RECLAMATION

Managing Water in the West

Appraisal Assessment of the Black Rock Alternative Facilities and Field Cost Estimates

A component of
Yakima River Basin Water Storage Feasibility Study, Washington

Technical Series No. TS-YSS-2

Black Rock Valley

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
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Mission Statement

The Mission of the U.S. 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.

Mission of the Bureau of Reclamation

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.

Preface

Congress directed the Secretary of the Interior, acting through the Bureau of Reclamation (Reclamation), to conduct a feasibility study of options for additional water storage for the Yakima River basin. Section 214 of the Act of February 20, 2003, (Public Law 108-7) contains this authorization and includes the provision "… with emphasis on the feasibility of storage of Columbia River water in the potential Black Rock Reservoir and the benefit of additional storage to endangered and threatened fish, irrigated agriculture, and municipal water supply."

Reclamation initiated the *Yakima River Basin Water Storage Feasibility Study* (Storage Study) in May 2003. As guided by the authorization, the purpose of the Storage Study is to identify and examine the viability and acceptability of alternate projects by: (1) diversion of Columbia River water to the potential Black Rock reservoir for further water transfer to irrigation entities in the lower Yakima River basin as an exchange supply, thereby reducing irrigation demand on Yakima River water and improving Yakima Project stored water supplies, and (2) creation of additional storage within the Yakima River basin. In considering the benefits to be achieved, study objectives will be to modify Yakima Project flow management operations to most closely mimic the historic flow regime of a Yakima River system for fisheries, provide a more reliable supply for existing proratable water users, and provide additional supplies for future municipal demands.

State support for the Storage Study was provided in the 2003 Legislative session. The capital budget included a $4 million appropriation for the Department of Ecology (Ecology) with the provision the funds "… are provided solely for expenditure under a contract between the department of ecology and the United States bureau of reclamation for the development of plans, engineering, and financing reports and other preconstruction activities associated with the development of water storage projects in the Yakima river basin, consistent with the Yakima river basin water enhancement project, P.L. 103-434. The initial water storage feasibility study shall be for the Black Rock reservoir project."

Reclamation's Upper Columbia Area Office in Yakima, Washington, is managing and directing the Storage Study. Pursuant to the legislative directives, Reclamation has placed initial emphasis on Black Rock alternative study activities. These study activities are collectively referred to as the Black Rock Alternative Assessment (Assessment).

The Assessment has three primary objectives. First, it provides the emphasis directed by Federal and State legislation. Second, it builds upon prior work and studies to provide more information on the configuration and field construction cost of the primary components of a Black Rock alternative. It examines legal and institutional considerations of water supply and use, and identifies areas where further study is needed. Third, it is a step forward in identifying the viability of a Black Rock alternative.

This technical document, prepared by Reclamation's Technical Service Center, Denver, Colorado, is one of a series of documents prepared under the Storage Study. This particular document is a component of the Assessment reporting on preliminary appraisal-level engineering evaluation of designs and field cost estimates of potential Black Rock alternative facilities to withdraw, store, and convey Columbia River water to irrigation entities in the lower Yakima River basin. Information and findings of this technical document are included in the Assessment Summary Report.

Further Consultations

The information available at this time is necessarily preliminary, has been developed only to an appraisal level of detail, and is therefore subject to change if this alternative is investigated further in the course of the Yakima River Basin Storage Feasibility Study (Storage Study). Finally, economic, financial, environmental, cultural, and social evaluations of the Black Rock alternative have not yet been conducted.

The policy of the Bureau of Reclamation (Reclamation) requires non-Federal parties to share the costs of financing feasibility studies and the eventual construction of Federal reclamation projects. In light of this policy, the preliminary cost estimates presented in the Assessment Summary Report, and current Federal budgetary constraints, Reclamation is not reaching a decision at this time as to whether the Black Rock alternative will be carried forward into the next phase of the Storage Study or dropped from further consideration. Rather, Reclamation will consult with the State of Washington (which is cost sharing in the Storage Study), the Yakama Nation, the potential water exchange participants, project proponents, and other interested parties before making a decision in this regard. It is anticipated that a decision will be reached by the fall of 2005.

If the Congress provides further funding for the Storage Study, all technically viable alternatives would be compared and an alternative(s) selected for further analyses in the feasibility phase. (Whether the Columbia River-Yakima River water exchange concept in the form of the Black Rock alternative is included will depend upon whether Reclamation, after these additional consultations, decides to carry that alternative forward into the plan formulation phase of the Storage Study.) The selected alternative(s) would then be subject to detailed evaluation in the feasibility phase in terms of engineering, economic, and environmental considerations, and cultural and social acceptability. This feasibility phase would be the last phase of the Storage Study. Preparation of the Feasibility Report/Environmental Impact Statement would be a part of this final phase.

Appraisal Assessment of the
Black Rock Alternative Facilities and Field Cost Estimates

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List of Abbreviations and Acronyms

af	Acre-feet
cfs	Flow rate in cubic feet per second
El.	Elevation
fps	Velocity in feet per second
ft	Foot or feet
ft^2	Area in square feet
ft^3	Volume in cubic feet
g	Acceleration of gravity (32.2 ft/s^2)
HGL	Hydraulic Grade Line
hp	Horsepower
H:V	Ratio of horizontal to vertical slope
ID	Inside diameter
kV	Kilovolt
kVA	Kilovolt-amperes
kwh	Kilowatt hours
lbs	Pounds
lf	Linear feet
miles/hr	Miles per hour
mm	Millimeter
MP	Mile post
MW	Megawatt
NMFS	National Marine Fisheries Service of the National Oceanic and Atmospheric Administration
OD	Outside diameter
PHA	Peak Horizontal Acceleration
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PSHA	Probabilistic Seismic Hazard Assessment
psi	Pressure in pounds per square inch
Q	Flow rate
RCC	Roller Compacted Concrete
rpm	Revolutions per minute
SH	State Highway

List of Abbreviations and Acronyms
(continued)

TSC	Technical Service Center
USGS	United States Geologic Survey
WIS	Washington Infrastructure Services, Inc.
WR^2	Pump Moment of Inertia
°	Degree
%	Percent

Related Reclamation Documents

- Preliminary Appraisal Assessment of Columbia River Water Availability for a Potential Black Rock Project, Technical Series No. TS-YSS-1, Prepared by Pacific Northwest Regional Office, 2004.

- Preliminary Assessment of Black Rock Delivery System for Roza, Terrace Heights, Selah-Moxee, and Union Gap Irrigation Districts, Technical Series No. TS-YSS-3, Prepared by Pacific Northwest Construction Office, 2004.

- Preliminary Assessment of Black Rock Delivery System for Sunnyside Division, Technical Series No. TS-YSS-4, Prepared by Pacific Northwest Regional Office, 2004.

- Preliminary Assessment of Geology at Black Rock Damsite, Technical Series No. TS-YSS-5, Prepared by Pacific Northwest Regional Office, 2004.

- Preliminary Assessment of Hydrogeology at Black Rock Damsite, Technical Series No. TS-YSS-6, Prepared by Pacific Northwest Regional Office, 2004.

- Summary Report – Appraisal Assessment of Black Rock Project, Technical Series No. TS-YSS-7, Prepared by Pacific Northwest Regional Office, 2004.

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Technical Findings and Conclusions

The objective of the Black Rock Project is to deliver Columbia River water to Yakima Project entities susceptible of receiving such water, and willing to exchange it for all or part of their current Yakima River diversions. Currently, these exchange participants consist of the Roza and Sunnyside Irrigation Districts who have expressed a willingness to consider water exchanges. In the future, it may also be possible to exchange water with other entities such as the Union Gap Irrigation District, Selah-Moxee Irrigation District, and the Terrace Heights Irrigation District. This report documents an appraisal assessment of likely configurations, sizes, and costs of Black Rock Project facilities needed to pump, store, and deliver water to willing exchange participants. It will be used to better define the project and/or project components to be carried into detailed feasibility analysis.

Three main options were considered during this study.

Option 1: The Large Reservoir - Pump Only Option includes an intake with fish screens from Priest Rapids Reservoir, a 3,500 cfs pumping plant to lift the water to Black Rock Valley, a dam to store 1,300,000 acre-feet of active storage in Black Rock Reservoir, and a 2,500 cfs outflow tunnel and pipeline from the reservoir to Roza Canal.

Option 2: The Large Reservoir - Pump-Generating Option is similar to the Large Reservoir - Pump Only Option except it also includes a multi-level intake to selectively withdraw water from Black Rock Reservoir back to the Columbia River, a 3,500 cfs powerplant, and a 3,500 cfs tailrace channel to return the water back to Priest Rapids Reservoir.

Option 3: The Small Reservoir - Pump Only Option includes an intake with fish screens from Priest Rapids Reservoir, a 6,000 cfs pumping plant to lift the water to Black Rock Valley, a dam to store 800,000 acre-feet of active storage in Black Rock Reservoir, and a 2,500 cfs outflow tunnel and pipeline from the reservoir to Roza Canal.

The following conclusions are based on the technical and cost analyses completed for this assessment study:

1. Construction of facilities to pump, store, and deliver Columbia River water to willing exchange participants in the Yakima Basin is technically viable.

2. Appraisal-level field cost estimates for constructing facilities to pump, store, and deliver Columbia River water to the Roza Canal range from $2.46 billion to $2.65 billion (June 2004 price levels). Field cost estimates include costs for the principal items of work, mobilization costs, and allowances for unlisted items and contingencies. Field cost estimates do not include non-contract costs.

3. The appraisal-level field cost estimates for the Large Reservoir – 3,500 cfs Pump Only Option (Option 1) and the Small Reservoir – 6,000 cfs Pump Only Option (Option 3) are the same. Both reservoir sizes should be considered during future feasibility studies. Further analysis of the extent of the water exchange, timing of Columbia River water availability and diversions, economics, and other aspects will help refine the most desirable Storage-Pump Option.

4. The appraisal-level field cost estimate for the Large Reservoir – 3,500 cfs Pump-Generating Option (Option 2) is $190 million greater than the field cost estimate for the Large Reservoir – 3,500 cfs Pump Only Option (Option 1). However, operational studies have not been completed for the Pump-Generating Option and these studies may indicate a need to increase plant capacity to ensure annual delivery of exchange water.

5. The appraisal-level field cost estimate for the All Tunnel (Discharge 1) inflow conveyance system is significantly less than the cost estimate for the Tunnel/Pipe (Discharge 2) inflow conveyance system. The Tunnel/Pipe alternative should be removed from further evaluation.

6. The appraisal-level field cost estimates for the Black Rock embankment dams are significantly lower than the cost estimates for the roller compacted concrete (RCC) dams. The RCC dams should be removed from further evaluation.

7. There is not a significant cost difference between the concrete face rockfill and central core rockfill dams. Both of these embankment dams should be considered during future feasibility studies.

8. The difference between the appraisal-level field cost estimates for the 1,500 cfs and 900 cfs Black Rock Powerplants at the Roza Canal is small (less than 2 percent). The majority of the field cost is associated with the bypass structure that was assumed to have the same capacity (2,500 cfs) for each plant. The selection of which option to pursue should consider costs associated with the Roza and Sunnyside Delivery Systems.

9. The appraisal-level field cost estimate for the Sunnyside Powerplant and Bypass Structure located at the end of the Sunnyside Delivery System is $47.0 million (June 2004 price levels).

Level of Study

This technical document provides the results of an appraisal-level engineering evaluation of the primary components of the proposed Black Rock Project. This study is identified as Objective 301.4.2.A/Task 1 of the Yakima River Basin Water Storage Options Feasibility Study, Plan of Study [1]. The purpose of this evaluation is to develop and screen options to be considered during future detailed feasibility investigations, and to bring preliminary designs of Black Rock Project facilities to the same level of detail as other identified storage options in the Yakima Basin. The Assessment Study's focus was to develop a better definition of features, understanding of project constraints, and more accurate construction cost estimates for features required to transfer water from the Columbia River to the Yakima Basin via a new Black Rock Reservoir.

This study is based on available existing design data from past work accomplished by Washington Infrastructure Services, Inc. (WIS) and the Bureau of Reclamation (Reclamation), and is generally limited to the references listed at the end of this report. Aerial topography developed by Reclamation and limited geologic explorations conducted near the proposed damsites were also used to better define features. The amount of data collection is not considered to be at the level required for feasibility-level assessment of project features. Design data collected for future studies can cause future cost estimates to significantly deviate from the cost estimates presented in this report.

Options developed in this study have not been subject to detailed design and value engineering. Preliminary identification and sizing of required features was accomplished based on engineering judgment, limited analyses and available design data. Field cost estimates prepared for this study were generated using industry-wide accepted cost estimating methodology, standards, and practices. Major features were broken down into pay items and approximate quantities were calculated for these items based on preliminary general designs and drawings. Unit prices, adjusted for location and current construction cost trends, were determined for the identified pay items.

The appraisal-level field cost estimates developed for this Assessment are for the sole purpose of screening potential facility options and developing preliminary configurations of the Black Rock alternative. **The cost estimates in this report are not intended to be at the feasibility-level required to request project authorization for construction and construction appropriations by Congress.**

Appraisal Assessment of the Black Rock Alternative Facilities and Field Cost Estimates

I. Introduction

The Black Rock Project is one of the options to be considered under the Yakima River Basin Water Storage Feasibility Study. Legislation authorizing this study requests Reclamation to conduct a feasibility study of options for additional water storage in the Yakima River Basin, Washington, with emphasis on the feasibility of storing Columbia River water in the potential offstream Black Rock Reservoir. The objective of the Black Rock Project is to deliver Columbia River water to Yakima Project entities susceptible of receiving such water, and willing to exchange it for all or part of their current Yakima River diversions. Currently, these exchange participants consist of the Roza and Sunnyside Irrigation Districts who have expressed a willingness to consider water exchanges. In the future, it may also be possible to exchange water with other entities such as the Union Gap Irrigation District, Selah-Moxee Irrigation District, and the Terrace Heights Irrigation District.

This Appraisal Assessment Study is identified as Objective 301.4.2.A/Task 1 of the Yakima River Basin Water Storage Options Feasibility Study, Plan of Study [1] and was requested to be performed by the Denver Technical Service Center (TSC) by the Upper Columbia Area Office (UCAO) of the Bureau of Reclamation's Pacific Northwest Region. Additional engineering work will be accomplished during the future Feasibility Study identified as Objective 401.1.1/Task 1 of the Plan of Study.

II. Purpose of Engineering Work

Under contract with the Benton County Sustainable Development Department, Washington Infrastructure Services, Inc. (WIS) completed a reconnaissance-level analysis to identify and compare multiple options to transfer water from the Columbia River to the Yakima Basin. The results of their study are documented in the Black Rock Reservoir Study - Final Report, dated May 2002 [2]. Cost estimates developed for the WIS study were used to compare options against each other and develop an order-of-magnitude estimate of project costs however; detailed design and cost analysis of any one option were not completed. Reclamation's Assessment Study used the WIS Report and data obtained since the report was completed to develop a few options in greater detail to permit a better definition of required features, understanding of project constraints, and development of more accurate construction cost estimates; and to use these cost estimates to compare options. Reclamation's Assessment also developed features and cost estimates required for delivery of Black Rock water to the Roza and Sunnyside Irrigation Districts which were not included in the WIS Report. Details of these features are described in separate reports [3] [4].

This report documents an appraisal-level assessment of likely configurations, sizes, and costs of Black Rock Project facilities to pump, store, and deliver water to willing exchange participants. It will be used to better define the project and/or project components to be carried into detailed feasibility analysis.

III. Basis of Designs

Existing Conditions

The Yakima River Basin is located in south-central Washington. As part of this Assessment, a Project Site Review Team was formed to review existing data and evaluate potential sites for features associated with the Black Rock Project. The Site Review Team visited the project area on October 23-27, 2003. Major findings and discussions are documented in a Travel Report that is included in Appendix A.

Water Supply and Needs

The availability of Columbia River water in excess of instream target flows for exchange with willing Yakima River Basin water users was investigated by Reclamation prior to the sizing of the features for this Assessment. The results of the water availability study are documented in the Preliminary Appraisal Assessment of Columbia River Water Availability for a Potential Black Rock Project Report [5]. The findings of the water availability study with direct impacts on this study are listed below and summarized in Table 1.

- Columbia River water appears to be available for exchange with willing Yakima River Basin water users contingent on obtaining State authorization in some form of water right approval.

• Instream flow targets at various points on the Columbia River downstream from Priest Rapids Dam limit diversions in every month except September, and the October flow target is relatively low.

• Because of the timing of water availability in excess of instream flow targets and Columbia River water supply deficiencies in some dry years, direct delivery (without storage) during the irrigation season to the Roza and Sunnyside Irrigation Districts is not viable. A Black Rock reservoir would be required in order to affect a water exchange with the Roza and Sunnyside Irrigation Districts.

• For a 1,300,000 acre-foot active capacity reservoir and a 3,500 cfs pumping plant, water diversions from the Columbia River would have to occur throughout the year during both light and heavy electric load hours to meet the water delivery criteria over an extended period. Diversions would only occur when water in excess of instream target flows is available and there is reservoir capacity available to store water.

• For an 800,000-acre-foot active capacity reservoir and a 6,000 cfs pumping plant, water diversions from the Columbia River would have to occur throughout the year during both light and heavy electric load hours to meet the water delivery criteria over an extended period. Diversions would only occur when water in excess of instream target flows is available and there is reservoir capacity available to store water.

Table 1. Summary of Data from Water Availability Study

		Large Reservoir	Small Reservoir
Active reservoir capacity		1,300,000 af	800,000 af
Water exchange April - October wet and average years		810,400 af	810,400 af
Water exchange April - October that meets water exchange delivery criteria in Yakima River basin dry years		662,000 af [a]	662,000 af [a]
Assumed seepage loss		15,000 af	15,000 af
Assumed evaporation loss		30,100 af	23,470 af
Months to fill		6 to 30 months	2 to 13 months
Average August end-of-month reservoir content	(Active)	888,000 af	468,000 af
Average August end-of-month reservoir elevation		El. 1721	El. 1646
Average August reservoir percent full		68%	59%
Pump capacity that meets water exchange delivery criteria			
Heavy and light load hours pumping		3,500 cfs	6,000 cfs
Light load hours pumping only		9,000 cfs	15,500 cfs

[a] The water delivery criteria is the sum for the Roza and Sunnyside Divisions of all authorized nonproratable water and: 100 percent of the nonproratable water in wet and normal water years and a minimum of 70 percent of proratable water in Yakima River basin dry years.

Topography

This Assessment utilized aerial photogrammetry that was developed for the Yakima River Basin Water Storage Feasibility Study. Survey control for the aerial flight was installed under the direction of Reclamation's Ephrata Survey Crew and the aerial flight and photogrammetric process were done by Aerometrics, Inc. in August 2003. Grids, contours, and orthophotos were generated from the resultant data by the Technical Service Center. The flight was done at approximately a 1:10,000 scale (5,000 feet above the ground surface). This enables plus/minus 0.5 foot accuracy in elevation and slightly better in the horizontal. Two foot contours were generated for most of the design work and accuracy was within mapping standards. The aerial photogrammetry covers the Columbia River intake area, Black Rock Reservoir area, Black Rock Outlet area, and most areas in between. For locations outside the coverage area, including the delivery systems for Roza and Sunnyside Irrigation Districts, and a small portion of the Outflow Conveyance System between Black Rock Reservoir and Roza Canal, 7.5 minute USGS maps with 20-foot contour intervals were used to determine topographic information.

Geology

The Black Rock Damsite was initially studied by WIS in 2002 after the completion of their reconnaissance study. WIS field investigations involved drilling five test borings and excavating ten test pits in the vicinity of their preferred dam alignment. The results of this investigation are documented in the Black Rock Reservoir Study -Initial Geotechnical Investigation - Final Report [6]. This geotechnical investigation indicated that the depth of overburden along the preferred (original) dam alignment was much greater (up to 200 feet) than had been assumed in WIS's reconnaissance study (20 feet). Based on this field exploration and geologic mapping completed during the geotechnical investigation, an alternate dam alignment located further west was hypothesized to be less complicated due primarily to the potential presence of a north-south fault that was believed to place the bedrock nearer the ground surface.

Reclamation performed field investigations of this alternate dam alignment between December 2003 and June 2004. These investigations involved drilling five shallow holes to define the bedrock surface, one deep hole to confirm the stratigraphy of the deep foundation, and one deep hole for hydraulic conductivity testing. The drilling information showed the depth to bedrock and overburden thickness at the alternate site was actually greater than the original damsite, indicating that if a north-south fault exists between the sites, the offset is insignificant. Reclamation geologic investigations will be documented in the Preliminary Assessment of

Geology at Black Rock Damsite Report [7] . The following is a brief description of the geology associated with the project area.

Regional Geology

The Black Rock Dam and Reservoir sites are located in the northwest-central portion of the Columbia Basin, a structural and depositional basin that forms much of eastern Washington. The basin is the site of large basalt flood lava known as the Columbia River Basalt Province. The basalts were erupted between 18 and 6 million years ago from vents near the present boundary between Washington, Oregon, and Idaho. Flows were up to 100 feet thick and cover hundreds to thousands of square miles. Extended time periods between eruptions allowed for sediment deposition. Sediments consisted primarily of lacustrine silt and fluvial sand and gravel. Basalt eruptions over millions of years resulted in a stack of relatively horizontal flows which are referred to as the Columbia Plateau.

Structural Geology

Shortly after the onset of the eruptive activity the western portion of the Columbia Plateau underwent north-south compression resulting in east-west and northwest-southwest trending folds. These folds are referred to as the Yakima Fold Belt. The ridges of the Yakima Fold Belt are generally asymmetrical, with one limb gently inclined while the other steeply folded, often with a thrust fault near the base of the fold. The anticlines represent the ridges and the synclines represent the valleys. This configuration exists at the Black Rock Damsite, which is between the Yakima Ridge anticline on the north, and Horse Thief Mountain/Rattlesnake Hills anticline on the south, and similarly at the Priest Rapids Intake, Pumping Plant and Inflow Conveyance System sites, which are bounded by or within the Umtanum anticline.

Black Rock Damsite Geology

The Black Rock damsite is underlain by an interbedded sequence of volcanic and sedimentary rocks of the Columbia River Basalt Group and late Pliocene to Holocene age fluvial, lacustrine and wind-blown deposits. The upper foundation at the damsite is composed of quaternary loess and alluvium deposits underlain by sedimentary Tertiary Ringold Formation. The deep foundation bedrock is composed of volcanic rocks of the Saddle Mountain Basalt and upper Wanapum Basalt formations of the Columbia River Basalt Group.

The alluvial units documented at the damsite include pediment and alluvium deposits. These are underlain by the Ringold Formation which consists of moderately- to well-indurated fine- to coarse-grained sediments deposited within the Yakima Fold Belt. The underlying Columbia River Basalt and Ellensburg Formation sedimentary interbeds include the following: the Rattlesnake Ridge sedimentary interbed, Pomona basalt member, Selah sedimentary interbed, Esquatzel and Umatilla Basalt members, and the Mabton sedimentary interbed. The upper Priest Rapids Basalt of the Wanapum Basalt formation was encountered during exploratory drilling.

Landslides frequently are present in the Yakima Fold Belt. The slides form on the sloping limbs of the anticlines due to failure of the lower strength sedimentary interbeds. Two ancient landslides have been identified on the Horse Thief Mountain anticline that forms the south (right) abutment of the dam. The first slide is located on the north limb of the anticline upstream of the damsite; the second is downstream of the damsite on the plunging east slope of the anticline.

Groundwater in the Black Rock Valley occurs primarily in the basalt interflow zones which generally include a flow breccia at the bottom of one flow and the vesicular flow top of the underlying flow. The dense interior section of the basalt flows are confining layers between the interflow zones. Where the interbedded sediments are coarse-grained, the interbeds are included in the aquifer; however, the interbedded sediments are often fine grained and act as confining layers. During Reclamation's geologic investigations a deep hole was drilled to better define groundwater in the Black Rock Valley. Groundwater in the hole was first encountered during drilling at about 254 feet, at the bottom of the Pomona Basalt. The water level rose in the hole and the static water level was about 195-feet below ground surface [8].

Priest Rapids Intake, Pumping Plant, and Inflow Conveyance Geology

The geologic conditions for the intake, pumping plant and inflow conveyance structures are based primarily on information provided by the Grant County Public Utility District that was used to design and construct Priest Rapids Dam. The pumping plant and intake structures adjacent to Priest Rapids Reservoir will likely be founded on either Priest Rapids Basalt or Columbia River terrace deposits. The inflow tunnel will penetrate the Umtanum and Yakima anticlines which are composed of folded and faulted Saddle Mountains Basalt, Wanapum Basalt and possibly Grande Ronde Basalt formations. In the Priest Rapids Dam area, the north limb of the Umtanum anticline is overturned and dips to the south. An upper fault, the

Buck thrust, and a lower fault, Umtanum fault, define the overturned flows of the fold. Landslides have been identified along the steep overturned north slope of the anticline. Groundwater in the vicinity will be influenced by water levels in Priest Rapids Reservoir and Columbia River. Based on limited permeability and exploration data, it appears that the pumping plant will be located in an area with a shallow thickness (less than 20 feet) of unconsolidated terrace gravel lying above the Priest Rapids basalt and it is expected that the excavation for the pumping plant will have relatively minor water control needs.

Seismic Hazard

An initial probabilistic seismic hazard assessment (PSHA) was conducted for use in this Assessment Study of the proposed Black Rock Dam and is included as Appendix B. This PSHA is based on limited, readily available data from existing studies and limited, preliminary evaluation of the data. Figure 2 shows the primary product of this assessment, a preliminary hazard curve for peak horizontal acceleration (PHA) and relative contributions of the various seismic sources to the total PHA hazard. At this stage of the evaluation, existing data indicate that some faults in the immediate vicinity may need to be considered as potential earthquake sources and that the characterization of these faults strongly influences the results. Thus, issues such as surface faulting and secondary coseismic folding and faulting may also be of potential engineering significance to the proposed dam.

Results from the PSHA indicate that the Black Rock Project is located in an area of high seismicity and potential ground motions at the site are greatly influenced by the characterization of nearby seismic sources. Specifically, at return periods of about 10,000 years, total PHA is about 0.95 g. For motions greater than about 0.3 g, about 70% of the total hazard is derived from the current characterization of the Black Rock Valley fault. Cascadia seismic sources do not appear to be significant relative to the Black Rock Valley fault for the PHA hazard at the site for PHA of 0.3 or greater. However, these sources may be important at longer periods; periods which may be significant in more detailed analyses of engineered structures at the Black Rock site. Further evaluation of the potential seismic sources or identification of additional sources, may significantly alter the preliminary results developed in this study.

Reclamation typically designs its major power and pumping facilities for earthquakes having a return period of 2,500 years (2 percent probability of exceedance within a 50-year period), and assesses the risk of dam failure using an earthquake with a return period of 10,000 years. For the Priest Rapids Intake and Black Rock damsite, an earthquake having a return period of 2,500 years has a total PHA of about 0.50 g, and at a return period of 10,000 years, the total PHA is about 0.95 g.

Regionally, Black Rock damsite lies within the Yakima fold belt, a group of mostly east-west striking folds which formed during and subsequent to eruption of the Columbia River Basalts, about 10-15 million years ago. The geometry of the folds is consistent with activity shown by regional seismicity and stress data, which is dominated by north-south compression. However, there are significantly differing interpretations published in the technical literature regarding the origin and age of these folds that have profound implications for seismic hazard assessment. Despite these differing interpretations, one of the most critical issues in the hazard assessments is the proximity of the fault sources to the sites of interest. The relatively large PHA values contained in the present assessment are the direct result of the relative proximity of potential fault sources to the Black Rock site as compared to other sites that have had detailed seismic hazard evaluations in the region.

Initial geologic mapping indicates that a significant thrust fault is present in the right abutment of the proposed damsite. For the present characterization, this fault is included as part of the Black Rock Valley fault and considered as a potential earthquake source. If large earthquakes occur on this fault they could potentially be accompanied by up to several meters of surface faulting. The age and characteristics of this fault need further study for issues related to seismic source characterization at the site.

A hypothesis developed from currently in-progress mapping at the damsite indicates that the large fold on Horse Thief Mountain, the right abutment of the proposed dam, is related to the thrust fault that daylights in the lower portion of the right abutment and dips to the south beneath Horse Thief Mountain. Several secondary faults, scarps, and lineaments that appear to be related to secondary extension along the fold atop Horse Thief Mountain may be related to Quaternary deformation of this fault/fold. These features are also potential sites of coseismic secondary faulting, fissuring, and landslides.

Although not addressed in the initial probabilistic seismic hazard assessment, studies for potential reservoir-induced seismicity will be addressed in the future. The setting of site in a region of tectonic compression, very large and deep reservoir, and operations that may involve large fluctuations in depth and volume, all indicate that the probability of induced seismicity may be significant.

Hydrologic Hazard

A feasibility-level Probable Maximum Flood (PMF) Study was conducted by Reclamation to evaluate the hydrologic hazard associated with the potential Black Rock Reservoir. The results of this study are shown in Appendix C and summarized in Table 2.

Table 2 - Black Rock Dam - Feasibility Level PMF Study Summary

Flood Description	Peak Flow (cfs)	Volume (acre-feet)	Duration
Winter General PMP Storm with 100-yr antecedent rain flood (November to March.)	20,200	29,100	10.5 days
Summer General PMP Storm with no antecedent flood (June to October)	28,900	28,700	3.5 days
Summer Local PMP Storm with no antecedent flood (June to October)	74,900	17,000	1-day

Reservoir Sizing Criteria

Based on the results of the Water Availability Study [5], two reservoir sizes were investigated for this assessment of project features. The Large Reservoir was sized for an active storage of 1,300,000 acre-feet and the Small Reservoir was sized for an active storage of 800,000 acre-feet. Aerial topographic data was used to develop elevation versus reservoir volume and area curves. See Figure 3. To reduce the dam heights required for total storage, the inactive storage was held to a minimum. To eliminate the need for a spillway, the PMF will be stored in the reservoir. Reservoir parameters for the large and small reservoirs are shown in Table 3.

Table 3 - Black Rock Reservoir Parameters

Design Parameter	Large Reservoir	Small Reservoir
Maximum Water Surface	Elevation 1778	Elevation 1712
Top of Active Water Surface	Elevation 1775	Elevation 1707
Active Capacity	1,300,000 af	800,000 af
Surface Area at Top of Active	13.5 sq. miles	10 sq. miles
Top of Inactive Water Surface	Elevation 1500	
Inactive Capacity	157,610 af	
Surface Area at Top of Inactive	3.25 sq. miles	

IV. Overview of Project Features

Large Reservoir Storage Options

Option 1: Large Reservoir - Pump Only Option

The Large Reservoir - Pump Only Option includes an intake with fish screens from Priest Rapids Reservoir, a 3,500 cfs pumping plant to lift the water to Black Rock Valley, a dam to store 1,300,000 acre-feet of active storage in Black Rock Reservoir, and a 2,500 cfs outflow tunnel and pipeline from the reservoir to Roza Canal. Table 4 summarizes the major features associated with this option between the Columbia River and Roza Canal. Figure 1 shows their relative locations as well as the locations of the distribution systems beyond the Roza Canal.

Option 2: Large Reservoir - Pump-Generating Option

In addition to the facilities identified for the Large Reservoir - Pump Only Option, the Large Reservoir - Pump-Generating Option includes a multi-level intake to selectively withdraw water from Black Rock Reservoir back to the Columbia River, a 3,500 cfs powerplant, and a 3,500 cfs tailrace channel to return the water back to Priest Rapids Reservoir. Table 5 summarizes the major features associated with this option between the Columbia River and Roza Canal. Figure 1 shows their relative locations as well as the locations of the distribution systems beyond the Roza Canal.

Small Reservoir Storage Option – Option 3

The Small Reservoir - Pump Only Option includes an intake with fish screens from Priest Rapids Reservoir, a 6,000 cfs pumping plant to lift the water to Black Rock Valley, a dam to store 800,000 acre-feet of active storage in Black Rock Reservoir, and a 2,500 cfs outflow tunnel and pipeline from the reservoir to Roza Canal. Table 6 summarizes the major features associated with this option between the Columbia River and Roza Canal. Figure 1 shows their relative locations as well as the locations of the distribution systems beyond the Roza Canal.

Table 4. Major Features of the Large Reservoir-Pump Only Option – Option 1

Priest Rapids Intake and Fish Screen
- Design Flow Capacity= 3,500 cfs
- Intake on right side of Priest Rapids Reservoir
- Normal Operating Water Surface Range= El. 481.5 to 488.0

Priest Rapids Pumping Plant
- Design Flow Capacity= 3,500 cfs
- Three 500 cfs, Two-stage spiral case pumps
- Two 1,000 cfs, Two-stage spiral case pumps

Inflow Conveyance System
- Design Flow Capacity= 3,500 cfs
- Two Conveyance Options: Discharge 1 - All Tunnel Option
  Discharge 2 - Tunnel/Pipe Option

Black Rock Dam
- Located on Original WIS Damsite
- Three Types: Concrete-face Rockfill, Central-core Rockfill, Roller-compacted Concrete

Black Rock Reservoir
- Active Storage: 1,300,000 af
- Inactive Storage: 157,610 af
- Top of Inactive Storage: El. 1500.0
- Top of Active Storage: El. 1775.0
- Maximum Reservoir Water Surface: El. 1778.0
- Spillway: None.
- Low Level Outlet: Dam type dependent.

Outflow Conveyance System
- Design Flow Capacity= 2,500 cfs
- Single level fish screened intake structure
- One Conveyance Option: Tunnel/Pipe Option

Black Rock Outlet Facility
- Located at MP 22.6 of Roza Canal
- One Bypass Structure Option: Design Flow Capacity= 2,500 cfs
- Two Powerplant Options: Option 1 - 1,500 cfs Design Flow Capacity
  Option 2 - 900 cfs Design Flow Capacity

Table 5. Major Features of the Large Reservoir - Pump-Generating Option – Option 2

Priest Rapids Intake and Fish Screen

- Design flow Capacity= 3,500 cfs
- Intake on right side of Priest Rapids Reservoir
- Normal Operating Water Surface Range= El. 481.5 to 488.0
- Separate tailrace channel to Priest Rapids Reservoir

Priest Rapids Pump/Generating Plant

- Pump Design Flow Capacity= 3,500 cfs
  - Three 500 cfs, Two-stage spiral case pumps
  - Two 1,000 cfs, Two-stage spiral case pumps
- Power Design Flow Capacity= 3,500 cfs
  - Two 1,750 cfs Francis turbines with 150 MW Generators

Inflow Conveyance System

- Design Flow Capacity= 3,500 cfs
- One Conveyance Option: Discharge 1 - All Tunnel Option
- Multi-level fish screened inlet/outlet structure

Black Rock Dam

- Located on Original WIS Damsite
- Three Types: Concrete-face Rockfill, Central-core Rockfill, Roller-compacted Concrete

Black Rock Reservoir

- Active Storage: 1,300,000 af
- Inactive Storage: 157,610 af
- Top of Inactive Storage: El. 1500.0
- Top of Active Storage: El. 1775.0
- Maximum Reservoir Water Surface: El. 1778.0
- Spillway: None.
- Low Level Outlet: Dam type dependent.

Outflow Conveyance System

- Design Flow Capacity= 2,500 cfs
- Single level fish screened intake structure
- One Conveyance Option: Tunnel/Pipe Option

Black Rock Outlet Facility

- Located at MP 22.6 of Roza Canal
- One Bypass Structure Option: Design Flow capacity= 2,500 cfs
- Two Powerplant Options: Option 1 - 1,500 cfs Design Flow Capacity
Option 2 - 900 cfs Design Flow Capacity

Table 6. Major Features of the Small Reservoir-Pump Only Option – Option 3

Priest Rapids Intake and Fish Screen
- Design Flow Capacity= 6,000 cfs
- Intake on right side of Priest Rapids Reservoir
- Normal Operating Water Surface Range= El. 481.5 to 488.0

Priest Rapids Pumping Plant
- Design Flow Capacity= 6,000 cfs
- Six 1,000 cfs, Two-stage spiral case pumps

Inflow Conveyance System
- Design Flow Capacity= 6,000 cfs
- One Conveyance Option: Discharge 1 - All Tunnel Option

Black Rock Dam
- Located on Original WIS Damsite
- Three Types: Concrete-face Rockfill, Central-core Rockfill, Roller-compacted Concrete

Black Rock Reservoir
- Active Storage: 800,000 af
- Inactive Storage: 157,610 af
- Top of Inactive Storage: El. 1500.0
- Top of Active Storage: El. 1707.0
- Maximum Reservoir Water Surface: El. 1712.0
- Spillway: None.
- Low Level Outlet: Dam type dependent.

Outflow Conveyance System
- Design Flow Capacity= 2,500 cfs
- Single level fish screened intake structure
- One Conveyance Option: Tunnel/Pipe Option

Black Rock Outlet Facility
- Located at MP 22.6 of Roza Canal
- One Bypass Structure Option: Design Flow capacity= 2,500 cfs
- Two Powerplant Options: Option 1 - 1,500 cfs Design Flow Capacity
Option 2 - 900 cfs Design Flow Capacity

The following sections describe each feature in detail.

V. Columbia River Intake

The Large Reservoir storage option requires a 3,500 cfs intake and pumping plant on the Columbia River to meet water delivery criteria, and the Small Reservoir storage option requires a 6,000 cfs intake and pumping plant on the Columbia River to meet water delivery criteria. In addition to these two options, a pump-generating option that permits Columbia River water stored in Black Rock Reservoir to be returned to the Columbia River to generate power was evaluated with the Large Reservoir storage option.

The potential site for the intake structure is located on the right bank of Priest Rapids Reservoir. See Figure 4. Priest Rapids Dam was constructed on the Columbia River between 1956 and 1961 and consists of left and right earth embankment sections, right bank gravity dam, two fish ladders, a gated spillway, and a powerhouse. The dam is operated by the Grant County Public Utility District and the active storage of the reservoir at maximum operating water elevation (488.0) is 48,600 acre-feet.

During the technical site review (Appendix A), the right bank of the Columbia River downstream from Priest Rapids Dam was evaluated for potential alternate intake locations. These downstream locations were limited to within four miles of the dam in order to avoid locating an intake within the environmentally-sensitive Hanford Reach of the Columbia River. Downstream of Priest Rapids Dam, the Columbia River is generally wide and shallow and the potential intake locations appeared to be less favorable compared to an inlet from the reservoir. Another consideration for placing the intake on the reservoir in lieu of the river downstream was to avoid the potential for significant daily fluctuation of water level. Discussions with Grant County Public Utility District personnel indicate that river fluctuations downstream of the dam can be as high as 14 feet, although operation of Priest Rapids Dam attempts to limit fluctuations to 5 to 6 feet. Daily fluctuation of Priest Rapids Reservoir is about 3 to 4 feet.

The intake for the Black Rock Project is located approximately 3,600 feet upstream from Priest Rapids Dam which provides adequate room for the physical layout of the intake, intake channel, pumping plant, switchyard, and tunnel portal, and also provides minimal impact to the existing embankment portion of Priest Rapids Dam. In addition to the stable water surface, locating the intake upstream of Priest Rapids Dam provides adequate hydraulic head for fish bypasses and adequate area for the fish screens, pumping plant, and switchyard. The upstream location of the intake will also minimize encroachment of the pumping plant facilities on the Wanapum Indian Village located downstream of the dam on the right side of the river.

Priest Rapids Intake and Fish Screen - 3,500 cfs Pump Only

Design Considerations

The design considerations for the intake channels and fish screens include hydraulic and biological criteria. The hydraulics must meet the maximum and minimum operating water surface elevations of Priest Rapids Reservoir and diversion flow requirements to Black Rock Reservoir. The maximum operating water surface elevation of Priest Rapids Reservoir is 488.0 feet, and the minimum operating water surface elevation is 481.5 feet. Intake facilities were provided with sufficient freeboard to prevent overtopping from the maximum water surface with flood surcharge, elevation 491.5 feet. Minimum intake pump submergence criteria for the pumping plant established the low point of the intake channel.

The National Marine Fisheries Services, Northwest Region criteria for Salmonids were used to design the fish screens and bypass pipes. These criteria include channel velocities, screen approach velocities, screen sweeping velocities, exposure time along screen, maximum bypass pipe flow velocity, and minimum radius of bypass pipe bends.

Structural loadings such as lateral earth pressure, uplift stability, seismic, and vehicle loads were not used at this level of design. These loadings would be a factor in the structural concrete thickness and reinforcing requirements for the walls. The structural concrete layouts and dimensions are based on past experience and designs of similar Reclamation fish screen structures.

Concept Description

From the intake at Priest Rapids Reservoir to the face of the pumping plant, the total length of the intake channel is approximately 2,366 feet. The channel consists of two different cross sections. See Figures 4 and 5. The initial 1,412 feet of the intake channel has three channel bays with vertical structural concrete walls. Two of the channel bays are sized for flows of 1,500 cfs each, and a third channel is sized for 500 cfs for a total of 3,500 cfs flow capacity. The channels were laid out with the top of concrete at elevation 495.50 feet and the invert elevation 468.00 feet. The channel depths are 27 feet 6 inches. The widths of the two 1,500 cfs channels are 36 feet 6 inches, and the 500 cfs channel is 15 feet wide. Currently the channel invert is assumed flat with no slope; however in final design, the channel inverts would have mild slopes to provide drainage when the channels are dewatered for maintenance. At minimum reservoir water surface elevation, the water depth in the channel is 13.5 feet and the maximum channel velocity is 4 feet per second (fps). At the maximum water surface, the flow velocities would be less than 4 fps.

Trashracks with an automated rake and a conveyor system are provided to collect trash at the inlet. This prevents large debris from flowing down to the fish screens and plugging them. A log boom may also be required in the reservoir in front of the trashracks but is not included in the current concept. Three top-sealed radial gates are provided at the reservoir intake to isolate the channels for emergency or short term maintenance of the fish screens and can also be used to regulate the downstream water surfaces. An access bridge deck is located over the inlet to allow access across the intake channel.

Bulkheads and guides are required at locations upstream and downstream of the structural intake channels. Each of the three structural channels will require sets of the bulkheads and guides in order to isolate each individual channel and still maintain the water diverting operation. Bulkheads will permit maintenance of the channels and associated mechanical equipment without shutting down the entire diversion. Mobile cranes were assumed to be available for installation and removal of bulkheads.

The fish screens are designed to meet the National Marine Fisheries Service (NMFS), Northwest Region, screen criteria for salmonid fry criteria. These criteria state that for salmonid fry, the approach velocity shall not exceed 0.40 fps. Approach velocity is defined as the water velocity component perpendicular and approximately three inches in front of the screen face. The total required submerged screen area (excluding area affected by structural components) was calculated by dividing the maximum diverted flow by the allowable approach velocity.

The fish screens for the Priest Rapids Intake are vertical flat panels installed within metal guide/support structures. The screen panels were assumed to be stainless steel wedge wire panels bolted to steel backing panels or supports. The NMFS screen criteria states that the screen slot openings (narrowest dimension) shall not exceed 0.0689 inches (1.75 mm). Adjustable baffles are provided in guides directly downstream of the screens to provide for uniform flow distribution over the screen surface. The fish screens will be cleaned by horizontal brush-type fish screen cleaners. Since the screens are designed for the maximum flow at the minimum operating water depth, metal barrier panels are provided above the screens to extend above the maximum design operating water surface.

To meet exposure time criteria, V-configurations of the fish screens were utilized for the 1,500 cfs option and fish screens in a single diagonal configuration were utilized for the 500 cfs channel. The following tables list the design criteria for the fish screens and the design values associated with the selected concept. Three 54-inch diameter bypass pipes are located at the end of the fish screens to deliver screened fish to the river channel below Priest Rapids Dam.

Table 7. 1,500 cfs Screen Design Parameters at Minimum Water Surface El. 481.5 feet

Fish Screen Parameters	Screen Criteria Values	1,500 cfs Design Values
Approach velocity	0.4 ft./sec.*	0.4 ft./sec.
Sweeping velocity	Greater than approach velocity	3.98 ft./sec.
Screen angle (from parallel with channel)	Less than 45^{o}	5.74^{o}
Exposure time along screen	60 to 90 seconds**	39 sec.
Screen length plus 10% for metal works	n/a	153 ft.

Table 8. 1,500 cfs Screen Design Parameters at Maximum Water Surface El. 488.0 feet

Fish Screen Parameters	Screen Criteria Values	1,500 cfs Design Values
Approach velocity	0.4 ft./sec.*	0.23 ft./sec.
Sweeping velocity	Greater than approach velocity	2.30 ft./sec.
Screen angle (from parallel with channel)	Less than 45^{o}	5.74^{o}
Exposure time along screen	60 to 90 seconds**	65 sec.
Screen length plus 10% for metal works	n/a	153 ft.

Table 9. 500 cfs Screen Design Parameters at Minimum Water Surface El. 481.5 feet

Fish Screen Parameters	Screen Criteria Values	500 cfs Design Values
Approach velocity	0.4 ft./sec.*	0.4 ft./sec.
Sweeping velocity	Greater than approach velocity	3.98 ft./sec.
Screen angle (from parallel with channel)	Less than 45^{o}	6.21^{o}
Exposure time along screen	60 to 90 seconds**	26 sec.
Screen length plus 10% for metal works	n/a	102 ft.

Table 10. 500 cfs Screen Design Parameters at Maximum Water Surface El. 488.0 feet

Fish Screen Parameters	Screen Criteria Values	500 cfs Design Values
Approach velocity	0.4 ft./sec.*	0.4 ft./sec.
Sweeping velocity	Greater than approach velocity	2.71 ft./sec.
Screen angle (from parallel with channel)	Less than 45^{o}	6.21^{o}
Exposure time along screen	60 to 90 seconds**	42 sec.
Screen length plus 10% for metal works	n/a	102 ft.

* Criteria for Salmonid fry.

**Not part of 1995 NMFS Criteria

Downstream from the fish screens, the three structural channels open to a single channel having a trapezoidal cross section. The bottom width of this channel is approximately 93 feet, side slopes are 1.5:1 (H:V), and the top of the channel is at elevation 500.0 feet. The channel would be lined with a 3.5 inch unreinforced concrete lining. The velocities in this section of the channel vary from 1.5 to 2.3 fps depending on the water surface elevation of the reservoir. This segment of the channel is approximately 608 feet long. The channel then widens and transitions to the pumping plant. The width of the channel at the pumping plant face is approximately 218 feet. The 346-foot long transition section is made at 10 degree angles parallel to the channel alignment and expands the bottom width from 93 feet to 218 feet. The transition invert is sloped vertically to meet the pumping plant intakes.

Maintenance roads are provided on each side of the channel. The access road on the left side (looking downstream) is 20 feet wide, and the access road on the right side is 12 feet wide. Guardrails would be provided for safety protection along the channel. Safety fencing would also be provided along both sides of the channel to protect against people and animals falling down the excavated side slopes.

Priest Rapids Intake and Fish Screens - 3,500 cfs Pump-Generating

This option has the same arrangement and criteria as described for the 3,500 cfs intake channel concept. The only change is the configuration of the intake area of the channel to accommodate a tailrace for the power generating units. See Figures 6, 7, and 8.

The tailrace channel for the power generating side of the plant is located between the intake channel and Priest Rapids Reservoir and is approximately 483 feet long. The physical layout of the channel consists of a transition from the powerplant face to a 35-foot wide structural channel with vertical walls. The top of the concrete walls are at elevation 500.5 feet, and the invert elevation is at 471.50 feet.

The design velocity of the channel is 10 fps during the minimum water surface elevation with the maximum discharge of 3,500 cfs. The velocity decreases as the reservoir water surface rises to the maximum water surface. The channel layout selects the shortest possible path back to the reservoir. This short layout was selected for its minimal channel friction loss however, the short tailrace channel will pass through the embankment section of Priest Rapids Dam. Cutoffs are provided to prevent seepage between the embankment and structure.

Two 20-foot wide maintenance roads are provided on either side of the tailrace channel. The channel has an access bridge aligned with the centerline of the existing Priest Rapids Dam embankment. A deck is also provided at the location of the tailrace bend downstream of the channel transition.

Priest Rapids Intake and Fish Screen - 6,000 cfs Pump Only

This concept is similar to the 3,500 cfs concept except that it consists of four channel bays of 1,500 cfs. See Figures 9 and 10. Each channel bay is approximately 36 feet 6 inches wide. The total length of the channel is approximately 2,340 feet which includes 1,433 feet of structural concrete channels, 727 feet of excavated, unreinforced, concrete-lined, trapezoidal cross section channel, and 180 feet of transition to the pumping plant.

The excavated trapezoidal channel for this concept has a bottom width of 154 feet and side slopes of 1.5:1. The section then transitions to the pumping plant both horizontally and vertically to accommodate the plant width and pump submergence requirements.

All required appurtenances are similar to the 1,500 cfs channel bays of the 3,500 cfs concept. There are four sets of bulkheads and guides for both upstream and downstream use. There are also four top sealed radial gates. The access bridge and maintenance roads are the same widths. Since there are four bays, the total channel width is greater than the 3,500 cfs concept. Trashracks and rakes are increased to accommodate the extra bay for this concept. Guardrails and safety fencing will be required and will be similar to the 3,500 cfs concept.

Fish screen criteria and design values meet those shown in Tables 7 and 8 for the minimum and maximum water surface elevations. Lengths and locations of the bypass pipes and outfalls are assumed the same as the 3,500 cfs concept, except that there will be four 54-inch diameter bypass pipes for the four fish screen bays.

Priest Rapids Pumping Plant and Switchyard - 3,500 cfs

Design Considerations

The location of the pumping plant and service yard was controlled by the intake channel location, fish bypass requirements, location and alignment of the tunnel portal to the discharge line, space requirements for the plant and switchyard, access into and around the plant, and access into the Service Bay. See Figure 11. The service yard was set at elevation 507.5 feet for compatibility with the existing ground elevation and to reduce the visibility of the plant structure and switchyard from the Wanapum Indian Village. Reclamation decided to go with a lower structure for the Unit Bay and raised superstructure for the Service Bay to keep the service yard at an elevation more compatible with the existing ground surface and to allow access and handling of equipment into and out of the building structure from the service yard elevation. The lower profile for most of the superstructure also helps mitigate the structural demand for lateral earthquake loads. These loads are anticipated to be significant based on available seismic data.

Pumping units with capacities of 500 cfs and 1,000 cfs were selected to accommodate months when downstream flow targets in the Columbia River would restrict the volume of water that could be pumped from the river. Besides flexibility of operations, more smaller units reduces the submergence requirements for the units and permits unit maintenance without sacrificing a large percentage of the plant capacity. The lift from Priest Rapids Reservoir to Black Rock Reservoir is very high (approximately 1400 feet steady state) and the size of the units led to the use of spiral case pumps. Pumping could be accomplished by single-stage or two-stage pumps, however because of the high pumping head, submergence requirements for a single-stage unit are much greater than requirements for a two-stage unit. For single-stage pumps the required submergence is on the order of 180 feet, while for two-stage pumps the submergence requirement is approximately 60 feet. Two-stage pumps were selected for this study to reduce the depth of excavation for the pumping plant.

Concept Description

The pumping plant is a reinforced concrete structure approximately 375 feet long by 163 feet wide. The indoor type structure will house five units: three 500 cfs units with 98,000 hp motors, and two 1000 cfs units with 200,000 hp motors. The rated head of the pumps is 1,400 feet. The pumping units require 62 feet of submergence below the minimum intake water surface elevation of 481.5 feet which set the centerline elevation for the lower stage of the pump impeller at elevation 419.5 feet. See Table 11 for unit data. Handling requirements for the rotor/shaft assembly controlled building and overhead crane elevations and the estimated weight of the rotor/shaft assembly (700,000 lbs) controlled the selection of two 200-ton overhead cranes acting in tandem in the Unit Bays. In the Service Bay, a 100-ton overhead crane is provided. Space was provided in the plant for unit disassembly, auxiliary mechanical, and electrical equipment. Precast concrete double tees were selected for the roof structure based on span and anticipated availability. See Figures 12 through 17 for 3,500 cfs pumping plant general arrangement details.

Table 11. Priest Rapids 3,500 cfs Pumping Plant Unit Data

Unit Data	**500 cfs Unit**	**1, 000 cfs Unit**
Number/Type of Units:	3 - Two-stage spiral case	2 - Two-stage spiral case
Design Discharge:	500 cfs	1,000 cfs
Design Head:	1,400 feet	1,400 feet
Min. Impeller Submergence	62 feet	62 feet
Max. Spiral Case Dimension	18.2 feet	26.0 feet
Top of Suction Tube Invert	El. 468.0	El. 468.0
Guard Valve:	60-inch spherical	78-inch spherical

Due to the high head at the plant, the pump discharge valves were assumed to be heavy spherical valves supplied by the pump manufacturer.

Steel piping for the tunnels, manifolds, and penstocks were designed in accordance with AWWA M11 [9] and ASCE Manuals and Reports on Engineering Practice No. 79 [10]. The large diameter tunnel liners and high pressure manifolds were designed with ASTM A572 Grade 50 steel plate. All other manifolds, penstocks, and outlet works piping were fabricated from ASTM A36 steel plate. The discharge line earthwork quantities were calculated based on the typical pipe trench section shown on Figure 32.

The estimated size and weights of the synchronous machines (generators and motors) were based on existing Reclamation machines having similar speed and kVA or horsepower ratings. Standard 3-phase utilization voltages of 480; 6,900; and 13,800 volts were assumed for the study. Because of the high continuous current loads at the Priest Rapids Pumping Plant, high capacity isolated-phase bus was used in the estimate. All the 15 kV switchgear utilized SF6 type unit circuit breakers.

The estimate also assumes that a new 500-kilovolt line will be constructed from the Midway Substation located 6 miles east of the Priest Rapids Pumping Plant and Switchyard. The connection at the Midway Substation includes a circuit breaker and disconnect switches. The pumping plant switchyard will include transformers, circuit breakers, and disconnect switches.

Priest Rapids Pump-Generating Plant and Switchyard - 3,500 cfs

This option has a similar arrangement as described in the 3,500 cfs Pump Only option except, the structure and yard have been expanded to accommodate two turbines and a tailrace channel adjacent to the pumping plant intake channel. The offset height of the superstructure between the Unit Bay and Service Bay and the use of two separate crane levels has also been eliminated from this option because the turbine and generator elevation settings do not facilitate taking advantage of this arrangement. A single crane and roof level are shown for this option. See Figures 18 through 25.

One of the unfortunate results of choosing two-stage pumps to deliver the water is that it made the use of pump-turbines less attractive. Similar size two-stage pump-turbines have been built but they are near state-of-the-art and maintenance requirements are expected to be high. For these reasons, separate turbines were selected for the pump-generating option.

The pump-generating plant is a reinforced concrete structure approximately 490 feet long by 163 feet wide. The structure will house five pumping units: three 500 cfs units with 98,000 hp motors, and two 1000 cfs units with 200,000 hp motors, and two Francis turbine units each with a design discharge of 1,750 cfs. Pump unit data is shown in Table 11 and turbine data is shown in Table 12. Handling requirements for the pumping units controlled over the handling requirements for the turbines.

Table 12. Priest Rapids 3,500 cfs Powerplant Unit Data

Unit Data	1,750 cfs Unit
Number/Type of Units:	2 Francis
Design Discharge:	1,750 cfs
Design Head:	1,130 feet
Speed:	400 rpm
Assumed Unit Efficiency	90 percent
Power Output at Design Head:	150 MW
Min. Turbine Submergence	29.8 feet
Max. Scroll Case Dimension	26.5 feet
Bottom of Draft Tube	El. 431.5
Guard Valve:	102-inch spherical

Priest Rapids Pumping Plant and Switchyard - 6,000 cfs

This option has a similar arrangement as described for the 3,500 cfs Pump Only option except the structure has been expanded to accommodate six 1,000 cfs pumping units. See Figures 26 through 31.

Construction Considerations

Construction Access: The current access to the right side of Priest Rapids Reservoir is across Priest Rapids Dam. The clear width and sharp turns across the spillway deck would restrict movement of large construction equipment across the dam and an alternate means for construction access, and future operation and maintenance access was developed along the right side of the Columbia River from State Highway 24 (SH24) to the Intake facilities. The proposed road follows the alignment of the abandoned railroad tracks.

Cofferdam: A cofferdam will be required in the reservoir to permit construction of the intake. Our estimate assumed a circular-type, cellular cofferdam would be constructed. A cellular cofferdam is a gravity retaining structure formed by a series of interconnected straight web steel sheet pile cells filled with free draining granular soil. The circular-type cofferdam consists of individual large diameter circles connected together by arcs of smaller diameter. The

380-foot long cofferdam was assumed to be constructed with 32-foot-diameter cells that are 28 feet high. The top of the cofferdam was assumed to be at elevation 488.0 feet.

Excavations: The depth of overburden over sound basalt was assumed to be 20 feet. All rock excavation was assumed to have a 0.25:1 cut slope and overburden earth excavation is assumed to have 1.5:1 cut slope. Based on available geologic and groundwater data, dewatering is not necessary because groundwater is not likely to seep into the foundation excavation.

VI. Inflow Conveyance System

Inflow Conveyance System - 3,500 cfs Pump Only

Two different inflow conveyance systems were analyzed to transport the flow of 3,500 cfs from Priest Rapids Reservoir to Black Rock Reservoir. Both alignments encroach on the Yakima Firing Center Military Reservation to some extent. See Figures 1 and 32. The first option, Discharge 1, is an all tunnel option with a 16-foot-diameter manifold connecting to a 17-foot-diameter tunnel sloping steadily up towards the reservoir. The tunnel has a 22-foot-diameter surge shaft located 3,850 feet from the pumping plant and extending to El. 2106. See Figure 33. The second option, Discharge 2, is a tunnel/pipe option comprised of a 16-foot-diameter discharge pipe and tunnel, 16-foot-diameter vertical shaft, 21-foot-diameter gravity tunnel, and an 18-foot-diameter pipe transitioning to a 17-foot-diameter pipe connected to the low level outlet works at Black Rock Dam. See Figure 34.

General Design Considerations

The tunnel and pipeline diameters were sized using a flow of 3,500 cfs. The transient design was based on an additional 5% (3,675 cfs) to account for the pump wear factor and manufacturer's allowance. The Priest Rapids Reservoir water surface elevation used for the hydraulics and transient study was El. 488 (Normal Maximum). A Black Rock Reservoir level of El. 1500 (Top of Inactive) was used to calculate the maximum downsurge; to size the tunnel and pipeline diameters; and to size the surge tank diameter. A Black Rock Reservoir level of El. 1775 (Top of Active) was used to calculate the maximum upsurge pressure at the pumping plant and to determine the elevation required at the top of the surge tank.

The following factors and assumptions were used for the hydraulic and transient analysis of the 3,500 cfs inflow conveyance systems:

Design Flow:	3,500 cfs
Transient Design Flow:	3,675 cfs
Colebrook White Rugosity Value:	0.002 (Tunnel)
Colebrook White Rugosity Value:	0.001 (Pipeline)
Downsurge pressures:	No negative pressures.
Rated head:	1,450 feet
Speed:	400 rpm
WR^2:	5,000,000 per unit
Efficiency:	0.85
Pumps:	5 equal two-stage pumps*

* Five equal units were assumed to simplify the transient analysis.

<u>Discharge 1 (All Tunnel) - Hydraulic Design Considerations</u>

Initially, the tunnel was designed with a shaft similar to the WIS Report [2], however, the design was later simplified to have a tunnel with a constant slope from Priest Rapids to Black Rock Reservoir. The tunnel portal was located just outside of the pumping plant switchyard fence with the centerline at El. 495. Based on the transient analyses, the end of the tunnel was located at El. 1440 to prevent a negative downsurge in the tunnel near the Black Rock Reservoir. See Figure 33.

The top of the surge shaft was set at approximate El. 2106 to prevent overtopping and was located to provide a level spot for construction activities. The top elevation is based on upsurge from the pumping plant shutdown while Black Rock Reservoir is at El. 1775. The maximum design grade line at the pumping plant was determined to be El. 2800 which converts to 2,370 feet of pressure based on a pump/pipeline centerline elevation of 430 feet. The steady state hydraulic grade line at the pumping plant, not including friction loss through the pumps and manifold, was elevation 1876.0 feet. See Figure 35 for a graphical representation of the design and hydraulic grade lines for Discharge 1.

<u>Discharge 2 (Tunnel/Pipe) - Hydraulic Design Considerations</u>

The design of the tunnel/pipe initially was to be a pressurized system from the pumping plant to Black Rock Reservoir. However, after review of the hydraulic and transient analyses, increasing the size of the tunnel after the surge shaft and using a gravity tunnel provided a more efficient and effective solution. The downstream tunnel diameter was increased to 21 feet which provided a normal depth of 15.1 feet and slope of 0.0015 using a Manning's n of .0015. The elevation of the gravity tunnel downstream portal was based on the hydraulic grade line required to allow the 3,500 cfs to flow around Yakima Ridge in an 18 foot-diameter pipe at approximately El. 1800. Beyond the south side of the Yakima Ridge, the pipe diameter was reduced to 17 feet. See Figure 34.

The manifold and initial tunnel diameter were sized to minimize the diameter while maintaining a flow velocity below 20 fps. A 16-foot-diameter discharge pipe and tunnel have a flow velocity of approximately 18 fps at 3,500 cfs. The maximum design grade line at the pumping plant was determined to be El. 2700 which converts to 2,270 feet of pressure based on a pump/pipeline centerline elevation of 430 feet. The steady state hydraulic grade line at the pumping plant, not including friction loss through the pumps and manifold, was elevation 1910.0 feet. See Figure 36 for a graphical representation of the design and hydraulic grade lines for Discharge 2.

Tunnel Design Considerations

Appraisal designs for the tunnel support were based on existing geologic design data and Chapter 4 of Reclamation's Design Standards No. 3 [11]. The tunnel designs include initial and final support. The initial support holds the tunnel opening stable until installation of the final support, or lining. The contractor will install the initial support immediately after advancing the heading. Figures 37 and 38 show the initial and final support used in this Assessment.

Tunnel excavation will probably be accomplished using Tunnel Boring Machines (TBMs). Basalt generally does not preclude this method of excavation and the design does not anticipate unusual bit (disk cutter) wear. Shorter tunnels with lengths less than 4,000 feet may be excavated by drill and blast methods. Intermediate length tunnels may be excavated by either method, depending on the particular contractor's resources.

Most shaft excavation will probably be by full raise bore, raise bore and slash down, or raise bore and ream down excavation methods. The shaft excavation on the outlet tunnel will be by raise bore and slash down as the diameter precludes using shaft boring machines or raise boring to the final diameter. Raise bore excavation is accomplished by boring a small hole from the surface, removing the small boring cutter head, and attaching a boring head with the same diameter as the final excavated diameter of the shaft to the drill steel at the shaft bottom, then pulling the boring head upward to the surface. The operation removes the drilling waste from the small hole at the shaft top and miners remove shaft waste from the raise bore and shaft bottom. The per unit cost of removing waste at the shaft top is much higher than at the shaft bottom.

The raise bore and slash down method begins similar to the full raise bore except the raise bore is a smaller diameter than the shaft's final excavated diameter. Miners then remove the boring head and drill steel at the shaft top and begin slashing down using drill and blast, or other techniques to excavate to the final shaft diameter. The shaft waste falls through the raised bored hole and down to the tunnel below, where miners remove it. The raise bore and ream down method is similar to the raise bore and slash down method except the final shaft diameter is excavated by reaming the raised bored hole to a larger diameter.

Water is always a major concern in tunneling, however all of the potential tunnels are above the current water table so groundwater should not be a major problem. Surface waters coming from rains will eventually enter the tunnel. All tunnels can be excavated uphill, alleviating minor water problems. The initial tunnel support will depend on the intercepted geology, and may be interdependent with the final lining for a particular reach. For this Assessment, rock quality was assumed in order to determine what initial support would be required and general lengths of reaches of structural steel tunnel supports along with a percentage of the remaining tunnel that needed patterned rock reinforcement, spot rock reinforcement, or no reinforcement were determined.

Final tunnel lining design was based on Reclamation design standards. While the mineralogy of the rock indicates that an unlined tunnel is possible, the design uses a lining to assure reasonable hydraulic friction and account for areas where the rock may be highly fractured. While the tunnel design calls for mostly unreinforced lining, the design prescribes some reinforcement to curtail leakage in highly fractured reaches in the pressure tunnels. Tunnel design also incorporates steel lining at the portals to insure water tightness as the tunnel nears the surface. This steel liner will be backfilled with concrete and grouted. The tunnels will not require steel lining when the portal is under Black Rock Reservoir.

Pipeline Design Considerations

The pipeline for the Tunnel/Pipe option (Figure 34) was designed using steel pipe and AWWA M11 guidelines [9] for internal pressure. The steel pipe wall thickness was sized using a design pressure based on the water surface at the end of the tunnel, El. 1881.0. The design pressure was not increased for transient pressure because the valves in the dam's low level outlet works at the end of the pipeline would be able to close slow enough to prevent harmful pressure surges. An allowable design stress of 18,000 psi was used which is 50% of the minimum yield point of ASTM A36 steel. For this study, the pipeline was divided into three sections and designed for the parameters shown in Table 13. Future studies would further refine the steel pipe design, hydraulics, and transient pressures.

Table 13. Discharge 2 Pipeline Design Parameters

Stations	Diameter Feet (inches)	Design Pressure psi	Pipe Wall Thickness, inches
154+50 to 415+60	18 (216)	168	1.0
415+60 to 465+60	17 (204)	165	1.0
465+60 to 545+00	17 (204)	229	1.3

The pipeline vertical alignment was based on a minimum cover of 5 feet. The average cover depth was 13 feet. During feasibility design, the pipeline vertical profile could be refined and the average cover depth decreased. The side slopes and bench widths were determined based on a review of available geologic data. See Typical Pipe Trench Section in Figure 32.

At Black Rock Reservoir, the pipeline was assumed to connect to the low level outlet works pipe so that both the low level outlet works and pipeline would use the same tunnel through the dam abutment.

Reservoir Outlet Design Considerations

Given the anticipated high flows (3,500 to 6,000 cfs) and velocities during the initial filling of the Black Rock Reservoir inactive pool space, provisions for erosion control/protection of the reservoir rim were included in the estimates. The inflow conveyance systems enter the reservoir approximately 100 feet above the valley floor at a distance of approximately 4,000 feet from the valley bottom. Reclamation decided that some type of conveyance would be needed to minimize erosion of the hillside until the reservoir reaches the inlet elevation. For this Assessment, a short open channel was assumed to direct flow from the outlet structure into a large diameter (20- to 24-foot) steel pipe. The pipe would carry the flow downhill towards the valley bottom where it would terminate with a 90-degree upward bend. A large concrete thrust block would be necessary to handle the thrust loads at the end of the 90-degree bend. No attempt to optimize alternatives or costs for this erosion control plan was done at this level of study, however this should be completed as part of any future studies.

Inflow Conveyance System - 3,500 cfs Pump-Generating

For this study, the inflow conveyance system for the Pump-Generating option was assumed to be the same as the All Tunnel conveyance system for the 3,500 cfs pump only option. (Discharge 1). One difference is the need for a multi-level intake structure at Black Rock Reservoir to control the withdrawal elevation for water returning to the Columbia River to meet as yet to be determined water quality objectives. For this Assessment, the proposed Multi-Level Inlet/Outlet Structure is a free-standing tower with fixed intakes at elevations 1450.0, 1540.0, 1630.0, and 1720.0 feet. These ports are valve controlled so any combination of withdrawal levels can be achieved. The intakes discharge into a wet well before entering the 17-foot-diameter tunnel to Priest Rapids Pump-Generating Plant. See Figures 39 and 40.

Fish screens would be installed at each intake level. Fish screen sizing criteria was assumed to be the same criteria used to size the intake structure at Priest Rapids Reservoir. The fish screens would be stationary, half-cylinder-shaped screens with flat side panels attached to the intake tower. The fish screens will only be used when in the generating mode. However, cleaning of these screens was assumed to be by passing pumped (back flush) water through the screens for a short period when in the pumping mode. During normal pumping operations, pumped water will be discharged through two 17-foot by 17-foot gates located at the bottom of the wet well.

Inflow Conveyance System - 6,000 cfs Pump Only

Only one conveyance system was analyzed to transport the 6,000 cfs flow from Priest Rapids Dam to Black Rock Reservoir. A 22-foot-diameter tunnel sloping steadily up towards the reservoir was used. The tunnel has a 22-foot-diameter surge shaft located 4,050 feet from the upstream end of the tunnel, extending to El. 2107. See Figure 41.

General Design Considerations

The tunnel diameter was sized using a design flow of 6,000 cfs. The transient design was based on an additional 5% (6,300 cfs) to account for the pump wear factor and manufacturer's allowance. The Priest Rapids Reservoir water surface elevation used for the hydraulics and transient study was El. 488 (Normal Maximum). A Black Rock Reservoir level of El. 1500 (Top of Dead Pool) was used to calculate the maximum downsurge; to size the tunnel diameter; and to size the surge shaft diameter. A Black Rock Reservoir level of El. 1775 (Top of Active) was used to calculate the maximum upsurge pressure at the pumping plant and to determine the minimum elevation at the top of the surge shaft.

The following factors were used for the hydraulic and transient analysis for the 6,000 cfs inflow conveyance system:

Pipeline Design Flow:	6,000 cfs
Transient Design Flow:	6,300 cfs
Colebrook White Rugosity:	0.002 (Friction Loss Coefficient)
Downsurge pressures:	No negative pressures.
Rated head:	1450 feet
Speed:	400 rpm
WR^2:	5,000,000 per unit
Efficiency:	0.85
Pumps:	6 equal-sized two-stage pumps

Tunnel design considerations are similar to those discussed for the 3,500 cfs Pump only Option.

Discharge 1 (All Tunnel) - Hydraulic Design Considerations

The tunnel was designed similar to the 3,500 cfs tunnel design which has a constant slope from Priest Rapids to Black Rock Reservoir. The tunnel portal is located just outside of the pumping plant switchyard with a centerline at elevation 495. Based on the transient analyses, the end of the tunnel was located at elevation 1440 to prevent a negative downsurge in the tunnel near the Black Rock Reservoir. The top of the surge shaft was set at approximate elevation 2107.0 to prevent overtopping and was located to provide a level spot for construction activities. The maximum design grade line at the pumping plant was determined to be El. 2650 which converts to 2,220 feet of pressure based on a pump/pipeline centerline elevation of 430 feet. The steady state hydraulic grade line at the pumping plant, not including friction loss through the pumps and manifold, was elevation 1782.0 feet. See Figure 42 for a graphical representation of the design and hydraulic grade lines for Discharge 1.

Construction Considerations

Pipe Fabrication: Steel pipe sections 16-feet in diameter and greater will have to be transported in pieces by truck or rail and welded together and pressure tested in the field.

Tunnel Excavation: The potential for varying rock quality encountered during tunnel excavation will necessitate a flexible working relationship with the contractor. Differing ground, water and gas conditions from assumed conditions will affect the tunnel construction. Based on current knowledge of the tunnel alignment, bedrock will consist of a series of basaltic lava flows and associated interflow sediments. The basaltic portion of the tunnel will be in rock which will likely vary structurally and texturally from massive nonvesicular to highly vesicular and flow-breccia types. Soft, relatively uncemented interflow sediments will also likely be encountered. A number of shear zones, consisting of fractured rock with soft gouge materials may also be encountered during tunneling.

VII. Black Rock Dam and Reservoir

Large Embankment Dams

Design Considerations

There are a number of design considerations associated with the construction of a large embankment dam in the Black Rock Valley. None of these considerations are viewed to be "fatal flaws" that would indicate the site is not technically feasible. Rather, it is believed that a safe dam could be constructed, and that no unusual measures or features beyond what is typically done for a major embankment dam would be required. Nonetheless, there are a number of issues that will need special attention during design, and some of the most significant are listed below.

High Seismicity

Black Rock Dam would be located in an area of high seismicity, or earthquake potential. The presence of the Black Rock Valley fault is the largest contributor to the seismic hazard, although there are a large number of other contributing earthquake sources. Two additional notable ones are the Yakima Ridge East fault, the second largest contributor to the hazard after the Black Rock Valley fault, and the deep zone of the Cascadia Subduction Zone, capable of producing very large magnitude earthquakes. Based on Reclamation's initial probabilistic seismic hazard assessment (Appendix B), the peak horizontal ground acceleration expected from a 10,000-year earthquake has a mean value of 0.95g. This is a large ground motion and dictates that a dam needs to be able to resist significant earthquake shaking.

This high level of shaking leads to the potential of causing lower density embankment or foundation saturated soils to experience liquefaction, which is essentially a loss of strength that can result in large slope failures. To mitigate this concern, it is critical that all potentially liquefiable foundation soils are removed and that all embankment materials are compacted to high densities, which can be routinely accomplished through the use of large rollers.

Another potential concern is that earthquake shaking, if severe and long enough, can induce slope failures in an embankment. This concern can be addressed by carefully analyzing the dam for potential deformations from the expected earthquake load, and designing crest dimensions, zoning, and embankment slopes to ensure stability, as well as selecting strong materials and keeping the phreatic surface (water level) in the embankment as low as possible.

Potential Fault Displacements

Preliminary investigations indicate that at least one significant thrust fault is located within the proposed footprint of the dam, at the base of the right (south) abutment. This fault has not been studied in sufficient detail to define its activity or the magnitude of potential displacements. At this stage of study and based on available information, it can only be assumed that fault offsets within the dam footprint are possible, and that such displacements could range from a few centimeters to several meters. Given the orientation of the east-west folds comprising the Yakima Fold Belt which includes Black Rock Valley, the orientation of the displacements would be in the north-south (cross valley) direction, reflecting compression of the folds. From a dam engineering standpoint, this orientation would likely be favorable over an upstream-downstream displacement which would create transverse cracks through the dam. However, severe cracking would still likely result from a significant fault offset.

The potential for and impact of such potential displacement of a fault at the right abutment must be considered and accommodated in the dam design. Because an embankment dam is generally viewed as less stiff or rigid than a concrete dam, an embankment alternative may be best able to accommodate potential fault displacements. Key features to include in an embankment would be filters and drains of sufficient dimension to ensure that cracking, offsets, or differential movements will not exceed the width of the filters. These filters and drains should be constructed of clean, cohesionless, and permeable sands and gravels so that if the dam is cracked, these materials will collapse or rearrange so that a crack is not supported within these zones. While the upstream water barrier (an earth core or concrete face, for example) would be expected to crack and possibly stay open from a fault offset, the filter would serve to ensure that no fine-grained materials from a core would be able to erode downstream. The gravel drain located downstream from the filter would provide for safe collection of any seepage that is passed through the crack in the earth core or concrete face. In addition, filters placed upstream of the water barrier may serve as crack "pluggers" that introduce sand into cracks in the water barrier to help seal the cracks.

Another design feature frequently utilized when fault displacement is possible is the use of large rockfill shells. These rockfill shells, constructed of rock up to 3-foot size, form an extremely stable downstream buttress for the earth core or concrete face. Of equal importance is the proven ability of rockfill to allow extensive reservoir leakage or flows to safely "flow through" the rockfill without causing dam failure. This is possible because of the high horizontal permeability of rockfill and the fact that extremely high seepage velocities are required to erode or move large size rocks.

Varying Rock Quality

The bedrock forming the abutments and valley section beneath Black Rock Dam consist of interbedded and folded volcanic and sedimentary rocks of the Columbia River Basalt Group. In essence, these are a series of basalt flows that were extruded and flowed over the Columbia Basin between 18 and 6 million years ago. Individual flows were up to 100 feet thick, and the time periods between sequential flows was from hundreds to tens of thousands of years, which allowed for sediment deposition between basalt flows. As a result, the bedrock stratigraphy consists of a number of different basalt flows with sedimentary interbeds separating some of these flows. In addition, due to the nature of the flow deposition, the basalts may contain sediments that are "rafted" within the basalt or contain "pillow" structures that also contain pods of fine sediment and fractured basalt. It is not unusual to see "interflow zones" of higher permeability at the top or bottom of flows due to shearing and intermixing during deposition or resulting from differences in cooling of the flows.

As the bedrock surface is excavated during construction, it would be expected that rock quality could vary significantly as different areas of one flow or different flows are uncovered. This is by no means a significant detriment for an embankment foundation, but does mean some flexibility will be needed during construction to ensure a suitable foundation is reached. Considerable onsite geologic and geotechnical presence will thus be needed to determine the adequacy of the bedrock and the degree of foundation treatment measures such as additional excavation, slush grouting, and filter placement.

In addition, the varying bedrock composition and quality will require additional investigations during advanced design phases to better understand the bedrock properties and permeability (fracture density, openness, infilling characteristics, etc.), to develop a foundation grouting program, to explore foundation conditions, and to potentially reduce bedrock seepage.

Thick Overburden Deposit of Varying Composition

Geologic explorations by both WIS and Reclamation have confirmed the presence of a thick deposit of overburden overlying the basalt bedrock. Drill holes have indicated that the overburden in the Black Rock Valley is deeper than 200 feet near the base of the right abutment, and may average more than 100 feet deep across the right center portion of the valley. Although the overburden includes some surficial loess (wind-blown silt), colluvium, and recent alluvium, the large majority appears to consist of the Ringold Formation. Based on the limited explorations, the Ringold appears to be a highly variable deposit, consisting mainly of basalt gravels and cobbles in a sand with fines matrix, but also including significant layers of fluvial sand, silt, and clay. These varying materials have been described as poorly to well-consolidated, and poorly- to semi-indurated.

An obvious design consideration with this type of overburden is determining how much to remove beneath the dam. On one hand, a reasonable but perhaps conservative approach would be to remove all of the overburden down to bedrock beneath the entire footprint of the dam. Given the significant height of the proposed Black Rock Dam, the relatively steep slopes of the embankment, and the high seismicity of the site, this option would certainly be defendable. On the other hand, portions of the Ringold, particularly the deeper layers, are described in the drill logs as a dense, indurated deposit of gravels and cobbles. This type of material would be expected to be a firm and non-liquefiable foundation capable of supporting a large dam, although some type of cutoff to bedrock may be needed to minimize and protect against seepage. During advanced design phases, additional characterization of the Ringold Formation will be important in helping to determine the optimum definition (a blend of technical and economic considerations) of the amount of Ringold to remove beneath Black Rock Dam.

<u>Construction Material Availability</u>

A key consideration for the design of any embankment dam is utilization of available materials. The nature and availability of construction materials is important for both technical and economic reasons. For a dam the size of the proposed Black Rock Dam, it will be important to secure high quality materials for the key zones in the embankment. If such materials are located reasonably nearby, that is a large economic advantage since the costs of hauling large volumes of materials can be huge. In addition, since potentially large volumes of materials will be generated from excavation of much, if not all, of the foundation overburden, an ideal embankment design would include the use of those materials in a non-critical zone as opposed to wasting them.

<u>Large Dam Height</u>

Inherent in some of the above considerations, but worth emphasizing separately, is that the proposed Black Rock Dam will be a very high embankment, approaching 800 feet in structural height. Although well within the precedents set in terms of high embankments, this dam will nonetheless deserve special attention due to its height and the large hydraulic head behind it. Large site investigation and materials testing programs will be needed to ensure the site conditions are well understood. Detailed analyses will be critical to ensure a safe design is developed. In addition to these measures, such a design would need to be independently reviewed by an expert board of consultants.

<u>Type of Embankment Dam</u>

Given the design considerations listed above, an initial step in the design process is to select the appropriate type or types of embankment dam to consider for this damsite. A rockfill dam is an obvious choice for the Black Rock site, and better suited than a zoned earthfill embankment for several reasons. First of all, there is a relative lack of impervious soils or even unconsolidated pervious soils at the damsite. The only immediately available impervious soil is the relatively thin loessial layer that blankets much of the site, particularly the higher areas. Much of the foundation overburden consists of the Ringold Formation, which is several million years old, somewhat variable in material composition (clays, siltstones, and conglomerates to name a few), and often cemented. Extensive development of the Ringold as a borrow source would likely lead to a wide range of material properties and differing degrees of difficulty of excavation. Basalt, however, is present throughout the dam and reservoir area, with relatively little soil cover on the abutment and reservoir rims. The basalt, through quarrying, provides an unlimited source of rockfill.

Secondly, the proposed damsite is in an area of relatively high seismicity. Based on the PSHA (Appendix B), the expected 10,000-year ground motion at the site is 0.95g. Furthermore, there is some potential that displacements could occur on faults that pass beneath the dam alignment. Such high ground motions and the potential for fault movement require a dam type that is seismically stable even under very large loadings. Rockfill dams are recognized to be one of the best dams under these conditions, primarily because their design affords a large downstream portion that remains unsaturated and strong, and yet provides permeability to let seepage pass through in the event that the impervious element of the dam is cracked or similarly damaged. Later paragraphs will describe two different rockfill embankments that appear best suited to the Black Rock site – a concrete face rockfill dam and a central core rockfill dam.

Axis Location

Two potential alignments were explored during this assessment study. The original, or farthest east (downstream) alignment, was initially proposed and explored by WIS, while an alternate alignment located further west (upstream) was investigated by Reclamation. The original alignment was found to have the shortest crest length, although explorations encountered thick (greater than 200 feet) deposits of overburden toward the south abutment. Subsequent explorations on the alternate alignment revealed that the overburden was at least as deep at the upstream axis. A determination of above ground embankment quantities showed that the alternate alignment resulted in about 10 percent fewer cubic yards, even though the crest length was longer and the dam higher (to get an equivalent reservoir storage). This appears to be because the original ground surface rises as one heads upstream. However, when evaluating the amount of below ground excavation required at both alignments, the longer axis at the alternate site resulted in significantly more excavation than the original site. When looking at total embankment quantities (all above and below ground fill materials), the alternate axis was estimated to have about 10 million more cubic yards than the original axis.

Since there were no obvious technical advantages (such as improved rock quality, better outlet works location, etc.), the large difference in embankment volumes, and resulting large cost increase, made it a relatively straightforward determination to select the original WIS site as Reclamation's preferred alignment.

Once the optimum axis was selected and the general type of embankment (rockfill dam) chosen, the next step was to further develop the two types of rockfill dams deemed most suitable to the Black Rock site. As mentioned earlier, these two alternatives are a concrete face rockfill dam and a central core rockfill dam. Both of these will be discussed in more detail in the following paragraphs. A plan view and typical sections of both alternatives are presented in Figures 43 and 44.

Concrete Face Rockfill Dam

General Design Concepts

One of the main advantages of a concrete face rockfill dam over any other type of embankment dam is that it does not contain a soil core vulnerable to erosion under a concentrated leak. The impervious element for this dam type is the upstream reinforced concrete face, which is not susceptible to erosion. This concrete face is tied into the rock foundation with a concrete plinth that acts as a thrust block or footing for the concrete face. Immediately downstream of the reinforced concrete face is a zone of sand and gravel with fines, which serves not only as a firm foundation for the concrete face slab, but also a key feature of the design. In the event of any leaks through the concrete face, a properly designed zone 2 forms a semi-pervious barrier that significantly increases head losses and thus reduces the amount of seepage. Thus, in the event of damage to the concrete face, whether from a failed waterstop or cracking induced by some type of differential settlement, seismic shaking or fault displacement, the zone 2 serves as an additional barrier to retard seepage.

A pervious transition, zone 3, is placed immediately downstream of the zone 2 and designed to be filter compatible with both the zone 2 and the downstream rockfill. In this way, should excessive flows occur through concentrated leaks, the zone 3 ensures that the zone 2 cannot erode and also provides sufficient drainage capability to handle seepage flows and allow them to pass into and through the large downstream rockfill section of the dam.

The rockfill zones are typically constructed in 3-foot thick lifts, and compacted with large vibratory rollers. The practice of spreading 3-foot lifts and then applying compaction tends to create a layer with larger rock at the bottom and an accumulation of fines at the top. Because of these stratified rockfill layers, it is widely accepted that the downstream rockfill will have high horizontal permeability and be able to drain off large leakage flows safely. This advantage is sometimes referred to as "flow-through capability of rockfill." A more detailed description of the various embankment zones, including expected material descriptions and construction procedures, are included in a later paragraph entitled "Embankment Zoning."

Crest Elevation

For all dam types being considered for the large reservoir size, the top of normal water surface (top of active conservation) is set at elevation 1775 to store 1.3 million acre-feet. The maximum reservoir water surface, assuming full storage of the Probable Maximum Flood above the normal water surface, corresponds to elevation 1778.

Freeboard heights were established using general rules, as well as checking with quick analyses. Because of the long reservoir and potential for high winds in the Black Rock Valley, wave runup will be a consideration at this site, as the combination of long fetch and high winds could create significant waves on the reservoir surface. The large reservoir option has a total reservoir length on the order of 10 miles, and it appears that wind gusts approaching 100 miles/hr are possible. A quick calculation of potential wave heights and runup confirmed that large waves would be possible. According to general guidance given in the Design of Small Dams [12], wave heights could be over 6 feet, and the suggested normal freeboard is 10 feet (about 1-1/2 times the wave height) for a typical dam with a riprap upstream slope. However, a different freeboard is required for a concrete face rockfill dam than for a rockfill dam with a rock upstream face. That is because the rougher surface of a rock face is much more effective than smooth concrete in dissipating wave runup. Design of Small Dams recommends providing 50 percent more freeboard if a smooth pavement is used on the upstream face. Consequently, the crest elevation for the concrete face rockfill dam will be 1790, providing a normal freeboard of 15 feet (as opposed to 10 feet for the earth core rockfill).

A quick check of expected deformations in the event of large ground motions possible at Black Rock Dam suggests that potential crest deformations would be only a few feet or less. Based on the seismic stability of a well constructed rockfill dam, extra freeboard in case of major embankment deformations does not appear to be required.

A general philosophy underlying the assignment of a 15-foot freeboard value is the belief that Black Rock Dam would not operate at full normal reservoir level very frequently. A full reservoir would likely require optimum conditions, not just in a particular water year but probably for a number of consecutive years. Thus, the average reservoir level in any given year will probably be below, and possibly well below, the top of active conservation level. Thus, the chances of a very large earthquake or flood occurring at the same time the reservoir is completely full is not judged to be very likely. What this means is that normally the freeboard will be greater than 15 feet.

Embankment Slopes

The crest width of Black Rock Dam will be 40 feet. Although wider than most dams, this width judged reasonable given the height of the dam and the high level of seismicity in the area. At this level of design, both the upstream and downstream slopes will be set at 1.5:1 (H:V). These are certainly not steep slopes for a concrete face rockfill dam, as some dams of this type have been built with 1.3:1 slopes, and a significant number have 1.4:1 slopes. However, considering the tall height, the high seismicity, and potential questionable areas of rock quality, these slopes appear justified. As the design progresses into future phases and more analysis is performed, steeper slopes and thus less material may be possible.

Thickness of Concrete Face

Recent design practice has been to have the concrete face thickness equal to around 1 foot (or slightly less) for dams less than 300 feet high, and for higher dams adding an incremental 0.002(H) thickness, where H is the total height of the dam. This means that the face slab will be 1 foot thick at the top of the dam and then gradually thicken at a constant rate of 0.2-foot for every 100 feet in dam height. Thus, at the deepest portion of the potential Black Rock Dam, the concrete face will be over 2 feet thick at the base of the dam.

Plinth Dimensions

The width (upstream to downstream) of the plinth is typically around 1/20 to 1/25 the height of the dam on hard rock foundations. Where rock quality is more suspect, plinth widths have been as wide as 1/10 the dam height. Since Black Rock Dam will have varying areas of rock quality, it is envisioned that the plinth width will vary in various portions of the foundation. For the purposes of an appraisal-level design and cost estimate, the plinth width will be designed to be approximately equal to 1/15 of the dam height. In areas of good rock and low dam height, the minimum width of the plinth will be set at 10 feet.

The thickness of the plinth is generally on the order of 1 to 1.5 feet, but in some cases reaches the thickness of the concrete face. At Black Rock Dam, it is envisioned that most areas of the plinth will range from 1 to 2 feet thick. For estimating purposes, the average thickness will be assumed to 1.5 feet.

Embankment Zoning

Since the concrete face serves as the impermeable membrane or water barrier of this dam type, the rest of the embankment consists primarily of rockfill. However, there are a couple of key zones immediately adjacent to the concrete face, as well as several zones comprised of materials from required excavation. These zones are shown on Figure 43 and discussed below.

Zone 1: This zone is comprised of any loessial materials that are excavated from the footprint of the dam. These fine-grained soils will be limited in extent, as they are believed to form a relatively thin (3 feet or less) mantle over much of the valley. These materials are to be separately stockpiled during excavation, and then placed along the toe of the concrete face as shown on Figure 43. As such, these materials may serve to fill in any crack in the concrete face should a significant fault offset occur during the life of the dam. These materials would be placed in 6-inch lifts and compacted by tamping rollers.

Zone 2: This is a processed, well graded sand and gravel zone, with fines, that serves a couple of key purposes. When compacted, this type of material serves as an excellent sub base for the concrete face. However, due to its well graded nature and fines content, it is not particularly permeable and serves to a certain extent as a second water barrier. In the event of cracks in the concrete face and resulting seepage passing through the face, this type of material should result in significant head losses. Typically, this material has a maximum particle size of 3 inches, and contains 45 to 65 percent gravel, 35 to 45 percent sand, and 2 to 12 percent fines. It is compacted by vibratory rollers. A secondary use of zone 2 material may be as a filter that is placed on areas of the bedrock foundation that are extensively weathered or perhaps fractured. As a filter, it would prevent piping of altered rock or underlying soil interbeds within the basalt.

Zone 3: This is a processed clean gravel and cobble zone, placed immediately downstream of the zone 2. It serves as a transition zone between the zone 2 and the rockfill, and also as a drainage element to control any flows that pass through the concrete face and zone 2. This zone will also be compacted by vibratory rollers. As with the zone 2, it may also be used as a foundation filter/drain in areas of questionable rock quality.

Zone 4: This is the basalt rockfill that forms the mass of the dam. It is envisioned to be quarried from the reservoir rims. Maximum size of the rock will be 3 feet. This rockfill will be placed in 3-foot lifts and compacted by large vibratory rollers, with moisture added as necessary.

Zone 5: This is a random fill zone comprised of the coarse-grained materials excavated from beneath the dam footprint. It will largely consist of Ringold sands, gravels, and cobbles. Because the properties and quality of these materials are expected to vary, this zone is embedded within the downstream portion of the rockfill, where it would have relatively the least impact on dam performance. These materials will be placed in approximate 2-foot layers and compacted to a dense state by large vibratory rollers. To achieve drainage through this layer (in the unlikely case drainage is required), periodic layers of zone 4 will be placed to ensure horizontal permeability.

Zone 6: This is a second random fill material comprised of the fine-grained materials excavated from beneath the dam. It is expected to consist mostly of lacustrine silt and clay layers within the Ringold Formation. This zone, in conjunction with zone 5, will comprise a portion of the downstream embankment, as well as serve as a relatively impermeable fill upstream of toe of the dam (refilling the excavation upstream from the concrete face and plinth. These materials will be placed in about 9-inch lifts and compacted to a dense state by tamping rollers.

Foundation Treatment

Because the concrete face and plinth are the key components comprising the water barrier of the concrete face rockfill dam, that is where the foundation treatment will be concentrated. Foundation treatment beneath the remainder of a rockfill dam is much less important, except in areas of highly weathered rock or fault zones where seepage/piping or displacement concerns exist. That type of special foundation treatment is discussed in a later section entitled "Additional Foundation Treatment for Embankment Dams". The amount of foundation treatment required in the upstream toe area will depend in large part on the quality of rock encountered. As discussed earlier, the width (as well as the depth) of the plinth will be adjusted as needed to accommodate rock quality, with a wider and perhaps deeper plinth in areas of poorer rock quality. In all areas, however, a minimum amount of treatment will be a combination of blanket (consolidation) and curtain grouting. Given the presence of fracturing in the basalts and areas of poor rock quality, extensive grouting is envisioned in certain areas. For this appraisal estimate, blanket grouting has been assumed for 30-foot depths and 7.5-foot centers throughout the plinth area. In addition, a multiple row grout curtain is envisioned, with depths ranging from 60 to 450 feet on 10-foot centers. For cost estimating purposes, a two-row curtain has been assumed and the average grout take for the entire grouting operation is assumed to be 2 sacks of cement per lineal foot of drill hole.

Central Core Rockfill Dam

General Design Concepts

One advantage of a rockfill dam with an earth core instead of a concrete face is that less damage may result in the event of fault offset within the dam footprint. Any type of fault offset would likely cause an area of extensive cracking in the concrete face. Although the rockfill dam would not be expected to fail, the reservoir may have to be drained after such an event and the concrete deck repaired. An earth core, by virtue of being more plastic or deformable, would be able to withstand fault offsets with a lesser degree of cracking. Furthermore, if the core contains appreciable clay, some healing of the cracks would be expected to occur. There is a distinct possibility that major repairs may not be required after a fault offset, or if repairs were required, they might include measures such as grouting, which would not entail draining the reservoir.

Whereas the concrete face rockfill dam relies on the concrete face as the water barrier, the barrier with this second alternative consists of an earth core comprised of relatively impermeable soils. An upstream sloping and relatively thin earth core was chosen for several reasons. The primary reason is that inclining the core upstream ensures that a large portion of the dam (the massive downstream zone) will consist of a strong, unsaturated rockfill, affording much static and dynamic stability. Secondly, the relative lack of impervious material available in the immediate area makes the core relatively expensive. Keeping this zone relatively thin is a means of minimizing costs to some extent. Additional cost savings are realized in a need for less foundation treatment, as the large zone of downstream rockfill needs far less foundation treatment than what is required beneath an impervious zone. Finally, inclining the core should help reduce the potential for the core to crack due to differing settlement properties of the rockfill and impervious material.

Immediately downstream of the earth core is a zone 2 filter zone, consisting of clean sand and gravel designed to be filter compatible with the zone 1 core thus preventing erosion of the core materials in the event of a crack. Downstream of the zone 2 filter is a clean gravel and cobble drainage zone to safely control and convey any seepage resulting from cracks in the core. The majority of the central core dam would be rockfill, as described above for the concrete face dam option. A more detailed description of the various embankment zones, including expected material descriptions and properties and construction procedures, are included in a later paragraph entitled "Embankment Zoning."

Crest Elevation

The selection of required freeboard has been described above under the concrete face rockfill dam alternative. To briefly repeat, for the large reservoir size, the top of normal water surface (top of active conservation) is set at elevation 1775 and the maximum reservoir water surface resulting from storage of the Probable Maximum Flood corresponds to elevation 1778. Because of the large fetch and potential for high winds, general guidance suggests a normal freeboard of 10 feet for an embankment dam with a rock face. Therefore, the crest elevation for the central core rockfill dam will be 1785 (five feet lower than for the concrete face dam), providing a freeboard of 10 feet.

Embankment Slopes

The crest width of a central core rockfill dam will be 40 feet, same as described for the concrete face rockfill alternative. Also similar to the concrete face dam, the downstream slope will be set at 1.5:1 (H:V). For the same reasons described for the concrete face alternative, this slope is judged reasonable, but may be able to be steepened during later designs. The upstream slope of the central core rockfill dam will be 1.75:1, slightly flatter than the concrete face dam. The flatter slope is to ensure stability of the upstream sloping central core.

Embankment Zoning

Although several of the zones in this rockfill dam are similar to the zones in the concrete face rockfill dam, there are some differences. The zones for the central core rockfill dam are shown on Figure 44 and discussed below.

Zone 1: This zone is significantly different from the zone 1 in the concrete face alternative (which was basically a random zone used at the upstream toe). For this central core rockfill dam, the zone 1 serves as the core, or water barrier, for the dam. As such, it is a critical zone and must be comprised of good materials. The ideal core material would be a clayey gravel, although a lean clay or silty gravel would also serve well. Because of the lack of such materials at the damsite, it is envisioned that these materials will need to be borrowed offsite. The zone 1 materials will be placed in 6-inch lifts and compacted to a dense state by tamping rollers. The moisture content of these soils will be carefully controlled to ensure that optimum properties for the core are achieved.

Zone 2: This is a processed, clean sand and gravel zone that serves as a critical filter for the zone 1 core. Although fairly similar to the zone 2 for the concrete face rockfill dam, this zone 2 will have a very low fines content. Because the zone serves as a filter, it is important that the material is as cohesionless as possible. This means that fines will be minimized, plastic fines not permitted, and any materials that display even a slight tendency toward cementation will be rejected. Zone 2 materials will be compacted by vibratory rollers. A secondary use of zone 2 material may be as a filter that is placed on areas of the bedrock foundation that may be extensively weathered or perhaps fractured. As a filter, it would prevent piping of altered rock or underlying soil interbeds within the basalt into the coarse rockfill.

Zone 3: This is a processed clean gravel and cobble zone, placed immediately downstream of the zone 2. It will be nearly identical to the zone 3 in the concrete face rockfill dam alternative. It serves as a transition zone between the zone 2 and the rockfill, and also as a drainage element to control any flows that pass through the concrete face and zone 2. This zone will also be compacted by vibratory rollers. As with the zone 2, it may also be used as a foundation filter/drain in areas of questionable rock quality.

Zone 4: This is the basalt rockfill that forms the mass of the dam. It is the same as described above for the concrete face rockfill alternative.

Zone 5: This is a random fill zone comprised of the coarse-grained materials excavated from beneath the dam. It is the same as described above for the concrete face rockfill alternative.

Zone 6: This is a second random fill material comprised of the fine-grained materials excavated from beneath the dam. It is the same as described above for the concrete face rockfill alternative.

Foundation Treatment

For the central core rockfill dam, foundation treatment measures will be concentrated beneath the zone 1 core of the dam (the water barrier). As described for the concrete face alternative, foundation treatment beneath the remainder of a rockfill dam is much less important, except in areas of highly weathered rock or fault zones where seepage/piping or displacement concerns exist. The amount of foundation treatment required beneath the core will depend in large part on the quality of rock encountered. To minimize the potential for stress concentrations and differential cracking, rock excavation and dental concrete will be used to shape the bedrock surface so as to minimize abrupt changes, overhangs, etc. In addition, slush grouting may be needed in areas where the rock is highly fractured or jointed and poses a risk of the zone 1 piping into such discontinuities. As with the concrete face alternative, a combination of blanket (consolidation) and curtain grouting will be utilized to improve rock strength and create a low permeability zone beneath the core. Given the presence of fracturing in the basalts and areas of poor rock quality, extensive grouting is envisioned in certain areas. For this Assessment, blanket grouting has been assumed for 30-foot depths and 10-foot centers over the entire footprint of the zone 1 core. In addition, a multiple row grout curtain is envisioned, with depths ranging from 60 to 450 feet on 10-foot centers. For cost estimating purposes, a two-row curtain has been assumed, and the average grout take for the entire grouting operation is assumed to be 2 sacks of cement per lineal foot of drill hole.

Additional Foundation Treatment for Embankment Dams

The previous discussions of the two rockfill alternatives have described anticipated foundation treatment measures beneath the impervious barriers. This section will describe additional foundation treatment measures applicable to both dams.

Overburden Excavation

As discussed under "Design Considerations," it is difficult to determine at this level of design the amount of Ringold Formation to be removed. For this assessment study, two variations were developed, and the "average" excavation used in the cost estimate. The first option involved complete excavation to bedrock beneath the entire footprint of both rockfill dam alternatives. This will positively reduce all uncertainties of foundation liquefaction, and would also help support the use of steeper rockfill slopes in later designs. This option is shown on Figures 43 and 44 as "Complete Excavation to Bedrock."

A second option is to excavate all of the overburden to bedrock beneath the upstream portions of both rockfill dam alternatives. This will ensure that the plinth and zone 1 core are founded on competent bedrock, and that foundation treatment and grouting can be effectively accomplished. In addition, for the concrete face alternative, it would serve to minimize the potential for settlement of overburden that may cause cracking of the concrete face slab. For most of the downstream portion of both rockfill alternatives, the foundation excavation would be taken down to competent Ringold materials, envisioned to be the compact and sometimes indurated gravels and cobbles indicated at depth in the drill logs. By removing the finer grained lacustrine deposits in the upper portions of the Ringold, this would minimize foundation settlements and the possibility of liquefaction of silt or sand layers. This option is shown on Figures 43 and 44 as "Excavation to Competent Ringold." Either of these options may prove to be the best choice once additional information is learned about the properties of the Ringold. Since either option appears defendable at this stage, the cost estimates were based on the average of a total excavation of overburden and excavation to competent Ringold.

Localized Overexcavation of Rock

Due to the dipping nature of the basalt flows resulting from the folding in the Black Rock Valley, several different basalt flows, as well as sedimentary interbeds, will be encountered during foundation excavation. The quality of rock at the contacts of these various flows is expected to be poor, and localized overexcavation to remove poor quality rock is anticipated. In addition, there will likely be some areas where only a thin veneer of basalt exists over an interbed. An example of this occurs in WIS drill hole DH-3 in the upper left abutment, where only about 22 feet of basalt overlies 33 feet of a silty clay interbed zone. In a case like this, depending on the height of the overlying embankment, it may be prudent to remove both the thin veneer of basalt and the interbed zone to found the embankment on a thicker and more competent basalt unit. This would minimize settlement, seepage, and potentially even liquefaction concerns.

Right Abutment Fault Treatment

There is insufficient information at this stage to positively confirm the presence and particularly the nature of the apparent fault beneath the right abutment. Such a fault zone could consist of a thick clayey gouge zone or perhaps a wide area of extensive shearing of rock units. A clayey fault zone might be fairly impermeable but might still be vulnerable to piping considering the high hydraulic heads due to this large dam. A highly fractured zone would raise issues of extensive seepage at the base of the right abutment. A combination of clay and fracturing might raise a concern about the clay piping into the fractured rock. Either clayey or fractured materials may not provide an ideal foundation for a plinth or even a clay core.
The types of treatment considered for any fault zone uncovered will depend on the nature of the material exposed. Soft materials will require additional excavation to ensure that the plinth or core can be founded on a relatively firm foundation. Fractured rock will likely require an increased amount of blanket and curtain grouting beneath the plinth or zone 1 core. In addition, a highly permeable fault zone may require the placement of impermeable soil materials upstream of the water barrier which would serve as an upstream blanket to reduce seepage and increase head losses. Downstream of the plinth or zone 1 core, such a pervious zone would likely be covered by a two-stage zone 2 and zone 3 filter/drain to minimize the potential for piping of any deteriorated rock or embankment materials into the rockfill shells. A very deep fault zone may even require some type of cutoff such as a secant pile wall to depth.

Miscellaneous Bedrock Treatment

Special foundation treatment downstream (and perhaps upstream) of the plinth or the zone 1 core will be required in areas of particularly poor rock quality, which may include highly fractured rock, highly weathered or altered rock, or areas of faulting. In such locations, filters may need to be placed downstream of the plinth or core for a distance of about one-quarter of the water head. (If severe fracturing was encountered, perhaps a lean concrete or shotcrete blanket would first be placed on the foundation before filter placement.) The filters would consist of two stages, similar to zone 2 and zone 3 used behind the concrete face and zone 1 core. This method is envisioned to prevent any potential piping of poor foundation materials (particular fault gouge or weathered rock) into the coarse rockfill embankment. Potential upstream treatment in areas of faulting or highly fractured rock might be to locally increase the width of the plinth or core, perform additional grouting, or even place an impervious blanket for a distance upstream of the plinth or core.

Small Embankment Dams

Design Considerations

The same design considerations that were discussed for the larger dam alternatives also apply to the smaller dam alternatives.

Concept Description

The dams impounding the small reservoir are still very large embankments and the previous discussions of the large reservoir options also apply to the small dams. For all dam types being considered for the small reservoir size, the top of normal water surface (top of active conservation) is set at elevation 1707.0 to store 800,000 acre-feet. The maximum reservoir water surface, assuming full storage of the Probable Maximum Flood above the normal water surface, corresponds to elevation 1712.0. The only difference between the large and small dams is their crest elevation. A comparison of the large and small embankment dams is shown in Table 14 below.

Table 14. Comparison of Large and Small Embankment Dams

Alternative	**Crest Elevation (feet)**	**Crest Length (feet)**	**Dam Height* (feet)**
Concrete Face Rockfill – Large Reservoir	1790	6,615	760
Concrete Face Rockfill – Small Reservoir	1722	6,255	692
Central Core Rockfill – Large Reservoir	1785	6,590	755
Central Core Rockfill – Small Reservoir	1717	6,220	687

*Note: Dam height is the maximum structural height (from crest of dam to bottom of foundation excavation)

A plan view and typical sections of both small dam alternatives are presented in Figures 45 (concrete face rockfill dam) and 46 (central core rockfill dam).

Large Roller Compacted Concrete (RCC) Dam

Design Considerations

Roller Compacted Concrete (RCC) is a no-slump concrete that is placed by earth-moving equipment and compacted by vibrating rollers in horizontal lifts up to 12 inches thick. The materials used for RCC are the same as those used for conventional mass concrete and include water, cementitious materials (cement and pozzolan), admixtures, and fine and coarse aggregate. RCC was selected for the concrete dam alternative instead of mass concrete because it is more economical for wide canyons. The upstream and downstream faces of the dam would be slip-formed conventional concrete that would serve as forms for the RCC placement. Crack inducers and waterstops would be placed to form contraction joints. The dam would have a drainage gallery, and formed drains would be drilled from the top of the dam to the gallery located near the upstream face to intercept leakage through the lift lines.

Concept Description

The dam crest elevation was established to contain the maximum reservoir resulting from storing the PMF with six feet of freeboard to the top of the parapets. This set the top of dam at elevation 1781.0 and top of parapets at elevation 1784.0. The crest width would be 20 feet, which is typical for RCC gravity dams, and the downstream slope would be 0.75:1 starting at the downstream edge of the crest. A cursory stability analysis run to validate that the downstream slope of 0.75:1 provided sufficient weight for stability identified that internal drains would be important for stability. Bonding mortar at each lift line was included in the estimate based on the large surface area and assuming that the preferred “8 hour cure time” between lifts would likely not be met. A plan view and typical sections of the large RCC dam alternative are presented in Figures 47 and 48.

Contraction joints were located at 50 foot spacing and waterstops were incorporated into the upstream face of the dam at all joints. Galleries were located near original ground to provide drainage by gravity flow. The formed drains into the galleries were assumed to be spaced at 10-foot centers.

A cement content of 275 lbs/yd^3 with 40 percent fly ash and 60 percent cement was selected for the RCC mix. Aggregate was assumed to be hauled from either the Columbia River or Yakima River area due to the anticipated high cost of on-site processing of the Ringold Formation. An RCC test section was assumed to be constructed which would later be used as a thrust block for the outlet works.

Foundation Treatment

The RCC dam requires a competent rock foundation under the entire footprint of the dam. Foundation excavation was assumed to the top of competent rock based on available geologic data which results in 200 feet of excavation towards the right abutment. It was assumed that 10 feet of rock would need to be removed from the overall footprint to reach competent material.

Foundation drainage and grouting was patterned in accordance with standard Reclamation criteria. Adits were assumed into the right abutment for grouting and drainage of the shear zone and foundation grout takes was assumed to be 2 sacks of cement per lineal foot of drill hole.

Small Roller Compacted Concrete (RCC) Dam

The small RCC dam is still a very large dam and previous discussions of the large reservoir option also apply to the small reservoir option. The only difference is the top of dam will be set at elevation 1715.0 and top of parapets at elevation 1718.0. A comparison of the large and small RCC dams is shown in Table 15 below. A plan view and typical sections of the small RCC dam alternative are presented in Figures 49 and 50.

Table 15. Comparison of Large and Small RCC Dams

Alternative	**Top of Dam Elevation (feet)**	**Crest Length (feet)**	**Dam Height* (feet)**
Large Reservoir	1781	6,695	751
Small Reservoir	1715	6,200	685

*Note: Dam height is the maximum structural height (from top of dam to bottom of foundation excavation)

Spillway

During the technical site review (Appendix A), the project team viewed the WIS proposed saddle dam/spillway location on the south side of the reservoir. Although the saddle dam/spillway location appeared feasible, there was concern that significant channel improvements including modification or replacement of an existing bridge on State Highway 241 would be required to safely carry any spillway discharge to Dry Creek. There is also some concern about the environmental impacts of channeling discharges from Black Rock Reservoir into Dry Creek that would eventually find their way to the Yakima River. Because of these concerns, Reclamation investigated the possibility of storing the Probable Maximum Flood (PMF) in the reservoir instead of constructing appurtenant structures to handle the flood. The fact that this is an offstream storage reservoir with a large surface area, led to the decision to raise the dams to store the PMF volumes identified in the Hydrologic Hazard section of this report (Appendix C), thus eliminating the need for a spillway. For the large dam, the increase in height for storage of the winter PMF in the reservoir was 3 feet. For the small dam, the increase in height for storage of the winter PMF was 5 feet.

Low Level Outlet Works

The low level outlet works is a dam safety feature that will evacuate the reservoir in the event of an emergency, spilling flows into the normally dry Dry Creek. The outlet works were sized to meet Reclamation's reservoir evacuation criteria outlined in ACER Technical Memorandum No. 3 [13]. Trashracks were provided at the river outlet works intakes; however, fish screens were not provided since this outlet would be used infrequently for emergency evacuation only. No separate detailed designs were prepared for the outlet works for the small reservoir, but rather, quantities were reviewed and a judgment made that costs for the small reservoir outlet works options would be about 95 percent of the costs of the outlet works for the large reservoir options.

Outlet Works for Embankment Dams

The outlet works for the embankment dams was located on the left (north) abutment as opposed to the right (south) abutment because the right abutment has what is perceived to be a significant shear zone. The right abutment would result in a shorter distance, however tunneling through this material was considered too risky without additional data. Concrete thicknesses for the conduits were based on other Reclamation projects with features of similar sizes. The upstream conduit was steel-lined due to extreme pressures and potentially weak geology (fractured rock). Steel pipe thicknesses were sized to handle full reservoir pressures. The downstream steel pipe was assumed to be buried for support in lieu of using concrete or steel structural support. An emergency fixed-wheel gate housed in a gate chamber at the bottom of a vertical shaft was selected to reduce the length of the pressure pipe through the dam. See Figures 51 and 52 for plans and sections of the proposed low level outlet works for the large and small embankment dams respectively.

The outlet works discharge is controlled by two 108-inch diameter jet flow gates. These gates were chosen and sized based on velocities which could be safely tolerated without special fabrication requirements. In consideration of the anticipated limited use of the outlet works, a plunge pool stilling basin, lined with impervious material and riprap, was selected in lieu of a conventional concrete stilling basin to reduce costs. The basin size was estimated using equations currently being developed via a research project with Reclamation’s Water Resources Research Laboratories. Large concrete thrust blocks are required and were sized with a factor of safety of 2.0 to handle anticipated thrust loads at the pipe bends.

Outlet Works for RCC Dam

The intake for the outlet works for the RCC dam alternative was located on the upstream face of the dam near its right abutment. Because the outlet works would be constructed within the dam structure itself, it was located near the right abutment to reduce its length. The outlet works intake structure would have trashracks and an emergency fixed-wheel gate. The downstream steel pipe was assumed to be buried for support in lieu of using concrete or steel structural support. The outlet works discharge is controlled by two, 108-inch-diameter jet flow gates. In consideration of the anticipated limited use of the outlet works, a plunge pool stilling basin, lined with impervious material and riprap, was selected in lieu of a conventional concrete stilling basin to reduce costs. Large concrete thrust blocks are required and were sized using a safety factor of 2.0 to handle anticipated thrust loads at the pipe bends. See Figures 48 and 50 for plans and sections of the proposed low level outlet works for the large and small RCC dams respectively.

Highway and Utility Relocations

The proposed Black Rock Reservoir will inundate up to 13.5 square miles of Black Rock Valley including State Highway 24 (SH24), a buried fiber optic line along SH24, and two overhead 115-kV lines on H-frame type wood-pole supports. For this Assessment, SH24 was assumed to be relocated from the valley floor and the transmission lines removed and routed along the new SH24 alignment. The existing buried fiber optic line would be abandoned in place and a new line would be run along the new SH24 alignment.

Design Considerations

The WIS Final Report [2] relocated SH24 to the south of the reservoir in the Rattlesnake Hills and indicated that residents of Black Rock Valley would prefer a northern relocation. For this study, Reclamation also relocated SH24 to the south of the reservoir because topography on the north side of the reservoir is not conducive for this road relocation. A north side valley alignment would require several bridges to span over existing draws or the road would need to be constructed on land currently within the Yakima Firing Center Military Reservation. The bridges would add significant cost to the road relocation and construction on the firing center raises security concerns and the possibility of encountering unexploded ordinance during construction.

Concept Description

The selected alignment for the relocated SH24 is similar to the alignment in the study by WIS [2], however, since the aerial topography provided for this study is more detailed than the USGS topographic maps that were used by WIS, a more refined horizontal alignment and vertical profile were defined. The alignment was adjusted in order to avoid some of the difficult terrain encountered and to improve the crossing over Rattlesnake Hills. In addition, the alignment was straightened and larger horizontal curves were included in order to accommodate a 50-70 mph speed limit. Also, the vertical profile was adjusted in order to follow the existing terrain and to better balance cut and fill volumes. Even with these modifications, large cut and fill areas were encountered along the proposed alignment which significantly affected the estimated cost of this road relocation.

The selected alignment consists of approximately 11.8 miles of relocated highway. See Figures 53 and 54. The road cross-section is typically 40-feet wide with two 12-foot lanes and 8-foot wide shoulders on each side, and consists of a 9-inch base course and 6 inches of asphalt concrete surfacing. Guardrail is provided on either side of the road when the height of embankment exceeds 10-feet. The width of the road is increased by at least 4 feet when guardrail is provided. Therefore, when guardrail is provided on both sides the road width is increased to 48 feet minimum. The horizontal alignment has a minimum road centerline radius of 4,000 feet, and the vertical alignment uses a maximum grade of 7 percent. The fill and cut slopes vary from 6:1 to 2:1 depending on the height of the cut or fill. The design speed is 70 mph for level terrain, and 50 mph for mountainous terrain.

Construction Considerations

Foundation treatment: The potential for varying rock quality and faults within the foundation for Black Rock Dam will necessitate a flexible working relationship with the contractor. Additional excavation will be required in some areas while additional treatment measures such as dental concrete, slush grouting, and filter blankets, will be required in other areas. These locations can not be identified on design drawings and will need to be determined during construction.

Depth of Ringold excavation: If the final design founds part of the dam on competent Ringold Formation, the field staff and designers will need to carefully evaluate the surface of the exposed Ringold and possibly conduct explorations during construction in order to determine a suitable depth of excavation. It is envisioned that only the lower portion of Ringold will provide a satisfactory foundation for much of the embankment.

Embankment compaction: Due to the high seismicity, it will be critical to ensure that all embankment zones are compacted to maximum practicable densities in order to preclude liquefaction. Close inspection and testing will be necessary to ensure proper moisture contents and densities are being achieved.

Random fill zones: As shown on the drawings, a large random fill zone will be located within the downstream portion of the rockfill embankment to utilize materials from required excavation. It is anticipated that these materials will vary widely in composition. These materials will be excavated and stockpiled separately into two general categories – fine-grained and coarse-grained materials. The finer grained materials will be placed in thinner lifts and compacted by tamping rollers while the coarser materials will be placed in thicker lifts and compacted by vibratory rollers. As both excavation/stockpiling and fill placement operations proceed, careful attention will need to be paid to ensure that these random fill materials are properly classified, moisture control is optimized, and the proper method of compaction is used to ensure a thoroughly compacted zone.

Staged construction: To gain additional knowledge of the site prior to issuing a full contract, as well to optimize scheduling of the construction work, a staged construction could be considered. A first stage could include foundation excavation and stockpiling, and possibly foundation grouting. A second stage would include the bulk of the earthwork placement.

Highway Relocation: Detours should not be necessary as long as the existing SH24 can be left in place during the construction of the relocated highway alignment. Disruptions to traffic on SH24 and SH241 will occur when the relocated alignment is connected to the existing highways. The excavation was assumed to be mostly in bedrock and therefore drilling and blasting will be required.

VIII. Outflow Conveyance System

Design Considerations

During their reconnaissance study, WIS investigated several options to deliver water from Black Rock Reservoir to the Roza Canal and all delivery options included a multi-level intake to selectively withdraw water from the reservoir. For this assessment study, outflow conveyance options that deliver water to the Roza Canal at MP 22.6 (near the intersection of SH24 and Roza Canal) were considered. A design flow capacity of 2,500 cfs was selected for the outflow conveyance based on the assumption of providing the Roza and Sunnyside Divisions' entire water supply from the Columbia River in lieu of Yakima River. This amounts to an instantaneous flow of about 2,362 cfs plus an allowance for other entities whose main conveyance facilities are in the vicinity of the Roza Canal.

Hydraulic Design

The initial outflow conveyance system from Black Rock Reservoir to the Roza Canal investigated during this Assessment consisted of an 18-foot-diameter tunnel and a 15.5-foot-diameter pipeline through Moxee Valley along SH24. For this alignment, the best surge tank site was located where the conveyance was still in basalt bedrock, about 10 miles from Black Rock Reservoir, and about 8 miles from Roza Canal. However, transient analyses of this arrangement indicated that the surge tank was located too far from the proposed Black Rock Powerplant at Roza Canal to prevent negative downsurge pressures from occurring in the pipeline and tunnel when the wicket gates on the Francis turbine closed in 60 seconds or less. Attempts to mitigate the negative pressures by slowing down wicket gate closure times led to unreasonable gate closure times near 10 minutes.

To maintain the valley alignment and prevent negative downsurge pressures, use of a synchronous bypass with the Francis turbine, or use of a Pelton turbine in lieu of the Francis turbine were considered. The use of a synchronous bypass where a valve opens at the same time as the wicket gates close upon load rejection could minimize and/or eliminate the negative downsurge pressure. However, the design would rely on a mechanical and/or electrical means to open the valve. While this may be technically feasible, Reclamation's current practice is to not rely on mechanical devices to prevent detrimental transient pressures because we consider the risks associated with a synchronous bypass failure (valve failure and/or valve reaction lag time) to be unacceptable.

Another method to mitigate the downsurge pressures is through the use of a Pelton turbine in lieu of the Francis turbine. Pelton turbines are easier to put into a system with transient problems because upon load rejection, deflectors aim the water away from the turbine wheel, maintaining flow without prolonged overspeed conditions which are harmful to the generator. The flow through the Pelton turbine can thus be reduced very slowly, preventing or at least lessening high transient pressures. However, a Pelton turbine is not suitable for the low head acting on the outflow conveyance system. At low reservoir water surface elevation of 1500 feet, the static head, without including friction loss through the tunnel and pipe is 330 feet. The heads typically required for Pelton turbines to be economical are approximately 500 feet and higher.

A canal through the Black Rock and Moxee Valleys was also investigated but topographic features in these valleys preclude the economic use of a canal to deliver water to the Roza Canal. On the west side of Black Rock Reservoir, the ground is at approximate elevation 1800.0 feet and then slopes gradually down to Roza Canal. In order to make deliveries at low reservoir, elevation 1500 feet, a long tunnel would be needed to convey water to a point in the Moxee Valley where the ground is at or below elevation 1500 feet. This location is close to the Roza Canal so the canal length would be small compared to the tunnel length and any cost savings from canal construction would be offset by the tunnel construction. In order to reduce the length of the tunnel and increase length of canal, a pumping plant would be required to lift water from Black Rock Reservoir over the high point between the Black Rock and Moxee Valleys

In the end, Reclamation decided to reduce the distance between the powerplant and surge tank to mitigate the downsurge pressures. This required moving the outflow alignment out of the valley floor. A route following the southern edge of the Yakima Ridge Mountains was analyzed and found to work for the pressures and flows of the outflow system. The tunnel and pipeline diameters were sized using the maximum flow of 2,500 cfs and turbine flow of 1,500 cfs as explained in the Black Rock Outlet Facility section of this report. A Black Rock Reservoir elevation of 1500.0 feet (Top of Inactive) was used to calculate the maximum downsurge, to size the tunnel and pipeline diameters, and to size the surge shaft. A Black Rock Reservoir elevation of 1775.0 feet (Top of Active) was used to calculate the maximum pressure at the powerplant and to determine the elevation required at the top of the surge shaft. The required minimum water surface, or hydraulic grade line at the Black Rock Powerplant was established at elevation 1364.0 feet. This hydraulic grade line enables the water to be delivered to the Sunnyside Powerplant without the need for an intermediate pumping plant.

To accommodate surge shaft requirements, the outflow conveyance system was aligned as shown in Figures 55 and 56. The plan and profiles are based on USGS topographic maps because this alignment is outside the contour data developed from the aerial photogrammetry. The 17-foot-diameter tunnel begins southeast of Taylor Ranch on the north side of Black Rock Reservoir and parallels the southern edge of Yakima Ridge for approximately 14 miles to reach the 40-foot-diameter surge shaft location. After the surge shaft, the tunnel angles out of the mountains and ends on the north side of SH24 where it transitions to a 17-foot-diameter buried steel pipe that crosses under SH24 and runs to Black Rock Powerplant. The distance from the surge shaft to the powerplant for this alignment is approximately 19,000 feet (about 3.5 miles).

The following factors and assumptions were used for the hydraulic and transient analysis of the 2,500 cfs outflow conveyance system:

Tunnel Design Flow:	2,500 cfs
Turbine Design Flow:	1,500 cfs
Colebrook White Rugosity Value:	0.002
Downsurge pressures:	No negative pressures.
Required HGL for Sunnyside Diversion:	El. 1364.0
Wicket gates closing time:	60 seconds

The tunnel was sized using the Colebrook and White Rugosity value of 0.002 as listed in Reclamation's Design Standards No. 3 [11] for concrete lined tunnels and checked using the Hazen Williams equation and a coefficient of 120. The hydraulic grade line at Roza Canal for a 17-foot-diameter tunnel and steel pipe at the design flow of 2,500 cfs is approximately elevation 1368 at minimum reservoir water surface elevation of 1500 feet.

A transient analysis was performed using Reclamation's Transient Analysis for Pipe Systems (TAPS). The transient analysis showed that at the full design flow of 2,500 cfs, large negative downsurge pressures would occur if a surge relief device was not within 2,000 feet of the powerplant. However, using the turbine design flow of 1,500 cfs, the surge relief point could be farther upstream from the powerplant and the distance of 19,000 feet between surge shaft and powerplant was determined to be acceptable. The surge shaft diameter was set at 40 feet to prevent dewatering and the top of the surge shaft was set at elevation 1900 feet to prevent overtopping during a unit load rejection. Both the high and low Black Rock Reservoir elevations were analyzed to get the worst-case upsurge and downsurge conditions, respectively. The maximum hydraulic grade line at the powerplant was determined to be elevation 1950 feet which converts to 810 feet of pressure based on a pump/pipeline centerline elevation of 1140 feet. See Figure 57 for a graphical representation of the hydraulic grade lines for the Outflow Conveyance System. Transient analyses using a turbine flow of 900 cfs were not completed during this study.

Concept Description

In Black Rock Reservoir, a single-level intake at elevation 1500 feet was sized for the outflow conveyance system. A multi-level intake was not considered for this study because no specific water quality objectives have been identified for the irrigation water and there are no downstream fish water quality considerations. Fish screens were included on the outlet structure to prevent fish that may be stocked in the reservoir from migrating into the Yakima Basin. Fish screen sizing criteria was assumed to be the same criteria used to size the intake structure at Priest Rapids Reservoir. The fish-screened intake assumed for this study is a half-cylinder shaped screen supported on a reinforced concrete slab. An air burst backwash system is included for cleaning of the screens and bulkhead gates and guides are included for dewatering the outflow conveyance system during emergencies.

The outflow tunnel design considerations are similar to the inflow tunnel design considerations noted in the Inflow Conveyance section of this report. The steel pipe earthwork quantities between the downstream tunnel portal and Black Rock Powerplant were calculated based on the Outflow Pipe Trench Section shown on Figure 56. At the deep excavation for the downstream tunnel portal, the earthwork quantities assumed 10 foot benches every 20 feet in depth.

