Yakima River Basin Study

Cle Elum Pool Raise
Technical Memorandum

U.S. Bureau of Reclamation
Contract No. 08CA10677A ID/IQ, Task 4.5

Prepared by

Anchor QEA

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Columbia-Cascades Area Office

State of Washington
Department of Ecology
Office of Columbia River

March 2011

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The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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1.0 Introduction

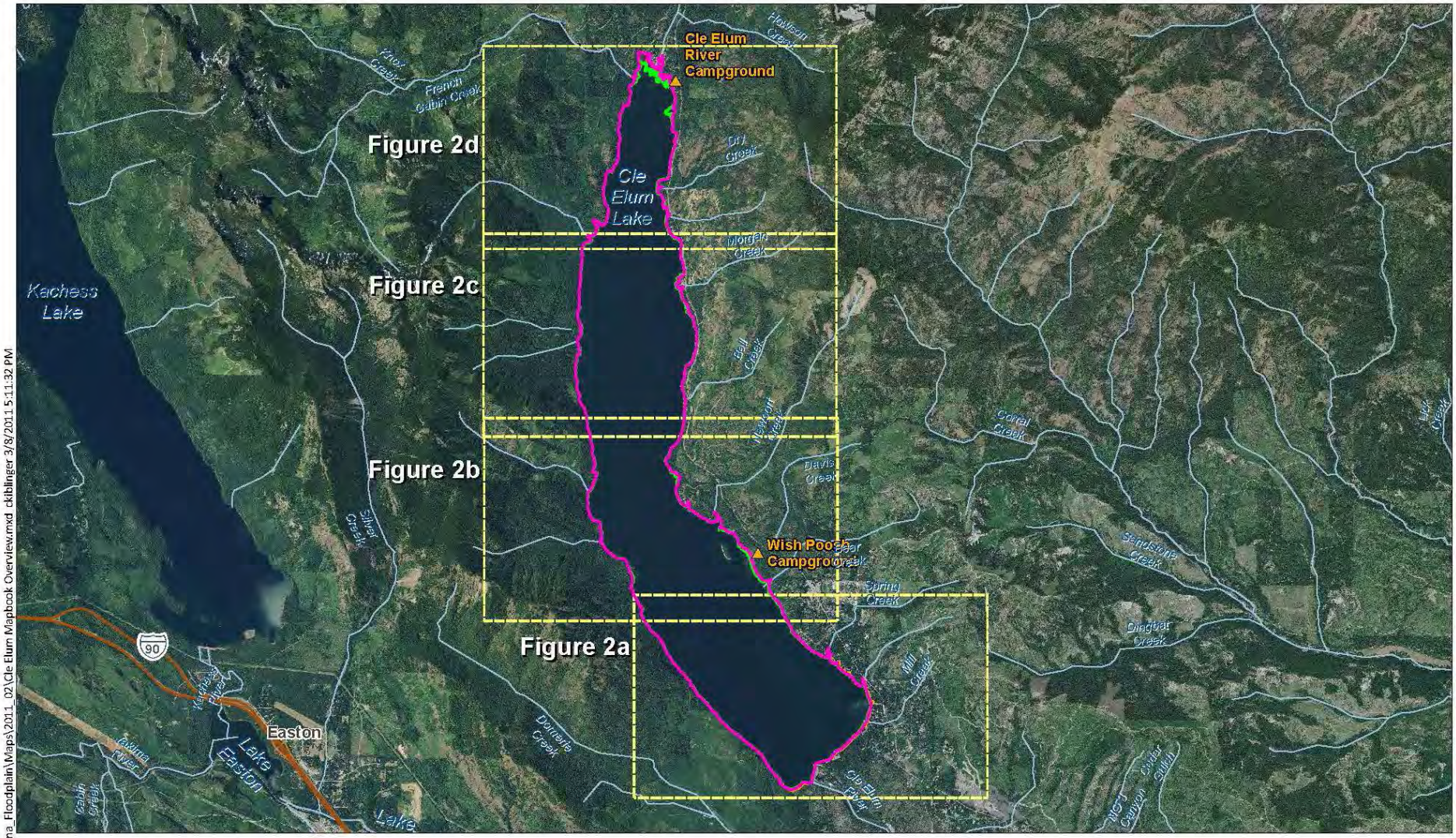
This technical memorandum describes proposed improvements to Cle Elum Dam designed to increase the pool elevation and capacity of Cle Elum Lake. This memorandum summarizes existing information from work completed as part of the Cle Elum Improvements Project Final Cost Estimate study (Reclamation 2000) and also includes results from additional evaluation completed as part of the Yakima River Basin Study. The additional evaluation included:

- Geographical information system (GIS) mapping of parcel ownership around the lake
- Mapping inundation limits using available topography
- Preparing a list of properties affected by the proposed pool raise and updating real estate acquisition costs
- Characterizing shoreline improvements and estimated quantities for cost estimation

This project was selected by the Yakima River Basin Water Enhancement Project (YRBWEP) Workgroup for further evaluation as part of the Yakima River Basin Study. The proposed Cle Elum Pool Raise project (Pool Raise) consists of raising the maximum water level of Cle Elum Lake by 3 feet from a current maximum elevation of 2,240 feet to 2,243 feet. The Pool Raise would increase the volume of available storage in Cle Elum Lake by approximately 14,600 acre-feet. The project was authorized under Phase 2 of YRBWEP (Title XII of the Act of October 31, 1994 [108 Stat. 4550, Public Law 103-434]). The purpose for the increased storage under Title XII was to improve flows for fish. For the Yakima River Basin Study, the purpose of the increased storage is assumed to be improved flows for fish and increased water supply for out-of-stream needs in the Yakima River Basin downstream of Cle Elum Lake. Figure 1 shows an overview of the project area and Figures 2a, 2b, 2c and 2d show the approximate extent of the current and proposed maximum pool elevations (in four sections, from south to north), areas proposed for shoreline protection, and non-federally-owned property that would be affected and need to be purchased or easement obtained upon for the Pool Raise project.

The 2000 Reclamation study identified five major components of the Pool Raise project which are dam safety, engineering, environmental review, land acquisition, and fish passage. In the 2000 study only three of the five components (engineering, land acquisition and fish passage) were described in detail with cost estimates. Detailed descriptions and estimated costs were not developed for dam safety improvements as it was determined that dam safety costs would be incurred with or without the Pool Raise. Detailed descriptions and estimated costs were also not developed for environmental review and mitigation as it was assumed those would be detailed at a future stage in project development.

While fish passage improvements were identified in the 2000 study that information has been superseded by additional studies as Cle Elum fish passage is now considered a separate project from the Pool Raise. This technical memorandum describes proposed engineering improvements, costs for recreation impacts, and land acquisition acreage and costs.



Recreation Site
2,240-foot Elevation Contour (Current Maximum Pool)
2,243-foot Elevation Contour (Proposed Maximum Pool
Areas Proposed for Shoreline Protection

NOTES:
1. Elevations from Bureau of Reclamation Bare Earth LiDAR 2000.
2. Aerial photo from National Agriculture Imagery Program, June 26 2009.

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Figure 1 - Index
Aerial Photos of Proposed Cle Elum Lake Pool Raise
Yakima Basin Study

2,243-foot Elevation Contour (Proposed Maximum Pool)

2,240-foot Elevation Contour (Current Maximum Pool)

Areas Proposed for Shoreline Protection

NOTES:
1. Elevations from Bureau of Reclamation Bare Earth LiDAR 2000.
2. Aerial photo from National Agriculture Imagery Program, June 26 2009.

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Figure 2a
Cle Elum Lake Existing and Proposed Maximum Water Surface Elevation
Yakima Basin Study

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Recreation Site

2,243-foot Elevation Contour (Proposed Maximum Pool)

2,240-foot Elevation Contour (Current Maximum Pool)

NOTES:
1. Elevations from Bureau of Reclamation Bare Earth LiDAR 2000.
2. Aerial photo from National Agriculture Imagery Program, June 26 2009.

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Figure 2b
Cle Elum Lake Existing and Proposed Maximum Water Surface Elevation
Yakima Basin Study

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2,243-foot Elevation Contour (Proposed Maximum Pool)

2,240-foot Elevation Contour (Current Maximum Pool)

NOTES:
1. Elevations from Bureau of Reclamation Bare Earth LiDAR 2000.
2. Aerial photo from National Agriculture Imagery Program, June 26 2009.

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Figure 2c
Cle Elum Lake Existing and Proposed Maximum Water Surface Elevation
Yakima Basin Study

Recreation Site

2,243-foot Elevation Contour (Proposed Maximum Pool)

2,240-foot Elevation Contour (Current Maximum Pool)

NOTES:
1. Elevations from Bureau of Reclamation Bare Earth LiDAR 2000.
2. Aerial photo from National Agriculture Imagery Program, June 26 2009.

