PESHASTIN SUBBASIN

NEEDS AND ALTERNATIVES STUDY

Prepared for

Chelan County Natural Resource Department
316 Washington Street, Suite 401
Wenatchee, Washington 98801

Prepared by

Anchor Environmental, L.L.C.
811 Kirkland Avenue, Suite 200
P.O. Box 2517
Kirkland, Washington 98083-2517

EES Consulting, Inc.
1155 North State Street, Suite 700
Bellingham, Washington 98225

January 2007

Prepared Under Washington State Department of Ecology Grant G0700003

ANCHOR ENVIRONMENTAL, L.L.C.

Anchor Environmental, L.L.C.
811 Kirkland Ave, Suite 200
P.O. Box 2517
Kirkland, WA 98083-2517
Phone 425.827.3243
Fax 425.827.3509

January 16, 2007

Mike Kaputa
Natural Resource Director
Chelan County Natural Resource Department
316 Washington Street, Suite 401
Wenatchee, Washington 98801

Re: Peshastin Subbasin Needs and Alternatives Study

Dear Mike:

Enclosed is our final report for the Peshastin Subbasin Needs and Alternatives Study. The findings of the report are that the wide gravel bars in lower Peshastin Creek likely pose a significant barrier to fish passage at low flows. The flow needed for fish passage in July and August could range from 1,400 to 3,600 acre-feet per year, depending on the volume of natural runoff that occurs and the instream flow desired. Alternatives to supplying that flow were reviewed, including the Campbell Creek reservoir, modifications to Icicle and Peshastin Irrigation District facilities, pumping from the Wenatchee River into the Peshastin Canal, and modifications to lower Peshastin Creek to improve fish passage conditions.

There are six recommendations from the study:

1. Complete the piping project on the Peshastin Canal from Brender Spill to the end of the canal to conserve water that would otherwise be diverted from Peshastin Creek
2. Coordinate with the Bureau of Reclamation on their geomorphic study of lower Peshastin Creek to assess whether modifications to gravel bars could help fish passage
3. Work with the Instream Flow Subcommittee of the Wenatchee Watershed Planning Unit to develop an instream flow strategy for Peshastin Creek
4. Continue discussions with the U.S. Forest Service and property owners on the Campbell Creek reservoir
5. Work with the Icicle Irrigation District to evaluate the feasibility of Icicle Canal modifications to deliver additional water in July and August
6. Perform more detailed analyses of the pump station alternative

We appreciated the opportunity to prepare this report and look forward to assisting Chelan County in its implementation.

Sincerely,

Bob Montgomery, P.E.
Partner
Anchor Environmental, L.L.C.

Table of Contents

List of Tables

List of Figures

List of Photos

List of Appendices

1 INTRODUCTION

The purpose of this study is to review water needs in the Peshastin Subbasin and alternatives that could meet those needs. The primary water needs are out-of-stream needs for irrigation for the Tandy Ditch Company and the Peshastin Irrigation District and instream needs for fish passage in lower Peshastin Creek. An alternative to help meet those needs is the Campbell Creek off-stream reservoir. The Campbell Creek reservoir was identified as an alternative for water storage by the Peshastin Irrigation District and a preliminary review was performed in the Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed dated June 15, 2006. The reservoir has the potential to store 500 acre-feet of water that would be pumped from the Tandy Ditch. Natural inflow from the Campbell Creek basin would also help fill the reservoir. Water could be diverted in spring and early summer into the reservoir and released in late summer. The water would be used to either replace the water supply for Tandy Ditch, supply the Peshastin Irrigation District, or enhance instream flows in Peshastin Creek. This report provides additional review of the Campbell Creek reservoir and compares its ability to meet instream and out-of-stream needs to other alternatives such as a pump station on the Wenatchee River and modifications to Icicle and Peshastin Irrigation District facilities. Those modifications include piping part of the district to conserve water and increasing deliveries from the head of the Icicle Canal to the Peshastin Canal or Peshastin Creek.

This study was prepared for Chelan County Natural Resource Department and was funded by a grant provided by the Washington State Department of Ecology (Ecology).

2 WATER NEEDS FROM PESHASTIN CREEK

The primary water needs in the Peshastin Subbasin during the summer months are irrigation deliveries and instream flow to provide passage for bull trout (*Salvelinus confluentus*) and Chinook salmon (*Oncorhynchus tshawytscha*) swimming upstream from the Wenatchee River to past the Peshastin Diversion Dam.

2.1 Irrigation Diversions

There are two main diversions from Peshastin Creek: one for the Tandy Ditch Company and one for the Peshastin Canal by the Peshastin Irrigation District. The Tandy Ditch Company diverts about 4.6 cubic feet per second (cfs) peak from Peshastin Creek while the Peshastin Irrigation District diverts about 40 cfs peak into the Peshastin Canal. The diversions occur from April through mid-September. Table 2-1 presents data on diversions by the Peshastin Irrigation District for 2002 and Table 2-2 presents data for 2003. The data is presented in bi-weekly time periods to allow comparison to flow needed for fish passage in similar time periods. The data is graphed in Figure 2-1. The data was obtained from Ecology from records submitted by the Peshastin Irrigation District.

Table 2-1
Peshastin Canal Diversions – 2002

Bi-weekly Time Period		Average Flow (cfs)	Total Volume of Flow (acre-feet)
Apr	10-15	15.6	154.4
	16-30	11.0	326.7
May	1-15	12.9	383.1
	16-31	22.0	697.0
Jun	1-15	30.1	894.0
	16-30	30.8	914.8
Jul	1-15	31.2	926.6
	16-31	32.5	1,029.6
Aug	1-15	26.4	784.1
	16-31	17.1	541.7
Sep	1-15	13.5	213.8

Table 2-2
Peshastin Canal Diversions – 2003

Bi-weekly Time Period		Average Flow (cfs)	Total Volume of Flow (acre-feet)
Apr	10-15	0	0
	16-30	13.0	386.1
May	1-15	14.5	430.7
	16-31	No data May 10-31	No data
Jun	1-15	29.6	879.1
	16-30	31.3	929.6
Jul	1-15	32.0	950.4
	16-31	24.9	788.8
Aug	1-15	17.0	504.9
	16-31	9.7	307.9
Sep	1-15	7.6	211.5

Figure 2-1
Peshastin Canal Diversions – 2002/2003

The diversions are highest during June and July and taper off in August and September. The reduction in diversions is due to factors such as flow availability in Peshastin Creek, timing of fruit harvest, and reduced water use after fruit is harvested. The Peshastin Irrigation District typically stops diverting on September 15.

In addition to the diversions from Peshastin Creek, the Peshastin Irrigation District uses water delivered from the bifurcation structure on Icicle Division 2 Canal when streamflow is not adequate for water supply. The water in the Icicle Division 2 Canal is diverted from Icicle Creek. The Icicle and Peshastin Irrigation Districts share water supply, the intake, and canals from Icicle Creek to the bifurcation structure. The water is delivered via a 16-inch steel pipe from the bifurcation structure, which is located on the hillside north of Peshastin Creek. Flow is also discharged from the pipe into Peshastin Creek. The flow capacity of the pipeline is estimated at 30 cfs (Teeley, pers. corr. 2006). Three additional means of spilling water to Peshastin Creek exist: the Icicle Canal 3A siphon with a capacity of about 50 cfs, the Gibbs spillway pipeline (capacity not known), and an emergency spillway for the Icicle Canal Division 2 Bifurcation (capacity not known, but likely about 80 cfs).

2.2 Fish Passage Flow

Methods to estimate preferred stream flows for salmon and trout were reported by Thompson (1972) after 10 years of research on depth and velocity in streams in Oregon. Thompson concluded that the depth over "the shallow bars most critical for adult passage" was the feature that determined the likelihood of successful migration. Thompson's recommended minimum depths of 0.8 feet for Chinook and 0.6 feet for large trout to achieve successful passage have been used by biologists in the Northwest since the 1970s.

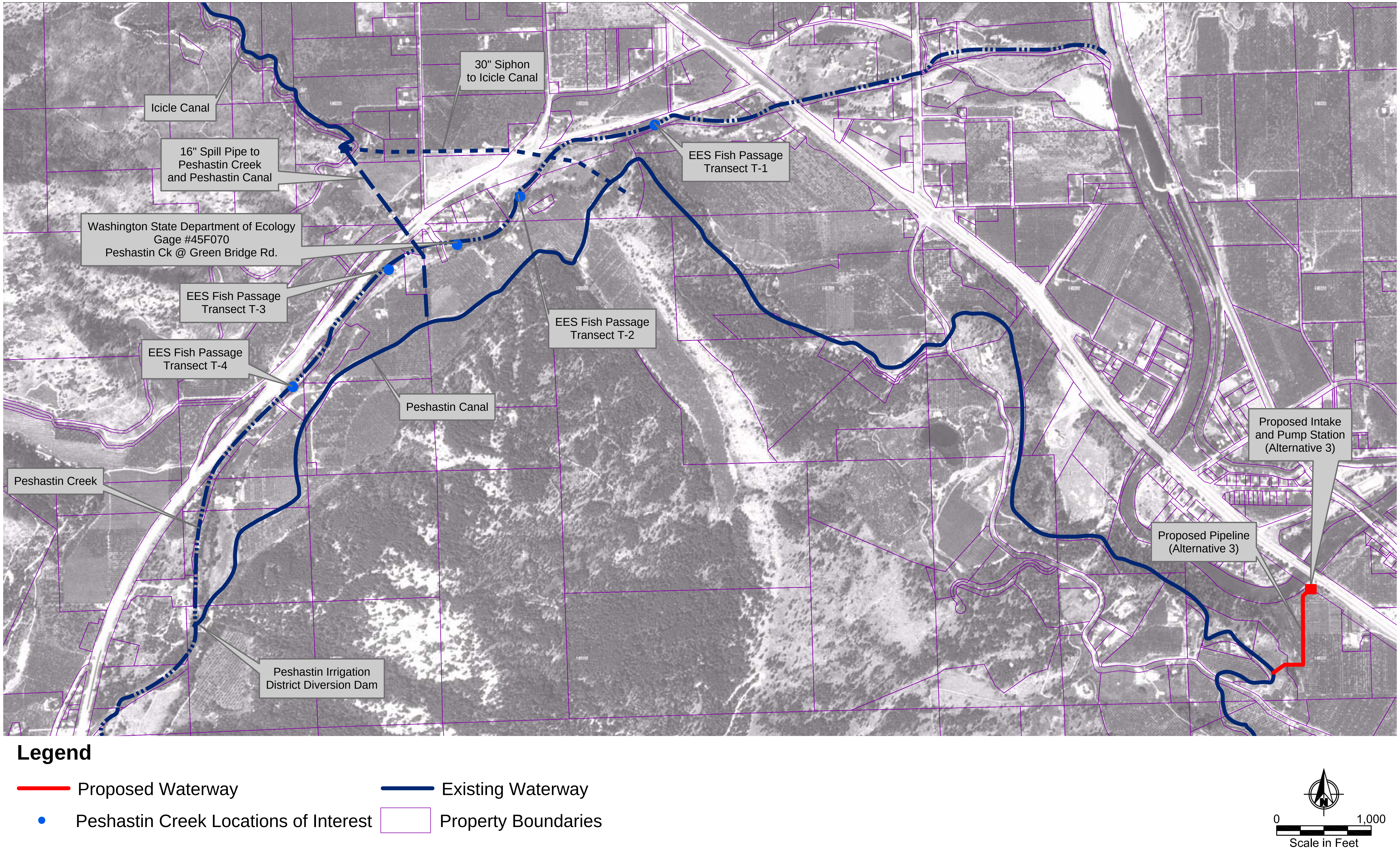
The "Oregon method," as it is now commonly called, concludes that the passage flow is adequate when the depth criteria is met on at least 25 percent of the transect width <u>and</u> on at least a 10 percent continuous portion. Rather than relying on individual transects, Thompson recommends the average flow of all transects.

2.2.1 Methods

On July 20, 2006, a stream survey was completed on lower Peshastin Creek from the Peshastin Irrigation District diversion, downstream to the Wenatchee River. Potential study transects on shallow bars were flagged and noted on a map for possible inclusion in the passage study. Four transects were selected for field study. The transects were representative of the most critical and shallow bars in lower Peshastin Creek. Figure 2-2 shows the location of all transects.

Cross sections were surveyed at each transect. Head pins on each bank as well as a bench mark were surveyed to establish elevations. A tape was stretched horizontally across the channel and attached to the head pins. With an auto level and stadia rod, elevation of the stream bed and banks were surveyed at regular intervals along the tape and water surface elevations were surveyed at locations where accurate measurements could be obtained. Water depth was also measured at each station in order to cross check the bed and water surface elevation measurements. Photographs of each transect site are shown in Photos 2-1 through 2-5.

Photo 2-1
Transect 1 Photo



Jan 02, 2007 10:04am ahill Z:\Company Shared Folders\1000\1026 Chelan County\04 Campbell Creek\CADD\Aerial Photo.dwg Anc-B-Land

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 2-2
Study Area Map
Peshastin Subbasin Needs and Alternatives Study

Photo 2-2
Transect 1 Photo

Photo 2-3
Transect 2 Photo

Photo 2-4
Transect 3 Photo

Photo 2-5
Transect 4 Photo

Transects were surveyed at high, medium, and low stream flows. At each flow level, discharge measurements were taken so a rating curve could be computed for each transect. Discharge measurements were taken above and below significant areas of inflow (e.g., Icicle pipeline) to account for changes in discharge. Recorded stage measurements from the gage on Peshastin Creek at Green Bridge, operated by Ecology, were examined to determine flow changes during the day of the measurements. Minor adjustments were made to the measured flows based on stage changes at the gage and timing between the surveys and discharge measurements. Table 2-3 shows the dates and computed discharges for each transect during the field study.

