RECLAMATION
Managing Water in the West

Yakima River Basin Storage Study
Wymer Dam and Reservoir
Appraisal Report

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

Technical Series No. TS-YSS-16

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region

September 2007

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.

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.

Yakima River Basin Storage Study
Wymer Dam and Reservoir
Appraisal Report

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

Technical Series No. TS-YSS-16

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region

September 2007

PREFACE

The Congress directed the Secretary of the Interior, acting through the Bureau of Reclamation, to conduct a feasibility study of options for additional water storage in 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 a 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 water storage within the Yakima River basin. In considering the benefits to be achieved, study objectives are to modify Yakima Project flow management operations to improve the flow regime of the Yakima River system for fisheries, provide a more reliable supply for existing proratable water users, and provide water supply for future municipal demands.

State support for the Storage Study was provided in the 2003 Legislative session. The 2003 budget included appropriations for the Washington State Department of Ecology (Ecology) with the provision that 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." Since that initial legislation, the State of Washington has appropriated additional matching funds.

Storage Study alternatives were identified from previous studies by other entities and Reclamation, appraisal assessments by Reclamation in 2003 through 2006, and public input. Reclamation filed a Notice of Intent and Ecology filed a Determination of Significance to prepare a combined Planning Report and Environmental Impact Statement (PR/EIS) on December 29, 2006. A scoping process, including public scoping meetings, in January 2007 identified several concepts to be considered in the Draft PR/EIS. Those concepts have been developed into "joint" and "state" alternatives.

The joint alternatives fall under the congressional authorization and the analyses are being cost-shared by Reclamation and Ecology. The state alternatives are outside the congressional authorization, but within the authority of the state legislation, and will be analyzed by Ecology only. Analysis of all alternatives will be included in the Draft PR/EIS.

This technical document and others explain the analyses performed to determine how well the alternatives meet the goals of the Storage Study and the impacts of the alternatives on the environment. These documents will address such issues as hydrologic modeling, sediment modeling, temperature modeling, fish habitat modeling, and designs and costs. All technical documents will be referenced in the Draft PR/EIS and available for review.

Wymer Dam and Reservoir
Appraisal Study

Signature Sheet

Prepared by:

P.E.

9/10/07

Richard LaFond, 86-68120, Structural Engineer, P.E.
Team Leader

Date

Peer Reviewed by:

Michael R. O'Shea, P.E.

9-10-07

Mike O'Shea, 86-68120, Structural Engineer, P.E.

Date

List of Abbreviations and Acronyms

af	Acre-feet
cfs	Flow rate in cubic feet per second
El.	Elevation
f’c	Compressive strength of concrete
fps	Velocity in feet per second
ft	Foot or feet
ft^2	Area in square feet
ft^3	Volume in cubic feet
ft^3/s	Flow rate in cubic feet per second
fy	Yield strength
HGL	Hydraulic Grade Line
hp	Horsepower
H:V	Ratio of horizontal to vertical slope
ID	Inside diameter
kV	Kilovolt
lbs	Pounds
lf	Linear feet
MP	Mile post
NMFS	National Marine Fisheries Service of the National Oceanic and Atmospheric Administration
NWS	Normal water surface
OD	Outside diameter
psi	Pressure in pounds per square inch
Q	Flow rate
rpm	Revolutions per minute
TDH	Total design head
TSC	Technical Service Center
USGS	United States Geological Survey
WR^2	Pump Moment of Inertia
WS	Water surface
°	Degree
%	Percent

Contents

Tables

Figures

Appendices

Executive Summary

Yakima River Basin Storage Study

Wymer Dam and Reservoir

Background

Legislation authorizing the Yakima River Basin Water Storage Feasibility Study (Storage Study) directs the Bureau of 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. In 2004, Reclamation completed their appraisal assessment of likely configurations, sizes, and costs of Black Rock Project facilities needed to pump, store, and deliver water to willing exchange participants in the Yakima Basin [1]. In 2006, Reclamation prepared an appraisal assessment of three other alternatives, the Bumping Lake enlargement, Wymer dam and reservoir, and Keechelus-to-Kachess pipeline [2]. The conclusions reached in these two appraisal assessments were that the Black Rock and Wymer Alternatives should be included in the Plan Formulation Phase of the Storage Study.

The 2006 evaluation of Wymer dam and reservoir used indexed costs for features that were originally designed and cost estimated in 1985. Following this evaluation, the Upper Columbia Area Office (UCAO) of Reclamation's Pacific Northwest Region requested the Denver Technical Service Center (TSC) to review past work and update the appraisal-level designs and costs to meet current standards and needs so that Wymer dam and reservoir could be compared to other alternatives. This report documents an updated appraisal assessment of the costs and features required to construct Wymer dam and reservoir.

The primary purpose of Wymer dam and reservoir is to create additional water storage in the Yakima River basin to:

- Improve anadromous fish habitat.
- Improve the water supply for proratable irrigation water rights.
- Meet future municipal water supply.

Technical Findings

Wymer dam is an off-channel storage facility on Lmuma Creek, approximately 8 miles upstream of Roza Diversion Dam. As currently proposed, Wymer reservoir has an active reservoir storage capacity of 169,076 acre-feet,[1] with most of the stored water pumped from the Yakima River via a pumping plant and pipeline to the reservoir. The current concept includes:

- A fish screen intake on the Yakima River
- A 7-unit, 400-cfs pumping plant
- An electrical switchyard
- A 96-inch-diameter discharge pipeline and outlet structure
- A concrete-face rockfill dam
- A central-core rockfill dike
- An uncontrolled spillway with slotted bucket stilling basin
- Outlet works with two intake levels returning water to Lmuma Creek and the Yakima River.

See Table ES-1 for a more detailed description of major features and Figure 12 for a general location of features.

Conclusions

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

- Construction of the Wymer dam and reservoir facility is technically viable.
- The appraisal-level field cost estimate for construction of the features associated with the proposed Wymer dam and reservoir offstream storage facility is $780.0 million. This field cost estimate is in **April 2007** price level dollars and includes mobilization, unlisted items, and contingencies. The field cost estimate does not include non-contract costs.

[1] Of the 169,076 acre-feet active capacity, 6,512 acre-feet are associated with sediment deposition that will eventually fill, leaving a residual of 162,564 acre-feet.

Table ES-1. Major Features of the Wymer Dam and Reservoir Project

Yakima River Intake:	Design Flow Capacity: 480 cfs (includes 5% increase for pump wear factor and 60 cfs for fish bypass flows) Min. Operating River WS= El. 1275.0 Max. River WS= El. 1284 (1985 Planning Study) Criteria for fish screens - Juvenile Fish Screen Criteria For Pump Intakes (NMFS-Northwest Region-1996): Approach velocity= 0.4 fps
Pumping Plant:	Design pumped flow capacity at TDH_{max} of 475 feet: 400 cfs (w/o wear factor) Head Range: 365 ft to 475 ft Centerline units: El. 1256.67 7 equal-sized, fixed-speed, horizontal centrifugal pumps Indoor plant with overhead crane
Discharge Pipe:	96-inch-diameter steel pipe Pipe length= 4,700 feet 46-foot-diameter steel air chamber Outlet elevation in reservoir: El. 1610 Gate at reservoir outlet to unwater pipe when reservoir above El. 1610.
Reservoir:	Maximum WS= controlled by I-82 eastbound bridge crossing Maximum WS= El. 1741.7 (PMF) Normal WS (Top of Active Storage)= El. 1730 Bottom of Active Storage= El. 1375 Active Storage between El. 1375 and El. 1730: 169,076 A-F
Main Dam:	Type: Concrete face rockfill embankment Top of Dam: El. 1750 Crest Length= 3,200 feet Maximum Structural Height= 450 feet
Saddle Dike:	Type: Central core rockfill embankment Top of Dike: El. 1750 Crest Length= 2,700 feet Maximum Structural Height= 180 feet
Spillway:	Type: Reinforced concrete uncontrolled ogee crest Top of Crest= El. 1730 Crest Length= 60 feet Rectangular chute on left abutment with air slots Stilling Basin: Type II with slotted flip bucket Discharge into Lmuma Creek
Outlet Works:	Two-level intake at reservoir Bottom Intake Invert Elevation= El. 1375 Upper Intake Invert Elevation= El. 1456 Sized for reservoir evacuation and releases. 9.5-foot ID upstream tunnel 15-foot ID downstream tunnel with 102-inch-diameter pipe. Discharge into Lmuma Creek.
Lmuma Creek:	Channel modified for 100-year flood (1,600 cfs)
I-82 Bridge Protection:	Lowest elevation of eastbound bridge girders: El. 1741.7 Coat piers with waterproofing membrane Riprap embankments
* All elevations are in NGVD29.	

Level of Study

This technical document provides the results of an appraisal-level engineering evaluation of features associated with Wymer dam and reservoir as defined in Reclamation Policy, Directives and Standards.

The designs are based on available design data from past Reclamation work and limited additional data obtained during the study. Preliminary identification and sizing of required features were accomplished based on comparisons to similar features designed for other projects, engineering judgment, and limited analyses. The field cost estimate was 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 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 study are intended for use in comparing the Wymer dam and reservoir alternative to other delivery alternatives developed as part of the Storage Study.

Reclamation considers the cost estimates provided for this study to be comparable to an AACE (Association for the Advancement of Cost Engineering) Class 4 cost estimate. While Reclamation has not run range-of-costs analyses for the estimates included in this report, AACE's guidance states that the accuracy range for Class 4 estimates typically runs from 15% on the low side (i.e. the Class 4 estimate may **overestimate** the actual cost by 15%) to 30% on the high side (i.e. the Class 4 estimate may **underestimate** the actual costs by 30%).

AACE recommends a more refined (Class 3) estimate be used as the basis for project budget authorization. Reclamation Directives and Standards also require a more refined estimate (Feasibility) be used to request project authorization for construction and construction appropriations by the Congress.

I. Introduction

Legislation authorizing the Yakima River Basin Water Storage Feasibility Study (Storage Study) directs 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. In 2004, Reclamation completed their appraisal assessment of likely configurations, sizes, and costs of Black Rock Project facilities needed to pump, store, and deliver water to willing exchange participants in the Yakima Basin [1]. In 2006, Reclamation prepared an appraisal assessment of three other alternatives, the Bumping Lake enlargement, Wymer dam and reservoir, and Keechelus-to-Kachess pipeline [2]. The conclusions reached in these two appraisal assessments were that the Black Rock and Wymer alternatives should be included in the Plan Formulation Phase of the Storage Study.

The 2006 evaluation of Wymer dam and reservoir used indexed costs for features that were originally designed and cost estimated in 1985. Following this evaluation, the Upper Columbia Area Office (UCAO) of Reclamation's Pacific Northwest Region requested the Denver Technical Service Center (TSC) to review past work and update the appraisal-level designs and costs to meet current standards and needs so that Wymer dam and reservoir could be compared to other alternatives. This report documents an updated appraisal assessment of the costs and features required to construct Wymer dam and reservoir.

II. Purpose of Study

The purpose of this appraisal study is to review past work and update the designs and costs to meet current standards and needs so that Wymer dam and reservoir can be compared to other alternatives. The primary purpose of Wymer dam and reservoir is to create additional storage in the Yakima River basin to:

- Improve anadromous fish habitat.
- Improve the water supply for proratable irrigation water rights.
- Meet future municipal water supply.

III. Background

Wymer dam and reservoir is an off-channel storage facility on Lmuma Creek, approximately 8 miles upstream of Roza Diversion Dam (see Figures 1 and 2). In 1985, Reclamation completed an appraisal-level design and estimate for Wymer dam and reservoir. The 1985 study estimated the active reservoir storage to be 174,000 acre-feet with most of the stored water pumped from the Yakima River via a pumping plant and pipeline to the reservoir. The 1985 concept included the following features:

- An unlined approach channel from Yakima River to pumping plant
- A 5-unit, 400-cfs pumping plant
- An electrical switchyard
- A 96-inch-diameter discharge and outlet structure
- A concrete-face rockfill dam and dike
- A gated spillway with slotted bucket stilling basin
- A single-level low-level outlet works returning water to Lmuma Creek and the Yakima River.

The results of this study are documented in a Planning Study Report dated April 1985 [3] and major features are shown in Figures 3 through 5. The field cost estimate for the proposed features was $206.2 million (April 1985 price level). In August 1985, the estimate was revised to a most probable field cost estimate of $151.7 million (July 1985 price level) based on modifications of proposed features for additional geologic data [4].

Various studies have occurred since 1985 including a Value Engineering (VE) Study completed in 1989 [5], a 2002 study completed by Montgomery Water Group [6], and the 2006 assessment of Yakima River Basin Storage Alternatives [2]. All of these studies have relied on the quantities developed during the 1985 study and cost indexing to bring costs to current levels.

IV. Basis of Designs

This study is based on data previously developed for past studies of Wymer dam and reservoir and additional data developed to support the present study. In particular, the design data developed for the 1985 Planning Study [7] and the 1985 Planning Study itself [3] were used to identify existing conditions and proposed features where updated design data were not available. As part of this appraisal study, the Design Team visited the site on February 27, 2007. Major findings and discussions were documented in a Travel Report that is included in Appendix A.

Topography and Bathymetry

Three sets of topographic data were used to locate and size the features associated with Wymer dam and reservoir. The majority of the study, including the dam and reservoir areas, utilized topography developed from a United States Geological Survey (USGS) 10-meter Digital Elevation Model product (DEM) generated from USGS 7.5 minute maps with 20-foot-contour intervals. Along the Yakima River, more accurate LIDAR data developed by Reclamation in October 2000 were used for the intake and pumping plant sites. These data have a higher accuracy than the USGS data (±2-feet versus ±10-feet). To better define intake characteristics, a limited bathymetric survey was completed by Reclamation's Ephrata Survey Crew on March 20, 2007, when the flow in the Yakima River at the project site was approximately 5,800 cfs.

Horizontal coordinates noted in this report are Washington State Plane coordinates referenced to the North American Datum of 1983 (NAD83). All elevations noted in this report are referenced to the National Geodetic Vertical Datum of 1929 (NGVD29) because it is the basis for the USGS topographic data and has been used extensively in past studies. Present-day surveys in this area are referenced to North American Vertical Datum (NAVD88). NGVD29 elevations can be converted to NAVD88 elevations by adding 3.566 feet.

Geology

The following sections are based primarily upon the data from the *Geologic Report, Wymer Damsite* (October 1984) [8], and *Addendum No. 1 Geologic Report, Wymer Damsite* (December 1988) [9]. Preliminary data were also obtained from the initial drill holes conducted for a geologic investigation program which began in April 2007. Completion of this investigation program and submittal of the Geologic Data Report [10] will not occur in time for its full inclusion in this appraisal report.

Geologic Investigations

Geologic investigations of the Lmuma Creek area were undertaken in 1984 and 1985. The earlier work was done at a proposed damsite (upper site) located about three-fourths of a mile upstream of the currently proposed damsite (lower site). Investigations at the upper site consisted of geologic mapping, drilling, and identifying potential borrow sources. Drilling consisted of one core hole on each abutment—DH-84-1 on the right abutment and DH-84-2 on the left abutment. The holes were drilled to a depth of 174.7 feet and 290.4 feet, respectively. Pressure percolation tests and falling head tests were conducted in each of the drill holes.

The lower damsite was investigated in 1985 primarily to determine the depth to bedrock along the proposed dam axis and to define the characteristics of the bedrock and the overburden materials. The program consisted of three drill holes, DH-85-1, -2 and -3, located in the valley bottom near the dam axis; one drill hole, DH-85-4, located at the proposed saddle dike site; and four shallow, "hand dug" test pits, TP-85-1 through TP-85-4, located on the dam abutments (refer to Figure 6). No drilling was done in 1985 at the pumping plant site because of an inability to obtain right of entry [9]. Some additional geologic mapping was done at the dam and dike site areas. The three drill holes in the valley bottom were fairly shallow, with depths ranging from 23.8 feet to 50.5 feet.

Current geologic investigations in support of the Wymer damsite appraisal study were started in April 2007. The program consists of additional drilling and sampling at the dam, saddle dike, and pumping plant sites. The following are general outstanding items to be addressed during the current geologic investigations:

- Further characterization of foundation materials and properties at the main damsite and a saddle dike, including depth to bedrock.
- Characterization of foundation materials and properties at the pumping plant site adjacent to the Yakima River.
- Assessment of the Vantage sandstone, an interbed within the Columbia River basalts, with emphasis on reservoir seepage losses and slope stability.
- Assessment of seepage losses and slope stability of the abutments.
- Investigation of potential borrow sources.

At the time of this writing, three drill holes have been completed; a drill hole at the pumping plant site (DH-07-1), a drill hole (DH-07-2) located high on the left abutment of the proposed dam; and a drill hole on the left abutment of the dike site (DH-07-3).

Regional Geology

The proposed Wymer 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 basaltic flood lava known as the Columbia River Basalt Province. The basalts are derived from volcanic eruptions which occurred between 18 and 6 million years ago from vents near the present boundary between Washington, Oregon, and Idaho. Individual flows were up to 100 feet thick and covered hundreds to thousands of square miles. Extended time periods between eruptions allowed for sediment deposition in interflow zones. Basaltic eruptions over millions of years resulted in a stack of relatively horizontal flows that are referred to as the Columbia Plateau. Two bedrock formations of the Miocene age Columbia River Basalt Group (the Wanapum Basalt Formation and the Grande Ronde Basalt Formation) will provide the foundation for the proposed dam, dike, and pumping structures.

The western portion of the Columbia Plateau underwent north-south directed compression resulting in faulting and generally east-west trending folds. The folds are referred to as the Yakima fold belt. The Yakima fold belt between Ellensburg, and Yakima, Washington, is a zone of anticlinal ridges formed in Columbia River Basalt and cut through by the south-flowing Yakima and Columbia Rivers.

Alluvium of varying thicknesses is present in the drainages and occurs as terraces in some places along the Yakima River. Slopewash, from a few to many tens of feet thick, is present in many places along the mainstream and in lesser quantities along the side drainages.

Site Geology

<u>Pumping Plant Site</u>: The following description of the pumping plant site geology is based on preliminary information from drill hole DH-07-1. The proposed pumping plant is located across a fairly flat area on the inside of a broad meander of the Yakima River. Ground elevation at the drill hole location is 1287.2 feet (NGVD29). This hole encountered 24.7 feet of Quaternary alluvium deposits (Qal) overlying basalt bedrock (Tgr). The Yakima River alluvial deposits consist of undifferentiated gravel, sand, and fines with cobbles. Poorly graded gravel *(GP)* was the predominant soil type encountered in this hole; however, a 5-foot zone of loose, silty sand with gravel *(SM)g* was encountered from about 16 to 21

feet deep. Sample recovery was generally poor within the alluvium. Therefore, soil descriptions and estimates of cobble content are often based on drilling conditions and cuttings. Sample recovery was fairly good (71 percent) in the lower portion of the alluvium—from 21.2 to 24.7 feet. Within this zone, cobbles are estimated to comprise about 30 percent of the total sample. The cobbles are mostly 3 to 5 inches in size, and are composed of hard, subrounded basaltic clasts with lesser amounts of granitic material. Although down-hole permeability tests were not performed in drill hole DH-07-1, the alluvium can be expected to have high to very high permeability due to the abundance of poorly graded gravel with a low fines content. Excavations in the alluvium should be stable on 2:1 slopes provided dewatering has been accomplished first.

Underlying the Qal is basalt bedrock of the Grande Ronde Basalt Formation (Tgr). Drill hole DH-07-1 penetrated 24.5 feet of this basalt unit, with 95 to 100 percent core recovery. The basalt is described as black to gray, fine grained to aphanitic, and slightly vesicular to dense. It is slightly weathered, hard, and intensely to moderately fractured. Core was recovered in lengths from fragments to 0.9 inches, mostly less than 0.3 inches. The joints are generally subhorizontal; however, some subvertical joints were also encountered in specific core intervals. Joint surfaces are generally slightly rough. RQD ranged from 33 to 68.

Clear water was used as the drilling fluid throughout the entire drill hole. Fluid return (during drilling) ranged from 50 to 100 percent in the alluvium, and 40 to 60 percent in the bedrock. The depth to groundwater level, measured in the hole upon completion of drilling, was 10.6 feet (elevation 1276.6).

<u>Damsite:</u> The proposed dam is located in the lower portion of the Lmuma Creek Canyon just downstream of the confluence with Scorpion Creek. The dam axis spans a relatively flat-lying valley bottom, a fairly steep left abutment, and a gentler right abutment. Two basalt flow units and a sedimentary interflow unit will provide the foundation bedrock for the dam structure. These units are nearly horizontal, dipping gently southwestward (from the right to left abutment).

Except for sporadic outcrops of bedrock, the abutments are covered with a surficial layer of slopewash and talus. The 1985 test pits, located on the abutments, encountered between 1.5 feet and 5.0 feet of slopewash overlying bedrock. Description of the local geology in the 1988 Addendum Geologic Report [9] states that “talus and slopewash cover much of the valley sides from a few feet up to an estimated 10 feet deep.”

The valley bottom is about 300- to 400-feet wide at the damsite. Three drill holes completed in 1985 within the valley bottom encountered about 20 feet of alluvium overlying basalt of the Miocene Grande Ronde Member (previously referred to as the Museum Basalt Member). Summary logs of these holes describe the alluvium as "mostly sand, gravel and cobbles." No other characteristics of the alluvium are provided on these logs.

The Grande Ronde Member (Tgr) basalt will provide the foundation for the dam across the valley section and up the majority of both abutments. This is the same basalt unit encountered at the pumping plant site. The 1985 and 2007 drill holes describe this basalt as dark gray to black, very hard to hard, moderately vesicular to dense, slightly to moderately fractured (with occasional intensely fractured zones), and slightly to moderately weathered. Drill hole DH-07-2 encountered basalt breccia in the upper 10 feet of this unit. The breccia consists of brownish black fragments of vesicular basalt in a pumice and ash matrix. Two of the 1985 drill holes located in the valley section encountered artesian water that flowed at the surface at a rate of about 20 gallons per minute (gpm). The artesian water was encountered in the basalt at a depth of about 35 feet.

Overlying the Grande Ronde Member basalt is the Vantage sandstone (Tv) interflow unit. Drill hole DH-07-2 encountered about 75 feet of the Vantage unit consisting of interbedded sandstone, siltstone, and minor claystone. These interbeds are generally made up of sand- to silt-size lithic fragments with pumice and ash. They are mostly well indurated, slightly weathered, moderately soft, and moderately to slightly fractured (with occasional intensely fractured zones). Most joints recovered in the core samples were subhorizontal with slightly rough surfaces. Magleby [9] noted that seeps and springs appeared at the lower contact of the Vantage sandstone unit. Along the canyon walls, some small landslides occurred in this unit.

The uppermost bedrock unit on both abutments of the dam is the Frenchman Springs Member (Tfs) of the Wanapum Basalt Formation. Core samples recovered from drill hole DH-07-2 consisted of black to gray, fine-grained, hard, dense to slightly vesicular, and slightly to moderately weathered basalt. This unit is slightly to moderately fractured in some intervals, and intensely or very intensely fractured in other intervals. The joints are generally subhorizontal with slightly rough surfaces. However, scattered vertical fractures (probably representing columnar joints) were also recovered. All drill fluid was lost (i.e. zero drill fluid return) below a depth of 28.3 feet, indicating that many of the joints are open and the overall permeability of this bedrock unit may be high. A pressure permeability test was attempted in the interval from 43.3 to 61.0 feet, and a gravity permeability test was attempted from 79.0 to 84.6 feet. A back pressure or water level could not be established in either test, which further supports the evidence that this bedrock unit is not tight.

Examination of oblique aerial photos of the Wymer damsite during a VE study in 1989 [5] indicated the possibility of an ancient landslide covering "most of the left abutment area of the proposed dam site." However, based on geologic reconnaissance of the left abutment area during the 2007 investigation program, there appears to be no evidence of a large landslide. Only minor slope instability, primarily in portions of the Vantage sandstone unit, is evident on the left abutment. The appraisal study team decided that the dam axis should not be relocated due to a potential slide, and that any slide material encountered during dam construction would be excavated and potentially used for the rockfill structure.

<u>Saddle Dike Site:</u> The site for the dike is in a broad, low saddle on the right canyon side about 2,000 feet upstream from the right abutment of the damsite. The dike abutments and center saddle area are covered with slopewash deposits. Although there are no bedrock outcrops in the immediate vicinity of the dike site, the two drill holes (1985 and 2007) encountered the same bedrock stratigraphy as at the damsite. Frenchman Springs Member (Tfs) basalt, which occurs on the upper portions of the dike abutments, overlies the Vantage sandstone (Tv) interflow unit. In drill hole DH-07-3A, the Vantage unit was encountered between about elevations 1670 and 1730. The underlying bedrock unit at the dike site is the Grande Ronde Member (Tgr) basalt. In drill hole DH-07-3A, each of these bedrock units had similar composition, weathering, hardness, and fracture density to the damsite units. However, drill hole DH-85-4, located in lowest part of the saddle, encountered somewhat different conditions in the Grande Ronde bedrock unit. The upper 7 feet of this unit is described as highly altered and fractured "basaltic products." Beneath this upper section were alternating soft to hard, altered scoriaceous to vesicular basaltic rock. This occurrence of poor quality Grande Ronde Member bedrock is anomalous to the very hard, slightly to moderately fractured and slightly weathered basalt encountered in the left abutment drill hole, and in the holes at the damsite.

<u>Reservoir Basin:</u> The geology of the reservoir basin is mostly flat-lying lava flows exposed in a steep, narrow canyon that extends upstream for about 6 miles on Lmuma Creek and about 2 miles upstream in the broader canyon of Scorpion Creek. The Vantage sandstone interflow zone is present on both canyon sides and will be within the reservoir pool in most of the reservoir basin. Under a reservoir condition, the interflow zone will be subject to some small landslides as the pool fluctuates. The slopewash deposits along the canyon sides will also be subject to sloughing and minor sliding along the reservoir shoreline.

The potential reservoir seepage losses are judged to be inconsequential for the major, upstream part of the reservoir [9]. However, near the damsite and dike site, the potential for reservoir seepage becomes more of a concern given the fractured nature of the upper basalt unit, the low-strength Vantage sandstone, and the steep gradient from a full reservoir across relatively narrow reservoir rims to deep adjacent, dry drainages.

Borrow Materials

The pumping plant, dam, and saddle dike will require materials consisting of concrete products (cement, sand, and aggregate), processed filter/drain materials, rock fill, riprap, and semi-pervious fill. Table 1 provides a summary of the availability of these materials showing approximate haul distances that were used to develop costs for this study. Future studies should evaluate the quality and volume of available borrow materials in relation to construction needs.

Table 1. Summary of Construction Materials/Haul Distances

Site	Concrete Products (cement, sand, and aggregate)[1]	Processed Filter/Drain Materials[1]	Rock Fill [2]	Riprap [2]	Semi-pervious Fill [3]
	Approximate Haul Distance (miles) [4]	Approximate Haul Distance (miles) [4]	Approximate Haul Distance (miles) [4]	Approximate Haul Distance (miles) [4]	Approximate Haul Distance (miles) [4]
Pumping Plant	16	16	3	3	N/A
Main Dam	17	17	2	2	5
Saddle Dike	18	18	3	3	5

[1] The nearest commercial sources of natural material are in Yakima, Selah, or Ellensburg, WA; all are about the same distance from the project site. Quarry rock within the reservoir basin could be processed (crushed, graded, and washed) for filter drain material if acceptable.
[2] Potential borrow sites are within the reservoir basin [8].
[3] Potential borrow sites include mining and blending basalt and sedimentary rock from exposures of Vantage Sandstone (siltstone, claystone) near the upper end of the Scorpion Creek, and/or mining and blending basalt and alluvial fan deposits from uplands near Interstate 82 at the head of Scorpion Creek (Schuster, J.E., 1994, Geologic Map of the East Half of the Yakima 1:100,000 Quadrangle, Washington, *Washington Division of Geology and Earth Resources Open file Report 94-12*, Olympia, Washington).
[4] Haul distances shown are one-way.

Seismic Hazard

The seismic hazard used for this study is conservatively based on the probabilistic seismic hazard assessment (PSHA) that was conducted for the Black Rock dam assessment study [1]. The Black Rock dam PSHA is based on limited, readily available data from existing studies and limited, preliminary evaluation of that data and may overstate the seismic hazard at the proposed Wymer damsite.

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 this study, it is assumed that 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 will be about 0.95 g.

Hydrology

An appraisal-level Probable Maximum Flood (PMF) Study was conducted by Reclamation to provide the necessary appraisal-level hydrographs for the preliminary design of the dam and appurtenant structures. The results of this study are shown in Appendix B. Peak flows and volumes for the PMFs are shown in Table 2. Peak flows and volumes for the 25-year, 100-year and 500-year floods are shown in Tables 3 and 4.

Table 2. Wymer Dam Probable Maximum Floods

		Volume (ac-ft)				
PMF	Peak (ft^3/s)	6-hour	1-day	3-day	15-day	Total
Nov-Feb	27,509	11,994	33,154	51,770	66,026	66,026
Apr-May	21,708	9,394	25,635	39,391	53,219	53,219
Local	94,895	18,742	23,151	24,937	n/a	29,796

Table 3. Peak Inflow to Wymer Dam

		Duration Average Discharge (ft^3/s)					
Return Period (yr)	Peak (ft^3/s)	1-day	2-day	3-day	5-day	7-day	15-day
25	1227	876	757	718	673	642	558
100	1589	1014	820	771	720	688	600
500	2033	1146	866	807	751	720	630

Table 4. Frequency Volumes for Wymer dam

	Volume (ac-ft)					
Return Period (yr)	1-day	2-day	3-day	5-day	7-day	15-day
25	1737	3002	4275	6675	8909	16596
100	2010	3254	4590	7138	9557	17853
500	2273	3435	4803	7444	9999	18736

The current PMF study indicates significant differences from the 1985 design study. The latest PMFs are smaller than the 1985 PMFs which resulted in a smaller and less costly type of spillway. The following Table 5 summarizes a comparison of the 1985 and 2007 hydrology.

Table 5. Comparison of 1985 Hydrology to 2007 Hydrology

Study	General Flood PMF's	Peak (cfs)	Volume (ac-ft)	% Comparison To 1985 Study	
				Peak (cfs)	Volume (ac-ft)
1985	Rain-On-Snow	33462	92943	N/A	N/A
2007	November-February	27509	55835	-18%	-40%
2007	April-June	21708	42865	-35%	-54%
Study	**Local Flood PMFs**	**Peak (cfs)**	**Volume (ac-ft)**	**% Comparison To 1985 Study**	
				Peak (cfs))	**Volume (ac-ft)**
1985	Local Storm	110347	38209	N/A	N/A
2007	Local Storm	94895	23309	-14%	-39%

Reservoir Sizing Criteria

The reservoir behind Wymer dam backs up water under the existing bridges for Interstate 82 (I-82) (see Figures 2 and 7). An objective of this study was to maximize the active storage of the reservoir without requiring significant modifications to the I-82 bridges. To expedite the study, the 1985 Planning Study [3] was used to set the normal water surface (top of active storage capacity) at El. 1730.0 feet, and flood storage space was limited by the I-82 bridge girders. Design drawings for the I-82 bridges, obtained from the Washington State Department of Transportation (WSDOT), indicate that the bridge supporting the eastbound lanes is lower than the bridge supporting the westbound lanes. To verify that the elevations shown on the WSDOT design drawings were referenced to NGVD29, Reclamation's Ephrata Survey crew verified that the lowest point of the bridge girders was El. 1741.7 feet (NGVD29). Therefore, our design criteria limited the maximum water surface elevation to 1741.7 feet for routing the three PMFs through the reservoir. WSDOT recommends a minimum freeboard of 3 feet for the 100-year flood. This freeboard requirement is less stringent than the PMF design criteria used for this study because our minimum freeboard requirements are based on floods having much larger inflows. Had the WSDOT criteria been used to establish the normal water surface, the I-82 bridges would have been inundated by the PMFs.

The 1984 design data [7] located the dike in the saddle area between Scorpion Coulee and McPherson Canyon so that the reservoir would inundate Scorpion Coulee. However, the 1985 design study [3] located the dike closer to the dam which reduced its size but prevented inundation of Scorpion Coulee. For this study, it was decided to locate the dike similar to the 1984 design data in order to take advantage of the additional storage in Scorpion Coulee (see Figure 8, Dike 1). An alternative dike site in McPherson Canyon, which is the drainage to the north, was also considered to gain additional storage in McPherson Canyon (see Figure 8, Dike 2). Although this site would add approximately 16,900 acre-feet of storage, not all of this storage would be active storage unless an additional outlet works was added. Also, the dike in McPherson Canyon would be approximately 100 feet higher than the saddle dike. Reclamation dam safety criteria would require the ability to evacuate the reservoir behind the dike due to the relatively significant height. Although no specific cost estimates were done, it was judged that the costs for the additional outlet works and higher dike would not justify the added storage; therefore, this alternative was removed from consideration.

There is conflicting existing data regarding reservoir sedimentation. The 1984 design data [7] estimated the 100-year sediment load to be 7,100 acre-feet. However, the 1985 design document states that this estimate was later revised to about 210 acre-feet. The samples used as the basis for the 1984 estimate were taken at the Umtanum gauging station on the Yakima River, about 4-½ miles upstream of the pumping plant site. Whether the sampling and estimating considered the planned operations is unknown, and may be the reason for the reduced 1985 estimate. Sedimentation data are utilized to determine the outlet works invert elevation and bottom of active storage. For this study, it was assumed that the 1984 sediment estimate of 7,100 acre-feet was a conservative estimate of reservoir sedimentation and should be considered in our outlet works design, but should not be deducted from our potential active storage estimates. Hence, we located the high level of the proposed two-level intake for the river outlet works above the anticipated 7,100 acre-feet of sediment but are reporting the bottom of active conservation relative to our lower outlet elevation. Site-specific estimates of reservoir sedimentation based on planned operations should be performed if more advanced feasibility studies are undertaken in the future.

To estimate the potential additional active storage if a higher normal water surface (top of active conservation) were permitted, additional flood routings were performed using higher starting water surface elevations which identified alternative spillway sizes and greater active storage in the reservoir. The spillway and river outlet works were both utilized to route all of the PMF events. Due to limited time, all of the routings utilized a standard ogee crest configuration. Results of these routings are shown in Table 6.

Table 6. Summary of PMF Flood Routings for Various Normal Water Surface Elevations

Starting Water Surface (elevation)	Total Active Reservoir Capacity* (acre-feet)	Additional Reservoir Storage** (acre-feet)	Spillway Crest Width Required (feet)	Maximum Reservoir (elevation)	Controlling Flood
1730	169,076	0	60	1741.7	Nov-Feb PMF
1733	173,157	4081	160	1741.1	Local PMF
1736	177,304	8228	690	1741.7	Local PMF

* Total Active Reservoir Capacity is based on the bottom of active at El. 1375.0.
** Additional reservoir storage gained as compared to the designs for NWS = 1730.0.

Table 7 identifies this study's significant reservoir water surface elevations and corresponding total storage. An Elevation-Capacity curve is shown in Figure 9 and a Reservoir Capacity Allocation Sheet is given in Figure 10.

Table 7. Reservoir Water Surface Profile

	Elevation	Cumulative Storage (ac-ft)
Top of Streambed	El. 1330.0	0
Invert of Low-Level Outlet (Bottom of Active Conservation)	El. 1375.0	603
Invert of High-Level Outlet (Top of 100-Year Sediment Load)	El. 1456.0	7,115
Normal Water Surface (Top of Active Conservation)	El. 1730.0	169,679
Maximum Water Surface (Top of Flood Surcharge)	El. 1741.7	186,005

In summary, the active storage of 169,076 acre-feet is based on a reservoir sediment accumulation less than 603 acre-feet and a normal water surface elevation of 1730 feet. Active storage would be reduced by 6,512 acre-feet if the low-level outlet became inoperable due to sediment accumulation and withdrawal was from the higher outlet. Additional active reservoir storage could be obtained by raising the normal water surface elevation above 1730 feet and providing a wider spillway crest. For the specific conditions at Wymer, mainly the limited available flood surcharge space, a more efficient and economical spillway crest structure arrangement such as a labyrinth-type structure (see Figure 11), would be recommended for the higher normal water surface elevations. The labyrinth shape would reduce the spillway crest widths noted in Table 6.

Reservoir Operations

The following general reservoir operations were used for this study:

- From October through May, releases will be made from Cle Elum Reservoir to increase flows in the Yakima River upstream of Wymer. These flows, totaling 82,500 acre-feet/year, will be pumped into Wymer reservoir.

- From September through May, excess flows in the Yakima River from runoff estimated at 80,000 acre-feet/year will be pumped into Wymer reservoir and used for drought relief in prorated water years.

- From July through August, releases will be made from Wymer reservoir into the Yakima River.

- The minimum flow in the Yakima River required for diverting 400 cfs into Wymer reservoir is 2,000 cfs, which leaves 1,600 cfs in the river downstream from the diversion.

- Pulse release discharges through the outlet works up to 1,200 cfs may be required at times to support the fish in the Yakima River.

Assessment of Power Generation Capabilities

The primary objectives of storing water behind Wymer dam are to improve anadromous fish habitat, improve water supply for proratable irrigation rights in dry years, and meet future municipal water supply needs. The potential to generate power when releasing from the reservoir was evaluated early in the study. However, it was determined that reservoir operations to meet the primary objectives do not permit operation of Wymer dam as an efficient pump-storage facility necessary to justify the costs of installing and operating power facilities at this site. Specifically:

- Anticipated reservoir operations limits the duration of power generation to 2 months out of the year, July and August. Releases during this timeframe will be dictated by the primary objectives noted above and not power demand. Similarly, pumping to fill the reservoir will occur when excess capacity is in the Yakima River which may or may not coincide with times of low power cost. Efficient pump-storage facilities typically operate on a frequent fill/discharge cycle, often daily, pumping at times of low power demand and generating at times of high power demand in order to minimize pumping costs and maximize generating revenue.

- The large anticipated fluctuation of reservoir water surface required selection of horizontal centrifugal pumps and setting of the discharge outlet into the reservoir at El. 1610 feet. This limits the head range on the units to 345 to 475 feet. With the discharge outlet at El. 1610 feet, generation of power from flows back through the discharge line would only be possible for reservoir water surface elevations above 1610 feet. At lower reservoir elevations, water would flow back through the outlet works, not the pump discharge line. The volume of water between El. 1610 and 1730 feet (NWS) available for pump generation would be 111,330 acre-feet.

- Power generation using pump-turbines would only utilize the reverse of the pumped flows, 400 cfs. Releasing more than 400 cfs through the pump discharge line would require additional generating units or a bypass structure, and increasing the size of the discharge line to reduce head loss. The long discharge line and general system configuration could produce extreme hydraulic transient problems.

- Generation of power utilizing reverse operating pumps would require custom-sized centrifugal pumps. A design to cover a wide head range pumping and generating with a single pump/generating set has not been utilized in any facility to our knowledge.

- When developing a pump/generating capability, a wide head range works against the inherent machine design. Commercial pumps can typically operate efficiently at +/- 15% of their design head. Operating over a wider range requires staging of the pump impellers. Although two-stage pump turbines have been built, their limited commercial availability prevents them from being considered a viable procurement option for a government contract.

- The hydraulic machine design of the pump also dictates the capability in the turbine direction. A characteristic of pumps running as turbines means the turbine best operating conditions are at heads 25% higher than the pumping heads. This further limits the operating head range of pump-turbine units.

- Power generating facilities could be added to the outlet works to enable power generation over the full volume of the reservoir. This would add costs of a separate generating facility and require the outlet works pipe and valves to be enlarged to reduce velocity and associated head losses. Currently, the outlet works' 8.5-foot-diameter pipe is sized for evacuation and a maximum design velocity of 25 fps to prevent coating damage. For typical power waterways, a maximum velocity of 15 fps would be recommended to reduce friction which would require a 10.0-foot-diameter pipe and greater outlet works cost.

- A preliminary assessment of benefits versus costs based on our current understanding of reservoir operations indicates that future consideration of installing power generating facilities at this site is not warranted.

V. Overview of Project Features

Table 8 summarizes the major features associated with the Wymer dam and reservoir project and Figure 12 locates these features relative to each other. Major differences between the features developed for the current study and the 1985 Study are:

- Addition of fish screening facilities on the Yakima River.

- Use of seven horizontal centrifugal pumps in lieu of five spiral-case pumps.

- Definition of energy dissipation features below the discharge line outlet in the reservoir.

- Raising maximum reservoir water surface to El. 1741.7 from El. 1740.0.

- Raising dam and dike crest elevations to El. 1750.0 from 1745.0.

- Use of an uncontrolled spillway crest with a bridge in lieu of a crest with radial gates.

- Use of a two-level outlet works intake in lieu of a single-level intake.

- Definition of modifications to Lmuma Creek downstream of the outlet works discharge.

- Definition of modifications to I-82 bridge piers and embankments due to submergence.

Table 8. Major Features of the Wymer Dam and Reservoir Project*

Yakima River Intake:	Design Flow Capacity: 480 cfs (includes 5% increase for pump wear factor and 60 cfs for fish bypass flows) Min. Operating River WS= El. 1275.0 Max. River WS= El. 1284 (1985 Planning Study) Criteria for fish screens - Juvenile Fish Screen Criteria For Pump Intakes (NMFS-Northwest Region-1996): Approach velocity= 0.4 fps
Pumping Plant:	Design pumped flow capacity at TDH_{max} of 475 feet: 400 cfs (w/o wear factor) Head Range: 365 ft to 475 ft Centerline units: El. 1256.67 7 equal-sized, fixed-speed, horizontal centrifugal pumps Indoor plant with overhead crane
Discharge Pipe:	96-inch-diameter steel pipe Pipe length= 4,700 feet 46-foot-diameter steel air chamber Outlet elevation in reservoir: El. 1610 Gate at reservoir outlet to unwater pipe when reservoir above El. 1610.
Reservoir:	Maximum WS= controlled by I-82 eastbound bridge crossing Maximum WS= El. 1741.7 (PMF) Normal WS (Top of Active Storage)= El. 1730 Bottom of Active Storage= El. 1375 Active Storage between El. 1375 and El. 1730: 169,076 A-F
Main Dam:	Type: Concrete face rockfill embankment Top of Dam: El. 1750 Crest Length= 3,200 feet Maximum Structural Height= 450 feet
Saddle Dike:	Type: Central core rockfill embankment Top of Dike: El. 1750 Crest Length= 2,700 feet Maximum Structural Height= 180 feet
Spillway:	Type: Reinforced concrete uncontrolled ogee crest Top of Crest= El. 1730, Crest Length= 60 feet Rectangular chute on left abutment with air slots Stilling Basin: Type II with slotted flip bucket Discharge into Lmuma Creek
Outlet Works:	Two-level intake at reservoir Bottom Intake Invert Elevation= El. 1375 Upper Intake Invert Elevation= El. 1456 Sized for reservoir evacuation and releases. 9.5-foot ID upstream tunnel 15-foot ID downstream tunnel with 102-inch-diameter pipe. Discharge into Lmuma Creek.
Lmuma Creek:	Channel modified for 100-year flood (1,600 cfs)
I-82 Bridge Protection:	Lowest elevation of eastbound bridge girders: El. 1741.7 Coat piers with waterproofing membrane Riprap embankments
* All elevations are in NGVD29.	

