix (Active Harvest). The Matrix lands consist of those federal lands outside the six categories of designated areas. Development, such as the construction of a reservoir is feasible within these lands.

Obtaining aquatic permits for the Eagle Creek Tributary Lake storage projects is feasible, but would require rigorous coordination with the USFS to obtain their permit. The feasibility of obtaining Section 404/401 and HPA permits would depend on the quantity of impacts to aquatic habitats. A project of this size would likely require an individual Section 404 permit thus requiring longer permitting timeline and mitigation for impacts. Section 7 ESA-consultation would be feasible as no ESA-listed fish species currently utilize the Eagle Creek Tributary lakes.

Another issue that affects the feasibility will be the cost of $1.3M and $16,000 per acre-foot. Those costs are high for water storage projects.

5.4.2 Eagle Creek SW Tributary Lakes

5.4.2.1 Description of Project

Figure 5-12 shows the location of potential off-channel reservoir sites that would enlarge the storage capacity of existing lakes on the Southwest Tributary of Eagle Creek. The reservoirs shown have a potential impoundment volume of 54 acre-feet and would require embankments approximately 20 feet high. The increase in water levels at the lakes would be 10-15 feet from existing lake levels. The reservoir and dam footprint for both sites is approximately 5,8 acres. The drainage area to the reservoirs is 31 acres and no stream is available to divert from. The reservoirs would each require an outlet and emergency spillway. The water from the reservoirs would be released to a small stream via the outlet pipelines.

5.4.2.2 Potential Water Yield and Use of Water

Appendix D contains estimates of the yield of the drainage basins tributary to the lakes. The reservoirs should be able to be filled with snowmelt and runoff from their tributary basin. As long as there is sufficient streamflow available in the Chumstick subwatershed the maximum allocation proposed in the Watershed Plan would not limit diversions into the reservoirs. However no assessment of instream resources or water rights was made to determine if the flow would be allowed to be diverted. The water stored could be released in summer and fall to augment streamflow in Eagle Creek. The flow augmentation would be 0.6 cfs for 30 days and 0.3 cfs for 60 days, accounting for evaporation from the reservoir in summer.

5.4.2.3 Geology

The existing lakes are located adjacent to a large landslide overlying Chumstick Formation sandstone. A detailed geotechnical investigation is needed to determine the extent of the slide and foundation requirements for a dam to impound more water at the existing lakes. A liner may be required on a portion of the lake.

5.4.2.4 Baseline Environmental Resources and Potential Impacts

The Eagle Creek SW Tributary Lake reservoir projects are located outside of the main creek channel, at existing lakes. Associated with each lake is deepwater aquatic habitat, and fringe wetlands. Summer steelhead distribution is isolated to the lower 2-miles of Eagle Creek, well below the project areas. All of the projects are located in spring and summer bighorn sheep habitat (PHS 2005).

Each Eagle Creek SW Tributary Lake project would require the construction of an impoundment at the lake outlet, resulting in raised water levels. The impoundment structures would be placed across wetland and outlet streams. The footprint of these impoundments will total 0.7 acres, and would include wetland and stream area. The reservoirs would cover another 5.1 acres, subsequently raising lake levels, inundating adjacent wetlands, and terrestrial riparian habitat. Existing wetland and riparian vegetation within the reservoir area would be inundated and killed. As there are no known fish within these lakes, and no instream impoundment structures would be required, no impacts to resident fish are expected.

The construction of the impoundments associated with these projects would require the clearing of forested habitat used by bighorn sheep and the inundation of potential foraging habitat at the lake fringes. Noise during construction also has the potential to disturb bighorn sheep during spring lambing and summer foraging. Construction timing to avoid spring lambing is appropriate to avoid animal disturbance during this sensitive period.

5.4.2.5 Costs

Table 5-29 summarizes the estimated costs of implementing the water storage project. Appendix E contains spreadsheets with more detailed information on quantities and costs estimated for the potential project.

Table 5-29
Estimated Implementation Cost
Eagle Creek SW Tributary Lakes

Item	Cost
Estimated Construction Cost	$528,000
Contingency (30%)	$158,400
Engineering, permitting, construction mgmt (20%)	$105,600
Sales Tax (7.7%)	$3,696
Estimated Land Acquisition or Lease Costs	$64,000
Estimated Total Implementation Cost	**$860,000**

The estimated cost of implementing the project is $0.86M, or $15,800 per acre-foot. The cost of the project is high as it is assumed that most all of the dam embankment would be constructed with imported fill materials, not materials within or adjacent to the reservoir If the dam embankments could be constructed with material excavated from the reservoir, construction costs would be much less.

The estimated Operations & Maintenance cost for the project is listed in Table 5-30. No power costs would be incurred.

Table 5-30
Operation & Maintenance Costs
Eagle Creek SW Tributary Lakes

Item	Cost
Annual Operations & Maintenance Cost	$6,800
Power Cost	$0
Totals	**$6,800**

5.4.2.6 Implementation Issues

The Eagle Creek SW Tributary Lake storage projects would raise current lake levels resulting in impacts to existing riparian and lakeshore wetland communities. Impacts to wetlands through flooding may require mitigation compensation through the Section 404 permitting mechanism. The extent of wetland impacts would drive the feasibility of the Section 404 permitting. Impacts resulting in greater than 0.10 acre of direct fill or flooding of wetlands would require an individual permit from the Corps, as opposed to the streamlined Nationwide Permit. Aquatic permits would also require BMPs to protect habitats during construction.

The project sites are located within Managed Late Successional Areas (Managed Harvest). Managed Late Successional Areas are managed through silvicultural treatments and fire hazard reduction treatments to help prevent complete stand destruction from large catastrophic events such as high intensity, high severity fires; or disease or insect epidemics. Development, such as the construction of a reservoir is not likely a permittable activity within these lands.

Obtaining aquatic permits for the Eagle Creek SW Tributary Lake storage projects is feasible, but would require rigorous coordination with the USFS to obtain their permit. The feasibility of obtaining Section 404/401 and HPA permits would depend on the quantity of impacts to aquatic habitats. A project of this size would likely require an individual Section 404 permit thus requiring longer permitting timeline and mitigation for impacts. Section 7 ESA-consultation would be feasible as no ESA-listed fish species currently utilize the Eagle Creek Tributary lakes. Although this reservoir project would provide for the public benefit, obtaining a permit to develop a water storage facility on USFS-designated Managed Late Successional Area lands may not be feasible.

Another issue that affects the feasibility will be the cost of $0.86M and $15,800 per acre-foot. Those costs are high for water storage projects.

5.4.3 East Van Creek Off-Channel Reservoir

5.4.3.1 Description of Project

Figure 5-13 shows the location of a potential off-channel reservoir site adjacent to East Van Creek. A diversion dam on East Van Creek would be required as well as a pipeline from the dam to the reservoir. The reservoir would have approximately 100 acre-feet of storage and have a reservoir and embankment footprint of 5.7 acres. The reservoir would be constructed by excavating the reservoir area and building embankments. Additional fill for the embankments would need to be imported to construct the project. The reservoirs would each require an outlet and emergency spillway. The water from the reservoirs would be released to East Van Creek via the outlet pipeline.

5.4.3.2 Potential Water Yield and Use of Water

Appendix D contains estimates of the yield of the drainage basins tributary to the lakes. The reservoir should be able to be filled with snowmelt and runoff from a diversion on East Van Creek and runoff from its uphill drainage area. The maximum allocation proposed in the Wenatchee Watershed Plan would not limit diversions into the potential reservoir. However no assessment of instream resources or water rights was made to determine if the flow would be allowed to be diverted. The water stored could be released in summer and fall to augment streamflow in Eagle Creek. The flow augmentation would be 1.3 cfs for 30 days and 0.7 cfs for 60 days, accounting for evaporation from the reservoir in summer.

5.4.3.3 Geology

The reservoir and embankment site is located on sediments overlaying the Chumstick sandstone formation. The depth to sandstone is not know but is likely shallow. The issues relating to the project include the depth to sandstone which affects how the embankments would be constructed and the requirement for a liner in the reservoir if insufficient fine grain material or rock is present to hold water. The assumptions made in producing a cost estimate will need to be reviewed when additional geotechnical data is collected.

5.4.3.4 Baseline Environmental Resources

The proposed East Van Creek off-channel reservoir site is located directly adjacent to East Van Creek within known spring and summer bighorn sheep habitat (PHS 2005). The reservoir site is not located within known stream or wetland resources, however the project would require a water intake from East Van Creek and a discharge back into the creek. Both locations potentially have riparian wetlands and instream habitats. No ESA-listed fish are known to occur within this reach of East Van Creek.

5.4.3.5 Potential Impacts

The construction of the reservoir would require the clearing of 5.7 acres of forested habitat used by bighorn sheep and the inundation of potential foraging habitat at the lake fringes. Noise during construction also has the potential to disturb bighorn sheep during spring lambing and summer foraging. Construction timing to avoid spring lambing is appropriate to avoid animal disturbance during this sensitive period. Potential impacts to aquatic habitats and wetlands could occur in association with the construction of the water intake and discharge locations.

5.4.3.6 Costs

Table 5-31 summarizes the estimated costs of implementing the water storage project. Appendix D contains spreadsheets with more detailed information on quantities and costs estimated for the potential project.

Table 5-31
Estimated Implementation Cost
East Van Creek Water Storage Reservoir

Item	Cost
Estimated Construction Cost	$1,834,000
Contingency (30%)	$550,200
Engineering, permitting, construction mgmt (20%)	$366,800
Sales Tax (7.7%)	$211,827
Estimated Land Acquisition or Lease Costs	$63,000
Estimated Total Implementation Cost	**$3,026,000**

The estimated cost of implementing the project is $3.03M, or $30,300 per acre-foot. The reservoir configuration shown in Figure 5-13 did not attempt to balance cut and fills on-site, primarily because of the potential for rock to be present at shallow depths. Additional geotechnical information is required to determine the most cost-effective way of constructing a reservoir at the site.

The estimated Operations & Maintenance cost for the project is listed in Table 5-32. No power costs would be incurred.

Table 5-32
Operation & Maintenance Costs
East Van Creek Water Storage Reservoir

Item	Cost
Annual Operations & Maintenance Cost	$23,800
Power Cost	$0
Totals	**$23,800**

5.4.3.7 Implementation Issues

The East Van Creek off-channel reservoir project would be constructed outside of the main stream channel resulting in only minor impacts to instream habitat from construction and operation of the water intake and outlet locations. Additional impacts to riparian wetlands located within the floodplain may require mitigation compensation through the Section 404 permitting mechanism. The extent of wetland impacts would drive the feasibility of the Section 404 permitting. Impacts resulting in greater than 0.10 acre of direct fill or flooding of wetlands would require an individual permit from the Corps, as opposed to the streamlined Nationwide Permit. Aquatic permits would also require BMPs to protect habitats during construction.

The project site is located within National Forest Land allocated as Matrix (Active Harvest). The Matrix consists of those federal lands outside the six categories of designated areas. Development, such as the construction of a reservoir is feasible within these lands.

Obtaining aquatic permits for the East Van Creek off-channel reservoir project is feasible, but would require rigorous coordination with the USFS to obtain their permit. The feasibility of obtaining Section 404/401 and HPA permits would depend on the quantity of impacts to aquatic habitats. This project would likely qualify for a Nationwide Permit due to the minimal impacts to streams and wetlands expected to occur. An HPA would also likely be granted by WDFW as no impact to fish migration would occur. Section 7 ESA-consultation would be feasible as no ESA-listed fish species are present.

Another issue that affects the feasibility will be the cost of $3.03M and $30,300 per acre-foot. Those costs are very high for water storage projects.

5.4.4 Pump From Upper Wenatchee into Little Chumstick Creek

5.4.4.1 Description of Project

This project would entail construction of a pump station alongside the Wenatchee-Chiwawa Irrigation District canal and pumping water over a ridge into a tributary of Little Chumstick Creek. The Wenatchee-Chiwawa canal diverts water from the Chiwawa River and delivers to the area around Plain. The intake headworks are sized to divert 12 cfs. According to the District, about 3 cfs remains in their canal near Plain where water could be pumped over the ridge.

There are at least two potential configurations of this project. They are:

- Pump only water that is present in the canal and not needed by the Irrigation District. This would constrain the amount of water pumped but require the least work to implement. Very little change in the current operations of the District would occur. The water yield for this configuration would likely be in the range of 1-3 cfs.

- Improve the Irrigation District canal to provide additional capacity. This would require identifying constrictions in the canal system and constructing upgrades. The water yield for this configuration would likely be in the range of 3-5 cfs.

For this alternative, we have assumed the irrigation district canal would be improved to allow 5 cfs pumping. A storage reservoir would be placed in the Little Chumstick Creek tributary adjacent to Hwy 209. The reservoir would impound 210 acre-feet. The dam embankment would be approximately 75 ft high and the footprint of the reservoir and dam would be approximately 11 acres. Figure 5-14 shows the configuration of this potential project.

5.4.4.2 Potential Water Yield and Use of Water

The water supplied to the project would be diverted from the Chiwawa River through the Wenatchee-Chiwawa Irrigation District canal and pumped to the storage reservoir. The pumping could occur in early spring after the irrigation district starts up operations. Maximum allocations are proposed for the Chiwawa River that could limit the period of time the reservoir is filled during the winter but would also allow the reservoir to fill starting March 16. Water could be released from the reservoir during the August through October time period during the period of lowest flow or water supply in Little Chumstick and Chumstick Creek. Approximately 1.6 cfs could be supplied from the reservoir for 60 days and 1.1 cfs for 90 days assuming one fill of the reservoir in early spring. If the pump station was operated during other times of the irrigation season, the yield would be greater as storage released would be replenished. Pumping would probably not be allowed when instream flows in the Wenatchee River are not met.

The flow released from the reservoir would flow down Little Chumstick Creek and likely seep into the ground. It is not certain that surface flow in Little Chumstick Creek and Chumstick Creek would occur in currently dry reaches with the water added to the system. However groundwater supplies would be augmented providing water for irrigation and domestic use.

5.4.4.3 Geology

The pump station, reservoir and embankment sites are located on alluvium overlaying the Chumstick sandstone formation. The depth to sandstone is not known but is likely shallow. The pipeline would traverse the Chumstick formation and most of the route would be along an existing roadway (Hwy 209). The issues relating to the project include the depth to sandstone which affects how the reservoir embankment would be constructed and the requirement for a liner in the reservoir if insufficient fine grain material or rock is present to hold water. Given the shallow depth of sandstone, a liner would not likely be required. The assumptions made in producing a cost estimate will need to be reviewed when additional geotechnical data is collected.

5.4.4.4 Baseline Environmental Resources and Potential Impacts

The Upper Wenatchee-pump-to-Little Chumstick Creek project would require a water intake from the Wenatchee-Chiwawa Irrigation Ditch and a discharge into a reservoir site located in the upper Little Chumstick Creek. The reservoir location is an impoundment of a tributary to Little Chumstick Creek. No resident fish are known to occur within this tributary to Little Chumstick Creek, however resident fish are known to use the mainstem Little Chumstick Creek. No ESA-listed fish are known to occur within this reach of Little Chumstick Creek. No sensitive terrestrial wildlife species or habitats are known to be associated with the three project sites.

The construction of the pump and pipe system would require clearing of forested vegetation and minor grading. This activity may impact riparian wetland and stream habitats. The withdrawal of water from the Upper Wenatchee sub-watershed would incrementally reduce flows within the mainstem Wenatchee River.

Potential impacts to aquatic habitats and wetlands could occur in association with the construction of the water intake and discharge locations. The impoundment in the tributary to Little Chumstick Creek would inundate stream channel and riparian habitats.

5.4.4.5 Costs

Table 5-33 summarizes the estimated costs of implementing the water storage project. Appendix E contains spreadsheets with more detailed information on quantities and costs estimated for the potential project. For this estimate, no specific work was identified to upgrade the Wenatchee-Chiwawa Irrigation District canal system but an allowance of $250,000 was placed in the cost estimate to cover that item.

Table 5-33
Estimated Implementation Cost
Pump from Upper Wenatchee into Little Chumstick Creek

Item	Cost
Estimated Construction Cost	$2,791,000
Contingency (30%)	$837,300
Engineering, permitting, construction mgmt (20%)	$558,200
Sales Tax (7.7%)	$214,907
Estimated Land Acquisition or Lease Costs	$116,550
Estimated Total Implementation Cost	**$4,518,000**

The estimated costs of implementing the project are $ 4.5M or $21,600 per acre-foot. Those costs include the costs of upgrading the Wenatchee-Chiwawa Irrigation District canal and constructing a pump station, pipeline and reservoir.

The estimated Operations & Maintenance cost for the project is listed in Table 5-34. Power costs are estimated to be $3,200 annually based upon one fill of the reservoir. The power costs would increase if the reservoir is filled during other times of the year.

Table 5-34
Operation & Maintenance Costs
Pump from Upper Wenatchee into Little Chumstick Creek

Item	Cost
Annual Operations & Maintenance Cost	$36,300
Power Cost	$3,200
Totals	**$39,500**

5.4.4.6 Implementation Issues

The main implementation issues will be the diversion of flow from the Chiwawa River and the Wenatchee River to the Chumstick sub-watershed and the use of the Wenatchee – Chiwawa Irrigation District facilities. It is not certain that the diversion would be allowed during times that instream flows in the Wenatchee River are not met.

The impoundment on the tributary to Little Chumstick Creek may result in impacts to stream and wetland resources from the fill associated with the impoundment and the backwater of the creek. Impacts to wetlands through fill or flooding may require mitigation compensation through the Section 404 permitting mechanism. The extent of wetland impacts would drive the feasibility of the Section 404 permitting. Impacts resulting in greater than 0.10 acre of direct fill or flooding of wetlands would require an individual permit from the Corps, as opposed to the streamlined Nationwide Permit. Aquatic permits would also require BMPs to protect habitats during construction. As no ESA-listed fish or resident fish utilize this tributary to Little Chumstick Creek, a fishway may not be required by WDFW .

The reservoir, impoundment, and pumping sites are located on private lands. The pipeline needed to connect the project across watershed boundaries would likely cross National Forest Land allocated as Matrix (Active Harvest). The Matrix consists of those federal lands outside the six categories of designated areas. Development, such as the construction of a water pipeline is feasible within these lands. In addition, most of the pipeline route is alongside an existing roadway which will minimize disturbance.

Obtaining aquatic permits for the Upper Wenatchee-pump-to-Little Chumstick Creek project is feasible, but would require rigorous coordination with the USFS to obtain their permit. The feasibility of obtaining Section 404/401 and HPA permits would depend on the quantity of impacts to aquatic habitats. This project would likely qualify for a Nationwide Permit due to the minimal impacts to streams and wetlands expected to occur. An HPA would also likely be granted by WDFW as no impact to fish migration would occur. Section 7 ESA-consultation would be feasible as no ESA-listed fish species are present.

Another issue that affects the feasibility will be the cost of $4.5M and $21,600 per acre-foot. Those costs are very high for water storage projects.

5.4.5 Permits Required for Each Reservoir Site

The permits requirements described in Section 4 were reviewed and those permits required for each of the reservoir sites in the Chumstick Sub-watershed identified. Table 5-35 provides a list of the permits required.

Table 5-35
Permits Required for Chumstick Sub-Watershed Water Storage Projects

Federal Permits/Approvals					State Permits/Approvals							Chelan County		
Project Name	**Forest Service Special Use Permit**	**COE 404/ Sec. 10**	**Sec. 7 Consult. (BA)**	**NEPA**	**Dam Safety Permit**	**Sec. 401 Water Quality Cert.**	**Res. & Water Right Permit**	**HPA / JARPA**	**Sec. 106 Nat'l Historic Pres. Act**	**Aquatic Lease**	**NPDES**	**Shore-line Permits**	**SEPA**	**Critical Areas Ord.**
Eagle Creek Tributary Lk.	√	√	√	√	√	√	√	√	√		√		√	√
Eagle Creek SW Tributary Lk.	√	√	√	√	√	√	√	√	√		√		√	√
East Van Creek Off-channel Res.	√	√	√	√	√	√	√	√	√		√		√	√
Pump from Upper Wenatchee into Little Chumstick Creek	√	√	√	√	√	√	√	√	√		√		√	√

5.5 Icicle Sub-Watershed

5.5.1 Alpine Lakes Optimization

5.5.1.1 Description of Project

The Alpine Lakes are operated by the Icicle Irrigation District and Peshastin Irrigation District (Klonaqua, Square, Colchuck, Eight Mile Lakes) and U.S. Fish and Wildlife Service (USFWS) (Snow, Nada Lakes). The lakes are used to augment water supply for Icicle and Peshastin Irrigation Districts and the Leavenworth National Fish Hatchery operated by the USFWS. The lakes are located in the Alpine Lakes Wilderness Area with no access roads. Valves on the lakes are operated manually and are accessed by hiking in or by helicopter; therefore, the valve openings are set infrequently and the discharge from the lakes doesn't always match demand for water.

This project would retrofit or replace the existing outlet gates to allow motorized operation from the irrigation district and USFWS offices. The equipment may include low-voltage motors run off of batteries that are recharged by solar panels. Communication may be via satellite link or radio. The intent of the project will be to optimize the discharge from the lakes to retain water longer and provide more flow in late summer and early fall.

This project is not studied for this report because supplemental funding for water storage funding was obtained from Department of Ecology. That funding will be used in part to prepare a detailed study of the costs and benefits of optimizing the operations of the lakes.

5.5.1.2 Potential Water Yield and Use of Water

A hydrologic study of the lakes to determine their yield will be performed for the studies funded by Ecology. That work will include monitoring of water levels and flow from the lakes and preparation of a hydrologic model of the basins feeding the lakes. The most recent study of the Snow Lake watershed has been performed by USFWS (Management Recommendations For Reservoir Releases From Upper Snow Lake: Leavenworth National Fish Hatchery, Wurster, 2006).

The report provided estimates of yield from Snow Lake and concluded that:

1) "When full, Upper Snow Lake contains enough water to supplement instream flows in Icicle Creek downstream of the Leavenworth National Fish Hatchery diversion structure.

2) Approximate total annual yield of the Upper Snow Lake Watershed ranges from 4,400 ac-ft to 13,000 ac-ft, with an average of 8,600 ac-ft between 1994 and 2005.

3) Approximate October-July yield of the Upper Snow Lake Watershed ranges from 3,800 ac-ft to 11,800 ac-ft, with an average of 7,800 ac-ft between 1994 and 2005.

4) The estimated probability that Upper Snow Lake will fill after releasing 80 cfs in August and September is about 30% for any given year.

5) The estimated probability that Upper Snow Lake will fill after releasing 60 cfs in August and September is about 60% for any given year."

It appears to be feasible to release additional water from Snow Lake to supplement instream flow in Icicle Creek in August and September. The release would also increase flow in the Wenatchee River and provide habitat and water supply benefits. Maximum allocations are proposed for Icicle Creek in the Wenatchee Watershed Plan however they would not affect this project as the water rights for the lakes are existing and the storage volume in the lakes would not change.

Additional flow may be made available from the other reservoirs with improved management.

5.5.1.3 Implementation Issues

The Alpine Lake Optimization project would maintain lake levels at higher elevations throughout the summer which may result in impacts to existing riparian and lakeshore wetland communities. The project site is located within Congressionally Designated Wilderness Area. Development, such as the expansion of an existing reservoir is likely to be prohibited within these lands. However retrofitting existing dams and outlet structures would likely be approved.

5.5.2 Mountain Home Off-Channel Reservoirs

5.5.2.1 Description of Project

The Mountain Home Reservoirs are a water storage project that has been proposed on land owned by Rob Johnson. Mr. Johnson provided the Water Quantity Subcommittee a drawing showing two instream reservoirs that would store a total of 350 acre-feet. The source of water would be tributaries to Mountain Home Creek. The location of the projects are shown in Figure 5-15. Mr. Johnson applied for a reservoir permit from the Department of Ecology in 1994 (see Table 2-2). The projects would propose to use earthfill dams to impound the tributaries. No analyses of the projects were performed for this study as the projects would be privately owned and the use of the water appears to be for a golf course development. If it were proposed the water impounded in the reservoirs be used at least in part for public benefit, more study of the project would be warranted by the Water Quantity Subcommittee.

5.6 Nason Sub-Watershed

5.6.1 Mill Creek Instream Reservoir

5.6.1.1 Description of Project

The location and potential configuration of the Mill Creek instream reservoir is shown in Figure 5-16. The site is located on federal land managed by the USFS in the upper Nason Sub-watershed. A dam would be constructed to impound Mill Creek; water would be discharged through a low-level outlet to augment creek flows during the late summer. The dam would be about 70 feet high and impound 1,360 acre-feet. The project foot print is approximately 47.9 acres. Other project facilities required would be a spillway to discharge high flows and a fishway to pass resident fish. A group of large powerlines is located on the east side of the proposed reservoir. The reservoir size was limited in our configuration to avoid impacts to the power lines but it is not known at this time if any of the power lines would need to be relocated. The Cascade Tunnel is located to the north of the reservoir approximately 300 feet underground.

5.6.1.2 Potential Water Yield and Use of Water

Appendix D contains an estimate of flow in Mill Creek. The reservoir could be filled by retaining 20-30 cfs of streamflow for 3-5 weeks. The proposed maximum allocation for Nason Creek is 44 cfs in April, 99 cfs in May and 114 cfs in June. However no assessment of instream resources or water rights was made to determine if the flow would be allowed to be diverted. A diversion of 20-30 cfs would represent about half of the streamflow in Mill Creek in early spring. An estimate of the reservoir yield was made assuming the reservoir is full at the beginning of April and water is released in late summer. The potential yield in late summer is estimated to be 19 cfs for 30 days and 9.5 cfs for 60 days, accounting for evaporation during summer. The releases would increase instream flow in Nason Creek to its mouth and slightly increase flow in the Wenatchee River.

5.6.1.3 Geology

The reservoir and embankment site is located on alluvial and glacial deposits in a narrow valley carved into the Chiwakum Schist Formation. The depth to rock is not known but is likely shallow. The issues relating to the project include the depth to rock which affects how the embankments would be constructed and the requirement for a liner in the reservoir if insufficient fine grain material or rock is present to hold water. The formation should provide an adequate formation for an embankment. The cost estimate was prepared assuming a fill only embankment with material imported to the site. The costs shown in the following section could be reduced if the reservoir could be constructed with cuts balancing fills thereby reducing the volume and cost of material imported to the site and also reducing the volume of embankment fill required.

5.6.1.4 Baseline Environmental Resources and Potential Impacts

The proposed Mill Creek Instream Reservoir site is located within known elk habitat (PHS 2005). The elk habitat is identified as a transitional area between winter and summer habitats, as well as summer habitat. Environmental resources associated with the Mill Creek Instream Reservoir project site include Mill Creek, adjacent wetlands, riparian habitat, and non-listed resident fish. Although Mill Creek is a tributary to Nason Creek, no ESA-Listed fish species currently use the upper reaches of this creek.

This project would require the construction of an instream impoundment resulting in a reservoir backwater within the creek channel and adjacent lands. The dam footprint would cover approximately 4.4 acres, and be placed across the existing creek channel and adjacent wetlands. The reservoir would cover another 43.5 acres, subsequently inundating the creek channel, adjacent wetlands, and floodplain/riparian habitat. Existing riparian and floodplain vegetation within the reservoir area would be inundated and killed. A fishway would be required to allow passage of resident fish species and bull trout, however due to the steep gradient of the creek at the proposed impoundment site the effectiveness of this fishway may be limited.

The construction of the reservoir would require the clearing of x-acres of forested habitat used by elk. Noise during construction also has the potential to disturb elk, however construction would occur during summer months and would not disturb winter elk migration, and likely can be conducted outside of the spring elk calving season (May 1 – June 30).

5.6.1.5 Costs

Table 5-36 summarizes the estimated costs of implementing the water storage project. Appendix D contains spreadsheets with more detailed information on quantities and costs estimated for the potential project.

Table 5-36
Estimated Implementation Cost
Mill Creek Water Storage Reservoir

Item	Cost
Estimated Construction Cost	$3,915,000
Contingency (30%)	$1,174,500
Engineering, permitting, construction mgmt (20%)	$783,000
Sales Tax (7.7%)	$301,455
Estimated Land Acquisition or Lease Costs	$528,150
Estimated Total Implementation Cost	**$6,703,000**

The total implementation cost is estimated to be $6.7M and $4,900 per acre-foot. The estimated Operations & Maintenance cost for the project is listed in Table 5-37. No power costs would be incurred.

Table 5-37
Operation & Maintenance Costs
Mill Creek Water Storage Reservoir

Item	Cost
Annual Operations & Maintenance Cost	$50,900
Power Cost	$0
Totals	**$50,900**

5.6.1.6 Implementation Issues

The Mill Creek Instream Reservoir storage project would impound Mill Creek resulting in impacts to wetlands and stream habitats. Impacts to wetlands through fill or flooding may require mitigation compensation through the Section 404 permitting mechanism. The extent of wetland impacts would drive the feasibility of the Section 404 permitting. Impacts resulting in greater than 0.10 acre of direct fill or flooding of wetlands would require an individual permit from the Corps, as opposed to the streamlined Nationwide Permit. Aquatic permits would also require BMPs to protect habitats during construction. Bull trout and resident fish use this reach of Mill Creek, and per state RCW 77.57.030 fish passage must be provided. This would be a requirement of the HPA permitting through WDFW, and as part of Section 7 ESA consultation with the Services.

The project site is located within National Forest Land allocated as Late Successional Reserve. Development, such as the construction of a reservoir is discouraged within this designation, however, development in LSR's may be permitted to go forward if the proposal address public needs or provide significant public benefits. Proposals would be reviewed on a case-by-case basis.

Obtaining aquatic permits for the Mill Creek Instream Reservoir storage project would be difficult. The feasibility of obtaining Section 404/401 permits would depend on the quantity of impacts to aquatic habitats and the impacts to resident and ESA-listed fish migration. As such, this project would likely require an individual Section 404 permit. Section 7 ESA-consultation and the HPA permit process would be problematic as the feasibility of constructing an effective fishway for bull trout and resident fish is reduced by the desired operation of the reservoir with large drawdowns during late summer. As this reservoir project is located within USFS-designated LSR obtaining a permit to develop a water storage facility would require rigorous coordination with the USFS.

Another issue that affects the feasibility will be the cost of $6.7M and $21,600 per acre-foot.

5.6.2 Permits Required for the Reservoir Site

The permits requirements described in Section 4 were reviewed and those permits required for the Mill Creek reservoir site. Table 5-38 provides a list of the permits required.

Table 5-38
Permits Required for Nason Sub-Watershed Water Storage Projects

	Federal Permits/Approvals				State Permits/Approvals							Chelan County		
Project Name	**Forest Service Special Use Permit**	**COE 404/ Sec. 10**	**Sec. 7 Consult. (BA)**	**NEPA**	**Dam Safety Permit**	**Sec. 401 Water Quality Cert.**	**Res. & Water Right Permit**	**HPA / JARPA**	**Sec. 106 Nat'l Historic Pres. Act**	**Aquatic Lease**	**NPDES**	**Shore-line Permits**	**SEPA**	**Critical Areas Ord.**
Mill Creek Instream Res..	√	√	√	√	√	√	√	√	√		√		√	√

6.0 Programmatic Recommendations

There are a number of smaller types of water storage projects or strategies that the Water Quantity Subcommittee wished to include in this report because of their potential benefit to the Wenatchee Watershed. The strategies are recommended to be listed in the Wenatchee Watershed Plan. Those strategies are described below.

6.1 Stream Channel Restoration

This strategy entails actions that restore habitat and riparian conditions to streams. It includes headcut repairs, placement of wood and gravel in streams to improve habitat, construction of off-channel rearing areas and planting to enhance riparian areas. A number of creeks were identified by the Water Quantity Subcommittee as needing headcut repairs. Those creeks include Peavine Canyon, Poison Canyon, Sand, Ruby, Lower Camas, Mill and Larsen Creeks. There likely are other creeks that would also benefit from this strategy. Channel migration zone projects that enhance off-channel or floodplain areas could also fall into this strategy. The stream channel restoration actions could increase bank storage and off-channel storage along streams and rivers while improving habitat and riparian conditions.

6.2 Small Water Storage Tanks for Fire Protection

This strategy entails placing 10,000 gallon water tanks in areas that are not served by a water system with fireflow capability. The tanks could be filled from nearby streams and left until needed. In discussions with Fire District 3 in the Leavenworth area, there were about 10 locations for water tanks identified that would greatly improve the Fire District's capability to fight fires. Fire District 6 would have a similar need. The need for additional water storage was identified in the Peshastin Creek Drainage Community Wildfire Protection Plan (CCCD, Sept 2005) and Leavenworth Area Community Wildfire Protection Plan (CCCD, December 2005).

6.3 Rainwater Capture

Rainwater capture is a strategy that can be used by residents to funnel snowmelt or rainfall off of the roof of their house and into a storage basin where it can be used for domestic or irrigation purposes. This strategy is becoming common in rural areas, especially where water supplies are very limited. For example, rainwater catchment systems have been installed in San Juan and Jefferson County in Washington State in areas with limited groundwater availability because of bedrock or sea water intrusion into the aquifer. The annual rainfall in those areas is also low, less than 24 inches.

There are a number of areas in the Wenatchee Watershed with groundwater availability problems because of their location in small bedrock underlain canyons with limited precipitation. It is recognized that it may be impractical to capture enough water to irrigate lawns or extensive landscaping however any roof runoff captured could supplement the production from a domestic well. Although the volume of water that can be captured in the Wenatchee Watershed seems limited, a 1000 square foot roof on a house in an area that receives 24 inches of precipitation per year could capture over 10,000 gallons of water annually. Most of the precipitation occurs in the winter, so a large volume of storage would be required to efficiently capture precipitation in this region. An article describing rain barrels is attached in Appendix F. An organization that promotes rainwater capture and has some articles on its use is the American Rainwater Catchment Systems Association which can be found at http://www.arcsa-usa.org/.

7.0 Ranking of Projects

Table 7-1 presents a summary of the costs and potential benefit in terms of water supply. The table does not include the project to optimize the operations of Snow Lakes as that project was not studied in this report. The most cost-effective projects are also the largest projects, such as the Mill Creek Instream Reservoir, Negro Creek Instream Reservoir and Little Camas Creek Reservoir. All three sites are instream reservoirs where the most efficient impoundments can be constructed as less excavation and backfill is needed per acre-foot of storage provided. The unit costs of those projects are from about $4,900 to $8,000 per acre-foot of storage. Although expensive in terms of total cost to implement, the unit costs for storage are consistent with the cost of providing new storage that we have seen elsewhere. The Snow Lakes optimization project is likely to cost much less per acre-foot as only retrofits to existing dams and outlet structures are required.

The three top ranked projects would provide a substantial instream flow benefit to the streams they release to. The Mill Creek project could provide about 19 cfs for a month to Nason Creek and the Wenatchee River, the Negro Creek project could provide about 6 cfs for a month to Negro Creek, Peshastin Creek and the Wenatchee River and the Little Camas Creek project could provide about 13 cfs for a month to Camas Creek, Mission Creek and the Wenatchee River.

The difficulty of permitting the three projects is extremely high, given they are located on federal land managed by the USFS and would require an extensive environmental review. The most difficult sites to permit would be the Negro Creek and Mill Creek sites because of USFS land allocations that restrict the types of developments permitted. All three sites would require a fishway; the design and operation of a fishway at the sites would be difficult because of fluctuating reservoir levels and the drawdown that is desired during late summer.

Projects located at existing lakes in the Chumstick and Mission Creek sub-watersheds, where some efficiency is gained by having an existing depression where lakes have formed, are estimated to cost about $16,000 to $25,000 per acre-foot of storage. The primary issues at these projects are the cost and permitting difficulty as they are located on federal land managed by the USFS with restrictions on development. They also provide a small benefit in terms of water supply (0.5 to 1.0 cfs per project for 30 days).

The Campbell Creek Reservoir would be located on private and federal land managed by the USFS and contain 500 acre-feet of storage. The cost of the project is very high ($9.8M and $19,500 per acre-foot of storage) and alternatives to an earth embankment dam should be reviewed for that site if further interest is expressed in the project. The permitting process will also be difficult because of the USFS land allocation the reservoir is located in.

The project to pump from the Wenatchee-Chiwawa Irrigation District canal to the Little Chumstick Sub-watershed would provide about 3 cfs to Little Chumstick Creek. That flow would considerably improve water supplies in the Little Chumstick Creek and Chumstick Creek valleys. It is not known whether the additional flow would cause the two creeks to have surface flow in late summer. The cost of the project is about $21,600 per acre-foot of water stored. There would likely be fewer permitting challenges to this project compared to the other water storage projects.

An analysis of smaller off-channel reservoirs in the Lower Wenatchee, Peshastin and Chumstick Sub-watersheds was performed. The off-channel reservoirs are more expensive than instream reservoirs because of the excavation and backfill required to construct the reservoir and embankment dam. The unit costs range from about $26,000 to $176,000 per acre-foot of storage provided. Assumptions were made in the analyses about the suitability of on-site materials so the cost estimates are probably conservative (high). Most of the off-channel reservoirs would have small benefits in terms of water supply. However even small increases in flow in small tributaries may provide significant benefits in terms of water supply and instream habitat. Siting and permitting off-channel reservoirs may be easier especially if private property is used for the project.

This study of water storage opportunities in the Wenatchee Watershed should be viewed as a reconnaissance-level or preliminary study. Much more detailed information is required to adequately assess the feasibility of any of the projects. Information required to determine the technical feasibility of the potential projects includes:

- Subsurface explorations to determine geotechnical engineering issues
- Additional streamflow measurements and gaging at the site of the reservoirs to determine the yield of the basins
- Topographic information to determine the size of the project facilities
- Environmental reviews to assess wetland and fisheries impacts
- Hydrologic modeling of basins to determine the effect the reservoirs will have on streamflow, both when capturing flow during spring and when releasing during late summer
- Public participation and input into new water storage projects to determine public acceptability
- Additional review of permitting requirements with USFS and other agencies. The opportunities that will be studied in the next phase of water storage assessments will likely be wholly or partially sited on land managed by the USFS. For a project to take place, a proponent would submit a proposal to the USFS. The USFS will follow agency regulations, including use of the NEPA process to evaluate the opportunities and alternatives to the proposed action.