Construction Considerations

Pipe Fabrication: Steel pipe sections 16-feet in diameter and greater will have to be transported in pieces by truck or rail and welded together and pressure tested in the field.

Tunnel Excavation: The potential for varying rock quality encountered during tunnel excavation will necessitate a flexible working relationship with the contractor. Differing ground, water and gas conditions from those anticipated will affect the tunnel construction. Based on current knowledge of the tunnel alignment, bedrock will consist of a series of basaltic lava flows and associated interflow sediments. The basaltic portion of the tunnel will be in rock which will likely vary structurally and texturally from massive nonvesicular to highly vesicular and flow-breccia types. Soft, relatively uncemented interflow sediments will also likely be encountered. A number of shear zones, consisting of fractured rock with soft gouge materials may also be encountered during tunneling.

IX. Black Rock Outlet Facility

The proposed Black Rock Outlet Facility is located adjacent to the Roza Canal (MP 22.6) on the southeast corner of the Roza Canal and SH 24 intersection. The facility includes a powerplant, bypass structure to permit water deliveries when the unit is not on line or to pass flows in excess of powerplant design flows, flowmeter, and manifold piping and valving for pressure pipe diversions to the Roza and Sunnyside Irrigation Districts. Reclamation selected this location based on its position within the Roza and Sunnyside delivery systems, proximity to Black Rock Reservoir, and ease of access from SH24. See Figures 1 and 60.

Design Considerations

Two powerplant design flow options were developed to account for at least two of the possible delivery scenarios to the Roza and Sunnyside Irrigation Districts. Option 1 would pass all water from Black Rock Reservoir through the powerplant and/or bypass structure into a modified Roza Canal before being delivered to Roza and Sunnyside water users. Option 2 would require a smaller capacity powerplant because bifurcations upstream from the plant would provide pressurized pipeline water deliveries to Roza water users north of the delivery point, and all Sunnyside water users. Although the peak design flow of the outflow system is 2,500 cfs, the powerplant for Option 1 was designed for a flow of 1,500 cfs, and the powerplant for Option 2 was designed for a flow of 900 cfs. This was done so that the plants could be operated at full capacity for most of the irrigation season (April through October) and to reduce equipment costs. Reclamation selected a 1,500 cfs turbine design flow for Option 1 based on providing the Roza and Sunnyside District's entire water supply from the Columbia River in lieu of Yakima River and it is representative of their combined April Yakima River water rights. The 900 cfs turbine design flow was selected for Option 2 assuming water for Sunnyside and Roza water users north of MP 22.6 would be diverted upstream from the powerplant and is representative of anticipated deliveries to Roza water users south of MP 22.6 (885 cfs). The bypass structure for both options was sized to pass the total outflow design flow of 2,500 cfs. The two distribution scenarios are shown schematically in Figures 58 and 59. Other combinations of one district's water being delivered to the canal while the other district's water is bifurcated upstream from the powerplant are possible but were not evaluated during this study. Future power operations studies should be conducted during the feasibility design to better define the rated capacity of the plants.

Black Rock Reservoir operating water surface elevations range from a low of 1500 feet to a high of 1775 feet. The water surface elevation in the Roza Canal at MP 22.6 was assumed to be approximately 1170 feet. The steady state head at the Black Rock Outlet Facility (measured from canal water surface) ranges from a low of 198 feet to a high of 477 feet. The powerplant design head for turbine sizing was assumed to be the average of the steady state head. Details and quantities for the 1,500 cfs powerplant and 2,500 cfs bypass structure were developed during this study but no detailed layout or transient study of the 900 cfs powerplant was prepared. For the 900 cfs powerplant option, the bypass was conservatively sized for the full outflow capacity to provide a means of bypassing the powerplant and pressurized water deliveries. This sizing should be reviewed and revised as necessary during the feasibility design. Quantities used to estimate the cost of the 900 cfs powerplant and 2,500 cfs bypass structure were obtained by reducing the excavation and concrete quantities for the reduced unit submergence and adjusting major mechanical items. A comparison of the 1,500 cfs and 900 cfs plants is shown in Table 16.

Table 16. Black Rock Powerplant Unit Data

Unit Data	1,500 cfs Powerplant	900 cfs Powerplant
Number/Type of Units:	1 Francis	1 Francis
Design Discharge:	1,500 cfs	900 cfs
Design Head:	338 feet	338 feet
Speed:	327 rpm	400 rpm
Assumed Unit Efficiency:	90 percent	90 percent
Power Output at Design Head:	38 MW	23 MW
Min. Turbine Submergence	30.5 feet	25 feet
Max. Scroll Case Dimension	23.5 feet	19.0 feet
Bottom of Draft Tube	El. 1118.8	El. 1128.3
Turbine Guard Valve:	108-inch spherical	84-inch spherical

Concept Description

The Black Rock Powerplant is an indoor type plant with a structural steel superstructure enclosed with concrete masonry walls. The intermediate and substructure are reinforced concrete. The powerplant consists of a service bay and a single unit bay. The powerplant and bypass structure share the same superstructure but are separated structurally by an expansion joint. The Bypass Structure houses four 84-inch sleeve valves to dissipate head. Each sleeve valve discharges into a 33-foot-diameter by 20-foot high stainless steel-lined stilling chamber. One 90-ton overhead traveling crane is provided to handle the powerplant and bypass electrical and mechanical items. See Figures 61 though 65 for general arrangements of the powerplant and bypass structure.

The guard valves selected for the turbines and sleeve valves are spherical valves. Spherical valves are fully ported valves designed for high velocities and high pressures. Because they are designed for high velocities, smaller valve diameters can be used in larger diameter pipe. Because of the large valves needed for these facilities, they would most likely be shipped in parts with the final assembly and testing being done in the field.

Steel Piping for the tunnels, manifolds, and penstocks was designed in accordance with AWWA M11 [9] and ASCE Manuals and Reports on Engineering Practice No. 79 [10]. The large diameter tunnel liners and high pressure manifolds were designed with ASTM A572 Grade 50 steel plate. All other manifolds, penstocks, and outlet works piping were fabricated from ASTM A36 steel plate.

A concrete-lined, open-channel outlet transition structure was sized to convey the outlet flows into the Roza Canal. The service yard was sized to permit mobile crane access around the structures and a 7-foot chain link fence was provided around the yard for security. See Figure 60.

The Black Rock Powerplant utilizes standard 5 kV non-segregated bus and vacuum type unit circuit breakers. Incoming power was assumed to be from a tap on the Reclamation power line about 1,000 feet from the Black Rock Outlet Facility. For this Assessment, Reclamation assumed that this is a 34.5-kilovolt line that originates at the existing Roza Powerplant switchyard. The line tap will be a wood-pole tap structure. A 75-foot by 100-foot switchyard is located within the outlet facility service yard. The switchyard will include a transformer, circuit breakers, and disconnect switches. The use of SCADA equipment was not included in the study.

Construction Considerations

Canal Bypass: The need for a temporary canal bypass was assumed in Reclamation's estimates. Upstream and downstream earthen cofferdams with geomembrane linings would be constructed in order to connect the transition structures to the canals. Three 9-foot-diameter corrugated metal pipes between the cofferdams would permit canal operation during construction.

X. Delivery Systems

Roza Division Delivery System

Options to deliver Black Rock water from MP 22.6 of the Roza Canal to water users within the Roza Irrigation District were evaluated by Reclamation's Pacific Northwest

Construction Office. The results of their evaluation are documented in the report entitled Preliminary Assessment of Black Rock Delivery System for Roza, Terrace Heights, Selah-Moxee, and Union Gap Irrigation Districts [3]. At the Black Rock Outlet Facility location, 215 cfs of water delivery is required to Roza water users located upstream (north) from MP 22.6, and 885 cfs of water delivery is required to Roza water users located downstream (south) from MP 22.6. Upstream deliveries are proposed to be made by one of two methods: 1) Bifurcation of a steel pipe off the outflow conveyance pipe upstream of the new Black Rock Powerplant, or 2) Pass all Roza water through the Black Rock Powerplant and bypass structure and construct a canal-side pumping plant to lift water to a new high pressure distribution pipeline to supply the Roza-North water users.

Sunnyside Division Delivery System

Options to deliver Black Rock water from MP 22.6 of the Roza Canal to water users within the Sunnyside Irrigation District were evaluated by Reclamation's Pacific Northwest Regional Office. The results of this evaluation are documented in the report entitled Preliminary Assessment of Black Rock Delivery System for Sunnyside Division [4]. Two methods of delivery were evaluated:

- Option 1: Bifurcation of a steel pipe off the outflow conveyance pipe upstream of the new Black Rock Powerplant.

- Option 2: Pass all Sunnyside water through the Black Rock Powerplant and bypass structure and modify the Roza Canal for the higher flows.

Sunnyside Division Delivery Option 1 – Hydraulic Design Considerations

For this option, a pipe would bifurcate off the outflow conveyance pipe directly upstream of the new Black Rock Powerplant. This pipeline is a continuation of the outflow conduit from Black Rock Reservoir and will be subject to the pressures associated with the reservoir fluctuation. The alignment begins by generally following the Roza Canal across orchards to the top of Konnowock Pass, and then following Konnowock Pass Road down to Sunnyside Canal. At the Sunnyside Canal, a powerplant and bypass structure would be constructed to dissipate the excess 435 feet of head. The pipeline diameter was sized using a flow of 1,262 cfs, while the design of the turbine was based on a flow of 900 cfs. This was done so that the plant could be operated at full capacity for most of the irrigation season (April through October) and to reduce equipment costs. The 900 cfs turbine design flow was selected based on providing the Sunnyside District's entire water supply from the Columbia River in lieu of Yakima River and is representative of their April Yakima River water rights.

The Black Rock Reservoir elevation of 1500.0 feet (Top of Inactive) was used to calculate maximum downsurge pressures, and the Black Rock Reservoir elevation of 1775 feet (Top of Active) was used to calculate the maximum pressure at the powerplant. The following factors were used for the hydraulic and transient analysis for the Sunnyside Pipeline:

Pipeline Design Flow:	1,262 cfs
Turbine Design Flow:	900 cfs
Hazen Williams Coefficient:	135 (Friction Loss)
Pipeline Diameter:	12 feet
Downsurge pressures:	No negative pressures.

The transient analysis of the Sunnyside Powerplant and pipeline from Black Rock Powerplant showed that closing the turbine wicket gates at Sunnyside Powerplant in 60 seconds would result in negative downsurge pressures at approximate Station 206+00. In order to keep the downsurge pressures from being negative, the wicket gate closure time was increased to 68 seconds. Other options that were evaluated to address the negative pressures are shown in Table 17.

Table 17. Sunnyside Pipe Options

Option	Diameter feet	Turbine design flow cfs	Wicket gate closure time seconds
1	12	900	68
2	12	700	60
3	14	900	60

The maximum elevation of the hydraulic grade line at the pumping plant was determined to be El. 2144 feet which converts to 1,272 feet of pressure based on a pump/pipeline centerline elevation of 872 feet. The effects of the Sunnyside transient pressures at Black Rock Powerplant and the rest of the system are less than the transient pressures generated by Black Rock Powerplant. Future Studies should analyze the effects of both powerplants shutting down at the same time.

The use of in-line generators to reduce head in the Roza and Sunnyside pressure delivery systems was considered. This would recover power and allow a reduced head class pipe downstream of this facility, saving substantial money on the pipe. In-line units have been used for about 15 years by the Yakima-Tieton Irrigation District and have provided reliable service. Cursory investigation revealed that in-line generators with flow and head ranges required for the Sunnyside and Roza deliveries are not in common production. Also, there would be transient problems which would be difficult to estimate, as they would be compounded by other transients from other units on the same pipe system. Therefore in-line generators were not considered at this study level.

Pressure reducing systems using valves or orifices are available from manufacturers in the flow and head ranges required; however, they were not included herein because of reliability concerns with regard to preventing the system pressure getting beyond the valves. If pressure reducing systems were to be used, it would be necessary to insure bypass around them could not be installed. Also, protection from misoperation would be needed to insure the downstream pipe would never see full reservoir head. While not included in this study, in-line generators and pressure reducing systems can be addressed in future studies.

XI. Sunnyside Powerplant and Switchyard

The proposed Sunnyside Powerplant, Bypass and Switchyard are located adjacent to the Sunnyside Canal near its intersection with Konnowock Pass Road. The Sunnyside Powerplant is similar in arrangement to the proposed Black Rock Powerplant arrangement. Details and quantities for the 900 cfs powerplant at the end of the pipeline delivery option (Sunnyside Delivery Option 1) and 1,250 cfs bypass structure were developed but no detailed layout of the 900 cfs powerplant at the end of the canal delivery option (Sunnyside Delivery Option 2) was completed for this study. A comparison of the two turbine units is shown in Table 18.

Concept Description

The Sunnyside Powerplant is an indoor type plant with a structural steel superstructure enclosed with concrete masonry walls. The intermediate and substructure are reinforced concrete. The powerplant consists of a service bay and a single unit bay. A 125-ton overhead traveling crane is provided to handle the powerplant electrical and mechanical items. See Figures 67 through 69.

The Sunnyside Bypass Structure is a separate indoor structure with a reinforced concrete substructure and a structural steel superstructure enclosed with concrete masonry walls. The Bypass Structure houses two 84-inch sleeve valves to dissipate head. Each sleeve valve discharges into a 33-foot-diameter by 20-foot high stainless steel-lined stilling chamber. See Figures 70 and 71. The bypass structure discharges into a 12-foot-diameter steel pipe that discharges into the riprap-lined outlet transition channel that carries powerplant and bypass flows to the Sunnyside Canal.

Table 18. Sunnyside Powerplant Unit Data

Unit Data	Pipeline Delivery Option 1	Canal Delivery Option 2
Number/Type of Units:	1 Francis	1 Francis
Design Discharge:	900 cfs	900 cfs
Design Head:	435 feet	221 feet
Speed:	400 rpm	300 rpm
Assumed Unit Efficiency:	90 percent	90 percent
Power Output at Design Head:	29.5 MW	15 MW
Min. Distributor Submergence (Negative if distributor is above tailwater)	+ 10.6 feet	- 1.1 feet
Max. Scroll Case Dimension	19.4 feet	20.5 feet
Bottom of Draft Tube	El. 859.2	El. 854.5
Turbine Guard Valve:	78-inch spherical	84-inch spherical

The service yard was sized to permit mobile crane access around the structures and a 7-foot chain link fence was provided around the yard for security. Incoming power was assumed to be from a tap on an existing Bonneville Power Authority line about 1 mile southwest of the switchyard. The line tap will include circuit breakers and disconnect switches and a new 69-kilovolt wood-pole line would be constructed from the tap to the switchyard. A 75-foot by 100-foot switchyard is located within the service yard. The switchyard will include transformers, circuit breakers, and disconnect switches. See Figure 66.

Construction Considerations

Canal Bypass: Reclamation assumed there would be a need for a temporary canal bypass during construction. Upstream and downstream earthen cofferdams with geomembrane linings would be constructed in order to connect the transition structures to the canals. Three 9-

foot-diameter corrugated metal pipes between the cofferdams would permit canal operation during construction.

XII. Field Cost Estimates

Field cost estimates were prepared for the major features identified for each option. Field cost estimates include construction contract costs and contingencies. Construction contract costs include itemized pay items and mobilization, plus an allowance for unlisted items. Field cost estimates do not include non-contract distributive-type costs (environmental studies, site investigations, design, construction management, ...) and non-contract corollary-type costs. Field cost estimates do not include land acquisition, relocation, or right-of-way costs that may be required for construction of the project features. Operation, maintenance, and replacement costs are also not included in field cost estimates.

Cost estimates were prepared using available existing design data from past work accomplished by WIS and Reclamation. Aerial topography developed by Reclamation and limited geologic explorations conducted near the proposed damsites were also used to better define features. The amount of data collection is not considered to be at the level required for feasibility-level assessment of project features. Design data collected for future studies can cause future cost estimates to significantly deviate from the cost estimates presented in this report.

Field costs prepared for this study were generated using industry-wide accepted cost estimating methodology, standards, and practices. Major features were broken down into pay items and approximate quantities were calculated for these items based on preliminary general designs and drawings. Unit prices, adjusted for location and current construction cost trends, were determined for the identified pay items.

The appraisal-level field cost estimates developed for this assessment study are for the purpose of evaluating which options should be investigated in greater detail as the Storage Study progresses. **The cost estimates in this report are not intended to be at the feasibility-level required to request project authorization for construction and construction appropriations by Congress.** All field costs are in **June 2004** price level dollars and include mobilization, unlisted items, and contingencies as explained below:

- Mobilization **-** Mobilization costs include mobilizing contractor personnel and equipment to the project site during initial project start-up. The assumed 5 (+/-) percent of the subtotal cost used in the cost estimates contained in this report is based on past experience of similar projects. The mobilization line item is a rounded value per Reclamation rounding criteria which may cause the dollar value to deviate from the actual percentage shown.

• Unlisted Items - Unlisted items are a means to recognize the confidence level in the estimate and the level of detail and knowledge that was used to develop the estimated cost. This line item may be considered as a contingency for minor design changes and also as an allowance to cover minor pay items that have not been itemized, but will have some influence on the total cost. As per Reclamation Cost Estimating Handbook guidelines, the allowance for unlisted items in appraisal estimates should be at least 10 (+/-) percent of the listed items. Typically a value of 15 (+/-) percent is used. Based on the level of detail provided for this study's cost estimates, the unlisted items line item was set at 10 (+/-) percent of the subtotal cost plus mobilization for all features. The unlisted items line item is a rounded value per Reclamation rounding criteria which may cause the dollar value to deviate from the actual percentage shown.

• Contingencies - Contingencies are considered funds to be used after construction starts and not for design changes during project planning. The purpose of contingencies is to identify funds to pay contractors for overruns on quantities, changed site conditions, change orders, etc. As per Reclamation Cost Estimating Handbook guidelines, appraisal-level estimates should have 25 (+/-) percent added for contingencies. Based on the current level of design data, geologic information, and general knowledge of the conditions at the various sites, the contingency line item was set at 25 (+/-) percent of the contract cost for all features. The contingency line item is a rounded value per Reclamation rounding criteria which may cause the dollar value to deviate from the actual percentage shown.

Table 19 is a summary table of the appraisal-level field cost estimates that were prepared for this Assessment. Estimate worksheets showing a detailed breakdown of these field cost estimates are shown in Appendix D. Table 20 shows a comparison of itemized costs (pay items only) for the major features between the Columbia River and MP22.6 of the Roza Canal. Costs shown in Table 20 do not include mobilization, unlisted items, and contingencies. From Table 20, preferred options based on cost can be assembled for the Large Reservoir – Pump Only Option (Option 1), Large Reservoir – Pump-Generating Option (Option 2), and Small Reservoir – Pump Only Option (Option 3). Table 21 compares the combined field cost estimates for each preferred Storage-Pump Option. Tables 20 and 21 do not include costs for the Sunnyside Powerplant and Bypass Structure located at the end of the Sunnyside Delivery System.

Table 19. Summary of Appraisal-Level Field Cost Estimates			
Feature	Large Reservoir	Large Reservoir	Small Reservoir
	Active Storage= 1.3 MAF	Active Storage= 1.3 MAF	Active Storage= 0.8 MAF
	Pump Only	Pump-Generating	Pump Only
	Q (Pump)= 3,500 cfs	Q (Pump)= 3,500 cfs	Q (Pump)= 6,000 cfs
		Q (Generate)= 3,500 cfs	
	(Option 1)	(Option 2)	(Option 3)
Priest Rapids Intake, Pumping Plant, Switchyard,			
and Inflow Conveyance System:			
Discharge 1 (Tunnel/Tunnel)	$620,000,000	$810,000,000	$870,000,000
Discharge 2 (Tunnel/Pipeline)	$860,000,000	Not Priced	Not Priced
Black Rock Dam and Reservoir:			
Dam Type 1: Concrete-faced Rockfill	$1,300,000,000	$1,300,000,000	$1,100,000,000
Dam Type 2: Central Core Rockfill	$1,250,000,000	$1,250,000,000	$1,000,000,000
Dam Type 3: Roller Compacted Concrete	$1,900,000,000	$1,900,000,000	$1,550,000,000
Black Rock Outflow Conveyance System and			
Black Rock Outlet Facility:			
Option 1: 1,500 cfs Power Plant	$590,000,000	$590,000,000	$590,000,000
Option 2: 900 cfs Power Plant	$590,000,000	$590,000,000	$590,000,000
Sunnyside Powerplant and Bypass Structure	$47,000,000	$47,000,000	$47,000,000

Table 20. Cost Comparison of Major Features Between Columbia River and Roza Canal*			
Feature	Large Reservoir	Large Reservoir	Small Reservoir
	Pump Only	Pump-Generating	Pump Only
	Q = 3,500 cfs	Q = 3,500 cfs	Q = 6,000 cfs
	(Option 1)	(Option 2)	(Option 3)
Priest Rapids Fish Screen and Intake	$58,035,920	$64,551,120	$78,815,990
Priest Rapids Pumping Plant	$182,919,070		$275,309,975
Priest Rapids Pump-Generating Plant		$226,254,880	
Black Rock Inlet/Outlet Tower		$85,565,400	
(Priest Rapids to Black Rock Reservoir)			
Inflow Conveyance			
(Priest Rapids to Black Rock Reservoir)			
Discharge 1 (Tunnel/Tunnel)	$186,471,700	$186,471,700	$248,397,600
Discharge 2 (Tunnel/Pipeline)	$357,838,420		
Black Rock Dam:			
Dam Type 1: Concrete-faced Rockfill	$774,496,000	$774,496,000	$621,530,800
Dam Type 2: Central Core Rockfill	$733,280,000	$733,280,000	$573,117,150
Dam Type 3: Roller Compacted Concrete	$1,239,036,300	$1,239,036,300	$980,587,000
Low Level Outlet Works			
For Dam Types 1 and 2	$83,494,115	$83,494,115	$79,000,000
For Dam Type 3	$23,384,515	$23,384,515	$22,000,000
Highway and Utility Relocations	$57,320,000	$57,320,000	$57,320,000
Black Rock Reservoir Outlet Structure	$3,269,850	$3,269,850	$3,269,850
(Black Rock Reservoir to Roza Canal)			
Outflow Conveyance (2,500 cfs)	$306,402,600	$306,402,600	$306,402,600
(Black Rock Reservoir to Roza Canal)			
Black Rock Outlet Facility			
Option 1: 1,500 cfs Powerplant	$104,010,535	$104,010,535	$104,010,535
Option 2: 900 cfs Powerplant	$102,165,985	$102,165,985	$102,165,985

* Mobilization, unlisted items, and contingencies are not included in Table 20.

Table 21. Field Cost Comparison of Preferred Options (Columbia River to MP22.6 of Roza Canal)			
Feature	**Large Reservoir Pump Only Q = 3,500 cfs (Option 1)**	**Large Reservoir Pump-Generating Q = 3,500 cfs (Option 2)**	**Small Reservoir Pump Only Q = 6,000 cfs (Option 3)**
Priest Rapids Fish Screen and Intake	$58,035,920	$64,551,120	$78,815,990
Priest Rapids Pumping Plant	$182,919,070		$275,309,975
Priest Rapids Pump-Generating Plant		$226,254,880	
Inflow Conveyance: Discharge 1 (All Tunnel)	$186,471,700	$186,471,700	$248,397,650
Black Rock Inlet/Outlet Tower		$85,565,400	
Black Rock Dam: Type 2 (Central Core Rockfill)	$733,280,000	$733,280,000	$573,117,150
Low Level Outlet Works	$83,494,115	$83,494,115	$79,000,000
Highway and Utility Relocations	$57,320,000	$57,320,000	$57,320,000
Black Rock Reservoir Outlet Structure	$3,269,850	$3,269,850	$3,269,850
Outflow Conveyance	$303,132,750	$303,132,750	$303,132,750
Black Rock Outlet Facility: Option 1 (1,500 cfs)	$104,010,535	$104,010,535	$104,010,535
Subtotal of Pay Items	**$1,711,933,940**	**$1,847,350,350**	**$1,722,373,900**
Total Mobilization Costs:	**$86,000,000**	**$93,000,000**	**$86,000,000**
PR Intake, PP/PG, Swtchyd & Inflow Conveyance	$21,000,000	$28,000,000	$30,000,000
Black Rock Dam and Reservoir	$44,000,000	$44,000,000	$35,000,000
Black Rock Outflow Conveyance & Outlet Facility	$21,000,000	$21,000,000	$21,000,000
Total Unlisted Items:	**$162,066,060**	**$179,649,650**	**$181,626,100**
PR Intake, PP/PG, Swtchyd & Inflow Conveyance	$41,573,310	$59,156,900	$67,476,385
Black Rock Dam and Reservoir	$81,905,885	$81,905,885	$75,562,850
Black Rock Outflow Conveyance & Outlet Facility	$38,586,865	$38,586,865	$38,586,865
Construction Contract Cost	**$1,960,000,000**	**$2,120,000,000**	**$1,990,000,000**
Total Contingencies:	**$500,000,000**	**$530,000,000**	**$470,000,000**
PR Intake, PP/PG, Swtchyd & Inflow Conveyance	$130,000,000	$160,000,000	$170,000,000
Black Rock Dam and Reservoir	$250,000,000	$250,000,000	$180,000,000
Black Rock Outflow Conveyance & Outlet Facility	$120,000,000	$120,000,000	$120,000,000
Field Cost	**$2,460,000,000**	**$2,650,000,000**	**$2,460,000,000**
Field costs are in June 2004 dollars.			
Field costs do not include Sunnyside Powerplant and delivery systems downstream of MP22.6. See Summary Report.			

XIII. Conclusions

Construction of facilities to pump, store, and deliver Columbia River water to willing exchange participants in the Yakima Basin is technically viable. The following conclusions are based on the technical and cost analyses completed for this Assessment study:

Priest Rapids Intake Facilities

The 3,500 cfs Pumping Plant is the least cost intake and plant facility at Priest Rapids Reservoir. The overall cost of the 3,500 cfs Pump-Generating Option (Option 2) is not significantly greater than the 3,500 cfs Pump Only Option (Option 1); however, operational studies have not been completed for the Pump-Generating Option. These studies may indicate a need to increase plant capacity to ensure annual delivery of exchange water. The decision to provide for pump-generating capability at the Columbia River should be made after these operational studies are complete and costs of the Pump-Generating Option are adjusted to meet the requirements of the operational studies.

Inflow Conveyance System

The cost of the All Tunnel (Discharge 1) inflow conveyance system is significantly less than the cost for the Tunnel/Pipe (Discharge 2) alternative. The Tunnel/Pipe alternative should be removed from further evaluation.

Black Rock Dams

Given the limited available information and explorations of the foundation conditions and construction materials, it is difficult to determine which of the two rockfill dam alternatives would be the optimum choice for the Black Rock site. The relative strengths of both alternatives are that each is an excellent dam to construct in a highly seismic area. The strong and dry downstream rockfill shells provide excellent resistance to extreme seismic shaking. In the unlikely event of a fault offset beneath the dam, neither dam would be expected to fail due to the presence of zone 2 and 3 filters and drains and the "flow-through" capability of the rockfill. In addition, both alternatives feature relatively narrow impermeable barriers, which minimizes expensive and time-consuming foundation treatment work. In short, both alternatives are excellent technical choices, with no clear advantages.

From an economic standpoint, the appraisal-level cost estimates indicate that the central core rockfill alternative has a slight economic advantage. The estimated field costs for the large reservoir are $1.3 billion for the concrete face rockfill and $1.25 billion for the central core rockfill. It should be stressed that appraisal level designs are based on very limited data and explorations, so cost estimates at this stage contain a great deal of uncertainty. More data collection and studies are necessary before fine-tuning the costs to levels that would support cost authorizations and similar efforts.

Due to relative similarity in costs and the equality of technical advantages, it does not appear prudent to rule out either alternative at this point. At the feasibility (or higher) level, additional investigations, explorations, and studies may better define any technical or economic advantages for these two dam types.

The costs of embankment dams are significantly lower than the costs of the roller compacted concrete (RCC) dams. The RCC dams should be removed from further evaluation.

Outflow Conveyance System

Transient analysis of the outflow conveyance system indicates that a surge tank needs to be located close to Black Rock Powerplant to address negative downsurge pressures. To accommodate this requirement, Reclamation moved the alignment of the outflow conveyance from the valley floor to the Yakima Ridge Mountains so that a surge shaft could be excavated near the powerplant. Future studies should investigate alternate alignments assuming power production facilities at the end of the outflow conveyance system are removed.

Black Rock Outlet Facility

The cost difference between the 1,500 cfs and 900 cfs powerplants is small. The bulk of the costs reside with the bypass structure that was conservatively assumed to be the same capacity for both alternatives. The selection of which option to pursue should be made based on economies associated with the Roza and Sunnyside Delivery Systems.

XIV. Recommendations

Should the decision be made to carry the Black Rock alternative into the feasibility design stage, it is recommended that additional data be collected and the preferred options refined for the collected data. Value Engineering methods of analysis should be applied to the identified concepts to identify needs, major cost components, and to reduce overall costs. Value Engineering is a problem-solving methodology that examines component features of a project to determine pertinent functions, governing criteria, and associated costs. Alternative proposals are then developed that meet necessary requirements at lower cost or with an increase in long-term value.

Future Investigations and Studies

General Geologic Investigations

Further geologic study of the reservoir area, damsite, plant sites, and water conveyance alignments will be required during the feasibility stage. Additional geologic investigations will also be required for final design and construction of these facilities. The goal of the exploratory or investigations programs will be to prioritize and produce the amount of data required for that level of study or design. The objective of the engineering geology programs will be adequate identification of all the relevant geologic considerations. Collection and presentation of the geologic data will provide important information regarding geologic and geotechnical considerations for design and construction. Geologic data will be collected to address potential issues relating to stability and strength of the foundation materials, slope stability, deformability of materials, ground-water occurrence and behavior, seepage paths, unwatering and dewatering requirements, groutability, reservoir water-holding capability, seismicity and faulting, reservoir-induced seismicity, landslides, and sedimentation.

Priest Rapids Intake Facilities

Pump-Generating Operational Study: An operational study should be completed to determine how Black Rock Reservoir would be operated if stored water were released back to the Columbia River for power generation purposes.

Pump-Turbine Units : Future studies should investigate the relative costs of a pump-turbine unit installation versus the proposed separate pumps and turbines installation.

Land Development at Priest Rapids Reservoir: According to representatives from the Grant County Public Utility District, the Wanapum Band of the Yakama Nation have jurisdiction over the land proposed for the intake, fish screen, and pumping plant facilities, and they should be consulted regarding construction of these features. See Appendix A.

Inflow Conveyance Systems

Sloping Multi-Level Inlet/Outlet Structure: Future studies should adapt the proposed multi-level inlet/outlet structure to the topography and geology available in the vicinity of the structure. A sloping intake structure should be considered in lieu of the proposed free-standing tower.

Erosion Control During First Filling: Future studies should consider alternative to the proposed erosion protection features required for the initial filling of Black Rock Reservoir.

Black Rock Dams

Use of Asphaltic Concrete Core: Should a central core rockfill prove to have significant technical advantages and impervious soil is not readily available, consideration should be given to a central asphalt core dam. Asphalt simply replaces earthfill as the core material. Such embankments have been used in a number of areas, and have proven to be effective and economical when good quality impervious fill is not an economical option.

Using Crushed Basalt for Filters/Drains: In general, filter and drain materials that consist of subrounded materials (or similar) are preferred to particles with much more angular shapes. However, if such materials are located at a significant distance from the damsite and are thus quite expensive, crushed basalt (available locally) should be investigated as an option.

Grout Curtain Details: A better understanding of the basalt bedrock will likely influence the final design of the grout curtain. Details that would be impacted would include the number of rows (expected to range from one to three), the depth of the holes, and the anticipated grout take.

Potential Adit: Should considerable uncertainty still exist regarding the bedrock permeability even after additional investigations, it may be necessary to construct an adit beneath the water barrier to allow for the possibility of future grouting efforts. For a concrete face rockfill dam, such an adit would be constructed as part of an oversized plinth at the upstream toe. For a central core rockfill, a thick layer of roller compacted concrete (RCC) might be placed beneath the earthfill core on top of the bedrock, and an adit constructed within the RCC. These adits would be sized to allow grouting of additional curtain holes in the event that significant seepage and reservoir losses occur upon first filling of the reservoir.

Highway Relocation: Geologic mapping along the proposed relocated SH24 alignment is not complete at this time and a more detailed geologic analysis is needed in order to determine potential landslide areas and location and depth of bedrock and colluvium layers along the proposed alignment. Given the estimated cost of the road relocation, future studies should consider alternate alignments. Residents of the Black Rock Valley and others have indicated a preference for relocating SH24 north of the proposed Black Rock Reservoir. For purposes of this document it was relocated on the south side of the reservoir because of more desirable topography and the desire to stay outside the Yakima Firing Center Military

Reservation. However, as the Storage Study proceeds further consideration for the relocation of SH 24 should be given and discussions conducted with appropriate State and County entities, Yakima Firing Center Military Reservation, and local residents.

Outflow Conveyance Systems

Future hydraulic and transient studies should refine the flows and pressures associated with the Black Rock and Sunnyside Powerplants. The transient studies should explore the effects of both powerplants shutting down at the same time and one of the plants shutting down while the other one is operating. Future studies should also investigate cost savings associated with removing power production facilities at one or both of these locations. Various highway crossing alternatives near the Black Rock Powerplant should also be evaluated to determine the most cost effective alternative.

Black Rock Outlet Facility

Pressure Reducing Features: The use of pressure reducing features in the Roza and Sunnyside delivery system pipes should be re-evaluated during future studies to see if a fail-safe system can be identified to reduce design pressures in the delivery pipelines.

Future Power Operations Studies : Future power operations studies should be conducted during the feasibility design to better define the rated capacity of the powerplant .

Bypass and Outlet Transition Structure: The design flow for the bypass structure should be re-evaluated during the feasibility study to better match canal delivery requirements and reduce the size of this facility. Alternatives to the outlet channel shared by the bypass and powerplant should also be investigated.

XV. References

[1] Yakima River Basin Water Storage Options, Feasibility Study, Washington, Plan of Study, dated September 2003.

[2] Yakima River Storage Enhancement Initiative - Black Rock Reservoir Study - Final Report, Prepared by Washington Infrastructure Services, Inc., May 2002.

[3] Preliminary Assessment of Black Rock Delivery System for Roza, Terrace Heights, Selah-Moxee, and Union Gap Irrigation Districts, Technical Series No. TS-YSS-3, Prepared by Pacific Northwest Construction Office, 2004.

[4] Preliminary Assessment of Black Rock Delivery System for Sunnyside Division, Technical Series No. TS-YSS-4, Prepared by Pacific Northwest Regional Office, 2004.

[5] Preliminary Appraisal Assessment of Columbia River Water Availability for a Potential Black Rock Project, Technical Series No. TS-YSS-1, Prepared by Pacific Northwest Regional Office, March 2004.

[6] Black Rock Reservoir Study - Initial Geotechnical Investigation - Final Report, Prepared by Washington Infrastructure Services, Inc., January 2003.

[7] Preliminary Assessment of Geology at Black Rock Damsite, Technical Series No. TS-YSS-5, Prepared by Pacific Northwest Regional Office, 2004.

[8] Preliminary Assessment of Hydrogeology at Black Rock Damsite, Technical Series No. TS-YSS-6, Prepared by Pacific Northwest Regional Office, 2004.

[9] AWWA M11, Steel Water Pipe, A Guide for Design and Installation.

[10] ASCE Manuals and Reports on Engineering Practice No. 79, Steel Penstocks.

[11] Design Standards No. 3, Water Conveyance Systems, Chapter 4 - Tunnels, Shafts, and Caverns, 1994.

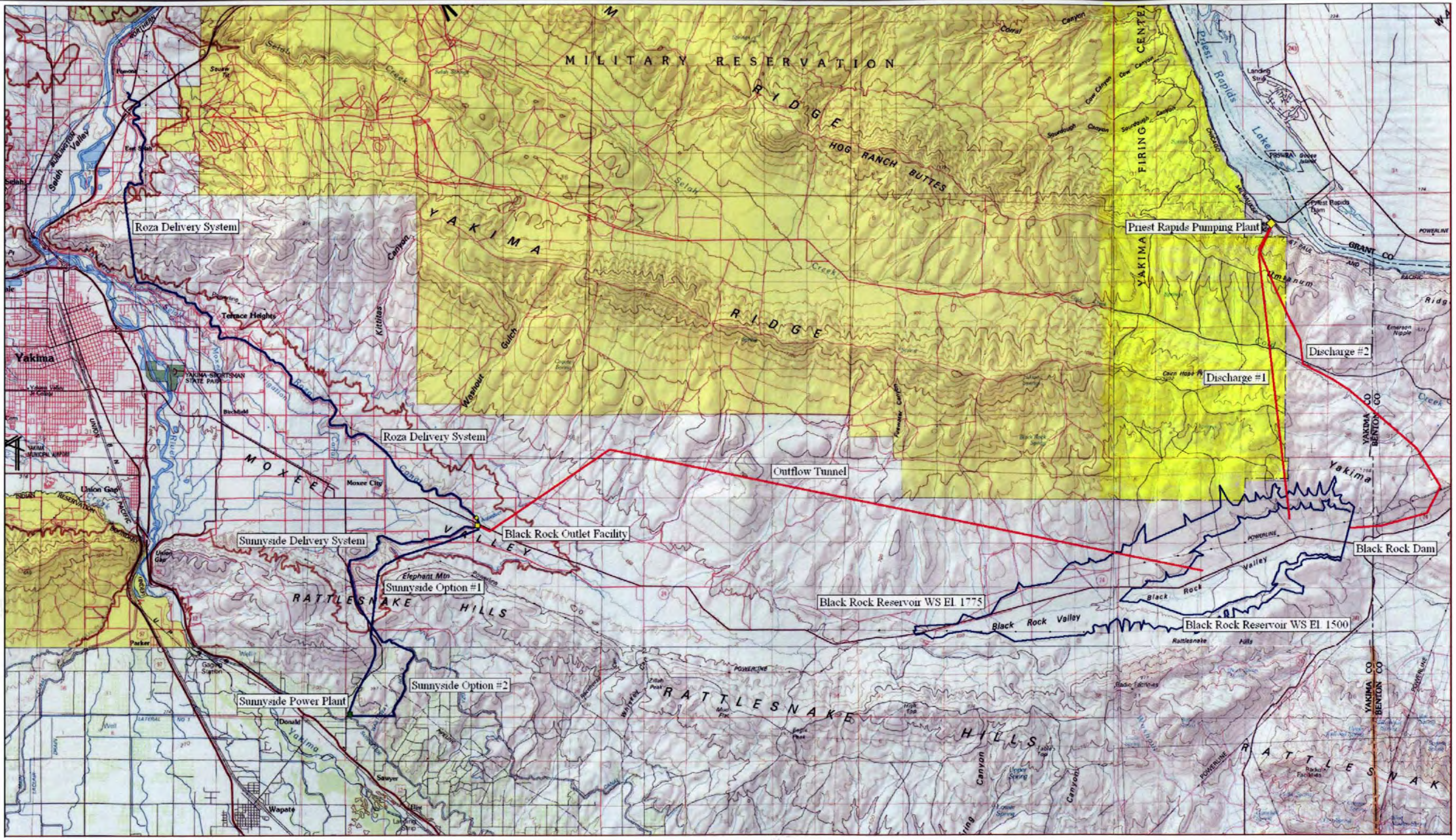
[12] Design of Small Dams, Bureau of Reclamation, Denver, Colorado.

[13] Criteria and Guidelines for Evacuating Storage Reservoirs and Sizing Low-level Outlet Works, ACER Technical Memorandum No. 3, Bureau of Reclamation, Denver, Colorado, 1990.

Figures

Figure

FIGURE 1



LOCATION MAP

0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 miles
0 1 2 3 4 5 km

KEY MAP

PRELIMINARY
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NOTES

1. Topography created using TOPO! software from National Geographic.

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BLACK ROCK ASSESSMENT STUDY

LOCATION MAP

DESIGNED [signature]

REVIEWED BY [signature] P.E.

Structural and Architectural Group

CADD SYSTEM AutoCAD Rel. 16.0s
CADD FILENAME FIGURE 1-LOCATION MAP.DWG
DENVER, COLORADO JUNE 24, 2004 SHEET 1 OF 1
FIGURE 1

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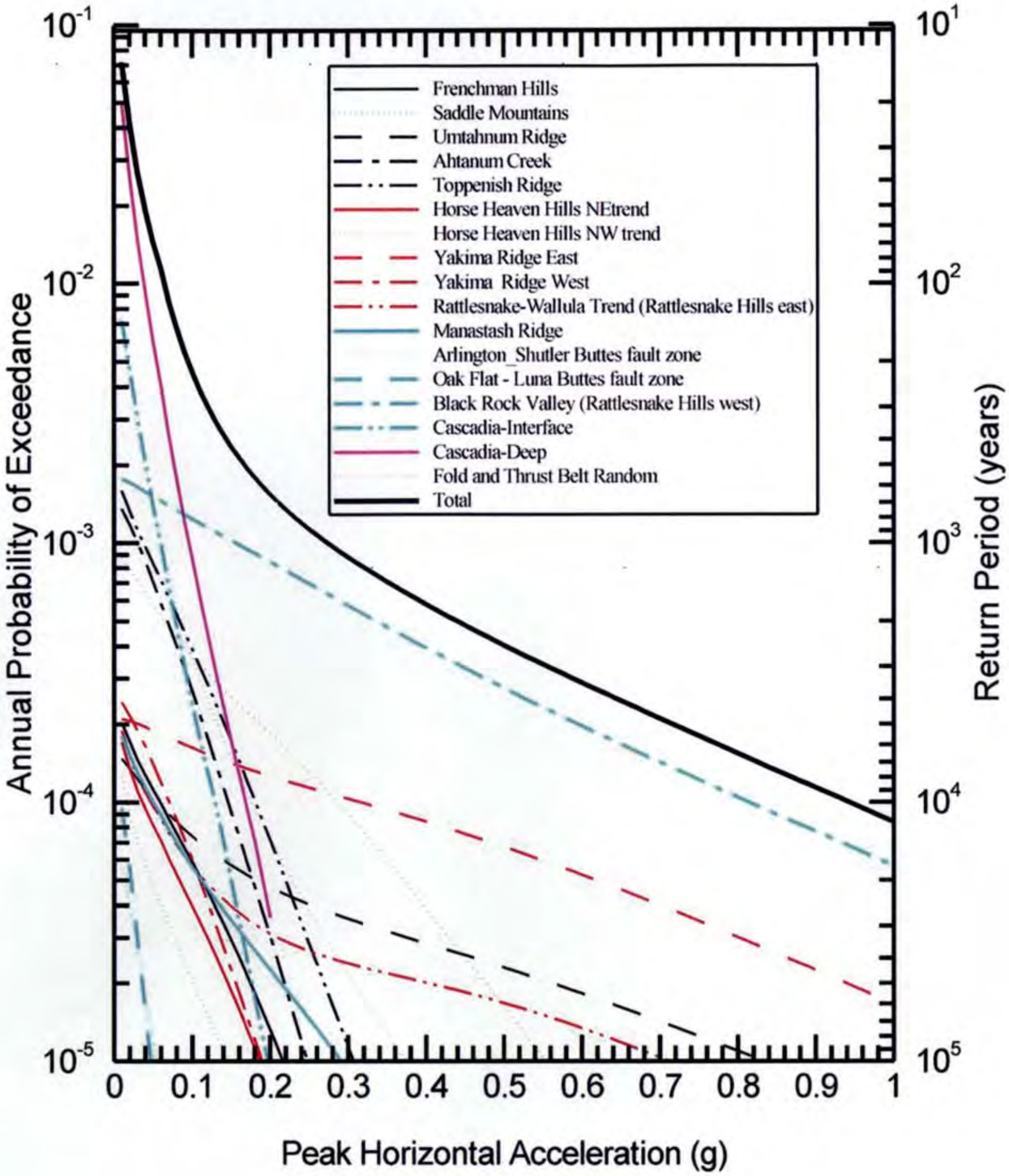
PLOTTED BY: LBOWLES
AUGUST 17, 2004 08:49



Preliminary mean hazard curves for PHA, Black Rock Site.

Figure 2

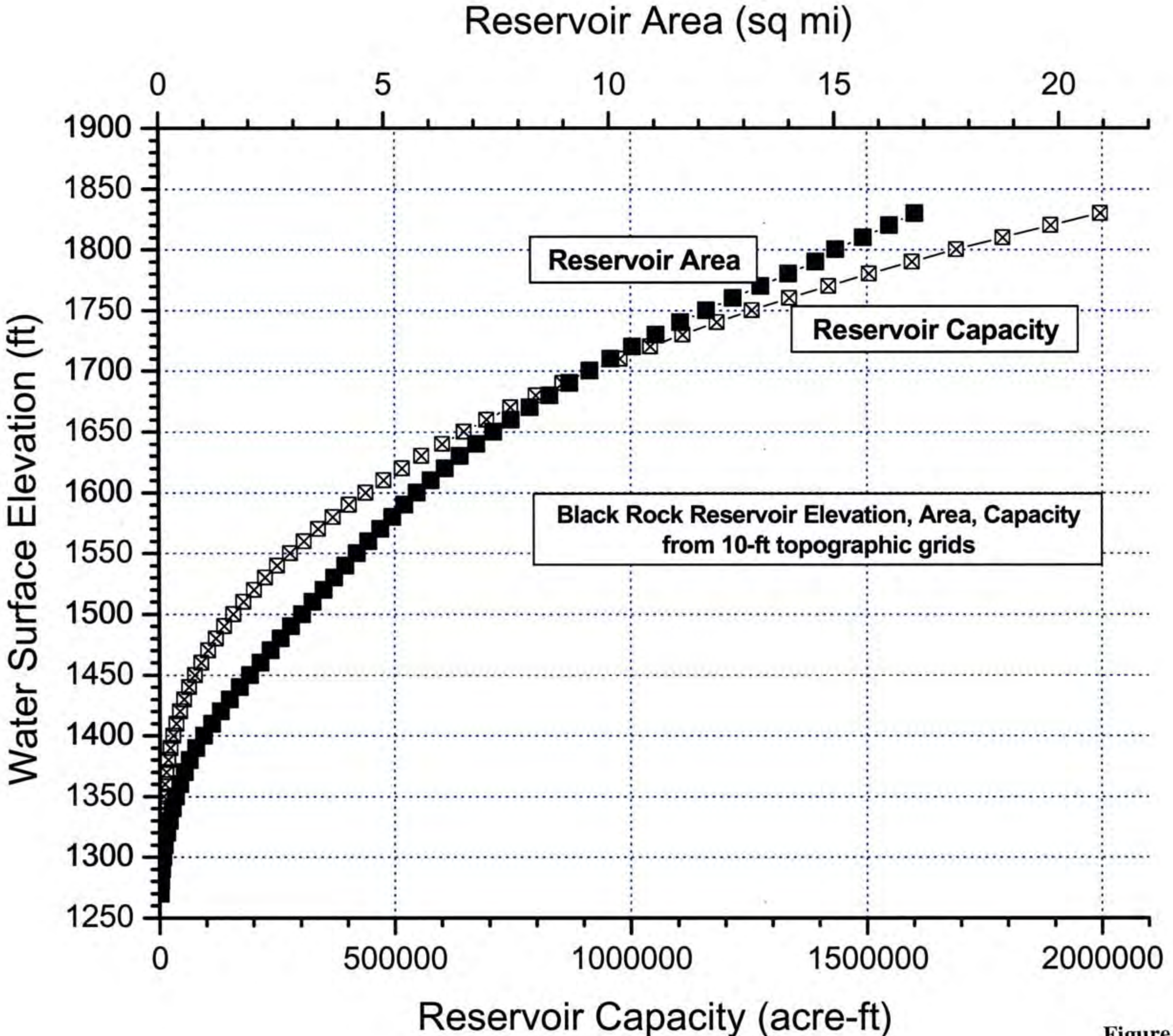
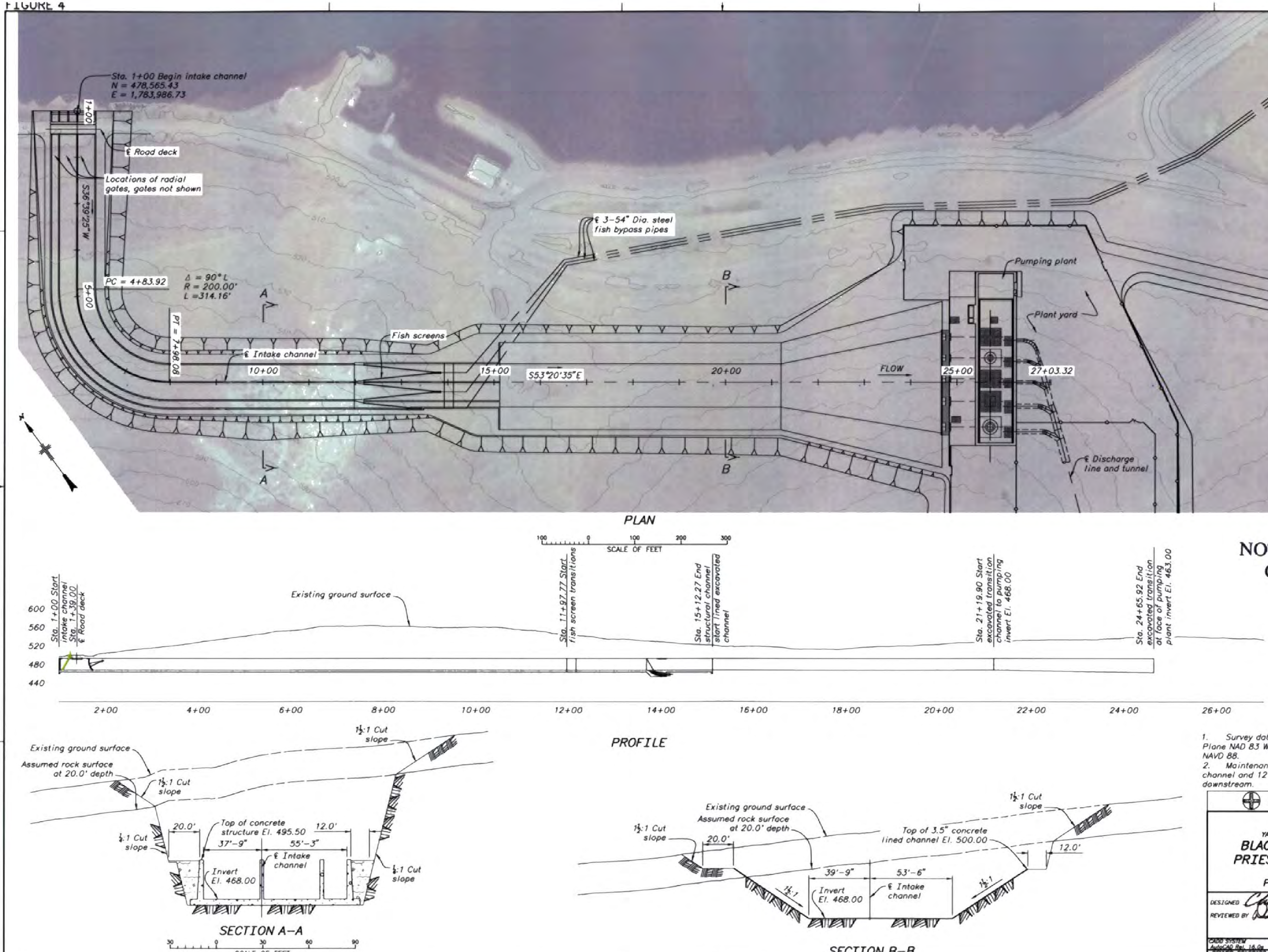

Reservoir Area (sq mi)
0
5
10
15
20
1900
1850
1800
1750
1700
1650
1600
1550
1500
1450
1400
1350
1300
1250
Water Surface Elevation (ft)
Reservoir Area
Reservoir Capacity
Black Rock Reservoir Elevation, Area, Capacity
from 10-ft topographic grids
0
500000
1000000
1500000
2000000
Reservoir Capacity (acre-ft)

Figure 3

FIGURE 4



PRELIMINARY
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NOTES

1. Survey data are based on a horizontal projection in State Plane NAD 83 Washington South Zone and vertical control in NAVD 88.
2. Maintenance roads are 20 feet wide on left side of channel and 12 feet wide on right side of channel looking downstream.

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BLACK ROCK ASSESSMENT STUDY
PRIEST RAPIDS INLET STRUCTURE
3,500 CFS INTAKE OPTION
PLAN, PROFILE, AND SECTIONS

DESIGNED
REVIEWED BY
Water Conveyance Group

CADD SYSTEM AutoCAD Rel. 16.0s
CADD FILENAME FIGURE 4 AND 5.DWG
DENVER, COLORADO APRIL 22, 2004 SHEET 1 OF 2
FIGURE 4

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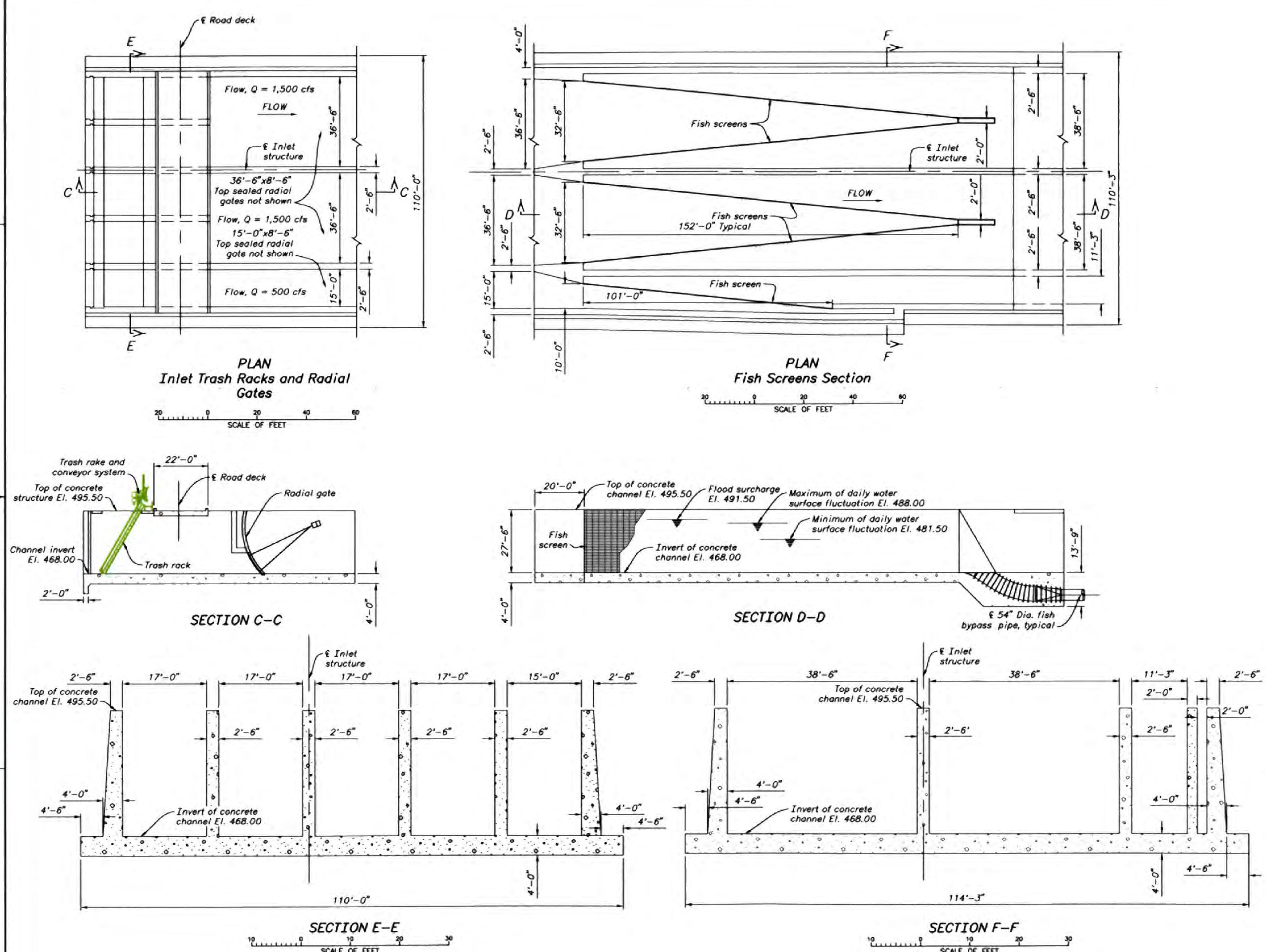
PLOTTED BY: CCHA
AUGUST 5, 2004 10:16

FIGURE 5



PRELIMINARY
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NOTES

1. The 54" dia. steel pipes with mortar lining is typical for all fish bypass pipes.

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3,500 CFS INTAKE OPTION
PLAN AND SECTIONS

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CADD SYSTEM AutoCAD Rel. 16.0a
DENVER, COLORADO
APRIL 20, 2004
SHEET 2 OF 2
CADD FILENAME FIGURE 4 AND 5.DWG
FIGURE 5

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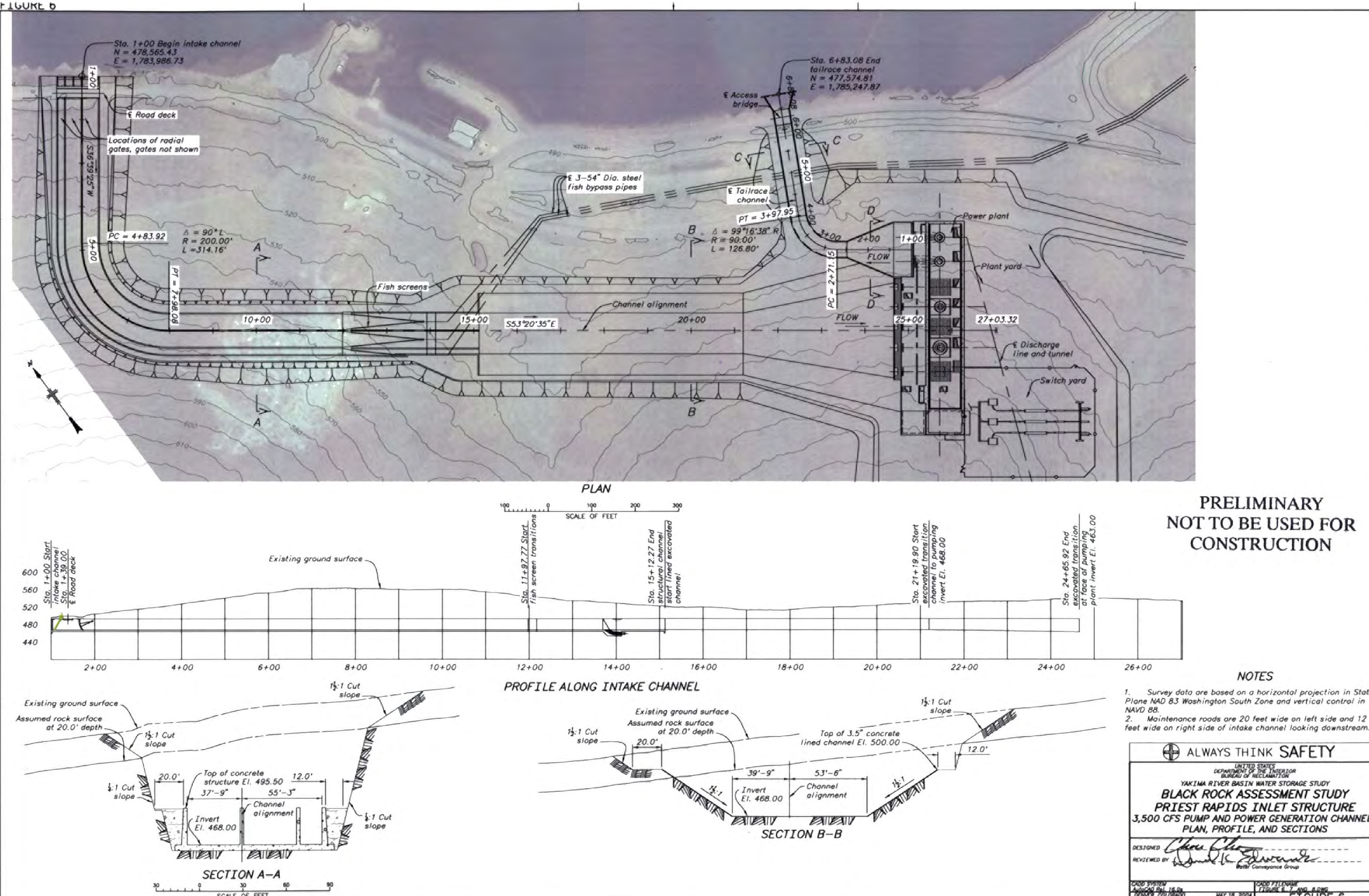
AUGUST 5, 2004 10:17

FIGURE 6



NOTES

1. Survey data are based on a horizontal projection in State Plane NAD 83 Washington South Zone and vertical control in NAVD 88.
2. Maintenance roads are 20 feet wide on left side and 12 feet wide on right side of intake channel looking downstream.

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PRIEST RAPIDS INLET STRUCTURE
3,500 CFS PUMP AND POWER GENERATION CHANNELS
PLAN, PROFILE, AND SECTIONS

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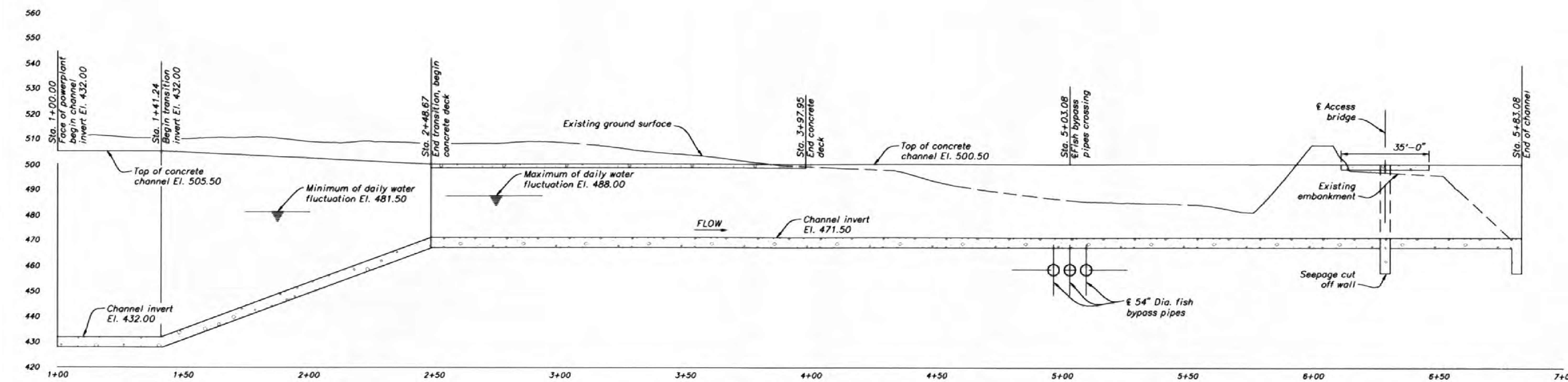
REVIEWED BY
Water Conveyance Group

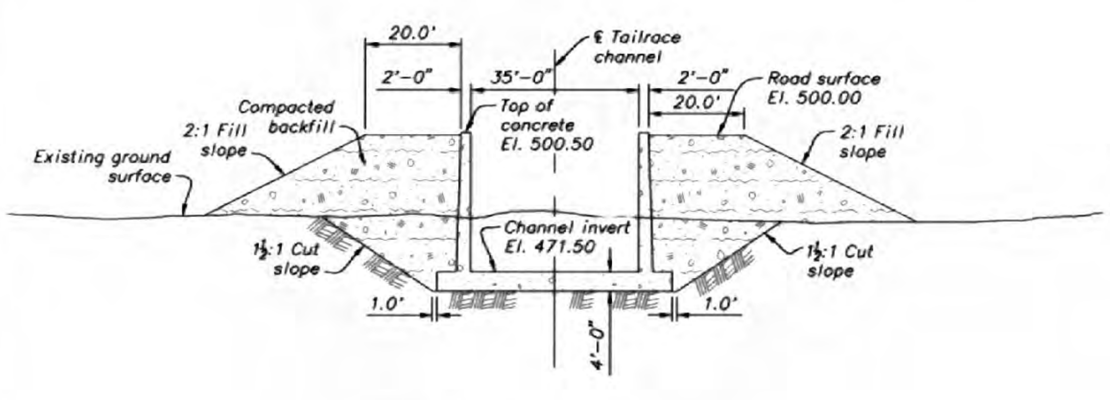
DENVER, COLORADO MAY 18, 2004 SHEET 1 OF 3

FIGURE 6

FIGURE 7

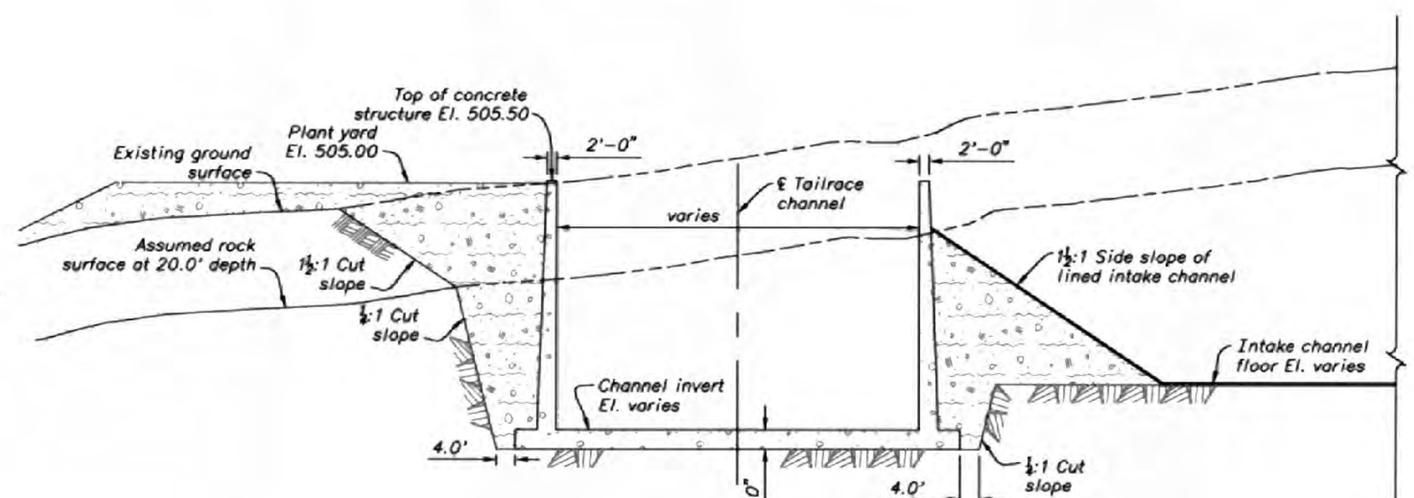


PROFILE ALONG TAILRACE CHANNEL



SECTION C-C

20 0 20 40 60
SCALE OF FEET



SECTION D-D

PRELIMINARY
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NOTES

1. Survey data are based on a horizontal projection in State Plane NAD 83 Washington South Zone and vertical control in NAVD 88.
2. Maintenance roads are 20 feet wide on both sides of tailrace channel.

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3,500 CFS PUMP AND POWER GENERATION CHANNELS
PROFILE AND SECTIONS

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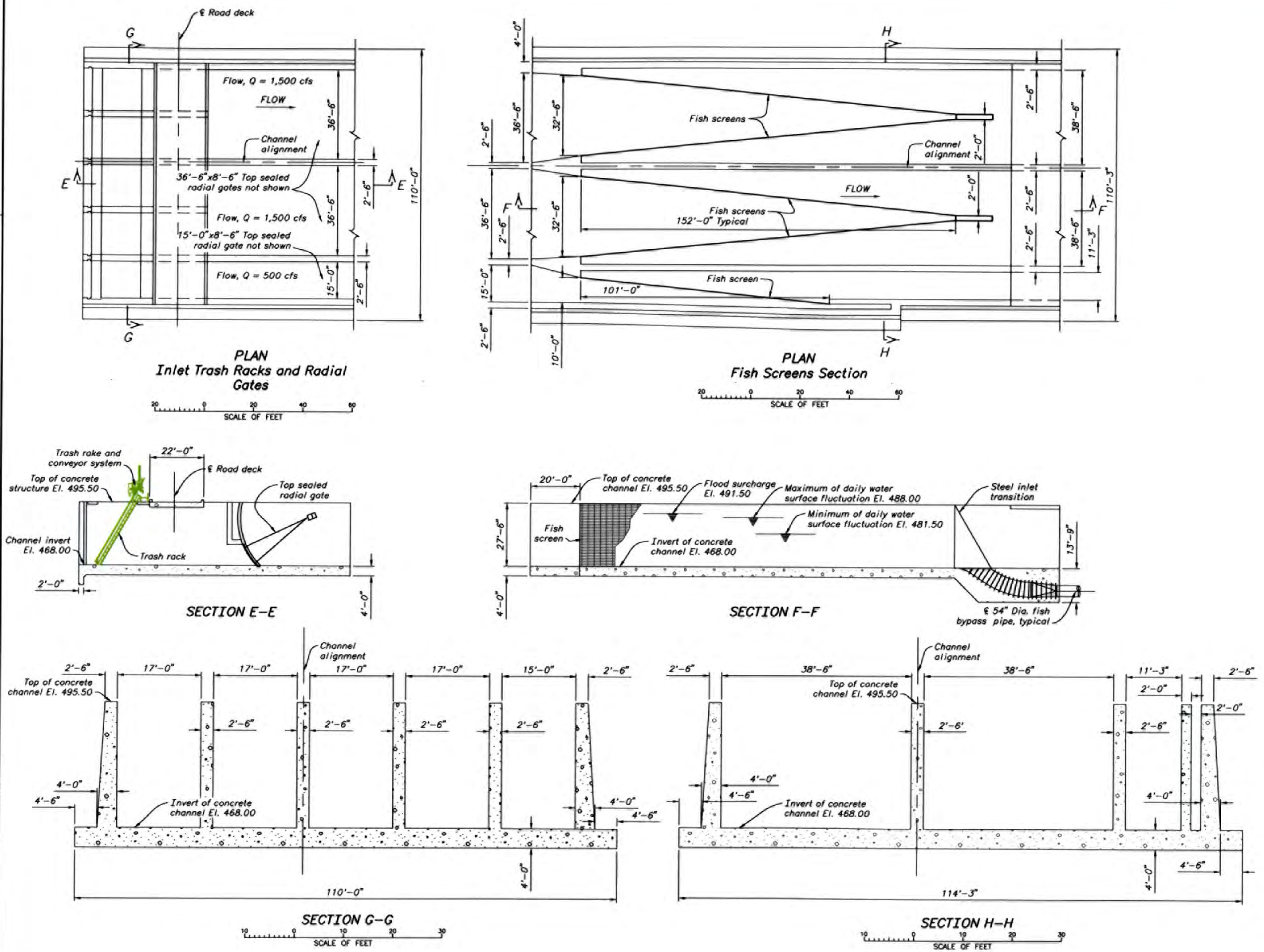
CADD SYSTEM AutoCAD Rel. 16.0s
DENVER, COLORADO MAY 18, 2004 SHEET 2 OF 3
CADD FILENAME FIGURE 6, 7 AND 8.DWG
FIGURE 7

FIGURE 8



PRELIMINARY
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NOTES

1. The 54" dia. steel pipe with mortar lined is typical for all fish bypass pipes.

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PLANS AND SECTIONS

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CADD SYSTEM AutoCAD Rel. 16.0a
DENVER, COLORADO MAY 18, 2004 SHEET 3 OF 3
CADD FILENAME FIGURE 6, 7, AND 8.DWG

FIGURE 8

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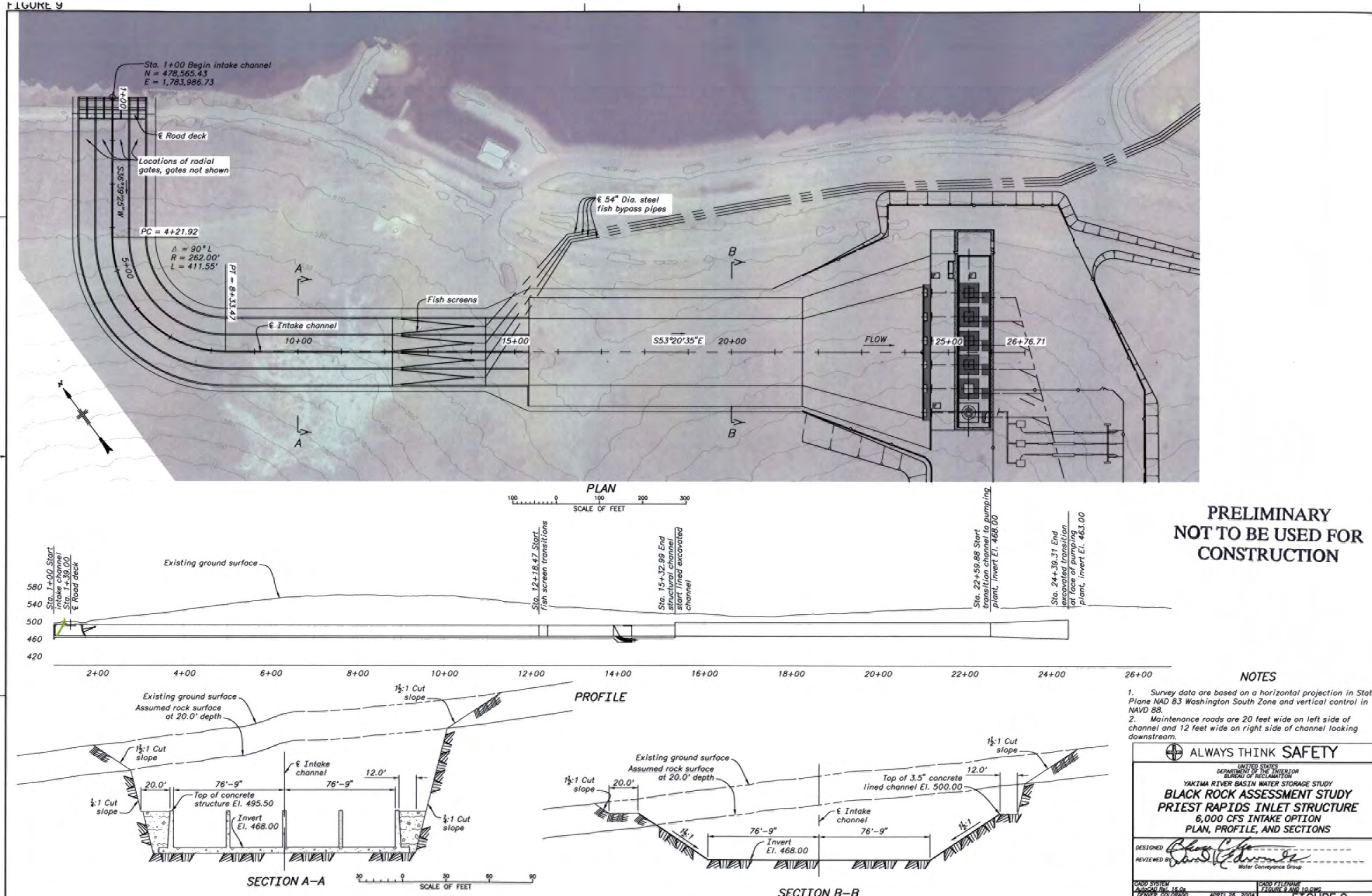
AUGUST 5, 2004 10:22

FIGURE 9



Sta. 1+00 Begin intake channel
N = 478,565.43
E = 1,783,986.73
1+00
℄ Road deck
Locations of radial gates, gates not shown
S36°39'25"W
PC = 4+21.92
Δ = 90° L
R = 262.00'
L = 411.55'
5+00
PT = 8+33.47
A
℄ Intake channel
10+00
Fish screens
℄ 54" Dia. steel fish bypass pipes
15+00
S53°20'35"E
20+00
B
FLOW
25+00
26+76.71
PLAN
SCALE OF FEET
Sta. 1+00 Start intake channel
Sta. 1+39.00 ℄ Road deck
Existing ground surface
Sta. 12+18.47 Start fish screen transitions
Sta. 15+32.99 End structural channel start lined excavated channel
Sta. 22+59.88 Start transition channel to pumping plant, invert El. 468.00
Sta. 24+39.31 End excavated transition at face of pumping plant, invert El. 463.00
580
540
500
460
420
2+00
4+00
6+00
8+00
10+00
12+00
14+00
16+00
18+00
20+00
22+00
24+00
26+00
PROFILE
Existing ground surface
Assumed rock surface at 20.0' depth
1½:1 Cut slope
℄ Intake channel
20.0'
76'-9"
76'-9"
12.0'
Top of concrete structure El. 495.50
Invert El. 468.00
¼:1 Cut slope
SECTION A-A
SCALE OF FEET
Existing ground surface
Assumed rock surface at 20.0' depth
1½:1 Cut slope
20.0'
12.0'
Top of 3.5" concrete lined channel El. 500.00
℄ Intake channel
76'-9"
76'-9"
Invert El. 468.00
SECTION B-B
PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION
NOTES
1. Survey data are based on a horizontal projection in State Plane NAD 83 Washington South Zone and vertical control in NAVD 88.
2. Maintenance roads are 20 feet wide on left side of channel and 12 feet wide on right side of channel looking downstream.
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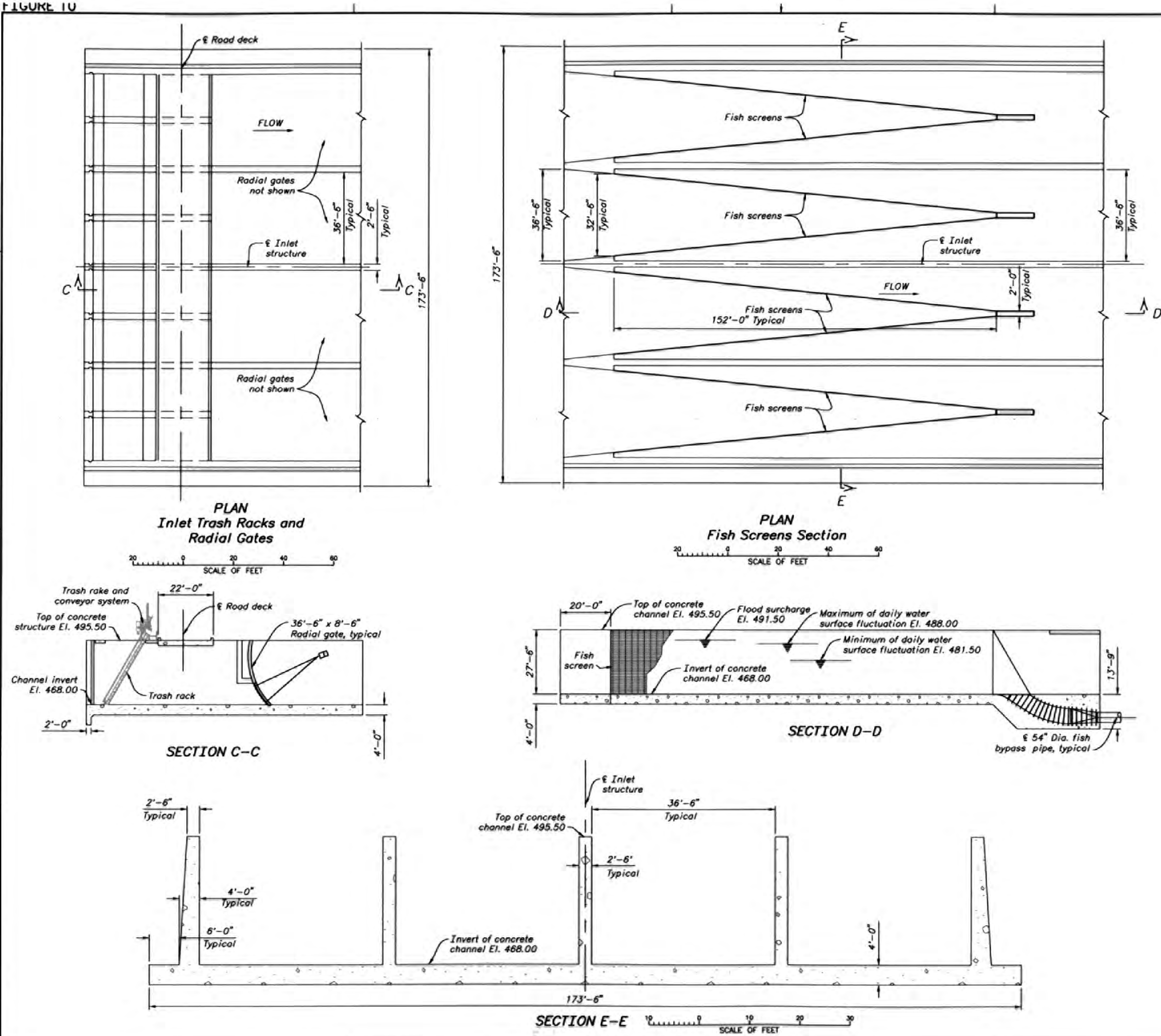
BLACK ROCK ASSESSMENT STUDY
PRIEST RAPIDS INLET STRUCTURE
6,000 CFS INTAKE OPTION
PLAN, PROFILE, AND SECTIONS
DESIGNED
REVIEWED BY
Water Conveyance Group
CADD SYSTEM AutoCAD Rel. 16.0s
DENVER, COLORADO
APRIL 26, 2004
SHEET 1 OF 2
CADD FILENAME FIGURE 9 AND 10.DWG
FIGURE 9

FIGURE 10



PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION

NOTES

1. Flow per channel is 1,500 cfs for a total of 6,000 cfs.
2. 54" Dia. steel bypass pipes with mortar lining are typical for each of the four channels.
3. 36'-6" x 8'-6" Radial gates are typical for each channel.

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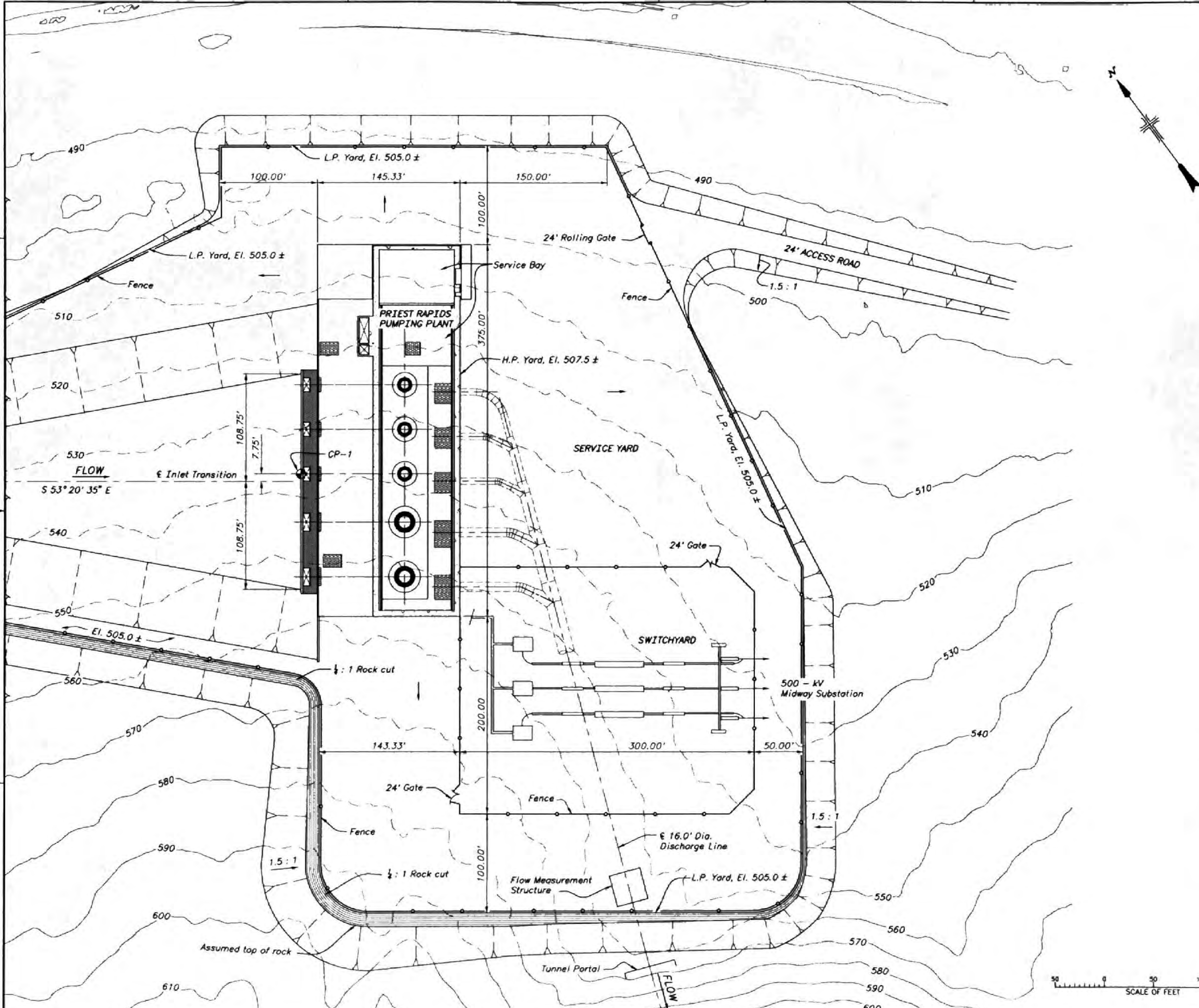
BLACK ROCK ASSESSMENT STUDY
PRIEST RAPIDS INTLET STRUCTURE
6,000 CFS INTAKE OPTION
PLAN AND SECTIONS

DESIGNED
REVIEWED BY
Water Conveyance Group

CADD SYSTEM AutoCAD Rel. 16.0s | CADD FILENAME FIGURE 9 AND 10.DWG
DENVER, COLORADO APRIL 26, 2004 SHEET 2 OF 2 | FIGURE 10



50 0 50 100 150
SCALE OF FEET

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

NOTES

1. Top of rock is assumed to be 20 ft. below existing ground surface throughout the plant site.
2. Temporary and permanent rock cut slopes are ¼ : 1.
3. Permanent cut slopes in overburden are 1.5 : 1.
4. Control Point, CP-1 coordinates are:

   N 476,929.58
   E 1,785,051.47

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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

PRIEST RAPIDS PUMPING PLANT – 3500 CFS OPTION

SITE PLAN

DESIGNED BY M. R. O'Shea
REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 15.06
CADD FILENAME
DENVER, COLORADO AUGUST 20, 2004

FIGURE 11

FILE PATH: H:\CivilEng Share\PROJ\Yakima Storage Study\BRR Assessment Study\Plant Structures\Drawings\Priest Rapids PP\
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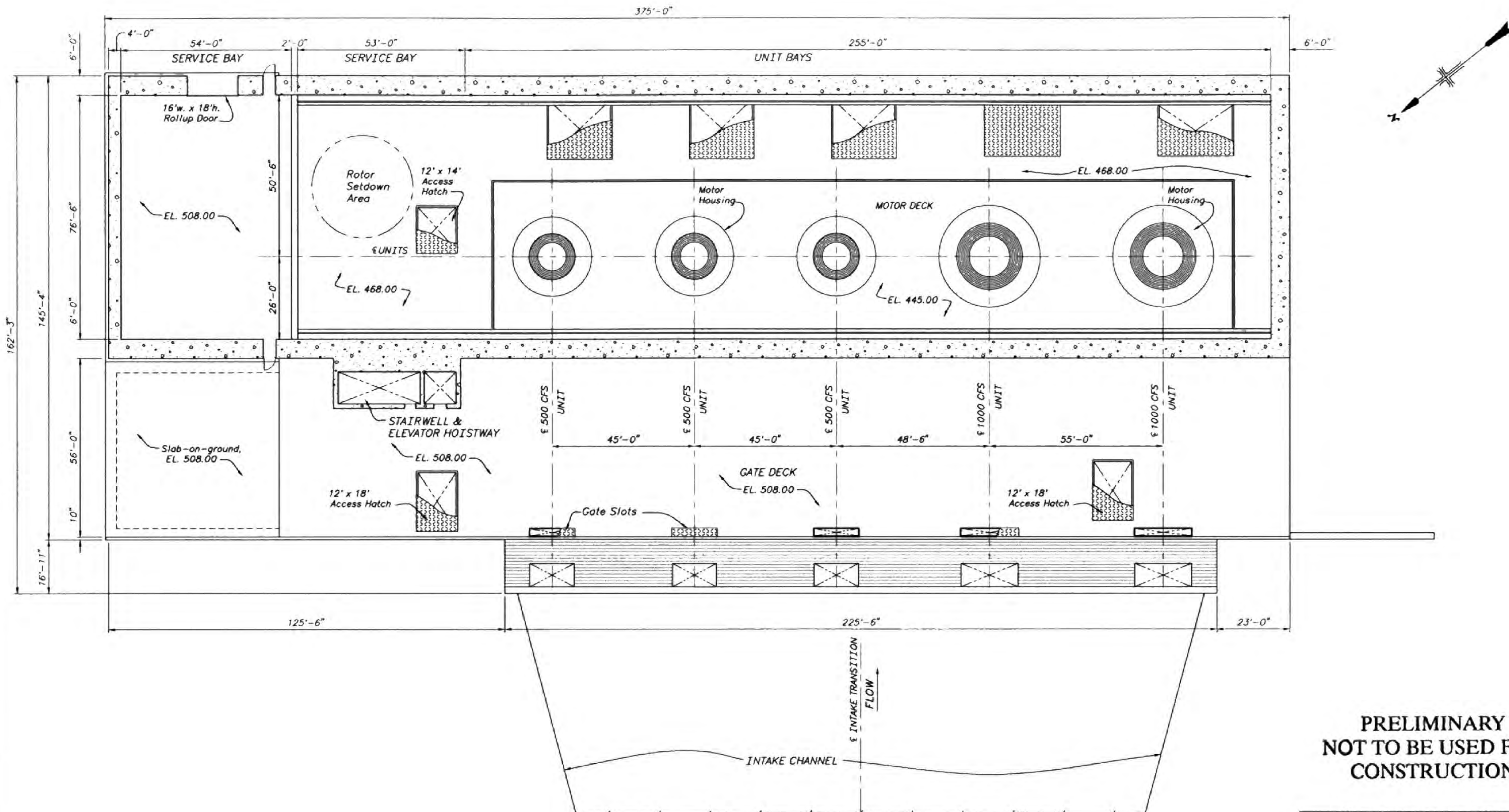

PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION

PLAN – EL. 508.00, EL. 468.00 & El. 445.00 – SERVICE BAY, GATE DECK & MOTOR DECK

16 0 16 32
SCALE OF FEET

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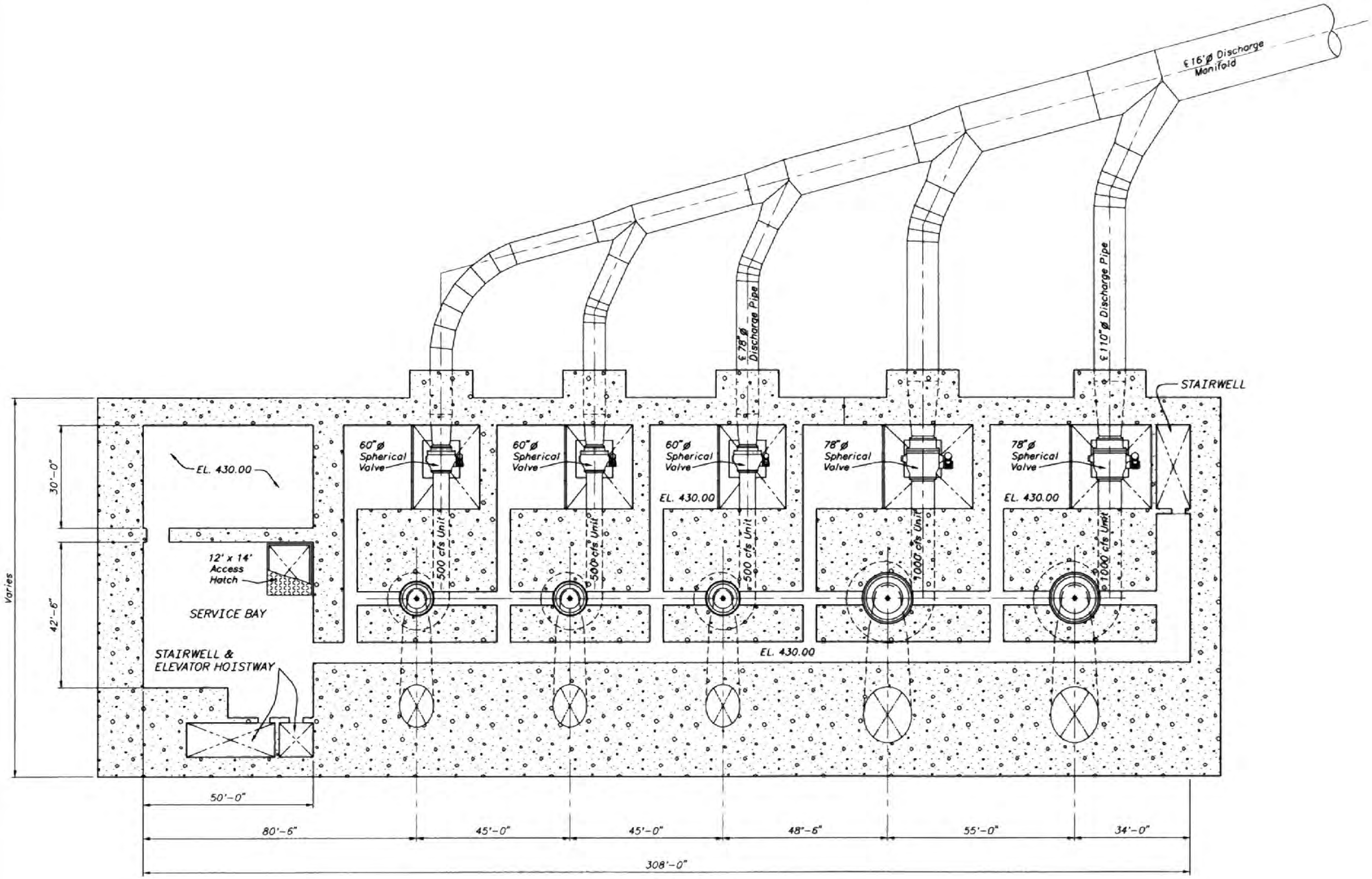
YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

PRIEST RAPIDS PUMPING PLANT – 3500 CFS OPTION
PLAN – EL. 508.00, EL. 468.00 & EL. 445.00

DESIGNED BY M. R. O'Shea
REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s
CADD FILENAME
DENVER, COLORADO
AUGUST 20, 2004
FIGURE 12



PLAN – EL. 430.00 – PUMP GALLERY

16 0 16 32
SCALE OF FEET

**PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION**

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
YAKIMA RIVER BASIN WATER STORAGE STUDY

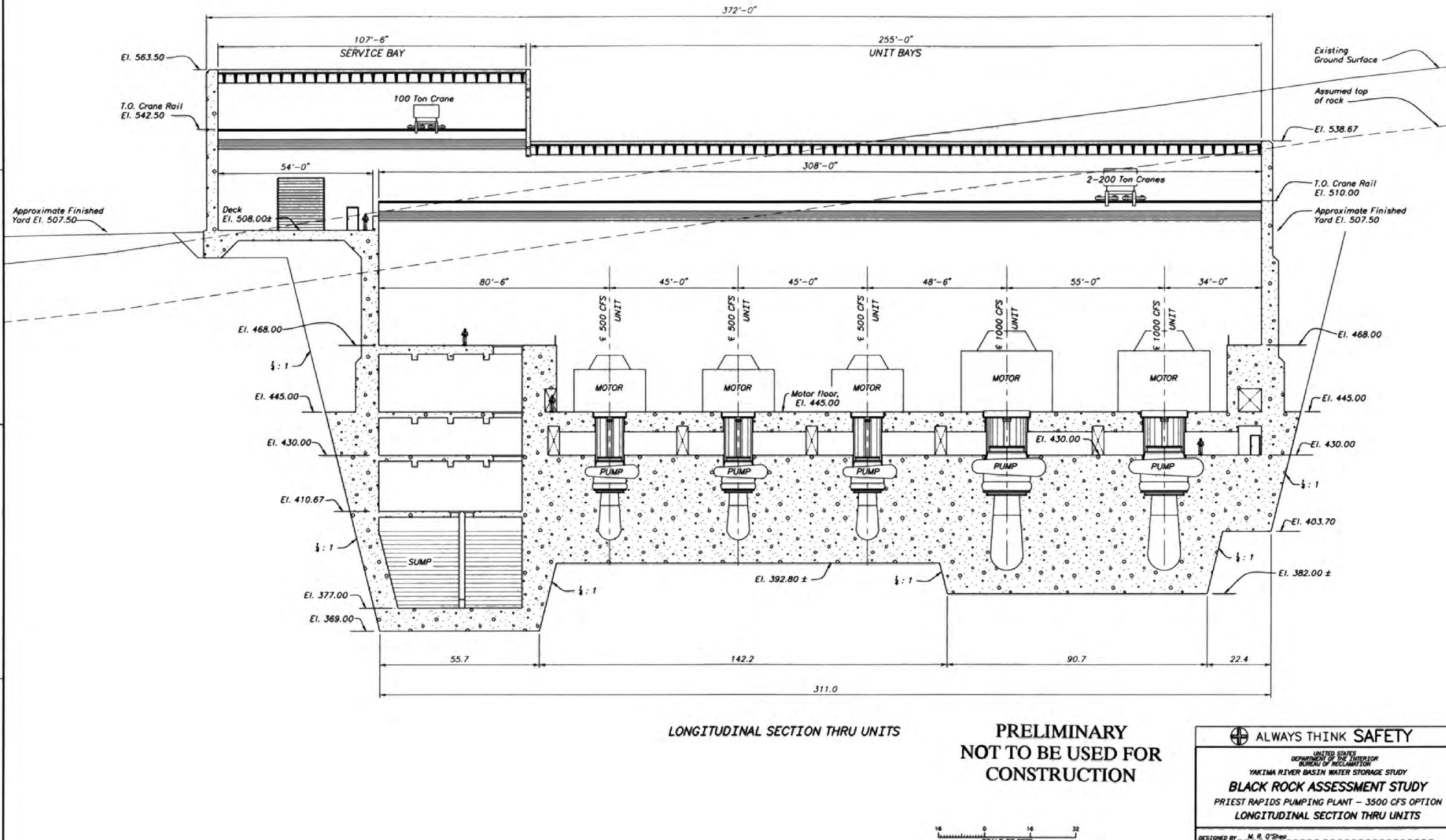
BLACK ROCK ASSESSMENT STUDY

PRIEST RAPIDS PUMPING PLANT – 3500 CFS OPTION

PLAN – EL. 430.00 – PUMP GALLERY

DESIGNED BY M. R. O'Shea
REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s | CADD FILENAME
DENVER, COLORADO | AUGUST 20, 2004 | FIGURE 13



LONGITUDINAL SECTION THRU UNITS

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BLACK ROCK ASSESSMENT STUDY

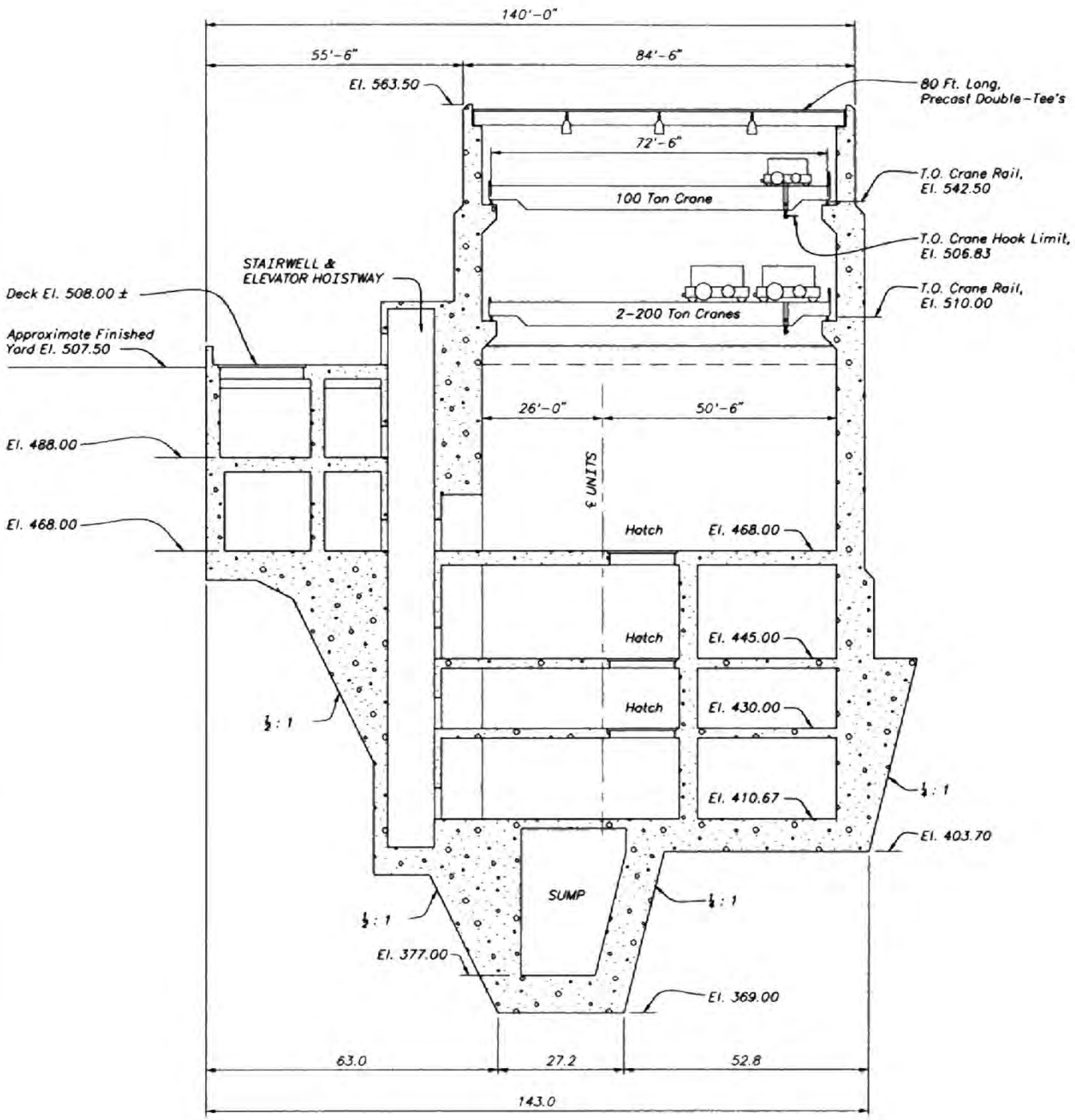
PRIEST RAPIDS PUMPING PLANT – 3500 CFS OPTION

LONGITUDINAL SECTION THRU UNITS

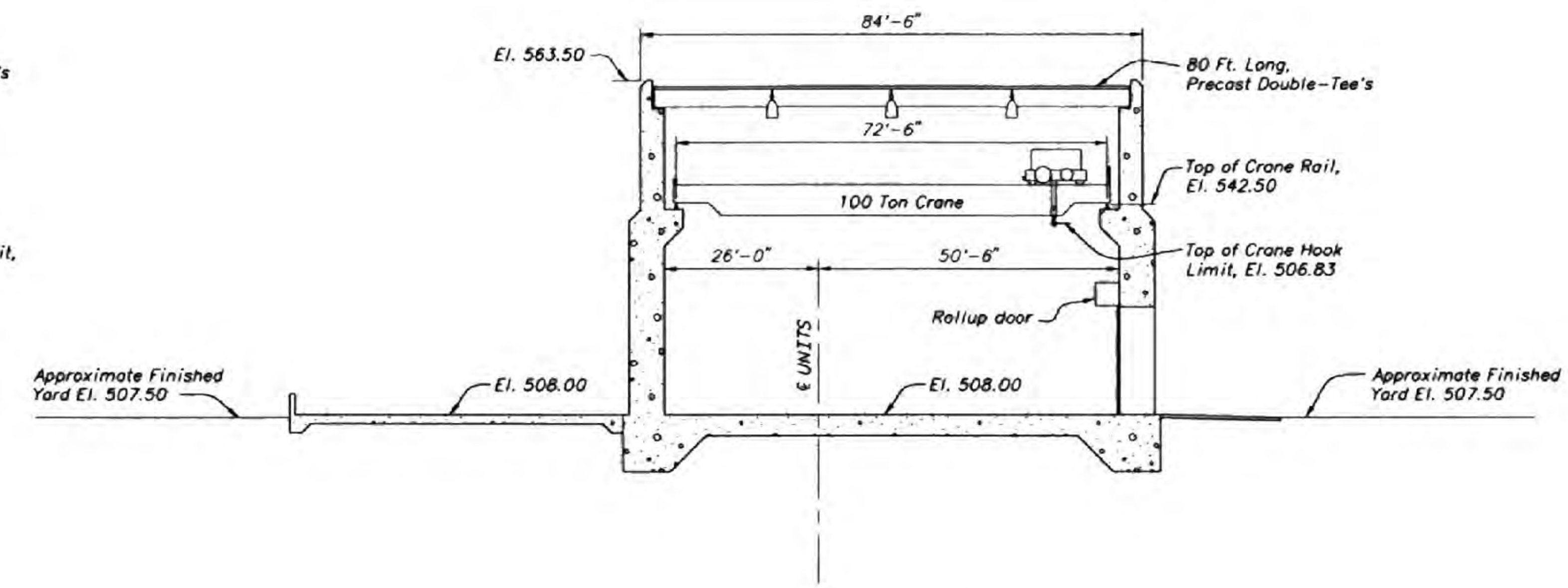
DESIGNED BY M. R. O'Shea

REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s | CADD FILENAME
DENVER, COLORADO | AUGUST 20, 2004 | FIGURE 14



TRANSVERSE SECTION THRU SERVICE BAY



TRANSVERSE SECTION THRU SERVICE ENTRANCE

PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION

16 0 16 32
SCALE OF FEET

ALWAYS THINK SAFETY

UNITED STATES
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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

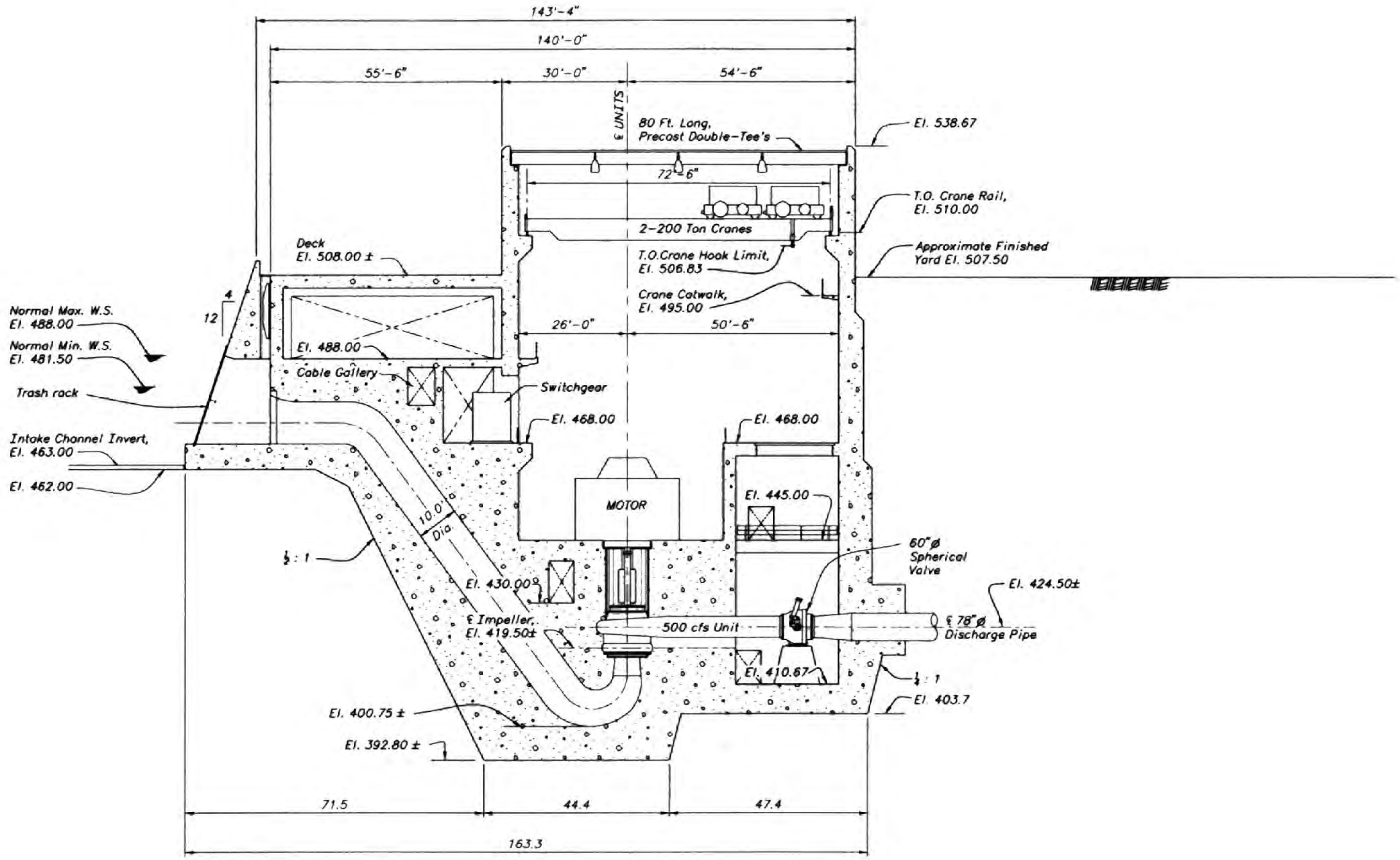
PRIEST RAPIDS PUMPING PLANT – 3500 CFS OPTION

TRANSVERSE SECTIONS THRU THE SERVICE BAY

DESIGNED BY M. R. O'Shea
REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s
CADD FILENAME
DENVER, COLORADO
AUGUST 20, 2004

FIGURE 15



TRANSVERSE SECTION THRU 500 CFS UNIT

SCALE OF FEET

PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

PRIEST RAPIDS PUMPING PLANT – 3500 CFS OPTION

SECTION THRU 500 CFS UNIT

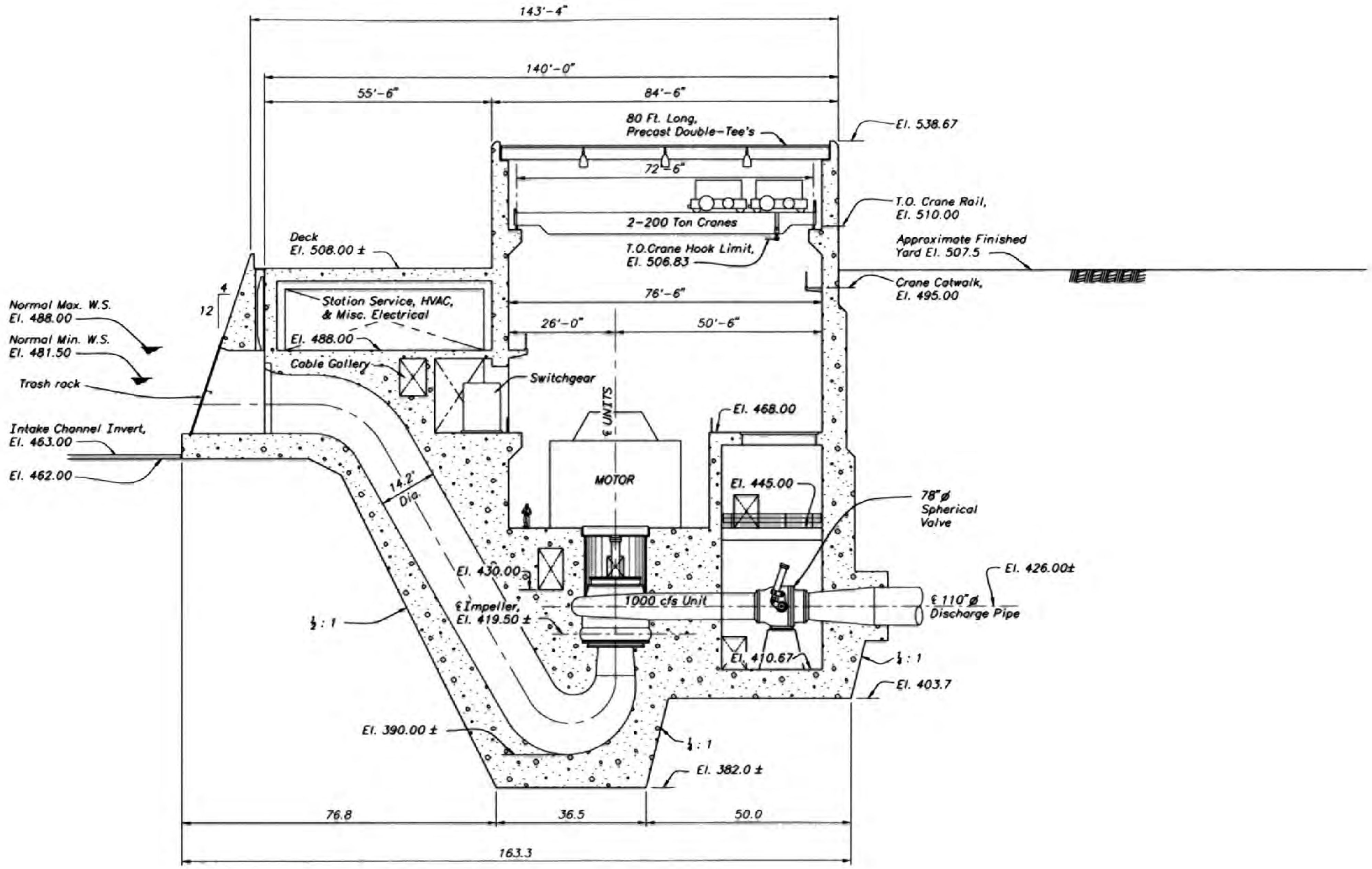
DESIGNED BY M. R. O'Shea

REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s | CADD FILENAME

AUGUST 20, 2004

FIGURE 16



TRANSVERSE SECTION THRU 1000 CFS UNIT

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

PRIEST RAPIDS PUMPING PLANT – 3500 CFS OPTION

SECTION THRU 1000 CFS UNIT

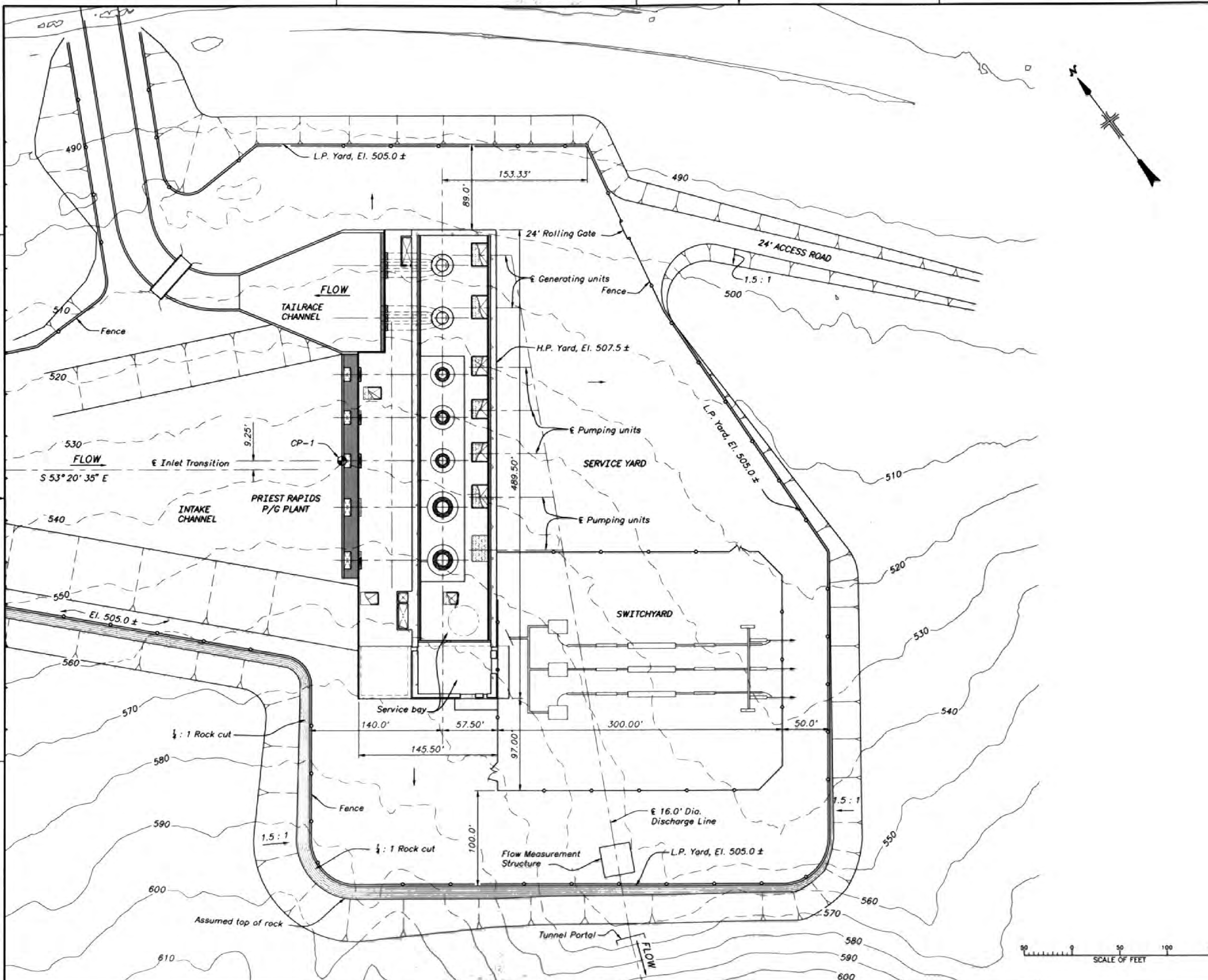
DESIGNED BY M. R. O'Shea

REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s
CADD FILENAME
DENVER, COLORADO
AUGUST 20, 2004

FIGURE 17

16 0 16 32
SCALE OF FEET



PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION

NOTES

1. Top of rock is assumed to be 20 ft. below existing ground surface throughout the plant site.
2. Temporary and permanent rock cut slopes are ¼ : 1.
3. Permanent cut slopes in overburden are 1.5 : 1.
4. Control Point, CP-1 coordinates are:

   N 476,929.58
   E 1,785,051.47

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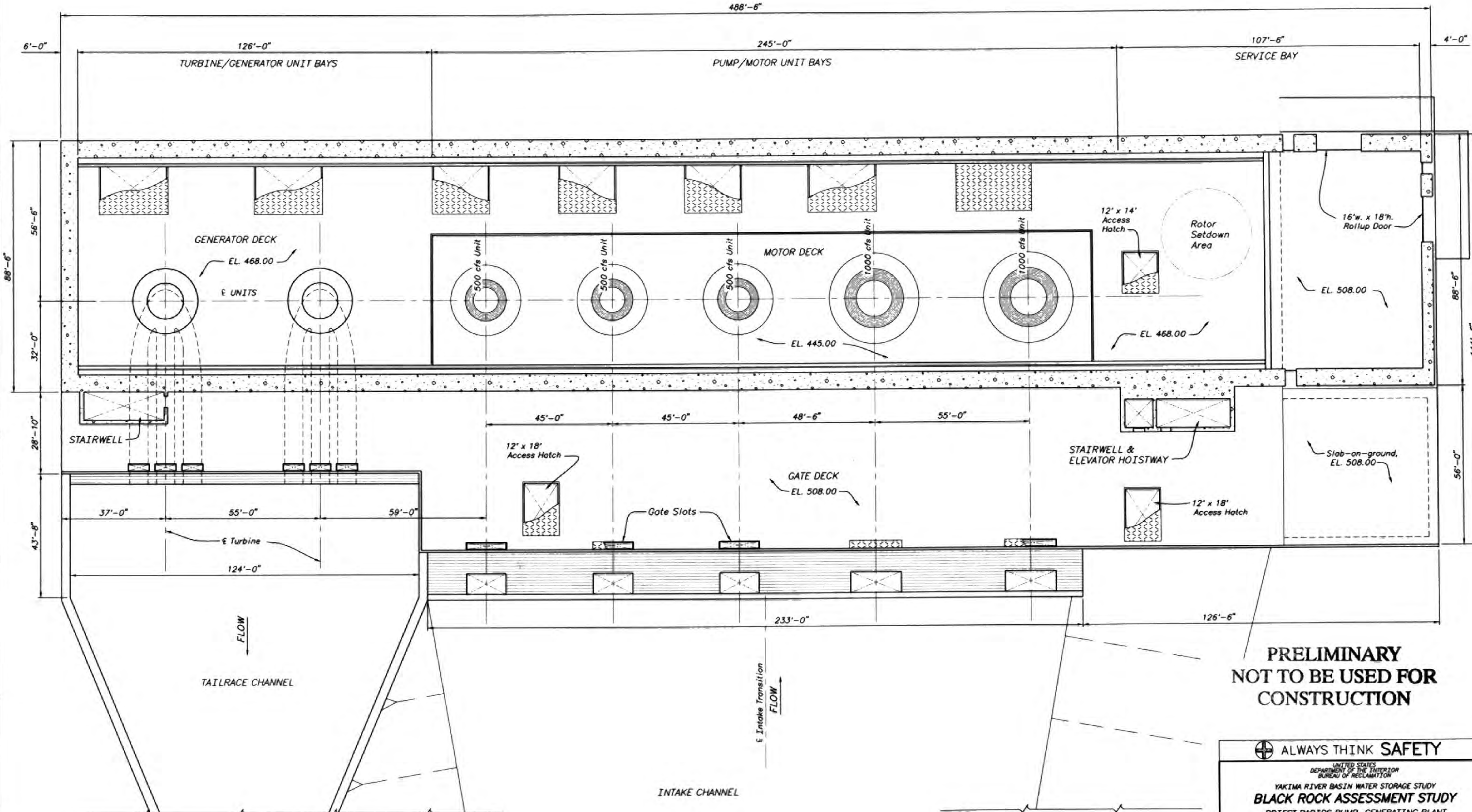
YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

PRIEST RAPIDS PUMP-GENERATING PLANT
3500 CFS OPTION
SITE PLAN

DESIGNED BY M. R. O'Shea
REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 15.06 | CADD FILENAME
DENVER, COLORADO AUGUST 20, 2004 | FIGURE 18



PLAN – EL. 508.00, EL. 468.00 & El. 445.00 – SERVICE BAY, GATE DECK & MOTOR DECK

SCALE OF FEET

PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION

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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