Table 2-3
Discharges For Transects At Lower Peshastin Creek

Date	T-1	T-2	T-3	T-4
July 26, 2006	35.6 cfs	33.5 cfs	32.4 cfs	31.4 cfs
August 4, 2006	23.3 cfs	24.3 cfs	13.8 cfs	13.8 cfs
August 21, 2006	9.9 cfs	9.9 cfs	7.1 cfs	7.1 cfs

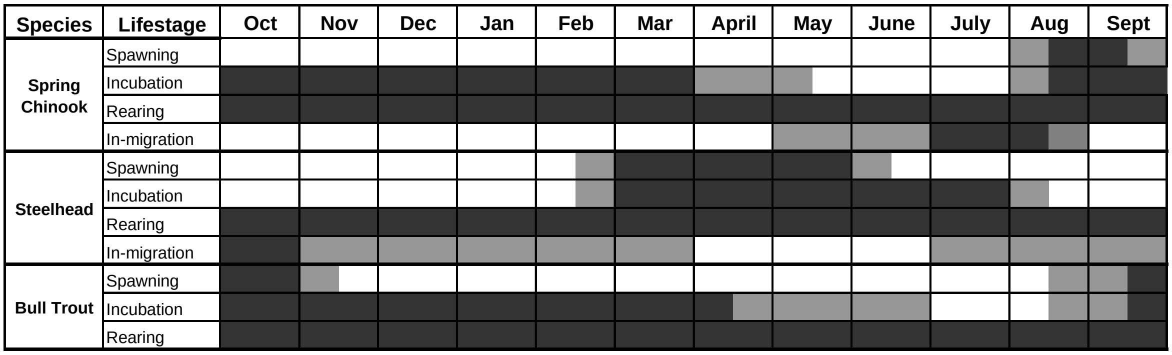
2.2.2 Computations

Station location, stream bed elevations, discharges, water surface stage, slope, and stage of zero flow were entered into the PHABSIM hydraulic model and depths at each station were simulated for a range of flows between 5 and 50 cfs. Depths equal to or exceeding the passage depth criteria for each species were tallied at each modeled flow. Adjoining cells with depths equal or exceeding the criteria were also tallied. The total width of the cells in each of these categories at each modeled flow was divided by the total wetted width at each flow to compute the percent of the transect that is currently passable.

2.2.3 Periodicity of Migrating Chinook and Bull Trout in Peshastin Creek

Salmonid periodicity information for Peshastin Creek is based on information from Andonaegui (2001), and local resource agencies. Migration and spawning timing for salmonids using Peshastin Creek are shown in Figure 2-3. No in-migration timing is given for bull trout; this study assumes that in-migration occurs from July through September. The species used in this analysis are bull trout and Chinook salmon because the timing of their migration coincides with diversions for irrigation and low natural flow in Peshastin Creek.

Figure 2-3
Peshastin Creek Migration and Spawning Timing



Based on:
Andonaegui, C., 2001. *Salmon, Steelhead and Bull Trout Habitat Limiting Factors for the Wenatchee Subbasin (WRIA 45) and Portions of WRIA 40 within Chelan County (Squilchuck, Stemilt and Colockum Drainages).* Washington State Conservation Commission.
Comments from: USFS (Cam Thomas, Cindy Raekes), WDFW (Andrew Murdoch, Bob Vadas, Mark Cookson), USFWS (Kate Terrell) and NOAA-Fisheries (Dale Bambrick)

Key:
Black indicates periods of heaviest use — Grey indicates periods of moderate use — Blank areas indicate periods of little or no use

2.2.4 Results for Bull Trout

Figures 2-4 through 2-7 show the relationship at each transect between stream discharge and the percent of total width and contiguous width (adjoining cells) that is passable to bull trout at each flow. Table 2-4 shows that 25 percent of total width, the passage depth criteria for bull trout, is met on individual transects at 13 to 22 cfs. On three of four transects, the 10 percent of contiguous passage depth criteria is met at lower discharges. Discharges for contiguous passage range from 5 to 22 cfs. The discharge at which both passage criteria are met ranges from 13 to 22 cfs, with an average of 17.25 cfs.

Table 2-4
Discharges For Meeting Bull Trout Passage Criteria

Passage Criteria	T-1	T-2	T-3	T-4	Average
Total (25%)	22 cfs	17 cfs	13 cfs	17 cfs	17.25 cfs
Contiguous (10%)	22 cfs	5 cfs	11 cfs	8 cfs	11.5 cfs
Both Criteria	22 cfs	17 cfs	13 cfs	17 cfs	17.25 cfs

Figure 2-4
Fish Passage – Transect 1 Bull Trout

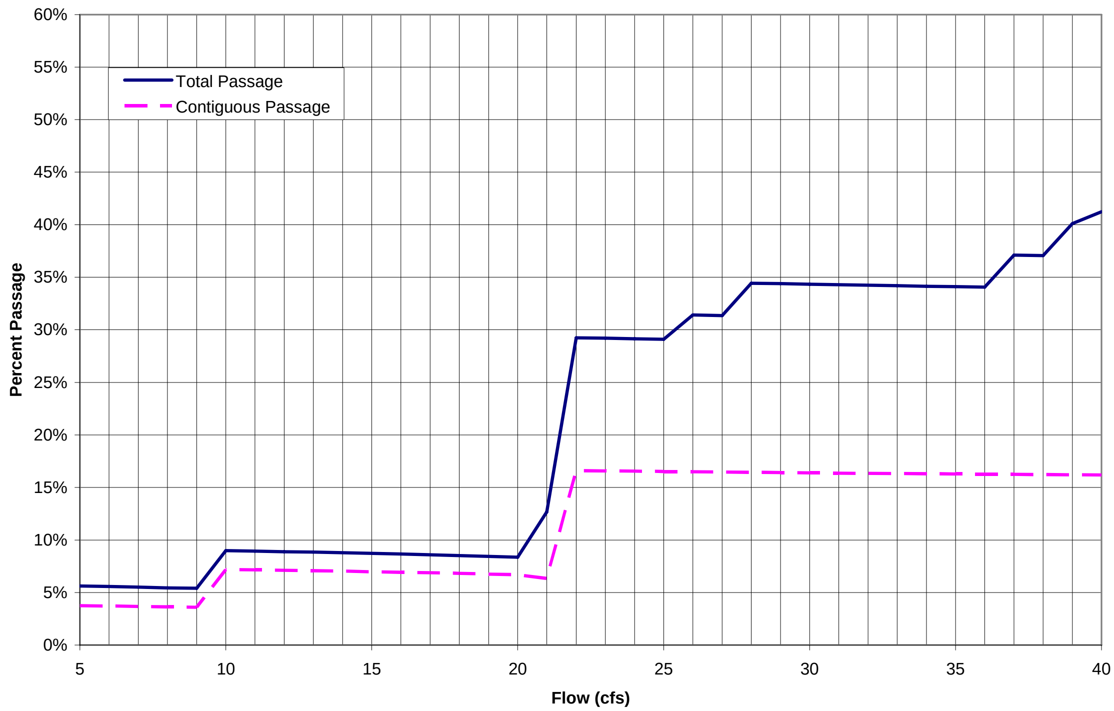


Figure 2-5
Fish Passage – Transect 2 Bull Trout

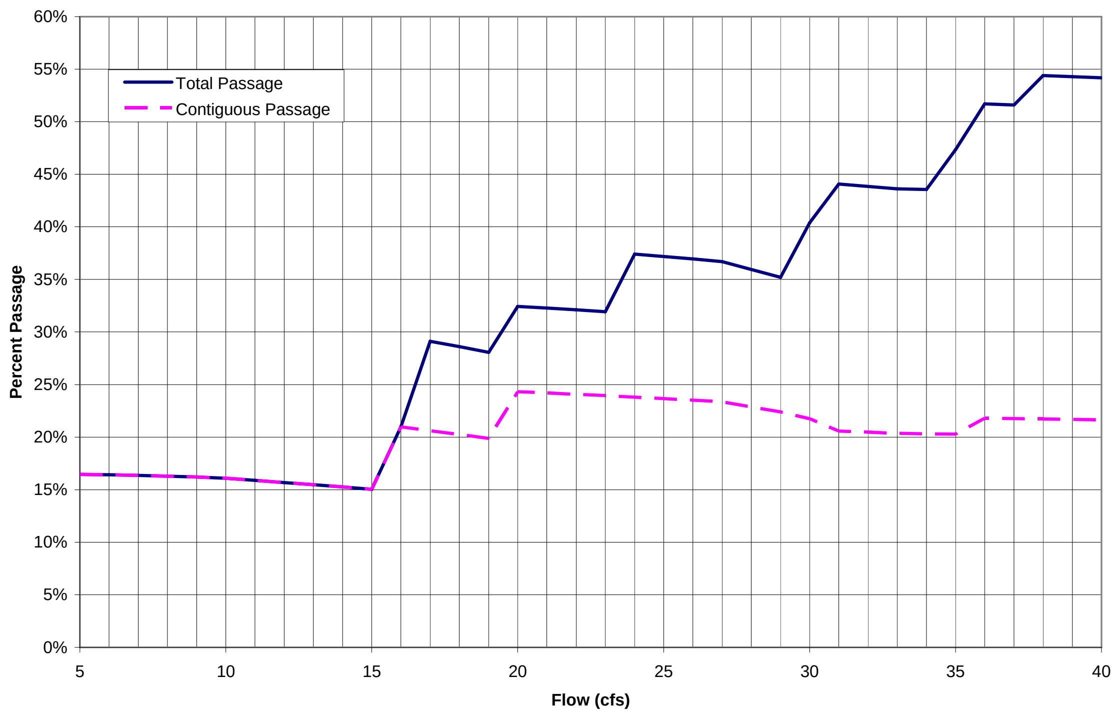


Figure 2-6
Fish Passage – Transect 3 Bull Trout

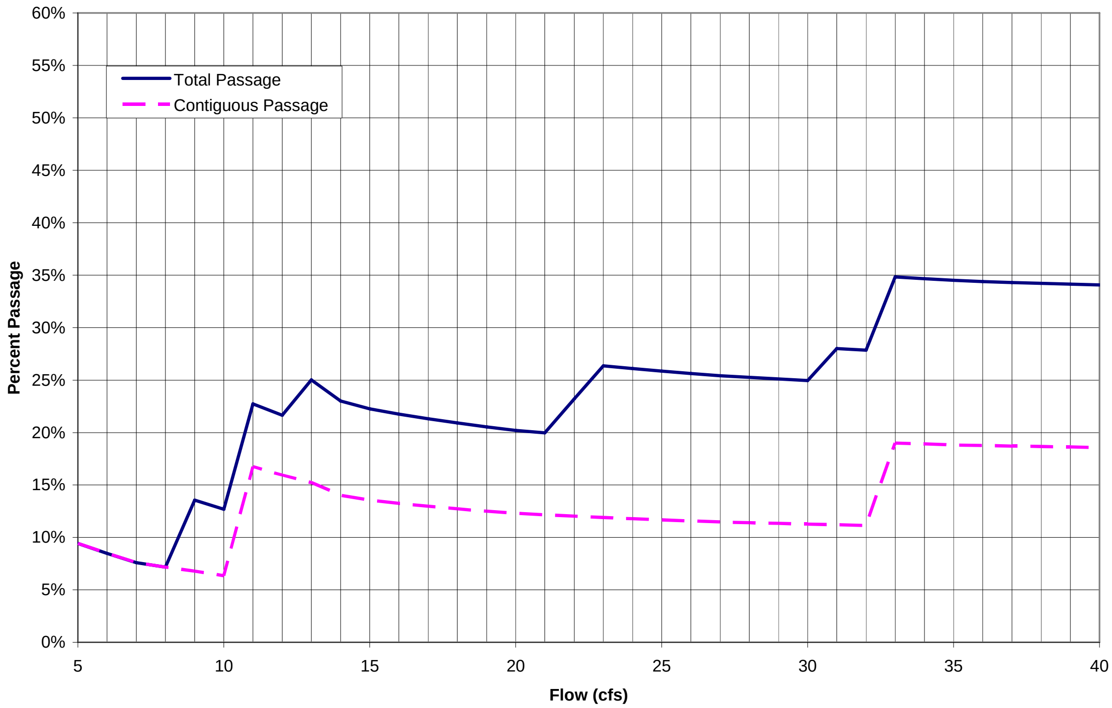
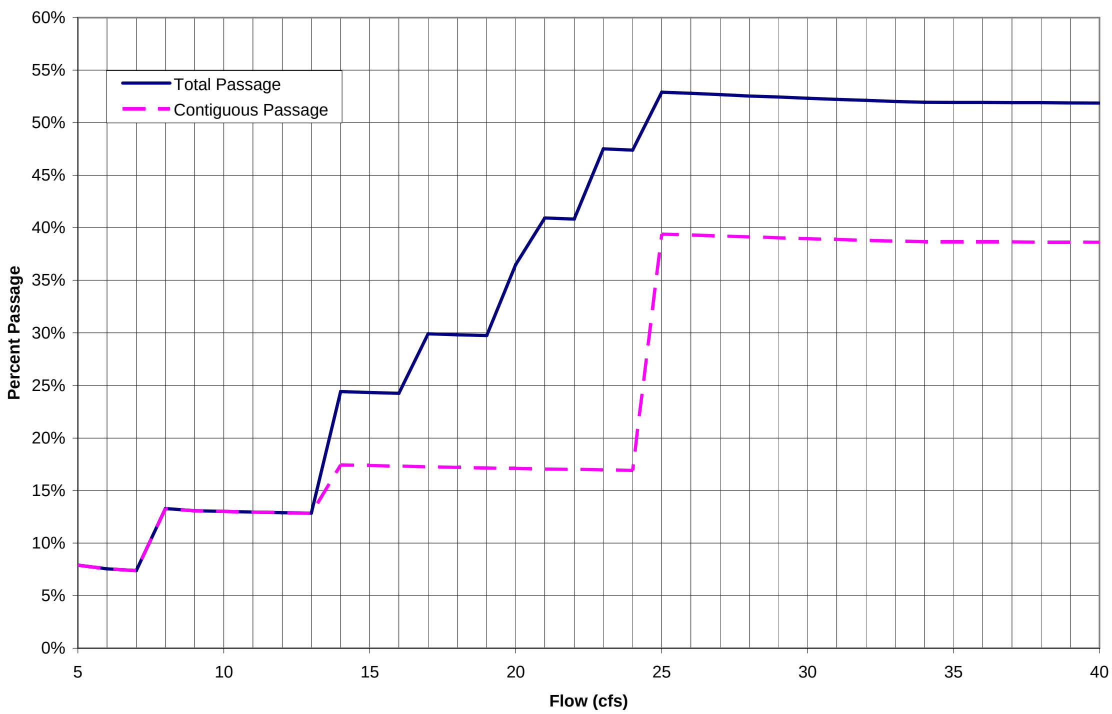


Figure 2-7
Fish Passage – Transect 4 Bull Trout



2.2.5 Results for Chinook Salmon

Figures 2-8 through 2-11 show the relationship between stream discharge and the percent of total width and contiguous width (adjoining cells) at each transect that is passable to Chinook. Table 2-5 shows that 25 percent of total width, the passage depth criteria for Chinook, is met on individual transects from 33 to 50 cfs. Discharges for contiguous passage range from 5 to 37 cfs. The discharge at which both passage criteria are met ranges from 33 to 50 cfs with an average of 39.75 cfs.