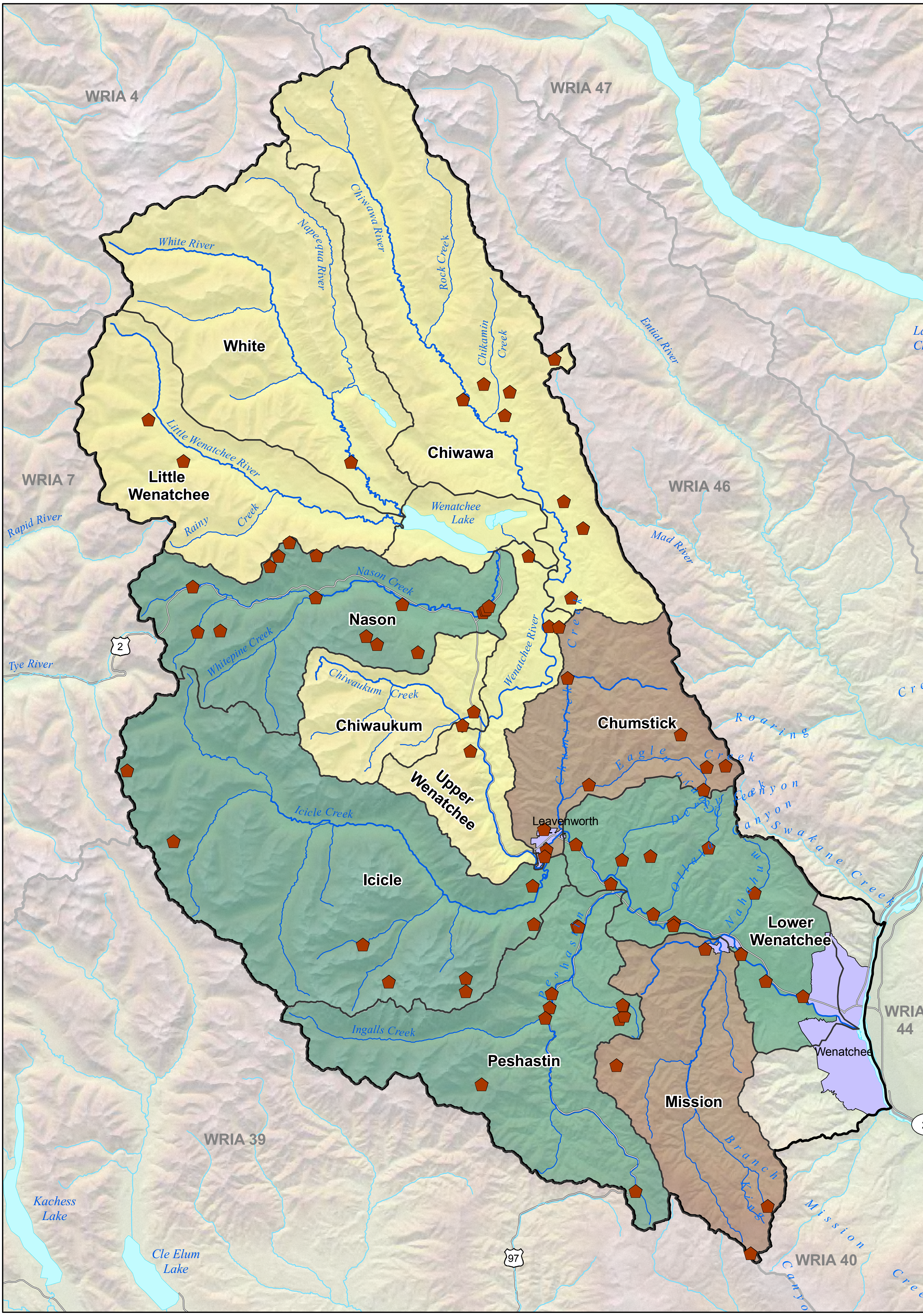
Respectfully submitted,
MONTGOMERY WATER GROUP, INC.

Bob Montgomery

Robert A. Montgomery, P.E.
Principal Engineer

Table 7-1
Summary and Ranking of Water Storage Projects by Cost per Acre-Foot
Excluding Icicle Lakes Optimization Project

Sub-basin	Project	Volume (Acre-feet)	Estimated Implementation Cost	Estimated Cost/Acre-ft	Water Storage Benefit in terms of cfs/30 days
Nason	Mill Creek Instream Reservoir	1,363	$ 6,703,000	$ 4,900	18.9
Peshastin	Negro Creek Instream Reservoir	437	$ 3,471,000	$ 7,900	5.9
Mission	Little Camas Creek Reservoir	926	$ 7,443,000	$ 8,000	12.9
Chumstick	SW Eagle Creek Tributary Lakes	54	$ 860,000	$ 15,800	0.6
Chumstick	Eagle Creek Tributary Lakes	79	$ 1,263,000	$ 16,000	1.0
Peshastin	Campbell Creek Off-Channel Reservoir	504	$ 9,800,000	$ 19,500	7.1
Upper Wenatchee	Upper Wenatchee to Chumstick	210	$ 4,518,000	$ 21,600	3.2
Mission	Upper Reach Mission Creek Lakes	51	$ 1,259,000	$ 24,700	0.5
Lower Wenatchee	Nahahum Canyon Off-Channel Reservoir	165	$ 4,226,000	$ 25,600	2.3
Peshastin	Ingalls Creek Off-Channel Reservoir	258	$ 6,645,000	$ 25,700	3.5
Chumstick	East Van Creek Off-Channel Reservoir	99	$ 3,026,000	$ 30,700	1.3
Peshastin	Tronsen Creek Off-Channel Reservoir	175	$ 8,629,000	$ 49,400	2.4
Mission	East Fork Mission Creek Reservoir	95	$ 5,494,000	$ 58,000	1.2
Lower Wenatchee	Williams Canyon Off-Channel Reservoir	68	$ 4,980,000	$ 73,400	0.9
Lower Wenatchee	Derby Canyon Off-Channel Reservoir	17	$ 1,824,000	$106,400	0.2
	Typical 5 Acre-ft Reservoir	5	$ 633,000	$126,600	0.07
Lower Wenatchee	Ollala Canyon Off-Channel Reservoir	9	$ 1,614,000	$176,200	0.1



LEGEND

- Water Storage Opportunity Step A Assessment
- WRIA 45 Boundary
- WRIA Boundary
- Sub-Watershed Boundary
- Major Road
- Waterbody
- Watercourse
- Urban Area

0 10,000

Scale in Feet

Map Projection: Washington State Plane, North Zone, NAD 83, Feet

Source: Chelan County Conservation District, Chelan County Department of Natural Resources, Normandeau, USFS, USGS, WDFW, WSDOT, WSDOE

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Distribution of Water Storage Opportunities

Drawn: BGF	Revison: 2	Date: 3-6-06	Figure: 3-1

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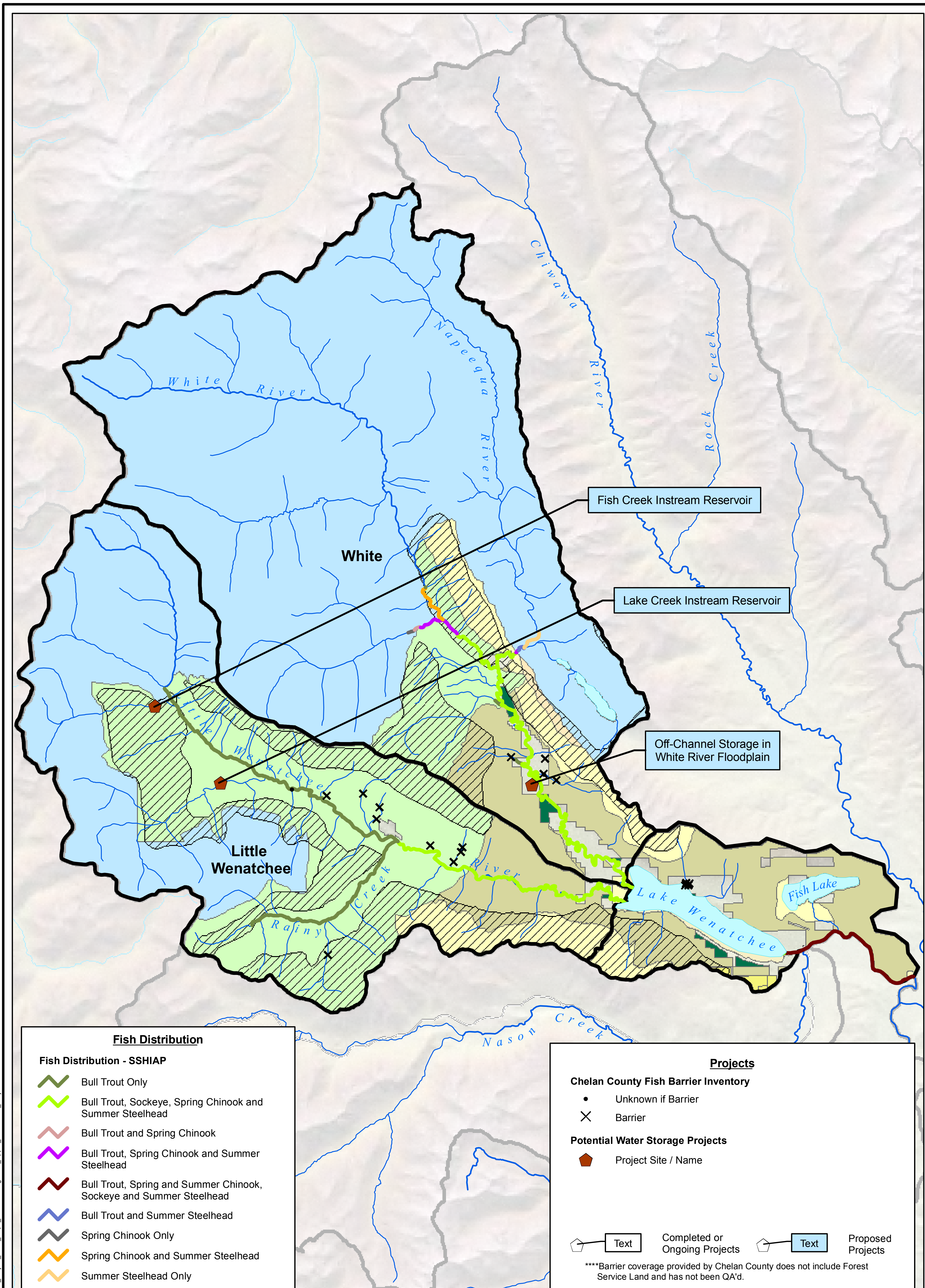
GIS\Source Data\Montgomery Group\GIS\MXDs\JS Project Base Maps 20051014\Figure2 Lower Wenatchee Projects.mxd



Map Projection: Washington State Plane, North Zone, NAD 83, Feet

Source: Chelan County Conservation District, Chelan County Department of Natural Resources, Normandeau, USFS, USGS, WDFW, WSDOT, WSDOE

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Upper Watershed (Lake Wenatchee, White, and Little Wenatchee sub-watersheds): Potential Water Storage Projects

Chelan/WRIA 45 Watershed Plan/WA

Drawn: BGF	Revison: 2	Date: 3-6-06	Figure: 3-10

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MONTGOMERY WATER GROUP, INC.

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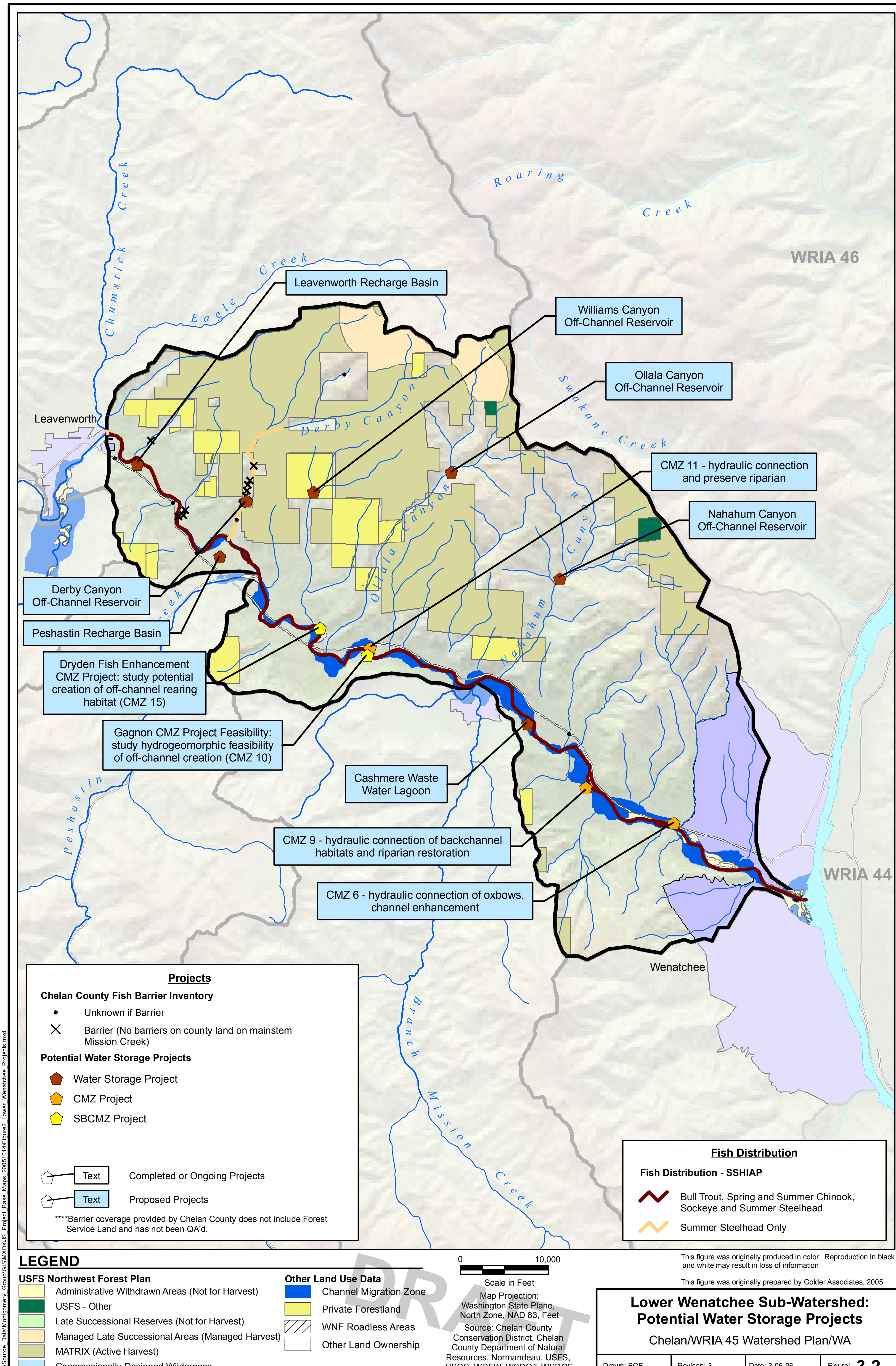

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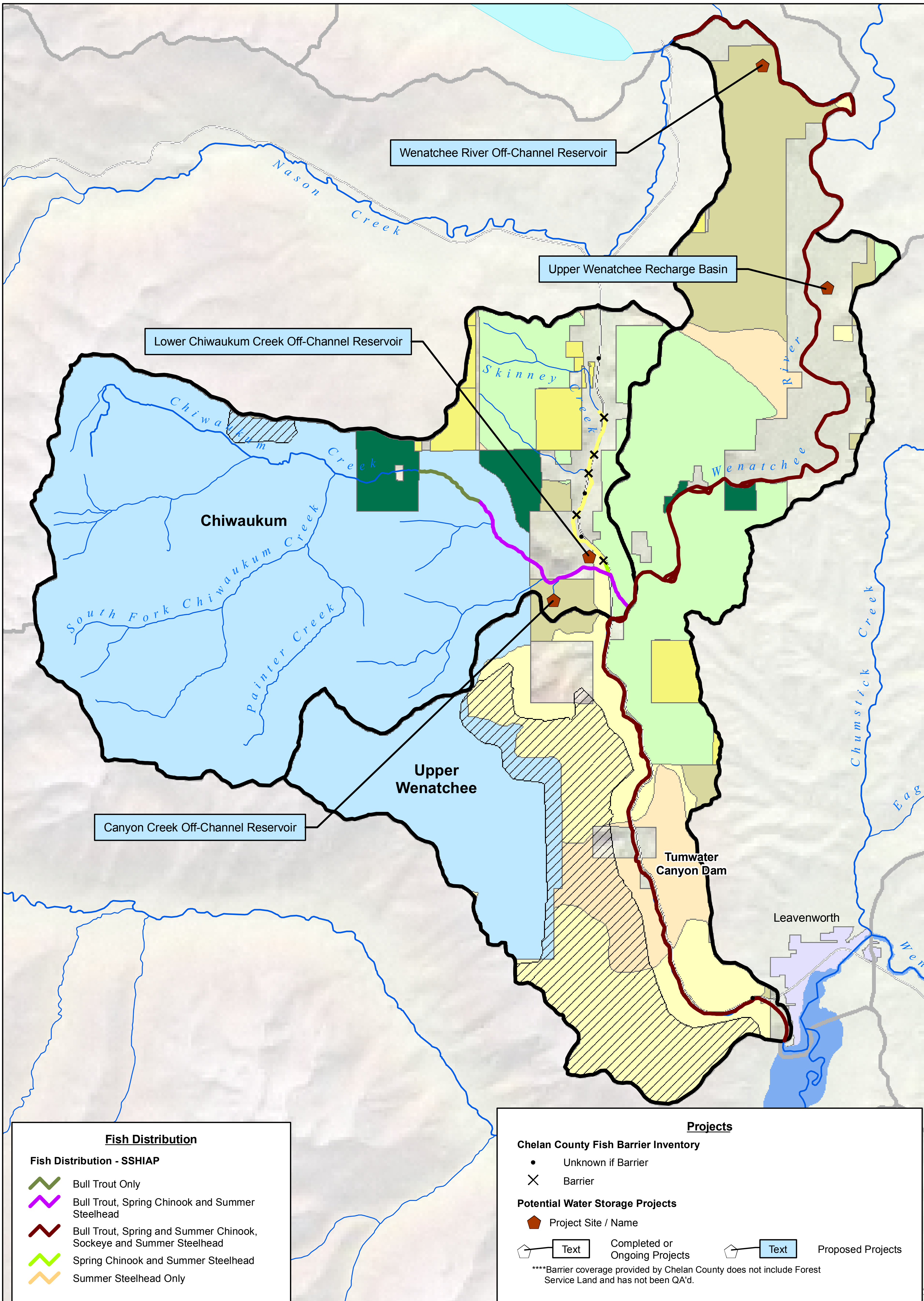

LEGEND

USFS Northwest Forest Plan
- Administrative Withdrawn Areas (Not for Harvest)
- USFS - Other
- Late Successional Reserves (Not for Harvest)
- Managed Late Successional Areas (Managed Harvest)
- MATRIX (Active Harvest)
- Congressionally Designed Wilderness

Other Land Use Data
- Channel Migration Zone
- Private Forestland
- WNF Roadless Areas
- Other Land Ownership

0 1.5
Scale in Miles

Map Projection: Washington State Plane, North Zone, NAD 83, Feet

Source: Chelan County Conservation District, Chelan County Department of Natural Resources, Normandeau, USFS, USGS, WDFW, WSDOT, WSDOE

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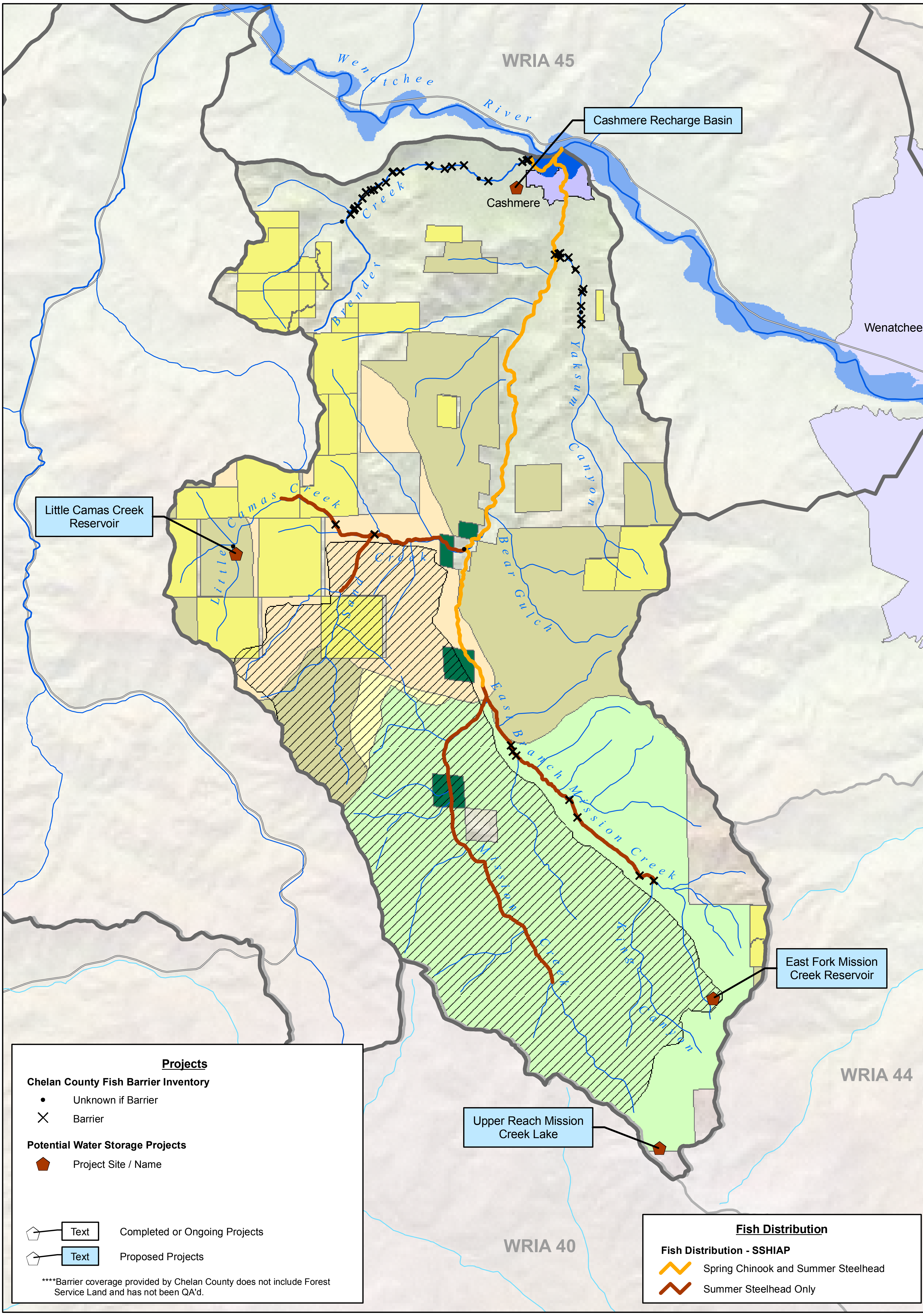
Upper Wenatchee and Chiwaukum Sub-Watershed: Potential Water Storage Projects
Chelan/WRIA 45 Watershed Plan/WA

Drawn: BGF	Revison: 3	Date: 3-6-06	Figure: **3-3**



LEGEND

USFS Northwest Forest Plan

- Administrative Withdrawn Areas (Not for Harvest)
- USFS - Other
- Late Successional Reserves (Not for Harvest)
- Managed Late Successional Areas (Managed Harvest)
- MATRIX (Active Harvest)
- Congressionally Designed Wilderness

Other Land Use Data

- Channel Migration Zone
- Private Forestland
- WNF Roadless Areas
- Other Land Ownership

0 1.5

Scale in Miles

Map Projection: Washington State Plane, North Zone, NAD 83, Feet

Source: Chelan County Conservation District, Chelan County Department of Natural Resources, Normandeau, USFS, USGS, WDFW, WSDOT, WSDOE

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Mission Sub-Watershed: Potential Water Storage Projects

Chelan/WRIA 45 Watershed Plan/WA

Drawn: BGF	Revison: 3	Date: 3-6-06	Figure: 3-4

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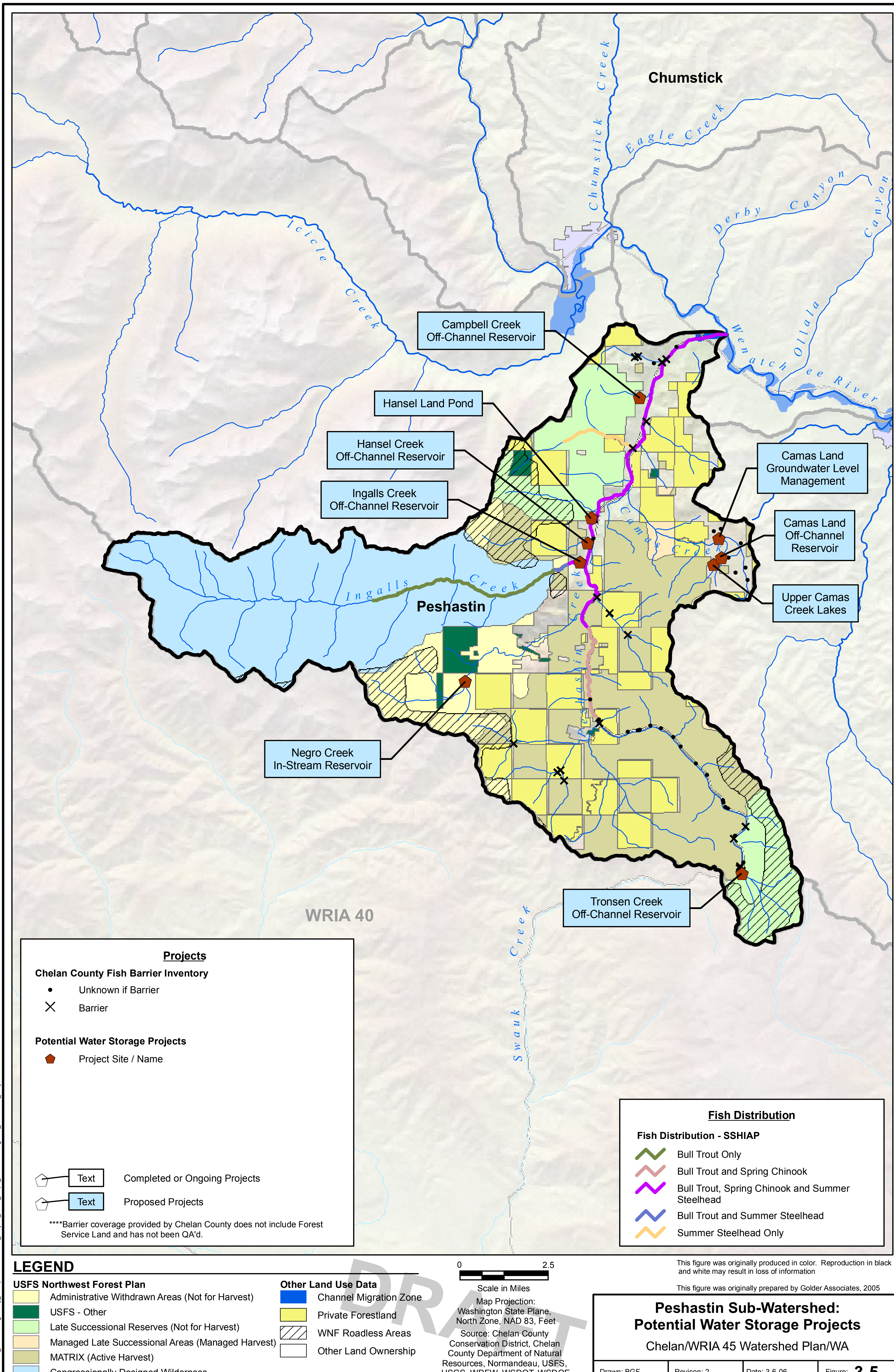
Chumstick
Chumstick Creek
Eagle Creek
Derby Canyon
Canyon
Icicle Creek
Wenatchee River
Ollala
Campbell Creek Off-Channel Reservoir
Hansel Land Pond
Hansel Creek Off-Channel Reservoir
Ingalls Creek Off-Channel Reservoir
Camas Land Groundwater Level Management
Camas Land Off-Channel Reservoir
Upper Camas Creek Lakes
Camas Creek
Ingalls Creek
Peshastin
Peshastin Creek
Negro Creek In-Stream Reservoir
Tronsen Creek Off-Channel Reservoir
WRIA 40
Swauk Creek
Projects
Chelan County Fish Barrier Inventory
Unknown if Barrier
Barrier
Potential Water Storage Projects
Project Site / Name
Text
Completed or Ongoing Projects
Text
Proposed Projects
****Barrier coverage provided by Chelan County does not include Forest Service Land and has not been QA'd.
Fish Distribution
Fish Distribution - SSHIAP
Bull Trout Only
Bull Trout and Spring Chinook
Bull Trout, Spring Chinook and Summer Steelhead
Bull Trout and Summer Steelhead
Summer Steelhead Only
LEGEND
USFS Northwest Forest Plan
Administrative Withdrawn Areas (Not for Harvest)
USFS - Other
Late Successional Reserves (Not for Harvest)
Managed Late Successional Areas (Managed Harvest)
MATRIX (Active Harvest)
Congressionally Designed Wilderness
Other Land Use Data
Channel Migration Zone
Private Forestland
WNF Roadless Areas
Other Land Ownership
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2.5
Scale in Miles
Map Projection: Washington State Plane, North Zone, NAD 83, Feet
Source: Chelan County Conservation District, Chelan County Department of Natural Resources, Normandeau, USFS, USGS, WDFW, WSDOT, WSDOE
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Peshastin Sub-Watershed:
Potential Water Storage Projects
Chelan/WRIA 45 Watershed Plan/WA
Drawn: BGF
Revison: 2
Date: 3-6-06
Figure: 3-5
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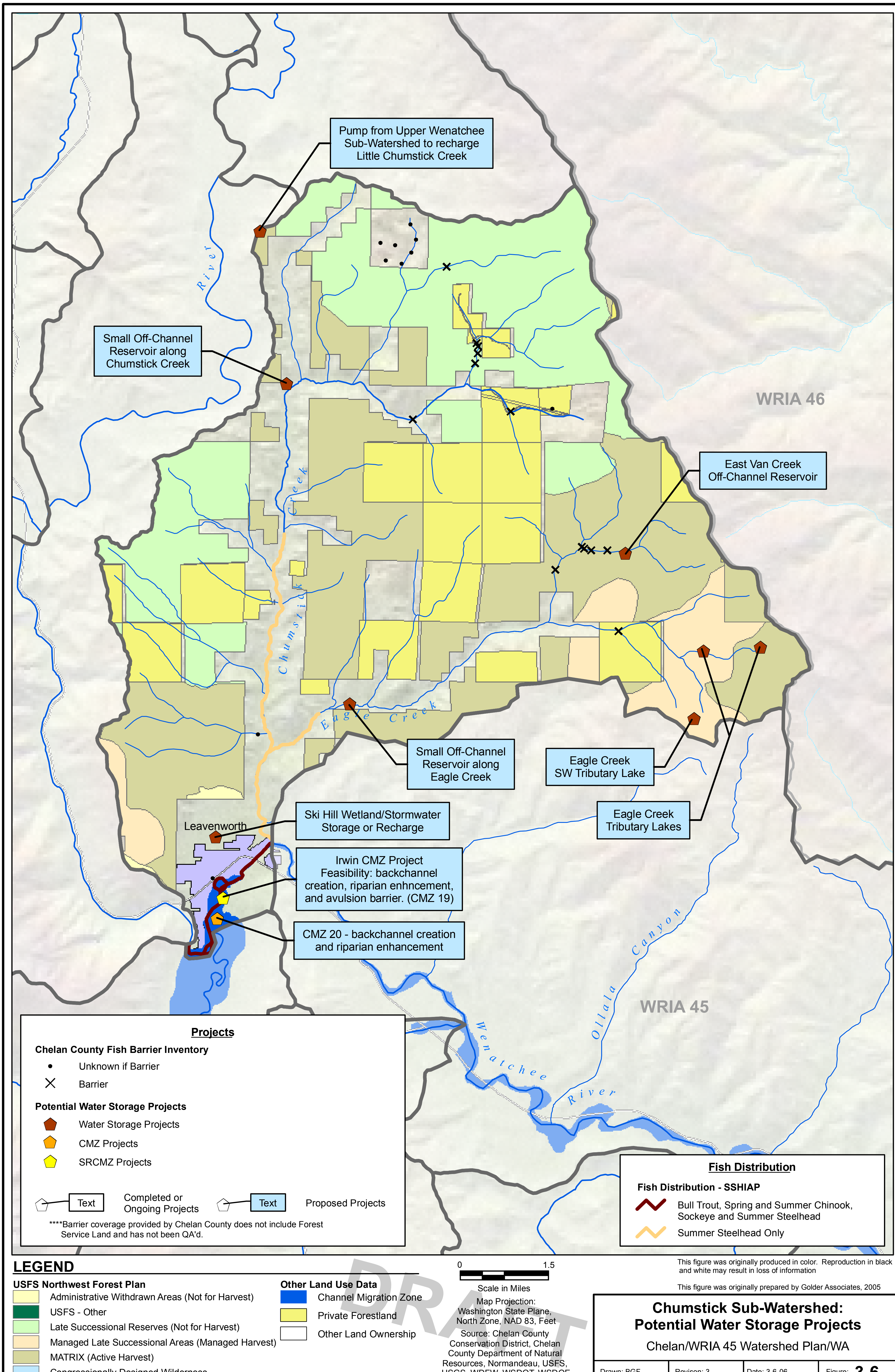

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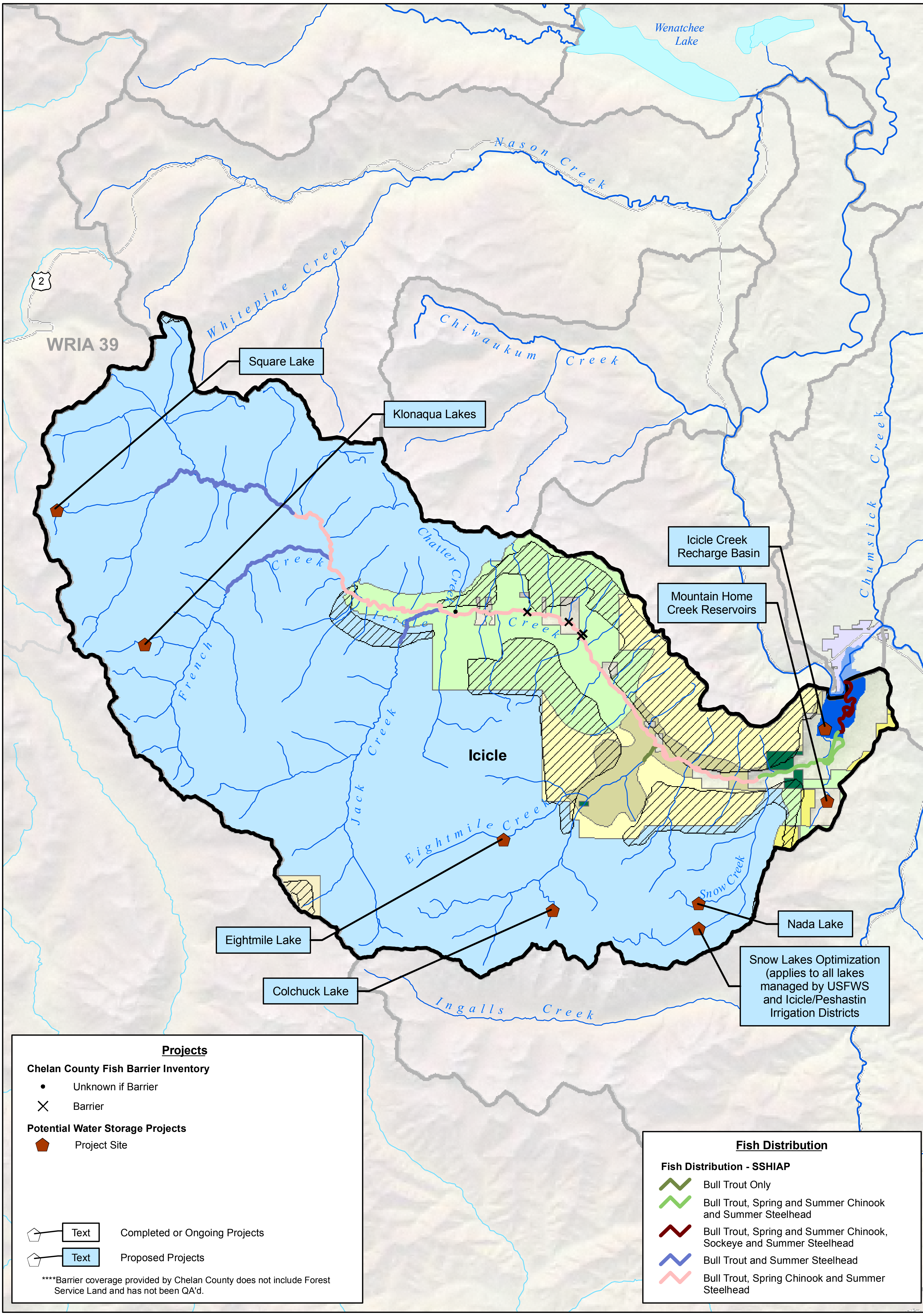