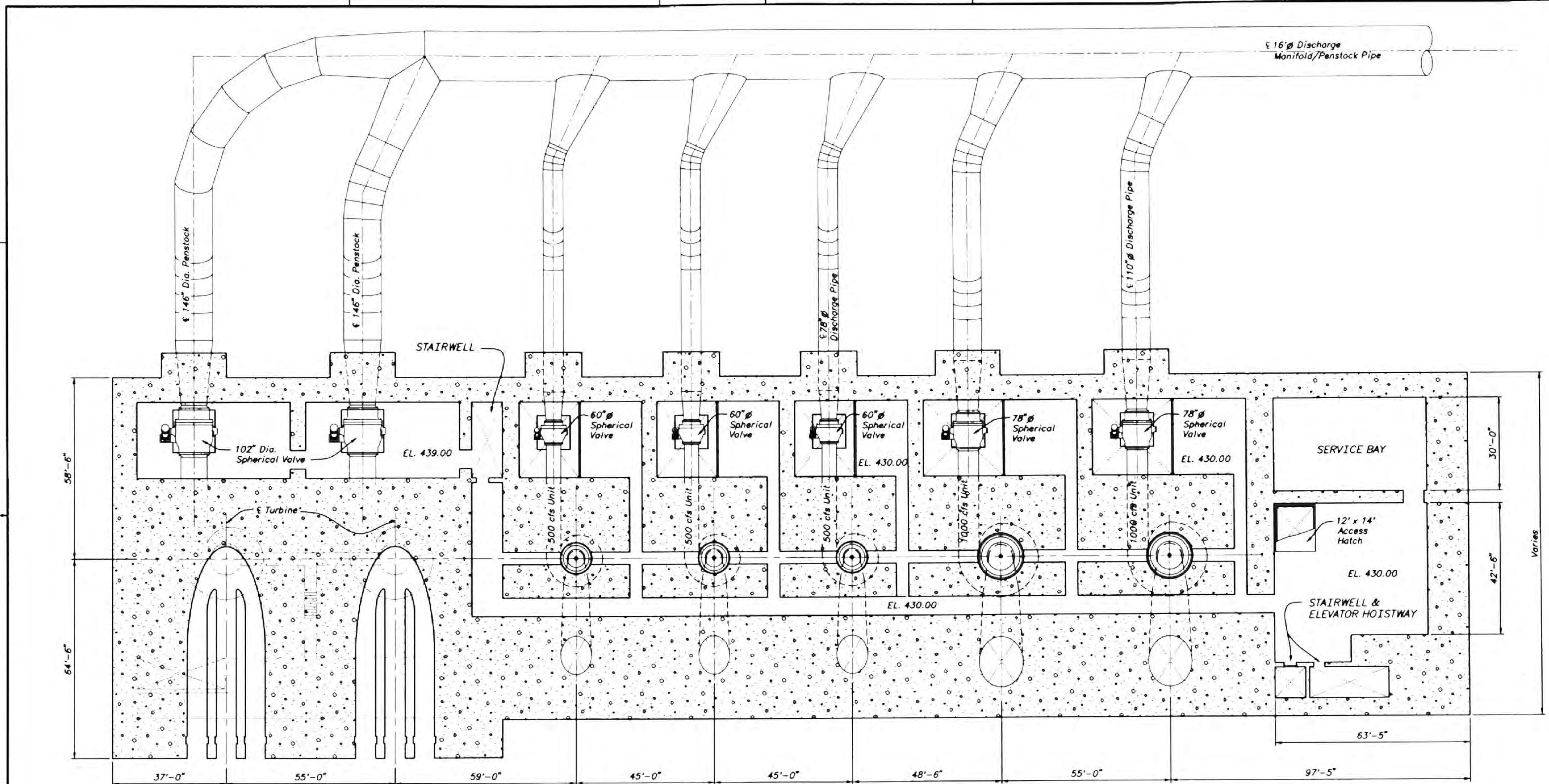
PRIEST RAPIDS PUMP–GENERATING PLANT
3500 CFS OPTION

PLAN – EL. 508.00, EL. 468.00 & EL. 445.00

DESIGNED BY M. R. O'Shea

REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 15.06 | CADD FILENAME
DENVER, COLORADO | AUGUST 20, 2004 | FIGURE 19



PLAN – EL. 430.00 – PUMP GALLERY

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

16 0 16 32
SCALE OF FEET

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

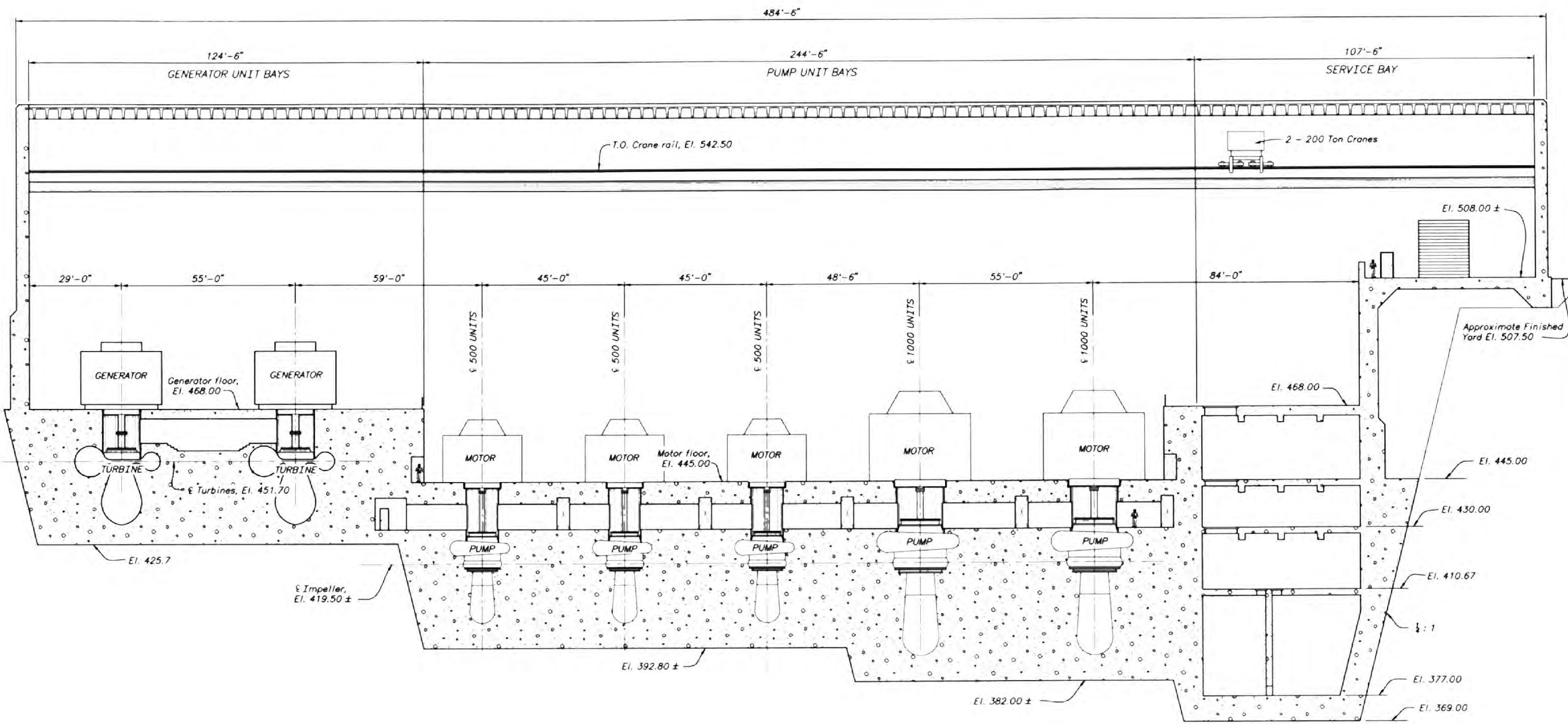
YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

PRIEST RAPIDS PUMP-GENERATING PLANT
3500 CFS OPTION
PLAN – EL. 430.00 – PUMP GALLERY

DESIGNED BY M. R. O'Shea
REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rev. 15.06 | CADD FILENAME
DENVER, COLORADO | AUGUST 20, 2004 | FIGURE 20



LONGITUDINAL SECTION THRU UNITS

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

16 0 16 32
SCALE OF FEET

ALWAYS THINK **SAFETY**

UNITED STATES
DEPARTMENT OF THE INTERIOR
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YAKIMA RIVER BASIN WATER STORAGE STUDY

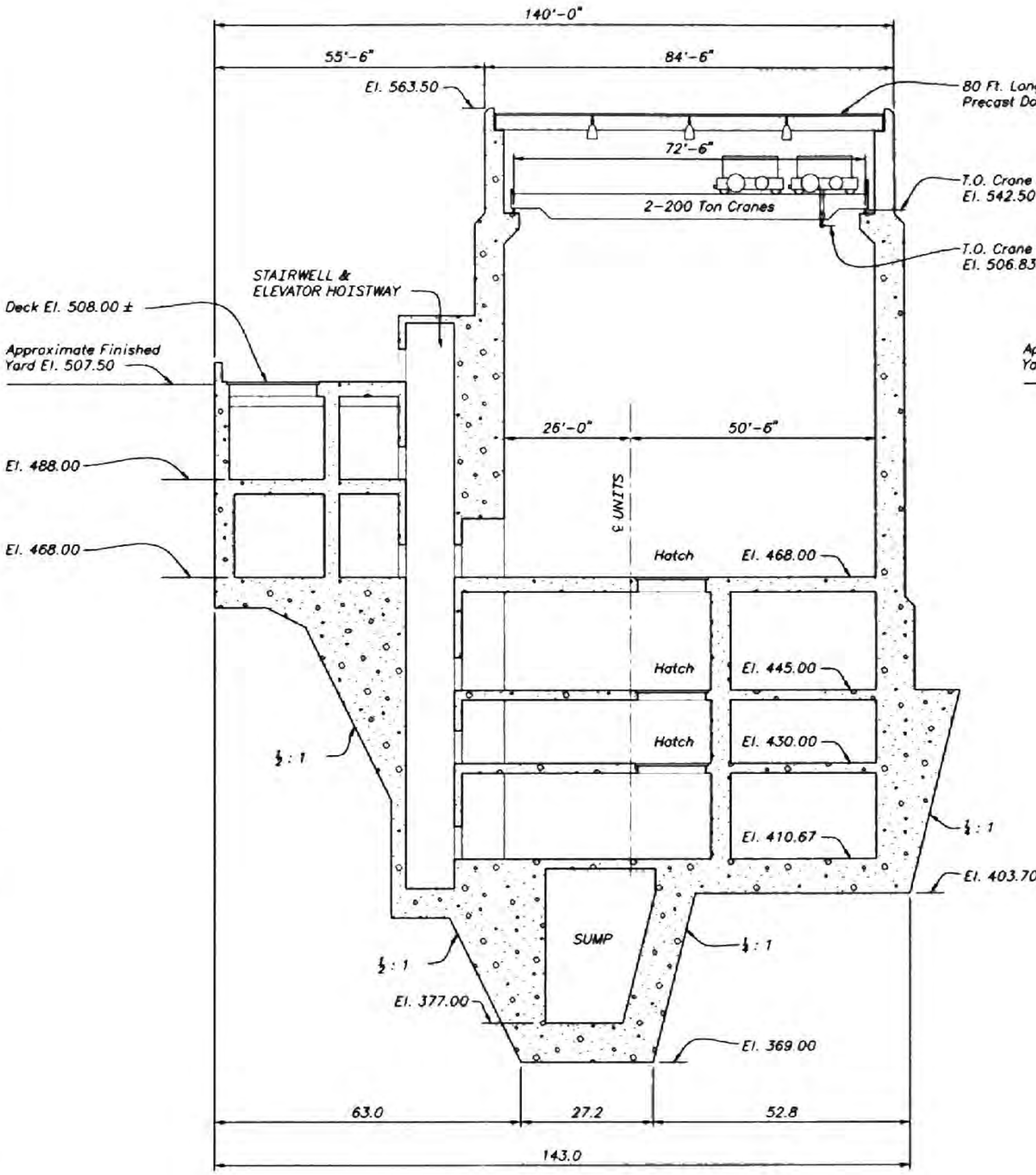
BLACK ROCK ASSESSMENT STUDY

PRIEST RAPIDS PUMP-GENERATING PLANT
3500 CFS OPTION

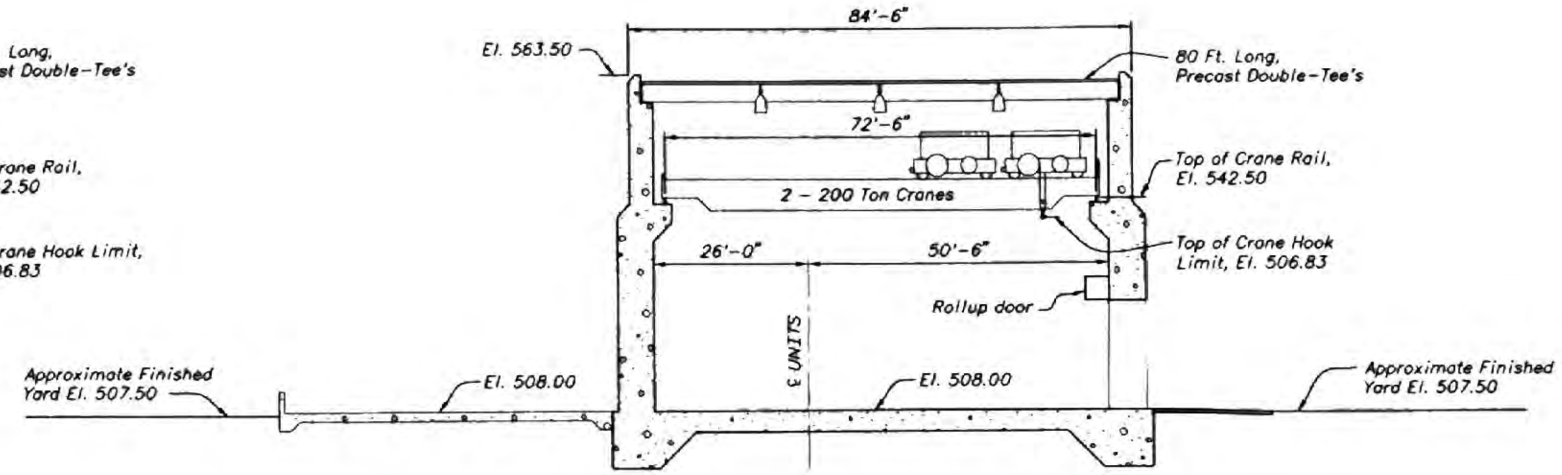
LONGITUDINAL SECTION

DESIGNED BY M. R. O'Shea
REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 15.06	CADD FILENAME
DENVER, COLORADO AUGUST 20, 2004	FIGURE 21



TRANSVERSE SECTION THRU SERVICE BAY



TRANSVERSE SECTION THRU SERVICE ENTRANCE

PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION

16 0 16 32
SCALE OF FEET

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
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YAKIMA RIVER BASIN WATER STORAGE STUDY

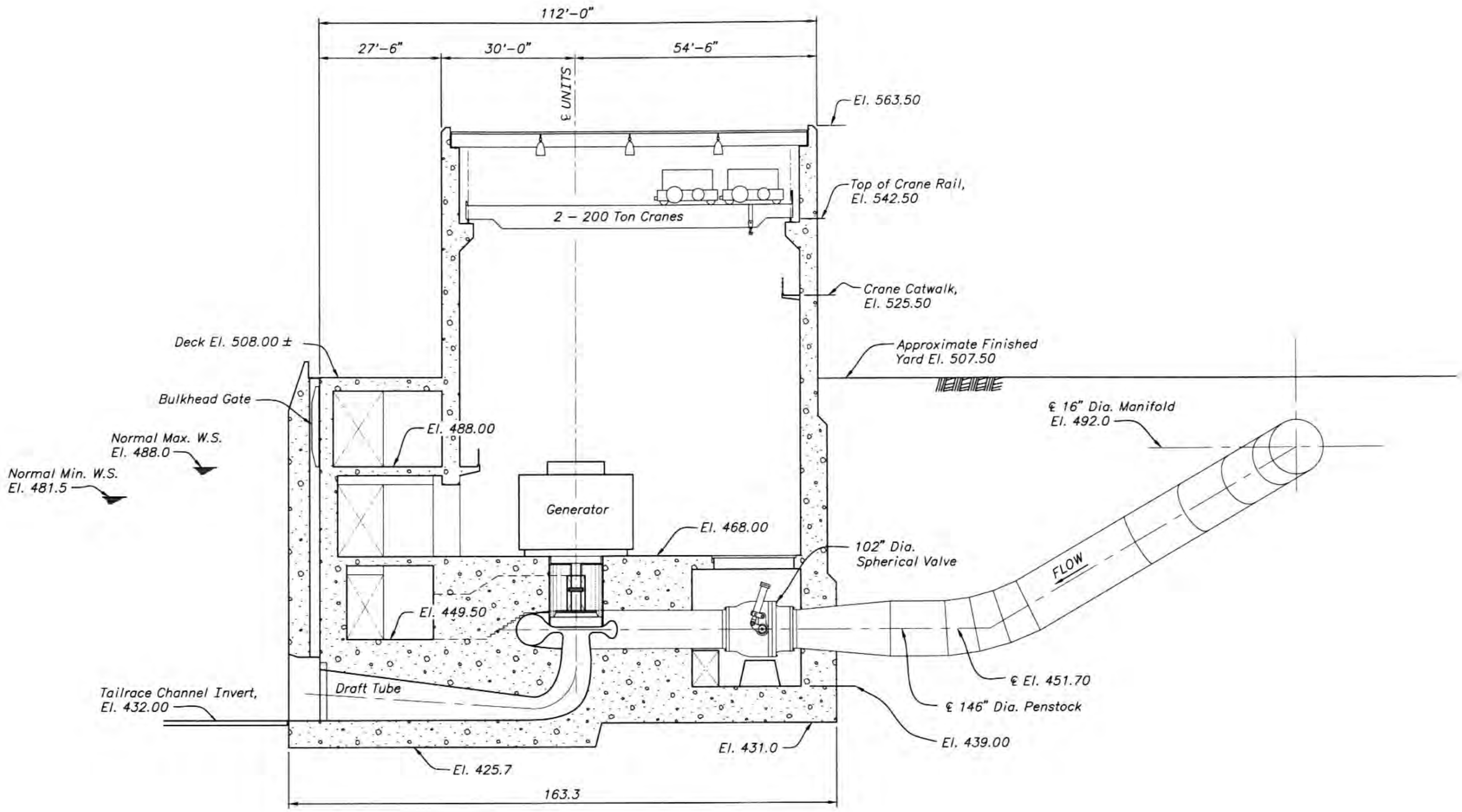
BLACK ROCK ASSESSMENT STUDY

PRIEST RAPIDS PUMP-GENERATING PLANT
3500 CFS OPTION

TRANSVERSE SECTIONS THRU SERVICE BAY

DESIGNED BY M. R. O'Shea
REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 14.0s | CADD FILENAME
DENVER, COLORADO | AUGUST 20, 2004 | FIGURE 22



TRANSVERSE SECTION THRU TURBINE/GENERATOR

PRELIMINARY NOT TO BE USED FOR CONSTRUCTION

8 0 8 16
SCALE OF FEET

ALWAYS THINK SAFETY

UNITED STATES
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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

PRIEST RAPIDS PUMP–GENERATING PLANT
3500 CFS OPTION

TRANSVERSE SECTION THRU GENERATOR

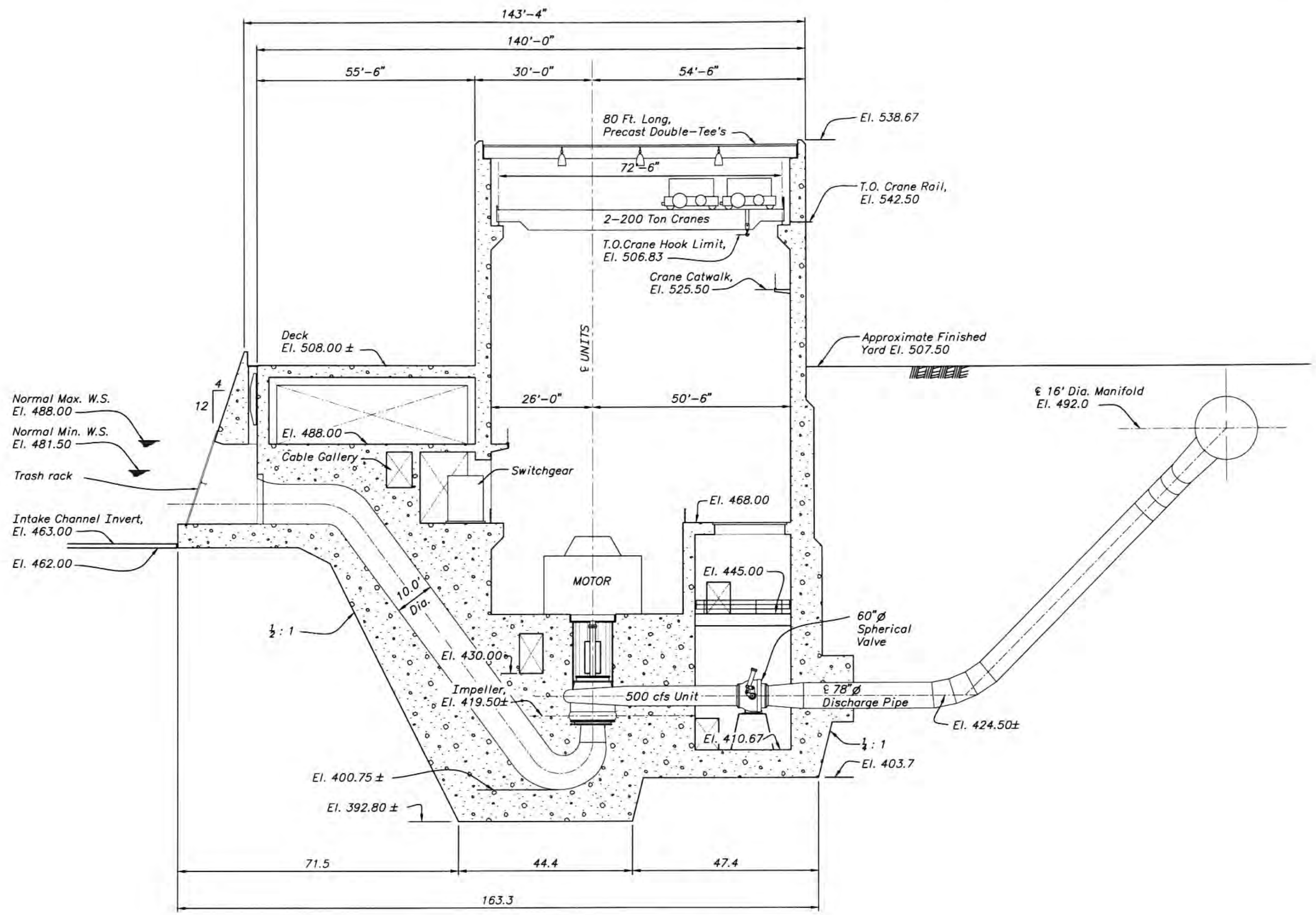
DESIGNED BY M. R. O'Shea

REVIEWED BY R. W. LaFond, P.E.

STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 15.06 | CADD FILENAME
DENVER, COLORADO | AUGUST 20, 2004 | FIGURE 23

FILE PATH:
PLOTTED BY:



TRANSVERSE SECTION THRU 500 CFS UNIT

PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION

16 0 16 32
SCALE OF FEET

ALWAYS THINK SAFETY

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YAKIMA RIVER BASIN WATER STORAGE STUDY

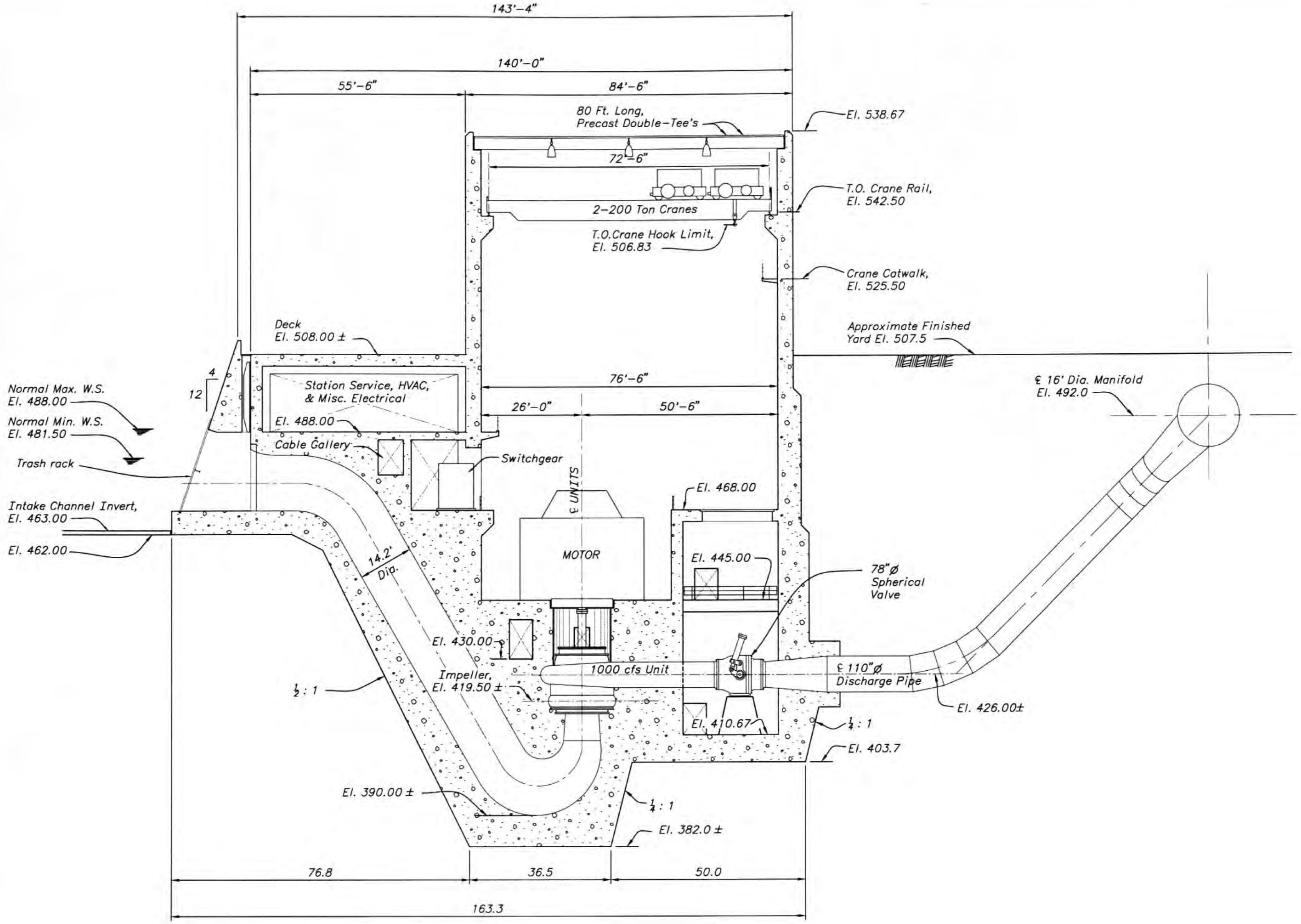
BLACK ROCK ASSESSMENT STUDY

PRIEST RAPIDS PUMP-GENERATING PLANT
3500 CFS OPTION
TRANSVERSE SECTION THRU 500 CFS UNIT

DESIGNED BY M. R. O'Shea
REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 15.06 | CADD FILENAME
DENVER, COLORADO | AUGUST 20, 2004 | FIGURE 24

FILE PATH:
PLOTTED BY:



TRANSVERSE SECTION THRU 1000 CFS UNIT

PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION

16 0 16 32
SCALE OF FEET

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
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YAKIMA RIVER BASIN WATER STORAGE STUDY

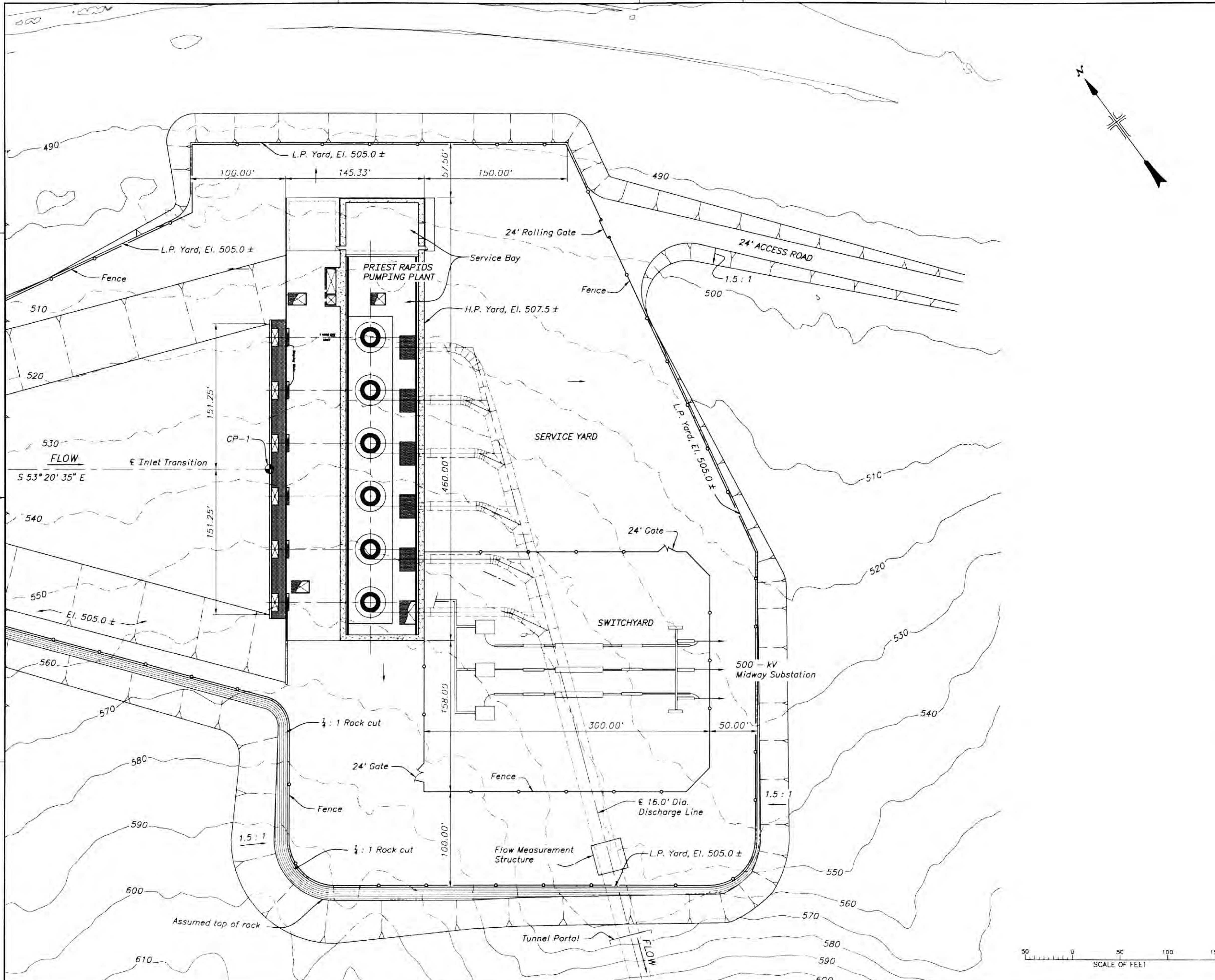
BLACK ROCK ASSESSMENT STUDY

PRIEST RAPIDS PUMP-GENERATING PLANT
3500 CFS OPTION
TRANSVERSE SECTION 1000 CFS UNIT

DESIGNED BY M. R. O'Shea
REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 15.06 | CADD FILENAME
DENVER, COLORADO | AUGUST 20, 2004 | FIGURE 25

FILE PATH:
PLOTTED BY:



PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

NOTES

1. Top of rock is assumed to be 20 ft. below existing ground surface throughout the plant site.
2. Temporary and permanent rock cut slopes are $\frac{1}{4}$: 1.
3. Permanent cut slopes in overburden are 1.5 : 1.
4. Control Point, CP-1 coordinates are:

   N 476,929.58
   E 1,785,051.47

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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

PRIEST RAPIDS PUMPING PLANT – 6000 CFS OPTION

SITE PLAN

DESIGNED BY M. R. O'Shea

REVIEWED BY R. W. LaFond, P.E.

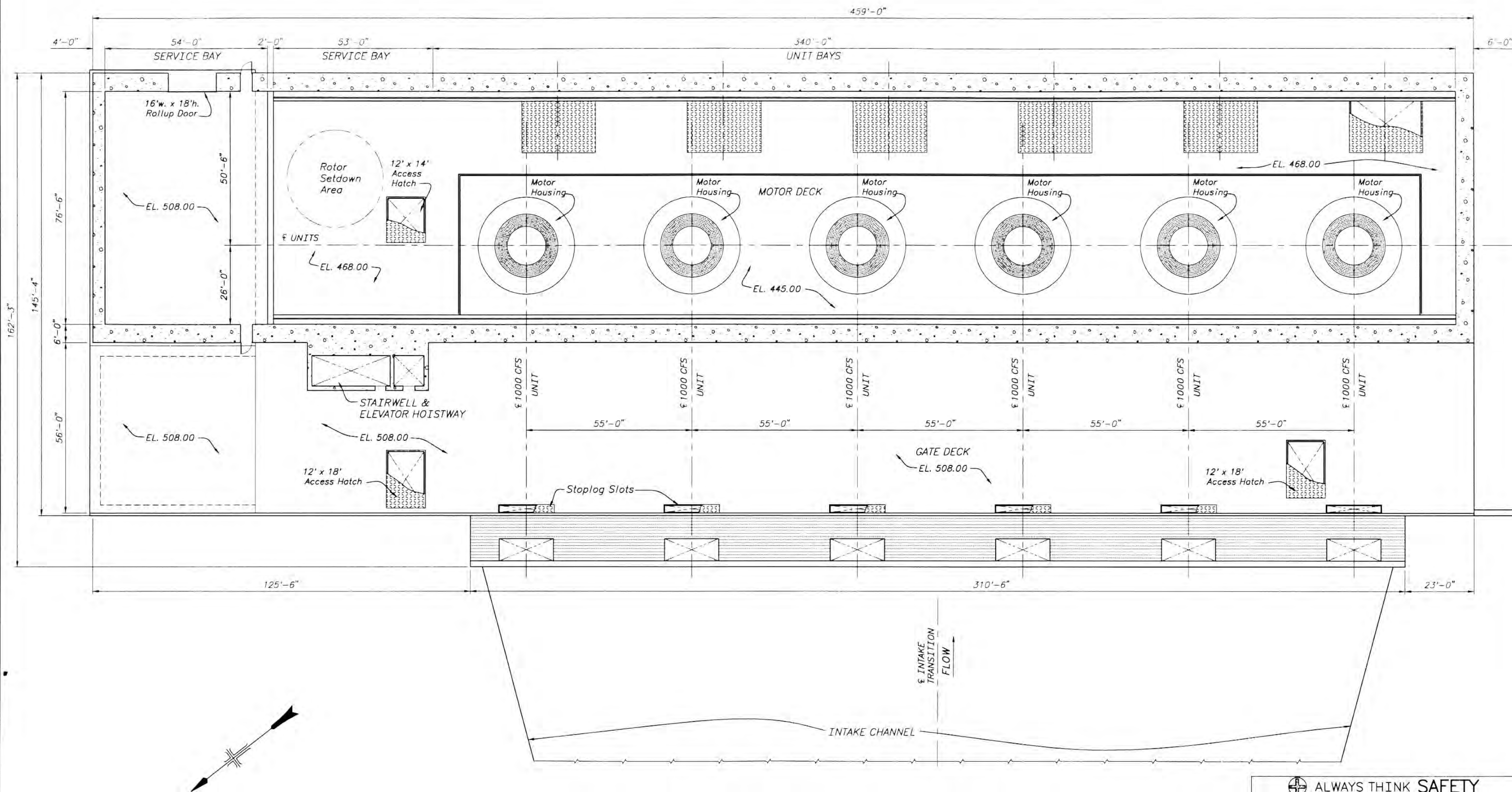
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 15.06
DENVER, COLORADO AUGUST 20, 2004

CADD FILENAME

FIGURE 26

FILE PATH: H:\CivilEng Share\PROJ\Yakima Storage Study\BRR Assessment Study\Plant Structures\Drawings\Priest Rapids PP\6000 CFS OPTION\
PLOTTED BY:



PLAN – EL. 508.00, EL. 468.00 & El. 445.00 – SERVICE BAY, GATE DECK & MOTOR DECK

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

16 0 16 32
SCALE OF FEET

ALWAYS THINK SAFETY

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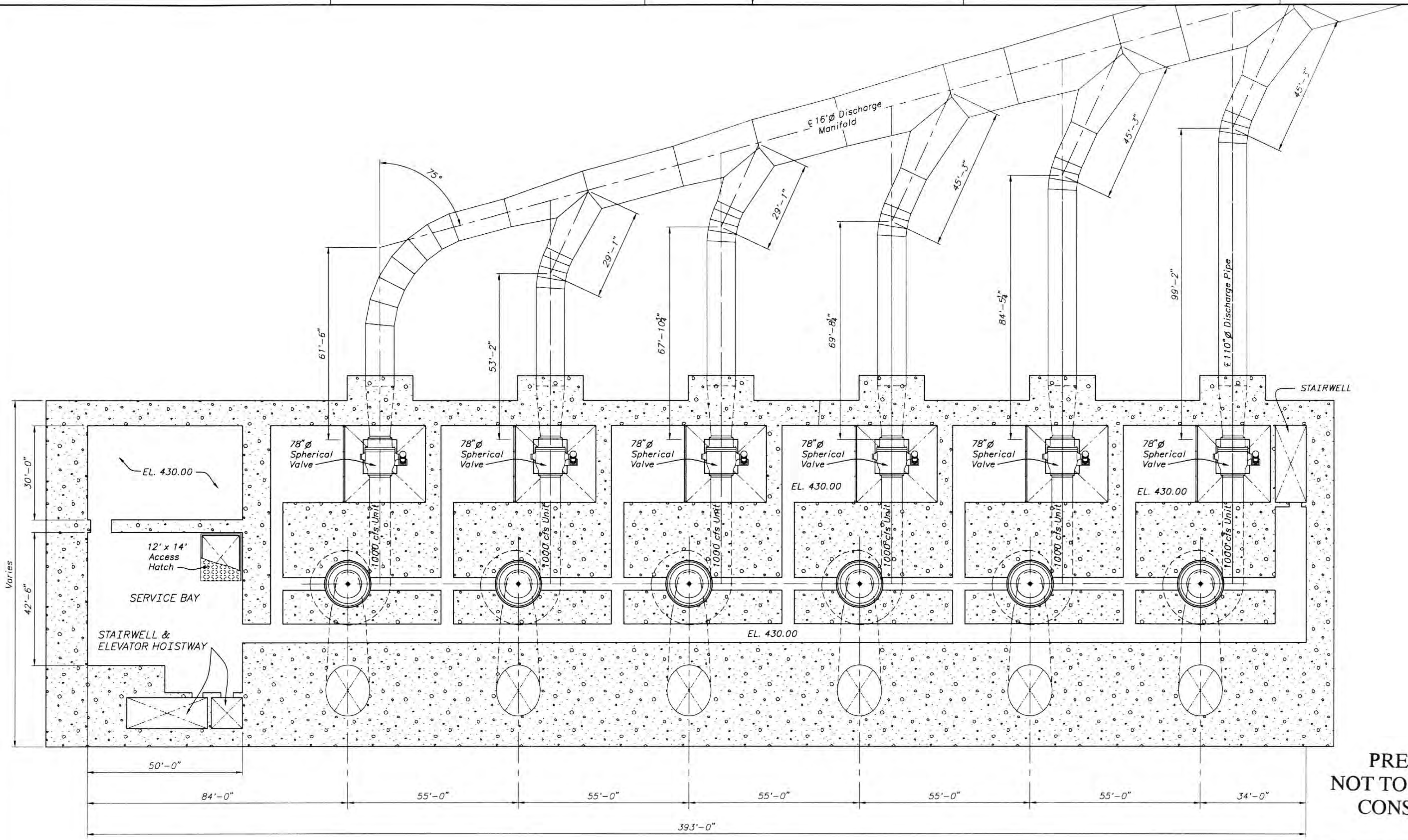
BLACK ROCK ASSESSMENT STUDY

PRIEST RAPIDS PUMPING PLANT – 6000 CFS OPTION
PLAN – EL. 508.00, EL. 468.00 & EL. 445.00

DESIGNED BY M. R. O'Shea
REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0a
CADD FILENAME
DENVER, COLORADO
AUGUST 20, 2004
FIGURE 27

FILE PATH: H:\HOME\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\PLANT STRUCTURES\DRAWINGS\PRIEST RAPIDS PP\6000 CFS OPTION
PLOTTED BY:



PLAN – EL. 430.00 – PUMP GALLERY

PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION

SCALE OF FEET (16 0 16 32)

ALWAYS THINK SAFETY

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YAKIMA RIVER BASIN WATER STORAGE STUDY

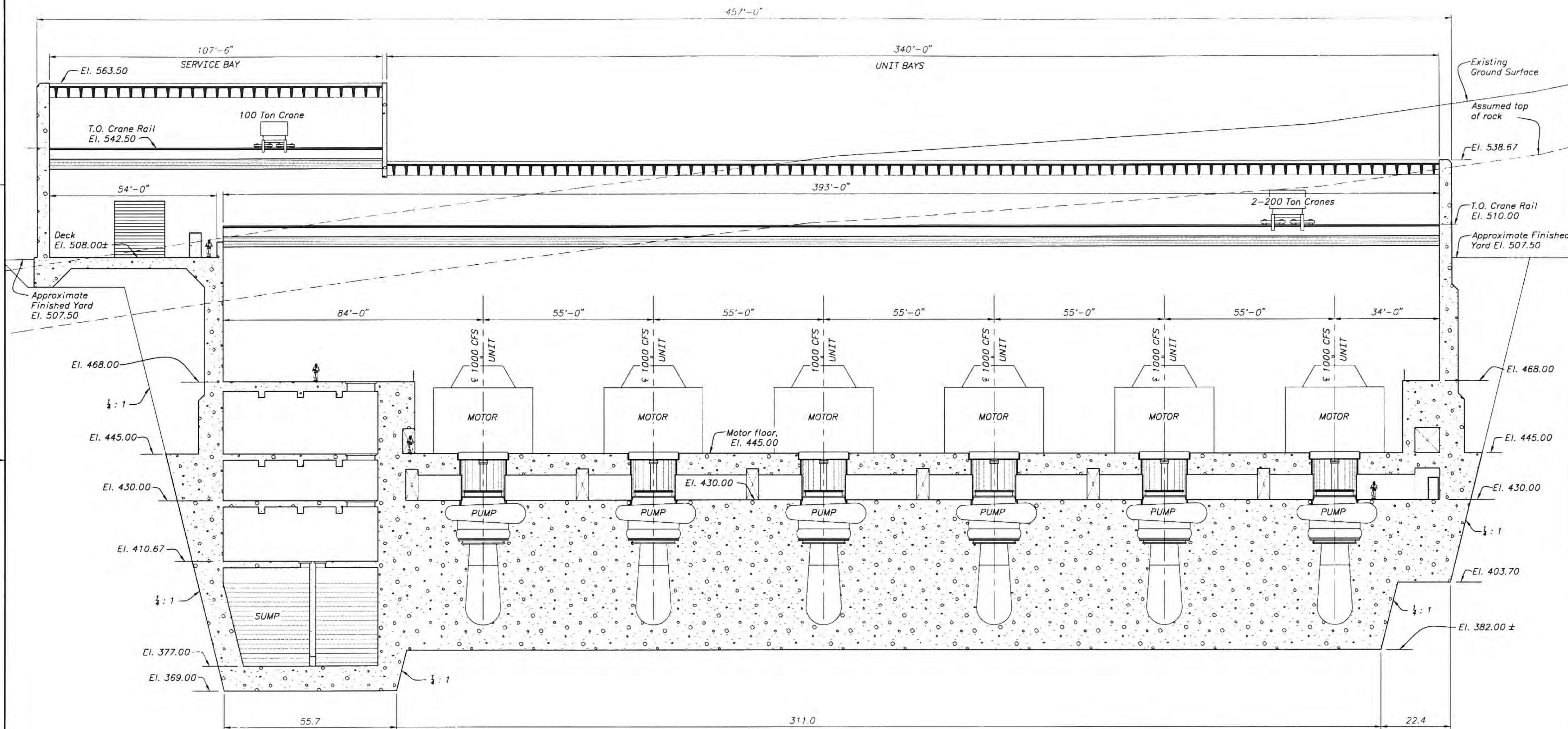
BLACK ROCK ASSESSMENT STUDY

PRIEST RAPIDS PUMPING PLANT – 6000 CFS OPTION
PLAN – EL. 430.00 – PUMP GALLERY

DESIGNED BY M. R. O'Shea
REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s | CADD FILENAME
DENVER, COLORADO | AUGUST 20, 2004 | FIGURE 28

FILE PATH: H:\HOME\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\PLANT STRUCTURES\DRAWINGS\PRIEST RAPIDS PP\6000 CFS OPTION
PLOTTED BY:



LONGITUDINAL SECTION THRU UNITS

PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION

16 0 16 32
SCALE OF FEET

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

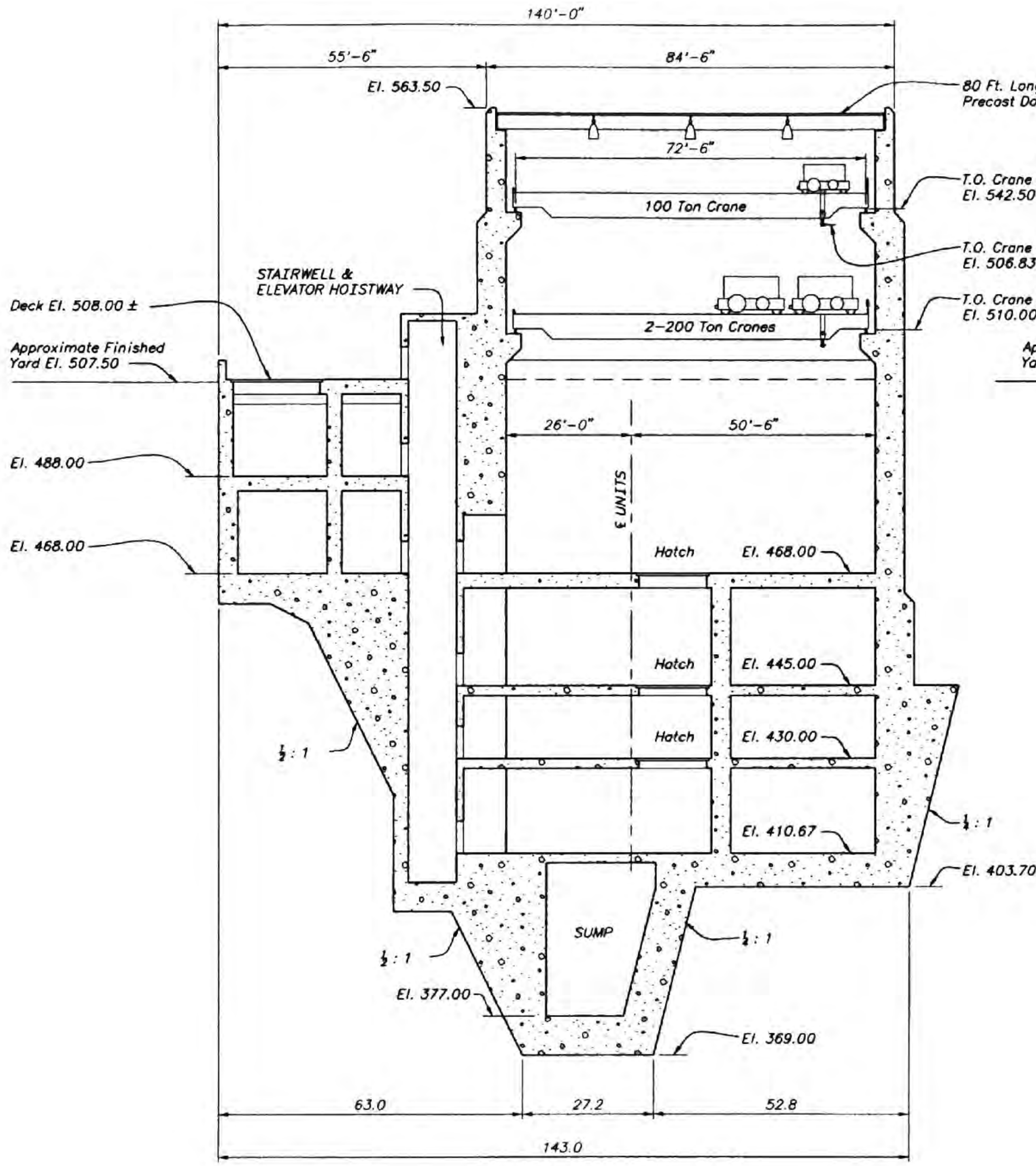
PRIEST RAPIDS PUMPING PLANT – 6000 CFS OPTION

LONGITUDINAL SECTION THRU UNITS

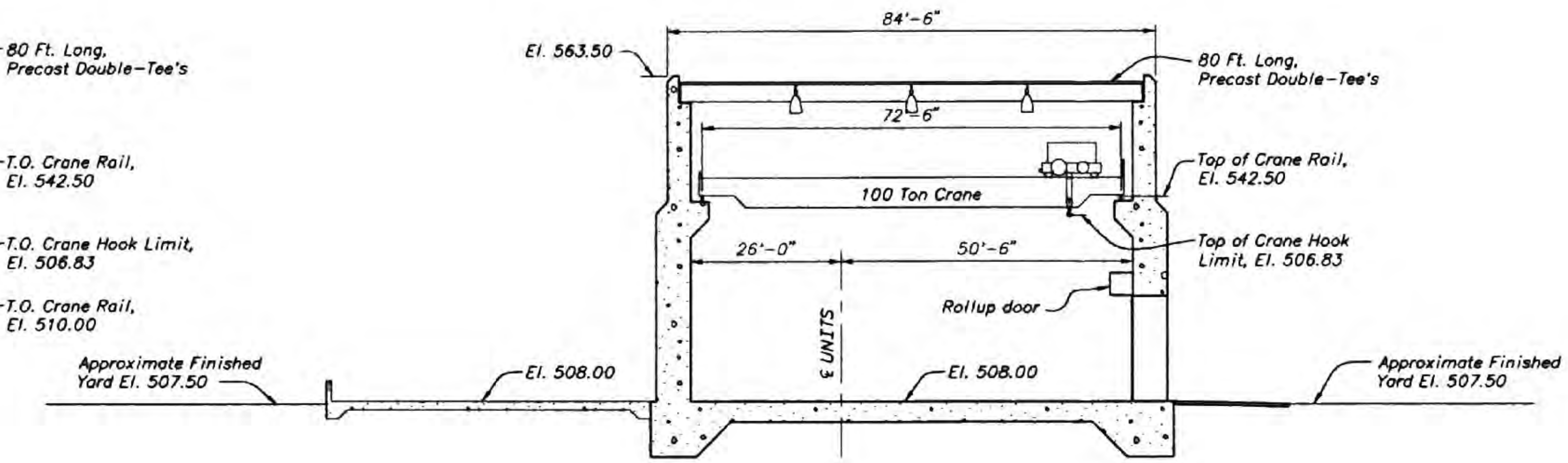
DESIGNED BY M. R. O'Shea
REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s
CADD FILENAME
DENVER, COLORADO
AUGUST 20, 2004
FIGURE 29

FILE PATH: H:\HOME\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\PLANT STRUCTURES\DRAWINGS\PRIEST RAPIDS PP\6000 CFS OPTION
PLOTTED BY:



TRANSVERSE SECTION THRU SERVICE BAY



TRANSVERSE SECTION THRU SERVICE ENTRANCE

PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION

16 0 16 32
SCALE OF FEET

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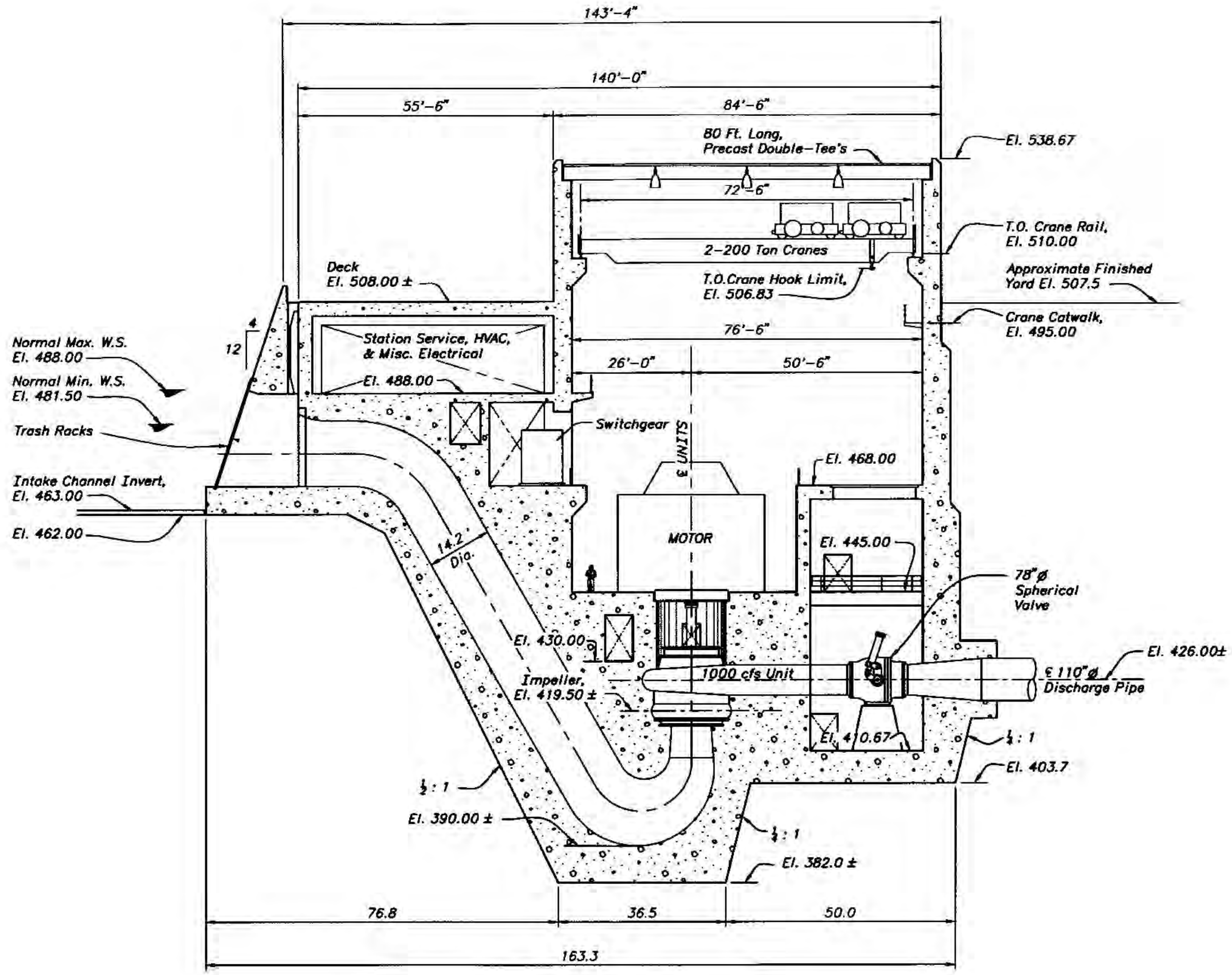
YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

PRIEST RAPIDS PUMPING PLANT – 6000 CFS OPTION
TRANSVERSE SECTIONS THRU THE SERVICE BAY

DESIGNED BY M. R. O'Shea
REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0a | CADD FILENAME
DENVER, COLORADO | AUGUST 20, 2004 | FIGURE 30



TRANSVERSE SECTION THRU 1000 CFS UNIT

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

16 0 16 32
SCALE OF FEET

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

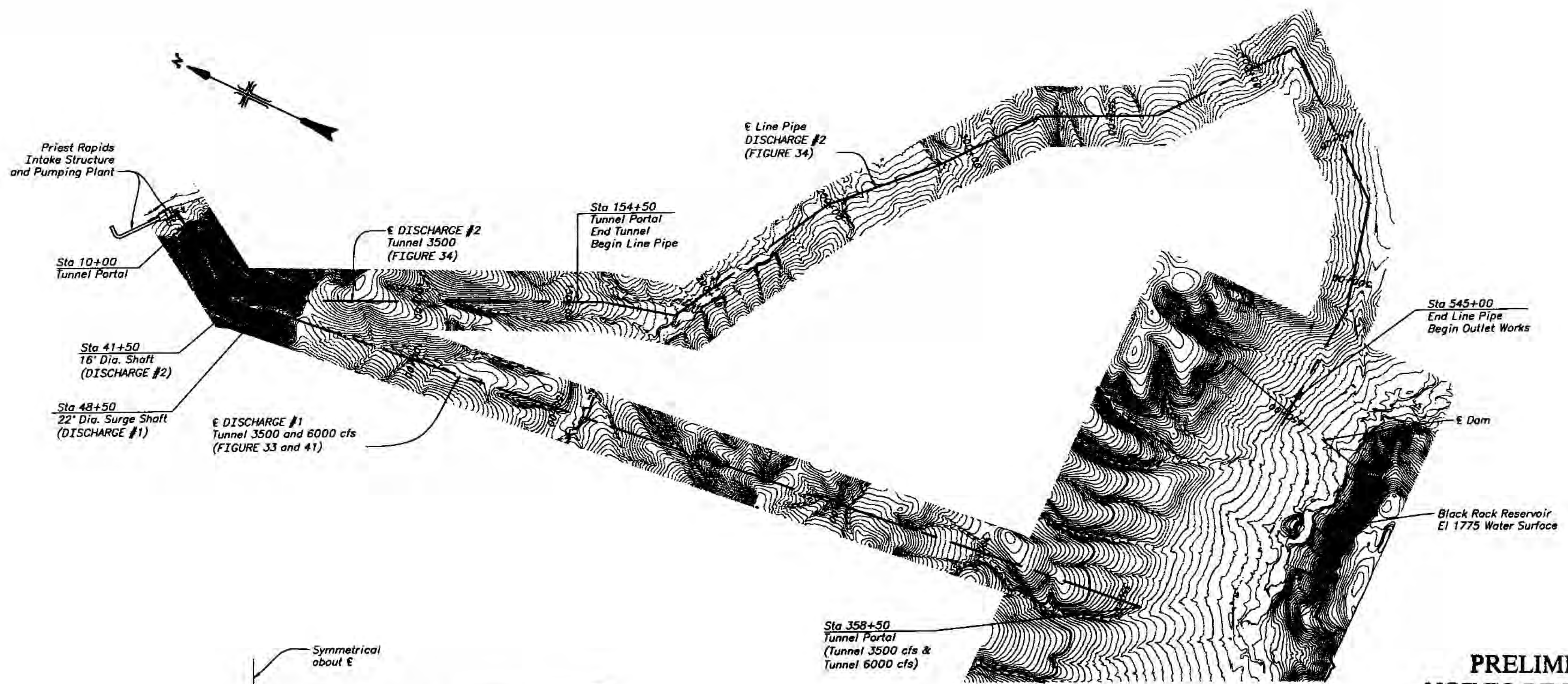
PRIEST RAPIDS PUMPING PLANT – 6000 CFS OPTION
SECTION THRU 1000 CFS UNIT

DESIGNED BY M. R. O'Shea
REVIEWED BY R. W. LaFond, P.E.
STRUCTURAL AND ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s
DENVER, COLORADO
CADD FILENAME
AUGUST 20, 2004

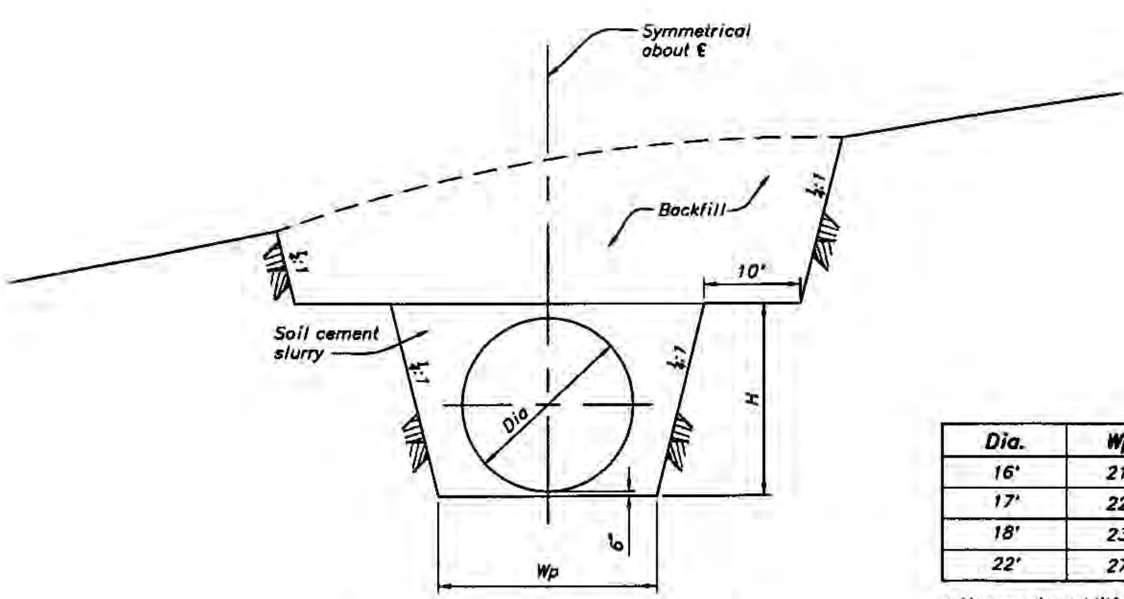
FIGURE 31

FIGURE 32



PLAN

2000 0 2000 4000 6000
SCALE OF FEET



TYPICAL PIPE TRENCH SECTION

Dia.	Wp	H	Description	Alternative
16'	21'	18'	Discharge Line	Tunnel/Pipeline 3500 cfs and Tunnel 3500 cfs
17'	22'	19'	Line Pipe	Tunnel/Pipeline 3500 cfs
18'	23'	20'	Line Pipe	Tunnel/Pipeline 3500 cfs
22'	27'	24'*	Discharge Line	Tunnel 6000 cfs

* May require additional benches during final design

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

NOTES

1. For Tunnel 3500 cfs profile, see FIGURE 33.
2. For Tunnel/Pipeline 3500 cfs profile, see FIGURE 34.
3. For Tunnel 6000 cfs profile, see FIGURE 41.
4. For tunnel sections, see FIGURE 37.
5. For surge tank and shaft details, see FIGURE 38.

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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

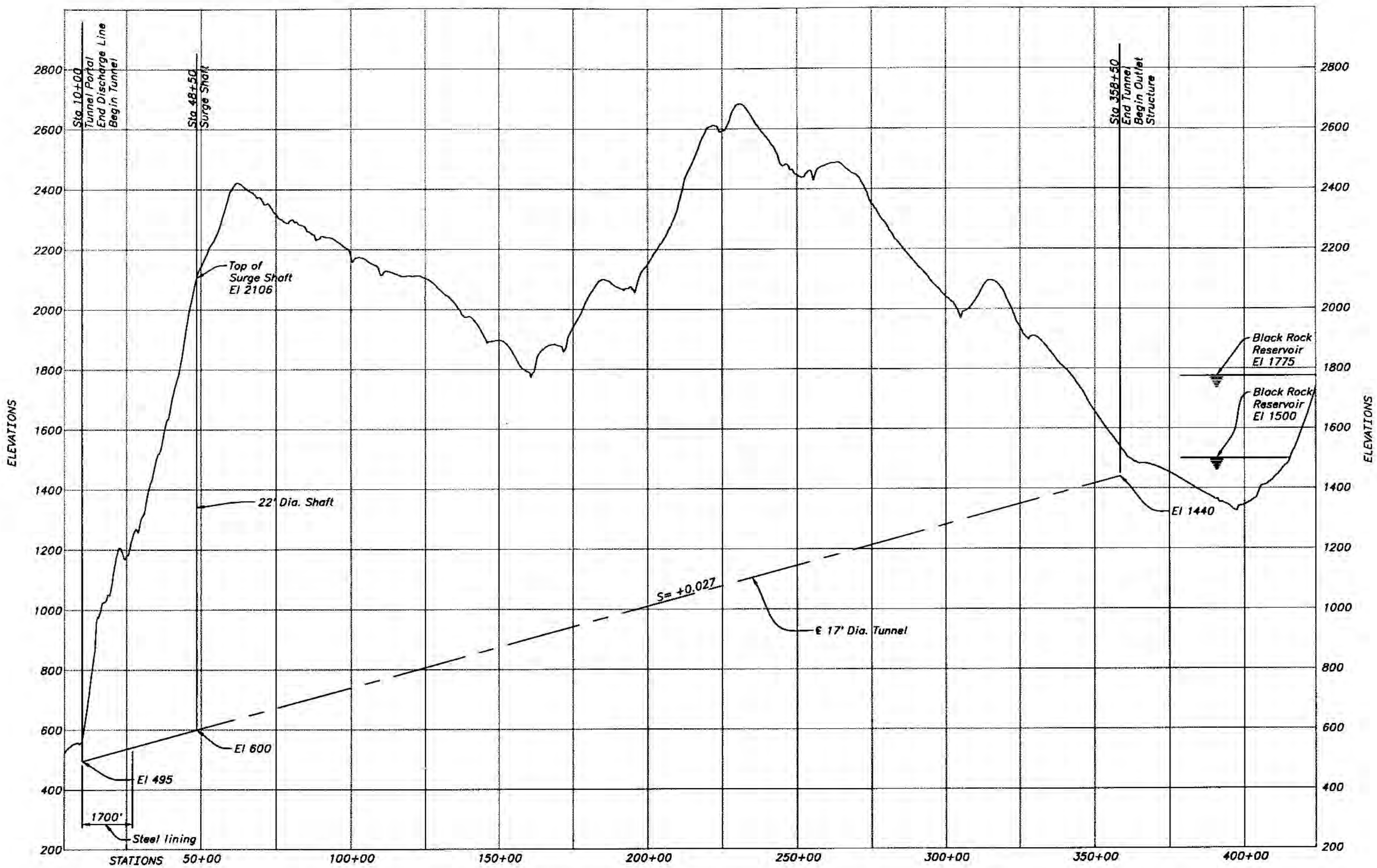
INFLOW OPTIONS
PLAN AND SECTION

DESIGNED Linda M Bowles PE
REVIEWED BY Richard P. Fuest P.E.
WATER CONVEYANCE GROUP

CADD SYSTEM AutoCAD Rel. 15.0a
DENVER, COLORADO APRIL 23, 2004 SHEET 1 OF 4
CADD FILENAME FIGURES 32 AND 34.DWG
FIGURE 32

FILE PATH: H:\HOME\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\WATER CONVEYANCE\
PLOTTED BY: LBOWLES
AUGUST 5, 2004 07:54

FIGURE 33



PROFILE

NOTES

1. For plan, see FIGURE 32.
2. For tunnel sections and details, see FIGURE 37.
3. For shaft section and details, see FIGURE 38.

PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION

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UNITED STATES
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BUREAU OF RECLAMATION
YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

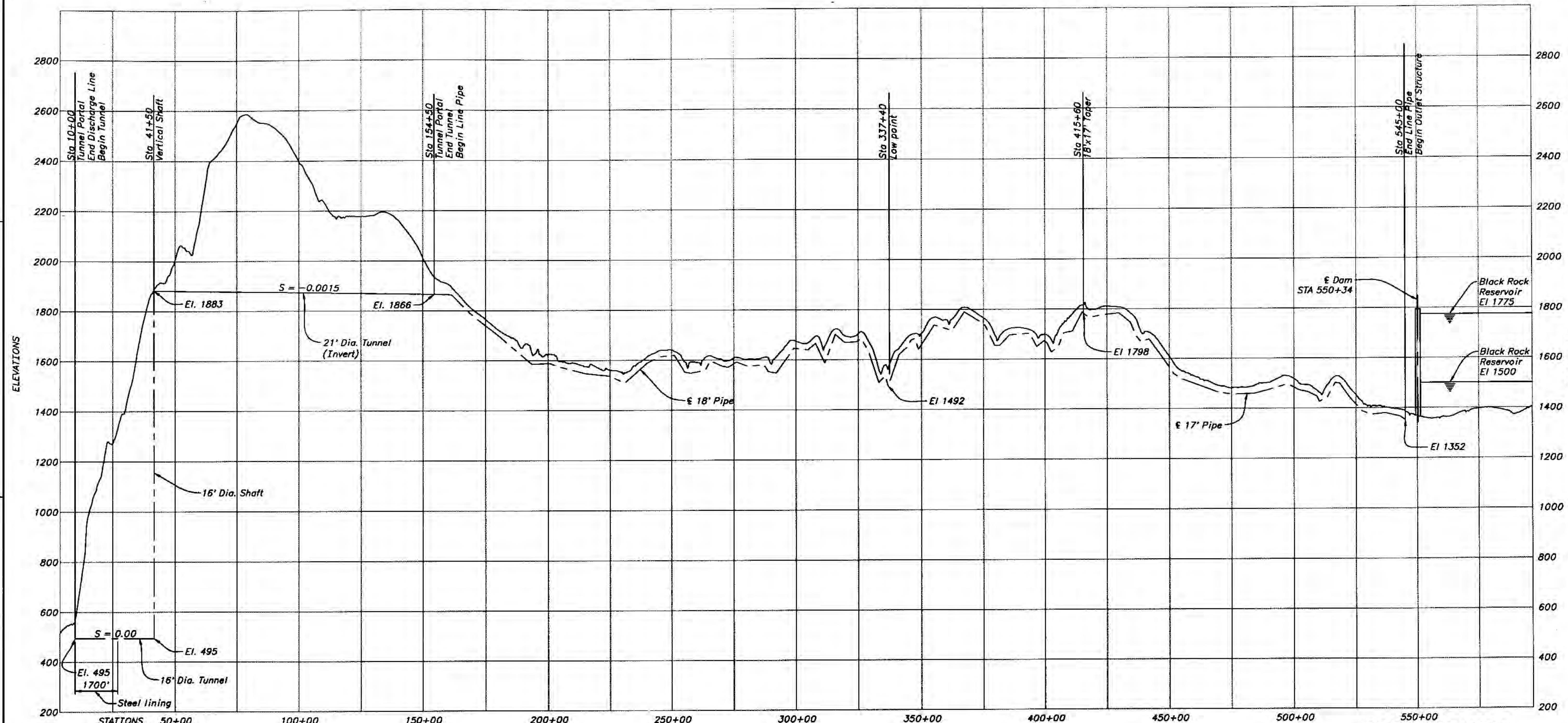
INFLOW 3500 CFS TUNNEL OPTION
TUNNEL PROFILE

DESIGNED Rick M Benik PE
REVIEWED BY Richard P. Fernandez PE
WATER CONVEYANCE GROUP

CADD SYSTEM AutoCAD Rel. 16.0a
DENVER, COLORADO APRIL 23, 2004
SHEET 2 OF 4
CADD FILENAME FIGURE 33.DWG
FIGURE 33

FILE PATH: H:\HOME\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\WATER CONVEYANCE\
PLOTTED BY: LBOWLES
AUGUST 5, 2004 08:22

FIGURE 34



PROFILE

PRELIMINARY
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CONSTRUCTION

NOTES

1. For plan, see FIGURE 32.
2. For tunnel sections and details, see FIGURE 37.
3. For shaft section and details, see FIGURE 38.

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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

INFLOW 3500 CFS TUNNEL/PIPE OPTION

PROFILE

DESIGNED Lily M Rendes PE

REVIEWED BY Roland P. Fuesch PE

Water Conveyance Group

CADD SYSTEM AutoCAD Rel. 16.0a | CADD FILENAME FIGURES 33 AND 34.DWG
DENVER, COLORADO APRIL 23, 2004 SHEET 3 OF 4 | FIGURE 34

FILE PATH: H:\HOME\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\WATER CONVEYANCE\
PLOTTED BY: LBOWLES
AUGUST 5, 2004 07:54

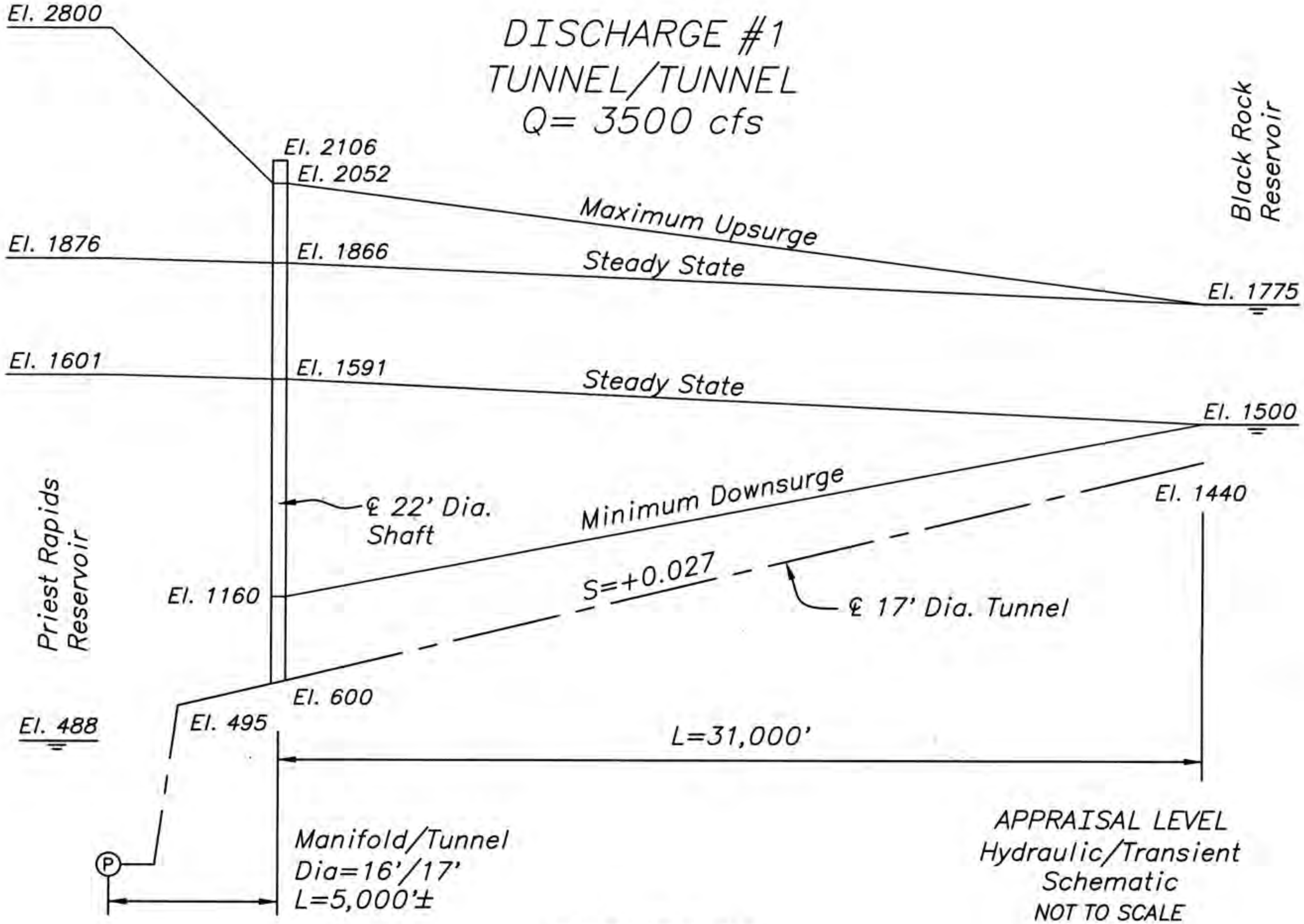

DISCHARGE #1
TUNNEL/TUNNEL
Q= 3500 cfs
El. 2800
El. 2106
El. 2052
Maximum Upsurge
Black Rock
Reservoir
El. 1876
El. 1866
Steady State
El. 1775
El. 1601
El. 1591
Steady State
El. 1500
Minimum Downsurge
El. 1440
℄ 22' Dia.
Shaft
Priest Rapids
Reservoir
El. 1160
S=+0.027
℄ 17' Dia. Tunnel
El. 600
El. 488
El. 495
L=31,000'
Manifold/Tunnel
Dia=16'/17'
L=5,000'±
P
APPRAISAL LEVEL
Hydraulic/Transient
Schematic
NOT TO SCALE

FIGURE 35

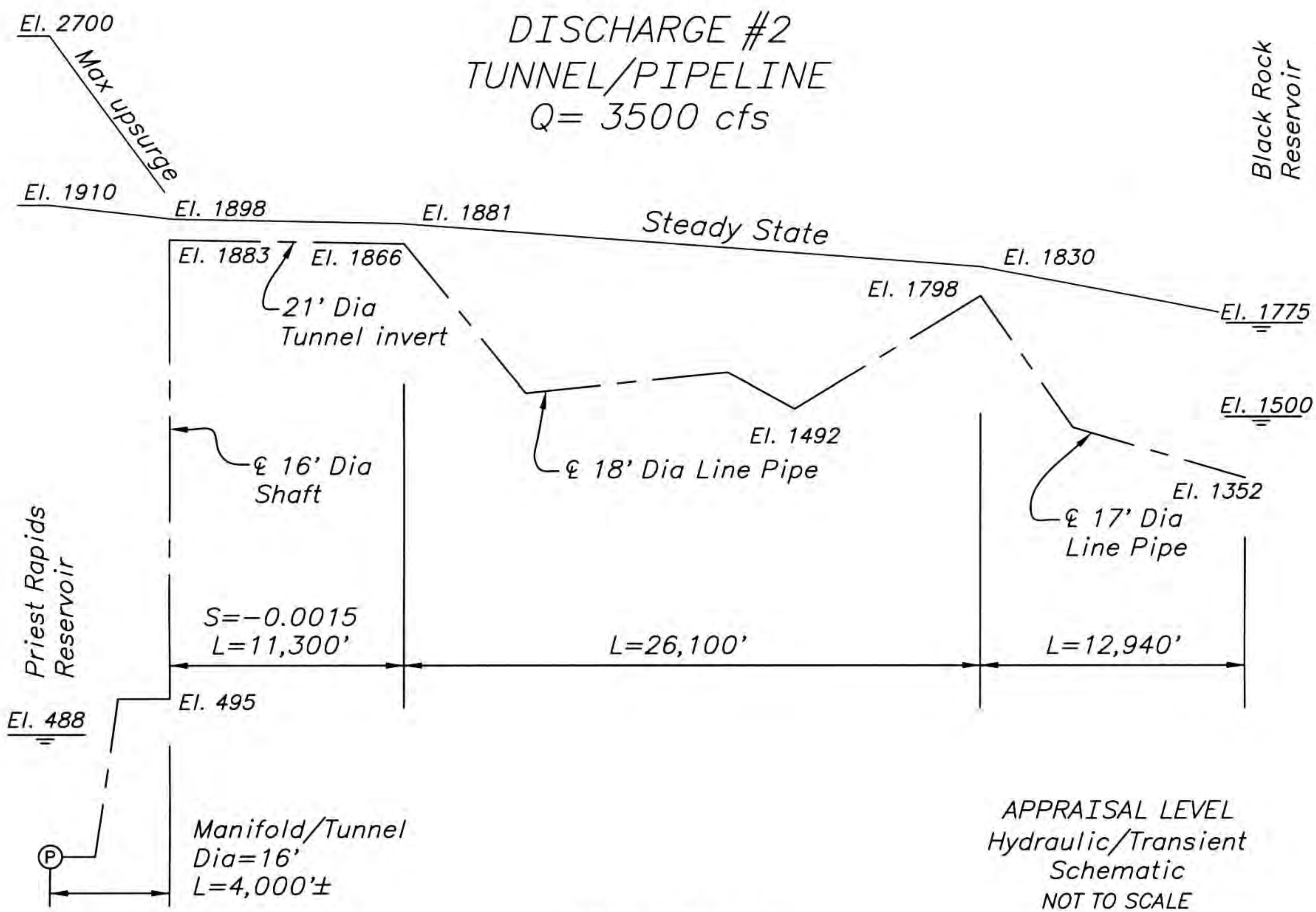
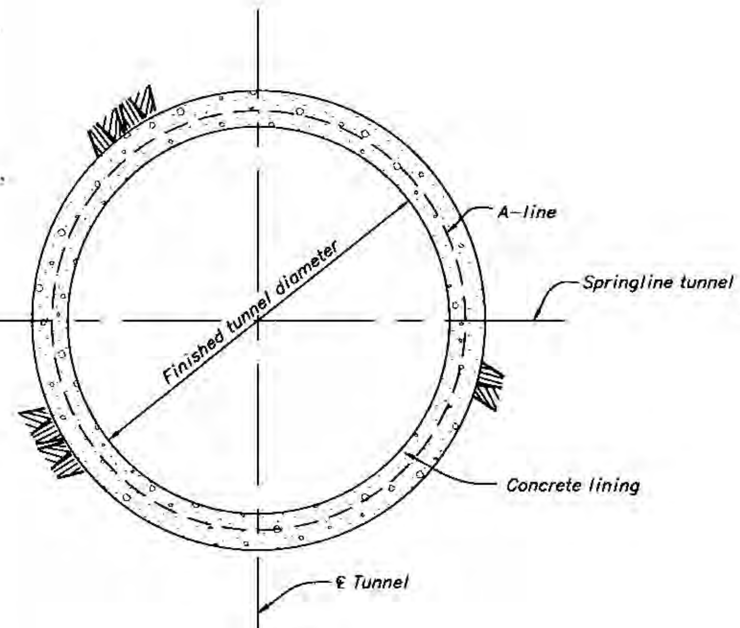
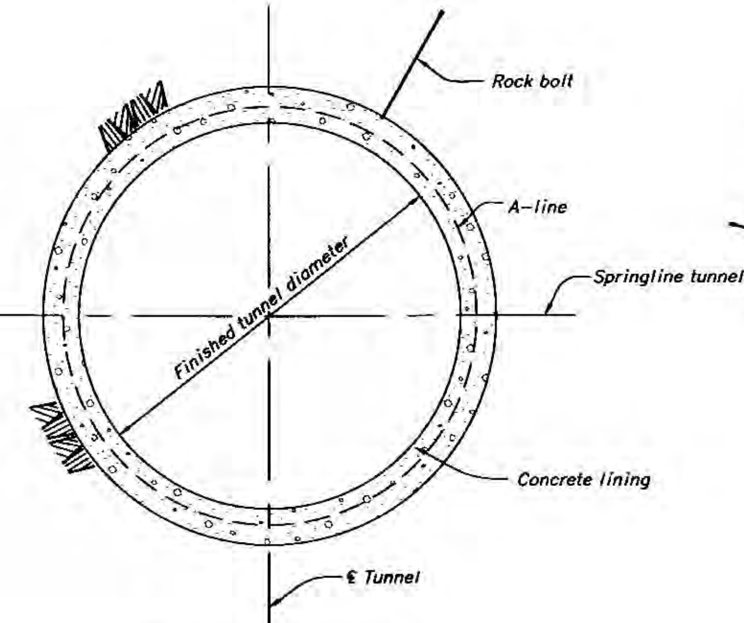

DISCHARGE #2
TUNNEL/PIPELINE
Q= 3500 cfs
El. 2700
Max upsurge
El. 1910
El. 1898
El. 1881
Steady State
El. 1830
El. 1775
Black Rock
Reservoir
El. 1883
El. 1866
21' Dia
Tunnel invert
El. 1798
El. 1500
El. 1492
℄ 16' Dia
Shaft
℄ 18' Dia Line Pipe
El. 1352
℄ 17' Dia
Line Pipe
Priest Rapids
Reservoir
S=−0.0015
L=11,300'
L=26,100'
L=12,940'
El. 495
El. 488
P
Manifold/Tunnel
Dia=16'
L=4,000'±
APPRAISAL LEVEL
Hydraulic/Transient
Schematic
NOT TO SCALE

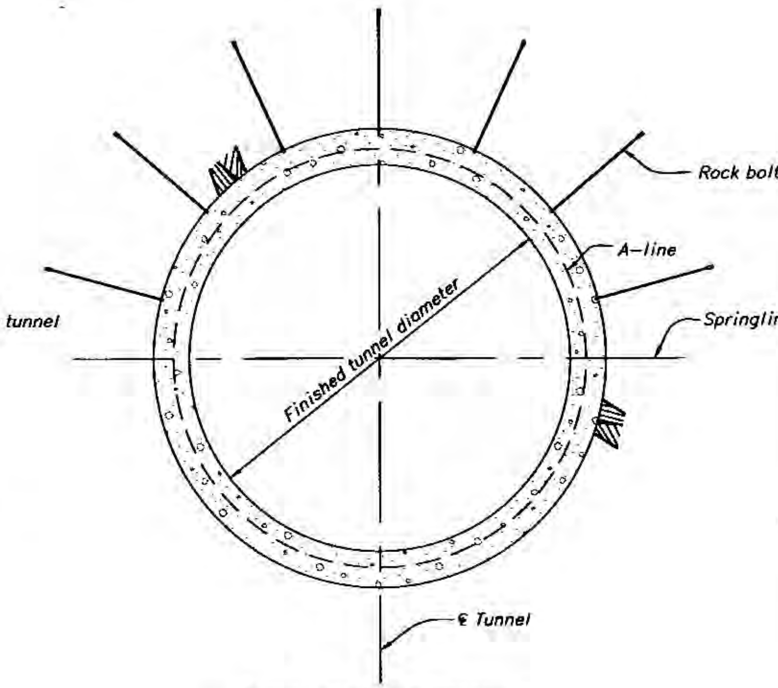
FIGURE 36



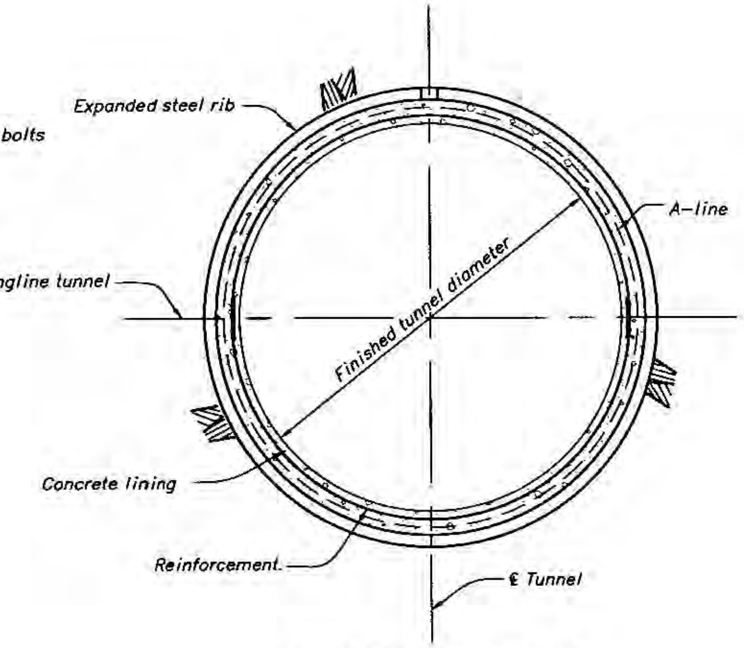
UNSUPPORTED CONCRETE LINED



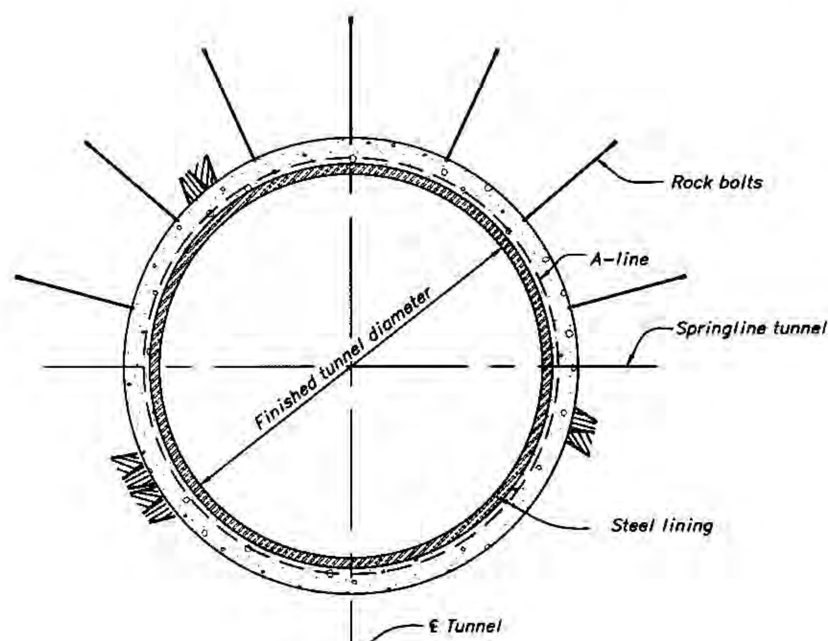
SPOT ROCK BOLT SUPPORTED CONCRETE LINED



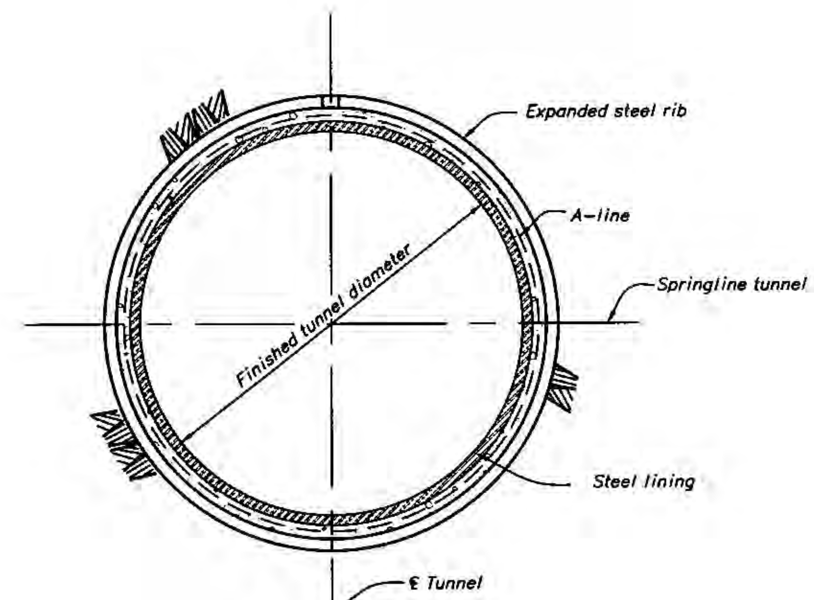
PATTERN ROCK BOLT SUPPORTED CONCRETE LINED



EXPANDED STEEL RIB SUPPORTED REINFORCED CONCRETE LINED



PATTERN ROCK BOLT SUPPORTED STEEL LINING



EXPANDED STEEL RIB SUPPORTED STEEL LINING

PRELIMINARY NOT TO BE USED FOR CONSTRUCTION

NOTES

1. For plan of Inflow Tunnel (Q = 3500 c.f.s), see Figure 32.
2. For profile of Inflow Tunnel (Q = 3500 c.f.s.), see Figure 33.
3. For plan of Inflow Tunnel (Q = 6000 c.f.s.), see Figure 32.
4. For profile of Inflow Tunnel (Q = 6000 c.f.s.), see Figure 41.
5. For plan of Inflow Tunnel/Pipe (Q = 3500 c.f.s.), see Figure 32.
6. For profile of Inflow Tunnel/Pipe (Q = 3500 c.f.s.), see Figure 34.
7. For plan and profile of Outflow (Q = 2500 c.f.s.), see Figure 55.

TUNNEL TABLE

OPTION	FINISHED DIAMETER (ft.)	MINIMUM BORE DIAMETER (ft.)	TUNNEL LENGTH (ft.)	SUPPORT				LINING		
				LENGTH UNSUPPORTED (ft.)	LENGTH SPOT ROCK BOLTED (ft.)	LENGTH PATTERN ROCK BOLT (ft.)	LENGTH EXPANDED STEEL RIB (ft.)	LENGTH STEEL LINING (ft.)	LENGTH UNREINFORCED CONCRETE LINING (ft.)	LENGTH REINFORCED CONCRETE LINING (ft.)
Inflow Tunnel, Q = 3500 c.f.s.	17.00	20.00	34850	8200	4950	19700	2000	1700	32150	1000
Inflow Tunnel, Q = 6000 c.f.s.	22.00	25.00	34850	8200	4950	19700	2000	1700	32150	1000
Inflow Tunnel/Pipe, Q = 3500 c.f.s. (Lower/Upper)	16.00/21.00	19.00/23.67	3150/11300	550/2580	300/1540	1300/6180	1000/1000	1700/0	1450/11300	0/0
Outflow	17.00	19.67	90000	21800	13000	52200	3000	7400	80600	2000

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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

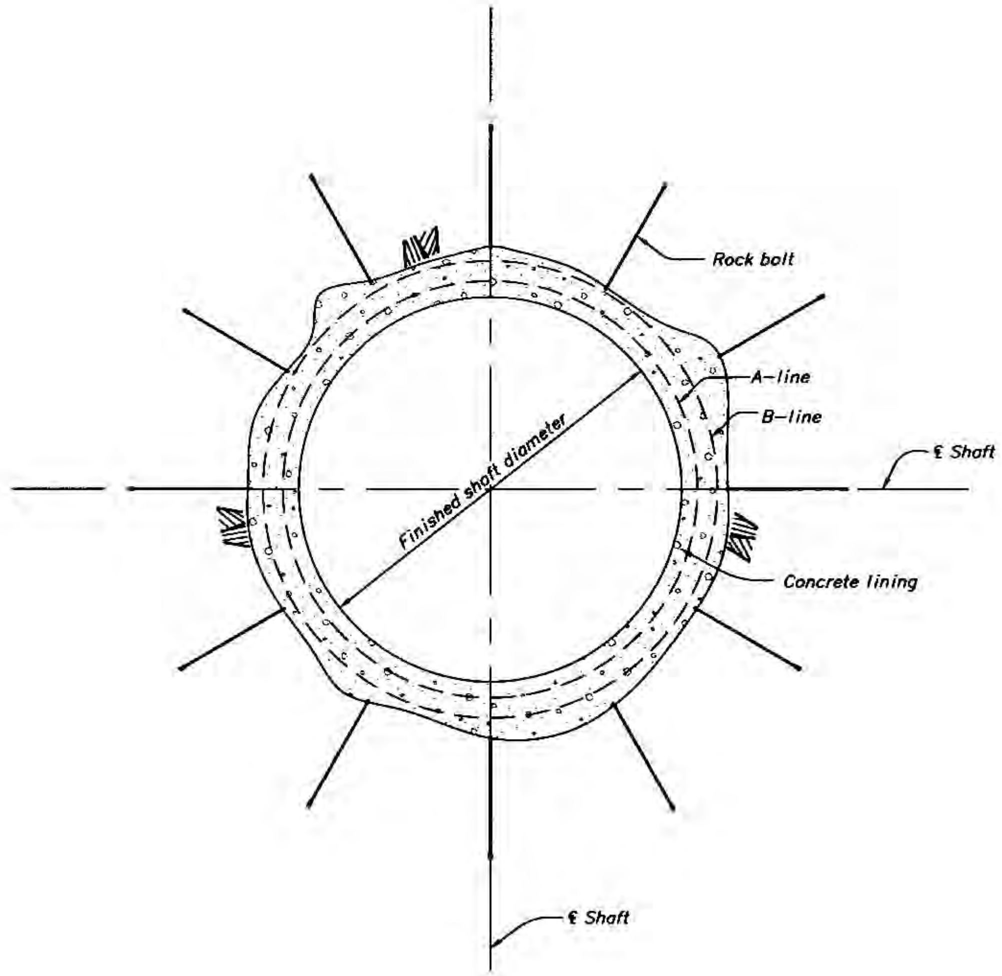
TYPICAL TUNNEL SUPPORT AND LINING
SECTIONS AND TABLE

DESIGNED ____
REVIEWED BY ____
WATER CONVEYANCE GROUP

CADD SYSTEM AutoCAD Rel. 16.0s | CADD FILENAME FIGURES 37 AND 38.DWG
DENVER, COLORADO APRIL 21, 2004 SHEET 1 OF 1

FIGURE 37

SPECIFICATION NO. 0000



PATTERN ROCK BOLT SUPPORTED CONCRETE LINED

SHAFT TABLE

OPTION	FINISHED DIAMETER (ft.)	B–Line DIAMETER (ft.)	SHAFT DEPTH (ft.)	LENGTH UNREINFORCED CONCRETE LINING (ft.)	LENGTH REINFORCED CONCRETE LINING (ft.)
Inflow Tunnel, Q = 3500 c.f.s.	22.00	24.34	1506	1206	300
Inflow Tunnel, Q = 6000 c.f.s.	22.00	24.34	1506	1206	300
Inflow Tunnel/Pipe, Q = 3500 c.f.s.	16.00	18.00	1380	1080	300
Outflow	40.00	46.00	530	430	100

PRELIMINARY NOT TO BE USED FOR CONSTRUCTION

NOTES

1. For plan of Inflow Tunnel (Q = 3500 c.f.s), see Figure 32.
2. For profile of Inflow Tunnel (Q = 3500 c.f.s.), see Figure 33.
3. For plan of Inflow Tunnel (Q = 6000 c.f.s.), see Figure 32.
4. For profile of Inflow Tunnel (Q = 6000 c.f.s.), see Figure 41.
5. For plan of Inflow Tunnel/Pipe (Q = 3500 c.f.s.), see Figure 32.
6. For profile of Inflow Tunnel/Pipe (Q = 3500 c.f.s.), see Figure 34.
7. For plan and profile of Outflow (Q = 2500 c.f.s.), see Figure 55.

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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

TYPICAL SHAFT SUPPORT AND LINING
SECTION AND TABLE

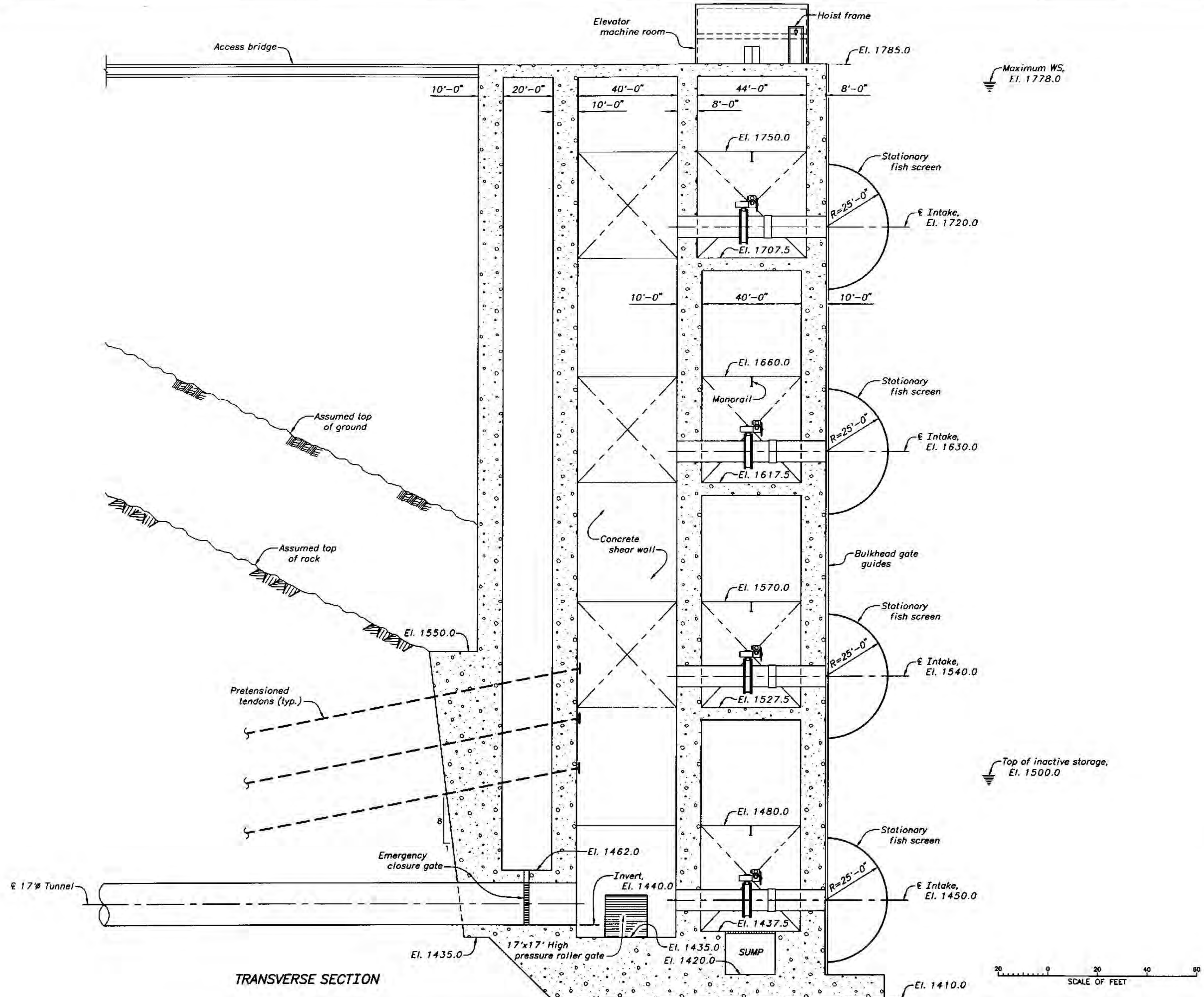
DESIGNED
REVIEWED BY
WATER CONVEYANCE GROUP

CADD SYSTEM AutoCAD Rel. 16.0a
DENVER, COLORADO APRIL 21, 2004 SHEET 1 OF 1
CADD FILENAME FIGURES 37 AND 38.DWG

FIGURE 38

SPECIFICATION NO. 0000

FILE PATH: H:\HOME\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\WATER CONVEYANCE\INFLOW\
PLOTTED BY: KATWATER
AUGUST 18, 2004 11:02



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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

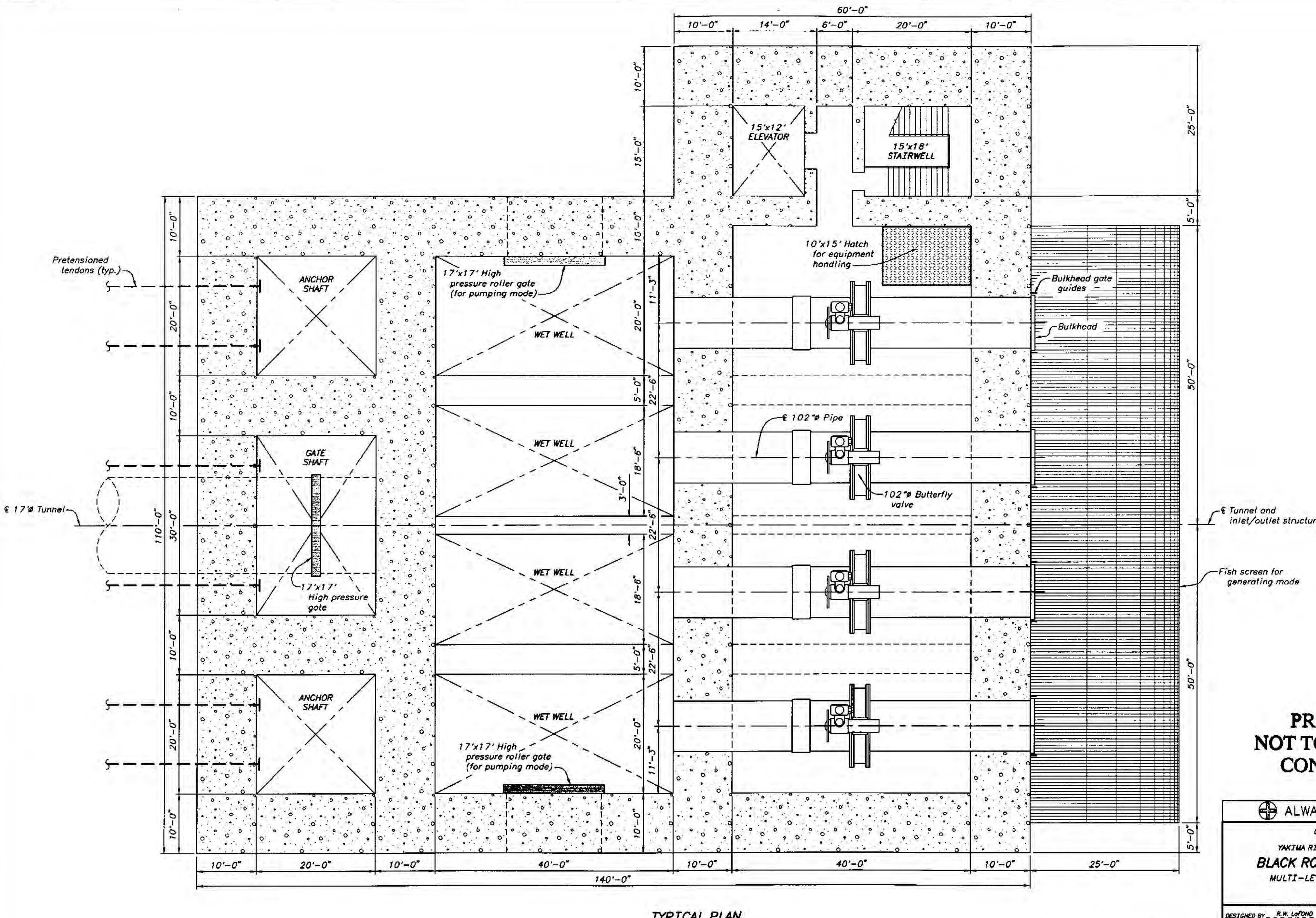
MULTI-LEVEL INLET/OUTLET STRUCTURE
TRANSVERSE SECTION

DESIGNED BY R.W. LaFOND
REVIEWED BY M.R. O'Shea
STRUCTURAL & ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0x
DENVER, COLORADO AUGUST 20, 2004
CADD FILENAME FIGURE 39.DWG

FIGURE 39

FILE PATH: I:\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\PLANT STRUCTURES\DRAWINGS\MULTILEVEL INTAKE\
PLOTTED BY: RRODRIGU
AUGUST 20, 2004 07:20



TYPICAL PLAN

SCALE OF FEET 8 0 8 16

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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

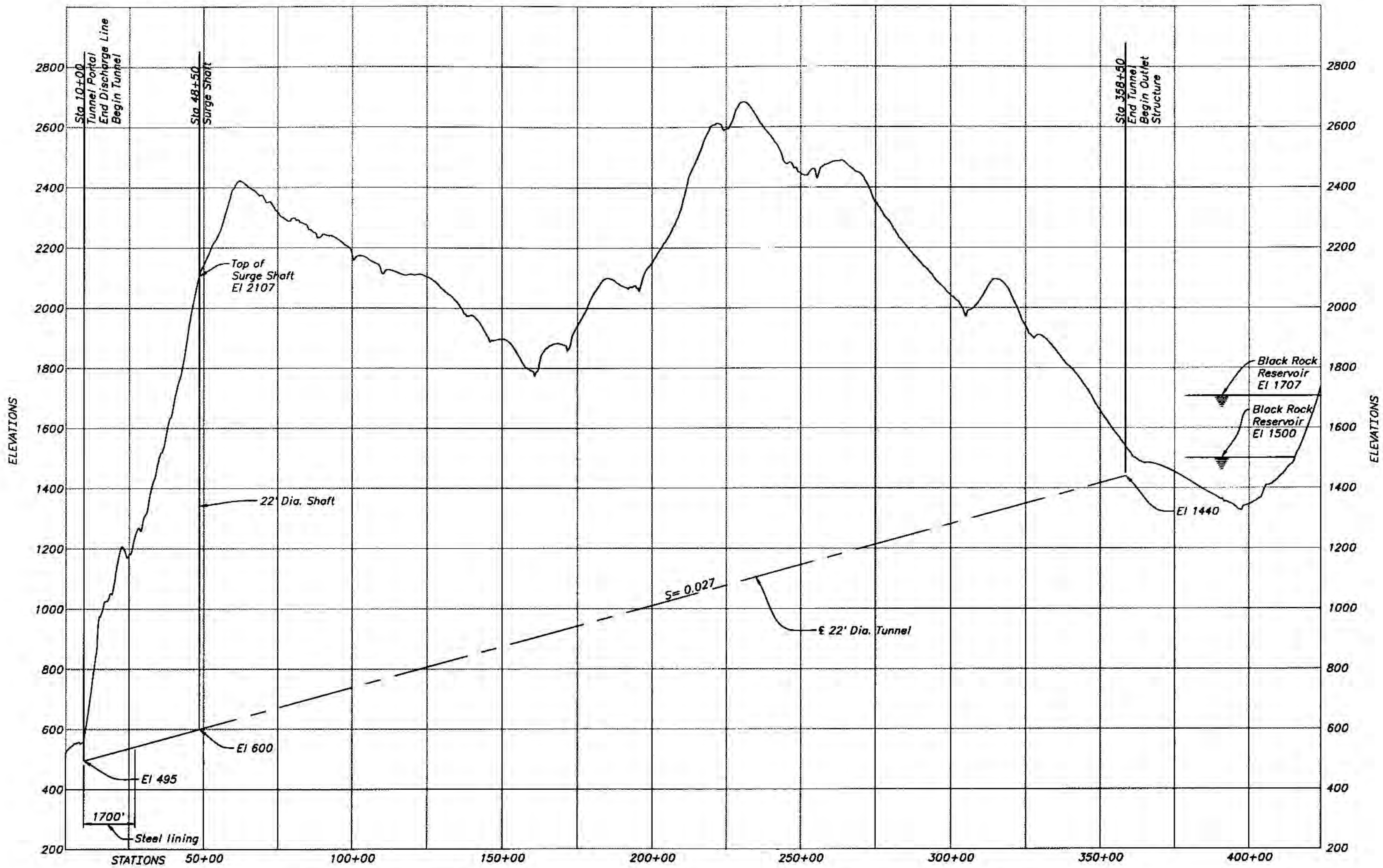
MULTI-LEVEL INLET/OUTLET STRUCTURE

TYPICAL PLAN

DESIGNED BY R.W. LaFOND
REVIEWED BY M.R. D'Elia
STRUCTURAL & ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s | CADD FILENAME FIGURE 40.DWG
DENVER, COLORADO | AUGUST 20, 2004 | FIGURE 40

FILE PATH: I:\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\PLANT STRUCTURES\DRAWINGS\MULTILEVEL INTAKE\
PLOTTED BY: RROOKEJ
AUGUST 20, 2004 08:57



PROFILE

NOTES

1. For plan, see FIGURE 32.
2. For tunnel sections and details, see FIGURE 37.
3. For shaft section and details, see FIGURE 38.

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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

INFLOW 6000 CFS TUNNEL OPTION

TUNNEL PROFILE

DESIGNED Linda M Bowles PE
REVIEWED BY Richard L Fussell PE
WATER CONVEYANCE GROUP

CADD SYSTEM AutoCAD Rel. 16.0a
DENVER, COLORADO APRIL 23, 2004
SHEET 4 OF 5
CADD FILENAME FIGURE 41.DWG

FIGURE 41

FILE PATH: H:\HOME\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\WATER CONVEYANCE\
PLOTTED BY: LBOWLES
AUGUST 5, 2004 08:27

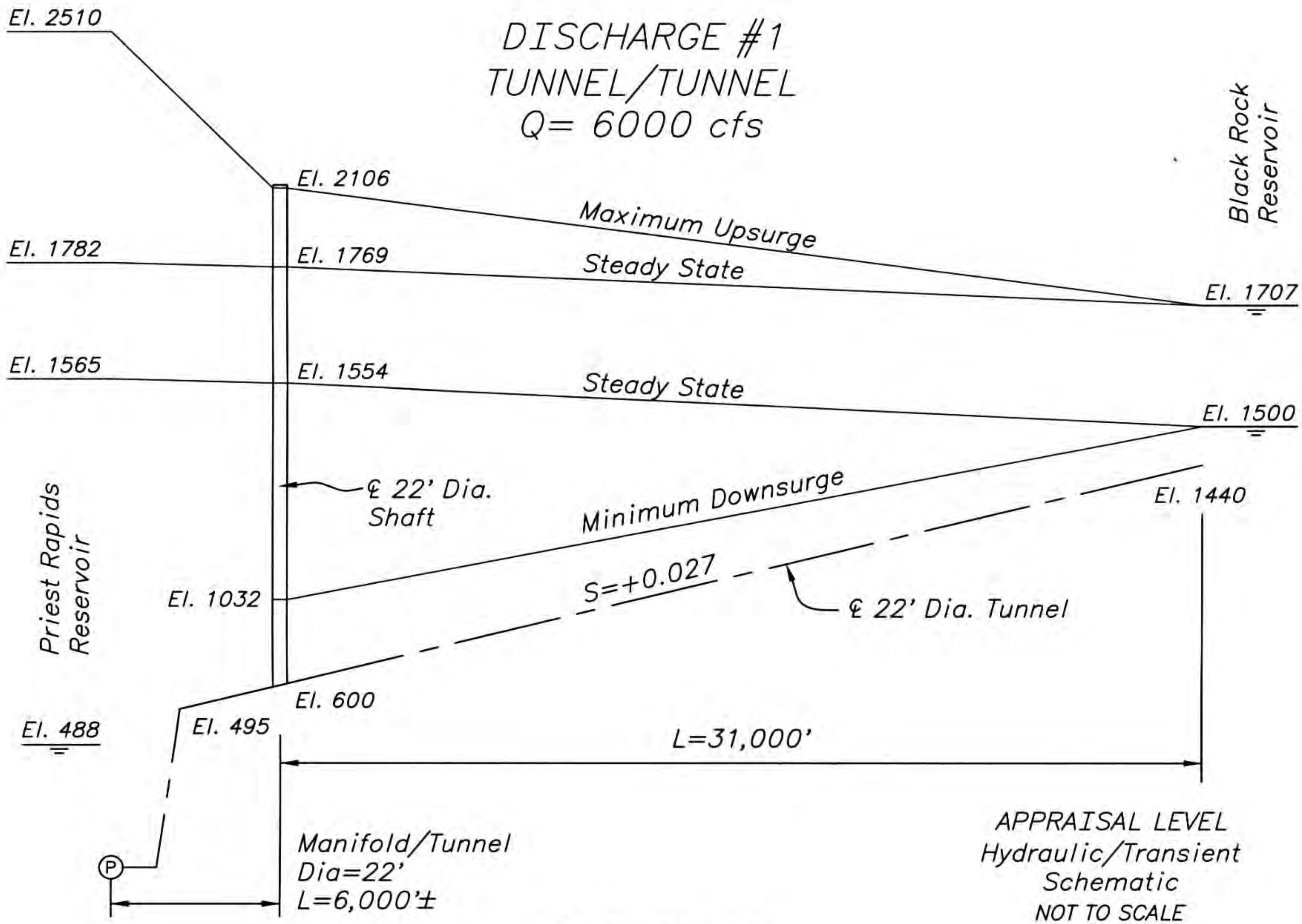
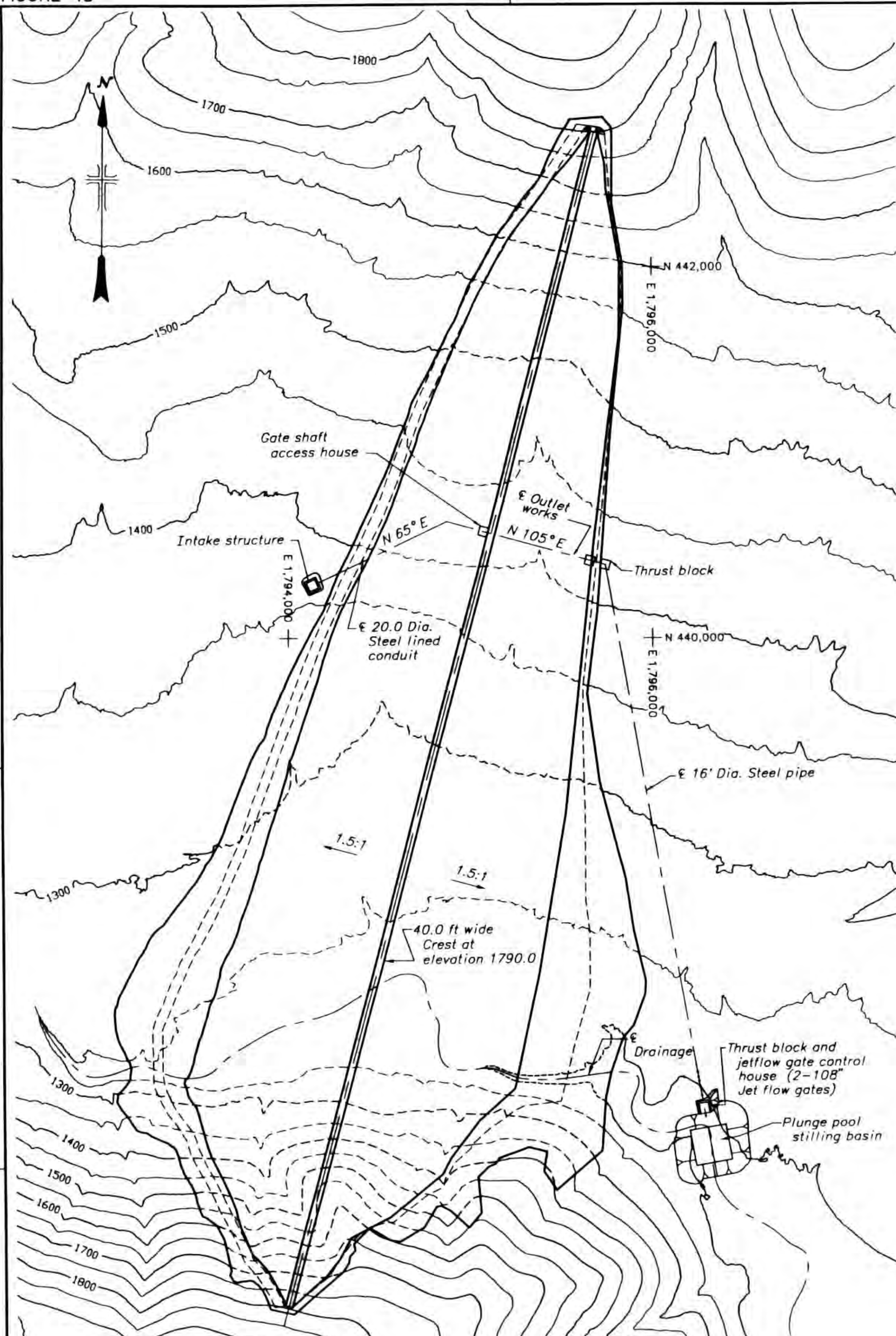

DISCHARGE #1
TUNNEL/TUNNEL
Q= 6000 cfs
El. 2510
El. 2106
Maximum Upsurge
El. 1782
El. 1769
Steady State
El. 1707
Black Rock
Reservoir
El. 1565
El. 1554
Steady State
El. 1500
℄ 22' Dia.
Shaft
Minimum Downsurge
El. 1440
S=+0.027
℄ 22' Dia. Tunnel
El. 1032
Priest Rapids
Reservoir
El. 600
El. 495
El. 488
L=31,000'
P
Manifold/Tunnel
Dia=22'
L=6,000'±
APPRAISAL LEVEL
Hydraulic/Transient
Schematic
NOT TO SCALE

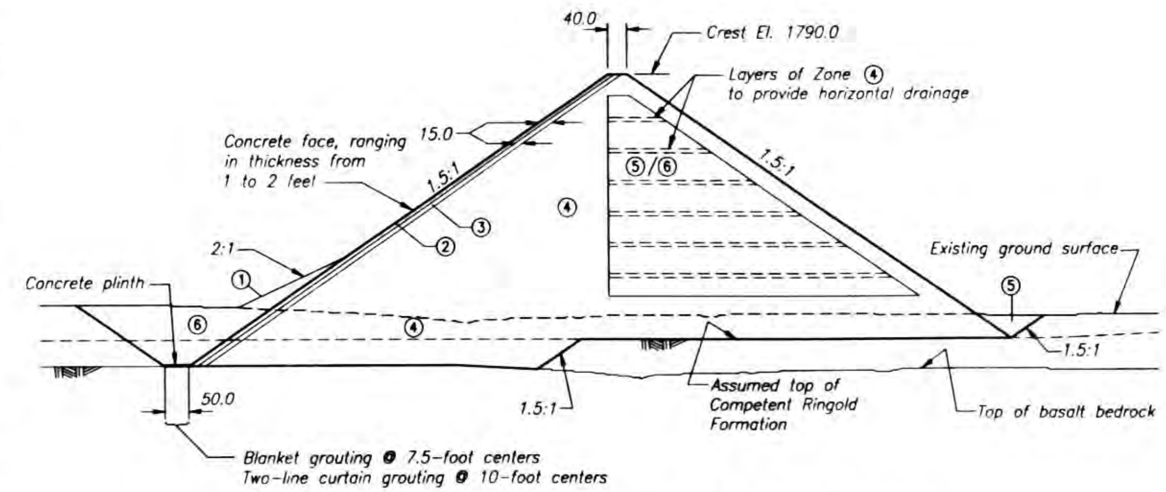
FIGURE 42

FIGURE 43

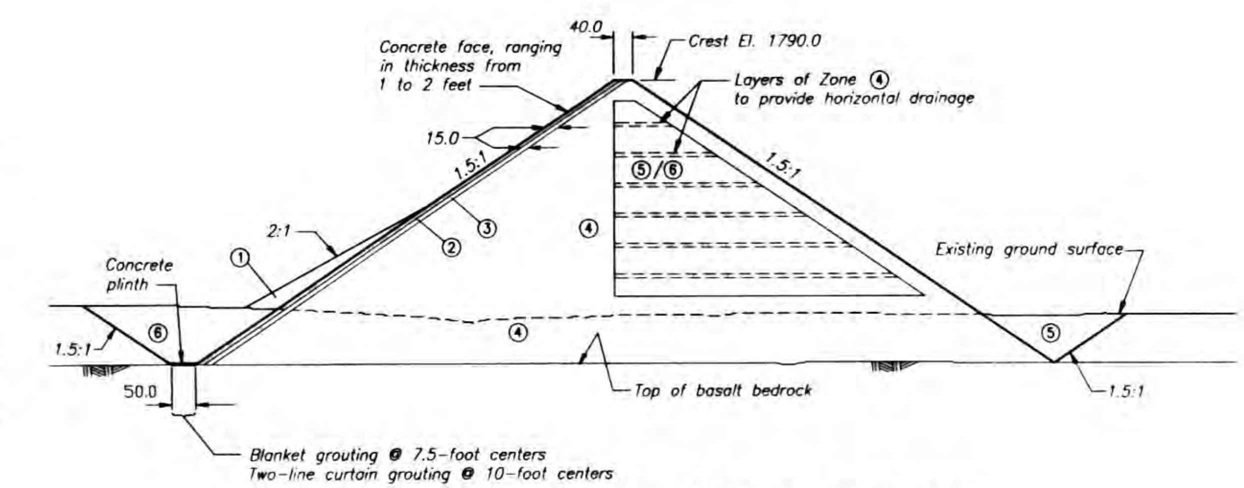


PLAN VIEW

(SHOWING COMPLETE EXCAVATION TO BEDROCK)



TYPICAL SECTION – EXCAVATION TO COMPETENT RINGOLD



TYPICAL SECTION – COMPLETE EXCAVATION TO BEDROCK

200 0 200 400 600
SCALE OF FEET

EMBANKMENT MATERIALS

- Zone ①: Impervious fill compacted by tamping rollers to 6-inch layers.
- Zone ②: Processed sand & gravel filter material compacted by vibratory rollers to 12-inch layers.
- Zone ③: Processed gravel drain material compacted by vibratory rollers to 12-inch layers.
- Zone ④: Basalt rockfill placed in 3-foot layers and compacted by vibratory rollers.
- Zone ⑤: Coarse grained random fill from required excavation, compacted in 2-foot layers by vibratory rollers.
- Zone ⑥: Fine grained random fill from required excavation, compacted to 9-inch layers by tamping rollers.