Table 2-5
Discharges For Meeting Chinook Passage Criteria

Passage Criteria	T-1	T-2	T-3	T-4	Average
Total (25%)	37 cfs	33 cfs	50 cfs	39 cfs	39.75 cfs
Contiguous (10%)	37 cfs	5 cfs	27 cfs	20 cfs	22.5 cfs
Both Criteria	37 cfs	33 cfs	50 cfs	39 cfs	39.75 cfs

Figure 2-8
Fish Passage – Transect 1 Chinook

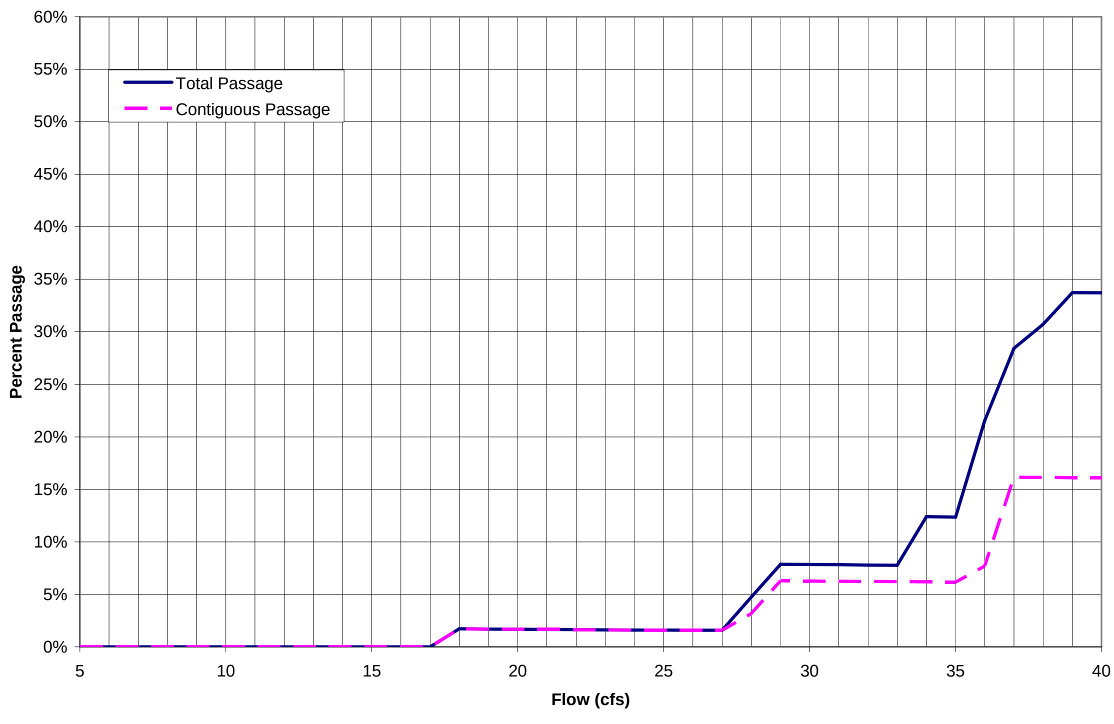


Figure 2-9
Fish Passage – Transect 2 Chinook

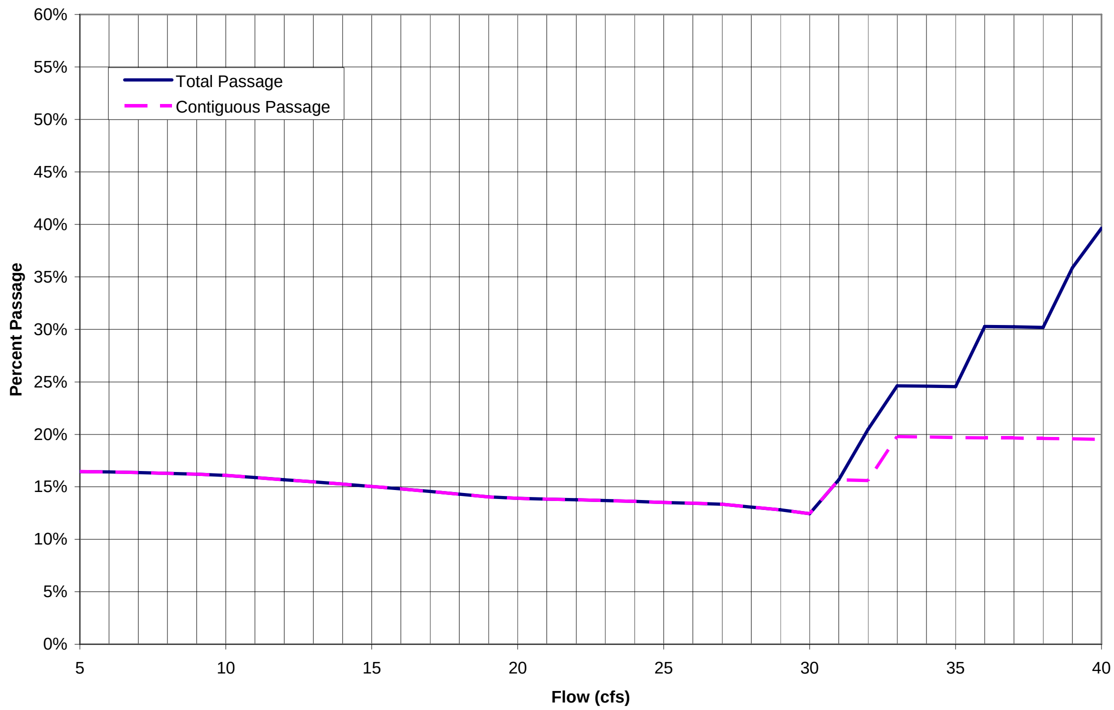


Figure 2-10
Fish Passage – Transect 3 Chinook

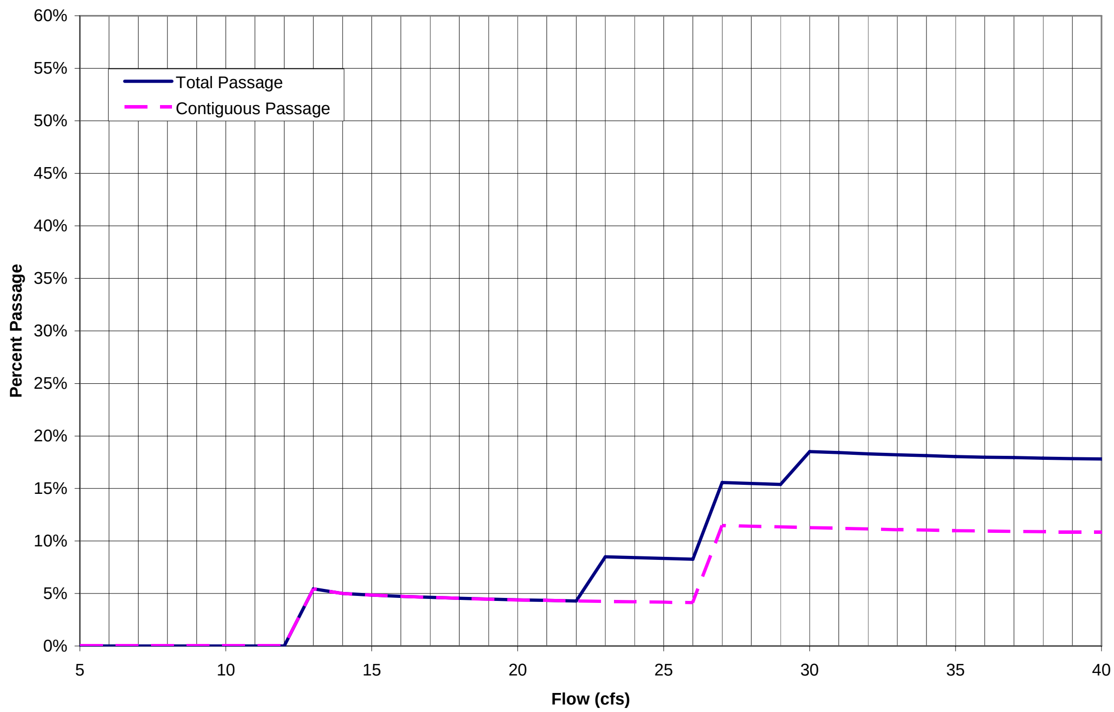
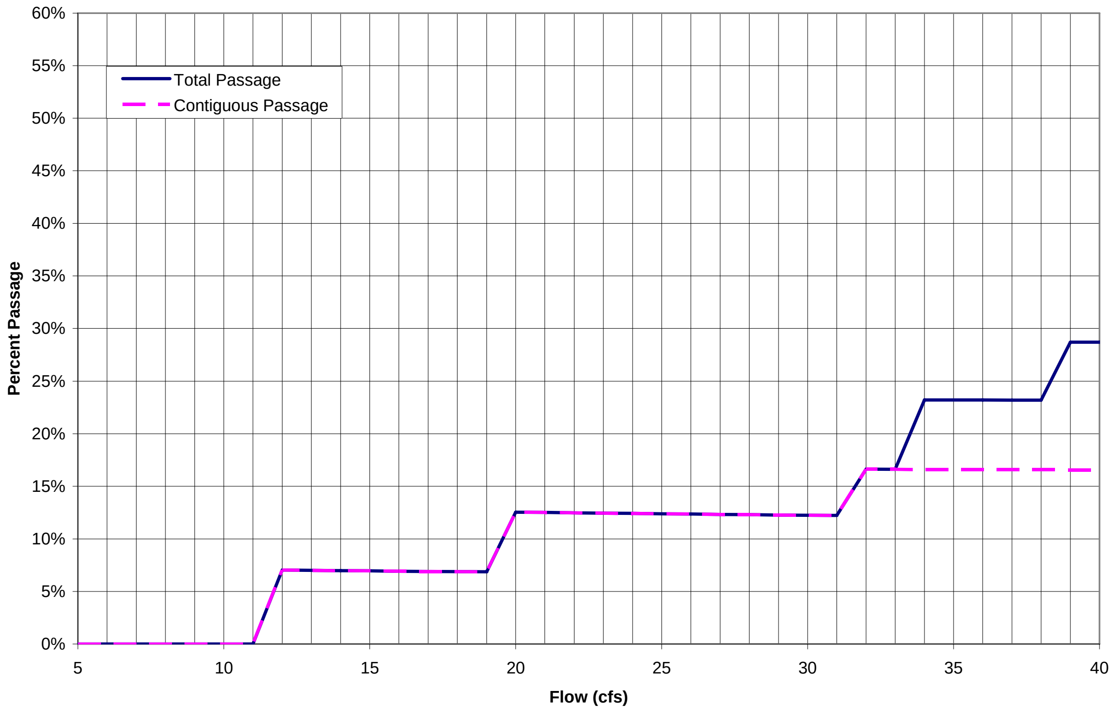


Figure 2-11
Fish Passage – Transect 4 Chinook



2.2.6 Discussion

The results of this study show that the wide gravel bars in lower Peshastin Creek likely pose a significant barrier to fish passage at low flows. Chinook salmon require considerably higher flows for passage than bull trout. This is due to the greater depth criteria for Chinook passage.

Flow records for water years 2003 and 2004 for Peshastin Creek at Green Bridge indicate that consistent snow melt keeps flows higher than required for minimum passage depth, for the Chinook migration period between May and early July. In mid July of both years, the flows receded to below the flow indicated for Chinook migration and stayed low through September, except when rainstorms temporarily increased the flow. The timing of the flows at which passage is likely impeded is important because it happens during the time of heaviest use for Chinook in-migration. It is also important to note that natural flows on Peshastin Creek (without irrigation diversions) are lower than the fish passage flow for Chinook salmon. More discussion of natural flow is provided in Section 3.

Similarly, bull trout migration may be impacted during late July, August, and September, when prolonged periods of low flow occur during times of expected in-migration. Since bull trout require less flow for passage than Chinook, a smaller increase in flow may prove beneficial to bull trout migration.

Even though resource agencies still use the Oregon method, Thompson (1972) cautions that the relationship between flow conditions on a transect and the relative ability of fish to pass has not been evaluated. It is recommended that this report be submitted to the Instream Flow Subcommittee of the Wenatchee Watershed Planning Unit for review. The subcommittee includes representatives of the Washington Department of Fish and Wildlife (WDFW), Ecology, and other fisheries agencies. A review will be helpful to obtain input and acceptance of the methodologies and findings of this report.