LEGEND

USFS Northwest Forest Plan
- Administrative Withdrawn Areas (Not for Harvest)
- USFS - Other
- Late Successional Reserves (Not for Harvest)
- Managed Late Successional Areas (Managed Harvest)
- MATRIX (Active Harvest)
- Congressionally Designed Wilderness

Other Land Use Data
- Channel Migration Zone
- Private Forestland
- WNF Roadless Areas
- Other Land Ownership

0 1.5
Scale in Miles

Map Projection: Washington State Plane, North Zone, NAD 83, Feet

Source: Chelan County Conservation District, Chelan County Department of Natural Resources, Normandeau, USFS, USGS, WDFW, WSDOT, WSDOE

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Icicle Sub-Watershed: Potential Water Storage Projects

Chelan/WRIA 45 Watershed Plan/WA

Drawn: BGF	Revison: 3	Date: 3-6-06	Figure: 3-7

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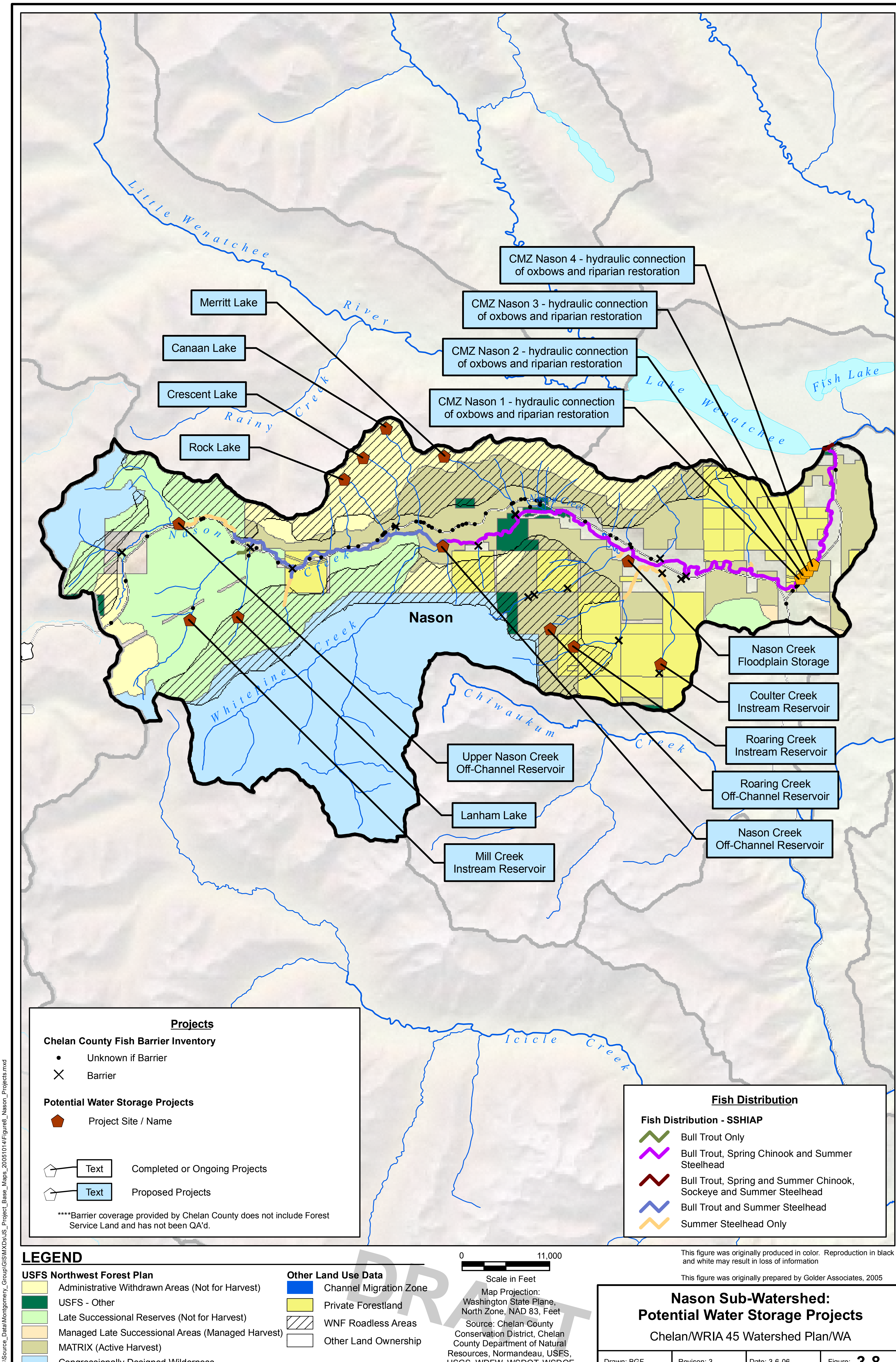

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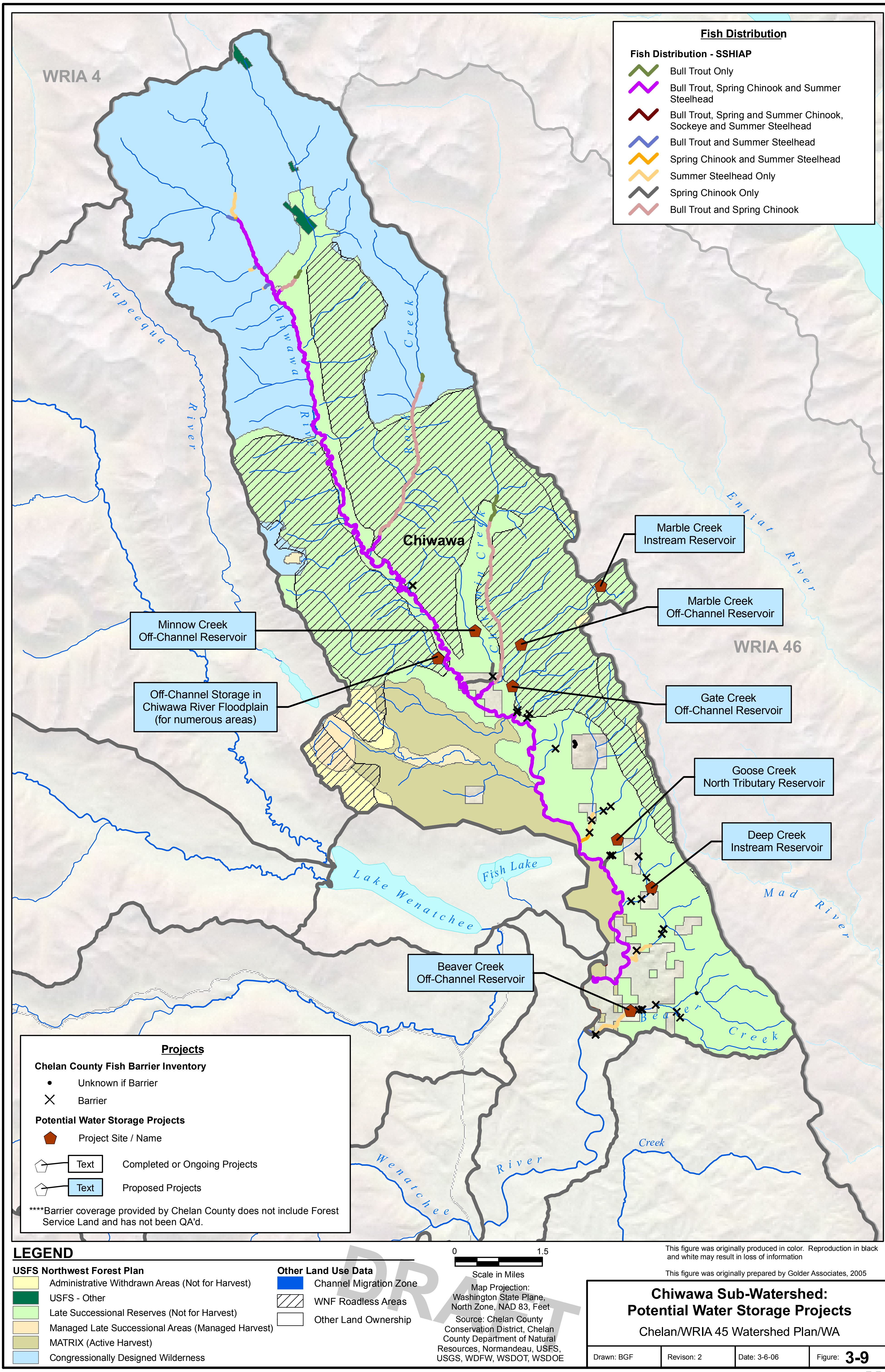

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Chiwawa Sub-Watershed: Potential Water Storage Projects

Chelan/WRIA 45 Watershed Plan/WA

Drawn: BGF	Revison: 2	Date: 3-6-06	Figure: 3-9

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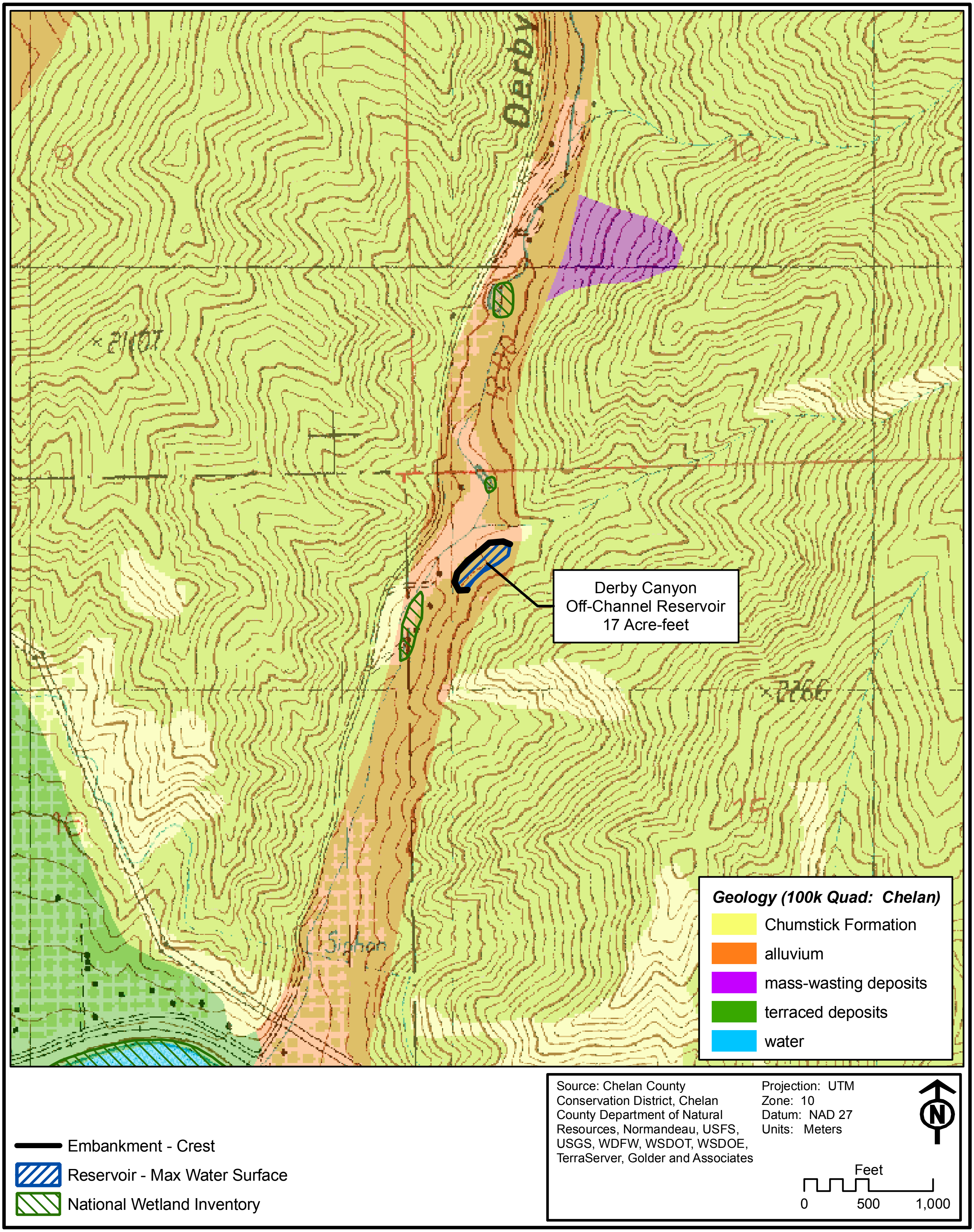

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Figure 5-1. Lower Wenatchee Sub-Watershed: Potential Water Storage Projects

Derby Canyon Off-Channel Reservoir

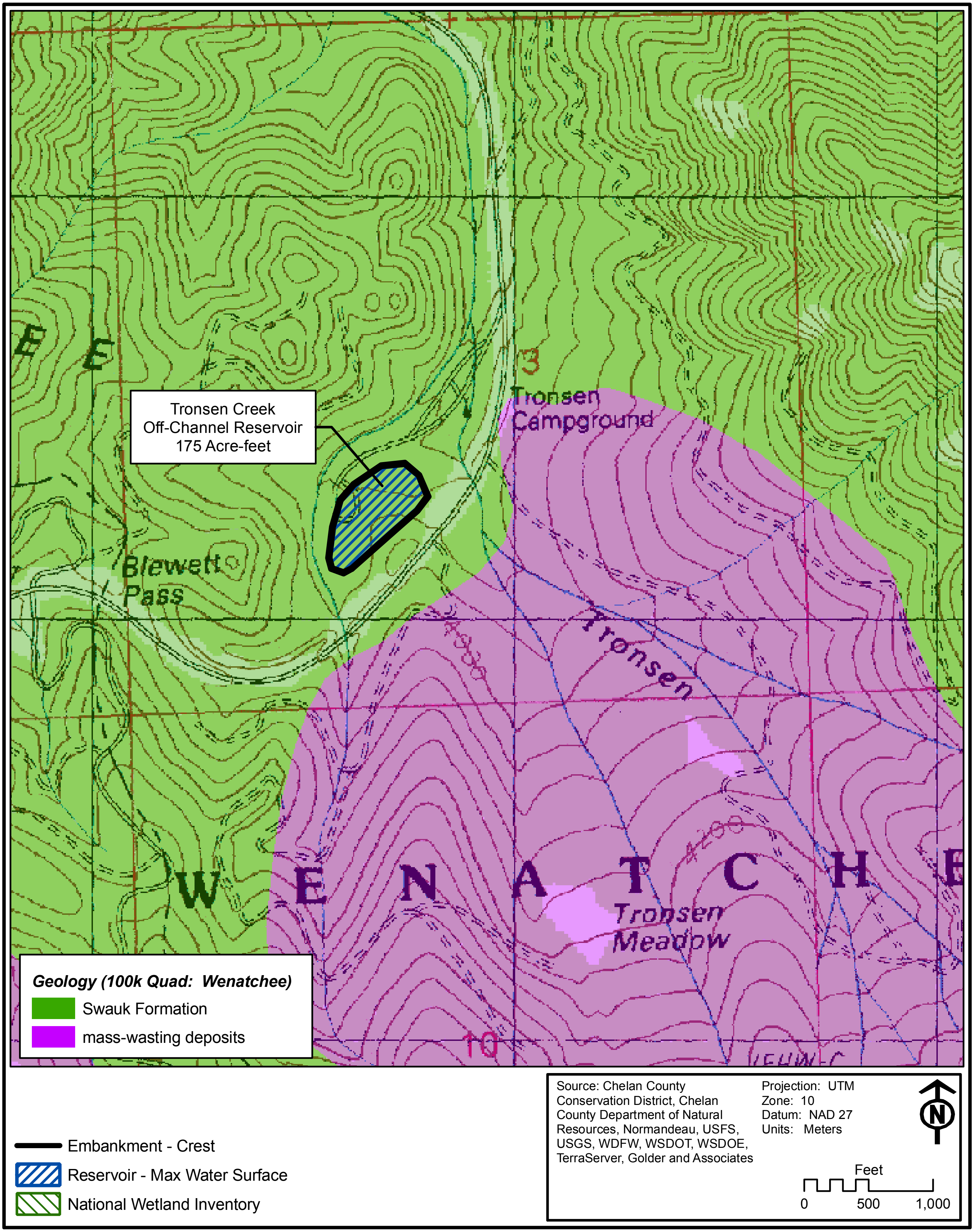

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Figure 5-10. Peshastin Sub-Watershed: Potential Water Storage Projects

Tronsen Creek Off-Channel Reservoir

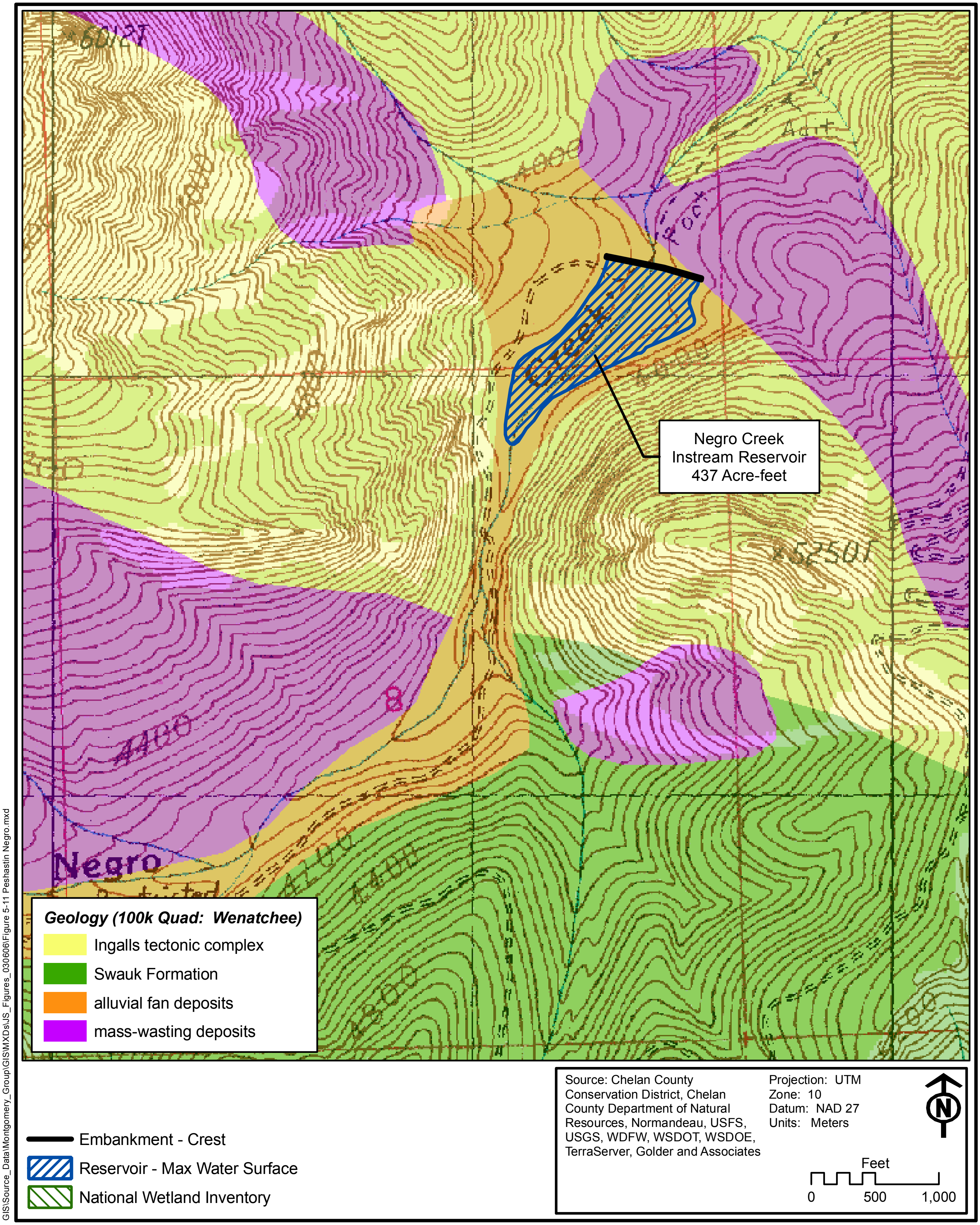

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Figure 5-11. Peshastin Sub-Watershed: Potential Water Storage Projects

Negro Creek Instream Reservoir

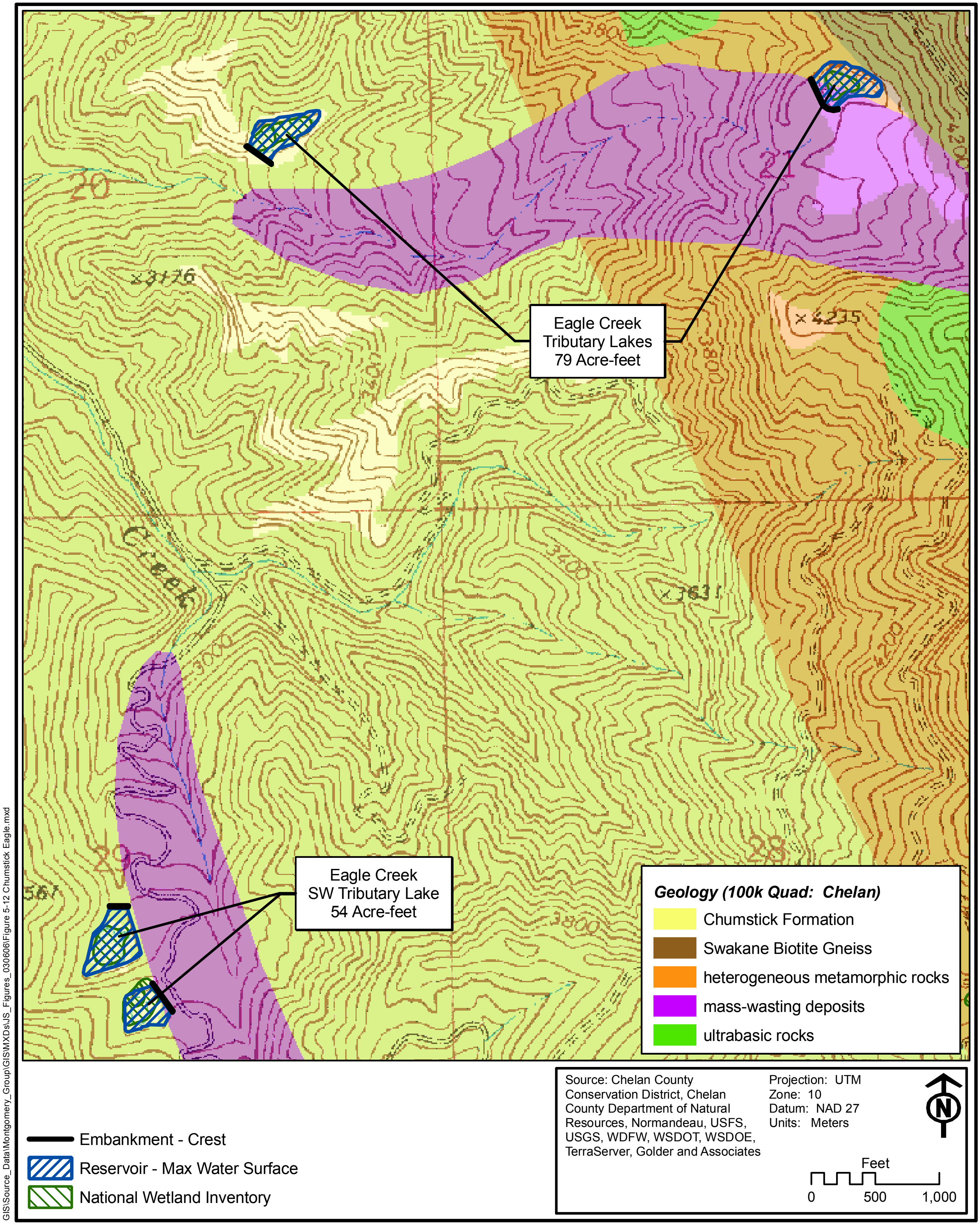

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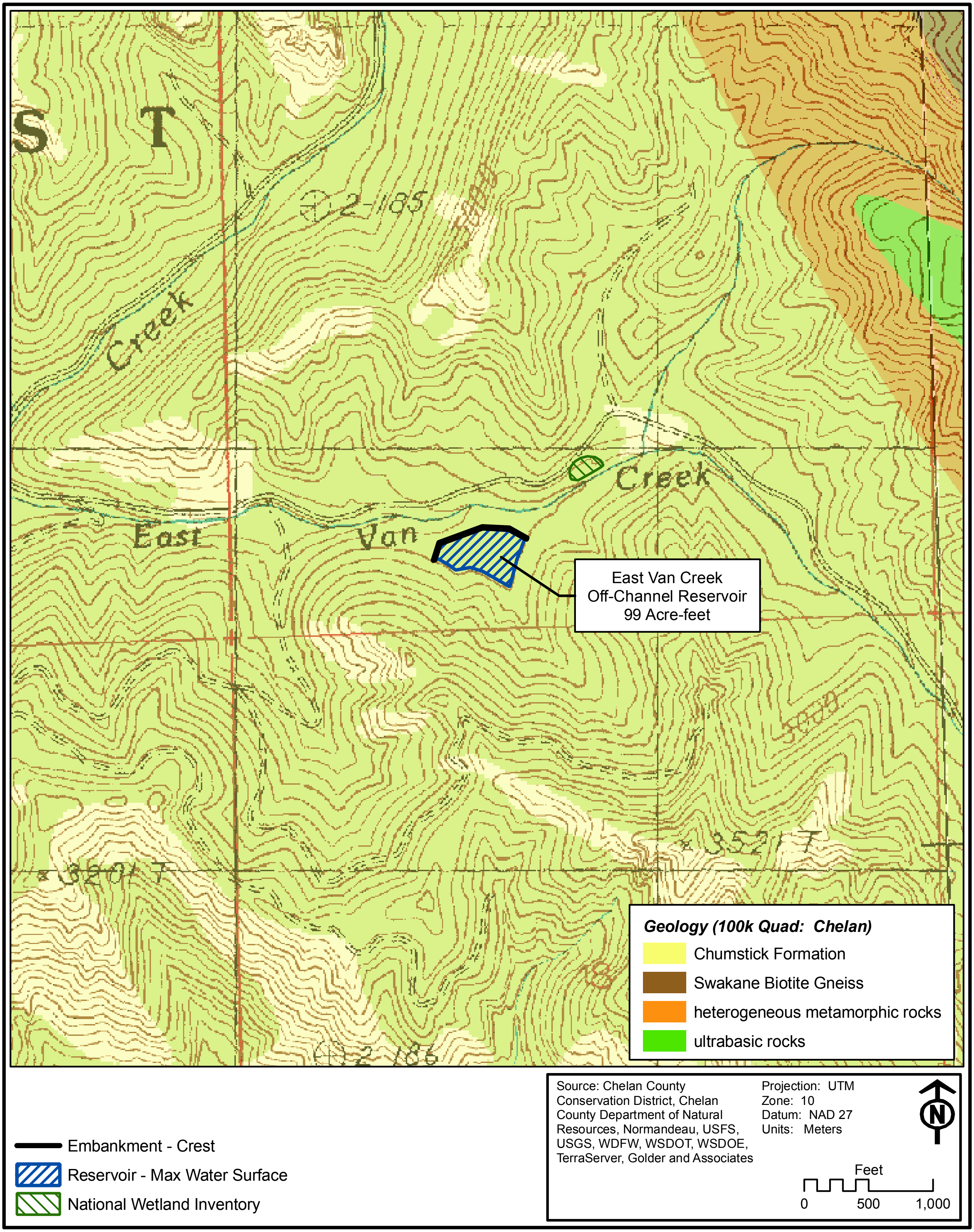
Figure 5-12. Chumstick Sub-Watershed: Potential Water Storage Projects

Eagle Creek Tributary Lakes



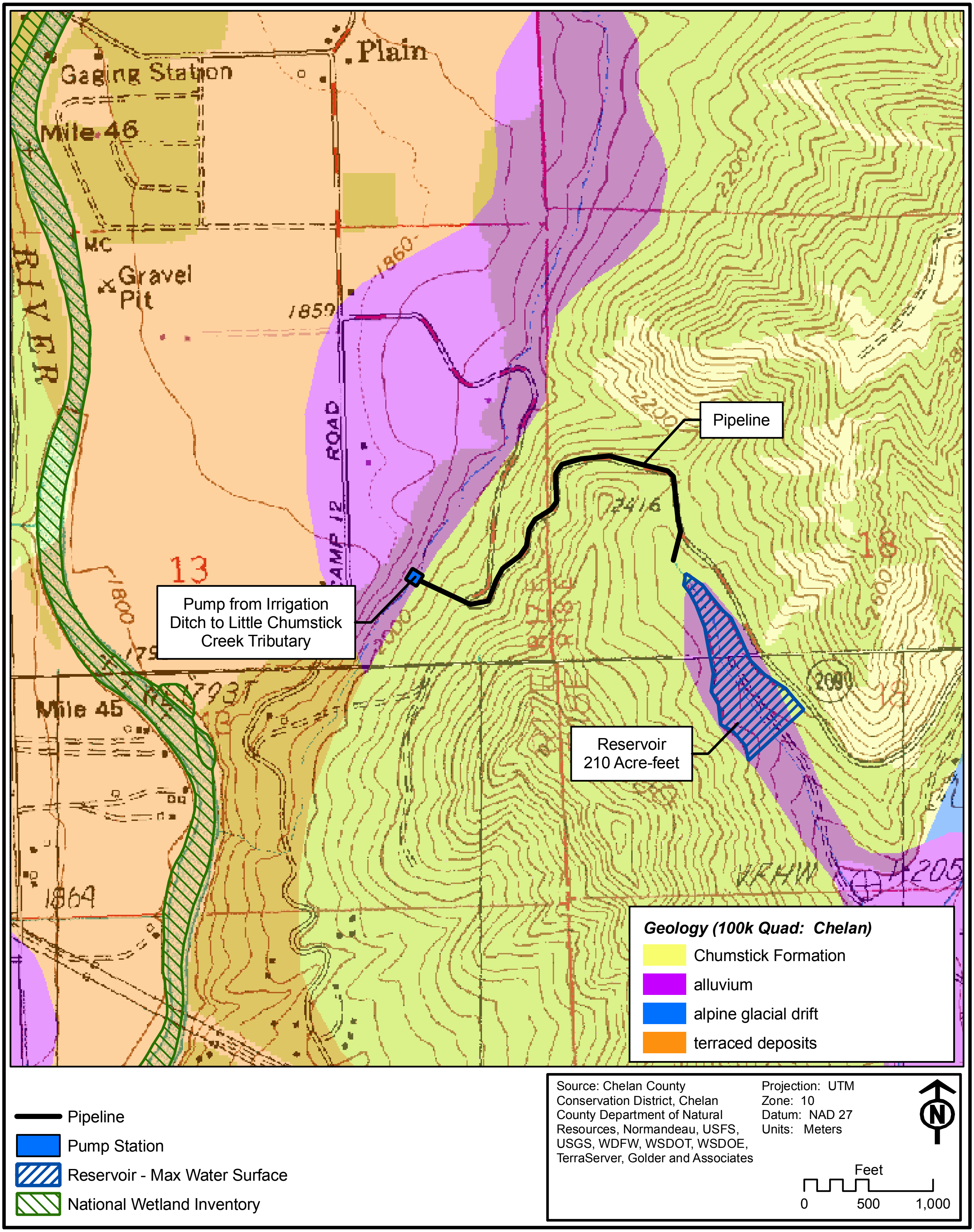
GIS\Source_Data\Montgomery_Group\GIS\MXDs\US_Figures_030606\Figure 5-13 Chumstick East.mxd

MONTGOMERY WATER GROUP, INC.

Jones & Stokes

Figure 5-13. Chumstick Sub-Watershed: Potential Water Storage Projects

East Van Creek Off-Channel Reservoir



GIS\Source_Data\Montgomery_Group\GIS\MXDs\US_Figures_030606\Figure 5-14 Chumstick Pump UW LCC.mxd

MONTGOMERY WATER GROUP, INC.

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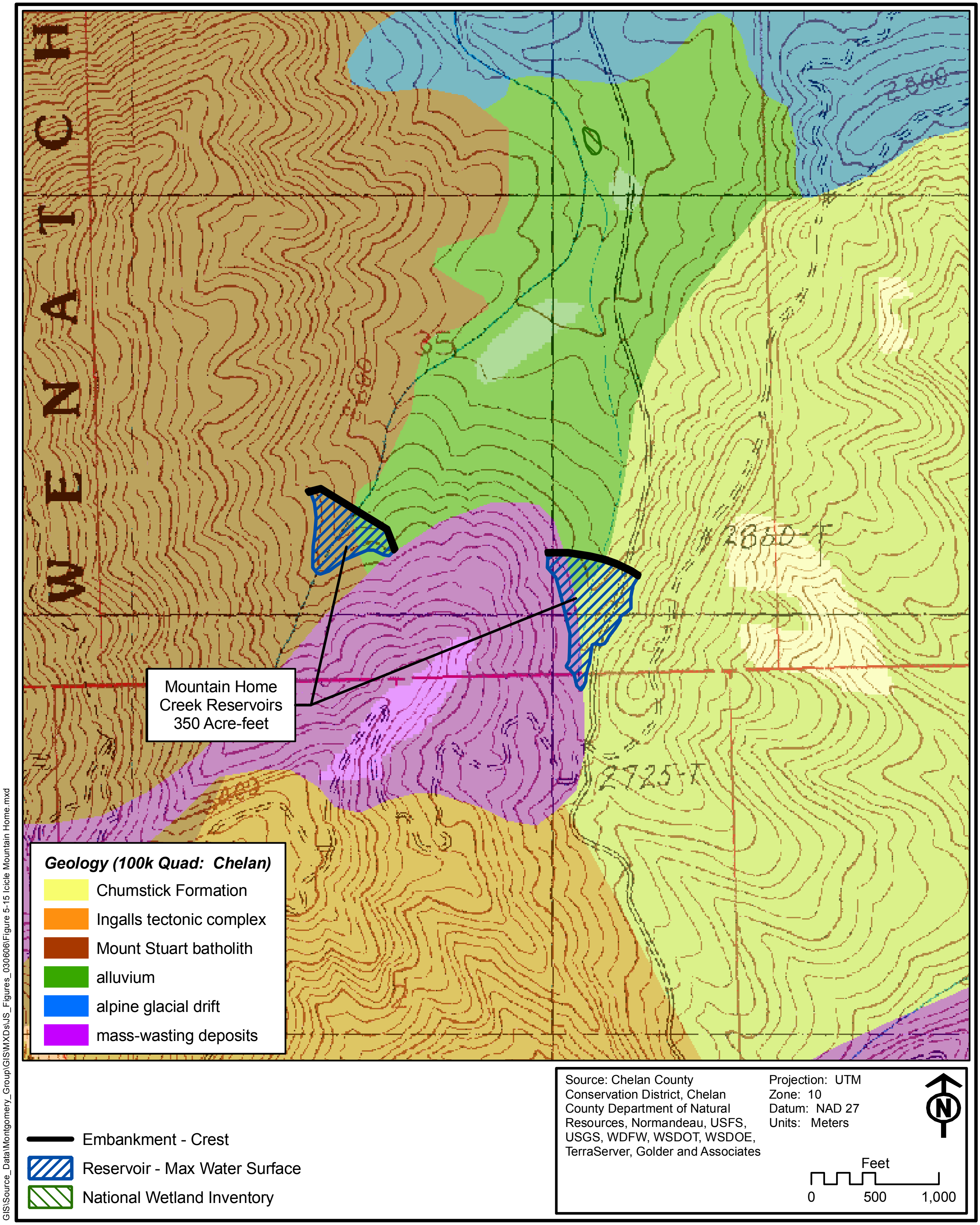
Figure 5-14. Chumstick Sub-Watershed: Potential Water Storage Projects

Pump from Upper Wenatchee into Little Chumstick Creek



MONTGOMERY WATER GROUP, INC.