VI. Yakima River Intake

The fish screen intake structure is a concrete structure consisting of an in-river diversion flared-mouth inlet, trashracks, fish screens, fish bypass inlet, and transition inlet sump to the pumping plant. The intake structure can divert up to 480 cfs from the Yakima River; 420 cfs into the pumping plant for Wymer reservoir plus 60 cfs for the fish bypass system. The intake will screen and return fish to the Yakima River prior to water being pumped into the reservoir (see Figure 13).

The Fish Screen Intake Structure is located on the east side of the Yakima River; a flared inlet protruding into the flow of the river from the bank (see Figure 14). Concrete retaining walls on the upstream and downstream sides of the flared inlet mouth protect against erosion, as well as transition river water flow into the intake channel. The retaining walls also allow access to the upstream end of the intake structure from the bank by having embankment behind the walls for a finished yard. General layout of the Fish Screen Intake Structure and fish bypass system can be seen in Figures 15 and 16.

The following paragraphs describe the design assumptions, concept design, and criteria used to size the intake features. An in-river fish screen diversion structure was initially considered, but at the available minimum depth, such a structure would require an enormous screen length along the bank in the direction of the river flow and was considered impractical.

Design Assumptions and Concept Description

Fish Screen Intake Structure

The fish screen intake structure is located downstream of an existing stream bar feature on the opposite bank where the river narrows slightly. This location was selected because this section of the Yakima River is relatively straight with uniform width. The river continues straight and uniformly downstream of the intake for approximately 900 feet before bending dramatically to the southeast.

The fish screens were sized using the minimum water depth in the Yakima River with an assumed flow of 420 cfs through the screens. Preliminary river hydraulics modeling using the Corps of Engineer’s Hydrologic Engineering Center’s River Analysis System (HEC-RAS) model was conducted to estimate the minimum water surface in the river for the fish screen intake structure. This analysis utilized bathymetric and water surface survey data which were collected in front of the proposed pumping plant site on March 20, 2007; flow data from the

Umtanum stream gauge were recorded on the same day. The HEC-RAS model was calibrated by using the recorded flow at the Umtanum gauge, surveyed river cross sections, and by varying the Manning's n value until the model closely matched the surveyed water surface at the intake location. A minimum water surface elevation of approximately 1275 feet was computed using the calibrated model and minimum Yakima River flow of 2,000 cfs. Since the minimum water surface elevation is based on limited bathymetric data and does not consider river sediment issues, future studies should include a comprehensive river study to verify river water surfaces at the intake.

The design flow for the pumping plant is 400 cfs at a rated head of 475 feet. However, the fish screen intake structure is sized for 480 cfs to meet fish screening requirements of 420 cfs (pump capacity when the pumps are new) and 60 cfs for the fish bypass system to return water and screened fish back to the Yakima River.

The velocities in the fish screen intake structure vary from the intake mouth through the trashrack and through the fish screens. The design flow velocity at the intake mouth is 3 ft/s. This velocity allows for the necessary flow to be diverted into the structure while minimizing the width of the intake mouth. The velocity is reduced to 2 ft/s through the trashracks to minimize hydraulic loss. The flow velocity then increases back to 3 ft/s to maintain a higher sweeping velocity along the fish screens. Downstream of the fish screens the design flow velocity is 2 ft/s.

After passing through the fish screens, water transitions into a steel intake pipe leading to the pumping plant. This intake pipe is a 120-inch-diameter steel pipe with zero slope along its profile. The flat slope is provided to meet pump hydraulic requirements. Because of the deeper depth required for the intake pipe, a deep sump at the end of the fish screen intake structure achieves this transition.

Past experience with similar intake structures was used to approximate the dimensions and thicknesses of the concrete for the fish screen intake structure. These dimensions are good estimates to handle the forces that the structure may encounter including seismic loading. Further detailed structural design and analysis will be required to address actual loading, final concrete member sizes, and steel reinforcement.

Stoplogs and guides are provided to isolate the intake structure from the river for maintenance. A 3-ton electric wire rope monorail hoist will be provided for installation and removal of the intake structure stoplogs.

Fish Bypass System

The fish bypass system consists of: a bypass inlet transition located immediately downstream of the fish screens, a bypass pipe, a crossover pipe, a pair of centrifugal screw pumps, and an outfall structure. The bypass inlet transition is located immediately downstream of the fish screens. The bypass inlet transition serves to collect screened fish and move the fish forward to the bypass pipe. Although preferable, a gravity-driven fish bypass system is not possible at this location due to lack of slope in the Yakima River.

At the crossover structure, the bypass system branches into two separate bypass pipes; one for each centrifugal screw pump. Only one of the pumps is in operation, with the second pump serving as a backup. The crossover structure serves as a point where the bypass pipe can be connected to either the primary pump or the backup pump by rotating (crossing over) the section of pipe which is normally connected to the primary pump to the backup pump (see Figure 17).

The Fish Pump Structure supports a pair of 60-cfs centrifugal screw pumps. In the event that the primary pump must be taken out of service, the backup pump allows the facility to continue operations. These types of pumps have been used effectively at other locations such as Red Bluff Diversion Dam, and research has proven that these pumps do not injure fish. A straight length of bypass pipe upstream of the pumps is provided at ten times the diameter of the pipe to meet pump hydraulics and pump efficiency criteria.

The fish pumps will be required to drive a total assumed head of 14 feet. This hydraulic head includes static lift, entrance and exit losses, pipe friction, and minor losses. The velocity in the bypass pipe ranges between 8 ft/s to 12 ft/s. The bypass pipe starts at the bypass inlet transition from the fish screen intake channel with a 36-inch-diameter fish bypass pipe. Immediately downstream of the fish pump structure, the discharge piping manifolds back into a single 30-inch-diameter pipe, which continues to the outfall structure.

The outfall structure is designed as a concrete encasement around the bypass pipe and will be installed in the river where river flow velocities would decrease the chances of predation. The outfall structure would be positioned to prevent a vertical drop at the structure and ensure the pipe outlet is always submerged.

Electrical controls for the fish bypass pumps will be housed in the fish pump bypass control building. A ventilating system is provided for use by plant personnel during operation and maintenance activities.

Design Criteria

Design criteria for the fish screen intake structure and fish bypass system are in accordance to the National Marine Fisheries Service (NMFS) (Northwest Region 1996) criteria for Juvenile Salmonids [11]. The criteria are presented below:

Fish Screen Intake Structure

The fish screens in the fish screen intake structure channel are in a "V" shape configuration with a center bypass dropping below the bottom of the intake channel. In this application, the "V" screen has two advantages because it shortens the length of the structure as well as minimizes the exposure time for the fish along the screen face. The approach velocity is 0.4 ft/s in accordance with NMFS fry criteria and the sweeping velocity is 3 ft/s. The screen length is 60 feet on either side of the "V." This total length includes a 10 percent screen length addition for blockages due to metal supports and bracings behind the screens. The length also includes 3 feet of blank steel paneling downstream for the automatic screen sweeps and return equipment. The exposure time for the fish along the face of the screen is 20 seconds.

The fish screens are vertical flat panels installed within metal guide/support structures. The screen panels are 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.

Fish Bypass System

Although the fish screen criteria for the NMFS-Northwest Region does not address fish pumps, Reclamation has had success with fish pumps in our existing facilities. The current layout at this Yakima River site requires the use of a fish centrifugal screw pump to bypass the screened fish back into the river. The pipe bends for the bypass system are made at a radius of five times the diameter of the pipe. The velocity in the bypass pipe will range between 8 ft/s before the pumps to about 12 ft/s downstream of the pumps. These velocities exceed the minimum criteria of 2 ft/s and are far below the 25 ft/s for outfall impact velocity.

While the capacity of the fish bypass pump needed is 60 cfs, an additional spare 60-cfs fish pump is needed in the event the primary pump is down for repairs and to keep the pumping plant fully operational. Two Wemco screw centrifugal fish pumps with shrouded impellers each rated for 60 cfs at 14 feet total head were used for this appraisal study. Vertical, 1,200 rpm, inverter-rated induction motors with totally-enclosed, fan-cooled enclosure (TEFC) rated at 150 hp will be used to power the pumps through a right-angle gear reducer at the pump. The motors are mounted on top of the fish bypass structure above the high-water level and connected to the right-angle gear drive via a vertical shaft system.

Steel pipe and valves are furnished for the fish bypass at the river intake. A steel rectangular inlet is installed immediately upstream of the fish screen. A steel rectangular-to-round transition is connected from the inlet to a buried 36-inch-diameter, 0.25-inch wall, steel pipe. Thirty-six-inch-diameter pipe extends from the intake structure through the cross-over structure to the fish pump structure. More 36-inch-diameter pipe extends from the fish pump structure to a buried 30-inch, 0.25-inch wall, steel pipe. The 30-inch-diameter pipe extends from this connection to the fish bypass outlet structure.

The steel pipes are buried and supported above ground. Steel pipe is designed in accordance with American Water Works Association (AWWA) M11 [12] and American Society of Civil Engineers (ASCE) Manuals and Reports on Engineering Practice No. 79 [13]. The minimum plate for handling is calculated in accordance with AWWA recommendations. This minimum thickness is the lesser of d/288 and (d+20)/400 where d is the pipe diameter in inches. After fabrication, all piping would be hydrostatically tested to 1.5 times the design pressure.

Two 36-inch-diameter, fully ported, knife-gate valves are provided at the fish pump structure for fish pump maintenance. The knife-gate valves are manufacturer designed, commercially available, and suitable for pressures up to 150 psig.

Construction Considerations

Cofferdams

Cofferdams were located at two locations along the Yakima River to facilitate construction. For design purposes, the maximum river water surface elevation during construction was assumed to be 1280.0. One cofferdam is located to assist in construction of the fish screen intake structure and the second cofferdam is located to assist in construction of the fish bypass outfall structure. The use of gravity-style cofferdams was selected due to the shallow depth of the rock interface, top of rock, making driving sheet piles impractical. For this appraisal-level estimate, use of large (1 cubic yard), soil-filled bags known as “super sacks” were utilized to construct the gravity cofferdams.

Intake and Pumping Plant Dewatering

For this study, it was assumed that dewatering (removal of water from soil) and unwatering (removal of surface water) would be required for excavations below El. 1280.0 and a single dewatering system would be utilized for both the intake and pumping plant excavations. Dewatering efforts will be performed to maintain excavated slopes between top of assumed groundwater (El. 1280 feet) and top of rock (El. 1262 feet). Dewatering down to a relatively impervious layer is difficult and will require reduced well spacing so as not to leave a large window between well points. Well points at 6-foot centers were selected as the method of groundwater removal for the appraisal-level estimate. Installation of well points will require predrilling due to the gravel and cobble nature of the soils. Unwatering by “French” drains and sump pumps were estimated for all other areas of excavation.

VII. Wymer Pumping Plant and Switchyard

The Wymer pumping plant is a seven-unit, 400-cfs pumping plant modeled after the Durango Pumping Plant currently under construction in Durango, Colorado. As recommended by the 1989 Value Engineering (VE) Study [5], the pumping plant was revised from the five-unit spiral case plant identified in the 1985 study. The VE Study recommended using vertical turbine pumps; however, standard vertical turbine units could not be found to meet flow and head criteria so horizontal centrifugal pumps were used instead. The location of the pumping plant and service yard was selected based on the intake channel location, fish screening and bypass requirements, location and alignment of State Highway 821 (SH-821), space requirements for the plant and switchyard, access into and around the plant, and access into the service bay. The high point of the service yard was set at El. 1287 feet for compatibility with the existing ground elevation and to keep the yard above the design maximum river water surface. Access to the service yard would be via a new access road from SH-821 (see Figure 13).

Initial unit selection criteria attempted to identify units capable of operating over the full range of the reservoir, from El. 1375 feet to El. 1730 feet. However, units could not be located to operate over this wide range of head. (This was also the case in the 1985 study.) To reduce the head range acting on the pumps, the discharge pipe outlet into the reservoir was raised to permit pumping operations in a single lift while minimizing the head acting on the pumps at times of minimum reservoir elevations. To that extent, the reservoir outlet was fixed at El. 1610 feet and units were selected to operate over reservoir water surface elevations 1610 feet and 1730 feet (NWS). The following criteria, based on preliminary reservoir operation information, were used to select pumps for the pumping plant:

- Minimum pumping plant capacity of 400 cfs at maximum total head of 475 feet.
- Use fixed-speed units capable of operating through a head range of 365 feet to 475 feet to minimize unit costs compared to variable frequency drive units.
- Use a sufficient number of pumps to permit river withdrawals whenever flows exceed 1,600 cfs. For this study, minimum pump size was assumed to be 60-80 cfs so pumped diversion can be made whenever the river is flowing above 1,650 or 1,680 cfs.
- Provide ductile iron casings and stainless steel impellers with stainless steel wearing rings to improve durability with regard to suspended sediment during pumping operations.
- Include provisions for wear by oversizing rated unit capacities by 5 percent.

Seven horizontal centrifugal pumps each rated for 60 cfs (26,930 gpm) at 475 feet total head were selected for the pumping plant. At minimum head of 365 feet, the minimum flow for a single pump is 80 cfs (36,000 gpm). It was assumed that half-size units would not be required to meet delivery needs and utilizing the same size pumps will minimize spare parts required. If the pump capacity at low head is too high, smaller pumps and/or variable-speed pumps could be evaluated in future studies. Horizontal, 900 rpm, synchronous motors rated at 4,000 hp each, will be used to drive the pumps. See Table 9 for pump unit data.

Table 9. Wymer Pumping Unit Data

Unit Data	
Type of Units:	**Horizontal centrifugal (split case)**
Discharge Capacity: At TDH_{Max} of 475 feet At TDH_{Min} of 365 feet	 60 cfs (includes 5% wear factor) 80 cfs (includes 5% wear factor)
Minimum Submergence	18.3 feet
Motors	4,000 hp @ 900 rpm
Intake Manifold Diameter	120-inch
Guard Valve (Intake)	48-inch butterfly
Discharge Manifold Diameter	96-inch
Guard Valve (Discharge)	42-inch butterfly
Check Valve (Discharge)	42-inch tilting disc

General Description

The layout of Wymer pumping plant is governed by the number, type, and size of the selected pumps and equipment, the relationship between the electrical and mechanical systems, required clearances to maintain a safe work environment for the operation and maintenance personnel, and handling requirements for the various pieces of equipment during initial installation and subsequent maintenance operations. The pumping plant is separated into two distinct areas, which are the Unit Bay and the Service Bay. These two distinct areas are separated by a 1-inch-wide expansion joint. The Unit Bay is that portion of the plant that houses the main pumping units and associated manifold piping, gates, and valves. The Service Bay contains the majority of the electrical and mechanical equipment that is necessary for the operation and maintenance of the plant.

The elevation of the bottom floor of the pumping plant was established based on the water surface elevations in the Yakima River for various flow rates, hydraulic losses that will occur as the water passes through the intake structure/fish screen, and the required pump submergence that is needed to ensure that the pumps operate efficiently. Based on these design parameters, the bottom floor of the plant was set at El. 1250.0.

The length and width of the unit bay is based on the size and arrangement of the pumping units and the required clearances for operation and maintenance of the plant. To minimize the width of the plant, the intake and discharge manifolds were located beneath the exterior side walls and are encased in reinforced concrete, which forms the base of the side walls. The length and width of the service bay is based on the size and arrangement of the auxiliary electrical and mechanical and unit handling requirements between the unit bay and service bay.

The pumping plant has a reinforced concrete substructure approximately 250 feet long by 100 feet wide, and a structural steel superstructure with standing seam metal roof. Handling requirements for the units controlled the building and overhead crane elevations and the selection of 20-ton overhead traveling bridge cranes in the unit and service bays for plant equipment maintenance activities. A passenger elevator of the electric-traction type is provided in the service bay to transport personnel and equipment to all floors of the plant. Space was provided in the plant for unit disassembly and auxiliary mechanical and electrical equipment. See Figures 18 through 20 for pumping plant general arrangement details.

Steel Piping and Valves

The intake manifold is a 120-inch-diameter, 0.75-inch steel pipe connected to the 120-inch-diameter intake pipe with an insulating flanged joint located at the downstream end of the intake structure. The 120-inch suction manifold continues into the pumping plant structure where it manifolds into the individual pump intake lines that feed pumping units No. 1 through 7. Downstream of each pump, the individual pump discharge pipes connect into the single 96-inch-diameter, 1.0-inch wall steel discharge manifold. The 96-inch-diameter steel pipe extends from the pumping plant structure, through an insulating flanged joint, under and past the 46-foot-diameter air chamber where it connects to the 96-inch-diameter discharge pipe at another insulating flanged joint. Steel piping was designed in accordance with AWWA M11 [12] and ASCE Manuals and Reports on Engineering Practice No. 79 [13]. The minimum plate thickness for handling is calculated in accordance with AWWA recommendations. This minimum thickness is the lesser of d/288 and (d+20)/400 where d is pipe diameter in inches. After fabrication, all piping would be hydrostatically tested to 1.5 times the design pressure.

Each individual pump suction line is provided with a 48-inch-diameter motor-operated butterfly valve. It is only to be closed for maintenance on the pump. Each individual pump discharge line is provided with a 42-inch-diameter check valve and a 42-inch-diameter motor-operated discharge butterfly valve. The check valve is utilized during the start-up procedure of the pumps and will prevent reverse flow through the pumps during a power outage. The motor-operated maintenance butterfly valve is only to be closed for maintenance on the pump and the check valve.

Auxiliary Mechanical Systems

The auxiliary mechanical systems in the pumping plant consist of fire suppression, unit cooling water, compressed air, service water, plant unwatering, gravity drainage, domestic water, sanitary waste plumbing and heating, ventilating, and air conditioning.

The fire suppression system consists of portable and wheel-mounted fire extinguishers, fire hose reels, and a wet pipe sprinkler system to extinguish fires in flammable materials and equipment in the interior of the plant. A fire department connection and a fire hydrant will be provided on the exterior of the plant. An automatic clean-agent gas, life-sustaining, fire-extinguishing system will be provided for the control room. In order to provide fire suppression water of adequate pressure and capacity, a fire pump supplied with a water supply from both the discharge and suction side of the plant will be installed.

The unit cooling water system provides cooling water for the main pump motor air cooler heat exchangers. The water supply for the unit cooling water system will come from the plant's suction raw water supply through the automatic, motor-operated, self-cleaning strainers which strain the water for large particles. Each main pumping unit will be supplied with cooling water from its own dedicated cooling water pump for automatically furnishing the proper amount of cooling water for the pumping unit components.

The compressed air system in the plant provides air to the service air outlets located throughout the building for use by pneumatic tools and associated plant maintenance activities. It will also provide makeup air to the domestic water hydropneumatic tank and operational air for air-operated valves in the plant piping systems.

The plant unwatering system consists of two high-capacity, vertical turbine-type sump pumping units to empty the plant sump of water from the plant drainage system and from the unwatering of the main pump suction and discharge lines. The sump water will be removed from the plant by use of exposed and embedded piping. The sump pumping unit motors and discharge heads will be located two floors above the sump, so that in the event the sump and first floor would become flooded with water, the sump pumping units will continue to operate. To completely empty the sump of all water that cannot be pumped out with the high-capacity sump pumping units, a low-capacity drainage pumping unit will be provided. A waste oil collection skimmer will be provided in the plant sump to prevent environmental contamination when the sump water is discharged to the plant exterior.

Service water from the pumping plant raw water supply will be available from the service water hose outlets for maintenance purposes and to supply water to other plant systems such as the heating and ventilating system. The service water will be distributed throughout the pumping plant by use of the service water pumping unit which boosts the service water pressure in the hydropneumatic tank.

The gravity drainage system consists of floor drains around the perimeter of the pumping plant interior and in floor areas where the leakage of water can be expected. Sloped cast iron hub and spigot soil pipe will collect water from the floor drains and will convey the water by gravity to the plant sump. Floor drains from the restrooms will discharge into the sanitary waste system.

Domestic and sanitary waste plumbing systems are provided for the men’s and women’s restrooms in accordance with the International Plumbing Code and state and local regulations. The sanitary waste sewage ejector system will collect and discharge liquid and solid sewage from the plant plumbing and sanitary waste system into the plant exterior wastewater treatment and disposal system.

The heating, ventilating, and air conditioning (HVAC) system maintains space temperatures within the plant at acceptable limits for personnel and equipment. The HVAC system will consist of standard commercially available equipment that will be easily maintained by plant personnel. Various exhaust and air transfer fans will be located throughout the plant to be used in conjunction with the main air handling units to remove stale or contaminated air from the plant. Hot water boilers will be used to provide freeze protection and comfort of plant personnel in the winter months. The control/communications rooms and office/administrative areas will be air conditioned. The plant stairwells will be ventilated under positive pressures for life safety evacuation in the event of a fire or smoke event. The control system for all HVAC equipment will be designed to enable using the HVAC equipment for smoke purging of all areas of the plant. Control of HVAC equipment for smoke exhaust operation will be interfaced with the plant fire detection and alarm system.

Air Chamber

In the event of a power failure at the pumps or a valve closure, high pressure or a water column separation can be created due to hydraulic transients in the discharge lines. Using the Reclamation-developed computer program TAPS (Transient Analysis for Pipeline Systems), hydraulic transient simulations were run to determine the air chamber volumes and design pressures (see Discharge Pipeline section of this report). An air chamber of sufficient capacity is required to handle the expected upsurge and to admit sufficient water into the discharge pipe during downsurges. Surge suppression from an air chamber provides the most economical means to prevent formation of a vacuum and to keep the maximum pressure below the pressure limits of the pipe and valves. The air chamber is provided with a level-indicating and switch module assembly.

The proposed air chamber is a 46-foot-diameter, 2.375-inch wall spherical air chamber. The design pressure for the air chamber is 300 pounds per square inch. It is enclosed in a subsurface vault with a domed aluminum cover to protect it from the elements. It is designed for year-round pumping operations. For freeze protection, the interior of the air chamber is provided with four immersion heaters and a thermostat. If the temperature of the water inside the air chamber reaches 40 degrees Fahrenheit or less, the immersion heaters will energize to keep the water from freezing.

The foundation for the air chamber is set almost entirely below the finished grade. The circular foundation for the air chamber has an outside diameter of 56.5 feet to accommodate the 46-foot-spherical air chamber. The size of the foundation was established based on access requirements for inspection and access into the air chamber. A domed roof is provided for enclosure above grade. The domed roof consists of a 56-foot-diameter, 2-foot-thick concrete wall that extends about 11 feet above grade topped with an aluminum low-profile dome.

The air chamber would be a contractor-designed pressure vessel, fabricated from ASTM A 516, grade 70 steel or a comparable type of steel chosen by the air chamber fabricator. These types of steels are readily weldable and have physical properties most applicable for the intended pressure vessel design. The air chamber would be designed and fabricated in accordance with the requirements of Section VIII, Division I, of the ASME Boiler and Pressure Vessel Code. The contractor’s air chamber designer may perform a stress analysis to reduce the wall thickness of the air chamber.

Switchyard

The switchyard single-line was modeled after the switchyard at Durango Pumping Plant which includes a ‘spare’ transformer. Each transformer has three cooling ratings, a lower rating to handle load from half of the plant in normal operation, a middle rating, and a higher rating to handle full load of plant if the other transformer is out of service. Each transformer is protected on the high side by a power circuit breaker. The physical size of each transformer was estimated from similar sized units at Reclamation facilities.

Layout of the yard is based on a dual 115-kV bay. Incoming power will be from a 115-kV overhead transmission line; outgoing power to the pumping plant will be via a 115-kV nonsegregated phase bus. Transformer size was based on an anticipated load of 30 MVA for full plant operation. According to IEEE

C57.12.10, to get a 30 MVA rating and to efficiently provide for a 15 MVA half-plant load, the best transformer size would then be 20/26.66/33.33 MVA with two stages of forced air (fans) cooling.

Ampacity of the high side protection device, i.e., power circuit breaker, only needs to be approximately 200A; however, for a 115-kV device, Reclamation policy is to specify no smaller than a 1200A unit. Also, since the PCBs will be rated 1200A, the service disconnect switches on each side of each PCB will also need to be 1200A rated, minimum. See Figure 21 for switchyard layout concept.

The 1984 design data submittal [7] indicates a Bonneville Power Authority (BPA) 115-kV line can be tapped to provide power to the facility. This line is approximately 5 miles away and this quantity was used to estimate cost of new transmission lines. Costs for power equipment needed to tap the line are not included in our estimate as they should be furnished by BPA.

Operation

The pumping plant will be tied into the Yakima Project Hydromet System and operated remotely. Pumping operations will take place 10 months out of the year, September through June (reservoir releases occur in July and August). An engine generator set will provide auxiliary backup power for the critical power loads of the pumping plant such as the plant elevator, heating, ventilating, and lighting systems in addition to the fire suppression system in the event of primary power failure.

Construction Considerations

Because of its proximity to the Yakima River intake, the unwatering and dewatering system required for pumping plant construction is included in the system developed and described for the fish screen intake. See Section VI.

VIII. Discharge Pipeline

Concept Description

The discharge system consists of a discharge pipeline with access features, concrete outlet structure, and an outlet chute. The discharge pipeline is approximately 4,700 linear feet of 96-inch-diameter steel pipe. The discharge pipeline begins 30 feet from a flowmeter structure at Station 10+00. The discharge pipe alignment follows a similar alignment as the 1985 appraisal study where the alignment travels northeast from the pumping plant, crosses SH-821, passes under the dam at the right abutment, and discharges into an outlet structure approximately 300 feet upstream from the toe of the dam. A bend near the end of the discharge line was included to align flows in the direction of the outlet structure. The outlet structure connects to a rectangular outlet chute which will convey the inlet flows as much as 250 vertical feet down to the reservoir pool. Refer to Figure 22 for a plan view of the discharge line system.

Design Considerations

Pipe thickness was selected based on the AWWA M11 design manual and assuming a flexible coating and mortar lining. The pipe wall thickness varies between 0.4375-inch at the dam and 1-inch at the pumping plant.

The typical trench section shown on Figure 22 was designed with the bottom width 2 feet wider than the pipe diameter. Earthwork quantities for the pipeline are based on 1.5:1 side slopes except where the pipeline passes through a concrete conduit located under the right abutment of the dam. Using 1.5:1 side slopes for the discharge line trench excavation accounts for benching that would be required for safety. The pipe trench section could be refined in future studies when the geologic conditions are better defined. The vertical alignment for the pipeline was based on a minimum cover depth of 5 feet. See Figure 23 for a profile of the pipe.

A transient study was performed for the 1985 appraisal study and that information was used as a starting point for the current analysis. Since some of the discharge line details were modified from the 1985 study, a new transient study was performed.

Basic Design Criteria

Flow -The design flow was 400 cfs. The transient design was based on an additional 5% plus 10% flow (462 cfs) to account for the pump wear factor and the specifications manufacturer’s tolerance, respectively.

River Level - The Yakima River water surface used for the hydraulics and transient study was El. 1275 feet (minimum operating water surface).

Reservoir Level - The Wymer reservoir water surface used for the maximum hydraulic grade line calculations was El. 1730 feet, normal water surface. The Wymer reservoir water surface used for the minimum hydraulic grade line calculations was El. 1615 feet. This is not the lowest reservoir elevation, but is approximately the lowest reservoir water surface that would maintain a water surface over the top of the pipe when a transient event was occurring.

Hydraulic Design Factors

The following factors were used for the hydraulic and transient analysis for the discharge line. The discharge pipeline size, 96 inches in diameter, was sized from a previous study for approximately the same flow. The pipe size was not altered in this study. The system was designed so that the maximum Design Grade Line (DGL) at the pumping plant would not exceed 300 psi.

Pump Design Flow	420 cfs
Transient Design Flow, max DGL	462 cfs
Transient Design Flow, min DGL	580 cfs
Colebrook White Rugosity (friction factor)	0.002
Wave velocity, celerity	3,300 ft/s
Down surge pressures	>0 *

* The down surge pressures did fall below the zero level for extreme pump conditions. See results discussion.

The transient analysis used the following to model the pumping plant shut down:

7 equal sized pumps, single stage, double suction

Rated head	475 feet
Speed	900 rpm
WR^2	77,875 all 7 units
Efficiency	0.86

The intake pipe between fish screen and pumping plant was modeled as 120 inches in diameter. The check valve used 3.9 feet of head loss across it and closed in 0.1 seconds. The air chamber was sized based on a spherical air chamber using 4 to 6 times the initial air volume as a guide. The air chamber inflow and outflow was not throttled and used a head loss coefficient of 0.00001 for both.

Hydraulic and Transient Design

The hydraulic design of the pipeline was verified from the previous study. The 96-inch pipe size was found to be acceptable. Without doing a more detailed, life-cycle cost comparison, there was no reason to alter the pipe size.

The spherical air chamber size in the 1985 study was 40 feet in diameter with 5,000 cubic feet of air. This study started with those parameters for the air chamber but quickly determined that because the manifold pipe was lowered 16 feet (El. 1270 to El. 1254), a larger air chamber was required. The resulting air chamber size, to keep the maximum design grade line for the manifold at or below 300 psi (693 feet of water, transient design grade line = El. 1947), was 46 feet in diameter with 9,500 cubic feet of air.

The minimum design grade line was also checked at the maximum flow, 580 cfs, that all seven pumps would be capable of pumping. The minimum grade line did fall below the pipeline by 15 feet. In order to minimize the amount of negative pressure in the pipeline when the reservoir is at elevation of 1630 feet, the flow will need to be restricted to the design flow, 400 cfs or less. This means that measures should be taken to keep all of the pumps from operating when the reservoir water surface is between El. 1610 and El. 1655. See Figure 24 for a hydraulic grade line (HGL) schematic.

Discharge Line Access Features

The discharge line requires an isolation gate near the dam to isolate the pipeline from the reservoir; thus enabling temporary pipe shut down for inspections or emergencies. The discharge line access features are located where the discharge line passes under the dam embankment on the right abutment. The isolation gate was located as far upstream as possible to maximize the length of pipe that could be shut down. See Figure 23.

The proposed access features consist of:

- An access house located near the downstream toe of the dam which would contain gate controls, ventilation, and electrical utilities.
- A cut-and-cover reinforced concrete cast-in-place access shaft below the access house.
- A 14-foot, modified horseshoe-shaped access conduit which would contain the 8-foot steel discharge pipe.
- A gate chamber to contain the motor-operated 96-inch slide gate.
- A heating and ventilating system to remove stale or contaminated air from the access shaft and conduit.

Steel pipe provided from the end of the discharge line to the slide gate at the inlet to the reservoir is 96 inches in diameter and 0.375-inch thick. It is supported on concrete saddle supports inside the conduit that extends through the dam.

Discharge Outlet Structure

The outlet structure for the discharge pipeline consists of a concrete box with an overflow weir and transition to the outlet chute. The overflow weir is set at El. 1610. The purpose of the weir is to keep the discharge pipeline submerged to the top of the pipeline and to uniformly direct flow into the outlet chute. The outlet structure will convey flow into the outlet chute until the outlet structure becomes submerged by the reservoir pool. Refer to Figure 25 for a plan view of the outlet structure.

Discharge Outlet Chute

A 1,450-foot-long discharge outlet chute is provided to safely channel the pumped flows from the outlet structure to the reservoir pool without causing damage to the right abutment or upstream face of the dam. The outlet chute is 12-feet wide with 8-foot-high walls for the top 750 feet where the bottom slope is 0.001. The wall height decreases to 6-foot-high walls for the remaining 700 feet where the chute bottom slope increases to 0.33. The existing drainage swale near the upstream end of the outlet chute is embankment filled and riprap protected. Refer to Figure 25 for cross sections of the outlet chute. The chute was sized to carry a maximum flow of 580 cfs. The design flow of 580 cfs will be subcritical in the upstream reach of the outlet chute where the chute slope is 0.001 and will become supercritical in the downstream reach of the chute where the chute is sloped at 0.33. Computed normal depths in the upstream and downstream reaches are 6.3 feet and 0.9 feet, respectively. An energy dissipation structure is not included in this structure since water velocities in the outlet chute can be dissipated in the reservoir pool. The cost of a 50-foot by 50-foot-wide riprap area is included in the cost estimate to provide erosion protection at the downstream end of the chute for initial filling of the reservoir. The initial reservoir pool can be created slowly from Lmuma Creek flows and lower initial pumped inflows. The pumped inflows can begin at a lower flow rate and build to the design flow as the reservoir pool rises.

Construction Considerations

For this study, cut-and-cover construction methods were assumed for the entire length of the discharge pipeline. Therefore, a construction detour will be necessary where the pipeline crosses SH-821. In order to estimate construction costs of building a detour and rehabilitation of SH-821, the following assumptions were made:

SH-821: Remove and replace approximately 120 linear feet of 30-foot-wide road with cross section consisting of 12-inch-thick base course and 6-inch-thick concrete asphalt layer.

Detour: Construct approximately 800 linear feet of 30-foot-wide roadway with 8-inch-thick base course and 4-inch-thick concrete asphalt layer.

IX. Wymer Dam and Dike

The proposed Wymer reservoir will be impounded by two embankment structures; the main dam and a dike. Both are proposed to be embankment dams, specifically rockfill embankments. Design and construction considerations for these embankment structures are discussed below, along with detailed descriptions of the design concepts for each.

Design Considerations for Embankments

There are several key design considerations associated with the construction of the embankment structures at the Wymer site. In general, these considerations are typical of many embankment damsites, and are not viewed to be indicative of any "fatal flaws" that would indicate the site is not technically feasible. Rather, it is judged that safe embankments can be designed and constructed, without any particularly unusual measures or features beyond what are typically considered for a major embankment dam. The key design considerations affecting both the dam and the dike are listed below.

1. Potential High Seismicity

Although a site-specific seismotectonic evaluation has not been performed for the Wymer damsite, it is possible that the site may be subject to relatively high seismicity, or earthquake potential. Potential contributors to the seismic hazard are the Yakima fold belt, a prominent group of mostly east-west striking folds, and the deep zone of the Cascadia Subduction Zone which is capable of producing very large magnitude earthquakes. Other local faults may be present in the vicinity which could have some contribution to the site seismicity. Given the lack of site-specific information, the Wymer site was assumed to have potentially high seismicity, with peak horizontal ground acceleration expected from a 10,000-year earthquake in the range of 1.0g.

This assumed potentially high level of shaking leads to the possibility that lower density embankment or foundation saturated soils may 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 earthquake shaking. If shaking is severe and of sufficiently long duration, it could 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.

One final concern in areas subject to earthquake loading is the possibility of fault displacements within the footprint of the embankments. Based on the limited preliminary geologic characterization of the site, there is no evidence to indicate that a potentially active fault exists within the dam, dike, or reservoir area. However, it is important to note that relatively little exploration has been conducted to date, and further investigations could conceivably find evidence of foundation faulting. Fortunately, 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 (through the filter). 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 or zones containing relatively cohesionless materials 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 feet in 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 (boulders).

2. Varying Rock Quality

The bedrock at the Wymer site consists of an interbedded sequence of 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 were from hundreds to tens of thousands of years, which allowed for sedimentation deposition between basalt flows. As a result, the bedrock stratigraphy consists of a number of different basalt flows with sedimentary interbeds (such as the Vantage sandstone) 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 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 permeability (fracture density, openness, infilling characteristics, etc.) and to develop a foundation grouting program to explore foundation conditions and to potentially reduce bedrock seepage. Based on limited drilling of the site to date, some of the bedrock has proven to be of poor quality, consisting of highly fractured areas which may accept considerable grout.

3. Potential Left Abutment Landslide

Previous studies of the Wymer site have indicated the possibility that part, and perhaps a large portion, of the left abutment for the main dam consists of an ancient landslide. However, the limited amount of geologic investigations at this appraisal stage found no evidence of a large landslide although there are areas of minor slope instability and indications of poor rock quality in the left abutment.

Should a slide exist, the impact to dam (and appurtenant structure) stability would be carefully analyzed in future design studies. A proactive approach to the potential existence of a slide or presence of poor rock quality will be to assume additional excavation of the left dam abutment to remove unstable materials.

4. Construction Material Availability

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 Wymer dam, it will be important to secure high quality materials for the key zones in the embankment. Hauling large volumes of material can be a major cost driver and if embankment materials are located reasonably nearby, there is a large economic advantage. In addition, since potentially significant volumes of foundation excavation 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 noncritical zone as opposed to wasting them.

5. Selection of Dam Type

Given the types of design considerations listed above, an initial step in the appraisal design process was to select the appropriate type of dam to consider for this damsite. Early in design it was decided to proceed with an embankment-type dam in lieu of roller compacted concrete (RCC) dam based on previous Wymer studies and cost comparisons from the Black Rock Assessment [1]. Rockfill embankments are an obvious choice for the Wymer site, and better suited than a zoned earthfill embankment for several reasons. First, there is a relative lack of impervious soils or even unconsolidated pervious soils at the damsite. The overburden at the site is relatively shallow and would thus not provide a large volume of embankment materials. Basalt, however, is present throughout the dam, dike, 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 may be in an area of relatively high seismicity. In addition, there is some (perhaps small) potential that future site characterization could indicate the presence of foundation faults beneath either embankment. These potential seismic concerns dictate 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.

Concept Description - Dam

The main dam is proposed to consist of a concrete face rockfill embankment. Details of the proposed design are discussed in the following paragraphs and shown on Figure 26.

1. 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 concrete face, which is not susceptible to erosion. 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 reduces 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 about 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. (Fines tend to rise to the top of a lift during compaction similar to how fines and cement paste rises to the top of concrete when compacted and worked.) 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 later in subparagraph 6 entitled, “Embankment Zoning.”

2. Crest Elevation

For the Wymer reservoir, the top of normal water surface (top of active conservation) has been set at El. 1730 feet to store approximately 169,679 acre-feet. The maximum reservoir water surface, assuming a combination of storage and passage of the PMF, corresponds to El. 1741.7.

Freeboard heights were established using general rules and engineering judgment. Because of the reservoir size and potential for high winds in the Wymer area, 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 reservoir has a total reservoir length of approximately 6 miles, and it appears possible that wind gusts approaching 100 mph are possible in the area. According to general guidance given in the *Design of Small Dams* [14], wave heights could be close to 6 feet, and the suggested normal freeboard is 10 feet (about 1-½ 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. Consequently, *Design of Small Dams* recommends providing 50 percent more freeboard if a smooth pavement is used on the upstream face. Consequently, the suggested normal freeboard for a concrete face rockfill dam at Wymer would be about 15 feet.

However, an additional consideration at the Wymer site is the potential for large ground motions. Since the proposed dam will have a maximum height of approximately 450 feet, it will be important to provide adequate freeboard to ensure that crest deformations and cracking of the concrete deck during large earthquakes does not jeopardize the safety of the embankment. Given that additional consideration, it is judged that a normal freeboard of 20 feet would not be unreasonable at this large dam. Therefore, the crest elevation will be set at 1750 feet. (It may be possible to lower this elevation in future phases of design as more analyses are conducted.)

3. Embankment Slopes

The crest width of Wymer dam will be 35 feet. Although slightly wider than most dams, this width is judged reasonable given the height of the dam and the potential for high seismicity in the area. At this level of design, both the upstream and downstream slopes will be set at 1.5 (horizontal) to 1 (vertical). 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 400-foot-plus height, the potentially significant seismicity, and likely 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.

4. Thickness of Concrete Face

The design practice of the past 10 to 20 years 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), where H is the total height of the dam. However, as presented at the 2006 International Commission on Large Dams (ICOLD) Congress, several recently designed concrete face rockfill dams have experienced significant cracking shortly after being filled. These recent developments appear likely to generate new criteria in the design of concrete faces. It appears that the trend may move toward thicker and more heavily reinforced concrete faces. Whereas the concrete face at Wymer dam may have varied from 1 to 1.5 feet under previous design rules, it might vary from an estimated 1 to 3 feet under future guidance. Thus, for this appraisal design, the average thickness of the concrete face will be assumed to be 2 feet.

5. Plinth Dimensions

The width (upstream to downstream) of the plinth (footing) for a concrete face rockfill dam 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 Wymer dam will have varying areas of rock quality, it is envisioned that the plinth width will vary over portions of the foundation. For the purposes of an appraisal grade 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 Wymer 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.

6. 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 additional zones comprised of materials from required excavation.

Zone 1: This zone is comprised of any impervious or semi-pervious materials that are excavated from the footprint of the dam. Such finer-grained soils may be limited in extent. These materials are to be separately stockpiled during excavation, and then placed in the foundation excavation along the toe of the concrete face as shown in Figure 26. As such, these materials may serve to fill in any crack or defect at the plinth-face contact or in the lower portion of the concrete face that might 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 subbase 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-like 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 (Miscellaneous Fill): This is a random fill zone comprised of the materials excavated from beneath the dam footprint or for the appurtenant structures. It will largely consist of overburden soils including silts, clays, sands, gravels, and cobbles, but it is also likely to include some weathered bedrock materials. 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 1- to 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. The location of this random zone is shown on Figure 26.

Concept Description - Dike

The dike is proposed to consist of a central core rockfill embankment. Details of the proposed design are discussed in the following paragraphs and shown in Figure 27.

1. General Design Concepts

Whereas the concrete face rockfill dam relies on the concrete face as the water barrier, the barrier with this alternative selected for the dike consists of an earth core comprised of relatively impermeable soils. Given the significantly lower embankment height (180 feet vs. 450 feet) yet reasonably similar crest length (about 2,700 feet vs. 3,200 feet), it appears that an earthfill core would be more economical than a concrete face at the dike. 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 dike (the large 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 later in subparagraph 4 entitled, “Embankment Zoning.”