3 COMPARISON OF WATER NEEDS TO FLOW

Three stream gauges exist on Peshastin Creek: one is located upstream of the confluence with Ingalls Creek, the second is located just downstream of the confluence with Ingalls Creek, and the third is located just downstream of Green Bridge Road. The two upstream gauges have staff gauges and are read periodically, while a continuous stage recorder is used on the gauge downstream of Green Bridge Road. Data from the three gauges can be obtained from the Ecology website https://fortress.wa.gov/ecy/wrx/wrx/flows/regions/state.asp?region=3 . Figures 3-1 through 3-3 show flow records for the two most downstream gauges for the 2003 through 2005 water years for the period of July through September. The gauge located downstream of Green Bridge Road records the flow in Peshastin Creek after diversions for the Tandy Ditch and Peshastin Canal and after any water that is supplied to Peshastin Creek from the Icicle Canal Division 2 bifurcation. Although data for the 2006 water year is available on Ecology's website, it was not used because additional data review and checking is believed to be needed. The flow records at Green Bridge Road show that flows during the summer period when Chinook are migrating are less than needed for passage. A flow need for Chinook passage of 40 cfs is overlain on Figures 3-1 through 3-3 for the period of mid-July to August. The total volume of flow needed to bring the flow up to 40 cfs is shown on the figures and is listed in Table 3-1. The total volume of flow needed to bring the flow up to the flow measured at the gauge downstream of Ingalls Creek (natural flow) is also shown in Table 3-1. Even though the 40 cfs passage flow is higher than the flow measured at the gauge downstream of Ingalls Creek during some time periods, it is likely that flow may be needed to ensure fish passage. The reasons are the stream channel downstream of the Peshastin diversion dam appears to have been modified through activities like straightening, bank armoring, and floodplain modifications. Those activities likely affected the channel shape and streambed composition, possibly creating more difficult fish passage conditions in summer than would occur in natural or undisturbed conditions.

Table 3-1
Flow Needed to Maintain Fish Passage Flow

	Flow Needed to Maintain 40 cfs		Flow Needed to Maintain Natural Flow	
Year	Flow Volume (acre-feet)	Peak Flow Need (cfs)	Flow Volume (acre-feet)	Peak Flow Need (cfs)
2003	1,808	29.6	1,385	22.3
2004	1,873	34.6	1,550	27.9
2005	3,065	38.9	2,105	24.5

Figure 3-1
Comparison of Peshastin Creek Flow to Fish Passage Flow – 2003

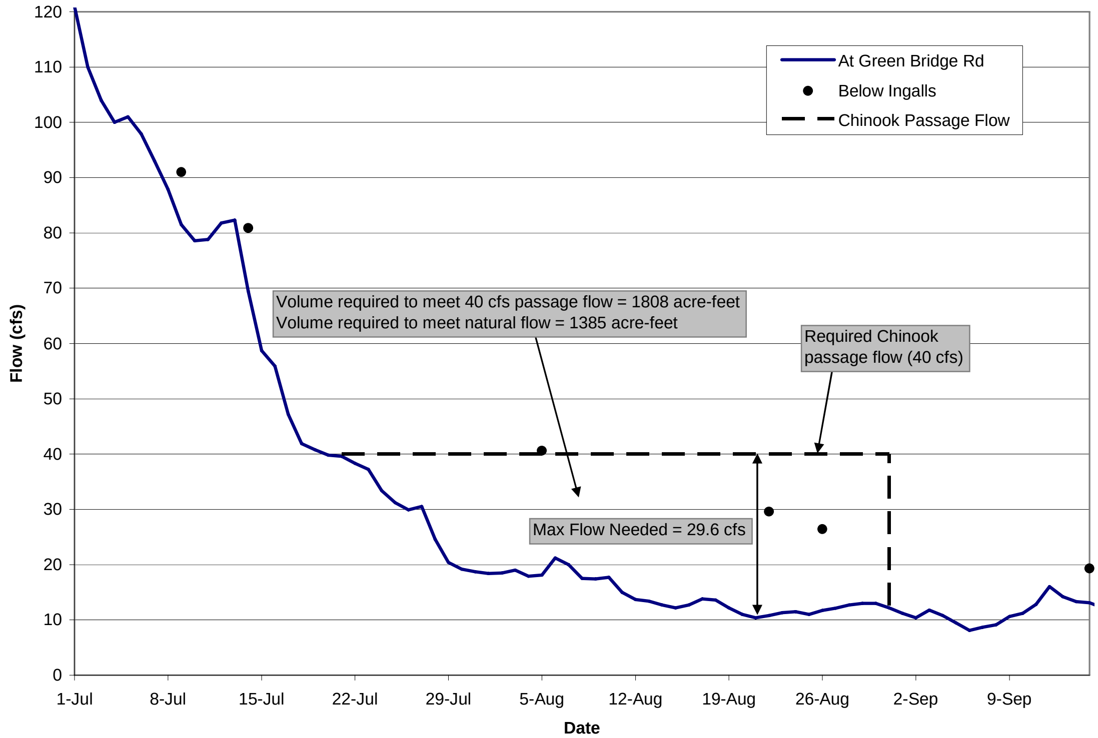


Figure 3-2
Comparison of Peshastin Creek Flow to Fish Passage Flow – 2004

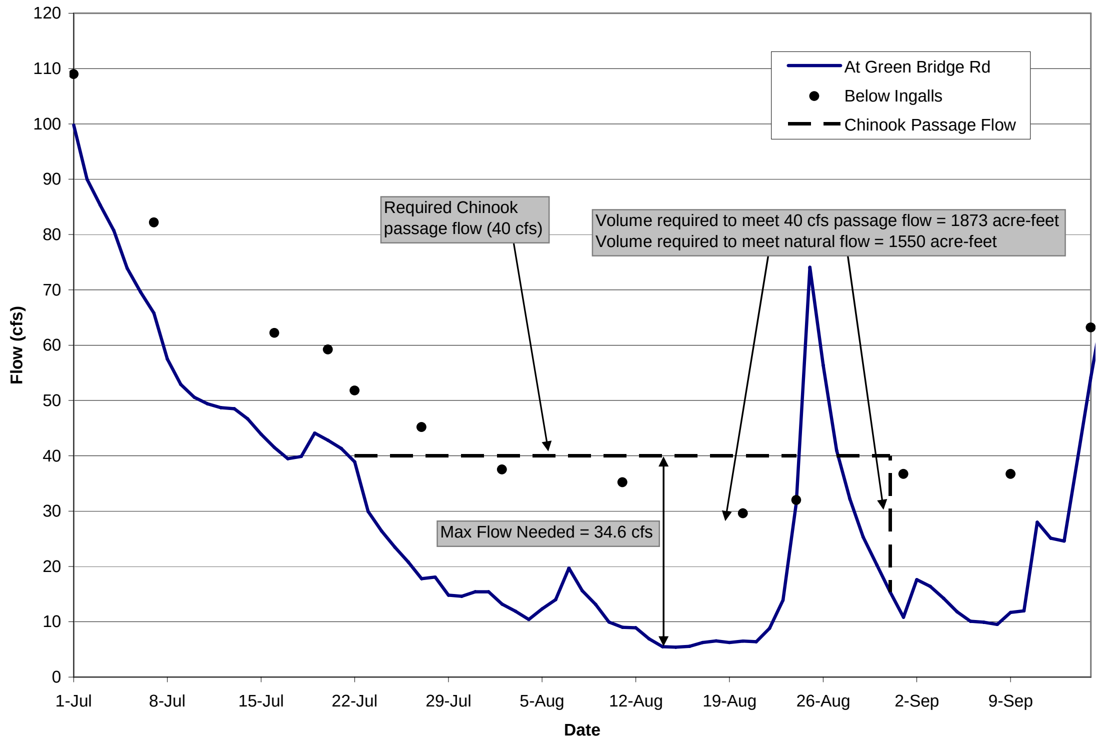
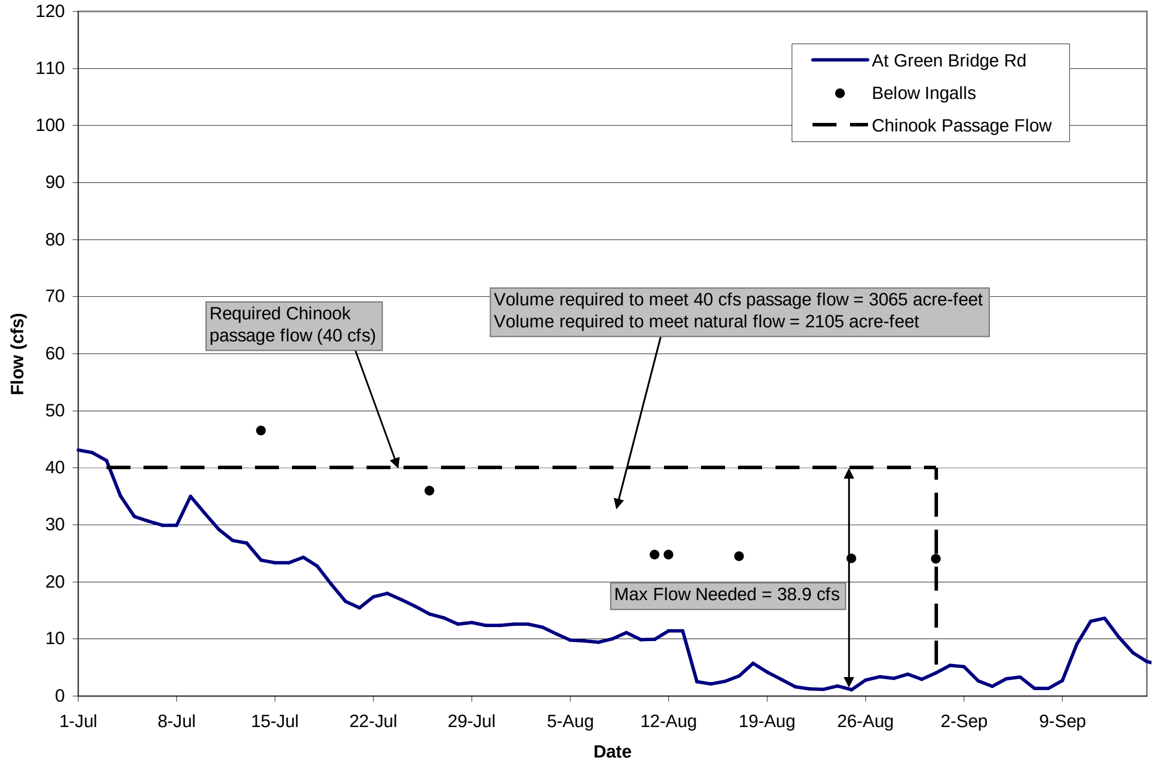


Figure 3-3
Comparison of Peshastin Creek Flow to Fish Passage Flow – 2005



The flow volume needed to maintain 40 cfs passage flow for Chinook ranges from approximately 1,800 to over 3,000 acre-feet. The peak flow needed is also shown in Table 3-1, which ranges from approximately 30 to 39 cfs. The flow volume needed to maintain natural flow (up to 40 cfs) ranges from approximately 1,400 to 2,100 acre-feet. The peak flow needed ranges from approximately 22 to 28 cfs.

The estimate of flow volume needed was based upon providing a continuous flow through August 31. It may be possible to provide adequate passage with a reduced volume of flow by reducing the time the fish passage flow is provided. This may result if studies show passage is completed before August 31 or a continuous flow is not required. Meetings with biologists from WDFW, Ecology, and the Yakama Nation would be necessary to determine what solutions would be acceptable given the management goals for the Peshastin Subbasin. A meeting to illustrate the summer flow and channel passage conditions and to discuss potential solutions would be the first step in determining the level of interest in a solution that considered flow alternatives. The discussions of flow alternatives will need to take place in the context of determining which alternatives would provide sufficient flow for fish passage and can be implemented with available funding and within permitting constraints. Those alternatives are discussed in Section 4.

4 ALTERNATIVES

4.1 Changes to Irrigation District Facilities

This alternative includes water conservation activities (piping and lining) in the Peshastin Irrigation District, modifications to the pipelines that lead from the Division 2 Bifurcation structure on the Icicle Canal, and increased feed from Alpine Lakes to provide flow for the Peshastin Canal.

The piping project reviewed for the Peshastin Irrigation District is completing the replacement of the section of canal from Brender Spill to the end of the system. This reach of the system appears to be the leakiest. The Peshastin Irrigation District has constructed some 6,000 feet of pipe in this reach and the project requires 9,000 feet more to be completed. The reach that remains to be completed starts at Brender Spill. We estimate the pipeline would need to be 21-inches in diameter to convey the required flow. The pipeline would be designed and operated as a pressure pipe. Additional engineering study is required to determine the exact pipe size needed, its pressure rating, and the exact route and construction details.

Modifications to the pipelines from the Division 2 Bifurcation on the Icicle Canal may be needed to deliver additional water from the Icicle Canal to the Peshastin Canal. Currently, there is a 16-inch-diameter pipe that conveys flow to the Peshastin Canal and Peshastin Creek, a 30-inch pipe that conveys flow to the Icicle Canal and another pipe (unknown size) that conveys water spilled from the bifurcation structure to Peshastin Creek. Although the capacity of the existing pipes may be adequate to deliver additional flow to Peshastin Creek that could then be diverted, the better solution from an operational view would be to enlarge the pipeline to Peshastin Canal.

The additional water would be released from the Alpine Lakes operated by the Peshastin Irrigation District into Icicle Creek and the Icicle Canal. The additional water would be obtained by optimizing the water supply from the Alpine Lakes by installing remotely operated valves and monitoring instrumentation.