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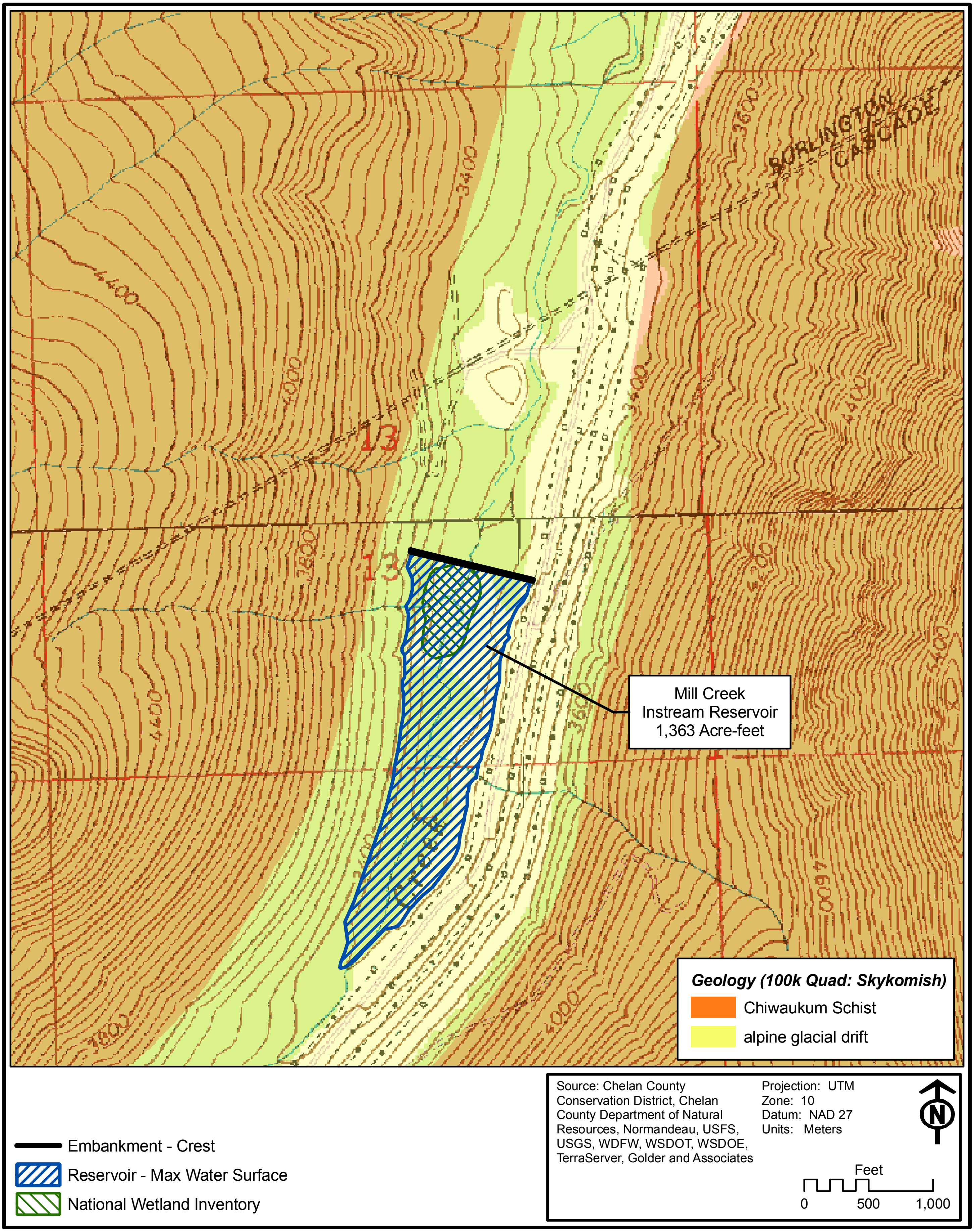
Figure 5-15. Icicle Sub-Watershed: Potential Water Storage Projects

Mountain Home Creek Reservoirs



GIS\Source_Data\Montgomery_Group\GIS\MXDs\US_Figures_030606\Figure 5-16 Nason Mill.mxd

MONTGOMERY WATER GROUP, INC.

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Figure 5-16. Nason Sub-Watershed: Potential Water Storage Projects

Mill Creek Instream Reservoir

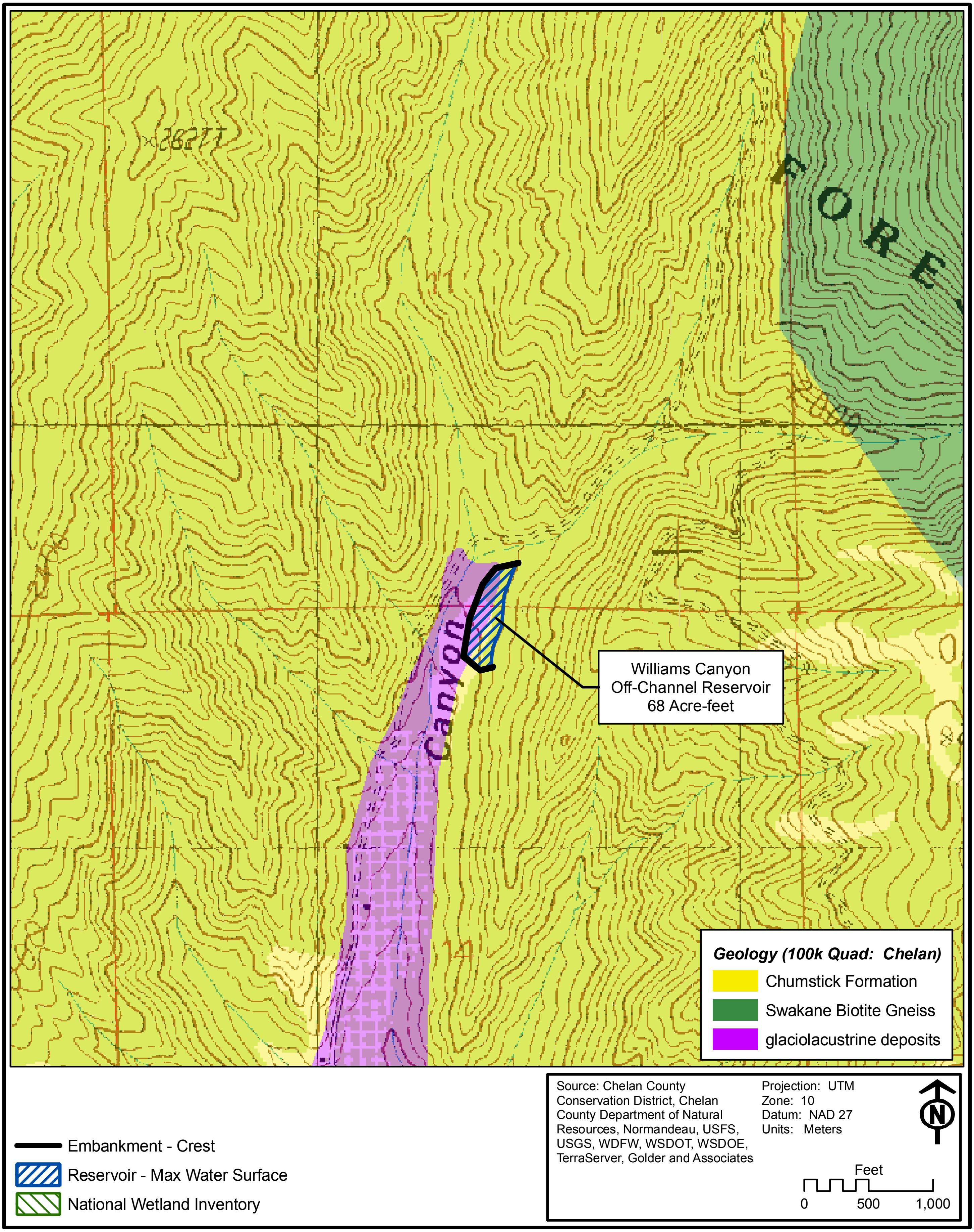

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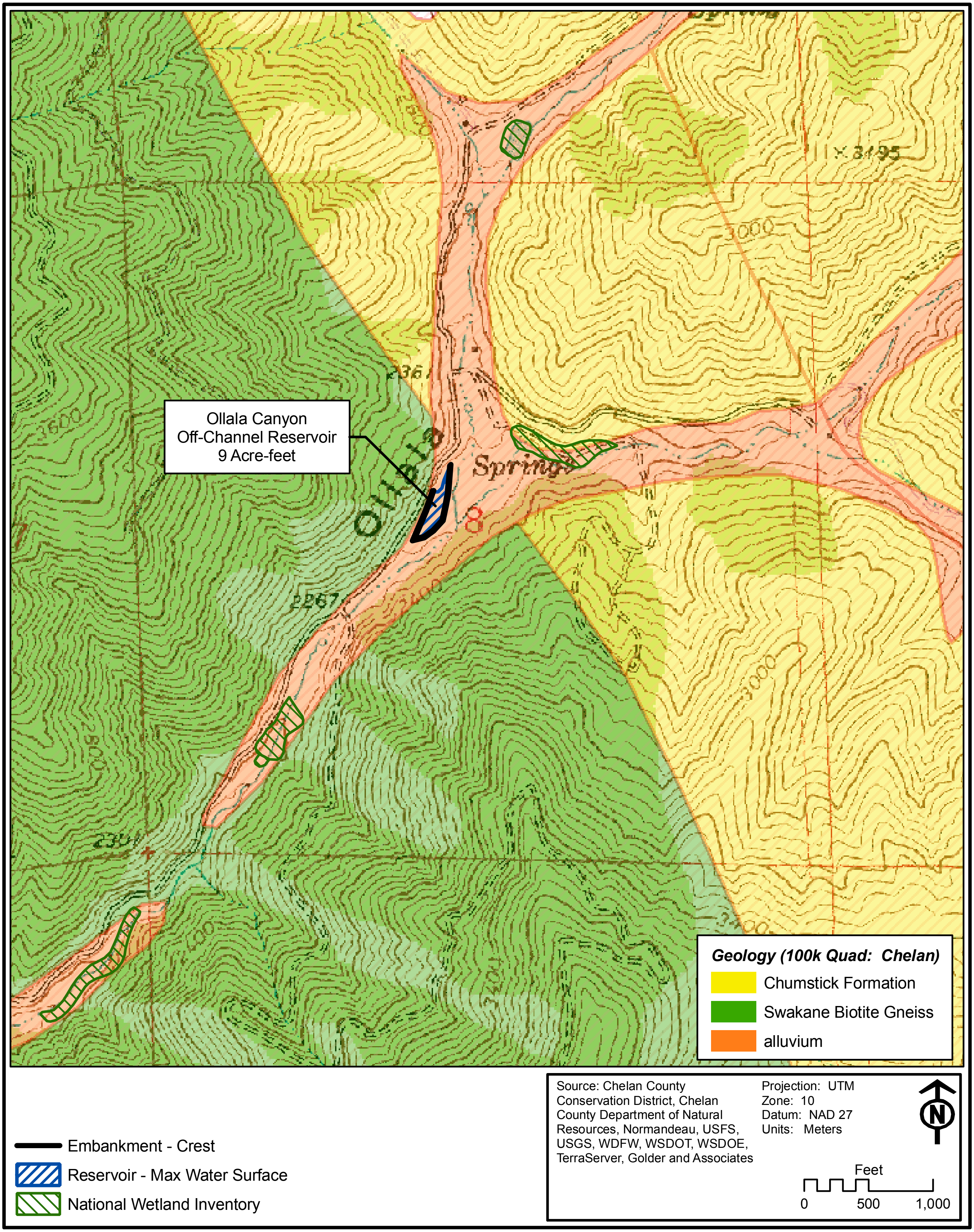
Figure 5-2. Lower Wenatchee Sub-Watershed: Potential Water Storage Projects

Williams Canyon Off-Channel Reservoir



GIS\Source_Data\Montgomery_Group\GIS\MXDs\JS_Figures_030606\Figure 5-3 Lower Wenatchee Ollala.mxd

MONTGOMERY WATER GROUP, INC.

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Figure 5-3. Lower Wenatchee Sub-Watershed: Potential Water Storage Projects

Ollala Canyon Off-Channel Reservoir

GIS\Source_Data\Montgomery_Group\GIS\MXDs\US_Figures_030606\Figure 5-4 Lower Wenatchee Nahahum.mxd

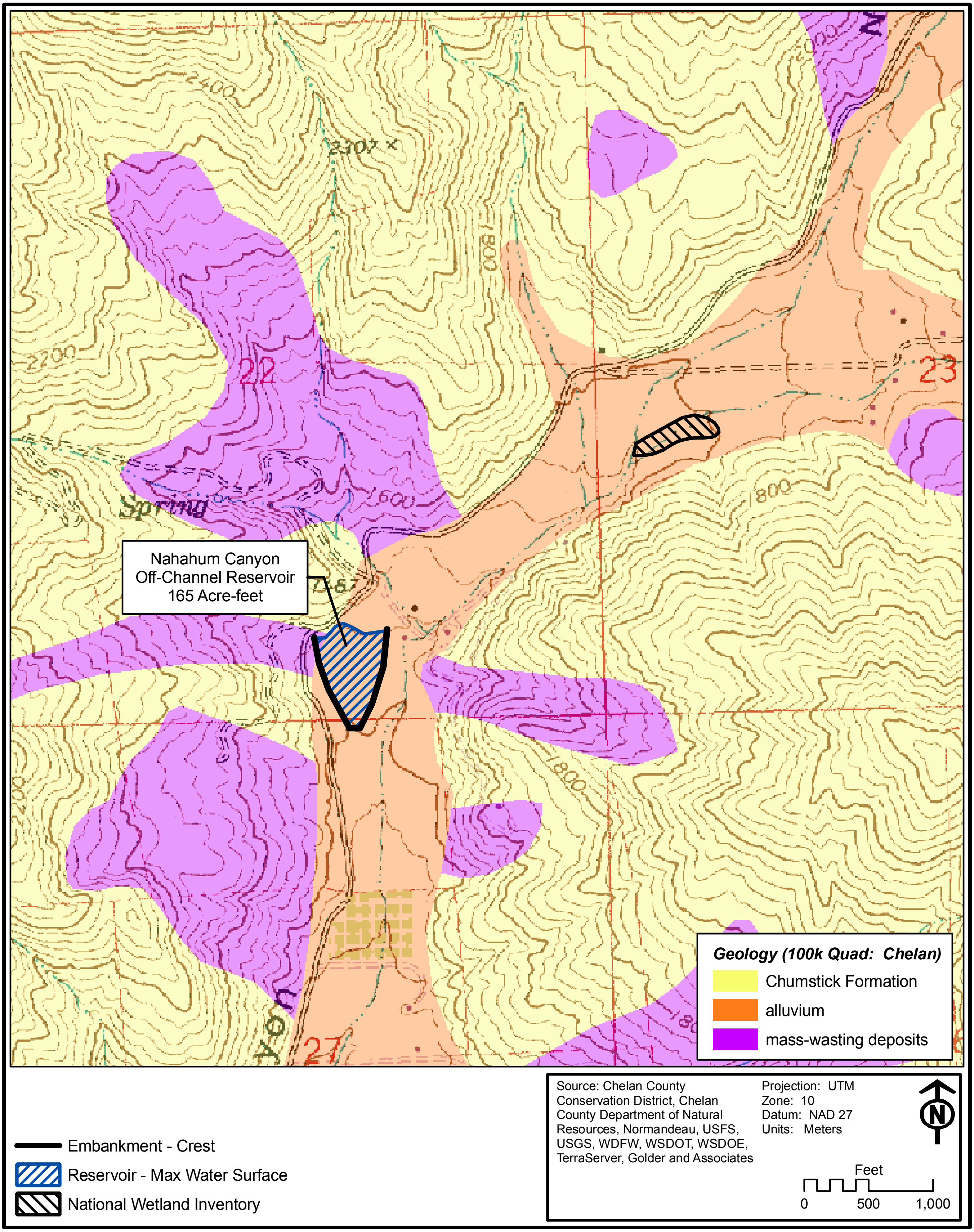

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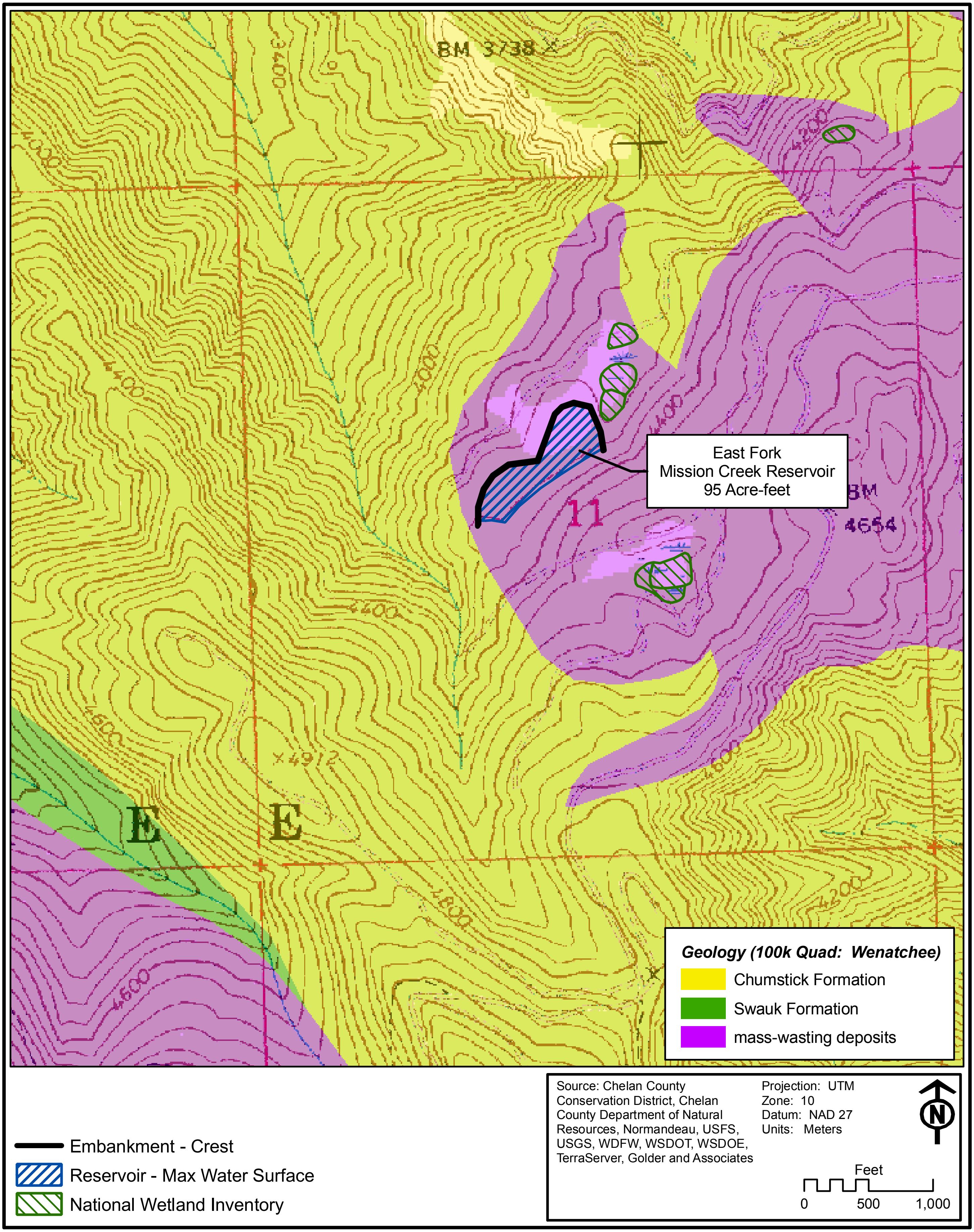
Figure 5-4. Lower Wenatchee Sub-Watershed: Potential Water Storage Projects

Nahahum Canyon Off-Channel Reservoir



GIS\Source_Data\Montgomery_Group\GIS\MXDs\US_Figures_030606\Figure 5-5 Mission East Fork.mxd

MONTGOMERY WATER GROUP, INC.

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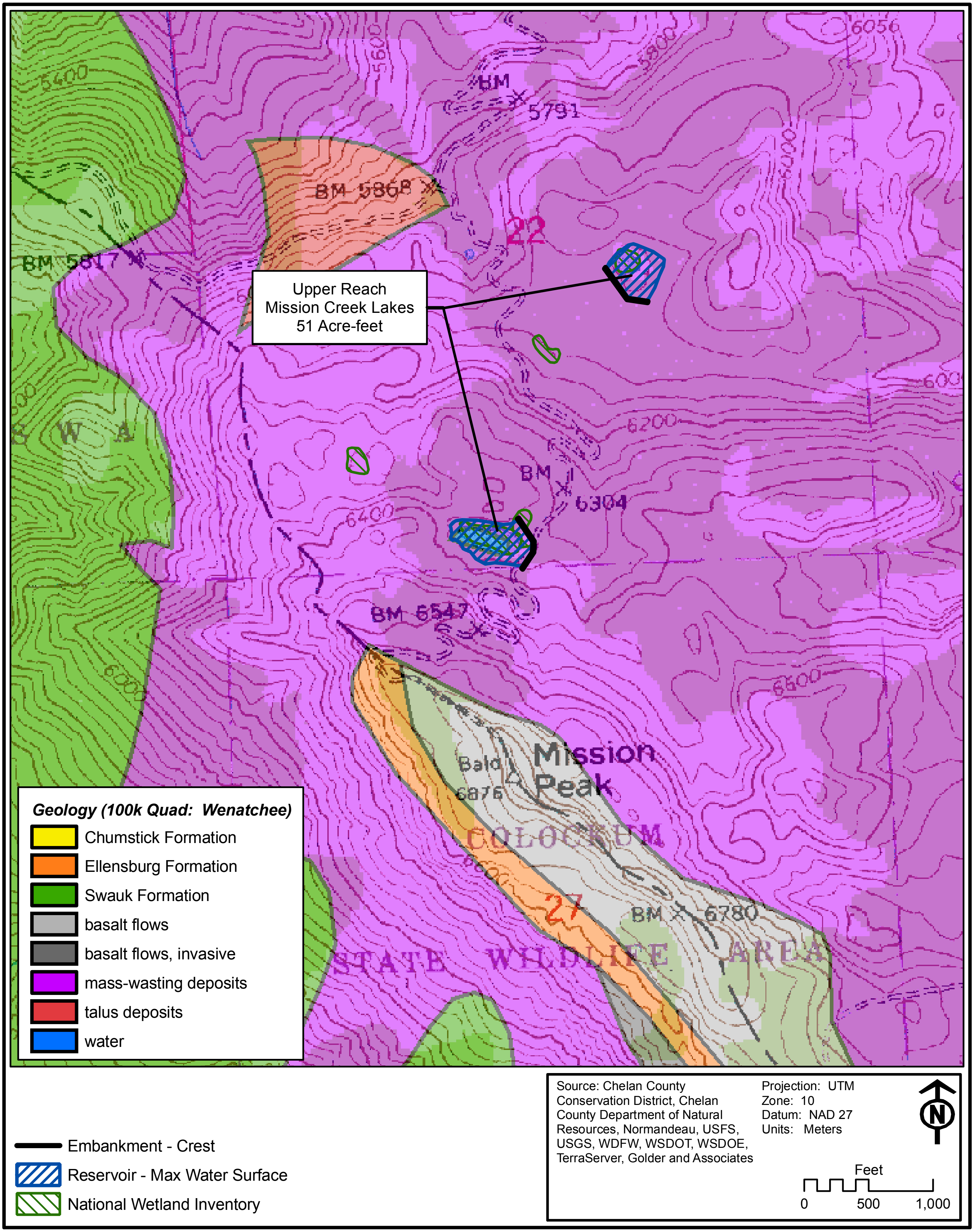
Figure 5-5. Mission Sub-Watershed: Potential Water Storage Projects

East Fork Mission Creek Reservoir



GIS\Source_Data\Montgomery_Group\GIS\MXDs\US_Figures_030606\Figure 5-6 Mission Upper Reach.mxd

MONTGOMERY WATER GROUP, INC.

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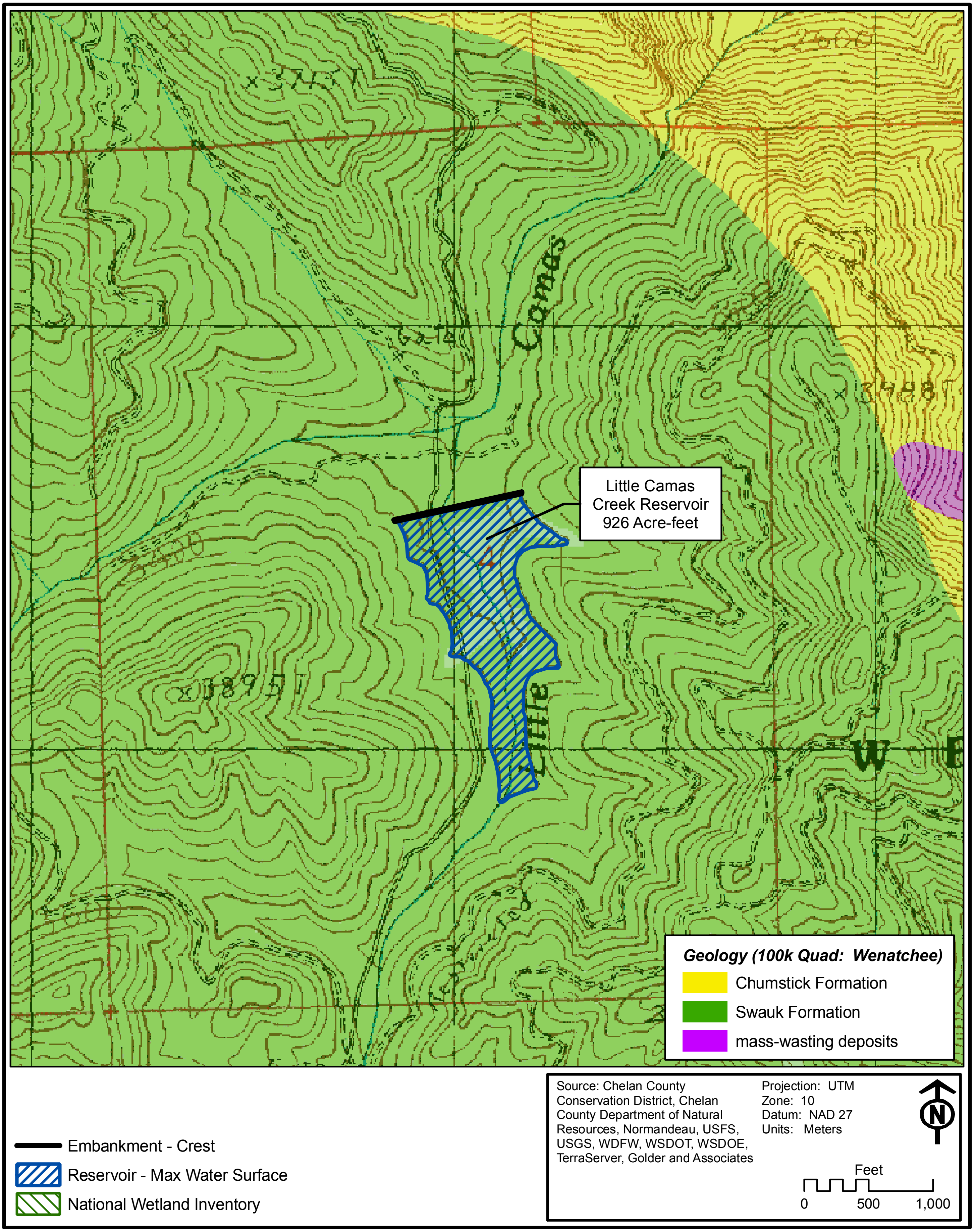
Figure 5-6. Mission Sub-Watershed: Potential Water Storage Projects

Upper Reach Mission Creek Lake



GIS\Source_Data\Montgomery_Group\GIS\MXDs\US_Figures_030606\Figure 5-7 Mission Little Camas.mxd

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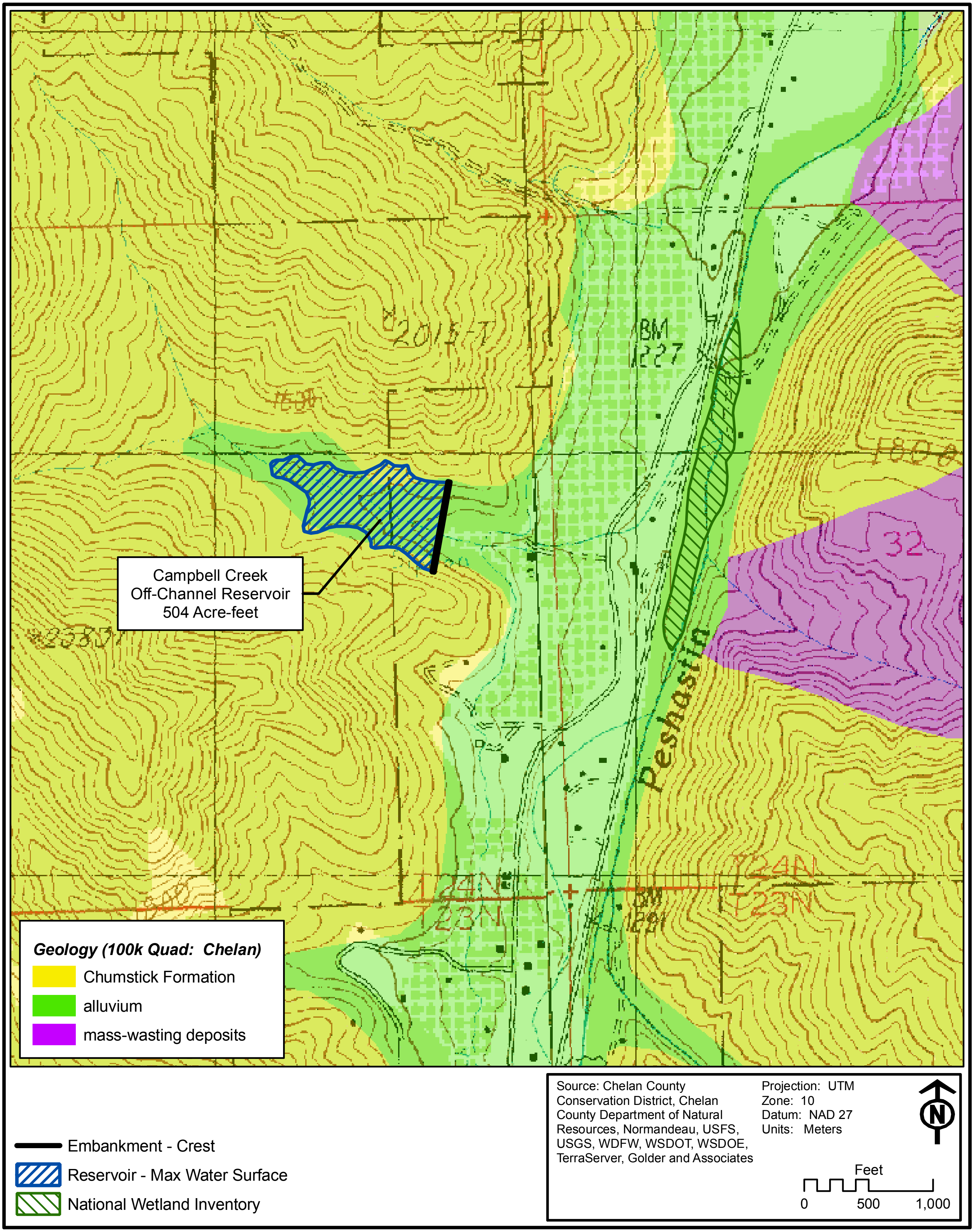
Figure 5-7. Mission Sub-Watershed: Potential Water Storage Projects

Little Camas Creek Reservoir



GIS\Source_Data\Montgomery_Group\GIS\MXDs\US_Figures_030606\Figure 5-8 Peshastin Campbell Creek.mxd

MONTGOMERY WATER GROUP, INC.

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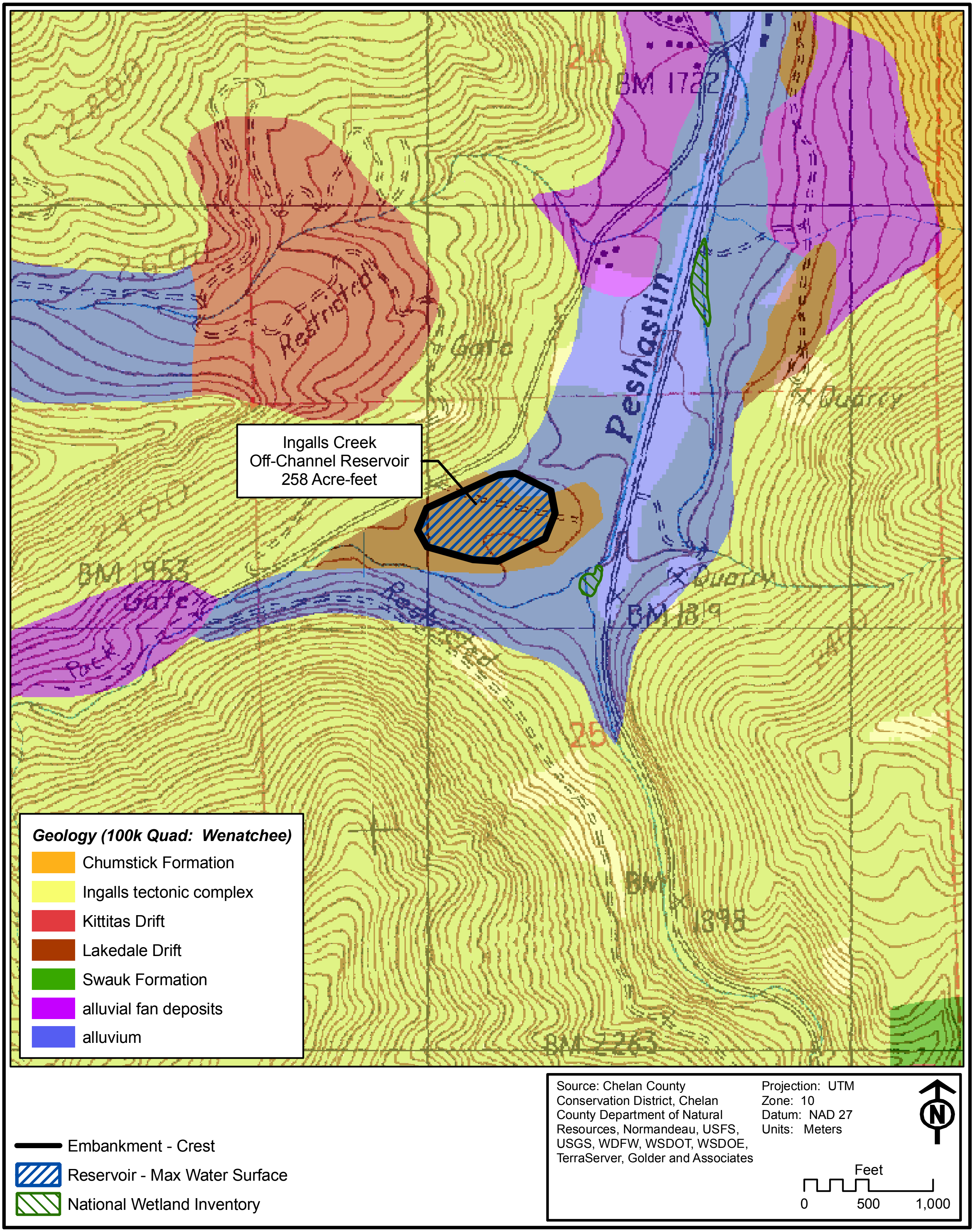
Figure 5-8. Peshastin Sub-Watershed: Potential Water Storage Projects

Campbell Creek Off-Channel Reservoir



GIS\Source_Data\Montgomery_Group\GIS\MXDs\US_Figures_030606\Figure 5-9 Peshastin Ingalls.mxd

MONTGOMERY WATER GROUP, INC.

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Figure 5-9. Peshastin Sub-Watershed: Potential Water Storage Projects

Ingalls Creek Off-Channel Reservoir

Appendix A
Scope of Work

Statement of Work and Costs
Wenatchee Watershed Water Storage Study

The following Tasks 1 through 3 describe the work that is required to complete the Water Storage Study. At the end of each section is a description of the deliverables and schedule to complete those tasks. A table summarizing the costs is included at the end of this document.

Project Tasks:

Task 1 – Facilitation, Public Involvement, Stakeholder Interaction

This task involves direct interaction with the Planning Unit and the sub-committee that addresses the storage assessment and interested stakeholders regarding the storage assessment. The contractor will be primarily focused on workshops or meetings with the Planning Unit and/or sub-committee. The contractor will:

- Facilitate eight (8) periodic meetings with the Planning Unit or sub-committee to discuss findings and receive input on technical notes, project summaries, findings, reports, and alternatives.
- Prepare outreach materials (technical notes and project summaries) to appropriate agencies, the Planning Unit and the general public regarding the work being conducted, the findings of any technical studies, and the types of management actions under consideration.
- Conduct one mid-project workshop to select from a range of storage options evaluated in Step A (Task 2) for further detailed assessment in Step B (Task 3) of the storage assessment.
- Conduct one final public workshop regarding the technical findings and management recommendations under consideration.

Task 1 Deliverables

Meeting agendas, documentation, outreach material, as needed throughout the project.

Task 1 Timeline:

Initial meeting with County and Subcommittee: July 2005
Monthly Subcommittee meetings: July – January 2006
First or mid-project Public Workshop: September 2005
Second Public Workshop: December or January 2006

Task 2: Step A - Baseline Assessment

The purpose of this task is to list alternative water storage projects, classify them as to their benefits to Planning Unit objectives and perform an initial reconnaissance of the projects to help determine which projects should be further evaluated. At the outset of this task, we will identify types of water storage strategies that may be applicable to the Wenatchee Watershed. We will prepare a primer on groundwater recharge and aquifer storage and recovery (ASR) to assist the County and Water Quantity subcommittee in evaluating different types of groundwater projects. We will also identify a broad range of projects and locations that may be suitable for water storage. Those will include using natural lakes to augment streamflow, reviewing floodplain restoration projects and other projects discussed by the Water Quantity Subcommittee. We will meet with the County and Water Quantity Subcommittee to discuss those projects and further identify storage projects. A list of storage projects will be generated for distribution. The list will be inclusive unless there is an obvious fatal flaw to the potential project.

The Baseline Assessment will:

- Consider the type of storage projects that would be useful in the watershed, given the current and future water supply and demand and instream flow considerations.

- Consider and scope reasonable and applicable storage alternatives and identify potential site locations for: off-channel storage, underground storage, and other alternatives (a conventional in-channel storage assessment was completed for the Wenatchee in 2003: the Lake Wenatchee Water Storage Feasibility Study, June 2003). Both large and small scale storage options will be considered, including but not limited to: use of wetlands in channel migration zones for storage and infiltration, infiltration of reclaimed water or stormwater and aquifer storage coupled with instream flow augmentation.

- Include an inventory and assessment of the water storage infrastructure needs including public and private water systems, where information is available. This inventory will ensure that small drinking water systems and fire safety needs are addressed.

- Consider how to balance the full range of potential uses for stored water (multipurpose).

- Identify potential environmental effects associated with the different storage alternatives.