2. Crest Elevation

The selection of required freeboard has been described above under the concrete-face rockfill dam alternative. It would be possible to construct the dike to a lower crest height, since the upstream riprap is apt to result in much lower wave runup than the smooth concrete face at the dam. However, it is generally preferred to keep multiple structures impounding a reservoir at the same elevation unless the specific design intent is to allow a certain structure to have less freeboard and thus potentially fail first (serving in essence as a fuse plug). For this appraisal design, the dike crest elevation will be assumed to be the same as for the dam, or El. 1750.

3. Embankment Slopes

The crest width of Wymer dike will be 30 feet, a typical width for an embankment of this size. As with the concrete-face dam, the downstream slope will be set at 1.5 (horizontal) to 1 (vertical). 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 dike will be 2:1, somewhat flatter than the concrete face dam. The flatter slope is to ensure stability of the upstream sloping central core.

4. Embankment Zoning

Although several of the zones in this rockfill dike are similar to the zones in the concrete-face rockfill dam, there are some differences, as spelled out 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 embankment, 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 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 dam, this zone 2 will have 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-like 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 likely be identical to the zone 3 in the concrete-face 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 dike. It is the same as described above for the concrete face rockfill dam.

Zone 5 (Miscellaneous Fill): This is a random fill zone comprised of the foundation materials excavated from beneath the dike. It is the same as described above for the concrete-face rockfill alternative. The location of this random zone is shown in Figure 27.

Foundation Treatment

1. Treatment Beneath the Impervious Barrier

Because the concrete face and plinth are the key components comprising the water barrier of the 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 later in subparagraph 4 entitled, “Miscellaneous Bedrock Treatment.” The amount of foundation treatment required in the upstream toe area of the main dam 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 75 to 225 feet on 10-foot centers. For cost estimate purposes, a three-row curtain has been assumed and the average grout take for the entire curtain grouting operation is assumed to be three sacks of cement per lineal foot of drill hole.

At the dike, 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 core 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 appraisal estimate, 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 120 feet on 10-foot centers. For cost estimate purposes, a two-row curtain has been assumed, and the average grout take for the entire curtain grouting operation is assumed to be three sacks of cement per lineal foot of drill hole.

2. Overburden Excavation

As discussed under "Design Considerations," a key design consideration for the dam and dike is to prevent the potential for foundation liquefaction. Thus, for this appraisal study, complete excavation to bedrock beneath the entire footprint of both rockfill embankments is assumed. This will positively reduce all uncertainties of foundation liquefaction, and would also help support the use of steeper rockfill slopes in later designs.

The foundation overburden in the valley portion of the dam footprint appears to be relatively shallow, on the order of 20 feet thick. As discussed earlier, left abutment rock quality appears to be poor and there is a remote possibility that a portion of the left abutment for the dam is located in an ancient landslide. To account for the poor rock quality (or potential landside) at this appraisal stage, the design and cost estimates have assumed that the foundation excavation of the entire left abutment will extend to a depth of 50 feet.

3. Localized Over Excavation of Rock

Different basalt flows, as well as sedimentary interbeds, may 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 other areas, particularly under the dam plinth or the dike core, where the rock quality is suspect and not ideally competent to support the impervious barrier. In such areas, additional rock excavation, sometimes requiring drilling and blasting, may be required.

At the dike, localized irregularities in the rock, depending on the size, may create concerns for differential settlement or stress concentrations. If dental concrete is considered too extensive, it may be preferable to excavate the rock to create more gradual or uniform contours beneath the zone 1 core.

4. 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 in areas of faulting. In such locations, filters may need to be placed downstream of the plinth or core for a distance of about one-fourth the water head. (If fracturing was bad enough, 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 necessary 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.

Diversion and Dewatering

Due to the presence of Lmuma Creek flowing through the damsite, there will be some need for diversion and dewatering. Since the creek is relatively small, these work items are not expected to be particularly large or complex. Appraisal-level concepts for diversion and dewatering are discussed below.

1. Diversion

Because Lmuma Creek flows through the damsite, there will be some diversion work required at the dam. The dike does not have any watercourse flowing through it, and thus there will be no need for any diversion activities at the dike site. At this stage of design, a 25-year flood was selected for sizing the diversion works. The diversion scheme consists of a cofferdam located approximately 450 feet upstream from the upstream toe of the dam. The cofferdam is assumed to be a 57-foot-high embankment constructed of earthfill obtained from excavation for the dam foundation. The slopes of the cofferdam are assumed to be 3:1 upstream and 2:1 downstream. A 10-foot-deep cutoff trench with a 10-foot base width will be excavated at the upstream toe of the cofferdam. A geomembrane, extending from the embankment crest down to the base of the cutoff trench, will serve as the water barrier for the cofferdam. To protect the geomembrane, it will be sandwiched between geotextile layers and covered with an 8-foot horizontal layer of earthfill.

A 60-inch pipe with an invert at approximate El. 1375 will be used to convey flood flows impounded by the cofferdam past the damsite (and ultimately through the outlet works tunnel). The combination of cofferdam surcharge and pipe flow capacity will be sufficient to pass a 25-year diversion flood with 2 feet of freeboard. To minimize ponding of water behind the cofferdam (which could complicate dam foundation dewatering efforts), the pool below El. 1375 will be intermittently pumped into the 60-inch pipe. Thus, there will generally be little water impounded behind the cofferdam. Additional information regarding diversion can be found in the Construction Considerations section for the Wymer Reservoir - Appurtenant Structures.

2. Dewatering

The foundation overburden in the valley portion of the dam footprint appears to be relatively shallow, on the order of 20-feet thick. The groundwater level is estimated to be about 10 feet below the ground surface, and limited to the valley section. Lmuma Creek is a relatively small stream. Given these considerations, dewatering is expected to be relatively straight-forward and comprise a very small component of the overall work. Conceptually, the dam foundation may be able to be dewatered by a relatively small number of wellpoints (or perhaps wells) and supplementary sumping. Due to the relatively small amount of dewatering work compared to the major earthwork activities associated with constructing a 450-foot-high dam and 180-foot-high dike, costs are expected to be minor. Thus, for this appraisal design, the dewatering scheme was not specified, and the costs are simply assumed to be a part of the unlisted items.

Construction Considerations

Construction considerations are typically items or issues that design and construction personnel need to be aware of and evaluate during the ongoing construction activities. A few key ones include:

1. Foundation Treatment

The potential for varying rock quality (and possibly faults) within the foundation for Wymer dam and dike will necessitate a flexible working relationship with the contractor. Additional excavation will be required in places and treatment measures such as dental concrete, slush grouting, and filter blankets will be required in other areas. These locations cannot be identified on design drawings and will need to be determined during construction.

2. Embankment Compaction

Due to the potentially 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.

3. Miscellaneous Fill Zone (Zone 5)

As shown on the figures, a large random fill zone will be located within the downstream portion of both rockfill embankments to utilize materials from required excavation. It is anticipated that these materials will vary widely in composition. These materials will be excavated and stockpiled, to be later placed in the embankments and compacted by vibratory rollers. As both excavation/ stockpiling and fill placement operations proceed, careful attention will need to be paid to ensuring that these random fill materials are properly classified, moisture control is optimized, and that the proper method of compaction is utilized to ensure a thoroughly compacted zone.

4. Staged Construction

To gain additional knowledge of the site prior to issuing a full contract, as well as 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 and construction of the outlet works for diversion. A second stage would include the bulk of the earthwork placement.

X. Wymer Reservoir – Appurtenant Structures

Spillway

The spillway was located on the left abutment similar to previous designs to provide an acceptable alignment of the discharges relative to the stream channel alignment. Although no geologic data was available at the time of this study, it would be desirable to have a rock foundation for the structure, although not mandatory. It was identified that the floods were significantly less than in previous studies which resulted in being able to eliminate a gated crest structure. It was also identified through the flood routings that the outlet works would be capable of passing significant flood events (greater than a 500-year frequency); therefore, the spillway would not have discharges until inflows in the estimated range of a 1,000-year flood frequency occur, assuming a relatively high reservoir condition.

The potential for locating the spillway on the dike and discharging into McPherson Canyon was briefly considered. However, this option was not pursued due to the potential for significant erosion should the spillway operate. This option might be considered in future studies due to the very remote possibility of the spillway ever operating. Significant cost savings could result if only a control structure was considered necessary and if erosion concerns could be addressed.

Concept Description

The spillway is located on the left abutment adjacent to the embankment. The reinforced concrete spillway consists of an uncontrolled (ungated) ogee crest structure with a crest length of 60 feet and an open chute extending down to near the streambed elevation with a slotted flip bucket stilling basin structure. The maximum spillway discharge under the controlling PMF condition is approximately 27,500 cfs at maximum reservoir water surface El. 1741.7. Although improvements to the downstream channel are included, if the spillway were to operate, it is anticipated that erosion in the downstream channel would occur. However, since the erosion would be located significantly downstream from the toe of the dam, there would be no dam safety related issues. Key design parameters for the spillway included:

- Normal Water Surface (NWS) and spillway crest at El. 1730.0.
- Maximum allowable reservoir water surface = El. 1741.7 to prevent inundation of I-82 bridge from PMFs.
- Minimum of 3 feet freeboard for the I-82 bridge required for 100-year flood per WSDOT.
- The River Outlet Works was assumed to operate throughout the flood routings.

See Figure 28 for spillway details.

Outlet Works

Viable options for locating the river outlet works were either the left abutment or the right abutment. No specific geologic data were available to favor either side and both sides would provide a similar alignment and length. The left side was chosen due to the favorable topography relative to better accommodating the diversion during construction. Due to the significant reservoir head, the designs for the outlet works included tunneling into the abutment as opposed to a cut-and-cover conduit scheme due to structural loading guidelines for outlet works.

Key design parameters for sizing the outlet works included three criteria—planned release requirements, reservoir evacuation criteria, and acceptable velocities relative to potential impacts on the interior coatings of the steel pipe. The maximum planned release requirement was identified as 1,200 cfs. Evacuation criteria [15] for Reclamation dams were considered a minimum requirement for the designs. A maximum velocity of 25 ft/s was considered a safe condition for interior pipe coatings and was chosen as the design criteria that would be applied.

The general configuration for the outlet works designs was chosen to provide pressure flow throughout the entire length with the control gates located at the downstream end of the system. This configuration provides the least risk relative to dam safety considerations. The controlling condition for sizing the outlet works was the allowable velocity in the pipe relative to coatings considerations. The most critical area is immediately upstream of the outlet gates in the control house. As a result, the outlet works is oversized relative to evacuation criteria and minimum release requirements; however, a benefit of that would be that the risk of the spillway operating would be significantly reduced to the range of a 1,000-year frequency event.

Evacuation criteria outline target reservoir elevations and times for reservoir drawdown based on the hazard and risk categories for the dam [15]. Inflow during the period of evacuation was calculated by the Flood Hydrology Group to be 200 cfs, as compared to the previous studies which estimated inflow at 450 cfs. The most conservative criteria would be for a High Hazard and High Risk category. Wymer dam would probably be classified in the High Hazard, Low Risk Category. Criteria for both categories are shown in Table 10 as well as the results of the evacuation routings for the designs. The output file for the reservoir evacuation routing is contained in Appendix C.

Table 10. Reservoir Evacuation Results

Evacuation Stage	Reservoir Elevation (feet)	High Hazard High Risk (days)	High Hazard Low Risk (days)	Wymer Dam Evac. Results (days)	(elev.)
75% Height	1635	10-20	30-40	15	1633.8
50% Height	1540	30-40	50-60	24	1536.3
10% Storage	1508	40-50	60-70	26	1504.1
25% Height	1445	60-80	80-100	29	1433.7

Normal Water Surface Elevation = 1730.0
Streambed Elevation at the dam = 1350.0
Hydraulic Height of Dam = 380 feet

Concept Description

The river outlet works is located on the left abutment and would be constructed utilizing tunneling through the basalt. The river outlet works structures consist of the following:

- Two reinforced concrete box-type intake structures with trashracks. The lower intake would be at invert El. 1375.0 and the upper intake would be at invert elevation of 1456.0. The lower intake would allow diversion during construction utilizing a 57-foot-high cofferdam and the upper intake was located above the 100-year sediment load elevation. The lower intake would be capable of being bulkheaded off if sediment accumulation became a problem.

- A short 114-inch ID steel-lined, cast-in-place conduit to connect the intake structure to the tunnel section of the outlet works. The upper intake would also require a 114-inch I.D. steel-lined, reinforced concrete tunneled shaft.

- An upstream, circular, 114-inch ID steel-lined, reinforced concrete tunnel.

- A gate chamber, approximately 20 feet in diameter to contain a 9-foot by 7-foot, high-pressure emergency outlet gate.

- A downstream 15-foot ID, circular reinforced concrete tunnel which carries a 102-inch steel conveyance pipe. This tunnel serves as an access way from the control house to the gate chamber.

- A downstream 15-foot-inside-diameter, cast-in-place reinforced concrete conduit which contains the 102-inch steel pipe. The conduit bridges the distance between the control house and the tunnel.

- A downstream control house which contains the control gates, gate operating equipment, ventilation, lighting, etc.

- Four 4-foot by 6-foot tandem high-pressure outlet gates; two control gates and two emergency gates.

- A 30-inch steel bypass pipe, 30-inch ball valve, and 30-inch outlet gate for making smaller releases.

- An engine generator set at the outlet works control house for auxiliary backup power to operate the outlet works emergency and regulating gates and valves, and for heating, ventilating, and lighting systems in the event of primary power failure.

See Figure 29 for outlet works details.

Steel pipe provided for the outlet works was designed in accordance with AWWA M11 [12] and ASCE Manuals and Reports on Engineering Practice No. 79 [13]. After fabrication, all piping would be hydrostatically tested to 1.5 times the design pressure. A 114-inch-diameter, 0.875-inch-wall, steel liner encased in concrete extends from the intake structure to the gate chamber. A 102-inch-diameter, 0.5-inch-wall steel pipe extends from the gate chamber to the outlet works structure at the downstream end of the dam. This pipe is exposed inside the downstream conduit and supported on concrete saddle supports. The 102-inch-diameter pipe bifurcates into two 72-inch-diameter, 0.375-inch-wall steel pipes. These pipes each connect to steel round to rectangular transitions that connect to the outlet gates.

A 30-inch-diameter, 0.25-inch-wall, steel pipe connects to the 102-inch-diameter steel pipe upstream of the bifurcation. The 30-inch-diameter pipe extends from this connection to the 30-inch-diameter ball valve and 30-inch-diameter outlet gate. The 30-inch-diameter ball valve is commercially available suitable for pressures up to 300 psi.

The discharge curve for the outlet works is $Q = 182.1H^{(1/2)}$; where H is the elevation difference from the reservoir water surface elevation to El. 1330.0; downstream end at the control gates. At normal water surface, the maximum discharge through the outlet works is 3,642 cfs. The outlet works can meet the required pulse flows to support fish in the Yakima River (1,200 cfs) with a nearly empty reservoir.

Construction Considerations

The spillway foundations are desired to be located on rock; however, due to the relatively light loads, an adequately compacted soil foundation would also be acceptable. The crest structure would be an exception in that a rock foundation would be more important to avoid any foundation consolidation. Some foundation grouting would be expected and would likely be combined with the grouting of the embankment foundation.

The outlet works will need to be constructed during the initial construction phase in order to accommodate the need to divert the stream during the foundation work for the dam. Reclamation guidelines dictated that for an anticipated 3-year construction period, a diversion plan should be able to accommodate a 25-year flood which is the basis of the diversion plan. Physically, a 6-foot-diameter pipe would be connected to the upstream end of the river outlet works intake structure at El. 1375 and extend to the upstream end of a cofferdam located on Lmuma Creek (see Figure 29). The streambed elevation at the cofferdam is approximately 1355 feet, which would result in a 20-foot dead pool. It was desirable to minimize the dead pool behind the cofferdam during construction to reduce the impacts on the dewatering/unwatering system required for constructing the foundation of the main embankment. Thus, designs included installing pumps upstream of the cofferdam to keep the dead pool at low levels. Conceptually, the pumps would operate intermittently and only allow a small pool to build up before the pumps would kick on and pump the pool into the diversion pipe and discharge back into Lmuma Creek downstream of the dam. During flood conditions, the pumps would be abandoned and the pool upstream of the cofferdam would flow into the outlet works by gravity.

Two submersible dewatering pumps, each rated for 10 cfs at 20 feet total head, were estimated for evacuating the water behind the cofferdam. The submersible pump motors operate at 900 rpm and are rated at 50 hp. Each pump discharge line would have a check valve and isolation valve. The following criteria were used to select pumps for dewatering during construction:

- During dam construction water behind the cofferdam needs to be pumped to the diversion pipe to keep flows from topping the cofferdam. Up to 20 cfs capacity, flows may need to be pumped to keep the site adequately dewatered during the anticipated construction period.

- Two equal-sized dewatering pumps are required to have some redundancy if one pump needs repair or replacement.

- The pumps are estimated to be operated 6 hours per day over the 2-year construction period.

Outlet Channel Modifications

General Channel Design Considerations

The Lmuma Creek channel modifications will extend from the outlet works stilling basin downstream of the dam to the Yakima River. The modified channel length is approximately 4,500 feet and is designed to convey the peak inflow for the 100-year flood of 1,600 cfs. Because this is a large increase in flows compared to natural creek flows, the Lmuma Creek channel cross section will be enlarged to accept the 1,600 cfs design flow and pass it under the SH-821 bridge with 3 feet minimum of freeboard. If the spillway were to operate, the downstream SH-821 bridge would have already been overtopped due to the outlet works releases of approximately 3,600 cfs (estimated 1,000 year recurrence interval) prior to spillway releases.

The channel cross section is a trapezoidal shape with a bottom width of 60 feet and height of 6 feet. The channel side slopes are 2:1. The entire length of the channel is riprap-lined to protect exposed native soils from erosion after the channel is excavated. The natural channel slope of approximately 1.2 percent will be decreased to 0.6 percent to ensure subcritical flows in the channel. The decrease in channel slope is accomplished by constructing seven drop structures along the channel alignment with each structure providing 3 feet of vertical drop. The channel drops will be constructed with sheet piles embedded 10 feet deep. The sheet piles extend 40 feet on either side of the channel to prevent bank cutting. It was assumed that the native soil would likely contain enough cobbles that driving sheet piles would not be possible in this area; therefore, costs for trench excavation and cement bentonite slurry to facilitate sheet installation are included in the cost estimate. See Figure 30 for details of channel modifications.

The following data summarize the channel design:

Design Q = 1,600 cfs
Channel Base = 60 feet
Normal Water Depth = 4 feet
Side Slopes = 2:1
Manning's n = 0.045
Channel Velocity = 5.9 ft/s
Channel Slope = 0.006
Froude Number = 0.55

XI. Roadwork

Access Roads

All roadway sections utilized two 12-foot-wide lanes without shoulders. A ditch with side slopes of 3:1 and a depth of 1 foot was used on both sides of the typical roadway cross section. Culvert crossings (35 linear feet of 24-inch CMP) were estimated every 500 feet of roadway. Cut/Fill slopes were 2:1. For surfacing, 6-inch-thick gravel was assumed. In this appraisal-level design, several areas had a grade up to 15.0 percent. In future design studies, the horizontal and vertical alignments would be refined to satisfy maximum grade constraints of 12 percent and would balance earthwork favorably to overall site conditions.

Road from SH-821 to the Northwest Side of Dam

This roadway is 8,200 feet in length with 17 culvert crossings. Guardrail was assumed along both sides of embankment dam. No roadway earthwork was estimated along the top of the dam. This portion of the roadway work has the greatest potential for variability of earthwork quantities.

Spillway Bridge

The spillway bridge consists of a single span, supported on the spillway walls. The bridge, which is designed for HS20-44 live loads, has a clear width of 24 feet (two 12-foot lanes) and an overall length of 65 feet. The bridge will be supported on bearing seats formed onto the spillway walls, and therefore this design does not include abutment design.

The bridge superstructure design is based on the current *Standard Specifications for Highway Bridges, 17th Edition* (2002), published by the American Association of State Highway and Transportation Officials (AASHTO). Final design will be made using the AASHTO LRFD Bridge Design Specifications, Third Edition, 2004.

The bridge superstructure consists of four AASHTO Type III precast, prestressed concrete beams, with a cast-in-place deck. The bridge rail consists of Jersey safety shape. The precast beams will have a minimum concrete compressive strength (f'_c) of 5,000 psi, and the cast-in-place concrete will have a minimum compressive strength (f'_c) of 4,000 psi. Deck slab and Jersey shape reinforcement is epoxy coated with minimum specified yield strength (f_y) of 60,000 psi.

Road from Discharge Line Access House to Northeast Side of Dike

This roadway is 2,600 feet long with five culvert crossings. Guardrail was assumed along both sides of the dike. No roadway earthwork was estimated along the top of the dike.

Road from SH-821 to Outlet Works

This roadway is 3,600 feet in length with seven culvert crossings. This work should mainly consist of resurfacing the existing road to the base of the proposed embankment dam. A small quantity of earthwork will be necessary to route the road from the existing alignment to the south side of the valley.

Existing Interstate 82 Bridges

The proposed Wymer reservoir will inundate the piers of two existing Interstate 82 bridges located between Yakima and Ellensburg near Mile Post 15. These bridges provide east- and westbound access over Lmuma Creek.

The appraisal-level cost estimate in this study is based on the assumption that the existing conditions of the bridge are adequate and mitigation measures are only required to address submergence of bridge features. For the piers, a liquid-applied waterproofing membrane has been estimated to increase protection of the reinforcement in the existing concrete columns. The columns would be cleaned, sand blasted, and coated with a liquid applied urethane coating.

Protection of the bridge/road embankments will be provided by a 3-foot layer of 24-inch-diameter riprap on top of a 15-inch layer of sand and gravel bedding. The embankments will be prepared for the riprap and bedding by excavating an 18-inch layer of existing embankment. See Figure 31 for location and details of riprap protection. We have assumed that slope stability of the submerged embankments will withstand normal water surface elevation fluctuations due to operations of the reservoir and that there will be no rapid drawdown.

XII. Field Cost Estimate

Field cost estimates include construction contract costs and contingencies. Construction contract costs include itemized pay items, mobilization, and an allowance for unlisted items. Field cost estimates do not include non-contract costs (environmental studies, site investigations, design, construction management, etc.). Field cost estimates also 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.

The appraisal-level field cost estimate for construction of the features associated with the proposed Wymer dam and reservoir offstream storage facility is $780 million. This field cost estimate is in **April 2007** price level dollars and includes mobilization, unlisted items, and contingencies as explained below:

- Mobilization **-** Mobilization costs include mobilizing contractor personnel and equipment to the project site during initial project startup. The assumed 5 (+/-) percent of the subtotal cost used in the cost estimates is based on past experience on 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 estimates 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-level estimates should be at least 10 percent and is often set at 15 percent. Based on the level of detail provided for this study's cost estimate, the unlisted items line item was set at 10 (+/-) percent of the subtotal cost, plus mobilization. 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. 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.

The field cost estimate developed for this study is for the purpose of comparing the Wymer dam and reservoir alternative to other alternatives analyzed in the Storage Study. The estimate is not intended to be at the feasibility-level required to request project authorization for construction and construction appropriations by the Congress.

The designs are based on available design data from past Reclamation work and limited additional data obtained during the study. The amount of data collected to adequately define major cost drivers and technical adequacy is not considered to be at the level required for a feasibility-level assessment of project features. Design data collected for future studies may change future cost estimates significantly from the cost estimates presented in this report.

Features developed in this study have not been subject to detailed engineering analysis and design. Preliminary identification and sizing of required features were accomplished based on comparisons to similar features designed for other projects, engineering judgment, and limited analyses. The field cost estimate was 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 designs and drawings. Unit prices, adjusted for location and current construction cost trends, were determined for the identified pay items.

Table 11 shows the distribution of costs relative to major features and items. Estimate worksheets showing a detailed breakdown of the field cost estimate are shown in Appendix D.

It should be noted that the 2007 appraisal-level estimate for Wymer dam and reservoir is approximately $500 million greater than the indexed appraisal-level estimate prepared in 2006 [2]. The major factors for the cost increase are:

- The 2006 estimate was based on features, quantities, and prices identified in the 1985 appraisal study and used solely to compare to other alternatives developed in the same manner. Reclamation guidelines state that indexing construction costs older than 5 years should be avoided.

- The current estimate is a more detailed estimate than the indexed 1985 study.

- The 2006 cost estimate is at an April 2004 price level. The 2007 cost estimate is at an April 2007 price level.

- Cost indices are developed for various typical features but do not appear to have adequately captured the changing market conditions since 1985, especially with respect to steel and concrete. The construction industry has experienced a high inflationary period for the last 4 years, compounding the difficulties with indexing previously prepared cost estimates.

- The 1985 pumping plant intake does not meet current requirements for fish screening.

- The 2007 pumping plant configuration is larger than the 1985 pumping plant configuration.

- The 2007 quantities for the dam and dike are larger than the 1985 quantities for these features. Specific dike quantities are not identified in the 1985 estimate.

Table 11. Breakdown of Appraisal-Level Field Cost Estimate

Feature	Cost
Yakima River Intake	$18,352,464
Pumping Plant	$54,246,343
Switchyard and Transmission Line	$6,070,102
Discharge Line	$24,306,490
Dam	$306,452,950
Dike	$63,553,000
Spillway	$29,150,727
Outlet Works	$33,125,567
Roadwork	$3,402,070
Subtotal	**$538,659,713**
Mobilization (5%)	$27,000,000
Unlisted Items (10%)	$54,340,287
Contingencies (25%)	$160,000,000
Total Field Cost	**$780,000,000**

XIII. Conclusions

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

1. Construction of the Wymer dam and reservoir facility is technically viable.

2. The appraisal-level field cost estimate for construction of the features associated with the proposed Wymer dam and reservoir offstream storage facility is $780 million. This field cost estimate is in **April 2007** price level dollars and includes mobilization, unlisted

items, and contingencies. The field cost estimate does not include non-contract costs.

XIV. Recommendations

The cost of the proposed Wymer dam and reservoir facility is significantly greater than the indexed cost estimate developed in 2006. Should the decision be made to continue into feasibility design, it is required that additional data be collected, reservoir operations refined, and features modified for knowledge gained during this study and future data collection. Value Engineering methods of analysis could be applied to identify needs, major cost components, and 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 Yakima River intake site, pumping plant, discharge line, damsite, dike site, reservoir area, roads, and Lmuma Creek downstream of the dam will be required during the feasibility stage. Additional geologic investigations will also be required for final design and construction of these facilities. Geologic data should 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, soil-resistivity, permeability, unwatering and dewatering requirements, groutability, reservoir water-holding capability, seismicity and faulting, reservoir-induced seismicity, landslides, sedimentation, and location and availability of borrow materials.

Reservoir

Detailed reservoir operations studies should be conducted to verify sizing of features to lift water from the Yakima River to Wymer reservoir and reservoir capacity requirements.

More advanced hydrologic studies should be conducted to verify the reservoir design floods.

Raising the top of active reservoir water surface elevation should be considered for future design studies to provide more active storage in the reservoir. To utilize this option, alternative spillway considerations should be evaluated.

Future studies could consider moving the dam upstream similar to the initial 1984 alignment and replacing the I-82 bridges to obtain more storage.

Yakima River Intake

Conduct a comprehensive river study to better define flows and associated river elevations at the intake, sedimentation, and river topography.

A diversion dam in the Yakima River was not included as a part of this study because the dam would potentially create an obstacle to fish passage. A diversion dam would allow for the fish screen bypass to be driven by gravity rather than by centrifugal screw pumps; however, fish ladders would be required to allow for upstream fish passage past the diversion dam. If such an alternative is considered for future study, river hydraulic modeling would be required to evaluate the inundation impacts to existing roads and railroads as well as the riparian habitat.

Pumping Plant

As recommended by the 1989 VE Study, the pumping plant was reconfigured from a five-unit spiral case plant to a seven-unit, horizontal centrifugal plant (standard vertical turbine units could not be found to meet flow and head criteria). Although this change decreased the depth of the plant excavation, it increased the footprint of the plant which increased concrete quantity and dewatering requirements.

Variable speed pumping units and/or half-sized fixed-speed units should be investigated in the future to better address the wide head range.

Discharge Line

One possible future consideration would be to explore adding a surge tank near the access house for the isolation valve structure. If a surge tank is feasible, it would be beneficial because the air chamber size could be reduced, the vertical pipeline alignment through the dam could be leveled out, and the risk of collapsing the pipe due to mismanagement of the pumps would be reduced.

Dam and Dike

Due to limited time available, the only dam type considered for this study was a concrete-face rockfill dam. Based on previous recommendations noted in the Montgomery Water Group Report [6], it appears that a roller-compacted concrete

(RCC) dam could be a competitive alternative for consideration in any future, more advanced-level studies. Locating suitable material sources for this type of dam would be critical to obtaining an accurate cost estimate.

Spillway and Outlet Works

A labyrinth-type spillway crest structure or fuseplug-type spillway should be considered for future design studies since this arrangement would result in more active storage in the reservoir for what is likely to be a lower overall cost as compared to the ogee-shaped crest structure.

Due to the very remote possibility of the spillway ever operating, future studies should reinvestigate the spillway location to allow discharging into adjacent drainages. Utilizing shallow rock foundations to reduce the length and eliminate stilling basin requirements appears to be a viable alternative for consideration and could result in significant cost savings. Erosion and sediment considerations would need to be accounted for.

A reservoir sediment study should be conducted to verify anticipated sediment load based on the envisioned operational conditions. Previous studies indicated a fairly high sediment volume (7,100 acre-feet), which should be verified prior to further design studies. The sediment levels would be important to verify where the outlet works intake structures could be located.

The modified Lmuma channel alignment is straightened after the SH-821 bridge crossing to provide a direct path to the Yakima River. As an alternative to the new channel alignment downstream of the SH-821 bridge, a future study could consider the possibility of preserving the original creek alignment downstream of the SH-821 bridge. Channel erosion could be limited by planting trees along the channel banks rather than using riprap. This may be a viable option downstream of the bridge since it is not as critical to retain channel sediment and control channel meanders. The channel reach upstream of the SH-821 bridge would still need to be riprap-lined to protect the bridge.

XV. References

[1] Appraisal Assessment of the Black Rock Alternative Facilities and Field Cost Estimates, Technical Series No. TS-YSS-2, Prepared by Technical Service Center, December 2004.

[2] Yakima River Basin Storage Alternatives Appraisal Assessment, Technical Series No. TS-YSS-8, Prepared by Pacific Northwest Region Office, May 2006.

[3] Stage 1 Planning Design Summary for Wymer Dam and Pumping Plant, April 12, 1985.

[4] Memorandum from Chief of Planning Technical Services to Regional Director, Subject: Revised Cost Estimate for Planning Designs for Bumping Lake, Enlargement, Wymer Dam and Pumping Plant, and Horsetail Dam and Powerplant, August 20, 1985.

[5] Wymer Dam Value Engineering Study Report – U.S. Department of the Interior, Bureau of Reclamation, Denver Office, June 1989.

[6] Yakima River Basin Watershed Management Plan, Wymer Dam and Reservoir Project Review, Draft Technical Memorandum – Prepared by Montgomery Water Group, Inc., November 2002.

[7] Memorandum To: Chief Division of Planning Technical Services, E&R Center, Attention D-720, From: Regional Director, Boise, Idaho, Subject: Design Request, Wymer Dam, Dike, and Pumping Plant, Yakima River Basin Water Enhancement Project, Washington, dated November 30, 1984.

[8] Geologic Report for Wymer Damsite, Yakima River Basin Water Enhancement Project, Washington – U.S. Department of the Interior, Bureau of Reclamation, Pacific Northwest Region, Division of Design and Construction, Geology Branch, October 1984.

[9] Addendum No. 1 Geologic Report for Wymer Damsite, Yakima River Basin Water Enhancement Project, Washington – U.S. Department of the Interior, Bureau of Reclamation, Pacific Northwest Region, Division of Design and Construction, Geology Branch, December 1988.

[10] Appraisal Assessment of Geology at a Potential Wymer Damsite, Technical Series No. TS-YSS-20, By Pacific Northwest Region, (In preparation).

[11] Juvenile Salmonids Fish Screen Criteria – National Marine Fisheries Service, 1996.

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

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

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

[15] ACER Technical Memorandum No. 3, Assistant Commissioner – Engineering and Research, Denver, Colorado, “Criteria and Guidelines for Evacuating Storage Reservoirs and Sizing Low-Level Outlet Works,” U.S. Department of the Interior, Bureau of Reclamation, 1990.

APPENDIX A

Site Review Travel Report

BUREAU OF RECLAMATION
Technical Service Center

TRAVEL REPORT

PRJ-8.10
86-68120

Codes: 86-68120, 86-68130, 86-68140, 86-68312, 86-68320 Date: April 4, 2007

To: Lowell Pimley
Chief, Civil Engineering Services

Bob Dewey
Acting Chief, Geotechnical Engineering Division

From: Dick LaFond, 86-68120, Structural Engineer and TSC Engineering Team Leader
Doug Stanton, Civil Engineer, 86-68130
Anne Pavol, Civil Engineer, 86-68140
Bill Engemoen, Geotechnical Engineer, 86-68312
Gary Russell, Geologist, 86-68320

Subject: Site Review of Proposed Wymer Reservoir and Pumping Plant Sites, Yakima River Basin Water Storage Options, Feasibility Study, Washington

1. Travel period: February 26-28, 2007.

2. Places or offices visited: Proposed Wymer Reservoir Site and Upper Columbia Area Office, Yakima, WA.

3. Purpose of trip: To view proposed sites for features associated with the Wymer Reservoir and Pumping Plant project and to discuss scope of work and design assumptions with representatives from the Pacific Northwest Region, Upper Columbia Area, and Pacific Northwest Construction Offices.

4. Synopsis of trip:

   A. Kickoff Meeting – On the afternoon of February 26, 2007, we met with representatives from the Pacific Northwest Region Office, Upper Columbia Area Office, and Pacific Northwest Construction Office to discuss design data, proposed features, and plans for the site review. A list of attendees and major discussion items is included as attachment 1.

   B. Site Visit – On February 27, 2007, we visited the proposed sites for the Wymer Reservoir and Pumping Plant and viewed the I-82 Bridge substructure that would be inundated by the reservoir. A list of major observations is included as attachment 2.

C. Closeout Meeting – On the afternoon of February 27, 2007, we reconvened with representatives from the Pacific Northwest Region Office, Upper Columbia Area Office, and Pacific Northwest Construction Office 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 of the 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 Wendy Christensen of the Pacific Northwest Construction Office for coordinating the site review.

Attachment 1 – Kickoff Meeting Notes
Attachment 2 – Site Visit Observations
Attachment 3 – Closeout Meeting Notes
Attachment 4 – Photographs

cc: Regional Director, Boise, ID
Attn: PN-3400 (Jennings), PN-3600 (Link)
Manager, Upper Columbia Area Office, Yakima, WA
Attn: UCAO-1000 (Kelso), UCAO-1100 (Ries), UCA-1120 (McCartney)
Manager, Lower Columbia Area – Bend Field Office
Attn: BFO-3230 (Stelma)
Project Construction Engineer, Yakima, WA
Attn: NCO-3173 (Christensen)
Manager, Grand Coulee Power Office, Grand Coulee, WA
Attn: GCP-5500 (Didricksen)
(w/all att to ea)

bc: 86-68120 (LaFond), 86-68130 (Stanton), 86-68140 (Pavol), 86-68170 (Maag), 86-68312 (Engemoen), 86-68320 (Russell), 86-68410 (Egan), 86-68420 (Zelenka), 86-68430 (Schuh), 86-68440 (Crawford)
(w/all att to ea)

WBR:RLafond:lcasey:3/22/07:303/445-3226
(Wymer_Trip0227_032307.doc)

SIGNATURES AND SURNAMES FOR:

Travel to: Proposed Wymer Reservoir Site and Upper Columbia Area Office, Yakima, WA.

Dates of Travel: February 26-28, 2007.

Names and Codes of Travelers:

Traveler	Date
Doug Stanton, 86-68130	4/5/07
Anne Pavol, 86-68140	4/5/07
Bill Engemoen, 86-68312	4/5/07
Gary Russell, 86-68320	4/5/07
Dick LaFond, 86-68120	4/5/07

Attachment 1

Wymer Reservoir and Pumping Plant Project

Site Review Kickoff Meeting
February 26, 2007

PARTICIPANTS:

NAME	COMPANY
Dick Link	Pacific Northwest Region Office
Kayti Didricksen	Pacific Northwest Region Office
Don Stelma	Pacific Northwest Region Office
A.J. Mitchell	Pacific Northwest Region Office
Kim McCartney	Upper Columbia Area Office
Joel Hubble	Upper Columbia Area Office
Wendy Christensen	Pacific Northwest Construction Office
Doug Stanton	Technical Service Center
Anne Pavol	Technical Service Center
Bill Engemoen	Technical Service Center
Gary Russell	Technical Service Center
Dick LaFond	Technical Service Center

MAJOR DISCUSSION TOPICS: The following items were discussed:

1. Kim McCartney explained the proposed operation of the Wymer Offstream Storage facility. Between October through March, releases will be made from Cle Elum Reservoir to increase flows in the Yakima River upstream of Wymer. These flows, totaling 90,000 a-ft/year, will be stored in the Wymer reservoir. From March to June, excess flows in the Yakima River from runoff estimated at 85,000 a-ft/year will be stored in the Wymer reservoir. From July to August, releases will be made form Wymer reservoir.

2. Joel Hubble stated that pulse flows up to 1200 ft^3/s are required to be released from Wymer reservoir to support the fish in the Yakima River.

3. During the site visit we will need to assess the landslide on the left abutment that was noted in the 1989 Value Engineering Study. It may be necessary to move the axis of the dam upstream from the 1985 study location to avoid this feature.

4. The proposed reservoir will impound water under the existing I-82 bridges. To minimize free board requirements under the bridges, consider a safety boom across the water to restrict boat access under the bridges. We need to verify the datum for the I-82 bridge elevations shown on

the WSDOT drawings so that we have an accurate understanding of reservoir restrictions (maximum water surface) imposed by the bridges.

5. During the winter time, there is a lot of truck traffic on State Highway (SH) 821 which crosses Lmuma (Squaw) Creek directly downstream of the proposed Wymer reservoir.

6. Dick LaFond explained the Technical Service Center (TSC) concerns about developing hydropower at the site including the head range of the reservoir and limited time of releases. It was agreed that pump-generation would not be included in the designs but the report would clearly explain why power was omitted from the study.

Attachment 2

Wymer Reservoir and Pumping Plant Project

Site Review
February 27, 2007

MAJOR OBSERVATIONS:

General:

1. Kim McCartney, A.J. Mitchell, and Dick LaFond met with landowners Jack and Benita Eaton and their son, Ken, to explain portions of the proposed work. Jack Eaton stated that he was installing a new pump on the Yakima River to replace his existing pump and was concerned that the proposed Wymer features would render it useless. Kim McCartney explained that any Wymer work would be way in the future. Dick LaFond stated that any Wymer intake would be located downstream of the existing pump.

Proposed Wymer Dam Site

1. The landslide does not appear to be a deep landslide and it was decided that we should leave the dam axis at the approximate location of the 1985 study and excavate the slide material on the left abutment. It is possible that the slide material could be used for the rockfill structure.

2. There is rock exposed on the left abutment upstream of the 1985 axis if shifting the axis becomes a consideration in the future.

Proposed Intake and Pumping Plant Site

1. During the viewing of the proposed intake and pumping plant site, we were accompanied by Ken Eaton. Ken stated that flow ice can occur in this area and that it backs up from Roza Diversion Dam. He also said that about 15 feet away from his pump, the channel drops to about 10 feet deep.

Lmuma Creek

1. As defined in the 1985 study, the spillway and outlet works currently discharge into Lmuma Creek upstream of SH 821. The existing channel and bridge will need to be modified to accommodate the increased flows.

Existing SH 821 Crossing at McPherson Canyon

1. The crossing consists of a square conduit which would likely need to be enlarged if the dike is located in McPherson Canyon.

Existing Interstate 82 Bridge Site

1. The I-82 southbound bridge is the lower of the two bridges and is located near mile marker 15. The concrete looked to be in a good condition and no sloughing of the embankments was observed.

Attachment 3

Wymer Reservoir and Pumping Plant Project

Site Review Closeout Meeting
February 27, 2007

PARTICIPANTS:

NAME	COMPANY
Dick Link	Pacific Northwest Region Office
Kayti Didricksen	Pacific Northwest Region Office
Don Stelma	Pacific Northwest Region Office
A.J. Mitchell	Pacific Northwest Region Office
Jerry Kelso	Upper Columbia Area Office
Kim McCartney	Upper Columbia Area Office
Lynn Holt	Upper Columbia Area Office
Joel Hubble	Upper Columbia Area Office
Wendy Christensen	Pacific Northwest Construction Office
Doug Stanton	Technical Service Center
Anne Pavol	Technical Service Center
Bill Engemoen	Technical Service Center
Gary Russell	Technical Service Center
Dick LaFond	Technical Service Center

MAJOR DISCUSSION TOPICS: The following items were discussed:

General:

1. It is unlikely that the topography used for the 1985 study has been accurately digitized to permit development of 3-D AutoCAD models for excavation takeoffs. For digital topography, the TSC should use data developed by Patrick Wright of the TSC.

2. Site specific seismotectonic studies are not available for the Wymer site. Even though the Black Rock dam earthquake loads may be conservative, those loads will be assumed at Wymer for the appraisal estimate.

Intake on Yakima River:

1. Fish screens on the Yakima River should be sized using Washington State Fish Criteria.

Pumping Plant on Yakima River:

1. Releases would be made from Cle Elum Dam in the winter and 300 cfs could be pumped into Wymer Reservoir at this time (October through March). During the summer, (March through June) 400 cfs could be pumped into the reservoir.

Wymer Dam Area:

1. No adverse site conditions were noted and a concrete-face rockfill dam continues to look like a feasible alternative.

Wymer Dike (Saddle Dam) Area:

1. The 1984 design data located the dike so that the reservoir would inundate Scorpion Coulee. The 1985 study located it closer to the dam which would exclude this potential storage. It was decided that we would locate the dike similar to the 1984 design data. Locating a spillway on the dike did not look favorable.