4.1.1 Water Supply and Yield

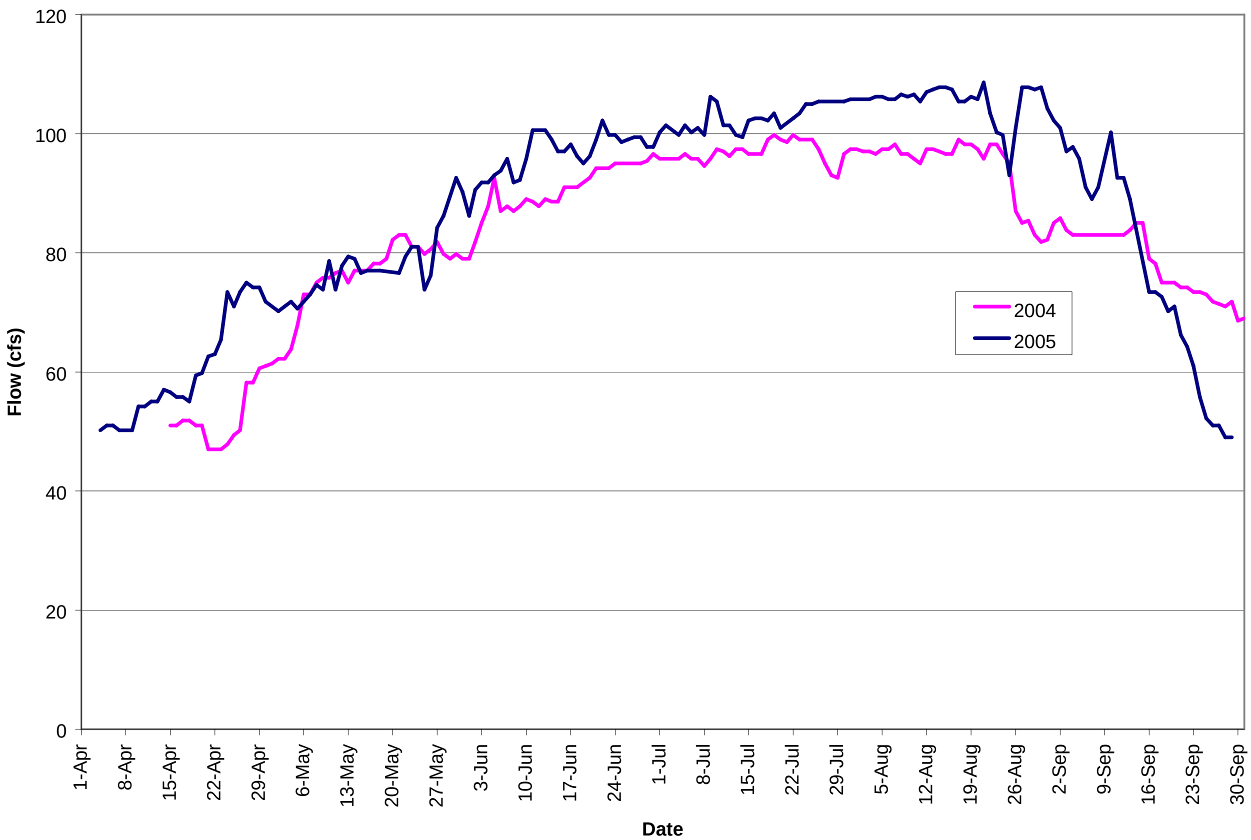
The water savings from piping or lining additional reaches of the Peshastin Irrigation District is estimated to be 3 to 4 cfs. The water savings are based upon an estimated conveyance efficiency of 81 percent from Stines Hill Spill to the Pioneer End Spill and spill estimates contained in the Peshastin Irrigation District Comprehensive Water Conservation Plan (Klohn Leonoff 1993). For this alternative we assumed the entire reach from Brender Canyon Road to the end of the system would be piped, eliminating seepage and spill at the end of the system. The yield from the middle of July (typically when flows measured at Green Bridge Road drop below 40 cfs) to the end of August is estimated to be 280 to 360 acre-feet.

The potential yield from supplying additional water from the Icicle Canal was estimated by reviewing available diversion records obtained from Ecology, reviewing the current operations of the Icicle Canal, and comparing these records to the timing of flow needs in Peshastin Creek. Figure 4-1 shows the pattern of diversions from the Icicle Creek watershed measured near the head of the Icicle Canal (head of Reach 1). The estimated capacity of the Icicle Canal is shown in Table 4-1 (Klohn Leonoff 1993).

Table 4-1
Icicle Canal Capacity

Reach	Estimated Capacity at Upstream End (cfs)	Estimated Capacity at Downstream End (cfs)
1 – Intake to Leavenworth Bifurcation	125	100
2 – Leavenworth Bifurcation to Peshastin Siphon	75	65

Figure 4-1
Icicle Canal Diversions – 2004/2005



No flow records were available for the second reach. The flow records from the head of the Icicle Canal show it reaching a peak diversion in July and remaining near that peak to about the end of August. During an average flow year such as 2004, the records indicate about 95 to 100 cfs is diverted during July and August. During a drought year, such as 2005, the diversions during July and August increased to 105 to 108 cfs. The increase in diversions was at least partially due to the Peshastin Canal demand not being fully met by diversions from Peshastin Creek, and increased supply from the Icicle Canal was needed.

Flow is delivered to the Icicle Canal during the entire irrigation season from the Division 2 Bifurcation and to the Peshastin Canal when natural flow in Peshastin Creek is low. The greatest demand for flow to the Peshastin Canal is during droughts (such as 2005) when supply from Peshastin Creek is reduced. That also coincides with the maximum need for fish passage flow in Peshastin Creek. Some additional capacity in the canal may exist, but without flow records in the Icicle Division 2 Canal we cannot determine what that capacity is. During normal or wet years there would be extra capacity in the Icicle Canal to deliver water to the Peshastin Canal, as shown by the 8 to 10 cfs difference in diversions from 2004 to 2005. If 8 to 10 cfs additional water supply were provided from July 15 to August 31 during normal or wet years, the volume of water provided would be 728 to 911 acre-feet.

The Alpine Lakes have the potential to supply additional water to the Icicle Canal through operational changes. However, the Icicle Canal may need to be expanded to take advantage of the additional supply as the canal runs at or near maximum capacity during the same time period that the most flow in Peshastin Creek is needed.

4.1.2 Design Features and Cost

The piping project that would reduce Peshastin Canal diversions by 3 to 4 cfs is replacing the section of canal from Brender Spill to the end of the system. This reach of the system appears to be the leakiest. The total length of that project is approximately 15,000 feet. The Peshastin Irrigation District has completed 6,000 feet of the project and 9,000 feet of pipe needs to be constructed to complete the project. The Peshastin Irrigation District estimates the cost to complete the project at $900,000 (Teeley, pers. comm., 2006).

The project that would be required to increase the amount of water delivered to Peshastin Canal from the Icicle Canal is a new 30-inch-diameter pipe extending from the Division 2 Bifurcation structure to the Peshastin Canal. The capacity of the pipe would be approximately 30 cfs, depending on the velocity the pipe is operated at. The estimated cost is $690,000. The cost includes a contingency of 30 percent and engineering and administrative costs of 20 percent. A more detailed cost summary is provided in Appendix A.

4.1.3 Natural Resources and Permitting Issues

The primary natural resource issue for the Peshastin Canal upgrade may be the effect of reduced seepage on groundwater supplies in the Brender Creek areas and streamflow in

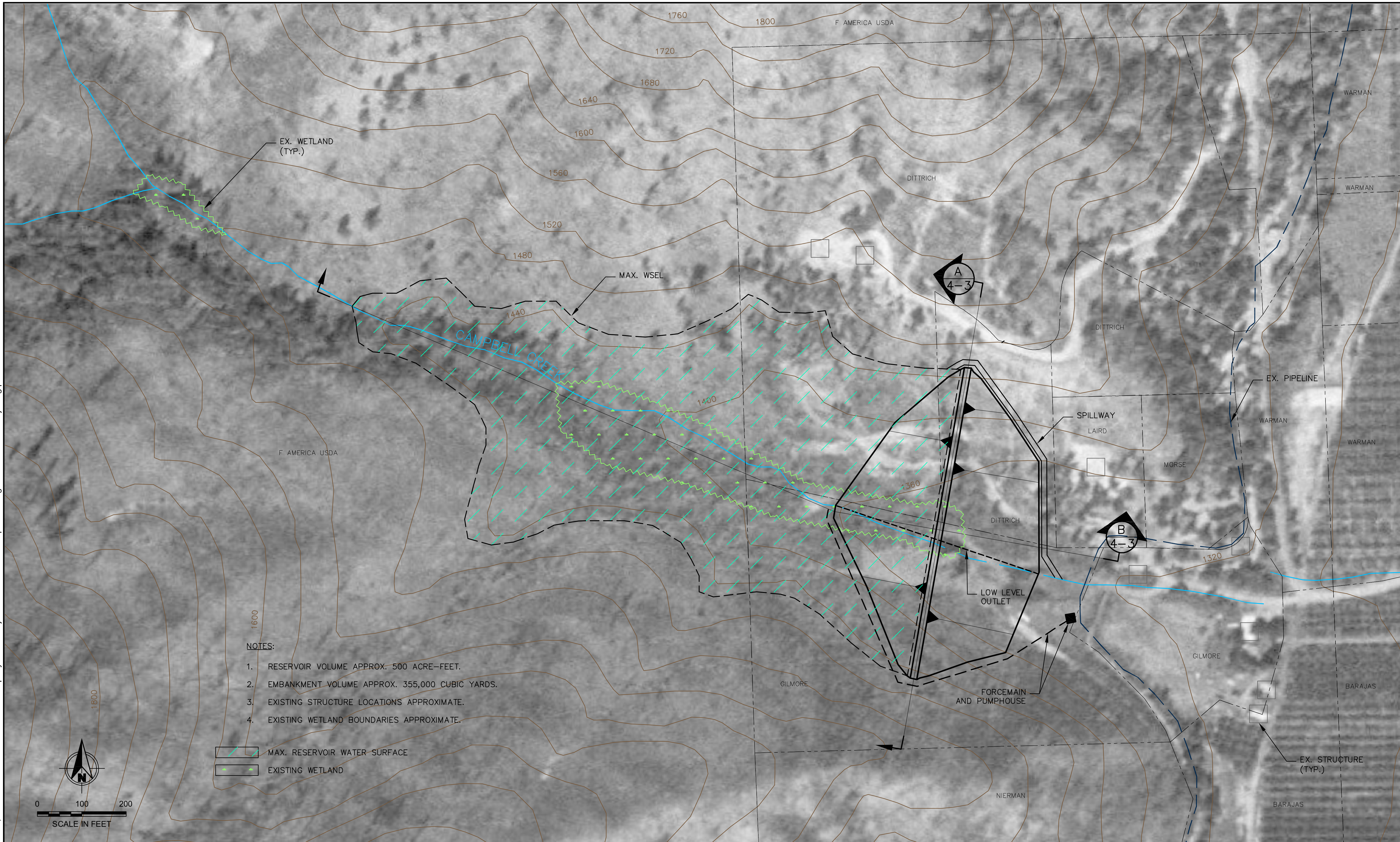
Brender Creek. Very few permitting issues would likely be encountered, as the work would be completed within existing canal rights-of-way.

The primary permitting issue for optimizing water storage in the Alpine Lakes is the need to obtain permits from the U.S. Forest Service (USFS) for construction in the Alpine Lakes Wilderness Area. A special use permit would be required. The effects of the optimization project may be a more frequent drawdown, which could affect scenic properties of the lakes and some recreational activities, which may cause opposition to a change in operations. Meetings with USFS will be needed to ensure their permitting requirements and process is followed.

If additional water is available for conveyance through the Icicle Canal and the Icicle Canal has the capacity to deliver more water to the Peshastin Canal, no permits would be needed for that alternative.

4.2 Campbell Creek Reservoir

The Campbell Creek reservoir site is located along the lower reach of Peshastin Creek, southwest of the Peshastin diversion dam. The site is located on both private land and federal land managed by USFS. The reservoir would be formed by constructing an earthen or rockfill dam across a broad canyon. The reservoir would be filled by pumping from the Tandy pipeline that is located immediately east of the potential dam and reservoir. Figure 4-2 shows the location of the dam, reservoir, and other project features. Two reservoir configurations were reviewed for this study: a 500 acre-foot reservoir and a 1,000 acre-foot reservoir. Water supplied from the reservoir would be used to either supplement Peshastin Creek flow, replace flow that could be diverted by the Tandy Ditch Company, or used to directly supplement flows in the Peshastin Canal during the time when Peshastin Creek flow is less than needed for passage of adult Chinook. The last option would require construction of a pipeline from the Campbell Creek reservoir to the Peshastin Canal.



Nov 08, 2006 11:23am dcisakowski C:\Company\David\Projects\1026-Chelan\Campbell\storage calculations 500 djc.dwg plan

ANCHOR
ENVIRONMENTAL, L.L.C.