Task 2.1 Develop Storage Project Framework

The purpose of this subtask is to develop criteria to classify and evaluate various storage options. Preliminary classifications have been provided by Chelan County and are listed below:

Type of Water Need (large and small)
- In-stream
- Out-of-stream
- Public water systems including municipal uses
- Private water systems
- Agricultural
- Industrial
- Fire Safety
- Other

Classification of storage type (large and small)
- Surface sites
- On-channel
- Aquifer Storage and Recovery Sites
- Wetlands/Natural Storage
- Conservation and other water saving strategies

Geographic Priority Areas and Extent

- Sub-watersheds
- Specific areas with out of stream supply needs
- Specific areas with instream flow needs

Timing and Magnitude

- Short-term (seasonal, emergency, interim)
- Long-term (sustainability, operational complexity)
- Conjunctive Use (groundwater/surface water)

The contractor has employed initial screening criteria for other water storage assessments that rank benefits to Planning Unit objectives such as increased or more reliable water supply, improved instream flow, improved habitat, augmenting aquifer levels, and improving water quality. The screening criteria also contain a ranking of implementation factors such as cost, the implementation complexity (permitting, land ownership, water rights, funding etc) and technical complexity (geology, civil engineering issues). At this level of study, it is proposed the screening criteria use a system that ranks benefits and other factors as having no benefit, low benefit, medium benefit or high benefit. The contractor will propose the screening criteria to the subcommittee for their review prior to their use in the initial or screening evaluation of the different projects.

Task 2.2 Water Budget

The most critical areas that may need storage projects will be preliminarily identified in Task 2.1 above (Geographic Priority Areas and Extent). A preliminary water budget was performed for the Watershed Planning process for each sub-basin. We will review the water budget, compare total inflows and outflows to the system and identify surpluses and deficits for each subbasin. High priority areas will be identified as those with projected water supply shortfalls. The studies of water storage strategies will be focused on the subbasins with projected water supply shortfalls. .

2.3 Resource Overview

The contractor will compile and review existing data sources to inventory natural resource elements associated with potential storage areas or projects. This baseline assessment will include the collection and review of the following elements:

- Topography (USGS 7.5-minute Topo)
- Georectified aerial photos
- Critical areas including National Wetland Inventory maps (USFWS)
- Streams
- Priority Habitats and Species (WDFW) and
- Wenatchee River Channel Migration Zone data
- Hydrologic conditions (stream flow, run-off, instream flow needs)
- Shallow hydrogeologic conditions and surface water – groundwater interaction
- Deep hydrogeologic conditions

The contractor will create a GIS database to compile the separate data sets and identify key natural resources elements and potential “fatal flaws” associated with each storage project area. This analysis will be incorporated into the prioritization of storage options in the Step A Storage Assessment Memorandum (Task 2.4).

Task 2.4 Step A Storage Assessment Memorandum

For this subtask, the information obtained in Tasks 2.1-2.3 will be compiled and the screening criteria described in Task 2.1 applied to each of the projects. The screening criteria will be evaluated with the subcommittee to ensure agreement on the projects. A summary document will be prepared that lists and describes the potential storage projects, summarizes the results of the screening criteria and ranks the projects from high priority to low priority. The information will be presented in a public workshop and refined as needed to guide the assessment described in Step B. The top storage projects will be retained for further evaluation in Step B (as determined in the workshop).

Task 2 Deliverables:

Step A Storage Assessment memorandum as described in Task 2.4, GIS layers of natural resource elements at each potential storage site.

Task 2 Timeline:

Develop Framework and Screening Criteria with County and Subcommittee: July 2005
Water Budget: July – August 2005
Resource Overview: July – August 2005
Storage Assessment Memorandum: August 2005
Public Workshop to present Step A results: September 2005

Task 3: Step B – Storage Assessment

Following the mid-project workshop wherein the storage options presented in the Step A Storage Memorandum are considered and prioritized, a second tier assessment of high priority storage options will be conducted wherein the selected priority multi-purpose storage options will be further developed and evaluated. This assessment will allow the projects to be developed into enough detail to be able to quantify the benefits of the project, the costs and the potential environmental issues and impacts that would need to be addressed when implementation funding for the project is pursued.

Task 3.1 Resource Overview

This task will provide a more detailed assessment of the natural resource elements of the selected (Step B) potential storage projects or areas, including but not limited to:

- Topography and ground cover
- Groundwater –surface water interaction
- Irrigation return flows
- Bank storage considerations
- Channel Migration Zone considerations
- Habitat conditions
- Hydrologic conditions (stream flow, run-off, instream flow needs)
- Potential changes in hydrology due to climate impacts
- Shallow hydrogeologic conditions
- Deep hydrogeologic conditions

The contractor will conduct a site reconnaissance to field-verify the natural resource elements identified in Task 2.3. Additional natural resources not inventoried in Task 2.3 will also be identified and added to the GIS database. Following the field reconnaissance and updating of the GIS database, the contractor will conduct an impacts analysis for each of the high priority storage options. Potential impacts will be calculated using the GIS database and overlaying each potential storage project footprint. This analysis will be presented in the Step B Storage Assessment Report (Task 3.4).

More detailed assessments of hydrogeologic conditions will be conducted to assess selected priority multi-purpose storage options that contain bank or floodplain storage and artificial recharge components. The assessment will review hydrogeologic parameters such as groundwater levels, hydraulic conductivity and porosity of floodplain and bank sediments. Data will be collected from available well log data, seepage data, aquifer test data and other available information to assess the feasibility and benefits of aquifer recharge or storage projects.

Task 3.2: Engineering Overview

For this task a review of geologic information and geotechnical engineering requirements will be performed, a preliminary layout of the water storage project features provided and a feasibility level cost estimate prepared. Estimates of the long-term operation & maintenance cost will also be provided, as often the operating cost of a project is a key factor in deciding whether to implement it. Issues relating to design, construction or permitting of the project will be identified. The potential water yield of the project will be described for both average conditions and drought conditions.

Task 3.3: Environmental Overview

This task will address the environmental effects and associated regulatory elements of the Step B storage projects or areas, for example:

- SEPA
- Permitting
- Water rights
- Instream flow
- Water quality

The contractor will conduct early environmental analysis of the proposal consistent with SEPA Rules (WAC 197-11), to incorporate environmental information into the decision-making process and establish the basis for future formal SEPA review. The environmental analysis will be based in part on the statewide programmatic Watershed Planning Environmental Impact Statement (WA Department of Ecology, 2003), which identifies a range of alternatives that represent actions that the Wenatchee Watershed Planning Unit may decide to include in its Watershed Plan.

The environmental analysis will evaluate key environmental benefits and negative impacts associated with the high priority water storage projects identified at the mid- project workshop. This analysis will be based upon the programmatic analysis provided in the Watershed Planning EIS and other readily available information on the proposal and project area. A technical memorandum that identifies key environmental issues (benefits and negative impacts) associated with each high priority storage project identified at the mid-project workshop will be prepared. The memorandum will include a brief description of each project, summary description of the key environmental issues and identification of potential mitigation measures.

The contractor will then review each high priority storage option proposed for the Wenatchee Watershed Plan for consistency with the alternatives provided in the Watershed Planning EIS (WP 19, 20, 21, 22, 23, 24). The purpose of this analysis is to determine the extent to which the Watershed Planning EIS is applicable and can be used in future SEPA review of the Wenatchee Watershed Plan. A summary matrix will also be prepared that compares each high priority storage option with the alternatives analysis in the Watershed Planning EIS, and provide an assessment of consistency relative to the statewide EIS.

We will then create a matrix to identify the probable local, state, and federal permits and regulatory approvals that would be required to implement each of the high priority storage options. The matrix will contain the permit type, permit timeline, applicability, and regulatory agency.

Task 3.4: Step B: Storage Assessment Report

For this subtask, the information obtained in Tasks 3.1-3.3 along with input received from a public meeting held near the end of the process will be compiled into a storage assessment report. The report will summarize the feasibility, benefits and costs of each project and how they relate specifically to Planning Unit goals and objectives. The findings of this report will also be provided as management strategies that will be integrated into the Phase III Watershed Management Plan for WRIA 45. The contractor shall coordinate the preparation of the management strategies with other contractors or subcommittees working on the preparation of the Watershed Management Plan (instream flow, habitat, and water quality).

Task 3 Deliverables

Final Water Storage Assessment Report summarizing the work completed for Tasks 3.1 – 3.3. Watershed Planning strategies that can be integrated into the ongoing Watershed Management Plan development.

Task 3 Timeline:
Prepare list of prioritized projects for Step B: September 2005
Resource Overview: September – December 2005
Engineering Overview: September – December 2005
Environmental Overview: September – December 2005
Public Workshop to present Step B results: December 2005
Storage Assessment Report: December 2005

Appendix B
Review of Potential Groundwater Recharge Areas in WRIA 45

Technical Memorandum

To: Bob Montgomery, MWG

From: Stephen Swope, PGG

Re: WRIA 45 Storage Locations

Date: November 10, 2005

There are two methods by which groundwater is stored, Aquifer Storage and Recharge (ASR) and recharge basins. The methods are similar in that they both involve recharging water to aquifers during high availability times and recovering the water during low availability times. They differ in that ASR involves recharging and recovering water at a single location, typically via wells, whereas with recharge basins, water is infiltrated in spreading basins and recovered downgradient for beneficial use via wells or discharged to springs or creeks to augment flow.

The site requirements are similar for both ASR and recharge basins in that they both require an aquifer that can store significant volumes of water. Site requirements differ in that ASR projects require aquifer boundaries that have minimal leakage and in which flow away from the recharge location is minimal. With recharge basins, some flow away from the basin is desirable and discharge boundaries may be incorporated as part of water recovery and beneficial use. The alluvial basins of interest in WRIA 45 are drained by significant rivers and therefore a confining unit between the river and aquifer would be required to decrease loss of stored water from the aquifer to the river.

The locations presented below were selected primarily based on area and geology. Well logs for the WRIA were reviewed to assess suitability for water storage projects. Those areas indicating extensive coarse-grained materials were further assessed to evaluate the presence of confining units and the degree of continuity with nearby surface water.

Most of the WRIA is composed of sandstone and shale sequences that cannot move water fast enough to allow recharge and recovery. However, valley bottoms typically contain alluvium that may contain sequences of coarse material. These wide valley areas with coarse alluvium have the potential to move and store large volumes of water necessary for a groundwater storage project. The valleys are bordered by sandstone and shale bedrock which form a low permeability boundary. Depending on the presence of a continuous confining unit, the area may be suitable either for ASR or a recharge basin. If a confining unit is present and the aquifer is sufficiently isolated from the adjacent stream, ASR is possible. If no confining unit is present, the location may still be suitable for a recharge basin.

Two attributes are useful in assessing the usability of each site: total volume of available water storage and the rate at which each will accept water. The storage rate for ASR is a function of aquifer transmissivity and available head. Typical storage rates for ASR range from 0.25 to 2 cfs per well. Multiple wells may be installed to increase storage rates depending on the aquifer.

The storage rate for a recharge basin is a function of a number of variables including basin size, hydraulic conductivity, and depth to water. For this estimate, the storage basin was presumed to be a canal 100 feet long by 5 feet wide. Hydraulic conductivity was estimated from well log descriptions of coarse alluvial sands and gravels as ranging from 1 x 104 to 1 x 105 gallons per day per foot squared. Using a water level rise below the canal of 20 feet yields a potential recharge rate of 0.5 to 10 cfs. Individual rates were not calculated for each site since individual hydraulic conductivities and basin configuration information was not available.

The total storage volume for ASR in a confined aquifer is a function of the saturated aquifer volume, storativity, and water level rise. For a recharge basin, the storage volume is a function of unsaturated aquifer volume and porosity. Storativity changes greatly depending on whether the aquifer is confined or not. An aquifer may change from confined to unconfined laterally as geology changes relative to the water table. In this case, estimating the volume of water stored is not possible without detailed mapping of hydrogeology. Little of the required site specific information is available to estimate storage volumes for the sites below. Therefore, storage volumes presented below are based on estimated or assumed values.

LEAVENWORTH RECHARGE BASIN

The alluvial infill in the Icicle Canyon near Leavenworth is composed primarily of sand and gravel. Overlying the sand and gravel aquifer is a 0 to 40 foot thick silt and clay layer that confines the aquifer in places. There are areas that lack confining units between Icicle Creek and the underlying aquifer. Therefore a recharge basin approach is more likely feasible than ASR for this location. Figure 1 presents the area likely to yield the best recharge basin locations based on geology. Basins should be located in areas lacking significant near-surface fine material. The total volume of water storable is not obtainable with the current level of information because of the variable degree of confined nature of the aquifer.

PESHASTIN CREEK RECHARGE BASIN

The valley south east of Peshastin widens and is infilled with coarse sand, gravel, and cobbles. The coarse material extends to a depth of up to 100 feet bgs and depth to water ranges from 20 to 60 feet bgs. No confining units are present with in the alluvial material although some silt is occasionally present. Therefore, this area is well suited for a recharge basin. Figure 2 presents the area likely to yield the best recharge basin locations.

Assuming a water level rise of 20 feet, an area of 425 acres, and a porosity of 0.2, this site could store up to 1,700 acre feet of groundwater.

CASHMERE (BRENDER CANYON) RECHARGE BASIN

The aquifer beneath Cashmere is overlain by a thick confining unit that is not continuous laterally and therefore unlikely to allow the use of ASR. However, the confining unit will slow groundwater recharged from a recharge basin and allow for greater flexibility in the timing of recharge. Figure 3 presents the area likely to yield the best recharge basin locations. The total volume of water storable is not obtainable with the current level of information because of the variable degree of confinement.

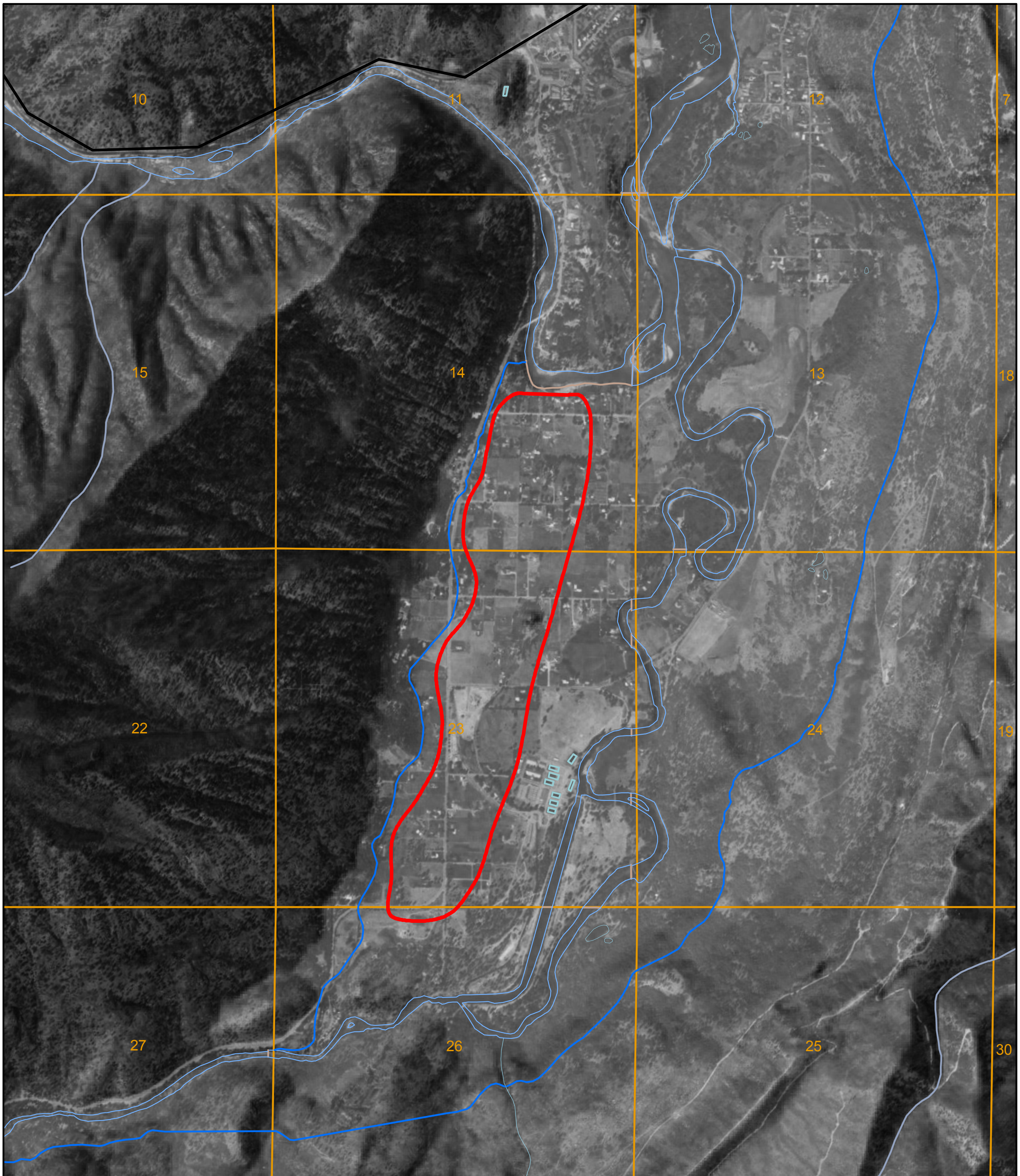
UPPER WENATCHEE ASR PROJECT

The proposed location for the Upper Wenatchee ASR project is within the valley surrounding the City of Plain. The predominant aquifer underlying Plain occurs at a minimum depth of 20 feet although typical depths are greater than 40 feet. The aquifer is coarse and is described as sand and gravel. The material above the aquifer is generally described as a mixture of gravel and clay. Depending on the proportions of these materials, this layer may form a sufficient confining unit for ASR. Figure 4 presents the approximate extent of the aquifer and target area for ASR recharge and recovery sites. Presuming confined aquifer conditions, this area could store on the order of 40 acre fee of water. If unconfined areas are significant and a recharge basin approach was used, the stored volume could be much larger.

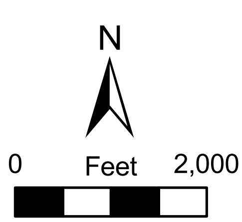
RECOMMENDATIONS

Once the planning unit selects areas of interest, detailed cross sections should be drafted to assess the hydrogeology. Information to be gained includes estimates of the areas of aquifer confinement, available storage capacity, and lateral continuity of confining units. Pivotal wells should be field located to provide for a more accurate cross section. Any available aquifer test data should be analyzed to improve hydraulic conductivity estimates. Groundwater models should be developed for recharge basins to assess the timing of recharge to adjacent streams.

gwrechargeprojectsmemo.doc



Major Roads
Sections
Recharge Areas



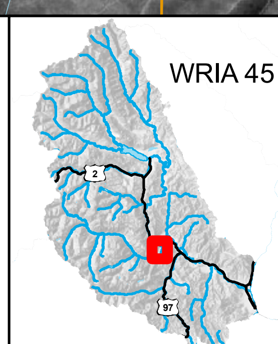
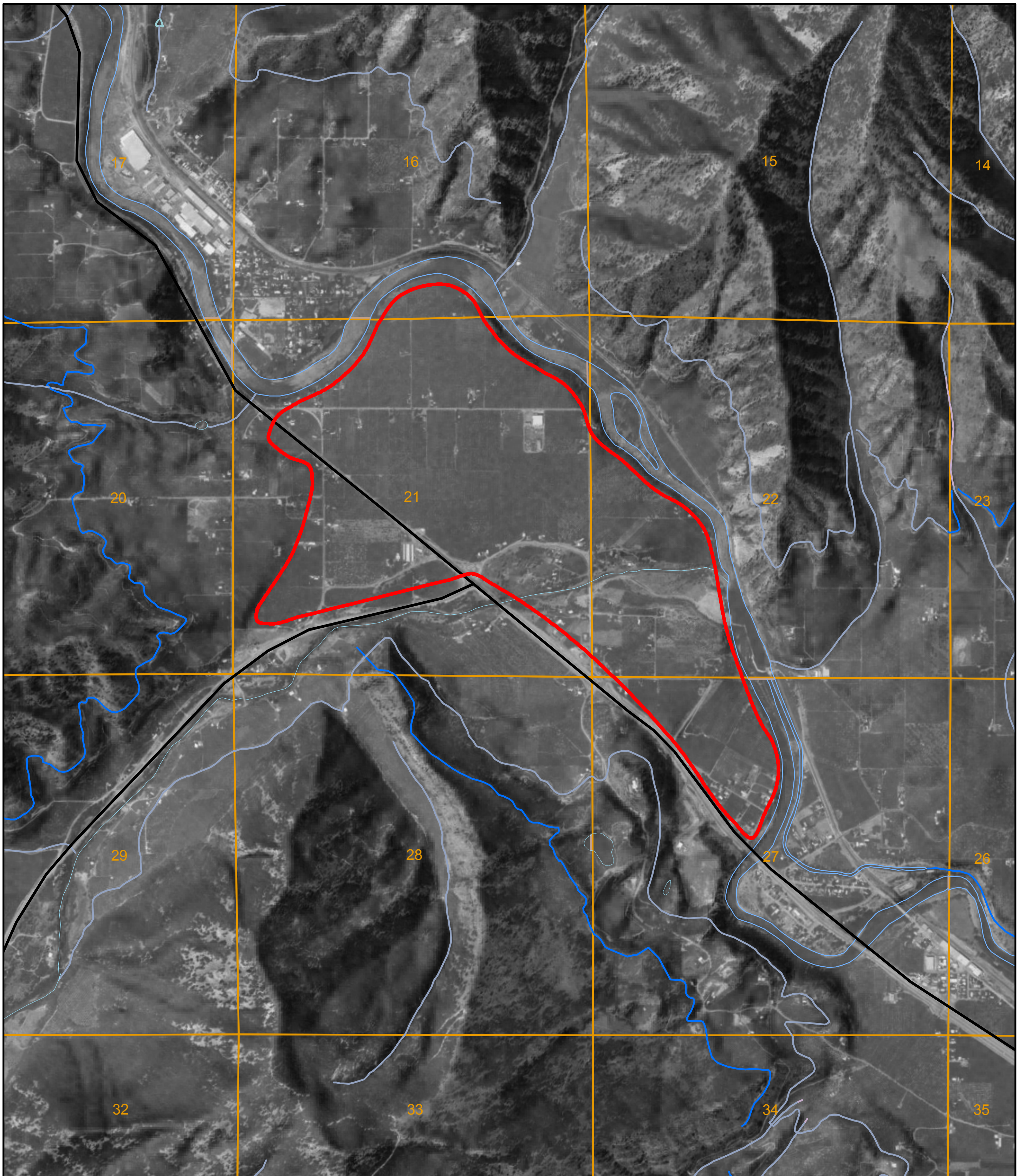


Figure 1
Leavenworth Recharge Basin

PGG



Major Roads
Sections
Recharge Areas

N

0 Feet 2,000

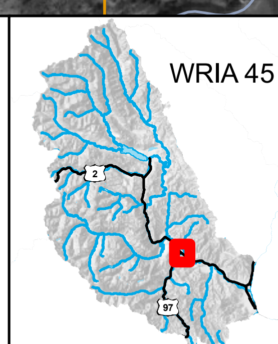
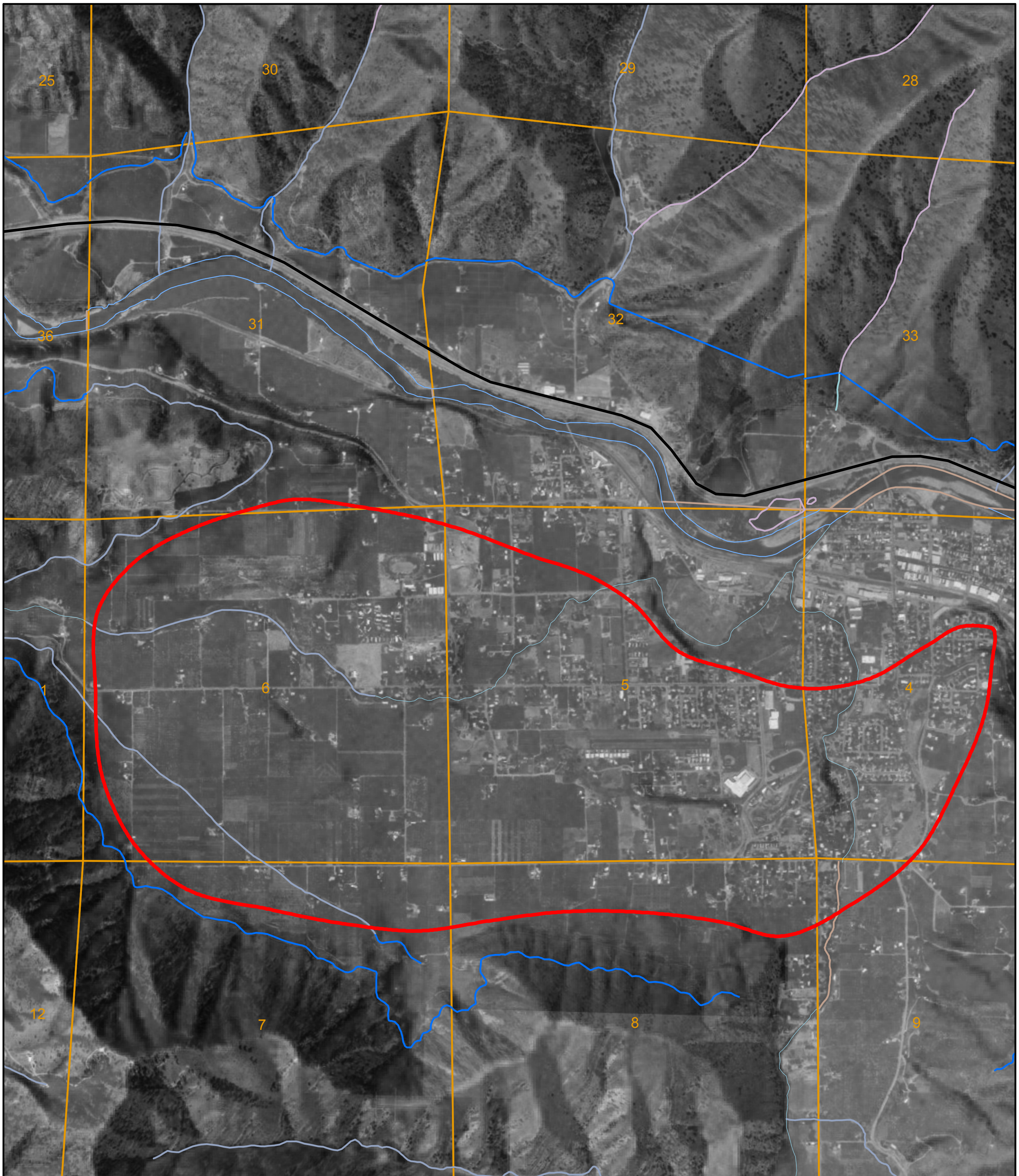


Figure 2
Peshastin Creek
Recharge Basin

PGG



Major Roads
Sections
Recharge Area

N

0 Feet 2,000

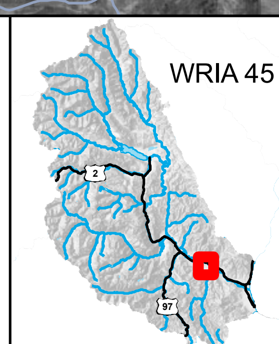
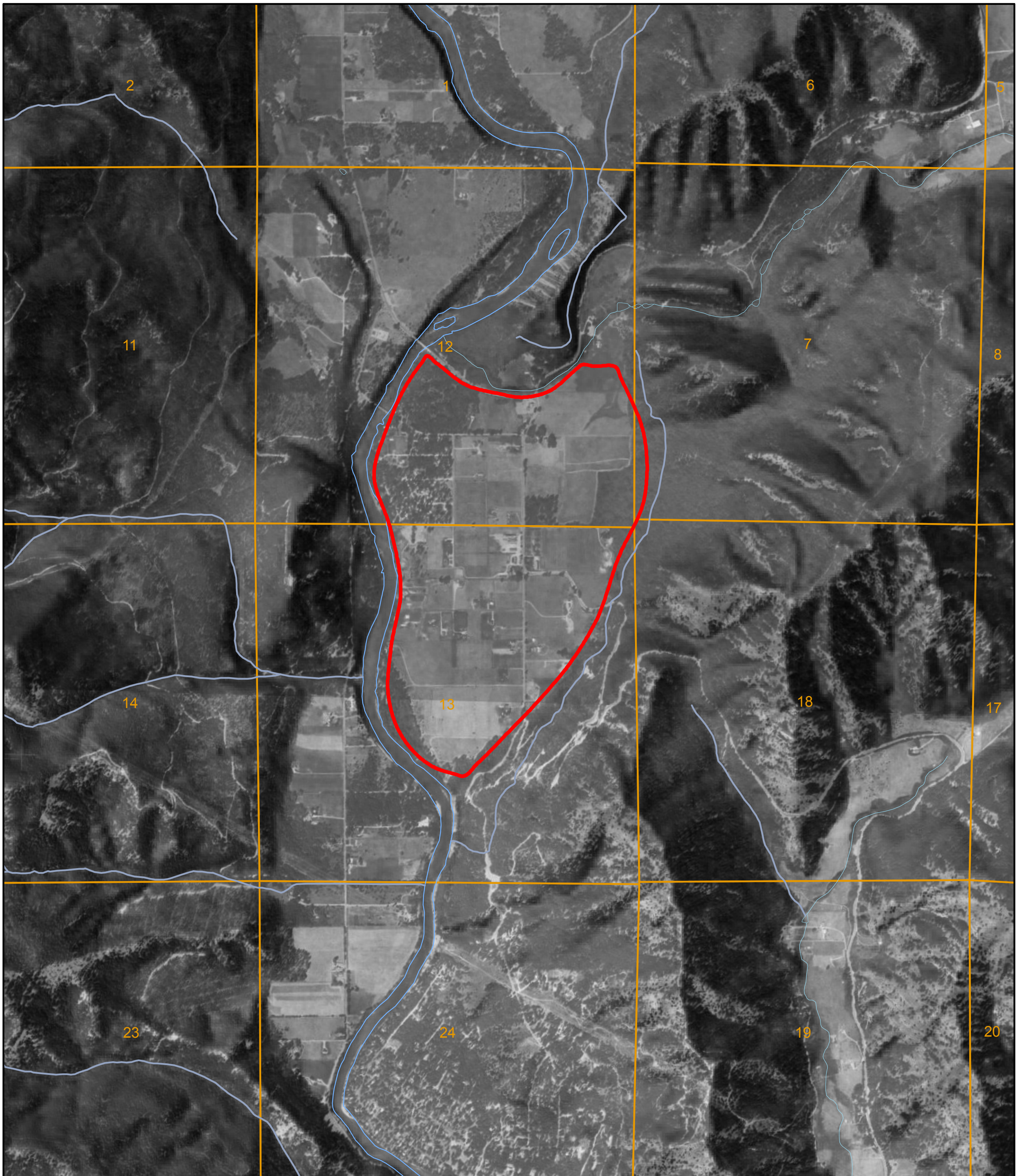


Figure 3
Cashmere
(Brender Canyon)
Recharge Basin

PGG



Major Roads
Sections
Recharge Areas

N

0 Feet 2,000

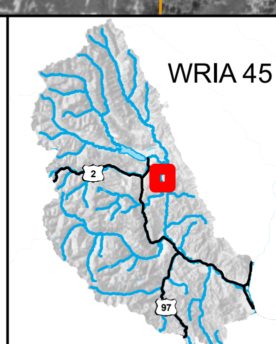


Figure 4
Upper Wenatchee Recharge Basin

PGG

Appendix C
Photos of Existing Lakes in Chumstick Sub-watershed and Other Potential Water Storage Sites

This group of photos is courtesy of Dave Klinger.

1. Eagle Creek Tributary Lakes, Sec20, T25N, R19E, Lower Pond. Looking West toward beaver dam.

2. Eagle Creek Tributary Lakes, Sec 20, T25N, R19E. Lower Pond. Looking East into draw.

3. Eagle Creek, Sec 20, T25N, R19E. Lower Pond. Looking West from near the East end of the pond.

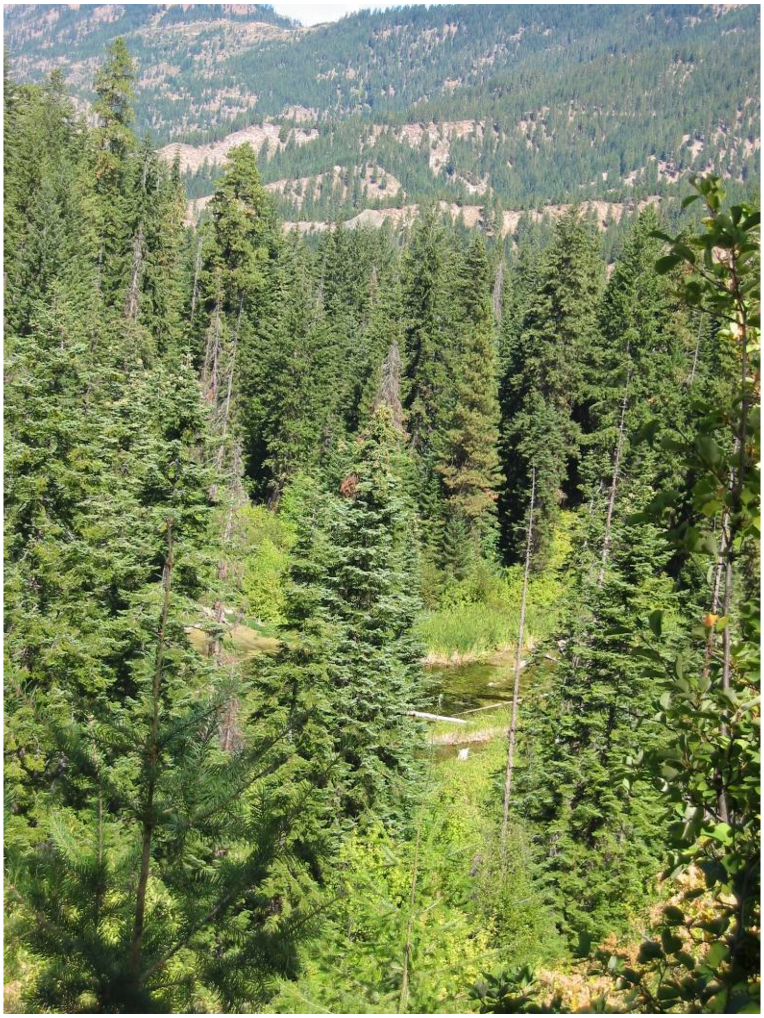
4. Eagle Creek, Sec 21, T25N, R19E. Upper Pond. Looking South across a mostly dry pond with some water remaining.

5. Eagle Creek, Sec 21, T25N, R19E. Upper Pond. Looking North. The area is a depression and no evident drainage west out of the depression was noted.

6. Eagle Creek, Sec 21, T25N, R19E. Upper Pond. Some water remaining in the center of the pond.

7. Eagle Creek SW Tributary Lakes, Sec 29, T25N, R19E. Lower Pond. Looking West from east bank with water in the center of the pond.

8. Eagle Creek SW Tributary Lakes, Sec 29, T25N, R19E. Lower Pond. Looking Southwest from what appears to be an earthen dam. Note the old wooden watering trough in foreground.


9. Eagle Creek SW Tributary Lakes, Sec 29, T25N, R19E. Lower Pond. Looking North from high on the ridge to the south of the pond.


10. Eagle Creek SW Tributary Lakes, Sec 29, T25N, R19E. Upper Pond. This pond appears mostly dry as I walked through it. It is even closer to USFS Road #7500 than the lower pond.


11. Eagle Creek SW Tributary Lakes , Sec 29, T25N, R19E. Upper Pond. This was the dry center of the pond with some damp spots.


12. Eagle Creek SW Tributary Lakes, Sec 29, T25N, R19E. Upper Pond. Looking Northwest toward a narrow defile where the water drains out and down to the lower pond. No obvious dam was noted.

These photos taken by Bob Montgomery

Campbell Creek Reservoir Site looking Upstream from Tandy Ditch

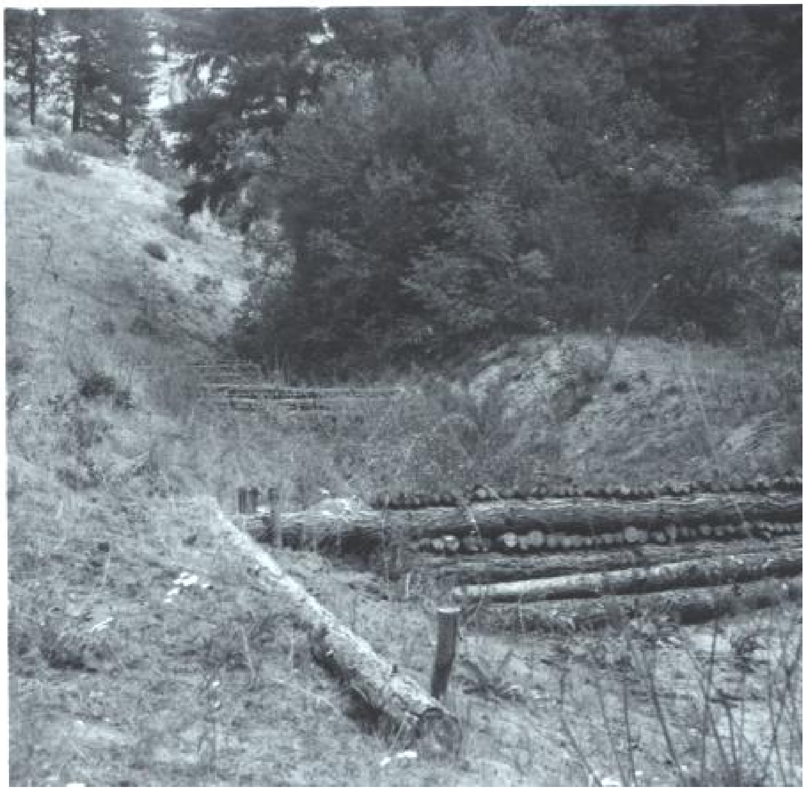
Mill Creek Reservoir Site, looking upstream. Picture taken from cleared area downstream of potential dam site.