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Figure 2d
Cle Elum Lake Existing and Proposed Maximum Water Surface Elevation
Yakima Basin Study

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2.0 Engineering

The engineering component of the Pool Raise project summarized in this memorandum includes three elements:

- Shoreline protection
- Radial gate modification
- Mitigation of upstream inundation impacts

These three elements are described in the sections below.

2.1 Shoreline Protection

The extent of shoreline protection required for the proposed Pool Raise project was previously determined by Reclamation staff. Quantities were included in the 2000 study for site development, material production, shoreline placement, shoreline earthwork, and site maintenance. Table 1 includes these original quantities.

The quantities estimate was based on a preliminary design to prevent wind generated wave erosion that was done as part of a risk analysis for Cle Elum Dam. The preliminary design was based upon a wind wave analysis that uses wind speed and direction data and lake characteristics (fetch lengths) to estimate the size of waves a shoreline could experience. The analysis was applied to the right abutment of the dam, and it was recommended that the abutment be filled and riprap added to an elevation of 2,250 feet. This recommendation was also applied to the shoreline protection areas and may be an overestimation of the amount of protection needed since the areas away from the dam will not have the same wind fetch and wave regime. Protecting against a wave run-up of 7 feet seems excessive at the shoreline areas beyond the dam, based on the study team's experience with shoreline protection on lakes in central Washington.

Table 1. Original Shoreline Protection Quantities for Cle Elum Pool Raise

DESCRIPTION	QUANTITY	UNIT
Site Development		
Geology borrow selection and testing	1	Lump Sum
Surveying, conventional, topographical	10	Acres
Haul road widening and improvement (0.7 miles, 20 feet wide)	8,215	Square Yards
Haul road construction along shoreline (0.8 miles, 20 feet wide)	9,800	Square Yards
Borrow area clearing and restoration	10	Acres
Material Production		
Drilling and blasting (88,000 cubic yards use, 12,000 cubic yards waste)	100,000	Cubic Yards
Pit excavation, material handling, and grizzly (88,000 cubic yards use, 12,000 cubic yards waste)	100,000	Cubic Yards
Crusher	50,000	Cubic Yards
Haul (riprap and bedding, 80,000 cubic yards use, 8,000 cubic yards loss)	88,000	Cubic Yards
Shoreline Placement		
Riprap placement (45,600 cubic yards use, 4,400 cubic yards loss)	50,000	Cubic Yards
Bedding placement (34,400 cubic yards use, 3,600 cubic yards loss)	38,000	Cubic Yards
Shoreline Earthwork		
Clear and grub (U.S. Forest Service harvest trees, grub stumps)	4	Acres
Shoreline excavation	143,000	Cubic Yards
Slope toe backfill	28,000	Cubic Yards
In-reservoir disposal	104,000	Cubic Yards
Site Maintenance		
Haul road maintenance	100	day
Dust control, heavy	100	day
Flaggers (2 total: 1 at borrow road and highway, 1 are shoreline and highway)	200	day

This shoreline protection approach was updated as part of the additional evaluation completed for the Yakima River Basin Study. To better approximate the quantities for this project, shoreline protection was estimated assuming the same shoreline areas identified for the 2000 study and cost estimate. However, protection would only be added to an elevation of 2,246 feet for areas outside the right abutment of the dam. That would provide protection for a wave run-up of 3 feet when Cle Elum Lake is at the full pool elevation, which would likely only occur for a short time during the spring. This updated approach will need further validation by conducting detailed wind-fetch and wave analysis before determining more precisely where and how shoreline protection would be provided with the Pool Raise project. Figure 3 shows a representative cross-section of the proposed revision to the shoreline protection for the Cle Elum Pool Raise.

The estimate of shoreline protection assumes rock protection would be used along the shoreline consistent with the previous estimate by Reclamation. Permitting agencies would likely require alternative slope protection plans that incorporate bioengineering techniques where suitable conditions exist for their use. The cost estimate prepared for this study does not include the use of bioengineering stabilization techniques. However, the cost of rock protection should provide a conservative estimate that would cover the cost of alternative stabilization techniques.

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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA, SNAKE, RIVER, SALMON, RECOVERY, FOUNDATION
METHOW, RIVER

CLE ELUM POOL RAISE
YAKIMA RIVER BASIN STUDY

REV. NO.