PRELIMINARY
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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

LARGE RESERVOIR

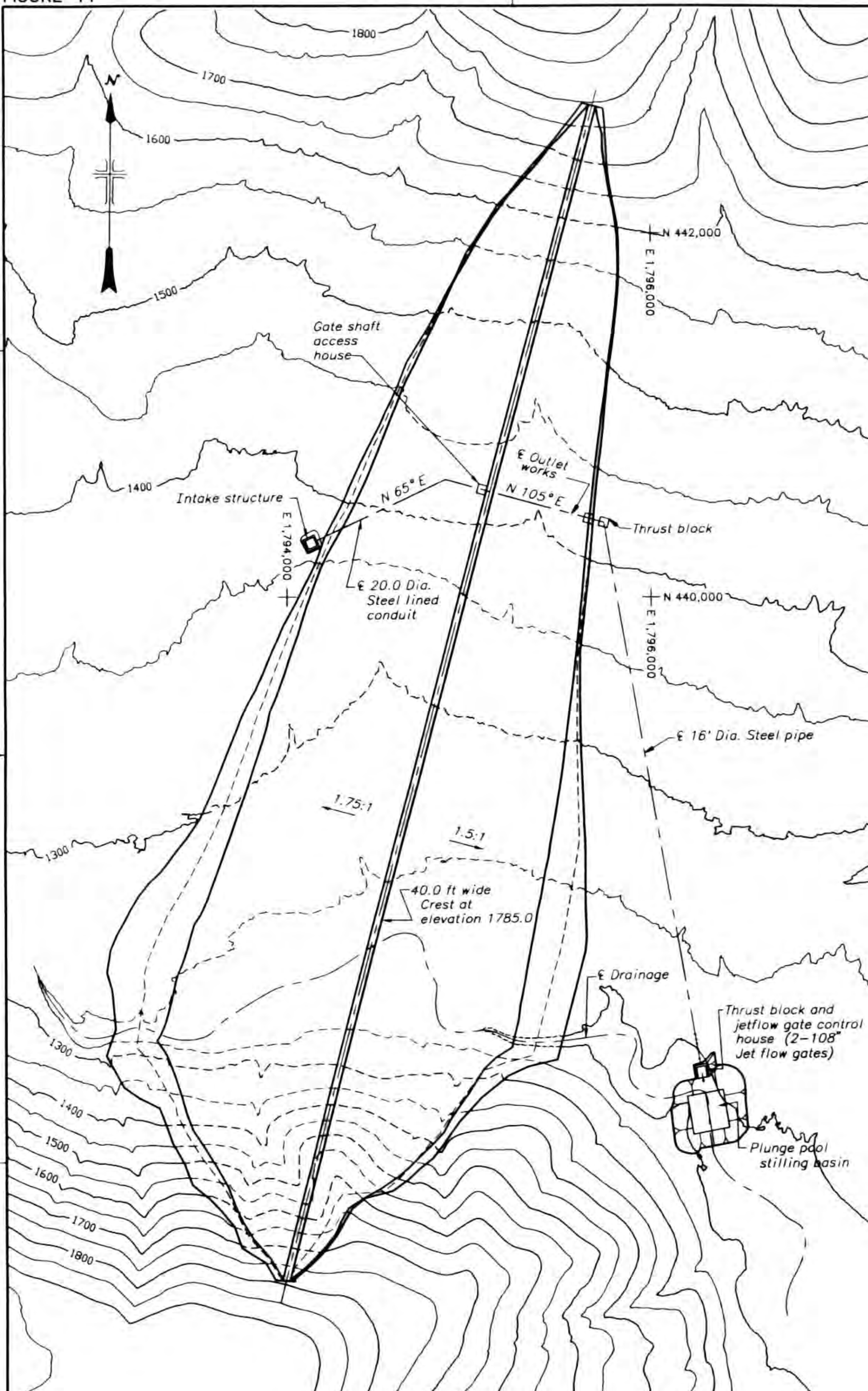
CONCRETE FACE ROCKFILL DAM PLAN AND SECTIONS

DESIGNED ______ P.E.
REVIEWED ______ P.E.
GEOTECHNICAL ENGINEERING GROUP

DENVER, COLORADO AUGUST 10, 2004
SHEET 1 OF 2

FIGURE 43

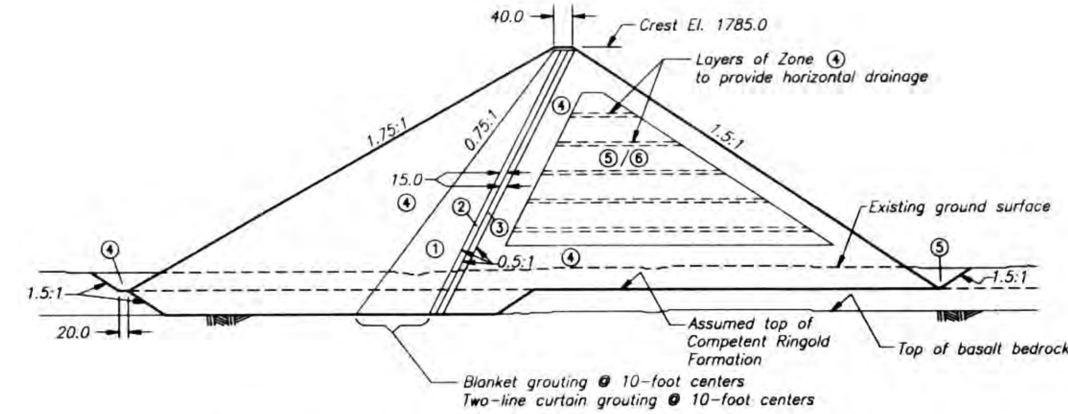
FIGURE 44



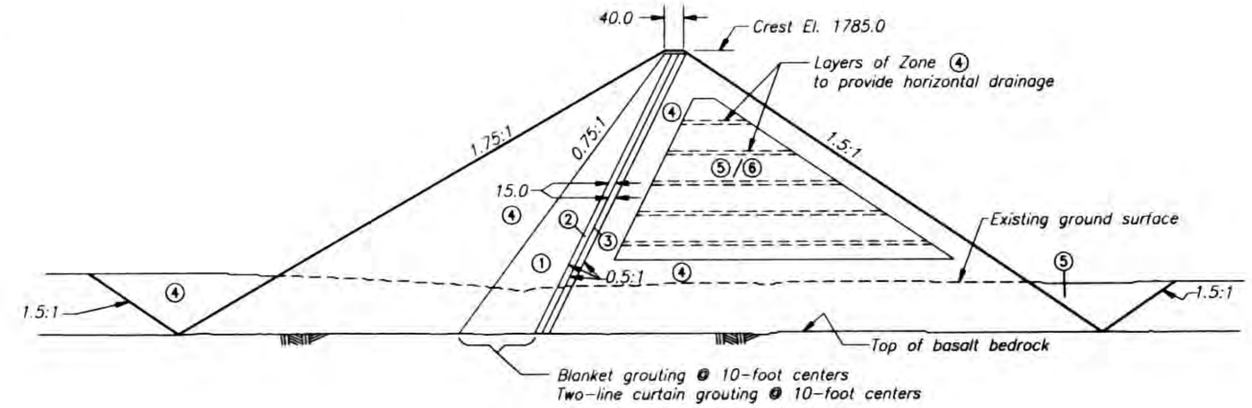
PLAN VIEW

(SHOWING COMPLETE EXCAVATION TO BEDROCK)

400 0 400 800 1200
SCALE OF FEET



TYPICAL SECTION – EXCAVATION TO COMPETENT RINGOLD



TYPICAL SECTION – COMPLETE EXCAVATION TO BEDROCK

200 0 200 400 600
SCALE OF FEET

EMBANKMENT MATERIALS

- Zone ①: Impervious fill compacted by tamping rollers to 6-inch layers.
- Zone ②: Processed sand & gravel filter material compacted by vibratory rollers to 12-inch layers.
- Zone ③: Processed gravel drain material compacted by vibratory rollers to 12-inch layers.
- Zone ④: Basalt rockfill placed in 3-foot layers and compacted by vibratory rollers.
- Zone ⑤: Coarse grained random fill from required excavation, compacted in 2-foot layers by vibratory rollers.
- Zone ⑥: Fine grained random fill from required excavation, compacted to 9-inch layers by tamping rollers.

PRELIMINARY
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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

LARGE RESERVOIR

CENTRAL CORE ROCKFILL DAM PLAN AND SECTIONS

DESIGNED ________ P.E.

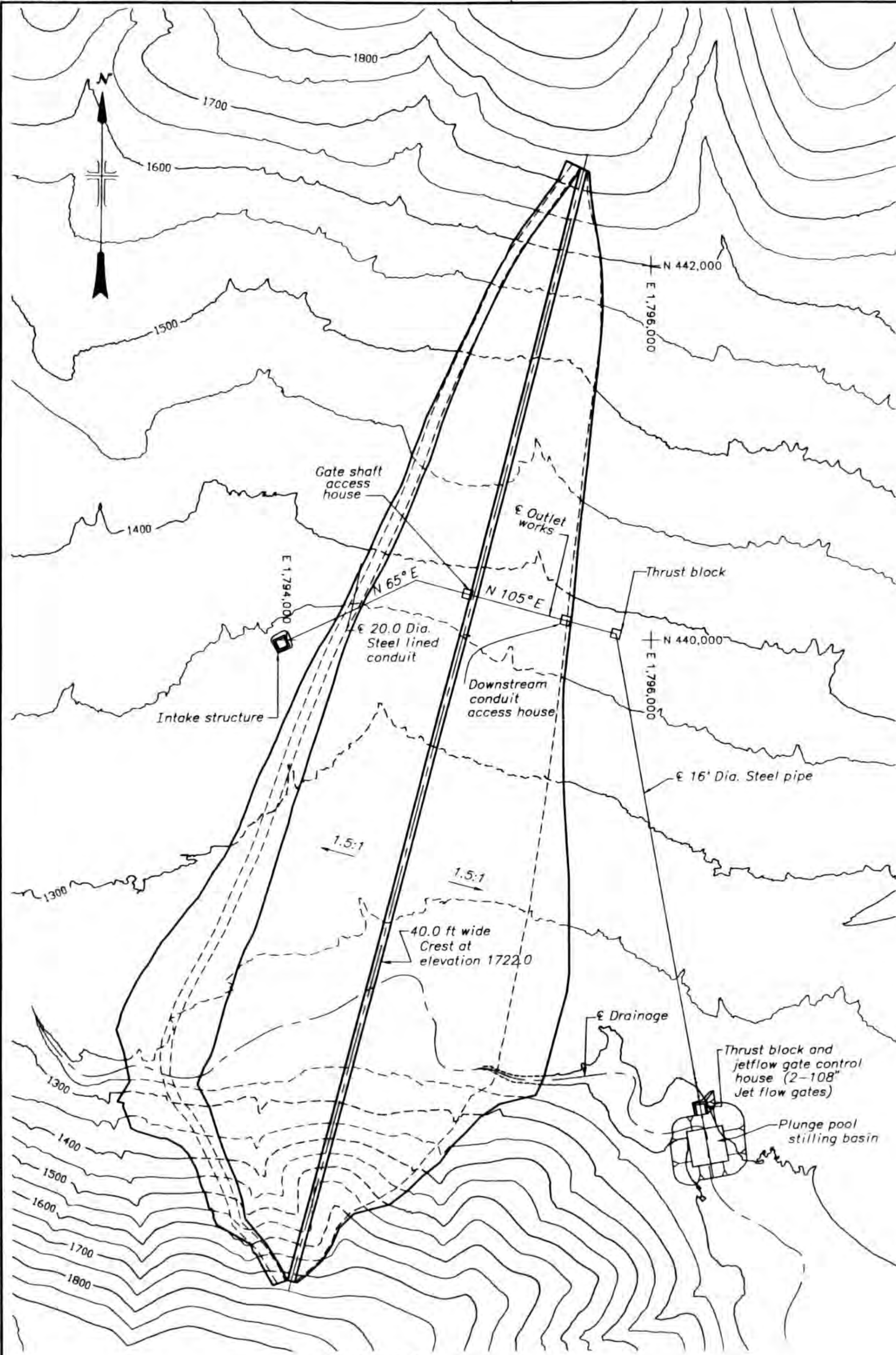
REVIEWED ________ P.E.

GEOTECHNICAL ENGINEERING GROUP

DENVER, COLORADO AUGUST 10, 2004
SHEET 1 OF 2

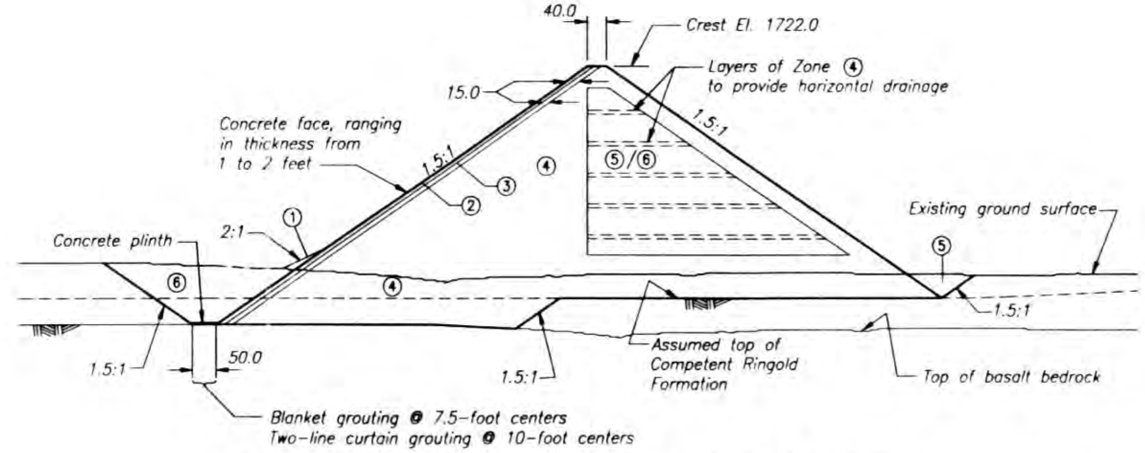
FIGURE 44

FIGURE 45

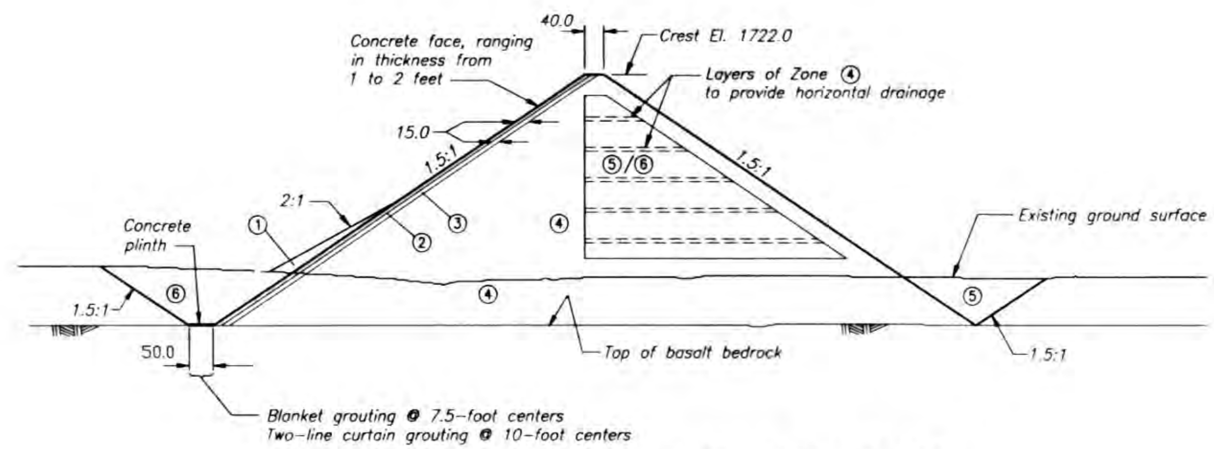


PLAN VIEW

(SHOWING COMPLETE EXCAVATION TO BEDROCK)



TYPICAL SECTION – EXCAVATION TO COMPETENT RINGOLD



TYPICAL SECTION – COMPLETE EXCAVATION TO BEDROCK

200 0 200 400 600
SCALE OF FEET

EMBANKMENT MATERIALS

- Zone ①: Impervious fill compacted by tamping rollers to 6-inch layers.
- Zone ②: Processed sand & gravel filter material compacted by vibratory rollers to 12-inch layers.
- Zone ③: Processed gravel drain material compacted by vibratory rollers to 12-inch layers.
- Zone ④: Basalt rockfill placed in 3-foot layers and compacted by vibratory rollers.
- Zone ⑤: Coarse grained random fill from required excavation, compacted in 2-foot layers by vibratory rollers.
- Zone ⑥: Fine grained random fill from required excavation, compacted to 9-inch layers by tamping rollers.

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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

SMALL RESERVOIR

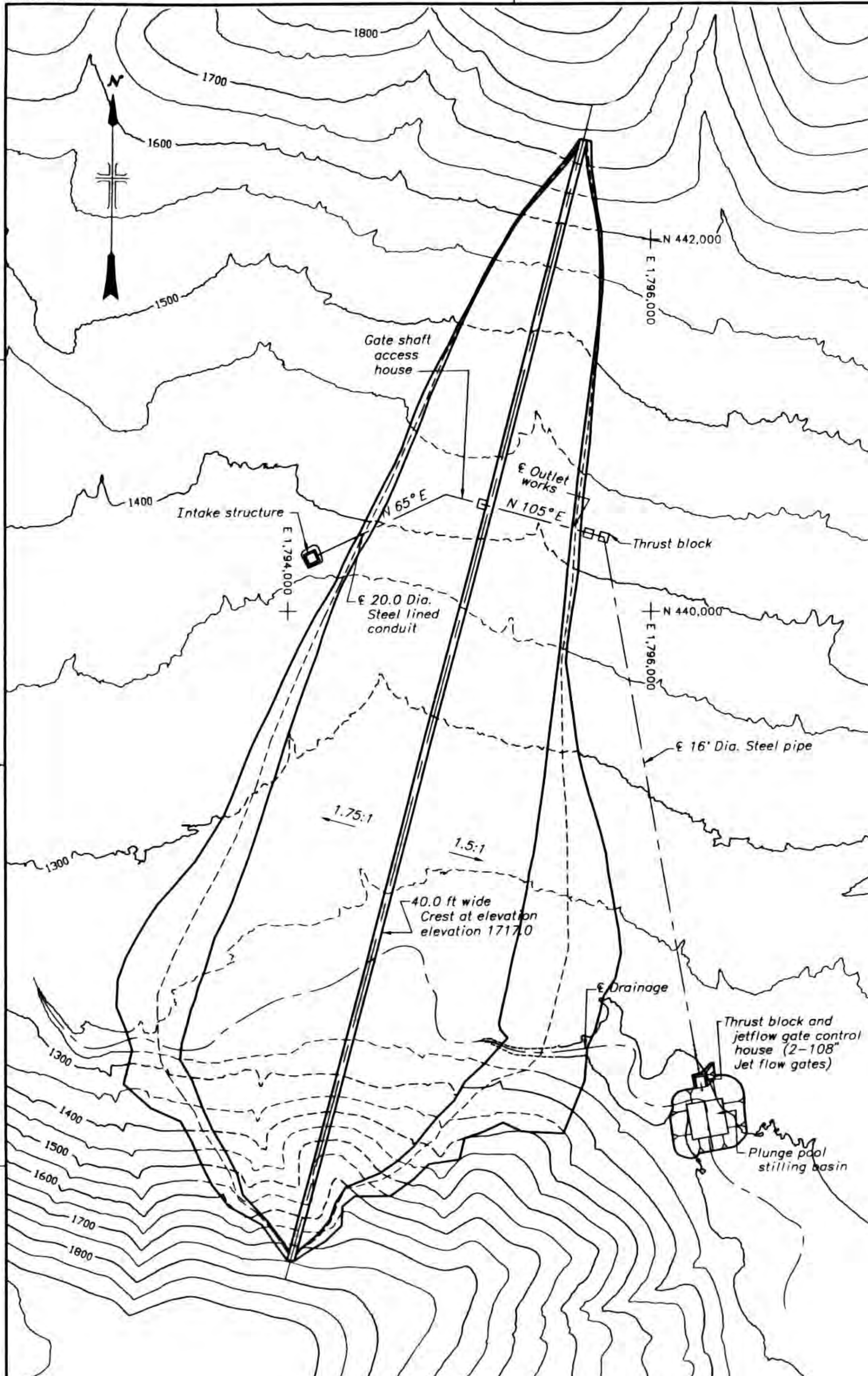
CONCRETE FACE ROCKFILL DAM PLAN AND SECTIONS

DESIGNED ________ P.E.
REVIEWED ________
GEOTECHNICAL ENGINEERING GROUP

DENVER, COLORADO AUGUST 10, 2004
SHEET 2 OF 2

FIGURE 45

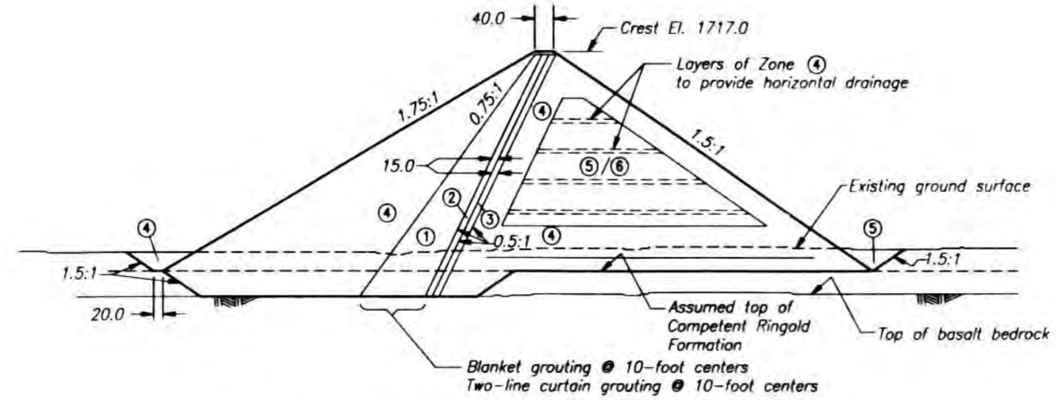
FIGURE 46



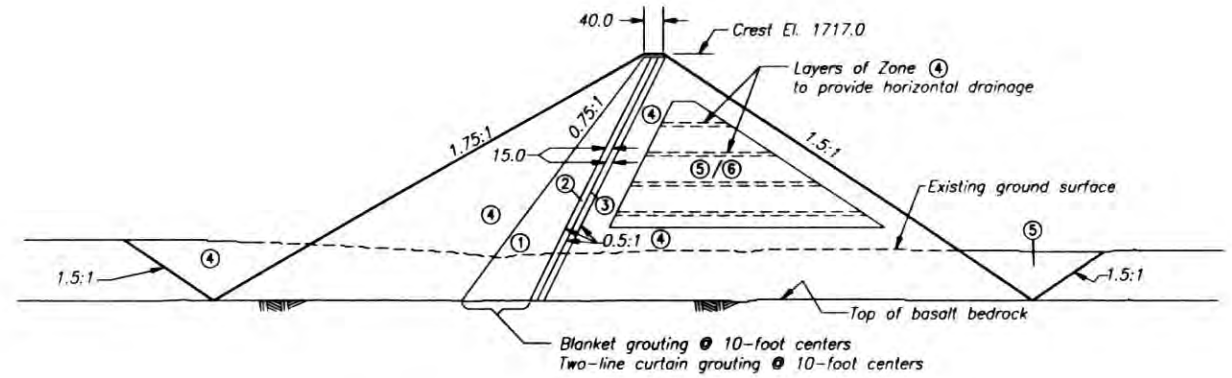
PLAN VIEW

(SHOWING COMPLETE EXCAVATION TO BEDROCK)

400 0 400 800 1200
SCALE OF FEET



TYPICAL SECTION – EXCAVATION TO COMPETENT RINGOLD



TYPICAL SECTION – COMPLETE EXCAVATION TO BEDROCK

200 0 200 400 600
SCALE OF FEET

EMBANKMENT MATERIALS

Zone ①:	Impervious fill compacted by tamping rollers to 6-inch layers.
Zone ②:	Processed sand & gravel filter material compacted by vibratory rollers to 12-inch layers.
Zone ③:	Processed gravel drain material compacted by vibratory rollers to 12-inch layers.
Zone ④:	Basalt rockfill placed in 3-foot layers and compacted by vibratory rollers.
Zone ⑤:	Coarse grained random fill from required excavation, compacted in 2-foot layers by vibratory rollers.
Zone ⑥:	Fine grained random fill from required excavation, compacted to 9-inch layers by tamping rollers.

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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

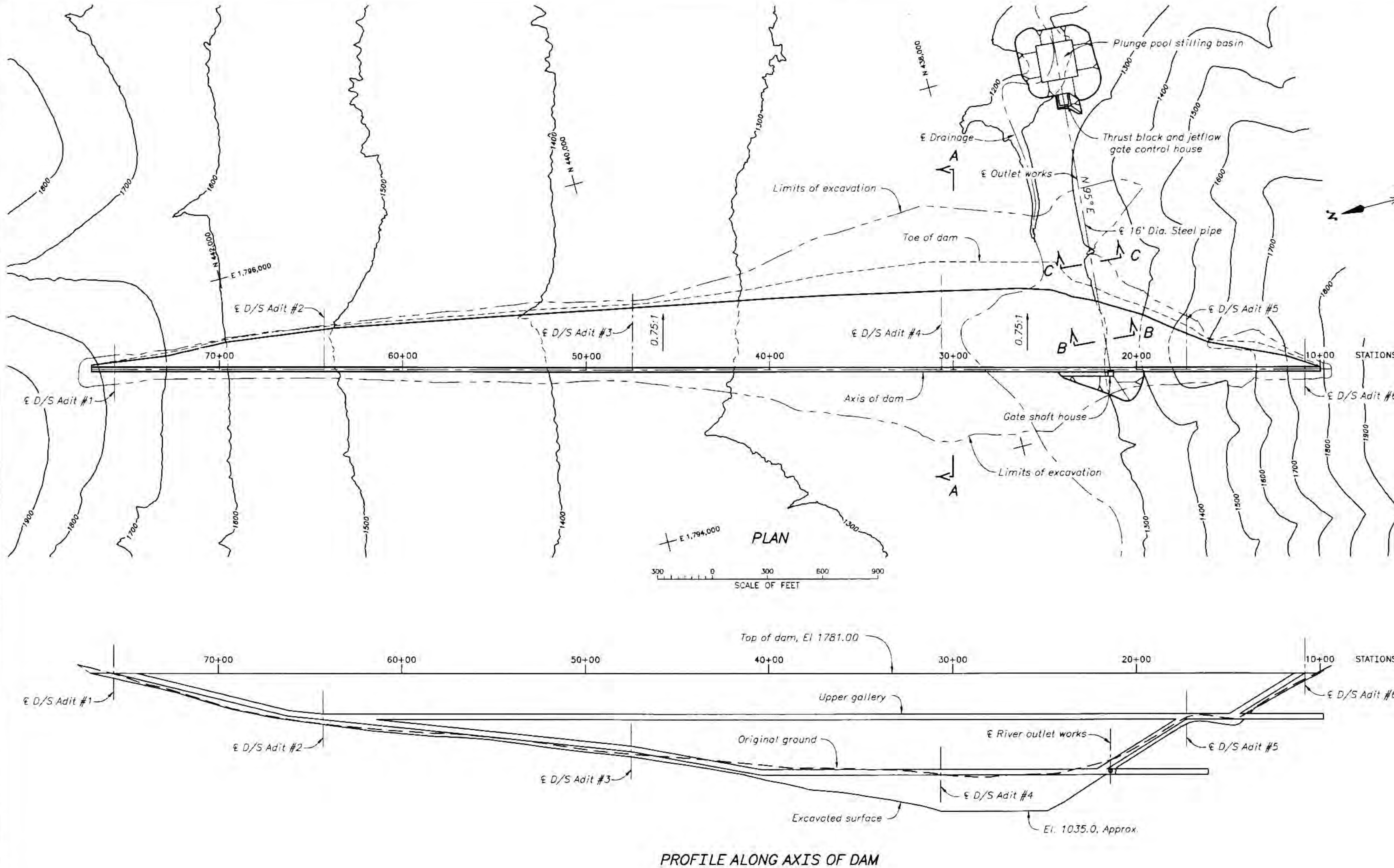
SMALL RESERVOIR

CENTRAL CORE ROCKFILL DAM PLAN AND SECTIONS

DESIGNED P.E.
REVIEWED P.E.
GEOTECHNICAL ENGINEERING GROUP

DENVER, COLORADO AUGUST 10, 2004
SHEET 2 OF 2

FIGURE 46



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YAKIMA RIVER BASIN WATER STORAGE STUDY

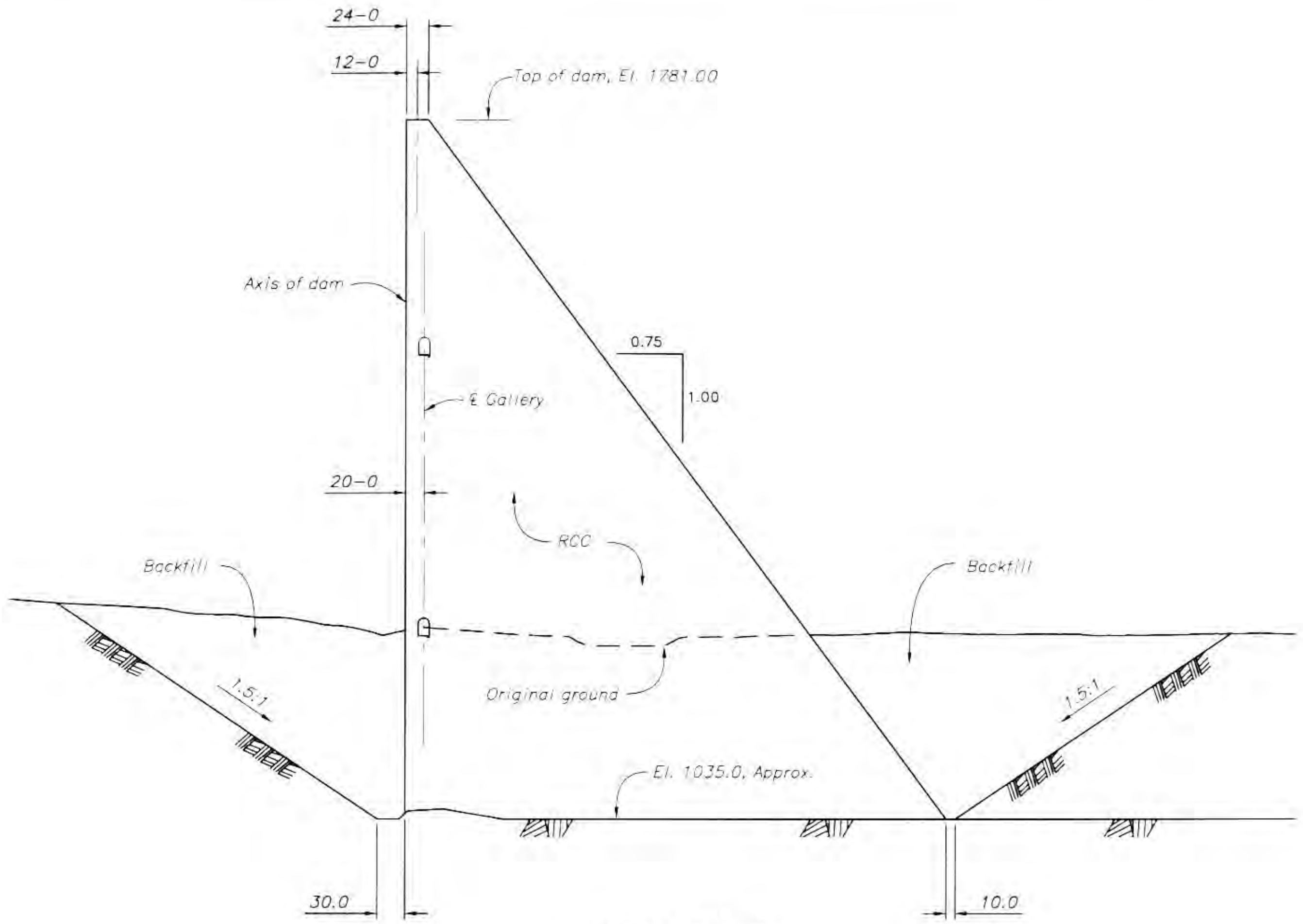
BLACK ROCK ASSESSMENT STUDY

LARGE RESERVOIR
RCC DAM AND OUTLET WORKS

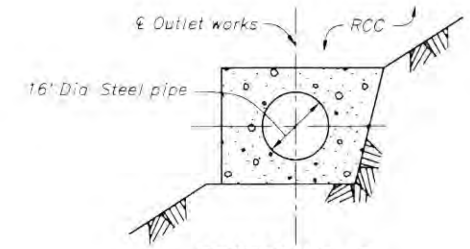
DESIGNED DOUG STANTON, P.E.
REVIEWED BY JOHN H. LABOON, P.E.
Waterways and Concrete Dams

CADD SYSTEM AutoCAD Rel. 16.0s | CADD FILENAME FIGURE 47.48.DWG
DENVER, COLORADO | SHEET 1 OF 2 | FIGURE 47

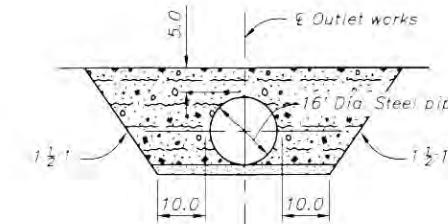
FILE PATH: H:\HOME\CIVILENG SHARE\W&CDPROJ\BLACK_ROCK\
PLOTTED BY: JMARKLEY
AUGUST 10, 2004 11:12



SECTION A-A

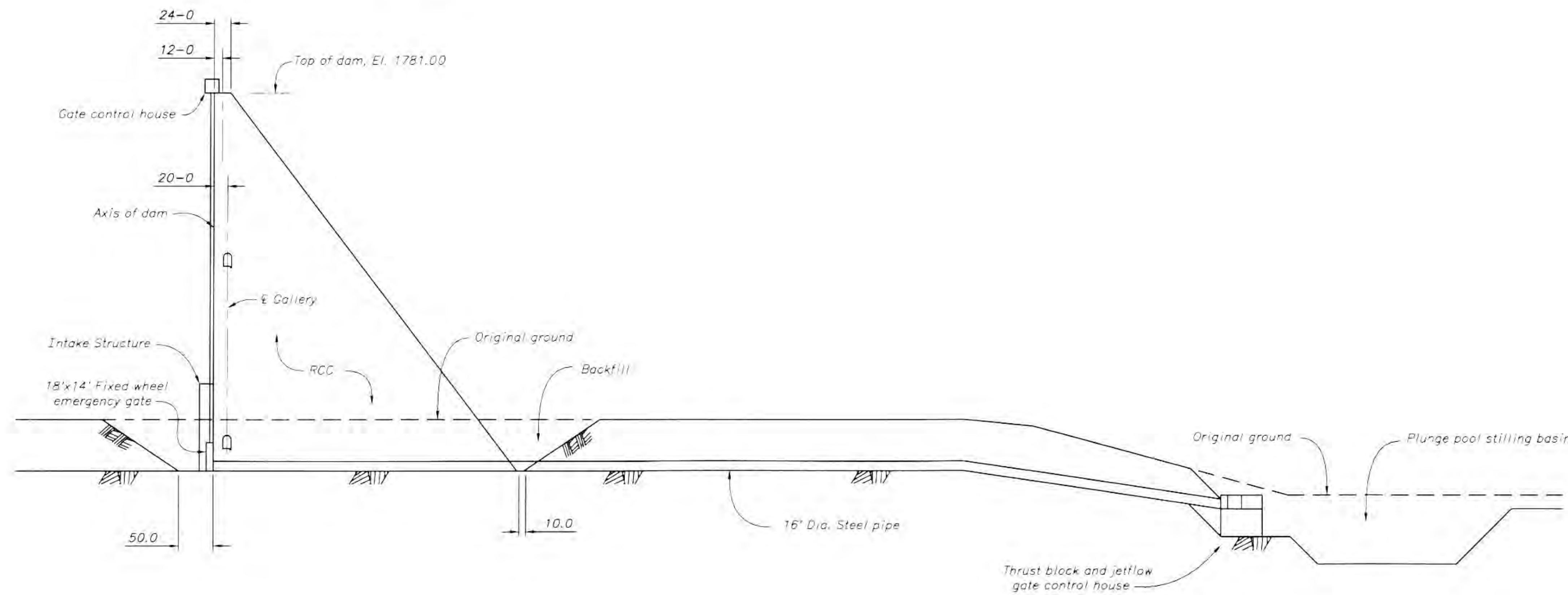


SECTION B-B
(INSIDE DAM)



SECTION C-C
(BETWEEN DAM AND CONTROL HOUSE)

20 0 20 40 60
SCALE OF FEET



100 0 100 200 300
SCALE OF FEET

SECTION ALONG ℄ OUTLET WORKS

PRELIMINARY
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CONSTRUCTION

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UNITED STATES
DEPARTMENT OF THE INTERIOR
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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

LARGE RESERVOIR

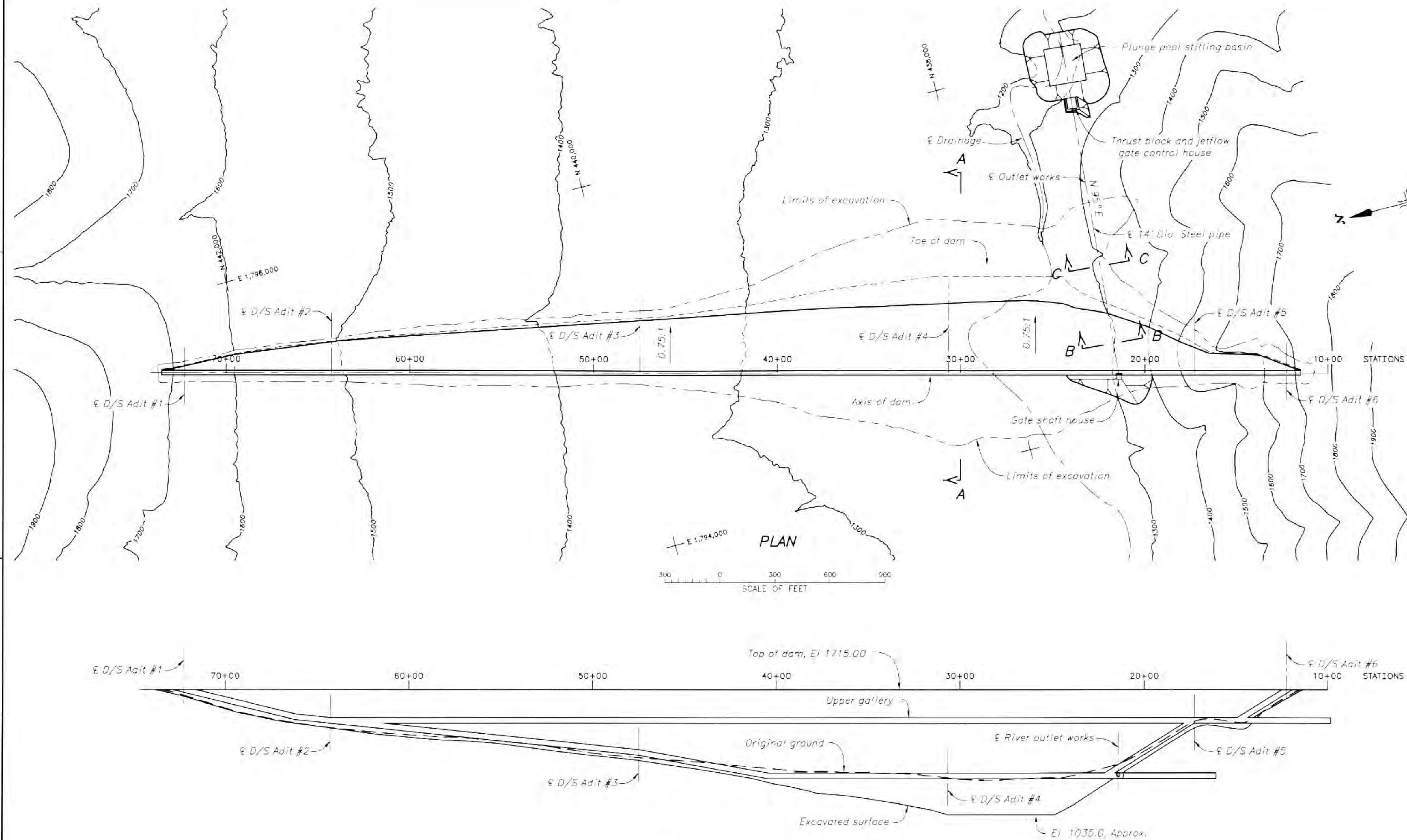
RCC DAM AND OUTLET WORKS

DESIGNED DOUG STANTON, P.E.
REVIEWED BY JOHN H. LABOON, P.E.
Waterways and Concrete Dams

CADD SYSTEM AutoCAD Rel. 16.0s
DENVER, COLORADO
CADD FILENAME FIGURE 47.48.DWG
SHEET 2 OF 2

FIGURE 48

FILE PATH: H:\HOME\CIVILENG SHARE\W&CDPRO\BLACK_ROCK\
PLOTTED BY: JMARKLEY
AUGUST 10, 2004 11:12



PROFILE ALONG AXIS OF DAM

**PRELIMINARY
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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

SMALL RESERVOIR

RCC DAM AND OUTLET WORKS

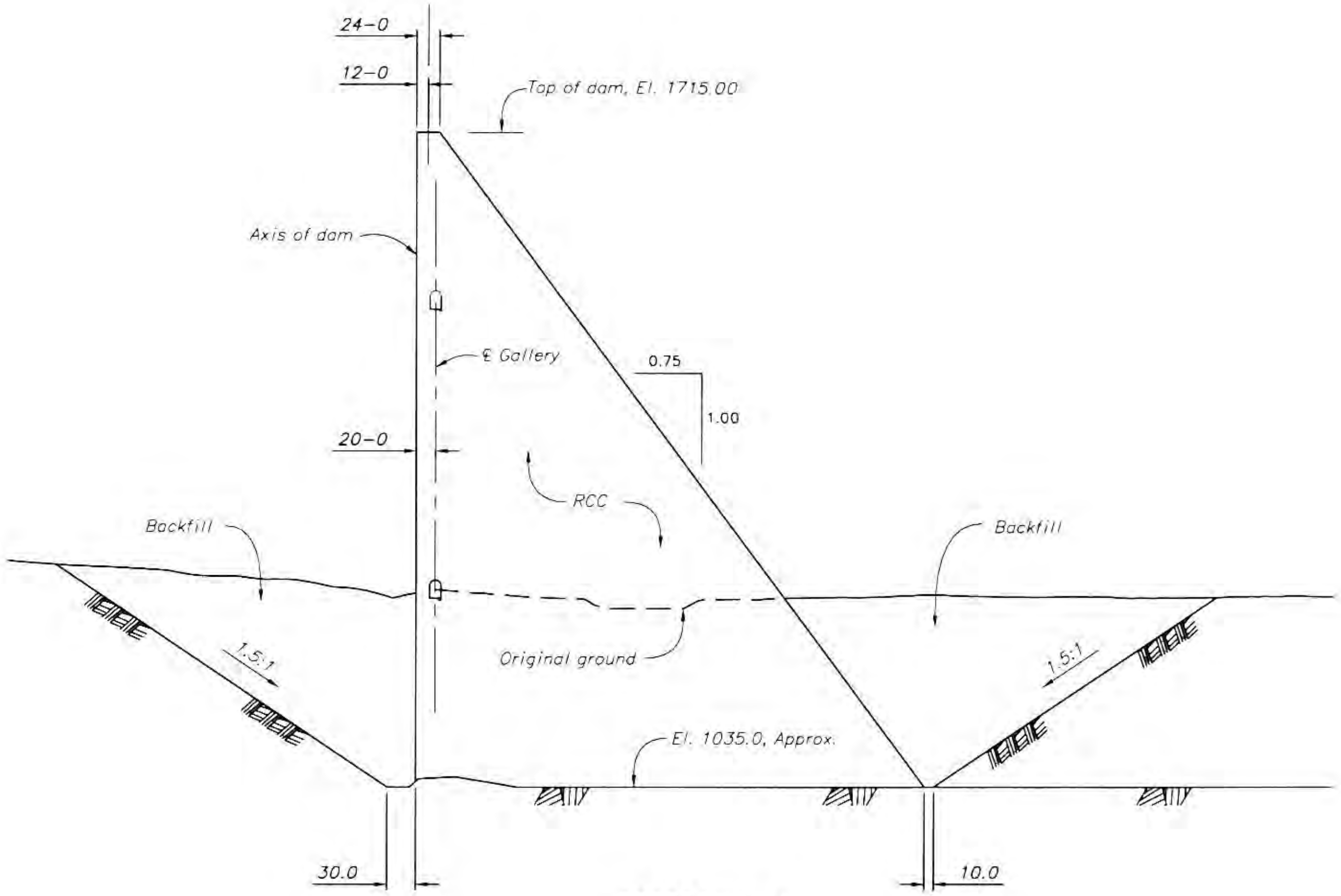
DESIGNED DOUG STANTON, P.E.

REVIEWED BY JOHN H. LABOON, P.E.
Waterways and Concrete Dams

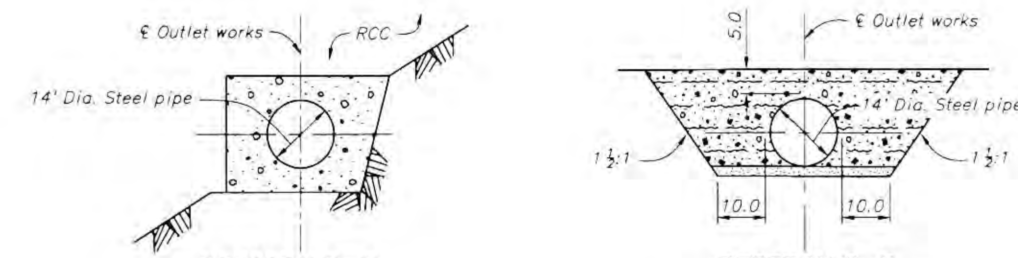
CADD SYSTEM AutoCAD Rel. 15.0s | CADD FILENAME FIGURE 49.50.DWG
DENVER, COLORADO SHEET 1 OF 2

FIGURE 49

FILE PATH: H:\HOME\CIVILENG SHARE\W&CDPROJ\BLACK_ROCK\
PLOTTED BY: JMARKLEY
AUGUST 16, 2004 10:50

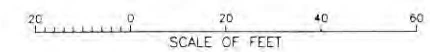


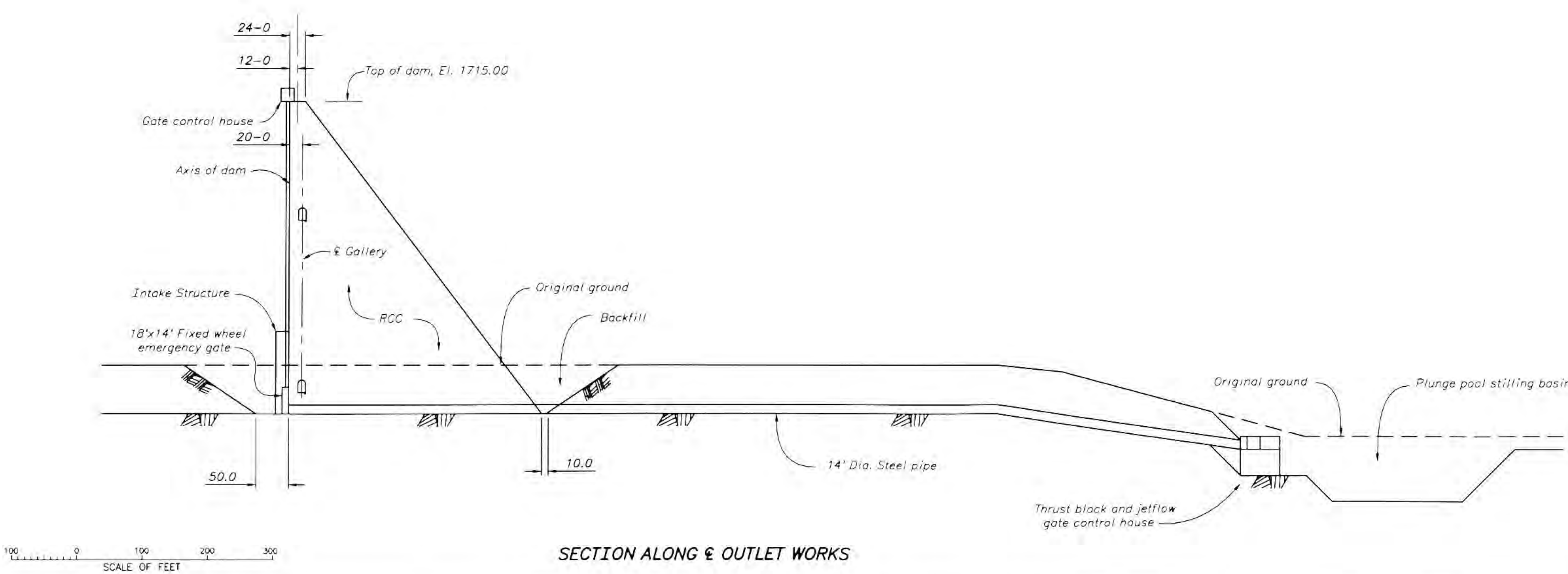
SECTION A–A



SECTION B–B
(INSIDE DAM)

SECTION C–C
(BETWEEN DAM AND CONTROL HOUSE)





SECTION ALONG ℄ OUTLET WORKS

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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

SMALL RESERVOIR

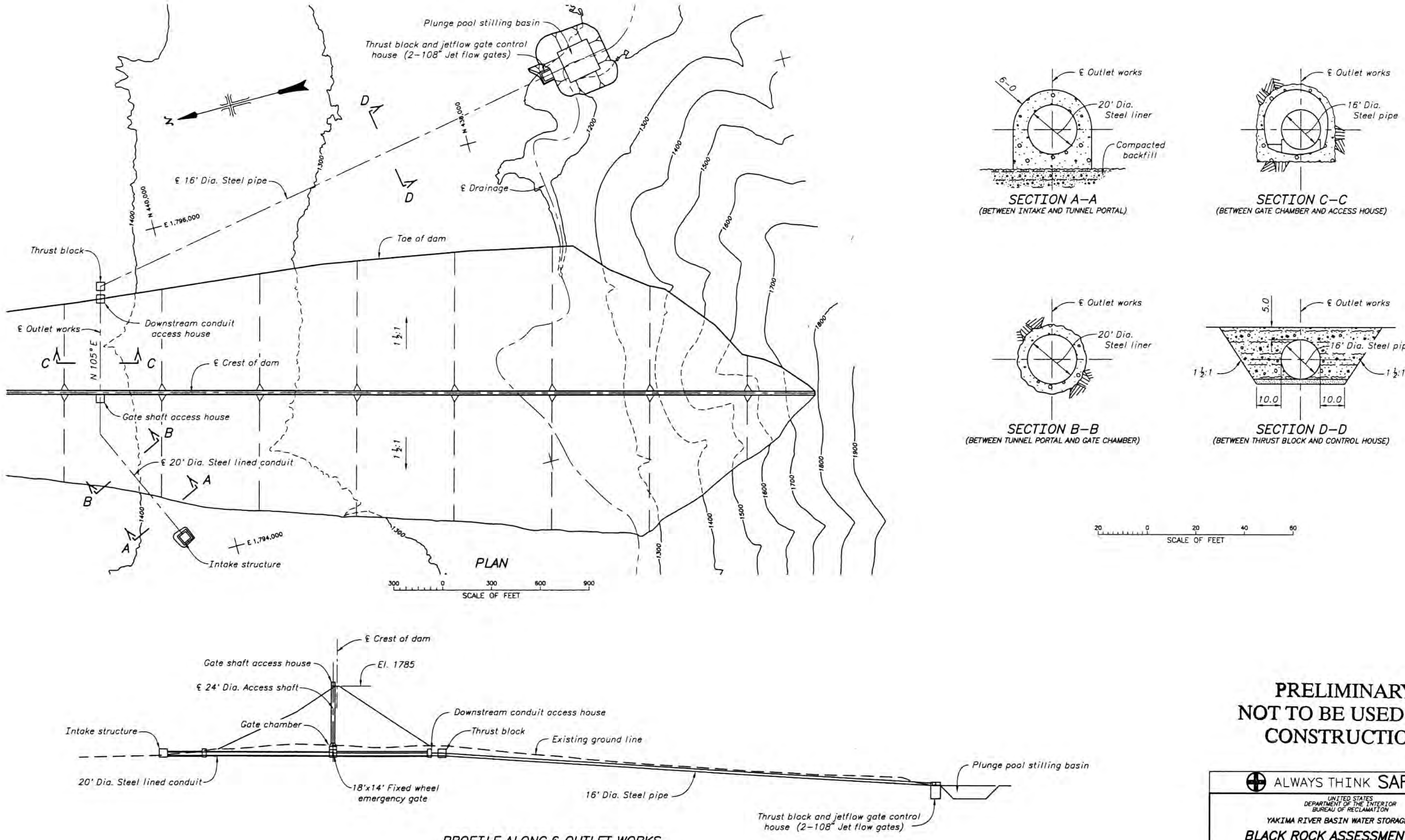
RCC DAM AND OUTLET WORKS

DESIGNED DOUG STANTON, P.E.

REVIEWED BY JOHN H. LABOON, P.E.
Waterways and Concrete Dams

CADD SYSTEM AutoCAD Rel. 16.0s | CADD FILENAME FIGURE 49.50.DWG
DENVER, COLORADO | SHEET 2 OF 2 | FIGURE 50

FILE PATH: H:\HOME\CIVILENG SHARE\W&CDPROJ\BLACK_ROCK\
PLOTTED BY: JMARKLEY
AUGUST 16, 2004 10:50



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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

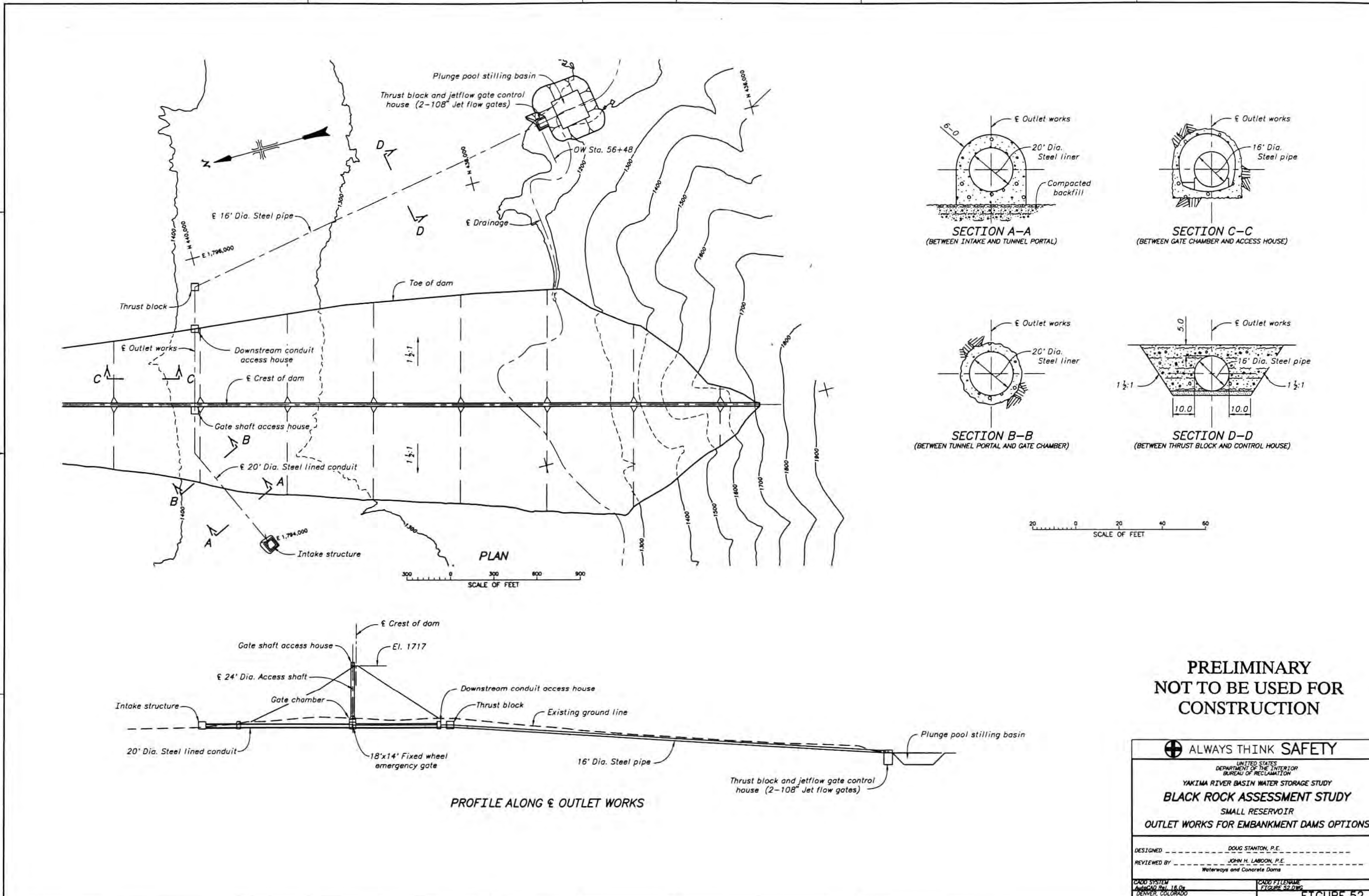
LARGE RESERVOIR

OUTLET WORKS FOR EMBANKMENT DAMS OPTIONS

DESIGNED DOUG STANTON, P.E.
REVIEWED BY JOHN H. LABOON, P.E.
Waterways and Concrete Dams

CADD SYSTEM AutoCAD Rel. 16.0a DENVER, COLORADO
CADD FILENAME FIGURE 51.DWG

FIGURE 51


Plunge pool stilling basin
Thrust block and jetflow gate control house (2–108" Jet flow gates)
OW Sta. 56+48
℄ 16' Dia. Steel pipe
℄ Drainage
Toe of dam
Thrust block
℄ Outlet works
Downstream conduit access house
℄ Crest of dam
Gate shaft access house
℄ 20' Dia. Steel lined conduit
Intake structure
PLAN
SCALE OF FEET
Compacted backfill
20' Dia. Steel liner
16' Dia. Steel pipe
SECTION A–A
(BETWEEN INTAKE AND TUNNEL PORTAL)
SECTION B–B
(BETWEEN TUNNEL PORTAL AND GATE CHAMBER)
SECTION C–C
(BETWEEN GATE CHAMBER AND ACCESS HOUSE)
SECTION D–D
(BETWEEN THRUST BLOCK AND CONTROL HOUSE)
El. 1717
℄ 24' Dia. Access shaft
Gate chamber
Existing ground line
20' Dia. Steel lined conduit
18'x14' Fixed wheel emergency gate
16' Dia. Steel pipe
PROFILE ALONG ℄ OUTLET WORKS
PRELIMINARY
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CONSTRUCTION
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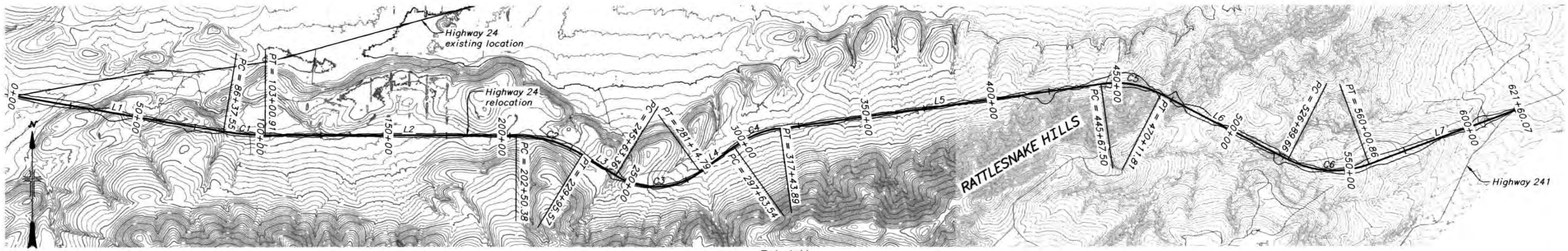
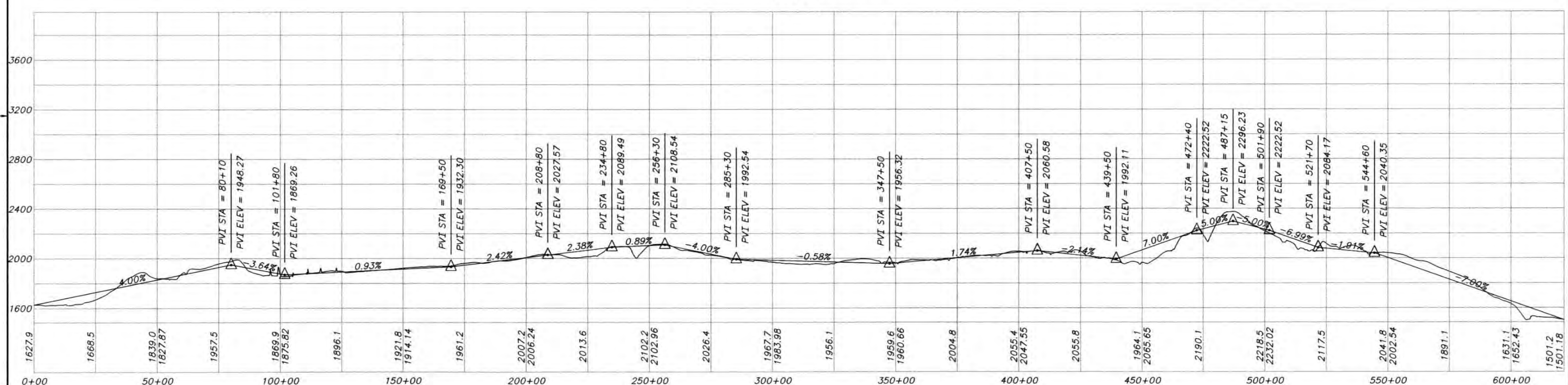
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
YAKIMA RIVER BASIN WATER STORAGE STUDY
BLACK ROCK ASSESSMENT STUDY
SMALL RESERVOIR
OUTLET WORKS FOR EMBANKMENT DAMS OPTIONS
DESIGNED DOUG STANTON, P.E.
REVIEWED BY JOHN H. LABOON, P.E.
Waterways and Concrete Dams
CADD SYSTEM AutoCAD Rel. 16.0s
DENVER, COLORADO
CADD FILENAME FIGURE 52.DWG
FIGURE 52

FIGURE 53



PLAN

2000 0 2000 4000 6000
SCALE OF FEET



CURVE TABLE					
CURVE	LENGTH	RADIUS	DELTA	TANGENT	CHORD
C1	1663.35	10000.00	9°31'49"	833.60	1661.44
C2	2745.20	5000.00	31°27'27"	1408.15	2710.85
C3	3551.42	3000.00	67°49'38"	2016.95	3347.65
C4	1980.35	4000.00	28°21'59"	1010.91	1960.19
C5	2444.31	4000.00	35°00'44"	1261.66	2406.46
C6	3311.20	4000.00	47°25'46"	1757.10	3217.46

LINE TABLE		
LINE	LENGTH	BEARING
L1	8637.55	S80°17'46"E
L2	9949.47	S89°49'35"E
L3	1567.79	S58°22'07"E
L4	1648.75	N53°48'15"E
L5	12823.61	N82°10'14"E
L6	5677.86	S62°49'02"E
L7	6159.20	N69°45'12"E

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YAKIMA RIVER BASIN WATER STORAGE STUDY

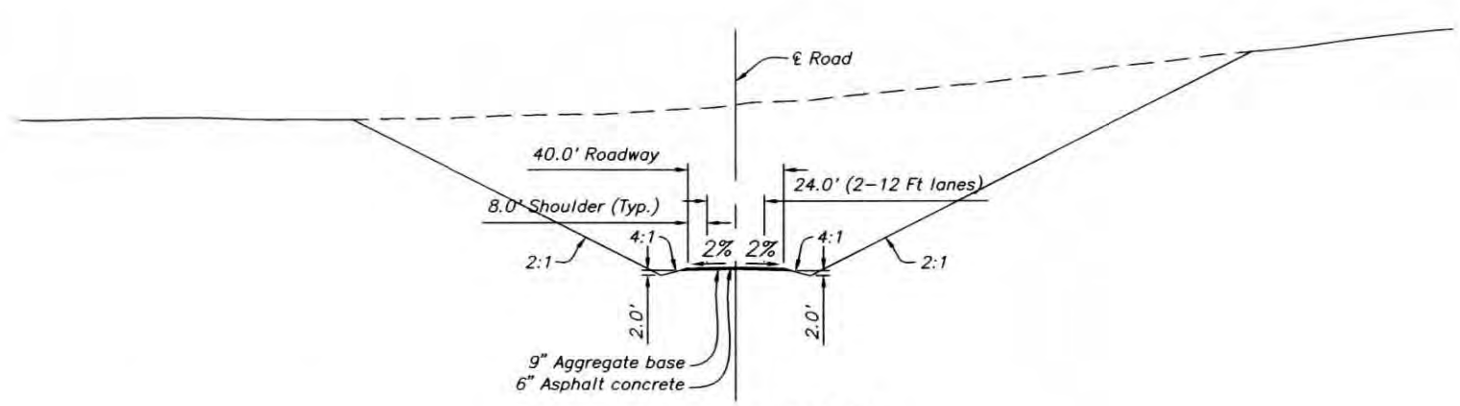
BLACK ROCK ASSESSMENT STUDY

ROAD RELOCATION
PLAN AND PROFILE

DESIGNED
REVIEWED BY
WATER CONVEYANCE GROUP

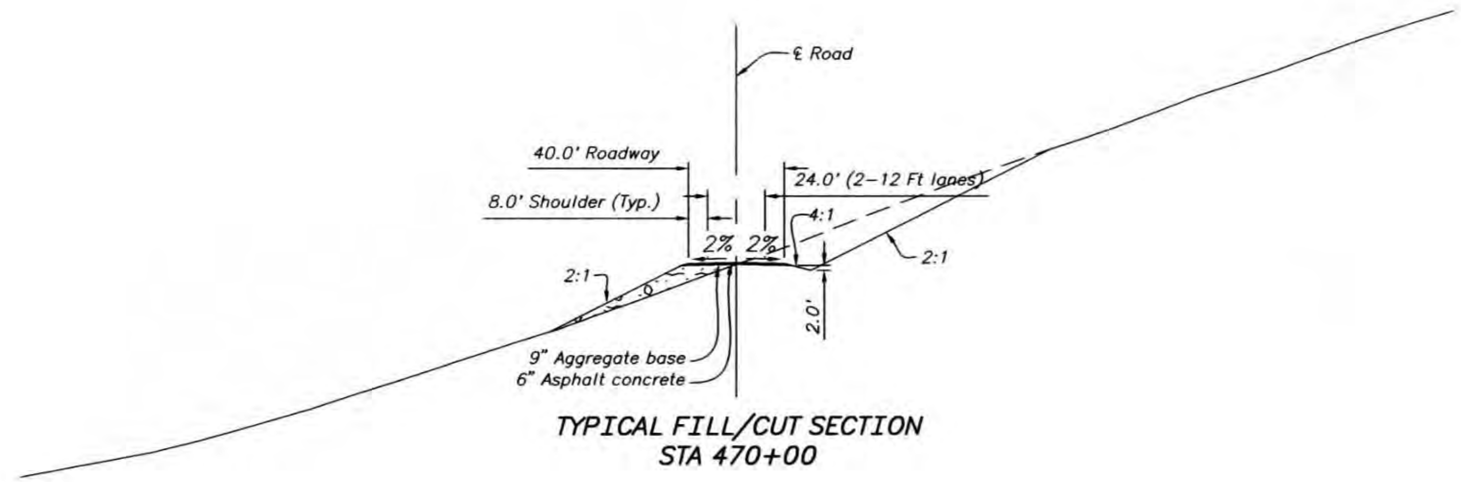
CADD SYSTEM AutoCAD Rel. 16.0s
DENVER, COLORADO MAY 20, 2004 SHEET 1 OF 2
CADD FILENAME FIGURES 53.DWG
FIGURE 53

FILE PATH: H:\HOME\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\WATER CONVEYANCE\
PLOTTED BY: APAVOL
AUGUST 11, 2004 12:22

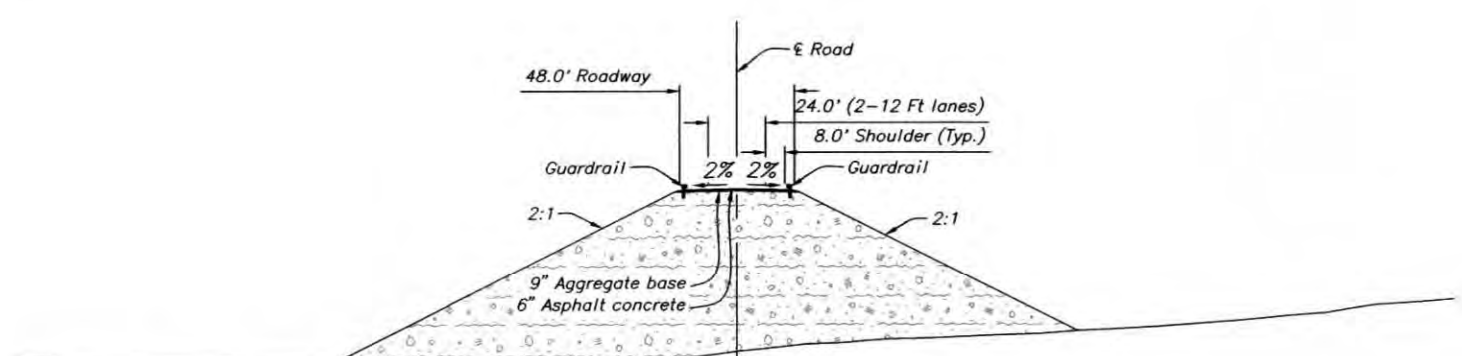


TYPICAL CUT SECTION
STA 570+00

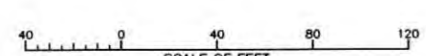
SLOPE TABLE		
FILL/CUT HEIGHT	FILL SLOPE	CUT SLOPE
0 – 5	6 : 1	6 : 1
5 – 10	6 : 1	3 : 1
10 – 20	4 : 1	3 : 1
20 – 30	3 : 1	2 : 1
OVER 30	2 : 1	2 : 1



TYPICAL FILL/CUT SECTION
STA 470+00



TYPICAL FILL SECTION
STA 20+00



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NOTES

1. Fill and cut slopes vary depending on the height of the embankment or excavation. Refer to slope table.
2. Guardrail should be constructed where the height of embankment exceeds 10ft.

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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

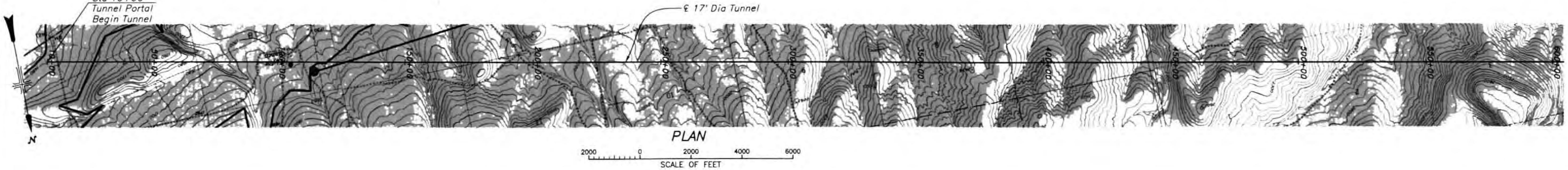
ROAD RELOCATION
TYPICAL SECTIONS

DESIGNED Anne Parsed
REVIEWED BY David K. Edwards
WATER CONVEYANCE GROUP

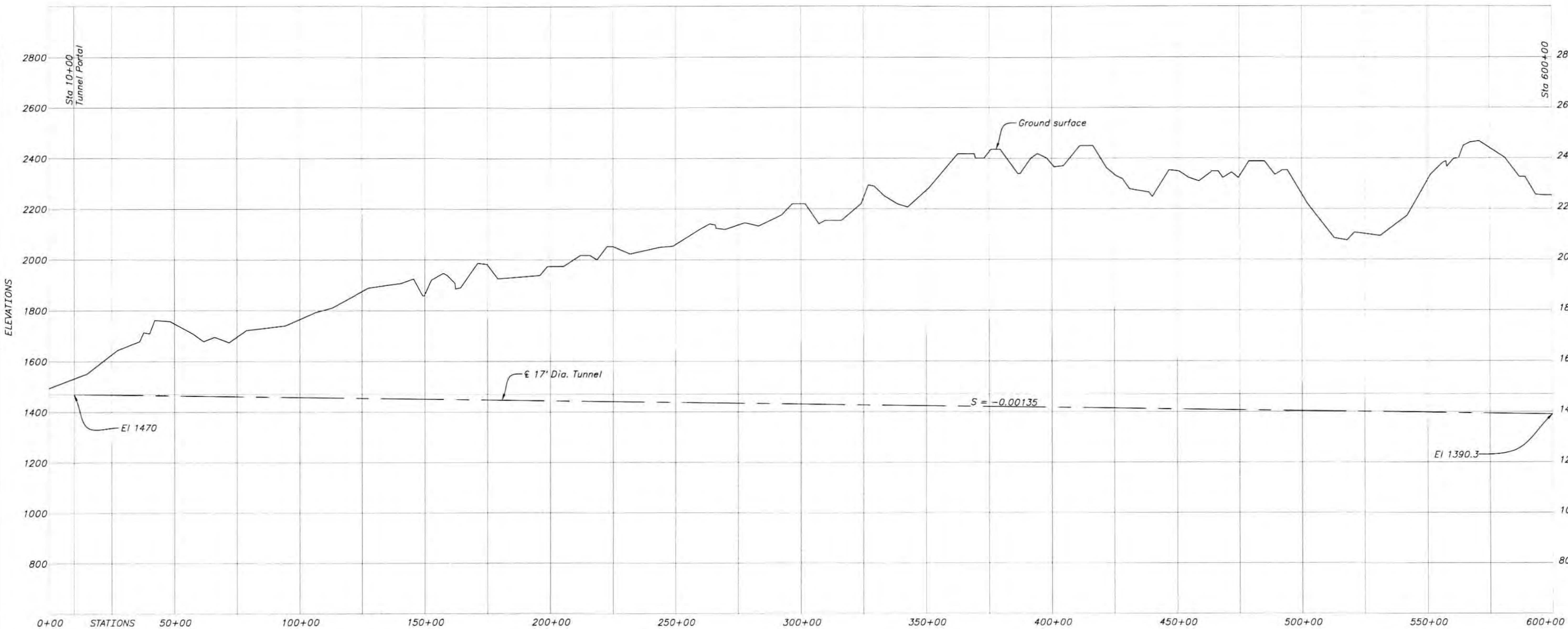
CADD SYSTEM AutoCAD Rel. 16.0s
DENVER, COLORADO MAY 20, 2004 SHEET 2 OF 2
CADD FILENAME FIGURE 54.DWG
FIGURE 54

FILE PATH: H:\HOME\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\WATER CONVEYANCE\
PLOTTED BY: APAVOL
AUGUST 11, 2004 12:10

FIGURE 55



PLAN



PROFILE

NOTES

1. For tunnel sections and details, see Figure 37.
2. The topography and profile is generated from TOPO! by National Geographic.

PRELIMINARY
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CONSTRUCTION

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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

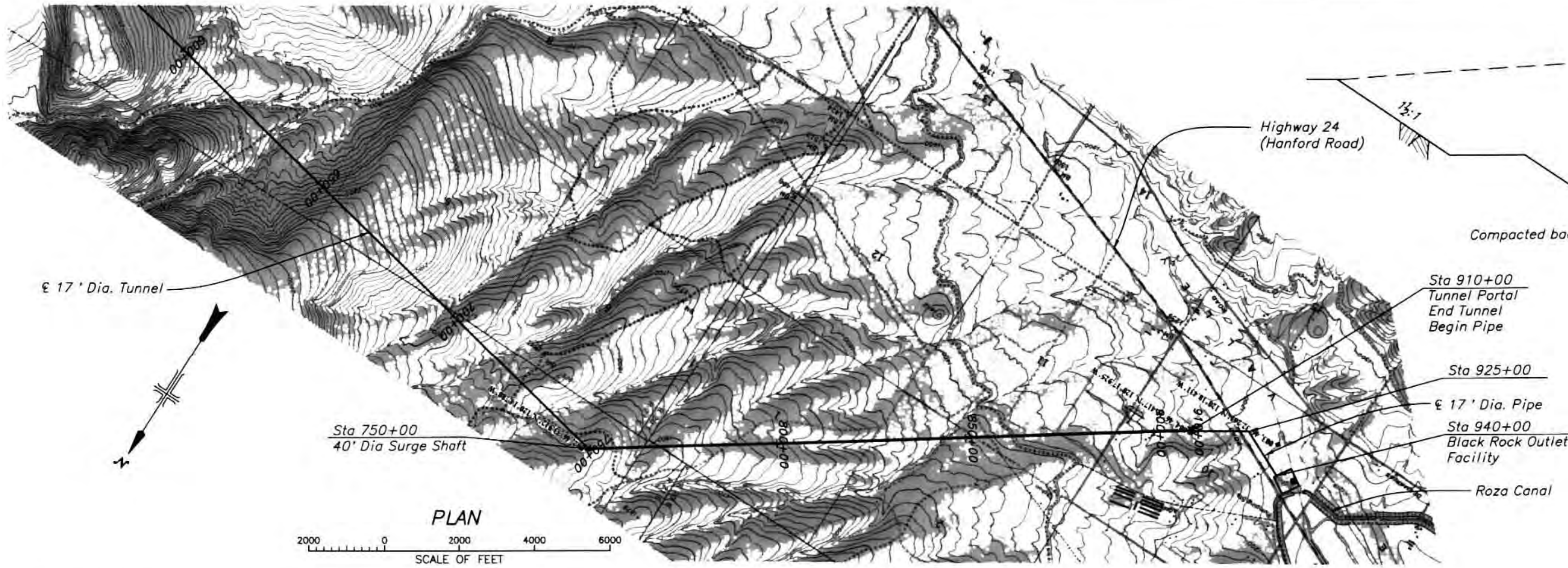
OUTFLOW 2500 CFS
PLAN AND PROFILE

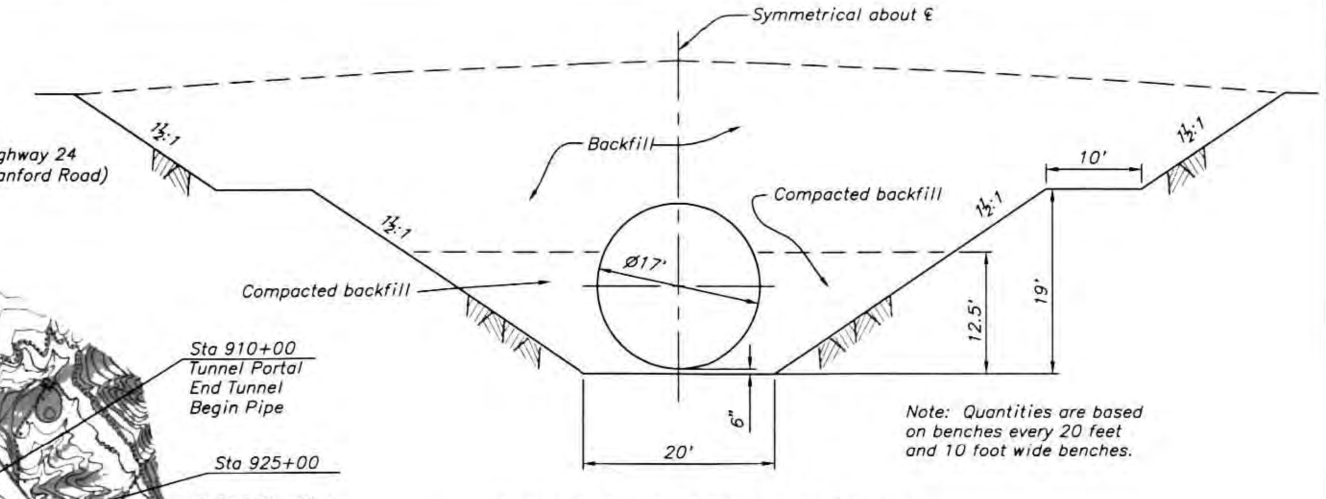
DESIGNED [signature]
REVIEWED BY [signature]
WATER CONVEYANCE GROUP

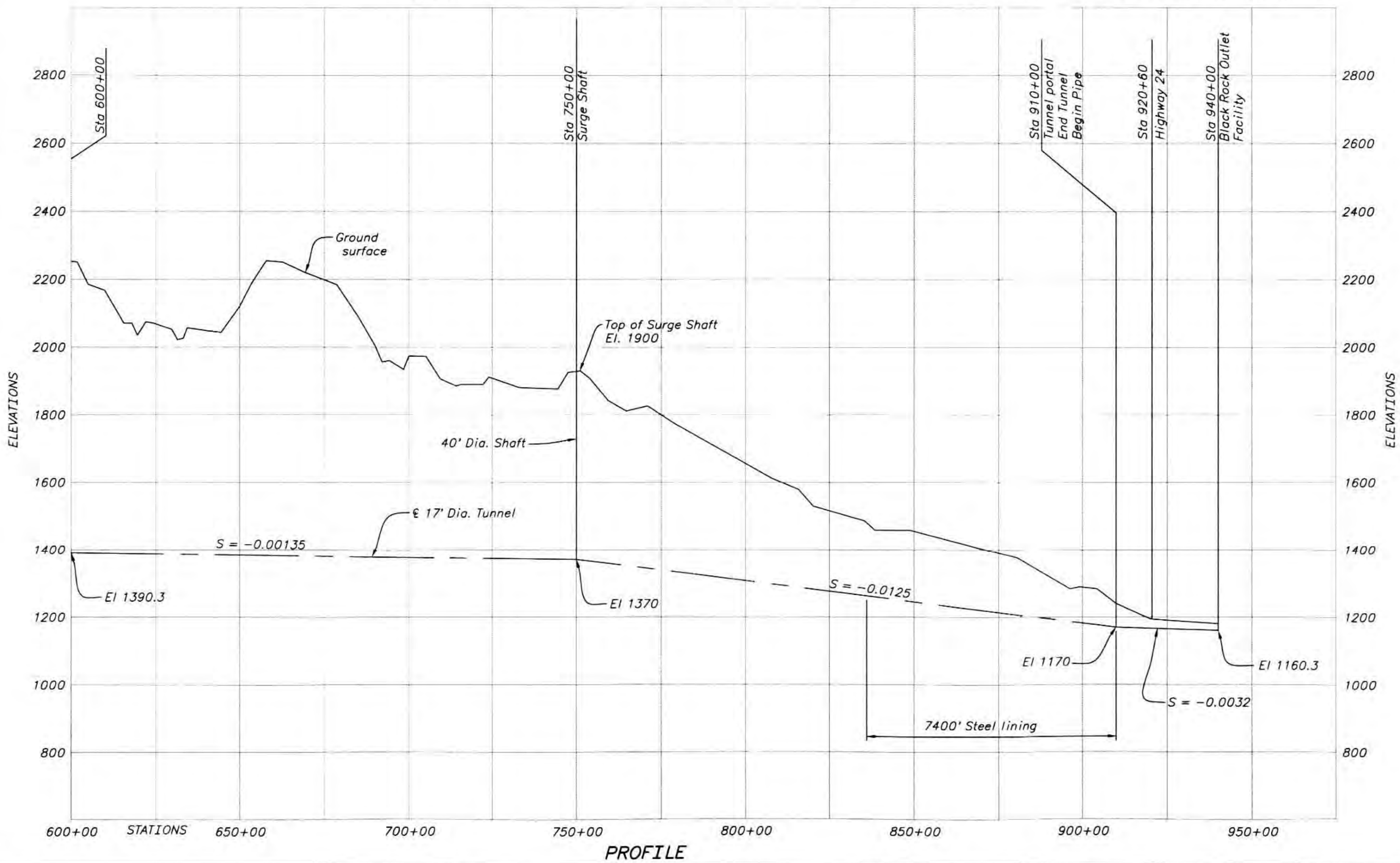
CADD SYSTEM AutoCAD Rel. 16.0s
DENVER, COLORADO APRIL 9, 2004 SHEET 1 OF 2
CADD FILENAME FIGURES 55 AND 56.DWG
FIGURE 55

FILE PATH: H:\HOME\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\WATER CONVEYANCE\
PLOTTED BY: LBOWLES
AUGUST 16, 2004 09:03

FIGURE 56







PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION

NOTES

1. For tunnel sections, see Figure 37.
2. For shaft section and details, see Figure 38.
3. The topography and profile is generated from TOPO! by National Geographic.

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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

OUTFLOW 2500 CFS

PLAN AND PROFILE

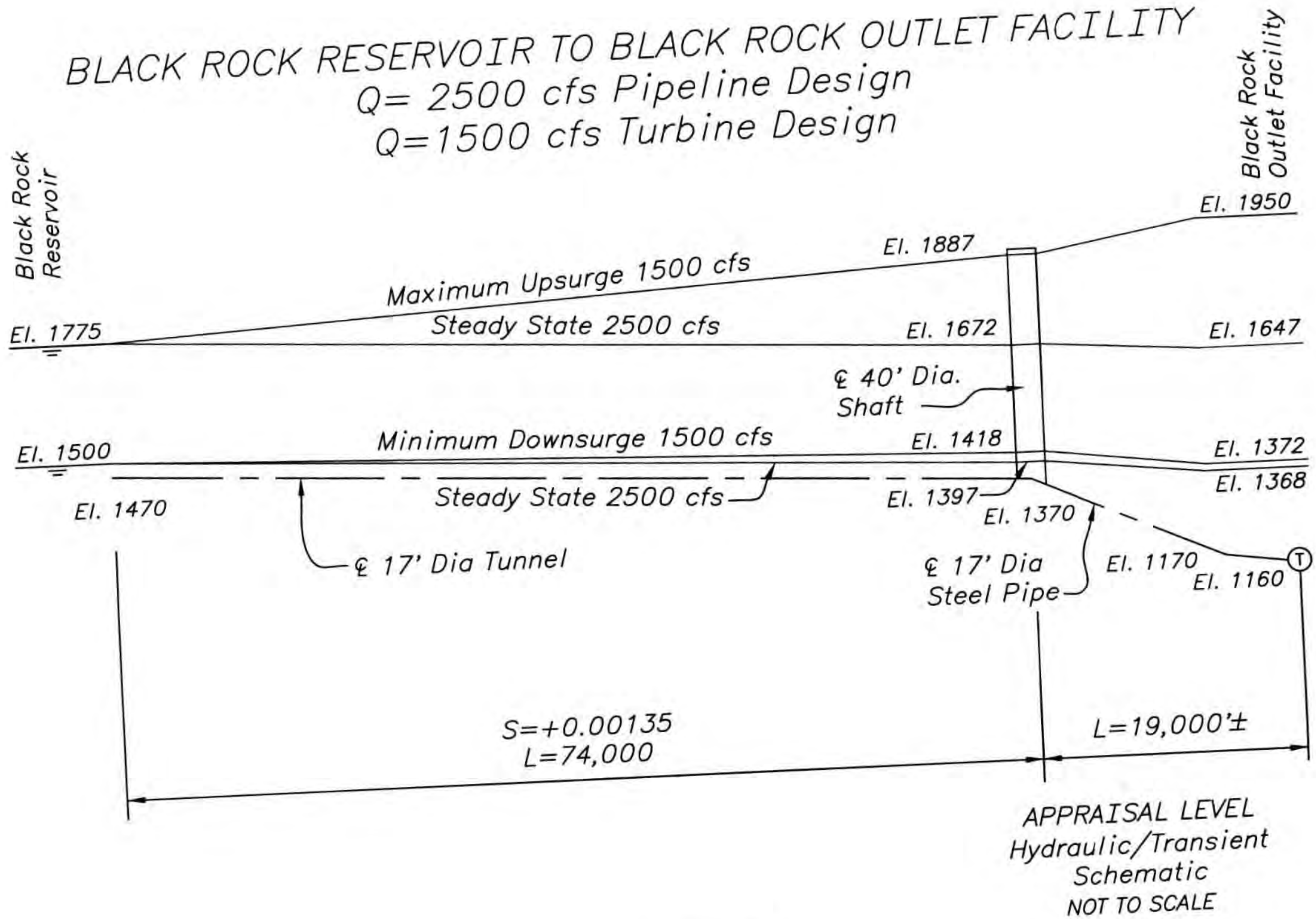
DESIGNED Lily M Bowles

REVIEWED BY Richard [signature]

WATER CONVEYANCE GROUP

CADD SYSTEM AutoCAD Rel. 16.0s | CADD FILENAME FIGURES 55 AND 56.DWG
DENVER, COLORADO APRIL 9, 2004 SHEET 2 OF 2 | FIGURE 56

FILE PATH: H:\HOME\CIVIL\ENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\WATER CONVEYANCE\
PLOTTED BY: LBOWLES
AUGUST 17, 2004 09:10



BLACK ROCK RESERVOIR TO BLACK ROCK OUTLET FACILITY
Q= 2500 cfs Pipeline Design
Q=1500 cfs Turbine Design
Black Rock Reservoir
Black Rock Outlet Facility
El. 1950
El. 1887
Maximum Upsurge 1500 cfs
Steady State 2500 cfs
El. 1775
El. 1672
El. 1647
℄ 40' Dia. Shaft
Minimum Downsurge 1500 cfs
El. 1500
El. 1418
El. 1372
El. 1368
Steady State 2500 cfs
El. 1397
El. 1370
El. 1470
℄ 17' Dia Tunnel
℄ 17' Dia Steel Pipe
El. 1170
El. 1160
T
S=+0.00135
L=74,000
L=19,000'±
APPRAISAL LEVEL
Hydraulic/Transient
Schematic
NOT TO SCALE

FIGURE 57

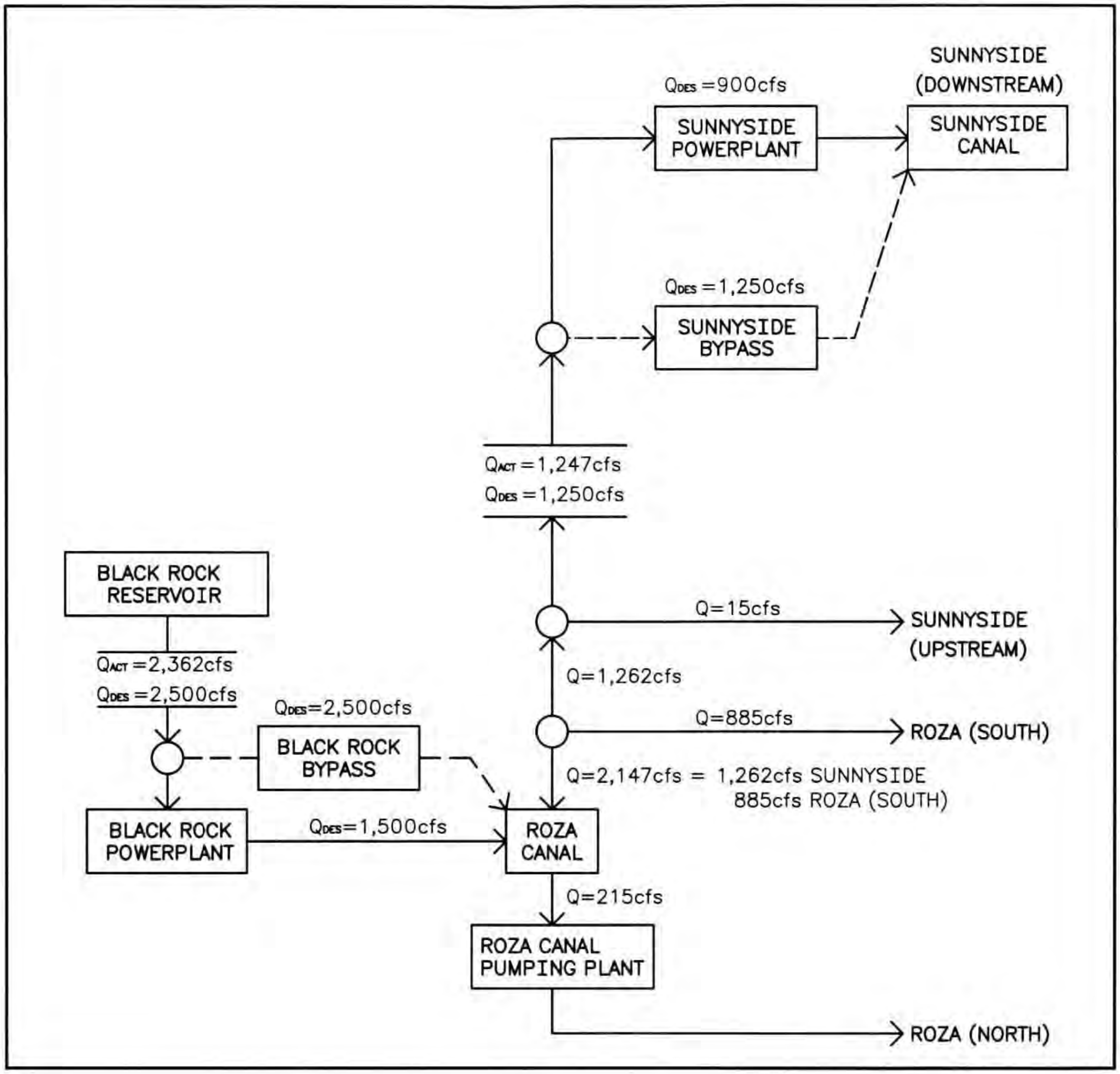


Figure 58. - Black Rock Powerplant Schematic - Option 1

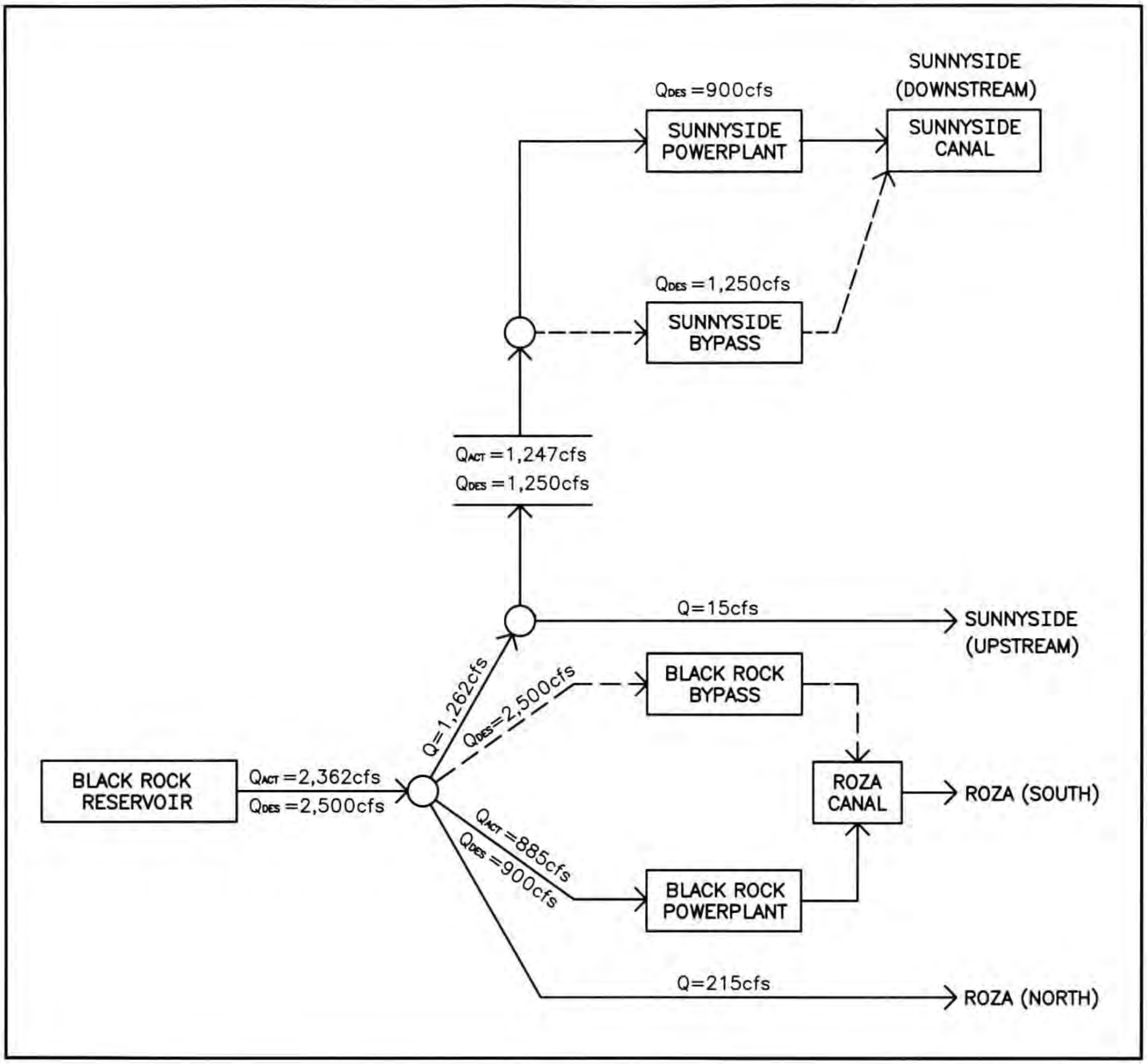
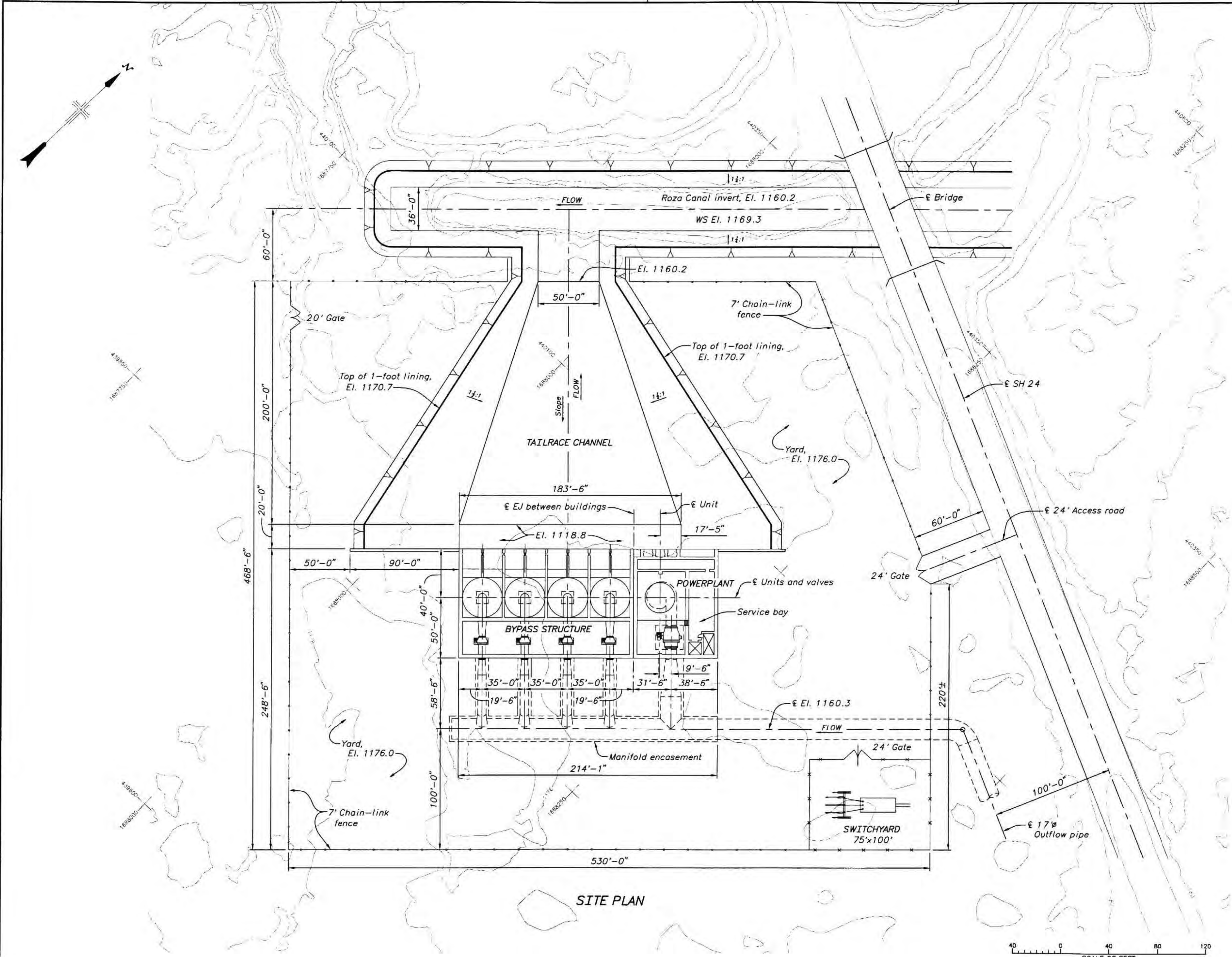


Figure 59. - Black Rock Powerplant Schematic - Option 2

FIGURE 60



**PRELIMINARY
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CONSTRUCTION**

NOTES

1. Power plant sized for flow of 1,500 cfs and head of 338 feet as shown.
2. Bypass structure sized for flow of 2,500 cfs.

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BUREAU OF RECLAMATION

YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

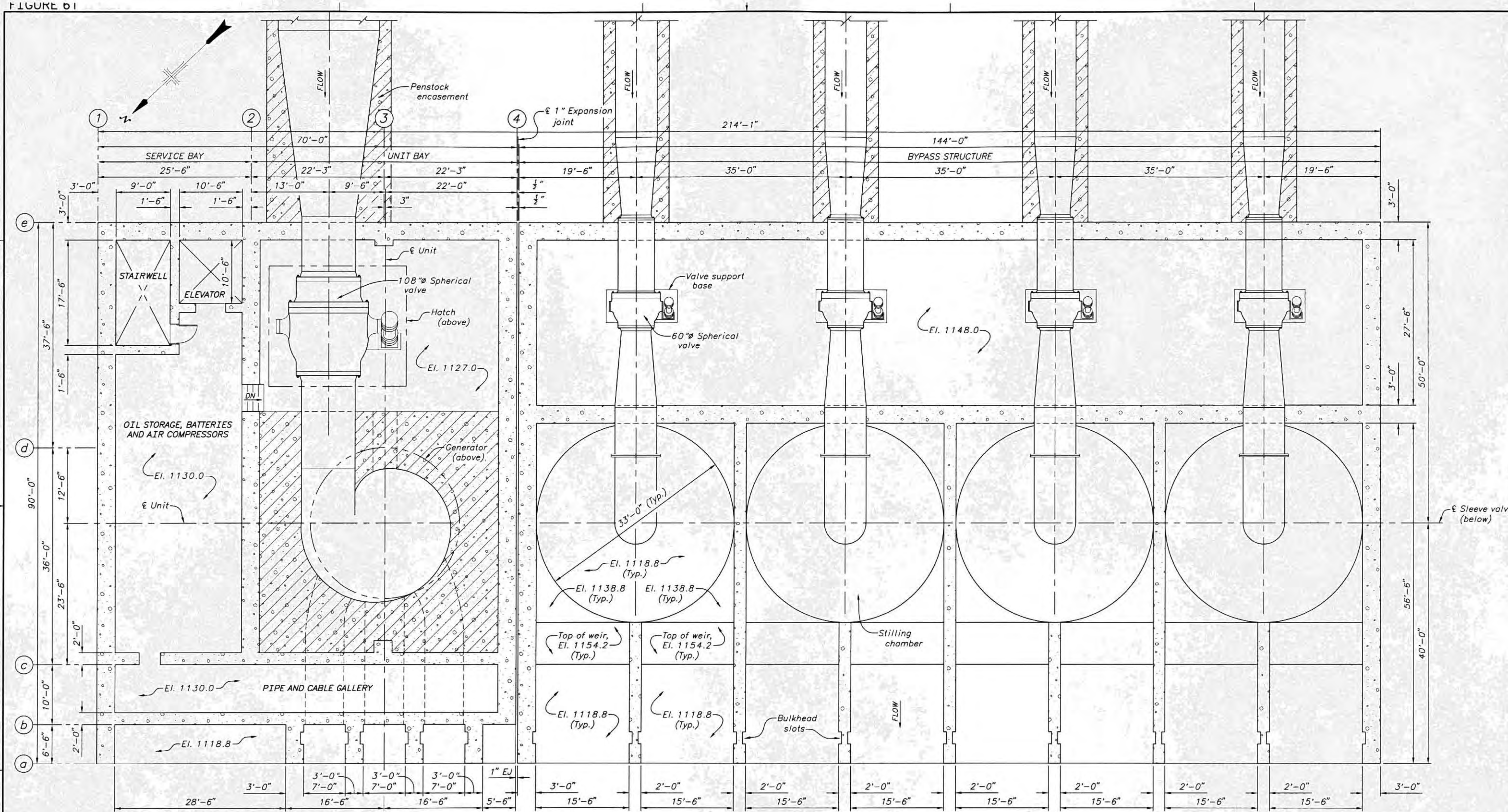
BLACK ROCK OUTLET FACILITY
SITE PLAN

DESIGNED BY R.W. LaFOND
REVIEWED BY M.R. O'Shea
STRUCTURAL & ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s	CADD FILENAME FIGURE 60.DWG
DENVER, COLORADO AUGUST 20, 2004	FIGURE 60

FILE PATH: I:\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\PLANT STRUCTURES\DRAWINGS\BLACK ROCK ASSESS. STUDY\
PLOTTED BY: RRODRIGU
AUGUST 20, 2004 07:56

FIGURE 61



POWERPLANT
PLAN – EL. 1138.8

BYPASS STRUCTURE
PLAN – EL. 1160.3

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

NOTES

1. Power plant sized for flow of 1,500 cfs and head of 338 feet as shown.
2. Bypass structure sized for flow of 2,500 cfs.

LEGEND

Indicates Concrete

Indicates Second Stage Concrete

8 0 8 16
SCALE OF FEET

ALWAYS THINK SAFETY

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YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

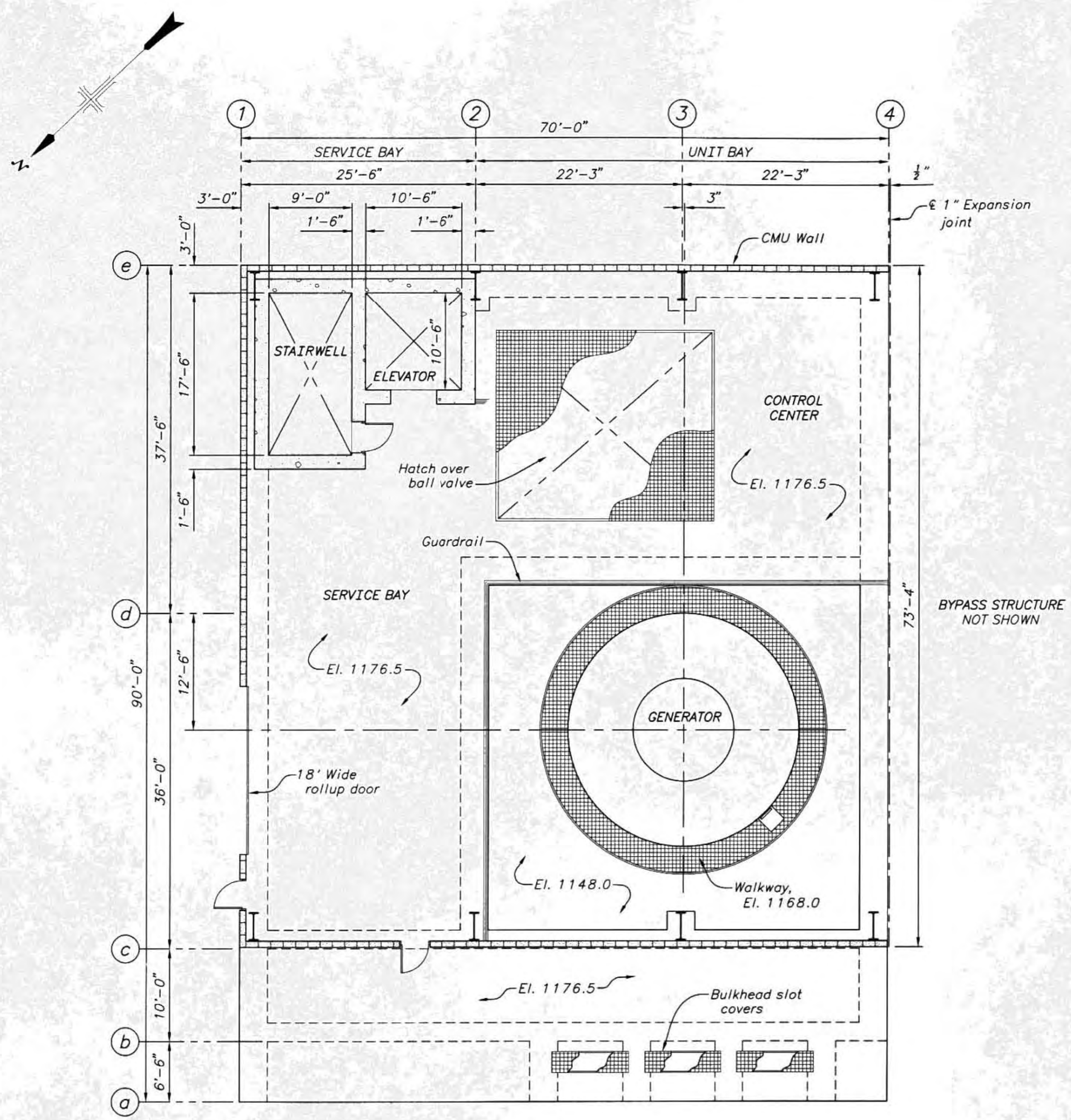
BLACK ROCK OUTLET FACILITY

PLANS – EL. 1138.8 AND EL. 1160.3

DESIGNED BY R.W. LaFOND
REVIEWED BY M.Q. O'Shea
STRUCTURAL & ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s
DENVER, COLORADO AUGUST 20, 2004
CADD FILENAME FIGURE 61.DWG
FIGURE 61

FILE PATH: F:\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\PLANT STRUCTURES\DRAWINGS\BLACK ROCK ASSESS. STUDY\
PLOTTED BY: RRODRIGU
AUGUST 20, 2004 09:20



PLAN – EL. 1176.5

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

NOTES

1. Power plant sized for flow of 1,500 cfs and head of 338 feet as shown.
2. Bypass structure sized for flow of 2,500 cfs.

LEGEND

Indicates Concrete
Indicates Second Stage Concrete

8 0 8 16
SCALE OF FEET

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

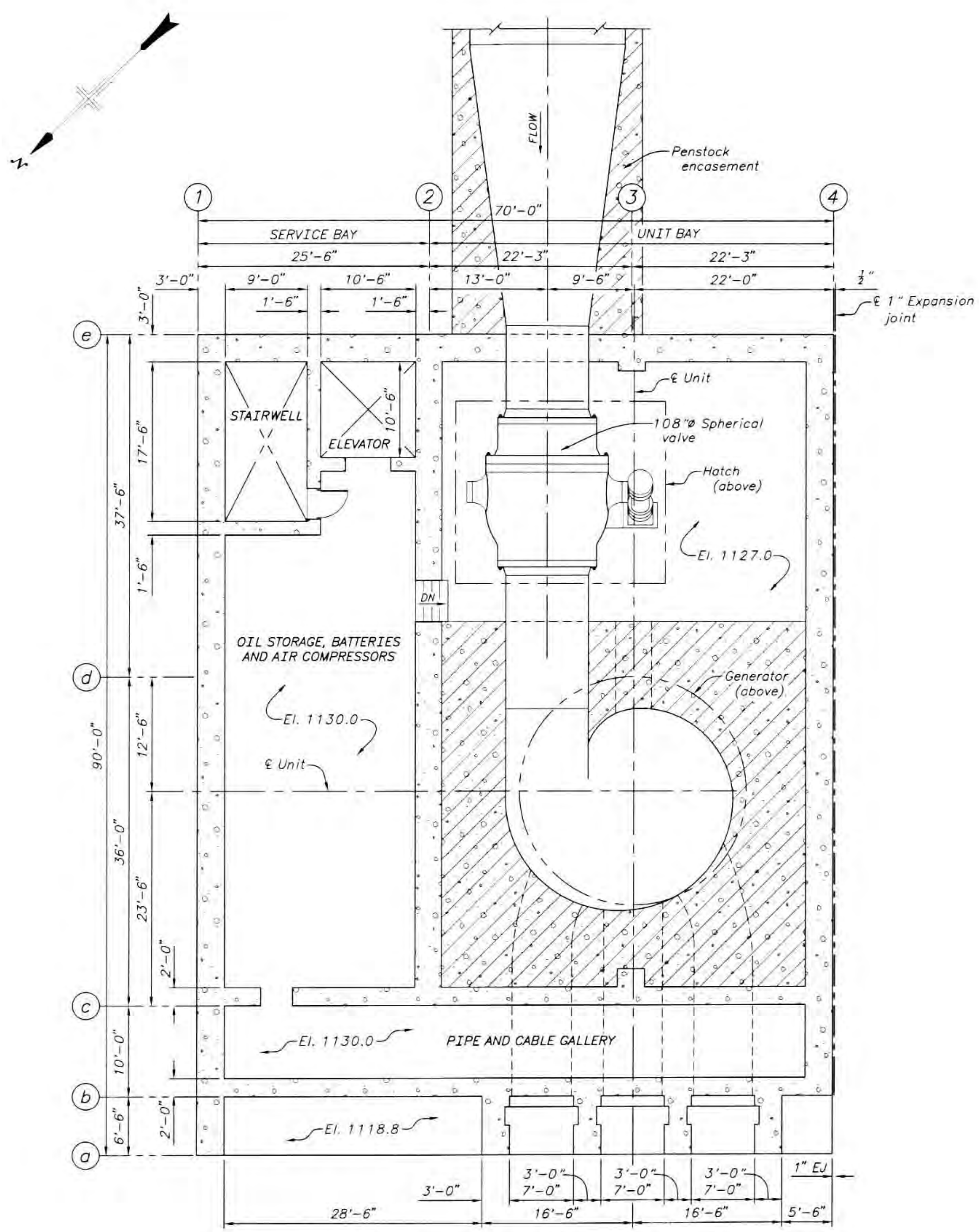
BLACK ROCK POWERPLANT

PLAN – EL. 1176.5

DESIGNED BY R.W. LaFOND
REVIEWED BY M.R. O'Shea
STRUCTURAL & ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s
DENVER, COLORADO AUGUST 20, 2004
CADD FILENAME FIGURE 62.DWG

FILE PATH: I:\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\PLANT STRUCTURES\DRAWINGS\BLACK ROCK ASSESS. STUDY\
PLOTTED BY: RRODRIGU
AUGUST 20, 2004 09:28



PLAN – EL. 1138.8

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

NOTES

1. Power plant sized for flow of 1,500 cfs and head of 338 feet as shown.
2. Bypass structure sized for flow of 2,500 cfs.

LEGEND

Indicates Concrete

Indicates Second Stage Concrete

8 0 8 16
SCALE OF FEET

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

BLACK ROCK POWERPLANT

PLAN – EL. 1130.0

DESIGNED BY R.W. LaFOND

REVIEWED BY M. R. O'Shea

STRUCTURAL & ARCHITECTURAL GROUP

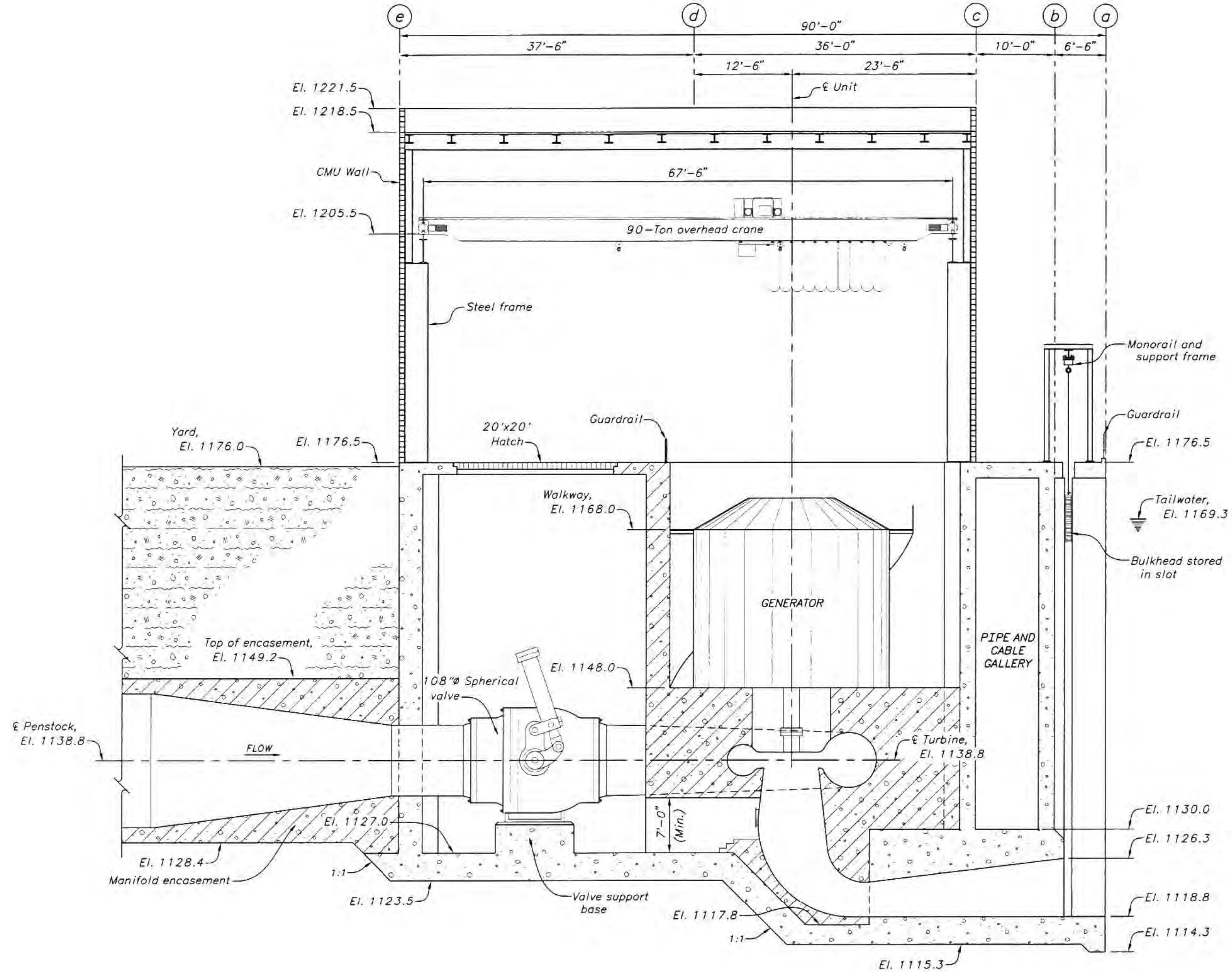
CADD SYSTEM AutoCAD Rel. 16.0s

DENVER, COLORADO AUGUST 20, 2004

CADD FILENAME FIGURE 63.DWG

FIGURE 63

FILE PATH: I:\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\PLANT STRUCTURES\DRAWINGS\BLACK ROCK ASSESS. STUDY\
PLOTTED BY: RRODRIGU
AUGUST 20, 2004 09:48



TRANSVERSE SECTION THRU UNIT

LEGEND

- Indicates Concrete
- Indicates Second Stage Concrete
- Indicates Compacted Backfill

8 0 8 16
SCALE OF FEET

**PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION**

NOTES

1. Power plant sized for flow of 1,500 cfs and head of 338 feet as shown.
2. Bypass structure sized for flow of 2,500 cfs.