Figure 4-2
500 acre-foot Reservoir Plan
Campbell Creek Reservoir
Chelan County

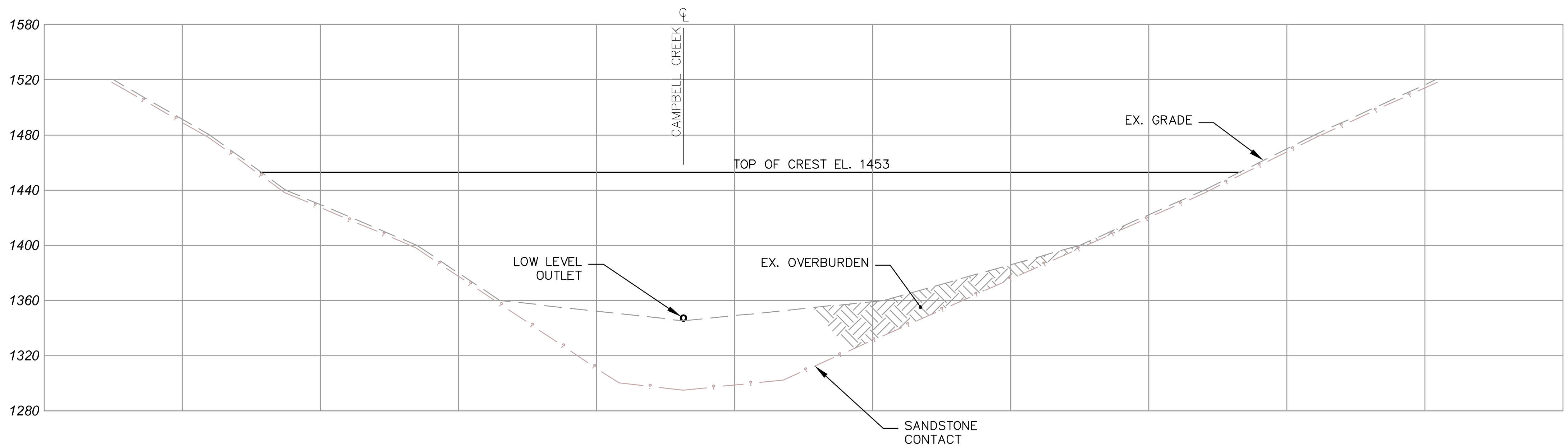
4.2.1 Water Supply and Yield

The reservoir would be supplied from the Tandy pipeline and would receive natural runoff. The capacity of the Tandy pipeline is 4.6 cfs. Assuming the Tandy pipeline could be fully used prior to the irrigation season (which starts approximately April 15), it would take 54 days (about 8 weeks) to provide 500 acre-feet by April 15. However, the reservoir would also partially fill from capture of natural runoff. Since the reservoir would be used to supplement flow in July and August, it could fill all spring before the water is used. We conservatively estimate that 250 acre-feet of natural runoff could be captured from the 520 acre Campbell Creek basin during normal years, provided discharge from the reservoir to Campbell Creek is reduced to a minimum when capturing flow. However, natural flow produced in the Campbell Creek basin is highly variable and could not be counted on producing a significant quantity of water every year. The use of the Tandy pipeline would ensure the reservoir is filled. Accounting for 250 acre-feet of natural runoff, the filling time would be reduced to about 4 weeks. For the 750 acre-foot option, the filling time would be 12 weeks.

The flow stored in Campbell Creek reservoir would be released in July and August to either supplement flow in Peshastin Creek, feed the Tandy pipeline, or directly feed the Peshastin Canal. The expected yield of the either of the two reservoir options (470 acre-feet and 950 acre-feet, accounting for evaporation) is less than the need for Chinook passage flow needs (1,800 to 3,000 acre-feet) identified in Chapter 2 but would still provide 25 to 50 percent of flow needs during normal years and 15 to 30 percent during drought years, assuming the reservoir can be filled during drought years.

4.2.2 Design Features and Cost

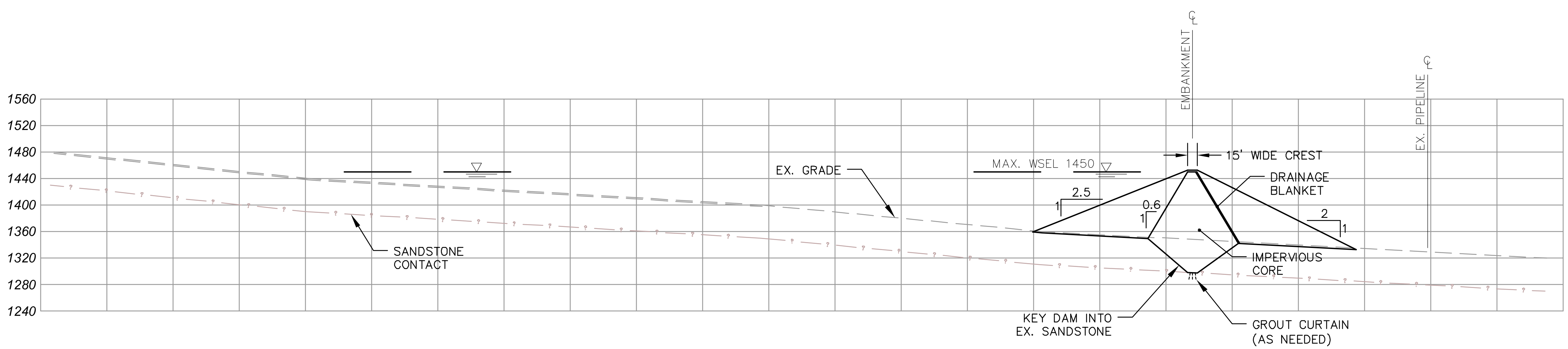
Figures 4-2 and 4-3 show the features of the potential 500 acre-foot reservoir. Figures 4-4 and 4-5 show the configuration of a potential 1,000 acre-foot reservoir. The required features include an embankment dam, pump station to fill the reservoir, low-level outlet to release flow to Campbell Creek, and emergency spillway. Table 4-2 summarizes the estimated costs of constructing the water storage projects. Appendix A contains a more detailed cost estimate.



CROSS SECTION
(looking west)

A 4–2

0 50 100 FEET



LONGITUDINAL SECTION
(looking north)

B 4–2

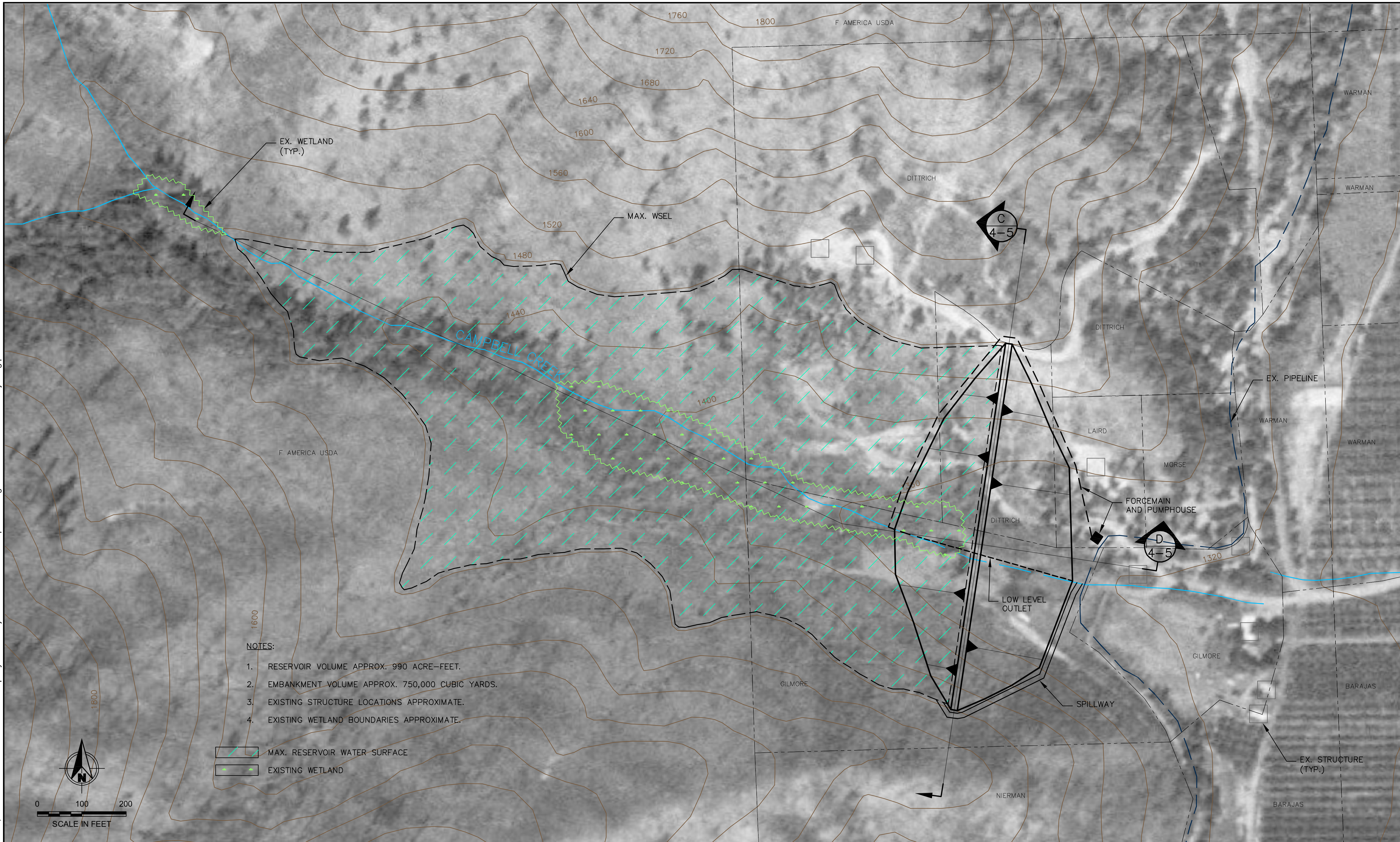
0 100 200 FEET

Nov 08, 2006 11:24am dcisakowski C:\Company\David\Projects\1026-Chelan\Campbell\storage calculations 500 djc.dwg sections

ANCHOR ENVIRONMENTAL, L.L.C.

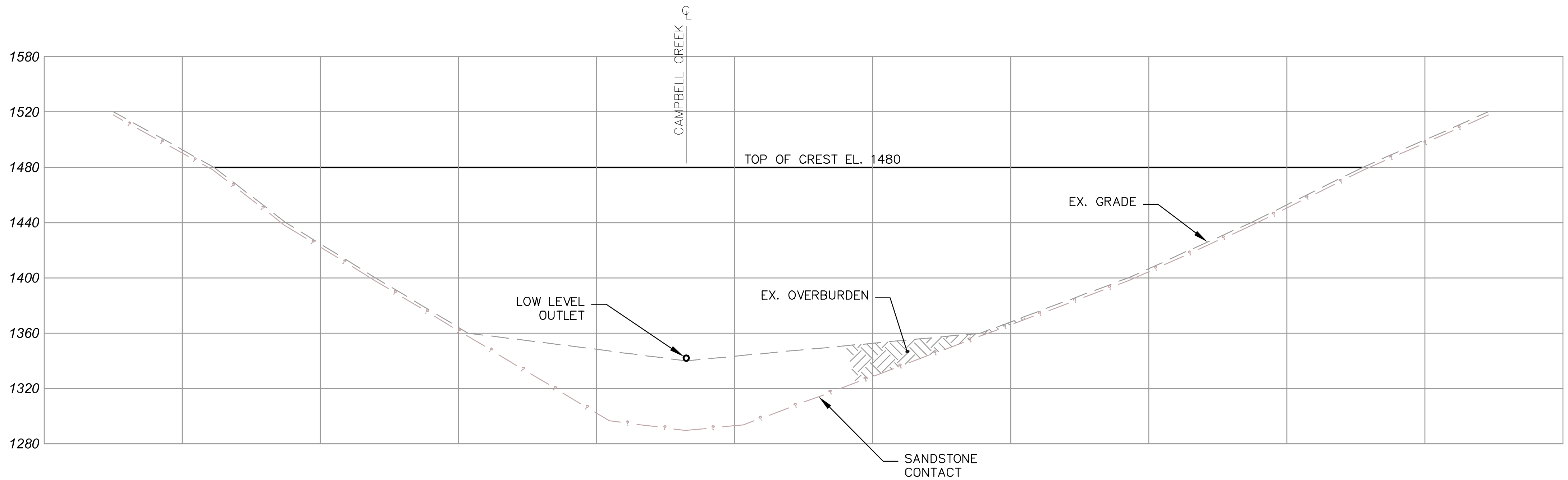
Figure 4-3
500 acre-foot Reservoir Sections
Campbell Creek Reservoir
Chelan County

Nov 08, 2006 11:52am dcisakowski C:\Company\David\Projects\1026-Chelan\Campbell\storage calculations 1000 conc djc.dwg plan



ANCHOR ENVIRONMENTAL, L.L.C.

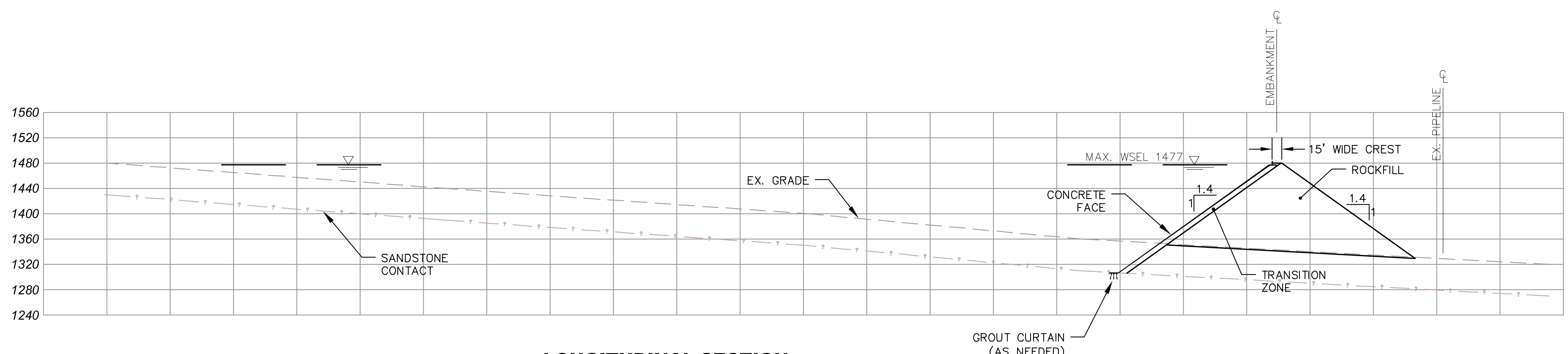
Figure 4-4
1,000 acre-foot Reservoir Plan - Concrete Faced Rockfill Dam Option
Campbell Creek Reservoir
Chelan County



CROSS SECTION
(looking west)

C
4–4

0 50 100
FEET



LONGITUDINAL SECTION
(looking north)

D
4–4

0 100 200
FEET

ANCHOR
ENVIRONMENTAL, L.L.C.