Mill Creek Reservoir Site, looking downstream

Mill Creek in September, 2005

These photos were provided by the USFS, showing headcut repairs performed in Mission Creek Sub-watershed in the mid-1950s. Similar types of repairs are described in the report.

Beaver Dam



Appendix D
Hydrologic Assessment of Reservoir Sites

APPENDIX D
TABLE OF CONTENTS

1.0 Hydrology Assessments

Hydrologic assessments of the Wenatchee Watershed were performed to supplement the water storage analyses. The following sections present the assessments of streamflow available to fill the reservoir by sub-watershed. These analyses are preliminary and more detailed hydrologic investigations will be needed at any site that water storage is considered for. Section 1.7 presents calculations of the expected yield from each reservoir considering evaporation and usable storage.

1.1 Lower Wenatchee Sub-Watershed

No streamflow data was found for the tributaries that Step B projects would be located on (Derby Canyon, Williams Canyon, Ollala Canyon and Nahahum Canyon). The creeks are known to be seasonal, with peak flows occurring in winter and early spring time and portions or the entire stream drying out in late summer.

The closest stream gage found to the Lower Wenatchee Sub-Watershed is located on Eagle Creek in the Chumstick Sub-watershed which is adjacent to the Derby Canyon basin. The Department of Ecology maintains a staff gage on Eagle Creek near its confluence with Chumstick Creek (viewed at https://fortress.wa.gov/ecy/wrx/wrx/flows/station.asp?sta=45Q060). The staff gage is read periodically. Table D-1 shows the available data on Eagle Creek. The drainage area of Eagle Creek is 28 square miles. The average annual precipitation in the basin is approximately 35 inches. That estimate was obtained by reviewing annual precipitation data and GIS maps prepared for the Wenatchee Watershed Assessment (MWG, 2003). The volume of runoff that occurs in Eagle Creek appears to be about 0.3 to 0.5 cfs per square mile during late winter and early spring.

Table D-1
Measured Streamflow in Eagle Creek

Date	Measured Flow, cfs	Flow per Square mile, cfs
12/18/2002	0.4	0.01
2/24/2003	5.5	0.20
3/14/2003	15.2	0.54
4/11/2003	7.5	0.27
3/10/2004	9.1	0.33
4/28/2004	2.7	0.10

1.1.1 Water Yield at Derby Canyon Off-Channel Reservoir

The average annual precipitation in the Derby Canyon sub-watershed is approximately 35 inches, very similar to that of Eagle Creek.

The approximate drainage area upstream of the Derby Canyon reservoir site is 12.3 square miles. Using the same unit runoff as Eagle Creek, the flow in Derby Canyon Creek is then estimated to be about 4 cfs to 6 cfs during the late winter and early spring.

The reservoir could likely fill in 9 days, assuming a diversion rate of 1 cfs from Derby Canyon Creek.

1.1.2 Water Yield at Williams Canyon Off-Channel Reservoir

The average annual precipitation in the Williams Canyon sub-watershed upstream of the site of the potential water storage reservoir is approximately 30 inches. The approximate drainage area upstream of the Williams Canyon reservoir site is 0.6 square miles.

To estimate the streamflow in Williams Canyon Creek the flow in Eagle Creek was scaled by basin area and multiplied by the ratio of average annual precipitation. This is an approximate method of estimating flows and if additional studies on this reservoir are desired, a stream gage should be installed to obtain better data. The approximate flow in Williams Canyon Creek is then estimated to be less than .5 cfs during late winter and early spring.

Assuming 0.3 cfs could be diverted and stored in the reservoir, the reservoir would fill over the winter (3-4 months).

1.1.3 Water Yield at Ollala Canyon Off-Channel Reservoir

No streamflow information was found for Ollala Canyon Creek. The creek is known to be seasonal, with peak flows occurring in winter and early spring time and portions or the entire stream drying out in late summer. The average annual precipitation in the basin is approximately 32-35 inches. The basin area upstream of the potential reservoir site is about 4.1 square miles. The basin backs up to the Eagle Creek Basin.

The same technique to estimate streamflow as described for Williams Creek was performed for Ollalla Canyon. Flow in Eagle Creek was scaled by basin area and multiplied by the ratio of average annual precipitation. The approximate flow in Ollala Canyon Creek is then estimated to be about 1 cfs to 2 cfs during late winter and early spring.

Since the reservoir is small, it was assumed that only 0.5 cfs would be needed to divert in late winter and early spring flow to store in the reservoir. At that rate of diversion, the reservoir would fill in approximately 9 days.

1.1.4 Water Yield at Nahahum Canyon Off-Channel Reservoir

No streamflow information was found for Nahahum Canyon Creek. The creek is known to be seasonal, with peak flows occurring in winter and early spring time and portions or the entire stream drying out in late summer. The basin area upstream of the potential reservoir site is about 9.65 square miles. The average annual precipitation in the basin is approximately 30 inches.

The same technique to estimate streamflow as described for the other creeks in the Lower Wenatchee Sub-Watershed was performed for Nahahum Canyon. Flow in Eagle Creek was scaled by basin area and multiplied by the ratio of average annual precipitation. The approximate flow in Nahahum Canyon Creek is then estimated to be about 2 cfs to 5 cfs during late winter and early spring.

Assuming 1-2 cfs of the late winter and early spring flow could be diverted and stored in the reservoir, the reservoir would fill in approximately 2-4 weeks.

1.1.5 Comparison of Diversions to Maximum Allocation

There are no maximum allocations for the tributaries to the lower Wenatchee River however an instream flow control point exists on the Wenatchee River at Monitor which is located downstream from the projects listed in the previous paragraphs. The maximum allocation for all projects located upstream of Monitor (including the tributaries) ranges from 148 cfs in February to 360 cfs in April. As long as there is sufficient streamflow available in the tributaries the maximum allocation proposed in the Watershed Plan would not limit diversions into the potential reservoirs.

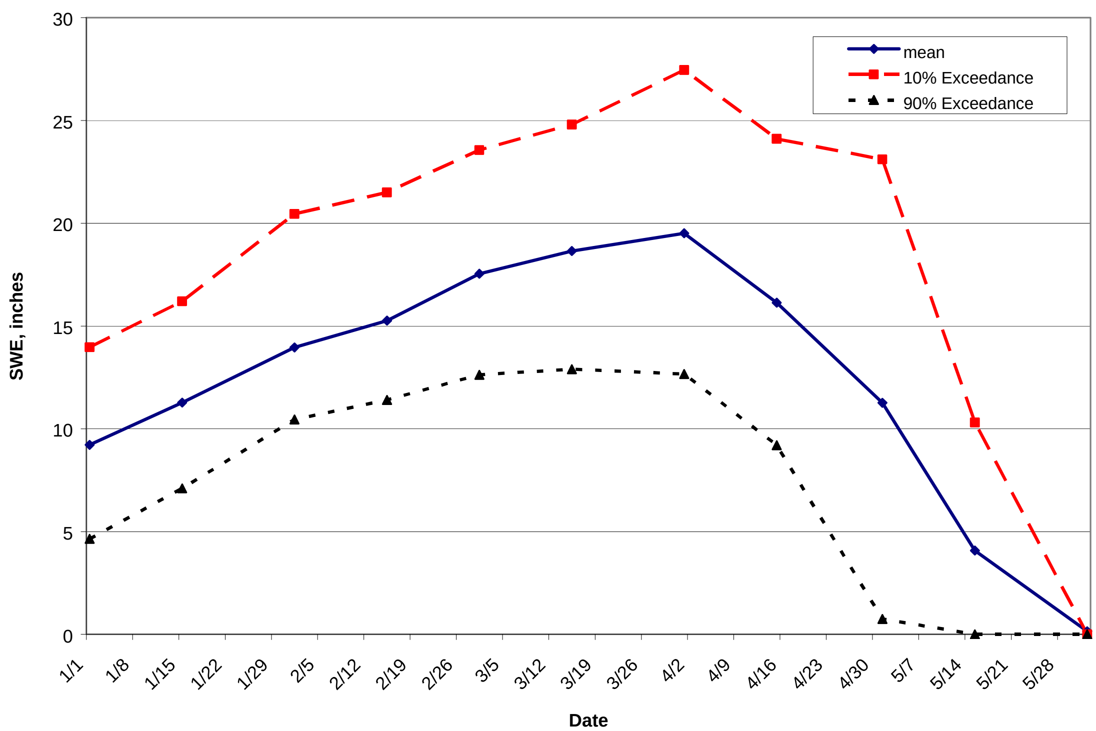
1.2 Mission Sub-Watershed

1.2.1 Water Yield at East Fork Mission Creek Reservoir

No streamflow data is available in the upper Mission Creek watershed. The average annual precipitation in the basin tributary to the potential reservoir site is approximately 30 inches, according to precipitation data obtained for the Watershed Assessment. Two NRCS SnoTel sites are located nearby; Grouse Camp and Upper Wheeler. The Grouse Camp site is located in Kittitas County about 5 miles southwest of the reservoir site at elevation 5380 feet while the Upper Wheeler site is located about 4 miles southeast at an elevation of 4400 ft. Precipitation reduces in an easterly direction and with elevation in the region of the SnoTel sites. The Grouse Camp average annual precipitation is 31.7 inches while Upper Wheeler's is 27 inches. The SnoTel data can be found at http://www.wcc.nrcs.usda.gov/snow/ . The drainage area tributary to the potential reservoir site is about 250 acres and the reservoir is at an elevation of approximately 4320 feet.

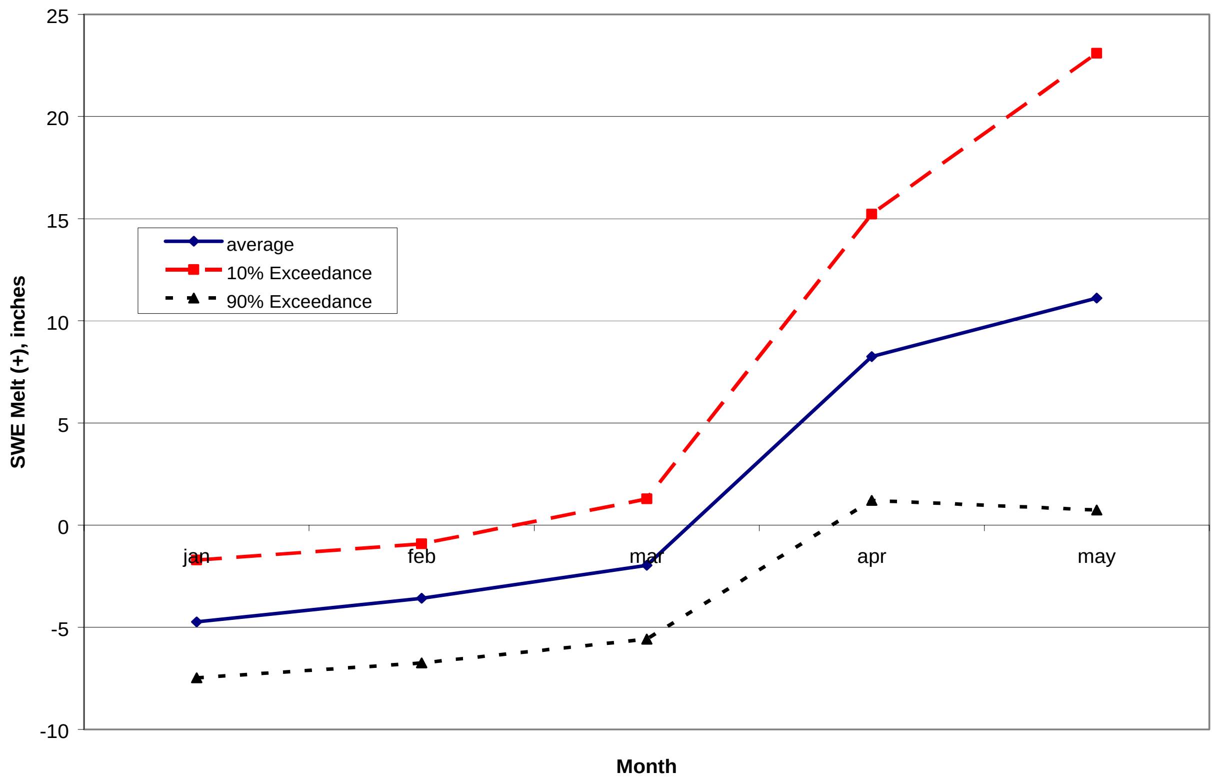
The Grouse Camp snow data was reviewed to estimate the amount of runoff that occurs in late winter. Figure D-1 shows the snow-water equivalent from January to the end of May. The snowpack is depleted by the end of May.

Figure D-1
Snow-water Equivalent, Grouse Camp SnoTel Site



One measure of the runoff is the amount the snowpack gets depleted. Typically snowfall can occur into March then starts to deplete. Figure D-2 presents the snow depletion measured in snow water equivalent inches at the Grouse Camp SnoTel site.

Figure D-2
Snowpack Depletion at Grouse Camp SnoTel Site



The depletion of snowpack in April and May is 19 inches on average, and 2 inches for an extremely dry year. Additional snowmelt (and accumulation) occurs prior to April, so the total runoff would be greater than the snowpack depletion. The total volume of snowpack depletion over the 250 acre tributary basin would be about 400 acre-feet in April and May. The potential reservoir size is 95 acre-feet, so sufficient runoff should be available to fill the reservoir.

1.2.2 Water Yield at Upper Reach Mission Creek Lakes

These potential reservoir sites are near the East Fork site and would have similar hydrology. The lakes are located above 6000 ft. The tributary area to the lakes is 31 acres and the volume of snowpack depletion of that size of basin is estimated to be 49 acre-feet during the April-May time period. Some of the snowmelt is lost to infiltration into the ground and evapotranspiration. Since additional runoff occurs earlier in the year, the 51 acre-foot reservoirs should fill in average water years. In dry conditions, the reservoirs may not totally fill.

1.2.3 Water Yield at Little Camas Creek Reservoir

The tributary area to the Little Camas Creek Reservoir is 1.63 square miles. The average annual precipitation is 30 inches. The reservoir site is at an elevation of 3240 feet and would impound 926 acre-feet. No streamflow data is available for this creek. Using the same runoff characteristics as the other Mission Creek projects, the volume of snowmelt depletion expected in the April-May time frame would be about 1,600 acre-feet. Additional runoff would occur throughout winter so the reservoir should refill in average hydrologic conditions. In dry years, the reservoir may not fill. An issue for this site will the amount of water that will be permitted to be impounded as the storage will reduce streamflow in Camas

Creek and Mission Creek during the period of impoundment. Typically, instream flow studies are performed and flow targets throughout the year negotiated with agencies to determine how much flow can be captured.

1.2.4 Comparison of Diversions to Maximum Allocation

The maximum allocation proposed for Mission Creek is shown in Table D-2. The total annual allocation is approximately 700 acre-feet. With the proposed allocation, the Little Camas Creek reservoir could not be filled. A smaller reservoir could be investigated for the site that would divert less than the maximum allocation. The other reservoirs reviewed could be filled within the maximum allocation.

Table D-2
Proposed Maximum Allocation in Mission Creek Subwatershed

Time Period	Avg 50% Exceedance	Max Allocation	
		cfs	Acre-ft/day
	3	0	0
October	4	0.4	0.9
November	4	0.4	0.9
December	6	0.6	1.1
January	12	1.2	2.5
February 1-14	12	1.2	2.5
February 14-28	14	1.4	2.8
March 1-15	14	1.4	2.8
March 16-31	27	2.7	5.3
April	31	3.1	6.2
May	19	1.9	3.8
June	7	0	0
July	3	0	0
August 1-15	3	0.3	0.6
August 16-31	2	0	0
September 1-15	2	0	0

1.3 Peshastin Sub-Watershed

1.3.1 Water Yield at Campbell Off-Channel Reservoir

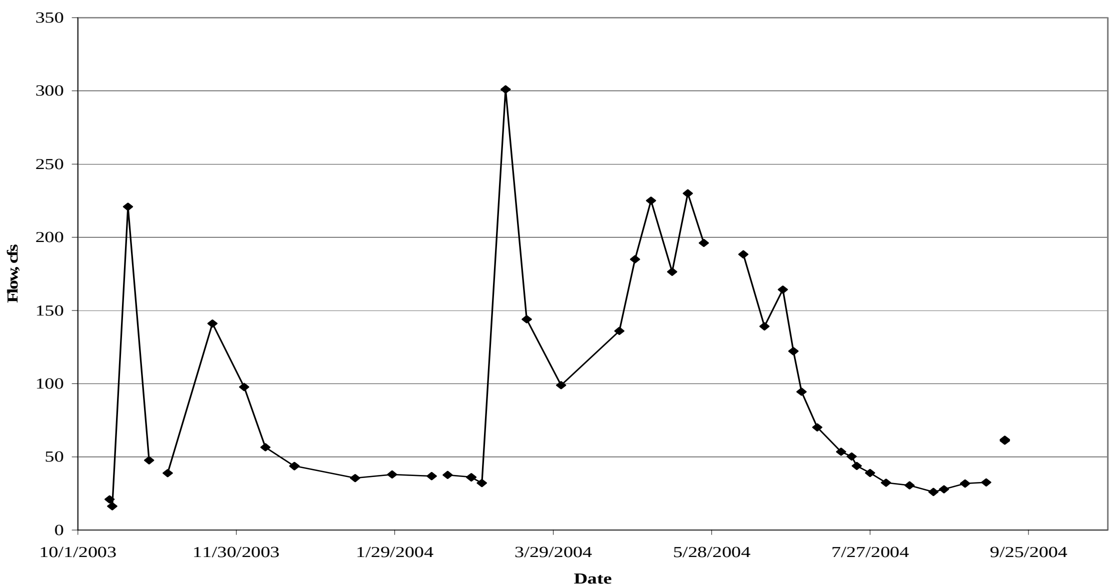
The sources of water for the reservoir would be Campbell Creek and Tandy Ditch. The Tandy ditch (now enclosed in a pipeline) diverts water from Peshastin Creek and conveys it past the base of the proposed reservoir. The pipeline capacity is 8 cfs. The Tandy pipeline could be used to fill the reservoir prior to irrigation season if water is available to divert. At a filling rate of 8 cfs, the reservoir would fill in just over one month.

Flow from Campbell Creek would also contribute to filling the reservoir. No streamflow data are available for that basin. The average annual precipitation in the basin is about 25 inches per year. The basin area is approximately 0.81 square miles. The closest creek with a stream gage is Brender Creek, however the gage is manually read and is affected by irrigation return flows. From scaling the basin areas it appears the average flow in Campbell Creek would be in the range of 1-2 cfs in winter and spring and less than one cfs in summer. The runoff in Campbell Creek would not likely fill the reservoir but would contribute flow to keep the reservoir full and offset evaporation losses.

1.3.2 Water Yield at Ingalls Creek Off-Channel Reservoir

No stream gaging information was found for Ingalls Creek. The closest stream gage is located on Peshastin Creek, downstream of the potential reservoir site and downstream of the confluence of Ingalls Creek and Peshastin Creek (https://fortress.wa.gov/ecy/wrx/wrx/flows/station.asp?sta=45F100). The Department of Ecology installed a staff gage that is periodically read at that site. Another staff gage is located on Peshastin Creek upstream of Ingalls Creek. The upstream staff gage is read on the same day as the downstream staff gage and the flow in Ingalls Creek is represented by the differences in flows between the two gages. Figure D-3 shows the flow in Ingalls Creek for the 2004 water year.

Figure D-3
Streamflow in Ingalls Creek

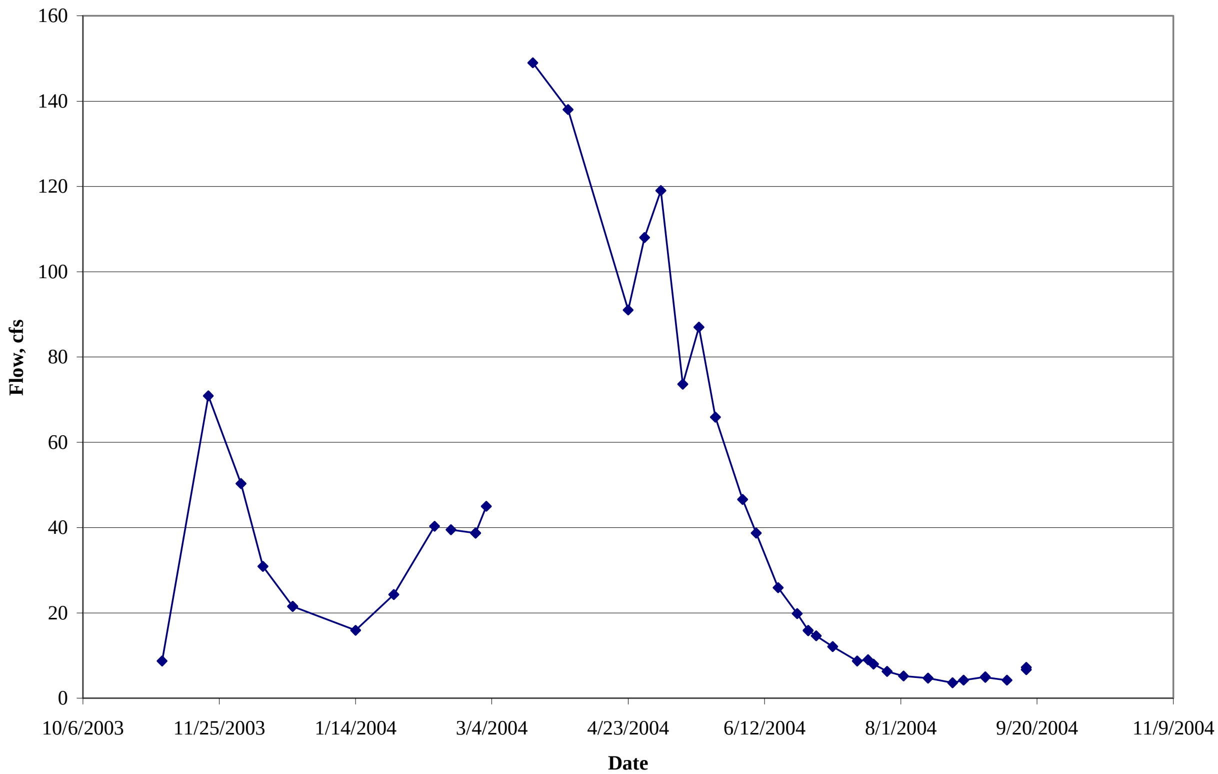


The streamflow in Ingalls Creek during spring melt ranged between 100 and 225 cfs in 2004. The size of the potential reservoir is 300 acre-feet which could be filled at a rate of 10 cfs diversion in 15 days or 5 cfs diversion for a month.

1.3.3 Water Yield at Tronsen Creek Off-Channel Reservoir

No stream gaging information was found for Tronsen Creek. The drainage area tributary to the potential reservoir site is 3.4 square miles. The proposed reservoir is at elevation 3900 feet and would have a volume of 175 acre-feet. The closest SnoTel site is located at Blewett Pass, very close to the basin. The average annual precipitation at that site is 36 inches. The closest stream gage is located on Peshastin Creek downstream of the potential reservoir site and upstream of its confluence with Ingalls Creek (https://fortress.wa.gov/ecy/wrx/wrx/flows/station.asp?sta=45F110). Figure D-5 shows the gage data.

Figure D-5
Peshastin Creek abv. Ingalls Creek



Scaling the flows measured by Ecology by basin area we would expect average flows at the site to be in the range of 5-15 cfs in winter and spring. Assuming a capture of 5 cfs during that time frame, the reservoir could be filled in 18 days, or 30 days at 3 cfs.

1.3.4 Water Yield at Negro Creek Instream Reservoir

No stream gaging information was found for Negro Creek. The drainage area tributary to the potential reservoir site is 5.8 square miles. The reservoir is an instream reservoir with a storage volume of 430 acre-feet. The reservoir configuration studied has a water surface elevation of 3905 ft at maximum stage. The closest stream gage is located on Peshastin Creek, downstream of the potential reservoir site and downstream of the confluence of Negro Creek and Peshastin Creek. The gage information for 2004 was presented in Table D-5.

Scaling the flows measured by Ecology by basin area we would expect average flows at the site to be in the range of 15-25 cfs in winter and spring. Assuming a capture of 5-10 cfs during that time frame, the reservoir could be filled in 20-40 days.

1.3.5 Comparison of Diversions to Maximum Allocation

The maximum allocation proposed for Peshastin Creek is shown in Table D-3. The maximum allocation would allow the Campbell Creek reservoir to fill at a rate of 6-7 cfs prior to the irrigation season. The Ingalls, Tronsen and Negro Creek reservoirs could be filled within the maximum allocation.

Table D-3
Proposed Maximum Allocation in Peshastin Creek Subwatershed

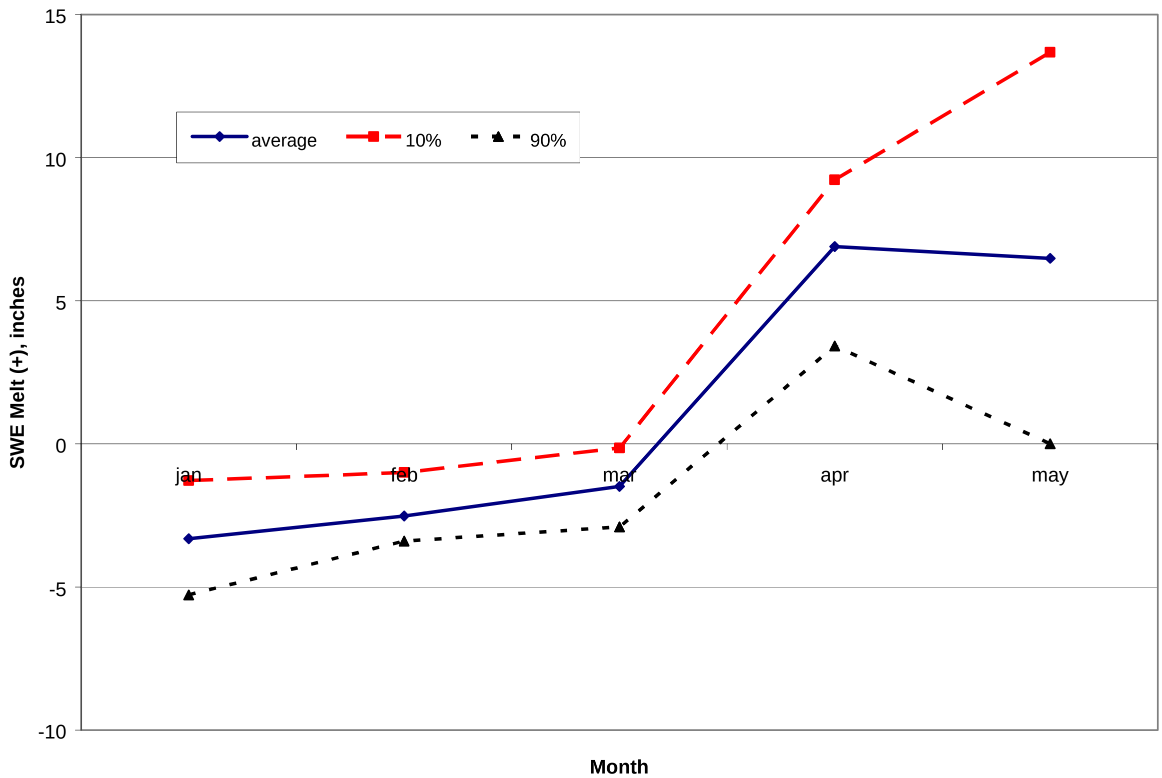
Time Period	Avg 50% Exceedance	Max Allocation	
		cfs	Acre-ft/day
October	165	0	0
November	235	23	46
December	249	25	50
January	215	21	42
February 1-14	199	20	40
February 14-28	193	0	0
March 1-15	238	0	0
March 16-31	238	0	0
April	590	59	117
May	1490	149	295
June	1752	175	347
July	762	76	150
August 1-15	279	28	55
August 16-31	179	0	0
September 1-15	145	0	0
September 16-30	145	0	0

1.4 Chumstick Sub-Watershed

1.4.1 Water Yield at Eagle Creek Tributary Lakes

The area tributary to the lakes is 0.42 square miles (270 acres). The lake configurations studied have a water level at elevation 3040 ft and 3977 ft. The potential storage volume of the expanded lakes is 79 acre-feet. Most of the precipitation falls as snow in the tributary drainage to the lakes. There is not a nearby SnoTel site. The Blewett Pass, Grouse Camp and Upper Wheeler SnoTel sites are located south of the Chumstick sub-watershed. However a review of their snowmelt depletion provides an estimate of the potential runoff. Section 1.2.1 described the snow depletion from Grouse Camp (elv 5380 ft) as 19 inches in April and May. For Upper Wheeler (elv. 4400 ft) the snowmelt depletion is 13 inches in April and May (see Figure D-6 below). The Upper Wheeler site is at a lower elevation which may be more representative of the snowpack at Eagle Lakes.

Figure D-6
Snowpack Depletion at Upper Wheeler SnoTel Site



At a snowpack depletion of 13 inches, the runoff is about 290 acre-feet in April and May. The runoff will be less because of losses to infiltration and evapotranspiration. However there should be sufficient runoff in average water years to fill the reservoirs.

1.4.2 Water Yield at Eagle Creek SW Tributary Lakes

The area tributary to the lakes is 0.0.09 square miles (59 acres). The potential storage volume of the expanded lakes is 54 acre-feet. The amount of runoff in April-May based upon the snowpack depletion described in the previous section is 64 acre-feet in average water years. Snowmelt also occurs prior to April so the basin runoff would likely fill the lakes in average water years. In dry years, the lakes may not fill.

1.4.3 Water Yield at East Van Creek Off-Channel Reservoir

The area tributary to the point at which a diversion into the reservoir would occur is 1258 acres (1.97 square miles. In addition, the area uphill of the reservoir is 270 acres. The potential storage reservoir is located at an elevation of 2600 ft. The reservoir would have a volume of 99 acre-feet. To estimate runoff, the flow measured at Eagle Creek was scaled by basin area. The estimated flow in late winter and early spring is 1-2 cfs. Assuming 1 cfs could be diverted; the reservoir would take 7 weeks to fill with water from East Van Creek. However, runoff from the uphill area that would drain into the reservoir would help fill it more quickly. Only 4.4 inches of runoff from the tributary basin would fill the reservoir without a diversion.

1.4.4 Comparison of Diversions to Maximum Allocation

There are no maximum allocations for the Chumstick subwatershed however an instream flow control point exists on the Wenatchee River at Peshastin, which is located downstream from where the Chumstick flows into the Wenatchee River. The proposed maximum allocation for all projects located upstream of the Peshastin control point (including the Chumstick subwatershed) ranges from 111 cfs in February to 335 cfs in April. As long as there is sufficient streamflow available in the Chumstick subwatershed the maximum allocation proposed in the Watershed Plan would not limit diversions into the potential reservoirs.

1.5 Icicle Sub-Watershed

No hydrologic calculations were performed for this sub-watershed. The most recent information available is from “Management Recommendations For Reservoir Releases From Upper Snow Lake: Leavenworth National Fish Hatchery” (Wurster, 2006) and “Water Management Plan For USFWS Leavenworth National Fish Hatchery” (Montgomery Water Group, 2004). Both of those studies conclude storage at Snow Lakes can be used to augment streamflow in Icicle Creek in late summer.

1.6 Nason Sub-Watershed

1.6.1 Water Yield at Mill Creek Instream Reservoir

No stream gaging information was found for Mill Creek. The closest stream gages are located on Nason Creek, near the mouth of the creek (https://fortress.wa.gov/ecy/wrx/wrx/flows/station.asp?sta=45J070) and on White Pine Creek (https://fortress.wa.gov/ecy/wrx/wrx/flows/station.asp?sta=45P050) which is a tributary to Nason Creek located east of Mill Creek. The Nason Creek gage is a continuous recording gage while the White Pine Creek gage is a staff gage that is read periodically. A hydrograph of the flow in Nason Creek for water year 2005 is shown in Figure D-7. A hydrograph of flow in White Pine Creek is shown in Figure D-8.

Figure D-7
Streamflow in Nason Creek - 2005

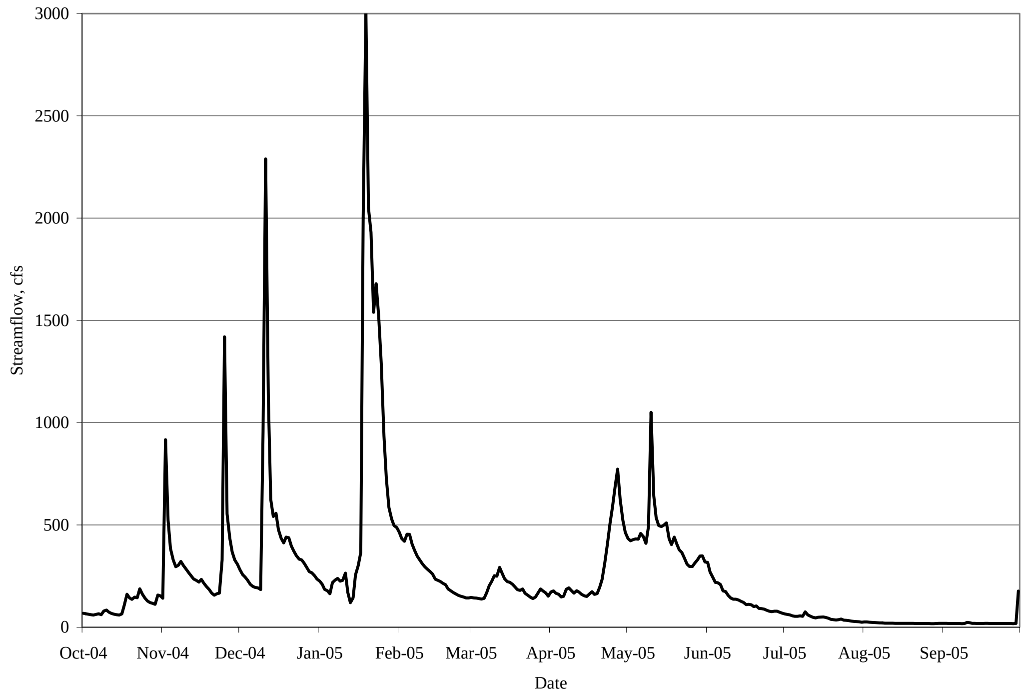
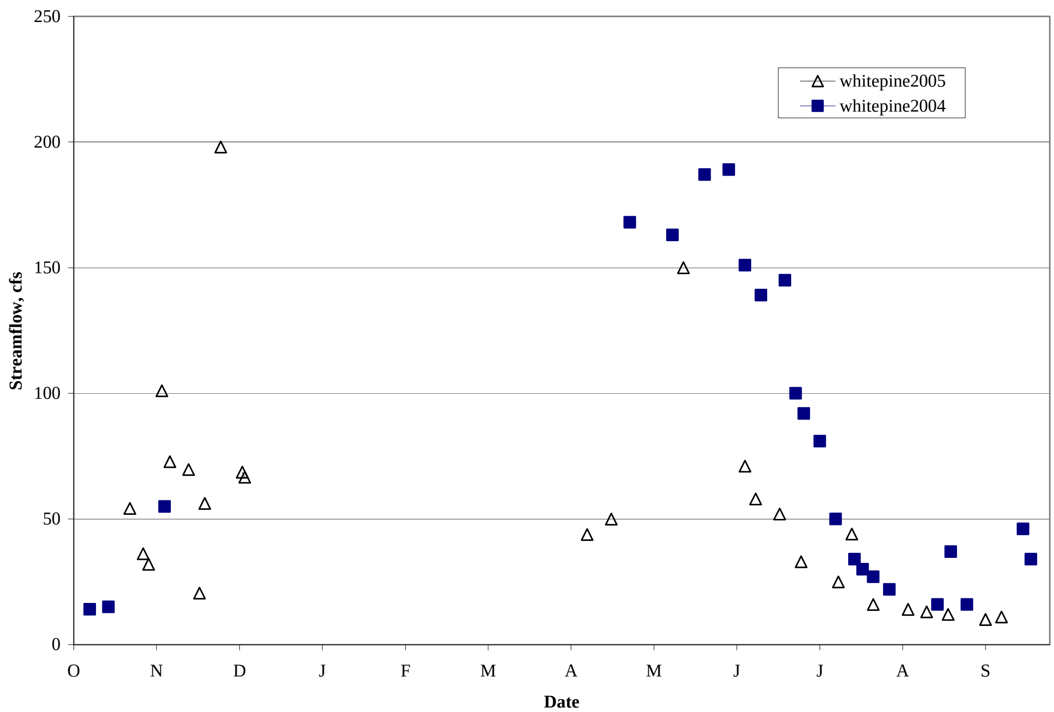
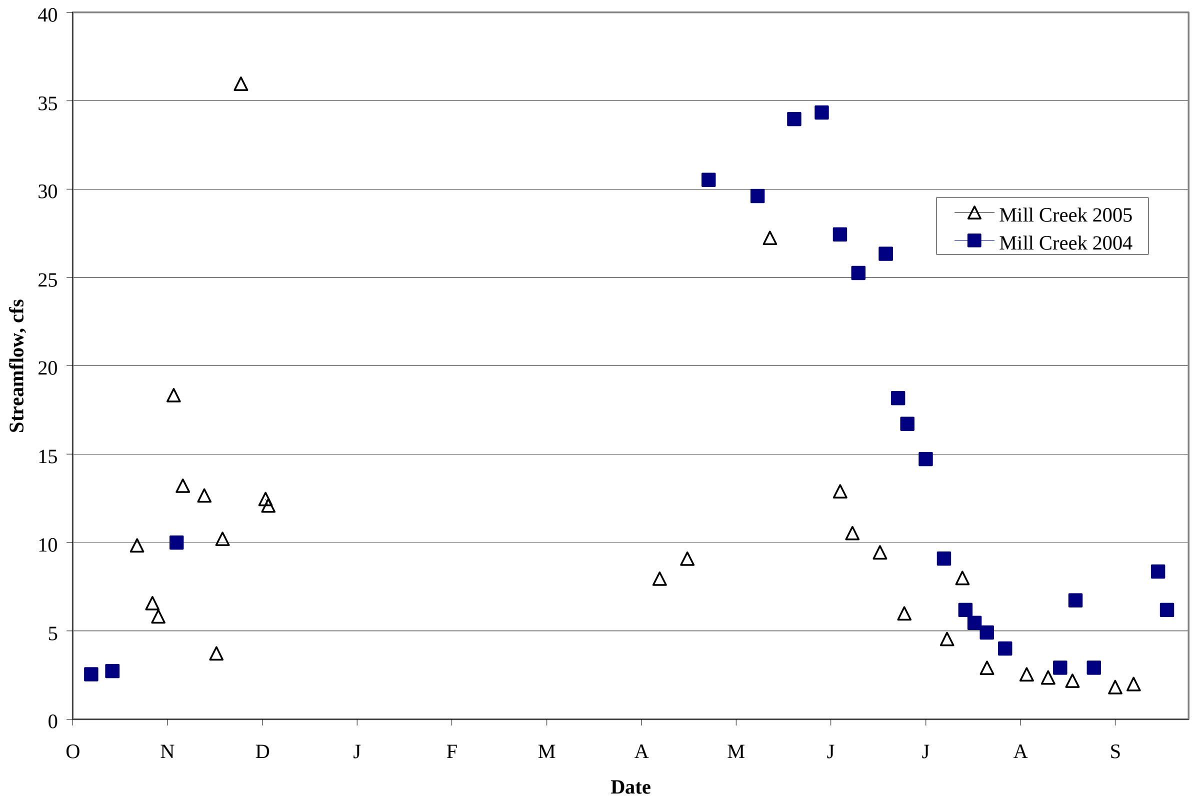


Figure D-8
White Pine Creek Streamflow



The drainage area of White Pine Creek is approximately 24.5 square miles. The average annual precipitation in the White Pine Creek basin is 80-90 inches which is similar to that of the Mill Creek basin. An estimate of streamflow in Mill Creek was made by scaling flows measured in White Pine Creek to the drainage area of the potential reservoir (4.45 square miles). Scaling the flows measured by Ecology by basin area we would expect average flows at the site to be in the range of 25-40 cfs in winter and spring. Assuming a capture of 10 cfs during that time frame, the reservoir could be filled in 65 days. Figure D-9 presents the estimated streamflow in Mill Creek.