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

BLACK ROCK POWERPLANT

TRANSVERSE SECTION THRU UNIT

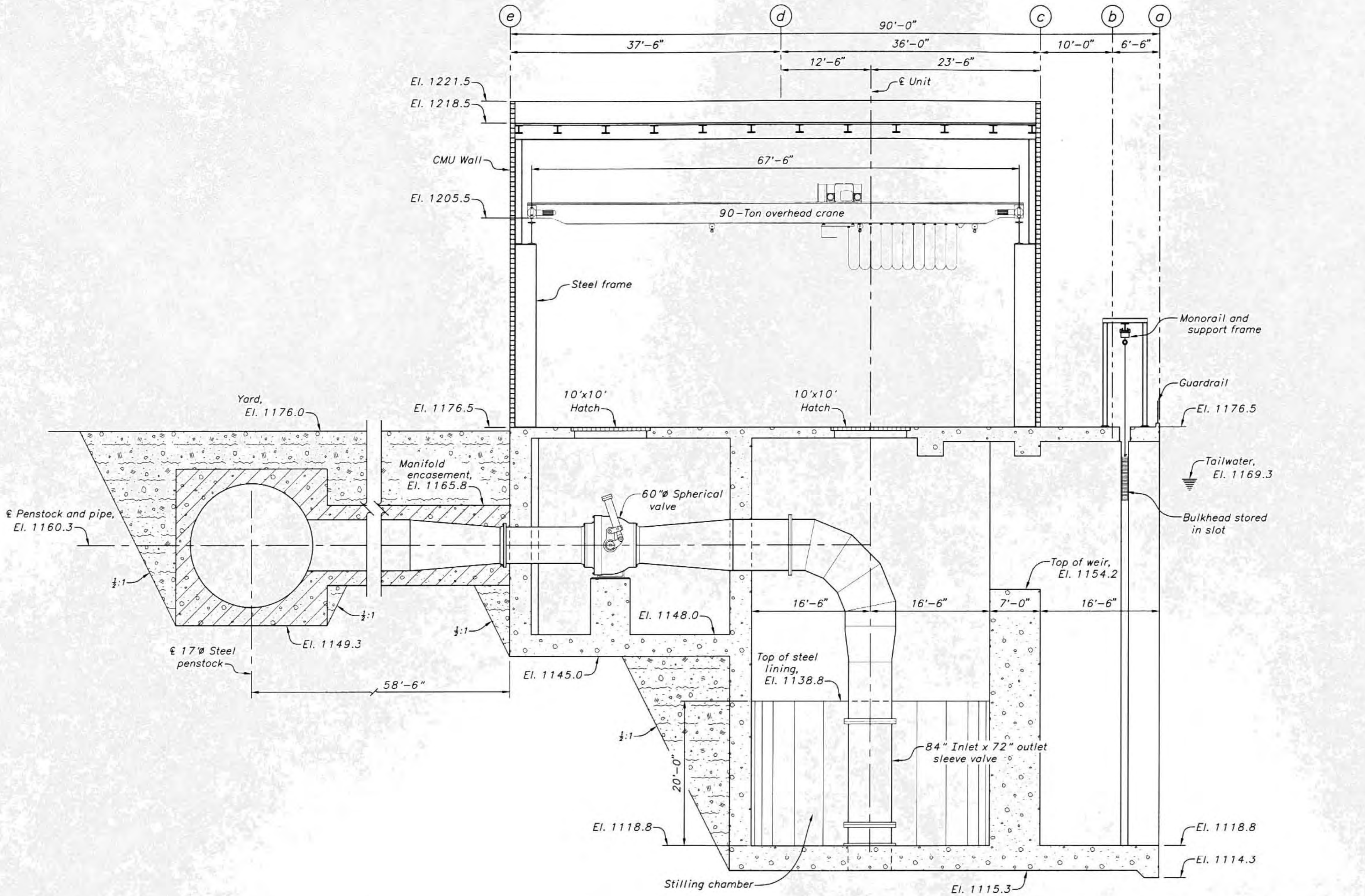
DESIGNED BY R.W. LaFOND
REVIEWED BY M. O'Shea
STRUCTURAL & ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s | CADD FILENAME FIGURE 64.DWG
DENVER, COLORADO AUGUST 20, 2004

FIGURE 64

FILE PATH: I:\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\PLANT STRUCTURES\DRAWINGS\BLACK ROCK ASSESS. STUDY\
PLOTTED BY: RRODRIGU
AUGUST 20, 2004 10:28

FIGURE 65



TRANSVERSE SECTION THRU BYPASS STRUCTURE

LEGEND

- Indicates Concrete
- Indicates Second Stage Concrete
- Indicates Compacted Backfill

8 0 8 16
SCALE OF FEET

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

NOTES

1. Power plant sized for flow of 1,500 cfs and head of 338 feet as shown.
2. Bypass structure sized for flow of 2,500 cfs.

ALWAYS THINK SAFETY

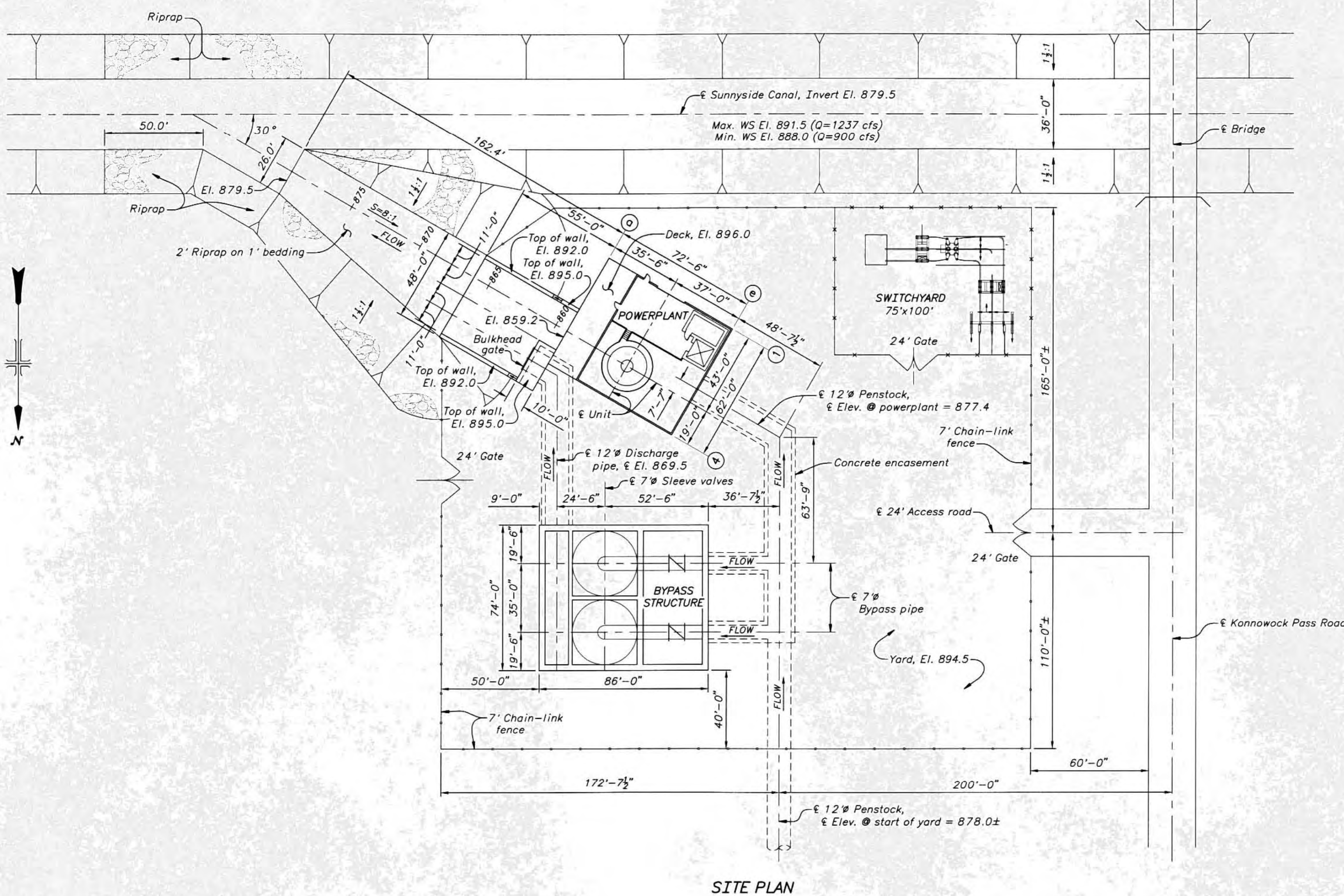
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
YAKIMA RIVER BASIN WATER STORAGE STUDY
BLACK ROCK ASSESSMENT STUDY
BLACK ROCK BYPASS STRUCTURE
TRANSVERSE SECTION THRU BYPASS STRUCTURE

DESIGNED BY R.W. LaFOND
REVIEWED BY M.R. O'Shea
STRUCTURAL & ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0a
DENVER, COLORADO AUGUST 20, 2004
CADD FILENAME FIGURE 65.DWG
FIGURE 65

FILE PATH: I:\CIVIL\ENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\PLANT STRUCTURES\DRAWINGS\BLACK ROCK ASSESS. STUDY\
PLOTTED BY: RRODRIGU
AUGUST 20, 2004 10:50

FIGURE 66



PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION

NOTES

1. Powerplant sized for flow of 900 cfs and head of 438 feet as shown. Powerplant sized for 900 cfs and head of 221 feet similar.
2. Bypass structure sized for flow of 1,250 cfs.

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

SUNNYSIDE POWERPLANT

SITE PLAN

DESIGNED BY R.W. LaFOND

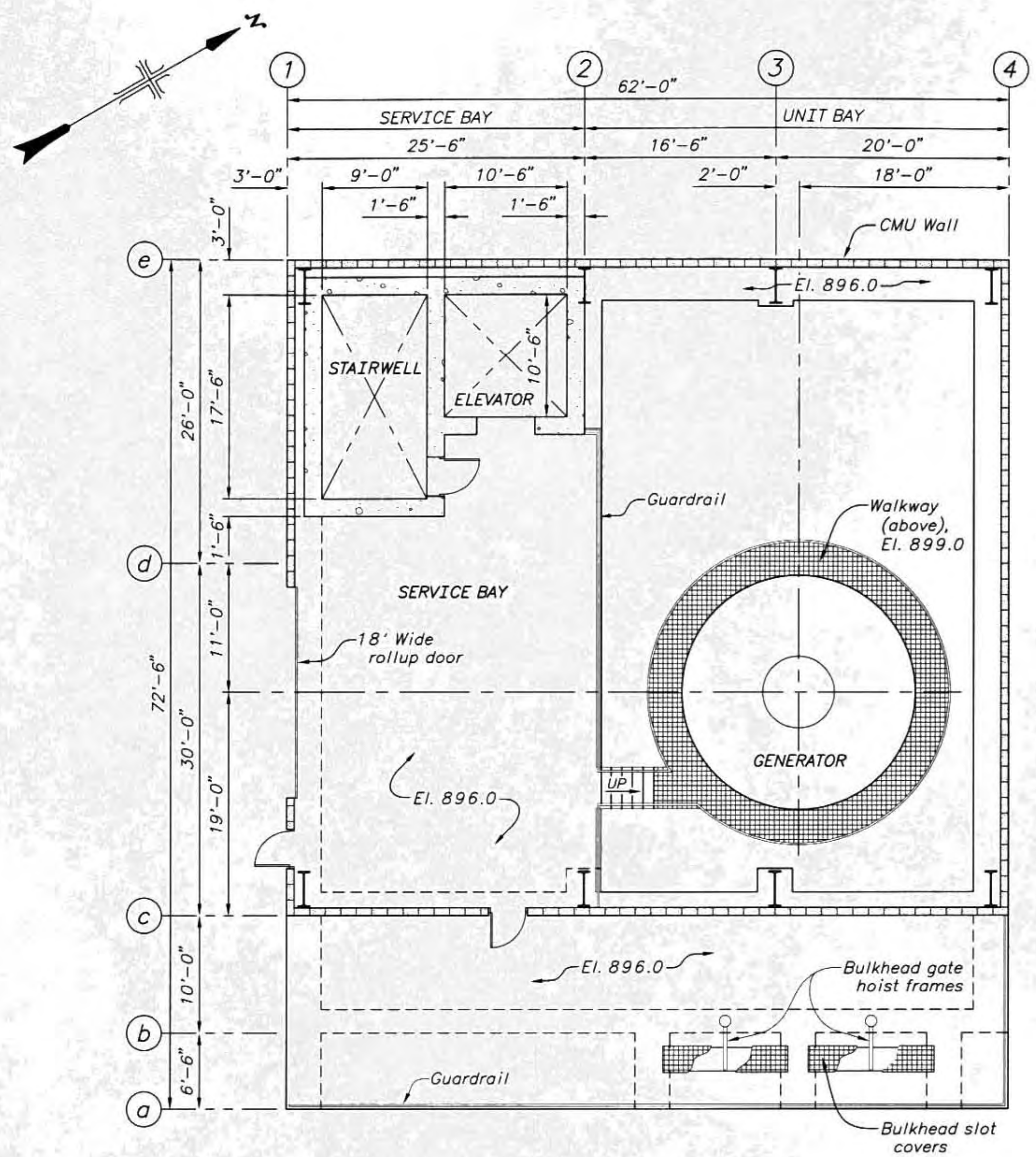
REVIEWED BY M.R. O'Shea

STRUCTURAL & ARCHITECTURAL GROUP

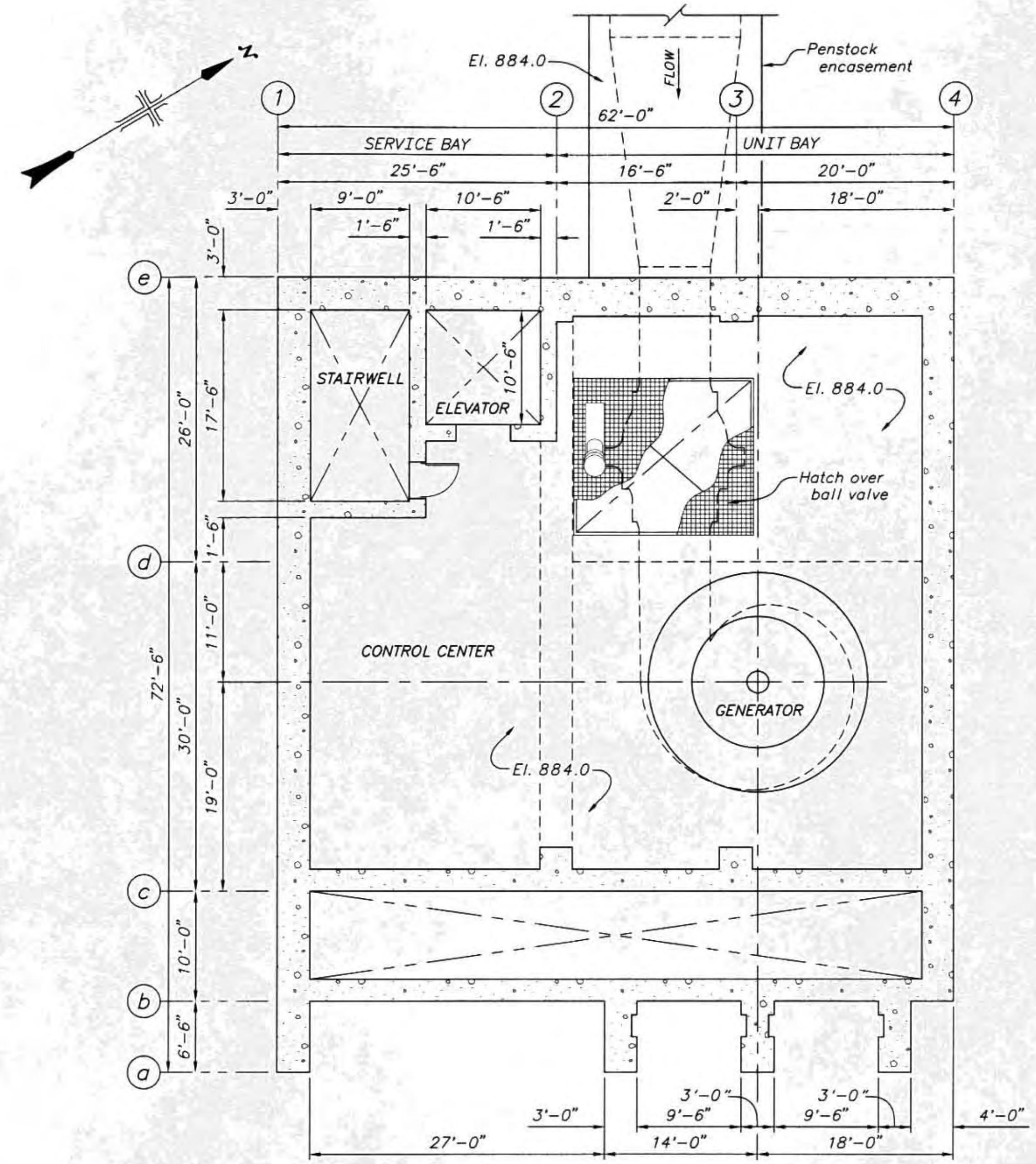
CADD SYSTEM AutoCAD Rel. 16.0s | CADD FILENAME FIGURE 66.DWG

DENVER, COLORADO | AUGUST 20, 2004 | FIGURE 66

FILE PATH: I:\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\PLANT STRUCTURES\DRAWINGS\SUNNYSIDE CANAL POWER PLANT\
PLOTTED BY: RRODRIGU
AUGUST 20, 2004 11:45



PLAN – EL. 896.0



PLAN – EL. 884.0

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

NOTES

1. Powerplant sized for flow of 900 cfs and head of 438 feet as shown. Powerplant sized for 900 cfs and head of 221 feet similar.
2. Bypass structure sized for flow of 1,250 cfs.

LEGEND

Indicates Concrete

SCALE OF FEET: 8 0 8 16

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

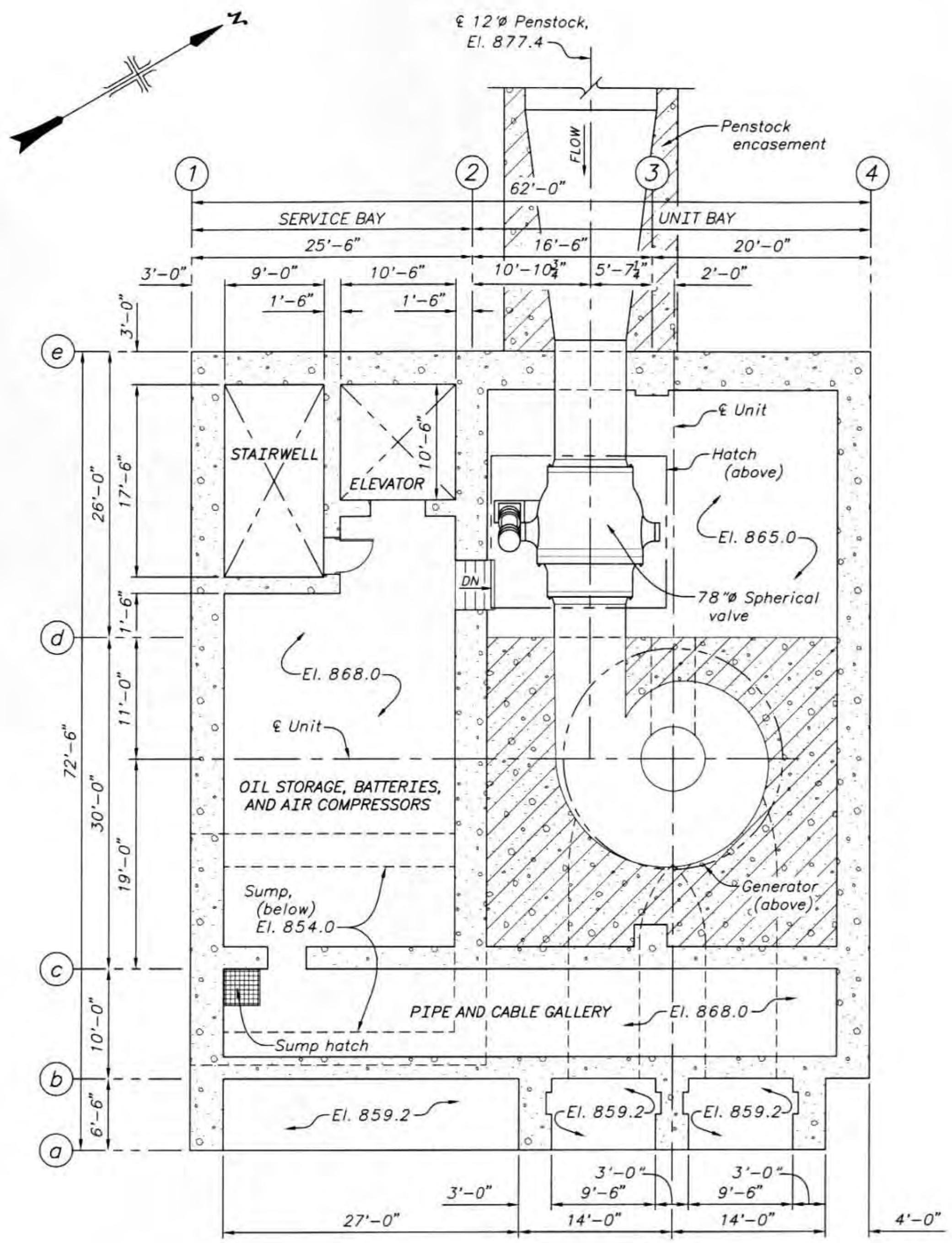
SUNNYSIDE POWERPLANT

PLAN – EL. 896.0 AND PLAN – EL. 884.0

DESIGNED BY R.W. LaFOND
REVIEWED BY [signature]
STRUCTURAL & ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s DENVER, COLORADO	AUGUST 20, 2004	CADD FILENAME FIGURE 67.DWG	FIGURE 67

FIGURE 68



PLAN – EL. 877.4

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

NOTES

1. Powerplant sized for flow of 900 cfs and head of 438 feet as shown. Powerplant sized for 900 cfs and head of 221 feet similar.
2. Bypass structure sized for flow of 1,250 cfs.

LEGEND

- Indicates Concrete
- Indicates Second Stage Concrete

8 0 8 16
SCALE OF FEET

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

SUNNYSIDE POWERPLANT

PLAN – EL. 877.4

DESIGNED BY R.W. LaFOND

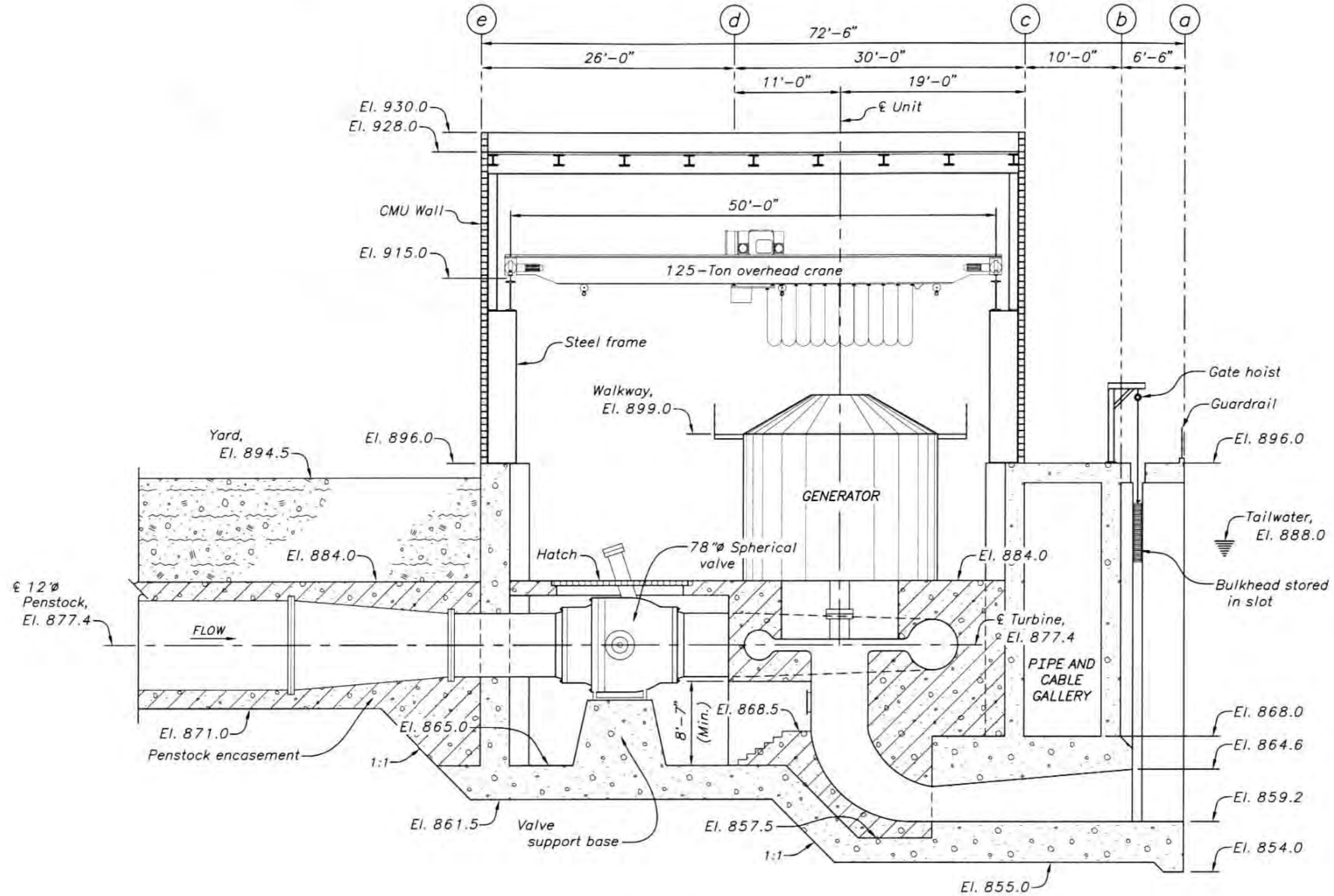
REVIEWED BY

STRUCTURAL & ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s | CADD FILENAME FIGURE 68.DWG
DENVER, COLORADO | AUGUST 20, 2004 | FIGURE 68

FILE PATH: F:\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\PLANT STRUCTURES\DRAWINGS\SUNNYSIDE CANAL POWER PLANT\
PLOTTED BY: RRODRIGU
AUGUST 20, 2004 12:30

FIGURE 69



TRANSVERSE SECTION THRU UNIT

PRELIMINARY
NOT TO BE USED FOR
CONSTRUCTION

NOTES

1. Powerplant sized for flow of 900 cfs and head of 438 feet as shown. Powerplant sized for 900 cfs and head of 221 feet similar.
2. Bypass structure sized for flow of 1,250 cfs.

LEGEND

Indicates Concrete
Indicates Second Stage Concrete
Indicates Compacted Backfill

8 0 8 16
SCALE OF FEET

ALWAYS THINK SAFETY

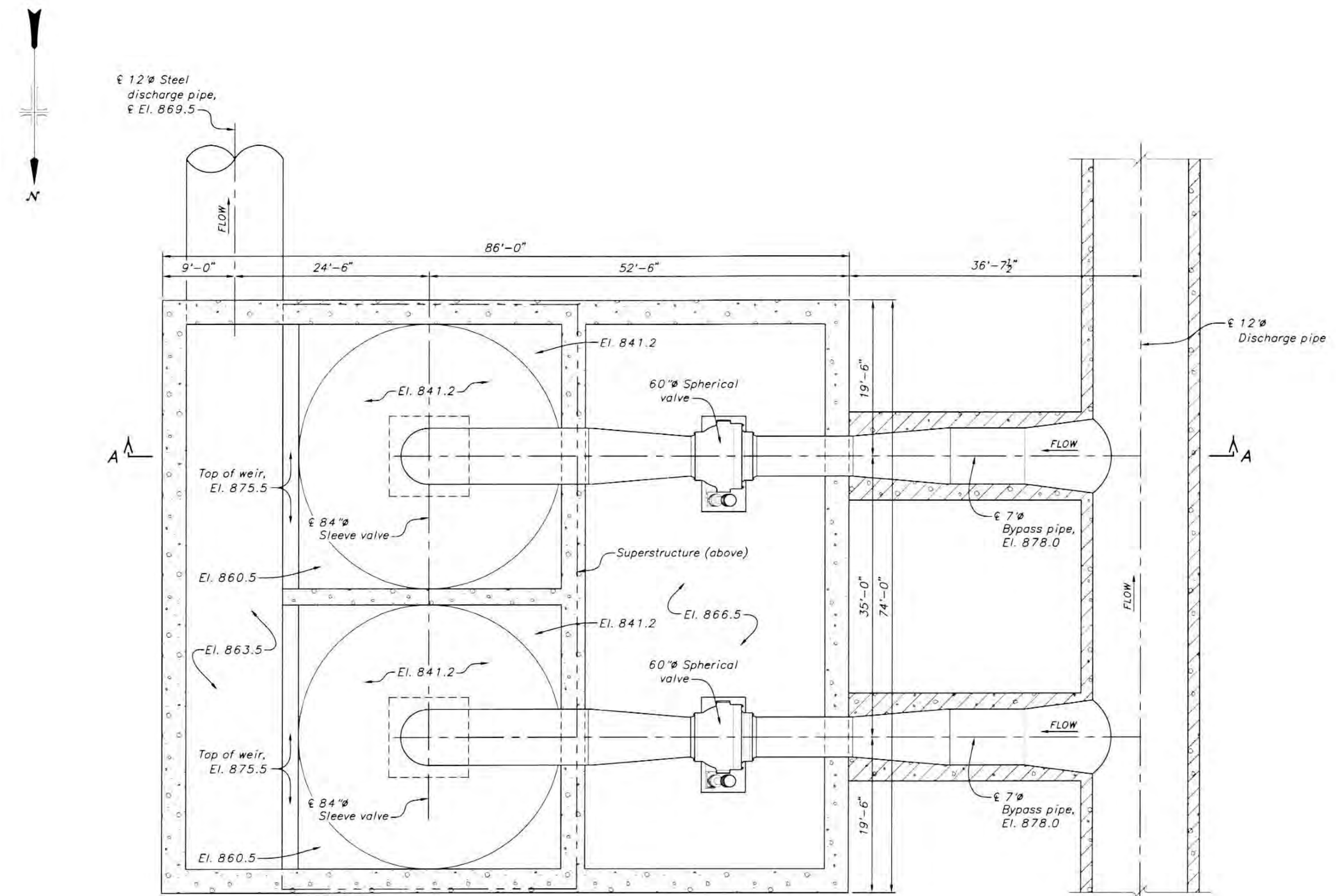
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN WATER STORAGE STUDY
BLACK ROCK ASSESSMENT STUDY
SUNNYSIDE POWERPLANT
TRANSVERSE SECTION THRU UNIT

DESIGNED BY R.W. LaFOND
REVIEWED BY M.R. O'Shea
STRUCTURAL & ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s
DENVER, COLORADO AUGUST 20, 2004
CADD FILENAME FIGURE 69.DWG
FIGURE 69

FILE PATH: I:\CIVILENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\PLANT STRUCTURES\DRAWINGS\SUNNYSIDE CANAL POWER PLANT\
PLOTTED BY: RRODRIGU
AUGUST 20, 2004 12:40



PLAN – EL. 878.0

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

NOTES

1. Bypass structure sized for flow of 1,250 cfs.

LEGEND

Indicates Concrete
Indicates Second Stage Concrete

8 0 8 16
SCALE OF FEET

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN WATER STORAGE STUDY

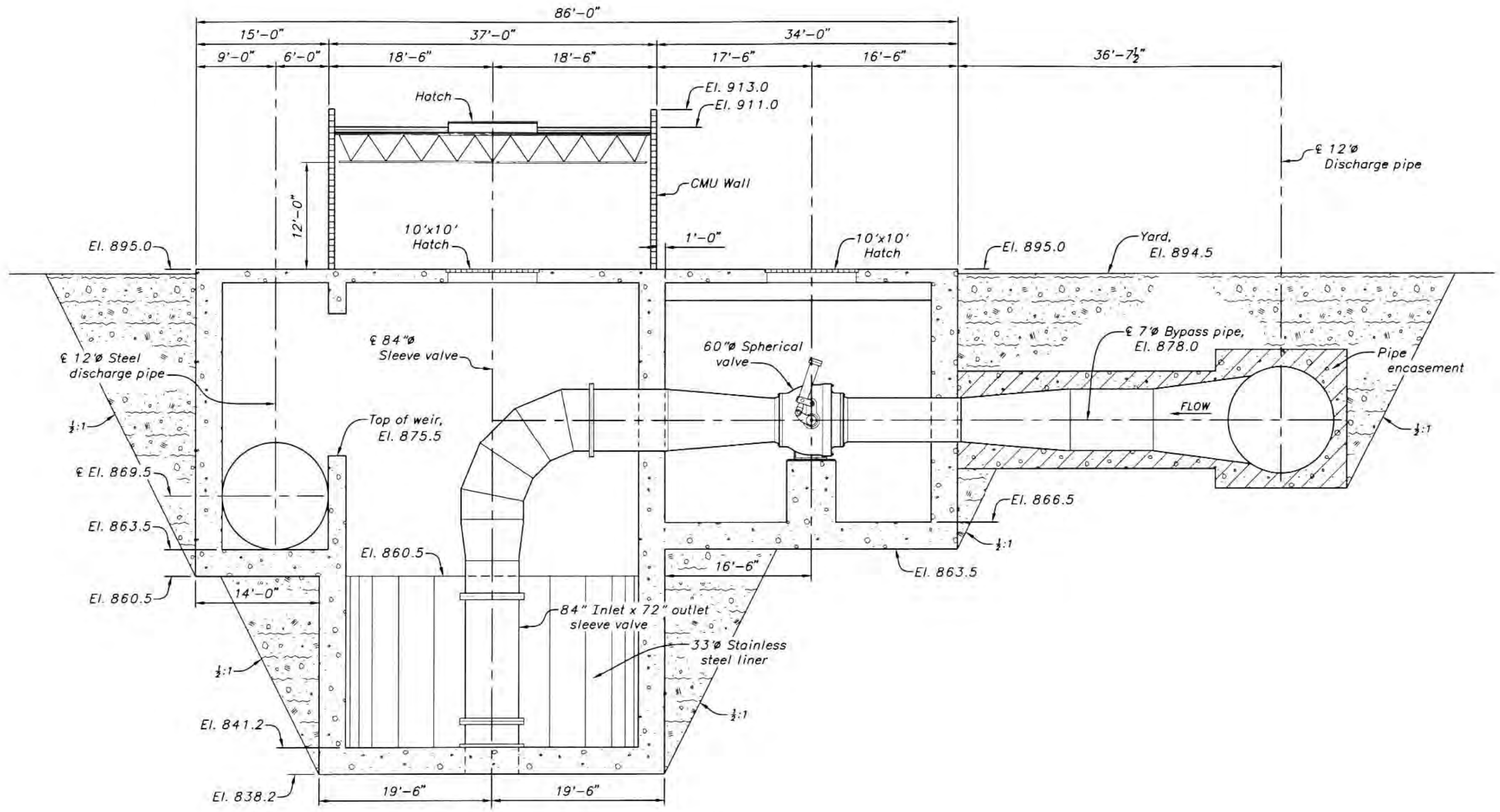
BLACK ROCK ASSESSMENT STUDY

SUNNYSIDE BYPASS STRUCTURE
PLAN – EL. 878.0

DESIGNED BY R.W. LaFOND
REVIEWED BY
STRUCTURAL & ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s
DENVER, COLORADO AUGUST 20, 2004
CADD FILENAME FIGURE 70.DWG
FIGURE 70

FILE PATH: I:\CIVIL\ENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\PLANT STRUCTURES\DRAWINGS\SUNNYSIDE CANAL POWER PLANT\
PLOTTED BY: RRODRIGU
AUGUST 20, 2004 12:44



SECTION A–A

PRELIMINARY NOT TO BE USED FOR CONSTRUCTION

NOTES

1. Bypass structure sized for flow of 1,250 cfs.

LEGEND

- Indicates Concrete
- Indicates Second Stage Concrete
- Indicates Compacted Backfill

8 0 8 16
SCALE OF FEET

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN WATER STORAGE STUDY

BLACK ROCK ASSESSMENT STUDY

SUNNYSIDE BYPASS STRUCTURE

SECTION A–A

DESIGNED BY R.W. LaFOND

REVIEWED BY M.R. O'Shea

STRUCTURAL & ARCHITECTURAL GROUP

CADD SYSTEM AutoCAD Rel. 16.0s | CADD FILENAME FIGURE 71.DWG
DENVER, COLORADO AUGUST 20, 2004

FIGURE 71

FILE PATH: I:\CIVIL\ENG SHARE\PROJ\YAKIMA STORAGE STUDY\BRR ASSESSMENT STUDY\PLANT STRUCTURES\DRAWINGS\SUNNYSIDE CANAL POWER PLANT\
PLOTTED BY: RRODRIGU
AUGUST 20, 2004 12:56

Appendices

Appendix

A. Technical Site Review Travel Report

B. Probabilistic Seismic Hazard Assessment

C. Probable Maximum Flood Study

D. Field Cost Estimates

Appendix A

Site Review
Travel Report

BUREAU OF RECLAMATION
Technical Service Center

TRAVEL REPORT

PRJ-8.10
D-8120

Codes : D-8120/D-8130/D-8140/D-8312/D-8320 Date: December 9, 2003

To : Thomas C. Fisher
Manager, Structural and Architectural Group

From : Dick LaFond, D-8120, Structural Engineer and TSC Engineering Team Leader
Doug Stanton, Civil Engineer, D-8130
Dave Edwards, Civil Engineer, D-8140
Bill Engemoen, Geotechnical Engineer, D-8312
Pete Rohrer, Geologist, D-8320

Subject: Technical Site Review of Proposed Black Rock Project Sites, Yakima River Basin Water Storage Options, Feasibility Study, Washington

1. Travel period: October 27-30, 2003.

2. Places or offices visited: Priest Rapids Dam, Proposed Black Rock Reservoir Site, Roza Canal, and Pacific Northwest Construction Office, Yakima, WA.

3. Purpose of trip: To view proposed sites for features associated with the Black Rock Storage Project and to discuss ongoing and future work with representatives from the Pacific Northwest Region, Upper Columbia Area, and Pacific Northwest Construction Offices.

4. Synopsis of trip:

A. Site Review Kickoff Meeting- On the morning of October 28, 2003, we met with representatives from the Pacific Northwest Region Office, Upper Columbia Area Office, Pacific Northwest Construction Office, Yakama Nation Water Resources, and Washington Department of the Ecology to discuss work to date, ongoing work, and plans for the site review. A list of attendees and major discussion items is included as attachment 1.

B. Site Visit to Proposed Black Rock Project Features - On October 28 and 29, 2003, we visited the proposed sites for the Columbia River Pumping Plant, Black Rock Reservoir and Roza Canal Outlet Structure. A list of major observations and discussions is included as attachment 2.

C. Site Review Closeout Meeting - On the morning of October 30, 2003, we met with representatives from the Pacific Northwest Region Office, Upper Columbia Area Office, Pacific Northwest Construction Office, Yakama Nation Water Resources, and Washington Department of the Ecology to discuss general observations from the site review and future work. A list of attendees and major discussion items is included as attachment 3.

5. Conclusions: The trip provided an opportunity to obtain a clearer understanding the of scope of TSC work. See attachments for other conclusions.

6. Action correspondence initiated: None. See attachments for action items.

7. Client feedback: The Technical Service Center site investigation team would like to thank Dick Link of the Pacific Northwest Region Office for coordinating the site review.

Attachments

cc: Regional Director, Boise, ID
Attention: PN-3400 (Jennings), PN-3440 (Montague), PN-3600 (Link)
Manager, Upper Columbia Area Office, Yakima, WA
Attention: UCAO-1000 (Glover), UCAO-1100 (Ries)
Project Construction Engineer, Yakima, WA
Attention: NCO-3100 (Meskimen), NCO-3110 (Manfredi), NCO-3173 (Christensen)
Manager, Grand Coulee Power Office, Grand Coulee, WA
Attention: GCP-5500 (Didricksen)
(w/all attachments to each)

bc: D-8120 (LaFond), D-8130 (Stanton), D-8140 (Edwards), D-8160 (Donat), D-8170 (Donaldson), D-8312 (Engemoen), D-8320 (Rohrer), D-8410 (Christensen), D-8420 (Zelenka), D-8430 (Rossi), D-8440 (Gamuciello), D-8580 (Quinn), D-8580 (Holz)
(w/all attachments to each)

WBR:RLaFond:jp:12-08-03:303-445-3226
FILE: BlackRock_Trip1028_r2.doc

SIGNATURES AND SURNAMES FOR:

Travel to: Priest Rapids Dam, Proposed Black Rock Reservoir Site, Roza Canal, and Pacific Northwest Construction Office, Yakima, WA.

Dates of Travel: October 27-30, 2003

Names and Codes of Travelers:

Traveler	Date
Doug Stanton, D-8130	12-11-03
Dave Edwards, D-8140	12/11/03
Bill Engemoen, D-8312	12/11/03
Pete Rohrer, D-8320	
Dick LaFond, D-8120	12/10/03

Noted and Dated By:

10/11/03

Attachment 1

Black Rock Storage Project

Site Review Kickoff Meeting
October 28, 2003

PARTICIPANTS:

NAME	COMPANY
Dick Link	Pacific Northwest Region Office
Kayti Didricksen	Pacific Northwest Region Office
Don Stelma	Pacific Northwest Region Office
John Kirk	State of Washington - Department of Ecology
David Cummings	State of Washington - Department of Ecology
Tom Ring	Yakama Nation - Water Resources
Norbert Ries	Upper Columbia Area Office
Mark DeLeon	Upper Columbia Area Office
Bernie Meskimen	Pacific Northwest Construction Office
Wendy Christensen	Pacific Northwest Construction Office
Charles Ferguson	Pacific Northwest Construction Office
Erin Quinn	Technical Service Center
Doug Stanton	Technical Service Center
Dave Edwards	Technical Service Center
Bill Engemoen	Technical Service Center
Pete Rohrer	Technical Service Center
Dick LaFond	Technical Service Center

MAJOR DISCUSSION TOPICS: The following items were discussed:

1. Norbert Ries stated that the Black Rock Storage Project is one option to be considered during the Yakima River Basin Water Storage Feasibility Study. Legislation authorizing this study requests Reclamation to conduct a feasibility study of options for additional water storage in the Yakima River Basin with emphasis on the feasibility of storing Columbia River water in the proposed offstream Black Rock Reservoir.

a. The objective of the Black Rock Storage Project is to deliver Columbia River water to Yakima Project entities susceptible to receiving such water and willing to exchange it for all or part of their current Yakima River diversions. No new irrigation will result from this exchange and no Columbia River water will be discharged directly into the Yakima River.

b. The present focus is to conduct an appraisal level assessment of likely configurations and sizes of Black Rock Project facilities to pump, store, and deliver water to willing exchange participants. Currently, these consist of the Roza and Sunnyside Divisions who have expressed a willingness to consider water exchanges. It may also be possible to exchange water with other entities such as the Union Gap Irrigation District and the Selah-Moxee Irrigation District. The Washington Infrastructure Services (WIS) Final Report dated May 2002, was a reconnaissance level analysis to identify and compare multiple options to transfer water from the Columbia River to the Yakima Basin. Costs developed for the WIS study were used to compare the identified options against each other and develop an order-of-magnitude estimate of project costs but detailed design/cost analyses of any one option were not completed. Reclamation's Assessment Study should use information in the WIS Report and data obtained since the report was completed to develop one or two options in greater detail to permit a better definition of required features, understanding of obstacles, and development of more accurate construction costs. The Assessment Study Findings will be documented in a report prepared by Reclamation that is tentatively due by June 30, 2004.

2. Don Stelma reported on the findings of the geologic investigations that were completed by WIS after their May 2002 Final Report. Field investigations were located along the preferred dam alignment identified by WIS. These geologic investigations are documented in the Black Rock Reservoir Study -Initial Geotechnical Investigation - Final Report dated January 2003.

a. Along the present dam alignment, the depth of overburden deposits range from a few feet to 200 feet near the right abutment. WIS cost estimates assumed bedrock would be within 20 feet of the surface.

b. It may be acceptable to not excavate the Ringold Formation and use it as part of an embankment dam foundation, provided that the Ringold proves to be a satisfactory foundation material.

c. There is a thrust fault in the right (south) abutment. The abutment is highly fractured and may be the site of an old rockslide.

d. No recent active faults have been identified to date.

e. The basalt foundation rock has permeable zones. Although the Ringold Formation and interbeds which might be aquitards are present, the areal extent and thickness of these units are not well defined. Creation of an adequate grout curtain might be problematic because there appears to be no water barrier below the dam to tie in a grout curtain that would positively cut off seepage.

f. The Selah Interbed material is composed chiefly of fine-grained silts and clays; reservoir landslides are possible where folding along the Rattlesnake Hills anticline has oversteepened the bedrock sequence. The Selah Interbed represents a potential plane of weakness where sliding could occur under saturated conditions resulting from a Black Rock reservoir.

3. Bedrock is exposed at a draw near Horsethief Point located about 2,500 feet upstream of the preferred WIS alignment. Don said they think there is a cross-valley fault between this location and the preferred WIS alignment and overburden along the new alignment may not be as deep. The PN Region drill crew plans to drill a 400-foot-deep hole along the new alignment to locate top of rock and perform water tests to check permeability.

4. Geologic mapping of the new alignment by Dr. Robert Bentley is ongoing. Dr. Bentley is a consulting geologist and professor emeritus at Central Washington University in Ellensburg, WA. Field work is nearly completed and a draft geologic report is expected on or about December 1, 2003.

5. Dick Link stated that Matt Jones (TSC) is working on the photogrammetry. Several files received from the contractor are corrupt and Matt has requested corrected data. To date, reservoir storage calculations have been developed from USGS Quad Sheets. Topography developed from the aerial surveys should be available mid-December.

6. Kayti Didricksen discussed existing groundwater information at the proposed reservoir site. She said her studies will address impacts of the reservoir on regional groundwater surfaces.

a. The jointing of the basalt flows permits vertical communication between aquifers. Interflow zones between the basalt flows permit horizontal flow from the site. The horizontal permeability of the basalt is much greater than the vertical permeability.

b. Currently there is very little aquifer recharge at the proposed Black Rock reservoir site but this will change when water storage is initiated.

c. Permeability tests performed by WIS encountered problems (leaky packers) and data developed from this testing tend to overestimate potential reservoir seepage.

d. Kayti is trying to get groundwater data from the Hanford Nuclear Repository Site to help define groundwater flow characteristics in the reservoir area. The gradient at the proposed Black Rock site moves towards Hanford.

7. In summary, Dick Link stated that from a geologic perspective the possible presence of subsurface faults, reservoir seismicity, foundation rock quality, and availability of construction materials are items that could significantly affect the feasibility and cost of constructing a dam and reservoir in the Black Rock Valley.

Attachment 2

Black Rock Storage Project

Technical Site Review
October 28-29, 2003

MAJOR OBSERVATIONS AND DISCUSSIONS:

Priest Rapids Dam and Columbia River Intake Sites

1. The Site Review Team met Leon Hoepner and Dave Moore of the Grant County Public Utility District (PUD) at Priest Rapids Dam and proceeded across the dam to the right abutment to view possible locations for an intake, fish screen, and pumping plant.

2. Leon Hoepner stated that locating a river-side pumping plant more than 4 miles downstream of the dam would place the plant within the Hanford Reach which may not be politically and/or environmentally acceptable.

3. Daily river fluctuations downstream of the dam can be as high as 14 feet but they try to operate to limit fluctuations to 5-6 feet. There is a gauging station located downstream of the dam. Daily reservoir fluctuation is 3-4 feet.

4. Leon stated that a fish biologist for Washington Infrastructure Services (WIS) had visited the dam and recommended moving the intake and fish screen facility to the left side of the dam in a follow-up report.

5. Leon stated that lamprey impingement on passive fish screens could control screen design over salmonid concerns.

6. There appears to be sufficient room between the right reservoir dike and foothills of the Umtanum Ridge to locate a channel intake with diagonal fish screens to supply a pumping plant located at the base of the ridge. The intake would be located directly downstream of the existing Grant County PUD dock facility and hazard boom anchor. A bypass pipe could be run along the groin of the dam to pass screened fish downstream of the dam. The pumping plant could be located slightly downstream of the dam and a tunnel excavated to cross under the ridge instead of piping up and over it. Topography, reservoir bathymetry, and geology for Priest Rapids Dam are available from Grant County PUD. (See Photos 1 through 6.)

7. Current access to the right side of the dam is across Priest Rapids Dam only. The clear width and 90 degree turns across the spillway deck could restrict use of large construction equipment and an easement may be required to allow O&M personnel to access the new intake and pumping plant facilities.

8. The road over Priest Rapids Dam is the main access for the residents of the Wanapum Indian Village located downstream of the dam on the right side of the river. Leon stated that the Wanapum have jurisdiction over the land proposed for the intake, screening, and pumping

facilities and they should be consulted regarding construction of these features. Above ground features downstream of the dam may cause concern to the Wanapum Band of the Yakama Nation and those enrolled members of the Yakama Nation.

9. The dam was constructed between 1956 and 1961. Tapping the reservoir for water would translate into lost power revenue for Grant County PUD and they would be looking for compensation for this lost power revenue.

10. If the intake location was moved to the left side of the dam, the intake could use the existing overflow weir gravity intake structure to access the reservoir. The pumping plant could be located on the left side of the river upstream from the existing power plant switchyard, however, the discharge line would need to cross the river to get back on the correct alignment.

11. Ice flows and expanding ice sheets have not been a problem at the dam.

12. There are transmission lines on the left side of the river that can be tapped for power to the new facilities.

13. The dam historically does not spill often. Leon indicated that in order to meet Hanford Reach target flow requirements, we should plan on pumping low volumes over long periods of time.

14. The river below the dam at the proposed intake sites for WIS Schemes 3 and 4 is wide and shallow and these locations appear to be less favorable compared to an inlet within the reservoir. (See Photo 7.)

<u>Black Rock Reservoir Site</u>

1. The proposed reservoir will inundate Black Rock Valley, a grassy valley with a few residences that will need to be relocated. State Highway 24 is a 2-lane asphalt road with heavy truck traffic that runs through the middle of the valley. There are also phone and power poles on both sides of the valley that will need to be relocated. Mark DeLeon stated that there is also a pioneer cemetery in the valley that may require relocation. (See Photos 8 through 13.)

2. The saddle dam/spillway on the south side of reservoir will require placement of about 20 feet of fill on top of an existing high topography feature to bring it up to elevation 1815 feet. (See Photo 14.) Rock appears to be near the surface of this feature.

3. The WIS proposed spillway discharge channel to Dry Creek will need to be improved and may require modification of a timber bridge on State Highway 241 in order to pass any significant flow. This bridge, 241-17, currently has 6 feet of clearance between beams and channel bottom. (See Photos 15 and 16.)

4. If maximum reservoir water surface is at or above elevation 1800 feet, a saddle dike will be necessary on the west end of the reservoir. (See Photo 17.) The land is relatively flat on the west side of the reservoir and small fluctuations in reservoir elevation will result in large movement of the shoreline.

5. The outlet structure to the Roza Canal should be closer to the dam to reduce the amount of dead reservoir storage volume.

6. Reservoir seepage is a concern. The Ringold Formation and an overlying mantel of loess blankets much of the reservoir basin and are both believed to have relatively low permeability. Within the reservoir basin, these formations should not be disturbed if practicable during construction except as required for founding the dam. Additional investigation of the permeability of the reservoir foundation materials is needed.

Roza Canal

1. The powerplant/outlet structure facility at the Roza Canal should be located on the southwest corner of the Roza Canal and State Highway 24 intersection. (See Photos 18, 19, and 20.)

2. If a powerplant is constructed at Roza Canal, a bypass structure should be included to permit water deliveries when the units are not on line. (See Photo 21.)

ACTION ITEMS:

1. Norbert Ries will obtain a copy of the WIS fish biologist report that recommends moving the intake to the left side of Priest Rapids Dam.

2. Norbert Ries will investigate Tribal land ownership near Priest Rapids Dam.

Photo 1 - Priest Rapids Dam - Looking upstream along right embankment section.

Photo 2 - Priest Rapids Dam - Looking upstream along right embankment section.
Note docking facility in background.

Photo 3 - Priest Rapids Dam - Looking upstream along right embankment section. Proposed canal and fishscreens would be located between embankment and ridge.

Photo 4 - Priest Rapids Dam - Looking upstream along proposed intake canal alignment.

Photo 5 - Priest Rapids Dam - Looking at proposed pumping plant site.

Photo 6 - Priest Rapids Dam - Looking downstream along proposed intake canal.


Photo 7 - Columbia River - Looking at WIS Scheme 4 Intake site.


Photo 8 - Black Rock Reservoir - Looking toward left abutment of WIS original dam alignment.

Photo 9 - Black Rock Reservoir - Looking at right abutment of WIS original dam alignment.

Photo 10 - Black Rock Reservoir - Looking upstream from proposed damsite along south reservoir rim.

Photo 11 - Black Rock Reservoir - Looking upstream from proposed damsite.

Photo 12 - Black Rock Reservoir - Looking upstream from proposed damsite at State Highway 24.

Photo 13 - Black Rock Reservoir - Looking upstream from proposed damsite.

Photo 14 - Black Rock Reservoir - View of saddle dam area on south side of reservoir.

Photo 15 - Black Rock Reservoir - WIS proposed spillway channel near State Highway 241.

Photo 16 - Black Rock Reservoir - WIS proposed spillway channel under State Highway 241.

Photo 17 - Black Rock Reservoir - View of possible saddle dike area at west end of reservoir across State Highway 24.

Photo 18 - Roza Canal - Looking at southwest corner of State Highway 24 and Roza Canal intersection at proposed powerplant/outlet structure facility.

Photo 19 - Roza Canal near State Highway 24 - Looking upstream.

Photo 20 - Roza Canal near State Highway 24 - Looking downstream.

Photo 21 - Roza Canal - Looking at possible powerplant site at Sunnyside Delivery point.

Attachment 3

Black Rock Storage Project

Site Review Closeout Meeting
October 30, 2003

PARTICIPANTS:

NAME	COMPANY
Dick Link	Pacific Northwest Region Office
Don Stelma	Pacific Northwest Region Office
Steve Montague	Pacific Northwest Region Office
John Kirk	State of Washington - Department of Ecology
David Cummings	State of Washington - Department of Ecology
Tom Ring	Yakama Nation - Water Resources
Norbert Ries	Upper Columbia Area Office
Bernie Meskimen	Pacific Northwest Construction Office
Wendy Christensen	Pacific Northwest Construction Office
Charles Ferguson	Pacific Northwest Construction Office
John Manfredi	Pacific Northwest Construction Office
Doug Stanton	Technical Service Center
Dave Edwards	Technical Service Center
Bill Engemoen	Technical Service Center
Pete Rohrer	Technical Service Center
Dick LaFond	Technical Service Center

MAJOR DISCUSSION TOPICS: The following items were discussed:

General:

Land acquisition and right-of-way costs are not included in the WIS Report (p. 9-2) but should be included in future studies to better estimate project costs.

Intake at Priest Rapids Dam:

1. The intake on the right side of the dam looks best. Placing the intake on the left side would be difficult and expensive to pipe water across the river.

2. Initial preference is to locate intake near the docking facility on the right side of the reservoir, which would entail a penetration of the embankment. The water would then be conveyed about 1,000 feet in a canal paralleling the hills. The canal would create sweeping velocities and thus allow for placement of diagonal fish screens within the canal. One or more bypasses would be provided to pass the screened fish downstream (perhaps along the downstream embankment toe) to the Columbia River below the dam.

3. A cofferdam will be required in the reservoir to permit construction of the intake. Also, construction access across the dam will be difficult. Consideration should be given to developing an access road through the Yakima Firing Center Military Reservation property on the right side.

4. Priest Rapids operating personnel expressed that obtaining Tribal permission to construct any surface features on the right side of the dam could be controversial.

5. The TSC should consider a low profile pumping plant similar to the existing Columbia River Plant located downstream from Priest Rapids Dam. It may be possible, although expensive, to construct an underground plant in an exposed rock face if above ground features are restricted.

Inflow Options to Black Rock Reservoir:

1. Washington's Scheme 1A featuring a tunnel through the Umtanum and Yakima Ridges to Black Rock Reservoir appears feasible, however, the pumped-storage scheme (1B) does not appear to be economically feasible at this time. Although expensive, Scheme 1A would result in significant savings in annual pumping costs.

2. To reduce costs of the inflow system, D-8140 will develop a tunnel/pipeline option based on the preferred intake location downstream of the Grant PUD docking facility.

3. It may be worth looking at an all pipeline alternative (similar to Scheme 3) as well in the fast track study although a river intake may be problematic.

4. Construction of a powerplant on the end of the intake system at Black Rock Reservoir will depend on available head at the outlet and anticipated operation of the intake system.

5. Monthly maximum and minimum projected flows are required to properly size facilities.

Black Rock Damsite:

1. At this point, it appears premature to rule out any one of the three considered dam types: concrete faced rockfill, central core rockfill, and roller compacted concrete (RCC). Cost estimates may need to be developed for all three dam types.

2. Both the original WIS alignment and the newer upstream alignment appear feasible. No other preferred alignment was apparent from the site visit.

3. There appear to be advantages to each alignment. The WIS axis has the shortest dam length, apparently by several hundred feet. With such a high dam, this probably results in a savings of several million cubic yards of embankment or RCC materials. The upstream axis, however, **may** have less overburden, which would result in significant excavation (and replacement) and dewatering cost savings. In addition, the rock quality **may** be better, which could lead to lower foundation treatment costs.

4. It is likely that the preliminary seismic hazard assessment will not be able to rule out the potential for fault displacements within the dam footprints. This issue will need to be considered in more detail in higher level designs, when more definitive predictions of movement will hopefully be available. This may have a significant impact on selection of dam type.

5. Efforts are currently underway in the Pacific Northwest Region Office to better evaluate the water supply availability and thus the resulting optimum reservoir size. A reservoir size will be needed before significant work on the designs and costs can be started.

6. Both the damsite and reservoir geology are quite complex, given the presence of the folding and faulting, highly variable rock quality, multiple aquifers, and questions on the depth and character of overburden deposits. The additional work to be undertaken in the next couple of months to better characterize the geology should help the design effort.

7. The above additional geologic work will concentrate on better defining the bedrock stratigraphy and properties, and the overburden (particularly the Ringold) properties as well.

8. Because the depth to bedrock will be quite important to design costs and possibly dam type, Dick Link will look into the possibility of fast-tracking a contract for a geophysical survey of the damsite in order to determine the depth to bedrock.

9. In addition to investigating foundation conditions, evaluating the availability of construction materials is equally important. Identifying potential sources and resulting haul distances for rockfill, impervious fill, granular filter/drain materials, and RCC aggregate would allow for better estimates of the costs of building the dam.

10. There was much discussion about the reservoir-holding capability. The Region will be conducting an evaluation of the hydrogeology of the foundation, which should help address this issue and perhaps shed light on the foundation grouting requirements. There was little indication that any interflow zones outcropped in the reservoir area. It was also noted, that the horizontal permeability of the interflow zones within the basalt flows is orders of magnitude higher than the vertical permeability. In addition, there are indications that the Ringold (and probably other overburden units like the loess) have lower permeability than the basalts. All of these factors are viewed as very positive aspects to reducing the potential for reservoir seepage.

Spillway/Saddle Dam Area:

1. Although it will depend on the size of the reservoir, it appears likely that some type of embankment will be needed in the low saddle area in the south reservoir rim. It also appears that rock will be close to the surface, which should allow for a relatively economical embankment.

2. The TSC will address the need for an emergency spillway. Given the large area of the reservoir and the fact that it is offstream storage, it may be possible to store the design flood. The TSC will look into the hydrology and evaluate if the PMF can be stored in the reservoir.

Low Level Outlet Works:

1. This is essentially a dam safety feature, that will evacuate the reservoir in the event of an emergency, spilling flows into the normally dry Dry Creek.

2. The sizing of the outlet works by WIS is somewhat unclear. During the Assessment Study, the TSC will size the low level outlet works to meet Reclamation evacuation criteria.

3. An option to consider in lieu of a low level outlet to Dry Creek might be to pump water back to the Columbia River. Given that an outlet works would release water into either the Columbia or Yakima Rivers, the impacts to existing fisheries would need to be addressed considering the likelihood of this ever occurring.

Outlet Tower and Outflow Schemes:

1. WIS designed a multi-level intake to discharge water into the outflow conduit to the Roza Canal. The team questions why a multi-level intake would be necessary if the water will be used for irrigation purposes only and there are no downstream fish considerations.

2. Fish screens will be required on the outlet structure to prevent fish that may be stocked in the reservoir from migrating to the Yakima Basin.

3. WIS Outflow Scheme 1, which requires a pumping plant to lift water from Black Rock Reservoir to the Roza Canal is not being developed at this time. The team would prefer to locate the outlet system to permit gravity flow to Roza Canal.

4. WIS Outflow Scheme 3 is eliminated because it delivers water too far below where it is needed.

5. For the Black Rock Project Assessment, water deliveries to the Roza and Sunnyside Divisions will be used to size features. The design maximum flow to the Roza Division will be 1,100 ft^3/s, and the design maximum flow to the Sunnyside Division will be 1,262 ft^3/s, for a total capacity of 2,362 ft^3/s. Water deliveries to Union Gap and or Selah-Moxee could be added in the future if they express an interest which would increase required capacity by 100 to 150 ft^3/s. Monthly maximum and minimum projected flows are required to properly size facilities.

Highway Realignment

1. The WIS Final Report relocated State Highway 24 to the south of the reservoir in the Rattlesnake Hills but indicated that residents of Black Rock Valley would prefer a northern relocation. Topography on the north side of the reservoir is not conducive for this road relocation because many bridges would be required to span over draws and the road would need to be constructed on land currently within the Yakima Firing Center Military Reservation.

2. Ongoing geologic mapping in the vicinity of the alternate alignment suggests a potential for significant landslides along the south rim of the reservoir due to oversteepening of bedrock foundation units. Development of highway relocation concepts should account for a high potential for landsliding along the south reservoir rim.

Roza and Sunnyside Distribution Systems

From the perspective of service areas and major conveyance facilities, the Roza and Sunnyside Divisions appear to be located so that a Columbia River water exchange may be feasible. Following discussions with these two irrigation divisions concerning their willingness to consider water exchanges, work was initiated early September 2003 by engineering staff of the PN Construction Office and the Regional Office to develop conceptual plans and cost estimates for the delivery of Columbia River water.

1. The powerplant/outlet structure facility at the Roza Canal should be located on the southeast corner of the Roza Canal and State Highway 24 intersection. The available head at the Roza canal will be reservoir dependent. Provisions for bypassing units should be provided to permit water deliveries when the units are not on line.

2. At the beginning of each irrigation season, the Roza and Sunnyside Irrigation Districts flush their canals and dump water into the Yakima River. This operating procedure may need to be modified to prevent discharging Columbia River water directly into the Yakima River.

3. Steve Montague has developed two options for supplying the Sunnyside Irrigation District.

a. Option A - Pipeline - A pipeline with 1,262 ft^3/s capacity would bifurcate off the outflow pipe directly upstream of the new Roza Canal Powerplant. The new pipeline would generally parallel the Roza Canal alignment across orchards to the top of Konnowock Pass, then generally parallel Konnowock Pass Road across open land and orchards until it ties into Sunnyside Canal at approximate mile 3.85. At the Sunnyside Canal, a powerplant would be constructed to burn the excess of approximately 400 feet of head. An 18-inch diameter pipe would bifurcate upstream of this powerplant to supply approximately 15 ft^3/s to upstream water users. The initial head required for this pipe will be approximately 185 feet (80 psi).

b. Option B - Canal - For this option, Sunnyside and Roza (south) flows would be combined in an enlarged Roza Canal. The enlarged canal would have a total capacity of 2,562 ft^3/s which is equal to the existing canal capacity of 1,300 ft^3/s plus an additional 1,262 ft^3/s for

Sunnyside water users. This option will require an enlargement of an existing tunnel or construction of a new tunnel adjacent to the existing. At Wasteway No. 3, Sunnyside water would be discharged into an enlarged wasteway. The capacity of the modified wasteway will be 2,514 ft^3/s (1,252 ft^3/s for the existing wasteway capacity plus 1,262 ft^3/s for Sunnyside water users). A series of check/drop structures will be required in the wasteway to decrease the hydraulic slope and velocities. At approximately wasteway station 95+00, the Sunnyside flow will be diverted to a pipe for delivery to a powerplant constructed to use the approximately 180 feet of head at Sunnyside Canal mile 3.85. An 18-inch diameter pipe would bifurcate upstream of this powerplant to supply approximately 15 ft^3/s to upstream water users.

4. Wendy Christensen is sizing delivery facilities to the Roza Irrigation District. At the proposed canal tie-in at State Highway 24, 215 ft^3/s is required to be delivered upstream (north), and 885 ft^3/s is required to be delivered downstream (south). The elevation of the Roza Canal near State Highway 24, is about 1,170 feet. Wendy estimates that she needs about 330 feet of head to make the upstream deliveries. This could be accomplished by one of two ways:

Option 1A - Bifurcate a pipeline with 215 ft^3/s capacity off the outflow pipe directly upstream of the new Roza Canal Powerplant. An energy dissipator would be required at the end of this pipe and pressure reducing valves would be required for deliveries.

Option 1B – Run all Roza water (1,100 ft^3/s) through a powerplant at the canal and supply pumps, manifold, and discharge pipe to lift 215 ft^3/s to north-side Roza water users. John Manfredi stated that if this option is selected, the Yakima Construction Office would prefer to use variable frequency drive pumping units to accommodate variations in water demand.

ACTION ITEMS:

Wendy Christensen (Roza) and Steve Montague (Sunnyside) will continue to work on irrigation delivery systems from where State Highway 24 crosses the Roza Canal to the termination of the irrigation. The TSC will assist them with tunnel design input, transient studies, powerplant, pumping plant, and air chamber sizing and quantities.

Appendix B

Probabilistic Seismic Hazard Assessment for Appraisal Studies of the Proposed Black Rock Dam

Technical Memorandum No. D-8330-2004-14

Black Rock Dam Yakima River Basin Storage Feasibility Study, Washington

Probabilistic Seismic Hazard Assessment for Appraisal Studies of the Proposed Black Rock Dam

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

July 2004

MISSION STATEMENTS

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.

Probabilisitic Seismic Hazard Assessment for the Proposed Black Rock Dam, Yakima River Basin Storage Feasibility Study, Washington

Bureau of Reclamation
Technical Service Center
Seismotectonic and Geophysics Group
Denver, Colorado

Technical Memorandum No. D8330-2004-014
July 2004

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Peer Review

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1.0 INTRODUCTION

An initial probabilistic seismic hazard assessment (PSHA) has been conducted for use in appraisal-level studies of the proposed Black Rock Dam. The proposed dam would be located in the vicinity of Horse Thief Point in Black Rock Valley (Plate 1). Specific alignment locations and designs are not yet determined, but current evaluations are considering dams with structural heights as large as 500 to 600 ft that could provide a reservoir capacity near 1.5 million acre-ft.

The primary product of this assessment is a preliminary hazard curve for peak horizontal acceleration (PHA) for use in the initial appraisal-level engineering studies. Also included is a de-aggregation by source, which shows the relative contributions of the various seismic sources to the total PHA hazard. At this stage of the evaluation, existing data indicate that some faults in the immediate site vicinity may need to be considered as potential earthquake sources. Thus, issues such as surface faulting and secondary coseismic folding and faulting may also be of potential engineering significance to the proposed dam. A brief discussion of these issues is included below.

1.1 Basis for this Evaluation

The current evaluation is based on limited, readily available data from existing studies and limited, preliminary evaluation thereof. These studies include probabilistic seismic hazard assessments for facilities at DOE Hanford (Geomatrix, 1996), several Bureau of Reclamation dams northwest of Yakima (Wong and others, 2002), and USGS and Canadian Geological Survey national seismic hazard mapping programs (Haller and others, 2002; Adams and Halchuk, 2002). At this stage of the evaluation, it is clear that while there is broad consistency between these previous studies, there are also numerous differences and gaps that are clearly significant to assessments at the Black Rock site that are not resolved in this assessment. Limited explorations and site characterization of the potential Black Rock damsite have been done to date (Washington Infrastructure Services, Inc., 2003; Columbia Geotechnical Asssociates, 2004; BOR, 2004). These data indicate that a major thrust fault is involved with folding of the basalt units on the right abutment of the damsite, and that this fault extends up valley along the southern edge of the proposed reservoir. Basalt on the left abutment mostly dips gently to the south towards Black

Rock Valley, where locally derived Quaternary alluvium and older sedimentary units appear to thicken to the south beneath the valley.

The current evaluation is based on the relatively limited characterization of the geologic structure of the Black Rock Valley and damsite area and the seismogenic potential of the faults in the immediate area contained in the existing reports. The structural setting of the damsite area is complex and further evaluations will undoubtedly result in significant changes to the assessments contained in this evaluation.

2.0 SEISMIC SOURCE CHARACTERIZATION

2.1 Significant Potential Fault Sources near the Proposed Black Rock Damsite

There are several issues that contribute uncertainty to the seismic source characterization that are not fully accounted for in this preliminary analysis. More comprehensive seismic hazard analysis will be required to resolve and characterize these uncertainties.

Regional Seismotectonic Setting and Tectonic Models. Regionally, Black Rock damsite lies within the Yakima fold belt, a group of mostly east-west striking folds which formed during and subsequent to eruption of the Columbia River Basalts, about 10-15 million years ago (Reidel and others, 2003). The geometry of the folds is consistent with activity shown by regional seismicity and stress data which is dominated by north-south compression. However, there are significantly differing interpretations published in the technical literature regarding the origin and age of these folds that have profound implications for seismic hazard assessment. At one extreme are models that indicate that faults associated with the folds are planar features that extend 20+ km to the base of the brittle seismogenic crust. In that model, large-magnitude earthquakes are plausible on these faults. Such faults would be considered fully "coupled" to stresses within the upper crust. An alternative model holds that most or all of the folding and faulting is limited to a relatively thin upper crustal layer composed mostly of basalts which is effectively "decoupled" from underlying, less competent rocks and deeper crustal stresses. In that model, faults that involve the basalts at the surface have limited depth extent and area, and hence limited potential to produce large magnitude earthquakes. In the decoupled model, surface deformation rates are the same, but this deformation is accommodated through significantly higher rates of moderate-magnitude earthquakes at shallow depths. In the Geomatrix (1996) assessments for Hanford, most of the faults closest to the Black Rock damsite were assigned a probability of coupling of only 0.15, while other faults in the region were assigned probability of coupling as high as 0.95. Assessments by Wong and others (2002) and Haller and others (2002) did not consider probability of coupling as a separate factor (hence, the probability of coupling = 1.0). For this preliminary assessment, we follow the lead of more recent assessments and assume that all faults are fully coupled. If indeed the fold/fault sources within the Yakima fold belt are a complex mixture of coupled and decoupled structures as portrayed by Geomatrix (1996) for the Hanford assessments, then at certain sites, inclusion of highly decoupled sources could result in higher rates of occurrence for some ground motion parameters, including PHA, than are obtained for coupled models. This is because sites very close to the decoupled sources would be subject to much higher rates of moderate-magnitude seismicity than in alternative models where larger magnitude earthquakes occurred, but less frequently.

Structural Setting of the Site. Previous seismic hazard assessments have either lumped together or neglected the details of potential seismic sources in the immediate vicinity, 0-10 km, of Black Rock damsite (e.g., Geomatrix, 1996; Wong and others, 2002). Existing regional mapping including the area of Black Rock Valley does not appear to resolve many structural details, and these detail were not highly important to prior assessments at other sites. Mapping in progress for the damsite area has indicated that a thrust fault along the south margin of the valley which extends through the area of the proposed dam foundation, may be part of a fault of regional extent (Columbia Geotechnical Associates, 2004). As the PHA hazard curves developed in the following section of this report demonstrate, because of the close proximity of the site to this fault, judgements on the potential activity and geometry of the nearby faults controls the seismic hazard and ground motion estimates for the site. For the present evaluation, each major fold near the site has been treated as an independent structure, essentially a single planar fault dipping beneath the fold. Alternative, potentially more complex characterization of the structure of nearby fold such as Yakima Ridge, could include backthrusts or "blind" structures that could have significant influences on estimates of seismic hazard for the site. These more complex fault geometries would significantly affect seismic hazard estimates because changes in fault dip and location would affect site-to-source distances and fault areas (size) considered in magnitude estimates. In addition, other potentially seismogenic faults could be present in the site area which have not been accounted for in the present analyses.

Slip Rates and Fault Activity. Fault assessments used for this evaluation are derived from data compiled from three previous regional hazard studies (Geomatrix, 1996; Haller and others, 2002; Wong and others, 2002) which are summarized in Tables 2-1 and 2-2 and portrayed on Plate 1. For most of the faults used in this seismic hazard analyses, slip rates are primarily based on estimated offsets of basalt units that range in age between 10-17 Ma. Little data are currently available to constrain offsets for shorter time periods. In general, arguments for or against more recent fault activity on most of the faults and folds considered as seismic sources in this assessment are based on indirect or sparse evidence.

In the previous seismic hazard studies, faults along the northern side of the Rattlesnake Hills near the Black Rock Valley have not been defined in great detail because they were not close to the sites of interest or not considered highly significant for those studies. Preliminary engineering studies at the damsite have provided some further details on the Black Rock Valley faults (Washington Infrastructure Services, Inc., 2003; Columbia Geotechnical Asssociates, 2004; BOR, 2004). However, existing estimates of potential activity and slip rates on the Black Rock Valley fault remain extremely preliminary and potentially speculative due to the limited data. Based on the present site investigations, the youngest rocks at the site which can be conclusively shown to be folded and faulted by the Black Rock Valley fault are basalts which are as young as about 10 Ma (Columbia Geotechnical Associates, 2004). Faulting and folding that is significantly younger than this age may be suggested by geomorphic features above Horse Thief Point and by possible faults scarps west of the damsite. However, no investigations of these features to determine their age or relationship to the Black Rock Valley fault have yet been undertaken. Evidence for deformation of post-basalt units including deposits that are probably Ringold Fm. at and near the damsite is mostly indirect. There has been no direct observation of faulted Ringold Fm. deposits in the site vicinity or inferred in direct association with the Black Rock Valley fault. However, the inferred Ringold Fm. deposits at the site consist of fluvial sands with Columbia River provenance. Correlation to apparently similar deposits described from cores at the Hanford site (Lindsey, 1996) would appear to indicate several hundred meters of relative structural uplift and subsidence of these deposits since 6-10 Ma. Ringold deposits at the damsite lie on the apparent footwall block of the surface trace of the Black Rock Valley fault, thus other faults would need to be active to produce this uplift. Prior to about 6.5 Ma, the ancestral Columbia River likely flowed through the Sunnyside Gap area south of the damsite (Lindsey, 1996). Since that time, at least a few hundred meters of relative uplift of the Sunnyside Gap area are required to explain the present elevations of the gap and correlative Ringold Deposits. Folding and uplift associated with the Black Rock Valley fault could potentially be consistent with this evidence.

Table 2-1: Black Rock Dam - Preliminary PSHA fault source slip rate and probability of activity assessment

Fault	Closest Distance to Black Rock damsite (km)	Geomatrix (1996)			Wong and others (2002)[1]		Haller and others. (2002)	This Study[1]	
		Slip Rate[2] range (mm/yr)	Probability of Activity (Revised)[3]	Probability of Coupling	Slip Rate[2] mean, range (mm/yr)	Probability of Activity[3]	Slip Rate[2] (mm/yr)	Slip Rate[2] mean, range (mm/yr)	Probability of Activity
Black Rock Valley	0	Not characterized separately			Not characterezed separately		Not characterized	0.1, 0.05-0.8	1.0
Rattlesnake Hills	4	0.103	0.25 (0.50-0.75)	0.15	Included with Ahtanum Creek		Not characterized	Included with Black Rock Valley fault	
Ahtanum Creek	40	Included as Rattlesnake Hills			0.05, 0.01-0.2	0.7	Not characterized	0.15, 0.01-0.65	1.0
Yakima Ridge (East and West)	5	0.024-0.067	0.25 (0.50)	0.15	Not characterized		Not characterized	0.05, 0.01-0.1	1.0
Umtanum Ridge and Gable Mtn.	10	0.024-0.117	0.25 (0.50-0.75)	0.15	0.04, 0.01-0.1	0.7	Not characterized	0.04, 0.01-0.1	1.0
Rattlesnake-Wallula Trend (RAW) REVERSE	5	0.02-0.086	0.25 (0.50)	0.30	0.05, 0.04-0.1	1.0	0.073	0.08, 0.04-0.1	1.0
Rattlesnake-Wallula Trend (RAW) STRIKE-SLIP	5	0.08-0.2	0.25 (0.50)	0.05	0.14, 0.08-0.2	1.0	Not characterized	Not evaluated separately	
Toppenish Ridge[4]	36	0.024-0.067	1.0	0.95	0.2, 0.01-1	1.0	0.065	0.2, 0.01-1	1.0

Notes:
[1] Probability of Coupling not estimated separately.
[2] Slip rate is estimated for 45° -dipping fault.
[3] Revised values for Probability of Activity are from DOE (2002).
[4] Source parameters from Wong and others (2002) are attributed to Satus Peak (Toppenish Ridge), Smyrna Bench and Saddle Gap (Saddle Mountains), or West Canal (Frenchman Hills) segments but are applied to weighted rupture length scenarios that include other sections of these structures.
[5] Closest distance of the section of Columbia Hills fault characterized by Wong and others (2002) is approximately 100 km from Black Rock Dam.

Table 2-1: Black Rock Dam - Preliminary PSHA fault source slip rate and probability of activity assessment

Fault	Closest Distance to Black Rock damsite (km)	Geomatrix (1996)			Wong and others (2002)[1]		Haller and others. (2002)	This Study[1]	
		Slip Rate[2] range (mm/yr)	Probability of Activity (Revised)[3]	Probability of Coupling	Slip Rate[2] mean, range (mm/yr)	Probability of Activity[3]	Slip Rate[2] (mm/yr)	Slip Rate[2] mean, range (mm/yr)	Probability of Activity
Saddle Mountains[4]	31	0.037-0.152	0.50 (0.50-0.75)	0.60	0.15, 0.01-0.65	1.0	0.088	0.15, 0.01-0.65	1.0
Frenchman Hills[4]	50	0.009-0.056	0.25 (0.50)	0.15	0.05, 0.01-0.1	0.7	Not characterized	0.05, 0.01-0.1	1.0
Manastash Ridge	24	0.014-0.085	0.25 (0.50)	0.15	Not characterized		Not characterized	0.05, 0.01-0.1	1.0
Horse Heaven Hills NE	39	0.044-0.050	0.25 (0.50)	0.70	Not characterized		Not characterized	0.05, 0.01-0.1	1
Horse Heaven Hills NW	41	0.044	0.25 (0.50)	0.15	0.05, 0.01-0.1	0.7	0.053	0.05, 0.01-0.1	1
Arlington -Shutler Buttes fault zone	78	Not characterized			0.05, 0.01-0.1	0.4	Not characterized	0.05, 0.01-0.1	1.0
Oak Flat - Luna Buttes fault zone	90	Not characterized			0.05, 0.01-0.1	0.4	Not characterized	0.05, 0.01-0.1	1.0

Notes:
1 Probability of Coupling not estimated separately.
2 Slip rate is estimated for 45° -dipping fault.
3 Revised values for Probability of Activity are from DOE (2002).
4 Source parameters from Wong and others (2002) are attributed to Satus Peak (Toppenish Ridge), Smyrna Bench and Saddle Gap (Saddle Mountains), or West Canal (Frenchman Hills) segments but are applied to weighted rupture length scenarios that include other sections of these structures.
5 Closest distance of the section of Columbia Hills fault characterized by Wong and others (2002) is approximately 100 km from Black Rock Dam.

Table 2-1: Black Rock Dam - Preliminary PSHA fault source slip rate and probability of activity assessment

Fault	Closest Distance to Black Rock damsite (km)	Geomatrix (1996)			Wong and others (2002)[1]		Haller and others. (2002)	This Study[1]	
		Slip Rate[2] range (mm/yr)	Probability of Activity (Revised)[3]	Probability of Coupling	Slip Rate[2] mean, range (mm/yr)	Probability of Activity[3]	Slip Rate[2] (mm/yr)	Slip Rate[2] mean, range (mm/yr)	Probability of Activity
Columbia Hills	67[5]	0.017-0.144	Not characterized		0.05, 0.01-0.1	0.3	Not characterized	Not characterized	
Hog Ranch	~30	?	0.10 (0.10-0.50)	0.50	Not characterized		Not characterized	Not characterized	

Notes:
[1] Probability of Coupling not estimated separately.
[2] Slip rate is estimated for 45° -dipping fault.
[3] Revised values for Probability of Activity are from DOE (2002).
[4] Source parameters from Wong and others (2002) are attributed to Satus Peak (Toppenish Ridge), Smyrna Bench and Saddle Gap (Saddle Mountains), or West Canal (Frenchman Hills) segments but are applied to weighted rupture length scenarios that include other sections of these structures.
[5] Closest distance of the section of Columbia Hills fault characterized by Wong and others (2002) is approximately 100 km from Black Rock Dam.

Table 2-2: Black Rock Dam - Preliminary PSHA fault source rupture length and maximum magnitude assessment

Fault	Closest Distance to Black Rock damsite (km)	Geomatrix (1996)[1]			Wong and others (2002)[1]		This Study	
		Segmented (Probability of Activity)	Rupture length[2] (km)	Maximum Magnitude[2] (M_W)	Rupture length (km)	Maximum Magnitude (M_W)	Maximum Rupture length (km)	Maximum Magnitude (M_W)
Black Rock Valley	0	Not characterized separately; partly included with Rattlesnake Hills			Not characterized separately; partly included with Ahtanum Cr.		38	6.7
Rattlesnake Hills	4	no	36[1]	7.1,7.3	Included with Ahtanum Creek		Included with Black Rock Valley fault	
Ahtanum Creek	40	Included as Rattlesnake Hills			28-36	6.8-6.9	33	6.6
Yakima Ridge (East and West)	5	no	39-46	7.1-7.4	Not characterized		48 (East) 30 (West)	6.9 (East) 6.6 (West)
Umtanum Ridge and Gable Mtn.	10	yes (0.6) no (0.4)	11-43 71	6.5-7.1 7.3	35,110[1]	6.9,7.4[1]	117	7.5
Rattlesnake-Wallula Trend (RAW) REVERSE	5	yes(0.7) no (0.3)	20,45,50 58	6.8,7.2 7.2,7.3	20,50	6.6,7.1	125	7.5
Rattlesnake-Wallula Trend (RAW) STRIKE-SLIP	5	no	58	7.1	45,115	7.0, 7.5	Not evaluated separately	
Toppenish Ridge[3]	36	no	25	6.9	30,50[1]	6.8,7.0[1]	56	7.0

Notes:

[1] Multiple values in these columns include alternate characterizations given weights >0.1 in the probabilistic characterizations of Geomatrix (1996) and Wong and others (2002). Scenarios weighted 0.1 each are not included.

[2] All fault lengths and Maximum Magnitudes are based on 45° dip scenarios except for Rattlesnake-Wallula Trend (RAW) STRIKESLIP, Arlington - Shutler Buttes and Oak Flat -Luna Buttes fault zones which assume a dip of 90°, and Hog Ranch which includes dips of 60°,75° and 90°. Maximum magnitude is also constrained by fault width which is determined by fault dip and an assumed seismogenic crustal thickness of 21 km.

[3] Source parameters from Wong and others (2002) are attributed to Satus Peak (Toppenish Ridge), Smyrna Bench and Saddle Gap (Saddle Mountains), or West Canal (Frenchman Hills) segments but are applied to weighted rupture length scenarios that include other sections of these structures.

[4] Closest distance of the section of Columbia Hills fault characterized by Wong and others (2002) is approximately 100 km from Black Rock Dam.

Table 2-2: Black Rock Dam - Preliminary PSHA fault source rupture length and maximum magnitude assessment

Fault	Closest Distance to Black Rock damsite (km)	Geomatrix (1996)[1]			Wong and others (2002)[1]		This Study	
		Segmented (Probability of Activity)	Rupture length[2] (km)	Maximum Magnitude[2] (M_w)	Rupture length (km)	Maximum Magnitude (M_w)	Maximum Rupture length (km)	Maximum Magnitude (M_w)
Saddle Mountains[3]	31	yes (0.6) no (0.4)	19-26 58[1]	6.8-6.9 7.3[1]	16,44,116	6.5,7.0,7.5	89	7.3
Frenchman Hills[3]	50	no	39	7.1,7.3	30,90	6.8,7.3	69	7.1
Manastash Ridge	24	40[1]	7.1[1]	no	Not characterized		67	7.1
Horse Heaven Hills NE	39	yes (0.8) no (0.2)	100,70 85[1]	7.3,7.5 7.3,7.4[1]	Not characterized		78	7.2
Horse Heaven Hills NW	41	no	35[1]	7.0[1]	14,28,48	6.4,6.8,7.0	86	7.3
Arlington -Shutler Buttes fault zone	78	Not characterized			25,45,70	6.7,7.0,7.2	63	7.1
Oak Flat - Luna Buttes fault zone	90	Not characterized			17,40	6.5,6.9	30	6.6
Columbia Hills	67[4]		Not characterized		9,17,72[1]	6.2,6.5,7.2[1]	Not characterized	
Hog Ranch	~30	no	75	7.0-7.6	Not characterized		Not characterized	

Notes:

[1] Multiple values in these columns include alternate characterizations given weights >0.1 in the probabilistic characterizations of Geomatrix (1996) and Wong and others (2002). Scenarios weighted 0.1 each are not included.

[2] All fault lengths and Maximum Magnitudes are based on 45° dip scenarios except for Rattlesnake-Wallula Trend (RAW) STRIKESLIP, Arlington - Shutler Buttes and Oak Flat -Luna Buttes fault zones which assume a dip of 90°, and Hog Ranch which includes dips of 60°,75° and 90°. Maximum magnitude is also constrained by fault width which is determined by fault dip and an assumed seismogenic crustal thickness of 21 km.

[3] Source parameters from Wong and others (2002) are attributed to Satus Peak (Toppenish Ridge), Smyrna Bench and Saddle Gap (Saddle Mountains), or West Canal (Frenchman Hills) segments but are applied to weighted rupture length scenarios that include other sections of these structures.

[4] Closest distance of the section of Columbia Hills fault characterized by Wong and others (2002) is approximately 100 km from Black Rock Dam.

Potential Surface Faulting at the Site. Preliminary geologic investigations at the site indicate that at least one significant thrust fault is present in the lower right abutment. If this fault is considered a part of a larger, more extensive fault that might be potentially active along the margin of Black Rock Valley or part of the Rattlesnake Hills structure, there is a potential for surface faulting within the dam foundation as a result of a large earthquake on these structures. Potential displacements could range from a few cm to several meters depending on the earthquake magnitude and details of the structural setting. Existing data are not sufficient to further define this potential at this time. The probability of surface faulting at the site is not separately analyzed at this time because there is insufficient information presently available on the age, slip rate, geometry, and extent of faults in the dam foundation.

3.0 PRELIMINARY HAZARD CURVES FOR PHA

A probabilistic seismic hazard analysis was performed, using an areal source zone presented in Wong and others (2002), the fault sources shown in the attached map (Plate 1), and Cascadia subduction zone sources as depicted on Figure 3-1.

3.1 Areal Source Zone

The areal zone, termed the Fold and Thrust Belt, covers an area of about 75,000 km^2. Earthquakes occurring through 2000 were compiled, declustered, and a recurrence curve fit to the data by the maximum likelihood method. Earthquakes with magnitudes between 5.0 and 6.5 were modeled in the probabilistic analysis by distributing them uniformly throughout the region. Depths were modeled as a triangular distribution with a maximum depth of 20 km, a peak at 5 km, and a near-surface magnitude-dependent depth restriction.

3.2 Fault Sources

Fault sources modeled are those shown in the attached map (Plate 1). Slip rates were modeled as asymmetric triangular distributions, according to the "range" and "mean" values shown in the "this study, slip rate" column of Table 2-1. Faults were assumed to have dips of 45°, and extend to 20 km in depth. Two recurrence models were used: the characteristic model of Youngs and Coppersmith (1985), and the maximum moment model (e.g., Wesnousky, 1986). The characteristic model assumes that earthquakes have a bimodal distribution, with smaller earthquakes occurring as an exponential distribution, but a range of largest, "characteristic" magnitudes occurring at a rate more frequent than the exponential portion of the recurrence relation would predict. The maximum moment model assumes that all slip on a fault is released in a narrow range of largest possible earthquakes, with the magnitude estimated from fault length-magnitude regressions (Wells and Coppersmith, 1994). The magnitudes used as "maximum" or "characteristic" in these models are shown in Table 2-2 under "this study". For the final hazard curves the results from the two models were weighted equally.

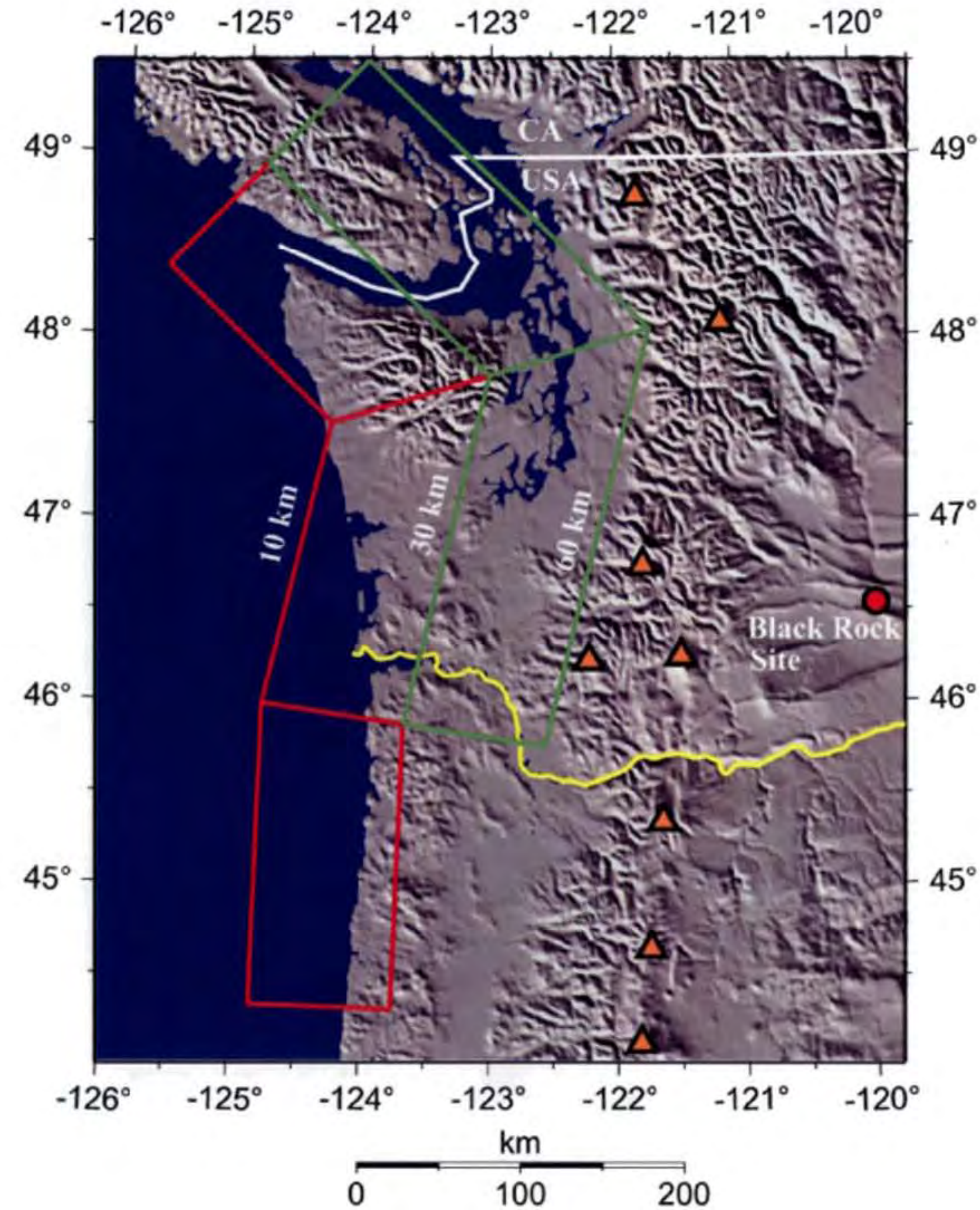

Figure 3-1: Cascadia subduction zone as modeled for this study. Red lines show plate interface zone; green lines the deep zone. Volcanoes are shown as orange triangles, the Black Rock Site as a red circle.

3.3 Cascadia Subduction Zone

The Cascadia subduction zone, site of the collision between the northeast moving Juan de Fuca plate relative to the North American plate, lies off the Washington coast, about 200 km east of the Black Rock Site. The Juan de Fuca plate descends into the upper mantle about as far as the Cascade range (in map view).

For this preliminary study we model an upper plate interface zone, the location of contact between the two plates and potential site of large thrust earthquakes, and a deep zone, site of earthquakes associated with deformation in the downgoing slab as it descends into the upper mantle. The plate interface zone was the site of a M_W 9 event in January, 1700 (Satake and others, 1996), and the deeper slab has produced damaging events in the 6-7 range (e.g., Seattle, 1965; Nisqually, 1991). The model, shown in Figure 3-1, is an approximation based on Flück and others (1997). The area outlined in red represents the plate interface zone, which dips 13° to the east between depths of 10 and 30 km. The blue zone represents the deep zone, dipping 19° between depths of 30 and 60 km.

Two equally weighted recurrence models were used for the plate interface zone, the characteristic model (Youngs and Coppersmith, 1985) and the maximum moment model (Wesnousky, 1986). The characteristic model assumed earthquakes between 6.5 and three equally weighted upper bound magnitudes, 8.0, 8.5, and 9.0. The maximum moment model assumed a trapezoidal distribution of earthquakes between 6.5 and 9.5. Both models used an asymmetrical triangular slip rate distribution with a lower bound of 7 mm/yr, and upper bound of 25 mm/yr, and a peak at 13 mm/yr. This recurrence scheme is described in LaForge (2000).

An exponential distribution between magnitudes 6.0 and 7.5 was assumed for the deep zone, with recurrence parameters taken from the Adams and Halchuk (2002) PUG zone, scaled for the different fault area used here.

3.4 Attenuation

Two attenuation functions were used; Sadigh and others (1997), and Abrahamson and Silva (1997). These are current relations based on largely California earthquakes. The Abrahamson and Silva (1997) relation contains correction factors for increased amplitudes near thrust faults, which were applied to the Black Rock Valley fault. Soft rock or stiff soil site conditions were assumed for both. The two relations were weighted equally in the analysis. For the Cascadia sources, the relations of Youngs and others (1997) were used.

3.5 Results

Figure 3-2 shows mean PHA hazard curves for all sources, and the total. It is clear that due to its proximity to the site the Black Rock Valley fault is the dominant contributor to the PHA hazard at all but very short return periods. The Cascadia deep zone is significant at PHA of 0.2 g and less. This is illustrated in Figure 3-3, which shows the relative contributions to the total hazard as a function of ground motion amplitude. It is likely that the Cascadia source would be more important at longer period response periods, due to the large magnitude events generated there. At ground motions of about 0.3 g and above (which corresponds to return periods greater than about 1000 years, the Black Rock Valley fault comprises about 70% of the hazard. The next most significant source is the Yakima Ridge East fault. At a return period of 10,000 years, the total PHA amplitude level is about 0.95 g. The mean PHA curve, along with 16th and 84th percentile curves, is shown in Figure 3-4. These fractiles represent epistemic uncertainties, due to the variability in slip rate and choice of attenuation function, in the mean hazard from the local fault sources. The Cascadia sources and random seismicity source are not included in this plot, but they are not significant at PHA's of about 0.3 g and greater.

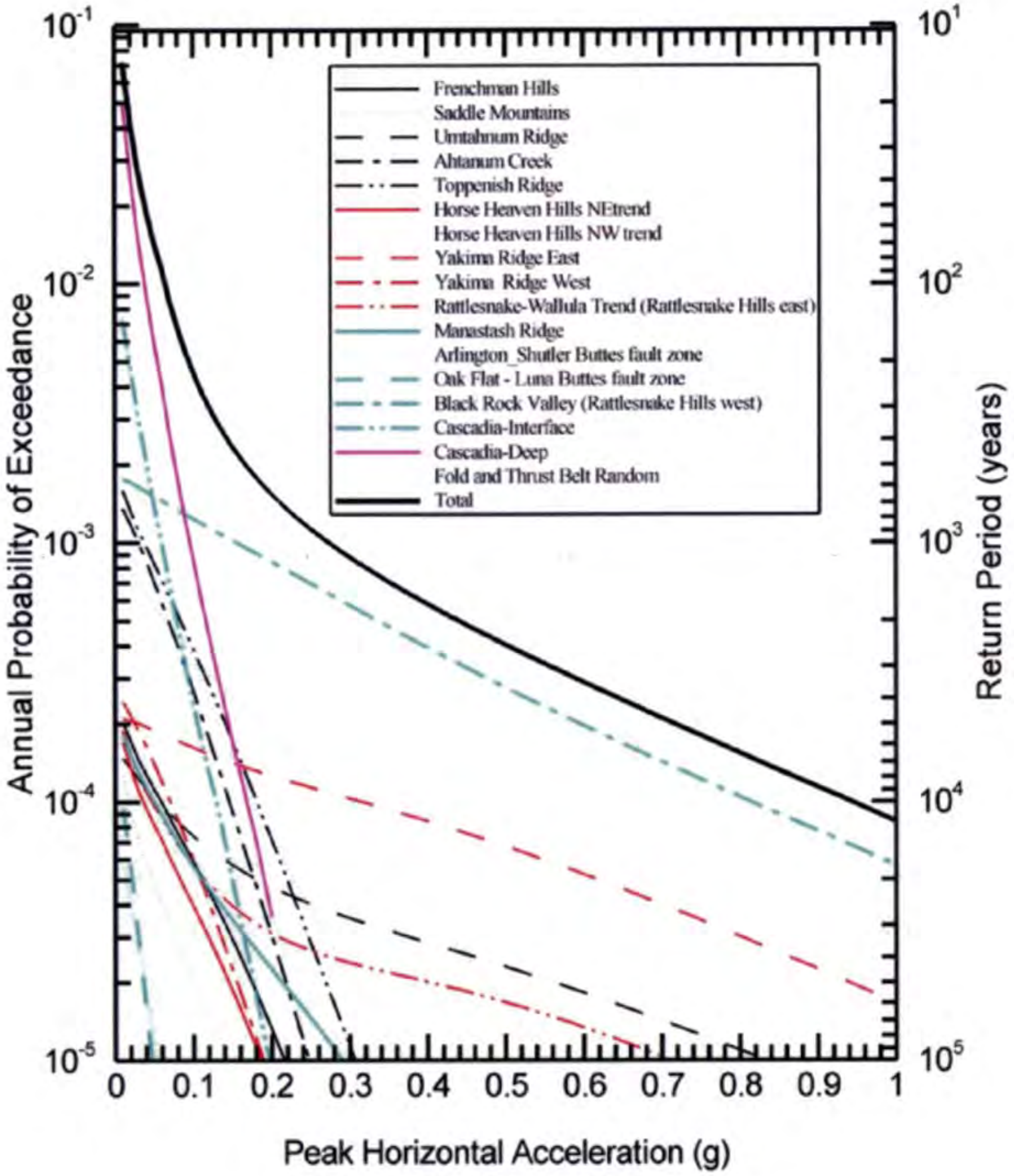

Figure 3-2: Preliminary mean hazard curves for PHA, Black Rock Site.

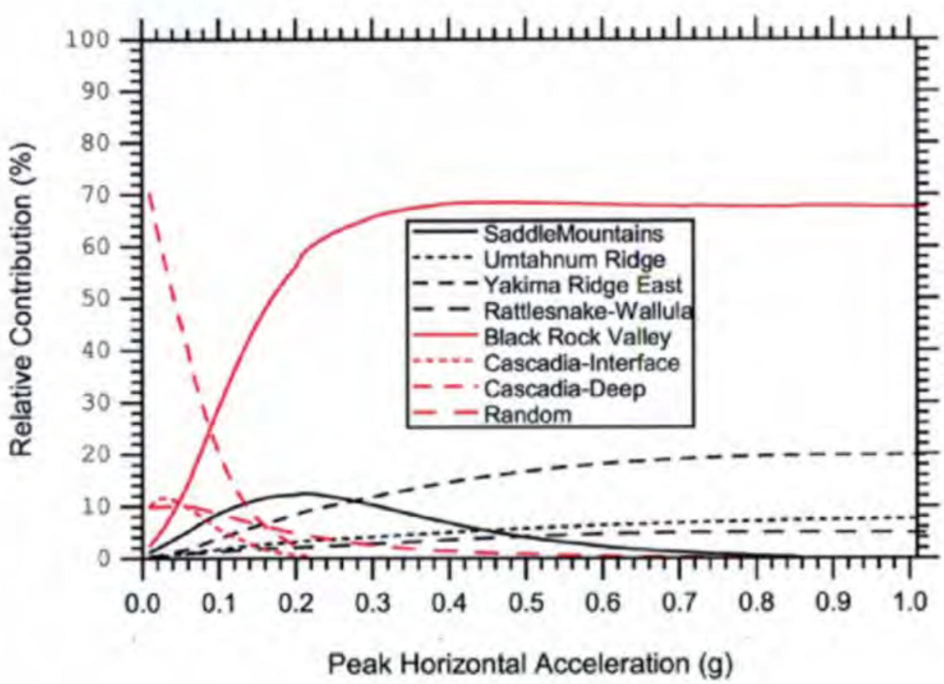

Figure 3-3: Relative contributions by source to the PHA hazard.

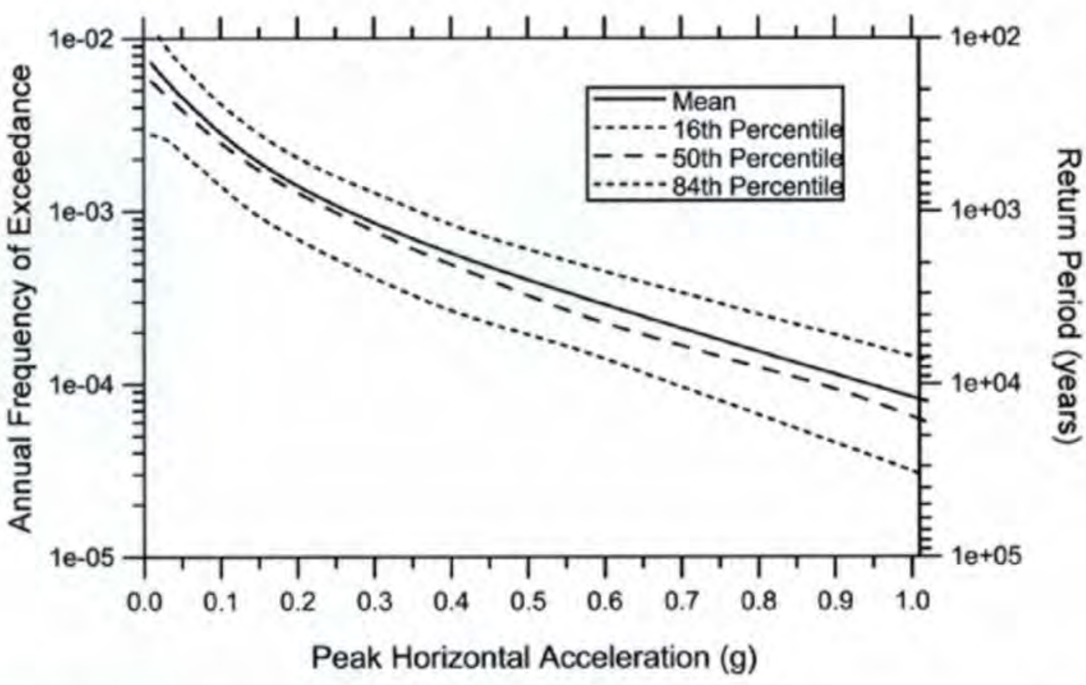

Figure 3-4: Mean PHA hazard curve, with 16th, 50th, and 84th fractiles of mean hazard. Cascadia and local random sources not included.

4.0 CONCLUSIONS AND ISSUES FOR FURTHER STUDY

Preliminary characterization of potential earthquake sources near the proposed Black Rock damsite shows that potential ground motions at the site are greatly influenced by the characterization of nearby potential seismic sources. Specifically, at return periods of about 10,000 years, total PHA is about 0.95 g. For motions greater than about 0.3 g, about 70% of the total hazard is derived from the current characterization of the Black Rock Valley fault. Further evaluation of these sources, or identification of additional sources, may significantly alter the preliminary results developed in this study.

Regional mapping indicates that contemporary deformation is compressional. Structures that are potentially consistent with the contemporary stress field are apparently present on both abutments. Initial mapping near the damsite area indicates that a significant thrust fault is present in the right abutment. For the present characterization, this fault is included as part of the Black Rock Valley fault and considered as a potential earthquake source. If large earthquakes occur on this fault they could potentially be accompanied by up to several meters of surface faulting. The age and characteristics of this fault need further study for issues related to seismic source characterization at the site.

A hypothesis developed from currently in-progress mapping at the damsite indicates that the large fold on Horse Thief Mountain, the right abutment of the proposed dam, is related to the thrust fault that daylights in the lower portion of the right abutment and dips to the south beneath Horse Thief Mountain. Several secondary faults, scarps, and lineaments that appear to be related to secondary extension along the fold atop Horse Thief Mountain may be related to Quaternary deformation of this fault/fold. These features are also potential sites of coseismic secondary faulting, fissuring, and landslides.

Cascadia seismic sources do not appear to be significant for the PHA hazard at the site for PHA of 0.3 or greater. However, these sources may be important at longer periods; periods which may be significant in more detailed analyses of engineered structures at the Black Rock site.

Although the present study has focused primarily on probabilistic PHA, more detailed engineering analyses will require more complete descriptions of ground motion parameters including time histories. Characterization of these motions will be greatly influenced by details of the structural details of local faults including directivity or hanging wall amplification effects. In addition, studies of site response will be needed for more detailed ground motion evaluations.

Although not addressed in this memorandum, baseline studies for potential reservoir-induced seismicity will be needed. The setting of site in a region of tectonic compression, very large and deep reservoir, and operations that may involve large fluctuations in depth and volume, all indicate that the probability of induced seismicity may be significant.

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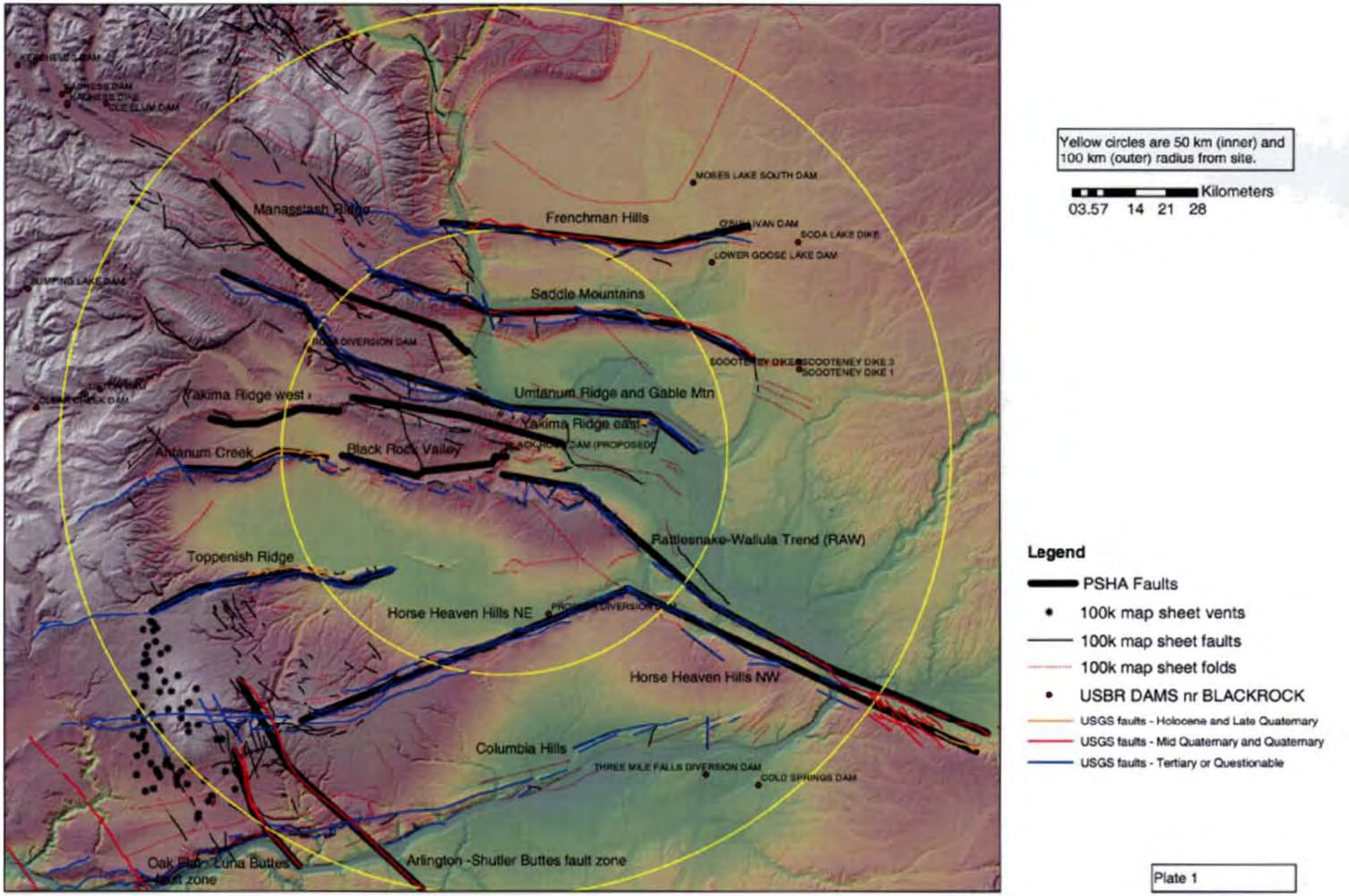

Manastash Ridge
Frenchman Hills
Saddle Mountains
Umtanum Ridge and Gable Mtn
Yakima Ridge west
Yakima Ridge east
Ahtanum Creek
Black Rock Valley
Rattlesnake-Wallula Trend (RAW)
Toppenish Ridge
Horse Heaven Hills NE
Horse Heaven Hills NW
Columbia Hills
Arlington -Shutler Buttes fault zone
MOSES LAKE SOUTH DAM
SODA LAKE DIKE
LOWER GOOSE LAKE DAM
SCOOTENEY DIKE 3
SCOOTENEY DIKE 1
THREE MILE FALLS DIVERSION DAM
COLD SPRINGS DAM
Yellow circles are 50 km (inner) and 100 km (outer) radius from site.
Kilometers
03.57 14 21 28
Legend
PSHA Faults
100k map sheet vents
100k map sheet faults
100k map sheet folds
USBR DAMS nr BLACKROCK
USGS faults - Holocene and Late Quaternary
USGS faults - Mid Quaternary and Quaternary
USGS faults - Tertiary or Questionable

Plate 1

Appendix C

Probable Maximum Flood Study

7-1596B(9-89)
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JAN 1 2 2004

MEMORANDUM

To: Team Leader, Black Rock Dam Design Team
Attention: D-8120 (LaFond)

From: Kenneth Bullard, Hydraulic Engineer
Flood Hydrology Group
Technical Service Center

Kenneth L. Bullard

Subject: Feasibility Design Level Probable Maximum Flood (PMF) Study and Frequency Floods for Diversion During Construction for Black Rock Dam, Washington

The attached report provides the requested feasibility design level probable maximum flood for Black Rock Dam. The current plans call for the dam to be built with no emergency spillway and the entire volume of the PMF hydrograph to be contained in flood surcharge space. For this reason the winter general storm with a larger volume should be considered for the feasibility level designs.

If future plans call for the dam to have some form of emergency spillway, then the summer general storm or the summer local storm PMF with larger peak flows should be considered. If future plans call for a significantly lower, or higher normal water surface than the assumed 1,800 feet then the PMF study should be redone to account for this change in the basin hydrologic characteristics. Before any final designs are completed for Black Rock Dam, a site visit by a qualified flood hydrologist should be made to verify the soil and runoff characteristics of the basin as well as provide a review and check of the current study for any other final design level considerations.

If you have any questions regarding this study please contact me at 303-445-2539 or E-mail at kbullard@do.usbr.gov.

Attachments

bc: D-8130 (Stanton), D-8530 (Bullard/Schreiner/File)

WBR:KBullard:amv:1-5-04:445-2539
(I:8530:BlackRock.MKB.doc)

Black Rock Dam, WA
(PMF)

TECHNICAL SERVICE CENTER
Denver, Colorado

BLACK ROCK DAM
WASHINGTON

Feasibility Level Probable Maximum Flood Study

Prepared by
Flood Hydrology Group
Water Resources Services

U.S. Department of the Interior
Bureau of Reclamation

DECEMBER 2003

Black Rock Dam, Washington
Feasibility Level Probable Maximum Flood Study

Authorization: Funds for studies related to the feasibility of construction of Black Rock Dam were included in the Energy and Water Development Appropriations Act for Fiscal Year 2004 signed into law on December 1, 2004. The Bureau of Reclamation had begun preliminary investigations into the proposed dam location for Black Rock Dam, Washington in FY2003. As part of the preliminary investigations for this dam a feasibility level Probable Maximum Flood study was requested. Specific authorization for the Flood Hydrology Group to proceed with this study was contained in a LAN message from the team Reclamation leader in November 2003.

Summary of Results:

Table 1
Black Rock Dam, Washington
Feasibility Level PMF Study

Flood Description	Peak (ft^3/s)	Volume (acre-feet)	Duration
Winter General PMP Storm (with 100-yr antecedent rain flood – Nov. – Mar.)	20,200	29,100	10.5 days
Summer General PMP Storm (with no antecedent flood June – Oct.)	28,900	28,900	3.5 days
Summer Local PMP Storm (with no antecedent flood June - Oct)	74,900	17,000	1-day

These hydrographs are displayed in figures 1, 2 and 3 and on tables 1, 2, and 3.

Previous Studies: There are no known previous PMF studies of this basin.

Project location and basin description: Black Rock Dam is to be located in south central Washington State near the eastern boarder of Yakima County where it crosses the existing highway 24 on what is referred to locally as Dry Creek. The dam is a potentially large structure with a hydraulic height of 400 feet or more. Most of the water for storage will be pumped from the Columbia River at Priest Rapids Dam during times of the year when excess water may be available at that location. The dam has a small natural drainage area with a large lake surface covering about 20 percent of the natural basin. It is envisioned that the dam will have enough freeboard to completely contain a full PMF (including any antecedent flood) with out using an emergency spillway. Water from the dam will be pumped into a pipeline and delivered to meet irrigation needs in the Yakima River basin to the west at beneficial times of the year.

The basin is described as being mostly steep slopes with grass and weed-cover. The basin area was measured using the WMS (Brigham University, 1999) computer program and available 1:250000 scale, with 30-meter resolution for elevation data points, USGS (United States Geological Survey) DEM (Digital Elevation Models). The total drainage area from this measurement was 61.2 square miles. Additional capabilities of the WMS model were used to determine the lake surface area at a proposed elevation of 1,800 feet. This elevation produces a lake surface area of 12.0 square miles based on the 1:250000 scale maps.

Some difficulties were encountered in the drainage area measurement processes using WMS. The basin straddles two UTM (Universal Transverse Mercator) zones. Since the dividing line between UTM zone 11 and zone 12 is the 120 degree longitude line, it was not possible to find a set of 7 ½ minute DEMs or DRGs (digital raster graphics) maps that could be readily incorporated into the WMS model. The difference in the UTM zones requires additional GIS processing to bring everything into one zone. This was not done for this feasibility level study because it was felt that the 1:250000 DEM maps would provide adequate information. The use of the 1:250000 maps at a 30-meter interval spacing between elevation points is somewhat less accurate than would be the 7 ½ minute DEM maps at a 10-meter elevation spacing. It appears there are some areas in the southwestern corner of the basin as drawn by WMS that may not flow into Black Rock Reservoir if more detailed maps are used. The drainage area and lake surface areas and other basin parameters based on the 1:250000 maps should be checked with the more accurate maps before final designs for this proposed structure.

Figure 4 provides a general location and basin boundary map with the proposed lake surface elevation of 1,800 feet identified.

Probable Maximum Precipitation Study: The Black Rock Dam basin is located in a region covered by Hydrometeorological Report Number 57 (NOAA, 1994) for the purposes of defining PMP (Probable Maximum Precipitation).

In determining PMP using the HMR 57 the month of occurrence of the storm is needed. It was anticipated that the winter conditions (November – March) would produce the maximum precipitation amounts for this type of study. However, on examination of the data in HMR 57 it was discovered that the PMP event for the summer months, June – October, would be approximately 20 percent larger.

It was also noted that larger antecedent floods would be more likely to occur in the winter months. Since the dam is being considered to have enough freeboard storage to completely contain a full PMF, including any antecedent flooding, both the winter and summer general storm conditions were considered in this feasibility study. For future reference a summer local storm (thunderstorm) PMP was calculated. This type of storm is generally much more intense and produces much higher peak flows, but with significantly lower flood volumes.

In calculating the PMP amounts an approximate total basin area of 60 square miles was used for area reductions to the point PMP. The mean basin elevation of 2,220 feet was calculated from the WMS program and was also used in the PMP calculations.

The tables 4 and 5 summarize the accumulated values of aerially reduced PMP calculated for the Black Rock basin. Figures 4 and 5 of this report display a depth versus duration plots of these PMP data.

Table 4
Summary of General Storm Probable Maximum Precipitation Estimates
Black Rock Dam, Washington

Time from Start of Storm (hours)	General storms Winter (inches)	Summer (inches)
0	0.00	0.00
1	1.00	1.18
6	3.37	3.97
24	6.56	7.73
48	9.20	10.84
72	10.25	12.07

Table 5
Summary of Local Storm Probable Maximum Precipitation Estimates
Black Rock Dam, Washington

Time from Start of Storm (hours)	Local Storm Summer (inches)
0.00	0.00
0.25	1.88
0.50	3.13
0.75	3.95
1.0	4.55
2.0	5.09
3.0	5.23
4.0	5.37
5.0	5.44
6.0	5.50

The data from the depth-duration plots were input to the Bureau of Reclamation's FHAR (Reclamation, 1986) rainfall-runoff program. This program reads the smooth incremental depths of PMP. Placing the maximum incremental rainfall value at the 2/3 point of the storm duration and alternating the remaining incremental values in decreasing order about this point creates the design storm sequence. This rainfall distribution is the standard PMP design storm arrangement as specified in the Bureau of Reclamation's Flood Hydrology Manual (Cudworth, 1989).

Basin Lag Times and Unit Hydrograph Computations: The standard Bureau of Reclamation Lag time equation was used to develop unit hydrographs for the different storm conditions on this basin. The lag time is computed b the following equation:

$$Lag = C*[(L * Lca)/(S)^{0.5})]^{0.33} \text{ (hours)}$$

Where:

C = a runoff efficiency coefficient for a basin and storm type
L = Length of the longest water course (miles)
(Measured to the upstream edge of the reservoir at the top of active conservation elevation)
Lca = Length to the centroid of the basin (miles)
(Measured along the longest water course)
S = Slope along the longest water course (feet/mile)

The HEC-WMS program computed the required lengths and channel slopes with topography data input from available USGS 30-meter DEMs. In this case, the total basin consists of several small parallel side channels flowing from north to the south, or south to north, and into the proposed lake at elevation 1,800 feet. Normal basin calculations start at a point at the upstream end of the reservoir at a normal water surface and follow the longest water course upstream to a saddle point on the basin boundary. The distance to a point along this main channel to a point opposite the basin centroid, and the distance to the basin centroid from the main channel are also measured. In this instance with many side channels, the total basin centroid would be located inside the proposed lake surface and the calculated Lca distance by normal methods would be in error.

To resolve the problems associated with the many small inflow channels, a single subbasin was created at the extreme northwest end of the total basin. This small subbasin had its downstream concentration point located at the proposed lake surface and the upstream end extended to the original total basin boundary. This small subbasin was judged to be the largest such subbasin that could be drawn within the total basin. The WMS program was used to calculate the necessary measurements for L and Lca and the slope values for this subbasin. The lag time calculated from this subbasin was then allowed to represent all of the other similar subbasins that could be defined. Figure 7 displays a map from the WMS program to illustrate the use of the selected subbasin to calculate the lag parameters.

Table 6 displays the various measurements and estimates of the "C" value used to establish the lag times for the total basin and the different storm conditions for the Black Rock basin.

Table 6
Black Rock Dam, Washington
Lag time computations

Season	Parameter	Value	Units
Winter	C	2.6	
	L	5.11	miles
	Lca	4.00	miles
	S	214.90	Feet/mile
	M	0.33	none
	Lag	2.90	hours
	D	0.5	hours
Summer	C	1.6	
	L	5.11	miles
	Lca	4.00	miles
	S	214.90	feet/mile
	M	0.33	none
	Lag	1.79	hours
	D	0.3	hours

The choice of the "C" parameter was made without the benefit of a site visit. The values chosen are similar to those for other Reclamation PMF studies that have been prepared in the region. In this instance the actual "C" value and the resulting lag times are not critical since the dam will be designed to contain the entire volume of the PMF. The lag time computations only affect the peak and not the volume of the computed PMF hydrographs.
Complete hydrographs are generated to assure that the proper volume of flooding is obtained for each critical duration.

The dimensionless graph selected for use with this study was originally prepared for Bully Creek Dam. This dam is in the western portions of the Yakima River basin and is the most representative of all of the available dimensionless graphs in the Reclamation collection. The same dimensionless graph was used for both the winter and a summer condition with only a change in the "C" value to help account for the potentially more intense summer rainfall. A different dimensionless graph could have been selected for the local storm PMF to help account for the even more intense rainfall. However the Bully Creek Dam dimensionless graph already has a peak flow of 30 ft^3/s, which is higher than the Rocky Mountain thunderstorm dimensionless graph peak. It is also true that the local storm PMF volume is not likely to control any design process and the actual dimensionless graph used is not significant in this process. The process to convert the dimensionless graph to a unit hydrograph is described in the USBR Flood Hydrology Manual (USBR, 1989).

Loss Rates: Figure 8 depicts the general soil hydrologic classifications taken from the NRCS STATSGO database (NRCS, undated) for this basin. It is important to realize that the proposed water surface at elevation 1,800 feet occupies about 20 percent of this total basin area. For the different hydrologic soil groups indicated the USBR Flood hydrology manual provides minimum loss rates to be used. The minimum loss rates for the various soils groups in this basin are indicated on figure 9. The various soil groups were measured using ARCVIEW and the resulting areas were used to help compute an area weighted constant loss rate for use on all of the land areas of this basin. Table 7 displays the measurements and computations used to derive the final constant loss rate for the entire land surface area of this basin.

The constant loss rate of 0.06 inches per hour is used with both the summer and winter conditions. There is no snow cover assumed on this basin during the winter season and loss rates associated with snow cover do not need to be considered.

Table 7

Black Rock Dam, Washington
PMF Study Infiltration Analysis

Soil Group	Sq. Mi.	Min Loss	Area*Loss	
B	5.0	0.15	0.75	
C	40.0	0.05	2.00	
D	4.0	0.00	0.00	
Total	49		2.75	
Weighted Average			**0.06**	**in/hr**

Lake Surface is treated separately with 0.0 in/hr on 12.0 square miles

By definition the PMF hydrographs calculated by Reclamation assume a very saturated basin prior to the onset of the PMP storm. This assumption allows for the elimination of any initial losses or any decaying loss rate function during the early time periods of the PMP storm. This soils information has not been verified by a field inspection. Prior to any final designs a field investigation of the site should be made by a qualified flood hydrologist to verify the soils and loss rate information used in this study as well as other hydrologic parameters that have been estimated.

Snow Cover Consideration: A check of several snow stations in the state of Washington was made to determine if any potential snow cover should be assumed during the winter or spring months. Figure 9 displays a map showing all of the snow gage stations reported by the NRCS (NRCS, 2003). There are no snow gage stations in the immediate vicinity of the Black Rock Dam drainage basin. There is no reason to believe that significant snowfall collects on this basin. The basin is to far southeast and at to low of an elevation to have prolong periods of snow accumulation. For this study it is assumed that there will be no snow pack on the basin during the winter months. Any antecedent flooding in the winter will be the result of preceding days of rainfall and associated runoff.

Antecedent Flood hydrographs: A further search available stream gage stations also indicated few stations in the area that are geographically near to or similar to the Black Rock Dam basin. The closet hydrologic similar stream gage record is for Providence Coulee near Cunningham, Washington (USGS gage site No. 12512550). This gage has a drainage area of 52.1 square miles and is at an elevation of 1,115 feet. These values are nearly the same as at the Black Rock Dam site. The gage has 19 years of record with from 1978 to 1998,with one missing year (1992). Data for peak flows was obtained from the USGS NWIS WEB site. In the 19 years of record only two maximum annual flood peak events occurred in the summer months, and both of those were very small, (43 ft^3/s and 41 ft^3/s in 1991 and 1994 respectively). All other maximum annual peak flows occurred in the winter months of January through March and has gone over 1,000 ft^3/s on one occasion. A further check of the daily flow records indicated that most summer month days have zero flow. On those summer days when flows are recorded the amount is very small, usually much less than 10 ft^3/s. The flows seldom last more than one or two days. In the winter months much larger daily flows can occur and the stream tends to have flow in it for several days or weeks at a time.