DESIGNED _ D. RICE
DRAWN _ T. GRIGA
CHECKED _ R. MONTGOMERY
TECH. APPR. _ NAME - TITLE
APPROVED _ ADMINISTRATIVE APPROVAL - NAME - TITLE

WINTHROP, WA

SHORELINE PROTECTION REPRESENTATIVE CROSS SECTIONS

FIGURE 3
SHEET 3 OF 3

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A more detailed analysis of the proposed areas of shoreline protection should be completed as part of a future phase of project development to obtain a more accurate estimate of the quantities for shoreline protection.

Excavation and backfill quantities were updated based on the revised shoreline protection assumptions. Only 50 percent of the original excavation was assumed for revised shoreline improvement areas. This value was determined by comparing the proposed excavation of two representative cross-sections with the excavation proposed as part of the 2000 estimate. Backfill quantities were assumed to be the greater of one-third of the excavation volume or the original backfill estimate for each cross-section. Table 2 compares the updated shoreline protection quantities to the original quantities.

Table 2. Updated Shoreline Protection Quantities for Cle Elum Pool Raise

DESCRIPTION	ORIGINAL QUANTITY	UPDATED QUANTITY	UNIT
Site Development			
Geology borrow selection and testing	1	No Change	Lump Sum
Surveying, conventional, topographical	10	No Change	Acres
Haul road widening and improvement (0.7 miles, 20 feet wide)	8,215	No Change	Square Yards
Haul road construction along shoreline (0.8 miles, 20 feet wide)	9,800	No Change	Square Yards
Borrow area clearing and restoration	10	No Change	Acres
Material Production			
Drilling and blasting (38,400 cubic yards use, 4,600 cubic yards waste)	100,000	43,000	Cubic Yards
Pit excavation, material handling, and grizzly (38,400 cubic yards use, 4,600 cubic yards waste)	100,000	43,000	Cubic Yards
Crusher	50,000	24,500	Cubic Yards
Haul (riprap and bedding, 35,000 cubic yards use, 3,400 cubic yards loss	88,000	38,400	Cubic Yards
Shoreline Placement			
Riprap placement (22,300 cubic yards use, 2,200 cubic yards loss)	50,000	24,500	Cubic Yards
Bedding placement (12,700 cubic yards use, 1,200 cubic yards loss)	38,000	13,900	Cubic Yards
Shoreline Earthwork			
Clear and grub (U.S. Forest Service harvest trees, grub stumps)	4	No Change	Acres
Shoreline excavation	143,000	80,500	Cubic Yards
Slope toe backfill	28,000	24,700	Cubic Yards
In-reservoir disposal	104,000	No Change	Cubic Yards
Site Maintenance			
Haul road maintenance	100	No Change	day
Dust control, heavy	100	No Change	day
Flaggers (2 total: 1 at borrow road and highway, 1 are shoreline and highway)	200	No Change	day

2.2 Radial Gate Modifications

Estimates for modifications to the radial gates were prepared by Reclamation staff in the 2000 study. The modifications would consist of fabricating and installing 3-foot by 37-foot-wide stiffened steel flashboards at each of the five radial spillway gates. An additional 8-inch-high flashboard would be installed above the 3-foot-high flashboards to act as a splashboard. The flashboards would be fabricated from ¼-inch-thick steel skinplate stiffened by M-shaped beams. Two steel flashboard arms would carry the load into existing arms. Table 3 lists the quantities used in the radial gate modifications estimate. No changes are recommended to the quantities used in the 2000 estimate.

Table 3. Radial Gate Modification Quantities

DESCRIPTION	QUANTITY	UNIT
Fabrication		
5 stiffened steel flashboards (2,500 pounds each)	12,500	Pounds
Installation		
Crane operator	100	Hours
Mobile crane	100	Hours
Foreman	100	Hours
Mechanic/Welder	200	Hours
Laborer	100	Hours

2.3 Upstream Inundation Impacts

The 2000 study indicated that the Pool Raise could potentially impact the Cle Elum River Bridge on French Cabin Creek Road (U.S. Forest Service Road #4308). Bridge replacement was included as a worst-case scenario with further review to be done after Light Detection and Ranging (LIDAR) topographic data was received. Upon receiving the LIDAR topographic data, it became apparent that the Pool Raise would not impact the bridge, thus bridge replacement would no longer be included as part of the project.