Figure D-9
Estimated Streamflow in Mill Creek
(Scaled from White Pine Creek)



1.6.2 Comparison of Diversions to Maximum Allocation

The maximum allocation proposed for Nason Creek is shown in Table D-4. The maximum allocation would allow the Mill Creek reservoir to be filled at a rate of at least 10 cfs in late winter and early spring and at a higher rate in April and May if needed.

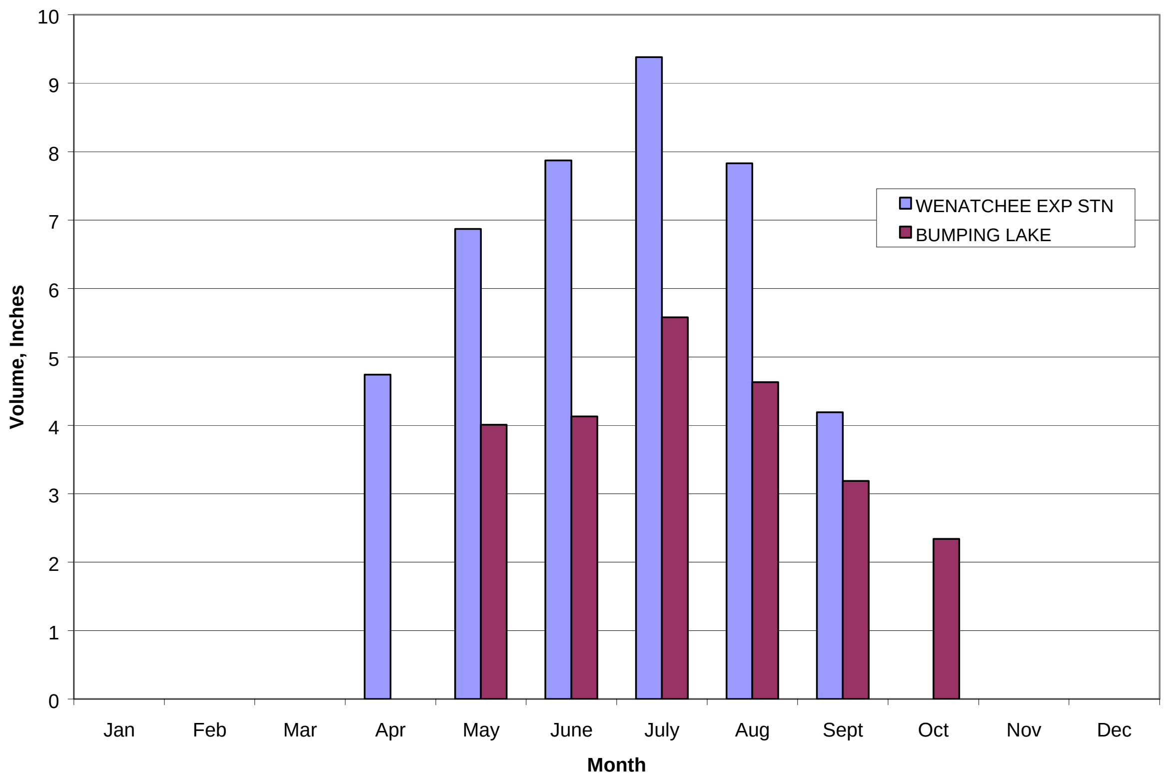
Table D-3
Proposed Maximum Allocation in Nason Creek Subwatershed

Time Period	Avg 50% Exceedance	Max Allocation	
		cfs	Acre-ft/day
October	88	0	0
November	153	15	30
December	148	15	30
January	126	13	26
February 1-14	119	12	24
February 14-28	119	12	24
March 1-15	154	15	30
March 16-31	154	15	30
April	437	44	87
May	988	99	196
June	1141	114	226
July	542	54	107
August 1-15	165	17	34
August 16-31	165	17	34
September 1-15	82	0	0
September 16-30	82	0	0

1.7 Reservoir Yield

The yield from each reservoir was estimated by assuming the reservoirs are full on April 1st and drawn down in late summer. An allowance for evaporation was made based upon evaporation measurements taken at the Wenatchee Experimental Station and at Bumping Lake, a high elevation lake (3440 ft) in the Yakima Watershed. Figure D-10 shows the average monthly evaporation in inches at the two measurement sites. Although evaporation will vary between the reservoir sites depending on elevation, an average evaporation of 24 inches was used for all the sites.

Figure D-10
Average Annual Evaporation at Wenatchee and Bumping Lake



In addition to evaporation, it was assumed that only 90% of the reservoir contents could be used because of dead storage requirements and limitations in draining the reservoirs. Table D-4 lists the estimated yield of the reservoirs assuming evaporation and 90% recovery of stored water.

Table D-4
Reservoir Yield Calculations

Sub-basin	Project	Volume, acre-feet	Max Water Surface Elevation, ft	Max. Water Surface Area, acres	Evaporation losses @2ft/summer, acre-feet	Yield over 30 days, cfs	Yield over 60 days, cfs
Chumstick	Eagle Creek Tributary Lakes	79	3,977/3,040	5.3	10.7	1.0	0.5
Chumstick	SW Eagle Creek Tributary Lakes	54	3,240/3,320	5.4	10.8	0.6	0.3
Chumstick	East Van Creek Off-Channel Reservoir	99	2600	4.2	8.5	1.3	0.7
Lower Wenatchee	Derby Canyon Off-Channel Reservoir	17	1180	1.4	2.9	0.2	0.1
Lower Wenatchee	Williams Canyon Off-Channel Reservoir	68	1640	3.5	7.1	0.9	0.4
Lower Wenatchee	Ollala Canyon Off-Channel Reservoir	9	2310	1.0	1.9	0.1	0.1
Lower Wenatchee	Nahahum Canyon Off-Channel Reservoir	165	1440	6.3	12.6	2.3	1.1
Mission	Little Camas Creek Reservoir	926	3240	30.2	60.4	12.9	6.4
Mission	East Fork Mission Creek Reservoir	95	4320	7.5	15.0	1.2	0.6
Mission	Upper Reach Mission Creek Lakes	51	6,360/6,050	6.8	13.6	0.5	0.3
Nason	Mill Creek Instream Reservoir	1363	3360	45.5	90.9	18.9	9.5
Peshastin	Negro Creek Instream Reservoir	437	3905	19.6	39.3	5.9	2.9
Peshastin	Ingalls Creek Off-Channel Reservoir	258	1870	10.7	21.4	3.5	1.8
Peshastin	Tronsen Creek Off-Channel Reservoir	175	3900	7.7	15.4	2.4	1.2
Peshastin	Campbell Creek Off-Channel Reservoir	504	1450	14.6	29.3	7.1	3.5
	Five acre-foot reservoir	5		0.7	1.4	0.05	0.03

Appendix E
Cost Estimates

Montgomery Water Group
Chelan County
Water Storage Evaluation 15-Jun-06

Eagle Creek Tributary Lakes (Chumstick Sub-basin)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	1.4	$5,000.00	$7,000
Logging	AC	1.4	$3,000.00	$4,200
Temporary & permanent access	LS	1	$25,000.00	$25,000
Stripping and stockpiling of organic material	CY	571	$5.00	$2,855
Erosion and sediment control	AC	1.4	$5,000.00	$7,000
Diversion and care of water	LS	1	$20,000.00	$20,000
Revegetation outer embankment	SY	3,670	$2.50	$9,175
Perimeter Fencing	LF	160	$12.00	$1,920
Reservoir Earthwork				
Foundation excavation and stockpile, soil	CY	3,424	$6.00	$20,544
Foundation excavation and stockpile, rock	CY	3,424	$15.00	$51,360
Foundation grouting allowance	SF	6,164	$5.00	$30,820
Cutoff trench excavation and stockpile, soil	CY	433	$6.00	$2,598
Toe and finger drains	LS	1	$4,000.00	$4,000
Reservoir excavation (cut)	CY	0	$3.00	$0
Reservoir embankment (imported fill)	CY	28,550	$12.00	$342,600
Reservoir embankment (fill with cut material)	CY	7,281	$6.00	$43,686
Disposal of excess cut material	CY	0	$4.00	$0
Dam crest surfacing	CY	335	$20.00	$6,700
Pipe and Fittings				
12" low-level outlet piping (concrete encased)	LF	630	$100.00	$63,000
12" Gate valve or Sluice gate on outlet	EA	2	$1,500.00	$3,000
Emergency Spillway/Overflow				
Overflow manhole structure	EA	2	$6,500.00	$13,000
18" overflow piping	LF	350	$50.00	$17,500
Overflow vent	LS	1	$4,000.00	$4,000
Appurtenances	LS	1	$8,000.00	$8,000
Subtotal				**$688,000**
Mobilization / Demobilization (10% of Subtotal (1))				$68,800
Subtotal - With Mobilization/Demobilization				**$757,000**
Contingency (30%)				$227,100
Engineering, design, enviromental review, permitting & construction management (20%)				$151,400
Subtotal - Construction, Engineering, Permitting				**$1,136,000**
Tax (7.7%)				$58,289
Est. Land Acquisition or Lease Cost	AC	6.9	$10,000.00	$69,000
Preliminary Construction Cost Estimate				**$1,263,000**
Additional Costs (if site soils are not suitable)				
HDPE Liner and subgrade prep	SY	13,810	$12.00	$165,720
Overex/Backfill to provide ballast for liner	CY	9,207	$8.00	$73,653

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SW Eagle Creek Tributary Lakes (Chumstick Sub-basin)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	0.7	$5,000.00	$3,500
Logging	AC	0.6	$3,000.00	$1,800
Temporary & permanent access	LS	1	$25,000.00	$25,000
Stripping and stockpiling of organic material	CY	278	$5.00	$1,390
Erosion and sediment control	AC	0.7	$5,000.00	$3,500
Diversion and care of water	LS	1	$20,000.00	$20,000
Revegetation outer embankment	SY	1,085	$2.50	$2,713
Perimeter Fencing	LF	160	$12.00	$1,920
Reservoir Earthwork				
Foundation excavation and stockpile, soil	CY	3,275	$6.00	$19,650
Foundation excavation and stockpile, rock	CY	3,275	$15.00	$49,125
Foundation grouting allowance	SF	2,999	$5.00	$14,995
Cutoff trench excavation and stockpile, soil	CY	318	$6.00	$1,908
Toe and finger drains	LS	1	$4,000.00	$4,000
Reservoir excavation (cut)	CY	0	$3.00	$0
Reservoir embankment (imported fill)	CY	6,868	$12.00	$82,416
Reservoir embankment (fill with cut material)	CY	5,955	$6.00	$35,730
Disposal of excess cut material	CY	913	$4.00	$3,652
Dam crest surfacing	CY	236	$20.00	$4,720
Pipe and Fittings				
12" low-level outlet piping (concrete encased)	LF	635	$100.00	$63,500
12" Gate valve or Sluice gate on outlet	EA	2	$1,500.00	$3,000
Emergency Spillway/Overflow				
Overflow manhole structure	EA	2	$6,500.00	$13,000
18" overflow piping	LF	2,250	$50.00	$112,500
Overflow vent	LS	1	$4,000.00	$4,000
Appurtenances	LS	1	$8,000.00	$8,000
Subtotal				**$480,000**
Mobilization / Demobilization (10% of Subtotal (1))				$48,000
Subtotal - With Mobilization/Demobilization				**$528,000**
Contingency (30%)				$158,400
Engineering, design, enviromental review, permitting & construction management (20%)				$105,600
Subtotal - Construction, Engineering, Permitting				**$792,000**
Tax (7.7%)				$3,696
Est. Land Acquisition or Lease Cost	AC	6.4	$10,000.00	$64,000
Preliminary Construction Cost Estimate				**$860,000**
Additional Costs (if site soils are not suitable)				
HDPE Liner and subgrade prep	SY	17,090	$12.00	$205,080
Overex/Backfill to provide ballast for liner	CY	11,394	$8.00	$91,152

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East Van Creek Off-Channel Reservoir (Chumstick Sub-basin)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	6.0	$5,000.00	$30,000
Logging	AC	6.0	$3,000.00	$18,000
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic material	CY	2,403	$5.00	$12,015
Erosion and sediment control	AC	6.0	$5,000.00	$30,000
Revegetation outer embankment	SY	4,902	$2.50	$12,255
Perimeter Fencing	LF	80	$12.00	$960
Reservoir Earthwork				
Foundation excavation and stockpile, soil	CY	4,863	$6.00	$29,178
Foundation excavation and stockpile, rock	CY	4,863	$15.00	$72,945
Foundation grouting allowance	SF	8,753	$5.00	$43,765
Toe and finger drains	LS	1	$6,000.00	$6,000
Reservoir excavation (cut)	CY	89,975	$3.00	$269,925
Reservoir embankment (imported fill)	CY	9,726	$12.00	$116,712
Reservoir embankment (fill with cut material)	CY	40,458	$6.00	$242,748
Disposal of excess cut material	CY	59,243	$4.00	$236,972
Dam crest surfacing	CY	479	$20.00	$9,580
Reservoir Liner				
HDPE Liner and subgrade prep	SY	21,700	$12.00	$260,400
Overex/Backfill to provide ballast for liner	CY	14,467	$8.00	$115,733
Diversion				
Diversion structure	CFS	2	$40,000.00	$80,000
Pipe and Fittings				
12" inlet piping (gravity)	LF	785	$15.00	$11,775
12" low-level outlet piping (concrete encased)	LF	230	$100.00	$23,000
12" Gate valve or Sluice gate on outlet	EA	1	$1,500.00	$1,500
Emergency Spillway/Overflow				
Overflow manhole structure	EA	1	$6,500.00	$6,500
24" overflow piping	LF	210	$75.00	$15,750
Overflow vent	LS	1	$2,000.00	$2,000
Appurtenances	LS	1	$4,000.00	$4,000
Subtotal				$1,667,000
Mobilization / Demobilization (10% of Subtotal (1)				$166,700
Subtotal - With Mobilization/Demobilization				**$1,834,000**
Contingency (30%)				$550,200
Engineering, design, enviromental review, permitting & construction management (20%)				$366,800
Subtotal - Construction, Engineering, Permitting				**$2,751,000**
Tax (7.7%)				$211,827
Est. Land Acquisition or Lease Cost	AC	6.3	$10,000.00	$63,000
Preliminary Construction Cost Estimate				**$3,026,000**
Additional Costs (if site soils are not suitable)				
Embankment fill haul	CY	40,458	$10.00	$404,580
Disposal of excess cut material	CY	40,458	$4.00	$161,832

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Derby Canyon Off-Channel Reservoir (Lower Wenatchee Sub-basin)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	3.2	$5,000.00	$16,000
Logging	AC	3.2	$3,000.00	$9,600
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic material	CY	1,279	$5.00	$6,395
Erosion and sediment control	AC	3.2	$5,000.00	$16,000
Revegetation outer embankment	SY	5,901	$2.50	$14,753
Perimeter Fencing	LF	80	$12.00	$960
Reservoir Earthwork				
Foundation excavation and stockpile, soil	CY	10,450	$6.00	$62,700
Foundation excavation and stockpile, rock	CY	0	$15.00	$0
Foundation grouting allowance	SF	9,402	$5.00	$47,010
Toe and finger drains	LS	1	$6,000.00	$6,000
Reservoir excavation (cut)	CY	2,921	$3.00	$8,763
Reservoir embankment (imported fill)	CY	42,485	$12.00	$509,820
Reservoir embankment (fill with cut material)	CY	13,371	$6.00	$80,226
Disposal of excess cut material	CY	0	$4.00	$0
Dam crest surfacing	CY	410	$20.00	$8,200
Reservoir Liner				
HDPE Liner and subgrade prep	SY	7,340	$12.00	$88,080
Overex/Backfill to provide ballast for liner	CY	4,893	$8.00	$39,147
Diversion				
Diversion structure	CFS	1	$40,000.00	$40,000
Pipe and Fittings				
12" inlet piping (gravity)	LF	1,275	$15.00	$19,125
12" low-level outlet piping (concrete encased)	LF	190	$100.00	$19,000
12" Gate valve or Sluice gate on outlet	EA	1	$1,500.00	$1,500
Emergency Spillway/Overflow				
Overflow manhole structure	EA	1	$6,500.00	$6,500
18" overflow piping	LF	215	$50.00	$10,750
Overflow vent	LS	1	$2,000.00	$2,000
Appurtenances	LS	1	$4,000.00	$4,000
Subtotal				**$1,032,000**
Mobilization / Demobilization (10% of Subtotal (1)				$103,200
Subtotal - With Mobilization/Demobilization				**$1,135,000**
Contingency (30%)				$340,500
Engineering, design, enviromental review, permitting & construction management (20%)				$227,000
Subtotal - Construction, Engineering, Permitting				**$1,703,000**
Tax (7.7%)				$87,395
Est. Land Acquisition or Lease Cost	AC	3.4	$10,000.00	$33,600
Preliminary Construction Cost Estimate				**$1,824,000**
Additional Costs (if site soils are not suitable)				
Embankment fill haul	CY	2,921	$10.00	$29,210
Disposal of excess cut material	CY	2,921	$4.00	$11,684

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Williams Canyon Off-Channel Reservoir (Lower Wenatchee Sub-basin)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	6.9	$5,000.00	$34,500
Logging	AC	3.4	$3,000.00	$10,200
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic material	CY	2,770	$5.00	$13,850
Erosion and sediment control	AC	6.9	$5,000.00	$34,500
Revegetation outer embankment	SY	11,610	$2.50	$29,025
Perimeter Fencing	LF	80	$12.00	$960
Reservoir Earthwork				
Foundation excavation and stockpile, soil	CY	10,796	$6.00	$64,776
Foundation excavation and stockpile, rock	CY	10,796	$15.00	$161,940
Foundation grouting allowance	SF	19,432	$5.00	$97,160
Toe and finger drains	LS	1	$8,000.00	$8,000
Reservoir excavation (cut)	CY	20,408	$3.00	$61,224
Reservoir embankment (imported fill)	CY	131,856	$12.00	$1,582,272
Reservoir embankment (fill with cut material)	CY	42,000	$6.00	$252,000
Disposal of excess cut material	CY	0	$4.00	$0
Dam crest surfacing	CY	676	$20.00	$13,520
Reservoir Liner				
HDPE Liner and subgrade prep	SY	19,200	$12.00	$230,400
Overex/Backfill to provide ballast for liner	CY	12,775	$8.00	$102,200
Diversion				
Diversion structure	CFS	1	$40,000.00	$40,000
Pipe and Fittings				
12" inlet piping (gravity)	LF	780	$15.00	$11,700
12" low-level outlet piping (concrete encased)	LF	310	$100.00	$31,000
12" Gate valve or Sluice gate on outlet	EA	1	$1,500.00	$1,500
Emergency Spillway/Overflow				
Overflow manhole structure	EA	1	$6,500.00	$6,500
24" overflow piping	LF	280	$75.00	$21,000
Overflow vent	LS	1	$2,000.00	$2,000
Appurtenances	LS	1	$4,000.00	$4,000
Subtotal				**$2,829,000**
Mobilization / Demobilization (10% of Subtotal (1)				$282,900
Subtotal - With Mobilization/Demobilization				**$3,112,000**
Contingency (30%)				$933,600
Engineering, design, enviromental review, permitting & construction management (20%)				$622,400
Subtotal - Construction, Engineering, Permitting				**$4,668,000**
Tax (7.7%)				$239,624
Est. Land Acquisition or Lease Cost	AC	7.2	$10,000.00	$72,450
Preliminary Construction Cost Estimate				**$4,980,000**
Additional Costs (if site soils are not suitable)				
Embankment fill haul	CY	20,408	$10.00	$204,080
Disposal of excess cut material	CY	20,408	$4.00	$81,632

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Ollala Canyon Off-Channel Reservoir (Lower Wenatchee Sub-basin)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	2.9	$5,000.00	$14,500
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic material	CY	1,186	$5.00	$5,930
Erosion and sediment control	AC	2.9	$5,000.00	$14,500
Revegetation outer embankment	SY	6,080	$2.50	$15,200
Perimeter Fencing	LF	80	$12.00	$960
Reservoir Earthwork				
Foundation excavation and stockpile, soil	CY	11,517	$6.00	$69,102
Foundation excavation and stockpile, rock	CY	0	$15.00	$0
Foundation grouting allowance	SF	10,365	$5.00	$51,825
Toe and finger drains	LS	1	$10,000.00	$10,000
Reservoir excavation (cut)	CY	3,246	$3.00	$9,738
Reservoir embankment (imported fill)	CY	37,976	$12.00	$455,712
Reservoir embankment (fill with cut material)	CY	14,763	$6.00	$88,578
Disposal of excess cut material	CY	0	$4.00	$0
Dam crest surfacing	CY	635	$20.00	$12,708
Reservoir Liner				
HDPE Liner and subgrade prep	SY	5,050	$12.00	$60,600
Overex/Backfill to provide ballast for liner	CY	3,363	$8.00	$26,904
Diversion				
Diversion structure	CFS	0.5	$40,000.00	$20,000
Pipe and Fittings				
12" inlet piping (gravity)	LF	370	$15.00	$5,550
12" low-level outlet piping (concrete encased)	LF	165	$100.00	$16,500
12" Gate valve or Sluice gate on outlet	EA	1	$1,500.00	$1,500
Emergency Spillway/Overflow				
Overflow manhole structure	EA	1	$6,500.00	$6,500
18" overflow piping	LF	115	$50.00	$5,750
Overflow vent	LS	1	$2,000.00	$2,000
Appurtenances	LS	1	$4,000.00	$4,000
Subtotal				**$913,000**
Mobilization / Demobilization (10% of Subtotal (1))				$91,300
Subtotal - With Mobilization/Demobilization				**$1,004,000**
Contingency (30%)				$301,200
Engineering, design, enviromental review, permitting & construction management (20%)				$200,800
Subtotal - Construction, Engineering, Permitting				**$1,506,000**
Tax (7.7%)				$77,308
Est. Land Acquisition or Lease Cost	AC	3.0	$10,000.00	$30,450
Preliminary Construction Cost Estimate				**$1,614,000**
Additional Costs (if site soils are not suitable)				
Embankment fill haul	CY	3,246	$10.00	$32,460
Disposal of excess cut material	CY	3,246	$4.00	$12,984

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Nahahum Canyon Off-Channel Reservoir (Lower Wenatchee Sub-basin)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	9.6	$5,000.00	$48,000
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic material	CY	3,857	$5.00	$19,285
Erosion and sediment control	AC	9.6	$5,000.00	$48,000
Revegetation outer embankment	SY	9,477	$2.50	$23,693
Perimeter Fencing	LF	80	$12.00	$960
Reservoir Earthwork				
Foundation excavation and stockpile, soil	CY	21,911	$6.00	$131,466
Foundation excavation and stockpile, rock	CY	0	$15.00	$0
Foundation grouting allowance	SF	20,080	$5.00	$100,400
Toe and finger drains	LS	1	$8,000.00	$8,000
Reservoir excavation (cut)	CY	116,140	$3.00	$348,420
Reservoir embankment (imported fill)	CY	21,911	$12.00	$262,932
Reservoir embankment (fill with cut material)	CY	104,685	$6.00	$628,110
Disposal of excess cut material	CY	33,365	$4.00	$133,460
Dam crest surfacing	CY	925	$20.00	$18,500
Reservoir Liner				
HDPE Liner and subgrade prep	SY	32,030	$12.00	$384,360
Overex/Backfill to provide ballast for liner	CY	3,363	$8.00	$26,904
Diversion				
Diversion structure	CFS	2	$40,000.00	$80,000
Pipe and Fittings				
18" inlet piping (gravity)	LF	590	$20.00	$11,800
18" low-level outlet piping (concrete encased)	LF	355	$135.00	$47,925
18" Gate valve or Sluice gate on outlet	EA	1	$3,500.00	$3,500
Emergency Spillway/Overflow				
Overflow manhole structure	EA	1	$6,500.00	$6,500
24" overflow piping	LF	330	$75.00	$24,750
Overflow vent	LS	1	$2,000.00	$2,000
Appurtenances	LS	1	$4,000.00	$4,000
Subtotal				**$2,378,000**
Mobilization / Demobilization (10% of Subtotal (1)				$237,800
Subtotal - With Mobilization/Demobilization				**$2,616,000**
Contingency (30%)				$784,800
Engineering, design, enviromental review, permitting & construction management (20%)				$523,200
Subtotal - Construction, Engineering, Permitting				**$3,924,000**
Tax (7.7%)				$201,432
Est. Land Acquisition or Lease Cost	AC	10.1	$10,000.00	$100,800
Preliminary Construction Cost Estimate				**$4,226,000**
Additional Costs (if site soils are not suitable)				
Embankment fill haul	CY	116,140	$10.00	$1,161,400
Disposal of excess cut material	CY	116,140	$4.00	$464,560

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Little Camas Creek In-stream Reservoir (Mission Sub-basin)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	34.8	$5,000.00	$174,000
Logging	AC	20.9	$3,000.00	$62,640
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic material	CY	14,026	$5.00	$70,130
Diversion and care of water	LS	1	$30,000.00	$30,000
Erosion and sediment control	AC	34.8	$5,000.00	$174,000
Revegetation outer embankment	SY	11,710	$2.50	$29,275
Perimeter Fencing	LF	80	$12.00	$960
Reservoir Earthwork				
Foundation excavation and stockpile, soil	CY	13,067	$6.00	$78,402
Foundation excavation and stockpile, rock	CY	13,067	$15.00	$196,005
Foundation grouting allowance	SF	23,521	$5.00	$117,604
Cutoff trench excavation and stockpile, soil	CY	1,700	$6.00	$10,200
Toe and finger drains	LS	1	$10,000.00	$10,000
Reservoir excavation (cut)	CY	0	$3.00	$0
Reservoir embankment (imported fill)	CY	216,190	$12.00	$2,594,280
Reservoir embankment (fill with cut material)	CY	26,134	$6.00	$156,804
Disposal of excess cut material	CY	0	$4.00	$0
Dam crest surfacing	CY	563	$20.00	$11,260
Fishway				
Fishway	LS	1	$250,000.00	$250,000
Pipe and Fittings				
24" low-level outlet piping (concrete encased)	LF	360	$150.00	$54,000
24" Gate valve or Sluice Gate	EA	1	$5,500.00	$5,500
Emergency Spillway/Overflow				
Spillway Channel	LF	397	$100.00	$39,700
Subtotal				**$4,080,000**
Mobilization / Demobilization (10% of Subtotal (1))				$408,000
Subtotal - With Mobilization/Demobilization				**$4,488,000**
Contingency (30%)				$1,346,400
Engineering, design, enviromental review, permitting & construction management (20%)				$897,600
Subtotal - Construction, Engineering, Permitting				**$6,732,000**
Tax (7.7%)				$345,576
Est. Land Acquisition or Lease Cost	AC	36.5	$10,000.00	$365,400
Preliminary Construction Cost Estimate				**$7,443,000**

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East Fork Mission Creek Reservoir (Mission Sub-basin)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	12.1	$5,000.00	$60,500
Logging	AC	7.2	$3,000.00	$21,600
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic material	CY	4,864	$5.00	$24,320
Erosion and sediment control	AC	12.1	$5,000.00	$60,500
Revegetation outer embankment	SY	14,678	$2.50	$36,695
Perimeter Fencing	LF	80	$12.00	$960
Reservoir Earthwork				
Foundation excavation and stockpile, soil	CY	29,944	$6.00	$179,664
Foundation excavation and stockpile, rock	CY	0	$15.00	$0
Foundation grouting allowance	SF	26,950	$5.00	$134,750
Toe and finger drains	LS	1	$10,000.00	$10,000
Reservoir excavation (cut)	CY	47,720	$3.00	$143,160
Reservoir embankment (imported fill)	CY	94,814	$12.00	$1,137,768
Reservoir embankment (fill with cut material)	CY	77,664	$6.00	$465,984
Disposal of excess cut material	CY	0	$4.00	$0
Dam crest surfacing	CY	1,030	$20.00	$20,600
Reservoir Liner				
HDPE Liner and subgrade prep	SY	37,220	$12.00	$446,640
Overex/Backfill to provide ballast for liner	CY	24,813	$8.00	$198,507
Diversion				
Diversion structure	CFS	1	$40,000.00	$40,000
Pipe and Fittings				
12" inlet piping (gravity)	LF	1,180	$15.00	$17,700
12" low-level outlet piping (concrete encased)	LF	315	$100.00	$31,500
12" Gate valve or Sluice gate on outlet	EA	1	$1,500.00	$1,500
Emergency Spillway/Overflow				
Overflow manhole structure	EA	1	$6,500.00	$6,500
24" overflow piping	LF	454	$75.00	$34,050
Overflow vent	LS	1	$2,000.00	$2,000
Appurtenances	LS	1	$4,000.00	$4,000
Subtotal				**$3,094,000**
Mobilization / Demobilization (10% of Subtotal (1)				$309,400
Subtotal - With Mobilization/Demobilization				**$3,403,000**
Contingency (30%)				$1,020,900
Engineering, design, enviromental review, permitting & construction management (20%)				$680,600
Subtotal - Construction, Engineering, Permitting				**$5,105,000**
Tax (7.7%)				$262,031
Est. Land Acquisition or Lease Cost	AC	12.7	$10,000.00	$127,050
Preliminary Construction Cost Estimate				**$5,494,000**
Additional Costs (if site soils are not suitable)				
Embankment fill haul	CY	47,720	$10.00	$477,200
Disposal of excess cut material	CY	47,720	$4.00	$190,880

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Upper Reach Mission Lakes (Mission Sub-basin)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	1.3	$5,000.00	$6,500
Logging	AC	1.3	$3,000.00	$3,900
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic material	CY	507	$5.00	$2,535
Erosion and sediment control	AC	1.3	$5,000.00	$6,500
Diversion and care of water	LS	1	$20,000.00	$20,000
Revegetation outer embankment	SY	2,378	$2.50	$5,945
Perimeter Fencing	LF	80	$12.00	$960
Reservoir Earthwork				
Foundation excavation and stockpile, soil	CY	6,091	$6.00	$36,546
Foundation excavation and stockpile, rock	CY	0	$15.00	$0
Foundation grouting allowance	SF	5,482	$5.00	$27,410
Cutoff trench excavation and stockpile, soil	CY	667	$6.00	$4,002
Toe and finger drains	LS	1	$4,000.00	$4,000
Reservoir excavation (cut)	CY	0	$3.00	$0
Reservoir embankment (imported fill)	CY	14,570	$12.00	$174,840
Reservoir embankment (fill with cut material)	CY	6,091	$6.00	$36,546
Disposal of excess cut material	CY	0	$4.00	$0
Dam crest surfacing	CY	508	$20.00	$10,160
Pipe and Fittings				
12" low-level outlet piping (concrete encased)	LF	400	$100.00	$40,000
12" Gate valve or Sluice gate on outlet	EA	2	$1,500.00	$3,000
Emergency Spillway/Overflow				
Overflow manhole structure	EA	2	$6,500.00	$13,000
18" overflow piping	LF	5,080	$50.00	$254,000
Overflow vent	LS	1	$4,000.00	$4,000
Appurtenances	LS	1	$8,000.00	$8,000
Subtotal				**$677,000**
Mobilization / Demobilization (10% of Subtotal (1))				$67,700
Subtotal - With Mobilization/Demobilization				**$745,000**
Contingency (30%)				$223,500
Engineering, design, enviromental review, permitting & construction management (20%)				$149,000
Subtotal - Construction, Engineering, Permitting				**$1,118,000**
Tax (7.7%)				$57,365
Est. Land Acquisition or Lease Cost	AC	8.4	$10,000.00	$84,000
Preliminary Construction Cost Estimate				**$1,259,000**
Additional Costs (if site soils are not suitable)				
HDPE Liner and subgrade prep	SY	23,860	$12.00	$286,320
Overex/Backfill to provide ballast for liner	CY	15,907	$8.00	$127,253

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Mill Creek In-stream Reservoir (Nason Sub-basin)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	50.3	$5,000.00	$251,500
Logging	AC	20.1	$3,000.00	$60,360
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic material	CY	20,287	$5.00	$101,435
Diversion and care of water	LS	1	$30,000.00	$30,000
Erosion and sediment control	AC	50.3	$5,000.00	$251,500
Revegetation outer embankment	SY	9,390	$2.50	$23,475
Perimeter Fencing	LF	80	$12.00	$960
Reservoir Earthwork				
Foundation excavation and stockpile, soil	CY	21,330	$6.00	$127,980
Foundation excavation and stockpile, rock	CY	0	$15.00	$0
Foundation grouting allowance	SF	19,200	$5.00	$96,000
Cutoff trench excavation and stockpile, soil	CY	1,630	$6.00	$9,780
Toe and finger drains	LS	1	$8,000.00	$8,000
Reservoir excavation (cut)	CY	0	$3.00	$0
Reservoir embankment (imported fill)	CY	172,701	$12.00	$2,072,412
Reservoir embankment (fill with cut material)	CY	21,330	$6.00	$127,980
Disposal of excess cut material	CY	0	$4.00	$0
Dam crest surfacing	CY	544	$20.00	$10,880
Pipe and Fittings				
48" low-level outlet piping (concrete encased)	LF	290	$250.00	$72,500
48" Gate valve or Sluice Gate	EA	1	$12,000.00	$12,000
Fishway				
Fishway	LS	1	$250,000.00	$250,000
Emergency Spillway/Overflow				
Spillway Channel	LF	374	$100.00	$37,400
Subtotal				**$3,559,000**
Mobilization / Demobilization (10% of Subtotal (1))				$355,900
Subtotal - With Mobilization/Demobilization				**$3,915,000**
Contingency (30%)				$1,174,500
Engineering, design, enviromental review, permitting & construction management (20%)				$783,000
Subtotal - Construction, Engineering, Permitting				**$5,873,000**
Tax (7.7%)				$301,455
Est. Land Acquisition or Lease Cost	AC	52.8	$10,000.00	$528,150
Preliminary Construction Cost Estimate				**$6,703,000**

Negro Creek Instream Reservoir (Peshastin Sub-basin)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	22.1	$5,000.00	$110,500
Logging	AC	22.1	$3,000.00	$66,300
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic material	CY	8,909	$5.00	$44,545
Diversion and care of water	LS	1	$30,000.00	$30,000
Erosion and sediment control	AC	22.1	$5,000.00	$110,500
Revegetation outer embankment	SY	4,882	$2.50	$12,205
Perimeter Fencing	LF	80	$12.00	$960
Reservoir Earthwork				
Foundation excavation and stockpile, soil	CY	12,167	$6.00	$73,002
Foundation excavation and stockpile, rock	CY	0	$15.00	$0
Foundation grouting allowance	SF	10,950	$5.00	$54,750
Cutoff trench excavation and stockpile, soil	CY	1,277	$6.00	$7,662
Toe and finger drains	LS	1	$10,000.00	$10,000
Reservoir excavation (cut)	CY	0	$3.00	$0
Reservoir embankment (imported fill)	CY	77,010	$12.00	$924,120
Reservoir embankment (fill with cut material)	CY	12,167	$6.00	$73,002
Disposal of excess cut material	CY	0	$4.00	$0
Dam crest surfacing	CY	426	$20.00	$8,520
Pipe and Fittings				
24" low-level outlet piping (concrete encased)	LF	295	$150.00	$44,250
24" Gate valve or Sluice Gate	EA	1	$5,500.00	$5,500
Fishway				
Fishway	LS	1	$250,000.00	$250,000
Emergency Spillway/Overflow				
Spillway Channel	LF	257	$100.00	$25,700
Subtotal				**$1,867,000**
Mobilization / Demobilization (10% of Subtotal (1)				$186,700
Subtotal - With Mobilization/Demobilization				**$2,054,000**
Contingency (30%)				$616,200
Engineering, design, enviromental review, permitting & construction management (20%)				$410,800
Subtotal - Construction, Engineering, Permitting				**$3,081,000**
Tax (7.7%)				$158,158
Est. Land Acquisition or Lease Cost	AC	23.2	$10,000.00	$232,050
Preliminary Construction Cost Estimate				**$3,471,000**