2. Kim McCartney asked if there was much storage benefit to locating the dike in McPherson Canyon instead of in the saddle area between Scorpion Coulee and McPherson Canyon. It appears that a dike in the canyon would be about 100 feet higher than in the saddle area and would require additional outlet works to permit reservoir evacuation. It was decided that we would compare reservoir storages associated with the two dike locations and decide final location based on this comparison.

Outlet Works:

1. Cold water releases into the Yakima River can be accomplished by a single low-level outlet. Maximum water temperature for releases is 70° F. The outlet works should be designed for 2 intake elevations in case temperature and/or dissolved oxygen concerns arise in the future.

2. The outlet works intake in the reservoir should be screened for fish using the same criteria as the river. (Note: Subsequent discussions with Joel Hubble have deleted the requirement for screening in the reservoir.)

Spillway:

1. Because of the onsite determination to excavate the slide area and keep dam located in the general orientation as of the 1985 study, there is no need to move the spillway to the dike section so it will remain in the left abutment.

I-82 Bridge Area:

1. We need to verify the bridge datum shown on the WSDOT drawings to relative to the datum of used to develop our study topography.

Geologic Investigations:

1. To help define geologic design parameters the following drill hole locations were identified:

   a. Pumping Plant – To determine alluvium and bedrock properties, groundwater level, and top of bedrock.
   b. Dike – Left Abutment – To characterize foundation materials and determine bedrock permeability. This hole will allow sample recovery of the Vantage sandstone interbed.
   c. Dam – Left Abutment – To characterize foundation materials and determine bedrock permeability. This hole will allow sample recovery of the Vantage sandstone interbed and provide information of the landslide slip surface.
   d. Dam – Valley – To determine alluvium and bedrock properties, groundwater level, and top of bedrock.

2. The timing of geologic investigations is such that designs will be occurring simultaneously with drilling. The design team will attempt to incorporate data as it is received but it is likely that data developed during the investigations will not be available to define project features.

3. Availability of construction materials will have a significant impact on costs of features and should be determined prior to preparation of costs estimates. Specifically, availability and haul distances for the following materials is needed:

   a. Concrete products (cement, sand, aggregate)
   b. Processed filter/drain materials (may be same source as concrete materials)
   c. Impervious material
   d. Rockfill
   e. Riprap

ACTION ITEMS:

1. The UCAO should perform a bathymetric survey at the proposed intake on the Yakima River to better define river bottom. This has significant impact on selecting and sizing the type of fish screens.

Wymer Reservoir and Pumping Plant Project
Site Review Photographs

Photo 1: Left abutment of proposed Wymer Dam.

Photo 2: Right abutment of proposed Wymer Dam.

Photo 3: Left abutment of proposed Wymer Saddle Dike.

Photo 4: Proposed Wymer Saddle Dike site looking from left towards right abutment.

Photo 5: Proposed Wymer Pumping Plant site.

Photo 6: Proposed Wymer intake on Yakima River.

Photo 7: SH821 near discharge line crossing.

Photo 8: SH821 Bridge over Lmuma Creek.

Photo 9: Pier No. 1 of I-82 Southbound Bridge.

APPENDIX B

Probable Maximum Flood Study

RECLAMATION
Managing Water in the West

Wymer Dam, Washington

Probable Maximum Flood Study

US Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

May 2007

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.

Wymer Dam, Washington
Probable Maximum Flood Study

Authority

This study was initiated at the request of the Design Engineers (86-68120) with the Bureau of Reclamation. The proposed Wymer Dam is located on Lmuma Creek, approximately one mile upstream of the confluence with the Yakima River, Washington. This study was requested to provide the necessary appraisal level hydrographs for the preliminary design of this structure.

Summary of Results

A summary of the appraisal level probable maximum flood (PMF) peaks and volumes for Wymer Dam is shown below.

Table 1 – Wymer Dam Probable Maximum Floods

		Volume (ac-ft)				
PMF	Peak (ft^3/s)	6-hour	1-day	3-day	15-day	Total
Nov-Feb	27,509	11,994	33,154	51,770	66,026	66,026
Apr-May	21,708	9,394	25,635	39,391	53,219	53,219
Local	94,895	18,742	23,151	24,937	n/a	29,796

Previous Flood Studies

In 1984, the Pacific Northwest Region of Reclamation conducted flood studies at proposed dam sites in the Yakima River Basin Water Enhancement Project [1]. The 1984 results for Wymer Dam are included in Tables 1 and 2. For this appraisal level study, the lag times and infiltration rates in Table 1 are assumed to accurately describe the current conditions at Wymer Dam.

Table 1 – Summary of 1984 Runoff Parameters for Wymer Dam [1]

			Local Event			Rain-on-Snow		
Drainage Area (mi^2)	Mean Elevation (ft)	Basin Factor	CT	Lag (hours)	Infiltraion (in/hr)	CT	Lag (hours)	Infiltraion (in/hr)
98	1900	4.71	1.4	2.3	0.10	5.0	8.4	0.05

Table 2 – Summary of 1984 Results for Wymer Dam [1]

	Local Event			Rain-on-Snow		
Drainage Area (mi^2)	Peak (ft^3/s)	Volume (ac-ft)	Duration (hours)	Peak (ft^3/s)	Volume (ac-ft)	Duration (days)
98	110,300	43,600	53	33,500	101,300	7

Drainage Basin Description

Wymer Dam and Reservoir will be situated in Lmuma Creek Canyon located approximately 10 miles south of Kittitas, WA, as shown in Figure 1. The basin has a drainage area of 104 mi^2 according to a 10 meter digital elevation model (DEM) from the National Elevation Dataset that was processed in ArcGIS. Elevations in the basin range from 1,320 feet to 3,750 feet with a mean elevation of 2,360 feet.

In the Lmuma Creek Canyon area, the sagebrush-covered hills form a broad, plateau like feature between the Yakima River Canyon to the west, the Manastash Ridge to the northeast, and the Umtanum Ridge to the southeast. These and other northwest-trending smaller ridges influence the drainage patterns [2].

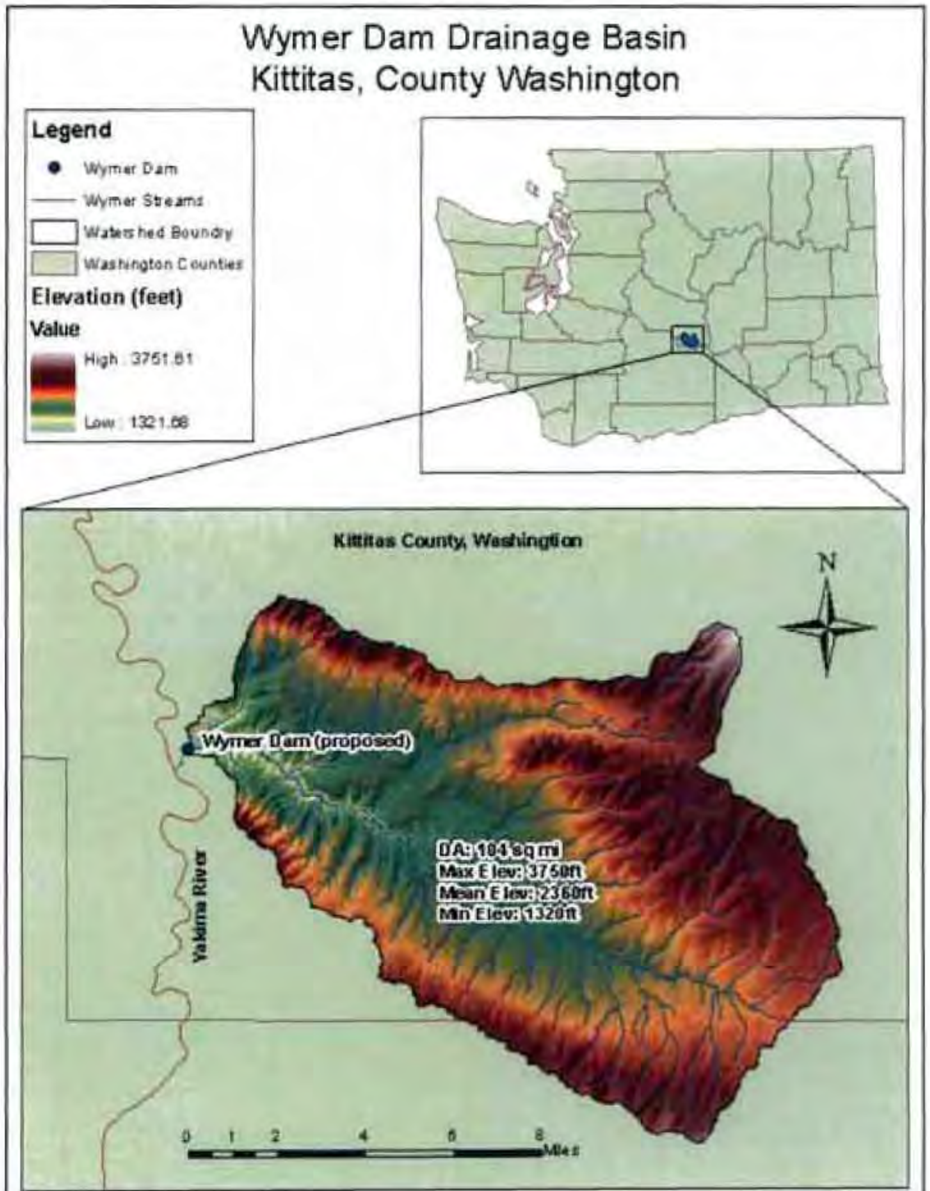


Figure 1 – Wymer Dam Drainage Basin

At Site Peak Flows

A local peak flow frequency analysis was performed for Wymer Dam utilizing existing gage data on Naneum Creek near Ellensburg, WA (U.S. Geological Survey (Survey) 12483800). This gage has a drainage area of 70 mi^2. It is located 21 miles north of Wymer Dam in the adjacent upstream drainage basin to the Yakima River. The gage's period of record spans from 1957-1978 and contains 21 years of annual peak data. A Log-Pearson III (LPIII) distribution was fit to the estimated annual peak flows using the method of moments to develop the flood frequency curve for Wymer Dam. This process is consistent with the procedure described in the Guidelines for Determining Flood Flow Frequency, *Bulletin 17B* [3]. A Regional skew value was not included in the calculations because the frequency curve being derived for this portion of the analysis is only taken to an annual accedance probability (AEP) of 0.01, and it is based on a 21 years of record. The calculations based on the station's skew alone are sufficient for this case.

Equation 1, developed by the Survey in *Methods for Estimating Flood Magnitude and Frequency in Washingtion, 2001* [4], was used to estimate the ungaged peak flows at Wymer Dam.

$$Q_u = Q_g \left(\frac{A_u}{A_g} \right)^{0.76} \qquad (1)$$

Q_u is the peak discharge, in ft^3/s, at the ungaged site, Q_g is the peak discharge, in ft^3/s, at the gaged site, A_u is the contributing drainage area, in mi^2, at the ungaged site, A_g is the contributing drainage area, in mi^2, at the gaged site, and, 0.76 is the regional exponent for the Wymer watershed specified in USGS publication [4]. Table 3 provides the results of the statistical analysis for Wymer Dam. The data and statistical parameters of the LPIII distribution are shown in Appendix A.

Table 3 – Wymer Dam - Local Peak Flow Frequency Analysis

Flood Frequency Analysis for Wymer Dam AEPs 0.99 - 0.01			
Exceedence Probability	Recurrence Interval T (years)	Discharge at Gage Location (ft^3/s)	Adjusted Discharge at Wymer Dam (ft^3/s)
0.99	1.01	142	192
0.98	1.02	161	218
0.975	1.03	168	227
0.96	1.04	185	250
0.95	1.05	194	262
0.9	1.11	229	309
0.8	1.25	280	378
0.7	1.43	324	438
0.6	1.67	367	496
0.5704	1.75	380	513
0.5	2	412	557
0.4296	2.33	446	603
0.4	2.5	462	624
0.3	3.33	522	705
0.2	5	603	815
0.1	10	736	994
0.05	20	866	1170
0.04	25	908	1227
0.025	40	998	1348
0.02	50	1041	1406
0.01	100	1176	1589

Balanced Hydrograph Calculations

Inflow hydrographs were created for Wymer Dam at the 25-, 100-, and 500-year recurrence intervals using a balance hydrograph approach. The following tables list the computed peak discharges and flood volumes used to create the balanced hydrographs.

Table 4 – Peak Discharges for Wymer Dam

		Duration Average Discharge (ft^3/s)					
Return Period (yr)	Peak (ft^3/s)	1-day	2-day	3-day	5-day	7-day	15-day
25	1227	876	757	718	673	642	558
100	1589	1014	820	771	720	688	600
500	2033	1146	866	807	751	720	630

Table 5 – Frequency Volumes for Wymer Dam

	Volume (ac-ft)					
Return Period (yr)	1-day	2-day	3-day	5-day	7-day	15-day
25	1737	3002	4275	6675	8909	16596
100	2010	3254	4590	7138	9557	17853
500	2273	3435	4803	7444	9999	18736

The calculations for the duration average discharges are based on the analysis of 20 years (1957 – 1971 and 1973 - 1978) of recorded data at the stream gage, Naneum Creek near Ellensburg, WA (Survey 12483800). The 1-, 2-, 3-, 5-, 7-, and 15-day duration discharges are computed for each year of record using the Flood Hydrology Group Program U_JFE. This program computes moving averages of the mean daily flow data for specific durations and returns the annual maximums for each of specified durations. The discharge frequencies are computed using a LPIII frequency analysis [3]. In order to relate the gage data to the actual basin data, the 1-, 2-, 3-, 5-, 7-, and 15-day duration discharges are adjusted using Equation 1. The balanced hydrographs, shown in Figure 2 are created using the peak discharges and duration average discharges for each return period from each moving average dataset.

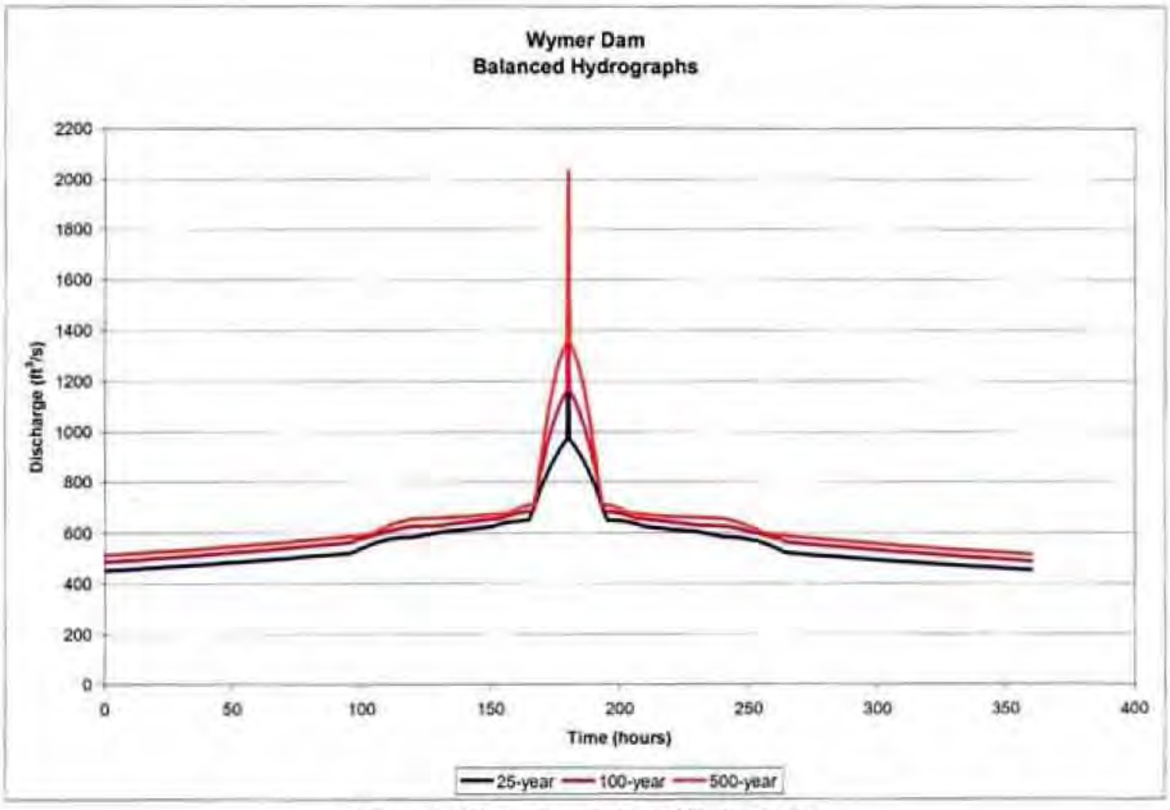


Figure 2 – Wymer Dam Balanced Hydrographs

Probable Maximum Precipitation (PMP) Calculations

For the current study, PMP estimates have been produced using Hydrometeorological Report (HMR) 57 [5]. Three storms were developed for the Wymer Dam drainage basin: a 72-hour general storm for months April-May, a 72-hour general storm for months November-February, and a 6-hour local storm. The calculated precipitation values for these storms are shown in Table 3.

Table 3 – PMP Calculations for Wymer Dam

General Storm (April-May)		General Storm (November-February)		Local Storm	
Duration (hours)	Depth (inches)	Duration (hours)	Depth (inches)	Duration (hours)	Depth (inches)
1	0.94	1	1.17	0.25	1.53
6	3.17	6	3.97	0.5	2.55
24	6.18	24	7.72	0.75	3.24
48	8.74	48	10.92	1	3.75
72	9.78	72	12.23	2	4.17
				3	4.29
				4	4.4
				5	4.47
				6	4.58

PMF Calculations

PMF hydrographs were computed for three conditions: April-May rain-on-snow general storm, November-February rain-on-snow general storm, and a local storm with a 100-year antecedent flood.

Loss Rate Estimates: The loss rates applied to the incremental PMP for this study were an initial loss of 0.0 inches and a constant infiltration rate of 0.05 in/hr for both general storms and a constant infiltration rate of 0.10 in/hr for the local storm. These values were taken from Table 1. The infiltration rate of the antecedent flood was estimated at 0.15 in/hr. This was computed by multiplying the constant infiltration rate of 0.10 in/hr for the local storm by 1.5.

Lag Time and Unit Duration: A lag time of 8.4 hours was applied to the general storm runoff calculations, and a lag time of 2.3 hours was applied to the local storm runoff calculations. These values were taken from Table 1. The lag time of the antecedent flood was estimated at 3.45 hours. This was computed by multiplying the lag time of 2.3 hours for the local storm by 1.5. The general PMFs have unit durations of 30 min, and the local PMF has unit duration of 15 min.

Unit Hydrograph Calculations: The lag time, the drainage area, and the unit duration are used with a dimensionless graph from the Reclamation collection of reconstituted historic flood to help compute a unit hydrograph for this basin. The dimensionless graph chosen for this study was the Bumping Lake, WA dimensionless graph [6]. The Bumping Lake dimensionless graph was converted into the unit hydrographs which will be used to compute the PMF hydrographs.

Snowmelt and Baseflow: The 100-year balanced hydrograph in Figure 2 was added to the runoff produced from the PMP general storms. It was not added to the local storm. A baseflow equal to the 2-year, 5-day peak runoff of 450 ft^3/s was added to the local PMF hydrograph.

Antecedent Flood Hydrograph: Current Reclamation practice is to place a 100-year flood hydrograph in front of the calculated local PMF hydrograph. A two day separation between the peak of the antecedent flood and start of the PMP is maintained [7]. The purpose of the 100-year antecedent flood is to allow the basin to become saturated prior to the onset of the PMP. This hydrograph was computed using the Soil Conservation Service method with a 100-year, 6-hour rainfall total of 1.59 inches for Wymer Dam.

Final Hydrograph Calculations: The drainage areas, loss rates and lag time information, design storm sequences, unit hydrographs, antecedent flood, snowmelt, and baseflows were used to create input files for the HEC-1 program. The input files are located in Appendix B. Using these files, HEC-1 computes the discharge versus time data that is used to create the final PMF hydrographs for the April-May rain-on-snow general storm, November-February rain-on-snow general storm, and a local storm with a 100-year antecedent flood. Figure 3 and 4 display the final PMF hydrographs.

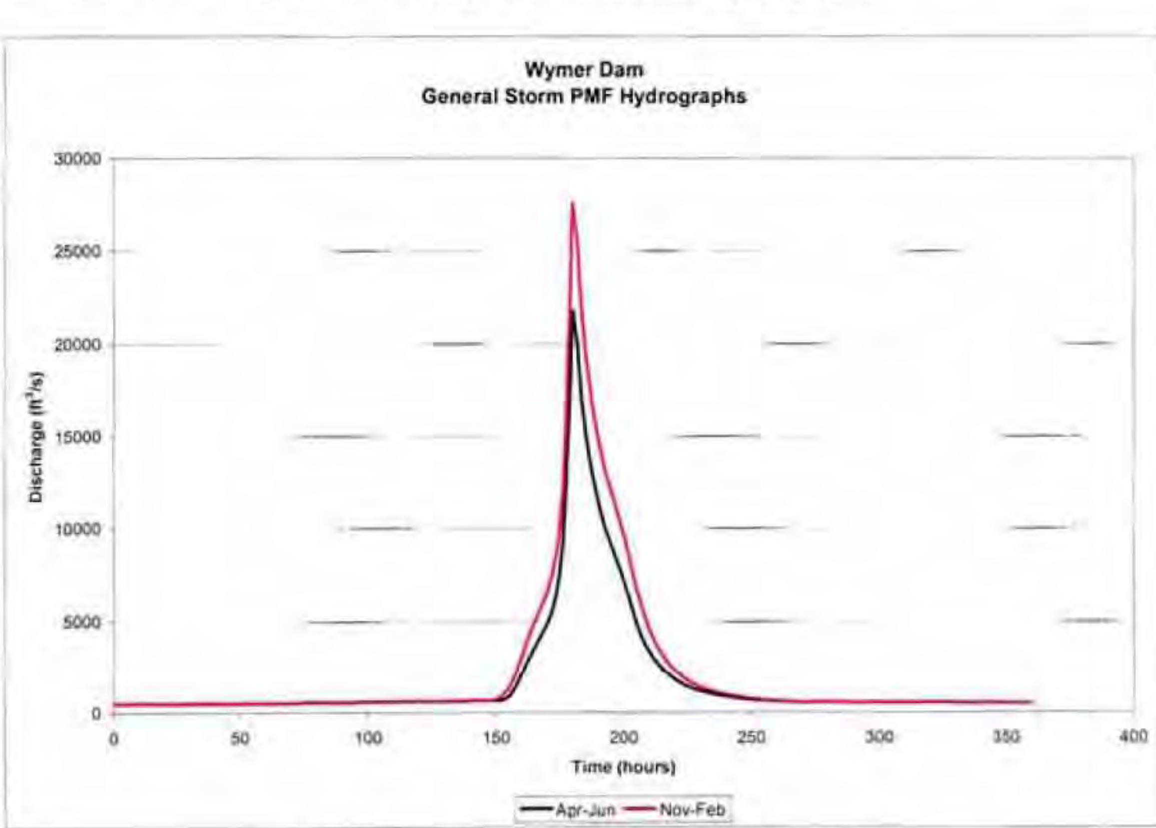


Figure 3 – Wymer Dam General Storm PMF Hydrographs

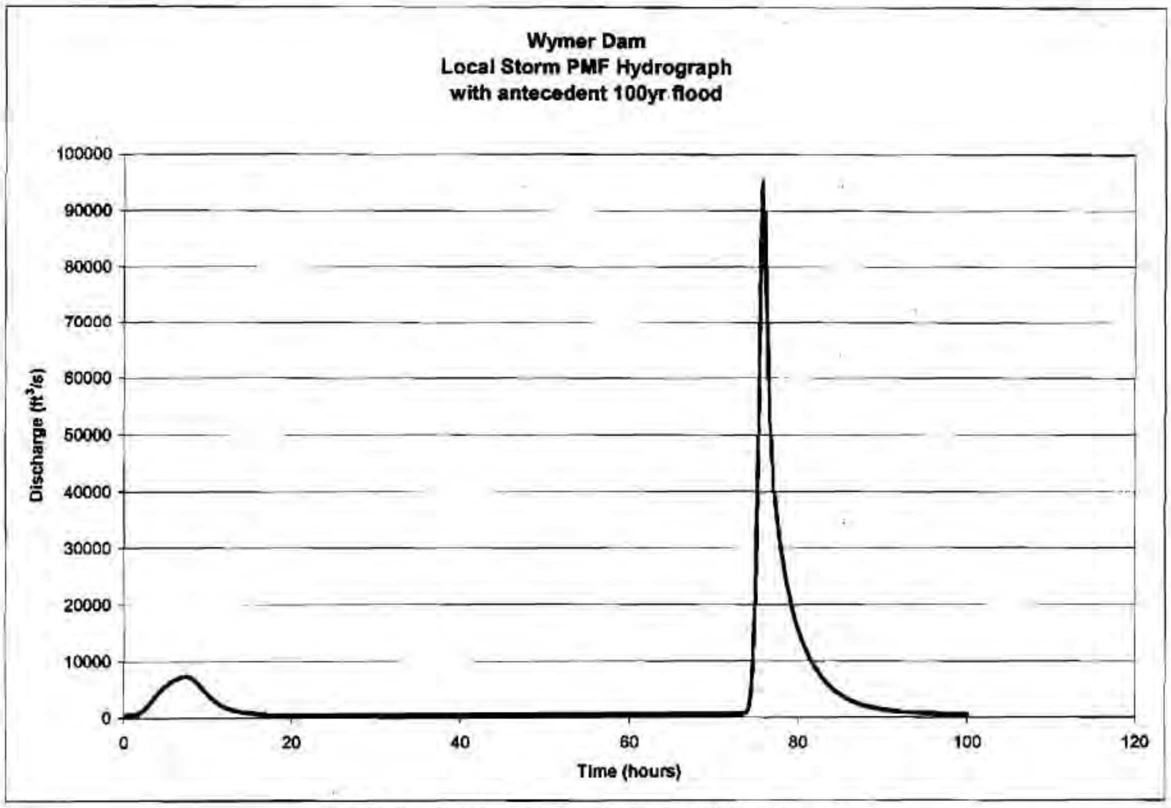


Figure 4 – Wymer Dam Local Storm PMF Hydrograph

Acknowledgements:

This report was prepared by David E. Sutley, Hydraulic Engineer. Peer review was provided by Kenneth L. Bullard, Hydraulic Engineer. Both of these individuals are employed in the Flood Hydrology and Meteorology Group (86-68530) of the Bureau of Reclamation in Denver, Colorado.

References:

[1] Reclamation, Pacific Northwest Region, 1984, Flood Studies Results: Yakima River Basin Water Enhancement Project.

[2] Reclamation, Pacific Northwest Region, 2006, Yakima River Basin Storage Alternatives Appraisal Assessment, p. 64.

[3] Guidelines for Determining Flood Flow Frequency, *Bulletin #17B of the Hydrology Committee,* U.S. Department of the Interior, United States Water Resources Council, 1981.

[4] USGS, 2001. *Methods for Estimating Flood Magnitude and Frequency in Washington, 2001*, U.S. Geological Survey Fact Sheet 016-01.

[5] Hansen, E. M. and Schreiner, L. C., Probable Maximum Precipitation – Pacific Northwest States, Columbia River (including portions of Canada), Snake River and Pacific Coastal Drainages, Hydrometeorological Report 57, U.S. Department of Commerce: National Oceanic and Atmospheric Administration, U.S. Department of Interior: Bureau of Reclamation, and U.S. Department of Army: Corps of Engineers, October 1994.

[6] MGS Engineering Consultants (1997). Barker, B., Schaefer, M.G., Mumford, J., and Swain, R. *A Monte Carlo Approach to Determine the Variability of PMF Estimates*, dated July 1997.

[7] Cudworth, A. G., 1989, Flood Hydrology Manual, Bureau of Reclamation, 1989.

Appendix A

Frequency analysis at USGS gage 12483800.

Mean of Logs	Std.Dev	Data Skew	Reg.Skew	Final Skew			
2.6139	0.1976	-0.0216	0	-0.0216			
RANK	PlotPos	YEAR	Q	EXCEED.	FREQ.Q	LOW	HIGH
1	0.0283	1964	968	0.99	142	93	185
2	0.07547	1972	860	0.98	161	110	205
3	0.12264	1957	700	0.975	168	116	213
4	0.16981	1960	666	0.96	185	132	231
5	0.21698	1958	553	0.95	194	140	240
6	0.26415	1974	548	0.9	229	174	278
7	0.31132	1962	481	0.8	280	223	333
8	0.35849	1971	470	0.7	324	266	382
9	0.40566	1976	464	0.6	367	306	432
10	0.45283	1969	449	0.5704	380	318	448
11	0.5	1961	425	0.5	412	348	488
12	0.54717	1975	419	0.4296	446	378	532
13	0.59434	1967	396	0.4	462	392	553
14	0.64151	1977	343	0.3	522	443	638
15	0.68868	1959	293	0.2	603	508	757
16	0.73585	1968	280	0.1	736	607	970
17	0.78302	1962	280	0.05	866	699	1195
18	0.83019	1970	273	0.04	908	728	1271
19	0.87736	1965	235	0.025	998	789	1436
20	0.92453	1966	180	0.02	1041	817	1517
21	0.9717	1977	47	0.01	1176	905	1780
				0.005	1314	992	2062
				0.002	1504	1108	2464
				0.001	1653	1197	2793
				0.0005	1807	1288	3145
				0.0001	2186	1503	4051

Appendix B

HEC-1 input files for Wymer Dam PMFs

April – May General Storm PMF

```
ID  WYMER DAM
ID  GENERAL STORM
ID  APRIL TO MAY
IT     30  1MAY07     0000      720
IO      3
VS   FLOW
VV      2
KK    BAL  100YR BALANCED HYDROGRAPH
KO      0        0
BA    104
IN     60  1MAY07     0000
QI 488.6    489.2    489.9    490.5    491.1    491.7    492.4    493.0    493.6    494.3
QI 494.9    495.6    496.2    496.9    497.6    498.2    498.9    499.6    500.3    501.0
QI 501.7    502.3    503.0    503.7    504.4    505.0    505.8    506.5    507.2    507.9
QI 508.6    509.4    510.1    510.9    511.6    512.3    513.1    513.8    514.5    515.3
QI 516.0    516.8    517.5    518.3    519.1    519.8    520.7    521.4    522.2    523.0
QI 523.8    524.6    525.4    526.2    526.9    527.8    528.6    529.5    530.1    531.1
QI 531.9    532.7    533.5    534.4    535.3    536.0    536.9    537.8    538.5    539.4
QI 540.2    541.2    541.9    542.8    543.8    544.6    545.5    546.3    547.3    548.2
QI 549.0    549.9    550.9    551.7    552.7    553.5    554.4    555.4    556.3    557.2
QI 558.2    559.1    560.1    560.9    561.9    562.8    568.9    574.8    577.7    579.0
QI 580.8    583.2    585.7    588.5    591.0    593.9    596.8    599.9    602.7    605.6
QI 608.3    610.9    613.3    615.5    617.9    619.8    621.6    623.2    624.7    625.7
QI 626.1    626.5    626.9    627.1    627.4    627.6    627.8    628.0    628.0    629.1
QI 630.4    631.7    632.9    634.4    635.6    636.9    638.1    639.6    640.7    641.8
QI 643.2    644.3    645.5    646.8    647.9    649.2    650.2    651.3    652.4    653.5
QI 654.3    655.4    656.5    657.5    661.0    664.6    668.0    670.9    673.9    676.3
QI 678.6    680.2    681.7    682.8    683.5    683.7    721.4    769.8    820.4    867.9
QI 912.2    953.3    991.3   1026.1   1057.7   1086.2   1111.5   1133.6   1152.5   1589.0
QI1154.7   1136.1   1114.4   1089.5   1061.4   1030.2    995.8    958.2    917.5    873.6
QI 826.5    776.3    727.0    684.8    683.5    682.9    681.9    680.4    678.8    676.6
QI 674.4    671.3    668.3    665.1    661.5    657.6    656.5    655.5    654.5    653.5
QI 652.6    651.4    650.3    649.3    648.1    646.9    645.7    644.5    643.3    642.1
QI 640.8    639.6    638.3    637.1    635.9    634.5    633.2    631.9    630.6    629.3
QI 628.1    628.0    627.8    627.7    627.5    627.2    626.9    626.5    626.2    625.9
QI 624.8    623.5    621.9    620.0    618.1    615.9    613.7    611.0    608.4    605.8
QI 603.2    600.1    597.4    594.5    591.6    588.6    585.9    583.3    581.2    579.1
QI 577.8    575.6    569.6    563.3    562.1    561.1    560.1    559.2    558.3    557.4
QI 556.5    555.5    554.6    553.7    552.7    551.9    550.9    550.1    549.2    548.3
QI 547.4    546.6    545.6    544.7    543.9    543.0    542.2    541.2    540.5    539.5
QI 538.7    537.8    536.9    536.2    535.3    534.4    533.6    532.8    532.0    531.1
QI 530.4    529.5    528.7    527.9    527.1    526.2    525.4    524.7    523.9    523.1
QI 522.3    521.5    520.8    520.0    519.2    518.5    517.7    516.9    516.2    515.4
QI 514.7    513.9    513.1    512.4    511.6    510.9    510.3    509.5    508.8    508.0
QI 507.4    506.6    505.9    505.3    504.5    503.8    503.1    502.4    501.7    501.0
QI 500.3    499.6    499.1    498.4    497.7    496.9    496.4    495.7    495.1    494.4
QI 493.7    493.0    492.5    491.8    491.1    490.5    489.9    489.3    488.6    488.1
KK    PMP  NOVEMBER TO FEBRUARY PMP
KO      0        0
BA    104
IN     15  6MAY07     1800
PB   9.78
PI 0.008    0.008    0.008    0.008    0.008    0.009    0.009    0.009    0.009    0.009
PI 0.009    0.009    0.009    0.009    0.009    0.009    0.009    0.009    0.010    0.010
PI 0.010    0.010    0.010    0.010    0.010    0.011    0.011    0.011    0.011    0.011
```

```
PI 0.011    0.012    0.012    0.012    0.012    0.012    0.013    0.013    0.013    0.013
PI 0.014    0.014    0.014    0.014    0.015    0.015    0.015    0.015    0.016    0.017
PI 0.017    0.018    0.019    0.019    0.020    0.020    0.021    0.021    0.022    0.023
PI 0.023    0.024    0.024    0.025    0.025    0.026    0.026    0.026    0.027    0.027
PI 0.028    0.028    0.028    0.029    0.029    0.029    0.030    0.030    0.030    0.030
PI 0.031    0.031    0.031    0.031    0.031    0.032    0.032    0.032    0.032    0.032
PI 0.032    0.032    0.032    0.032    0.033    0.033    0.033    0.033    0.033    0.033
PI 0.033    0.033    0.033    0.034    0.034    0.034    0.035    0.035    0.036    0.036
PI 0.037    0.038    0.038    0.039    0.040    0.041    0.042    0.043    0.044    0.045
PI 0.046    0.047    0.048    0.049    0.050    0.052    0.053    0.054    0.056    0.057
PI 0.059    0.060    0.072    0.085    0.096    0.107    0.116    0.123    0.129    0.133
PI 0.136    0.138    0.138    0.526    0.138    0.138    0.137    0.135    0.131    0.126
PI 0.119    0.111    0.102    0.091    0.078    0.064    0.060    0.058    0.057    0.055
PI 0.054    0.052    0.051    0.050    0.049    0.047    0.046    0.045    0.044    0.043
PI 0.042    0.041    0.040    0.040    0.039    0.038    0.037    0.037    0.036    0.036
PI 0.035    0.035    0.034    0.034    0.034    0.033    0.033    0.033    0.033    0.033
PI 0.033    0.033    0.033    0.033    0.032    0.032    0.032    0.032    0.032    0.032
PI 0.032    0.032    0.032    0.031    0.031    0.031    0.031    0.030    0.030    0.030
PI 0.030    0.029    0.029    0.029    0.028    0.028    0.028    0.027    0.027    0.027
PI 0.026    0.026    0.025    0.025    0.024    0.024    0.023    0.023    0.022    0.022
PI 0.021    0.021    0.020    0.019    0.019    0.018    0.018    0.017    0.016    0.016
PI 0.015    0.015    0.015    0.014    0.014    0.014    0.014    0.013    0.013    0.013
PI 0.013    0.013    0.012    0.012    0.012    0.012    0.012    0.011    0.011    0.011
PI 0.011    0.011    0.010    0.010    0.010    0.010    0.010    0.010    0.010    0.010
PI 0.009    0.009    0.009    0.009    0.009    0.009    0.009    0.009    0.009    0.009
PI 0.009    0.009    0.009    0.008    0.008    0.008    0.008    0.008
LU      0    0.05
UI 0.032    46.01    424.7    647.7   1028.6   1495.6   2048.6   3142.5   4426.6   7570.1
UI9667.3   7864.0   6473.9   5371.7   4704.0   4058.7   3754.3   3386.7   3140.5   2955.5
UI2771.6   2594.9   2453.1   2298.1   2204.5   2104.0   1994.0   1922.1   1847.2   1778.1
UI1678.9   1595.3   1523.0   1450.2   1385.3   1324.4   1266.2   1206.9   1154.5   1103.2
UI1051.8   1009.4    974.3    932.8    895.6    859.0    826.0    793.0    759.7    728.9
UI 699.4    673.5    644.4    618.8    594.6    570.7    547.3    525.2    506.6    484.9
UI 467.3    446.5    429.1    411.7    396.7    378.6    364.2    349.5    334.6    322.4
UI 311.7    297.3    286.5    275.4    264.4    253.5    242.2    234.6    224.0    215.9
UI 205.9    199.0    191.6    184.3    176.9    169.7    162.0    156.9    150.6    146.3
UI 139.2    132.4    129.2    123.6    118.2    114.8    111.1    107.1    100.2    96.99
UI 93.23    89.55    85.94    82.41    82.04    77.96    74.52    70.41    69.87    66.57
UI 63.34    62.81    58.33    57.29    54.42    54.00    50.64    50.08    47.49    45.83
UI 44.12    44.63    41.19    40.81    37.64    38.47    35.88    34.71    34.94    31.52
UI 31.76    31.99    29.79    28.30    28.71    25.26    25.46    25.28    25.71    23.11
UI 22.04    22.19    18.90    18.20    15.51    15.93    15.85    15.86    15.84    16.03
UI 14.61    12.40    12.72    12.72    12.75    11.22    0.032
KK  FLOW
KM  COMBINE BALANCED HYD AND PMP
HC      2
ZZ
```