The conclusion of this investigation is that large antecedent floods are most likely to occur in the winter months but are not likely at all in the summer months. If they did occur in the summer they would have insignificant volumes compared to any PMF hydrograph volume. The PMF computations were based on this set of data with no antecedent flood for the summer conditions either for the general storm or for the local storm. It is a common Reclamation practice to produce local storm PMF hydrographs for summer months, in portions of the western United States, with no antecedent flood.

The winter months were further analyzed to produce estimates of the 100-year, 1-, 3-, and 7-day maximum daily flood flows. Tables 8, 9 and 10 display the frequency computations of the maximum daily flows. These estimates were then adjusted by the square root of the drainage area ration $((61.2/51.1)^{0.5} = 1.09)$ to make them more representative of the total drainage area above Black Rock Dam. These 100-year flow estimates were then used to form a 7-day balanced hydrograph by placing the maximum 1-day flow value in the center, the flow value equal to ½ of the volume of the maximum 3 days maximum 1-day value on the two surrounding days, and the flow value equal to ¼ of the volume of the maximum 7-days minus the maximum 3-days for the outside four days. The resulting 100-year balanced hydrograph for the winter months above Black Rock Dam was then considered to be an antecedent flood that could occur with a peak 3 days prior to the start of the PMP. The 3-day separation of the antecedent rain flood is recommended in the Reclamation Flood Hydrology Manual for this region of the country. Table 11 below lists the relevant data derived from this process for the 100-year 7-day winter antecedent flood.

Table 11
Black Rock Dam, Washington
100-year 7-day winter antecedent flood

Day	Average Flow (ft^3/s)
1	159
2	159
3	316
4	1728
5	316
6	159
7	159

This hydrograph can be seen in the winter general storm PMF hydrograph sequence displayed on figure 1. The primary purpose of this hydrograph is to provide the additional volume of flooding that could be associated with the winter general storm PMF conditions. It is not intended that this hydrograph represent any historic flood event.

Rain on Reservoir Computations: Because the reservoir surface area at elevation 1,800 feet covers a large portion of this basin, approximately 20 percent, the reservoir surface area was treated separately in the calculations. The design rainfall at each computation interval was placed over the reservoir surface with no losses considered. This gave a depth of rainfall over the 12.0 square mile water surface. This is a volume of water in a specified time interval. This value was then converted to an average reservoir inflow (in ft^3/s) for the specified time period for each storm type. The conversion factor is that 1 inch of water on one square mile of lake surface in 1 minute is the equivalent volume of 38,720 ft^3/s stream flooding entering the reservoir for 1 minute. To make use of the conversion factor it is multiplied by the total depth of rainfall (inches) in each computation interval, then multiplied by the total lake surface size (square miles) and then divided by the computation time increment (minutes) for each time interval in the storm sequence. The resulting hydrograph was then placed into a FHAR input hydrograph file and added with the appropriate PMF rainfall-runoff h hydrograph computation from the land portions of the basin for the storm type being considered. This computation often produces a leading peak on the combined hydrograph that is the result of the rain on the reservoir surface.

Pumping Inflows: A considerable volume of water will be added to the reservoir at certain times of the year by pumping from the Columbia River above Priest Rapids Dam when conditions permit. The exact details of this pumping scheme have not been worked out at the time of this study. It should be certain that under any conditions the pumping would cease when the reservoir reaches the maximum elevation of 1,800 feet. If the reservoir is assumed to be at a lower elevation at the start of the PMP storm then some additional pumping flows might also be considered. In all cases the worst possible condition for storing potential flood water would be when the PMF flood hits the reservoir after the maximum reservoir water surface of 1,800 feet is reached. For this reason no additional inflows due to pumping are considered in this feasibility level PMF hydrograph study.

PMF Rainfall-Runoff Computation: All of the data derived for the basin; the design storm arrangement, the loss rates, the unit hydrographs, the antecedent 100-year snowmelt flood, and the rain on the reservoir hydrographs for each storm sequence were placed in the Bureau of Reclamation's FHAR rainfall-runoff program to generate the final PMF hydrographs for Black Rock Dam.

For the winter general storm PMF, the combined land and reservoir surface hydrographs were lagged by 156 hours (312 time steps) and then added to the antecedent 100-year 7-day flood that was assumed to be based on antecedent rainfall. This was done to place the start of the PMP storm 72 hours after the peak of the antecedent 7-day flood.
Based on examination of available stream gage records that are applicable to the basin there was no antecedent flood assumed with the summer general storm or local storm PMF conditions.

The resulting PMF hydrographs are displayed graphically in figures 1, 2, and 3 and numerically in tables 1, 2, and 3. Because no flood routing of the actual PMF hydrographs is anticipated the values in the tables for the general storm PMF hydrographs are at 2-hour time steps. The actual computations were carried out at ½ hour time steps. The hydrographs at the smaller time interval are available with the backup data for this report in the Flood Hydrology Group files in the Denver Office of the Technical Service Center. Input and summary output pages from the FHAR program are included with Appendix A of this report.

Flood Routing Recommendation: For feasibility level design studies it is not anticipated that any formal flood routings of the PMF hydrographs will take place. The dam is to be designed to contain the entire volume of the PMF hydrograph and any antecedent flooding with out the use of an emergency spillway. Only the total volume of the incoming flood is required. This volume will then be added to the lake surface at elevation 1,800 feet to determine the required flood storage space in the reservoir.

If future design requirements suggest a formal flood routing is required, then the reservoir should be assumed to be full to elevation 1,800 feet and inflow equal to outflow through any available outlet works. No additional pumping should be assumed during the duration of the PMF if the starting elevation of the reservoir is at 1,800 feet.

Diversion During Construction Flood Peaks: Flood peaks for 10-, 25-, and 50-year diversion flood are provided in table 12. These peaks come from an application of the USGS National Flood Frequency Program (USGS, 2002), to the Black Rock Dam basin using the full 61.2 square mile drainage area. No large lake surface is assumed during construction. For application of this program the dam is located in what is termed Region 5 in the state of Washington. The dam is near Region 7, and a check of the values for that region was also made. The Region 5 values are higher for the 10-year to 50-year return periods.

Table 12
Black Rock Dam, Washington
Diversion Flood Peaks
(from USGS NFF Program, Version 3.2, 2002)

Return Period (years)	Diversion Flood Peak (Ft^3/S)
10	897
25	1190
50	1430

These flood peaks are considered to be all season, or the maximum peaks that could occur on an annual basis for the return periods indicated. The NFF program does not provide information about seasonal peak flows.

Envelope Curve Comparisons: Envelope curve comparisons are not provided with this report. The critical values from this PMF study are the volumes of flooding over several days. The PMF peak flows are not important to the design process for this dam. Envelope curves for volumes of flooding from hydrologically similar basins do not exist. The problem is further complicated by the fact that both the computed PMF peak and PMF volume of flooding result from a substantial portion of the basin being a lake surface. There are no data from near by basins that are similar to this situation. Envelope curve comparisons would be meaningless for this level of study and are not provided.

Should future design work require actual flood routing of some of the PMF hydrographs and also require more confidence in the actual PMF peak flow then some envelope curve comparisons could be provided at that time.

Acknowledgement: This report was prepared by Mr. Kenneth L. Bullard, Hydraulic Engineer, with the assistance of Mr. Walter Johnson, Meteorologist. Mr. Lex Kamstra, Hydraulic Engineer, provided peer review. All of these individuals are employed in the Flood Hydrology Group of the Bureau of Reclamation's Technical Service Center in Denver, Colorado.

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Watershed Management System (WMS), Copyright 1999 by Brigham Young University, Compiled March 4, 2002.

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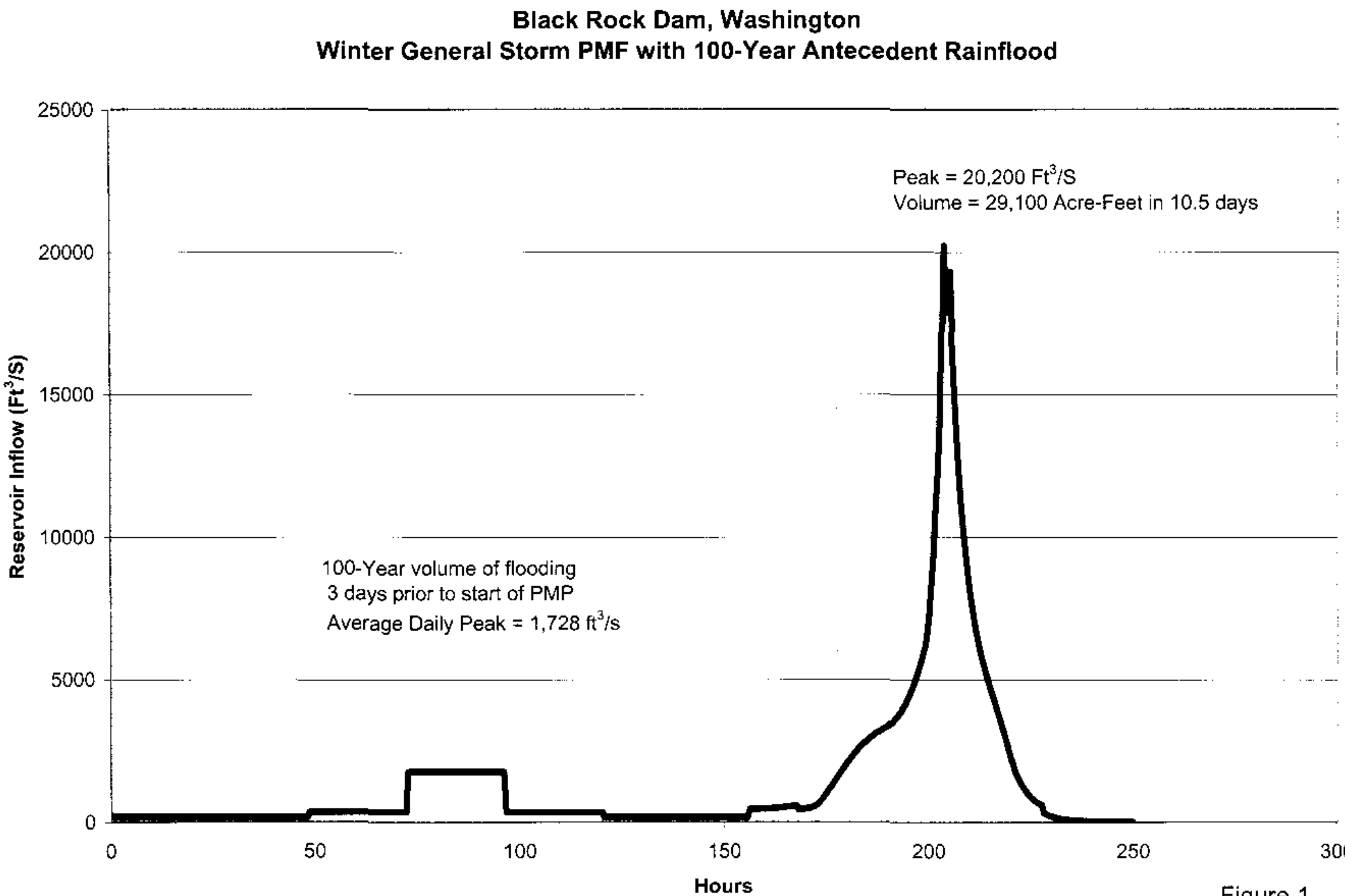
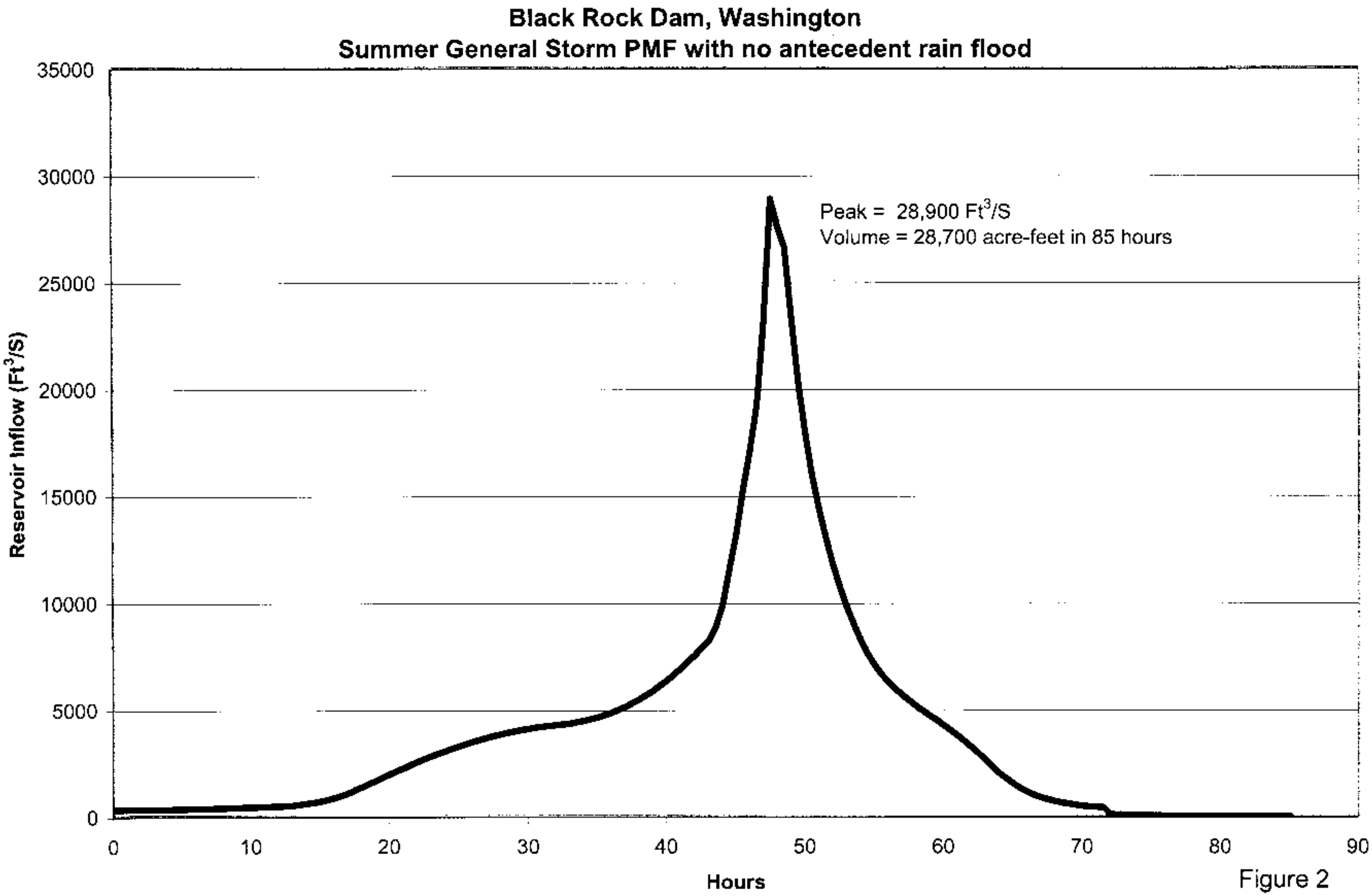
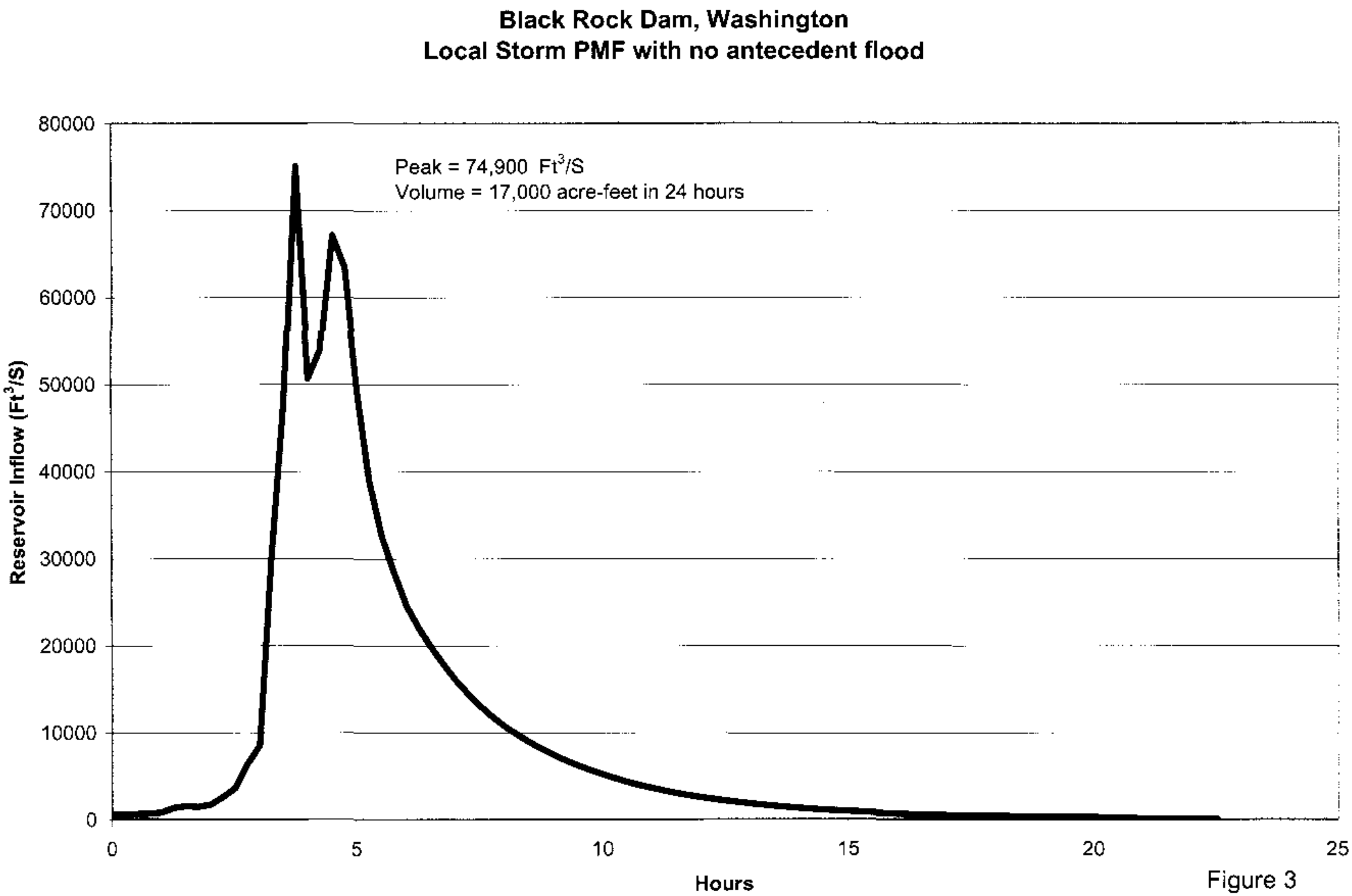


Black Rock Dam, Washington
Winter General Storm PMF with 100-Year Antecedent Rainflood
Peak = 20,200 Ft³/S
Volume = 29,100 Acre-Feet in 10.5 days
100-Year volume of flooding
3 days prior to start of PMP
Average Daily Peak = 1,728 ft³/s
Reservoir Inflow (Ft³/S)
25000
20000
15000
10000
5000
0
0
50
100
150
200
250
300
Hours

Figure 1


Black Rock Dam, Washington
Summer General Storm PMF with no antecedent rain flood
Reservoir Inflow (Ft³/S)
35000
30000
25000
20000
15000
10000
5000
0
Peak = 28,900 Ft³/S
Volume = 28,700 acre-feet in 85 hours
0
10
20
30
40
50
60
70
80
90
Hours
Figure 2


Black Rock Dam, Washington
Local Storm PMF with no antecedent flood
Peak = 74,900 Ft³/S
Volume = 17,000 acre-feet in 24 hours
80000
70000
60000
50000
40000
30000
20000
10000
0
Reservoir Inflow (Ft³/S)
0
5
10
15
20
25
Hours
Figure 3

Location and Basin Boundary Map - Proposed Black Rock Dam, WA

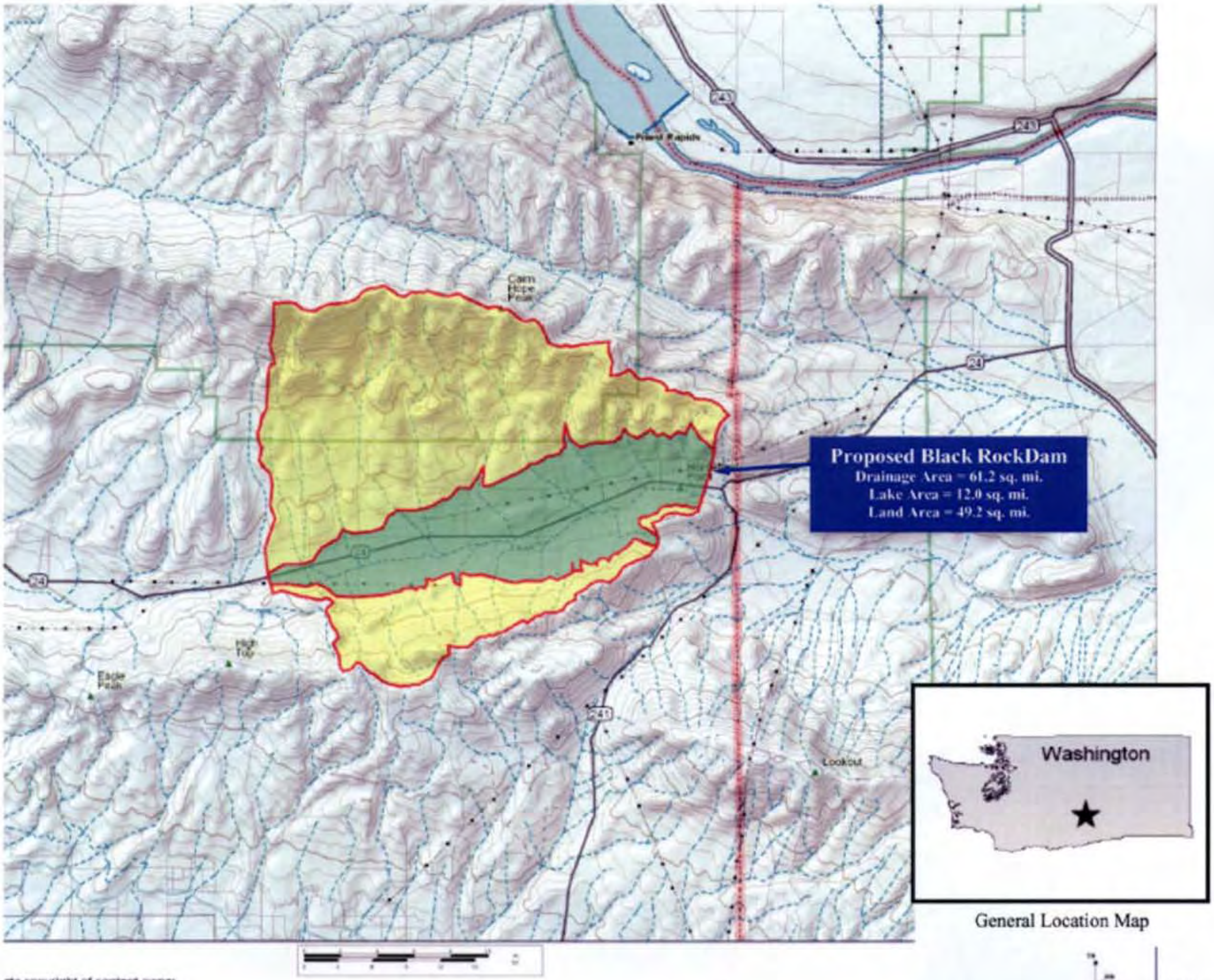


Figure 4

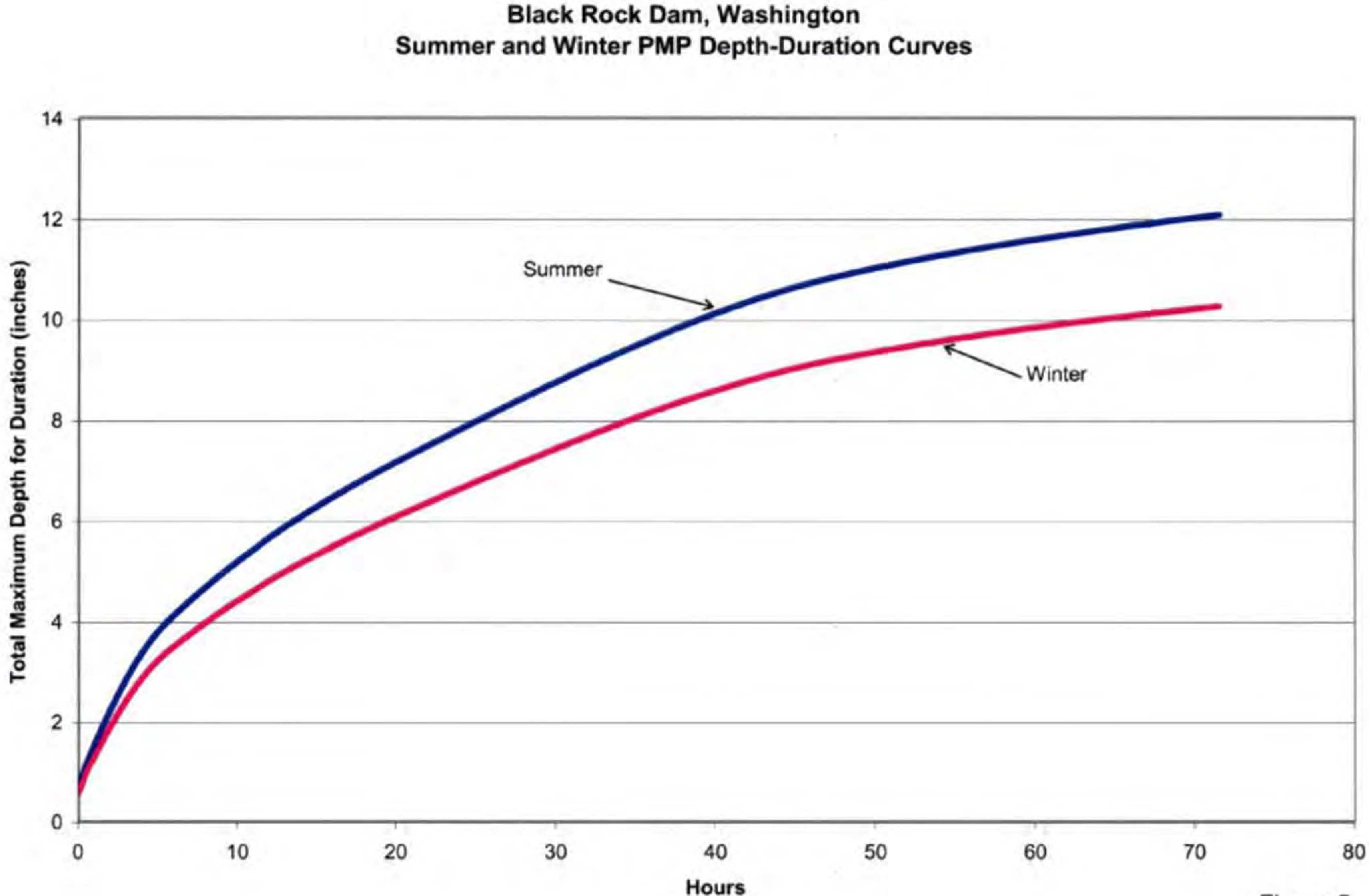

Black Rock Dam, Washington
Summer and Winter PMP Depth-Duration Curves
Total Maximum Depth for Duration (inches)
14
12
10
8
6
4
2
0
Summer
Winter
0
10
20
30
40
50
60
70
80
Hours

Figure 5

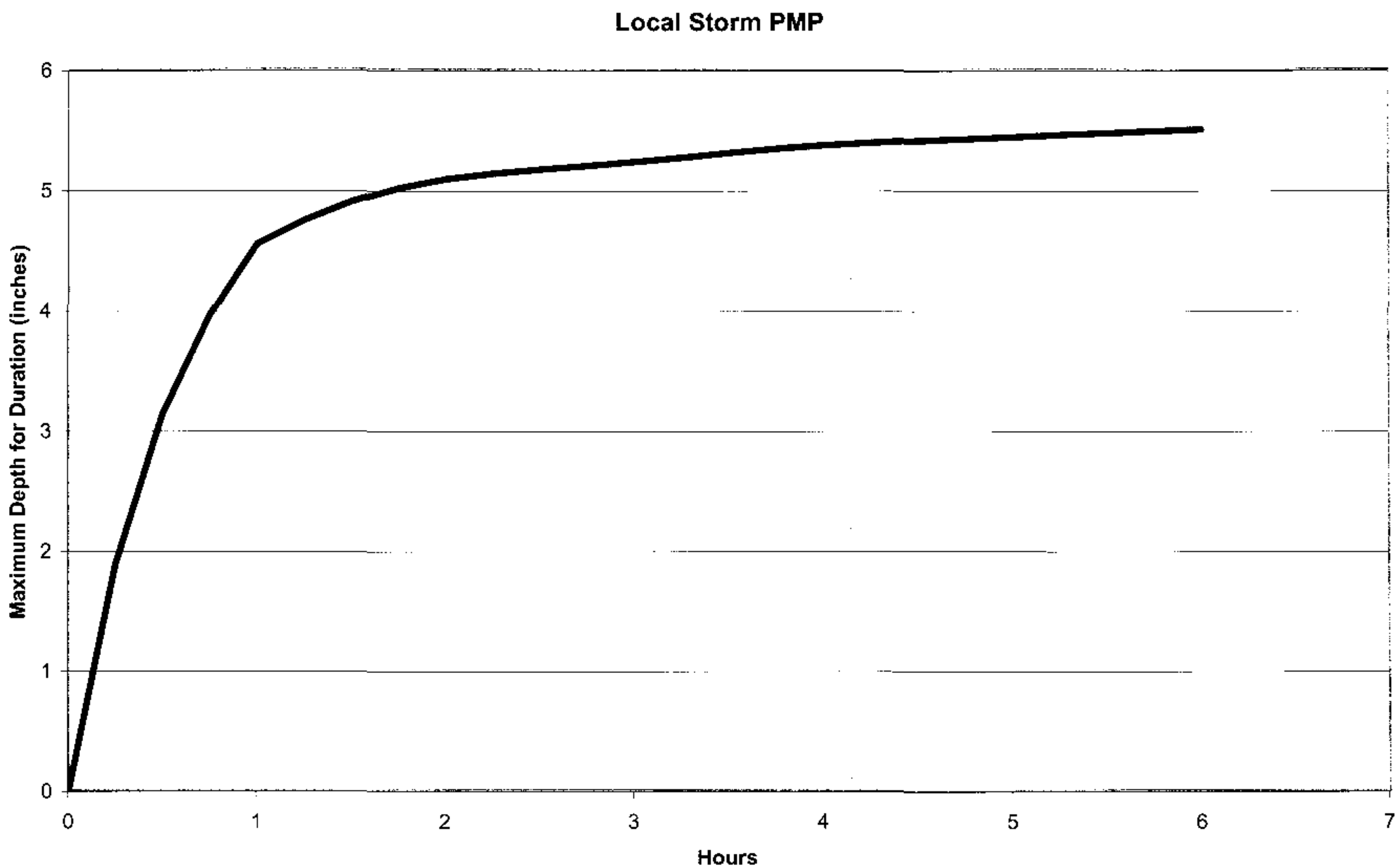

Local Storm PMP
Maximum Depth for Duration (inches)
0
1
2
3
4
5
6
0
1
2
3
4
5
6
7
Hours

Figure 6

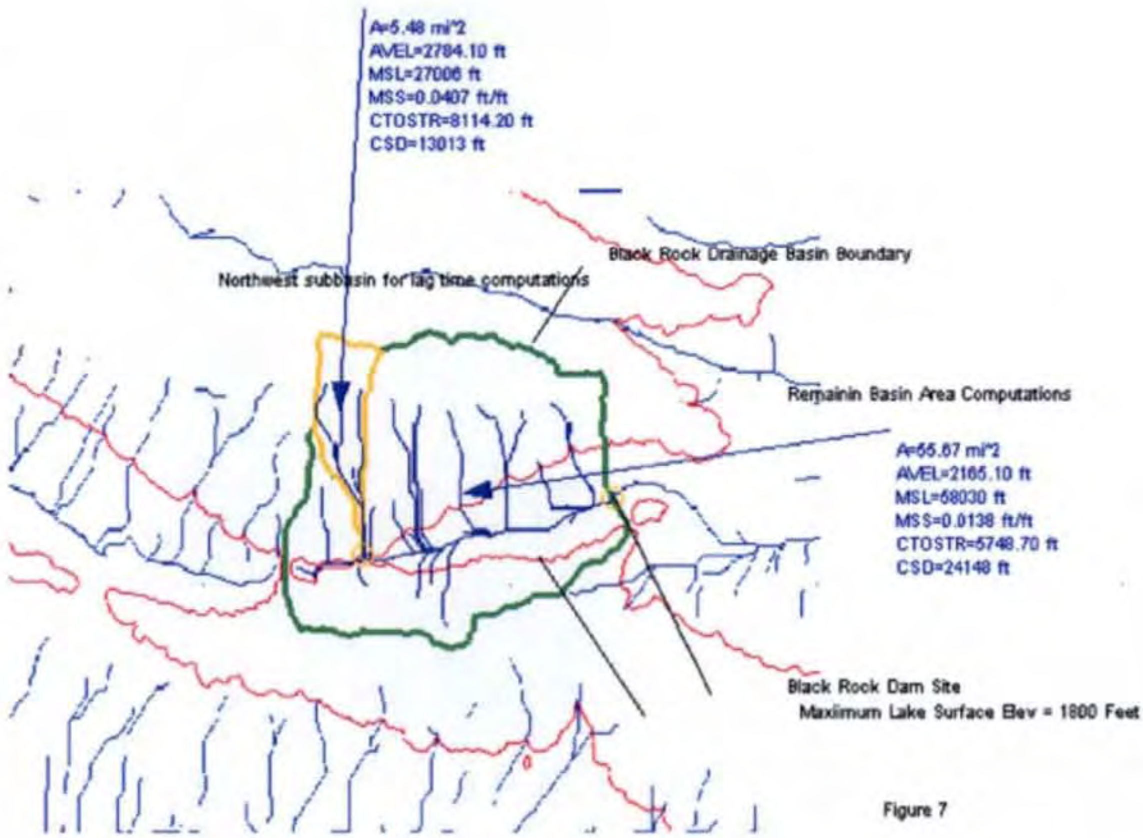
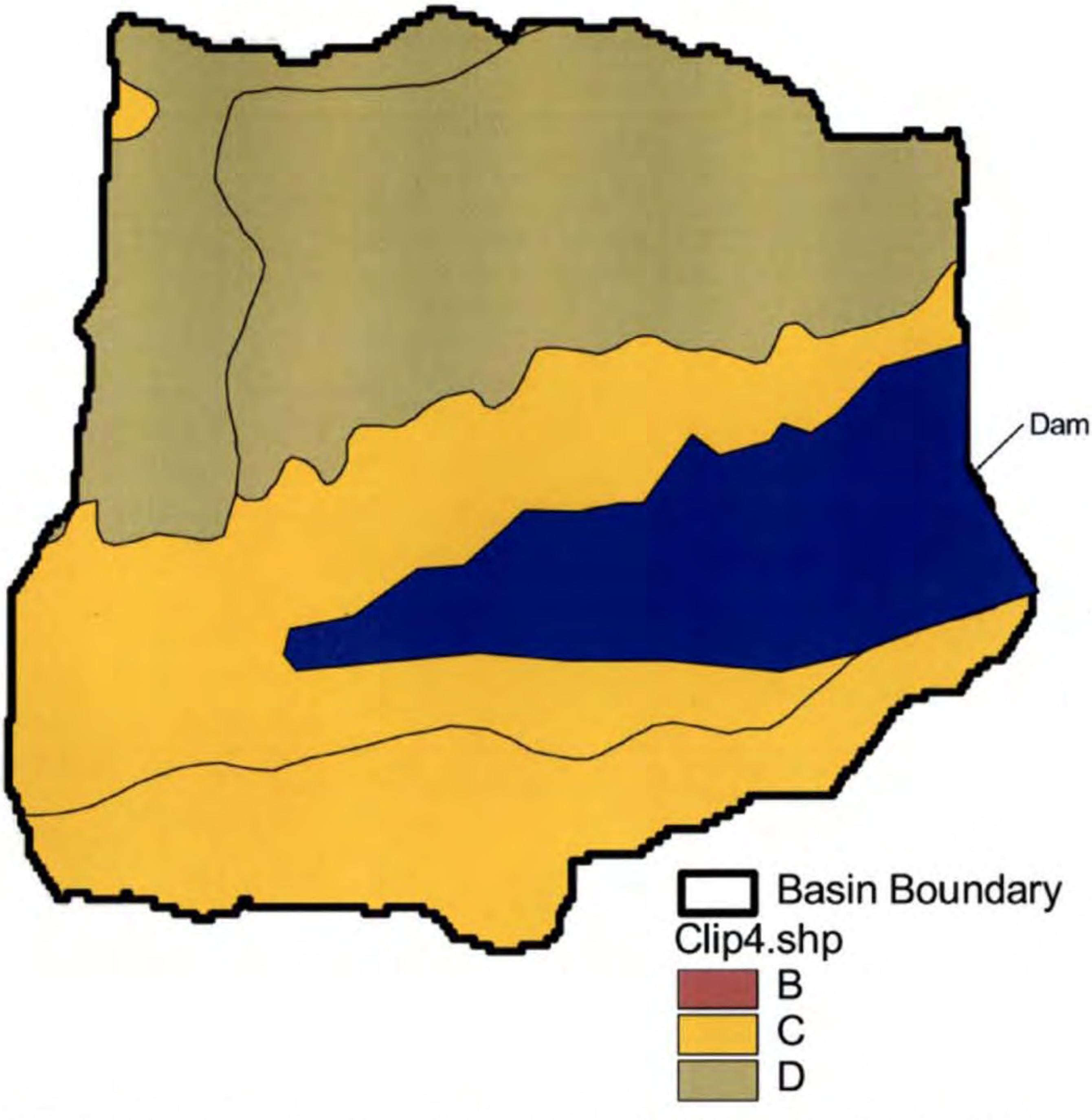
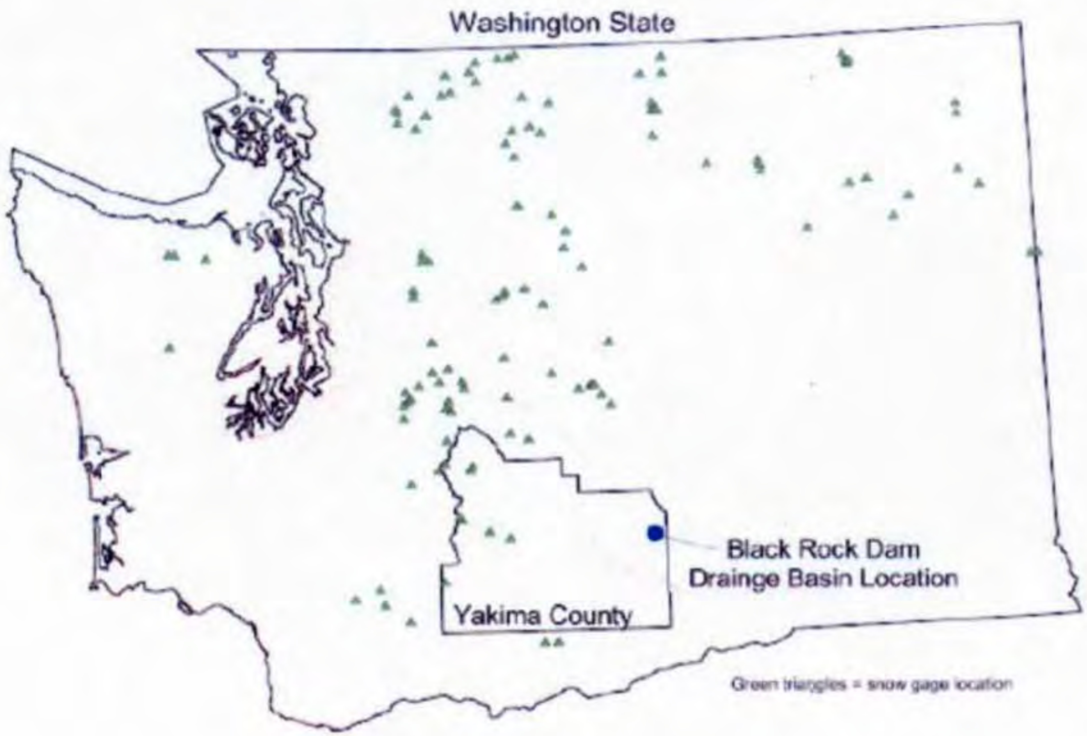

A=5.48 mi^2
AVEL=2784.10 ft
MSL=27006 ft
MSS=0.0407 ft/ft
CTOSTR=8114.20 ft
CSD=13013 ft
Black Rock Drainage Basin Boundary
Northwest subbasin for lag time computations
Remainin Basin Area Computations
A=65.67 mi^2
AVEL=2165.10 ft
MSL=68030 ft
MSS=0.0138 ft/ft
CTOSTR=5748.70 ft
CSD=24148 ft
Black Rock Dam Site
Maximum Lake Surface Elev = 1800 Feet

Figure 7



Black Rock Dam, Washington
Drainage Basin
Hydrologic Soils Groups
From STATSGO Soils Database

Figure 8



Location of NRCS snow gage sites
in the state of Washington

Figure 9

Appendix D
Field Cost Estimates

Priest Rapids Intake, Pumping Plant, Switchyard and Inflow Conveyance System

Q= 3,500 cfs

Field Cost Estimate

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs

Summary Sheet 1 of 2

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Estimate Worksheets Identify One Type of Intake and Pumping Plant and Two Types of Discharge Line Options					
		Discharge 1: Tunnel/Tunnel Inflow Line to BRR					
		Discharge 2: Tunnel/Pipeline Inflow Line to BRR					
		OPTION 1: PUMPING PLANT PLUS DISCHARGE 1: TUNNEL/TUNNEL					
		Intake - Civil/Structural Subtotal					$48,109,150.00 ✓
		Intake - Mechanical/Electrical Subtotal					$9,926,770.00 ✓
		Plant - Civil/Structural Subtotal					$63,295,370.00 ✓
		Plant - Mechanical Subtotal					$93,929,850.00 ✓
		Plant - Electrical Subtotal					$5,413,850.00 ✓
		Switchyard & Transmission Line Subtotal					$20,280,000.00 ✓
		Discharge 1 - Subtotal					$186,471,700.00 ✓
		Subtotal					$427,426,690.00 ✓
		Mobilization +/-	5%				$21,000,000.00 ✓
		Subtotal w/ mobilization					$448,426,690.00 ✓
		Unlisted Items +/-	10%				$41,573,310.00 ✓
		OPTION 1: CONTRACT COST					**$490,000,000.00** ✓
		Contingencies +/-	25%				$130,000,000.00 ✓
		OPTION 1: FIELD COST					**$620,000,000.00** ✓

QUANTITIES		PRICES	
BY	CHECKED	BY Craig A. Grush, Elizabeth Tran	CHECKED BJV 8/17/04
DATE PREPARED	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW JCR 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs

Summary Sheet 2 of 2

PROJECT:
Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		OPTION 2: PUMPING PLANT PLUS DISCHARGE 2: TUNNEL/PIPELINE					
		Intake - Civil/Structural Subtotal					$48,109,150.00 ✓
		Intake - Mechanical/Electrical Subtotal					$9,926,770.00 ✓
		Plant - Civil/Structural Subtotal					$63,295,370.00 ✓
		Plant - Mechanical Subtotal					$93,929,850.00 ✓
		Plant - Electrical Subtotal					$5,413,850.00 ✓
		Switchyard & Transmission Line Subtotal					$20,280,000.00 ✓
		Discharge 2 - Subtotal					$357,838,420.00 ✓
		Subtotal					$598,793,410.00 ✓
		Mobilization +/-	5%				$30,000,000.00 ✓
		Subtotal w/ mobilization					$628,793,410.00 ✓
		Unlisted Items +/-	10%				$61,206,590.00 ✓
		OPTION 2: CONTRACT COST					**$690,000,000.00** ✓
		Contingencies +/-	25%				$170,000,000.00 ✓
		OPTION 2: FIELD COST					**$860,000,000.00** ✓

QUANTITIES		PRICES	
BY	**CHECKED**	**BY** Craig A. Grush, Elizabeth Tran	**CHECKED** BOV 8/17/04
DATE PREPARED	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** Dcd 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs

Intake- Civil

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		CIVIL					
		Construct/Remove Cellular Cofferdam around Reservoir Intake					
		Assume construct from shore without barge.					
		Assume circular cellular cofferdam.					
		Length= 380 feet, 32-ft dia. cells, 28 ft high					
		Top of cofferdam - El. 488, Bottom of cofferdam - El. 460					
		Assume top of rock at reservoir bottom..					
	1	Furnish and install sheet pile walls	D8120	555	TONS	$2,200.00	$1,221,000.00
		Arbed AS 500-12, 30 psf					
	2	Backfill cells with free-draining granular material	D8120	11,700	CY	$30.00	$351,000.00
	3	Unwater behind cofferdam	D8120	6	MOS	$55,000.00	$330,000.00
		Assume sumps and surface pumps					
		Remove Cofferdam					
	4	Remove and stockpile granular material	D8120	11,700	CY	$25.00	$292,500.00
	5	Extract and salvage sheet pile cutoff wall	D8120	555	TONS	$300.00	$166,500.00
		Sheet Subtotal					**$2,361,000.00**

QUANTITIES		PRICES	
BY Dick LaFond	**CHECKED** M.R. O'Shea	**BY** Craig A. Grush	**CHECKED** BOV 8/17/04
DATE PREPARED 4/19/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs

Intake- Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Structural Excavation and Backfill					
		Assume dam excavation is all common.					
		Assume top 5 feet of excavation is common and the remainder is rock					
		Assume stockpile and use for backfill or embankment.					
	7	Excavation of common materials for structures	D8140	388,500	CY	$6.00	$2,331,000.00
	8	Excavation of rock for structures (drill & shoot)	D8140	671,700	CY	$15.00	$10,075,500.00
	9	Furnish & place backfill for structures (assume local borrow)	D8140	35,800	CY	$4.00	$143,200.00
	10	Place backfill around structures	D8140	35,800	CY	Included above	
	11	Compact backfill around structures	D8140	35,800	CY	$5.00	$179,000.00
		Roads and Fencing					
	12	Gravel surfacing		2,270	TONS	$20.00	$45,400.00
		20 ft wide road right side of channel					
		12 ft wide road left side of channel					
	13	Safety fencing		4,750	LF	$20.00	$95,000.00
		8' chainlink fence					
		STRUCTURAL					
		Construct Gated Intake and Fishscreen Structure					
	14	Furnish, form, and place reinforced concrete (f'c=4ksi)	D8140	40,150	CY	$350.00	$14,052,500.00
	15	Furnish and place concrete reinforcement.	D8140	6,424,000	LBS	$0.75	$4,818,000.00
	16	Furnish and handle cement	D8140	11,325	TONS	$110.00	$1,245,750.00
		Construct Lined Intake Canal					
	17	Furnish, form, and place unreinforced concrete	D8140	2,350	CY	$350.00	$822,500.00
		lining in excavated channel (f'c= 3 ksi)					
	18	Furnish and handle cement	D8140	665	TONS	$140.00	$93,100.00
		Construct Bypass Pipe					
	19	3 - 54" Dia. steel pipe for fish bypass.		15,840	LF	$330.00	$5,227,200.00
		Mortar line pipe					
	20	Bypass pipe common excavation		270,000	CY	$5.00	$1,350,000.00
	21	Bypass pipe rock excavation		130,000	CY	$15.00	$1,950,000.00
	22	Bypass pipe backfill		380,000	CY	$7.00	$2,660,000.00
	23	Bypass pipe soil cement bedding (100 psi)		12,000	CY	$55.00	$660,000.00
		Miscellaneous Metalwork					
		Listed under Intake - Mechanical Items					
		Intake - Civil/Structural Subtotal					**$48,109,150.00**

QUANTITIES		PRICES	
BY Chou Cha	**CHECKED** David Gesundheit/Anne Pavol	**BY** Craig A. Grush	**CHECKED** BDV 8/17/04
DATE PREPARED 4/19/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs

Intake- Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical					
	1	Furnish and install steel stoplog guides and seats	D8410	13,500	LBS	$6.00	$81,000.00
		(upstream of radial gates)					
	2	Furnish and install steel trashracks	D8410	102,000	LBS	$4.00	$408,000.00
	3	Furnish and install one trash rake, rails, supports	D8410	21,000	LBS	$10.00	$210,000.00
		(assume Atlas Polar DT8300 rake)					
	4	Furnish and install one conveyor, steel	D8410	13,000	LBS	$10.00	$130,000.00
	5	Furnish and install steel fish screen guides, supports,	D8410	360,000	LBS	$4.00	$1,440,000.00
		embedded seats, and bypass walls					
	6	Furnish and install fish screens, 10' W x14' H panel	D8410				
		70 panels + 6 spares					
		Structural steel		106,400	LBS	$4.00	$425,600.00
		Stainless steel		106,400	LBS	$15.00	$1,596,000.00
	7	Furnish and install barrier panels above fish screens	D8410				
		10' W x 11' H panels, 70 panels + 6 spares					
		Structural steel		209,000	LBS	$4.00	$836,000.00
	8	Furnish and install adjustable baffle panels	D8410				
		10' W x 25' H panels, 70 panels + 6 spares					
		Structural steel		570,000	LBS	$4.00	$2,280,000.00
	9	Furnish and install fish screen cleaners with travel rail,	D8410				
		5 systems with 2 brush cleaner arms per system					
		a. Structural steel		40,000	LBS	$4.00	$160,000.00
		b. Stainless steel		2,500	LBS	$20.00	$50,000.00
		c. 2 Hp motors/gear reducers, with adj. speed		5	UNITS	$5,000.00	$25,000.00
		controllers, and limit switches					
	10	Furnish and install water level measuring systems	D8410	12	UNITS	$11,000.00	$132,000.00
		Sheet Subtotal					**$7,773,600.00**

QUANTITIES		PRICES	
BY R Christensen/B Sund	CHECKED AMR	BY Craig A. Grush	CHECKED BOV 8/17/04
DATE PREPARED 4/21/2004	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DEA

FEATURE:	PROJECT:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs	Yakima River Basin Water Storage Options
	REGION PN / PRICE LEVEL: Appraisal
Intake- Mechanical	FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
	11	Furnish and install steel stoplog guides and seats (downstream of fish screens)	D8410	13,500	LBS	$6.00	$81,000.00
	12	Furnish and install one set of steel stoplogs for the two different size bays with lifting beam	D8410	101,000	LBS	$4.00	$404,000.00
	13	3' wide walkway, steel, safety grating along fish screens	D8410	19,500	LBS	$7.00	$136,500.00
	14	Handrail along each side of fish screen walkway	D8410	1,520	LF	$50.00	$76,000.00
		Radial Gates in Intake Structure					
		Furnish and install two 36.5-ft x 8.5-ft top seal radial gates and hoist equipment:	D8420				
	15	Gate (Weight/gate= 34,650 lbs)		69,120	LBS	$8.00	$552,960.00
	16	Embedded metalwork (Weight/bay= 5,000 lbs)		10,000	LBS	$5.00	$50,000.00
	17	Hoist operator (Weight/gate operator= 11,300 lbs)		22,600	LBS	$20.00	$452,000.00
	18	Motor - 5 hp (One per gate)		2	EA	Included in operator $	
		Furnish and install one 15.0-ft x 8.5-ft top seal radial gate and hoist equipment:	D8420				
	19	Gate (Weight/gate= 20,790 lbs)		20,790	LBS	$8.00	$166,320.00
	20	Embedded metalwork (Weight/bay= 3,000 lbs)		3,000	LBS	$5.00	$15,000.00
	21	Hoist operator (Weight/gate operator= 6,150 lbs)		6,150	LBS	$20.00	$123,000.00
	22	Motor - 3 hp		1	EA	Included in operator $	
		Sheet Subtotal					**$2,056,780.00**

QUANTITIES		PRICES	
BY R Christensen/B Sund (D8410) P. Hoffman (D8420)	CHECKED AMR	BY Craig A. Grush	CHECKED BOV 8/17/04
DATE PREPARED 4/21/2004	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

FEATURE: Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs Intake- Electrical	**PROJECT:** Yakima River Basin Water Storage Options **REGION** PN **PRICE LEVEL:** Appraisal **FILE:** C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		ELECTRICAL					
		Service Equipment (F&I)	D8430				
	23	Distribution panelboard, outdoor type		1	EA	$25,000.00	$25,000.00
		480 volts, 3-phase with 225 ampere bus					
	24	Outdoor transformer load center		1	EA	$11,000.00	$11,000.00
		15 kVA, 1-phase, 480-240/120 volt					
		Combination Motor Starters	D8430				
	25	NEMA size 2 non-reversing contactor,		6	EA	$8,000.00	$48,000.00
		480-120 volt control transformer					
		NEMA type 4 enclosure					
		Insulated Conductors (F&I)					
		600-volt, single-conductor, stranded copper					
	26	12 AWG		500	LF	$0.60	$300.00
	27	10 AWG		200	LF	$0.70	$140.00
	28	8 AWG		100	LF	$1.00	$100.00
		Conduit System (F&I)					
		Rigid steel conduit					
	29	1 inch		150	LF	$15.00	$2,250.00
		Lighting System (F&I)	D8430				
	30	High-pressure sodium, pole mounted, outdoor		6	EA	$1,600.00	$9,600.00
		70 watt, 120 volt					
		Intake - Mechanical/Electrical Subtotal					**$9,926,770.00**

QUANTITIES		PRICES	
BY Mike Schuh	**CHECKED** L Rossi	**BY** G for: Elizabeth Tran	**CHECKED** GOV 8/17/04
DATE PREPARED 4/16/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs

Plant- Civil

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Access Road (9.75 miles of 2-lane access road):					
		Assume construct access road from SH24 to PP.					
		Assume place road along abandoned railroad alignment					
		Assume no major excavation or embankment sections.					
	1	Clear roadway alignment	D8140	45	AC	$3,500.00	$157,500.00
	2	Furnish and place base course material (9-inch depth)	D8140	96,000	TONS	$16.00	$1,536,000.00
	3	Furnish and place asphalt concrete (6-inch depth)	D8140	70,000	TONS	$60.00	$4,200,000.00
	4	Furnish and install W-beam type guardrail	D8140	10,000	LF	$25.00	$250,000.00
	5	Furnish and install miscellaneous pipe culverts	D8140	1,000	LF	$200.00	$200,000.00
		Assume 36-inch-diameter, wt/ft= 35#/ft)					
		Service Yard (6" asphalt concrete surface)					
	6	Strip and clear pumping plant site to 1 foot depth	D8120	15,300	CY	$3.00	$45,900.00
	7	Common excavation to Service Yard El. 505.0	D8120	164,000	CY	$5.00	$820,000.00
	8	Rock excavation to Service Yard El. 505.0	D8120	208,000	CY	$15.00	$3,120,000.00
	9	Place and compact embankment for service yard	D8120	19,200	CY	$8.00	$153,600.00
	10	Furnish and place base course material (6-inch)	D8120	10,000	TONS	$20.00	$200,000.00
	11	Furnish and place asphalt concrete (6-inch)	D8120	11,000	TONS	$80.00	$880,000.00
	12	Furnish and install 7-foot chain link fence for PP Yard	D8120	3,100	LF	$20.00	$62,000.00
	13	Furnish and install 7-foot x 24-foot access gate	D8120	3	EA	$3,500.00	$10,500.00
		Dewatering During Construction:					
		Assume no groundwater flows into excavation.					
		Structural Excavation and Backfill					
		Assume all common material excavated under site excavation for yard.					
		Assume stockpile rock for later use as riprap or rockfill.					
	14	Excavation of rock for structures (drill & shoot)	D8120	200,000	CY	$15.00	$3,000,000.00
	15	Furnish backfill for structures (assume local borrow)	D8120	40,000	CY	$4.00	$160,000.00
	16	Place backfill around structures	D8120	40,000	CY	Included above	
	17	Compact backfill around structures	D8120	40,000	CY	$5.00	$200,000.00
	18	Rock Exc. for manifold pipe to edge of Service Yard	D8120	78,000	CY	$15.00	$1,170,000.00
	19	Furnish, place, & compact backfill for manifold pipe trench(assu	D8120	63,480	CY	$9.00	$571,320.00
	20	Furnish & place soil cement for manifold pipe trench	D8120	8,160	CY	$55.00	$448,800.00
		Sheet Subtotal					**$17,185,620.00** ✓

QUANTITIES		PRICES	
BY Dick LaFond, M.R. O'Shea	CHECKED RW, M.R. O'Shea	BY Craig A. Grush	CHECKED BDL 8/17/04
DATE PREPARED 4/19/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs

Plant- Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		STRUCTURAL					
		Construct Building Structure					
	21	Furnish, form, and place reinforced concrete	D8120	91,300	CY	$350.00	$31,955,000.00
	22	Furnish and place concrete reinforcement.	D8120	10,043,000	LBS	$0.75	$7,532,250.00
		Assume 110 #/CY					
	23	Furnish and handle cement (.282T/CY)	D8120	25,750	TONS	$110.00	$2,832,500.00
		Furnish & install precast, prestressed double tees for roof					
	24	10LDT 32+2 = 10' wide & 32" deep - 80' Span	D8120	36	EA.	$50,000.00	$1,800,000.00
		Structural Steel					
	25	Furnish and install structural steel (painted):	D8120	60,000	LBS	$4.00	$240,000.00
		crane rails, baseplates					
		Miscellaneous Metalwork					
	26	Furnish and install miscellaneous metalwork	D8120	250,000	LBS	$7.00	$1,750,000.00
		Includes gratings, hatches, ladders, guardrails,					
		catwalk, and cable trays and supports					
		Plant - Civil/Structural Subtotal					**$63,295,370.00** ✓

QUANTITIES		PRICES	
BY M. R. O'Shea	**CHECKED**	**BY** Craig A. Grush	**CHECKED** BDV 8/17/04
DATE PREPARED 4/19/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW**

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs

Plant - Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Major Mechanical Equipment					
		Prices below telephone quote from Bob Rittase, Voith Hydro, 717-792-7206					
		500 cfs two-stage spiral case pump, rated 500cfs at 1430 ft total dynamic head, ov verall efficiency more than 83% operating range from 1030 to 1430 feet					
	1	Pumps		3	EA	$5,000,000.00	$15,000,000.00
	2	Motors		3	EA	$2,500,000.00	$7,500,000.00
	3	Spherical discharge valves, with operators, rated at 1500 ft working pressure and :2000 ft surge pressure, with operators		3	EA	$3,000,000.00	$9,000,000.00
	4	Installation supervision of 500 cfs pumping unit		3	EA	$1,000,000.00	$3,000,000.00
		1000 cfs two-stage spiral case pump, rated 1000 cfs at 1430 ft total dynamic head, overall efficiency more than 83% operating range 1030 to 1430 ft					
	5	Pumps		2	EA	$9,000,000.00	$18,000,000.00
	6	Motors		2	EA	$4,500,000.00	$9,000,000.00
	7	Spherical discharge valves, with operators, rated at 1500 ft working pressure and :2000 ft surge pressure, with operators		2	EA	$4,500,000.00	$9,000,000.00
	8	Installation supervision of 1000 cfs pumping unit		2	EA	$1,500,000.00	$3,000,000.00
		Sheet Subtotal					**$73,500,000.00**

QUANTITIES		PRICES	
BY Richard Fehr	CHECKED	BY Craig A. Grush	CHECKED BDV 8/17/04
DATE PREPARED 4/16/04		DATE PREPARED 08/17/04	PEER REVIEW DCN

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs	Yakima River Basin Water Storage Options
	REGION: PN — PRICE LEVEL: Appraisal
Plant - Mechanical	FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		FURNISH-AND-INSTALL THE FOLLOWING:					
		Steel Manifold and Suction Tubes	D8420				
		Steel plate used for pipe fabrication:					
		ASTM A572 Gr. 50: Sy = 50 kpsi St = 65 kpsi					
		(All pipe sizes are inside diameters)					
	9	192" Inside Dia., 3 5/8" wall, L= 340 ft.	D-8420	2,600,000	LBS	$2.00	$5,200,000.00
	10	192" Dia., 3 3/4" wall, L= 152 ft.		1,200,000	LBS	$2.00	$2,400,000.00
	11	175" Dia., 3 3/8" wall, L= 58 ft.		375,000	LBS	$2.00	$750,000.00
	12	170" Dia., 1" wall, L= 134 ft.		260,000	LBS	$2.00	$520,000.00
	13	135" Dia., 2 7/8" wall, L= 54 ft.		210,000	LBS	$2.00	$420,000.00
	14	120" Dia., 7/8" wall, L= 122 ft.		150,000	LBS	$2.00	$300,000.00
	15	110" Dia., 2 1/8" wall, L= 261 ft.		670,000	LBS	$2.00	$1,340,000.00
	16	78" Dia., 1 1/2" wall, L= 260 ft.		340,000	LBS	$2.00	$680,000.00
		Sheet Subtotal					**$11,610,000.00**

QUANTITIES		PRICES	
BY Nathan Nakamoto, D8420	CHECKED Rick Frisz, D8420	BY Craig A. Grush	CHECKED BOV 8/17/04
DATE PREPARED 4/16/04		DATE PREPARED 08/17/04	PEER REVIEW DCL

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs

Plant - Mechanical

PROJECT: Yakima River Basin Water Storage Options

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
	17	CO2 High Pressure Fire Extinguishing System:	D-8410	2	each	$100,000.00	$200,000.00
		16 - 100# Storage Cylinders w/ control panel					
		and appurtenances and 2,000 lbs. of					
		sch. 80 carbon steel pipe, valves & fittings					
	18	Fire Suppression System:	D-8410	1	L.S.		$200,000.00
		10 Fire hose reels w/ 100 feet of hose					
		20 - Portable hand-held 20# extinguishers					
		12,000 lbs. of sch. 40 carbon steel pipe, valves & fittings					
		1 - Fire pump, split-case, 500 gpm @ 300 ft of head					
	19	Unit Cooling Water System:	D-8410	1	L.S.		$250,000.00
		6 - Cooling water pumps, end-suction type, 150 gpm					
		2 - 8-inch automatic, self-cleaning strainers					
		4,000 lbs. of type K copper tubing, valves & fittings					
		5,000 lbs. of ductile iron, mechanical joint pipe & fittings					
	20	Lubricating Oil System:	D-8410	1	L.S.		$50,000.00
		2- 500 gal carbon steel storage tanks					
		1 - 10 gpm @ 100 psi oil pump					
		1 - lube oil filter					
		3,000 lbs. of sch. 40 carbon steel pipe, valves & fittings					
	21	Compressed Air System:	D-8410	1	L.S.		$100,000.00
		2 - 100 cfm @ 125 psi rotary screw air compressors					
		1 - 250 gal. carbon steel air receiver					
		1 - 200 cfm air dryer					
		3,000 lbs. of sch. 40 carbon steel pipe, valves & fittings					
	22	Service Water System:	D-8410	1	L.S.		$100,000.00
		1 - Service water pump, 75 gpm @ 200 ft. of head					
		1 - Hydropneumatic Tank, 300 gal.					
		1,500 lbs. of type K copper tubing, valves & fittings					
	23	Gravity Drainage System:	D-8410	1	L.S.		$300,000.00
		50 - Floor drains, cast iron					
		25,000 lbs. of cast iron hub & spigot, service weight					
		soil pipe					
		Sheet Subtotal					**$1,200,000.00**

QUANTITIES		PRICES	
BY John Grass	**CHECKED** AMR	**BY** Craig A. Grush	**CHECKED** DOV 8/17/04
DATE PREPARED 4/16/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs

Plant - Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
	24	Plant Unwatering System:	D-8410	1	L.S.		$200,000.00
		2 - Vertical turbine type sump pump, 1000 gpm @ 50 ft hd					
		1 - Drainage jet type drainage pump					
		1,500 lbs. of type K copper tube, valves & fittings					
		4,000 lbs. of ductile iron, mechanical joint pipe & fittings					
	25	Domestic Water and Sanitary Waste System:	D-8410	1	L.S.		$100,000.00
		4 - Water Closets					
		2 - Urinal					
		4 - Lavatories & accessories					
		1 - Duplex Sewage Ejector					
		2,000 lbs. of cast iron hub & spigot service weight					
		sewer pipe					
		800 lbs. of type K copper tubing, valves & fittings					
	26	100-Ton overhead crane, 72'-6" span	D8410	153,000	LBS	$6.00	$918,000.00
	27	200-Ton overhead crane, 72'-6" span, two required	D-8410	520,000	LBS	$6.00	$3,120,000.00
	28	Electric traction elevator	D8410	1	unit	$500,000.00	$500,000.00
		overhead, geared, capacity = 3500 pounds,					
		travel = 100 feet, landings = 6, speed = 200 ft/min.					
	29	Ultrasonic flowmeter, 4-path	D8410	1	meter	$35,000.00	$35,000.00
	30	Trashracks (steel) at pumping plant	D8410	77,000	LBS	$4.00	$308,000.00
	31	Stoplogs, lifting beams and guides (steel)	D8410	45,000	LBS	$4.00	$180,000.00
		(assumes one set of stoplogs for each size bay)					
		Sheet Subtotal					**$5,361,000.00**

QUANTITIES		PRICES	
BY R. Christensen, B. Sund A. Ritt, C. Berte, P. Schlien, J. Grass	**CHECKED** AMR	**BY** Craig A. Grush	**CHECKED** DDJ 8/17/04
DATE PREPARED 4/16/2004	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DeD

FEATURE:	PROJECT:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs	Yakima River Basin Water Storage Options
	REGION PN / PRICE LEVEL: Appraisal
Plant - Mechanical	FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
		Heating, Ventilating, and Air Conditioning	D-8410	1	L.S.		$2,258,850.00
		HVAC for bulding except bus & switchgear					
		372-ft long by 77'-ft wide by 70-ft high unit/service bay					
		54-ft long by 77-ft wide by 20-ft high control bay					
		Two each 54-ft long by 77-ft wide by 17-ft equipment rooms					
		308-ft long by 56'-ft wide by 20-ft high Electrical Gallery					
		Pump/Motor/Valve Galleries= 756,000 ft^3					
		Plant - Mechanical Subtotal					**$93,929,850.00** ✓

QUANTITIES		PRICES	
BY: Paul Schlein	CHECKED: AHR	BY: Craig A. Grush	CHECKED: 60J 8/17/04
DATE PREPARED: 4/16/04	PEER REVIEW:	DATE PREPARED: 08/17/04	PEER REVIEW: DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs

Plant-Electrical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Plant Grounding System (F&I)	D8430				
	1	Ground rods, 10 ft, 3/4" dia., copper-clad		50	EA	$180.00	$9,000.00
		Stranded bare-copper conductor					
	2	250 MCM		1,500	LF	$5.50	$8,250.00
	3	4/0 AWG		1,000	LF	$4.00	$4,000.00
	4	2/0 AWG		1,000	LF	$3.50	$3,500.00
	5	4 AWG		700	LF	$2.50	$1,750.00
		Motor Bus & Switchgear (F&I)	D8430				
	6	Main motor isolated-phase bus:		400	LF	$5,000.00	$2,000,000.00
		15 kV; 24,000 amperes; 3-phase; 60 hz.					
		Self-cooled					
	7	Individual motor isolated-phase bus:					
		15 kV; 3,500 amperes; 3-phase; 60 hz.		150	LF	$1,500.00	$225,000.00
		Self-cooled					
	8	15 kV; 7,000 amperes; 3-phase; 60 hz.		100	LF	$2,000.00	$200,000.00
		Self-cooled					
		Motor reduced-voltage, static starting system with					
		15 kV, SF6 type unit circuit-breakers					
	9	3,500 amperes continous current		3	EA	$240,000	$720,000.00
	10	7,000 amperes continuous current		2	EA	$275,000	$550,000.00
		Motor Control Equipment (F&I)	D8430				
	11	Duplex control switchboard for operation of 5 main		1	EA	$200,000	$200,000.00
		pumping motors.					
		Motors					
		Listed under Plant-Mechanical					
		Sheet Subtotal					**$3,921,500.00**

QUANTITIES		PRICES	
BY Mike Schuh	CHECKED L Rossi	BY G. Fox / Elizabeth Tran	CHECKED BOV 8/17/04
DATE PREPARED 4/16/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE: Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs

Plant-Electrical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		15 kV Metal-Clad Switchgear (F&I)	D8430				
	12	15 kV metal-clad switchgear rated 1200 amperes with		1	EA	$350,000	$350,000.00
		two 1200 ampere vacuum type power circuit breakers					
		15 kV Non-Segregated-Phasae Bus (F&I)	D8430				
	13	15 kV, 1200 amperes		200	FT	$800.00	$160,000.00
		Plant Station-Service Equipment (F&I)	D8430				
		Indoor double-ended secondary unit substation with					
		following features:					
	14	Dry-type transformer 13.8 kV-480Y277 V, 2,500 KVA		2	EA	$90,000.00	$180,000.00
	15	480 V power-circuit breakers, 600 amperes		10	EA	$4,500.00	$45,000.00
		Building Lighting System (F&I)	D8430				
		Interior luminaires					
	16	High bay, high-pressure sodium, 400 W, 480 V		30	EA	$700.00	$21,000.00
	17	Emergency lighting system		1	LS		$900.00
	18	Exterior luminaires		10	EA	$400.00	$4,000.00
		High-pressure sodium, wall mounted, outdoor					
		70 watt, 120 volt					
		Sheet Subtotal					**$760,900.00**

QUANTITIES		PRICES	
BY Mike Schuh	CHECKED L Rossi	BY G for: Elizabeth Tran	CHECKED BGV 8/17/04
DATE PREPARED 4/16/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs	Yakima River Basin Water Storage Options
	REGION PN · PRICE LEVEL: Appraisal
Plant-Electrical	FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	19	**Building Fire Detection and Alarm System (F&I)**	D8430	1	LS		$150,000.00
	20	**Distribution Panelboards (F&I)**	D8430	3	EA	$80,000.00	$240,000.00
		480 volts, 3-phase with 400 ampere bus					
	21	**Motor Control Centers (F&I)**	D8430	2	EA	$120,000	$240,000.00
		480 volts, 3-phase with1200 ampere bus					
		Five 20 inch wide sections					
		Insulated Conductors (F&I)	D8430				
		600-volt, single-conductor, stranded copper					
	22	14 AWG		12,000	LF	$0.50	$6,000.00
	23	12 AWG		15,000	LF	$0.55	$8,250.00
	24	10 AWG		15,000	LF	$0.70	$10,500.00
	25	6 AWG		3,000	LF	$1.50	$4,500.00
	26	4 AWG		3,000	LF	$1.75	$5,250.00
	27	1/0 AWG		2,000	LF	$2.75	$5,500.00
		600-volt multi-conductor control cable					
	28	9 conductor 16 AWG		2,000	LF	$1.25	$2,500.00
	29	12 conductor 16 AWG		3,000	LF	$1.50	$4,500.00
	30	5 conductor 10 AWG		3,000	LF	$1.75	$5,250.00
		Conduit System (F&I)	D8430				
		Rigid steel conduit					
	31	1 inch		800	LF	$14.00	$11,200.00
	32	2 inch		500	LF	$22.00	$11,000.00
	33	2 1/2 inch		250	LF	$30.00	$7,500.00
	34	3 inch		250	LF	$42.00	$10,500.00
		Plastic-coated rigid steel					
	35	2 inch		300	LF	$30.00	$9,000.00
		Plant - Electrical Subtotal					**$5,413,850.00**

QUANTITIES		PRICES	
BY Mike Schuh	CHECKED L Ross	BY G for: Elizabeth Tran	CHECKED BOJ 8/17/04
DATE PREPARED 4/16/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs

Switchyard

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		STRUCTURAL	D8120				
		Assume switchyard structures covered under					
		unlisted items.					
		ELECTRICAL					
		Switchyard					
		Furnish and Install:					
	1	Oil-filled, conservator-type power transformer	D8440	3	EA	3,850,000	$11,550,000.00
		320 MVA; 500-13.8kV, 1-phase					
	2	500-kV disconnect switches, 1200 amp, 3-phase	D8440	4	EA	125,000	$500,000.00
	3	500-kV circuit breakers, 1200 amp, 3-phase	D8440	2	EA	1,115,000	$2,230,000.00
	4	**Construct Transmission Line**	D8440	6	MILES	1,000,000	$6,000,000.00
		Assume 6 miles of transmission line from					
		Midway substation to the east					
		500-kV, steel towers, 2167 AWG conductor					
		Switchyard & Transmission Line Subtotal					**$20,280,000.00**

QUANTITIES		PRICES	
BY L. Gamuciello (D8440)	**CHECKED**	**BY** G for: Elizabeth Tran	**CHECKED** BOV 8/17/04
DATE PREPARED 4/15/2004	**PEER REVIEW** James R. Zeiger (D8440)	**DATE PREPARED** 08/17/04	**PEER REVIEW** RCN

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs
Tunnel/Tunnel Option

DISCHARGE1

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Tunnel					
		Construct 34,850-ft long, 17.00-ft finished diameter, 20.00-ft minimum bore diameter, tunnel in rock. Tunnel will be excavated with TBM and driven uphill. Water problems will be minimal. Tunnel has three final support reaches.					
		32,150-ft long unreinforced concrete lined reach					
	1	Excavation (appr 12 cy/lf)	D-8140	32,150	lf	$1,700.00	$54,655,000.00
	2	Furnish and place unreinforced concrete tunnel lining	D-8140	104,000	cy	$350.00	$36,400,000.00
	3	Cementitious materials for concrete tunnel lining	D-8140	29,300	tons	$100.00	$2,930,000.00
	4	Furnish & install 7/8-in dia, 10-ft long rock bolts	D-8140	228,000	lin ft	$45.00	$10,260,000.00
		1,000-ft long reinforced concrete lined reach					
	5	Excavation (appr 12 cy/lf)	D-8140	1,000	lf	$2,500.00	$2,500,000.00
	6	Furnish and place reinforced concrete tunnel lining	D-8140	3,230	cy	$350.00	$1,130,500.00
	7	Cementitious materials for concrete tunnel lining	D-8140	910	tons	$120.00	$109,200.00
	8	Furnish and install concrete reinforcement	D-8140	50,400	lbs	$1.00	$50,400.00
	9	Furnish and install structural steel tunnel supports	D-8140	422,000	lbs	$4.00	$1,688,000.00
		1,700-ft long steel lined portal reach					
	10	Excavation (appr 12 cy/lf)	D-8140	1,700	lf	$2,500.00	$4,250,000.00
		Steel Tunnel Liner:					
		ASTM A572 Gr. 50: Sy = 50 kpsi St = 65 kpsi					
	10a	204" Inside Dia., 3 7/8" wall, L= 1700 ft.	D-8420	14,639,000	LBS	$2.00	$29,278,000.00
	11	Furnish and place backfill concrete	D-8140	5,490	cy	$300.00	$1,647,000.00
	12	Cementitious materials for backfill concrete	D-8140	1,550	tons	$130.00	$201,500.00
	13	Furnish & install 7/8-in dia, 10-ft long rock bolts	D-8140	8,400	lin ft	$55.00	$462,000.00
	14	Furnish and install structural steel tunnel supports	D-8140	422,000	lbs	$4.00	$1,688,000.00
		Sheet Subtotal					**$147,249,600.00**

QUANTITIES		PRICES	
BY Bill Thompson (D8140) Rick Frisz (D8420)	**CHECKED** KA (D8140)	**BY** G for: Craig A. Grush	**CHECKED** BDJ 8/17/04
DATE PREPARED 4/19/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs
Tunnel/Tunnel Option

DISCHARGE1

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Surge Shaft					
		Construct 1506-ft deep, 22.0-ft finished diameter, 24.34-ft minimum bore diameter, shaft in rock. Shaft will be excavated by raise bore and drill down method. Water problems will be minimal. Shaft has two final support reaches.					
		1,200-ft deep unreinforced concrete lined reach					
	15	Excavation (appr 17 cy/lf)	D-8140	1,200	lf	$6,000.00	$7,200,000.00
	16	Furnish and place unreinforced concrete shaft lining	D-8140	3,800	cy	$350.00	$1,330,000.00
	17	Cementitious materials for concrete shaft lining	D-8140	1,070	tons	$130.00	$139,100.00
	18	Furnish & install 5/8-in dia, 6-ft long rock bolts	D-8140	63,100	lin ft	$50.00	$3,155,000.00
		300-ft long reinforced concrete lined shaft top reach					
	19	Excavation (appr 17 cy/lf)	D-8140	300	lf	$6,000.00	$1,800,000.00
	20	Furnish and place reinforced concrete shaft lining	D-8140	945	cy	$400.00	$378,000.00
	21	Cementitious materials for concrete shaft lining	D-8140	265	tons	$160.00	$42,400.00
	22	Furnish and install concrete reinforcement	D-8140	15,700	lbs	$1.00	$15,700.00
	23	Furnish & install 5/8-in dia, 6-ft long rock bolts	D-8140	15,600	lin ft	$50.00	$780,000.00
	24	Furnish and install chain link protection	D-8140	13,000	sq yd	$20.00	$260,000.00
		Sheet Subtotal					**$15,100,200.00**

QUANTITIES		PRICES	
BY Bill Thompson	**CHECKED** KA	**BY** Craig A. Grush	**CHECKED** BOJ 8/17/04
DATE PREPARED 4/19/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs
Tunnel/Tunnel Option

DISCHARGE1

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Tunnel Outlet Features					
		Assume ~100' head to valley invert and L~ 4000'					
		Assume need to control flow from tunnel portal to					
		bottom of reservoir during initial fill.					
		Earthwork					
	25	Excavation at outlet area for portal and channel	D8130	50,000	CY	$15.00	$750,000.00
	26	Excavation for pipe trench	D8130	307,000	CY	$5.00	$1,535,000.00
	27	Excavation for thrust block	D8130	1,500	CY	$15.00	$22,500.00
	28	Concrete for open channel	D8130	500	CY	$400.00	$200,000.00
	29	F & P reinforcement (160 lbs/CY)	D8130	83,000	LBS	$1.00	$83,000.00
	30	Furnish and handle cement (.282T/CY)	D8130	150	TONS	$160.00	$24,000.00
	31	Concrete for thrust block	D8130	1,000	CY	$400.00	$400,000.00
	32	F & P reinforcement (100 lbs/CY)	D8130	100,000	LBS	$1.00	$100,000.00
	33	Furnish and handle cement (.235T/CY)	D8130	240	TONS	$160.00	$38,400.00
	34	Furnish and place Zone 3 bedding for pipe	D8130	24,000	CY	$40.00	$960,000.00
	35	Backfill pipe with excavated material	D8130	237,000	CY	$7.00	$1,659,000.00
	36	Furnish and place zone 3 bedding for riprap	D8130	5,000	CY	$40.00	$200,000.00
	37	Furnish and place riprap	D8130	10,000	CY	$35.00	$350,000.00
	38	20 ' dia. Steel pipe L = 4000' t= 3/4 inches	D8130	8,500,000	LBS	$2.00	$17,000,000.00
		Wt/ft + 10% for couplings and connections					
	39	Steel safety trashracks	D8410	80,000	LBS	$4.00	$320,000.00
	40	Steel Bulkhead	D8410	120,000	LBS	$4.00	$480,000.00
	41	Remove and salvage 20' dia. Steel pipe	D8410	7,650,000	LBS	N/A	N/A
		Assume diver-assisted removal in wet at a max					
		depth = 100'.					
		Assume removal of 90% of the pipe.					
		Assume lift bags to raise pipe and barge-mounted					
		crane to handle pipe at surface.					
		Salvage at $50/ton (quote), but salvage value is					
		much less than the cost to remove and cut up pipe.					
		Discharge 1 - Subtotal					**$186,471,700.00**

QUANTITIES		PRICES	
BY Doug Stanton (D8130) DS Rick Christensen (D8410)	**CHECKED** GYG Amr	**BY** Craig A. Grush	**CHECKED** BOV 8/17/04
DATE PREPARED 4/27/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs
Tunnel/Pipeline Option

DISCHARGE2

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Lower Tunnel					
		Construct 3,150-ft long, 16.00-ft finished diameter, 19.00-ft minimum bore diameter, tunnel in rock.					
		Tunnel will be excavated with TBM driven uphill (D&B also likely). Water problems will be minimal.					
		Tunnel has two final support reaches.					
		1,450-ft long unreinforced concrete lined reach					
	1	Excavation (appr 10.5 cy/lf)	D-8140	1,450	lf	$2,000.00	$2,900,000.00
	2	Furnish and place unreinforced concrete tunnel lining	D-8140	4,430	cy	$350.00	$1,550,500.00
	3	Cementitious materials for concrete tunnel lining	D-8140	1,250	tons	$130.00	$162,500.00
	4	Furnish & install 3/4-in dia, 8-ft long rock bolts	D-8140	8,520	lin ft	$55.00	$468,600.00
		1,700-ft long steel lined portal reach					
	5	Excavation (appr 10.5 cy/lf)	D-8140	1,700	lf	$2,000.00	$3,400,000.00
		Steel Tunnel Liner:					
		ASTM A572 Gr. 50: Sy = 50 kpsi St = 65 kpsi					
	5a	192" Inside Dia., 3 5/8" wall, L= 1,700 ft.	D-8420	12,890,000	LBS	$2.00	$25,780,000.00
	6	Furnish and place backfill concrete	D-8140	5,190	cy	$300.00	$1,557,000.00
	7	Cementitious materials for backfill concrete	D-8140	1,460	tons	$130.00	$189,800.00
	8	Furnish & install 3/4-in dia, 8-ft long rock bolts	D-8140	9,800	lin ft	$55.00	$539,000.00
	9	Furnish and install structural steel tunnel supports	D-8140	400,000	lbs	$4.00	$1,600,000.00
		Sheet Subtotal					**$38,147,400.00**

QUANTITIES		PRICES	
BY Bill Thompson (D8140) Rick Frisz (D8420)	CHECKED 4/4	BY Craig A. Grush	CHECKED DDV 8/17/04
DATE PREPARED 4/19/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs
Tunnel/Pipeline Option

DISCHARGE2

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Upper Tunnel					
		Construct 11,300-ft long, 21.00-ft finished diameter, 23.67-ft minimum bore diameter, tunnel in rock. Tunnel will be excavated with TBM and driven uphill. Water problems will be minimal. Tunnel has one final support reach.					
		11,300-ft long unreinforced concrete lined reach					
	10	Excavation (appr 16 cy/lf)	D-8140	11,300	lf	$2,500.00	$28,250,000.00
	11	Furnish and place unreinforced concrete tunnel lining	D-8140	39,200	cy	$350.00	$13,720,000.00
	12	Cementitious materials for concrete tunnel lining	D-8140	11,000	tons	$110.00	$1,210,000.00
	13	Furnish & install 1-in dia, 10-ft long rock bolts	D-8140	86,820	lin ft	$50.00	$4,341,000.00
	14	Furnish and install structural steel tunnel supports	D-8140	619,000	lbs	$4.00	$2,476,000.00
		Construct Surge Shaft					
		Construct 1,380-ft deep, 16.0-ft finished diameter, 18.00-ft minimum bore diameter, shaft in rock. Shaft will be excavated by raise bore and drill down method. Water problems will be minimal. Shaft has two final support reaches.					
		1,080-ft deep unreinforced concrete lined reach					
	15	Excavation (appr 10 cy/lf)	D-8140	1,080	lf	$4,000.00	$4,320,000.00
	16	Furnish and place unreinforced concrete shaft lining	D-8140	2,130	cy	$350.00	$745,500.00
	17	Cementitious materials for concrete shaft lining	D-8140	600	tons	$140.00	$84,000.00
	18	Furnish & install 5/8-in dia, 6-ft long rock bolts	D-8140	38,900	lin ft	$50.00	$1,945,000.00
		300-ft long reinforced concrete lined shaft top reach					
	19	Excavation (appr 10 cy/lf)	D-8140	300	lf	$4,000.00	$1,200,000.00
	20	Furnish and place reinforced concrete shaft lining	D-8140	592	cy	$400.00	$236,800.00
	21	Cementitious materials for concrete shaft lining	D-8140	167	tons	$160.00	$26,720.00
	22	Furnish and install concrete reinforcement	D-8140	11,500	lbs	$1.00	$11,500.00
	23	Furnish & install 5/8-in dia, 6-ft long rock bolts	D-8140	10,800	lin ft	$50.00	$540,000.00
	24	Furnish and install chain link protection	D-8140	8,830	sq yd	$20.00	$176,600.00
		Sheet Subtotal					**$59,283,120.00**

QUANTITIES		PRICES	
BY Mct	CHECKED KA	BY Craig A. Grush	CHECKED BOJ 8/17/04
DATE PREPARED	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DED

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs
Tunnel/Pipeline Option

DISCHARGE2

PROJECT: **Yakima River Basin Water Storage Options**

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Pipeline	D8140				
		Excavation for line pipe trenches					
	25	Rock Excavation (90%)	D8140	1,710,000	CY	$10.00	$17,100,000.00
	26	Common Excavation (10%)	D8140	190,000	CY	$5.00	$950,000.00
	27	Backfill for line pipe trenches	D8140	1,116,000	CY	$7.00	$7,812,000.00
	28	Soil cement slurry for line pipe trenches	D8140	428,000	CY	$55.00	$23,540,000.00
		Furnishing and installing steel line pipe in the following sizes:					
	29	18 ft diameter, t=1 inch, weight (lbs) per foot 2309	D8140	26,110	LF	$4,600.00	$120,106,000.00
	30	17 ft diameter, t= 1 inch, weight (lbs) per foot 2181	D8140	5,000	LF	$4,400.00	$22,000,000.00
	31	17 ft diameter, t=1.3 inches, weight (lbs) per foot 2835	D8140	7,940	LF	$5,700.00	$45,258,000.00
		Sheet Subtotal					**$236,766,000.00**

QUANTITIES		PRICES	
BY Linda Bowles	**CHECKED** Anne Pavol	**BY** Craig A. Grush	**CHECKED** BOV 8/17/04
DATE PREPARED 4/19/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DED

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 3,500 cfs
Tunnel/Pipeline Option

DISCHARGE2

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Inflow Pipe Outlet Features					
		Assume ~100' head to valley invert and L~ 4000'					
		Assume need to control flow from tunnel portal to					
		bottom of reservoir during initial fill.					
		Earthwork					
	32	Excavation at outlet area for portal and channel	D8130	50,000	CY	$15.00	$750,000.00
	33	Excavation for pipe trench	D8130	307,000	CY	$5.00	$1,535,000.00
	34	Excavation for thrust block	D8130	1,500	CY	$15.00	$22,500.00
	35	Concrete for open channel	D8130	500	CY	$400.00	$200,000.00
	36	F & P reinforcement (160 lbs/CY)	D8130	83,000	LBS	$1.00	$83,000.00
	37	Furnish and handle cement (.282T/CY)	D8130	150	TONS	$160.00	$24,000.00
	38	Concrete for thrust block	D8130	1,000	CY	$400.00	$400,000.00
	39	F & P reinforcement (100 lbs/CY)	D8130	100,000	LBS	$1.00	$100,000.00
	40	Furnish and handle cement (.235T/CY)	D8130	240	TONS	$160.00	$38,400.00
	41	Furnish and place Zone 3 bedding for pipe	D8130	24,000	CY	$40.00	$960,000.00
	42	Backfill pipe with excavated material	D8130	237,000	CY	$7.00	$1,659,000.00
	43	Furnish and place zone 3 bedding for riprap	D8130	5,000	CY	$40.00	$200,000.00
	44	Furnish and place riprap	D8130	10,000	CY	$35.00	$350,000.00
	45	20' dia. Steel pipe L = 4000' t= 3/4 inches	D8130	8,500,000	LBS	$2.00	$17,000,000.00
		Wt/ft + 10% for couplings and connections					
	46	Steel safety trashracks	D8410	80,000	LBS	$4.00	$320,000.00
		Discharge 2 - Subtotal					**$357,838,420.00**

QUANTITIES		PRICES	
BY Doug Stanton (D8130) DS Rick Christensen (D8410)	**CHECKED** RBR AHR	**BY** CG Craig A. Grush	**CHECKED** BDV 8/17/04
DATE PREPARED 4/27/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

Priest Rapids Intake, Pumping Plant, Switchyard and Inflow Conveyance System
Q= 6,000 cfs

Field Cost Estimate

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

SHEET 1 OF 25

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

Summary Sheet 1 of 1

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Estimate Worksheets Identify one Inlet and one Outlet to Priest Rapids, one Pump/Generating Plant, one Discharge/Penstock to BRR, and one Multi-Level Intake at BRR.					
		Discharge 1: Tunnel/Tunnel Inflow Line to BRR					
		PUMP-GENERATING PLANT PLUS DISCHARGE 1: TUNNEL/TUNNEL					
		Inlet/Outlet - Civil/Structural Subtotal					$54,437,850.00 ✓
		Inlet/Outlet - Mechanical/Electrical Subtotal					$10,113,270.00 ✓
		PG - Civil/Structural Subtotal					$75,889,950.00 ✓
		PG - Mechanical Subtotal					$116,806,730.00 ✓
		PG - Electrical Subtotal					$13,278,200.00 ✓
		Switchyard & Transmission Line Subtotal					$20,280,000.00 ✓
		Discharge 1 - Subtotal					$272,037,100.00 ✓
		Subtotal					$562,843,100.00 ✓
		Mobilization +/-	5%				$28,000,000.00 ✓
		Subtotal w/ mobilization					$590,843,100.00 ✓
		Unlisted Items +/-	10%				$59,156,900.00 ✓
		CONTRACT COST					**$650,000,000.00** ✓
		Contingencies +/-	25%				$160,000,000.00 ✓
		FIELD COST					**$810,000,000.00** ✓

QUANTITIES		PRICES	
BY	CHECKED	BY Craig Grush, Elizabeth Tran	CHECKED BDV 8/17/04
DATE PREPARED	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

Inlet/Outlet- Civil

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		CIVIL					
		Construct/Remove Cellular Cofferdam around Reservoir Intake					
		Assume construct from shore without barge.					
		Assume circular cellular cofferdam.					
		Length= 380 feet, 32-ft dia. cells, 28 ft high					
		Top of cofferdam - El. 488, Bottom of cofferdam - El. 460					
		Assume top of rock at reservoir bottom..					
	1	Furnish and install sheet pile walls	D8120	555	TONS	$2,200.00	$1,221,000.00
		Arbed AS 500-12, 30 psf					
	2	Backfill cells with free-draining granular material	D8120	11,700	CY	$30.00	$351,000.00
	3	Unwater behind cofferdam	D8120	6	MOS	$55,000.00	$330,000.00
		Assume sumps and surface pumps					
		Remove Cofferdam					
	5	Remove and stockpile granular material	D8120	11,700	CY	$25.00	$292,500.00
	6	Extract and salvage sheet pile cutoff wall	D8120	555	TONS	$300.00	$166,500.00
		Sheet Subtotal					**$2,361,000.00**

QUANTITIES		PRICES	
BY Dick LaFond	**CHECKED** MRL'Shea	**BY** Craig Grush	**CHECKED** BDV 8/17/04
DATE PREPARED 4/19/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCN

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

Inlet/Outlet- Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Structural Excavation and Backfill					
		Assume dam excavation is all common.					
		Assume top 5 feet of excavation is common and the remainder is rock					
		Assume stockpile and use for backfill or embankment.					
	7	Excavation of common materials for structures	D8140	432,900	CY	$6.00	$2,597,400.00
	8	Excavation of rock for structures (drill & shoot)	D8140	717,000	CY	$15.00	$10,755,000.00
	9	Furnish backfill for structures (assume local borrow)	D8140	70,800	CY	$4.00	$283,200.00
	10	Place backfill around structures	D8140	70,800	CY	Included above	
	11	Compact backfill around structures	D8140	70,800	CY	$5.00	$354,000.00
		Roads and Fencing					
	12	Gravel surfacing		2,680	TONS	$20.00	$53,600.00
		20 ft wide road right side of channel					
		12 ft wide road left side of channel					
		2 -20 ft wide road both sides of tailrace channel					
	13	Safety fencing		5,500	LF	$20.00	$110,000.00
		8' chainlink fence					
		STRUCTURAL					
		Construct Gated Intake, Fishscreen Structure, and Tailrace Channel					
	14	Furnish, form, and place reinforced concrete (f'c=4ksi)	D8140	50,220	CY	$350.00	$17,577,000.00
	15	Furnish and place concrete reinforcement.	D8140	8,035,000	LBS	$0.75	$6,026,250.00
	16	Furnish and handle cement	D8140	14,160	TONS	$110.00	$1,557,600.00
		Construct Lined Intake Canal					
	17	Furnish, form, and place unreinforced concrete	D8140	2,350	CY	$350.00	$822,500.00
		lining in excavated channel (f'c= 3 ksi)					
	18	Furnish and handle cement	D8140	665	TONS	$140.00	$93,100.00
		Construct Bypass Pipe					
	19	3 - 54" Dia. steel pipe for fish bypass.		15,840	LF	$330.00	$5,227,200.00
		Mortar line pipes					
	20	Bypass pipe common excavation		270,000	CY	$5.00	$1,350,000.00
	21	Bypass pipe rock excavation		130,000	CY	$15.00	$1,950,000.00
	22	Bypass pipe backfill		380,000	CY	$7.00	$2,660,000.00
	23	Bypass pipe soil cement bedding (100 psi)		12,000	CY	$55.00	$660,000.00
		Miscellaneous Metalwork					
		Listed under Intake - Mechanical Items					
		Inlet/Outlet - Civil/Structural Subtotal					**$54,437,850.00**

QUANTITIES		PRICES	
BY: Chou Cha	CHECKED: David Gesundheit/Anne Pavol	BY: Craig Grush	CHECKED: BOV 8/17/04
DATE PREPARED: 4/19/04	PEER REVIEW	DATE PREPARED: 08/17/04	PEER REVIEW: DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant,
Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

Inlet/Outlet- Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical					
		Pump Intake Channel					
	1	Furnish and install steel stoplog guides and seats	D8410	13,500	LBS	$6.00	$81,000.00
		(upstream of radial gates)					
	2	Furnish and install steel trashracks	D8410	102,000	LBS	$4.00	$408,000.00
	3	Furnish and install one trash rake, rails, supports	D8410	21,000	LBS	$10.00	$210,000.00
		(assume Atlas Polar DT8300 rake)					
	4	Furnish and install one conveyor, steel	D8410	13,000	LBS	$10.00	$130,000.00
	5	Furnish and install steel fish screen guides, supports,	D8410	360,000	LBS	$4.00	$1,440,000.00
		embedded seats, and bypass walls					
	6	Furnish and install fish screens, 10' W x 14' H panel	D8410				
		70 panels + 6 spares					
		Structural steel		106,400	LBS	$4.00	$425,600.00
		Stainless steel		106,400	LBS	$15.00	$1,596,000.00
	7	Furnish and install barrier panels above fish screens	D8410				
		10' W x 11' H panels, 70 panels + 6 spares					
		Structural steel		209,000	LBS	$4.00	$836,000.00
	8	Furnish and install adjustable baffle panels	D8410				
		10' W x 25' H panels, 70 panels + 6 spares					
		Structural steel		570,000	LBS	$4.00	$2,280,000.00
	9	Furnish and install fish screen cleaners with travel rail,	D8410				
		5 systems with 2 brush cleaner arms per system					
		a. Structural steel		40,000	LBS	$4.00	$160,000.00
		b. Stainless steel		2,500	LBS	$20.00	$50,000.00
		c. 2 Hp motors/gear reducers, with adj. speed		5	UNITS	$5,000.00	$25,000.00
		controllers, and limit switches					
	10	Furnish and install water level measuring systems	D8410	12	UNITS	$11,000.00	$132,000.00
		Sheet Subtotal					**$7,773,600.00**

QUANTITIES		PRICES	
BY R Christensen/B Sund	**CHECKED** Ane	**BY** Craig Grush	**CHECKED** GOV 8/17/04
DATE PREPARED 5/24/2004	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant,
Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

Inlet/Outlet- Mechanical

PROJECT: **Yakima River Basin Water Storage Options**

REGION PN | **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical - Pump Intake Channel (cont)					
	11	Furnish and install steel stoplog guides and seats	D8410	13,500	LBS	$6.00	$81,000.00
		(downstream of fish screens)					
	12	Furnish and install one set of steel stoplogs for the two	D8410	101,000	LBS	$4.00	$404,000.00
		different size bays with lifting beam					
	13	3' wide walkway, steel, safety grating alng fish screens	D8410	19,500	LBS	$7.00	$136,500.00
	14	Handrail along each side of fish screen walkway	D8410	1,520	LF	$50.00	$76,000.00
		Radial Gates in Intake Structure					
		Furnish and install two 36.5-ft x 8.5-ft top seal	D8420				
		radial gates and hoist equipment:					
	15	Gate (Weight/gate= 34,650 lbs)		69,120	LBS	$8.00	$552,960.00
	16	Embedded metalwork (Weight/bay= 5,000 lbs)		10,000	LBS	$5.00	$50,000.00
	17	Hoist operator (Weight/gate operator= 11,300 lbs)		22,600	LBS	$20.00	$452,000.00
	18	Motor - 5 hp (One per gate)		2	EA	Included in operator	
		Furnish and install one 15.0-ft x 8.5-ft top seal	D8420				
		radial gate and hoist equipment:					
	19	Gate (Weight/gate= 20,790 lbs)		20,790	LBS	$8.00	$166,320.00
	20	Embedded metalwork (Weight/bay= 3,000 lbs)		3,000	LBS	$5.00	$15,000.00
	21	Hoist operator (Weight/gate operator= 6,150 lbs)		6,150	LBS	$20.00	$123,000.00
	22	Motor - 3 hp		1	EA	Included in operator	
		Mechanical - Turbine Tailrace Channel					
	23	Furnish and install steel stoplog guides and seats	D8410	8,500	LBS	$5.00	$42,500.00
	24	Furnish and install trashrack (steel)	D-8410	36,000	LBS	$4.00	$144,000.00
		Sheet Subtotal					**$2,243,280.00**

QUANTITIES		PRICES	
BY R Christensen/B Sund (D8410) P. Hoffman (D8420)	CHECKED AMR	BY Craig Grush	CHECKED BOV 8/17/04
DATE PREPARED 5/24/2004	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCK

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

SHEET 6 OF 25

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

Inlet/Outlet- Electrical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		ELECTRICAL					
		Service Equipment (F&I)	D8430				
	25	Distribution panelboard, outdoor type		1	EA	$25,000.00	$25,000.00
		480 volts, 3-phase with 225 ampere bus					
	26	Outdoor transformer load center		1	EA	$11,000.00	$11,000.00
		15 kVA, 1-phase, 480-240/120 volt					
		Combination Motor Starters	D8430				
	27	NEMA size 2 non-reversing contactor,		6	EA	$8,000.00	$48,000.00
		480-120 volt control transformer					
		NEMA type 4 enclosure					
		Insulated Conductors (F&I)					
		600-volt, single-conductor, stranded copper					
	28	12 AWG		500	LF	$0.60	$300.00
	29	10 AWG		200	LF	$0.70	$140.00
	30	8 AWG		100	LF	$1.00	$100.00
		Conduit System (F&I)					
		Rigid steel conduit					
	31	1 inch		150	LF	$15.00	$2,250.00
		Lighting System (F&I)	D8430				
	32	High-pressure sodium, pole mounted, outdoor		6	EA	$1,600.00	$9,600.00
		70 watt, 120 volt					
		Inlet/Outlet - Mechanical/Electrical Subtotal					**$10,113,270.00**

QUANTITIES		PRICES	
BY Mike Schuh	**CHECKED** L Rossi	**BY** G for: Elizabeth Tran	**CHECKED** BOV 8/17/04
DATE PREPARED 4/16/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

PG - Civil

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Access Road (9.75 miles of 2-lane access road):					
		Assume construct access road from SH24 to PP.					
		Assume place road along abandoned railroad alignment					
		Assume no major excavation or embankment sections.					
	1	Clear roadway alignment	D8140	45	AC	$3,500.00	$157,500.00
	2	Furnish and place base course material (9-inch depth)	D8140	96,000	TONS	$16.00	$1,536,000.00
	3	Furnish and place asphalt concrete (6-inch depth)	D8140	70,000	TONS	$60.00	$4,200,000.00
	4	Furnish and install W-beam type guardrail	D8140	10,000	LF	$25.00	$250,000.00
	5	Furnish and install miscellaneous pipe culverts	D8140	1,000	LF	$200.00	$200,000.00
		Assume 36-inch-diameter, wt/ft= 35#/ft)					
		Service Yard (6" asphalt concrete surface)					
	6	Strip and clear pumping plant site to 1 foot depth	D8120	16,200	CY	$3.00	$48,600.00
	7	Common excavation to Service Yard El. 505.0	D8120	180,000	CY	$5.00	$900,000.00
	8	Rock excavation to Service Yard El. 505.0	D8120	220,000	CY	$15.00	$3,300,000.00
	9	Place and compact embankment for service yard	D8120	19,200	CY	$8.00	$153,600.00
	10	Furnish and place base course material (6-inch)	D8120	11,000	TONS	$20.00	$220,000.00
	11	Furnish and place asphalt concrete (6-inch)	D8120	12,000	TONS	$80.00	$960,000.00
	12	Furnish and install 7-foot chain link fence for PP Yard	D8120	3,200	LF	$20.00	$64,000.00
	13	Furnish and install 7-foot x 24-foot access gate	D8120	3	EA	$3,500.00	$10,500.00
		Dewatering During Construction:					
		Assume no groundwater flows into excavation.					
		Structural Excavation and Backfill					
		Assume all common material excavated under site excavation for yard.					
		Assume stockpile rock for later use as riprap or rockfill.					
	14	Excavation of rock for structures (drill & shoot)	D8120	246,500	CY	$15.00	$3,697,500.00
	15	Furnish backfill for structures (assume local borrow)	D8120	44,000	CY	$4.00	$176,000.00
	16	Place backfill around structures	D8120	44,000	CY	Included above	
	17	Compact backfill around structures	D8120	44,000	CY	$5.00	$220,000.00
	18	Rock Exc. for manifold pipe to edge of Service Yard	D8120	96,000	CY	$15.00	$1,440,000.00
	19	Furnish, place, & compact backfill for manifold pipe trench(assu	D8120	77,600	CY	$9.00	$698,400.00
	20	Furnish & place soil cement for manifold pipe trench	D8120	10,200	CY	$55.00	$561,000.00
		Sheet Subtotal					**$18,793,100.00**

QUANTITIES		PRICES	
BY Dick LaFond, M.R. O'Shea	CHECKED R.W. / M.R. O'Shea	BY Craig Grush	CHECKED DCD 8/17/04
DATE PREPARED 4/19/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

PG - Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		STRUCTURAL					
		Construct Building Structure					
	21	Furnish, form, and place reinforced concrete	D8120	113,600	CY	$350.00	$39,760,000.00
	22	Furnish and place concrete reinforcement.	D8120	12,500,000	LBS	$0.75	$9,375,000.00
		Assume 110 #/CY					
	23	Furnish and handle cement (.282T/CY)	D8120	32,035	TONS	$110.00	$3,523,850.00
		Furnish & install precast, prestressed double tees for roof					
	24	10LDT 32+2 = 10' wide & 32" deep - 80' Span	D8120	48	EA.	$50,000.00	$2,400,000.00
		Structural Steel					
	25	Furnish and install structural steel (painted):	D8120	72,000	LBS	$4.00	$288,000.00
		crane rails, baseplates					
		Miscellaneous Metalwork					
	26	Furnish and install miscellaneous metalwork	D8120	250,000	LBS	$7.00	$1,750,000.00
		Includes gratings, hatches, ladders, guardrails,					
		catwalk, and cable trays and supports					
		PG - Civil/Structural Subtotal					$75,889,950.00 √

QUANTITIES		PRICES	
BY M. R. O'Shea	CHECKED R.W.	BY Craig Grush	CHECKED GDV 8/17/04
DATE PREPARED 4/19/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DED

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

PG - Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Major Mechanical Equipment					
		Prices below telephone quote from Bob Rittase, Voith Hydro, 717-792-7206					
		500 cfs two-stage spiral case pump, rated 500cfs at 1430 ft					
		total dynamic head, ov verall efficiency more than 83%					
		operating range from 1030 to 1430 feet					
	1	Pumps	D8420	3	EA	$5,000,000.00	$15,000,000.00
	2	Motors	D8420	3	EA	$2,500,000.00	$7,500,000.00
		Spherical discharge valves, with operators, rated at 1500 ft					
	3	working pressure and :2000 ft surge pressure, with operators	D8420	3	EA	$3,000,000.00	$9,000,000.00
	4	Installation supervision of 500 cfs pumping unit	D8420	3	EA	$1,000,000.00	$3,000,000.00
		1000 cfs two-stage spiral case pump, rated 1000 cfs at 1430 ft					
		total dynamic head, overall efficiency more than 83%					
		operating range 1030 to 1430 ft					
	5	Pumps	D8420	2	EA	$9,000,000.00	$18,000,000.00
	6	Motors	D8420	2	EA	$4,500,000.00	$9,000,000.00
		Spherical discharge valves, with operators, rated at 1500 ft					
	7	working pressure and :2000 ft surge pressure, with operators	D8420	2	EA	$4,500,000.00	$9,000,000.00
	8	Installation supervision of 1000 cfs pumping unit	D8420	2	EA	$1,500,000.00	$3,000,000.00
		Turbines					
	9	Turbine Weight	D8420	632,000	LBS	$13.00	$8,216,000.00
		CF3 18-8 Stainless Runner 8.6' dia.					
		2 Turbines-Vertical Francis, 204,490 Hp ea.					
		400 rpm, 1130 ft. Design Head (Wt/Unit= 316,000 lbs)					
	10	Digital Governor, 322,600 ft.-lbs.	D8420	2	EA	$300,000.00	$600,000.00
		1,000 psi system, 2 governor systems					
		required in total (One per unit)					
	11	2 Governor Pressure Tanks 1800 Gal. each,	D8420	16,940	LBS	$7.00	$118,580.00
		piping and appurtenances. (Wt/Tank= 8,470 lbs)					
		Sheet Subtotal					**$82,434,580.00**

QUANTITIES		PRICES	
BY Richard Fehr, Toby Turnage	CHECKED	BY Craig Grush	CHECKED BOV 8/17/04
DATE PREPARED 5/24/04		DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

PG - Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		FURNISH-AND-INSTALL THE FOLLOWING:					
		Steel Manifold and Suction Tubes	D8420				
		Steel plate used for pipe fabrication:					
		ASTM A572 Gr. 50: Sy = 50 kpsi St = 65 kpsi					
		(All pipe sizes are inside diameters)					
	12	192" Dia., 3 5/8" wall, L= 1023 ft.		7,800,000	LBS	$2.00	$15,600,000.00
	13	146" Dia., 2 $^{13}/_{16}$" wall, L= 271 ft.		1,250,000	LBS	$2.00	$2,500,000.00
	14	170" Dia., 1" wall, L= 134 ft.		260,000	LBS	$2.00	$520,000.00
	15	120" Dia., $^{7}/_{8}$" wall, L= 122 ft.		150,000	LBS	$2.00	$300,000.00
	16	110" Dia., 2 $^{1}/_{8}$" wall, L= 305 ft.		780,000	LBS	$2.00	$1,560,000.00
	17	78" Dia., 1 $^{1}/_{2}$" wall, L= 460 ft.		590,000	LBS	$2.00	$1,180,000.00
		Turbine Guard Valves	D-8420				
	18	Two - 102" Dia. Spherical valve with hydraulic operators					
		180,000 lbs. per valve		360,000		$10.00	$3,600,000.00
		Sheet Subtotal					**$25,260,000.00**

QUANTITIES		PRICES	
BY Nathan Nakamoto, D8420	**CHECKED** Rick Frisz, D8420	**BY** Craig Grush	**CHECKED** BDV 8/17/04
DATE PREPARED 4/16/04		**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

PG - Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
	19	CO2 High Pressure Fire Extinguishing System:	D-8410	3	each	$100,000.00	$300,000.00
		16 - 100# Storage Cylinders w/ control panel					
		and appurtenances and 2,000 lbs. of					
		sch. 80 carbon steel pipe, valves & fittings					
	20	Fire Suppression System:	D-8410	1	L.S.		$225,000.00
		12 Fire hose reels w/ 100 feet of hose					
		24 - Portable hand-held 20# extinguishers					
		14,000 lbs. of sch. 40 carbon steel pipe, valves & fittings					
		1 - Fire pump, split-case, 500 gpm @ 300 ft of head					
	21	Unit Cooling Water System:	D-8410	1	L.S.		$275,000.00
		8 - Cooling water pumps, end-suction type, 150 gpm					
		2 - 8-inch automatic, self-cleaning strainers					
		6,000 lbs. of type K copper tubing, valves & fittings					
		7,000 lbs. of ductile iron, mechanical joint pipe & fittings					
	22	Lubricating Oil System:	D-8410	1	L.S.		$60,000.00
		2- 500 gal carbon steel storage tanks					
		1 - 10 gpm @ 100 psi oil pump					
		1 - lube oil filter					
		4,000 lbs. of sch. 40 carbon steel pipe, valves & fittings					
	23	Compressed Air System:	D-8410	1	L.S.		$110,000.00
		2 - 100 cfm @ 125 psi rotary screw air compressors					
		1 - 250 gal. carbon steel air receiver					
		1 - 200 cfm air dryer					
		4,000 lbs. of sch. 40 carbon steel pipe, valves & fittings					
	24	Service Water System:	D-8410	1	L.S.		$110,000.00
		1 - Service water pump, 75 gpm @ 200 ft. of head					
		1 - Hydropneumatic Tank, 300 gal.					
		2,000 lbs. of type K copper tubing, valves & fittings					
	25	Gravity Drainage System:	D-8410	1	L.S.		$350,000.00
		60 - Floor drains, cast iron					
		30,000 lbs. of cast iron hub & spigot, service weight					
		soil pipe					
		Sheet Subtotal					**$1,430,000.00**

QUANTITIES		PRICES	
BY John Grass	**CHECKED** AMR	**BY** Craig Grush	**CHECKED** BOV 8/17/04
DATE PREPARED 5/24/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCL

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

PG - Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
	26	Plant Unwatering System:	D-8410	1	L.S.		$210,000.00
		2 - Vertical turbine type sump pump, 1000 gpm @ 50 ft hd					
		1 - Drainage jet type drainage pump					
		1,500 lbs. of type K copper tube, valves & fittings					
		5,000 lbs. of ductile iron, mechanical joint pipe & fittings					
	27	Domestic Water and Sanitary Waste System:	D-8410	1	L.S.		$100,000.00
		4 - Water Closets					
		2 - Urinal					
		4 - Lavatories & accessories					
		1 - Duplex Sewage Ejector					
		2,000 lbs. of cast iron hub & spigot service weight sewer pipe					
		800 lbs. of type K copper tubing, valves & fittings					
	28	200-Ton overhead crane, 72'-6" span, two required	D-8410	520,000	LBS	$6.00	$3,120,000.00
	29	Electric traction elevator overhead, geared, capacity = 3500 pounds, travel = 100 feet, landings = 6, speed = 200 ft/min.	D8410	1	unit	$500,000.00	$500,000.00
	30	Ultrasonic flowmeter, 4-path	D8410	1	meter	$35,000.00	$35,000.00
	31	Trashracks (steel) at pumping plant	D8410	77,000	LBS	$4.00	$308,000.00
	32	Stoplogs, lifting beams and guides (steel) (assumes one set of stoplogs for each size pump bay, two sizes of bays, and assumes five sets of guides)	D8410	54,000	LBS	$4.00	$216,000.00
	33	Bulkhead gates, lifting beam and guides (steel) (assumes one set of bulkheads for isolation of 1 turbine) (assumes six sets of guides)	D8410	80,000	LBS	$4.00	$320,000.00
		Sheet Subtotal					**$4,809,000.00**

QUANTITIES		PRICES	
BY R. Christensen, B. Sund A. Ritt, C. Berte, J. Grass	**CHECKED** AMR	**BY** Craig Grush	**CHECKED** BDV 8/17/04
DATE PREPARED 5/24/2004	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DEA

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

PG - Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
		Heating, Ventilating, and Air Conditioning	D-8410	1	L.S.		$2,873,150.00
		HVAC for bulding except bus & switchgear					
		476.5-ft long by 77'-ft wide by 70-ft high unit/service bay					
		54-ft long by 77-ft wide by 20-ft high control bay					
		Two each 54-ft long by 77-ft wide by 17-ft equipment rooms					
		418-ft long by 56'-ft wide by 20-ft high Electrical Gallery					
		Pump/Motor/Valve Galleries= 1,000,000 ft^3					
		PG - Mechanical Subtotal					**$116,806,730.00**

QUANTITIES		PRICES	
BY: Paul Schlein	CHECKED: AMR	BY: Craig Grush	CHECKED: BDV 8/17/04
DATE PREPARED: 5/25/04	PEER REVIEW	DATE PREPARED: 08/17/04	PEER REVIEW: DCA

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

PG-Electrical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Electrical Generator (F&I)	D8430				
	1	150,000 kVA, 13.8 kV, 3-phase, 60 Hz.		2	EA	$2,450,000	$4,900,000.00
		400 rpm, 95% power factor					
		Vertical, synchronous machine					
		Static excitation system & voltage regulator					
		Plant Grounding System (F&I)	D8430				
	2	Ground rods, 10 ft, 3/4" dia., copper-clad		60	EA	$180.00	$10,800.00
		Stranded bare-copper conductor					
	3	250 MCM		1,500	LF	$5.50	$8,250.00
	4	4/0 AWG		1,200	LF	$4.00	$4,800.00
	5	2/0 AWG		1,200	LF	$3.50	$4,200.00
	6	4 AWG		1,000	LF	$2.50	$2,500.00
		Motor Bus & Switchgear (F&I)	D8430				
	7	Main motor isolated-phase bus:		300	LF	$5,000.00	$1,500,000.00
		15 kV; 24,000 amperes; 3-phase; 60 hz.					
		Self-cooled					
	8	Individual motor isolated-phase bus:					
		15 kV; 3,500 amperes; 3-phase; 60 hz.		150	LF	$1,500.00	$225,000.00
		Self-cooled					
	9	15 kV; 7,000 amperes; 3-phase; 60 hz.		100	LF	$2,000.00	$200,000.00
		Self-cooled					
		Motor reduced-voltage, static starting system with					
		15 kV, SF6 type unit circuit-breakers					
	10	3,500 amperes continous current		3	EA	$240,000	$720,000.00
	11	7,000 amperes continuous current		2	EA	$275,000	$550,000.00
		Generator Bus & Switchgear (F&I)	D8430				
	12	Generator isolated-phase bus:		250	LF	$4,000.00	$1,000,000.00
		15 kV; 15,000 amperes, 3-phase; 60 hz.					
		Self-cooled					
	13	Generator unit circuit breaker		2	EA	$900,000	$1,800,000.00
		15 kV, SF6 type circuit breakers					
		7,000 amperes continuous current					
		Sheet Subtotal					**$10,925,550.00**

QUANTITIES		PRICES	
BY Mike Schuh	CHECKED	BY J for: Elizabeth Tran	CHECKED ODV 8/17/04
DATE PREPARED 5/20/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

PG-Electrical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Motor Control Equipment (F&I)	D8430				
	14	Duplex control switchboard for operation of 5 main pumping motors.		1	EA	$200,000	$200,000.00
		Generator Control Equipment (F&I)	D8430				
	15	Duplex control switchboard for operation of 2 generators		1	EA	$500,000	$500,000.00
		Motors (Listed under Plant Mechanical)					
		15 kV Metal-Clad Switchgear (F&I)	D8430				
	16	15 kV metal-clad switchgear rated 1200 amperes with two 1200 ampere vacuum type power circuit breakers		1	EA	$350,000	$350,000.00
		15 kV Non-Segregated-Phase Bus (F&I)	D8430				
	17	15 kV, 1200 amperes		200	FT	$800.00	$160,000.00
		Plant Battery System (F&I)	D8430				
	18	125 VDC, 400 ampere-hour, lead-acid battery		1	EA	$30,000.00	$30,000.00
	19	Battery chargers		2	EA	$10,000.00	$20,000.00
	20	DC distribution panelboard, 100 ampere mains, and molded-case circuit breakers		1	EA	$12,500.00	$12,500.00
		Plant Station-Service Equipment (F&I)	D8430				
		Indoor double-ended secondary unit substation with following features:					
	21	Dry-type transformer 13.8 kV-480Y277 V; 3,000 KVA		2	EA	$110,000	$220,000.00
	22	480 V power-circuit breakers, 600 amperes		12	EA	$4,500.00	$54,000.00
		Building Lighting System (F&I)	D8430				
		Interior luminaires					
	23	High bay, high-pressure sodium, 400 W, 480 V		36	EA	$700.00	$25,200.00
	24	4 foot fluorescent lighting fixtures, 2 lamp		40	EA	$220.00	$8,800.00
	25	Emergency lighting system		1	LS		$900.00
	26	Exterior luminaires		14	EA	$400.00	$5,600.00
		High-pressure sodium, wall mounted, outdoor 70 watt, 120 volt					
		Sheet Subtotal					**$1,587,000.00**

QUANTITIES		PRICES	
BY Mike Schuh	CHECKED L Rossi	BY for: Elizabeth Tran	CHECKED GOV 8/17/04
DATE PREPARED 5/20/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

PG-Electrical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	27	**Building Fire Detection and Alarm System (F&I)**	D8430	1	LS		$150,000.00
	28	**Distribution Panelboards (F&I)**	D8430	4	EA	$24,500.00	$98,000.00
		480 volts, 3-phase with 400 ampere bus					
	29	**Motor Control Centers (F&I)**	D8430	2	EA	$195,000	$390,000.00
		480 volts, 3-phase with1600 ampere bus					
		Six 20 inch wide sections, 8 NEMA size 2 starters,					
		4 NEMA size 4 starters					
		Insulated Conductors (F&I)	D8430				
		600-volt, single-conductor, stranded copper					
	30	14 AWG		12,000	LF	$0.50	$6,000.00
	31	12 AWG		15,000	LF	$0.55	$8,250.00
	32	10 AWG		15,000	LF	$0.70	$10,500.00
	33	6 AWG		3,000	LF	$1.50	$4,500.00
	34	4 AWG		3,000	LF	$1.75	$5,250.00
	35	1/0 AWG		2,000	LF	$2.75	$5,500.00
		600-volt multi-conductor control cable					
	36	9 conductor 16 AWG		2,000	LF	$1.25	$2,500.00
	37	12 conductor 16 AWG		3,000	LF	$1.50	$4,500.00
	38	5 conductor 10 AWG		3,000	LF	$1.75	$5,250.00
		Conduit System (F&I)	D8430				
		Rigid steel conduit					
	39	1 inch		1,000	LF	$14.00	$14,000.00
	40	2 inch		800	LF	$22.00	$17,600.00
	41	2 1/2 inch		400	LF	$30.00	$12,000.00
	42	3 inch		400	LF	$42.00	$16,800.00
		Plastic-coated rigid steel					
	43	2 inch		500	LF	$30.00	$15,000.00
		PG - Electrical Subtotal					**$13,278,200.00**

QUANTITIES		PRICES	
BY Mike Schuh	CHECKED L Ross	BY G for: Elizabeth Tran	CHECKED 6DV 8/17/04
DATE PREPARED 5/20/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW Dell

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

Switchyard

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		STRUCTURAL	D8120				
		Assume switchyard structures covered under					
		unlisted items.					
		ELECTRICAL					
		Switchyard					
		Furnish and Install:					
	1	Oil-filled, conservator-type power transformer	D8440	3	EA	$3,850,000	$11,550,000.00
		520 MVA; 500-13.8kV, 1-phase					
	2	500-kV disconnect switches, 1200 amp, 3-phase	D8440	4	EA	$125,000	$500,000.00
	3	500-kV circuit breakers, 1200 amp, 3-phase	D8440	2	EA	$1,115,000	$2,230,000.00
	4	**Construct Transmission Line**	D8440	6	MILES	$1,000,000	$6,000,000.00
		Assume 6 miles of transmission line from					
		Midway substation to the east					
		500-kV, steel towers, 2167 AWG conductor					
		Switchyard & Transmission Line Subtotal					**$20,280,000.00**

QUANTITIES		PRICES	
BY L. Gamuciello (D8440)	**CHECKED**	**BY** Elizabeth Tran	**CHECKED** BOV 8/17/04
DATE PREPARED 4/15/2004	**PEER REVIEW** James R. Zeiger (D8440)	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCW

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs
Tunnel/Tunnel
DISCHARGE1

PROJECT: Yakima River Basin Water Storage Options

REGION PN | **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Tunnel					
		Construct 34,850-ft long, 17.00-ft finished diameter, 20.00-ft minimum bore diameter, tunnel in rock. Tunnel will be excavated with TBM and driven uphill. Water problems will be minimal. Tunnel has three final support reaches.					
		32,150-ft long unreinforced concrete lined reach					
	1	Excavation (appr 12 cy/lf)	D-8140	32,150	lf	$1,700.00	$54,655,000.00
	2	Furnish and place unreinforced concrete tunnel lining	D-8140	104,000	cy	$350.00	$36,400,000.00
	3	Cementitious materials for concrete tunnel lining	D-8140	29,300	tons	$110.00	$3,223,000.00
	4	Furnish & install 7/8-in dia, 10-ft long rock bolts	D-8140	228,000	lin ft	$45.00	$10,260,000.00
		1,000-ft long reinforced concrete lined reach					
	5	Excavation (appr 12 cy/lf)	D-8140	1,000	lf	$2,500.00	$2,500,000.00
	6	Furnish and place reinforced concrete tunnel lining	D-8140	3,230	cy	$350.00	$1,130,500.00
	7	Cementitious materials for concrete tunnel lining	D-8140	910	tons	$120.00	$109,200.00
	8	Furnish and install concrete reinforcement	D-8140	50,400	lbs	$1.00	$50,400.00
	9	Furnish and install structural steel tunnel supports	D-8140	422,000	lbs	$4.00	$1,688,000.00
		1,700-ft long steel lined portal reach					
	10	Excavation (appr 12 cy/lf)	D-8140	1,700	lf	$2,500.00	$4,250,000.00
		Steel Tunnel Liner:					
		ASTM A572 Gr. 50: Sy = 50 kpsi St = 65 kpsi					
	11	204" Dia., 3 7/8" wall, L= 1700 ft.	D-8420	14,639,000	LBS	$2.00	$29,278,000.00
	12	Furnish and place backfill concrete	D-8140	5,490	cy	$300.00	$1,647,000.00
	13	Cementitious materials for backfill concrete	D-8140	1,550	tons	$130.00	$201,500.00
	14	Furnish & install 7/8-in dia, 10-ft long rock bolts	D-8140	8,400	lin ft	$55.00	$462,000.00
	15	Furnish and install structural steel tunnel supports	D-8140	422,000	lbs	$4.00	$1,688,000.00
		Sheet Subtotal					**$147,542,600.00**

QUANTITIES		PRICES	
BY Bill Thompson (D8140) Rick Frisz (D8420)	**CHECKED** RA	**BY** Craig Grush	**CHECKED** BOV 8/17/04
DATE PREPARED 4/19/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