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Ingalls Creek Off-Channel Reservoir (Peshastin Sub-basin)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	16.0	$5,000.00	$80,000
Logging	AC	16.0	$3,000.00	$48,000
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic material	CY	6,453	$5.00	$32,265
Erosion and sediment control	AC	16.0	$5,000.00	$80,000
Revegetation outer embankment	SY	15,052	$2.50	$37,630
Perimeter Fencing	LF	80	$12.00	$960
Reservoir Earthwork				
Foundation excavation and stockpile, soil	CY	33,453	$6.00	$200,718
Foundation excavation and stockpile, rock	CY	0	$15.00	$0
Foundation grouting allowance	SF	30,108	$5.00	$150,540
Toe and finger drains	LS	1	$10,000.00	$10,000
Reservoir excavation (cut)	CY	156,278	$3.00	$468,834
Reservoir embankment (imported fill)	CY	33,453	$12.00	$401,436
Reservoir embankment (fill with cut material)	CY	170,026	$6.00	$1,020,156
Disposal of excess cut material	CY	19,705	$4.00	$78,820
Dam crest surfacing	CY	1,524	$20.00	$30,480
Reservoir Liner				
HDPE Liner and subgrade prep	SY	53,439	$12.00	$641,268
Overex/Backfill to provide ballast for liner	CY	35,626	$8.00	$285,008
Diversion				
Diversion structure	CFS	2	$40,000.00	$80,000
Pipe and Fittings				
18" inlet piping (gravity)	LF	760	$20.00	$15,200
18" low-level outlet piping (concrete encased)	LF	190	$135.00	$25,650
18" Gate valve or Sluice gate on outlet	EA	1	$3,500.00	$3,500
Emergency Spillway/Overflow				
Overflow manhole structure	EA	1	$6,500.00	$6,500
24" DI overflow piping	LF	220	$75.00	$16,500
Overflow vent	LS	1	$2,000.00	$2,000
Appurtenances	LS	1	$4,000.00	$4,000
Subtotal				**$3,734,000**
Mobilization / Demobilization (10% of Subtotal (1)				$373,400
Subtotal - With Mobilization/Demobilization				**$4,107,000**
Contingency (30%)				$1,232,100
Engineering, design, enviromental review, permitting & construction management (20%)				$821,400
Subtotal - Construction, Engineering, Permitting				**$6,161,000**
Tax (7.7%)				$316,239
Est. Land Acquisition or Lease Cost	AC	16.8	$10,000.00	$168,000
Preliminary Construction Cost Estimate				**$6,645,000**
Additional Costs (if site soils are not suitable)				
Embankment fill haul	CY	170,026	$10.00	$1,700,260
Disposal of excess cut material	CY	170,026	$4.00	$680,104

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Tronsen Creek Off-Channel Reservoir (Peshastin Sub-basin)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	12.9	$5,000.00	$64,500
Logging	AC	12.9	$3,000.00	$38,700
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic material	CY	5,217	$5.00	$26,085
Erosion and sediment control	AC	12.9	$5,000.00	$64,500
Revegetation outer embankment	SY	16,334	$2.50	$40,835
Perimeter Fencing	LF	80	$12.00	$960
Reservoir Earthwork				
Foundation excavation and stockpile, soil	CY	20,970	$6.00	$125,820
Foundation excavation and stockpile, rock	CY	20,970	$15.00	$314,550
Foundation grouting allowance	SF	18,873	$5.00	$94,365
Toe and finger drains	LS	1	$10,000.00	$10,000
Reservoir excavation (cut)	CY	310,977	$3.00	$932,931
Reservoir embankment (imported fill)	CY	41,940	$12.00	$503,280
Reservoir embankment (fill with cut material)	CY	128,419	$6.00	$770,514
Disposal of excess cut material	CY	224,499	$4.00	$897,996
Dam crest surfacing	CY	1,365	$20.00	$27,300
Reservoir Liner				
HDPE Liner and subgrade prep	SY	38,560	$12.00	$462,720
Overex/Backfill to provide ballast for liner	CY	25,707	$8.00	$205,653
Diversion				
Diversion structure	CFS	4	$40,000.00	$160,000
Pipe and Fittings				
24" inlet piping (gravity)	LF	510	$28.00	$14,280
Highway Crossing	LS	1	$50,000.00	$50,000
24" low-level outlet piping (concrete encased)	LF	215	$150.00	$32,250
24" Gate valve or Sluice gate on outlet	EA	1	$5,500.00	$5,500
Emergency Spillway/Overflow				
Overflow manhole structure	EA	1	$6,500.00	$6,500
24" Steel overflow piping	LF	350	$75.00	$26,250
Overflow vent	LS	1	$2,000.00	$2,000
Appurtenances	LS	1	$4,000.00	$4,000
Subtotal				**$4,896,000**
Mobilization / Demobilization (10% of Subtotal (1)				$489,600
Subtotal - With Mobilization/Demobilization				**$5,386,000**
Contingency (30%)				$1,615,800
Engineering, design, enviromental review, permitting & construction management (20%)				$1,077,200
Subtotal - Construction, Engineering, Permitting				**$8,079,000**
Tax (7.7%)				$414,722
Est. Land Acquisition or Lease Cost	AC	13.5	$10,000.00	$135,450
Preliminary Construction Cost Estimate				**$8,629,000**
Additional Costs (if site soils are not suitable)				
Embankment fill haul	CY	128,419	$10.00	$1,284,190
Disposal of excess cut material	CY	128,419	$4.00	$513,676

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Campbell Creek Instream Reservoir (Peshastin Sub-basin)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	18.5	$5,000.00	$92,500
Logging	AC	0.9	$3,000.00	$2,775
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic material	CY	7,491	$5.00	$37,455
Diversion and care of water	LS	1	$30,000.00	$30,000
Erosion and sediment control	AC	18.5	$5,000.00	$92,500
Revegetation outer embankment	SY	12,957	$2.50	$32,393
Perimeter Fencing	LF	80	$12.00	$960
Reservoir Earthwork				
Foundation excavation and stockpile, soil	CY	12,291	$6.00	$73,746
Foundation excavation and stockpile, rock	CY	12,291	$15.00	$184,365
Foundation grouting allowance	SF	22,124	$5.00	$110,621
Cutoff trench excavation and stockpile, soil	CY	1,185	$6.00	$7,110
Toe and finger drains	LS	1	$10,000.00	$10,000
Reservoir excavation (cut)	CY	0	$3.00	$0
Reservoir embankment (imported fill)	CY	355,706	$12.00	$4,268,472
Reservoir embankment (fill with cut material)	CY	24,582	$6.00	$147,492
Disposal of excess cut material	CY	0	$4.00	$0
Dam crest surfacing	CY	395	$20.00	$7,900
Pipe and Fittings				
18" inlet from pump station	LF	530	$85.00	$45,050
Air & vacuum valve	EA	1	$2,000.00	$2,000
Blowoff assy.	EA	1	$1,500.00	$1,500
18" Gate valve	EA	1	$3,500.00	$3,500
24" low-level outlet piping (concrete encased)	LF	495	$150.00	$74,250
24" Gate valve or Sluice Gate	EA	1	$5,500.00	$5,500
Pump Station				
Power and electrical equipment	LS	1	$50,000.00	$50,000
Pump Station Structure	LS	1	$20,000.00	$20,000
Pumps, controls and associated equipment	LS	1	$180,000.00	$180,000
Emergency Spillway/Overflow				
Spillway Channel	LF	420	$100.00	$42,000
Subtotal				**$5,537,000**
Mobilization / Demobilization (10% of Subtotal (1))				$553,700
Subtotal - With Mobilization/Demobilization				**$6,091,000**
Contingency (30%)				$1,827,300
Engineering, design, enviromental review, permitting & construction management (20%)				$1,218,200
Subtotal - Construction, Engineering, Permitting				**$9,137,000**
Tax (7.7%)				$469,007
Est. Land Acquisition or Lease Cost	AC	19.4	$10,000.00	$194,250
Preliminary Construction Cost Estimate				**$9,800,000**
Additional Costs (if site soils are not suitable)				
HDPE Liner and subgrade prep	SY	74,430	$12.00	$893,160

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Campbell Creek Instream Reservoir (Peshastin Sub-basin)

Pumping Electrical Cost Estimate

Chelan County PUD Rate Schedule 2 (General Service)

Item	Units	Quantity	Unit Cost	Cost
Basic Charge - Monthly for 3-Phase Meter (>40 kW)	EA	1	$14.50	$14.50
Monthly Demand Charge	kW	112	$2.20	$246.40
Monthly Energy Charge (>40 kW)				
January-February	kWh	0	$0.0232	$0.00
March	kWh	5,376	$0.0232	$124.72
April	kWh	79,968	$0.0232	$1,855.26
May	kWh	0	$0.0232	$0.00
June-December	kWh	0	$0.0232	$0.00
Monthly Minimum Charge	EA	1	$25.65	$25.65
Monthly Costs				
January-February				$25.65
March				$385.62
April				$2,116.16
May				$25.65
June-December				$25.65
Total Annual Costs				**$2,758.28**

NOTES:
1) Assumes that power is 3-phase.

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Upper Wenatchee to Little Chumstick Creek Pump Station and Pipeline

Item	Units	Quantity	Unit Cost	Cost
Pipe and Fittings				
18" pipeline from pump station to creek	LF	3,430	$85.00	$291,550
Air & vacuum valve	EA	1	$2,000.00	$2,000
Blowoff assy.	EA	1	$1,500.00	$1,500
18" Gate valve or Sluice Gate	EA	5	$3,500.00	$17,500
Pump Station				
Power and electrical equipment	LS	1	$50,000.00	$50,000
Pump Station Structure	LS	1	$20,000.00	$20,000
Pumps, controls and associated equipment	LS	1	$120,000.00	$120,000
Subtotal				**$503,000**
Mobilization / Demobilization (10% of Subtotal (1)				$50,300
Subtotal - With Mobilization/Demobilization				**$553,000**
Contingency (30%)				$165,900
Engineering, design, enviromental review, permitting & construction management (20%)				$110,600
Subtotal - Construction, Engineering, Permitting				**$830,000**
Tax (7.7%)				$42,581
Est. Land Acquisition or Lease Cost	LS	1	$15,000.00	$15,000
Preliminary Construction Cost Estimate				**$888,000**

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Upper Wenatchee to Little Chumstick Creek PS/Reservoir OPTION 1
(Includes PS and Pipeline)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	11.1	$5,000.00	$55,500
Logging	AC	11.1	$3,000.00	$33,300
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic material	CY	4,480	$5.00	$22,400
Diversion and care of water	LS	1	$30,000.00	$30,000
Erosion and sediment control	AC	11.1	$5,000.00	$55,500
Revegetation outer embankment	SY	6,414	$2.50	$16,035
Perimeter Fencing	LF	80	$12.00	$960
Reservoir Earthwork				
Foundation excavation and stockpile, soil	CY	6,372	$6.00	$38,232
Foundation excavation and stockpile, rock	CY	6,372	$15.00	$95,580
Foundation grouting allowance	SF	11,469	$5.00	$57,346
Cutoff trench excavation and stockpile, soil	CY	946	$6.00	$5,676
Toe and finger drains	LS	1	$10,000.00	$10,000
Reservoir excavation (cut)	CY	0	$3.00	$0
Reservoir embankment (imported fill)	CY	98,270	$12.00	$1,179,240
Reservoir embankment (fill with cut material)	CY	12,744	$6.00	$76,464
Disposal of excess cut material	CY	0	$4.00	$0
Dam crest surfacing	CY	319	$20.00	$6,380
Pipe and Fittings				
18" pipeline from pump station to creek	LF	3,430	$85.00	$291,550
Air & vacuum valve	EA	1	$2,000.00	$2,000
Blowoff assy.	EA	1	$1,500.00	$1,500
18" Gate valve or Sluice Gate	EA	5	$3,500.00	$17,500
24" low-level outlet piping (concrete encased)	LF	340	$150.00	$51,000
24" Gate valve or Sluice Gate	EA	1	$5,500.00	$5,500
Irrigation Canal Improvements				
Improve capacity of WC irrigation canal	LS	1	$250,000.00	$250,000
Pump Station				
Power and electrical equipment	LS	1	$50,000.00	$50,000
Pump Station Structure	LS	1	$20,000.00	$20,000
Pumps, controls and associated equipment	LS	1	$120,000.00	$120,000
Emergency Spillway/Overflow				
Spillway Channel	LF	305	$100.00	$30,500
Subtotal				**$2,537,000**
Mobilization / Demobilization (10% of Subtotal (1))				$253,700
Subtotal - With Mobilization/Demobilization				**$2,791,000**
Contingency (30%)				$837,300
Engineering, design, enviromental review, permitting & construction management (20%)				$558,200
Subtotal - Construction, Engineering, Permitting				**$4,187,000**
Tax (7.7%)				$214,907
Est. Land Acquisition or Lease Cost	AC	11.7	$10,000.00	$116,550
Preliminary Construction Cost Estimate				**$4,518,000**

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Upper Wenatchee to Little Chumstick Creek PS/Reservoir OPTION 1

(Includes PS and Pipeline)

Pumping Electrical Cost Estimate

Chelan County PUD Rate Schedule 2 (General Service)

Item	Units	Quantity	Unit Cost	Cost
Basic Charge - Monthly for 3-Phase Meter (>40 kW)	EA	1	$14.50	$14.50
Monthly Demand Charge	kW	179	$2.20	$393.80
Monthly Energy Charge (>40 kW)				
January-February	kWh	0	$0.0232	$0.00
March	kWh	12,888	$0.0232	$299.00
April	kWh	78,187	$0.0232	$1,813.94
May	kWh	0	$0.0232	$0.00
June-December	kWh	0	$0.0232	$0.00
Monthly Minimum Charge	EA	1	$25.65	$25.65
Monthly Costs				
January-February				$25.65
March				$707.30
April				$2,222.24
May				$25.65
June-December				$25.65
Total Annual Costs				**$3,186.04**

NOTES:
1) Assumes that power is 3-phase.

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Upper Wenatchee to Little Chumstick Creek PS/Reservoir OPTION 2

(Includes PS and Pipeline)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	10.1	$5,000.00	$50,500
Logging	AC	0.0	$3,000.00	$0
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic materia	CY	4,066	$5.00	$20,330
Erosion and sediment contro	AC	10.1	$5,000.00	$50,500
Revegetation outer embankmen	SY	14,000	$2.50	$35,000
Perimeter Fencing	LF	80	$12.00	$960
Reservoir Earthwork				
Foundation excavation and stockpile, so	CY	22,318	$6.00	$133,908
Foundation excavation and stockpile, roc	CY	0	$15.00	$0
Foundation grouting allowance	SF	2,232	$5.00	$11,160
Toe and finger drains	LS	1	$10,000.00	$10,000
Reservoir excavation (cut	CY	106,843	$3.00	$320,529
Reservoir embankment (imported fill	CY	22,318	$12.00	$267,816
Reservoir embankment (fill with cut material)	CY	124,616	$6.00	$747,696
Disposal of excess cut materia	CY	4,545	$4.00	$18,180
Dam crest surfacing	CY	785	$20.00	$15,700
Reservoir Liner				
HDPE Liner and subgrade prep	SY	30,954	$12.00	$371,448
Overex/Backfill to provide ballast for line	CY	20,636	$8.00	$165,088
Pipe and Fittings				
18" pipeline from pump station to creek	LF	6,840	$85.00	$581,400
Air & vacuum valve	EA	1	$2,000.00	$2,000
Blowoff assy.	EA	1	$1,500.00	$1,500
18" Gate valve	EA	8	$3,500.00	$28,000
24" low-level outlet piping (concrete encased	LF	105	$150.00	$15,750
24" Gate valve or Sluice Gate	EA	1	$5,500.00	$5,500
Pump Station				
Power and electrical equipment	LS	1	$50,000.00	$50,000
Pump Station Structure	LS	1	$20,000.00	$20,000
Pumps, controls and associated equipmen	LS	1	$120,000.00	$120,000
Emergency Spillway/Overflow				
Overflow manhole structure	EA	1	$6,500.00	$6,500
24" DI overflow piping	LF	195	$75.00	$14,625
Overflow vent	LS	1	$2,000.00	$2,000
Appurtenances	LS	1	$4,000.00	$4,000
Subtotal				**$3,085,000**
Mobilization / Demobilization (10% of Subtotal (1)				$308,500
Subtotal - With Mobilization/Demobilization				**$3,394,000**
Contingency (30%)				$1,018,200
Engineering, design, enviromental review, permitting & construction management (20%)				$678,800
Subtotal - Construction, Engineering, Permitting				**$5,091,000**
Tax (7.7%)				$261,338
Est. Land Acquisition or Lease Cos	AC	10.6	$10,000.00	$106,050
Preliminary Construction Cost Estimate				**$5,458,000**
Additional Costs (if site soils are not suitable				
Embankment fill haul	CY	106,843	$10.00	$1,068,430
Disposal of excess cut materia	CY	106,843	$4.00	$427,372

Montgomery Water Group
Chelan County
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Upper Wenatchee to Little Chumstick Creek PS/Reservoir OPTION 2
(Includes PS and Pipeline)
Pumping Electrical Cost Estimate
Chelan County PUD Rate Schedule 2 (General Service)

Item	Units	Quantity	Unit Cost	Cost
Basic Charge - Monthly for 3-Phase Meter (>40 kW)	EA	1	$14.50	$14.50
Monthly Demand Charge	kW	179	$2.20	$393.80
Monthly Energy Charge (>40 kW)				
January-February	kWh	0	$0.0232	$0.00
March	kWh	12,888	$0.0232	$299.00
April	kWh	67,662	$0.0232	$1,569.76
May	kWh	0	$0.0232	$0.00
June-December	kWh	0	$0.0232	$0.00
Monthly Minimum Charge	EA	1	$25.65	$25.65
Monthly Costs				
January-February				$25.65
March				$707.30
April				$1,978.06
May				$25.65
June-December				$25.65
Total Annual Costs				**$2,941.86**

NOTES:
1) Assumes that power is 3-phase.

Montgomery Water Group
Chelan County
Water Storage Evaluation 15-Jun-06

Upper Wenatchee to Little Chumstick Creek PS/Reservoir OPTION 3
(Includes PS and Pipeline)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	6.7	$5,000.00	$33,500
Logging	AC	0.0	$3,000.00	$0
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic material	CY	2,693	$5.00	$13,465
Erosion and sediment control	AC	6.7	$5,000.00	$33,500
Revegetation outer embankment	SY	4,329	$2.50	$10,823
Perimeter Fencing	LF	80	$12.00	$960
Reservoir Earthwork				
Foundation excavation and stockpile, soil	CY	10,853	$6.00	$65,118
Foundation excavation and stockpile, rock	CY	0	$15.00	$0
Foundation grouting allowance	SF	1,085	$5.00	$5,425
Toe and finger drains	LS	1	$10,000.00	$10,000
Reservoir excavation (cut)	CY	75,617	$3.00	$226,851
Reservoir embankment (imported fill)	CY	10,853	$12.00	$130,236
Reservoir embankment (fill with cut material)	CY	36,131	$6.00	$216,786
Disposal of excess cut material	CY	50,339	$4.00	$201,356
Dam crest surfacing	CY	529	$20.00	$10,580
Reservoir Liner				
HDPE Liner and subgrade prep	SY	25,023	$12.00	$300,276
Overex/Backfill to provide ballast for liner	CY	16,682	$8.00	$133,456
Diversion				
Diversion structure	CFS	2	$40,000.00	$80,000
Pipe and Fittings				
18" pipeline from pump station to creek	LF	3,430	$85.00	$291,550
18" inlet from diversion at creek	LF	500	$20.00	$10,000
Air & vacuum valve	EA	1	$2,000.00	$2,000
Blowoff assy.	EA	1	$1,500.00	$1,500
18" Gate valve	EA	5	$3,500.00	$17,500
24" low-level outlet piping (concrete encased)	LF	200	$150.00	$30,000
24" Gate valve or Sluice Gate	EA	1	$5,500.00	$5,500
Pump Station				
Power and electrical equipment	LS	1	$50,000.00	$50,000
Pump Station Structure	LS	1	$20,000.00	$20,000
Pumps, controls and associated equipment	LS	1	$120,000.00	$120,000
Emergency Spillway/Overflow				
Overflow manhole structure	EA	1	$6,500.00	$6,500
24" DI overflow piping	LF	230	$75.00	$17,250
Overflow vent	LS	1	$2,000.00	$2,000
Appurtenances	LS	1	$4,000.00	$4,000
Subtotal				**$2,065,000**
Mobilization / Demobilization (10% of Subtotal (1))				$206,500
Subtotal - With Mobilization/Demobilization				**$2,272,000**
Contingency (30%)				$681,600
Engineering, design, enviromental review, permitting & construction management (20%)				$454,400
Subtotal - Construction, Engineering, Permitting				**$3,408,000**
Tax (7.7%)				$174,944
Est. Land Acquisition or Lease Cost	AC	7.0	$10,000.00	$70,350
Preliminary Construction Cost Estimate				**$3,653,000**
Additional Costs (if site soils are not suitable)				
Embankment fill haul	CY	75,617	$10.00	$756,170
Disposal of excess cut material	CY	75,617	$4.00	$302,468

Montgomery Water Group
Chelan County
Water Storage Evaluation 15-Jun-06

Upper Wenatchee to Little Chumstick Creek PS/Reservoir OPTION 3
(Includes PS and Pipeline)
Pumping Electrical Cost Estimate
Chelan County PUD Rate Schedule 2 (General Service)

Item	Units	Quantity	Unit Cost	Cost
Basic Charge - Monthly for 3-Phase Meter (>40 kW)	EA	1	$14.50	$14.50
Monthly Demand Charge	kW	179	$2.20	$393.80
Monthly Energy Charge (>40 kW)				
January-February	kWh	0	$0.0232	$0.00
March	kWh	12,888	$0.0232	$299.00
April	kWh	30,502	$0.0232	$707.64
May	kWh	0	$0.0232	$0.00
June-December	kWh	0	$0.0232	$0.00
Monthly Minimum Charge	EA	1	$25.65	$25.65
Monthly Costs				
January-February				$25.65
March				$707.30
April				$1,115.94
May				$25.65
June-December				$25.65
Total Annual Costs				**$2,079.74**

NOTES:
1) Assumes that power is 3-phase.

Montgomery Water Group
Chelan County
Water Storage Evaluatior 15-Jun-06

Typical 5 Acre-ft Reservoir

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbinç	AC	2.4	$5,000.00	$12,000
Logging	AC	1.2	$3,000.00	$3,600
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic materia	CY	970	$5.00	$4,850
Erosion and sediment contro	AC	2.4	$5,000.00	$12,000
Revegetation outer embankmen	SY	6,330	$2.50	$15,825
Perimeter Fencing	LF	80	$12.00	$960
Reservoir Earthwork				
Foundation excavation and stockpile, so	CY	2,260	$6.00	$13,560
Foundation excavation and stockpile, rocl	CY	0	$15.00	$0
Foundation grouting allowance	SF	0	$5.00	$0
Toe and finger drains	LS	1	$5,000.00	$5,000
Reservoir excavation (cut)	CY	15,000	$3.00	$45,000
Reservoir embankment (imported fill)	CY	2,260	$12.00	$27,120
Reservoir embankment (fill with cut material)	CY	15,000	$6.00	$90,000
Disposal of excess cut materia	CY	2,260	$4.00	$9,040
Dam crest surfacing	CY	160	$20.00	$3,200
Reservoir Liner				
HDPE Liner and subgrade prep	SY	4,070	$12.00	$48,840
Overex/Backfill to provide ballast for line	CY	2,713	$8.00	$21,707
Diversion				
Diversion structure	CFS	0	$40,000.00	$0
Pipe and Fittings				
6" inlet piping (from pump)	LF	200	$15.00	$3,000
6" low-level outlet pipinç	LF	200	$15.00	$3,000
6" Gate valve or Sluice gate on outle	EA	1	$1,500.00	$1,500
Pump				
Power and electrical equipmen	LS	1	$2,000.00	$2,000
Pumps, controls and associated equipmen	LS	1	$3,000.00	$3,000
Emergency Spillway/Overflow				
Overflow manhole structure	EA	0	$6,500.00	$0
12" Steel overflow pipinç	LF	200	$30.00	$6,000
Overflow vent	LS	0	$2,000.00	$0
Appurtenances	LS	1	$4,000.00	$4,000
Subtotal				**$350,000**
Mobilization / Demobilization (10% of Subtotal (1))				$35,000
Subtotal - With Mobilization/Demobilization				**$385,000**
Contingency (30%)				$115,500
Engineering, design, enviromental review, permitting & construction management (20%)				$77,000
Subtotal - Construction, Engineering, Permitting				**$578,000**
Tax (7.7%)				$29,645
Est. Land Acquisition or Lease Cost	AC	2.5	$10,000.00	$25,200
Preliminary Construction Cost Estimate				**$633,000**
Additional Costs (if site soils are not suitable)				
Embankment fill haul	CY	15,000	$10.00	$150,000
Disposal of excess cut materia	CY	15,000	$4.00	$60,000

Montgomery Water Group
Chelan County
Water Storage Evaluation 15-Jun-06

Typical 5 Acre-ft Reservoir

Pumping Electrical Cost Estimate

Chelan County PUD Rate Schedule 2 (General Service)

Item	Units	Quantity	Unit Cost	Cost
Basic Charge - Monthly for 3-Phase Meter (<39 kW)	EA	1	$16.10	$16.10
Monthly Demand Charge	kW	1.9	$2.20	$4.18
Monthly Energy Charge (<39 kW)				
January-February	kWh	0	$0.0236	$0.00
March	kWh	0	$0.0236	$0.00
April	kWh	228	$0.0236	$5.38
May	kWh	0	$0.0236	$0.00
June-December	kWh	0	$0.0236	$0.00
Monthly Minimum Charge	EA	1	$25.65	$25.65
Monthly Costs				
January-February				$25.65
March				$25.65
April				$25.66
May				$25.65
June-December				$25.65
Total Annual Costs				**$307.81**

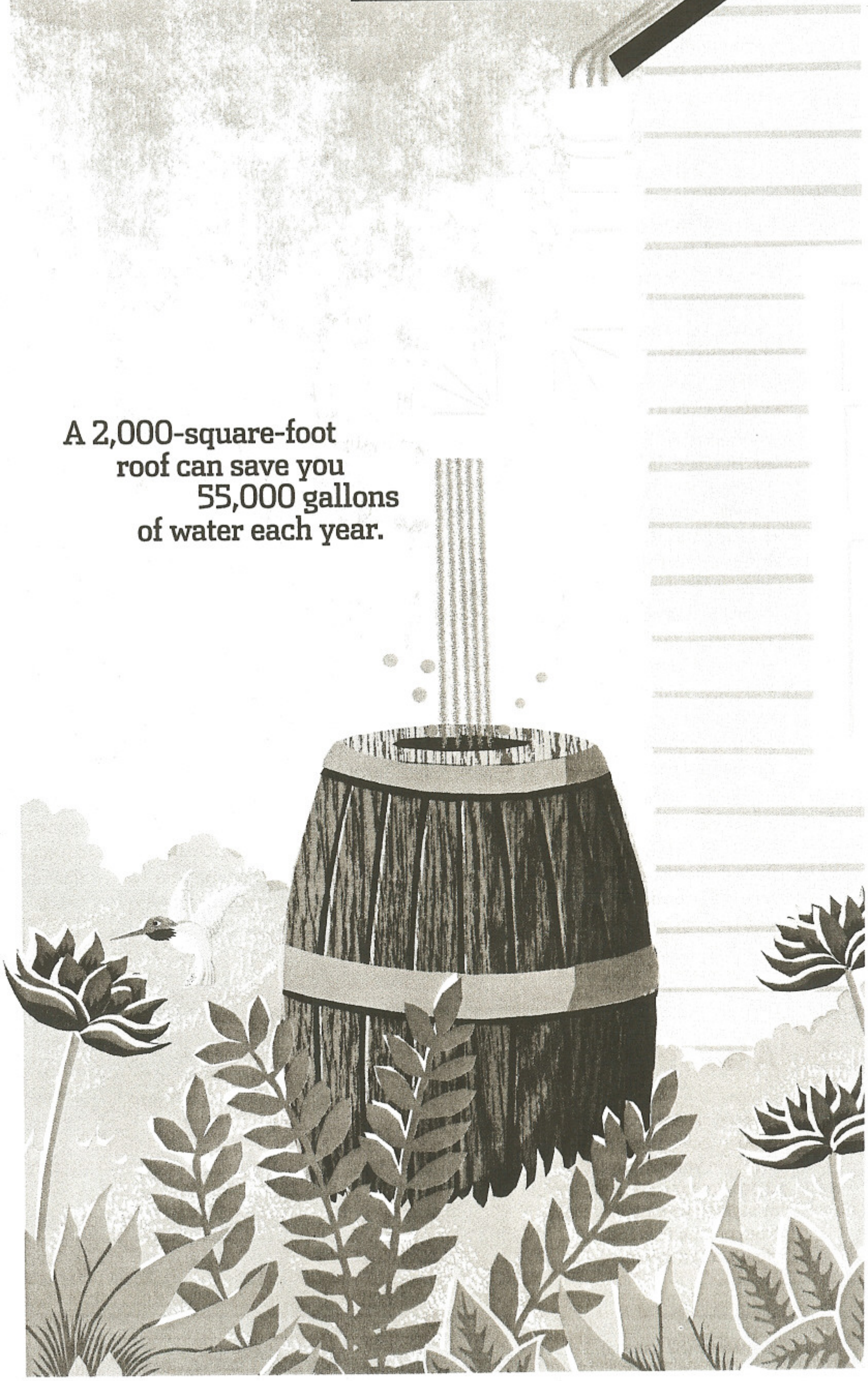
NOTES:
1) Assumes that power is single-phase.

Appendix F
Rainwater Capture Information

Tapping the Skies

>> Old-fashioned rain barrels conserve water while supercharging your lawn and garden

BY **KEITH PANDOLFI**
ILLUSTRATIONS BY **ANNIE BISSETT**

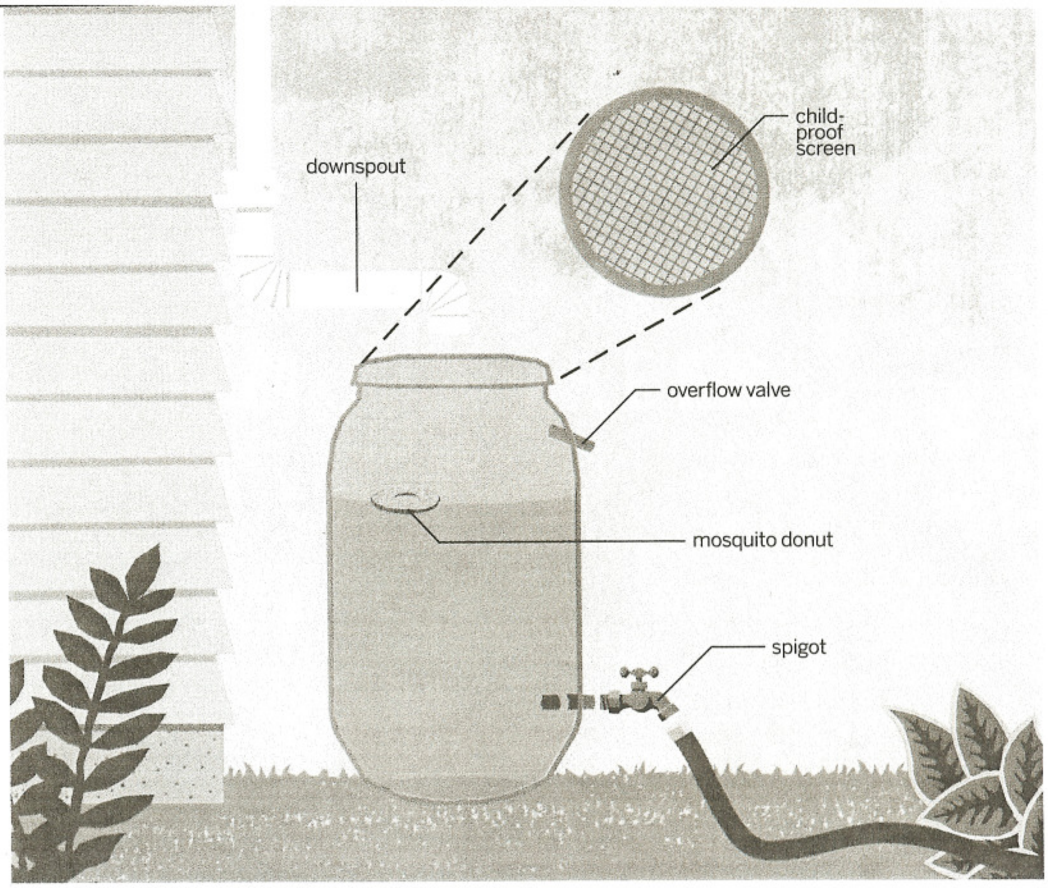


A 2,000-square-foot roof can save you 55,000 gallons of water each year.

STEPHEN BARRY HASN'T turned on his outdoor spigot in a year, but last summer his lawn was as lush as any in the neighborhood. Every drop of water he needed for the season came straight from the sky, captured in rain barrels installed behind his Maryland home.

Barry got the idea when the outdoor education center he works for started using rain barrels at several of its recreational facilities. He was astounded by how much water they captured. "Just an inch of rainfall from a 1,000-square-foot roof produces 632 gallons!" he says. Now he relies on four 61-gallon recycled Coke barrels, painted to match his house, to supply all the water for his landscaping needs. And what's more, his garden looks better than ever, owing to rainwater's freedom from chemicals like chlorine and fluoride, which can be tough on plants. "We don't need Miracle-Gro anymore," he says.

Rainwater collection is an age-old technology that has long been used in arid southwestern places such as Texas, Arizona, and New Mexico, as well as states like California and Nevada, where growing populations are stressing limited water supplies. Lately, though, it's been finding new practitioners even in more well-saturated environs, where rising water bills and dwindling rainfall levels are making homeowners think twice before blasting the tap. Stored water can be used for irrigation,



ANATOMY OF A RAIN BARREL
Installing your own rain barrel takes little more than a large container placed below your downspout, a childproof screen to keep out bugs and debris, a spigot to access the water, and an overflow valve. To keep mosquitoes away, try a "mosquito donut," which bans the bugs but won't harm plants or pets.

washing the car (or the dog), filling the swimming pool, even bathing and drinking if properly filtered. In addition to conserving an increasingly scarce resource, rainwater collection also helps reduce storm runoff—a growing problem caused by the acres of concrete and other impermeable surfaces that go along with booming housing or commercial development.

David Crawford, president of Salem, Virginia–based Rainwater Management Solutions, says business started to take off in his part of the country in the mid-1990s, when the eastern United States experienced a drought that reduced the region's average amount of rainfall by about 10 inches a year. Lately he's noticed a growing interest in the Gulf South, where victims of hurricanes Katrina and Rita are trying to find an alternative source of water in case they're faced with another catastrophe. Many of Crawford's clients who live in rural areas hard to reach by local fire departments keep rainwater stored just for fire-protection purposes. By having their own water supply, some of them get a break on their homeowner's insurance of up to 30 percent per year, he says.

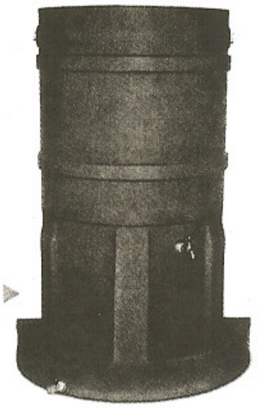
If you find yourself coming down with a case of barrel fever, you can find them in an array of styles and colors at hardware stores, gardening supply centers, and websites such as cleanairgardening.com and composters.com. A standard 55- to 75-gallon plastic barrel with a leaf screen, spout, and overflow valve costs between $80 and $200. Those in the market for something a little more luxe can opt for a high-end wooden wine or whiskey barrel. A nice one built by a professional cooper will probably run you $300 or more. Or, like Barry, you can make your own out of recycled food-grade containers. (For detailed do-it-yourself instructions, go to thisoldhouse.com/shortcuts).

To get the most bang for your barrel, consider including an overflow tank with your system. It's a second or third barrel connected to the first one via a hose. Whatever you do, make sure the overflow hose at the top of the barrel is placed as far away from your house as possible so you don't end up collecting too much of a good thing—right in your basement.

For information on installing a whole-house rainwater collection system: **thisoldhouse.com/shortcuts**

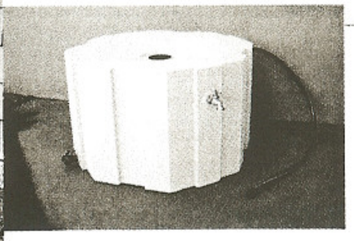
A Barrelful of Choices

If you'd rather not have a recycled pickle barrel in your backyard, there are now dozens of styles available, from plastic to wood. Here's a sampling:



Rainsaver (82 gallons), $199, cleanairgardening.com

Real Oak Rain Barrel (45 gallons), $149, gardeners.com



Octagon (54 gallons), $135, aridsolutionsinc.com

Pitcher Pump (52 gallons), $150, cleanairgardening.com

FOR MORE INFORMATION, SEE DIRECTORY, PAGE 113