3.0 Recreation Impacts

Recreation facility impacts were identified in the 2000 study based on the assumption that all facilities impacted by the Pool Raise would have to be replaced. The 2000 study assumed that two campground sites (Wish Poosh and Cle Elum River) would be impacted by the Pool Raise (See Figure 2b and 2d). The 2000 study only provided costs and did not include a description of the facilities impacted or quantities for individual work items that would need to be replaced. The 2000 cost estimate also included design and planning costs (see Table 4). These costs were escalated to current value in the cost estimating technical memorandum *Costs of the Integrated Water Resource Management Plan.*

Table 4. Recreation Replacement Cost Estimates (from 2000 Cost Estimate)

DESCRIPTION	ESTIMATED COST (2000)
Wish Poosh Campground	
Roads	$524,700
Parking	$176,100
Utilities	$33,000
Facilities	$56,100
Cle Elum River Campground	
Roads	$13,200
Parking	$15,000
Facilities	$28,300
Wish Poosh and Cle Elum River Campgrounds (subtotal)	$846,400
Contract and Construction Administration (15 percent)	$127,000
Contingencies – Primarily Surveying and Design (15 percent)	$127,000
NEPA, Planning, Survey, and Design* (25 percent)	$211,600
Total	$1,312,000

4.0 Land Acquisition

Land area needed to be acquired to allow for construction of shoreline protection and inundation of additional area was estimated by Reclamation in the 2000 study. The area is described in the following sections along with updated estimates based upon more accurate topographic data. The 2000 study also estimated costs for land acquisition and those are updated in the following sections.

4.1 Land Area

The non-federal land area needed for acquisition or easement was estimated in the 2000 study using two approaches: by reviewing survey maps of properties at the southeast portion of the lake where shoreline protection was proposed to prevent erosion, and by assuming a 300-ft wide strip of land would be needed to accommodate the additional inundation around the remaining perimeter of the lake that is not federally owned. Reclamation identified land in the southeast portion of the lake where shoreline protection would be needed. A portion of the land would need to be acquired to accommodate the shoreline protection project. Reclamation provided plan views of the shoreline protection area with estimated "take lines" (Young, personal communication). The area within the take lines was estimated to be 22 acres. The area of the 300-ft wide strip around the remaining perimeter of the lake on non-federal properties was estimated by Reclamation to be about 155 acres. The total acreage needed for purchase or easement is approximately 177 acres.

An updated approach was used to estimate the area within non-federal parcels below the 2,243-foot contour that would need to be obtained by purchase or easement to accommodate additional inundation around the rest of the lake. These were measured using LiDAR topography and GIS analysis. The results from this more specific analysis show 45 acres would need to be acquired,

in comparison to the 155 acres estimated by Reclamation in the 2000 study. The updated estimate of total area required for acquisition or easement is 67 acres. Figures 2a through 2d depict this area. The reason for the reduction in total area needed to be acquired in comparison to the 2000 study is a more exact definition of the area below the 2,243-foot elevation is possible with LiDAR mapping that was not available at the time of Reclamation's study. For their study, they assumed a 300-foot wide strip of land would need to be acquired.

4.2 Land Acquisition Costs

Land acquisition cost estimates were revised from the 2000 study based on updated land values and the updated total non-federal acreage that would need to be acquired. The Kittitas County Assessor provided land values for the non-federal acreage. It was assumed no structures would need acquiring or removing to accommodate the shoreline protection project and increased inundation. A review of aerial photos was made to confirm the assumption as best possible. The total estimated land acquisition cost using assessor's data is $2,612,000, with $2,251,000 of the cost from the 22 acres needed for shoreline protection projects. The cost of acquiring the remaining 45 acres was estimated to be $361,000. Because this estimate is based on assessor valuation, the estimate may not reflect market costs and may be understating the actual costs that may be incurred.

5.0 Costs

Cost estimates for the Cle Elum Pool Raise project are outlined in a separate cost memorandum, *Costs of the Integrated Water Resource Management Plan*. That memorandum estimates the costs for shoreline protection, radial gate modification and recreational facility improvements using the description of improvements provided in this memorandum. Property acquisition costs listed in the cost memorandum were obtained directly from Section 4.2 of this memorandum.

6.0 List of Preparers

NAME	BACKGROUND	RESPONSIBILITY
Anchor QEA		
Bob Montgomery, P.E.	Water Resources Engineering	Author
Adam Hill, P.E.	Water Resources Engineering	Contributing Author

7.0 References

1. U.S. Bureau of Reclamation (Reclamation), 2000, *Cle Elum Improvements Project Final Cost Estimate April 2000*.

2. U.S. Bureau of Reclamation (Reclamation) and State of Washington Department of Ecology (Ecology), 2010, *Cle Elum Dam Fish Passage Facilities and Fish Reintroduction Project January 2010*.

3. Young, Ed (U.S. Bureau of Reclamation). Personal Communication, June 21, 2010.