Figure 4-5
1,000 acre-foot Reservoir Sections - Concrete Faced Rockfill Dam Option
Campbell Creek Reservoir
Chelan County

Table 4-2
Estimated Construction Cost
Campbell Creek Water Storage Reservoir

Item	Cost of 500 acre-foot reservoir	Cost of 1,000 acre-foot reservoir
Estimated Construction Cost	$6,027,000	$9,964,000
Contingency (30%)	$1,808,100	$2,989,200
Engineering, permitting, construction management (20%)	$1,205,400	$1,992,800
Sales Tax (8.0%)	$482,160	$797,120
Estimated Land Acquisition or Lease Costs	$485,625	$813,750
Estimated Total Implementation Cost	**$10,009,000**	**$16,557,000**

The total estimated costs of implementing a 500 acre-foot reservoir project are $10M. The cost of the project is high, as it is assumed that almost all of the dam embankment would be constructed with imported fill materials, not materials within or adjacent to the reservoir. Another option would be a concrete-faced rockfill dam. This may be a less expensive option because steeper embankments could be constructed, thereby reducing the embankment volume.

A 1,000 acre-foot reservoir option was also reviewed. For this option, we estimated the costs using a concrete-faced rockfill embankment dam to determine if the dam could be built more efficiently. The estimated costs of constructing the reservoir are summarized in Table 4-2 and are $16.6M.

The estimated operations and maintenance cost for the two reservoir sizes is listed in Table 4-3. Power costs would be incurred with the pump station used to fill the reservoir.

Table 4-3
Operations and Maintenance Costs
Campbell Creek Water Storage Reservoir

Item	Cost for 500-acre foot reservoir	Cost for 1,000-acre foot reservoir
Annual Operations and Maintenance Cost	$120,600	$199,300
Power Cost	$1,800	$6,400
Totals	**$122,400**	**$205,700**

4.2.3 Natural Resources and Permitting Issues

The Campbell Creek reservoir site was reviewed by Anchor personnel to identify environmental resources. Prior to visiting the site, the National Wetland Inventory (NWI) maps (USFWS 2006), the Soil Conservation Service (SCS) soil survey (USDA SCS 1975), and a 1-meter U.S. Geological Survey (USGS) orthoquad aerial photo available from 1998 were reviewed. Although no wetlands were shown on the NWI maps or hydric soils mapped by the SCS, the aerial photograph shows vegetation along the channel that could indicate the presence of wetlands. The site was reviewed from Campbell Road to near the confluence of the major forks of the drainage. The key findings are:

- The culvert under Campbell Road is an upstream barrier to fish. The 24-inch corrugated high density polyethylene (HDPE) culvert is installed at an approximately 1 horizontal to 1 vertical (1H:1V) slope. Although a trickle of water was observed entering the culvert, no water was observed in the channel downstream of the culvert.
- An approximately 300-foot-long 24-inch corrugated metal pipe (CMP) is located further upstream that is also probably a barrier to upstream migration. Water was not visible in the channel at either end of this culvert, although the ends could not be fully investigated as the downstream end was obscured by riprap channel protection and the upstream was obscured by vegetation.
- Another culvert exists that crosses the Tandy Pipeline right-of-way. It could not be ascertained if the culvert would be a barrier to fish.
- Upstream of the Tandy Pipeline right-of-way, there is an open channel that leads to an outlet structure at the downstream end of the wetland area. The outlet has a wire screen, which was blocked by debris.
- A wetland area was found along the channel upstream of the pipeline right-of-way that extends approximately 1,000 feet upstream. In some areas, the wetland may be as much as 150 feet wide. Along the south side of the channel, the vegetation has been mowed for a picnic area. Because of the density of the plant material compared to the vegetation found on the adjoining slopes, some of this area may also be wetland. Because of the season, it was not possible to identify the plant species, although there were stands of cattails and areas of open water. This wetland area covers approximately 2.5 acres.

- Upstream of the wetland area, there was no defined channel. Much of the channel appears to be filled with woody debris and sandy soil materials. There were no defined banks or coarsening of the substrate, although the woody materials were stacked up and arranged by flowing water.
- Upstream of the reservoir site, near the confluence of the two main forks of the creek, there was increased density of vegetation that probably indicates additional wetlands, although the plants could not be identified.

Figure 4-2 shows the extent of possible wetlands seen on-site. The approximate area within the dam and reservoir footprint is 2.5 acres. The footprint of the dam and reservoir would eliminate most, if not all, of the wetland. If this project proceeds, a more detailed wetland delineation will be required. The delineation should be conducted in the spring, when the plants are growing, to best map the wetlands.

The main permitting issues include mitigating for filling wetland and stream habitat and obtaining a special use permit from the USFS. Part of the reservoir is located on National Forest Land allocated as Late Successional Reserve. Development, such as the construction of a reservoir, is discouraged within this designation; however, development in Late Successional Reserve areas may be permitted to go forward if the proposal addresses public needs or provides significant public benefits. Proposals are reviewed on a case-by-case basis. One of the purposes of this study is to identify the need for the Campbell Creek reservoir project and compare it to other feasible alternatives, which should help USFS determine if the project meets their criteria for approval. The USFS would likely become the lead agency for environmental review and meetings with the USFS are needed to discuss the alternatives presented in this report and determine what their needs will be if the additional steps towards implementing the reservoir projects are taken.

Impacts to wetlands through fill or flooding may require mitigation compensation through the Section 404 permitting mechanism. The cost estimate includes wetland mitigation costs using a 3:1 replacement ratio.

4.3 Pump from Wenatchee River

For this alternative, a pump station would be constructed on the Wenatchee River and water would be pumped to the Peshastin Canal. The Peshastin Irrigation District would reduce diversions with the amount reduced provided by the pump station. A potential location of the pump station is shown on Figure 2-2. The potential location is near the US 2/97 eastern crossing of the Wenatchee River just west of Dryden.

4.3.1 Water Supply and Yield

The pump station could be designed to supply any amount of water needed. The peak need identified in Section 3 is approximately 40 cfs. For this report, we reviewed pump station sizes that could deliver from 10 to 40 cfs. The flow volume provided from a 10 cfs pump station from mid-July to August 31 is 900 acre-feet, while a 40 cfs pump station could provide 3,600 acre-feet.

4.3.2 Design Features and Cost

The components needed for this alternative include an intake and fish screen, pump station, pipeline to the Peshastin Canal, and a structure at the canal to dissipate energy.

4.3.2.1 Pipeline Design

A preliminary pipeline path was selected from the US 2/97 crossing to the Peshastin Canal (shown in Figure 2-2). The total length of pipe is 1,360 feet with an elevation difference estimated to be 200 feet. Pipe diameters were selected using a range of discharges that may be used. The discharges used in the analysis are 10, 20, and 40 cfs. The required pipe diameters were estimated using an average velocity of 5 feet per second at the design flow. The 5 feet per second criteria is based upon experience with pipeline design and usually gives an efficient combination of pipe and pump size. The pipe sizes are listed in Table 4-4.

Table 4-4
Pipe Sizes

Discharge (cfs)	Proposed Pipe Diameter (in)
10	20
20	27
40	39

The design of steel pipelines requires a calculation of the required wall thickness, which is a function of steel strength and the internal pressure. The guidelines presented in the American Water Works Association (AWWA) Manual M11 (AWWA 1985) were used to determine proposed pipeline wall thickness. These guidelines include the following equation that was used to determine the required wall thickness of steel pipe:

$$t = \frac{pd}{2s}$$

Where:

t = pipe wall thickness (in)

p = pressure (psi)

d = pipe diameter (in)

s = allowable stress (psi)

The allowable stress, s, is equal to 50 percent of the minimum specified yield strength of steel. The pipelines proposed were assumed to consist of ASTM A572, Grade 60 steel pipe, which has a yield strength of 60 kips per square inch (ksi). The required thickness was calculated using a maximum transient pressure, which was assumed to be 1.3 times the operating pressure at the pump station, which is where the maximum pressure is located in this study.

This thickness was compared to the minimum wall thickness recommended in AWWA M11 for handling steel pipe. The following equation was used for estimating the minimum wall thickness for handling:

$$t = \frac{d + 20}{400}$$

Where:

t = pipe wall thickness (in)

d = pipe diameter (in)

Table 4-5 provides a summary of the required pipe thicknesses. These thicknesses were used to estimate the costs of the pipeline.

Table 4-5
Pipe Wall Thickness

Discharge (cfs)	Proposed Pipe Diameter (in)	Proposed Pipe Wall Thickness (in)
10	20	0.125
20	27	0.125
40	39	0.25

4.3.2.2 Pump Station Design

The required size of pumps is based upon the discharge and pressure head needed to deliver the flow to the Peshastin Canal. The Hazen-Williams Formula was applied to calculate friction head losses in the delivery pipelines. The total head is the sum of the friction loss and difference in elevation. Horsepower was calculated from the total head required and an assumed efficiency of 70 percent for the pump and motor combined. Pipeline pressures were also determined from the total head required. Table 4-6 lists the required horsepower for the range of discharges studied.

Table 4-6
Required Horsepower

Discharge (cfs)	Required Horsepower (hp)
10	375
20	675
40	1,350

Other components needed for the pump station are an intake and fish screen. The design of the intake and fish screen would need to meet WDFW criteria and standards.

4.3.2.3 Costs

Summaries of cost estimates for each pump station and delivery pipeline are provided in Table 4-7. The costs include a 30 percent contingency and 20 percent allowance for engineering and administrative costs. These costs are preliminary and further engineering review should be performed prior to using these costs to evaluate the projects. More detailed cost estimates are contained in Appendix A.

Table 4-7
Estimated Implementation Cost
Pump from Wenatchee River to Peshastin Canal

Item	Cost for 10 cfs pump station	Cost for 20 cfs pump station	Cost for 40 cfs pump station
Estimated Construction Cost	$834,900	$1,421,200	$2,417,800
Contingency (30%)	$250,470	$426,360	$725,340
Engineering, permitting, construction management (20%)	$201,900	$343,670	$584,670
Sales Tax (8.0%)	$102,980	$175,300	$298,230
Estimated Land Acquisition or Lease Costs	$20,000	$20,000	$20,000
Estimated Total Implementation Cost	**$1,410,000**	**$2,387,000**	**$4,046,000**

The estimated costs of implementing the project range from $1.41M for the 10 cfs option to $4.05M to supply 40 cfs.

The estimated operations and maintenance cost for the project is listed in Table 4-8.

Table 4-8
Operations and Maintenance Costs
Pump from Wenatchee River to Peshastin Canal

Item	Cost for 10 cfs pump station	Cost for 20 cfs pump station	Cost for 40 cfs pump station
Annual Operations and Maintenance Cost	$16,700	$28,500	$48,400
Power Cost	$8,700	$15,400	$30,500
Totals	**$25,400**	**$43,900**	**$78,900**

4.3.3 Natural Resources and Permitting Issues

The primary natural resource and permitting issue will be obtaining permits for the diversion structure and meeting fishery agency criteria for the intake structure.

4.4 Channel Modification

This alternative consists of modifying the lower Peshastin Creek channel to reduce the flow requirement for passage. Modifications would need to be made to reduce the flow width and increase the flow depth. Those modifications could include adding very large boulders and wood and constructing pool and riffle sequences to provide resting areas for fish and shorter reaches to swim while they migrate upstream. It is not likely that this alternative would fully meet passage requirements, but it could reduce the need for supplemental water.

A geomorphic study of lower Peshastin Creek is needed before further evaluating this alternative. The study should review the current sediment input to the channel, what factors have influenced the current shape of the channel, estimate what a "natural" or undisturbed reach of the channel would look like, and review the potential for channel modifications that could improve fish passage.

A very preliminary estimate of costs for this alternative is $400,000. That cost is based upon an assumption of modification of 10 gravel bar sites at $25,000 per site along with contingencies, engineering, permitting, and other costs consistent with the other alternatives. This cost should be used as a placeholder until the more detailed geomorphic study of Peshastin Creek is completed.

5 SUMMARY

A field study of flow needs to facilitate fish passage through the lower reach of Peshastin Creek was performed. The results of the study show that the wide gravel bars in lower Peshastin Creek likely pose a significant barrier to fish passage at low flows. Fish passage flows for two species of interest were reviewed: Chinook salmon and bull trout. Chinook salmon require greater depth of flow for passage than bull trout, and therefore considerably higher flows for passage. The estimated fish passage flow for lower Peshastin Creek for Chinook salmon averages 40 cfs. The total volume of flow needed in July and August (the period of in-migration for Chinook) was estimated using flow records for 2003 to 2005. Assuming a continuous supply of water is provided to Peshastin Creek that would maintain 40 cfs, the required flow volume ranges from 1,800 to 3,600 acre-feet.

The results of the field study should be discussed with the Instream Flow Subcommittee of the Watershed Planning Unit, which includes representatives of WDFW and other fisheries agencies, in order to gain their input and acceptance of the findings and to ascertain whether a lesser flow volume could be provided that would still meet a goal of providing passage for adult Chinook salmon. For example, if a fish passage flow that meets natural levels (as defined as flow measured at the stream gauge on Peshastin Creek downstream of Ingalls Creek) is provided, the required flow volume would be 1,400 to 2,100 acre-feet per year.

Alternatives that could provide some or all of the flow volume needed for fish passage were reviewed. These alternatives include the Campbell Creek reservoir, modifications to Peshastin and Icicle Irrigation District facilities, pumping from the Wenatchee River to the Peshastin Canal, and modification to lower Peshastin Creek to improve fish passage conditions. Table 5-1 provides a summary of the cost and yield of the various alternatives to provide additional water to Peshastin Creek.