DISCHARGE1

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Surge Shaft					
		Construct 1506-ft deep, 22.0-ft finished diameter, 24.34-ft minimum bore diameter, shaft in rock. Shaft will be excavated by raise bore and drill down method. Water problems will be minimal. Shaft has two final support reaches.					
		1,200-ft deep unreinforced concrete lined reach					
	16	Excavation (appr 17 cy/lf)	D-8140	1,200	lf	$6,000.00	$7,200,000.00
	17	Furnish and place unreinforced concrete shaft lining	D-8140	3,800	cy	$350.00	$1,330,000.00
	18	Cementitious materials for concrete shaft lining	D-8140	1,070	tons	$130.00	$139,100.00
	19	Furnish & install 5/8-in dia, 6-ft long rock bolts	D-8140	63,100	lin ft	$50.00	$3,155,000.00
		300-ft long reinforced concrete lined shaft top reach					
	20	Excavation (appr 17 cy/lf)	D-8140	300	lf	$6,000.00	$1,800,000.00
	21	Furnish and place reinforced concrete shaft lining	D-8140	945	cy	$400.00	$378,000.00
	22	Cementitious materials for concrete shaft lining	D-8140	265	tons	$160.00	$42,400.00
	23	Furnish and install concrete reinforcement	D-8140	15,700	lin ft	$1.00	$15,700.00
	24	Furnish & install 5/8-in dia, 6-ft long rock bolts	D-8140	15,600	lin ft	$50.00	$780,000.00
	25	Furnish and install chain link protection	D-8140	13,000	sq yd	$20.00	$260,000.00
		Sheet Subtotal					**$15,100,200.00**

QUANTITIES		PRICES	
BY Bill Thompson	**CHECKED** KA	**BY** Craig Grush	**CHECKED** BDV 8/13/04
DATE PREPARED 4/19/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DED

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

DISCHARGE1

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Multi-Level Intake at Black Rock Reservoir					
		CIVIL					
		Structural Excavation and Backfill					
		Assume T. O Rock is 60 feet below top of ground					
		Assume stockpile rock for later use as riprap.					
	26	Common excavation for structures	D8120	138,500	CY	$10.00	$1,385,000.00
	27	Rock excavation for structures (drill & shoot)	D8120	137,500	CY	$15.00	$2,062,500.00
	28	Furnish & install grouted pretensioned tendons	D8120	100	EA	$30,000.00	$3,000,000.00
		Assume 100 holes, each 60 foot deep,					
		Hole diameter= 8 inches					
		Each hole has 27 0.5-inch diameter 7-wire,					
		flow-fill, epoxy coated strand w/ ult. strength= 270 ksi					
		STRUCTURAL					
		Construct Intake Structure					
	29	Furnish, form, and place reinforced concrete	D8120	124,500	CY	$350.00	$43,575,000.00
	30	Furnish and place concrete reinforcement.	D8120	12,450,000	LBS	$0.75	$9,337,500.00
		Assume 100 #/CY					
	31	Furnish and handle cement (.282T/CY)	D8120	35,110	TONS	$110.00	$3,862,100.00
		Structural Steel					
	32	Furnish and install structural steel (painted):	D8120	50,000	LBS	$4.00	$200,000.00
		Includes monorail girder and hoist frame.					
		Miscellaneous Metalwork	D8120	50,000	LBS	$7.00	$350,000.00
	33	Assume ladders in shafts, elevator rail					
		supports, misc metal in valve rooms and					
		elevator tower					
		Construct Access Bridge					
		Assume 30-ft wide by 100-ft span					
	34	Furnish, form, and place reinforced concrete	D8120	150	CY	$500.00	$75,000.00
	35	Furnish and place concrete reinforcement.	D8120	19,500	LBS	$1.00	$19,500.00
		Assume 130 #/CY					
	36	Furnish and handle cement (.282T/CY)	D8120	45	TONS	$160.00	$7,200.00
	37	Furnish and install structural steel (painted):	D8120	250,000	LBS	$4.00	$1,000,000.00
		Sheet Subtotal					**$64,873,800.00**

QUANTITIES		PRICES	
BY Dick laFond	CHECKED M.R.O'Shea	BY Craig Grush	CHECKED BDV 8/17/04
DATE PREPARED 5/27/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

Discharge 1

PROJECT: **Yakima River Basin Water Storage Options**

REGION PN | **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical - Multi-level Intake at BRR					
		FURNISH-AND-INSTALL THE FOLLOWING:					
		Steel Piping:					
		Steel plate used for pipe fabrication:					
		ASTM A36; Sy = 36 kpsi					
		(All pipe sizes are inside diameters)					
	38	102" Dia., 7/16" wall, L= 252 ft.	D8420	120,000	LBS	$2.00	$240,000.00
	39	102" Dia., 5/16" wall, L= 756 ft.	D8420	260,000	LBS	$2.00	$520,000.00
		Valves:					
	40	Sixteen - 102" Dia. Butterfly valves, 150 psi class with motor operator	D8420	400,000	LBS	$7.00	$2,800,000.00
		Couplings:					
	41	Sixteen - 102" Dia. Pipe Couplings	D8420	16,500	LBS	$8.00	$132,000.00
		Gates:					
	42	Three - 17' x 7' High Pressure Roller Gates with controls	D8420	600,000	LBS	$8.00	$4,800,000.00
		Sheet Subtotal					**$8,492,000.00**

QUANTITIES		PRICES	
BY Nathan Nakamoto, D8420	**CHECKED**	**BY** Craig Grush	**CHECKED** BOV 8/17/04
DATE PREPARED 5/27/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs

Discharge 1

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical - Multi-level Intake at BRR					
	43	15-Ton capacity, electric wire rope hoists for monorails	D-8410	16,400	LBS	$25.00	$410,000.00
		15 hp motors, 43 ft lift, 4 req'd @ 4100 lb each					
	44	20-Ton capacity, electric wire rope hoist	D-8410	8,000	LBS	$25.00	$200,000.00
		30 hp motor, 380 ft lift					
	45	Electric traction elevator	D-8410	1	unit	$600,000	$600,000.00
		overhead, geared, capacity = 3500 lbs,					
		travel = 298 feet, landings = 5, speed = 500 ft/min					
	46	Stationary fish screens, 4 intake levels, R=25', L=100'	D-8410				
		Structural steel		589,000	LBS	$4.00	$2,356,000.00
		Stainless steel		393,000	LBS	$15.00	$5,895,000.00
	47	Trashracks around side gate openings (steel)	D-8410	80,000	LBS	$4.00	$320,000.00
	48	Bulkhead guides for isolating the two side gates (steel)	D-8410	99,000	LBS	$4.00	$396,000.00
		(assumes no bulkheads provided)					
	49	Bulkhead gates and guides for multilevel intakes (steel)	D-8410	266,000	LBS	$4.00	$1,064,000.00
		(assumes guides for each inlet and					
		one level set of 4 bulkheads)					
		Heating, Ventilating, and Air Conditioning	D-8410	1	L.S.		$440,850.00
		Sheet Subtotal					**$11,681,850.00**

QUANTITIES		PRICES	
BY P. Schlein	**CHECKED** AMR	**BY** Craig Grush	**CHECKED** BOV 8/17/04
DATE PREPARED 5/26/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs
Tunnel/Tunnel
DISCHARGE1

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Electrical Equipment					
		Service Equipment (F&I)	D8430				
	65	Dry-type distribution transformer		1	EA	$28,000.00	$28,000.00
		13.8 kV-480Y/277 volt, 225 kVA, 3-phase, 60 hz.					
	66	Distribution switchboard, indoor type		1	EA	$65,000.00	$65,000.00
		480 volt, 3-phase with 600 ampere bus					
		Molded-case circuit breakers:					
		16 - 50 amp breakers					
		10 - 30 ampere breakers					
		Low-Voltage Distribution Equipment (F&I)	D8430				
	67	Dry-type lighting transformer		2	EA	$5,000.00	$10,000.00
		480-208Y/120 volt, 30 kVA, 3-phase, 60 hz.					
	68	Lighting panelboard, indoor type		2	EA	$9,000.00	$18,000.00
		208Y/120 volt, 3-phase with 100 ampere bus					
		Safety Switches (F&I)	D8430				
	69	480 volt, 60-ampere, 3-pole, fusible		6	EA	$800.00	$4,800.00
		with NEMA type 12 enclosure					
		Sheet Subtotal					**$125,800.00**

QUANTITIES		PRICES	
BY M. Schuh D8430	CHECKED L Rossi	BY Elizabeth Tran	CHECKED BN 8/17/04
DATE PREPARED 5/24/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs
Tunnel/Tunnel
DISCHARGE1

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Combination Motor Starters (F&I)	D8430				
	70	NEMA size 2, non-reversing contactor		20	EA	$3,000.00	$60,000.00
		480-120 volt control transformer					
		NEMA type 12 enclosure					
		Insulated Conductors (F&I)	D8430				
	71	600-volt, single-conductor, stranded copper, THWN					
		12 AWG		1,500	FT	$0.70	$1,050.00
		10 AWG		1,200	FT	$0.80	$960.00
		8 AWG		800	FT	$1.00	$800.00
		1/0 AWG		200	FT	$3.00	$600.00
		Conduit System (F&I)	D8430				
	72	Rigid steel conduit					
		1 inch		800	FT	$15.00	$12,000.00
		2 inch		200	FT	$23.00	$4,600.00
		Lighting System (F&I)	D8430				
	73	Interior luminaries					
		High bay, high-pressure sodium, 200 watt		20	EA	$650.00	$13,000.00
		480-volt, 1-phase					
		4 foot fluorescent lighting fixtures, 120 volt, 2 lamp		12	EA	$220.00	$2,640.00
	74	Exterior luminaries					
		High-pressure sodium, wall-mounted, outdoor type		6	EA	$400.00	$2,400.00
		70 watt, 120 volt					
	75	Emergency lighting system		1	EA	$900.00	$900.00
		Sheet Subtotal					**$98,950.00**

QUANTITIES		PRICES	
BY M. Schuh D8430	**CHECKED**	**BY** G for: Elizabeth Tran	**CHECKED** GOV 8/17/04
DATE PREPARED 5/24/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pump/Generating Plant, Switchyard and Conveyance System To/From BRR
Pump/Generate Conveyance System - Q= 3,500 cfs
Tunnel/Tunnel
DISCHARGE1

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PumpGen_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Tunnel Outlet Features (Beyond Mulit-Level Intake)					
		Assume ~100' head to valley invert and L~ 4000'					
		Assume need to control flow from tunnel portal to bottom of reservoir during initial fill.					
		Earthwork					
	76	Excavation at outlet area for portal and channel	D8130	50,000	CY	$15.00	$750,000.00
	77	Excavation for pipe trench	D8130	307,000	CY	$5.00	$1,535,000.00
	78	Excavation for thrust block	D8130	1,500	CY	$15.00	$22,500.00
	79	Concrete for open channel	D8130	500	CY	$400.00	$200,000.00
	80	F & P reinforcement (160 lbs/CY)	D8130	83,000	LBS	$1.00	$83,000.00
	81	Furnish and handle cement (.282T/CY)	D8130	150	TONS	$160.00	$24,000.00
	82	Concrete for thrust block	D8130	1,000	CY	$400.00	$400,000.00
	83	F & P reinforcement (100 lbs/CY)	D8130	100,000	LBS	$1.00	$100,000.00
	84	Furnish and handle cement (.235T/CY)	D8130	240	TONS	$160.00	$38,400.00
	85	Furnish and place Zone 3 bedding for pipe	D8130	24,000	CY	$40.00	$960,000.00
	86	Backfill pipe with excavated material	D8130	237,000	CY	$7.00	$1,659,000.00
	87	Furnish and place zone 3 bedding for riprap	D8130	5,000	CY	$40.00	$200,000.00
	88	Furnish and place riprap	D8130	10,000	CY	$35.00	$350,000.00
	89	20 ' dia. Steel pipe L = 4000' t= 3/4 inches	D8130	8,500,000	LBS	$2.00	$17,000,000.00
		Wt/ft + 10% for couplings and connections					
	90	Steel safety trashracks	D8410	80,000	LBS	$4.00	$320,000.00
	91	Steel Bulkhead	D8410	120,000	LBS	$4.00	$480,000.00
	92	Remove and salvage 20' dia. Steel pipe	D8410	7,650,000	LBS	N/A	N/A
		Assume diver-assisted removal in wet at a max depth = 100'.					
		Assume removal of 90% of the pipe.					
		Assume lift bags to raise pipe and barge-mounted crane to handle pipe at surface.					
		Salvage at $50/ton (quote), but salvage value is much less than the cost to remove and cut up pipe.					
		Discharge 1 - Subtotal					**$272,037,100.00**

QUANTITIES		PRICES	
BY Doug Stanton (D8130) DS Rick Christensen (D8410)	CHECKED BLR AMR	BY Craig A. Grush	CHECKED DDV 8/17/04
DATE PREPARED 4/27/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

Priest Rapids Intake, Pump/Generating Plant, Switchyard and Inflow Conveyance System
Q= 3,500 cfs

Field Cost Estimate

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs

Summary Sheet 1 of 1

PROJECT:
Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_6000 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Estimate Worksheets Identify One Type of Intake, Pumping Plant and Discharge Line.					
		PUMPING PLANT PLUS DISCHARGE 1: TUNNEL/TUNNEL					
		Intake - Civil/Structural Subtotal					$62,549,800.00 ✓
		Intake - Mechanical/Electrical Subtotal					$16,266,190.00 ✓
		Plant - Civil/Structural Subtotal					$74,727,300.00 ✓
		Plant - Mechanical Subtotal					$162,681,500.00 ✓
		Plant - Electrical Subtotal					$8,171,175.00 ✓
		Switchyard & Transmission Line Subtotal					$29,730,000.00 ✓
		Discharge 1 - Subtotal					$248,397,650.00 ✓
		Subtotal					$602,523,615.00 ✓
		Mobilization +/-	5%				$30,000,000.00 ✓
		Subtotal w/ mobilization					$632,523,615.00 ✓
		Unlisted Items +/-	10%				$67,476,385.00 ✓
		CONTRACT COST					**$700,000,000.00** ✓
		Contingencies +/-	25%				$170,000,000.00 ✓
		FIELD COST					**$870,000,000.00** ✓

QUANTITIES		PRICES	
BY	**CHECKED**	**BY** Craig A. Grush, Elizabeth Tran	**CHECKED** GDV 8/17/04
DATE PREPARED	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCA 8/17/04

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs	Yakima River Basin Water Storage Options
	REGION PN — PRICE LEVEL: Appraisal
Intake- Civil	FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_6000 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		CIVIL					
		Construct/Remove Cellular Cofferdam around Reservoir Intake					
		Assume construct from shore without barge.					
		Assume circular cellular cofferdam.					
		Length= 380 feet, 32-ft dia. cells, 28 ft high					
		Top of cofferdam - El. 488, Bottom of cofferdam - El. 460					
		Assume top of rock at reservoir bottom..					
		Use same cofferdam as 3,500 option.					
	1	Furnish and install sheet pile walls	D8120	555	TONS	$2,200.00	$1,221,000.00
		Arbed AS 500-12, 30 psf					
	2	Backfill cells with free-draining granular material	D8120	11,700	CY	$30.00	$351,000.00
	3	Unwater behind cofferdam	D8120	6	MOS	$55,000.00	$330,000.00
		Assume sumps and surface pumps					
		Remove Cofferdam					
	5	Remove and stockpile granular material	D8120	11,700	CY	$25.00	$292,500.00
	6	Extract and salvage sheet pile cutoff wall	D8120	555	TONS	$300.00	$166,500.00
		Sheet Subtotal					**$2,361,000.00**

QUANTITIES		PRICES	
BY Dick LaFond	CHECKED M.L.O'Shea	BY Craig A. Grush	CHECKED BOV 8/17/04
DATE PREPARED 4/19/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs

Intake- Structural

PROJECT:
Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_6000 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Structural Excavation and Backfill					
		Assume dam excavation is all common.					
		Assume top 5 feet of excavation is common and the remainder is rock					
		Assume stockpile and use for backfill or embankment.					
	7	Excavation of common materials for structures	D8140	458,600	CY	$6.00	$2,751,600.00
	8	Excavation of rock for structures (drill & shoot)	D8140	843,000	CY	$15.00	$12,645,000.00
	9	Furnish backfill for structures (assume local borrow)	D8140	43,300	CY	$4.00	$173,200.00
	10	Place backfill around structures	D8140	43,300	CY	Included above	
	11	Compact backfill around structures	D8140	43,300	CY	$5.00	$216,500.00
		Roads and Fencing					
	12	Gravel surfacing		2,270	TONS	$20.00	$45,400.00
		20 ft wide road right side of channel					
		12 ft wide road left side of channel					
	13	Safety fencing		4,750	LF	$20.00	$95,000.00
		8' chainlink fence					
		STRUCTURAL					
		Construct Gated Intake and Fishscreen Structure					
	14	Furnish, form, and place reinforced concrete (f'c=4ksi)	D8140	56,890	CY	$350.00	$19,911,500.00
	15	Furnish and place concrete reinforcement.	D8140	9,102,400	LBS	$0.75	$6,826,800.00
	16	Furnish and handle cement	D8140	16,050	TONS	$110.00	$1,765,500.00
		Construct Lined Intake Canal					
	17	Furnish, form, and place unreinforced concrete	D8140	2,640	CY	$350.00	$924,000.00
		lining in excavated channel (f'c= 3 ksi)					
	18	Furnish and handle cement	D8140	740	TONS	$140.00	$103,600.00
		Construct Bypass Pipe					
	19	4 - 54" Dia. steel pipe for fish bypass.		21,120	LF	$330.00	$6,969,600.00
		Mortar lined pipes					
	20	Bypass pipe common excavation		303,250	CY	$5.00	$1,516,250.00
	21	Bypass pipe rock excavation		159,500	CY	$15.00	$2,392,500.00
	22	Bypass pipe backfill		435,700	CY	$7.00	$3,049,900.00
	23	Bypass pipe soil cement bedding (100 psi)		14,590	CY	$55.00	$802,450.00
		Miscellaneous Metalwork					
		Listed under Intake - Mechanical Items					
		Intake - Civil/Structural Subtotal					**$62,549,800.00**

QUANTITIES		PRICES	
BY Chou Cha	**CHECKED** David Gesundheit/Anne Pavol	**BY** Craig A. Grush	**CHECKED** BOV 8/17/04
DATE PREPARED 4/19/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs

Intake- Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_6000 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical					
	1	Furnish and install steel stoplog guides and seats	D8410	22,000	LBS	$6.00	$132,000.00
		(upstream of radial gates)					
	2	Furnish and install steel trashracks	D8410	170,000	LBS	$4.00	$680,000.00
	3	Furnish and install one trash rake, rails, supports	D8410	30,000	LBS	$10.00	$300,000.00
		(assume Atlas Polar DT8300 rake)					
	4	Furnish and install one conveyor, steel	D8410	20,000	LBS	$10.00	$200,000.00
	5	Furnish and install steel fish screen guides, supports,	D8410	623,000	LBS	$4.00	$2,492,000.00
		embedded seats, and bypass walls					
	6	Furnish and install fish screens, 10' W x14' H panel	D8410				
		120 panels + 6 spares					
		Structural steel		177,000	LBS	$4.00	$708,000.00
		Stainless steel		177,000	LBS	$15.00	$2,655,000.00
	7	Furnish and install barrier panels above fish screens	D8410				
		10' W x 11' H panels, 120 panels + 6 spares					
		Structural steel		347,000	LBS	$4.00	$1,388,000.00
	8	Furnish and install adjustable baffle panels	D8410				
		10' W x 25' H panels, 120 panels + 6 spares					
		Structural steel		945,000	LBS	$4.00	$3,780,000.00
	9	Furnish and install fish screen cleaners with travel rail,	D8410				
		8 systems with 2 brush cleaner arms per system					
		a. Structural steel		64,000	LBS	$4.00	$256,000.00
		b. Stainless steel		4,000	LBS	$20.00	$80,000.00
		c. 2 Hp motors/gear reducers, with adj. speed		8	UNITS	$5,000.00	$40,000.00
		controllers, and limit switches					
	10	Furnish and install water level measuring systems	D8410	17	UNITS	$11,000.00	$187,000.00
		Sheet Subtotal					**$12,898,000.00**

QUANTITIES		PRICES	
BY: R Christensen/B Sund	CHECKED: AMR	BY: Craig A. Grush	CHECKED: BDV 8/17/04
DATE PREPARED: 4/21/2004	PEER REVIEW	DATE PREPARED: 08/17/04	PEER REVIEW: DCD

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs

Intake- Mechanical

PROJECT:
Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_6000 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
	11	Furnish and install steel stoplog guides and seats (downstream of fish screens)	D8410	22,000	LBS	$6.00	$132,000.00
	12	Furnish and install one set of steel stoplogs for the two different size bays with lifting beam	D8410	167,000	LBS	$4.00	$668,000.00
	13	3' wide walkway, steel, safety grating alng fish screens	D8410	33,000	LBS	$7.00	$231,000.00
	14	Handrail along each side of fish screen walkway	D8410	2,560	LF	$50.00	$128,000.00
		Radial Gates in Intake Structure					
		Furnish and install four 36.5-ft x 8.5-ft top seal radial gates and hoist equipment:	D8420				
	15	Gate (Weight/gate= 34,650 lbs)		138,600	LBS	$8.00	$1,108,800.00
	16	Embedded metalwork (Weight/bay= 5,000 lbs)		20,000	LBS	$5.00	$100,000.00
	17	Hoist operator (Weight/gate operator= 11,300 lbs)		45,200	LBS	$20.00	$904,000.00
	18	Motor - 5 hp (One per gate)		4	EA	Included in operator $	
		Sheet Subtotal					**$3,271,800.00**

QUANTITIES		PRICES	
BY R Christensen/B Sund (D8410) P. Hoffman (D8420)	CHECKED AMR	BY Craig A. Grush	CHECKED BOV 8/17/04
DATE PREPARED 5/12/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW NCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs

Intake- Electrical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_6000 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		ELECTRICAL					
		Service Equipment (F&I)	D8430				
	19	Distribution panelboard, outdoor type		1	EA	$25,000.00	$25,000.00
		480 volts, 3-phase with 225 ampere bus					
	20	Outdoor transformer load center		1	EA	$11,000.00	$11,000.00
		15 kVA, 1-phase, 480-240/120 volt					
		Combination Motor Starters	D8430				
	21	NEMA size 2 non-reversing contactor,		6	EA	$8,000.00	$48,000.00
		480-120 volt control transformer					
		NEMA type 4 enclosure					
		Insulated Conductors (F&I)					
		600-volt, single-conductor, stranded copper					
	22	12 AWG		500	LF	$0.60	$300.00
	23	10 AWG		200	LF	$0.70	$140.00
	24	8 AWG		100	LF	$1.00	$100.00
		Conduit System (F&I)					
		Rigid steel conduit					
	25	1 inch		150	LF	$15.00	$2,250.00
		Lighting System (F&I)	D8430				
	26	High-pressure sodium, pole mounted, outdoor		6	EA	$1,600.00	$9,600.00
		70 watt, 120 volt					
		Intake - Mechanical/Electrical Subtotal					**$16,266,190.00**

QUANTITIES		PRICES	
BY Mike Schuh	CHECKED L Ross	BY G for: Elizabeth Tran	CHECKED DDV 8/17/04
DATE PREPARED 5/6/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs

Plant- Civil

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_6000 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Access Road (9.75 miles of 2-lane access road):					
		Assume construct access road from SH24 to PP.					
		Assume place road along abandoned railroad alignment					
		Assume no major excavation or embankment sections.					
	1	Clear roadway alignment	D8140	45	AC	$3,500.00	$157,500.00
	2	Furnish and place base course material (9-inch depth)	D8140	96,000	TONS	$16.00	$1,536,000.00
	3	Furnish and place asphalt concrete (6-inch depth)	D8140	70,000	TONS	$60.00	$4,200,000.00
	4	Furnish and install W-beam type guardrail	D8140	10,000	LF	$25.00	$250,000.00
	5	Furnish and install miscellaneous pipe culverts	D8140	1,000	LF	$200.00	$200,000.00
		Assume 36-inch-diameter, wt/ft= 35#/ft)					
		Service Yard (6" asphalt concrete surface)					
	6	Strip and clear pumping plant site to 1 foot depth	D8120	15,300	CY	$3.00	$45,900.00
	7	Common excavation to Service Yard El. 505.0	D8120	164,000	CY	$5.00	$820,000.00
	8	Rock excavation to Service Yard El. 505.0	D8120	208,000	CY	$15.00	$3,120,000.00
	9	Place and compact embankment for service yard	D8120	19,200	CY	$8.00	$153,600.00
	10	Furnish and place base course material (6-inch)	D8120	10,000	TONS	$20.00	$200,000.00
	11	Furnish and place asphalt concrete (6-inch)	D8120	11,000	TONS	$80.00	$880,000.00
	12	Furnish and install 7-foot chain link fence for PP Yard	D8120	3,100	LF	$20.00	$62,000.00
	13	Furnish and install 7-foot x 24-foot access gate	D8120	3	EA	$3,500.00	$10,500.00
		Dewatering During Construction:					
		Assume no groundwater flows into excavation.					
		Structural Excavation and Backfill					
		Assume all common material excavated under site excavation for yard.					
		Assume stockpile rock for later use as riprap or rockfill.					
	14	Excavation of rock for structures (drill & shoot)	D8120	248,400	CY	$15.00	$3,726,000.00
	15	Furnish backfill for structures (assume local borrow)	D8120	44,300	CY	$4.00	$177,200.00
	16	Place backfill around structures	D8120	44,300	CY	Included above	
	17	Compact backfill around structures	D8120	44,300	CY	$5.00	$221,500.00
	18	Rock Exc. for manifold pipe to edge of Service Yard	D8120	102,400	CY	$15.00	$1,536,000.00
	19	Furnish, place, & compact backfill for manifold pipe trench(assu	D8120	83,200	CY	$9.00	$748,800.00
	20	Furnish & place soil cement for manifold pipe trench	D8120	10,700	CY	$55.00	$588,500.00
		Sheet Subtotal					**$18,633,500.00**

QUANTITIES		PRICES	
BY Dick LaFond, M.R. O'Shea	CHECKED R.G. M.R. O'Shea (D-8120)	BY Craig A. Grush	CHECKED WV 8/17/04
DATE PREPARED 4/19/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs

Plant- Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		STRUCTURAL					
		Construct Building Structure					
	21	Furnish, form, and place reinforced concrete	D8120	111,800	CY	$350.00	$39,130,000.00
	22	Furnish and place concrete reinforcement.	D8120	12,298,000	LBS	$0.75	$9,223,500.00
		Assume 110 #/CY					
	23	Furnish and handle cement (.282T/CY)	D8120	31,530	TONS	$110.00	$3,468,300.00
		Furnish & install precast, prestressed double tees for roof					
	24	10LDT 32+2 = 10' wide & 32" deep - 80' Span	D8120	45	EA.	$50,000.00	$2,250,000.00
		Structural Steel					
	25	Furnish and install structural steel (painted):	D8120	68,000	LBS	$4.00	$272,000.00
		crane rails, baseplates					
		Miscellaneous Metalwork					
	26	Furnish and install miscellaneous metalwork	D8120	250,000	LBS	$7.00	$1,750,000.00
		Includes gratings, hatches, ladders, guardrails,					
		catwalk, and cable trays and supports					
		Plant - Civil/Structural Subtotal					$74,727,300.00 √

QUANTITIES		PRICES	
BY M. R. O'Shea	CHECKED R.W.	BY Craig A. Grush	CHECKED 60V 8/17/04
DATE PREPARED 4/19/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCP

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs

Plant - Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_6000 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Major Mechanical Equipment					
		Pump prices below telephone quote from Bob Rittase, Voith Hydro, 717-792-7206					
		1000 cfs two-stage spiral case pump, rated 1000 cfs at 1430 ft					
		total dynamic head, overall efficiency more than 83%					
		operating range 1030 to 1430 ft					
	1	Pumps		6	EA	$9,000,000.00	$54,000,000.00
	2	Motors		6	EA	$4,500,000.00	$27,000,000.00
		Spherical discharge valves, with operators, rated at 1500 ft					
	3	working pressure and 2000 ft surge pressure, with operators		6	EA	$4,500,000.00	$27,000,000.00
	4	Installation supervision of 1000 cfs pumping unit		6	EA	$1,500,000.00	$9,000,000.00
		FURNISH-AND-INSTALL THE FOLLOWING:					
		Steel Manifold and Suction Tubes	D8420				
		Steel plate used for pipe fabrication:					
		ASTM A572 Gr. 50: Sy = 50 kpsi St = 65 kpsi					
		(All pipe sizes are inside diameters)					
	5	264" Dia., 4.8125" wall, L= 320 ft.		4,450,000	LBS	$2.00	$8,900,000.00
	6	264" Dia., 4.625" wall, L= 540 ft.		7,200,000	LBS	$2.00	$14,400,000.00
	7	248" Dia., 4.5" wall, L = 110ft.		1,350,000	LBS	$2.00	$2,700,000.00
	8	170" Dia., 1" wall, L= 845 ft.		1,550,000	LBS	$2.00	$3,100,000.00
	9	222" Dia., 4" wall, L= 105 ft.		1,020,000	LBS	$2.00	$2,040,000.00
	10	192" Dia., 3.5" wall, L= 90 ft.		660,000	LBS	$2.00	$1,320,000.00
	11	110" Dia., 2 " wall, L= 502 ft.		1,200,000	LBS	$2.00	$2,400,000.00
	12	157 Dia., 2.875" wall, L= 90 ft.		445,000	LBS	$2.00	$890,000.00
		Sheet Subtotal					**$152,750,000.00**

QUANTITIES		PRICES	
BY Richard Fehr, Nathan Nakamoto	CHECKED	BY Craig A. Grush	CHECKED BOV 8/17/04
DATE PREPARED 5/6/04		DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs

Plant - Mechanical

PROJECT:
Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_6000 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
	13	CO2 High Pressure Fire Extinguishing System:	D-8410	2	each	$100,000.00	$200,000.00
		16 - 100# Storage Cylinders w/ control panel					
		and appurtenances and 2,500 lbs. of					
		sch. 80 carbon steel pipe, valves & fittings					
	14	Fire Suppression System:	D-8410	1	L.S.		$225,000.00
		12 Fire hose reels w/ 100 feet of hose					
		24 - Portable hand-held 20# extinguishers					
		13,000 lbs. of sch. 40 carbon steel pipe, valves & fittings					
		1 - Fire pump, split-case, 500 gpm @ 300 ft of head					
	15	Unit Cooling Water System:	D-8410	1	L.S.		$275,000.00
		7 - Cooling water pumps, end-suction type, 150 gpm					
		2 - 8-inch automatic, self-cleaning strainers					
		5,000 lbs. of type K copper tubing, valves & fittings					
		6,000 lbs. of ductile iron, mechanical joint pipe & fittings					
	16	Lubricating Oil System:	D-8410	1	L.S.		$60,000.00
		2- 500 gal carbon steel storage tanks					
		1 - 10 gpm @ 100 psi oil pump					
		1 - lube oil filter					
		4,000 lbs. of sch. 40 carbon steel pipe, valves & fittings					
	17	Compressed Air System:	D-8410	1	L.S.		$110,000.00
		2 - 100 cfm @ 125 psi rotary screw air compressors					
		1 - 250 gal. carbon steel air receiver					
		1 - 200 cfm air dryer					
		4,000 lbs. of sch. 40 carbon steel pipe, valves & fittings					
	18	Service Water System:	D-8410	1	L.S.		$110,000.00
		1 - Service water pump, 75 gpm @ 200 ft. of head					
		1 - Hydropneumatic Tank, 300 gal.					
		2,000 lbs. of type K copper tubing, valves & fittings					
	19	Gravity Drainage System:	D-8410	1	L.S.		$350,000.00
		60 - Floor drains, cast iron					
		35,000 lbs. of cast iron hub & spigot, service weight					
		soil pipe					
		Sheet Subtotal					**$1,330,000.00**

QUANTITIES		PRICES	
BY John Grass	**CHECKED** AMR	**BY** Craig A. Grush	**CHECKED** BOV 8/17/04
DATE PREPARED 5/6/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs

Plant - Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
	20	Plant Unwatering System:	D-8410	1	L.S.		$200,000.00
		2 - Vertical turbine type sump pump, 1000 gpm @ 50 ft hd					
		1 - Drainage jet type drainage pump					
		1,500 lbs. of type K copper tube, valves & fittings					
		4,000 lbs. of ductile iron, mechanical joint pipe & fittings					
	21	Domestic Water and Sanitary Waste System:	D-8410	1	L.S.		$100,000.00
		4 - Water Closets					
		2 - Urinal					
		4 - Lavatories & accessories					
		1 - Duplex Sewage Ejector					
		2,000 lbs. of cast iron hub & spigot service weight					
		sewer pipe					
		800 lbs. of type K copper tubing, valves & fittings					
	22	100-Ton overhead crane, 72'-6" span	D8410	153,000	LBS	$6.00	$918,000.00
	23	200-Ton overhead crane, 72'-6" span, two required	D-8410	520,000	LBS	$6.00	$3,120,000.00
	24	Electric traction elevator	D8410	1	unit	$500,000.00	$500,000.00
		overhead, geared, capacity = 3500 pounds,					
		travel = 100 feet, landings = 6, speed = 200 ft/min.					
	25	Ultrasonic flowmeter, 4-path	D8410	1	meter	$35,000.00	$35,000.00
	26	Trashracks (steel) at pumping plant	D8410	106,000	LBS	$4.00	$424,000.00
	27	Stoplogs, lifting beam, seats and guides (steel)	D8410	33,000	LBS	$4.00	$132,000.00
		(assumes one bay of stoplogs and 6 bays of guides)					
		Sheet Subtotal					**$5,429,000.00**

QUANTITIES		PRICES	
BY R. Christensen, B. Sund, A. Ritt, C. Berte, P. Schlien, J. Grass	**CHECKED** Aug	**BY** Craig A. Grush	**CHECKED** GDV 8/17/04
DATE PREPARED 5/6/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs

Plant - Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
		Heating, Ventilating, and Air Conditioning	D-8410	1	L.S.		$3,172,500.00
		HVAC for bulding except bus & switchgear					
		459-ft long by 77'-ft wide by 70-ft high unit/service bay					
		54-ft long by 77-ft wide by 20-ft high control bay					
		Two each 54-ft long by 77-ft wide by 17-ft equipment rooms					
		393-ft long by 56'-ft wide by 20-ft high Electrical Gallery					
		Pump/Motor/Valve Galleries= 756,000 ft^3					
		Plant - Mechanical Subtotal					**$162,681,500.00**

QUANTITIES		PRICES	
BY Paul Schlein	CHECKED AME	BY Craig A. Grush	CHECKED BAV 8/17/04
DATE PREPARED 5/6/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs

Plant-Electrical

PROJECT: Yakima River Basin Water Storage Options

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Plant Grounding System (F&I)	D8430				
	1	Ground rods, 10 ft, 3/4" dia., copper-clad		55	EA	$180.00	$9,900.00
		Stranded bare-copper conductor					
	2	250 MCM		1,600	LF	$5.50	$8,800.00
	3	4/0 AWG		1,200	LF	$4.00	$4,800.00
	4	2/0 AWG		1,000	LF	$3.50	$3,500.00
	5	4 AWG		700	LF	$2.50	$1,750.00
		Motor Bus & Switchgear (F&I)	D8430				
	6	Main motor isolated-phase bus:		600	LF	$6,500.00	$3,900,000.00
		15 kV; 38,000 amperes; 3-phase; 60 hz.					
		Self-cooled					
		Individual motor isolated-phase bus:					
	7	15 kV; 7,000 amperes; 3-phase; 60 hz.		300	LF	$2,000.00	$600,000.00
		Self-cooled					
		Motor reduced-voltage, static starting system with					
		15 kV, SF6 type unit circuit-breakers					
	8	7,000 amperes continuous current		6	EA	$275,000	$1,650,000.00
		Motor Control Equipment (F&I)	D8430				
	9	Duplex control switchboard for operation of 6 main		1	EA	$250,000	$250,000.00
		pumping motors.					
		Motors					
		Listed under Plant-Mechanical					
		Sheet Subtotal					**$6,428,750.00**

QUANTITIES		PRICES	
BY Mike Schuh	CHECKED L Rom	BY Elizabeth Tran	CHECKED BOV 8/17/04
DATE PREPARED 5/6/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE: Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs Plant-Electrical	**PROJECT:** Yakima River Basin Water Storage Options **REGION** PN **PRICE LEVEL:** Appraisal **FILE:** C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_6000 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		15 kV Metal-Clad Switchgear (F&I)	D8430				
	10	15 kV metal-clad switchgear rated 1200 amperes with		1	EA	$350,000	$350,000.00
		two 1200 ampere vacuum type power circuit breakers					
		15 kV Non-Segregated-Phase Bus (F&I)	D8430				
	11	15 kV, 1200 amperes		300	FT	$800.00	$240,000.00
		Plant Station-Service Equipment (F&I)	D8430				
		Indoor double-ended secondary unit substation with					
		following features:					
	12	Dry-type transformer 13.8 kV-480Y277 V, 2,500 KVA		2	EA	$90,000.00	$180,000.00
	13	480 V power-circuit breakers, 600 amperes		12	EA	$4,500.00	$54,000.00
		Building Lighting System (F&I)	D8430				
		Interior luminaires					
	14	High bay, high-pressure sodium, 400 W, 480 V		38	EA	$700.00	$26,600.00
	15	Emergency lighting system		1	LS		$900.00
	16	Exterior luminaires		14	EA	$400.00	$5,600.00
		High-pressure sodium, wall mounted, outdoor					
		70 watt, 120 volt					
		Sheet Subtotal					**$857,100.00**

QUANTITIES		**PRICES**	
BY Mike Schuh	**CHECKED** L Rossi	**BY** G for: Elizabeth Tran	**CHECKED** BDV 8/17/04
DATE PREPARED 5/6/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs

Plant-Electrical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_6000 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	17	**Building Fire Detection and Alarm System (F&I)**	D8430	1	LS		$150,000.00
	18	**Distribution Panelboards (F&I)**	D8430	4	EA	$80,000.00	$320,000.00
		480 volts, 3-phase with 400 ampere bus					
	19	**Motor Control Centers (F&I)**	D8430	2	EA	$150,000	$300,000.00
		480 volts, 3-phase with 1200 ampere bus					
		Six 20 inch wide sections					
		Insulated Conductors (F&I)	D8430				
		600-volt, single-conductor, stranded copper					
	20	14 AWG		12,000	LF	$0.50	$6,000.00
	21	12 AWG		15,500	LF	$0.55	$8,525.00
	22	10 AWG		15,500	LF	$0.70	$10,850.00
	23	6 AWG		3,000	LF	$1.50	$4,500.00
	24	4 AWG		3,000	LF	$1.75	$5,250.00
	25	1/0 AWG		2,000	LF	$2.75	$5,500.00
		600-volt multi-conductor control cable					
	26	9 conductor 16 AWG		2,500	LF	$1.25	$3,125.00
	27	12 conductor 16 AWG		3,500	LF	$1.50	$5,250.00
	28	5 conductor 10 AWG		3,500	LF	$1.75	$6,125.00
		Conduit System (F&I)	D8430				
		Rigid steel conduit					
	29	1 inch		1,000	LF	$14.00	$14,000.00
	30	2 inch		600	LF	$22.00	$13,200.00
	31	2 1/2 inch		350	LF	$30.00	$10,500.00
	32	3 inch		250	LF	$42.00	$10,500.00
		Plastic-coated rigid steel					
	33	2 inch		400	LF	$30.00	$12,000.00
		Plant - Electrical Subtotal					**$8,171,175.00**

QUANTITIES		PRICES	
BY Mike Schub	**CHECKED** L Rossi	**BY** G for: Elizabeth Tran	**CHECKED** BOV 8/17/04
DATE PREPARED 5/6/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCA

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs

Switchyard

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_6000 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		STRUCTURAL	D8120				
		Assume switchyard structures covered under unlisted items.					
		ELECTRICAL					
		Switchyard					
		Furnish and Install:					
	1	Oil-filled, conservator-type power transformer 873 MVA; 500-13.8kV, 1-phase	D8440	3	EA	$7,000,000	$21,000,000.00
	2	500-kV disconnect switches, 1200 amp, 3-phase	D8440	4	EA	$125,000	$500,000.00
	3	500-kV circuit breakers, 1200 amp, 3-phase	D8440	2	EA	$1,115,000	$2,230,000.00
	4	**Construct Transmission Line**	D8440	6	MILES	$1,000,000	$6,000,000.00
		Assume 6 miles of transmission line from Midway substation to the east 500-kV, steel towers, 2167 AWG conductor					
		Switchyard & Transmission Line Subtotal					**$29,730,000.00**

QUANTITIES		PRICES	
BY R. LaFond (D8120) L. Gamuciello (D8440)	**CHECKED**	**BY** G For: Elizabeth Tran	**CHECKED** BOV 8/17/04
DATE PREPARED 5/6/04	**PEER REVIEW** James R. Zeiger (D8440)	**DATE PREPARED** 08/17/04	**PEER REVIEW** DED

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs
Tunnel/Tunnel Option

DISCHARGE1

PROJECT: Yakima River Basin Water Storage Options

REGION PN | **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_6000 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Tunnel					
		Construct 34,850-ft long, 22.00-ft finished diameter, 25.00-ft minimum bore diameter, tunnel in rock. Tunnel will be excavated with TBM and driven uphill. Water problems will be minimal. Tunnel has three final support reaches.					
		32,150-ft long unreinforced concrete lined reach					
	1	Excavation (appr. 18 cy/lf)	D-8140	32,150	lf	$2,400.00	$77,160,000.00
	2	Furnish and place unreinforced concrete tunnel lining	D-8140	132,000	cy	$350.00	$46,200,000.00
	3	Cementitious materials for concrete tunnel lining	D-8140	37,200	tons	$100.00	$3,720,000.00
	4	Furnish & install 1-in dia, 10-ft long rock bolts	D-8140	266,000	lin ft	$50.00	$13,300,000.00
		1,000-ft long reinforced concrete lined reach					
	5	Excavation (appr. 18 cy/lf)	D-8140	1,000	lf	$3,000.00	$3,000,000.00
	6	Furnish and place reinforced concrete tunnel lining	D-8140	4,100	cy	$350.00	$1,435,000.00
	7	Cementitious materials for concrete tunnel lining	D-8140	1,160	tons	$120.00	$139,200.00
	8	Furnish and install concrete reinforcement	D-8140	64,400	lbs	$1.00	$64,400.00
	9	Furnish and install structural steel tunnel supports	D-8140	738,000	lbs	$4.00	$2,952,000.00
		1,700-ft long steel lined portal reach					
	10	Excavation (appr. 18 cy/lf)	D-8140	1,700	lf	$3,000.00	$5,100,000.00
		Steel Tunnel Liner:					
		ASTM A572 Gr. 50: Sy = 50 kpsi St = 65 kpsi					
	10a	264" Dia., 4.625" wall, L= 1700 ft., 13,281 lbs/ft	D-8420	22,577,700	LBS	$2.00	$45,155,400.00
	11	Furnish and place backfill concrete	D-8140	6,970	cy	$300.00	$2,091,000.00
	12	Cementitious materials for backfill concrete	D-8140	1,970	tons	$130.00	$256,100.00
	13	Furnish & install 1-in dia, 10-ft long rock bolts	D-8140	9,800	lin ft	$60.00	$588,000.00
	14	Furnish and install structural steel tunnel supports	D-8140	738,400	lbs	$4.00	$2,953,600.00
		Sheet Subtotal					**$204,114,700.00**

QUANTITIES		PRICES	
BY Bill Thompson (D8140) Rick Frisz (D8420)	CHECKED KA (DEHC)	BY Craig A. Grush	CHECKED BDV 8/17/04
DATE PREPARED 4/19/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DED

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs
Tunnel/Tunnel Option

DISCHARGE1

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_6000 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Surge Shaft					
		Construct 1506-ft deep, 22.0-ft finished diameter, 24.34-ft minimum bore diameter, shaft in rock. Shaft will be excavated by raise bore and drill down method. Water problems will be minimal. Shaft has two final support reaches.					
		1,200-ft deep unreinforced concrete lined reach					
	15	Excavation (appr. 17 cy/lf)	D-8140	1,200	lf	$6,000.00	$7,200,000.00
	16	Furnish and place unreinforced concrete shaft lining	D-8140	3,800	cy	$350.00	$1,330,000.00
	17	Cementitious materials for concrete shaft lining	D-8140	1,070	tons	$130.00	$139,100.00
	18	Furnish & install 5/8-in dia, 6-ft long rock bolts	D-8140	63,100	lin ft	$50.00	$3,155,000.00
		300-ft long reinforced concrete lined shaft top reach					
	19	Excavation (appr. 17 cy/lf)	D-8140	300	lf	$6,000.00	$1,800,000.00
	20	Furnish and place reinforced concrete shaft lining	D-8140	945	cy	$400.00	$378,000.00
	21	Cementitious materials for concrete shaft lining	D-8140	265	tons	$160.00	$42,400.00
	22	Furnish and install concrete reinforcement	D-8140	15,700	lin ft	$1.00	$15,700.00
	23	Furnish & install 5/8-in dia, 6-ft long rock bolts	D-8140	15,600	lin ft	$50.00	$780,000.00
	24	Furnish and install chain link protection	D-8140	13,000	sq yd	$20.00	$260,000.00
		Sheet Subtotal					**$15,100,200.00**

QUANTITIES		PRICES	
BY Bill Thompson	CHECKED KA	BY Craig A. Grush	CHECKED DO 8/17/04
DATE PREPARED 5/5/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Priest Rapids Intake, Pumping Plant, Switchyard, and Inflow Conveyance System - Q= 6,000 cfs
Tunnel/Tunnel Option
DISCHARGE1

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_6000 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		For Tunnel only inlet - For 6000 cfs from Priest Rapids					
		Assume ~100' head to valley invert and L~ 4000'					
		Quantities for the 6000 cfs flow are scaled up					
		from the 3500 cfs option.					
		Earthwork					
		Assume 110% of the 3500 cfs option unless otherwise shown					
	25	Excavation at outlet area for portal and channel	D8130	55,000	CY	$15.00	$825,000.00
	26	Excavation for pipe trench	D8130	337,700	CY	$5.00	$1,688,500.00
	27	Excavation for thrust block	D8130	1,650	CY	$15.00	$24,750.00
	28	Furnish and place Zone 3 bedding for pipe	D8130	26,400	CY	$40.00	$1,056,000.00
	29	Backfill pipe with excavated material	D8130	260,700	CY	$7.00	$1,824,900.00
	30	Furnish and place zone 3 bedding for riprap (120%)	D8130	6,000	CY	$40.00	$240,000.00
	31	Furnish and place riprap (120%)	D8130	12,000	CY	$35.00	$420,000.00
		Concrete					
	32	Concrete for open channel (150%)	D8130	750	CY	$400.00	$300,000.00
	33	F & P reinforcement (160 lbs/CY)	D8130	120,000	LBS	$1.00	$120,000.00
	34	Furnish and handle cement (.282T/CY)	D8130	210	TONS	$160.00	$33,600.00
	35	Concrete for thrust block (170%)	D8130	1,700	CY	$400.00	$680,000.00
	36	F & P reinforcement (100 lbs/CY)	D8130	170,000	LBS	$1.00	$170,000.00
	37	Furnish and handle cement (.235T/CY)	D8130	400	TONS	$160.00	$64,000.00
		Steel Pipe					
	38	24 ' dia. Steel pipe L = 4000' t= 3/4 inches	D8130	10,186,000	LBS	$2.00	$20,372,000.00
		Wt/ft + 10% for couplings and connections					
		(wt/ft = 2315 lbs/ft)					
	39	Furnish and install steel safety trashracks	D8410	135,000	LBS	$4.00	$540,000.00
	40	Furnish and install steel bulkhead	D8410	206,000	LBS	$4.00	$824,000.00
	41	Remove and salvage 24' dia. Steel pipe	D8410	9,167,400	LBS	N/A	N/A
		Assume diver-assisted removal in wet at a max					
		depth = 100'.					
		Assume removal of 90% of the pipe.					
		Assume lift bags to raise pipe and barge-mounted					
		crane to handle pipe at surface.					
		Salvage at $50/ton (quote), but salvage value is					
		much less than the cost to remove and cut up pipe.					
		Discharge 1 - Subtotal					**$248,397,650.00**

QUANTITIES		PRICES	
BY Doug Stanton (D8130) DS R. Christensen (D8410)	CHECKED [signature]	BY [signature] Craig A. Grush	CHECKED BOW 8/17/04
DATE PREPARED 5/7/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

Black Rock Dam and Reservoir
Large Reservoir
Active Storage= 1.3 MAF

Field Cost Estimate

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir

Large Reservoir - Active Storage= 1.3 MAF

Summary Sheet 1 of 3 WOID = YAKEN

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Estimate Worksheets Identify Three Dam Types					
		Dam Type 1: Concrete-Faced Rockfill Dam					
		Dam Type 2: Central-Core Rockfill Dam					
		Dam Type 3: Roller Compacted Concrete Dam					
		DAM TYPE 1: CONCRETE-FACED ROCKFILL					
		Includes foundation treatment, dam structure, river outlet works, and relocation of State Highway 24.					
		Dam1 Subtotal					$774,496,000.00 ✓
		River Outlet Works (ROW1) Subtotal					$83,494,115.00 ✓
		Relocation of State Highway 24 (SH24) Subtotal					$57,320,000.00 ✓
		Subtotal					$915,310,115.00 ✓
		Mobilization 5% (+/-)					$46,000,000.00 ✓
		Subtotal w/ mobilization					$961,310,115.00 ✓
		Unlisted Items 10% (+/-)					$88,689,885.00 ✓
		DAM TYPE 1: CONTRACT COST					**$1,050,000,000.00** ✓
		Contingencies 25% (+/-)					$250,000,000.00 ✓
		DAM TYPE 1: FIELD COST					**$1,300,000,000.00** ✓

QUANTITIES		PRICES	
BY	CHECKED	BY D. Donaldson DCD	CHECKED GOV 8/17/04
DATE PREPARED	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW [illegible] 8/17/04

ESTIMATE WORKSHEET

FEATURE: Black Rock Dam and Reservoir	**PROJECT:** Yakima River Basin Water Storage Options
Large Reservoir - Active Storage= 1.3 MAF	**REGION** PN **PRICE LEVEL:** Appraisal
Summary Sheet 2 of 3 WOID = YAKEN	**FILE:** C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		DAM TYPE 2: CENTRAL CORE ROCKFILL					
		Includes foundation treatment, dam structure,					
		river outlet works, and relocation of State Highway 24.					
		Dam2 Subtotal					$733,280,000.00 ✓
		River Outlet Works (ROW1) Subtotal					$83,494,115.00 ✓
		Relocation of State Highway 24 (SH24) Subtotal					$57,320,000.00 ✓
		Subtotal					$874,094,115.00 ✓
		Mobilization 5% (+/-)					$44,000,000.00 ✓
		Subtotal w/ mobilization					$918,094,115.00 ✓
		Unlisted Items 10% (+/-)					$81,905,885.00 ✓
		DAM TYPE 2: CONTRACT COST					**$1,000,000,000.00** ✓
		Contingencies 25% (+/-)					$250,000,000.00 ✓
		DAM TYPE 2: FIELD COST					**$1,250,000,000.00** ✓

QUANTITIES		PRICES	
BY	**CHECKED**	**BY** D. Donaldson DCD	**CHECKED** BDJ 8/17/04
DATE PREPARED	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** [illegible] 8/17/04

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir

Large Reservoir - Active Storage= 1.3 MAF

Summary Sheet 3 of 3 WOID = YAKEN

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		DAM TYPE 3: ROLLER COMPACTED CONCRETE					
		Includes foundation treatment, dam structure, river outlet works, and relocation of State Highway 24.					
		Dam3 Subtotal					$1,239,036,300.00 ✓
		River Outlet Works (ROW2) Subtotal					$23,384,515.00 ✓
		Relocation of State Highway 24 (SH24) Subtotal					$57,320,000.00 ✓
		Subtotal					$1,319,740,815.00 ✓
		Mobilization 5% (+/-)					$66,000,000.00 ✓
		Subtotal w/ mobilization					$1,385,740,815.00 ✓
		Unlisted Items 10% (+/-)					$114,259,185.00 ✓
		DAM TYPE 3: CONTRACT COST					**$1,500,000,000.00** ✓
		Contingencies 25% (+/-)					$400,000,000.00 ✓
		DAM TYPE 3: FIELD COST					**$1,900,000,000.00** ✓

QUANTITIES		PRICES	
BY	**CHECKED**	**BY** D. Donaldson DED	**CHECKED** DDV 8/17/04
DATE PREPARED	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** RAS 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
Dam Type 1: Concrete-Faced Rockfill Dam

Dam 1 - Civil/Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		GENERAL SITEWORK					
		Assume no clearing and grubbing required					
		Assume road improvements and haul roads are					
		part of unlisted items					
		DIVERSION & DEWATERING					
		Assume groundwater is below excavation					
		Assume natural stream beds in area are dry					
		FOUNDATION EXCAVATION					
		Assume common material stockpiled for reuse					
		Assume rock material stockpiled for reuse					
		Stockpiles will be upstream, within 1/2 mile of dam					
	1	Excavation, stripping, of dam foundation	D8312	360,000	CY	$2.00	$720,000.00
		Assume depth of stripping 12 inches or less					
		Assume stripping will be stockpiled for topsoil use					
	2	Excavation, common, for dam foundation	D8312	26,640,000	CY	$3.00	$79,920,000.00
		Assume about 35% of volume requires ripping					
		Assume fine-grained and coarse-grained materials					
		will be separately stockpiled					
	3	Excavation, rock, for dam foundation	D8312	2,000	CY	$45.00	$90,000.00
		Assume drill and blast in random locations					
		FOUNDATION TREATMENT					
		Includes misc. foundation treatment, fault zone					
		treatment, consolidation grouting, and curtain grouting					
		Miscellaneous Foundation Areas					
		Applied in areas of poor quality rock					
	4	Slush grouting of foundation surface	D8312	165,000	SF	$2.00	$330,000.00
		Over assumed 10% of area between u/s toe and axis					
	5	Dental concrete	D8312	2,000	CY	$150.00	$300,000.00
	6	Furnish/place zone 2 sand filter on foundation	D8312	40,000	CY	$28.00	$1,120,000.00
		Over assumed 10% of area between u/s toe and axis					
		Assume a 3-ft thickness					
	7	Furnish/place zone 3 gravel drain on foundation	D8312	40,000	CY	$25.00	$1,000,000.00
		Over the zone 2 filter in a 3-ft thickness					
		Dam1 Subtotal					**$83,480,000.00**

QUANTITIES		PRICES	
BY Will Gonzales	**CHECKED** Bill Engemoen	**BY** D. Donaldson DCD	**CHECKED** BDV 8/17/04
DATE PREPARED 4/12/2004	**PEER REVIEW** Bill Engemoen	**DATE PREPARED** 08/17/04	**PEER REVIEW** [illegible] 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
Dam Type 1: Concrete-Faced Rockfill Dam

Dam1 - Civil/Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		FOUNDATION TREATMENT (continued)					
		Treatment of south abutment fault area					
	8	Extra rock excavation for fault treatment	D8312	150,000	CY	$13.00	$1,950,000.00
		Assume south abutment is fractured					
		Assume excavate with hydraulic excavator					
	9	Dental concrete for fault treatment	D8312	5,000	CY	$140.00	$700,000.00
	10	Furnish/place zone 2 sand filter downstream of plinth	D8312	55,000	CY	$28.00	$1,540,000.00
		Assume a 3-ft thickness, 500' by 1000' area					
		Assume same source as listed under embankment					
	11	Furnish/place zone 3 gravel drain d/s of plinth	D8312	55,000	CY	$25.00	$1,375,000.00
		Assume 3-ft thickness, over zone 2 filter					
		Consolidation Grouting of Foundation					
		Generally limited to area beneath plinth					
	12	Setups for drilling grout holes	D8312	4,400	EA	$75.00	$330,000.00
		Assume 2-inch dia. drilled on 7.5-foot centers					
	13	Drill grout holes	D8312	132,000	LF	$15.00	$1,980,000.00
		Assume 2-inch dia. w/length= 30 feet					
	14	Hookups to grout holes	D8312	4,400	EA	$60.00	$264,000.00
	15	Pressure grout	D8312	200,000	CF	$7.00	$1,400,000.00
		Assume grouting process only minus cement					
		Assume 2 CF per 1 LF of hole					
	16	Furnish and handle cement for pressure grouting	D8312	200,000	BAGS	$8.00	$1,600,000.00
		Assume 1 bag per CF					
		Curtain Grouting of Foundation					
		Two-row curtain beneath plinth					
	17	Setups for drilling grout holes	D8312	1,400	EA	$100.00	$140,000.00
		Assume 2-rows of 2-inch dia.on 10-ft centers					
	18	Drill grout holes	D8312	275,000	LF	$15.00	$4,125,000.00
		Assume 2-inch dia. w/length from 60 to 250 feet					
	19	Hookups to grout holes	D8312	1,400	EA	$75.00	$105,000.00
	20	Pressure grout	D8312	550,000	CF	$7.00	$3,850,000.00
		Assume grouting process only minus cement					
		Assume 2 CF per 1 LF of hole					
	21	Furnish and handle cement for pressure grouting	D8312	550,000	BAGS	$8.00	$4,400,000.00
		Dam1 Subtotal					**$23,759,000.00**

QUANTITIES		PRICES	
BY Will Gonzales	**CHECKED** Bill Engemoen	**BY** D. Donaldson DD	**CHECKED** BDV 8/17/04
DATE PREPARED 4/12/2004	**PEER REVIEW** Bill Engemoen	**DATE PREPARED** 08/17/04	**PEER REVIEW** RAB 8/17/04

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Black Rock Dam and Reservoir *Large Reservoir - Active Storage= 1.3 MAF* *Dam Type 1: Concrete-Faced Rockfill Dam* Dam1 - Civil/Structural	**Yakima River Basin Water Storage Options** **REGION** PN **PRICE LEVEL:** Appraisal **FILE:** C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		EMBANKMENT CONSTRUCTION					
		Items are set up as furnish and place, which would					
		include purchasing from commercial sites,					
		processing onsite, development of quarry, or					
		transporting from stockpiles of required excavation					
	22	Furnish and place zone 1 upstream blanket	D8312	900,000	CY	$6.00	$5,400,000.00
		Consists of loess stockpiled from required exc					
		within 1/2 mile of dam					
		Compaction to 6-inch lifts by tamping roller					
	23	Furnish and place zone 2 filter	D8312	1,420,000	CY	$25.00	$35,500,000.00
		Sand/gravel material processed commercially					
		or developed onsite					
		If commercial, assume 17 mile one-way haul					
		Compacted to 12-inch layers by vibratory steel drum					
	24	Furnish and place zone 3 drain	D8312	1,420,000	CY	$23.00	$32,660,000.00
		Gravel/cobble material processed commercially or					
		developed onsite					
		If commercial, assume 17 mile one-way haul					
		Compacted to 12-inch layers by vibratory steel drum					
	25	Furnish and place zone 4 rockfill	D8312	64,500,000	CY	$6.50	$419,250,000.00
		Developed from basalt ridges surrounding reservoir					
		Assume average 1-mile haul to dam					
		Rock sizes up to 3-foot					
		Compacted in 3-ft layers by vibratory steel drum					
	26	Furnish and place zone 5 coarse grained random fill	D8312	14,800,000	CY	$4.00	$59,200,000.00
		Comes from stockpiles of required excavation					
		within 1/2 mile of dam					
		Generally consists of gravelly soils					
		Compacted in 2-ft layers by vibratory steel drum					
	27	Furnish and place zone 6 fine grained random fill	D8312	6,900,000	CY	$4.50	$31,050,000.00
		Comes from stockpiles of required excavation					
		within 1/2 mile of dam					
		Generally consists of sands/silts/clays					
		Compacted to 9-inch layers by tamping rollers					
		Dam1 Subtotal					**$583,060,000.00**

QUANTITIES		PRICES	
BY Will Gonzales	**CHECKED** Bill Engemoen	**BY** D. Donaldson DCD	**CHECKED** BOV 8/17/04
DATE PREPARED 4/12/2004	**PEER REVIEW** Bill Engemoen	**DATE PREPARED** 08/17/04	**PEER REVIEW** RAB 8/17/04

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
Dam Type 1: Concrete-Faced Rockfill Dam

Dam1 - Civil/Structural

PROJECT:
Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		CONCRETE FACE & PLINTH CONSTRUCTION					
		Plinth					
		Typical thickness will be 1.5 feet					
		Width will range from 10 to 50 feet					
		Grouted anchors may be needed in poor rock areas					
	28	Furnish and place reinforced concrete in plinth	D8312	11,000	CY	$350.00	$3,850,000.00
	29	Furnish and place concrete reinforcement (100#/CY)	D8312	1,100,000	LBS	$0.80	$880,000.00
	30	Furnish and handle cement for concrete (.282T/CY)	D8312	3,100	TONS	$120.00	$372,000.00
	31	Furnish and install grouted anchors	D8312	300,000	LF	$15.00	$4,500,000.00
		Assume 1-inch diameter rebar grouted into rock					
		Assume 15-foot lengths					
		Concrete Deck					
		Will vary in thickness from 1 to 2 feet					
		Adjacent panels will have waterstops and dowels					
	32	Furnish and place reinforced concrete in deck	D8312	185,000	CY	$300.00	$55,500,000.00
	33	Furnish and place concrete reinforcement (100#/CY)	D8312	18,500,000	LBS	$0.75	$13,875,000.00
	34	Furnish and handle cement for concrete (.282T/CY)	D8312	52,200	TONS	$100.00	$5,220,000.00
		MISCELLANEOUS					
		Instrumentation					
		Assume part of unlisted items					
		Toe Drains					
		Assume part of unlisted items					
		Site cleanup and relandscaping					
		Assume part of unlisted items					
		Dam1 Subtotal					**$84,197,000.00**

QUANTITIES		PRICES	
BY Will Gonzales	**CHECKED** Bill Engemoen	**BY** D. Donaldson DED	**CHECKED** BAV 8/17/04
DATE PREPARED 4/12/2004	**PEER REVIEW** Bill Engemoen	**DATE PREPARED** 08/17/04	**PEER REVIEW** RMH 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Black Rock Dam and Reservoir *Large Reservoir - Active Storage= 1.3 MAF* *Dam Type 2: Central -Core Rockfill Dam*	Yakima River Basin Water Storage Options
	REGION PN — PRICE LEVEL: Appraisal
Dam2 - Civil/Structural	FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		GENERAL SITEWORK					
		Assume no clearing and grubbing required					
		Assume road improvements and haul roads are					
		part of unlisted items					
		DIVERSION & DEWATERING					
		Assume groundwater is below excavation					
		Assume natural stream beds in area are dry					
		FOUNDATION EXCAVATION					
		Assume common material stockpiled for reuse					
		Assume rock material stockpiled for reuse					
		Stockpiles will be upstream, within 1/2 mile of dam					
	1	Excavation, stripping, of dam foundation	D8312	370,000	CY	$2.00	$740,000.00
		Assume depth of stripping 12 inches or less					
		Assume stripping will be stockpiled for topsoil use					
	2	Excavation, common, for dam foundation	D8312	27,130,000	CY	$3.00	$81,390,000.00
		Assume about 35% of volume requires ripping					
		Assume fine-grained and coarse-grained materials					
		will be separately stockpiled					
	3	Excavation, rock, for dam foundation	D8312	5,000	CY	$32.00	$160,000.00
		Assume drill and blast in random locations					
		FOUNDATION TREATMENT					
		Includes misc. foundation treatment, fault zone					
		treatment, consolidation grouting, and curtain grouting					
		Miscellaneous Foundation Areas					
		Applied in areas of poor quality rock					
	4	Slush grouting of foundation surface	D8312	165,000	SF	$2.00	$330,000.00
		Over assumed 10% of area beneath zone 1					
	5	Dental concrete	D8312	5,000	CY	$150.00	$750,000.00
	6	Furnish/place zone 2 sand filter on foundation	D8312	40,000	CY	$28.00	$1,120,000.00
		Over 10% of area between zone 1 and d/s toe					
		Assume a 3-ft thickness					
	7	Furnish/place zone 3 gravel drain on foundation	D8312	40,000	CY	$25.00	$1,000,000.00
		Over the zone 2 filter in a 3-ft thickness					
		Dam 2 Subtotal					**$85,490,000.00**

QUANTITIES		PRICES	
BY Will Gonzales	CHECKED Bill Engemoen	BY D. Donaldson DCD	CHECKED BOV 8/17/04
DATE PREPARED 4/12/2004	PEER REVIEW Bill Engemoen	DATE PREPARED 08/17/04	PEER REVIEW 8/17/04

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
Dam Type 2: Central -Core Rockfill Dam

Dam2 - Civil/Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		FOUNDATION TREATMENT (continued)					
		Treatment of south abutment fault area					
	8	Extra rock excavation for fault treatment	D8312	150,000	CY	$20.00	$3,000,000.00
		Assume south abutment is fractured					
		Assume excavate with hydraulic excavator					
	9	Dental concrete for fault treatment	D8312	5,000	CY	$140.00	$700,000.00
	10	Furnish/place zone 2 sand filter downstream of zone 1	D8312	55,000	CY	$28.00	$1,540,000.00
		Assume a 3-ft thickness, 500' by 1000' area					
		Assume same source as listed under emb.					
	11	Furnish/place zone 3 gravel drain d/s of zone 1	D8312	55,000	CY	$25.00	$1,375,000.00
		Assume 3-ft thickness, over zone 2 filter					
		Consolidation Grouting of Foundation					
		Generally limited to area beneath zone 1					
	12	Setups for drilling grout holes	D8312	6,000	EA	$75.00	$450,000.00
		Assume 2-inch dia. drilled on 10-foot centers					
	13	Drill grout holes	D8312	180,000	LF	$15.00	$2,700,000.00
		Assume 2-inch dia. w/length= 30 feet					
	14	Hookups to grout holes	D8312	6,000	EA	$60.00	$360,000.00
	15	Pressure grout	D8312	270,000	CF	$7.00	$1,890,000.00
		Assume grouting process only minus cement					
		Assume 2 CF per 1 LF of hole					
	16	Furnish and handle cement for pressure grouting	D8312	270,000	BAGS	$8.00	$2,160,000.00
		Assume 1 bag per CF					
		Curtain Grouting of Foundation					
		Two-row curtain beneath zone 1					
	17	Setups for drilling grout holes	D8312	1,400	EA	$100.00	$140,000.00
		Assume 2-rows of 2-inch dia.on 10-ft centers					
	18	Drill grout holes	D8312	275,000	LF	$15.00	$4,125,000.00
		Assume 2-inch dia. w/length from 60 to 250 feet					
	19	Hookups to grout holes	D8312	1,400	EA	$75.00	$105,000.00
	20	Pressure grout	D8312	550,000	CF	$7.00	$3,850,000.00
		Assume grouting process only minus cement					
		Assume 2 CF per 1 LF of hole					
	21	Furnish and handle cement for pressure grouting	D8312	550,000	BAGS	$8.00	$4,400,000.00
		Assume 1 bag per CF					
		Dam 2 Subtotal					**$26,795,000.00**

QUANTITIES		PRICES	
BY Will Gonzales	**CHECKED** Bill Engemoen	**BY** D. Donaldson DCD	**CHECKED** BOV 8/17/04
DATE PREPARED 4/12/2004	**PEER REVIEW** Bill Engemoen	**DATE PREPARED** 08/17/04	**PEER REVIEW** RAS 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
Dam Type 2: Central -Core Rockfill Dam

Dam2 - Civil/Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		EMBANKMENT CONSTRUCTION					
		Items are set up as furnish and place, which would					
		include purchasing from commercial sites,					
		processing onsite, development of quarry, or					
		transporting from stockpiles of required excavation					
	22	Furnish and place zone 1 core	D8312	9,000,000	CY	$8.50	$76,500,000.00
		Acquired from source 6 miles from dam					
		Compacted to 6-inch lifts by tamping roller					
	23	Furnish and place zone 2 filter	D8312	1,390,000	CY	$25.00	$34,750,000.00
		Sand/gravel material processed commercially					
		or developed onsite					
		If commercial, assume 17 mile one-way haul					
		Compacted to 12-inch layers by vibratory steel drum					
	24	Furnish and place zone 3 drain	D8312	1,390,000	CY	$23.00	$31,970,000.00
		Gravel/cobble material processed commercially or					
		developed onsite					
		If commercial, assume 17 mile one-way haul					
		Compacted to 12-inch layers by vibratory steel drum					
	25	Furnish and place zone 4 rockfill	D8312	58,700,000	CY	$6.50	$381,550,000.00
		Developed from basalt ridges surrounding reservoir					
		Assume average 1-mile haul to dam					
		Rock sizes up to 3-foot					
		Compacted in 3-ft layers by vibratory steel drum					
	26	Furnish and place zone 5 coarse grained random fill	D8312	15,000,000	CY	$4.00	$60,000,000.00
		Comes from stockpiles of required excavation					
		within 1/2 mile of dam					
		Generally consists of gravelly soils					
		Compacted in 2-ft layers by vibratory steel drum					
	27	Furnish and place zone 6 fine grained random fill	D8312	8,050,000	CY	$4.50	$36,225,000.00
		Comes from stockpiles of required excavation					
		within 1/2 mile of dam					
		Generally consists of sands/silts/clays					
		Compacted to 9-inch layers by tamping rollers					
		Dam 2 Subtotal					**$620,995,000.00**

QUANTITIES		PRICES	
BY Will Gonzales	**CHECKED** Bill Engemoen	**BY** D. Donaldson DCD	**CHECKED** BDI 8/17/04
DATE PREPARED 4/12/2004	**PEER REVIEW** Bill Engemoen	**DATE PREPARED** 08/17/04	**PEER REVIEW** RAN 8/17/04

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Black Rock Dam and Reservoir *Large Reservoir - Active Storage= 1.3 MAF* *Dam Type 2: Central -Core Rockfill Dam* Dam2 - Miscellaneous	**Yakima River Basin Water Storage Options** REGION: PN — PRICE LEVEL: Appraisal FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		MISCELLANEOUS					
		Instrumentation					
		Assume part of unlisted items					
		Toe Drains					
		Assume part of unlisted items					
		Site cleanup and relandscaping					
		Assume part of unlisted items					
		Dam 2 Subtotal					$0.00

QUANTITIES		PRICES	
BY Will Gonzales	CHECKED Bill Engemoen	BY D. Donaldson DED	CHECKED GOV 8/17/04
DATE PREPARED 4/12/2004	PEER REVIEW Bill Engemoen	DATE PREPARED 08/17/04	PEER REVIEW RAS 8/17/04

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
Dam Type 3: Roller Compacted Concrete (RCC) Dam

Dam3 - Civil/Structural

PROJECT: **Yakima River Basin Water Storage Options**

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		General Sitework					
		Clear and Grub reservoir area (not required)					
		Roads, haul roads, instrumentation, site cleanup and					
		relandscaping included in unlisted items					
		Diversion/Dewatering during Construction					
		Assume groundwater is below excavation.					
		Assume natural stream beds in area are dry.					
		Foundation Excavation and Backfill					
		Strip topsoil and stockpile for reuse					
		Assume stockpile common material for backfill					
		Assume stockpile rock material for riprap and erosion protection					
		Assume drill and shoot rock for tunnels in ROW					
		foundation excavation					
		Materials for RCC					
		Assume RCC plant set up at dam site and materials					
		trucked to the site					
		Assume concrete sand and aggregates come from					
		Columbia or Yakima river basins and have a					
		haul distance of 17-18 miles ave.					
		Assume cement shipped by rail to redi-mix plants					
		that are 20 miles ave. distance from site.					
		Dam excavation and backfill	D8130				
	1	Strip topsoil and stockpile (1ft. Thick)		135,000	CY	$2.00	$270,000.00
	2	Excavate common material for dam foundation		10,500,000	CY	$3.50	$36,750,000.00
	3	Excavate rock for dam foundation		105,000	CY	$13.00	$1,365,000.00
		Assume ~ 1% of common excavation					
	4	Excavate rock for OW on right abutment		5,300	CY	$32.00	$169,600.00
	5	Backfill with common material from excavation		4,300,000	CY	$3.50	$15,050,000.00
		Foundation Treatment - Exc. And concrete treatment	D8130				
	6	Extra rock excavation for fault treatment		75,000	CY	$13.00	$975,000.00
		Assume south abutment is fractured					
		Assume excavate with hydraulic excavator					
	7	Dental concrete for fault treatment		2,500	CY	$150.00	$375,000.00
	8	Dental concrete for general foundation treatment		10,000	CY	$130.00	$1,300,000.00
	9	Furnish and handle cement (.282T/CY)		3,500	TONS	$120.00	$420,000.00
		Dam 3 Subtotal					**$56,674,600.00**

QUANTITIES		PRICES	
BY Doug Stanton DS	**CHECKED** GAR	**BY** D. Donaldson DCD	**CHECKED** BOV 8/17/04
DATE PREPARED 4/24/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** LAS 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE: Black Rock Dam and Reservoir *Large Reservoir - Active Storage= 1.3 MAF* *Dam Type 3: Roller Compacted Concrete (RCC) Dam* Dam3 - Civil/Structural	**PROJECT:** Yakima River Basin Water Storage Options **REGION** PN **PRICE LEVEL:** Appraisal **FILE:** C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Foundation Treatment - Consolidation grouting	D8130				
	10	Setups for drilling grout holes		21,800	EA	$50.00	$1,090,000.00
		Assume 2-inch dia. drilled on 10-foot centers					
	11	Drill grout holes - 2-in. dia @ 30 ft long		654,000	LF	$15.00	$9,810,000.00
	12	Hookups to grout holes		21,800	EA	$35.00	$763,000.00
	13	Pressure grout		1,308,000	CF	$6.50	$8,502,000.00
		Assume grouting process only minus cement					
		Assume 2 CF per 1 LF of hole					
	14	Furnish and handle cement for pressure grouting		1,308,000	BAGS	$7.00	$9,156,000.00
		Assume 1 bag per CF					
		Foundation Treatment - Grout Curtain thru gallery	D8130				
	15	Setups for drilling grout holes		675	EA	$100.00	$67,500.00
		Assume 2-inch dia. Holes on 10-foot centers					
	16	Drill grout holes		170,000	LF	$15.00	$2,550,000.00
		Assume 2-inch dia. w/depth ~55% ave H					
	17	Hookups to grout holes		675	EA	$100.00	$67,500.00
	18	Pressure grout		340,000	CF	$7.00	$2,380,000.00
		Assume grouting process only minus cement					
		Assume 2 CF per 1 LF of hole					
	19	Furnish and handle cement for pressure grouting		340,000	BAGS	$8.00	$2,720,000.00
		Assume 1 bag per CF					
	20	F&I 4-inch dia. steel pipe nipples (assume 4'/drain)		2,700	LF	$60.00	$162,000.00
		Leveling Concrete for Foundation	D8130				
	21	Assume 6 sack mix, 3-foot thick over footprint		267,000	CY	$200.00	$53,400,000.00
	22	Furnish and handle cement (.282T/CY)		75,000	TONS	$100.00	$7,500,000.00
		Drill foundation drains from gallery	D8130				
	23	Setups (assume 10-ft centers)		700	EA	$100.00	$70,000.00
	24	Drill holes		175,000	LF	$15.00	$2,625,000.00
		Assume 4-inch dia. w/length= 33% dam height.					
		Drill formed drains in dam body along U/S face	D8130				
		Assume 10-ft ctrs and 6-inch dia.					
	25	Lower gallery - Setups		440	EA	$100.00	$44,000.00
	26	Lower gallery - Holes drilled from gallery upward		94,500	LF	$15.00	$1,417,500.00
	27	Upper gallery - Setups		670	EA	$100.00	$67,000.00
	28	Upper gallery - holes drilled from dam crest to gallery		142,500	LF	$15.00	$2,137,500.00
		Dam 3 Subtotal					**$104,529,000.00**

QUANTITIES		PRICES	
BY Doug Stanton DS	**CHECKED** BLR	**BY** D. Donaldson DLD	**CHECKED** GPV 8/17/04
DATE PREPARED 4/24/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** [illegible] 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

SHEET 14 OF 33

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
Dam Type 3: Roller Compacted Concrete (RCC) Dam

Dam3 - Civil/Structural

PROJECT: **Yakima River Basin Water Storage Options**

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct RCC Dam	D8130				
		Assume 275 lb/CY cementitious material					
		Assume 40% fly ash and 60% cement					
		Assume aggregate processed and hauled 15-20 miles					
		Assume cement hauled 20-25 miles					
	29	Construct RCC test section		4,100	CY	$140.00	$574,000.00
		Estimated dimensions = 100' x 35' x 30'					
		Assume convent. Conc. Facing elements					
		Assume incorporated into thrust block for stilling					
		basin and control house					
		Includes gallery forming, waterstops, Contraction					
		joint, facing elements, bonding mortar					
		(no grouting)					
	30	Construct RCC Dam (Complete in Place)		22,018,000	CY	$28.00	$616,504,000.00
	30A	Furnish and handle cement (.138T/CY)		3,027,500	TONS	$90.00	$272,475,000.00
	31	Bonding Mortar (Assume 1/2-inch thick/lift on all lifts)		975,000	CY	$70.00	$68,250,000.00
		Cast-in-place Conventional Concrete	D8130				
	32	Facing elements - slipformed on U/S face		200,000	CY	$100.00	$20,000,000.00
	33	Facing elements - slabs on D/S face		244,000	CY	$100.00	$24,400,000.00
	34	Furnish and handle cement (.282T/CY)		125,200	TONS	$100.00	$12,520,000.00
	35	FRP Reinforced concrete dam crest		11,200	CY	$250.00	$2,800,000.00
	36	Assume 1.5 foot thick (160 lbs/CY)		1,800,000	LBS	$0.80	$1,440,000.00
	37	Furnish and handle cement (.282T/CY)		3,100	TONS	$120.00	$372,000.00
	38	FRP Reinforced concrete parapets on dam crest		2,600	CY	$400.00	$1,040,000.00
		Estimated 6,700 on both u/s and d/s sides					
	39	F & P reinforcement (160 lbs/CY)		416,000	LBS	$0.80	$332,800.00
	40	Furnish and handle cement (.282T/CY)		750	TONS	$120.00	$90,000.00
		Dam 3 Subtotal					**$1,020,797,800.00**

QUANTITIES		PRICES	
BY Doug Stanton DS	CHECKED BdB	BY D. Donaldson DCD	CHECKED BDV 8/17/04
DATE PREPARED 4/24/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW RLH 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
Dam Type 3: Roller Compacted Concrete (RCC) Dam

Dam3 - Civil/Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct RCC Dam (continued)	D8130				
	41	Form lower drain/grout gallery/adits within RCC section		7,000	LF	$50.00	$350,000.00
		Assume 6-ft wide x 10-ft high across base of dam					
		Assume Symons Panel system for 12" RCC lifts					
	42	Form upper drainage gallery/adits within RCC section		4,800	LF	$50.00	$240,000.00
		Assume 6-ft wide x 10-ft high across base of dam					
		Assume Symons Panel system for 12" RCC lifts					
	43	F&I 12-in PVC waterstops for u/s CrJs & facing elements		119,000	LF	$15.00	$1,785,000.00
		Assume 135 CrJs @ 50-ft centers					
	44	F& I Crack inducers @ CrJ's in facing elements		59,500	LF	$15.00	$892,500.00
		(Assume 1/2 L of waterstops and 6 ft wide)					
		Similar to Milltown Hill					
	45	F&I Metal crack inducer plates for CrJs in RCC		5,587,000	LF	$8.00	$44,696,000.00
		Assume placed every other lift					
		Similar to Pueblo Dam					
		Abutment Adits	D8130				
	46	Drill and shoot 16-ft Dia. for adit (15,500 CY)		1,100	LF	$2,500.00	$2,750,000.00
	47	Remove and stockpile rock (assume local stockpile)		15,500	CY	$20.00	$310,000.00
	48	Furnish and install 2500-10-ft long x 1-inch dia.		12,500	LF	$60.00	$750,000.00
		A307, 20K rockbolts					
	49	Furnish and install steel sets (W8 x 48) in crown		200,000	LBS	$4.00	$800,000.00
	50	FF & P concrete in adits (6' x 10')		7,300	CY	$350.00	$2,555,000.00
	51	Furnish and handle cement (.282T/CY)		2,100	TONS	$120.00	$252,000.00
		Grout adits	D8130				
	52	Setups for drilling grout holes (2-in dia holes, 10 ft ctrs,		880	EA	$100.00	$88,000.00
		and 8 holes per ring)					
	53	Drill grout holes (2-in dia and L=30 ft)		26,400	LF	$20.00	$528,000.00
	54	Hookups to grout holes		880	EA	$100.00	$88,000.00
	55	Pressure grout (grouting process only minus cement)		52,800	CF	$8.00	$422,400.00
		Assume 2 CF per 1 LF of hole					
	56	Furnish and handle cement for pressure grouting		52,800	BAGS	$10.00	$528,000.00
		Assume 1 bag per CF					
		Dam 3 Subtotal					**$57,034,900.00**

QUANTITIES		PRICES	
BY Doug Stanton DS	CHECKED BAR	BY D. Donaldson DCD	CHECKED GDV 8/17/04
DATE PREPARED 4/24/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW LAS 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

SHEET 16 OF 33

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
Dam Type 3: Roller Compacted Concrete (RCC) Dam

Dam3 - Miscellaneous

PROJECT:
Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		MISCELLANEOUS					
		Instrumentation					
		Assume part of unlisted items					
		Dam 3 Subtotal					$0.00

QUANTITIES		PRICES	
BY Dick LaFond	CHECKED M.R.O'Shea	BY D. Donaldson DCD	CHECKED BDV 8/17/04
DATE PREPARED 4/24/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW RSS 8/17/04

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Black Rock Dam and Reservoir *Large Reservoir - Active Storage= 1.3 MAF* *River Outlet Works for Rockfill Dams*	**Yakima River Basin Water Storage Options**
	REGION PN — PRICE LEVEL: Appraisal
ROW1 - Civil/Structural	FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Establish Upstream Portal	D8130				
	1	Common excavation to establish tunnel portal		67,000	CY	$10.00	$670,000.00
	2	Rock excavation to establish tunnel portal		8,300	CY	$30.00	$249,000.00
	3	Furnish and install chain link fabric around portal		350	SY	$20.00	$7,000.00
	4	F&I 18-inch x 1/2 in. dia resin anchors for fabric support		40	EA	$75.00	$3,000.00
		Establish Downstream Portal	D8130				
	5	Common excavation to establish tunnel portal		67,000	CY	$10.00	$670,000.00
	6	Rock excavation to establish tunnel portal		8,300	CY	$30.00	$249,000.00
	7	Furnish and install chain link fabric around portal		350	SY	$20.00	$7,000.00
	8	F&I 18-inch x 1/2 in. dia resin anchors for fabric		40	EA	$75.00	$3,000.00
		Construct ROW tunnel u/s of gate chamber	D8130				
	9	Drill and shoot 28-ft Dia.circular shaped u/s tunnel (18,400 CY)		700	LF	$4,000.00	$2,800,000.00
	10	Remove and stockpile rock (assume local stockpile)		18,400	CY	$20.00	$368,000.00
	11	Furnish and install 790-10-ft long x 1-inch dia.					
		A307, 20K rockbolts		7,900	LF	$60.00	$474,000.00
	12	Furnish and install 9 steel sets (W8 x 48) in crown		45,000	LBS	$4.00	$180,000.00
		Construct ROW tunnel d/s of gate chamber	D8130				
	13	Drill and shoot 32-ft OD mod.HS shaped d/s tunnel (23,000 CY)		600	LF	$5,500.00	$3,300,000.00
	14	Remove and stockpile rock (assume local stockpile)		23,000	CY	$20.00	$460,000.00
	15	Furnish and install 740-10-ft long x 1-inch dia.					
		A307, 20K rockbolts		7,400	LF	$60.00	$444,000.00
	16	Furnish and install 9 steel sets (W10 x 54) in crown		47,000	LBS	$4.00	$188,000.00
		Construct ROW Gate Chamber and Shaft	D8130				
	17	Drill and shoot 24-ft diameter shaft (800 CY)		40	LF	$7,000.00	$280,000.00
	18	Remove and stockpile rock (assume local stockpile)		800	CY	$20.00	$16,000.00
	19	Furnish and install 64 - 10-ft long x 1-inch dia.					
		A307, 20K rockbolts		640	LF	$75.00	$48,000.00
	20	Furnish and install 4 circular steel sets (W8 x 48)		17,000	LBS	$4.00	$68,000.00
		Place Conc. Lining In Tunnel, Shaft & Gate Chamber	D8130				
	21	FF&P reinf. Concrete in u/s steel-lined tunnel		10,200	CY	$350.00	$3,570,000.00
	22	FF&P reinf. concrete gate chamber		600	CY	$500.00	$300,000.00
	23	FF&P reinf. Concrete in d/s tunnel		11,400	CY	$350.00	$3,990,000.00
	24	Furnish and place reinforcement (160 lbs/CY)		3,550,000	LBS	$0.90	$3,195,000.00
	25	Furnish and handle cement (.282T/CY)		6,300	TONS	$120.00	$756,000.00
		ROW1 Subtotal					**$22,295,000.00**

QUANTITIES		PRICES	
BY Doug Stanton DS	CHECKED BdR	BY D. Donaldson DCD	CHECKED BDV 8/17/04
DATE PREPARED 4/24/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW RB 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE: Black Rock Dam and Reservoir *Large Reservoir - Active Storage= 1.3 MAF* *River Outlet Works for Rockfill Dams* ROW1 - Civil/Structural	**PROJECT:** Yakima River Basin Water Storage Options **REGION** PN **PRICE LEVEL:** Appraisal **FILE:** C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Ring Grout Upstream Conduit	D8130				
	26	Setups for drilling grout holes (2-in dia holes, 20 ft ctrs,		36	EA	$150.00	$5,400.00
		and 8 holes per ring)					
	27	Drill grout holes (2-in dia and L=30 ft)		8,640	LF	$20.00	$172,800.00
	28	Hookups to grout holes		288	EA	$100.00	$28,800.00
	29	Pressure grout (grouting process only minus cement)		17,300	CF	$10.00	$173,000.00
		Assume 2 CF per 1 LF of hole					
	30	Furnish and handle cement for pressure grouting		17,300	BAGS	$12.00	$207,600.00
		Assume 1 bag per CF					
		Ring Grout Shaft and Gate Chamber	D8130				
	31	Setups for drilling grout holes (2-in dia holes, 20 ft ctrs,		5	EA	$200.00	$1,000.00
		and 8 holes per ring)					
	32	Drill grout holes (2-in dia and L=30 ft)		1,200	LF	$25.00	$30,000.00
	33	Hookups to grout holes		40	EA	$150.00	$6,000.00
	34	Pressure grout (grouting process only minus cement)		2,400	CF	$15.00	$36,000.00
		Assume 2 CF per 1 LF of hole					
	35	Furnish and handle cement for pressure grouting		2,400	BAGS	$15.00	$36,000.00
		Assume 1 bag per CF					
		Ring Grout Downstream Conduit	D8130				
	36	Setups for drilling grout holes (2-in dia holes, 20 ft ctrs,		6	EA	$200.00	$1,200.00
		and 8 holes per ring)					
	37	Drill grout holes (2-in dia and L=30 ft)		1,440	LF	$25.00	$36,000.00
	38	Hookups to grout holes		48	EA	$150.00	$7,200.00
	39	Pressure grout (grouting process only minus cement)		2,880	CF	$15.00	$43,200.00
		Assume 2 CF per 1 LF of hole					
	40	Furnish and handle cement for pressure grouting		2,880	BAGS	$15.00	$43,200.00
		Assume 1 bag per CF					
		Earthwork - intake, u/s conduit, d/s pipe,	D8130				
		stilling basin and discharge channel					
	41	Excavation of common materials for basin and channel		400,000	CY	$4.00	$1,600,000.00
	42	F & P impervious material (Zone 6 Ringold - local)		20,000	CY	$4.50	$90,000.00
	43	F & P bedding for riprap (zone 3 gravel)		10,000	CY	$30.00	$300,000.00
	44	F & P rockfill from dam excavation (riprap)		30,000	CY	$10.00	$300,000.00
	45	F & P backfill for intake and u/s conduit (Ringold - local)		16,000	CY	$7.00	$112,000.00
	46	Excavation of common materials for burying 16' pipe		312,000	CY	$5.00	$1,560,000.00
	47	Backfill for burying 16' dia. Pipe - zone 3 bedding		20,000	CY	$40.00	$800,000.00
	48	Backfill for burying 16' dia. Pipe - From common exc.		197,000	CY	$7.00	$1,379,000.00
		ROW1 Subtotal					**$6,968,400.00**

QUANTITIES		PRICES	
BY Doug Stanton *DS*	**CHECKED** *GLB*	**BY** D. Donaldson *DCD*	**CHECKED** *BOV 8/17/04*
DATE PREPARED 4/24/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** *RAS 8/17/04*

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
River Outlet Works for Rockfill Dams

ROW1 - Civil/Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct ROW cast in place (CIP) concrete	D8130				
	49	Furnish, form, and place reinf. Conc - Intake structure		12,000	CY	$350.00	$4,200,000.00
	50	Furnish and place reinforcement (est 180#/CY)		2,160,000	LBS	$0.80	$1,728,000.00
	51	Furnish and handle cement (.282T/CY)		3,400	TONS	$120.00	$408,000.00
	52	FFP Reinf. Conc - Steel lined U/S Conduit (L=400')		11,000	CY	$350.00	$3,850,000.00
	53	Furnish and place reinforcement (est 170#/CY)		1,870,000	LBS	$0.80	$1,496,000.00
	54	Furnish and handle cement (.282T/CY)		3,100	TONS	$120.00	$372,000.00
	55	FFP reinf. concrete - CIP shaft (L=375)		6,400	CY	$350.00	$2,240,000.00
	56	Furnish and place reinforcement (est 170#/CY)		1,088,000	LBS	$0.80	$870,400.00
	57	Furnish and handle cement (.282T/CY)		1,800	TONS	$130.00	$234,000.00
	58	FFP reinf. concrete - shaft control house		440	CY	$500.00	$220,000.00
	59	Furnish and place reinforcement (160#/CY)		70,000	LBS	$1.00	$70,000.00
	60	Furnish and handle cement (.282T/CY)		120	TONS	$160.00	$19,200.00
	61	FFP reinf. Concrete in gate chamber		450	CY	$500.00	$225,000.00
	62	Furnish and place reinforcement (160#/CY)		72,000	LBS	$1.00	$72,000.00
	63	Furnish and handle cement (.282T/CY)		130	TONS	$160.00	$20,800.00
	64	FFP reinf. concrete - D/S access house		500	CY	$500.00	$250,000.00
	65	Furnish and place reinforcement (160#/CY)		80,000	LBS	$1.00	$80,000.00
	66	Furnish and handle cement (.282T/CY)		140	TONS	$160.00	$22,400.00
	67	FFP reinf. concrete for thrust block @ 80 deg bend		5,100	CY	$400.00	$2,040,000.00
	68	Furnish and place reinforcement (130 #/cy)		663,000	LBS	$0.80	$530,400.00
	69	Furnish and handle cement (.20T/CY)		1,020	TONS	$130.00	$132,600.00
	70	FFP reinf. concrete - jet flow gate control house		700	CY	$800.00	$560,000.00
	71	Furnish and place reinforcement (160#/CY)		112,000	LBS	$1.00	$112,000.00
	72	Furnish and handle cement (.282T/CY)		200	TONS	$160.00	$32,000.00
	73	FFP reinf. concrete for thrust block @ jet gate house		4,100	CY	$400.00	$1,640,000.00
	74	Furnish and place reinforcement (130 #/cy)		533,000	LBS	$0.80	$426,400.00
	75	Furnish and handle cement (.20T/CY)		820	TONS	$140.00	$114,800.00
		ROW1 Subtotal					**$21,966,000.00**

QUANTITIES		PRICES	
BY Doug Stanton DS	**CHECKED** RXR	**BY** D. Donaldson DCD	**CHECKED** BDJ 8/17/04
DATE PREPARED 4/24/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** JAS 8/17/04

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
River Outlet Works for Rockfill Dams

ROW1 - Mechanical

PROJECT:
Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	76	Miscellaneous Metalwork	D8120	14,000	LBS	$7.00	$98,000.00
		Assume ladder in shaft to gate chamber, elevator rail supports, misc metal in gate house, gate chamber and D/S gate house.					
		Mechanical					
	77	Furnish and install steel trashracks	D8410	337,500	LBS	$4.00	$1,350,000.00
	78	Furnish and install one bulkhead 22' x 24' @ 400' head	D8410	144,000	LBS	$4.00	$576,000.00
	79	Furnish and install seats and guides with lid	D8410	23,900	LBS	$6.00	$143,400.00
	80	Furnish and install one elevator, capacity = 500 lbs (2 person), speed = 100 fpm, travel = 450', landings = 2, type = freight	D8410	1	UNIT	$150,000.00	$150,000.00
		HVAC for: **4200-ft long by 26-ft dia. penstock tunnel and 430-ft deep by 24'dia shaft to gate chamber)**	D-8410				
	81	Centrifugal fan rated: 16,000cfm @ 8" static pressure, 1200 fan rpm max, 2200-fpm max. fan outlet velocity, with adjustable sheave with 2-speed motor for 50% speed (8000-cfm at 2"sp) belt-drive, 30-Hp, 460-V, 3-Ph, 60-Hz, 1800-rpm motor. (approx 700-lbs+motor wt)	D-8410	2	EA	$15,000.00	$30,000.00
	82	48" Dia, 16-ga galv st. duct 4700 ft long (Wt with supports approx = 40-lbs/linear ft)	D-8410	188,000	LBS	$7.50	$1,410,000.00
		For 50-degree F temperature rise for winter ventilation, Assuming 90% recirculated air & 10% outside air					
	83	30-kVa Electric Duct heaters 480-V, 3-ph, 60-hz with thermostats Note: (100% outside air requires total of 515-kW heat for 32000 cfm for construction level ventilation or 210-kW for inspection level ventilation)	D-8410	2	EA	$15,000.00	$30,000.00
		ROW1 Subtotal					**$3,787,400.00**

QUANTITIES		PRICES	
BY D. LaFond (D8120) P. Schlein, A. Ritt, R. Christensen (D8410)	**CHECKED** M.R.O'Shea (D-8120) AHR	**BY** D. Donaldson DED	**CHECKED** BDV 8/17/04
DATE PREPARED 4/24/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** RM 8/17/04

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
River Outlet Works for Rockfill Dams

ROW1 - Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont.)					
		Heating and Ventilating	D-8410				
		50'x40'x24' Control House					
	84	Centrifugal fan: 1 each	D-8410	1	EA	$2,500.00	$2,500.00
		Single speed,1500 cfm at 0.50 inches w.g. static					
		pressure, forward curve, direct drive; 3/4 hp motor					
		rated 480 Vac, Three phase, 60 Hz.					
	85	Propeller fan assembly: 1 each	D-8410	1	EA	$3,000.00	$3,000.00
		Single speed, 4,800 cfm at 0.50 inches w.g. static					
		pressure, belt drive; 1.5 hp motor rated 460 Vac,					
		three phase, 60 Hz; include fan wall mount					
		housing with motor guard.					
	86	Unit heaters:	D-8410	4	EA	$750.00	$3,000.00
		Electric horizontal discharge rated 7.5 kw,					
		460 Vac, 3-phase, 60 Hz. (One each corner -18' throw)					
		with wall thermostats					
	87	Control dampers: All motor operated, parallel blade,	D-8410				
		low leakage type with edge and side seals:					
		48" wide x 48" high - 1 each		1	EA	$2,500.00	$2,500.00
		36" wide x 36" high - 1 each		1	EA	$1,500.00	$1,500.00
	88	Stationary louvers: All 16 gauge galvanized steel,	D-8410				
		4-inch deep frame, 45 degree blades on 4-inch centers,					
		45 percent free area, with insect and bird screen:					
		48" wide x 48" high - 1 each		1	EA	$2,000.00	$2,000.00
		36" wide x 36" high - 1 each		1	EA	$1,000.00	$1,000.00
		ROW1 Subtotal					**$15,500.00**

QUANTITIES		PRICES	
BY Paul Schlein	CHECKED AMR	BY D. Donaldson DeD	CHECKED GOV 8/17/04
DATE PREPARED 4/24/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW LAS 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
River Outlet Works for Rockfill Dams

ROW1 - Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical					
		(Continuation of HVAC System)	D-8410				
		(50'x40'x24' Control House)					
	89	Fan motor starters: Design, furnish and install control system	D-8410	2	EA	$2,500.00	$5,000.00
	90	Ductwork: All 16-gauge galvanized steel with extra heavy (ASTM A90 G120) galvanized coating: Air plenum: 250 lbs.	D-8410	250	LBS	$10.00	$2,500.00
	91	48"x48" galv steel intake air filter frames using nine(9) 24"x16"x2" disposable filter elements in frame with dirty filter differential pressure sensor with warning light and remote signal.	D-8410	1	EA	$2,000.00	$2,000.00
	92	16"x24"x2" disposable fiberglass, 30% min efficiency, Filter elements (estimate 9 elements with spares for testing, startup and two replacements each.	D-8410	36	EA	$25.00	$900.00
	93	Galv. Steel duct and fan supports.	D-8410	200	LBS	$10.00	$2,000.00
		ROW1 Subtotal					**$12,400.00**

QUANTITIES		PRICES	
BY: Paul Schlein	CHECKED: Aon	BY: D. Donaldson DCD	CHECKED: BOV 8/17/04
DATE PREPARED: 4/24/04	PEER REVIEW	DATE PREPARED: 08/17/04	PEER REVIEW: RDB 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
River Outlet Works for Rockfill Dams

ROW1 - Mechanical

PROJECT:
Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Steel penstock					
		FURNISH-AND-INSTALL THE FOLLOWING:	D8420				
	94	240-inch steel pipe, encased in concrete		4,260,000	LBS	$2.00	$8,520,000.00
		(1000 linear feet, 1-1/2-inch wall, 4290 lb per lin. ft.)					
	95	192-inch steel pipe, encased in concrete		2,840,000	LBS	$2.00	$5,680,000.00
		(1000 linear feet, 1-1/4-inch wall, 2841 lb per lin. ft.)					
	96	192-inch steel pipe, buried		660,000	LBS	$2.00	$1,320,000.00
		(273 linear feet, 1-1/16-inch wall, 2412 lb per lin. ft.)					
	97	192-inch steel pipe, buried		1,360,000	LBS	$2.00	$2,720,000.00
		(601 linear feet, 1-inch wall, 2269 lb per lin. ft.)					
	98	192-inch steel pipe, buried		1,280,000	LBS	$2.00	$2,560,000.00
		(601 linear feet, 15/16-inch wall, 2127 lb per lin. ft.)					
	99	192-inch steel pipe, buried		1,190,000	LBS	$2.00	$2,380,000.00
		(601 linear feet, 7/8-inch wall, 1985 lb per lin. ft.)					
	100	192-inch steel pipe, buried		1,110,000	LBS	$2.00	$2,220,000.00
		(600 linear feet, 13/16-inch wall, 1842 lb per lin. ft.)					
	101	120-inch steel pipe, buried and exposed		115,000	LBS	$2.00	$230,000.00
		(100 linear feet, 13/16-inch wall, 1154 lb per lin. ft.)					
	102	60-inch steel pipe, vertical, grouted, air vent		115,000	LBS	$2.50	$287,500.00
		(418 linear feet, 3/8-inch wall, 266 lb per lin. ft.)					
		ROW1 Subtotal					**$25,917,500.00** ✓

QUANTITIES		PRICES	
BY Ken Smith	CHECKED	BY D. Donaldson DED	CHECKED BDV 8/17/04
DATE PREPARED 4/26/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW RAS 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
River Outlet Works for Rockfill Dams

ROW1 - Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Gates and Gate Controls					
		Furnish and Install					
	103	F & I -18' x 14' Roller gate w/controls	D8420	180,400	LBS	$8.00	$1,443,200.00
		1 - gate and 1 control box (in shaft house)					
	104	F&I structural steel for hoist support		10,000	LBS	$4.00	$40,000.00
	105	F & I - 2 - 108-inch jet flow gates w/controls		89,400	LBS	$8.00	$715,200.00
		2 gates and 1 control box					
	106	F & I - 36-inch jet flow gate w/controls and bypass pipe		30,000	LBS	$8.00	$240,000.00
		1 gate and 1 control box (in shaft house)					
		ROW1 Subtotal					**$2,438,400.00**

QUANTITIES		PRICES	
BY: G. Rood	CHECKED	BY: D. Donaldson DCD	CHECKED: DDV 8/17/04
DATE PREPARED: 4/26/04	PEER REVIEW	DATE PREPARED: 08/17/04	PEER REVIEW: Rod 8/17/04

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
River Outlet Works for Rockfill Dams

ROW1 - Electrical

PROJECT: Yakima River Basin Water Storage Options

REGION PN | **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Electrical					
		This estimate is for 2 ROW control bldgs, one					
		on top of dam and the other downstream for the					
		regulating gates.					
		Assume bringing power to dam part of unlisted items.					
		Furnish and install the following electrical equipment:					
		Grounding System	D-8430				
	107	Ground rods, 10 ft, 3/4" dia., copper-clad		6	EA	$180.00	$1,080.00
	108	Stranded bare-copper conductor, 4 AWG		250	LF	$2.50	$625.00
		Conduit System	D-8430				
		Rigid steel conduit					
	109	3/4-inch		200	LF	$12.00	$2,400.00
	110	1-inch		100	LF	$14.00	$1,400.00
		PVC conduit, Schedule 40					
	111	1 1/2-inch		600	LF	$10.00	$6,000.00
		HDPE (High-density polyethylene)					
	112	2-inch		1,000	LF	$15.00	$15,000.00
		Conductors & Cable	D-8430				
		All cable single conductor, stranded copper					
	113	12 AWG		1,500	LF	$0.90	$1,350.00
	114	10 AWG		500	LF	$1.20	$600.00
	115	2 AWG		2,000	LF	$2.20	$4,400.00
	116	1/0 AWG		400	LF	$2.90	$1,160.00
		Electrical Service Equipment	D-8430				
	117	Pole-mounted transformer: 100 kVA, 13.8,kV-480V		1	EA	$5,000.00	$5,000.00
	118	Meter socket, NEMA 3R, 600V, 3-phase		1	EA	$1,500.00	$1,500.00
	119	Safety switch, heavy-duty, NEMA 3R, fusible 3-wire, 600V, 100 ampere		1	EA	$1,000.00	$1,000.00
		Panelboards & Electrical Distribution Equipment					
	120	Panelboard, 3-phase, 480V, 250 ampere		1	EA	$30,000.00	$30,000.00
	121	Distribution load center, 15 kVA, 1-phase 480-240/120V		2	EA	$11,000.00	$22,000.00
		ROW1 Subtotal					**$93,515.00**

QUANTITIES		PRICES	
BY: Mike Schuh	CHECKED: L Rossi	BY: D. Donaldson (signed DED)	CHECKED: DD 8/17/04
DATE PREPARED: 4/24/04	PEER REVIEW	DATE PREPARED: 08/17/04	PEER REVIEW: Rs 8/17/04

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
River Outlet Works for RCC Dam

ROW2 - Civil/Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		General assumptions					
		Assume ROW located on Rt abutment					
		Cut into rock after dam excavation					
		Assume pipe buried d/s of dam					
		Assume pipe encased in concrete in dam					
		Assume RCC test section will be the thrust block					
		Foundation preparation	D8130				
	1	Excavation of rock for OW pipe (hydraulic excavator)		6,000	CY	$32.00	$192,000.00
	2	Excavation of common materials for pipe and house		200,000	CY	$5.00	$1,000,000.00
	3	Backfill for burying 14' dia. Pipe - zone 3 bedding		5,000	CY	$40.00	$200,000.00
	4	Backfill pipe with common materials from excavation		200,000	CY	$7.00	$1,400,000.00
	5	Furnish and install - 40 -10-ft long x 1-inch dia., A307 20K rockbolts - assume 1 every 10 feet		400	LF	$100.00	$40,000.00
		Install pipe on abutment	D8130				
	6	Furnish, form, and place reinforced concrete		6,000	CY	$350.00	$2,100,000.00
	7	Furnish and place reinforcement (165 lbs/CY)		1,000,000	LBS	$0.80	$800,000.00
	8	Furnish and handle cement (.282T/CY)		1,700	TONS	$130.00	$221,000.00
		Construct Fixed Wheel Gate Control House	D8130				
	9	FFP reinf. concrete - fixed wheel gate control house		700	CY	$800.00	$560,000.00
	10	Furnish and place reinforcement (160#/CY)		112,000	LBS	$1.00	$112,000.00
	11	Furnish and handle cement (.282T/CY)		200	TONS	$160.00	$32,000.00
		Construct Jet Flow Gate Control House	D8130				
	12	FFP reinf. concrete - jet flow gate control house		700	CY	$800.00	$560,000.00
	13	Furnish and place reinforcement (160#/CY)		112,000	LBS	$1.00	$112,000.00
	14	Furnish and handle cement (.282T/CY)		200	TONS	$160.00	$32,000.00
		Construct stilling basin for jet flow gate discharge	D8130				
	15	Excavation of common materials for basin and channel		400,000	CY	$4.00	$1,600,000.00
	16	F & P impervious material (Zone 6 Ringold - local)		20,000	CY	$4.50	$90,000.00
	17	F & P bedding for riprap (zone 3 gravel)		10,000	CY	$30.00	$300,000.00
	18	F & P rockfill from dam excavation		30,000	CY	$8.00	$240,000.00
		ROW2 Subtotal					**$9,591,000.00**

QUANTITIES		PRICES	
BY Doug Stanton DS	CHECKED RDR	BY D. Donaldson DCD	CHECKED BDV 8/17/04
DATE PREPARED 4/24/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW Ron 8/17/04

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
River Outlet Works for RCC Dam

ROW2 - Mechanical

PROJECT:
Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	19	Miscellaneous Metalwork	D8120	3,000	LBS	$7.00	$21,000.00
		Assume misc metal in fixed wheel and					
		jet flow gate houses					
		Mechanical					
	20	Furnish and install steel trashracks	D8410	337,500	LBS	$4.00	$1,350,000.00
	21	Furnish and install one bulkhead 22' x 24' @ 500' head	D8410	160,000	LBS	$4.00	$640,000.00
	22	Furnish and install seats and guides	D8410	127,000	LBS	$6.00	$762,000.00
		Heating and Ventilating	D-8410				
		50'x40'x24' Control House					
	23	Centrifugal fan: 1 each	D-8410	1	EA	$2,500.00	$2,500.00
		Single speed,1500 cfm at 0.50 inches w.g. static					
		pressure, forward curve, direct drive; 3/4 hp motor					
		rated 480 Vac, Three phase, 60 Hz.					
	24	Propeller fan assembly: 1 each	D-8410	1	EA	$3,000.00	$3,000.00
		Single speed, 4,800 cfm at 0.50 inches w.g. static					
		pressure, belt drive; 1.5 hp motor rated 460 Vac,					
		three phase, 60 Hz; include fan wall mount					
		housing with motor guard.					
	25	Unit heaters:	D-8410	4	EA	$750.00	$3,000.00
		Electric horizontal discharge rated 7.5 kw,					
		460 Vac, 3-phase, 60 Hz. (One each corner -18' throw)					
		with wall thermostats					
	26	Control dampers: All motor operated, parallel blade,	D-8410				
		low leakage type with edge and side seals:					
		48" wide x 48" high - 1 each		1	EA	$2,500.00	$2,500.00
		36" wide x 36" high - 1 each		1	EA	$1,500.00	$1,500.00
	27	Stationary louvers: All 16 gauge galvanized steel,	D-8410				
		4-inch deep frame, 45 degree blades on 4-inch centers,					
		45 percent free area, with insect and bird screen:					
		48" wide x 48" high - 1 each		1	EA	$2,000.00	$2,000.00
		36" wide x 36" high - 1 each		1	EA	$1,000.00	$1,000.00
		ROW2 Subtotal					**$2,788,500.00**

QUANTITIES		PRICES	
BY R.Christensen, B.Sund P. Schlein	CHECKED AWR	BY D. Donaldson DCD	CHECKED BDV 8/17/04
DATE PREPARED 4/23/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW RDB 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
River Outlet Works for RCC Dam

ROW2 - Mechanical

PROJECT: **Yakima River Basin Water Storage Options**

REGION PN | **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
		(Continuation of HVAC System)	D-8410				
		(50'x40'x24' Control House)					
	28	Fan motor starters : Design, furnish and install control system	D-8410	2	EA	$2,500.00	$5,000.00
	29	Ductwork: All 16-gauge galvanized steel with extra heavy (ASTM A90 G120) galvanized coating: Air plenum: 250 lbs.	D-8410	250	LBS	$10.00	$2,500.00
	30	48"x48" galv steel intake air filter frames using nine(9) 24"x16"x2" disposable filter elements in frame with dirty filter differential pressure sensor with warning light and remote signal.	D-8410	1	EA	$2,000.00	$2,000.00
	31	16"x24"x2" disposable fiberglass, 30% min efficiency, Filter elements (estimate 9 elements with spares for testing, startup and two replacements each.	D-8410	36	EA	$25.00	$900.00
	32	Galv. Steel duct and fan supports.	D-8410	200	LBS	$10.00	$2,000.00
		ROW2 Subtotal					**$12,400.00**

QUANTITIES		PRICES	
BY Paul Schlein	**CHECKED** Arl	**BY** D. Donaldson Ded	**CHECKED** GOL 8/17/04
DATE PREPARED 4/26/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** Ron 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
River Outlet Works for RCC Dam

ROW2 - Mechanical

PROJECT:
Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
		Heating and Ventilating	D-8410				
		Galleries and Adits Avg X-section 6'x10' = 60 sq-ft					
	33	Axial fan:	D-8410	2	EA	$5,000.00	$10,000.00
		Three speed reversible; 9,000 cfm at 1.0 inches w.g.					
		static pressure in high speed mode, 2700 cfm in medium					
		speed mode; 1800 cfm in low speed mode.					
		speed mode; adjustable blade; belt drive,					
		(or adjustable seed controller if cheaper)					
		10 hp motor rated 460 volts, three					
		phase, 60 Hz. A-weighted, sound pressure level					
		not to exceed 85 dbA.					
	34	Axial fan:	D-8410	3	EA	$2,500.00	$7,500.00
		Two speed reversible; 6,000 cfm at 1.0 inches w.g.					
		static pressure in high speed mode, 1800 cfm in low					
		speed mode; adjustable blade; belt drive,					
		(or adjustable seed controller if cheaper)					
		3 hp motor rated 460 volts, three					
		phase, 60 Hz. A-weighted, sound pressure level					
		not to exceed 85 dbA.					
	35	40-kW Electric duct heaters with controls.	D-8410	2	EA	$20,000.00	$40,000.00
		(one at each fan -2 operate for inspection only					
		for 2700 cfm at 45-deg rise.					
		460 Vac, 3-phase, 60 Hz. (One each at each inlet)					
		with duct thermostats					
	36	Control dampers: All motor operated, parallel blade,	D-8410				
		low leakage type with edge and side seals:					
		48" wide x 48" high -		2	EA	$2,500.00	$5,000.00
		48" wide x 36" high -		5	EA	$2,000.00	$10,000.00
	37	Stationary louvers: All 16 gauge galvanized steel.	D-8410				
		4-inch deep frame, 45 degree blades on 4-inch centers,					
		45 percent free area, with insect and bird screen:					
		48" wide x 48" high -		2	EA	$2,000.00	$4,000.00
		48" wide x 36" high -		5	EA	$1,500.00	$7,500.00
		ROW2 Subtotal					**$84,000.00**

QUANTITIES		PRICES	
BY Paul Schlein	**CHECKED** AMR	**BY** D. Donaldson DCD	**CHECKED** GDV 8/17/04
DATE PREPARED 4/26/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** RAS 8/17/04

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
River Outlet Works for RCC Dam

ROW2 - Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
		(Continuation of HVAC System)	D-8410				
	38	Reversing, 3-Ph., Fan motor starters : Design, furnish and install: control system	D-8410	5	EA	$2,500.00	$12,500.00
	39	Ductwork: All 16-gauge galvanized steel with extra heavy (ASTM A90 G120) galvanized coating: Air plenum: 250 lbs. 48x48 = 45-lb/ft x20 ft 900 lb/fan x2 = 1800-lb 48x32= 38-lb/ft x 10-ft = 380 lbx5 units 1900	D-8410	3,700	LBS	$10.00	$37,000.00
	40	48"x48" galv steel intake air filter frames using sixteen(16) 16"x16"x2" disposable filter elements in frame with dirty filter differential pressure sensor with warning light and remote signal.	D-8410	2	EA	$2,000.00	$4,000.00
	41	16"x16"x2" disposable fiberglass, 30% min efficiency, Filter elements (estimate 16 elements with spares for testing, startup and two replacements each.	D-8410	128	EA	$25.00	$3,200.00
	42	Galv. Steel duct and fan supports.	D-8410	1,000	LBS	$10.00	$10,000.00
		ROW2 Subtotal					**$66,700.00**

QUANTITIES		PRICES	
BY Paul Schlein	**CHECKED** Ama	**BY** D. Donaldson DCD	**CHECKED** BOV 8/17/04
DATE PREPARED 4/26/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** Ros 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE: Black Rock Dam and Reservoir *Large Reservoir - Active Storage= 1.3 MAF* *River Outlet Works for RCC Dam* ROW2 - Mechanical	**PROJECT:** **Yakima River Basin Water Storage Options** **REGION** PN **PRICE LEVEL:** Appraisal **FILE:** C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
		FURNISH-AND-INSTALL THE FOLLOWING:					
		Steel outlet works pipe, air vent	D8420				
		Steel plate used for pipe fabrication:					
		ASTM A36: yield stress = 36000 psi					
		(All pipe sizes are inside diameter)					
	43	168-inch diameter, 1 5/16-inch wall		3,800,000	lbs	$2.00	$7,600,000.00
		1450 linear feet, 2613 lb/ft					
	44	120-inch diameter, 15/16-inch wall		135,000	lbs	$2.00	$270,000.00
		100 linear feet, 1333 lb/ft					
	45	60-inch diameter, 1/2-inch wall,		220,000	lbs	$2.00	$440,000.00
		vertical, for air vent					
		615 linear feet, 356 lb/ft					
		Gates and Gate Controls					
		Furnish and Install					
	46	F & I - 18' x 14' Roller gate w/controls	D8420	180,400	LBS	$8.00	$1,443,200.00
		1 - gate and 1 control box (in shaft house)					
	47	F&I structural steel for hoist support		10,000	LBS	$4.00	$40,000.00
	48	F & I - 2 - 108-inch jet flow gates w/controls		89,400	LBS	$8.00	$715,200.00
		2 gates and 1 control box					
	49	F & I - 36-inch jet flow gate w/controls and bypass pipe		30,000	LBS	$8.00	$240,000.00
		1 gate and 1 control box (in shaft house)					
		ROW2 Subtotal					**$10,748,400.00**

QUANTITIES		PRICES	
BY Ken Smith, Gary Rood	**CHECKED**	**BY** D. Donaldson DCD	**CHECKED** BOV 8/17/04
DATE PREPARED 4/27/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** RAS 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
River Outlet Works for RCC Dam

ROW2 - Electrical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Electrical					
		This estimate is for 2 ROW control bldgs, one					
		on top of dam and the other downstream for the					
		regulating gates.					
		Assume bringing power to dam part of unlisted items.					
		Furnish and install the following electrical equipment:					
		Grounding System	D-8430				
	50	Ground rods, 10 ft, 3/4" dia., copper-clad		6	EA	$180.00	$1,080.00
	51	Stranded bare-copper conductor, 4 AWG		250	LF	$2.50	$625.00
		Conduit System	D-8430				
		Rigid steel conduit					
	52	3/4-inch		200	LF	$12.00	$2,400.00
	53	1-inch		100	LF	$14.00	$1,400.00
		PVC conduit, Schedule 40					
	54	1 1/2-inch		600	LF	$10.00	$6,000.00
		HDPE (High-density polyethylene)					
	55	2-inch		1,000	LF	$15.00	$15,000.00
		Conductors & Cable	D-8430				
		All cable single conductor, stranded copper					
	56	12 AWG		1,500	LF	$0.90	$1,350.00
	57	10 AWG		500	LF	$1.20	$600.00
	58	2 AWG		2,000	LF	$2.20	$4,400.00
	59	1/0 AWG		400	LF	$2.90	$1,160.00
		Electrical Service Equipment	D-8430				
	60	Pole-mounted transformer; 100 kVA, 13.8,kV-480V		1	EA	$5,000.00	$5,000.00
	61	Meter socket, NEMA 3R, 600V, 3-phase		1	EA	$1,500.00	$1,500.00
	62	Safety switch, heavy-duty, NEMA 3R, fusible		1	EA	$1,000.00	$1,000.00
		3-wire, 600V, 100 ampere					
		Panelboards & Electrical Distribution Equipment					
	63	Panelboard, 3-phase, 480V, 250 ampere		1	EA	$30,000.00	$30,000.00
	64	Distribution load center, 15 kVA, 1-phase		2	EA	$11,000.00	$22,000.00
		480-240/120V					
		ROW2 Subtotal					**$93,515.00**

QUANTITIES		PRICES	
BY Mike Schuh	**CHECKED** L Rossi	**BY** D. Donaldson DCD	**CHECKED** BDV 8/17/04
DATE PREPARED 4/26/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** RM 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Large Reservoir - Active Storage= 1.3 MAF
Relocation of State Highway 24

SH24 - Civil

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_1.3MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		State Highway Relocation (11.8 miles)					
	1	Clear roadway alignment	D8140	280	AC	$3,000.00	$840,000.00
	2	Excavation from borrow	D8140	1,000,000	CY	$3.50	$3,500,000.00
	3	Excavation for roadway (assume 70% rock material)	D8140	5,200,000	CY	$5.50	$28,600,000.00
	4	Compacting roadway embankments (subbase)	D8140	5,900,000	CY	$1.50	$8,850,000.00
	5	Furnish and place base course material	D8140	150,000	TONS	$16.00	$2,400,000.00
	6	Furnish and place asphalt concrete	D8140	97,000	TONS	$60.00	$5,820,000.00
	7	Furnish and install W-beam type guardrail	D8140	58,000	LF	$30.00	$1,740,000.00
	8	Furnish and install miscellaneous pipe culverts	D8140	1,800	LF	$200.00	$360,000.00
		Assume 60-inch-diameter, wt/ft=100 lbs/ft.					
		Utility Relocations within Reservoir Inundation					
	9	Remove Existing Transmission Lines	D8440	7	miles	$50,000.00	$350,000.00
		Two 115-kV H-frame wood-pole					
		lines, 60-feet apart					
		954 AWG conductor					
	10	Construct Transmission Lines	D8440	12	miles	$375,000.00	$4,500,000.00
		Two 115-kV H-frame wood-pole					
		lines, 60-feet apart					
		954 AWG conductor					
	11	Install new buried fiber optic line along new SH24 ROW	D-8120	12	miles	$30,000.00	$360,000.00
		Assume abandon existing line.					
		SH24 Subtotal					**$57,320,000.00**

QUANTITIES		PRICES	
BY: Anne Pavot	CHECKED: Chou Chee	BY: D. Donaldson DED	CHECKED: BOV 8/17/04
DATE PREPARED: 4/24/04	PEER REVIEW	DATE PREPARED: 08/17/04	PEER REVIEW: RM 8/17/04

Black Rock Dam and Reservoir
Small Reservoir
Active Storage= 0.8 MAF

Field Cost Estimate

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir

Small Reservoir - Active Storage= 800,000 Acre-Feet

Summary Sheet 1 of 3

PROJECT:
Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Estimate Worksheets Identify Three Dam Types					
		Dam Type 1: Concrete-Faced Rockfill Dam					
		Dam Type 2: Central-Core Rockfill Dam					
		Dam Type 3: Roller Compacted Concrete Dam					
		DAM TYPE 1: CONCRETE-FACED ROCKFILL					
		Includes foundation treatment, dam structure, river outlet works, and relocation of State Highway 24.					
		Dam1 Subtotal					$621,530,800.00 ✓
		River Outlet Works (ROW1) Subtotal					$79,000,000.00 ✓
		Relocation of State Highway 24 Subtotal					$57,320,000.00 ✓
		Subtotal					$757,850,800.00 ✓
		Mobilization 5% (+/-)					$38,000,000.00 ✓
		Subtotal w/ mobilization					$795,850,800.00 ✓
		Unlisted Items 10% (+/-)					$84,149,200.00 ✓
		DAM TYPE 1: CONTRACT COST					**$880,000,000.00** ✓
		Contingencies 25% (+/-)					$220,000,000.00 ✓
		DAM TYPE 1: FIELD COST					**$1,100,000,000.00** ✓

QUANTITIES		PRICES	
BY	CHECKED	BY D. Donaldson DED	CHECKED DDV 8/17/04
DATE PREPARED	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DLS 8/17/04

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir

Small Reservoir - Active Storage= 800,000 Acre-Feet

Summary Sheet 2 of 3

PROJECT:
Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		DAM TYPE 2: CENTRAL CORE ROCKFILL					
		Includes foundation treatment, dam structure, river outlet works, and relocation of State Highway 24.					
		Dam2 Subtotal					$573,117,150.00 ✓
		River Outlet Works (ROW1) Subtotal					$79,000,000.00 ✓
		Relocation of State Highway 24 Subtotal					$57,320,000.00 ✓
		Subtotal					$709,437,150.00 ✓
		Mobilization 5% (+/-)					$35,000,000.00 ✓
		Subtotal w/ mobilization					$744,437,150.00 ✓
		Unlisted Items 10% (+/-)					$75,562,850.00 ✓
		DAM TYPE 2: CONTRACT COST					**$820,000,000.00** ✓
		Contingencies 25% (+/-)					$180,000,000.00 ✓
		DAM TYPE 2: FIELD COST					**$1,000,000,000.00** ✓

QUANTITIES		PRICES	
BY	CHECKED	BY D. Donaldson DCD	CHECKED GOV 8/17/04
DATE PREPARED	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW RAS 8/17/04

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir

Small Reservoir - Active Storage= 800,000 Acre-Feet

Summary Sheet 3 of 3

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		DAM TYPE 3: ROLLER COMPACTED CONCRETE					
		Includes foundation treatment, dam structure, river outlet works, and relocation of State Highway 24.					
		Dam3 Subtotal					$980,587,000.00
		River Outlet Works (ROW2) Subtotal					$22,000,000.00
		Relocation of State Highway 24 Subtotal					$57,320,000.00
		Subtotal					$1,059,907,000.00
		Mobilization 5% (+/-)					$53,000,000.00
		Subtotal w/ mobilization					$1,112,907,000.00
		Unlisted Items 10% (+/-)					$87,093,000.00
		DAM TYPE 3: CONTRACT COST					**$1,200,000,000.00**
		Contingencies 25% (+/-)					$350,000,000.00
		DAM TYPE 3: FIELD COST					**$1,550,000,000.00**

QUANTITIES		PRICES	
BY	CHECKED	BY D. Donaldson DCD	CHECKED BOV 8/17/04
DATE PREPARED	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW RAS 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Small Reservoir - Active Storage= 800,000 Acre-Feet
Dam Type 1: Concrete-Faced Rockfill Dam