November - February General Storm PMF

```
ID   WYMER DAM
ID   GENERAL STORM
ID   NOVEMBER TO FEBRUARY
IT     30  1DEC07    0000      720
IO      3
VS   FLOW
VV      2
KK    BAL   100YR BALANCED HYDROGRAPH
KO      0        0
BA    104
IN     60  1DEC07    0000
QI 488.6    489.2    489.9    490.5    491.1    491.7    492.4    493.0    493.6    494.3
QI 494.9    495.6    496.2    496.9    497.6    498.2    498.9    499.6    500.3    501.0
QI 501.7    502.3    503.0    503.7    504.4    505.0    505.8    506.5    507.2    507.9
QI 508.6    509.4    510.1    510.9    511.6    512.3    513.1    513.8    514.5    515.3
QI 516.0    516.8    517.5    518.3    519.1    519.8    520.7    521.4    522.2    523.0
QI 523.8    524.6    525.4    526.2    526.9    527.8    528.6    529.5    530.1    531.1
QI 531.9    532.7    533.5    534.4    535.3    536.0    536.9    537.8    538.5    539.4
QI 540.2    541.2    541.9    542.8    543.8    544.6    545.5    546.3    547.3    548.2
QI 549.0    549.9    550.9    551.7    552.7    553.5    554.4    555.4    556.3    557.2
QI 558.2    559.1    560.1    560.9    561.9    562.8    568.9    574.8    577.7    579.0
QI 580.8    583.2    585.7    588.5    591.0    593.9    596.8    599.9    602.7    605.6
QI 608.3    610.9    613.3    615.5    617.9    619.8    621.6    623.2    624.7    625.7
QI 626.1    626.5    626.9    627.1    627.4    627.6    627.8    628.0    628.0    629.1
QI 630.4    631.7    632.9    634.4    635.6    636.9    638.1    639.6    640.7    641.8
QI 643.2    644.3    645.5    646.8    647.9    649.2    650.2    651.3    652.4    653.5
QI 654.3    655.4    656.5    657.5    661.0    664.6    668.0    670.9    673.9    676.3
QI 678.6    680.2    681.7    682.8    683.5    683.7    721.4    769.8    820.4    867.9
QI 912.2    953.3    991.3   1026.1   1057.7   1086.2   1111.5   1133.6   1152.5   1589.0
QI1154.7   1136.1   1114.4   1089.5   1061.4   1030.2    995.8    958.2    917.5    873.6
QI 826.5    776.3    727.0    684.8    683.5    682.9    681.9    680.4    678.8    676.6
QI 674.4    671.3    668.3    665.1    661.5    657.6    656.5    655.5    654.5    653.5
QI 652.6    651.4    650.3    649.3    648.1    646.9    645.7    644.5    643.3    642.1
QI 640.8    639.6    638.3    637.1    635.9    634.5    633.2    631.9    630.6    629.3
QI 628.1    628.0    627.8    627.7    627.5    627.2    626.9    626.5    626.2    625.9
QI 624.8    623.5    621.9    620.0    618.1    615.9    613.7    611.0    608.4    605.8
QI 603.2    600.1    597.4    594.5    591.6    588.6    585.9    583.3    581.2    579.1
QI 577.8    575.6    569.6    563.3    562.1    561.1    560.1    559.2    558.3    557.4
QI 556.5    555.5    554.6    553.7    552.7    551.9    550.9    550.1    549.2    548.3
QI 547.4    546.6    545.6    544.7    543.9    543.0    542.2    541.2    540.5    539.5
QI 538.7    537.8    536.9    536.2    535.3    534.4    533.6    532.8    532.0    531.1
QI 530.4    529.5    528.7    527.9    527.1    526.2    525.4    524.7    523.9    523.1
QI 522.3    521.5    520.8    520.0    519.2    518.5    517.7    516.9    516.2    515.4
QI 514.7    513.9    513.1    512.4    511.6    510.9    510.3    509.5    508.8    508.0
QI 507.4    506.6    505.9    505.3    504.5    503.8    503.1    502.4    501.7    501.0
QI 500.3    499.6    499.1    498.4    497.7    496.9    496.4    495.7    495.1    494.4
QI 493.7    493.0    492.5    491.8    491.1    490.5    489.9    489.3    488.6    488.1
KK    PMP  NOVEMBER TO FEBRUARY PMP
KO      0        0
BA    104
IN     15  6DEC07    1800
PB12.236
PI 0.011    0.011    0.011    0.011    0.011    0.011    0.011    0.011    0.011    0.011
PI 0.011    0.011    0.011    0.011    0.012    0.012    0.012    0.012    0.012    0.012
PI 0.012    0.013    0.013    0.013    0.013    0.013    0.014    0.014    0.014    0.014
PI 0.014    0.015    0.015    0.015    0.015    0.016    0.016    0.016    0.016    0.017
PI 0.017    0.017    0.018    0.018    0.018    0.019    0.019    0.019    0.020    0.021
PI 0.022    0.022    0.023    0.024    0.025    0.026    0.026    0.027    0.028    0.028
PI 0.029    0.030    0.030    0.031    0.031    0.032    0.032    0.033    0.033    0.034
PI 0.034    0.035    0.035    0.036    0.036    0.037    0.037    0.037    0.038    0.038
PI 0.038    0.038    0.039    0.039    0.039    0.039    0.040    0.040    0.040    0.040
PI 0.040    0.040    0.040    0.041    0.041    0.041    0.041    0.041    0.041    0.041
```

```
PI 0.041    0.041    0.042    0.042    0.042    0.043    0.043    0.044    0.045    0.045
PI 0.046    0.047    0.048    0.049    0.050    0.051    0.052    0.053    0.054    0.056
PI 0.057    0.058    0.060    0.061    0.063    0.064    0.066    0.068    0.070    0.072
PI 0.073    0.075    0.090    0.106    0.121    0.134    0.145    0.154    0.162    0.168
PI 0.171    0.173    0.173    0.650    0.173    0.173    0.172    0.170    0.165    0.158
PI 0.150    0.140    0.128    0.114    0.098    0.081    0.074    0.072    0.071    0.069
PI 0.067    0.065    0.064    0.062    0.061    0.059    0.058    0.056    0.055    0.054
PI 0.052    0.051    0.050    0.049    0.048    0.047    0.047    0.046    0.045    0.044
PI 0.044    0.043    0.043    0.042    0.042    0.041    0.041    0.041    0.041    0.041
PI 0.041    0.041    0.041    0.041    0.041    0.040    0.040    0.040    0.040    0.040
PI 0.040    0.040    0.039    0.039    0.039    0.039    0.038    0.038    0.038    0.037
PI 0.037    0.037    0.036    0.036    0.036    0.035    0.035    0.034    0.034    0.033
PI 0.033    0.032    0.032    0.031    0.030    0.030    0.029    0.029    0.028    0.027
PI 0.027    0.026    0.025    0.024    0.024    0.023    0.022    0.021    0.020    0.020
PI 0.019    0.019    0.018    0.018    0.018    0.017    0.017    0.017    0.017    0.016
PI 0.016    0.016    0.015    0.015    0.015    0.015    0.015    0.014    0.014    0.014
PI 0.014    0.013    0.013    0.013    0.013    0.013    0.013    0.012    0.012    0.012
PI 0.012    0.012    0.012    0.012    0.011    0.011    0.011    0.011    0.011    0.011
PI 0.011    0.011    0.011    0.011    0.011    0.011    0.011    0.011
LU     0     0.05
UI 0.032    46.01    424.7    647.7   1028.6   1495.6   2048.6   3142.5   4426.6   7570.1
UI9667.3   7864.0   6473.9   5371.7   4704.0   4058.7   3754.3   3386.7   3140.5   2955.5
UI2771.6   2594.9   2453.1   2298.1   2204.5   2104.0   1994.0   1922.1   1847.2   1778.1
UI1678.9   1595.3   1523.0   1450.2   1385.3   1324.4   1266.2   1206.9   1154.5   1103.2
UI1051.8   1009.4    974.3    932.8    895.6    859.0    826.0    793.0    759.7    728.9
UI 699.4    673.5    644.4    618.8    594.6    570.7    547.3    525.2    506.6    484.9
UI 467.3    446.5    429.1    411.7    396.7    378.6    364.2    349.5    334.6    322.4
UI 311.7    297.3    286.5    275.4    264.4    253.5    242.2    234.6    224.0    215.9
UI 205.9    199.0    191.6    184.3    176.9    169.7    162.0    156.9    150.6    146.3
UI 139.2    132.4    129.2    123.6    118.2    114.8    111.1    107.1    100.2    96.99
UI 93.23    89.55    85.94    82.41    82.04    77.96    74.52    70.41    69.87    66.57
UI 63.34    62.81    58.33    57.29    54.42    54.00    50.64    50.08    47.49    45.83
UI 44.12    44.63    41.19    40.81    37.64    38.47    35.88    34.71    34.94    31.52
UI 31.76    31.99    29.79    28.30    28.71    25.26    25.46    25.28    25.71    23.11
UI 22.04    22.19    18.90    18.20    15.51    15.93    15.85    15.86    15.84    16.03
UI 14.61    12.40    12.72    12.72    12.75    11.22    0.032
KK   FLOW
KM   COMBINE BALANCED HYD AND PMP
HC      2
ZZ
```

Local Storm PMF

```
ID   WYMER DAM
ID   LOCAL STORM
ID   PRECEEDED 3 DAYS BY 100YR FLOOD
IT     15  1JUN07     0000      400
IO      3
VS   FLOW
VV      2
KK    ANT   100YR ANTECEDENT HYDROGRAPH
KO      0         0
BA    104
IN     15   1JUN07     0000
PB   1.59
PI 0.265    0.265    0.265    0.265    0.265    0.265    0.265    0.265    0.265    0.265
PI 0.265    0.265    0.265    0.265    0.265    0.265    0.265    0.265    0.265    0.265
PI 0.265    0.265    0.265    0.265
LU      0     0.15
UI 0.008    214.7    730.7   1703.2   3020.7     4796     6951     8967    11402    13472
UI 14718    15938    16281    16151    15574    14591    13569    12372    10989   9784.3
UI8702.3   7810.5   6879.5   6120.3   5472.1   4859.6   4328.1   3843.6   3356.9   2966.8
UI2631.5   2290.4   2024.2   1785.2   1611.1   1424.9   1266.7   1124.1   1010.3    890.5
UI 794.3    715.8    634.1    559.9    502.4    444.3    391.4    355.6    314.2    282.7
UI 249.4    225.3    197.6    176.4    154.1    140.0    127.0    110.3    100.0    85.00
UI 70.30    59.52    48.74    37.88    27.26    15.83    13.94     2.09    0.008
KK    PMP   LOCAL STORM
KO      0         0
BA    104
IN     15   3JUN07     2300
PB   4.58
PI 0.016    0.019    0.024    0.026    0.028    0.029    0.029    0.040    0.087    0.155
PI 0.690    1.530    1.020    0.510    0.119    0.059    0.031    0.029    0.029    0.027
PI 0.025    0.023    0.019    0.016
LU      0      0.1
UI 0.113 1310.56    3038.6   5939.2    11813    25680    30087    21082    16056    13347
UI 11343    10161   9066.8   8120.7   7533.3   6930.8   6464.3   5880.2   5415.3   4976.5
UI4594.3   4224.8   3899.4   3605.4   3361.7   3123.0   2908.4   2696.8   2506.1   2331.1
UI2164.8   2013.0   1871.9   1743.3   1625.5   1510.5   1405.0   1302.3   1207.9   1132.3
UI1048.4    979.4    909.7    847.3    789.0    729.9    683.7    637.0    590.3    555.0
UI 520.0    473.7    448.9    416.7    393.8    357.0    334.8    311.8    294.9    275.7
UI 251.5    241.5    227.1    204.5    193.0    181.3    169.7    157.8    156.6    145.1
UI 137.2    123.3    119.6    113.4    106.8    103.5    89.96    90.37    81.02    80.14
UI 68.26    56.71    56.69    56.60    54.86    45.61    44.76    32.72    0.113
KK   BASE   2YR 5DAY BASEFLOW
KO      0         0
BA
IN   6000   1JUN07     0000
QI    450      450
KK   FLOW
KM   COMBINE ANTECEDANT AND PMP AND BASEFLOW
HC      3
ZZ
```

Wymer Dam, Washington

Probable Maximum Flood
Appraisal Level Study

Prepared by
David E. Sutley
Hydraulic Engineer

5/2/2007
Date

Kenneth L. Bullard

Peer reviewed by
Kenneth L. Bullard, P.E.
Hydraulic Engineer

5/2/2007
Date

APPENDIX C

Flood Routing Data

UNITED STATES BUREAU OF RECLAMATION
TECHNICAL SERVICE CENTER
FLOOD ROUTING FOR DAMS

FEATURE: WYMER DAM — DATE 04/19/2007
FLOOD: Ave. Daily inflow — TIME 08:41:19
TITLE: Reservoir Evacuation
DATA FILE: Evacutation.200cfsinflow.9.5ftus.8.5ftds.txt

FLOOD ROUTING SUMMARY
****

BEGINING HOUR OF ROUTING...................... 1.00
ENDING HOUR OF ROUTING......................... 2400.00
INITIAL RESERVOIR ELEVATION.................... 1730.00 FT
MINIMUM OR NORMAL POOL ELEV.................... 1375.00 FT
MAXIMUM RESERVOIR ELEVATION..... 1730.00 AT HOUR 1
MINIMUM RESERVOIR ELEVATION..... 1375.00 FT AT HOUR 960
INFLOW PEAK DISCHARGE........... 200 CFS AT HOUR 2400
MAXIMUM TOTAL OUTFLOW........... 3642 CFS AT HOUR 1
ELEVATION TOLERANCE............................ 0.01 FT
INFLOW HYDROGRAPH ADJUSTMENT FACTOR............ 1.00
IPC OPTIONS (1 TO 10)..........................3101100000

WATERWAY PARAMETERS
****

WATERWAY NO. 1 - Outlet Works
TYPE - Power Equation
COEFFICIENT.................................... 182.10
EXPONENT ON HEAD............................... 0.50
CREST ELEVATION................................ 1330.00 FT
MAXIMUM DISCHARGE.............. 3642 CFS AT HOUR 1

RESULTS		ROUTING RESULTS				DISCHARGE	
		***************				*****************	
TIME	DAYS	INFLOW	OUTFLOW	STORAGE	ELEVATION	WATERWAY 1	RATING CURVE
1.00		200	3642	169679	1730.00	3642	0
2.00		200	3641	169395	1729.79	3641	0
240.00		200	3363	104442	1671.14	3363	0
288.00		200	3293	92033	1656.98	3293	0
336.00		200	3216	79917	1641.82	3216	0
360.00	15	200	3174	73977	1633.77	3174	0
384.00		200	3130	68122	1625.36	3130	0
432.00		200	3032	56695	1607.20	3032	0
480.00		200	2917	45688	1586.66	2917	0
528.00		200	2781	35179	1563.18	2781	0
552.00		200	2702	30138	1550.21	2702	0
576.00	24	200	2615	25261	1536.25	2615	0
600.00		200	2517	20568	1521.09	2517	0
624.00	26	200	2402	16086	1504.05	2402	0
672.00		200	2092	7965	1461.94	2092	0
696.00	29	200	1855	4448	1433.74	1855	0
720.00		200	1487	1531	1396.68	1487	0
960.00		200	200	603	1375.00	0	0
1200.00		200	200	603	1375.00	0	0
1440.00		200	200	603	1375.00	0	0
1680.00		200	200	603	1375.00	0	0
1920.00		200	200	603	1375.00	0	0

UNITED STATES BUREAU OF RECLAMATION
TECHNICAL SERVICE CENTER

FLOOD ROUTING FOR DAMS

FEATURE: Wymer Dam 2007 Appraisal Study DATE 04/23/2007
FLOOD: Nov-Feb_PMF TIME 13:54:57
TITLE: General Storms - With OW
DATA FILE: WYO30GEN.dat

FLOOD ROUTING SUMMARY
****

BEGINING HOUR OF ROUTING...................... 161.00
ENDING HOUR OF ROUTING......................... 360.00
INITIAL RESERVOIR ELEVATION.................... 1730.00 FT
MINIMUM OR NORMAL POOL ELEV.................... 1730.00 FT
MAXIMUM RESERVOIR ELEVATION..... 1741.66 AT HOUR 193
MINIMUM RESERVOIR ELEVATION..... 1730.00 FT AT HOUR 249
INFLOW PEAK DISCHARGE........... 27509 CFS AT HOUR 180
MAXIMUM TOTAL OUTFLOW........... 12785 CFS AT HOUR 193
ELEVATION TOLERANCE............................ 0.01 FT
INFLOW HYDROGRAPH ADJUSTMENT FACTOR............. 1.00
IPC OPTIONS (1 TO 10)..........................3100100000

WATERWAY PARAMETERS
****

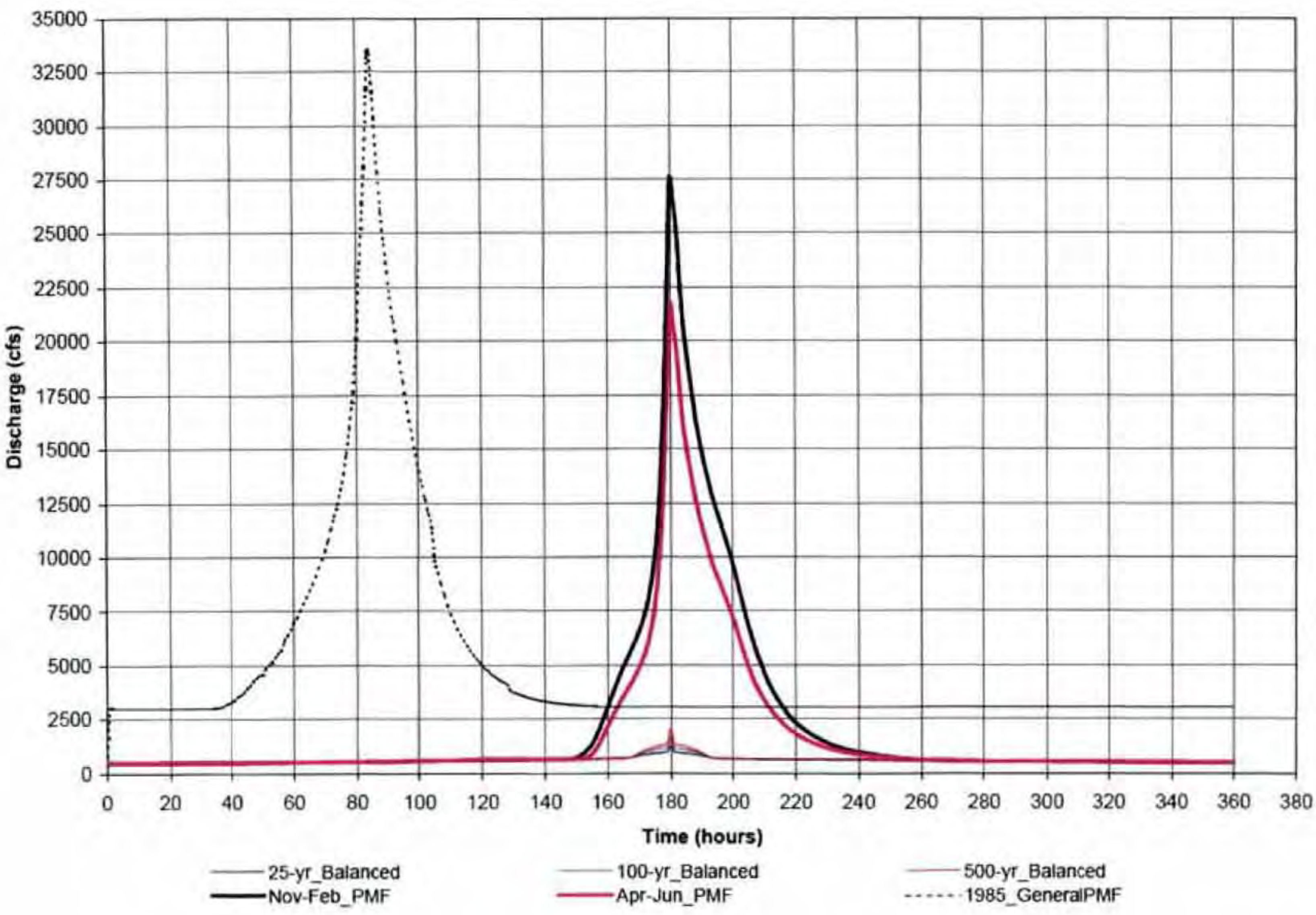
WATERWAY NO. 1 - Outlet Works (Fully Open)

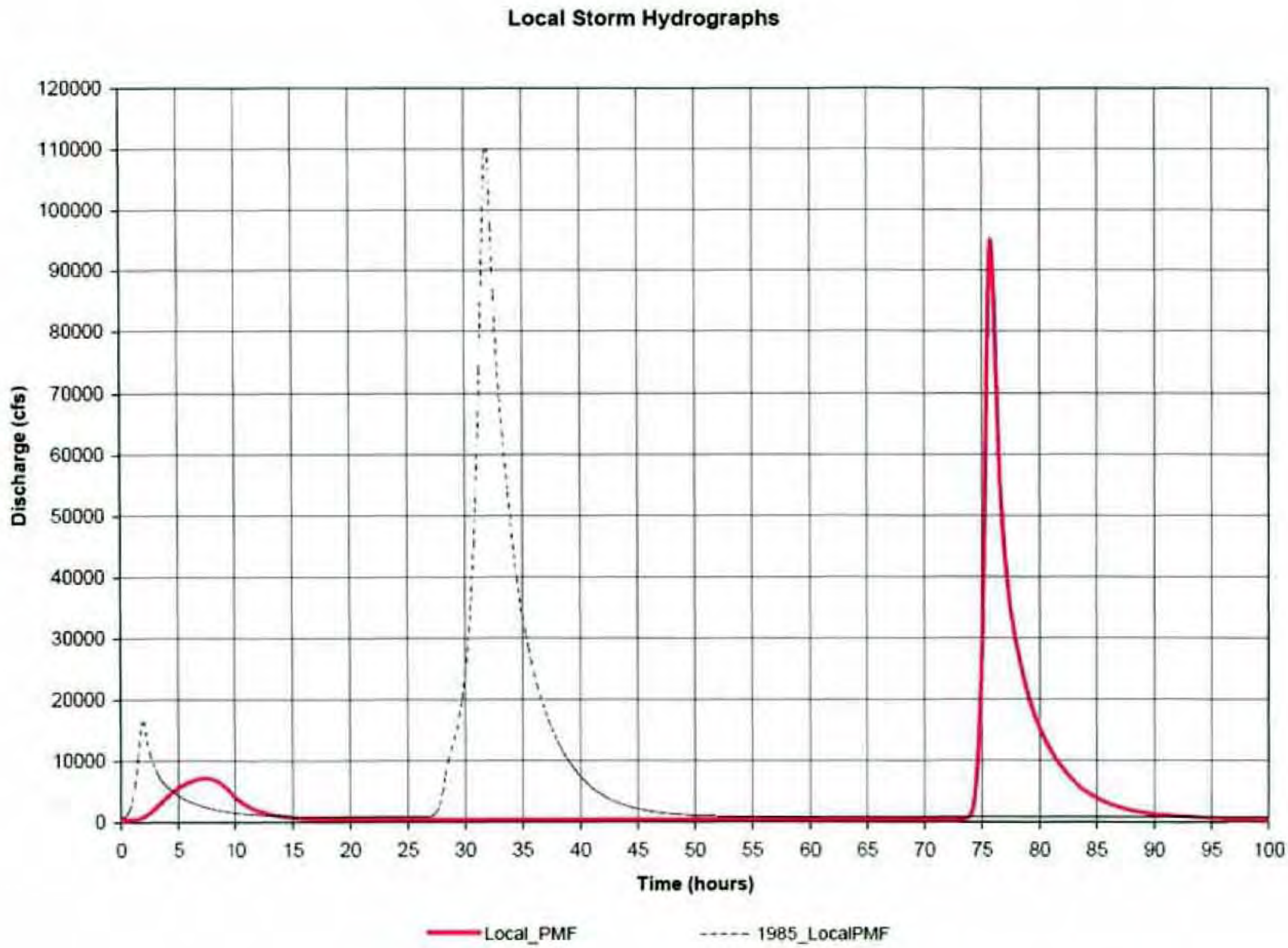
TYPE - Power Equation
COEFFICIENT.................................... 182.10
EXPONENT ON HEAD............................... 0.50
CREST ELEVATION................................ 1330.00 FT
MAXIMUM DISCHARGE............... 3695 CFS AT HOUR 193

WATERWAY NO. 2 - Spillway (Ogee Crest)

TYPE - Ogee Crest
COEFFICIENT IS COMPUTED BY FIG. 35 OF MONOGRAPH 9
DESIGN DISCHARGE COEFFICIENT (C0)............... 3.80
DESIGN HEAD (H0)............................... 11.70 FT
CREST ELEVATION................................ 1730.00 FT
CREST LENGTH................................... 60.00 FT
MAXIMUM DISCHARGE............... 9090 CFS AT HOUR 193

General Storm and Balanced Hydrographs





Local Storm Hydrographs
Discharge (cfs)
120000
110000
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Time (hours)
Local_PMF
1985_LocalPMF

Wymer Dam, Washington

Flood Routings
Appraisal Level Study

P.E.
Prepared by
Thomas Scobell, P.E.
Civil Engineer

8/16/07
Date

, P.E.
Peer Reviewed
Douglas Stanton, P.E.
Civil Engineer

8/16/07
Date

APPENDIX D

Field Cost Estimate

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Summary

Summary Sheet 1 of 1

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal

REGION PN | **PRICE LEVEL:** Apr-07

FILE: C:\Documents and Settings\jwzander\My Documents\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]River Intake(12)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Wymer Offstream Storage Facility consists of:					
		Fish-screened Intake on Yakima River, 400 cfs Pumping Plant and Switchyard,					
		Concrete-Faced Rockfill Dam, Crest El. 1750. Central Core Rockfill Dike, Crest EL. 1750.					
		Spillway and Outlet Works, Road (Access and I82) and Lmuma Creek Improvements					
		Yakima River Intake					$ 18,352,464.00
		Pumping Plant					$ 54,246,343.00
		Switchyard and Transmission Line					$ 6,070,102.00
		Discharge Line					$ 24,306,490.00
		Dam and Dike					$ 365,591,500.00
		Spillway and Outlet Works					$ 59,776,337.00
		Diversion during Construction					$ 4,414,450.00
		Road and Creek Improvements					$ 5,902,027.00
		Subtotal					$ 538,659,713.00
		Mobilization				+/- 5%	$ 27,000,000.00
		Subtotal w/ mobilization					$ 565,659,713.00
		Unlisted Items				+/- 10%	$ 54,340,287.00
		Procurement Strategy = (USC 638, TERO tax, etc)				+/- 0%	$ -
		CONTRACT COST					**$ 620,000,000.00**
		Contingencies				+/- 25%	$ 160,000,000.00
		FIELD COST					**$ 780,000,000.00**
		Note : Non-contract costs are to be provided by others. This estimate does not include non-contract costs.					
		This estimate should not be used for funding purposes.					
		Escalation for cost increases that will occur during the construction period and cost increases that may occur prior to the contract award are not included.					
		This estimate assumes a procurement strategy consisting of full and open competition.					

QUANTITIES		PRICES	
BY Design Team	**CHECKED**	**BY** JZ 6/4/2007 Jerry Zander	**CHECKED** [signature]
DATE PREPARED May 2, 2007	**PEER REVIEW**	**DATE PREPARED** June 4, 2007	**PEER REVIEW** [signature] 6/4/2007

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Yakima River Intake
Dewatering/Unwatering and Cofferdam

Geotechnical/Civil

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal

REGION PN | **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct/Remove Cofferdam around Intake					
		Max River WS: El. 1284					
		Bottom of River: El. 1272					
		Assumed Construction WS: El. 1280					
		Assumed top of Rock: ±El. 1260					
	1	Furnish, fill, install, and remove "Super Sacks"		1	LS	$ 82,000.00	$ 82,000.00
		- Use 540 sacks @ 3'x3'x3' = 540 cy of fill					
		- Place sacks with crane - 8 tons at 35ft reach					
		- Use fill from Intake excavation to fill sacks with minor					
		processing for 3"minus (run through "grizzly")					
	2	Furnish, install, and remove 40 mil PVC Geomembrane		600	SY	$ 15.00	$ 9,000.00
		- Use 20 ft long roll					
	3	Furnish, fill, and place Sand Bags		300	CF	$ 27.00	$ 8,100.00
		Placed by hand					
		Unwatering behind cofferdam					
		Furnish and install "french drains"					
	4	Gravel - (sand and/or gravel w/ less then 5% fines)		20	CY	$ 90.00	$ 1,800.00
	5	Slotted 6-in dia. PVC or HDPE		270	LF	$ 12.00	$ 3,240.00
		Sheet Subtotal =					**$ 104,140.00** ✓

QUANTITIES		PRICES	
BY Bob Davis	**CHECKED** Bill Engemoen	**BY** JZ Jerry Zander	**CHECKED** [signature]
DATE PREPARED April 30, 2007	**PEER REVIEW** Al Kiene	**DATE PREPARED** May 31, 2007	**PEER REVIEW** [signature]

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Yakima River Intake
Dewatering/Unwatering and Cofferdam

Geotechnical/Civil

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW **ESTIMATE LEVEL:** Appraisal

REGION PN **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\|Final Est - Wymer PP and Reservoir.xls}Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct/Remove Cofferdam around Intake Fish Return Structure					
		Max River WS: El. 1284					
		Bottom of River: El. 1272					
		Assumed Construction WS: El. 1280 (Q= cfs)					
		Assumed top of Rock: ±El. 1260					
	6	Furnish, fill, install, and remove "Super Sacks"		1	LS	$ 30,000.00	$ 30,000.00
		- Use 200 sacks @ 3'x3'x3' = 200 cy of fill					
		- Place sacks with crane - 8 tons at 35ft reach					
		- Use fill from pipeline excavation to fill sacks with minor					
		processing for 3"minus (run through "grizzly")					
	7	Furnish, install, and remove 40 mil PVC Geomembrane		225	SY	$ 15.00	$ 3,375.00
		- Use 20 ft long roll					
	8	Furnish, fill, and place Sand Bags		115	CF	$ 27.00	$ 3,105.00
		Unwatering behind cofferdam					
		Furnish and install "french drains"					
	9	Gravel - (sand and/or gravel w/ less then 5% fines)		8	CY	$ 90.00	$ 675.00
	10	Slotted 6-in dia. PVC or HDPE		100	LF	$ 12.00	$ 1,200.00
		Sheet Subtotal =					**$ 38,355.00** ✓

QUANTITIES		PRICES	
BY Bob Davis	**CHECKED** Bill Engemoen	**BY** Jerry Zander (initialed)	**CHECKED** (initialed)
DATE PREPARED April 30, 2007	**PEER REVIEW** Al Kiene	**DATE PREPARED** May 31, 2007	**PEER REVIEW** (signed)

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:	PROJECT:			
Wymer Offstream Storage Facility Yakima River Intake Dewatering/Unwatering and Cofferdam Geotechnical/Civil	Yakima River Basin Water Storage Study			
	WOID:	YRSSW	ESTIMATE LEVEL:	Appraisal
	REGION	PN	PRICE LEVEL:	Apr-07
	FILE:	J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Summary		

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Dewatering Intake and Pumping Plant					
		Max River WS: El. 1284					
		Bottom of River: El. 1272					
		Assumed Construction WS: El. 1280 (Q= cfs)					
		Assumed top of Rock: ±El. 1260					
		Assumed Ground WS: El. 1280 (same as river)					
	11	Wellpoints about Intake and PP structures		1	LS	$ 3,600,000.00	$ 3,600,000.00
		- Install and remove 340 wellpoints					
		- Operate well points approximately 9 months					
		- Do **not** assume well points are jetted.					
		- Each wellpoint installed by:					
		- Drilling borehole, 8" diameter 20-ft deep					
		- Backfill borehole with sand (place with sand casing)					
		- Install wellpoint using 1.5" steel riser pipe w/					
		self jetting wellpoint screen (2" dia typ)					
		- Wellpoints are placed at 6 ft centers 20 ft deep					
		- Assume excavation to El. 1280 before placement of wellpoints					
	12	Wellpoints behind cofferdam		1	LS	$ 700,000.00	$ 700,000.00
		- Install and remove 40 wellpoints					
		- Operate well points approximately 3 months					
		- Do **not** assume well points are jetted.					
		- Each wellpoint installed by:					
		- Drilling borehole, 8" diameter 12-ft deep					
		- Backfill borehole with sand (place with sand casing)					
		- Install wellpoint using 1.5" steel riser pipe w/					
		self jetting wellpoint screen (2" dia typ)					
		- Wellpoints are placed at 6 ft centers 12 ft deep					
		- Assume installation of cofferdam before placement of wellpoints					
		Sheet Subtotal =					**$ 4,300,000.00**

QUANTITIES		PRICES	
BY Bob Davis	CHECKED Bill Engemoen	BY Jerry Zander	CHECKED
DATE PREPARED April 30, 2007	PEER REVIEW Al Kiene	DATE PREPARED May 31, 2007	PEER REVIEW

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Yakima River Intake
Dewatering/Unwatering and Cofferdam

Geotechnical/Civil

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal

REGION: PN | **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Unwatering Intake and Pumping Plant					
		Max River WS: El. 1284					
		Bottom of River: El. 1272					
		Assumed Construction WS: El. 1280 (Q= cfs)					
		Assumed top of Rock: ±El. 1260					
		Assumed Ground WS: El. 1280 (same as river)					
		Unwatering at base of soil excavation					
		- Furnish, install, and remove (filter toe drain):					
	13	Sand/gravel filter material		715	CY	$ 71.00	$ 50,765.00
	14	Slotted pipe 6-in dia. PVC or HDPE		2,150	LF	$ 12.00	$ 25,800.00
	15	Wrap slotted pipe in non-woven filter fabric		475	SY	$ 6.00	$ 2,850.00
	16	- Furnish and operate sump pumps					
		- Operate 11 sump pumps for 9 months		1	LS	$ 750,000.00	$ 750,000.00
		- Each pump should have a 30 ft lift					
		and have a flow of about 4 gpm					
	17	Unwatering at base of rock excavation					
		- Furnish and operate sump pumps					
		- Operate 10 sump pumps for 9 months		1	LS	$ 820,000.00	$ 820,000.00
		- Each pump should have a 45 ft lift					
		and have a flow of about 5 gpm					
		- Operate 3 sump pumps for 9 months					
		- Each pump should have a 55 ft lift					
		and have a flow of about 5 gpm					
	18	Unwatering about fish return pipeline					
		- Furnish and operate sump pumps					
		- Operate 3 sump pumps for 2 months		1	LS	$ 110,000.00	$ 110,000.00
		- Each pump should have a 12 ft lift					
		and have a flow of about 5 gpm					
		Sheet Subtotal =					**$ 1,759,415.00**

QUANTITIES		PRICES	
BY Bob Davis	**CHECKED** Bill Engemoen	**BY** Jerry Zander	**CHECKED**
DATE PREPARED April 30, 2007	**PEER REVIEW** Al Kiene	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Yakima River Intake

Civil/Structural

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW **ESTIMATE LEVEL:** Appraisal

REGION PN **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Structural Excavation and Backfill					
		Excavation and backfill quantities are to existing ground level.					
		Excavation and backfill above existing ground level covered under PP yard.					
		Assume top of rock is at El.					
		Assume stockpile excavated material and use for backfill or embankment.					
	19	Excavation of common materials for structures (2:1)	8140	24,400	CY	$ 9.00	$ 219,600.00
	20	Excavation of rock for structures (drill & shoot) (1/2:1)	8140	2,060	CY	$ 60.00	$ 123,600.00
	21	Furnish backfill for structures (assume local borrow)	8140	13,715	CY	$0.00	$ -
	22	Place backfill around structures	8140	13,715	CY	$ 15.00	$ 205,725.00
	23	Compact backfill around structures	8140	13,715	CY	$ 17.00	$ 233,155.00
		STRUCTURAL					
		Construct Gated Intake and Fishscreen Structure					
	24	Furnish, form, and place reinforced concrete (f'c=4ksi)	8140	2,950	CY	$ 1,100.00	$ 3,245,000.00
	25	Furnish and place concrete reinforcement.	8140	353,860	LBS	$ 1.50	$ 530,790.00
	26	Furnish and handle cement	8140	840	TONS	$ 150.00	$ 126,000.00
	27	W-Beam guardrails	8140	40	LF	$ 80.00	$ 3,200.00
		Construct Intake Structure Retaining Walls					
	28	Furnish, form, and place reinforced concrete (f'c=4ksi)	8140	203	CY	$ 2,000.00	$ 406,000.00
	29	Furnish and place concrete reinforcement.	8140	24,300	LBS	$ 1.65	$ 40,095.00
	30	Furnish and handle cement	8140	58	TONS	$ 180.00	$ 10,440.00
		Construct Sump for Fish Pumps and Bypass					
	31	Furnish, form, and place reinforced concrete (f'c=4ksi)	8140	1,040	CY	$ 1,300.00	$ 1,352,000.00
	32	Furnish and place concrete reinforcement.	8140	124,620	LBS	$ 1.55	$ 193,161.00
	33	Furnish and handle cement	8140	295	TONS	$ 160.00	$ 47,200.00
		Sheet Subtotal =					$ 6,735,966.00

QUANTITIES		PRICES	
BY Joe Gemperline	**CHECKED** Chou Cha / Dave Gesundheit	**BY** J.erry Zander	**CHECKED**
DATE PREPARED 5/1/2007	**PEER REVIEW** David K. Edwards	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Yakima River Intake

Civil/Structural

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal

REGION PN | **PRICE LEVEL:** Apr-07

FILE: C:\Documents and Settings\jwzander\My Documents\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]River Intake(12)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Earthwork for Fish Bypass Pipe					
		Price Alternative 2. Alternative 1 for reference only.					
		Alternative 1 Prices not included in sheet total					
		Alternative 1 - Payline Quantities - Vertical Trench Walls					
		Bypass pipe common excavation	8140	580	CY		
		Bypass pipe backfill	8140	310	CY		
		Bypass pipe soil cement bedding (100 psi)	8140	175	CY		
		(Soil Cement Slurry CLSM)					
		Alternative 2 - Takeoff Quantities - 2:1 Trench Walls					
	34	Bypass pipe common excavation	8140	1,600	CY	$ 17.00	$ 27,200.00
	35	Bypass pipe backfill	8140	1,180	CY	$ 24.50	$ 28,910.00
	36	Bypass pipe soil cement bedding (100 psi)	8140	330	CY	$ 190.00	$ 62,700.00
		(Soil Cement Slurry CLSM)					
		Notes:					
		Clearing and grubbing by other group	8120				
		Fencing by other group	8120				
		People guardrail by other group	8120				
		Gravel surfacing by other group	8120				
		Yard earthwork by other group	8120				
		Coffer Dam and Dewatering by other group	8312				
		Sheet Subtotal =					$ 118,810.00

QUANTITIES		PRICES	
BY: Joe Gemperline	CHECKED: Chou Cha / Dave Gesundheit	BY: Jerry Zander	CHECKED
DATE PREPARED: 5/1/2007	PEER REVIEW: David K. Edwards	DATE PREPARED: June 4, 2007	PEER REVIEW

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Yakima River Intake

Structural

PROJECT: Yakima River Basin Water Storage Study

WOID:	YRSSW	**ESTIMATE LEVEL:**	Appraisal
REGION	PN	**PRICE LEVEL:**	Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Structural Steel					
	37	Furnish and install structural steel (painted):	8120	2,000	LBS	$ 5.00	$ 10,000.00
		3-Ton Hoist monorail beam and frames					
	38	**Miscellaneous Metalwork**	8120	8,000	LBS	$ 10.00	$ 80,000.00
		3' wide walkway, steel, safety grating along fish screens					
		75-ft ea side with support frames at 11-ft centers					
		Gripstrut panels @ 23.5 lbs/ft					
		Guardrail					
		Ladders and landings into Intake					
		Control Building					
	39	Pre-engineered metal building - 15 ft. eave height	8120	1	EA	$ 62,000.00	$ 62,000.00
		3:12 roof pitch, 20' long x 20' wide					
	40	Furnish, form, and place reinforced concrete (f'c=4ksi)	8120	18	CY	$ 1,000.00	$ 18,000.00
		Assume 1-ft x 22-ft x 22-ft base slab					
	41	Furnish and place concrete reinforcement. (135 lbs/CY)	8120	2,500	LBS	$ 1.80	$ 4,500.00
	42	Furnish and handle cement (.282T/CY)	8120	5	TONS	$ 210.00	$ 1,050.00
		Sheet Subtotal =					**$ 175,550.00**

QUANTITIES		PRICES	
BY Dick LaFond	**CHECKED** Brian Goplen	**BY** Jerry Zander	**CHECKED**
DATE PREPARED May 1, 2007	**PEER REVIEW** Brian Goplen	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Yakima River Intake

Mechanical

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW **ESTIMATE LEVEL:** Appraisal

REGION PN **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical					
	43	Ventilating System for Fish Pump	8410	1	L.S.	$ 3,000.00	$ 3,000.00
		Electrical Equipment Control Building:					
		Consists of:					
		1 - Centrifugal fan; 500 cfm					
		1 - Backdraft damper; 24-inch by 24-inch					
		1 - Intake counterbalance damper; 24-inch by 24-inch					
		2 - 24-inch by 24-inch stationary louver					
	44	One (3) ton capacity, electric, wirerope, monorail hoist	8410	1	L.S.	$ 6,000.00	$ 6,000.00
		with manual trolley for intake structure stop logs					
		(hoist only; hoist beam provided by 8120)					
	45	Stoplog guides and seats (steel)	8410	2,800	LBS	$ 11.00	$ 30,800.00
	46	Stoplog lifting beam (steel)	8410	1,000	LBS	$ 4.50	$ 4,500.00
	47	Stoplogs (steel)	8410	13,600	LBS	$ 4.00	$ 54,400.00
	48	Trashracks and seats (steel)	8410	20,400	LBS	$ 8.00	$ 163,200.00
	49	One trash rake, rails, supports	8410	11,000	LBS	$ 10.00	$ 110,000.00
		(assume Atlas Polar DT8300 rake)					
	50	One conveyor (steel)	8410	5,000	LBS	$ 10.50	$ 52,500.00
	51	Fish screen guides, support structure, braces	8410				
		embedded seats, blank panel, and bypass walls					
		Structural steel		105,000	LBS	$ 8.00	$ 840,000.00
		(Does not include walkway, see 8120)					
		Sheet Subtotal =					**$ 1,264,400.00** ✓

QUANTITIES		PRICES	
BY: J. Grass / P. Schlein R. Christensen	**CHECKED** Rick Christensen	**BY** JZ Jerry Zander	**CHECKED** [signature]
DATE PREPARED: 4/28/07	**PEER REVIEW** Dave Hulse	**DATE PREPARED** May 31, 2007	**PEER REVIEW** DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE: Wymer Offstream Storage Facility Yakima River Intake Mechanical	**PROJECT:** Yakima River Basin Water Storage Study
	WOID: YRSSW — **ESTIMATE LEVEL:** Appraisal
	REGION PN — **PRICE LEVEL:** Apr-07
	FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical					
	52	Fish screens 11' W x11' H panels, 10 + 2 spares	8410				
		Stainless steel		14,600	LBS	$ 25.00	$ 365,000.00
		Structural steel		14,600	LBS	$ 8.00	$ 116,800.00
	53	Barrier panels above fish screens, 11' W x 11' H	8410				
		10 + 2 spares					
		Structural steel		36,300	LBS	$ 5.00	$ 181,500.00
	54	Adjustable baffle panels, 10 bays	8410				
		Structural steel		60,500	LBS	$ 5.00	$ 302,500.00
	55	Fish screen cleaner with travel rail, 2 systems with	8410				
		one brush cleaner arm per system					
		a. Structural steel		8,200	LBS	$ 6.00	$ 49,200.00
		b. Stainless steel		1,000	LBS	$ 25.00	$ 25,000.00
		c. 2 Hp motors/gear reducers, with adj. speed		2	UNITS	$ 10,000.00	$ 20,000.00
		controllers and limit switches					
	56	Water level measuring systems	8410				
		Sensors/transducers		6	UNITS	$ 5,000.00	$ 30,000.00
		Receivers/transmitters		2	UNITS	$ 10,000.00	$ 20,000.00
		6" Dia. FRP pipe stilling wells		120	FT	$ 40.00	$ 4,800.00
		Sheet Subtotal =					**$ 1,114,800.00**

QUANTITIES		PRICES	
BY: R. Christensen	**CHECKED** John Grass	**BY** Jerry Zander (initialed)	**CHECKED** (signed)
DATE PREPARED: 4/28/07	**PEER REVIEW** Dave Hulse	**DATE PREPARED** May 31, 2007	**PEER REVIEW** (signed)

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Wymer Offstream Storage Facility Yakima River Intake Mechanical	Yakima River Basin Water Storage Study WOID: YRSSW — ESTIMATE LEVEL: Appraisal REGION: PN — PRICE LEVEL: Apr-07 FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Est Notes - A