Table 5-1
Alternative Comparison

Alternative		Yield (acre-feet)	Construction Cost ($)	Operations and Maintenance Cost ($)	Power Cost ($)	Comments
1	Water Conservation on Peshastin Canal	280 to 360	0.9M	-	-	
	Increased Supply from Icicle Canal	728 to 911	0.7M	-	-	Not a reliable source of supply at this time because of capacity constraints on Icicle Canal
2	Campbell Creek – 500 acre-feet	500	10.0M	120,600	1,800	
	Campbell Creek – 1000 acre-feet	1,000	16.6M	199,300	6,400	
3	Pump From Wenatchee River – 10 cfs	900	1.4M	16,700	8,700	
	Pump From Wenatchee River – 20 cfs	1,800	2.4M	28,500	15,400	
	Pump From Wenatchee River – 40 cfs	3,600	4.1M	48,400	30,500	
4	Modify Peshastin Creek	0	0.4M	Not known	-	May work in conjunction with other alternatives to reduce passage flow requirements

6 RECOMMENDATIONS

We offer the following recommendations:

1. Pipe 9,000-foot reach of Peshastin Canal downstream from Brender Canyon Road. The Peshastin Irrigation District estimate of costs is $900,000. Apply for grant funding to implement the project. Potential sources of funding include the Washington State Legislature, Salmon Recovery Funding Board, Northwest Power and Conservation Council through Bonneville Power Administration, Mid-Columbia Habitat Conservation Plan (HCP) Tributary Fund, and U.S. Bureau of Reclamation (USBR) Water 2025 program.
2. Coordinate with USBR on their geomorphic study of lower Peshastin Creek (ongoing). As part of the study, assess whether channel modifications at gravel bars can improve fish passage conditions and reduce fish passage flows below 40 cfs.
3. Work with Instream Flow Subcommittee of Wenatchee Watershed Planning Unit to develop instream flow needs strategy for Peshastin Creek.
4. Continue discussions with the USFS on the Campbell Creek reservoir to determine their permitting needs and process. Discuss property acquisition needs with property owners affected by the reservoir to determine the availability of the parcels needed to construct the reservoir.
5. Work with Icicle Irrigation District to evaluate the feasibility of Icicle Canal modifications. Perform additional study on the Icicle Canal to more accurately determine diversions and flow present in the Division 1 and Division 2 canals. The goal will be to determine how much and when additional capacity may be present in the Icicle Canal that can be used to increase the amount of water supplied to the Peshastin Canal. The study will require installation of accurate flow recording instruments at the head and end of Division 1 and Division 2 canals. The study will need to be coordinated with and agreed upon by the Icicle and Peshastin Irrigation Districts, the owner of the Icicle Canal.
6. Perform more detailed analyses of the pump station alternative to determine its feasibility.

7 REFERENCES

American Water Works Association (AWWA). 1985. Steel Water Pipe – A Guide for Design and Installation. AWWA Manual M11. Denver, CO.

Andonaegui, C. 2001. *Salmon, Steelhead and Bull Trout Habitat Limiting Factors for the Wenatchee Subbasin (WRIA 45) and Portions of WRIA 40 Within Chelan County (Squilchuck, Stemitt and Colockum Drainages)*. Washington State Conservation Commission.

Klohn Leonoff, Inc. 1993. Peshastin Irrigation District Comprehensive Water Conservation Plan. May 5, 1993.

Montgomery Water Group, Inc. (MWG). 2006. Multi-Purpose Water Storage Assessment in the Wenatchee River Watershed. Chelan County Natural Resource Program. June 15, 2006.

Teeley, Joel. 2006. Personal correspondence. October 2006.

Teeley, Joel. 2006. Personal correspondence. December 2006.

Thompson, K. 1972. Determining Stream Flows For Fish. Presented at Instream Flow Requirement Workshop, Pacific Northwest River Basins Commission. March 1972.

U.S. Department of Agriculture, Soil Conservation Service (USDA SCS). 1975. Soil Survey of Chelan Area, Washington. September 1975.

U.S. Fish and Wildlife Service (USFWS). 2006. National Wetlands Inventory website. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. http://www.fws.gov/nwi/. October 2006.

APPENDIX A

DETAILED COST ESTIMATES

Anchor Environmental A. Hill
CHELAN COUNTY 21-Nov-06
Peshastin Subwatershed Needs and Alternatives Study

Pipeline from Icicle Canal to Peshastin Irrigation District Canal Alternative

Item	Units	Quantity	Unit Cost	Cost
Site				
Diversion and care of water	LS	1	$30,000.00	$30,000
Temporary & permanent access	LS	1	$15,000.00	$15,000
Erosion and sediment control	AC	2.5	$5,000.00	$12,500
Clearing and grubbing	AC	2.5	$5,000.00	$12,500
Earthwork				
Excavation and stockpile, soil	CY	1,793	$6.00	$10,758
Excavation and stockpile, rock	CY	896	$15.00	$13,440
Special crossing (Hwy 97)	LS	1	$75,000.00	$75,000
Special crossing (Peshastin Creek)	LS	1	$30,000.00	$30,000
Pipe trench backfill (imported material)	CY	0	$12.00	$0
Pipe trench backfill (with excavated material)	CY	2,289	$6.00	$13,734
Disposal of excess material	CY	400	$4.00	$1,600
Pipeline				
30" steel pipe--2200 LF	LB	87,743	$2.00	$175,486
Subtotal				**$390,000**
Mobilization / Demobilization (10% of subtotal)				$39,000
Contingency (30%)				$128,700
Engineering, design & construction management (20%)				$77,805
Tax (8.0%)				$50,840
Est. Land Acquisition Cost	AC	0.0	$5,000.00	$0
Preliminary Construction Cost Estimate				**$686,000**

Anchor Environmental R. Montgomery
CHELAN COUNTY 21-Nov-06
Peshastin Subwatershed Needs and Alternatives Study

Campbell Creek Reservoir
(500 acre-feet capacity)

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	331,124	$12.00	$3,973,488
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				
15" inlet from pump station	LF	530	$55.00	$29,150
Air & vacuum valve	EA	1	$2,000.00	$2,000
Blowoff assy.	EA	1	$1,500.00	$1,500
18" Gate valve	EA	1	$1,500.00	$1,500
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	$60,000.00	$60,000
Emergency Spillway/Overflow				
Spillway Channel	LF	420	$100.00	$42,000
Wetland Mitigation				
Create new wetlands	AC	7.5	$50,000.00	$375,000
Subtotal				**$5,479,000**
Mobilization / Demobilization (10% of Subtotal (1))				$547,900
Subtotal - With Mobilization/Demobilization				**$6,027,000**
Contingency (30%)				$1,808,100
Engineering, design, enviromental review, permitting & construction management (20%)				$1,205,400
Subtotal - Construction, Engineering, Permitting				**$9,041,000**
Tax (8.0%)				$482,160
Est. Land Acquisition or Lease Cost	AC	19.4	$25,000.00	$485,625
Preliminary Construction Cost Estimate				**$10,009,000**

Anchor Environmental R. Montgomery
<u>CHELAN COUNTY</u> 21-Nov-06
Peshastin Subwatershed Needs and Alternatives Study

Campbell Creek Reservoir
(1000 acre-feet capacity)

Item	Units	Quantity	Unit Cost	Cost
Site Work				
Clearing and grubbing	AC	31.0	$5,000.00	$155,000
Logging	AC	1.6	$3,000.00	$4,650
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and stockpiling of organic material	CY	12,500	$5.00	$62,500
Diversion and care of water	LS	1	$30,000.00	$30,000
Erosion and sediment control	AC	31.0	$5,000.00	$155,000
Revegetation outer embankment	SY	0	$2.50	$0
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	0	$15.00	$0
Foundation grouting allowance	SF	22,000	$5.00	$110,000
Cutoff trench excavation and stockpile, soil	CY	0	$6.00	$0
Toe and finger drains	LS	1	$10,000.00	$10,000
Reservoir excavation (cut)	CY	0	$3.00	$0
Reservoir embankment (imported fill)	CY	460,316	$12.00	$5,523,792
Reservoir embankment (fill with cut material)	CY	12,291	$6.00	$73,746
Disposal of excess cut material	CY	0	$4.00	$0
Concrete Facing	SF	145,000	$15.00	$2,175,000
Dam crest surfacing	CY	395	$20.00	$7,900
Pipe and Fittings				
15" inlet from pump station	LF	530	$55.00	$29,150
Air & vacuum valve	EA	1	$2,000.00	$2,000
Blowoff assy.	EA	1	$1,500.00	$1,500
18" Gate valve	EA	1	$1,500.00	$1,500
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	$60,000.00	$60,000
Emergency Spillway/Overflow				
Spillway Channel	LF	420	$100.00	$42,000
Wetland Mitigation				
Create new wetlands	AC	7.5	$50,000.00	$375,000
Subtotal				**$9,058,000**
Mobilization / Demobilization (10% of Subtotal (1))				$905,800
Subtotal - With Mobilization/Demobilization				**$9,964,000**
Contingency (30%)				$2,989,200
Engineering, design, enviromental review, permitting & construction management (20%)				$1,992,800
Subtotal - Construction, Engineering, Permitting				**$14,946,000**
Tax (8.0%)				$797,120
Est. Land Acquisition or Lease Cost	AC	32.6	$25,000.00	$813,750
Preliminary Construction Cost Estimate				**$16,557,000**

Anchor Environmental A. Hill
CHELAN COUNTY 8-Dec-06
Peshastin Subwatershed Needs and Alternatives Study

Pipeline and Pump from Wenatchee River to Peshastin Irrigation District Canal Alternative (assuming 10 cfs)

Item	Units	Quantity	Unit Cost	Cost
Site				
Diversion and care of water	LS	1	$30,000.00	$30,000
Temporary & permanent access	LS	1	$15,000.00	$15,000
Erosion and sediment control	AC	1.6	$5,000.00	$8,000
Clearing and grubbing	AC	1.6	$5,000.00	$8,000
Earthwork				
Excavation and stockpile, soil	CY	718	$6.00	$4,308
Excavation and stockpile, rock	CY	598	$15.00	$8,970
Pipe trench backfill (imported material)	CY	488	$12.00	$5,856
Pipe trench backfill (with excavated material)	CY	718	$6.00	$4,308
Disposal of excess material	CY	598	$4.00	$2,392
Pipeline & Pump Station				
20" steel pipe--1360 LF	LB	36,085	$2.00	$72,170
Valves and appurtenances	LS	1	$50,000.00	$50,000
Pump station power and electrical equipment	LS	1	$50,000.00	$50,000
Pump station including intake and fish screens	LS	1	$300,000.00	$300,000
Pumps, controls, and associated equipment	LS	1	$200,000.00	$200,000
Subtotal				**$759,000**
Mobilization / Demobilization (10% of subtotal)				$75,900
Contingency (30%)				$250,470
Engineering, design & construction management (20%)				$201,894
Tax (8.0%)				$102,981
Est. Land Acquisition Cost	AC.	1.0	$20,000.00	$20,000
Preliminary Construction Cost Estimate				**$1,410,000**

Anchor Environmental A. Hill
CHELAN COUNTY 8-Dec-06
Peshastin Subwatershed Needs and Alternatives Study

Pipeline and Pump from Wenatchee River to Peshastin Irrigation District Canal Alternative (assuming 20 cfs)

Item	Units	Quantity	Unit Cost	Cost
Site				
Diversion and care of water	LS	1	$30,000.00	$30,000
Temporary & permanent access	LS	1	$15,000.00	$15,000
Erosion and sediment control	AC	1.6	$5,000.00	$8,000
Clearing and grubbing	AC	1.6	$5,000.00	$8,000
Earthwork				
Excavation and stockpile, soil	CY	831	$6.00	$4,986
Excavation and stockpile, rock	CY	831	$15.00	$12,465
Pipe trench backfill (imported material)	CY	631	$12.00	$7,572
Pipe trench backfill (with excavated material)	CY	831	$6.00	$4,986
Disposal of excess material	CY	831	$4.00	$3,324
Pipeline & Pump Station				
27" steel pipe--1360 LF	LB	48,794	$2.00	$97,589
Valves and appurtenances	LS	1	$100,000.00	$100,000
Pump station power and electrical equipment	LS	1	$100,000.00	$100,000
Pump station including intake and fish screen	LS	1	$550,000.00	$550,000
Pumps, controls, and associated equipment	LS	1	$350,000.00	$350,000
Subtotal				**$1,292,000**
Mobilization / Demobilization (10% of subtotal)				$129,200
Contingency (30%)				$426,360
Engineering, design & construction management (20%)				$343,672
Tax (8.0%)				$175,299
Est. Land Acquisition Cost	AC.	1.0	$20,000.00	$20,000
Preliminary Construction Cost Estimate				**$2,387,000**

Anchor Environmental A. Hill
CHELAN COUNTY 8-Dec-06
Peshastin Subwatershed Needs and Alternatives Study

Pipeline and Pump from Wenatchee River to Peshastin Irrigation District Canal Alternative (assuming 40 cfs)

Item	Units	Quantity	Unit Cost	Cost
Site				
Diversion and care of water	LS	1	$30,000.00	$30,000
Temporary & permanent access	LS	1	$15,000.00	$15,000
Erosion and sediment control	AC	1.6	$5,000.00	$8,000
Clearing and grubbing	AC	1.6	$5,000.00	$8,000
Earthwork				
Excavation and stockpile, soil	CY	945	$6.00	$5,670
Excavation and stockpile, rock	CY	1,574	$15.00	$23,610
Pipe trench backfill (imported material)	CY	1,156	$12.00	$13,872
Pipe trench backfill (with excavated material)	CY	945	$6.00	$5,670
Disposal of excess material	CY	1,574	$4.00	$6,296
Pipeline & Pump Station				
39" steel pipe--1360 LF	LB	140,709	$2.00	$281,418
Valves and appurtenances	LS	1	$150,000.00	$150,000
Pump station power and electrical equipment	LS	1	$150,000.00	$150,000
Pump station structure	LS	1	$900,000.00	$900,000
Pumps, controls, and associated equipment	LS	1	$600,000.00	$600,000
Subtotal				**$2,198,000**
Mobilization / Demobilization (10% of subtotal)				$219,800
Contingency (30%)				$725,340
Engineering, design & construction management (20%)				$584,668
Tax (8.0%)				$298,225
Est. Land Acquisition Cost	AC.	1.0	$20,000.00	$20,000
Preliminary Construction Cost Estimate				**$4,046,000**