Dam 1 - Civil/Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		GENERAL SITEWORK					
		Assume no clearing and grubbing required					
		Assume road improvements and haul roads are					
		part of unlisted items					
		DIVERSION & DEWATERING					
		Assume groundwater is below excavation					
		Assume natural stream beds in area are dry					
		FOUNDATION EXCAVATION					
		Assume common material stockpiled for reuse					
		Assume rock material stockpiled for reuse					
		Stockpiles will be upstream, within 1/2 mile of dam					
	1	Excavation, stripping, of dam foundation	D8312	315,000	CY	$2.00	$630,000.00
		Assume depth of stripping 12 inches or less					
		Assume stripping will be stockpiled for topsoil use					
	2	Excavation, common, for dam foundation	D8312	23,700,000	CY	$3.00	$71,100,000.00
		Assume about 35% of volume requires ripping					
		Assume fine-grained and coarse-grained materials					
		will be separately stockpiled					
	3	Excavation, rock, for dam foundation	D8312	1,700	CY	$45.00	$76,500.00
		Assume drill and blast in random locations					
		FOUNDATION TREATMENT					
		Includes misc. foundation treatment, fault zone					
		treatment, consolidation grouting, and curtain grouting					
		Miscellaneous Foundation Areas					
		Applied in areas of poor quality rock					
	4	Slush grouting of foundation surface	D8312	140,000	SF	$2.00	$280,000.00
		Over assumed 10% of area between u/s toe and axis					
	5	Dental concrete	D8312	1,700	CY	$150.00	$255,000.00
	6	Furnish/place zone 2 sand filter on foundation	D8312	34,000	CY	$28.00	$952,000.00
		Over assumed 10% of area between u/s toe and axis					
		Assume a 3-ft thickness					
	7	Furnish/place zone 3 gravel drain on foundation	D8312	34,000	CY	$25.00	$850,000.00
		Over the zone 2 filter in a 3-ft thickness					
		Dam1 Subtotal					**$74,143,500.00**

QUANTITIES		PRICES	
BY Will Gonzales	CHECKED Bill Engemoen	BY D. Donaldson DCD	CHECKED BDE 8/17/04
DATE PREPARED 4/12/2004	PEER REVIEW Bill Engemoen	DATE PREPARED 08/17/04	PEER REVIEW Jrs 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

SHEET 5 OF 19

FEATURE:
Black Rock Dam and Reservoir
Small Reservoir - Active Storage= 800,000 Acre-Feet
Dam Type 1: Concrete-Faced Rockfill Dam

Dam1 - Civil/Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		FOUNDATION TREATMENT (continued)					
		Treatment of south abutment fault area					
	8	Extra rock excavation for fault treatment	D8312	135,000	CY	$13.00	$1,755,000.00
		Assume south abutment is fractured					
		Assume excavate with hydraulic excavator					
	9	Dental concrete for fault treatment	D8312	4,200	CY	$140.00	$588,000.00
	10	Furnish/place zone 2 sand filter downstream of plinth	D8312	50,000	CY	$28.00	$1,400,000.00
		Assume a 3-ft thickness, 500' by 1000' area					
		Assume same source as listed under embankment					
	11	Furnish/place zone 3 gravel drain d/s of plinth	D8312	50,000	CY	$25.00	$1,250,000.00
		Assume 3-ft thickness, over zone 2 filter					
		Consolidation Grouting of Foundation					
		Generally limited to area beneath plinth					
	12	Setups for drilling grout holes	D8312	4,170	EA	$75.00	$312,750.00
		Assume 2-inch dia. drilled on 7.5-foot centers					
	13	Drill grout holes	D8312	125,000	LF	$15.00	$1,875,000.00
		Assume 2-inch dia. w/length= 30 feet					
	14	Hookups to grout holes	D8312	4,170	EA	$60.00	$250,200.00
	15	Pressure grout	D8312	190,000	CF	$7.00	$1,330,000.00
		Assume grouting process only minus cement					
		Assume 2 CF per 1 LF of hole					
	16	Furnish and handle cement for pressure grouting	D8312	190,000	BAGS	$8.00	$1,520,000.00
		Assume 1 bag per CF					
		Curtain Grouting of Foundation					
		Two-row curtain beneath plinth					
	17	Setups for drilling grout holes	D8312	1,330	EA	$100.00	$133,000.00
		Assume 2-rows of 2-inch dia.on 10-ft centers					
	18	Drill grout holes	D8312	260,000	LF	$15.00	$3,900,000.00
		Assume 2-inch dia. w/length from 60 to 250 feet					
	19	Hookups to grout holes	D8312	1,330	EA	$75.00	$99,750.00
	20	Pressure grout	D8312	520,000	CF	$7.00	$3,640,000.00
		Assume grouting process only minus cement					
		Assume 2 CF per 1 LF of hole					
	21	Furnish and handle cement for pressure grouting	D8312	520,000	BAGS	$8.00	$4,160,000.00
		Dam1 Subtotal					**$22,213,700.00**

QUANTITIES		PRICES	
BY Will Gonzales	**CHECKED** Bill Engemoen	**BY** D. Donaldson DCD	**CHECKED** BAV 8/17/04
DATE PREPARED 4/12/2004	**PEER REVIEW** Bill Engemoen	**DATE PREPARED** 08/17/04	**PEER REVIEW** RAM 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Black Rock Dam and Reservoir

Small Reservoir - Active Storage= 800,000 Acre-Feet

Dam Type 1: Concrete-Faced Rockfill Dam

Dam1 - Civil/Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		EMBANKMENT CONSTRUCTION					
		Items are set up as furnish and place, which would					
		include purchasing from commercial sites,					
		processing onsite, development of quarry, or					
		transporting from stockpiles of required excavation					
	22	Furnish and place zone 1 upstream blanket	D8312	850,000	CY	$6.00	$5,100,000.00
		Consists of loess stockpiled from required exc					
		within 1/2 mile of dam					
		Compaction to 6-inch lifts by tamping roller					
	23	Furnish and place zone 2 filter	D8312	1,200,000	CY	$25.00	$30,000,000.00
		Sand/gravel material processed commercially					
		or developed onsite					
		If commercial, assume 17 mile one-way haul					
		Compacted to 12-inch layers by vibratory steel drum					
	24	Furnish and place zone 3 drain	D8312	1,200,000	CY	$23.00	$27,600,000.00
		Gravel/cobble material processed commercially or					
		developed onsite					
		If commercial, assume 17 mile one-way haul					
		Compacted to 12-inch layers by vibratory steel drum					
	25	Furnish and place zone 4 rockfill	D8312	47,200,000	CY	$6.50	$306,800,000.00
		Developed from basalt ridges surrounding reservoir					
		Assume average 1-mile haul to dam					
		Rock sizes up to 3-foot					
		Compacted in 3-ft layers by vibratory steel drum					
	26	Furnish and place zone 5 coarse grained random fill	D8312	13,150,000	CY	$4.00	$52,600,000.00
		Comes from stockpiles of required excavation					
		within 1/2 mile of dam					
		Generally consists of gravelly soils					
		Compacted in 2-ft layers by vibratory steel drum					
	27	Furnish and place zone 6 fine grained random fill	D8312	6,100,000	CY	$4.50	$27,450,000.00
		Comes from stockpiles of required excavation					
		within 1/2 mile of dam					
		Generally consists of sands/silts/clays					
		Compacted to 9-inch layers by tamping rollers					
		Dam1 Subtotal					**$449,550,000.00**

QUANTITIES		PRICES	
BY Will Gonzales	**CHECKED** Bill Engemoen	**BY** D. Donaldson DCD	**CHECKED** BDV 8/17/04
DATE PREPARED 4/12/2004	**PEER REVIEW** Bill Engemoen	**DATE PREPARED** 08/17/04	**PEER REVIEW** RAB 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Small Reservoir - Active Storage= 800,000 Acre-Feet
Dam Type 1: Concrete-Faced Rockfill Dam

Dam1 - Civil/Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		CONCRETE FACE & PLINTH CONSTRUCTION					
		Plinth					
		Typical thickness will be 1.5 feet					
		Width will range from 10 to 50 feet					
		Grouted anchors may be needed in poor rock areas					
	28	Furnish and place reinforced concrete in plinth	D8312	10,400	CY	$350.00	$3,640,000.00
	29	Furnish and place concrete reinforcement (100#/CY)	D8312	1,040,000	LBS	$0.80	$832,000.00
	30	Furnish and handle cement for concrete (.282T/CY)	D8312	2,930	TONS	$120.00	$351,600.00
	31	Furnish and install grouted anchors	D8312	285,000	LF	$15.00	$4,275,000.00
		Assume 1-inch diameter rebar grouted into rock					
		Assume 15-foot lengths					
		Concrete Deck					
		Will vary in thickness from 1 to 2 feet					
		Adjacent panels will have waterstops and dowels					
	32	Furnish and place reinforced concrete in deck	D8312	165,000	CY	$300.00	$49,500,000.00
	33	Furnish and place concrete reinforcement (100#/CY)	D8312	16,500,000	LBS	$0.75	$12,375,000.00
	34	Furnish and handle cement for concrete (.282T/CY)	D8312	46,500	TONS	$100.00	$4,650,000.00
		MISCELLANEOUS					
		Instrumentation					
		Assume part of unlisted items					
		Toe Drains					
		Assume part of unlisted items					
		Site cleanup and relandscaping					
		Assume part of unlisted items					
		Dam1 Subtotal					**$75,623,600.00**

QUANTITIES		PRICES	
BY Will Gonzales	**CHECKED** Bill Engemoen	**BY** D. Donaldson DCD	**CHECKED** BDV 8/17/04
DATE PREPARED 4/12/2004	**PEER REVIEW** Bill Engemoen	**DATE PREPARED** 08/17/04	**PEER REVIEW** RAS 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Small Reservoir - Active Storage= 800,000 Acre-Feet
Dam Type 2: Central -Core Rockfill Dam

Dam2 - Civil/Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		GENERAL SITEWORK					
		Assume no clearing and grubbing required					
		Assume road improvements and haul roads are					
		part of unlisted items					
		DIVERSION & DEWATERING					
		Assume groundwater is below excavation					
		Assume natural stream beds in area are dry					
		FOUNDATION EXCAVATION					
		Assume common material stockpiled for reuse					
		Assume rock material stockpiled for reuse					
		Stockpiles will be upstream, within 1/2 mile of dam					
	1	Excavation, stripping, of dam foundation	D8312	320,000	CY	$2.00	$640,000.00
		Assume depth of stripping 12 inches or less					
		Assume stripping will be stockpiled for topsoil use					
	2	Excavation, common, for dam foundation	D8312	24,200,000	CY	$3.00	$72,600,000.00
		Assume about 35% of volume requires ripping					
		Assume fine-grained and coarse-grained materials					
		will be separately stockpiled					
	3	Excavation, rock, for dam foundation	D8312	4,200	CY	$32.00	$134,400.00
		Assume drill and blast in random locations					
		FOUNDATION TREATMENT					
		Includes misc. foundation treatment, fault zone					
		treatment, consolidation grouting, and curtain grouting					
		Miscellaneous Foundation Areas					
		Applied in areas of poor quality rock					
	4	Slush grouting of foundation surface	D8312	140,000	SF	$2.00	$280,000.00
		Over assumed 10% of area beneath zone 1					
	5	Dental concrete	D8312	4,200	CY	$150.00	$630,000.00
	6	Furnish/place zone 2 sand filter on foundation	D8312	34,000	CY	$28.00	$952,000.00
		Over 10% of area between zone 1 and d/s toe					
		Assume a 3-ft thickness					
	7	Furnish/place zone 3 gravel drain on foundation	D8312	34,000	CY	$25.00	$850,000.00
		Over the zone 2 filter in a 3-ft thickness					
		Dam 2 Subtotal					**$76,086,400.00**

QUANTITIES		PRICES	
BY Will Gonzales	**CHECKED** Bill Engemoen	**BY** D. Donaldson DED	**CHECKED** BOV 8/17/04
DATE PREPARED 4/12/2004	**PEER REVIEW** Bill Engemoen	**DATE PREPARED** 08/17/04	**PEER REVIEW** TM 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Small Reservoir - Active Storage= 800,000 Acre-Feet
Dam Type 2: Central -Core Rockfill Dam

Dam2 - Civil/Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		FOUNDATION TREATMENT (continued)					
		Treatment of south abutment fault area					
	8	Extra rock excavation for fault treatment	D8312	135,000	CY	$20.00	$2,700,000.00
		Assume south abutment is fractured					
		Assume excavate with hydraulic excavator					
	9	Dental concrete for fault treatment	D8312	4,200	CY	$140.00	$588,000.00
	10	Furnish/place zone 2 sand filter downstream of zone 1	D8312	50,000	CY	$28.00	$1,400,000.00
		Assume a 3-ft thickness, 500' by 1000' area					
		Assume same source as listed under emb.					
	11	Furnish/place zone 3 gravel drain d/s of zone 1	D8312	50,000	CY	$25.00	$1,250,000.00
		Assume 3-ft thickness, over zone 2 filter					
		Consolidation Grouting of Foundation					
		Generally limited to area beneath zone 1					
	12	Setups for drilling grout holes	D8312	5,000	EA	$75.00	$375,000.00
		Assume 2-inch dia. drilled on 10-foot centers					
	13	Drill grout holes	D8312	150,000	LF	$15.00	$2,250,000.00
		Assume 2-inch dia. w/length= 30 feet					
	14	Hookups to grout holes	D8312	5,000	EA	$60.00	$300,000.00
	15	Pressure grout	D8312	225,000	CF	$7.00	$1,575,000.00
		Assume grouting process only minus cement					
		Assume 2 CF per 1 LF of hole					
	16	Furnish and handle cement for pressure grouting	D8312	225,000	BAGS	$8.00	$1,800,000.00
		Assume 1 bag per CF					
		Curtain Grouting of Foundation					
		Two-row curtain beneath zone 1					
	17	Setups for drilling grout holes	D8312	1,330	EA	$100.00	$133,000.00
		Assume 2-rows of 2-inch dia.on 10-ft centers					
	18	Drill grout holes	D8312	260,000	LF	$15.00	$3,900,000.00
		Assume 2-inch dia. w/length from 60 to 250 feet					
	19	Hookups to grout holes	D8312	1,330	EA	$75.00	$99,750.00
	20	Pressure grout	D8312	520,000	CF	$7.00	$3,640,000.00
		Assume grouting process only minus cement					
		Assume 2 CF per 1 LF of hole					
	21	Furnish and handle cement for pressure grouting	D8312	520,000	BAGS	$8.00	$4,160,000.00
		Assume 1 bag per CF					
		Dam 2 Subtotal					**$24,170,750.00**

QUANTITIES		PRICES	
BY Will Gonzales	**CHECKED** Bill Engemoen	**BY** D. Donaldson DCD	**CHECKED** BOV 8/17/04
DATE PREPARED 4/12/2004	**PEER REVIEW** Bill Engemoen	**DATE PREPARED** 08/17/04	**PEER REVIEW** RAS 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Small Reservoir - Active Storage= 800,000 Acre-Feet
Dam Type 2: Central -Core Rockfill Dam

Dam2 - Civil/Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		EMBANKMENT CONSTRUCTION					
		Items are set up as furnish and place, which would					
		include purchasing from commercial sites,					
		processing onsite, development of quarry, or					
		transporting from stockpiles of required excavation					
	22	Furnish and place zone 1 core	D8312	7,500,000	CY	$8.50	$63,750,000.00
		Acquired from source 6 miles from dam					
		Compacted to 6-inch lifts by tamping roller					
	23	Furnish and place zone 2 filter	D8312	1,170,000	CY	$25.00	$29,250,000.00
		Sand/gravel material processed commercially					
		or developed onsite					
		If commercial, assume 17 mile one-way haul					
		Compacted to 12-inch layers by vibratory steel drum					
	24	Furnish and place zone 3 drain	D8312	1,170,000	CY	$23.00	$26,910,000.00
		Gravel/cobble material processed commercially or					
		developed onsite					
		If commercial, assume 17 mile one-way haul					
		Compacted to 12-inch layers by vibratory steel drum					
	25	Furnish and place zone 4 rockfill	D8312	41,100,000	CY	$6.50	$267,150,000.00
		Developed from basalt ridges surrounding reservoir					
		Assume average 1-mile haul to dam					
		Rock sizes up to 3-foot					
		Compacted in 3-ft layers by vibratory steel drum					
	26	Furnish and place zone 5 coarse grained random fill	D8312	13,350,000	CY	$4.00	$53,400,000.00
		Comes from stockpiles of required excavation					
		within 1/2 mile of dam					
		Generally consists of gravelly soils					
		Compacted in 2-ft layers by vibratory steel drum					
	27	Furnish and place zone 6 fine grained random fill	D8312	7,200,000	CY	$4.50	$32,400,000.00
		Comes from stockpiles of required excavation					
		within 1/2 mile of dam					
		Generally consists of sands/silts/clays					
		Compacted to 9-inch layers by tamping rollers					
		Dam 2 Subtotal					**$472,860,000.00**

QUANTITIES		PRICES	
BY Will Gonzales	**CHECKED** Bill Engemoen	**BY** D. Donaldson DeD	**CHECKED** BDV 8/17/04
DATE PREPARED 4/12/2004	**PEER REVIEW** Bill Engemoen	**DATE PREPARED** 08/17/04	**PEER REVIEW** RAB 8/17/04

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Black Rock Dam and Reservoir *Small Reservoir - Active Storage= 800,000 Acre-Feet* *Dam Type 2: Central -Core Rockfill Dam* Dam2 - Miscellaneous	**Yakima River Basin Water Storage Options** **REGION** PN **PRICE LEVEL:** Appraisal **FILE:** C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		MISCELLANEOUS					
		Instrumentation					
		Assume part of unlisted items					
		Toe Drains					
		Assume part of unlisted items					
		Site cleanup and relandscaping					
		Assume part of unlisted items					
		Dam 2 Subtotal					**$0.00**

QUANTITIES		PRICES	
BY Witl Gonzales	**CHECKED** Bill Engemoen	**BY** D. Donaldson DCD	**CHECKED** BOV 8/17/04
DATE PREPARED 4/12/2004	**PEER REVIEW** Bill Engemoen	**DATE PREPARED** 08/17/04	**PEER REVIEW** RMS 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Small Reservoir - Active Storage= 800,000 Acre-Feet
Dam Type 3: Roller Compacted Concrete (RCC) Dam

Dam3 - Civil/Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		General Sitework					
		Clear and Grub reservoir area (not required)					
		Roads, haul roads, instrumentation, site cleanup and					
		relandscaping included in unlisted items					
		Diversion/Dewatering during Construction					
		Assume groundwater is below excavation.					
		Assume natural stream beds in area are dry.					
		Foundation Excavation and Backfill					
		Strip topsoil and stockpile for reuse					
		Assume stockpile common material for backfill					
		Assume stockpile rock material for riprap and erosion protection					
		Assume drill and shoot rock for tunnels in ROW					
		foundation excavation					
		*** Small dam ~95% of large dam found. quantities					
		Materials for RCC					
		Assume RCC plant set up at dam site and materials					
		trucked to the site					
		Assume concrete sand and aggregates come from					
		Columbia or Yakima river basins and have a					
		haul distance of 17-18 miles ave.					
		Assume cement shipped by rail to redi-mix plants					
		that are 20 miles ave. distance from site.					
		*** RCC volume ~ 75% large dam H~90% large dam					
		Dam excavation and backfill	D8130				
	1	Strip topsoil and stockpile (1ft. Thick) (95%)		128,000	CY	$2.00	$256,000.00
	2	Excavate common material for dam foundation (Calc)		9,900,000	CY	$3.50	$34,650,000.00
	3	Excavate rock for dam foundation (95%)		99,000	CY	$13.00	$1,287,000.00
		Assume ~ 1% of common excavation					
	4	Excavate rock for OW on right abutment (95%)		5,000	CY	$32.00	$160,000.00
	5	Backfill with common material from excavation (Calc)		4,417,000	CY	$3.50	$15,459,500.00
		Foundation Treatment-Exc. and conc. Treatment (95%)	D8130				
	6	Extra rock excavation for fault treatment		71,000	CY	$13.00	$923,000.00
		Assume south abutment is fractured					
		Assume excavate with hydraulic excavator					
	7	Dental concrete for fault treatment		2,400	CY	$150.00	$360,000.00
	8	Dental concrete for general foundation treatment		9,500	CY	$130.00	$1,235,000.00
	9	Furnish and handle cement (.282T/CY)		2,700	TONS	$120.00	$324,000.00
		Dam 3 Subtotal					**$54,654,500.00**

QUANTITIES		PRICES	
BY Doug Stanton DS	CHECKED GAB	BY D. Donaldson DCD	CHECKED GOV 8/17/04
DATE PREPARED 5/1/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW KAB 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Black Rock Dam and Reservoir	Yakima River Basin Water Storage Options
Small Reservoir - Active Storage= 800,000 Acre-Feet	
Dam Type 3: Roller Compacted Concrete (RCC) Dam	REGION: PN — PRICE LEVEL: Appraisal
Dam3 - Civil/Structural	FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Foundation Treatment - Consolidation grouting	D8130				
	10	Setups for drilling grout holes		20,700	EA	$50.00	$1,035,000.00
		Assume 2-inch dia. drilled on 10-foot centers					
	11	Drill grout holes - 2-in. dia @ 30 ft long		621,300	LF	$15.00	$9,319,500.00
	12	Hookups to grout holes		20,700	EA	$35.00	$724,500.00
	13	Pressure grout		1,242,600	CF	$6.50	$8,076,900.00
		Assume grouting process only minus cement					
		Assume 2 CF per 1 LF of hole					
	14	Furnish and handle cement for pressure grouting		1,242,000	BAGS	$7.00	$8,694,000.00
		Assume 1 bag per CF					
		Foundation Treatment-Grout Curtain thru gallery (95%)	D8130				
	15	Setups for drilling grout holes		640	EA	$100.00	$64,000.00
		Assume 2-inch dia. Holes on 10-foot centers					
	16	Drill grout holes		161,500	LF	$15.00	$2,422,500.00
		Assume 2-inch dia. w/depth ~55% ave H					
	17	Hookups to grout holes		640	EA	$100.00	$64,000.00
	18	Pressure grout		323,000	CF	$7.00	$2,261,000.00
		Assume grouting process only minus cement					
		Assume 2 CF per 1 LF of hole					
	19	Furnish and handle cement for pressure grouting		323,000	BAGS	$8.00	$2,584,000.00
		Assume 1 bag per CF					
	20	F&I 4-inch dia. steel pipe nipples (assume 4'/drain)		2,600	LF	$60.00	$156,000.00
		Leveling Concrete for Foundation (95%)	D8130				
	21	Assume 6 sack mix, 3-foot thick over footprint		254,000	CY	$200.00	$50,800,000.00
	22	Furnish and handle cement (.282T/CY)		71,600	TONS	$100.00	$7,160,000.00
		Drill foundation drains from gallery (95%)	D8130				
	23	Setups (assume 10-ft centers)		665	EA	$100.00	$66,500.00
	24	Drill holes		166,000	LF	$15.00	$2,490,000.00
		Assume 4-inch dia. w/length= 33% dam height.					
		Drill formed drains in dam body along U/S face (95%)	D8130				
		Assume 10-ft ctrs and 6-inch dia.					
	25	Lower gallery - Setups		420	EA	$100.00	$42,000.00
	26	Lower gallery - Holes drilled from gallery upward		89,800	LF	$15.00	$1,347,000.00
	27	Upper gallery - Setups		635	EA	$100.00	$63,500.00
	28	Upper gallery - holes drilled from dam crest to gallery		135,000	LF	$15.00	$2,025,000.00
		Dam 3 Subtotal					**$99,395,400.00**

QUANTITIES		PRICES	
BY: Doug Stanton DS	CHECKED:	BY: D. Donaldson DCD	CHECKED: BDV 8/17/04
DATE PREPARED: 5/1/04	PEER REVIEW:	DATE PREPARED: 08/17/04	PEER REVIEW: 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Small Reservoir - Active Storage= 800,000 Acre-Feet
Dam Type 3: Roller Compacted Concrete (RCC) Dam

Dam3 - Civil/Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct RCC Dam	D8130				
		Assume 275 lb/CY cementitious material					
		Assume 40% fly ash and 60% cement					
		Assume aggregate processed and hauled 15-20 miles					
		Assume cement hauled 20-25 miles					
	29	Construct RCC test section (same as Large dam)		4,100	CY	$140.00	$574,000.00
		Estimated dimensions = 100' x 35' x 30'					
		Assume convent. Conc. Facing elements					
		Assume incorporated into thrust block for stilling basin and control house					
		Includes gallery forming, waterstops, Contraction joint, facing elements, bonding mortar (no grouting)					
	30	Construct RCC Dam (Complete in Place) (Calc)		16,658,000	CY	$28.00	$466,424,000.00
	30A	Furnish and handle cement (.138T/CY)		2,290,500	TONS	$90.00	$206,145,000.00
	31	Bonding Mortar (Assume 1/2-inch thick/lift on all lifts)(75%)		731,250	CY	$70.00	$51,187,500.00
		Cast-in-place Conventional Concrete (90%)	D8130				
	32	Facing elements - slipformed on U/S face		180,000	CY	$100.00	$18,000,000.00
	33	Facing elements - slabs on D/S face		219,600	CY	$100.00	$21,960,000.00
	34	Furnish and handle cement (.282T/CY)		112,700	TONS	$100.00	$11,270,000.00
	35	FRP Reinforced concrete dam crest		10,100	CY	$250.00	$2,525,000.00
	36	Assume 1.5 foot thick (160 lbs/CY)		1,616,000	LBS	$0.80	$1,292,800.00
	37	Furnish and handle cement (.282T/CY)		2,800	TONS	$120.00	$336,000.00
	38	FRP Reinforced concrete parapets on dam crest		2,300	CY	$400.00	$920,000.00
		Estimated 6,000 on both u/s and d/s sides					
	39	F & P reinforcement (160 lbs/CY)		368,000	LBS	$0.80	$294,400.00
	40	Furnish and handle cement (.282T/CY)		650	TONS	$120.00	$78,000.00
		Dam 3 Subtotal					**$781,006,700.00**

QUANTITIES		PRICES	
BY Doug Stanton DS	**CHECKED** [illegible]	**BY** D. Donaldson DCD	**CHECKED** BCV 8/17/04
DATE PREPARED 5/1/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** [illegible] 8/17/04

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Small Reservoir - Active Storage= 800,000 Acre-Feet
Dam Type 3: Roller Compacted Concrete (RCC) Dam

Dam3 - Civil/Structural

PROJECT: Yakima River Basin Water Storage Options

REGION PN | **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct RCC Dam (continued)	D8130				
	41	Form lower drain/grout gallery/adits within RCC section		6,300	LF	$50.00	$315,000.00
		Assume 6-ft wide x 10-ft high across base of dam					
		Assume Symons Panel system for 12" RCC lifts					
		Assume ~90% large dam quantity					
	42	Form upper drainage gallery/adits within RCC section		4,300	LF	$50.00	$215,000.00
		Assume 6-ft wide x 10-ft high across base of dam					
		Assume Symons Panel system for 12" RCC lifts					
		Assume ~90% large dam quantity					
	43	F&I 12-in PVC waterstops for u/s CrJs & facing elements		107,000	LF	$15.00	$1,605,000.00
		Assume 135 CrJs @ 50-ft centers (90%)					
	44	F& I Crack inducers @ CrJ's in facing elements		53,600	LF	$15.00	$804,000.00
		(Assume 1/2 L of waterstops and 6 ft wide) (90%)					
		Similar to Milltown Hill					
	45	F&I Metal crack inducer plates for CrJs in RCC (75%)		4,190,000	LF	$8.00	$33,520,000.00
		Assume placed every other lift					
		Similar to Pueblo Dam					
		Abutment Adits (same as large dam)	D8130				
	46	Drill and shoot 16-ft Dia. for adit		1,100	LF	$2,500.00	$2,750,000.00
	47	Remove and stockpile rock (assume local stockpile)		15,500	CY	$20.00	$310,000.00
	48	Furnish and install 2500-10-ft long x 1-inch dia.		12,500	LF	$60.00	$750,000.00
		A307, 20K rockbolts					
	49	Furnish and install steel sets (W8 x 48) in crown		200,000	LBS	$4.00	$800,000.00
	50	FF & P concrete in adits (6' x 10')		7,300	CY	$350.00	$2,555,000.00
	51	Furnish and handle cement (.282T/CY)		2,100	TONS	$120.00	$252,000.00
		Grout adits (same as large dam)	D8130				
	52	Setups for drilling grout holes (2-in dia holes, 10 ft ctrs,		880	EA	$100.00	$88,000.00
		and 8 holes per ring)					
	53	Drill grout holes (2-in dia and L=30 ft)		26,400	LF	$20.00	$528,000.00
	54	Hookups to grout holes		880	EA	$100.00	$88,000.00
	55	Pressure grout (grouting process only minus cement)		52,800	CF	$8.00	$422,400.00
		Assume 2 CF per 1 LF of hole					
	56	Furnish and handle cement for pressure grouting		52,800	BAGS	$10.00	$528,000.00
		Assume 1 bag per CF					
		Dam 3 Subtotal					**$45,530,400.00**

QUANTITIES		PRICES	
BY Doug Stanton DS	CHECKED BDR	BY D. Donaldson DCD	CHECKED BOV 8/17/04
DATE PREPARED 5/1/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW RAS 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Black Rock Dam and Reservoir *Small Reservoir - Active Storage= 800,000 Acre-Feet* *Dam Type 3: Roller Compacted Concrete (RCC) Dam* Dam3 - Miscellaneous	Yakima River Basin Water Storage Options REGION PN — PRICE LEVEL: Appraisal FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		MISCELLANEOUS					
		Instrumentation					
		Assume part of unlisted items					
		Dam 3 Subtotal					**$0.00**

QUANTITIES		PRICES	
BY Dick LaFond	CHECKED M.R. O'Shea	BY D. Donaldson DCD	CHECKED BOV 8/17/04
DATE PREPARED 5/1/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW RAS 8/17/04

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Small Reservoir - Active Storage= 800,000 Acre-Feet
River Outlet Works for Rockfill Dams

ROW1 - Civil/Structural, Mechanical, and Electrical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION		CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		River Outlet Works for 0.8 MAF Option will be slightly smaller than outlet works sized for the 1.3MAF Option.						
	1	ROW1 for Rockfill Dams (Complete and Inplace)		D8130	1	LS	$79,000,000.00	$79,000,000.00
		Assume cost is 95% (+/-) cost for 1.3 MAF Option						
		1.3MAF (ROW1) Subtotal:	$83,494,115.00					
		% of subtotal	0.95					
		Result (95% of subtotal):	$79,319,409.25					
		Round (+/-)	**$79,000,000.00**					

QUANTITIES		PRICES	
BY Doug Stanton DS	CHECKED BdR	BY D. Donaldson DED	CHECKED BOV 8/17/04
DATE PREPARED 5/1/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW RAB 8/17/04

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Small Reservoir - Active Storage= 800,000 Acre-Feet
River Outlet Works for RCC Dam

ROW2 - Civil/Structural, Mechanical, and Electrical

PROJECT: Yakima River Basin Water Storage Options

REGION PN | **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION		CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		River Outlet Works for 0.8 MAF Option will be slightly smaller than outlet works sized for the 1.3MAF Option.						
	1	ROW2 for RCC Dam (Complete and Inplace)		D8130	1	LS	$22,000,000.00	$22,000,000.00
		Assume cost is 95% (+/-) cost for 1.3 MAF Option						
		1.3MAF (ROW2) Subtotal:	$23,384,515.00					
		% of subtotal	0.95					
		Result (95% of subtotal):	$22,215,289.25					
		Round (+/-)	**$22,000,000.00**					

QUANTITIES		PRICES	
BY Doug Stanton [signature]	CHECKED [signature]	BY D. Donaldson [signature]	CHECKED BOJ 8/17/04
DATE PREPARED 5/1/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW [initials] 8/17/04

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Dam and Reservoir
Small Reservoir - Active Storage= 800,000 Acre-Feet
Relocation of State Highway 24

SH24 - Civil

PROJECT: Yakima River Basin Water Storage Options

REGION PN | **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Black Rock Dam_0.8MAF Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		State Highway Relocation (11.8 miles)					
	1	Clear roadway alignment	D8140	280	AC	$3,000.00	$840,000.00
	2	Excavation from borrow	D8140	1,000,000	CY	$3.50	$3,500,000.00
	3	Excavation for roadway (assume 70% rock material)	D8140	5,200,000	CY	$5.50	$28,600,000.00
	4	Compacting roadway embankments (subbase)	D8140	5,900,000	CY	$1.50	$8,850,000.00
	5	Furnish and place base course material	D8140	150,000	TONS	$16.00	$2,400,000.00
	6	Furnish and place asphalt concrete	D8140	97,000	TONS	$60.00	$5,820,000.00
	7	Furnish and install W-beam type guardrail	D8140	58,000	LF	$30.00	$1,740,000.00
	8	Furnish and install miscellaneous pipe culverts	D8140	1,800	LF	$200.00	$360,000.00
		Assume 60-inch-diameter, wt/ft=100 lbs/ft.					
		Utility Relocations within Reservoir Inundation					
	9	Remove Existing Transmission Lines	D8440	7	miles	$50,000.00	$350,000.00
		Two 115-kV H-frame wood-pole					
		lines, 60-feet apart					
		954 AWG conductor					
	10	Construct Transmission Lines	D8440	12	miles	$375,000.00	$4,500,000.00
		Two 115-kV H-frame wood-pole					
		lines, 60-feet apart					
		954 AWG conductor					
	11	Install new buried fiber optic line along new SH24 ROW	D-8120	12	miles	$30,000.00	$360,000.00
		Assume abandon existing line.					
		SH24 Subtotal					**$57,320,000.00**

QUANTITIES		PRICES	
BY: Anne Pavol	CHECKED: Alan Cha	BY: D. Donaldson DED	CHECKED: BDV 8/17/04
DATE PREPARED: 4/24/04	PEER REVIEW	DATE PREPARED: 08/17/04	PEER REVIEW: RDB 8/17/04

Black Rock Outlet Facility
and Outflow Conveyance
$Q_{(Conveyance)}$= 2,500 cfs
$Q_{(Power\ Plant)}$= 1,500 cfs

Field Cost Estimate

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

SHEET 1 OF 18

FEATURE:	PROJECT:
Black Rock Assessment Study Roza Canal Powerplant, Bypass, and Switchyard Outflow Conveyance System - Q= 2,500 cfs Powerplant Design Flow - Q= 1,500 cfs Summary	**Yakima River Basin Water Storage Options** REGION PN — PRICE LEVEL: Appraisal FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_Roza PP_1500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Roza Outflow Conveyance System sized for 2,500 cfs.					
		Roza Canal Powerplant sized for 1,500 cfs.					
		Assumes full Q goes through Powerplant.					
		Sunnyside Deliveries by Canal Option.					
		Roza North Deliveries by Pumping Plant.					
		Black Rock Outflow Conveyance Subtotal					$306,402,600.00 ✓
		Plant - Civil and Structural Subtotal					$21,069,650.00 ✓
		Plant - Mechanical Subtotal					$77,995,800.00 ✓
		Plant - Electrical Subtotal					$4,071,085.00 ✓
		Switchyard & Transmission Line Subtotal					$874,000.00 ✓
		Subtotal					$410,413,135.00 ✓
		Mobilization +/-	5%				$21,000,000.00 ✓
		Subtotal w/ mobilization					$431,413,135.00 ✓
		Unlisted Items +/-	10%				$38,586,865.00 ✓
		CONTRACT COST					**$470,000,000.00** ✓
		Contingencies +/-	25%				$120,000,000.00 ✓
		FIELD COST					**$590,000,000.00** ✓

QUANTITIES		PRICES	
BY	CHECKED	BY D. Donaldson DCD Elizabeth Tran	CHECKED GDV 8/17/04
DATE PREPARED	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q=1,500 cfs

Black Rock Outflow Conveyance

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_Roza PP_1500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Intake Structure with Fishscreens					
		Assume single level intake at Black Rock Reservoir.					
		Assume Top of Dead Pool @ El. 1500.0					
		Civil/Structural					
		Structural Excavation and Backfill					
		Assume top 5 feet of excavation is common and the remainder is rock					
	1	Excavation of common materials for structures	D8120	1,700	CY	$12.00	$20,400.00
	2	Excavation of rock for structures (drill & shoot)	D8120	1,000	CY	$45.00	$45,000.00
		Assume no backfill.					
		Construct Fishscreened Intake Structure (incl. Manifold Encasement)					
	3	Furnish, form, and place reinforced concrete (f'c=4ksi)	D8120	1,500	CY	$400.00	$600,000.00
	4	Furnish and place concrete reinforcement. (110#/CY)	D8120	165,000	LBS	$1.00	$165,000.00
	5	Furnish and handle cement	D8120	423	TONS	$150.00	$63,450.00
		Sheet Subtotal					**$893,850.00**

QUANTITIES		PRICES	
BY Dick LaFond 6/3/04	**CHECKED** M.R. O'Shea	**BY** D. Donaldson DCD	**CHECKED** BNV 8/17/04
DATE PREPARED	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** G

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q=1,500 cfs

Black Rock Outflow Conveyance

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_Roza PP_1500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Intake Structure with Fishscreens					
		Mechanical					
	6	Fish screen, radius = 20 ft, 90 ft long half cylinder shape	D-8410				
		structural steel weight		104,000	LBS	$4.00	$416,000.00
		stainless steel weight		70,000	LBS	$15.00	$1,050,000.00
	7	Air burst cleaning system, 250 psi working pressure	D-8410				
		a. 30,000 gallon receiver tank		60,000	LBS	$4.00	$240,000.00
		b. Air compressor units, each 30 hp, 87 cfm @ 250 psi		1,200	LBS	$20.00	$24,000.00
		@ 600 lbs each, two required					
		c. 6" dia. piping and butterfly valves (steel)		10,000	LBS	$7.00	$70,000.00
	8	Bulkhead gates and frames/guides (steel)	D-8410	144,000	LBS	$4.00	$576,000.00
		(assumes four - 10' by 10' bulkhead gates)					
		Sheet Subtotal					**$2,376,000.00**

QUANTITIES		PRICES	
BY R. Christensen	CHECKED AMR	BY D. Donaldson DCD	CHECKED BDV 8/17/04
DATE PREPARED 6/1/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW

FEATURE:	PROJECT:
Roza Canal Powerplant, Bypass, and Switchyard Outflow Conveyance System - Q= 2,500 cfs Powerplant Design Flow - Q=1,500 cfs Black Rock Outflow Conveyance	**Yakima River Basin Water Storage Options** **REGION** PN **PRICE LEVEL:** Appraisal **FILE:** C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_Roza PP_1500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Tunnel					
		Construct 90,000-ft long, 17.00-ft finished diameter, 19.67-ft minimum bore diameter, tunnel in rock. Tunnel will be excavated with TBM and driven uphill. Water problems will be minimal. Tunnel has three final support reaches.					
		80,600-ft long unreinforced concrete lined reach					
	9	Excavation	D-8140	80,600	lf	$1,200.00	$96,720,000.00
		(907,000 cy, appr 11 cy/lf)					
	10	Furnish and place unreinforced concrete tunnel lining	D-8140	229,000	cy	$350.00	$80,150,000.00
	11	Cementitious materials for concrete tunnel lining	D-8140	64,600	tons	$100.00	$6,460,000.00
	12	Furnish & install 3/4-in dia, 8-ft long rock bolts	D-8140	642,000	lin ft	$55.00	$35,310,000.00
		2,000-ft long reinforced concrete lined reach					
	13	Excavation	D-8140	2,000	lf	$1,200.00	$2,400,000.00
		(22,500 cy, appr 11 cy/lf)					
	14	Furnish and place reinforced concrete tunnel lining	D-8140	5,690	cy	$350.00	$1,991,500.00
	15	Cementitious materials for concrete tunnel lining	D-8140	1,600	tons	$130.00	$208,000.00
	16	Furnish and install concrete reinforcement	D-8140	81,700	lbs	$1.00	$81,700.00
	17	Furnish and install structural steel tunnel supports	D-8140	828,000	lbs	$4.00	$3,312,000.00
		7,400-ft long steel lined portal reach					
	18	Excavation	D-8140	7,400	lf	$1,200.00	$8,880,000.00
		(83,300 cy, appr 11 cy/lf)					
		Steel Tunnel Liner:					
		ASTM A572 Gr. 50: Sy = 50 kpsi St = 65 kpsi					
	19	204" Dia., 7/8" wall, L= 7770 ft., 1916 lbs/ft	D-8420	19,200,000	LBS	$2.00	$38,400,000.00
	20	Furnish and place backfill concrete	D-8140	21,100	cy	$300.00	$6,330,000.00
	21	Cementitious materials for backfill concrete	D-8140	5,940	tons	$120.00	$712,800.00
	22	Furnish & install 3/4-in dia, 8-ft long rock bolts	D-8140	89,600	lin ft	$55.00	$4,928,000.00
	23	Furnish and install structural steel tunnel supports	D-8140	415,000	lbs	$4.00	$1,660,000.00
		Sheet Subtotal					**$287,544,000.00**

QUANTITIES		PRICES	
BY Bill Thompson (D-8140) Nathan Nakamoto (D-8420)	CHECKED KA (D8420) Rick Frisz, D8420	BY D. Donaldson DCD	CHECKED BDV 8/17/04
DATE PREPARED 5/26/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Roza Canal Powerplant, Bypass, and Switchyard Outflow Conveyance System - Q= 2,500 cfs Powerplant Design Flow - Q=1,500 cfs Black Rock Outflow Conveyance	Yakima River Basin Water Storage Options REGION PN PRICE LEVEL: Appraisal FILE: Settings\bvanotte\ ments and Settings\bvanotte\Des

PLANT ACCT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Surge Shaft					
		Construct 530-ft deep, 40.0-ft finished diameter, 46-ft excavated diameter, shaft in rock.					
		Shaft will be excavated by raise bore and slash method (drill & blast).					
		Water problems will be minimal. Shaft has two final support reaches.					
		430-ft deep unreinforced concrete lined reach					
	24	Excavation	D-8140	430	lf	$17,000.00	$7,310,000.00
		(26,500 cy, approx. 62 cy/lf)					
	25	Furnish and place unreinforced concrete shaft lining	D-8140	6,450	cy	$400.00	$2,580,000.00
	26	Cementitious materials for concrete shaft lining	D-8140	1,820	tons	$130.00	$236,600.00
	27	Furnish & install 1-in dia, 12-ft long rock bolts	D-8140	21,000	lin ft	$60.00	$1,260,000.00
		100-ft deep reinforced concrete lined shaft top reach					
	28	Excavation	D-8140	100	lf	$17,000.00	$1,700,000.00
		(6,160 cy, approx. 62 cy/lf)					
	29	Furnish and place reinforced concrete shaft lining	D-8140	1,500	cy	$400.00	$600,000.00
	30	Cementitious materials for concrete shaft lining	D-8140	423	tons	$150.00	$63,450.00
	31	Furnish and install concrete reinforcement	D-8140	18,700	lin ft	$1.00	$18,700.00
	32	Furnish & install 1-in dia, 12-ft long rock bolts	D-8140	4,800	lin ft	$60.00	$288,000.00
	33	Furnish and install chain link protection	D-8140	76,600	sq yd	$20.00	$1,532,000.00
		Black Rock Outflow Conveyance Subtotal					**$306,402,600.00**

QUANTITIES		PRICES	
BY Bill Thompson	CHECKED	BY D. Donaldson DCD	CHECKED BDV 8/17/04
DATE PREPARED 4/19/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Roza Canal Powerplant, Bypass, and Switchyard Outflow Conveyance System - Q= 2,500 cfs Powerplant Design Flow - Q=1,500 cfs	Yakima River Basin Water Storage Options
	REGION PN — PRICE LEVEL: Appraisal
Civil/Site	FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_Roza PP_1500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Access Road (60 ft of 24ft wide bituminous surface):					
	1	Clear roadway alignment	D8120	1,440	SF	$1.00	$1,440.00
	2	Furnish and place base course material (9-inch depth)	D8120	75	TONS	$20.00	$1,500.00
	3	Furnish and place asphalt concrete (6-inch depth)	D8120	55	TONS	$100.00	$5,500.00
		Service Yard (6" asphalt concrete surface)					
		Assume T.O Yard= El 1176.0					
	4	Strip and clear pumping plant site to 1 foot depth	D8120	8,000	CY	$5.00	$40,000.00
	5	Common excavation to Yard (25% Strip & Clear)	D8120	2,000	CY	$7.00	$14,000.00
	6	Place and compact embankment for yard (25% Exc.)	D8120	500	CY	$12.00	$6,000.00
	7	Furnish and place base course material (6-inch)	D8120	4,700	TONS	$20.00	$94,000.00
	8	Furnish and place asphalt concrete (6-inch)	D8120	5,200	TONS	$100.00	$520,000.00
	9	Furnish and install 7-foot chain link fence for PP Yard	D8120	2,000	LF	$20.00	$40,000.00
	10	Furnish and install 7-foot x 24-foot access gates	D8120	3	EA	$3,500.00	$10,500.00
		Diversion During Construction:					
		Assume need to pass 900 cfs canal flow during construction. Assume local borrow.					
		Assume no dewwatering required.					
	11	Construct U/S & D/S earth cofferdams. (Height=15 ft)	D8120	2,000	CY	$15.00	$30,000.00
	12	F&I impervious geomembrane on cofferdams.	D8120	350	SY	$15.00	$5,250.00
	13	F&I three 9-ft dia. X .138-in galv., corrugated metal pipes btwn cofferdams. Wt/Ft= 210 lbs/ft.	D8120	1,000	LF	$500.00	$500,000.00
	14	Remove cofferdams and diversion structures	D8120	1	LS	$20,000.00	$20,000.00
		Sheet Subtotal					**$1,288,190.00** ✓

QUANTITIES		PRICES	
BY Dick LaFond	CHECKED M. R. O'Shea	BY D. Donaldson DCD	CHECKED BDV 8/17/04
DATE PREPARED 6/3/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW CJ

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Roza Canal Powerplant, Bypass, and Switchyard Outflow Conveyance System - Q= 2,500 cfs Powerplant Design Flow - Q=1,500 cfs Civil/Site	**Yakima River Basin Water Storage Options** **REGION** PN **PRICE LEVEL:** Appraisal **FILE:** C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_Roza PP_1500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Tailrace Channel Excavation					
		T.O Ground El. 1176. Assume T.O. Rock El. 1150					
		Assume stockpile rock and common material for reuse.					
	15	Common excavation for tailrace channel	D8120	44,500	CY	$5.00	$222,500.00
	16	Rock excavation for tailrace channel (drill and shoot)	D8120	25,000	CY	$32.00	$800,000.00
		Structural Excavation and Backfill (Powerplant & Bypass)					
		T.O Ground El. 1176. Assume T.O. Rock El. 1150					
		Assume stockpile rock for later use as riprap.					
	17	Common excavation for structures	D8120	24,700	CY	$12.00	$296,400.00
	18	Rock excavation for structures (drill & shoot)	D8120	22,000	CY	$32.00	$704,000.00
	19	Furnish backfill for structures (reuse excavation)	D8120	6,400	CY	$6.00	$38,400.00
	20	Place backfill around structures	D8120	6,400	CY	Included above	
	21	Compact backfill around structures	D8120	6,400	CY	$8.00	$51,200.00
		Pipe Trench Excavation and Backfill					
		Manifold excavation in yard.					
		T.O Ground El. 1176. Assume T.O. Rock El. 1150					
	22	Common excavation for pipe in Service Yard	D8120	18,000	CY	$10.00	$180,000.00
	24	Furnish, place, & compact backfill for pipe (local)	D8120	11,500	CY	$6.00	$69,000.00
		Pipe Trench Excavation and Backfill					
		From Tunnel Portal (Sta. 910+00) to Yard (Sta. 940+00)					
		Assume all common excavation					
	25	Common excavation for pipe	D8140	487,000	CY	$5.00	$2,435,000.00
	26	Furnish backfill for pipe	D8140	461,500	CY	Included above	
	27	Place backfill around pipe	D8140	461,500	CY	$3.00	$1,384,500.00
	28	Compact pipe backfill (F&P included in above items)	D8140	36,000	CY	$3.00	$108,000.00
		Sheet Subtotal					**$6,289,000.00** ✓

QUANTITIES		PRICES	
BY Dick LaFond (D8120) Linda Bowles (D8140)	**CHECKED** M. R. O'Shea (D-8120)	**BY** D. Donaldson DCD	**CHECKED** DOV 8/17/04
DATE PREPARED 6/4/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** G

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q=1,500 cfs

Structural and Architectural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		STRUCTURAL					
		Construct Concrete Tailrace Lining and Retaining Walls					
		Assume lining is 1-foot thick w/ #6@12" EW EF, 1.5:1 side slopes					
	29	Furnish, form, and place reinforced concrete lining	D8120	2,100	CY	$400.00	$840,000.00
		in excavated channel (f'c= 4 ksi)					
	30	Furnish, form, and place reinforced concrete walls	D8120	1,800	CY	$400.00	$720,000.00
	31	Furnish and place concrete reinforcement.	D8120	500,000	LBS	$0.80	$400,000.00
		Assume 130 #/CY					
	32	Furnish and handle cement (.282T/CY)	D8120	1,085	TONS	$140.00	$151,900.00
		Construct Powerplant and Bypass Substructure					
	33	Furnish, form, and place reinforced concrete	D8120	15,500	CY	$350.00	$5,425,000.00
	34	Furnish and place concrete reinforcement.	D8120	1,860,000	LBS	$0.65	$1,209,000.00
		Assume 120 #/CY					
	35	Furnish and handle cement (.282T/CY)	D8120	4,370	TONS	$120.00	$524,400.00
	36	**Construct Powerplant and Bypass Superstructure**	D8120	15,620	SF	$100.00	$1,562,000.00
		212.5-ft x 73.5-ft x 42-ft high superstructure					
		Structural steel superstructure with CMU walls.					
		Stepped columns for 90T crane support					
		Built-up roof on metal roof deck.					
		Sheet Subtotal					**$10,832,300.00** ✓

QUANTITIES		PRICES	
BY Dick LaFond	**CHECKED** M. A. O'Shea	**BY** D. Donaldson DCD	**CHECKED** BDV 8/17/04
DATE PREPARED 6/4/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** G

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q=1,500 cfs

Structural and Architectural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		STRUCTURAL (cont.)					
		Construct Pipe Encasements in Yard					
	37	Furnish, form, and place reinforced concrete	D8120	3,100	CY	$400.00	$1,240,000.00
	38	Furnish and place concrete reinforcement.	D8120	341,000	LBS	$0.80	$272,800.00
		Assume 110 #/CY					
	39	Furnish and handle cement (.282T/CY)	D8120	874	TONS	$140.00	$122,360.00
		Structural Steel					
	40	Furnish and install structural steel (painted):	D8120	175,000	LBS	$4.00	$700,000.00
		Includes crane girder, rail, and monorail support frames.					
		Does not include typ. building framework.					
		Miscellaneous Metalwork					
	41	Furnish and install miscellaneous metalwork	D8120	45,000	LBS	$7.00	$315,000.00
		Includes grating, hatches, ladders, guardrail, and					
		cable trays					
	42	Motor-operated, exterior insulated roll-up door	D8120	1	EA	$10,000.00	$10,000.00
		18' x 20'					
		Plant - Civil and Structural Subtotal					**$21,069,650.00**

QUANTITIES		PRICES	
BY Dick LaFond	CHECKED M.R. O'Shea	BY D. Donaldson DCD	CHECKED BAV 8/17/04
DATE PREPARED 6/5/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW G

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q=1,500 cfs

Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_Roza PP_1500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Major Mechanical Equipment					
	1	Turbine Weight	D8420	210,000	LBS	$20.00	$4,200,000.00
		CF3 18-8 Stainless Runner 6.8' dia.					
		Turbine-Vertical Francis, 52,419 Hp					
		327.27 rpm, 339 ft. Design Head					
	2	Digital Governor, 180,338 ft.-lbs.	D8420	1	EA	$275,000.00	$275,000.00
		1,000 psi system					
	3	Governor Pressure Tank 875 Gal., piping	D8420	7,640	LBS	$10.00	$76,400.00
		and appurtenances. Look to Flaming Gorge					
		Sheet Subtotal					**$4,551,400.00**

QUANTITIES		PRICES	
BY T J Turnage	**CHECKED** John Brooks	**BY** D. Donaldson DCD	**CHECKED** BDV 8/17/04
DATE PREPARED 6/3/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q=1,500 cfs

Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN | **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_Roza PP_1500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Furnish and install the following:					
		Steel Penstock:					
		Steel plate used for pipe fabrication:					
		ASTM A36: Sy = 36 kpsi					
		(All pipe sizes are inside diameters)					
	4	204" Dia., 1 15/16" wall, L= 4,993 ft., 4265 lbs/ft		21,300,000	LBS	$2.00	$42,600,000.00
	5	84" Dia., 13/16" wall, L= 492 ft., 737 lbs/ft		363,000	LBS	$2.00	$726,000.00
		Stainless Steel Stilling Basin for Sleeve Valves:					
		ASTM 316L Stainless steel plate					
	6	Four - 396" Dia., 1 1/4" wall cylindrical tanks with baseplates:					
		Each tank height = 20 feet					
		Total weight for four tanks = 1,180,000 lbs.	D8420	1,180,000	LBS	$15.00	$17,700,000.00
		Sleeve valves with hydraulic operators:					
	7	Four - 84" Dia. Inlet X 72" Dia. Outlet Valves	D8420	280,000	LBS	$15.00	$4,200,000.00
		ASTM 316L Stainless steel plate					
		Each valve weight = 70,000					
		Total weight for four valves = 280,000 lbs.					
		Spherical valves with hydraulic operators:					
	8	Sleeve valve guard valves	D8420	240,000	LBS	$10.00	$2,400,000.00
		Four - 60" Dia. Spherical valves with hydraulic operators					
		60,000 lbs. per valve					
		Turbine guard valve					
	9	One - 108" Dia. Spherical valve with hydraulic operator	D8420	180,000	LBS	$10.00	$1,800,000.00
		180,000 lbs. per valve					
		Sheet Subtotal					**$69,426,000.00**

QUANTITIES		PRICES	
BY Nathan Nakamoto, D8420	**CHECKED** Rick Frisz, D8420	**BY** D. Donaldson DCD	**CHECKED** DDJ 8/17/04
DATE PREPARED 5/26/04		**DATE PREPARED** 08/17/04	**PEER REVIEW** G

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q=1,500 cfs

Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN | **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	10	Furnishing and installing one 90-Ton overhead crane, 67.5' span	D-8410	157,500	LBS	$6.00	$945,000.00
	11	Furnishing and installing Hydraulic elevator capacity = 3500 pounds, travel = 31 ft. landings = 3, speed = 100 ft/min.	D-8410	1	unit	$400,000.00	$400,000.00
	12	Bulkhead gates and guides at turbine (steel) (assumes 3 bays of guides and 3 bulkhead gates)	D-8410	31,000	LBS	$4.00	$124,000.00
	13	Monorail hoist for bulkhead gate, electric wire rope, motorized trolley, 5-ton capacity	D-8410	1,500	LBS	$20.00	$30,000.00
	14	Stoplogs, lifting beam & guides at sleeve valves eight bays fo guides, 2 bays of stoplogs (steel)	D-8410	152,000	LBS	$4.00	$608,000.00
	15	CO2 High Pressure Fire Extinguishing System: 12 - 100# Storage Cylinders w/ control panel and appurtenances and 400 lbs. of sch. 80 carbon steel pipe, valves & fittings	D-8410	1	L.S.		$36,000.00
	16	Fire Suppression System: 3 Fire hose reels w/ 100 feet of hose 12 - Portable hand-held 20# extinguishers 2,000 lbs. of sch. 40 carbon steel pipe, valves & fittings 1 - Fire pump, split-case, 500 gpm @ 300 ft of head	D-8410	1	L.S.		$50,000.00
	17	Unit Cooling Water System: 2 - Cooling water pumps, end-suction type, 150 gpm 2 - 8-inch automatic, self-cleaning strainers 1,000 lbs. of type K copper tubing, valves & fittings 4,000 lbs. of ductile iron, mechanical joint pipe & fittings	D-8410	1	L.S.		$130,000.00
	18	Lubricating Oil System: 2- 500 gal carbon steel storage tanks 1 - 10 gpm @ 100 psi oil pump 1 - lube oil filter 1,000 lbs. of sch. 40 carbon steel pipe, valves & fittings	D-8410	1	L.S.		$20,000.00
		Sheet Subtotal					**$2,343,000.00**

QUANTITIES		PRICES	
BY R Christensen, B Sund, C Berte, J Grass	CHECKED AHR	BY D. Donaldson DCD	CHECKED BDV 8/17/04
DATE PREPARED 5/3/2004	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW G

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q=1,500 cfs

Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	19	Compressed Air System:	D-8410	1	L.S.		$50,000.00
		2 - 100 cfm @ 125 psi rotary screw air compressors					
		1 - 250 gal. carbon steel air receiver					
		1 - 100 cfm air dryer					
		500 lbs. of sch. 40 carbon steel pipe, valves & fittings					
	20	Service Water System:	D-8410	1	L.S.		$100,000.00
		1 - Service water pump, 75 gpm @ 200 ft. of head					
		1 - Hydropneumatic Tank, 300 gal.					
		750 lbs. of type K copper tubing, valves & fittings					
	21	Gravity Drainage System:	D-8410	1	L.S.		$50,000.00
		12 - Floor drains, cast iron					
		5,000 lbs. of cast iron hub & spigot, service weight					
		soil pipe					
	22	Plant Unwatering System:	D-8410	1	each		$70,000.00
		2 - Vertical turbine type sump pump, 500 gpm @ 50 ft hd					
		1 - Drainage jet type drainage pump					
		1,000 lbs. of type K copper tube, valves & fittings					
		3,000 lbs. of ductile iron, mechanical joint pipe & fittings					
	23	Domestic Water and Sanitary Waste System:	D-8410	1	each		$50,000.00
		2 - Water Closets					
		1 - Urinal					
		2 - Lavatories & accessories					
		1 - Duplex Sewage Ejector					
		2,000 lbs. of cast iron hub & spigot service weight					
		sewer pipe					
		400 lbs. of type K copper tubing, valves & fittings					
		Sheet Subtotal					**$320,000.00**

QUANTITIES		PRICES	
BY J Grass	**CHECKED** Ame	**BY** D. Donaldson DRD	**CHECKED** BOV 8/17/04
DATE PREPARED 5/27/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q=1,500 cfs

Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_Roza PP_1500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Heating, Ventilating, and Air Conditioning	D-8410	1	L.S.		$1,355,400.00
		Unmanned air cooled plant .					
		OA temp 95 degrees F.					
		Plant - Mechanical Subtotal					**$77,995,800.00** ✓

QUANTITIES		PRICES	
BY P Schlein	**CHECKED** Ase	**BY** D. Donaldson DCD	**CHECKED** BDV 8/17/04
DATE PREPARED 6/1/2004	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** G

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q=1,500 cfs

Electrical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_Roza PP_1500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	**Electrical Generator (F&I)**	D8430	1	EA	$1,550,000	$1,550,000.00
		25,000 kVA, 6,900 volts, 3-phase, 60 Hz					
		276.9 rpm, 95 % power factor					
		Vertical, synchronous machine					
		Static excitation system & voltage regulator					
		Plant Grounding System (F&I)	D8430				
	2	Ground rods, 10 ft, 3/4" dia, copper-clad		30	EA	$180.00	$5,400.00
		Stranded bare-copper conductor:					
	3	250 MCM		1,200	LF	$5.50	$6,600.00
	4	4/0 AWG		800	LF	$4.00	$3,200.00
	5	2/0 AWG		500	LF	$3.50	$1,750.00
	6	4 AWG		800	LF	$2.50	$2,000.00
		Generator Bus & Metal-Enclosed Switchgear (F&I)	D8430				
	7	Generator non-segragated phase bus:		250	LF	$1,400.00	$350,000.00
		15 kV, 3000 amperes, 3-phase, 60 Hz					
	8	Generator power circuit breaker:		1	EA	$730,000	$730,000.00
		15 kV, 3000 amperes, 3-phase, vacuum type					
	9	Station-service fused interrupter switch:		1	EA	$30,000.00	$30,000.00
		15 kV, 600 ampere, 3-phase, w/ power fuses					
		Generator Control Equipment (F&I)	D8430				
	10	Duplex control switchboard for operation of the generator		1	EA	$730,000	$730,000.00
		Sheet Subtotal					**$3,408,950.00**

QUANTITIES		PRICES	
BY M. Schuh D8430	CHECKED L Rom'	BY DCD. For Elizabeth Tran	CHECKED ADV 8/17/04
DATE PREPARED 5/27/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW G

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q=1,500 cfs

Electrical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_Roza PP_1500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Plant Battery System (F&I)	D8430				
	11	125 volt, 300 ampere-hour, lead-acid battery		1	EA	$25,000.00	$25,000.00
	12	Battery chargers		2	EA	$8,000.00	$16,000.00
	13	DC distribution panelboard, 100 ampere mains, and molded-case circuit breakers		1	EA	$12,500.00	$12,500.00
		Plant Station-Service Equipment (F&I)	D8430				
		Indoor secondary unit substation with following features:					
	14	Dry-type transformer, 6.9 kV-480Y/277, 1500 kVA		1	EA	$55,000.00	$55,000.00
	15	480 volt power-circuit breakers, 600 amperes		5	EA	$4,000.00	$20,000.00
		Building Lighting System (F&I)	D8430				
		Interior luminaires					
	16	High bay, high-pressure sodium, 400 Watt 480 volt, 1-phase		24	EA	$700.00	$16,800.00
	17	4 foot fluorescent lighting fixtures, 2 lamps		36	EA	$220.00	$7,920.00
	18	Emergency lighting system		1	LS	$900.00	$900.00
		Exterior luminaires					
	19	High-pressure sodium, wall-mounted, outdoor type 70 watt, 120 volt		12	EA	$400.00	$4,800.00
	20	**Building Fire Detection & Alarm System (F&I)**	D8430	1	LS	$150,000	$150,000.00
		Distribution Panelboards (F&I)	D8430				
	21	480-volts, 3-phase, 400 ampere bus, indoor type with 12 molded-case circuit breakers		2	EA	$30,000.00	$60,000.00
		Motor Control Center (F&I)	D8430				
	22	480 volts, 3-phase, 1600 ampere main bus Six 20 inch wide sections		1	EA	$195,000	$195,000.00
		Sheet Subtotal					**$563,920.00**

QUANTITIES		PRICES	
BY M. Schuh D8430	CHECKED L Rossi	BY DCD For Elizabeth Tran	CHECKED BDV 8/17/04
DATE PREPARED 5/27/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW G

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q=1,500 cfs

Electrical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_Roza PP_1500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Insulated Conductors (F&I)	D8430				
		15 kV shielded power cable:					
	23	4 AWG		300	FT	$12.00	$3,600.00
		600-volt single-conductor, stranded-copper:					
	24	12 AWG		6,000	FT	$0.65	$3,900.00
	25	10 AWG		4,000	FT	$0.80	$3,200.00
	26	6 AWG		1,000	FT	$1.55	$1,550.00
	27	4 AWG		1,000	FT	$1.80	$1,800.00
	28	1/0 AWG		600	FT	$2.90	$1,740.00
	29	4/0 AWG		600	FT	$5.00	$3,000.00
		600-volt multi-conductor control cable:					
	30	9 conductor 14 AWG		1,500	FT	$1.75	$2,625.00
	31	12 conductor 14 AWG		2,000	FT	$2.00	$4,000.00
	32	5 conductor 10 AWG		2,000	FT	$1.80	$3,600.00
		Conduit System (F&I)	D8430				
		Rigid steel conduit:					
	33	1 inch		1,000	FT	$14.00	$14,000.00
	34	1 1/2 inch		500	FT	$18.00	$9,000.00
	35	2 inch		600	FT	$22.00	$13,200.00
	36	2 1/2 inch		350	FT	$30.00	$10,500.00
		Plastic-coated rigid steel:					
	37	2 inch		750	FT	$30.00	$22,500.00
		Plant - Electrical Subtotal					**$4,071,085.00**

QUANTITIES		PRICES	
BY M. Schuh D8430	CHECKED L Rossi	BY DCD for Elizabeth Tran	CHECKED DD / 8/17/04
DATE PREPARED 5/27/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW G

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q=1,500 cfs

Switchyard and Transmission Line

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_Roza PP_1500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Switchyard					
		Furnish and Install:					
	1	Oil-filled power transformer	D8440	1	EA	$450,000	$450,000.00
		25 MVA; 34.5-6.9kV, 3-phase					
	2	F&I 34.5-KV PRIMARY UNIT SUBSTATION:	D8440	1	EA	$375,000	$375,000.00
		'INCOMING 34.5KV SECTION/BUS/INTERRUPTER					
		'OUTGOING 6.9KV SECTION/BUS/INTERRUPTER					
		'SURGE ARRESTORS, 30KV					
		Tap at existing 34.5-kV line					
		Furnish and Install:					
	3	Wood-pole tap structure	D8440	1	EA	$9,000.00	$9,000.00
	4	**Construct Transmission LIne**	D8440	1,000	FT	$40.00	$40,000.00
		Assume 1000 feet of transmission line from					
		existing 34.5-kV line					
		wood poles, 1115 AWG conductor					
		Switchyard & Transmission Line Subtotal					**$874,000.00**

QUANTITIES		PRICES	
BY L. Gamuciello	**CHECKED**	**BY** Dcal for Elizabeth Tran	**CHECKED** BOV 8/17/04
DATE PREPARED 5/27/04	**PEER REVIEW** James R. Zeiger	**DATE PREPARED** 08/17/04	**PEER REVIEW** J

Black Rock Outlet Facility
and Outflow Conveyance
$Q_{(Conveyance)}$= 2,500 cfs
$Q_{(Power\ Plant)}$= 900 cfs

Field Cost Estimate

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Assessment Study
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q= 900 cfs
Summary

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_SunnysidePP_1 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Roza Outflow Conveyance System sized for 2,500 cfs.					
		Roza Canal Powerplant sized for 900 cfs.					
		Assumes Roza South Q goes through Powerplant.					
		Sunnyside Deliveries by Pressure Pipe Option.					
		Roza North Deliveries by Pressure Pipe Option.					
		Black Rock Outflow Conveyance Subtotal					$306,402,600.00 ✓
		Plant - Civil and Structural Subtotal					$19,925,100.00 ✓
		Plant - Mechanical Subtotal					$77,295,800.00 ✓
		Plant - Electrical Subtotal					$4,071,085.00 ✓
		Switchyard & Transmission Line Subtotal					$874,000.00 ✓
		Subtotal					$408,568,585.00 ✓
		Mobilization +/-	5%				$20,000,000.00 ✓
		Subtotal w/ mobilization					$428,568,585.00 ✓
		Unlisted Items +/-	10%				$41,431,415.00 ✓
		CONTRACT COST					**$470,000,000.00** ✓
		Contingencies +/-	25%				$120,000,000.00 ✓
		FIELD COST					**$590,000,000.00** ✓

QUANTITIES		PRICES	
BY	**CHECKED**	**BY** D. Donaldson DCD Elizabeth Tran	**CHECKED** BOV 8/17/04
DATE PREPARED	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** G

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q= 900 cfs

Black Rock Outflow Conveyance

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Intake Structure with Fishscreens					
		Assume single level intake at Black Rock Reservoir.					
		Assume Top of Dead Pool @ El. 1500.0					
		Civil/Structural					
		Structural Excavation and Backfill					
		Assume top 5 feet of excavation is common and the remainder is rock					
	1	Excavation of common materials for structures	D8120	1,700	CY	$12.00	$20,400.00
	2	Excavation of rock for structures (drill & shoot)	D8120	1,000	CY	$45.00	$45,000.00
		Assume no backfill.					
		Construct Fishscreened Intake Structure (incl. Manifold Encasement)					
	3	Furnish, form, and place reinforced concrete (f'c=4ksi)	D8120	1,500	CY	$400.00	$600,000.00
	4	Furnish and place concrete reinforcement. (110#/CY)	D8120	165,000	LBS	$1.00	$165,000.00
	5	Furnish and handle cement	D8120	423	TONS	$150.00	$63,450.00
		Sheet Subtotal					**$893,850.00**

QUANTITIES		PRICES	
BY Dick LaFond 6/3/04	CHECKED N. R. O'Shea	BY D. Donaldson DCD	CHECKED BDV 8/17/04
DATE PREPARED	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW G

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q= 900 cfs

Black Rock Outflow Conveyance

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Intake Structure with Fishscreens					
		Mechanical					
	6	Fish screen, radius = 20 ft, 90 ft long half cylinder shape	D-8410				
		structural steel weight		104,000	LBS	$4.00	$416,000.00
		stainless steel weight		70,000	LBS	$15.00	$1,050,000.00
	7	Air burst cleaning system, 250 psi working pressure	D-8410				
		a. 30,000 gallon receiver tank		60,000	LBS	$4.00	$240,000.00
		b. Air compressor units, each 30 hp, 87 cfm @ 250 psi		1,200	LBS	$20.00	$24,000.00
		@ 600 lbs each, two required					
		c. 6" dia. piping and butterfly valves (steel)		10,000	LBS	$7.00	$70,000.00
	8	Bulkhead gates and frames/guides (steel)	D-8410	144,000	LBS	$4.00	$576,000.00
		(assumes four - 10' by 10' bulkhead gates)					
		Sheet Subtotal					**$2,376,000.00**

QUANTITIES		PRICES	
BY R. Christensen	CHECKED AOR	BY D. Donaldson DCD	CHECKED BOV 5/17/04
DATE PREPARED 6/1/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW CJ

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q= 900 cfs

Black Rock Outflow Conveyance

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Tunnel					
		Construct 90,000-ft long, 17.00-ft finished diameter, 19.67-ft minimum bore diameter, tunnel in rock. Tunnel will be excavated with TBM and driven uphill. Water problems will be minimal. Tunnel has three final support reaches.					
		80,600-ft long unreinforced concrete lined reach					
	9	Excavation	D-8140	80,600	lf	$1,200.00	$96,720,000.00
		(907,000 cy, appr 11 cy/lf)					
	10	Furnish and place unreinforced concrete tunnel lining	D-8140	229,000	cy	$350.00	$80,150,000.00
	11	Cementitious materials for concrete tunnel lining	D-8140	64,600	tons	$100.00	$6,460,000.00
	12	Furnish & install 3/4-in dia, 8-ft long rock bolts	D-8140	642,000	lin ft	$55.00	$35,310,000.00
		2,000-ft long reinforced concrete lined reach					
	13	Excavation	D-8140	2,000	lf	$1,200.00	$2,400,000.00
		(22,500 cy, appr 11 cy/lf)					
	14	Furnish and place reinforced concrete tunnel lining	D-8140	5,690	cy	$350.00	$1,991,500.00
	15	Cementitious materials for concrete tunnel lining	D-8140	1,600	tons	$130.00	$208,000.00
	16	Furnish and install concrete reinforcement	D-8140	81,700	lbs	$1.00	$81,700.00
	17	Furnish and install structural steel tunnel supports	D-8140	828,000	lbs	$4.00	$3,312,000.00
		7,400-ft long steel lined portal reach					
	18	Excavation	D-8140	7,400	lf	$1,200.00	$8,880,000.00
		(83,300 cy, appr 11 cy/lf)					
		Steel Tunnel Liner:					
		ASTM A572 Gr. 50: Sy = 50 kpsi St = 65 kpsi					
	19	204" Dia., 7/8" wall, L= 7770 ft., 1916 lbs/ft	D-8420	19,200,000	LBS	$2.00	$38,400,000.00
	20	Furnish and place backfill concrete	D-8140	21,100	cy	$300.00	$6,330,000.00
	21	Cementitious materials for backfill concrete	D-8140	5,940	tons	$120.00	$712,800.00
	22	Furnish & install 3/4-in dia, 8-ft long rock bolts	D-8140	89,600	lin ft	$55.00	$4,928,000.00
	23	Furnish and install structural steel tunnel supports	D-8140	415,000	lbs	$4.00	$1,660,000.00
		Sheet Subtotal					**$287,544,000.00**

QUANTITIES		PRICES	
BY Bill Thompson (D-8140) Nathan Nakamoto (D-8420)	**CHECKED** KA (D8140) Rick Frisz, D8420	**BY** D. Donaldson DED	**CHECKED** BAV 8/17/04
DATE PREPARED 5/26/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q= 900 cfs

Black Rock Outflow Conveyance

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Surge Shaft					
		Construct 530-ft deep, 40.0-ft finished diameter, 46-ft excavated diameter, shaft in rock.					
		Shaft will be excavated by raise bore and slash method (drill & blast).					
		Water problems will be minimal. Shaft has two final support reaches.					
		430-ft deep unreinforced concrete lined reach					
	24	Excavation	D-8140	430	lf	$17,000.00	$7,310,000.00
		(26,500 cy, approx. 62 cy/lf)					
	25	Furnish and place unreinforced concrete shaft lining	D-8140	6,450	cy	$400.00	$2,580,000.00
	26	Cementitious materials for concrete shaft lining	D-8140	1,820	tons	$130.00	$236,600.00
	27	Furnish & install 1-in dia, 12-ft long rock bolts	D-8140	21,000	lin ft	$60.00	$1,260,000.00
		100-ft deep reinforced concrete lined shaft top reach					
	28	Excavation	D-8140	100	lf	$17,000.00	$1,700,000.00
		(6,160 cy, approx. 62 cy/lf)					
	29	Furnish and place reinforced concrete shaft lining	D-8140	1,500	cy	$400.00	$600,000.00
	30	Cementitious materials for concrete shaft lining	D-8140	423	tons	$150.00	$63,450.00
	31	Furnish and install concrete reinforcement	D-8140	18,700	lin ft	$1.00	$18,700.00
	32	Furnish & install 1-in dia, 12-ft long rock bolts	D-8140	4,800	lin ft	$60.00	$288,000.00
	33	Furnish and install chain link protection	D-8140	76,600	sq yd	$20.00	$1,532,000.00
		Black Rock Outflow Conveyance Subtotal					**$306,402,600.00**

QUANTITIES		PRICES	
BY Bill Thompson	CHECKED KA	BY D. Donaldson DCD	CHECKED BOV 8/17/04
DATE PREPARED 4/19/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q= 900 cfs

Civil/Site

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Access Road (60 ft of 24ft wide bituminous surface):					
	1	Clear roadway alignment	D8120	1,440	SF	$1.00	$1,440.00
	2	Furnish and place base course material (9-inch depth)	D8120	75	TONS	$20.00	$1,500.00
	3	Furnish and place asphalt concrete (6-inch depth)	D8120	55	TONS	$100.00	$5,500.00
		Service Yard (6" asphalt concrete surface)					
		Assume T.O Yard= El 1176.0					
	4	Strip and clear pumping plant site to 1 foot depth	D8120	7,850	CY	$5.00	$39,250.00
	5	Common excavation to Yard (25% Strip & Clear)	D8120	2,000	CY	$7.00	$14,000.00
	6	Place and compact embankment for yard (25% Exc.)	D8120	500	CY	$12.00	$6,000.00
	7	Furnish and place base course material (6-inch)	D8120	4,600	TONS	$20.00	$92,000.00
	8	Furnish and place asphalt concrete (6-inch)	D8120	5,100	TONS	$100.00	$510,000.00
	9	Furnish and install 7-foot chain link fence for PP Yard	D8120	1,900	LF	$20.00	$38,000.00
	10	Furnish and install 7-foot x 24-foot access gates	D8120	3	EA	$3,500.00	$10,500.00
		Diversion During Construction:					
		Assume need to pass 900 cfs canal flow during					
		construction. Assume local borrow.					
		Assume no dewwatering required.					
	11	Construct U/S & D/S earth cofferdams. (Height=15 ft)	D8120	2,000	CY	$15.00	$30,000.00
	12	F&I impervious geomembrane on cofferdams.	D8120	350	SY	$15.00	$5,250.00
	13	F&I three 9-ft dia. X .138-in galv., corrugated metal pipes	D8120	1,000	LF	$500.00	$500,000.00
		btwn cofferdams. Wt/Ft= 210 lbs/ft.					
	14	Remove cofferdams and diversion structures	D8120	1	LS	$20,000.00	$20,000.00
		Sheet Subtotal					**$1,273,440.00**

QUANTITIES		PRICES	
BY Dick LaFond	CHECKED	BY D. Donaldson DCD	CHECKED BDV 8/17/04
DATE PREPARED 6/3/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q= 900 cfs

Civil/Site

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Tailrace Channel (Lined - Lining covered under structural)					
		T.O Ground El. 1176. Assume T.O. Rock El. 1150					
		Assume stockpile rock and common material for reuse.					
	15	Common excavation for tailrace channel	D8120	39,000	CY	$5.00	$195,000.00
	16	Rock excavation for tailrace channel (drill & shoot)	D8120	17,500	CY	$32.00	$560,000.00
		Structural Excavation and Backfill					
		T.O Ground El. 1176. Assume T.O. Rock El. 1150					
		Assume stockpile rock for later use as riprap.					
	17	Common excavation for structures	D8120	23,700	CY	$12.00	$284,400.00
	18	Rock excavation for structures (drill & shoot)	D8120	16,700	CY	$32.00	$534,400.00
	19	Furnish backfill for structures (reuse excavation)	D8120	5,800	CY	$6.00	$34,800.00
	20	Place backfill around structures	D8120	5,800	CY	Included above	
	21	Compact backfill around structures	D8120	5,800	CY	$8.00	$46,400.00
		Pipe Trench Excavation and Backfill					
		Manifold excavation in yard.					
		T.O Ground El. 1176. Assume T.O. Rock El. 1150					
	22	Common excavation for pipe in Service Yard	D8120	18,000	CY	$10.00	$180,000.00
	24	Furnish, place, & compact backfill for pipe (local)	D8120	11,500	CY	$6.00	$69,000.00
		Pipe Trench Excavation and Backfill					
		From Tunnel Portal (Sta. 910+00) to Yard (Sta. 940+00)					
		Assume all common excavation					
	25	Common excavation for pipe	D8140	487,000	CY	$5.00	$2,435,000.00
	26	Furnish backfill for pipe	D8140	461,500	CY	Included above	
	27	Place backfill around pipe	D8140	461,500	CY	$3.00	$1,384,500.00
	28	Compact pipe backfill (F&P included in above items)	D8140	36,000	CY	$3.00	$108,000.00
		Sheet Subtotal					**$5,831,500.00** ✓

QUANTITIES		PRICES	
BY Dick LaFond (D8120) Linda Bowles (D8140)	**CHECKED** Anna Taval (D8140) M.R. O'Shea (D-8120)	**BY** D. Donaldson DCD	**CHECKED** DDV 8/17/04
DATE PREPARED 5/15/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** G

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q= 900 cfs

Structural and Architectural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		STRUCTURAL					
		Construct Concrete Tailrace Lining and Retaining Walls					
		Assume lining is 1-foot thick w/ #6@12" EW EF, 1.5:1 side slopes					
	29	Furnish, form, and place reinforced concrete lining	D8120	2,000	CY	$400.00	$800,000.00
		in excavated channel (f'c= 4 ksi)					
	30	Furnish, form, and place reinforced concrete walls	D8120	1,500	CY	$400.00	$600,000.00
	31	Furnish and place concrete reinforcement.	D8120	455,000	LBS	$0.80	$364,000.00
		Assume 130 #/CY					
	32	Furnish and handle cement (.282T/CY)	D8120	980	TONS	$140.00	$137,200.00
		Construct Powerplant and Bypass Substructure					
	33	Furnish, form, and place reinforced concrete	D8120	14,500	CY	$350.00	$5,075,000.00
	34	Furnish and place concrete reinforcement.	D8120	1,740,000	LBS	$0.65	$1,131,000.00
		Assume 120 #/CY					
	35	Furnish and handle cement (.282T/CY)	D8120	4,090	TONS	$120.00	$490,800.00
	36	**Construct Powerplant and Bypass Superstructure**	D8120	15,620	SF	$100.00	$1,562,000.00
		212.5-ft x 73.5-ft x 42-ft high superstructure					
		Structural steel superstructure with CMU walls.					
		Stepped columns for 90T crane support					
		Built-up roof on metal roof deck.					
		Sheet Subtotal					**$10,160,000.00** ✓

QUANTITIES		PRICES	
BY Dick LaFond	CHECKED M.R. O'Shea	BY D. Donaldson DCD	CHECKED BDV 8/17/04
DATE PREPARED 6/4/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q= 900 cfs

Structural and Architectural

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		STRUCTURAL (cont.)					
		Construct Pipe Encasements in Yard					
	37	Furnish, form, and place reinforced concrete	D8120	3,100	CY	$400.00	$1,240,000.00
	38	Furnish and place concrete reinforcement.	D8120	341,000	LBS	$0.80	$272,800.00
		Assume 110 #/CY					
	39	Furnish and handle cement (.282T/CY)	D8120	874	TONS	$140.00	$122,360.00
		Structural Steel					
	40	Furnish and install structural steel (painted):	D8120	175,000	LBS	$4.00	$700,000.00
		Includes crane girder, rail, and hoist frames.					
		Does not include typ. building framework.					
		Miscellaneous Metalwork					
	41	Furnish and install miscellaneous metalwork	D8120	45,000	LBS	$7.00	$315,000.00
		Includes grating, hatches, ladders, guardrail, and					
		cable trays					
	42	Motor-operated, exterior insulated roll-up door	D8120	1	EA	$10,000.00	$10,000.00
		18' x 20'					
		Plant - Civil and Structural Subtotal					**$19,925,100.00**

QUANTITIES		PRICES	
BY Dick LaFond	CHECKED N.R. O'Shea	BY D. Donaldson DLD	CHECKED GDV 8/17/04
DATE PREPARED 5/15/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW G

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q= 900 cfs

Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Major Mechanical Equipment					
	1	Turbine-Vertical Francis, 31452 Hp	D8420	125,000	LBS	$20.00	$2,500,000.00
		400 rpm, 339 ft. Design Head					
		CF3 18-8 Stainless Runner 5.5' dia.					
	2	Digital Governor, 103,905 ft.-lbs.	D8420	1	EA	$275,000.00	$275,000.00
		150 psi system					
	3	Governor Pressure Tank 875 Gal.	D8420	7,640	LBS	$10.00	$76,400.00
		Look to Flaming Gorge Oil Tank					
		Sheet Subtotal					**$2,851,400.00**

QUANTITIES		PRICES	
BY TJ Turnage	**CHECKED** John Brooks	**BY** D. Donaldson DCD	**CHECKED** BDV 8/17/04
DATE PREPARED 4/14/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW**

ESTIMATE WORKSHEET

FEATURE: Roza Canal Powerplant, Bypass, and Switchyard Outflow Conveyance System - Q= 2,500 cfs Powerplant Design Flow - Q= 900 cfs Mechanical	**PROJECT:** Yakima River Basin Water Storage Options **REGION** PN **PRICE LEVEL:** Appraisal **FILE:** C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Furnish and install the following:					
		Steel Penstock:					
		Steel plate used for pipe fabrication:					
		ASTM A36: Sy = 36 kpsi					
		(All pipe sizes are inside diameters)					
	4	204" Dia., 1 15/16" wall, L= 4,993 ft., 4265 lbs/ft	D8420	21,300,000	LBS	$2.00	$42,600,000.00
	5	84" Dia., 13/16" wall, L= 492 ft., 737 lbs/ft	D8420	363,000	LBS	$2.00	$726,000.00
		Stainless Steel Stilling Basin for Sleeve Valves:					
		ASTM 316L Stainless steel plate					
	6	Four - 396" Dia., 1 1/4" wall cylindrical tanks with baseplates:					
		Each tank height = 20 feet					
		Total weight for four tanks = 1,180,000 lbs.	D8420	1,180,000	LBS	$15.00	$17,700,000.00
		Sleeve valves with hydraulic operators:					
	7	Four - 84" Dia. Inlet X 72" Dia. Outlet Valves	D8420	280,000	LBS	$15.00	$4,200,000.00
		ASTM 316L Stainless steel plate					
		Each valve weight = 70,000					
		Total weight for four valves = 280,000 lbs.					
		Spherical valves with hydraulic operators:					
	8	Sleeve valve guard valves	D8420	240,000	LBS	$10.00	$2,400,000.00
		Four - 60" Dia. Spherical valves with hydraulic operators					
		60,000 lbs. per valve					
		Turbine guard valve					
	9	One - 84" Dia. Spherical valve with hydraulic operator	D8420	140,000	LBS	$10.00	$1,400,000.00
		140,000 lbs. per valve					
		Sunnyside Power Plant Isolation Valve					
	10	One - 84" Dia. Spherical valve with hydraulic operator	D8420	140,000	LBS	$10.00	$1,400,000.00
		140,000 lbs. per valve					
		Sheet Subtotal					**$70,426,000.00**

QUANTITIES		PRICES	
BY Nathan Nakamoto, D8420	CHECKED Rick Frisz, D8420	BY D. Donaldson DCD	CHECKED DCD 8/17/04
DATE PREPARED 5/26/04		DATE PREPARED 08/17/04	PEER REVIEW

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q= 900 cfs

Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	10	Furnishing and installing one 90-Ton	D-8410	157,500	LBS	$6.00	$945,000.00
		overhead crane, 67.5' span					
	11	Furnishing and installing Hydraulic elevator	D-8410	1	unit	$400,000.00	$400,000.00
		capacity = 3500 pounds, travel = 31 ft.					
		landings = 3, speed = 100 ft/min.					
	12	Bulkhead gates and guides at turbine (steel)	D-8410	31,000	LBS	$4.00	$124,000.00
		(assumes 3 bays of guides and 3 bulkhead gates)					
	13	Monorail hoist for bulkhead gate, electric wire rope,	D-8410	1,500	LBS	$20.00	$30,000.00
		motorized trolley, 5-ton capacity					
	14	Stoplogs, lifting beam & guides at sleeve valves	D-8410	152,000	LBS	$4.00	$608,000.00
		eight bays fo guides, 2 bays of stoplogs (steel)					
	15	CO2 High Pressure Fire Extinguishing System:	D-8410	1	L.S.		$36,000.00
		12 - 100# Storage Cylinders w/ control panel					
		and appurtenances and 400 lbs. of					
		sch. 80 carbon steel pipe, valves & fittings					
	16	Fire Suppression System:	D-8410	1	L.S.		$50,000.00
		3 Fire hose reels w/ 100 feet of hose					
		12 - Portable hand-held 20# extinguishers					
		2,000 lbs. of sch. 40 carbon steel pipe, valves & fittings					
		1 - Fire pump, split-case, 500 gpm @ 300 ft of head					
	17	Unit Cooling Water System:	D-8410	1	L.S.		$130,000.00
		2 - Cooling water pumps, end-suction type, 150 gpm					
		2 - 8-inch automatic, self-cleaning strainers					
		1,000 lbs. of type K copper tubing, valves & fittings					
		4,000 lbs. of ductile iron, mechanical joint pipe & fittings					
	18	Lubricating Oil System:	D-8410	1	L.S.		$20,000.00
		2- 500 gal carbon steel storage tanks					
		1 - 10 gpm @ 100 psi oil pump					
		1 - lube oil filter					
		1,000 lbs. of sch. 40 carbon steel pipe, valves & fittings					
		Sheet Subtotal					**$2,343,000.00**

QUANTITIES		PRICES	
BY R Christensen, B Sund, C Berte, J Gruss	**CHECKED** AMR	**BY** D. Donaldson DCD	**CHECKED** BOV 8/17/04
DATE PREPARED 5/3/2004	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q= 900 cfs

Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	19	Compressed Air System:	D-8410	1	L.S.		$50,000.00
		2 - 100 cfm @ 125 psi rotary screw air compressors					
		1 - 250 gal. carbon steel air receiver					
		1 - 100 cfm air dryer					
		500 lbs. of sch. 40 carbon steel pipe, valves & fittings					
	20	Service Water System:	D-8410	1	L.S.		$100,000.00
		1 - Service water pump, 75 gpm @ 200 ft. of head					
		1 - Hydropneumatic Tank, 300 gal.					
		750 lbs. of type K copper tubing, valves & fittings					
	21	Gravity Drainage System:	D-8410	1	L.S.		$50,000.00
		12 - Floor drains, cast iron					
		5,000 lbs. of cast iron hub & spigot, service weight					
		soil pipe					
	22	Plant Unwatering System:	D-8410	1	each		$70,000.00
		2 - Vertical turbine type sump pump, 500 gpm @ 50 ft hd					
		1 - Drainage jet type drainage pump					
		1,000 lbs. of type K copper tube, valves & fittings					
		3,000 lbs. of ductile iron, mechanical joint pipe & fittings					
	23	Domestic Water and Sanitary Waste System:	D-8410	1	each		$50,000.00
		2 - Water Closets					
		1 - Urinal					
		2 - Lavatories & accessories					
		1 - Duplex Sewage Ejector					
		2,000 lbs. of cast iron hub & spigot service weight					
		sewer pipe					
		400 lbs. of type K copper tubing, valves & fittings					
		Sheet Subtotal					**$320,000.00**

QUANTITIES		PRICES	
BY: J Grass	CHECKED: AHK	BY: D. Donaldson DCD	CHECKED: BDV 8/17/04
DATE PREPARED: 5/27/04	PEER REVIEW	DATE PREPARED: 08/17/04	PEER REVIEW

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q= 900 cfs

Mechanical

PROJECT: Yakima River Basin Water Storage Options

REGION PN | **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Heating, Ventilating, and Air Conditioning	D-8410	1	L.S.		$1,355,400.00
		Unmanned air cooled plant .					
		OA temp 95 degrees F.					
		Plant - Mechanical Subtotal					**$77,295,800.00** ✓

QUANTITIES		PRICES	
BY: P Schlein	CHECKED: AUR	BY: D. Donaldson DCD	CHECKED: BDV 8/17/04
DATE PREPARED: 6/1/2004	PEER REVIEW	DATE PREPARED: 08/17/04	PEER REVIEW: [illegible]

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q= 900 cfs

Electrical

PROJECT:
Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	**Electrical Generator (F&I)**	D8430	1	EA	$1,550,000	$1,550,000.00
		25,000 kVA, 6,900 volts, 3-phase, 60 Hz					
		276.9 rpm, 95 % power factor					
		Vertical, synchronous machine					
		Static excitation system & voltage regulator					
		Plant Grounding System (F&I)	D8430				
	2	Ground rods, 10 ft, 3/4" dia, copper-clad		30	EA	$180.00	$5,400.00
		Stranded bare-copper conductor:					
	3	250 MCM		1,200	LF	$5.50	$6,600.00
	4	4/0 AWG		800	LF	$4.00	$3,200.00
	5	2/0 AWG		500	LF	$3.50	$1,750.00
	6	4 AWG		800	LF	$2.50	$2,000.00
		Generator Bus & Metal-Enclosed Switchgear (F&I)	D8430				
	7	Generator non-segragated phase bus:		250	LF	$1,400.00	$350,000.00
		15 kV, 3000 amperes, 3-phase, 60 Hz					
	8	Generator power circuit breaker:		1	EA	$730,000	$730,000.00
		15 kV, 3000 amperes, 3-phase, vacuum type					
	9	Station-service fused interrupter switch:		1	EA	$30,000.00	$30,000.00
		15 kV, 600 ampere, 3-phase, w/ power fuses					
		Generator Control Equipment (F&I)	D8430				
	10	Duplex control switchboard for operation of the generator		1	EA	$730,000	$730,000.00
		Sheet Subtotal					**$3,408,950.00**

QUANTITIES		PRICES	
BY M. Schuh D8430	CHECKED L Rom	BY DCA for Elizabeth Tran	CHECKED BOV 8/17/04
DATE PREPARED 5/27/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW

ESTIMATE WORKSHEET

FEATURE:
Roza Canal Powerplant, Bypass, and Switchyard
Outflow Conveyance System - Q= 2,500 cfs
Powerplant Design Flow - Q= 900 cfs

Electrical

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Plant Battery System (F&I)	D8430				
	11	125 volt, 300 ampere-hour, lead-acid battery		1	EA	$25,000.00	$25,000.00
	12	Battery chargers		2	EA	$8,000.00	$16,000.00
	13	DC distribution panelboard, 100 ampere mains,		1	EA	$12,500.00	$12,500.00
		and molded-case circuit breakers					
		Plant Station-Service Equipment (F&I)	D8430				
		Indoor secondary unit substation with following					
		features:					
	14	Dry-type transformer, 6.9 kV-480Y/277, 1500 kVA		1	EA	$55,000.00	$55,000.00
	15	480 volt power-circuit breakers, 600 amperes		5	EA	$4,000.00	$20,000.00
		Building Lighting System (F&I)	D8430				
		Interior luminaires					
	16	High bay, high-pressure sodium, 400 Watt		24	EA	$700.00	$16,800.00
		480 volt, 1-phase					
	17	4 foot fluorescent lighting fixtures, 2 lamps		36	EA	$220.00	$7,920.00
	18	Emergency lighting system		1	LS	$900.00	$900.00
		Exterior luminaires					
	19	High-pressure sodium, wall-mounted, outdoor type		12	EA	$400.00	$4,800.00
		70 watt, 120 volt					
	20	**Building Fire Detection & Alarm System (F&I)**	D8430	1	LS	$150,000	$150,000.00
		Distribution Panelboards (F&I)	D8430				
	21	480-volts, 3-phase, 400 ampere bus, indoor type		2	EA	$30,000.00	$60,000.00
		with 12 molded-case circuit breakers					
		Motor Control Center (F&I)	D8430				
	22	480 volts, 3-phase, 1600 ampere main bus		1	EA	$195,000	$195,000.00
		Six 20 inch wide sections					
		Sheet Subtotal					**$563,920.00**

QUANTITIES		PRICES	
BY M. Schuh D8430	CHECKED L Rossi	BY BDV for Elizabeth Tran	CHECKED BDV 8/17/04
DATE PREPARED 5/27/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW GJ

FEATURE:	PROJECT:
Roza Canal Powerplant, Bypass, and Switchyard Outflow Conveyance System - Q= 2,500 cfs Powerplant Design Flow - Q= 900 cfs Electrical	**Yakima River Basin Water Storage Options** REGION PN — PRICE LEVEL: Appraisal FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Insulated Conductors (F&I)	D8430				
		15 kV shielded power cable:					
	23	4 AWG		300	FT	$12.00	$3,600.00
		600-volt single-conductor, stranded-copper:					
	24	12 AWG		6,000	FT	$0.65	$3,900.00
	25	10 AWG		4,000	FT	$0.80	$3,200.00
	26	6 AWG		1,000	FT	$1.55	$1,550.00
	27	4 AWG		1,000	FT	$1.80	$1,800.00
	28	1/0 AWG		600	FT	$2.90	$1,740.00
	29	4/0 AWG		600	FT	$5.00	$3,000.00
		600-volt multi-conductor control cable:					
	30	9 conductor 14 AWG		1,500	FT	$1.75	$2,625.00
	31	12 conductor 14 AWG		2,000	FT	$2.00	$4,000.00
	32	5 conductor 10 AWG		2,000	FT	$1.80	$3,600.00
		Conduit System (F&I)	D8430				
		Rigid steel conduit:					
	33	1 inch		1,000	FT	$14.00	$14,000.00
	34	1 1/2 inch		500	FT	$18.00	$9,000.00
	35	2 inch		600	FT	$22.00	$13,200.00
	36	2 1/2 inch		350	FT	$30.00	$10,500.00
		Plastic-coated rigid steel:					
	37	2 inch		750	FT	$30.00	$22,500.00
		Plant - Electrical Subtotal					**$4,071,085.00**

QUANTITIES		PRICES	
BY M. Schuh D8430	CHECKED L Rossi	BY DCD for Elizabeth Tran	CHECKED BDV 8/17/04
DATE PREPARED 5/27/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW CJ

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Roza Canal Powerplant, Bypass, and Switchyard Outflow Conveyance System - Q= 2,500 cfs Powerplant Design Flow - Q= 900 cfs	Yakima River Basin Water Storage Options
	REGION PN — PRICE LEVEL: Appraisal
Switchyard and Transmission Line	FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[Priest Rapids PP_3500 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Switchyard					
		Furnish and Install:					
	1	Oil-filled power transformer	D8440	1	EA	$450,000	$450,000.00
		25 MVA: 34.5-6.9kV, 3-phase					
	2	F&I 34.5-KV PRIMARY UNIT SUBSTATION:	D8440	1	EA	$375,000	$375,000.00
		'INCOMING 34.5KV SECTION/BUS/INTERRUPTER					
		'OUTGOING 6.9KV SECTION/BUS/INTERRUPTER					
		'SURGE ARRESTORS, 30KV					
		Tap at existing 34.5-kV line					
		Furnish and Install:					
	3	Wood-pole tap structure	D8440	1	EA	$9,000.00	$9,000.00
	4	**Construct Transmission LIne**	D8440	1,000	FT	$40.00	$40,000.00
		Assume 1000 feet of transmission line from					
		existing 34.5-kV line					
		wood poles, 1115 AWG conductor					
		Switchyard & Transmission Line Subtotal					**$874,000.00**

QUANTITIES		PRICES	
BY L. Gamuciello	CHECKED	BY NCD for Elizabeth Tran	CHECKED BVV 8/17/04
DATE PREPARED 5/27/04	PEER REVIEW James R. Zeiger	DATE PREPARED 08/17/04	PEER REVIEW Cy

Sunnyside Powerplant, Bypass, and Switchyard

$Q_{(Bypass)}=$ 1,250 cfs

$Q_{(Power\ Plant)}=$ 900 cfs

Field Cost Estimate

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Assessment Study

Sunnyside Canal Powerplant, Byapss, and Switchyard

Summary

PROJECT: Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_SunnysidePP_1 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Sitework Subtotal					$2,320,815.00 ✓
		Structural & Architectural Subtotal					$5,365,170.00 ✓
		Mechanical Subtotal					$19,621,400.00 ✓
		Electrical Subtotal					$3,761,065.00 ✓
		Switchyard & Transmission Line Subtotal					$1,234,000.00 ✓
		Subtotal					$32,302,450.00 ✓
		Mobilization +/-	5%				$1,600,000.00 ✓
		Subtotal w/ mobilization					$33,902,450.00 ✓
		Unlisted Items +/-	10%				$3,097,550.00 ✓
		CONTRACT COST					**$37,000,000.00** ✓
		Contingencies +/-	25%				$10,000,000.00 ✓
		FIELD COST					**$47,000,000.00** ✓

QUANTITIES		PRICES	
BY	**CHECKED**	**BY** Craig A. Grush, Elizabeth Tran	**CHECKED** BOV 8/17/04
DATE PREPARED	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD 8/17/04

ESTIMATE WORKSHEET

FEATURE:
Black Rock Assessment Study

Sunnyside Canal Powerplant, Byapss, and Switchyard

Civil/Site

PROJECT:
Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_SunnysidePP_1 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Access Road (60 ft of 24ft wide bituminous surface):					
	1	Clear roadway alignment	D8120	1,440	SF	$1.00	$1,440.00
	2	Furnish and place base course material (9-inch depth)	D8120	75	TONS	$20.00	$1,500.00
	3	Furnish and place asphalt concrete (6-inch depth)	D8120	55	TONS	$100.00	$5,500.00
		Service Yard (6" asphalt concrete surface)					
		Assume T.O Ground= T.O Yard= El 894.5					
	4	Strip and clear pumping plant site to 1 foot depth	D8120	3,900	CY	$5.00	$19,500.00
	5	Common excavation to Yard (±50% Strip & Clear)	D8120	2,000	CY	$7.00	$14,000.00
	6	Place and compact embankment for yard (50% Exc.)	D8120	1,000	CY	$12.00	$12,000.00
	7	Furnish and place base course material (6-inch)	D8120	3,600	TONS	$20.00	$72,000.00
	8	Furnish and place asphalt concrete (6-inch)	D8120	4,000	TONS	$100.00	$400,000.00
	9	Furnish and install 7-foot chain link fence for PP Yard	D8120	1,400	LF	$20.00	$28,000.00
	10	Furnish and install 7-foot x 24-foot access gates	D8120	3	EA	$3,500.00	$10,500.00
		Diversion During Construction:					
		Assume need to pass 900 cfs canal flow during					
		construction. Assume loacl borrow.					
		Assume no dewwatering required.					
	11	Construct U/S & D/S earth cofferdams. (Height=15 ft)	D8120	2,000	CY	$15.00	$30,000.00
	12	F&I impervious geomembrane on cofferdams.	D8120	350	SY	$15.00	$5,250.00
	13	F&I three 9-ft dia. X .138-in galv., corrugated metal pipes	D8120	1,000	LF	$500.00	$500,000.00
		btwn cofferdams. Wt/Ft= 210 lbs/ft.					
	14	Remove cofferdams and diversion structures	D8120	1	LS		$20,000.00
		Sheet Subtotal					**$1,119,690.00**

QUANTITIES		PRICES	
BY Dick LaFond	**CHECKED** N.R. O'Shea	**BY** Craig A. Grush	**CHECKED** SDV 8/17/04
DATE PREPARED 5/15/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCW

ESTIMATE WORKSHEET

FEATURE: Black Rock Assessment Study

Sunnyside Canal Powerplant, Byapss, and Switchyard

Civil/Site

PROJECT: Yakima River Basin Water Storage Options

REGION PN | **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_SunnysidePP_1 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Tailrace Channel (Unlined)					
		Assume T.O. Rock El. 880					
		Assume stockpile rock and common material for reuse.					
	15	Common excavation for tailrace channel	D8120	3,800	CY	$5.00	$19,000.00
	16	Rock excavation for tailrace channel (drill and shoot)	D8120	1,900	CY	$45.00	$85,500.00
	17	Furnish and place riprap bedding (1-ft depth)	D8120	700	CY	$30.00	$21,000.00
	18	Furnish and place riprap (2-ft depth)	D8120	1,400	CY	$35.00	$49,000.00
		Structural Excavation and Backfill					
		Assume T. O Rock El. 880.0					
		Assume stockpile rock for later use as riprap.					
	19	Common excavation for structures	D8120	12,800	CY	$12.00	$153,600.00
	20	Rock excavation for structures (drill & shoot)	D8120	18,150	CY	$30.00	$544,500.00
	21	Furnish backfill for structures (reuse excavation)	D8120	5,675	CY	$6.00	$34,050.00
	22	Place backfill around structures	D8120	5,675	CY	Included above	
	23	Compact backfill around structures	D8120	5,675	CY	$8.00	$45,400.00
		Pipe Trench Excavation and Backfill					
	24	Common excavation for pipe in Service Yard	D8120	6,900	CY	$10.00	$69,000.00
	25	Rock Excavation for pipe in Service Yard	D8120	2,270	CY	$45.00	$102,150.00
	26	Furnish, place, & compact backfill for pipe (local)	D8120	6,425	CY	$6.00	$38,550.00
	27	Furnish & place soil cement for pipe	D8120	525	CY	$75.00	$39,375.00
		Sitework Subtotal					**$2,320,815.00**

QUANTITIES		PRICES	
BY Dick LaFond	CHECKED *MR O'Shea*	BY Craig A. Grush	CHECKED *KOV 8/17/04*
DATE PREPARED 5/15/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW *DCD*

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Black Rock Assessment Study	Yakima River Basin Water Storage Options
Sunnyside Canal Powerplant, Byapss, and Switchyard	REGION PN — PRICE LEVEL: Appraisal
Structural and Architectural	FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_SunnysidePP_1 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		STRUCTURAL					
		Construct Concrete Tailrace Structure					
	1	Furnish, form, and place reinforced concrete	D8120	560	CY	$400.00	$224,000.00
	2	Furnish and place concrete reinforcement.	D8120	72,800	LBS	$1.00	$72,800.00
		Assume 130 #/CY					
	3	Furnish and handle cement (.282T/CY)	D8120	158	TONS	$160.00	$25,280.00
		Construct Powerplant Substructure					
	4	Furnish, form, and place reinforced concrete	D8120	3,140	CY	$400.00	$1,256,000.00
	5	Furnish and place concrete reinforcement.	D8120	376,800	LBS	$0.80	$301,440.00
		Assume 120 #/CY					
	6	Furnish and handle cement (.282T/CY)	D8120	885	TONS	$140.00	$123,900.00
	7	**Construct Powerplant Superstructure**	D8120	4,500	SF	$100.00	$450,000.00
		72.5-ft x 62-ft x 37-ft high superstructure					
		Structural steel superstructure with CMU walls.					
		Stepped columns for 125T crane support					
		Built-up roof on metal roof deck.					
		Construct Byapss Substructure					
	8	Furnish, form, and place reinforced concrete	D8120	3,375	CY	$400.00	$1,350,000.00
	9	Furnish and place concrete reinforcement.	D8120	405,000	LBS	$0.80	$324,000.00
		Assume 120 #/CY					
	10	Furnish and handle cement (.282T/CY)	D8120	950	TONS	$140.00	$133,000.00
	11	**Construct Bypass Superstructure**	D8120	2,740	SF	$100.00	$274,000.00
		74.0-ft x 37-ft x 16-ft high superstructure					
		Built-up roof on metal roof deck supported by open					
		web joists. CMU bearing walls. No crane.					
		Sheet Subtotal					**$4,534,420.00**

QUANTITIES		PRICES	
BY Dick LaFond	CHECKED M.R. O'Sh—	BY Craig A. Grush	CHECKED BOV 8/17/04
DATE PREPARED 5/15/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Assessment Study

Sunnyside Canal Powerplant, Byapss, and Switchyard

Structural and Architectural

PROJECT: Yakima River Basin Water Storage Options

REGION PN | **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		STRUCTURAL (cont.)					
		Construct Pipe Encasements					
	12	Furnish, form, and place reinforced concrete	D8120	1,050	CY	$400.00	$420,000.00
	13	Furnish and place concrete reinforcement.	D8120	115,500	LBS	$1.00	$115,500.00
		Assume 110 #/CY					
	14	Furnish and handle cement (.282T/CY)	D8120	295	TONS	$150.00	$44,250.00
		Structural Steel					
	15	Furnish and install structural steel (painted):	D8120	34,000	LBS	$4.00	$136,000.00
		Includes crane girder, rail, and hoist frames.					
		Does not include typ. building framework.					
		Miscellaneous Metalwork					
	16	Furnish and install miscellaneous metalwork	D8120	15,000	LBS	$7.00	$105,000.00
		Includes grating, hatches, ladders, guardrail, and					
		cable trays					
	17	Motor-operated, exterior insulated roll-up door	D8120	1	EA	$10,000.00	$10,000.00
		18' x 20'					
		Structural & Architectural Subtotal					**$5,365,170.00**

QUANTITIES		PRICES	
BY Dick LaFond	**CHECKED** M. R. O'Shea	**BY** Craig A. Grush	**CHECKED** BDV 8/17/04
DATE PREPARED 5/15/04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Black Rock Assessment Study	Yakima River Basin Water Storage Options
Sunnyside Canal Powerplant, Byapss, and Switchyard	REGION PN; PRICE LEVEL: Appraisal
Mechanical	FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_SunnysidePP_1 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Major Mechanical Equipment					
	1	Turbine-Vertical Francis, 40485 Hp	D8420	200,000	LBS	$20.00	$4,000,000.00
		400 rpm, 435 ft. Design Head					
		CF3 18-8 Stainless Runner 5.4' dia.					
	2	Digital Governor, 156,523 ft.-lbs.	D8420	1	EA	$200,000	$200,000.00
		150 psi system					
	3	Governor Pressure Tank 875 Gal.	D8420	7,640	LBS	$10.00	$76,400.00
		Look to Flaming Gorge Oil Tank					
		Sheet Subtotal					**$4,276,400.00**

QUANTITIES		PRICES	
BY T.J Turnage	CHECKED John Brooks	BY Craig A. Grush	CHECKED BW 8/17/04
DATE PREPARED 4/14/04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Assessment Study

Sunnyside Canal Powerplant, Byapss, and Switchyard

Mechanical

PROJECT:
Yakima River Basin Water Storage Options

REGION PN | **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Furnish and install the following:					
		Steel Penstock:					
		Steel plate used for pipe fabrication:					
		ASTM A36: Sy = 36 kpsi					
		(All pipe sizes are inside diameters)					
	4	144" Dia., 2 1/4" wall, L= 252 ft.	D8420	890,000	LBS	$2.00	$1,780,000.00
	5	84" Dia., 1 5/16" wall, L= 311 ft.	D8420	665,000	LBS	$2.00	$1,330,000.00
	6	144" Dia., 3/4" wall, L= 132 ft.	D8420	155,000	LBS	$2.00	$310,000.00
		Stainless Steel Stilling Basin for Sleeve Valves:					
		ASTM 316L Stainless steel plate					
	7	Two - 396" Dia., 1 1/4" wall cylindrical tanks	D8420	295,000	LBS	$15.00	$4,425,000.00
		with baseplates:					
		Each tank height = 20 feet					
		Total weight for both tanks = 295,000 lbs.					
		Sleeve valves with hydraulic operators:					
	8	Two - 84" Dia. Inlet X 72" Dia. Outlet Valves	D8420	140,000	LBS	$15.00	$2,100,000.00
		ASTM 316L Stainless steel plate					
		Each valve weight = 70,000					
		Total weight for both valves = 140,000 lbs.					
		Spherical valves with hydraulic operators:					
	9	Sleeve valve guard valves	D8420	120,000	LBS	$10.00	$1,200,000.00
		Two - 60" Dia. Spherical valves with hydraulic operators					
		60,000 lbs. per valve					
		Turbine guard valve					
	10	One - 78" Dia. Spherical valve with hydraulic operator	D8420	115,000	LBS	$10.00	$1,150,000.00
		115,000 lbs. per valve					
		Sheet Subtotal					**$12,295,000.00**

QUANTITIES		PRICES	
BY Nathan Nakamoto, D8420	**CHECKED** Rick Frisz, D8420	**BY** Craig A. Grush	**CHECKED** BOV 8/17/04
DATE PREPARED 5/6/04		**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Assessment Study

Sunnyside Canal Powerplant, Byapss, and Switchyard

Mechanical

PROJECT:
Yakima River Basin Water Storage Options

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	11	Furnishing and installing one 125-Ton overhead crane, 50' span	D-8410	153,000	LBS	$6.00	$918,000.00
	12	Furnishing and installing Hydraulic elevator capacity = 3500 pounds, travel = 31 ft. landings = 3, speed = 100 ft/min.	D-8410	1	unit	$400,000	$400,000.00
	13	Bulkhead gates and guides at power plant (steel) (assumes two gates)	D-8410	25,000	LBS	$4.00	$100,000.00
	14	Two fixed hoists for bulkhead gates, 2-ton capacity (each hoist weighs 200 lbs)	D-8410	400	LBS	$50.00	$20,000.00
	15	Bulkhead gate, liftin beam & guides at sleeve valve pipe discharge to canal (steel)	D-8410	32,000	LBS	$4.00	$128,000.00
	16	CO2 High Pressure Fire Extinguishing System: 10 - 100# Storage Cylinders w/ control panel and appurtenances and 300 lbs. of sch. 80 carbon steel pipe, valves & fittings	D-8410	1	L.S.		$30,000.00
	17	Fire Suppression System: 3 Fire hose reels w/ 100 feet of hose; 12 - Portable hand-held 20# extinguishers; 2,000 lbs. of sch. 40 carbon steel pipe, valves & fittings; 1 - Fire pump, split-case, 500 gpm @ 300 ft of head	D-8410	1	L.S.		$50,000.00
	18	Unit Cooling Water System: 2 - Cooling water pumps, end-suction type, 150 gpm; 2 - 8-inch automatic, self-cleaning strainers; 1,000 lbs. of type K copper tubing, valves & fittings; 4,000 lbs. of ductile iron, mechanical joint pipe & fittings	D-8410	1	L.S.		$130,000.00
	19	Lubricating Oil System: 2- 500 gal carbon steel storage tanks; 1 - 10 gpm @ 100 psi oil pump; 1 - lube oil filter; 1,000 lbs. of sch. 40 carbon steel pipe, valves & fittings	D-8410	1	L.S.		$20,000.00
		Sheet Subtotal					**$1,796,000.00**

QUANTITIES		PRICES	
BY R Christensen, B Sund, C Berte, J Grass	**CHECKED** Ausr	**BY** Craig A. Grush	**CHECKED** BOJ 8/17/04
DATE PREPARED 5/3/2004	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DED

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Assessment Study

Sunnyside Canal Powerplant, Byapss, and Switchyard

Mechanical

PROJECT:
Yakima River Basin Water Storage Options

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	20	Compressed Air System:	D-8410	1	L.S.		$50,000.00
		2 - 100 cfm @ 125 psi rotary screw air compressors					
		1 - 250 gal. carbon steel air receiver					
		1 - 100 cfm air dryer					
		500 lbs. of sch. 40 carbon steel pipe, valves & fittings					
	21	Service Water System:	D-8410	1	L.S.		$100,000.00
		1 - Service water pump, 75 gpm @ 200 ft. of head					
		1 - Hydropneumatic Tank, 300 gal.					
		750 lbs. of type K copper tubing, valves & fittings					
	22	Gravity Drainage System:	D-8410	1	L.S.		$50,000.00
		12 - Floor drains, cast iron					
		5,000 lbs. of cast iron hub & spigot, service weight					
		soil pipe					
	23	Plant Unwatering System:	D-8410	1	L.S.		$70,000.00
		2 - Vertical turbine type sump pump, 500 gpm @ 50 ft hd					
		1 - Drainage jet type drainage pump					
		1,000 lbs. of type K copper tube, valves & fittings					
		3,000 lbs. of ductile iron, mechanical joint pipe & fittings					
	24	Domestic Water and Sanitary Waste System:	D-8410	1	L.S.		$50,000.00
		2 - Water Closets					
		1 - Urinal					
		2 - Lavatories & accessories					
		1 - Duplex Sewage Ejector					
		2,000 lbs. of cast iron hub & spigot service weight					
		sewer pipe					
		400 lbs. of type K copper tubing, valves & fittings					
		Sheet Subtotal					**$320,000.00**

QUANTITIES		PRICES	
BY J Grass	CHECKED [signature]	BY Craig A. Grush	CHECKED BOV 8/17/04
DATE PREPARED 5/3/2004	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCA

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Assessment Study

Sunnyside Canal Powerplant, Byapss, and Switchyard

Mechanical

PROJECT:
Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

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PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Heating, Ventilating, and Air Conditioning	D-8410	1	L.S.		$934,000.00
		Unmanned air cooled BUILDING AND VAULTS					
		OA temp 95 degrees F.					
		Mechanical Subtotal					**$19,621,400.00**

QUANTITIES		PRICES	
BY P Schlein	CHECKED Amg	BY Craig A. Grush	CHECKED BOV 8/17/04
DATE PREPARED 5/3/2004	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Black Rock Assessment Study	Yakima River Basin Water Storage Options
Sunnyside Canal Powerplant, Byapss, and Switchyard	REGION: PN — PRICE LEVEL: Appraisal
Electrical	FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_SunnysidePP_1 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	**Electrical Generator (F&I)**	D8430	1	EA	$1,700,000	$1,700,000.00
		30,000 kVA, 6,900 volts, 3-phase, 60 Hz					
		400 rpm, 95 % power factor					
		Vertical, synchronous machine					
		Static excitation system & voltage regulator					
		Plant Grounding System (F&I)	D8430				
	2	Ground rods, 10 ft, 3/4" dia, copper-clad		30	EA	$180.00	$5,400.00
		Stranded bare-copper conductor:					
	3	250 MCM		1,200	LF	$5.50	$6,600.00
	4	4/0 AWG		800	LF	$4.00	$3,200.00
	5	2/0 AWG		500	LF	$3.50	$1,750.00
	6	4 AWG		800	LF	$2.50	$2,000.00
		Generator Bus & Metal-Enclosed Switchgear (F&I)	D8430				
	7	Generator non-segragated phase bus:		250	LF	$1,400.00	$350,000.00
		15 kV, 3000 amperes, 3-phase, 60 Hz					
	8	Generator power circuit breaker:		1	EA	$730,000	$730,000.00
		15 kV, 3000 amperes, 3-phase, vacuum type					
	9	Station-service fused interrupter switch:		1	EA	$30,000.00	$30,000.00
		15 kV, 600 ampere, 3-phase, w/ power fuses					
		Generator Control Equipment (F&I)	D8430				
	10	Duplex control switchboard for operation of the generator		1	EA	$300,000	$300,000.00
		Sheet Subtotal					**$3,128,950.00**

QUANTITIES		PRICES	
BY M. Schuh D8430	CHECKED L Rossi	BY Elizabeth Tran	CHECKED BNV 8/17/04
DATE PREPARED 30 APR 04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DEA

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Assessment Study

Sunnyside Canal Powerplant, Byapss, and Switchyard

Electrical

PROJECT: Yakima River Basin Water Storage Options

REGION PN | **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_SunnysidePP_1 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Plant Battery System (F&I)	D8430				
	11	125 volt, 300 ampere-hour, lead-acid battery		1	EA	$25,000.00	$25,000.00
	12	Battery chargers		2	EA	$8,000.00	$16,000.00
	13	DC distribution panelboard, 100 ampere mains,		1	EA	$12,500.00	$12,500.00
		and molded-case circuit breakers					
		Plant Station-Service Equipment (F&I)	D8430				
		Indoor secondary unit substation with following					
		features:					
	14	Dry-type transformer, 6.9 kV-480Y/277, 1000 kVA		1	EA	$55,000.00	$55,000.00
	15	480 volt power-circuit breakers, 600 amperes		5	EA	$4,000.00	$20,000.00
		Building Lighting System (F&I)	D8430				
		Interior luminaires					
	16	High bay, high-pressure sodium, 400 Watt		20	EA	$700.00	$14,000.00
		480 volt, 1-phase					
	17	Emergency lighting system		1	LS		$900.00
		Exterior luminaires					
	18	High-pressure sodium, wall-mounted, outdoor type		12	EA	$400.00	$4,800.00
		70 watt, 120 volt					
	19	**Building Fire Detection & Alarm System (F&I)**	D8430	1	LS		$150,000.00
		Distribution Panelboards (F&I)	D8430				
	20	480-volts, 3-phase, 400 ampere bus, indoor type		2	EA	$24,500.00	$49,000.00
		with molded-case circuit breakers					
		Motor Control Center (F&I)	D8430				
	21	480 volts, 3-phase, 1200 ampere main bus		1	EA	$110,000	$110,000.00
		Four 20 inch wide sections					
		Sheet Subtotal					**$457,200.00**

QUANTITIES		PRICES	
BY M. Schuh D8430	CHECKED L Roni	BY G Tran Elizabeth Tran	CHECKED BOV 8/17/04
DATE PREPARED 30 APR 04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW DEA

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:
Black Rock Assessment Study

Sunnyside Canal Powerplant, Byapss, and Switchyard

Electrical

PROJECT:
Yakima River Basin Water Storage Options

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_SunnysidePP_1 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Insulated Conductors (F&I)	D8430				
		15 kV shielded power cable:					
	22	4 AWG		200	FT	$12.00	$2,400.00
		600-volt single-conductor, stranded-copper:					
	23	12 AWG		6,000	FT	$0.65	$3,900.00
	24	10 AWG		4,000	FT	$0.80	$3,200.00
	25	6 AWG		1,000	FT	$1.55	$1,550.00
	26	4 AWG		1,000	FT	$1.80	$1,800.00
	27	1/0 AWG		600	FT	$2.90	$1,740.00
	28	4/0 AWG		600	FT	$5.00	$3,000.00
		600-volt multi-conductor control cable:					
	29	9 conductor 14 AWG		1,500	FT	$1.75	$2,625.00
	30	12 conductor 14 AWG		2,000	FT	$2.00	$4,000.00
	31	5 conductor 10 AWG		2,000	FT	$1.80	$3,600.00
		Conduit System (F&I)	D8430				
		Rigid steel conduit:					
	32	1 inch		800	FT	$14.00	$11,200.00
	33	1 1/2 inch		500	FT	$18.00	$9,000.00
	34	2 inch		500	FT	$22.00	$11,000.00
	35	2 1/2 inch		350	FT	$30.00	$10,500.00
		Plastic-coated rigid steel:					
	36	2 inch		750	FT	$30.00	$22,500.00
		Sheet Subtotal					**$92,015.00**

QUANTITIES		PRICES	
BY M. Schuh D8430	CHECKED L Rossi	BY Elizabeth Tran	CHECKED BOV 8/17/04
DATE PREPARED 30 APR 04	PEER REVIEW	DATE PREPARED 08/17/04	PEER REVIEW NED

ESTIMATE WORKSHEET

FEATURE: Black Rock Assessment Study

Sunnyside Canal Powerplant, Byapss, and Switchyard

Electrical

PROJECT: **Yakima River Basin Water Storage Options**

REGION PN **PRICE LEVEL:** Appraisal

FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_SunnysidePP_1 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Bypass Structure Electrical System					
		Service Equipment (F&I)	D8430				
	37	Distribution panelboard, indoor type		1	EA	$22,000.00	$22,000.00
		480 volts, 3-phase, 225 ampere bus,					
		with molded-case circuit breakers					
		Transformer load center					
	40	15 kVA, 1-phase, 480-240/120		1	EA	$11,000.00	$11,000.00
		Combination Motor Starters (F&I)	D8430				
	41	NEMA size 2 non-reversing contactor,		6	EA	$7,000.00	$42,000.00
		480-120 volt control transformer					
		NEMA type 12 enclosure					
		Building Lighting System (F&I)	D8430				
		Interior luminaires					
	42	Fluorescent fixtures with two 4 foot lamps		8	EA	$220.00	$1,760.00
		Exterior luminaires					
	43	High-pressure sodium, wall-mounted, outdoor type		6	EA	$400.00	$2,400.00
		70 watt, 120 volt					
		Insulated Conductors (F&I)	D8430				
		600 volt, single-conductor, stranded copper					
	44	12 AWG		600	FT	$0.60	$360.00
	45	10 AWG		400	FT	$0.70	$280.00
	46	8 AWG		100	FT	$1.00	$100.00
		Conduit System (F&I)	D8430				
		Rigid steel conduit					
	47	1 inch		200	FT	$15.00	$3,000.00
		Electrical Subtotal					**$3,761,065.00**

QUANTITIES		PRICES	
BY M. Schuh D8430	**CHECKED** L Rossi	**BY** G. Fox Elizabeth Tran	**CHECKED** BOV 8/17/04
DATE PREPARED 30 APR 04	**PEER REVIEW**	**DATE PREPARED** 08/17/04	**PEER REVIEW** DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

SHEET 15 OF 15

FEATURE:	PROJECT:
Black Rock Assessment Study	Yakima River Basin Water Storage Options
Sunnyside Canal Powerplant, Byapss, and Switchyard	REGION PN — PRICE LEVEL: Appraisal
Switchyard and Transmission Line	FILE: C:\Documents and Settings\bvanotte\Desktop\Black Rock\Black Rock Revisions\[BR_SunnysidePP_1 Rev 1.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Switchyard					
		Furnish and Install:					
	1	Oil-filled, conservator-type power transformer	D8440	1	EA	$540,000	$540,000.00
		40 MVA; 69-6.9kV, 3-phase					
	2	69-kV disconnect switches, 1200 amp, 3-phase	D8440	2	EA	$36,000.00	$72,000.00
	3	69-kV circuit breakers, 1200 amp, 3-phase	D8440	1	EA	$200,000	$200,000.00
		Tap at existing 69-kV line					
		Furnish and Install:					
	4	69-kV disconnect switches, 1200 amp, 3-phase	D8440	2	EA	$36,000.00	$72,000.00
	5	69-kV circuit breakers, 1200 amp, 3-phase	D8440	1	EA	$200,000	$200,000.00
	6	**Construct Transmission LIne**	D8440	1	MILES	$150,000	$150,000.00
		Assume 1 mile of transmission line from					
		existing 69-kV line to the southwest					
		wood poles, 795 AWG conductor					
		Switchyard & Transmission Line Subtotal					**$1,234,000.00**

QUANTITIES		PRICES	
BY L. Gamuciello	CHECKED	BY G for: Elizabeth Tran	CHECKED DOV 8/17/04
DATE PREPARED 4/27/2004	PEER REVIEW James R. Zeiger	DATE PREPARED 08/17/04	PEER REVIEW DeD