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Pumping Units for Fish Bypass	8420				
		Furnish and Install:					
		Two - Wemco Hidrostal Model N36A screw					
		centrifugal fish pumps w/ shrouded s.st.					
		impellers, s.st. casings and s.st. pump					
		shafts, right-angle gear drives, 60 cfs @ 14' TDH,					
		150 hp, TEFC, vertical induction motors, and					
		vertical shafting with couplings					
		- Government to witness pump shop test					
		- Field testing with on-site pump mfr's rep.					
	57	a. stainless steel shrouded pump impellers,		22,000	LBS	$ 80.00	$ 1,760,000.00
		casings, and shafts					
	58	b. right-angle gear reducers (4:1)		2,200	LBS	$ 57.00	$ 125,400.00
	59	c. "Premium Efficiency" vertical induction		6,300	LBS	$ 21.00	$ 132,300.00
		motors, inverter-duty rated, TEFC, hollow					
		shaft, 150 hp, 1200 rpm, 3Ph/60Hz/460 V					
	60	d. vertical shafting (30') and couplings		2,800	LBS	$ 16.00	$ 44,800.00
	61	e. common pump/gear reducer baseplate		14,300	LBS	$ 5.00	$ 71,500.00
		(11.25 ft x 9.25 ft)					
		Variable Frequency Drives					
		(on 8430 qty. est. worksheet)					
		Sheet Subtotal =					**$ 2,134,000.00** ✓

QUANTITIES		PRICES	
BY: R. Zelenka	CHECKED: T. Hummel 4/24/07	BY: Jerry Zander (initials)	CHECKED: (signature)
DATE PREPARED: April 23, 2007	PEER REVIEW: T. Hummel 4/24/07	DATE PREPARED: May 31, 2007	PEER REVIEW: (signature)

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Yakima River Intake

Civil/Structural

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal

REGION PN | **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical					
		Steel Pipe for Fish Bypass	8420				
	62	36" ID X 1/4" wall steel pipe					
		233 lin. Ft. @ 96 lbs. per lin. Ft. (22368 lbs.)		233	LF	$ 384.00	$ 89,472.00
	63	30" ID X 1/4" wall steel pipe					
		524 lin. Ft. @ 80 lbs. per lin. Ft. (41920 lbs.)		524	LF	$ 320.00	$ 167,680.00
		Flanges					
	64	8 - 36" AWWA Class D flanges		2,144	lbs	$ 4.00	$ 8,576.00
		Rectangular Pipe and Transition (Bypass Inlet)	8420				
	65	All welded steel plates		35,000	lbs	$ 4.00	$ 140,000.00
		Valves for Fish Bypass	8420				
	66	2 - 36" Manually Operated Knifegate Valves					
		2500 lbs per valve		5,000	lbs	$ 11.00	$ 55,000.00
		Sheet Subtotal =					**$ 460,728.00**

QUANTITIES		PRICES	
BY Rick Frisz	**CHECKED** Ken Smith	**BY** Jerry Zander	**CHECKED**
DATE PREPARED 4-30-07	**PEER REVIEW**	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Yakima River Intake

Electrical

PROJECT: Yakima River Basin Water Storage Study

WOID:	YRSSW	**ESTIMATE LEVEL:**	Appraisal
REGION	PN	**PRICE LEVEL:**	Apr-07

FILE: C:\Documents and Settings\jwzander\My Documents\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Pumping Plant(12)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		ELECTRICAL					
		Service Equipment (F&I)	8430				
	67	Distribution panelboard, indoor type		1	EA	$ 11,000.00	$ 11,000.00
		480 volts, 3-phase with 225 ampere bus					
	68	Transformer load center		1	EA	$ 8,300.00	$ 8,300.00
		15 kVA, 1-phase, 480-240/120 volt					
		Combination Motor Starters (F&I)	8430				
	69	NEMA size 2 reversing contactor, 480V, 3-phase		2	EA	$ 5,000.00	$ 10,000.00
		480-120 volt control transformer					
		NEMA type 4 enclosure					
		Adjustable Speed Drives (F&I)	8430				
	70	480 volt, 3-phase, 200 ampere		2	EA	$ 55,000.00	$ 110,000.00
		Lighting System (F&I)	8430				
	71	120 volt, fluorescent fixtures for 10' x 10' bldg		1	LS	$ 7,000.00	$ 7,000.00
		Sheet Subtotal =					**$ 146,300.00**

QUANTITIES		PRICES	
BY Mike Schuh	**CHECKED** [signature]	**BY** Jerry Zander [initials]	**CHECKED** [signature]
DATE PREPARED April 25, 2007	**PEER REVIEW** George Girgis [signature]	**DATE PREPARED** May 29, 2007	**PEER REVIEW** [initials]

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Yakima River Pumping Plant

Civil/Structural

PROJECT: Yakima River Basin Water Storage Study

WOID:	YRSSW	**ESTIMATE LEVEL:**	Appraisal
REGION	PN	**PRICE LEVEL:**	Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		CIVIL	8120				
		HP Pumping Plant Yard= El. 1287					
		Site excavation for intake structure included in yard quantity.					
		Service Yard and Access Road					
	1	Stripping (remove and dispose 6" of topsoil)		34,500	SY	$ 5.00	$ 172,500.00
	2	Common excavation to Service Yard El. 1287		16,530	CY	$ 7.00	$ 115,710.00
	3	Place and compact embankment for service yard		18,500	CY	$ 10.00	$ 185,000.00
	4	Furnish and place 6-inch thick gravel surfacing		19,000	SY	$ 8.00	$ 152,000.00
	5	Furnish and place base course material - 6" thick		1,930	TONS	$ 30.00	$ 57,900.00
	6	Furnish and place bituminous Pavement - 3" thick		1,035	TONS	$ 95.00	$ 98,325.00
	7	Furnish and install 7-foot chain link fence for service yard		2,145	LF	$ 25.00	$ 53,625.00
	8	Furnish and install 7-foot x 24-foot access gate		1	EA	$ 4,400.00	$ 4,400.00
		Dewatering During Construction:					
		Included in quantities under River Intake.					
		Structural Excavation and Backfill					
		Assume top of rock= El. 1262.0					
		Assume stockpile rock for later use as riprap or rockfill.					
	9	Excavation of common materials for structures		79,900	CY	$ 7.00	$ 559,300.00
	10	Excavation of rock for structures (drill & shoot)		23,800	CY	$ 30.00	$ 714,000.00
	11	Furnish backfill for structures (assume local borrow, include in #12)		63,200	CY	$ -	$ -
	12	Place backfill around structures		63,200	CY	$ 4.00	$ 252,800.00
	13	Compact backfill around structures		63,200	CY	$ 3.60	$ 227,520.00
	14	Furnish & place embedment material for manifold pipe trench (CLSM)		485	CY	$ 100.00	$ 48,500.00
		Sheet Subtotal =					**$ 2,641,580.00** ✓

QUANTITIES		PRICES	
BY Brian Goplen	**CHECKED** John Pattie	**BY** Jerry Zander (initialed)	**CHECKED** (signed)
DATE PREPARED April 26, 2007	**PEER REVIEW** Dick LaFond	**DATE PREPARED** May 31, 2007	**PEER REVIEW** (signed)

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Yakima River Pumping Plant

Civil/Structural

PROJECT:

Yakima River Basin Water Storage Study

WOID:	YRSSW	**ESTIMATE LEVEL:**	Appraisal
REGION	PN	**PRICE LEVEL:**	Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		STRUCTURAL	8120				
		Concrete for Structures					
		Includes: Pumping Plant Structure = 13,000 CY					
		Air Chamber Foundation = 1800 CY					
		Flow Meter Vault = 240 CY					
		Miscellaneous Slabs = 10 CY					
	15	Furnish, form, and place reinforced concrete		15,050	CY	$ 790.00	$ 11,889,500.00
	16	Furnish and place concrete reinforcement.		1,956,500	LBS	$ 1.40	$ 2,739,100.00
		Assume 130 #/CY					
	17	Furnish and handle cement (.282T/CY)		4,244	TONS	$ 130.00	$ 551,720.00
	18	Furnish and install 6" PVC Waterstop		8,000	LF	$ 9.00	$ 72,000.00
		Structural Steel					
	19	Furnish and install structural steel (painted):					
		Superstructure roof trusses and crane girders		328,000	LBS	$ 5.00	$ 1,640,000.00
		Miscellaneous Metalwork					
	20	Furnish and install miscellaneous metalwork		73,000	LBS	$ 10.00	$ 730,000.00
	21	Pre-engineered metal stairs		26,000	LBS	$ 9.00	$ 234,000.00
	22	Roof Hatches: Bilco Type 8'x14' Type D Double leaf insul alum.		1	EA	$ 17,000.00	$ 17,000.00
	23	Floor Hatches: 3'x3' Type J alum floor hatch		3	EA	$ 9,000.00	$ 27,000.00
		Metal decking for roof system					
	24	1.5B20		15,820	SF	$ 5.50	$ 87,010.00
	25	1.5VL22		780	SF	$ 10.00	$ 7,800.00
	26	Air chamber cover:		1	LS	$ 830,000.00	$ 830,000.00
		Triang. Alum. Space Truss w/ non corrugated closure					
		panels. 58 ft. dia. clear span, 7 ft. high					
		self supporting from periphery concrete walls					
		(similar to Durango Pumping Plant)					
		Sheet Subtotal =					**$ 18,825,130.00**

QUANTITIES		PRICES	
BY Brian Goplen	**CHECKED** Dick LaFond	**BY** Jerry Zander	**CHECKED**
DATE PREPARED April 26, 2007	**PEER REVIEW** Dick LaFond	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Yakima River Pumping Plant

Mechanical

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW **ESTIMATE LEVEL:** Appraisal

REGION PN **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		ARCHITECTURAL	8120				
	27	**Standing Seam Roofing System**		15,820	SF	$ 8.80	$ 139,216.00
		Service Bay - 1" high rib @ 18" o.c., 24ga.,					
		G-90 hot-dipped galvanized steel, UL 90 rated					
		Large roof - 3/12 hipped - 3,460 s.f.					
		Small roof - 3/12 hipped - 560 s.f.					
		Unit Bay - 1" high rib @ 18" o.c., 24ga., G-90,					
		hot-dipped galvanized steel, UL 90 rated					
		Gabled with 3/12 pitch each side - 11,800 s.f.					
		Roofing Felt					
	28	2-layers 15# - 31,640 s.f.	8120	31,640	SF	$ 0.60	$ 18,984.00
		Roof Insulation					
	29	4" thick, rigid	8120	4,020	SF	$ 4.20	$ 16,884.00
	30	2" thick, rigid	8120	11,800	SF	$ 2.20	$ 25,960.00
		Roll-up Doors (complete with hardware)					
		Exterior					
	31	4'-0" x 7'-0", manual operated, insulated		1	EA.	$ 6,400.00	$ 6,400.00
		roll-up door					
	32	14'-0" x 14'-0", manual operated, insulated		1	EA.	$ 9,000.00	$ 9,000.00
		roll-up door					
		Steel Doors & Frames (complete with hardware)					
		Interior					
	33	3'-0" x 7'-0" x 1 3/4", single, 90 min.		18	EA.	$ 1,100.00	$ 19,800.00
	34	3'-0" x 7'-0" x 1 3/4", double, 90 min.		5	EA.	$ 1,700.00	$ 8,500.00
		Sheet Subtotal =					**$ 244,744.00**

QUANTITIES		PRICES	
BY Brian Goplen	**CHECKED** Dick LaFond	**BY** Jerry Zander	**CHECKED**
DATE PREPARED April 26, 2007	**PEER REVIEW** Dick LaFond	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Wymer Offstream Storage Facility Yakima River Pumping Plant Mechanical	Yakima River Basin Water Storage Study WOID: YRSSW — ESTIMATE LEVEL: Appraisal REGION: PN — PRICE LEVEL: Apr-07 FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Est Notes - A

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Major Mechanical Equipment:					
		Furnish and Install:					
	35	Seven 60 cfs Pumps	8420	161,000	LBS	$ 22.00	$ 3,542,000.00
		Double suction, horizontal split-case pumps,					
		coupling, 900 rpm, rated 480 feet TDH,					
		ductile iron casing, s.st. impeller w/ s.st.					
		casing/impeller wearing rings, and common					
		steel base plate for pump and motor					
		(23,000 lbs. ea.)					
		- Government to witness pump shop test					
		- pump shop testing with job motor					
	36	Seven 4,000 hp Motors	8430	210,000	LBS	$ 26.00	$ 5,460,000.00
		Horizontal synchronous, 6600 volt, 900 rpm,					
		TEWAC motor enclosure, brushless exciter					
		(30,000 lbs. ea.)					
		Sheet Subtotal =					**$ 9,002,000.00**

QUANTITIES		PRICES	
BY R. Zelenka	CHECKED T. Hummel 4/24/07	BY Jerry Zander JZ	CHECKED
DATE PREPARED April 23, 2007	PEER REVIEW T. Hummel 4/24/07	DATE PREPARED May 31, 2007	PEER REVIEW

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Yakima River Pumping Plant

Mechanical

PROJECT: Yakima River Basin Water Storage Study

WOID:	YRSSW	**ESTIMATE LEVEL:**	Appraisal
REGION	PN	**PRICE LEVEL:**	Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Major Mechanical Equipment					
		Valves	8420				
	37	AWWA Class 150, Motor operated butterfly valves:					
		7 -48" Diameter valves, 7725 lbs. per valve.		54,075	LBS	$ 5.00	$ 270,375.00
	38	ANSI Class 300, Motor operated butterfly valves:					
		7 -42" Diameter valves, 6000 lbs. per valve.		42,000	LBS	$ 27.00	$ 1,134,000.00
	39	ANSI Class 300, Tilting disk check valves:					
		7 -42" Diameter valves, 8300 lbs. per valve.		58,100	LBS	$ 24.00	$ 1,394,400.00
	40	ANSI Class 300, Manually operated butterfly valves:					
		4 -24" Diameter valves, 1350 lbs. per valve.		5,400	LBS	$ 22.00	$ 118,800.00
	41	ANSI Class 300, Manually operated butterfly valves:					
		2 -16" Diameter valves, 550 lbs. per valve.		1,100	LBS	$ 27.00	$ 29,700.00
	42	2" Combination Air Valves					
		22 - 300 psi valves, 75 lbs. per valve		1,650	LBS	$ 11.00	$ 18,150.00
	43	2" Ball Valves					
		22 - 300 psi valves, 3 lbs. per valve		66	LBS	$ 100.00	$ 6,600.00
		Sheet Subtotal =					**$ 2,972,025.00**

QUANTITIES		PRICES	
BY Rick Frisz	**CHECKED** Ken Smith	**BY** Jerry Zander JZ	**CHECKED** [signature]
DATE PREPARED 4-30-07	**PEER REVIEW** KRS	**DATE PREPARED** May 31, 2007	**PEER REVIEW** [signature]

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Wymer Offstream Storage Facility Yakima River Pumping Plant Mechanical	Yakima River Basin Water Storage Study WOID: YRSSW — ESTIMATE LEVEL: Appraisal REGION: PN — PRICE LEVEL: Apr-07 FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Pumping Plant(12)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Steel Manifold (Suction and Discharge Manifolds)	8420				
		Steel plate used for pipe fabrication:					
		ASTM A36: Sy = 36 kpsi					
		(All pipe sizes are inside diameters)					
	44	120" ID, 3/4" wall, L= 321 ft., 968 lbs/ft (310728 lbs)		321	Lin. Ft.	$ 2,900.00	$ 930,900.00
	45	96" ID, 1" wall, L= 400 ft., 1036 lbs/ft (414400 lbs)		1,036	Lin. Ft.	$ 3,100.00	$ 3,211,600.00
	46	48" ID, 1/4" wall, L= 210 ft., 128 lbs/ft (26880 lbs)		210	Lin. Ft.	$ 380.00	$ 79,800.00
	47	42" ID., 7/16" wall, L= 210 ft., 198 lbs/ft (41580 lbs)		210	Lin. Ft.	$ 590.00	$ 123,900.00
	48	24" ID, 1/4" wall, L= 40 ft., 64 lbs/ft (2560 lbs)		40	Lin. Ft.	$ 190.00	$ 7,600.00
	49	16" ID, 1/4" wall, L= 90 ft., 43 lbs/ft (3870 lbs)		90	Lin. Ft.	$ 130.00	$ 11,700.00
		Flanges					
	50	2 - 96" AWWA Class E (3625 lb. ea.)		7,250	LBS	$ 3.70	$ 26,825.00
	51	14 - 48" AWWA Class D (440 lb. ea.)		6,160	LBS	$ 5.20	$ 32,032.00
	52	28 - 42" AWWA Class F (992 lb. ea.)		27,780	LBS	$ 5.00	$ 138,900.00
	53	21 - 36" AWWA Class D (268 lb. ea.)		5,630	LBS	$ 5.20	$ 29,276.00
	54	21 - 30" AWWA Class F (545 lb. ea.)		11,450	LBS	$ 5.10	$ 58,395.00
	55	20 - 24" AWWA Class F (384 lb. ea.)		7,680	LBS	$ 4.90	$ 37,632.00
	56	10 - 16" AWWA Class F (174 lb. ea.)		1,740	LBS	$ 5.40	$ 9,396.00
	57	2 - 120" AWWA Class D (3558 lb. ea.)		7,120	LBS	$ 3.90	$ 27,768.00
		Steel Air Chamber	8420				
	58	46 ft. ID, Spherical air chamber		705,000	LBS	$ 10.00	$ 7,050,000.00
		ASTM A 516 Grade 70 steel					
	59	200 horsepower, 750 cfm air compressor, 230 psig		1	LS	$ 220,000.00	$ 220,000.00
		Sheet Subtotal =					**$ 11,995,724.00**

QUANTITIES		PRICES	
BY: Rick Frisz	CHECKED: Ken Smith	BY: Jerry Zander (JZ)	CHECKED: [signature]
DATE PREPARED: 4-30-07	PEER REVIEW: KRS	DATE PREPARED: May 31, 2007	PEER REVIEW: [signature]

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Yakima River Pumping Plant

Mechanical

PROJECT:

Yakima River Basin Water Storage Study

WOID:	YRSSW	**ESTIMATE LEVEL:**	Appraisal
REGION	PN	**PRICE LEVEL:**	Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical					
	60	Fire Suppression System: Consists of	8410	1	L.S.	$ 210,000.00	$ 210,000.00
		10 - Fire hose reels w/ 100 feet of hose					
		20 - Portable hand-held 20 lb. extinguishers					
		3 - Wheeled portable 125 lb. extinguishers					
		55 - Sprinkler system discharge heads					
		1 - 4-inch deluge valve, electric actuated					
		1 - Fire hydrant, dry type					
		1 - Fire department siamese connection					
		1 - Fire pump, horz. split-case, 500 gpm @ 300 ft of hd					
		10,000 lbs. of sch. 40 carbon steel pipe and fittings					
		1 - Clean agent gas fire suppression system for					
		4,500 ft^3 control room					
	61	Unit Cooling Water System: Consists of	8410	1	L.S.	$ 310,000.00	$ 310,000.00
		7 - Supply pumps, end-suction type, 150 gpm at 60 ft hd.					
		2 - 8-inch automatic, self cleaning strainers					
		4,000 lbs. of type K copper tubing & fittings					
		5,000 lbs. of ductile iron, mechanical joint pipe & fittings					
		4,000 lbs. of cast iron valving					
		2 - Mechanical seal end-suction pumping units; 25 gpm					
		at 100 ft hd.					
		2 - 4-inch self-cleaning filters, 25 micron					
	62	Compressed Air System: Consists of	8410	1	L.S.	$ 40,000.00	$ 40,000.00
		2 - 40 cfm @ 125 psi rotary screw air compressors					
		1 - 300 gal. carbon steel air receiver					
		1 - 80 cfm air dryer					
		3,000 lbs. of sch. 40 carbon steel pipe, valves & fittings					
	63	Service Water System: Consists of	8410	1	L.S.	$ 47,000.00	$ 47,000.00
		1 - Service water pump, 75 gpm @ 200 ft. of hd.					
		1 - Hydropneumatic steel tank, 300 gal.					
		1,500 lbs. of type K copper tubing, valves & fittings					
		10 - Service water rubber hose; 1-inch dia., 50 ft lengths					
		Sheet Subtotal =					**$ 607,000.00**

QUANTITIES		PRICES	
BY: J. Grass	**CHECKED** Rick Christensen	**BY** Jerry Zander	**CHECKED**
DATE PREPARED: 4/27/07	**PEER REVIEW** Dave Hulse	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Yakima River Pumping Plant

Mechanical

PROJECT:

Yakima River Basin Water Storage Study

WOID:	YRSSW	**ESTIMATE LEVEL:**	Appraisal
REGION	PN	**PRICE LEVEL:**	Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\|Final Est - Wymer PP and Reservoir.xls|Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
	64	Gravity Drainage System: Consists of	8410	1	L.S.	$ 150,000.00	$ 150,000.00
		50 - Floor drains, cast iron, 4-inch					
		25,000 lbs. of cast iron hub & spigot, service weight					
		soil pipe					
	65	Plant Unwatering System: Consists of	8410	1	L.S.	$ 210,000.00	$ 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					
		4,000 lbs. of ductile iron, mechanical joint pipe & fittings					
	66	Domestic Water and Sanitary Waste and Vent System:	8410	1	L.S.	$ 71,000.00	$ 71,000.00
		Consists of:					
		4 - Water Closets					
		2 - Urinal					
		4 - Lavatories w/ faucets & accessories					
		1 - Duplex sewage ejector assembly					
		2 - Drench shower and eye wash					
		1 - Water heater, 20 gallons, electric					
		1 - Janitor's service sink, 36" x 36" molded stone					
		2,000 lbs. of cast iron hub & spigot service weight					
		sewer and vent pipe					
		800 lbs. of type K copper tubing, valves & fittings					
	67	20-ton Electric overhead traveling unit bay bridge crane,	8410	1	L.S.	$ 330,000.00	$ 330,000.00
		remote control, 56'-0" span; 30 ft. lift					
	68	20-ton Electric overhead traveling service bay bridge	8410	1	L.S.	$ 280,000.00	$ 280,000.00
		crane, remote control, 55'-0" span; 25 ft. lift					
	69	Electric passenger elevator:	8410	1	L.S.	$ 170,000.00	$ 170,000.00
		Overhead, Geared traction type, Capacity =3500 pounds,					
		Travel = 43 feet, Landings = 4, Speed = 200 ft/min.					
	70	Sump waste oil skimmer assembly, electric operated,	8410	1	L.S.	$ 17,000.00	$ 17,000.00
		w/ 55 gallon collection drum					
		Sheet Subtotal =					**$ 1,228,000.00**

QUANTITIES		PRICES	
BY: J. Grass / A. Ritt	**CHECKED** Rick Christensen	**BY** Jerry Zander	**CHECKED**
DATE PREPARED: 4/27/07	**PEER REVIEW** Dave Hulse	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Wymer Offstream Storage Facility Yakima River Pumping Plant Mechanical	Yakima River Basin Water Storage Study
	WOID: YRSSW — ESTIMATE LEVEL: Appraisal
	REGION PN — PRICE LEVEL: Apr-07
	FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
	71	Heating, Ventilating, and Air Conditioning System (HVAC)	8410	1	L.S.	$ 1,000,000.00	$ 1,000,000.00
		for pumping plant building interior consisting of					
		197-ft long by 57-ft wide by 50-ft high unit bay,					
		55-ft long by 57-ft wide by 82-ft high service bay and					
		250-ft long by 25-ft wide by 12-ft high equipment gallery					
		for a total pumping plant volume of 893,520 ft^3					
		HVAC system designed for:					
		Outdoor summer design conditions: 100 degrees F					
		dry bulb and 86 degrees F wet bulb					
		Outdoor winter design conditions: minus 3.8 degree					
		dry bulb					
		Indoor plant summer design conditions: 90 degrees F					
		Indoor plant winter freeze protection: 45 degrees F dry bulb					
		Indoor control room, communication room and					
		office : 74 degrees F cooling and 68 degrees F heating					
		HVAC equipment consists of:					
		Central air handling units w/ hot water heating coils					
		Hot water boilers, circulating pumps and appurtenances					
		Office, control and communicating rooms air conditioning units					
		Unit heaters - hot water type					
		Electric fan forced wall heaters					
		Stairwell ventilation fans					
		Ducts - galvanized steel					
		Fire and smoke dampers					
		Backdraft dampers					
		Centrifugal fans					
		Propeller fans					
		Register/grills/louvers					
		Panel filters					
		Control system					
		Copper tubing					
		5,000 gallon propane tank and appurtenances					
		Carbon steel gas piping components					
		Sheet Subtotal =					**$ 1,000,000.00** ✓

QUANTITIES		PRICES	
BY: J. Grass / P. Schlein	**CHECKED** Rick Christensen	**BY** Jerry Zander [signature]	**CHECKED** [signature]
DATE PREPARED: 4/27/07	**PEER REVIEW** Dave Hulse	**DATE PREPARED** May 31, 2007	**PEER REVIEW** [signature]

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Yakima River Pumping Plant

Mechanical

PROJECT: Yakima River Basin Water Storage Study

WOID:	YRSSW	**ESTIMATE LEVEL:**	Appraisal
REGION	PN	**PRICE LEVEL:**	Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical (cont)					
	72	200 Kw diesel engine generator set with 500 gallon fuel tank (assume ConVault tank)	8410	1	L.S.	$ 120,000.00	$ 120,000.00
		Sheet Subtotal =					$ 120,000.00

QUANTITIES		PRICES	
BY: R. Christensen	CHECKED John Grass	BY Jerry Zander	CHECKED
DATE PREPARED: 4/28/07	PEER REVIEW Dave Hulse	DATE PREPARED May 31, 2007	PEER REVIEW

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Yakima River Pumping Plant

Electrical

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal

REGION PN | **PRICE LEVEL:** Apr-07

FILE: C:\Documents and Settings\jwzander\My Documents\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Est Notes - A

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		15 kV Non-Segregated-Phase Bus (F&I)	8430				
	73	15 kV, 3,000 amperes, outdoor type		300	FT	$ 6,500.00	$ 1,950,000.00
		15 kV Metal-Clad Switchgear (F&I)	8430				
	74	Indoor metal-clad switchgear with following features:		1	EA	$ 400,000.00	$ 400,000.00
		15 kV, 3,000 ampere bus					
		three 3,000 ampere vacuum power circuit breakers*					
		two 1,200 ampere vacuum power circuit breakers*					
		Plant Station-Service Equipment (F&I)	8430				
	75	Indoor double-ended secondary unit substation with		1	EA	$ 220,000.00	$ 220,000.00
		following features:					
		600 volts, 2,000 ampere main bus					
		Two dry-type transformers 6.9 kV-480Y/277 V, 1,500 KVA					
		Two 480 V power-circuit breakers, 2,000 amperes					
		Six 480 V power-circuit breakers, 800 amperes					
		7.2 kV Motor Control Equipment (F&I)	8430				
	76	NEMA 1 enclosure with following features:		1	EA	$ 2,800,000.00	$ 2,800,000.00
		7.2 kV, 3,000 ampere bus					
		Seven 400 ampere, class E2 full-voltage vacuum					
		contactors					
		Excitation equipment for 7 synchronous motors					
		Motor Control Centers (F&I)	8430				
	77	480 volts, 3-phase with 800 ampere bus		2	EA	$ 50,000.00	$ 100,000.00
		Five 20 inch wide sections w/ following equipment:					
		7 NEMA size 0 FVR contactors **					
		2 NEMA size 2 FVNR contactors ***					
		Three 100 A, 3-pole molded-case circuit breakers					
		* Continuous current rating					
		** FVR - Full-voltage reversing					
		*** FVNR - Full-voltage non-reversing					
		Sheet Subtotal =					**$ 5,470,000.00**

QUANTITIES		PRICES	
BY Mike Schuh	CHECKED	BY J.erry Zander	CHECKED
DATE PREPARED April 25, 2007	PEER REVIEW George Girgis	DATE PREPARED May 29, 2007	PEER REVIEW

ESTIMATE WORKSHEET

FEATURE: Wymer Offstream Storage Facility Yakima River Pumping Plant Electrical	**PROJECT:** Yakima River Basin Water Storage Study **WOID:** YRSSW **ESTIMATE LEVEL:** Appraisal **REGION** PN **PRICE LEVEL:** Apr-07 **FILE:** C:\Documents and Settings\jwzander\My Documents\2007 JWZ Estimates\Red River 3 - WTP\Estimators Log|Estimators Log - Red River 3 - ND.xls|Estimate Log

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	78	**Distribution Panelboards (F&I)**	8430				
	a	480 volts, 3-phase with 800 ampere bus &		4	EA	$ 8,000.00	$ 32,000.00
		main circuit breaker					
	b	208Y/120, 3-phase with 225 ampere bus &		3	EA	$ 3,500.00	$ 10,500.00
		main circuit breaker					
	79	**Lighting & Distribution Transformer (F&I)**	8430				
		75 kVA, 480-208Y/120 volt, dry type		3	EA	$ 20,000.00	$ 60,000.00
		Building Lighting System (F&I)	8430				
		Interior luminaires:					
	80	High bay, high-pressure sodium, 400 W, 208 V		14	EA	$ 1,600.00	$ 22,400.00
	81	4 foot, 2 lamp, 120 V fluorescent fixtures		40	EA	$ 240.00	$ 9,600.00
	82	Exterior luminaires:					
		High-pressure sodium, wall mounted, outdoor		12	EA	$ 470.00	$ 5,640.00
		70 watt, 120 volt					
		Assumptions:					
		Redundant power transformers in switchyard					
		Split motor bus with tie breaker					
		Sheet Subtotal =					**$ 140,140.00**

QUANTITIES		PRICES	
BY Mike Schuh	CHECKED [signature]	BY Jerry Zander [initials]	CHECKED [signature]
DATE PREPARED April 25, 2007	PEER REVIEW George Girgis [signature]	DATE PREPARED May 29, 2007	PEER REVIEW [signature]

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Wymer Offstream Storage Facility Switchyard and Transmission Line	Yakima River Basin Water Storage Study
	WOID: YRSSW — ESTIMATE LEVEL: Appraisal
	REGION PN — PRICE LEVEL: Apr-07
Civil/Structural	FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		CIVIL/STRUCTURAL	8120				
	1	**Excavation** (Common)		1,005	CY	$ 21.00	$ 21,105.00
	2	**Structural Concrete**		120	CY	$ 1,400.00	$ 168,000.00
		(Switchyard foundations and pullboxes)					
	3	**Concrete Reinforcement**		15,310	LBS	$ 1.70	$ 26,027.00
	4	**Compacting Backfill about Structures**		790	CY	$ 14.00	$ 11,060.00
	5	**Switchyard Steel Structures**		35,800	LBS	$ 5.50	$ 196,900.00
	6	**Gravel Surfacing - 6-inch thick**		2,045	SY	$ 13.00	$ 26,585.00
	7	**Oil-Spill Containment System**		1	LS	$ 38,000.00	$ 38,000.00
		Geotextile fabric 4,255 SF (12 oz per sq yard, 110 mils non-woven)					
		Geomembrane liner: 2,130 SF (30 Mils XR-5 Seaman Corporation)					
		Geocel: 1,635 SF (8" deep "enviro grid" polymeric cellular confinement system)					
		Piping: 140 LF (6" Dia. Schedule 80 PVC pipe perforated)					
		Piping: 3 EA (6" Dia. Schedule 80 PVC "L")					
		Piping: 1 EA (12" Dia. 3'-2" long Schedule 80 PVC Cap)					
		Piping: 3 LF (12" Dia. Schedule 80 PVC perforated pipe)					
		Preservative-Treated Lumber: 75 LF (2"x4")					
		Expansion Anchors (Stainless steel 3/8" x 5" drilled in conc): 84 EA					
		Excavation: Included in excavation for structures					
		Uncompacted crushed aggregate: 135 CY (ASTM C33 Size No 4, 1 1/2" to 3/4")					
	8	**Gravelfill for Switchyard Foundations** (Compacted)		65	CY	$ 55.00	$ 3,575.00
	9	**5-Inch PVC Schedule 80 Conduit** (CIP Power Duct Bank)		115	LF	$ 270.00	$ 31,050.00
		Includes:					
		115 LF of 1.5' tall x 2.33' wide concrete CIP					
		15 CY of concrete					
		1970 lbs of reinforcement					
	10	**7-foot Chain link fence**		400	LF	$ 37.00	$ 14,800.00
		Sheet Subtotal =					**$ 537,102.00**

QUANTITIES		PRICES	
BY Brian Goplen	CHECKED Dick LaFond	BY Jerry Zander	CHECKED
DATE PREPARED April 26, 2007	PEER REVIEW Dick LaFond	DATE PREPARED May 31, 2007	PEER REVIEW

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Switchyard and Transmission Line

Electrical

PROJECT: Yakima River Basin Water Storage Study

WOID:	YRSSW	**ESTIMATE LEVEL:**	Appraisal
REGION	PN	**PRICE LEVEL:**	Apr-07

FILE: H:\D8170\EST\Spreadsheet\Mar\Wymer Offstream Storage\[Wymer PP& Resrv Part of Electical Worksheets - dmar- 5-07.xls]Switchyard&T-Line(2)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		ELECTRICAL					
		Switchyard					
		Furnish and Install:					
	11	Oil-filled, conservator-type power transformer	-68440	2	EA	$ 1,100,000.00	$ 2,200,000.00
		20/26.66/33.33 MVA OA/FA/FA; 115-6.9kV, 3-phase					
	12	115-kV disconnect switches, 1200 amp, 3-phase	-68440	4	EA	$ 35,000.00	$ 140,000.00
	13	115-kV circuit breakers, 1200 amp, 31.5-kA Int,	-68440	2	EA	$ 160,000.00	$ 320,000.00
		3-phase, dead-tank, SF6 type					
	14	115-kV oil-filled voltage transformers	-68440	3	EA	$ 21,000.00	$ 63,000.00
	15	115-kV oil-filled 1200:5 MR current transformers	-68440	3	EA	$ 20,000.00	$ 60,000.00
	16	**Construct Transmission Line**	-68440	5	MILES	$ 550,000.00	$ 2,750,000.00
		115-kV, steel single-pole towers, 556.5 AWG,					
		26/7 ACSR conductor					
		Sheet Subtotal =					**$ 5,533,000.00**

QUANTITIES		PRICES	
BY Doug Crawford	**CHECKED** Jim Zeiger	**BY** Dan Mar	**CHECKED**
DATE PREPARED April 20, 2007	**PEER REVIEW** Jim Zeiger	**DATE PREPARED** 05-22-07	**PEER REVIEW**

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Wymer Offstream Storage Facility Discharge Line to Reservoir Civil/Structural	Yakima River Basin Water Storage Study
	WOID: YRSSW — ESTIMATE LEVEL: Appraisal
	REGION PN — PRICE LEVEL: Apr-07
	FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est|Final Est - Wymer PP and Reservoir.xls|Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Discharge Line					
		Discharge line quantities are from PP yard to outlet.					
		Discharge line piping through dam covered by 8410					
		Discharge line outlet: El. 1610, right abutment					
		Earthwork for Discharge Pipe					
		Price Alternative 2. Alternative 1 for reference only.					
		Alternative 1 - Payline Quantities - Vertical Trench Walls					
		Clearing and Grubbing (150 ft wide along pipeline)	8140	78,000	SY		
		Common Excavation for pipe	8140	24,000	CY		
		Rock Excavation for pipe - (drill and shoot)	8140	30,000	CY		
		Backfill for pipe	8140	22,000	CY		
		Rockfill for pipe (used instead of backfill under dam)	8140	12,000	CY		
		Soil Cement Slurry (CLSM)	8140	3,700	CY		
		Alternative 2 - Takeoff Quantities - 1-1/2:1 Trench Walls					
		except use 1/2:1 trench walls under dam)					
	1	Clearing and Grubbing (150 ft wide along pipeline)	8140	78,000	SY	$ 1.00	$ 78,000.00
	2	Common Excavation for pipe	8140	135,000	CY	$ 6.00	$ 810,000.00
	3	Rock Excavation for pipe - (drill and shoot)	8140	100,000	CY	$ 23.00	$ 2,300,000.00
	4	Backfill for pipe	8140	181,000	CY	$ 4.50	$ 814,500.00
	5	Rockfill for pipe (used instead of backfill under dam)	8140	37,000	CY	$ 44.00	$ 1,628,000.00
	6	Soil Cement Slurry (CLSM)	8140	14,000	CY	$ 100.00	$ 1,400,000.00
		96-inch Diameter Steel Pipe					
		(Mortar lined w/ flexible lining)					
	7	96 300, pipe thickness = 0.4375 (456 lb/ft steel weight)	8140	1,310	LF	$ 1,140.00	$ 1,493,400.00
	8	96 350, pipe thickness = 0.500 (521 lb/ft steel weight)	8140	400	LF	$ 1,300.00	$ 520,000.00
	9	96 425, pipe thickness = 0.625 (652 lb/ft steel weight)	8140	600	LF	$ 1,630.00	$ 978,000.00
	10	96 475, pipe thickness = 0.6875 (718 lb/ft steel weight)	8140	500	LF	$ 1,800.00	$ 900,000.00
	11	96 525, pipe thickness = 0.75 (784 lb/ft steel weight)	8140	300	LF	$ 1,960.00	$ 588,000.00
	12	96 575, pipe thickness = 0.8125 (850 lb/ft steel weight)	8140	300	LF	$ 2,130.00	$ 639,000.00
	13	96 650, pipe thickness = 0.9375 (982 lb/ft steel weight)	8140	400	LF	$ 2,460.00	$ 984,000.00
	14	96 700, pipe thickness = 1.0 (1048 lb/ft steel weight)	8140	400	LF	$ 2,620.00	$ 1,048,000.00
	15	**Cathodic protection for pipeline**	8140	1	LS	$ 63,000.00	$ 63,000.00
	16	**96"x96"x36" Tee for buried manhole**	8140	1	EA	$ 59,000.00	$ 59,000.00
		Sheet Subtotal =					**$ 14,302,900.00**

QUANTITIES		PRICES	
BY Anne Pavol	CHECKED Linda M. Bowles/Joe Gemperline	BY J.erry Zander	CHECKED
DATE PREPARED May 1, 2007	PEER REVIEW David K. Edwards	DATE PREPARED May 31, 2007	PEER REVIEW

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Discharge Line to Reservoir

Civil/Structural

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal

REGION PN | **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		SH821 Detour for open cut discharge line					
	17	Remove and Replace Concrete Asphalt on SH821	8140	135	ton	$ 110.00	$ 14,850.00
	18	Remove and Replace Aggregate base on SH821	8140	250	ton	$ 50.00	$ 12,500.00
	19	Compacted Embankment	8140	6,900	CY	$ 18.00	$ 124,200.00
	20	Concrete Asphalt for detour	8140	630	ton	$ 100.00	$ 63,000.00
	21	Aggregate base for detour	8140	1,150	ton	$ 50.00	$ 57,500.00
	22	Concrete Jersey Barriers	8140	200	LF	$ 100.00	$ 20,000.00
	23	Detour signage	8140	1	LS	$ 70,000.00	$ 70,000.00
	24	Detour removal	8140	1	LS	$ 40,000.00	$ 40,000.00
		Discharge Line Outlet Structure					
	25	Excavation of common materials for structures (2:1)	8140	960	CY	$ 22.00	$ 21,120.00
	26	Backfill (2:1)	8140	700	CY	$ 28.00	$ 19,600.00
	27	Compacted Backfill (2:1)	8140	700	CY	$ 10.00	$ 7,000.00
	28	Embankment	8140	790	CY	$ 15.00	$ 11,850.00
	29	Compacted Embankment	8140	790	CY	$ 7.00	$ 5,530.00
	30	Riprap (d50=24") (120 lb/cf)	8140	1,100	TONS	$ 70.00	$ 77,000.00
	31	Riprap Bedding (130 lb/cf)	8140	450	TONS	$ 50.00	$ 22,500.00
	32	Furnish, form, and place reinforced concrete	8140	240	CY	$ 1,580.00	$ 379,200.00
	33	Furnish and place concrete reinforcement.	8140	29,000	LBS	$ 1.65	$ 47,850.00
		Assume 120 #/CY					
	34	Furnish and handle cement (.282T/CY)	8140	60	TONS	$ 180.00	$ 10,800.00
		Discharge Line Outlet Chute					
	35	Excavation of common materials for structures (2:1)	8140	16,000	CY	$ 15.00	$ 240,000.00
	36	Backfill (2:1)	8140	3,600	CY	$ 22.40	$ 80,640.00
	37	Compacted Backfill (2:1)	8140	3,600	CY	$ 8.00	$ 28,800.00
	38	Embankment (chute crosses swale)	8140	44,000	CY	$ 8.70	$ 382,800.00
	39	Compacted Embankment (chute crosses swale)	8140	44,000	CY	$ 3.50	$ 154,000.00
	40	Riprap (d50=24") (120 lb/cf)	8140	8,300	TONS	$ 63.00	$ 522,900.00
	41	Riprap Bedding (130 lb/cf)	8140	3,700	TONS	$ 45.00	$ 166,500.00
	42	Furnish, form, and place reinforced concrete	8140	1,550	CY	$ 1,270.00	$ 1,968,500.00
	43	Furnish and place concrete reinforcement.	8140	185,000	LBS	$ 1.50	$ 277,500.00
		Assume 120 #/CY					
	44	Furnish and handle cement (.282T/CY)	8140	430	TONS	$ 160.00	$ 68,800.00
		Sheet Subtotal =					**$ 4,894,940.00**

QUANTITIES		PRICES	
BY Anne Pavol	**CHECKED** Joe Gemperline/ K. A. Sayer	**BY** Jerry Zander	**CHECKED**
DATE PREPARED May 1, 2007	**PEER REVIEW** David K. Edwards	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Discharge Line
Access conduit

Civil

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW **ESTIMATE LEVEL:** Appraisal

REGION PN **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\|Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	45	**Concrete**	8130				
		Concrete in access house (18 x 18 x 1 foot walls)		60	CY	$ 1,850.00	$ 111,000.00
		Concrete in access shaft (H = 50')		240	CY	$ 1,580.00	$ 379,200.00
		Concrete in Gate Chamber (20 ft dia.)		210	CY	$ 1,600.00	$ 336,000.00
		Concrete in access conduit (L =440)		1,980	CY	$ 1,175.00	$ 2,326,500.00
		Concrete in pipe saddles		35	CY	$ 1,950.00	$ 68,250.00
		(concrete total)		2,525			
	46	Furnish and place concrete reinforcement.					
		Assume 160 #/CY		404,000	LBS	$ 1.50	$ 606,000.00
	47	Furnish and handle cement (.282T/CY)		712	TONS	$ 150.00	$ 106,800.00
		Sheet Subtotal =					**$ 3,933,750.00**

QUANTITIES		PRICES	
BY Doug Stanton	CHECKED Tom Scobell	BY J.erry Zander	CHECKED
DATE PREPARED May 2, 2007	PEER REVIEW	DATE PREPARED May 31, 2007	PEER REVIEW

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Discharge Line to Reservoir

Mechanical

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW **ESTIMATE LEVEL:** Appraisal

REGION PN **PRICE LEVEL:** Apr-07

FILE: H:\D8170\EST\Spreadsheet\Mar\Wymer Offstream Storage\[Wymer PP& Resrv - Part of Electical Worksheets - dmar- 5-07.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical					
	48	Heating and Ventilating System for Discharge	8410	1	L.S.		$ 75,000.00
		Line Valve Access Tunnel:					
		Consists of:					
		2 - Electric unit heater; 7.5 kw					
		1 - Centrifugal fan; 750 cfm					
		1 - Propeller fan; 2400 cfm					
		1 - Axial fan: 5,000 cfm					
		550 ft. Oval steel duct; 38-inch x 16-inch; galvanized					
		2 - Control damper; 60-inch by 60-inch; motor-operated					
		2 - Control damper; 32-inch by 32-inch; motor-operated					
		2 - 60-inch by 60-inch stationary louver					
		2 - 32-inch by 32-inch stationary louver					
	49	Ventilating System for Flowmeter Vault:	8410	1	L.S.		$ 6,000.00
		Consists of:					
		1 - Centrifugal fan, 450 cfm					
		25 ft. carbon steel pipe and fittings, 8-inch dia., galv.					
	50	Ventilating System for Air Chamber	8410	1	L.S.		$ 25,000.00
		Structure:					
		Consists of:					
		1 - Centrifugal fan, 4000 cfm					
		50 ft. carbon steel pipe and fittings, 18-inch dia., galv.					
	51	Ultrasonic flowmeter, 2-path	8410	1	L.S.		$ 95,000.00
	52	Bulkhead gate (13' x 13'), bulkhead gate frame	8410	39,000	LBS	$ 6.00	$ 234,000.00
		and guides above frame (steel)					
		Sheet Subtotal =					**$ 435,000.00**

QUANTITIES		PRICES	
BY: J. Grass / P. Schlein R. Christensen	**CHECKED** Rick Christensen	**BY** Dan Mar	**CHECKED**
DATE PREPARED: 4/28/07	**PEER REVIEW** Dave Hulse	**DATE PREPARED** 05-29-07	**PEER REVIEW**

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Discharge Line to Reservoir

Mechanical

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal

REGION PN | **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical					
		Discharge/Isolation Valve					
	53	96-inch dia. Motor-operated Slide gate					
		(for Discharge manifold outlet into the					
		reservoir. Pressure on downstream side of gate)					
		Differential head = 132 feet					
		Slide gate frame, slide, and stem: 25,000 #					
		Motor operator: 1,800 #	8420	26,800	LBS	$ 9.00	$ 241,200.00
		Steel Pipe: Sta. 49+00 to Sta. 53+70 (End of Discharge Pipe)					
	54	96-inch ID, 3/8-inch wall, 386 lb/ft	8420	470	LF	$ 970.00	$ 455,900.00
	55	14-inch OD steel pipe for filling line					
		(1/4-inch wall, 38 lb per lin. ft.)	8420	20	LF	$ 100.00	$ 2,000.00
		Valves					
	56	AWWA Class 150, manually operated butterfly valves (for filling line):					
		2 -14" Diameter valves, 400 lbs. per valve.	8420	800	LBS	$ 15.00	$ 12,000.00
		Sheet Subtotal =					**$ 711,100.00**

QUANTITIES		PRICES	
BY Don Read, Rick Frisz	**CHECKED** Rick Frisz, Ken Smith	**BY** Jerry Zander (initialed)	**CHECKED** (initialed)
DATE PREPARED May 1, 2007	**PEER REVIEW** KRS	**DATE PREPARED** May 31, 2007	**PEER REVIEW** DCD

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Discharge Line to Reservoir

Electrical

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW **ESTIMATE LEVEL:** Appraisal

REGION PN **PRICE LEVEL:** Apr-07

FILE: H:\D8170\EST\Spreadsheet\Mar\Wymer Offstream Storage\[Wymer PP& Resrv - Part of Electical Worksheets - dmar- 5-07.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		ELECTRICAL					
		Access Shaft/Gate Chamber Structure					
		Bldg Electrical Service Equipment (F&I)	8430				
	57	Distribution panelboard, indoor type		1	EA	$ 10,500.00	$ 10,500.00
		480 volts, 3-phase with 225 ampere bus					
	58	Transformer load center		1	EA	$ 8,300.00	$ 8,300.00
		15 kVA, 1-phase, 480-240/120 volt					
		Combination Motor Starters (F&I)	8430				
	59	NEMA size 2 reversing contactor, 480V, 3-phase		1	EA	$ 5,000.00	$ 5,000.00
		480-120 volt control transformer					
		NEMA type 4 enclosure					
		Lighting System (F&I)	8430				
	60	120 volt, fluorescent NEMA type 4 fixtures for		1	LS		$ 5,000.00
		tower/gate chamber					
		Assumptions:					
		Bringing power to dam is part of unlisted items					
		Sheet Subtotal =					$ 28,800.00

QUANTITIES		PRICES	
BY: Mike Schuh	CHECKED: [signature]	BY: Dan Mar [initials]	CHECKED: [signature]
DATE PREPARED: April 25, 2007	PEER REVIEW: George Girgis [signature]	DATE PREPARED: 05-29-07	PEER REVIEW: [signature]

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Dam and Dike
Concrete-Faced Rockfill Dam

Dam Civil/Structural

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal

REGION: PN | **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		GENERAL SITEWORK	8312				
		Assume no clearing and grubbing required					
		Assume road improvements and haul roads are					
		part of unlisted items					
		DIVERSION & DEWATERING	8312				
		Given shallow alluvium & narrow valley, dewatering					
		assumed to be minor (part of unlisted items)					
		FOUNDATION EXCAVATION					
		Assume common material stockpiled for reuse					
		in misc. fill, haul roads, and similar					
		Assume rock material stockpiled for use (zone 4)					
		Stockpiles will be located within 1/2 mile of dam					
	1	Excavation, stripping, of dam foundation	8312	110,000	CY	$ 2.50	$ 275,000.00
		Assume depth of stripping 12 inches or less					
		Assume stripping will be stockpiled for topsoil use					
	2	Excavation, common, for dam foundation	8312	2,680,000	CY	$ 5.00	$ 13,400,000.00
		Assume about 35% of volume requires ripping					
		Assume suitable materials will be					
		stockpiled for use as miscellaneous fill					
	3	Excavation, rock, for dam foundation	8312	22,000	CY	$ 28.00	$ 616,000.00
		Assume drill and blast in areas along plinth					
		FOUNDATION TREATMENT					
		Includes misc. surface foundation treatment,					
		consolidation grouting, and curtain grouting					
	4	Slush grouting of foundation surface	8312	35,000	SF	$ 6.00	$ 210,000.00
		Over assumed 40% of plinth area					
	5	Dental concrete	8312	2,000	CY	$ 200.00	$ 400,000.00
	6	Furnish/place zone 2 sand filter on foundation	8312	40,000	CY	$ 45.00	$ 1,800,000.00
		Over assumed 10% of area between u/s toe and axis					
		Assume a 3-ft thickness above & below zone 3					
	7	Furnish/place zone 3 gravel drain on foundation	8312	20,000	CY	$ 40.00	$ 800,000.00
		Between the zone 2 filters in a 3-ft thickness					
		Sheet Subtotal =					**$ 17,501,000.00**

QUANTITIES		PRICES	
BY Will Gonzales	**CHECKED** Bill Engemoen	**BY** Jerry Zander	**CHECKED**
DATE PREPARED May 2, 2007	**PEER REVIEW** Chuck Redlinger	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Dam and Dike
Concrete-Faced Rockfill Dam

Dam Civil/Structural

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal

REGION PN | **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		FOUNDATION TREATMENT (continued)					
		Consolidation Grouting of Foundation					
		Generally limited to area beneath plinth					
	8	Setups for drilling grout holes	8312	2,100	EA	$ 150.00	$ 315,000.00
		Assume 2-inch dia. drilled on 7.5-foot centers					
	9	Drill grout holes	8312	63,000	LF	$ 35.00	$ 2,205,000.00
		Assume 2-inch dia. w/length= 30 feet					
	10	Hookups to grout holes	8312	2,100	EA	$ 60.00	$ 126,000.00
	11	Pressure grout	8312	130,000	CF	$ 10.00	$ 1,300,000.00
		Assume grouting process only minus cement					
		Assume 2 CF per 1 LF of hole					
	12	Furnish and handle cement for pressure grouting	8312	130,000	BAGS	$ 11.00	$ 1,430,000.00
		Assume 1 bag per CF					
		Curtain Grouting of Foundation					
		Three-row curtain beneath plinth					
	13	Setups for drilling grout holes	8312	1,200	EA	$ 150.00	$ 180,000.00
		Assume 3 rows of 2-inch dia.on 10-ft centers					
	14	Drill grout holes	8312	180,000	LF	$ 40.00	$ 7,200,000.00
		Assume 2-inch dia. w/length from 75 to 225 feet,					
		with average of 150 feet					
	15	Hookups to grout holes	8312	1,200	EA	$ 60.00	$ 72,000.00
	16	Pressure grout	8312	540,000	CF	$ 10.00	$ 5,400,000.00
		Assume grouting process only minus cement					
		Assume 3 CF per 1 LF of hole					
	17	Furnish and handle cement for pressure grouting	8312	540,000	BAGS	$ 10.00	$ 5,400,000.00
		Sheet Subtotal =					**$ 23,628,000.00**

QUANTITIES		PRICES	
BY Will Gonzales	CHECKED Bill Engemoen	BY Jerry Zander	CHECKED
DATE PREPARED May 2, 2007	PEER REVIEW Chuck Redlinger	DATE PREPARED May 31, 2007	PEER REVIEW

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Dam and Dike
Concrete-Faced Rockfill Dam

Dam Civil/Structural

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal

REGION PN | **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

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					
	18	Furnish and place zone 1	8312	285,000	CY	$ 10.00	$ 2,850,000.00
		Consists of selected impervious soils stockpiled					
		from reqd exc within 1/2 mile of dam					
		Compaction to 6-inch lifts by tamping roller					
	19	Furnish and place zone 2 filter	8312	450,000	CY	$ 40.00	$ 18,000,000.00
		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					
	20	Furnish and place zone 3 drain	8312	450,000	CY	$ 30.00	$ 13,500,000.00
		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					
	21	Furnish and place zone 4 rockfill	8312	12,240,000	CY	$ 11.50	$ 140,760,000.00
		Developed from basalt ridges surrounding reservoir					
		Assume average 2-mile haul to dam					
		Rock sizes up to 3-foot					
		Compacted in 3-ft layers by vibratory steel drum					
	22	Furnish and place miscellaneous fill	8312	1,500,000	CY	$ 8.00	$ 12,000,000.00
		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					
		Sheet Subtotal =					**$ 187,110,000.00**

QUANTITIES		PRICES	
BY Will Gonzales	**CHECKED** Bill Engemoen	**BY** Jerry Zander	**CHECKED**
DATE PREPARED May 2, 2007	**PEER REVIEW** Chuck Redlinger	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Dam and Dike
Concrete-Faced Rockfill Dam

Dam Civil/Structural

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal

REGION PN | **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

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 45 feet, avg=20 ft					
		Grouted anchors may be needed in poor rock areas					
	23	Furnish and place reinforced concrete in plinth	8312	4,500	CY	$ 550.00	$ 2,475,000.00
	24	Furnish and place concrete reinforcement (100#/CY)	8312	450,000	LBS	$ 1.50	$ 675,000.00
	25	Furnish and handle cement for concrete (.282T/CY)	8312	1,300	TONS	$ 145.00	$ 188,500.00
	26	Furnish and install grouted anchors	8312	86,000	LF	$ 26.00	$ 2,236,000.00
		Assume 1-inch diameter rebar grouted into rock					
		Assume 15-foot lengths					
		Concrete Deck					
		Thickness will average 2 feet					
		Adjacent panels will have waterstops and dowels					
		Concrete paved on 1.5:1 upstream face of dam					
	27	Furnish and place reinforced concrete in deck	8312	125,000	CY	$ 385.00	$ 48,125,000.00
	28	Furnish and place concrete reinforcement (100#/CY)	8312	12,500,000	LBS	$ 1.30	$ 16,250,000.00
	29	Furnish and handle cement for concrete (.282T/CY)	8312	35,000	TONS	$ 110.00	$ 3,850,000.00
		MISCELLANEOUS					
		Instrumentation					
		Assume part of unlisted items					
		Toe Drains					
		Assume part of unlisted items					
		Site cleanup and relandscaping					
		Assume part of unlisted items					
		Sheet Subtotal =					**$ 73,799,500.00**

QUANTITIES		PRICES	
BY Will Gonzales	**CHECKED** Bill Engemoen	**BY** Jerry Zander	**CHECKED**
DATE PREPARED May 2, 2007	**PEER REVIEW** Chuck Redlinger	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Dam and Dike
Central Core Rockfill Dike

Dike Civil/Structural

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal

REGION: PN | **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

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 located within 1/2 mile of dam					
	30	Excavation, stripping, of dam foundation	8312	45,000	CY	$ 4.00	$ 180,000.00
		Assume depth of stripping 12 inches or less					
		Assume stripping will be stockpiled for topsoil use					
	31	Excavation, common, for dam foundation	8312	1,260,000	CY	$ 5.00	$ 6,300,000.00
		Assume about 35% of volume requires ripping					
		Assume suitable materials will be stockpiled					
		for use as miscellaneous fill					
	32	Excavation, rock, for dam foundation	8312	2,000	CY	$ 48.00	$ 96,000.00
		Assume drill and blast in random locations					
		FOUNDATION TREATMENT					
		Includes misc. foundation surface treatment,					
		consolidation grouting, and curtain grouting					
		Miscellaneous Foundation Areas					
		Applied in areas of poor quality rock					
	33	Slush grouting of foundation surface	8312	36,000	SF	$ 6.00	$ 216,000.00
		Over assumed 30% of area beneath zone 1					
	34	Dental concrete	8312	2,000	CY	$ 200.00	$ 400,000.00
	35	Furnish/place zone 2 sand filter on foundation	8312	14,000	CY	$ 45.00	$ 630,000.00
		Over 10% of area between zone 1 and d/s toe					
		Assume a 3-ft thickness above and below zone 3					
	36	Furnish/place zone 3 gravel drain on foundation	8312	7,000	CY	$ 40.00	$ 280,000.00
		Between the zone 2 filters in a 3-ft thickness					
		Sheet Subtotal =					**$ 8,102,000.00**

QUANTITIES		PRICES	
BY Will Gonzales	**CHECKED** Bill Engemoen	**BY** Jerry Zander JZ	**CHECKED**
DATE PREPARED May 2, 2007	**PEER REVIEW** Chuck Redlinger	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Dam and Dike
Central Core Rockfill Dike

Dike Civil/Structural

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal

REGION PN | **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		FOUNDATION TREATMENT (continued)					
		Consolidation Grouting of Foundation					
		Generally limited to area beneath zone 1					
	37	Setups for drilling grout holes	8312	1,600	EA	$ 150.00	$ 240,000.00
		Assume 2-inch dia. drilled on 10-foot centers					
	38	Drill grout holes	8312	48,000	LF	$ 35.00	$ 1,680,000.00
		Assume 2-inch dia. w/length= 30 feet					
	39	Hookups to grout holes	8312	1,600	EA	$ 60.00	$ 96,000.00
	40	Pressure grout	8312	100,000	CF	$ 10.00	$ 1,000,000.00
		Assume grouting process only minus cement					
		Assume 2 CF per 1 LF of hole					
	41	Furnish and handle cement for pressure grouting	8312	100,000	BAGS	$ 10.00	$ 1,000,000.00
		Assume 1 bag per CF					
		Curtain Grouting of Foundation					
		Two-row curtain beneath zone 1					
	42	Setups for drilling grout holes	8312	500	EA	$ 150.00	$ 75,000.00
		Assume 2-rows of 2-inch dia.on 10-ft centers					
	43	Drill grout holes	8312	45,000	LF	$ 40.00	$ 1,800,000.00
		Assume 2-inch dia. w/length from 60 to 120 feet,					
		with an average of 90 feet					
	44	Hookups to grout holes	8312	500	EA	$ 60.00	$ 30,000.00
	45	Pressure grout	8312	135,000	CF	$ 10.00	$ 1,350,000.00
		Assume grouting process only minus cement					
		Assume 3 CF per 1 LF of hole					
	46	Furnish and handle cement for pressure grouting	8312	135,000	BAGS	$ 10.00	$ 1,350,000.00
		Assume 1 bag per CF					
		Sheet Subtotal =					**$ 8,621,000.00**

QUANTITIES		PRICES	
BY Will Gonzales	**CHECKED** Bill Engemoen	**BY** Jerry Zander	**CHECKED**
DATE PREPARED May 2, 2007	**PEER REVIEW** Chuck Redlinger	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Wymer Offstream Storage Facility Dam and Dike Central Core Rockfill Dike Dike Civil/Structural	Yakima River Basin Water Storage Study WOID: YRSSW — ESTIMATE LEVEL: Appraisal REGION: PN — PRICE LEVEL: Apr-07 FILE: C:\Documents and Settings\jwzander\My Documents\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Dam and Dike(8)

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					
	47	Furnish and place zone 1 core	8312	390,000	CY	$ 13.00	$ 5,070,000.00
		Acquired from source 5 miles from dam					
		Compacted to 6-inch lifts by tamping roller					
	48	Furnish and place zone 2 filter	8312	190,000	CY	$ 42.00	$ 7,980,000.00
		Sand/gravel material processed commercially					
		or developed onsite					
		If commercial, assume 18 mile one-way haul					
		Compacted to 12-inch layers by vibratory steel drum					
	49	Furnish and place zone 3 drain	8312	160,000	CY	$ 33.00	$ 5,280,000.00
		Gravel/cobble material processed commercially or					
		developed onsite					
		If commercial, assume 18 mile one-way haul					
		Compacted to 12-inch layers by vibratory steel drum					
	50	Furnish and place zone 4 rockfill	8312	2,000,000	CY	$ 12.00	$ 24,000,000.00
		Developed from basalt ridges surrounding reservoir					
		Assume average 2-mile haul to dam					
		Rock sizes up to 3-foot					
		Compacted in 3-ft layers by vibratory steel drum					
	51	Furnish and place miscellaneous fill	8312	500,000	CY	$ 9.00	$ 4,500,000.00
		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					
		Sheet Subtotal =					**$ 46,830,000.00**

QUANTITIES		PRICES	
BY Will Gonzales	CHECKED Bill Engemoen	BY Jerry Zander	CHECKED
DATE PREPARED May 2, 2007	PEER REVIEW Chuck Redlinger	DATE PREPARED May 31, 2007	PEER REVIEW

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Wymer Offstream Storage Facility Dam and Dike Central Core Rockfill Dike Dike Civil/Structural	Yakima River Basin Water Storage Study WOID: YRSSW — ESTIMATE LEVEL: Appraisal REGION: PN — PRICE LEVEL: Apr-07 FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

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					
		Sheet Subtotal =					$ -

QUANTITIES		PRICES	
BY Will Gonzales	CHECKED Bill Engemoen	BY Jerry Zander	CHECKED
DATE PREPARED May 2, 2007	PEER REVIEW Chuck Redlinger	DATE PREPARED May 31, 2007	PEER REVIEW

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Spillway and Outlet Works
Spillway

Civil

PROJECT:

Yakima River Basin Water Storage Study

WOID:	YRSSW	**ESTIMATE LEVEL:**	Appraisal
REGION	PN	**PRICE LEVEL:**	Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Uncontrolled Spillway (no gates)					
		Located on left abutment with crest at El. 1730					
		Earthwork	8130				
	1	Common excavation		560,000	CY	$ 5.00	$ 2,800,000.00
	2	Rock excavation (drill and blast)		145,000	CY	$ 21.00	$ 3,045,000.00
	3	Pervious backfill behind chute walls		4,000	CY	$ 11.50	$ 46,000.00
	4	Misc backfill behind chute walls		15,000	CY	$ 7.80	$ 117,000.00
	5	Riprap inlet structure		2,600	CY	$ 50.00	$ 130,000.00
	6	Bedding for riprap inlet structure		1,400	CY	$ 40.00	$ 56,000.00
	7	Riprap for stilling basin		1,700	CY	$ 50.00	$ 85,000.00
	8	Bedding for riprap stilling basin		1,000	CY	$ 40.00	$ 40,000.00
		Concrete	8130				
	9	Concrete in Inlet structure		1,100	CY	$ 1,290.00	$ 1,419,000.00
	10	Concrete in Crest structure		1,500	CY	$ 1,230.00	$ 1,845,000.00
	11	Concrete in Chute		14,500	CY	$ 795.00	$ 11,527,500.00
	12	Concrete in Stilling Basin structure		1,900	CY	$ 1,180.00	$ 2,242,000.00
	13	Furnish and place concrete reinforcement.		2,800,000	LBS	$ 1.40	$ 3,920,000.00
		Assume 150 #/CY					
	14	Furnish and handle cement (.282T/CY)		5,300	TONS	$ 130.00	$ 689,000.00
		Drains - Furnish and install	8130				
	15	6-inch dia PVC perf. And non perf. (90% perf.)		16,000	LF	$ 7.00	$ 112,000.00
	16	Furnish and install sand for drains		4,600	CY	$ 31.00	$ 142,600.00
	17	Furnish and install gravel for drains		4,000	CY	$ 31.00	$ 124,000.00
	18	Furnish and install 2-inch rigid insulation		130,000	SF	$ 2.10	$ 273,000.00
	19	Furnish and install 9-inch waterstops - spillway joints	8130	15,000	LF	$ 9.00	$ 135,000.00
	20	Drill and grout anchor bars	8130	370	EA	$ 180.00	$ 66,600.00
		(Total length of rock drilling= 1,850 feet)					
	21	Reinforcement for anchor bars	8130	9,400	LBS	$ 1.70	$ 15,980.00
	22	Furnish and install 48-inch chain link fencing	8130	6,300	LF	$ 20.00	$ 126,000.00
		for spillway					
		Sheet Subtotal =					**$ 28,956,680.00**

QUANTITIES		PRICES	
BY Tom Scobell	CHECKED	BY Jerry Zander	CHECKED
DATE PREPARED May 1, 2007	PEER REVIEW	DATE PREPARED May 31, 2007	PEER REVIEW

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Spillway and Outlet Works
Spillway

Civil/Structural

PROJECT:

Yakima River Basin Water Storage Study

WOID:	YRSSW	**ESTIMATE LEVEL:**	Appraisal
REGION	PN	**PRICE LEVEL:**	Apr-07

FILE: C:\DOCUME~1\Rlafond\LOCALS~1\Temp\[SpillwayandOW.estimateworksheet.Stanton.v3.xls]Spillway and Outlet Works

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Access Bridge across Spillway	8140				
	23	Furnish and install AASHTO Type III precast,		4	Each	$ 10,200.00	$ 40,800.00
		prestressed concrete beams, L = 65 feet					
	24	Furnish and place reinforced concrete for deck					
		parapets and diaphragms, f'c = 4,000 psi		60	CY	$ 1,850.00	$ 111,000.00
	25	Furnish and handle cement material		17	Tons	$ 195.00	$ 3,315.00
	26	Furnish and install epoxy coated reinforcing steel		16,000	LBS	$ 1.70	$ 27,200.00
		Fy = 60,000 psi					
	27	Furnish and install elastomeric bearing pads,		22	SF	$ 280.00	$ 6,160.00
		(3" x 1'-6" x 1'-10"), total # = 8					
	28	Furnish and install compression joint seals		54	LF	$ 8.00	$ 432.00
		DS Brown CV-3500 preformed neoprene					
		compression joint seals, or equal					
		Deck drains (2 per side)					
	29	R-4005-A2 as manufactured by NEENAH		4	EA	$ 525.00	$ 2,100.00
		Foundry or equal. Each one weighs~ 105 lbs					
	30	8-inch diameter black steel pipe, each L = 4'		16	LF	$ 190.00	$ 3,040.00
		Bridge will span spillway walls, which are 60-feet apart. The bridge superstructure will be supported on bearing seats, formed onto the spillway walls. Therefore, no foundation elements are included in this estimate worksheet.					
		The bridge is located near the left abutment. The dam crest will be gravel surfaced. Chain link fence is required along the length of the spillway, so it is not included here. No approach guardrail is included in this estimate (see roadwork estimate).					
		Water treatment for deck drainage is not included in this estimate.					
		Sheet Subtotal =					**$ 194,047.00**

QUANTITIES		PRICES	
BY Jesus G. Romero	**CHECKED** Nicholas W. Clough, PE	**BY** Jerry Zander	**CHECKED**
DATE PREPARED 5/1/07	**PEER REVIEW** David K. Edwards, PE	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Spillway and Outlet Works
Outlet Works

Civil

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal
REGION PN | **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Earthwork U/S - channel, intake, conduit, portal	8130				
	31	Excavate common materials for structures		500	CY	$ 35.00	$ 17,500.00
	32	Excavate rock materials for structures (drill & shoot)		1,500	CY	$ 44.00	$ 66,000.00
	33	F & P bedding for riprap (processed on-site)		70	CY	$ 40.00	$ 2,800.00
	34	F & P rockfill from dam excavation (riprap)		140	CY	$ 47.00	$ 6,580.00
	35	Furnish and install chain link fabric around portal		1,750	SF	$ 3.00	$ 5,250.00
	36	F&I 18-inch x 1/2 in. dia resin anchors for fabric support		24	EA	$ 50.00	$ 1,200.00
		Earthwork D/S - portal, conduit, house, stilling basin	8130				
	37	Excavate common materials for structures		1,000	CY	$ 35.00	$ 35,000.00
	38	Excavate rock materials for structures (drill & shoot)		3,000	CY	$ 42.00	$ 126,000.00
	39	Excavate common materials for basin		12,000	CY	$ 10.00	$ 120,000.00
	40	Excavate rock materials for basin (drill & shoot)		4,000	CY	$ 42.00	$ 168,000.00
	41	F & P bedding for riprap (processed on-site)		4,500	CY	$ 26.00	$ 117,000.00
	42	F & P rockfill from dam excavation (riprap)		2,250	CY	$ 45.00	$ 101,250.00
	43	Furnish and install chain link fabric around portal		2,000	SF	$ 3.00	$ 6,000.00
	44	F&I 18-inch x 1/2 in. dia resin anchors for fabric support		30	EA	$ 50.00	$ 1,500.00
		Construct ROW tunnel u/s of gate chamber	8130				
	45	Drill and shoot 13.5-ft O.D.circular shaped u/s tunnel		850	LF	$ 2,000.00	$ 1,700,000.00
	46	Remove and stockpile rock (assume local stockpile)		4,500	CY	$ 19.00	$ 85,500.00
		Furnish, drill and install 750-10-ft long x 1-inch dia.					
	47	A307, 20K rockbolts		5,200	LF	$ 72.00	$ 374,400.00
	48	Furnish and install 6 steel sets (W8 x 40) (full circle)		11,400	LBS	$ 6.00	$ 68,400.00
		Construct ROW tunnel d/s of gate chamber	8130				
	49	Drill and shoot 19-ft OD circular shaped d/s tunnel		1,200	LF	$ 2,800.00	$ 3,360,000.00
	50	Remove and stockpile rock (assume local stockpile)		13,000	CY	$ 19.00	$ 247,000.00
		Furnish, drill and install 1250-10-ft long x 1-inch dia.					
	51	A307, 20K rockbolts		8,800	LF	$ 72.00	$ 633,600.00
	52	Furnish and install 6 steel sets (W10 x 40) in crown		20,000	LBS	$ 6.00	$ 120,000.00
		Construct Gate chamber					
	53	Drill and shoot 20-ft OD spherical shaped chamber		20	LF	$ 3,000.00	$ 60,000.00
	54	Remove and stockpile rock (assume local stockpile)		340	CY	$ 23.00	$ 7,820.00
		Furnish, drill and install 30-10-ft long x 1-inch dia.					
	55	A307, 20K rockbolts		300	LF	$ 140.00	$ 42,000.00
		Sheet Subtotal =					**$ 7,472,800.00**

QUANTITIES		PRICES	
BY Doug Stanton	CHECKED	BY J.erry Zander	CHECKED
DATE PREPARED May 1, 2007	PEER REVIEW	DATE PREPARED May 31, 2007	PEER REVIEW

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Spillway and Outlet Works
Outlet Works

Civil

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW **ESTIMATE LEVEL:** Appraisal

REGION PN **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct Upper Intake Structure					
	56	FFP reinf. Conc - Upper Intake structure	8130	250	CY	$ 1,500.00	$ 375,000.00
	57	Furnish and place reinforcement (est 200#/CY)		50,000	LBS	$ 1.60	$ 80,000.00
	58	Furnish and handle cement (.282T/CY)		71	TONS	$ 180.00	$ 12,780.00
	59	FFP reinf. Conc (Steel lined) upper intake shaft (L=30')	8130	80	CY	$ 2,050.00	$ 164,000.00
	60	Furnish and place reinforcement (est 150#/CY)		12,000	LBS	$ 1.70	$ 20,400.00
	61	Furnish and handle cement (.282T/CY)		23	TONS	$ 190.00	$ 4,370.00
		Construct Intake Shaft	8130				
	62	Drill and shoot 13.5-ft OD vertical shaft		30	LF	$ 180.00	$ 5,400.00
	63	Remove and stockpile rock (assume local stockpile)		160	CY	$ 60.00	$ 9,600.00
		Furnish, drill and install 12-10-ft long x 1-inch dia.					
	64	A307, 20K rockbolts		120	LF	$ 81.00	$ 9,720.00
		Ring Grout Upper Intake Shaft	8130				
	65	Setups for drilling grout holes (2-in dia holes, 1 ring		1	EA	$ 500.00	$ 500.00
		with 6 holes per ring					
	66	Drill grout holes (2-in dia and L=25 ft)		150	LF	$ 70.00	$ 10,500.00
	67	Hookups to grout holes		6	EA	$ 100.00	$ 600.00
	68	Pressure grout (grouting process only minus cement)		300	CF	$ 15.00	$ 4,500.00
		Assume 2 CF per 1 LF of hole					
	69	Furnish and handle cement for pressure grouting		300	BAGS	$ 17.00	$ 5,100.00
		Assume 1 bag per CF					
		Sheet Subtotal =					**$ 702,470.00**

QUANTITIES		PRICES	
BY Doug Stanton (signed)	**CHECKED** (signed)	**BY** J.erry Zander (signed)	**CHECKED** (signed)
DATE PREPARED May 1, 2007	**PEER REVIEW** (signed)	**DATE PREPARED** May 31, 2007	**PEER REVIEW** (signed)

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Spillway and Outlet Works
Outlet Works

Civil

PROJECT:

Yakima River Basin Water Storage Study

WOID:	YRSSW	**ESTIMATE LEVEL:**	Appraisal
REGION	PN	**PRICE LEVEL:**	Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Ring Grout Upstream Conduit	8130				
	70	Setups for drilling grout holes (2-in dia holes, 20 ft ctrs,		43	EA	$ 250.00	$ 10,750.00
		and 6 holes per ring)					
	71	Drill grout holes (2-in dia and L=25 ft)		6,450	LF	$ 50.00	$ 322,500.00
	72	Hookups to grout holes		260	EA	$ 50.00	$ 13,000.00
	73	Pressure grout (grouting process only minus cement)		13,000	CF	$ 13.00	$ 169,000.00
		Assume 2 CF per 1 LF of hole					
	74	Furnish and handle cement for pressure grouting		13,000	BAGS	$ 15.00	$ 195,000.00
		Assume 1 bag per CF					
		Ring Grout Gate Chamber	8130				
	75	Setups for drilling grout holes (2-in dia holes, low, mid		3	EA	$ 400.00	$ 1,200.00
		and high rings and 6 holes per ring					
	76	Drill grout holes (2-in dia and L=25 ft)		450	LF	$ 60.00	$ 27,000.00
	77	Hookups to grout holes		18	EA	$ 70.00	$ 1,260.00
	78	Pressure grout (grouting process only minus cement)		900	CF	$ 14.00	$ 12,600.00
		Assume 2 CF per 1 LF of hole					
	79	Furnish and handle cement for pressure grouting		900	BAGS	$ 16.00	$ 14,400.00
		Assume 1 bag per CF					
		Sheet Subtotal =					**$ 766,710.00**

QUANTITIES		PRICES	
BY Doug Stanton	CHECKED	BY Jerry Zander	CHECKED
DATE PREPARED May 1, 2007	PEER REVIEW	DATE PREPARED May 31, 2007	PEER REVIEW

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Spillway and Outlet Works
Outlet Works

Civil

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal

REGION PN | **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\|Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Construct ROW cast in place (CIP) concrete	8130				
	80	Furnish, form, and place reinf. Conc - Intake structure		250	CY	$ 1,500.00	$ 375,000.00
	81	Furnish and place reinforcement (est 200#/CY)		50,000	LBS	$ 1.60	$ 80,000.00
	82	Furnish and handle cement (.282T/CY)		71	TONS	$ 180.00	$ 12,780.00
	83	FFP reinf. Conc - Steel lined U/S conduit (L=50' u/s of tunnel)		375	CY	$ 1,500.00	$ 562,500.00
	84	Furnish and place reinforcement (est 150#/CY)		56,250	LBS	$ 1.60	$ 90,000.00
	85	Furnish and handle cement (.282T/CY)		106	TONS	$ 175.00	$ 18,550.00
	86	FFP reinf. Conc - Steel lined U/S tunnel (L=850')		2,300	CY	$ 1,150.00	$ 2,645,000.00
	87	Furnish and place reinforcement (est 150#/CY)		350,000	LBS	$ 1.50	$ 525,000.00
	88	Furnish and handle cement (.282T/CY)		650	TONS	$ 150.00	$ 97,500.00
	89	FFP reinf. Concrete in gate chamber		180	CY	$ 1,650.00	$ 297,000.00
	90	Furnish and place reinforcement (160#/CY)		29,000	LBS	$ 1.70	$ 49,300.00
	91	Furnish and handle cement (.282T/CY)		51	TONS	$ 180.00	$ 9,180.00
	92	FFP reinf. Concrete - D/S tunnel (L=1200')		5,200	CY	$ 990.00	$ 5,148,000.00
		includes walkway and saddles					
	93	Furnish and place reinforcement (est 150#/CY)		780,000	LBS	$ 1.45	$ 1,131,000.00
	94	Furnish and handle cement (.282T/CY)		1,500	TONS	$ 145.00	$ 217,500.00
	95	FFP reinf. concrete - D/S conduit (L=130 ft d/s of tunnel)		290	CY	$ 1,500.00	$ 435,000.00
		includes walkway and saddles					
	96	Furnish and place reinforcement (est 150#/CY)		43,500	LBS	$ 1.60	$ 69,600.00
	97	Furnish and handle cement (.282T/CY)		82	TONS	$ 175.00	$ 14,350.00
	98	FFP reinf. concrete - D/S access house (30' x 30' x 12' tall)		580	CY	$ 1,400.00	$ 812,000.00
		includes wingwalls					
	99	Furnish and place reinforcement (est 150#/CY)		87,000	LBS	$ 1.60	$ 139,200.00
	100	Furnish and handle cement (.282T/CY)		164	TONS	$ 170.00	$ 27,880.00
	101	Furnish and install 48-inch chain link fencing	8130				
		on wingwalls @ Control House		80	LF	$ 43.00	$ 3,440.00
		Sheet Subtotal =					**$ 12,759,780.00**

QUANTITIES

BY Doug Stanton — CHECKED

DATE PREPARED May 1, 2007 — PEER REVIEW

PRICES

BY Jerry Zander — CHECKED

DATE PREPARED May 31, 2007 — PEER REVIEW

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Spillway and Outlet Works
Outlet Works

Mechanical

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW **ESTIMATE LEVEL:** Appraisal

REGION PN **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\|Final Est - Wymer PP and Reservoir.xls|Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Mechanical	8410				
	102	Heating and Ventilating Systems for Outlet Works	8410	1	L.S.	$ 160,000.00	$ 160,000.00
		Access Tunnel and Control House:					
		Consists of:					
		2 - Electric unit heater; 7.5 kw					
		1 - Centrifugal fan; 750 cfm					
		1 - Propeller fan; 2400 cfm					
		1 - Axial fan: 6,000 cfm					
		1,900 ft. Oval steel duct; 38-inch x 16-inch, galvanized					
		2 - Control damper; 60-inch by 60-inch; motor-operated					
		2 - Control damper; 32-inch by 32-inch; motor-operated					
		2 - 60-inch by 60-inch stationary louver					
		2 - 32-inch by 32-inch stationary louver					
		Lower Intake					
	103	Trashracks (steel)	8410	32,400	LBS	$ 8.00	$ 259,200.00
	104	Bulkhead gate (13' x 13'), bulkhead gate frame	8410	93,800	LBS	$ 6.50	$ 609,700.00
		and guides above frame (steel)					
		Upper Intake					
	105	Trashracks (steel)	8410	32,400	LBS	$ 8.00	$ 259,200.00
	106	Bulkhead gate (13' x 13'), bulkhead gate frame	8410	86,300	LBS	$ 6.50	$ 560,950.00
		and guides above frame (steel)					
	107	Ultrasonic flowmeter, 2-path	8410	1	L.S.	$ 95,000.00	$ 95,000.00
	108	50 Kw Diesel engine-generator set with 125 gallon	8410	1	L.S.	$ 60,000.00	$ 60,000.00
		fuel tank (assume ConVault)					
		Sheet Subtotal =					**$ 2,004,050.00**

QUANTITIES		PRICES	
BY John Grass, Paul Schlein, Rick Christensen	CHECKED Rick Christensen	BY Jerry Zander, Dan Mar	CHECKED
DATE PREPARED April 28, 2007	PEER REVIEW Dave Hulse	DATE PREPARED May 31, 2007	PEER REVIEW

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Spillway and Outlet Works
Outlet Works

Mechanical

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW **ESTIMATE LEVEL:** Appraisal

REGION PN **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Steel Pipe	8420				
	109	114-inch ID steel liner		900	LF	$ 2,700.00	$ 2,430,000.00
		(7/8-inch wall, 1074 lb per lin. ft.)					
	110	102-inch ID steel pipe, Supported on concrete saddles		1,330	LF	$ 1,400.00	$ 1,862,000.00
		(1/2-inch wall, 547 lb per lin. ft.)					
	111	72-inch ID steel pipe, encased in concrete		60	LF	$ 3,900.00	$ 234,000.00
		(3/8-inch wall, 290 lb per lin. ft.)					
	112	30-inch ID steel pipe					
		(1/4-inch wall, 80 lb per lin. ft.)		30	LF	$ 200.00	$ 6,000.00
	113	24-inch ID steel pipe for air vent					
		(1/4-inch wall, 64 lb per lin. ft.)		20	LF	$ 160.00	$ 3,200.00
	114	14-inch ID steel pipe for filling line					
		(1/4-inch wall, 38 lb per lin. ft.)		20	LF	$ 95.00	$ 1,900.00
		Valves					
	115	AWWA Class 250, manually operated butterfly valve (for air vent):					
		1 -24" Diameter valve, 1350 lbs. per valve.		1,350	LBS	$ 8.00	$ 10,800.00
	116	Combination air valve (for air vent to prevent vacuum)					
		1 -24" Diameter valve, 2600 lbs. per valve.		2,600	LBS	$ 10.00	$ 26,000.00
	117	AWWA Class 300, hydraulically operated ball valve:					
		1 -30" Diameter valve, 5900 lbs. per valve.		5,900	LBS	$ 14.00	$ 82,600.00
	118	AWWA Class 250, manually operated (filling line)butterfly valves:					
		2 -14" Diameter valves, 450 lbs. per valve.		900	LBS	$ 10.00	$ 9,000.00
		Sheet Subtotal =					**$ 4,665,500.00**

QUANTITIES		PRICES	
BY Rick Frisz	CHECKED Ken Smith	BY Jerry Zander JZ	CHECKED JZ
DATE PREPARED 4-30-07	PEER REVIEW KRS	DATE PREPARED May 31, 2007	PEER REVIEW DCD

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Wymer Offstream Storage Facility Spillway and Outlet Works **Outlet Works** Mechanical	Yakima River Basin Water Storage Study WOID: YRSSW — ESTIMATE LEVEL: Appraisal REGION: PN — PRICE LEVEL: Apr-07 FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Gates and Gate Controls					
		Furnish and Install					
		7'x9' Hydraulically-actuated outlet gate					
	119	Head = 367 feet	8420	102,000	LBS	$ 8.00	$ 816,000.00
		Two tandem sets 4'x6' hydraulically-actuated outlet gates					
	120	Head = 367 feet	8420	130,000	LBS	$ 9.00	$ 1,170,000.00
		30" Hydraulically-actuated jet-flow gate and stand					
	121	Head = 367 feet	8420	10,000	LBS	$ 10.00	$ 100,000.00
		Hydraulic controls for 7'x9' emergency outlet gate, and					
	122	four 4'x6' outlet gates	8420	3,200	LBS	$ 11.00	$ 35,200.00
	123	Hydraulic controls for 30" jet-flow gate	8420	800	LBS	$ 12.00	$ 9,600.00
		Sheet Subtotal =					**$ 2,130,800.00**

QUANTITIES		PRICES	
BY Don Read	CHECKED Rick Frisz	BY Jerry Zander	CHECKED
DATE PREPARED May 1, 2007	PEER REVIEW	DATE PREPARED May 31, 2007	PEER REVIEW

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Spillway and Outlet Works
Outlet Works

Mechanical

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW **ESTIMATE LEVEL:** Appraisal

REGION PN **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Electrical					
		Bldg Electrical Service Equipment (F&I)	8430				
	124	600 volt motor control center, 3-phase, 800 amp bus		1	EA	$ 40,000.00	$ 40,000.00
		Four 20 inch wide sections					
		5 NEMA size 1 FVR contactors *					
		Three 100 A, 3-pole molded-case circuit breakers					
	125	Transformer load center		1	EA	$ 18,500.00	$ 18,500.00
		30 kVA, 3-phase, 480-208Y/120 volt					
		Lighting System (F&I)	8430				
	126	120 volt, fluorescent NEMA Type 4 fixtures for control		1	LS	$ 65,000.00	$ 65,000.00
		house, 1900 foot long tunnel, & gate chamber					
		* FVR - Full-voltage reversing					
		Assumptions:					
		Bringing power to dam is part of unlisted items					
		Sheet Subtotal =					$ 123,500.00

QUANTITIES		PRICES	
BY Mike Schuh	CHECKED [signature]	BY Dan Mar [signature]	CHECKED [signature]
DATE PREPARED April 25, 2007	PEER REVIEW George Girgis [signature]	DATE PREPARED May 31, 2007	PEER REVIEW [signature]

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Diversion During Dam Construction

Geotechnical

PROJECT:

Yakima River Basin Water Storage Study

WOID:	YRSSW	**ESTIMATE LEVEL:**	Appraisal
REGION	PN	**PRICE LEVEL:**	Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Excavation					
		For Cofferdam					
	1	Common		4,400	CY	$ 20.00	$ 88,000.00
		(assume alluvial soils; no dewatering)					
		Cofferdam					
	2	Embankment fill		171,000	CY	$ 16.00	$ 2,736,000.00
		(assume overburden from dam excavation					
		is used; probably of mix of silts to gravels,					
		placed and compacted in 9-inch lifts)					
	3	Geomembrane		13,000	SY	$ 15.00	$ 195,000.00
		(assume 40-mil HDPE)					
	4	Geotextile		26,000	SY	$ 3.00	$ 78,000.00
		(assume 16-ounce non-woven fabric)					
		Sheet Subtotal =					**$ 3,097,000.00**

QUANTITIES		PRICES	
BY Bill Engemoen	**CHECKED** [signature]	**BY** Jerry Zander [signature]	**CHECKED** M.C. [signature]
DATE PREPARED May 2, 2007	**PEER REVIEW** Chuck Redlinger	**DATE PREPARED** May 31, 2007	**PEER REVIEW** [signature]

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Diversion During Dam Construction

Civil/Structural

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW **ESTIMATE LEVEL:** Appraisal

REGION PN **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Diversion (4)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Excavation					
		For 6-foot pipe and saddles	8130				
	5	Common		4,000	CY	$ 16.00	$ 64,000.00
		(Assume alluvial soil and weathered rock; no dewatering)					
	6	Rock		2,000	CY	$ 42.00	$ 84,000.00
		(Assume drill and blast; no dewatering)					
	7	Furnish and place reinforced concrete for pipe supports	8130	20	CY	$ 2,000.00	$ 40,000.00
		spaced @ 40 feet (16 required)					
	8	Furnish and place unreinforced concrete thrust blocks	8130	75	CY	$ 800.00	$ 60,000.00
		Assume 2 blocks 10 x 10 x 10 @ 3000 psi					
	9	Furnish and handle cement (.212T/CY)	8130	22	TONS	$ 190.00	$ 4,180.00
	10	Furnish and place concrete reinforcement.	8130	3,400	LBS	$ 1.80	$ 6,120.00
		Assume 170 #/CY					
		Sheet Subtotal =					**$ 258,300.00**

QUANTITIES		PRICES	
BY Doug Stanton	**CHECKED**	**BY** Jerry Zander	**CHECKED** M.C.
DATE PREPARED May 1, 2007	**PEER REVIEW**	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Diversion During Dam Construction

Mechanical/Electrical

PROJECT: Yakima River Basin Water Storage Study

WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal

REGION PN | **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\|Final Est - Wymer PP and Reservoir.xls|Diversion (4)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Diverting Stream into Diversion pipe					
		Dewatering Pumps:	8420				
	11	Two - 10 cfs (4500 gpm) Flygt C 3300 Wastewater Submersible Pumps, low head (LT), Curve/ Impeller No. 809, S-installation, 20' TDH, 900 rpm, 50 hp (34 kW), ~12" disch., 3 ph/60 Hz/460 V (2300 lbs. ea.)		4,600	lbs	$ 20.00	$ 92,000.00
		Submersible electrical cable	8430				
	12	3 - power conductor, 600 V, #4 AWG		500	LF	$ 20.00	$ 10,000.00
	13	2 - thermal sensor cables, #10 AWG		500	LF	$ 1.50	$ 750.00
	14	1 - ground cable, #6 AWG		500	LF	$ 2.00	$ 1,000.00
	15	Combination pump motor starters, 600 volt, NEMA 4 enclosure, Size 3, non-reversing contactor	8430	2	each	$ 5,500.00	$ 11,000.00
	16	Pump sump level controls	8430				
		2 floats, control relay in a NEMA 4 enclosure		1	each	$ 1,600.00	$ 1,600.00
	17	Pumping Costs					
		Estimate pumping 6 hours per day for 2 years		4,400	HRS	$ 95.00	$ 418,000.00
		Sheet Subtotal =					**$ 534,350.00**

QUANTITIES		PRICES	
BY R. Zelenka	**CHECKED** T. Hummel 4/26/07	**BY** Dan Mar	**CHECKED** A.C.
DATE PREPARED April 25, 2007	**PEER REVIEW** T. Hummel 4/26/07	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Diversion During Construction

Mechanical

PROJECT: Yakima River Basin Water Storage Study

WOID:	YRSSW	**ESTIMATE LEVEL:**	Appraisal
REGION	PN	**PRICE LEVEL:**	Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Summary

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Diverting Stream into Diversion pipe					
		Steel Pipe	8420				
	18	72-inch dia. Steel pipe, 5/16-in thick wall, 241 lb/ft		600	LF	$ 780.00	$ 468,000.00
	19	20-inch dia. Sch. 10, 1/4-in thick wall, 53 lb/ft		250	LF	$ 170.00	$ 42,500.00
	20	12-inch dia. Sch. 20, 1/4-in thick wall, 34 lb/ft		50	LF	$ 110.00	$ 5,500.00
		Valves	8420				
	21	2 - 12-inch, Class 125 Double door check valves					
		(150 lbs. each)		300	lbs	$ 11.00	$ 3,300.00
	22	2 - 12-inch, Class 150 AWWA Butterfly Valves					
		(250 lbs. each)		500	lbs	$ 11.00	$ 5,500.00
		Sheet Subtotal =					**$ 524,800.00**

QUANTITIES		PRICES	
BY Rick Frisz	**CHECKED** Bob Zelenka	**BY** Jerry Zander	**CHECKED**
DATE PREPARED April, 30, 2007	**PEER REVIEW**	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:	PROJECT:
Wymer Offstream Storage Facility Road and Creek Improvements Dam and Dike Access Roads Civil/Structural	Yakima River Basin Water Storage Study WOID: YRSSW — ESTIMATE LEVEL: Appraisal REGION: PN — PRICE LEVEL: Apr-07 FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		CIVIL - ROAD					
		All roadway sections assume two 12' lanes w/o shoulders, 3:1 sloped ditches to 1' depth, and cut slopes of 2:1. A slope greater than 12% was utilized in several areas. Upon final design, alignment will be modified to better suit existing earthwork conditions and eliminate slopes greater than 12%.					
		Road from SH821 to other side of Dam					
		8200 LF of roadway					
	1	Excavation		25,000	CY	$ 6.00	$ 150,000.00
	2	Compacted Embankment		52,000	CY	$ 6.80	$ 353,600.00
	3	Gravel Surfacing (6" Depth)		7,000	TON	$ 45.00	$ 315,000.00
	4	24" CMP Culvert (assume five 35' lengths)		595	LF	$ 60.00	$ 35,700.00
	5	Metal Beam Guard Railing with Wooden Post to be installed across dam		6,400	LF	$ 38.00	$ 243,200.00
		Road from access house to other side of dike					
		2600 LF of roadway					
	6	Excavation		5,700	CY	$ 11.00	$ 62,700.00
	7	Compacted Embankment		13,000	CY	$ 11.00	$ 143,000.00
	8	Gravel Surfacing (6" Depth)		4,300	TON	$ 45.00	$ 193,500.00
	9	24" CMP Culvert (assume four 35' lengths)		175	LF	$ 60.00	$ 10,500.00
	10	Metal Beam Guard Railing with Wooden Post to be installed across dike		5,200	LF	$ 38.00	$ 197,600.00
		Road from SH821 to outlet works					
		3600 LF of roadway					
	11	Excavation		100	CY	$ 50.00	$ 5,000.00
	12	Compacted Embankment		330	CY	$ 22.00	$ 7,260.00
	13	Gravel Surfacing (6" Depth)		3,000	TON	$ 50.00	$ 150,000.00
	14	24" CMP Culvert (assume two 35' lengths)		245	LF	$ 60.00	$ 14,700.00
		Sheet Subtotal =					**$ 1,881,760.00**

QUANTITIES		PRICES	
BY Nick Clough	CHECKED Chris Duke, Anne Pavol	BY Jerry Zander	CHECKED M.C.
DATE PREPARED May 2, 2007, Revised May 9, 2007	PEER REVIEW Dave Edwards	DATE PREPARED May 31, 2007	PEER REVIEW

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Road and Creek Improvements
Improvements to Existing Lmuma Creek

Civil/Structural

PROJECT:

Yakima River Basin Water Storage Study

WOID:	YRSSW	**ESTIMATE LEVEL:**	Appraisal
REGION	PN	**PRICE LEVEL:**	Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		Earthwork (Lmuma Creek)					
	15	Common excavation of outlet channel	8140	86,000	CY	$ 5.00	$ 430,000.00
	16	Embankment	8140	11,500	CY	$ 10.00	$ 115,000.00
	17	Compacted Embankment	8140	11,501	CY	$ 7.00	$ 80,507.00
	18	Furnish/place rock riprap (d50 6", d100 12"), 120lb/cf	8140	24,000	TONS	$ 30.00	$ 720,000.00
	19	Furnish/place geotextile	8140	45,000	SY	$ 13.00	$ 585,000.00
	20	Furnish 7 steel sheet pile control structures	8140	17,000	SF	$ 20.00	$ 340,000.00
		using AZ13 sheet piles					
	21	Excavation for sheet piles	8140	1,300	CY	$ 25.00	$ 32,500.00
	22	Furnish and place cement bentonite slurry	8140	1,300	CY	$ 120.00	$ 156,000.00
	23	Furnish and handle cement in cement bentonite slurry	8140	195	TONS	$ 210.00	$ 40,950.00
		Sheet Subtotal =					**$ 2,499,957.00**

QUANTITIES		PRICES	
BY K. A. Sayer	**CHECKED** Anne Pavol	**BY** Jerry Zander	**CHECKED**
DATE PREPARED May 1, 2007	**PEER REVIEW** David K. Edwards	**DATE PREPARED** May 31, 2007	**PEER REVIEW**

BUREAU OF RECLAMATION

ESTIMATE WORKSHEET

FEATURE:

Wymer Offstream Storage Facility
Road and Creek Improvements
I-82 Bridge Protection

Civil/Structural

PROJECT: Yakima River Basin Water Storage Study

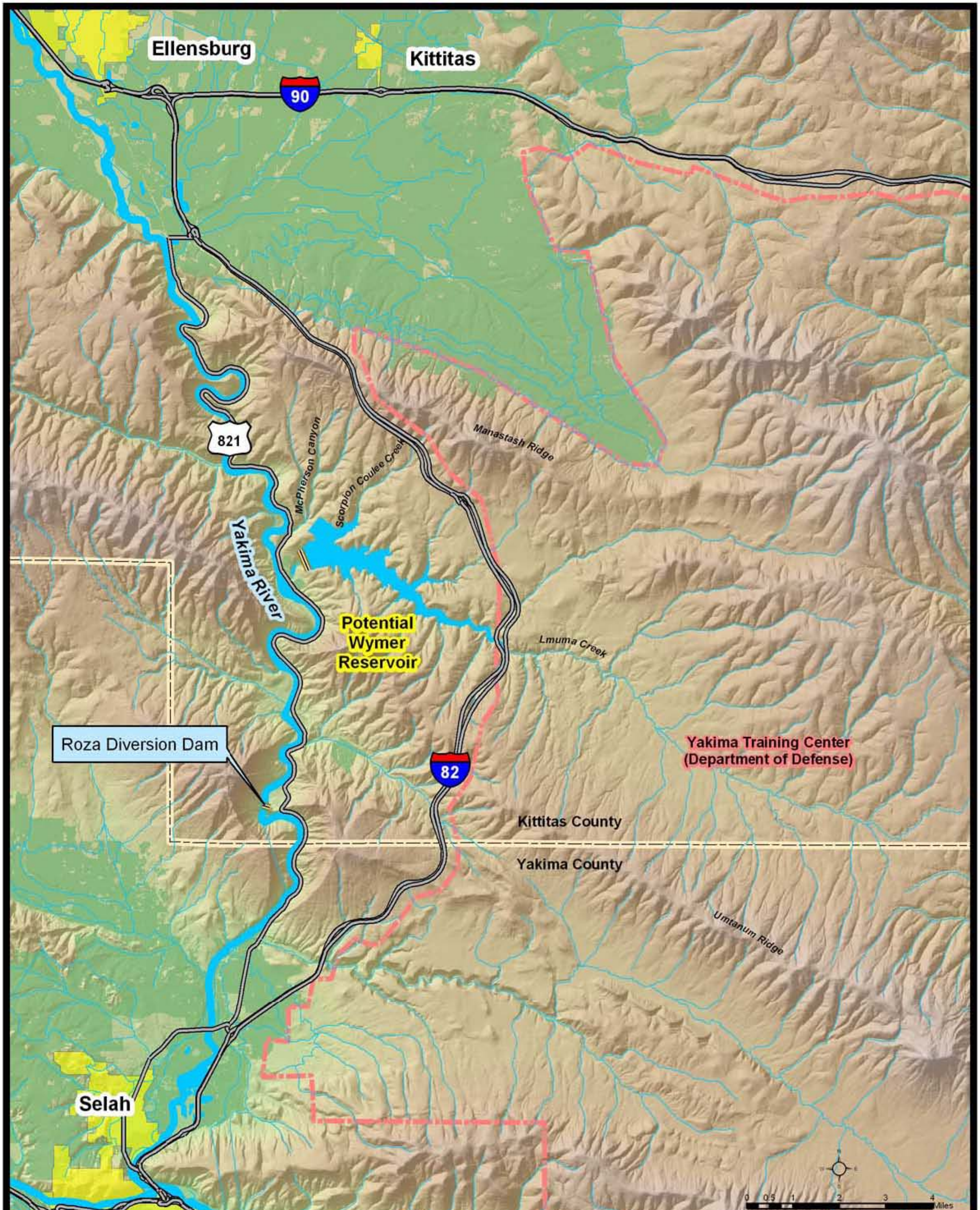
WOID: YRSSW | **ESTIMATE LEVEL:** Appraisal

REGION PN | **PRICE LEVEL:** Apr-07

FILE: J:\2007 JWZ Estimates\Wymer Dam\Total Final Est\[Final Est - Wymer PP and Reservoir.xls]Discharge (6)

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
		I-82 Bridges					
		Protect existing 2:1 slope bridge embankments					
		Apply waterproof membrane to existing bridge piers					
		that will be submerged					
		Embankment Protection					
	24	Furnish and place riprap on embankments, (D50 = 24")	8140	34,000	TONS	$ 30.00	$ 1,020,000.00
	25	Furnish and place riprap bedding	8140	16,000	TONS	$ 20.00	$ 320,000.00
	26	Excavate existing protection (18" deep)	8140	10,500	CY	$ 15.00	$ 157,500.00
		Bridge Pier Protection					
		Apply membrane to Bridge piers					
	27	Water jet face of piers	8140	490	SY	$ 20.00	$ 9,800.00
	28	Remove spalling concrete (5% total area)	8140	25	SY	$ 50.00	$ 1,250.00
	29	Furnish and install liquid applied CIM 1000 urethane	8140	490	SY	$ 11.00	$ 5,390.00
		(spray application)					
	30	Furnish and install liquid applied CIM 61 primer	8140	490	SY	$ 13.00	$ 6,370.00
		(spray application)					
		coating on piers manufactured by					
		Permabond, Inc. Telephone (801) 465-2890.					
		Contact: Stan Terry 720-368-1357					
		Sheet Subtotal =					**$ 1,520,310.00**

QUANTITIES		PRICES	
BY Joe Gemperline	**CHECKED** Anne Pavol	**BY** Jerry Zander (initialed)	**CHECKED** M.C. (initialed)
DATE PREPARED April 30, 2007	**PEER REVIEW** David K. Edwards	**DATE PREPARED** May 31, 2007	**PEER REVIEW** (signed)



Potential Wymer Reservoir

This reference graphic is intended for informational purposes only. It is meant to assist in feature location relative to other landmarks. Geographic features have been intentionally simplified in an attempt to provide a more readable product. No representation is made as to accuracy of this document.

Figure 1

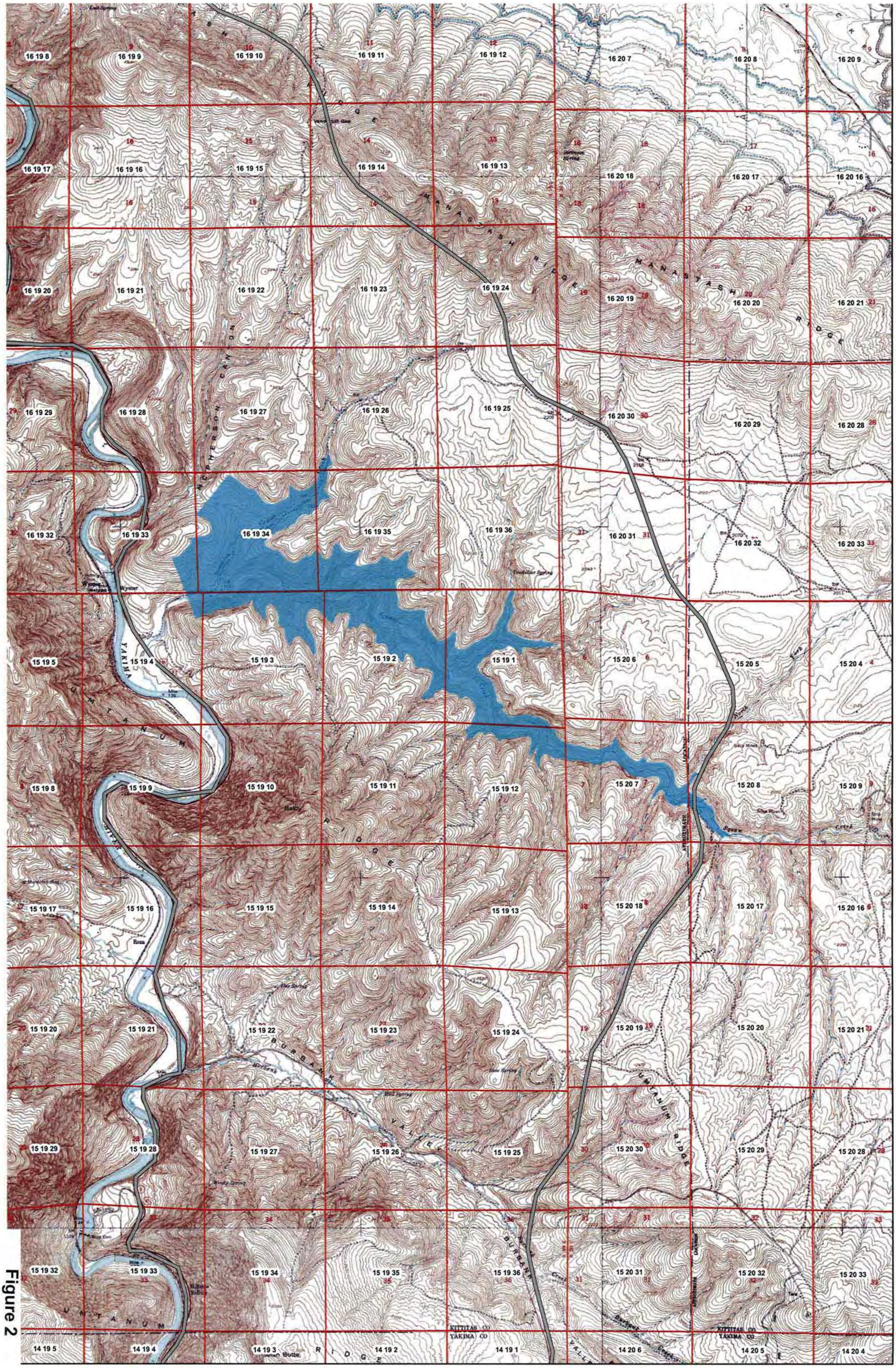
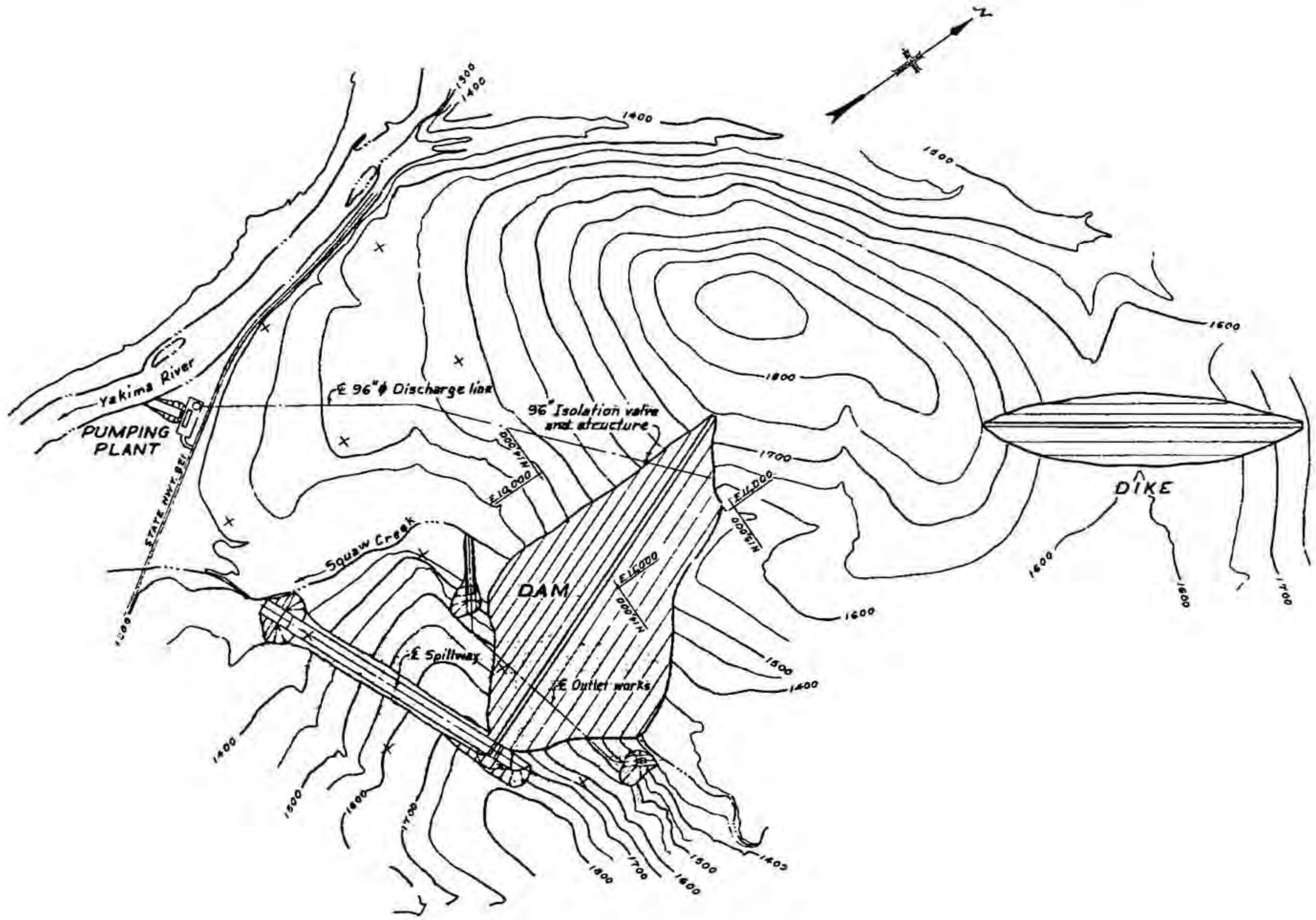


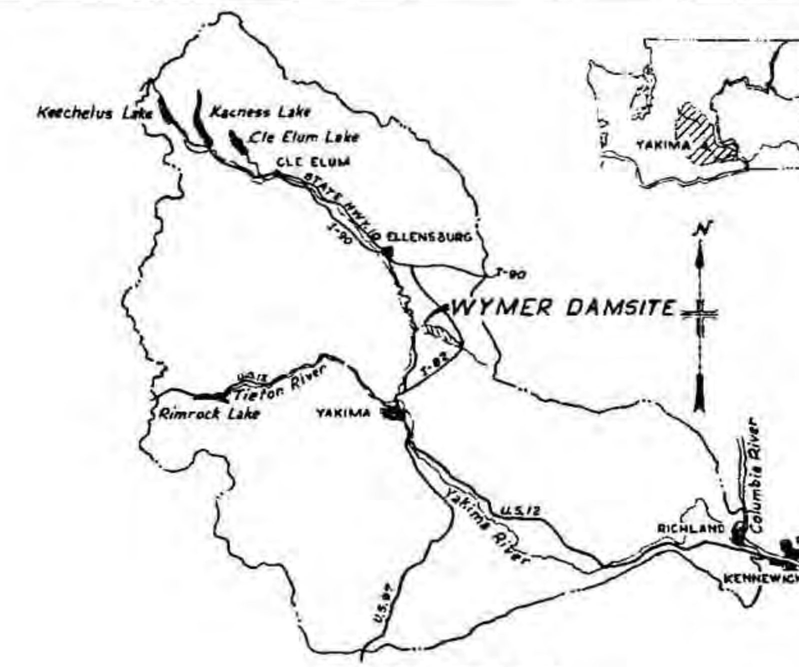
Figure 2

Potential Wymer Reservoir Reference



PROJECT GENERAL PLAN

SCALE OF FEET



Yakima River Basin
VICINITY MAP

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN
WATER ENHANCEMENT PROJECT-WASHINGTON

WYMER DAM
PLANNING DESIGN

DESIGNED ... SUBMITTED ...
DRAWN ... RECOMMENDED ...
CHECKED ... APPROVED ...
ACT. ASST. C. - MM. - ENGINEERING & RESEARCH

DENVER, COLORADO MARCH 22, 1985 SHEET 1 OF 3 1407-D-5

Figure 3

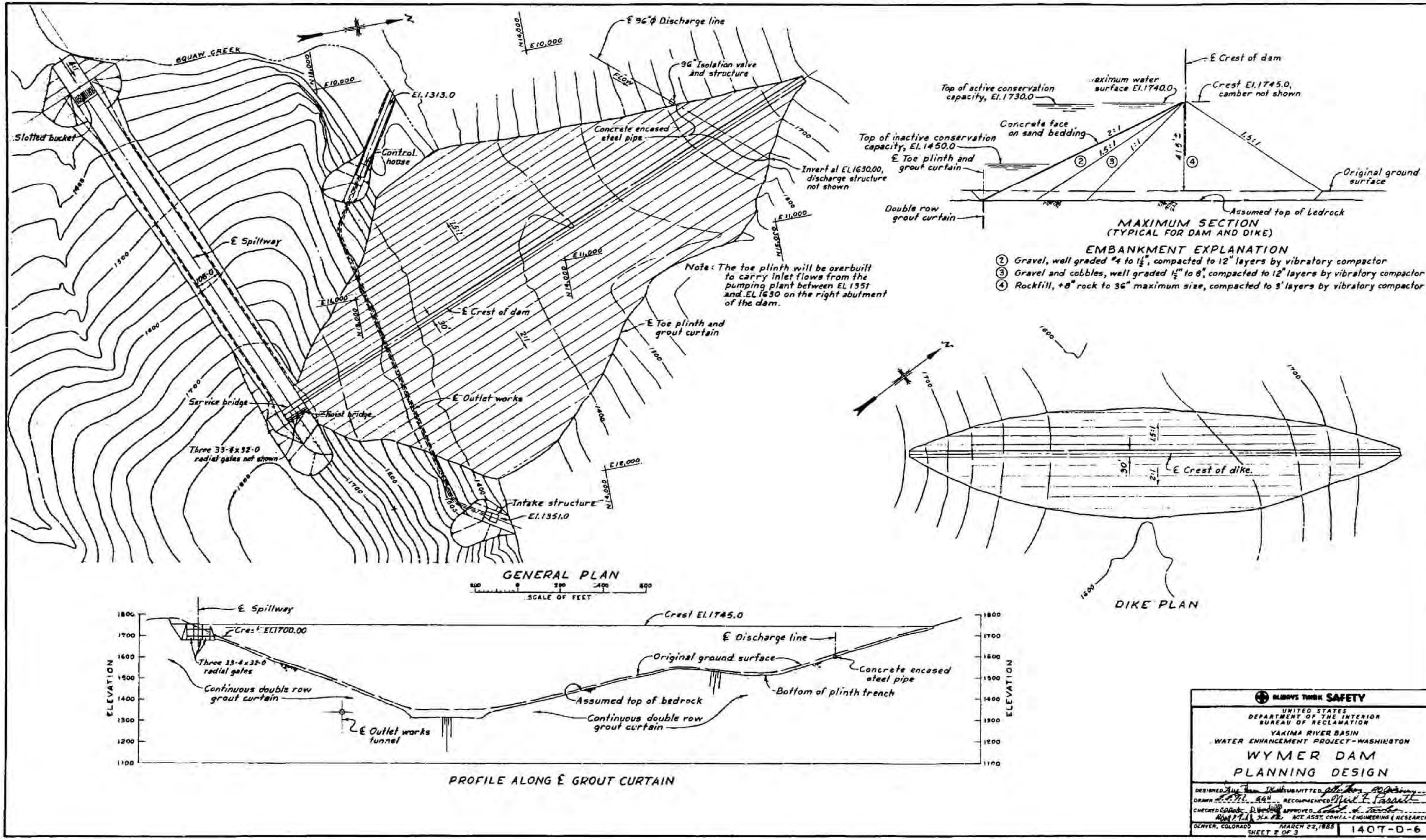
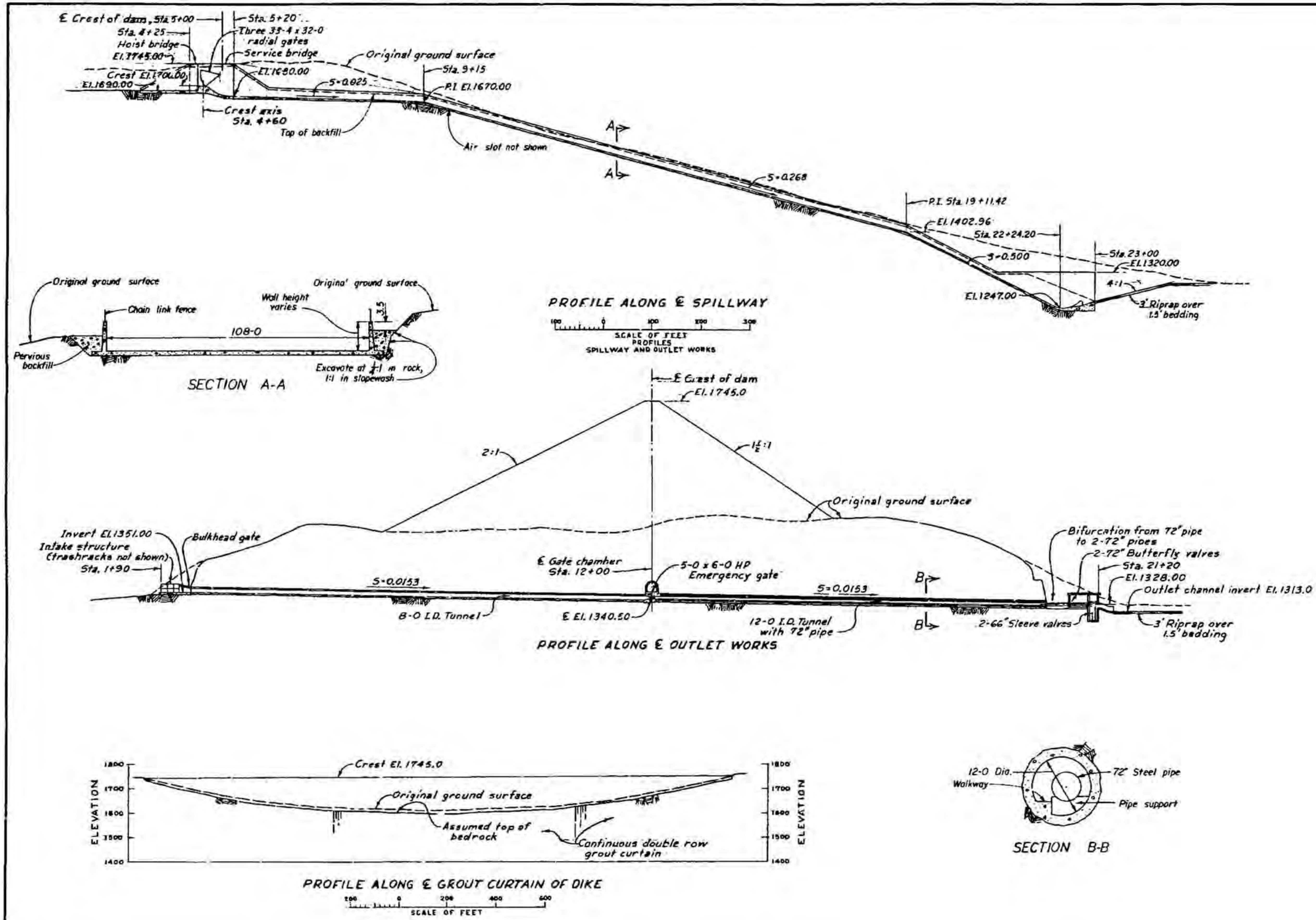

GENERAL PLAN
SCALE OF FEET
Squaw Creek
Slotted bucket
℄ Spillway
108'-0
Service bridge
Hoist bridge
Three 33'-4"x32'-0 radial gates not shown
El. 1313.0
Control house
℄ 36"ϕ Discharge line
36" Isolation valve and structure
Flow
Concrete encased steel pipe
Invert at El. 1630.00, discharge structure not shown
℄ Crest of dam
℄ Outlet works
℄ Toe plinth and grout curtain
Intake structure
El. 1351.0
Note: The toe plinth will be overbuilt to carry inlet flows from the pumping plant between EL 1351 and EL 1630 on the right abutment of the dam.
MAXIMUM SECTION
(TYPICAL FOR DAM AND DIKE)
℄ Crest of dam
Crest El. 1745.0, camber not shown
Maximum water surface El. 1740.0
Top of active conservation capacity, El. 1730.0
Top of inactive conservation capacity, El. 1450.0
Concrete face on sand bedding
℄ Toe plinth and grout curtain
Double row grout curtain
Original ground surface
Assumed top of bedrock
EMBANKMENT EXPLANATION
② Gravel, well graded #4 to 1½", compacted to 12" layers by vibratory compactor
③ Gravel and cobbles, well graded 1½" to 8", compacted to 12" layers by vibratory compactor
④ Rockfill, +8" rock to 36" maximum size, compacted to 3' layers by vibratory compactor
DIKE PLAN
℄ Crest of dike
PROFILE ALONG ℄ GROUT CURTAIN
ELEVATION
℄ Spillway
Crest El. 1745.0
Crest El. 1700.00
Three 33-4x32-0 radial gates
℄ Discharge line
Original ground surface
Concrete encased steel pipe
Continuous double row grout curtain
Assumed top of bedrock
Bottom of plinth trench
℄ Outlet works tunnel
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
YAKIMA RIVER BASIN
WATER ENHANCEMENT PROJECT-WASHINGTON
WYMER DAM
PLANNING DESIGN
DENVER, COLORADO
MARCH 22, 1985
SHEET 2 OF 3
1407-D-6

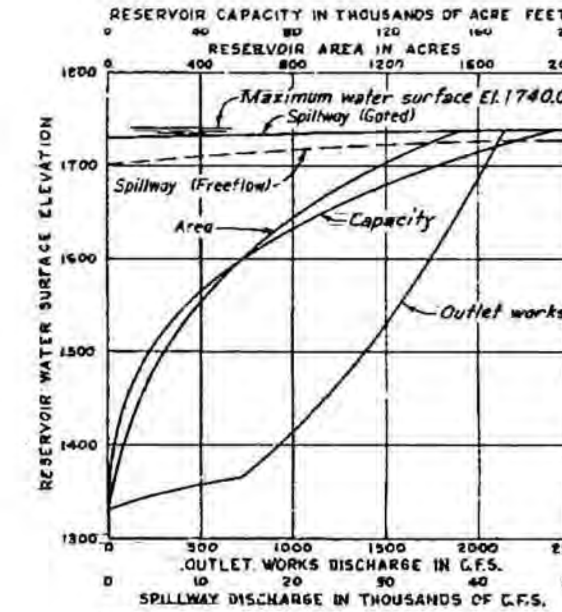
Figure 4



RESERVOIR CAPACITY ALLOCATIONS

PURPOSE	ELEVATIONS	CAPACITY ACRE - FEET
Active conservation	1351.0 to 1730.0	180,870
Dead	1330.0 to 1351.0	210
Total reservoir capacity		181,080

A surcharge of 14,440 a.f. (Max. W.S. El. 1740.0) in combination with a spillway discharge of 50,100 c.f.s. is provided to protect against the inflow design flood which has a peak inflow of 110,350 c.f.s. and a 53-hour volume of 43,610 a.f.



AREA-CAPACITY-DISCHARGE CURVES

PUMP DATA

UNITS	RATED CAPACITY (C.F.S.)	RATED CAPACITY (FT.)	MOTOR HP
1,2	52.5 ea.	475	4000 ea.
3,4,5	105 ea.	475	8000 ea.
TOTAL	420	475	32000

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN
WATER ENHANCEMENT PROJECT-WASHINGTON

WYMER DAM
PLANNING DESIGN

DESIGNED D.J. Kovacik SUBMITTED
DRAWN S.K. Morrison RECOMMENDED Neil F. Parrett
CHECKED APPROVED ACT. ASST. COMM.-ENGINEERING & RESEARCH

DENVER, COLORADO MARCH 22, 1985 SHEET 3 OF 3 | 1407-D-7

Figure 5

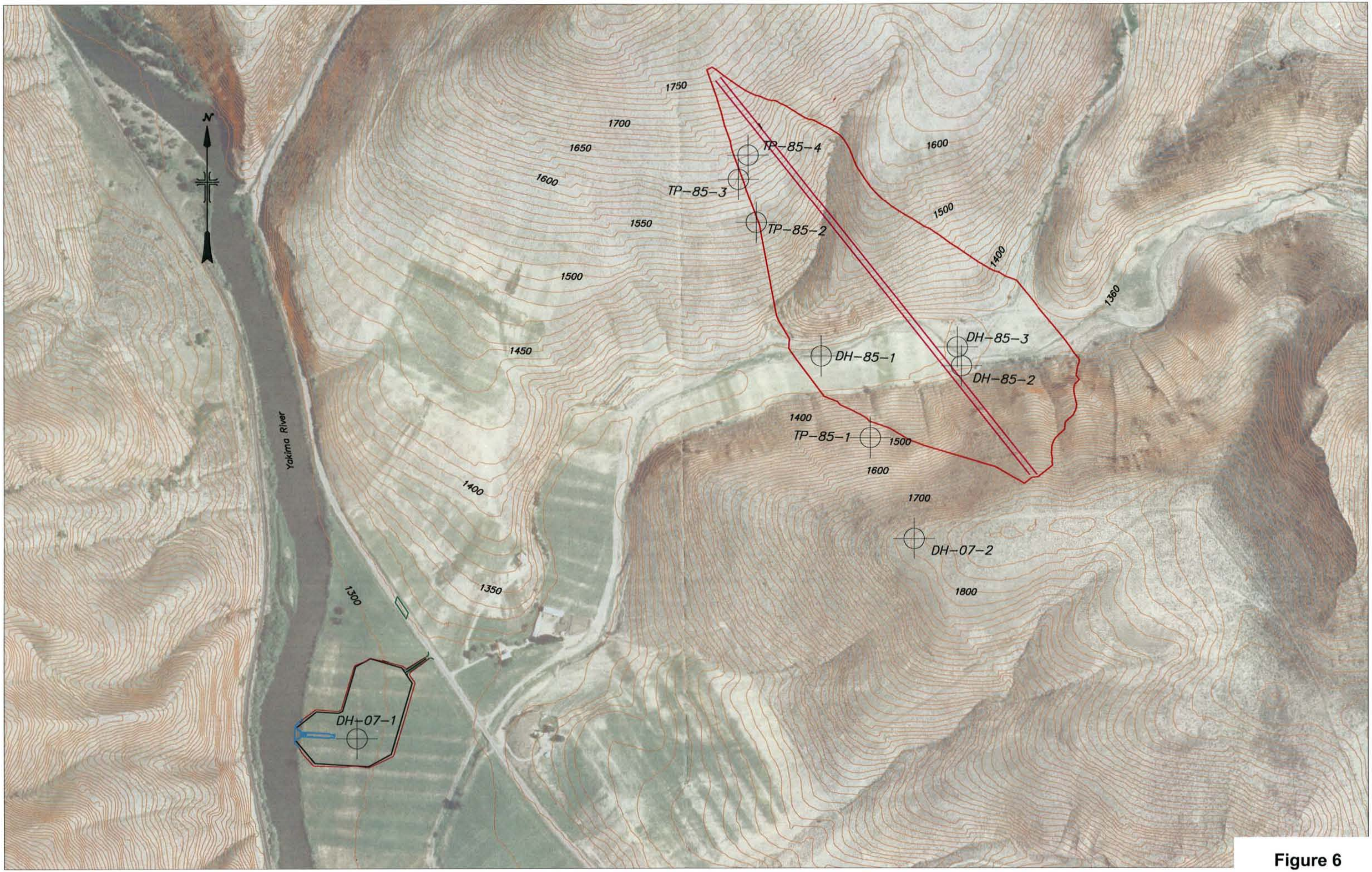

N
Yakima River
1750
1700
1650
1600
1550
1500
1450
1400
1350
1300
1360
1800
TP-85-4
TP-85-3
TP-85-2
TP-85-1
DH-85-1
DH-85-2
DH-85-3
DH-07-1
DH-07-2

Figure 6

Figure 7

WYMER DAM SITE

N

0 305 610 1,220 1,830 2,440 Feet

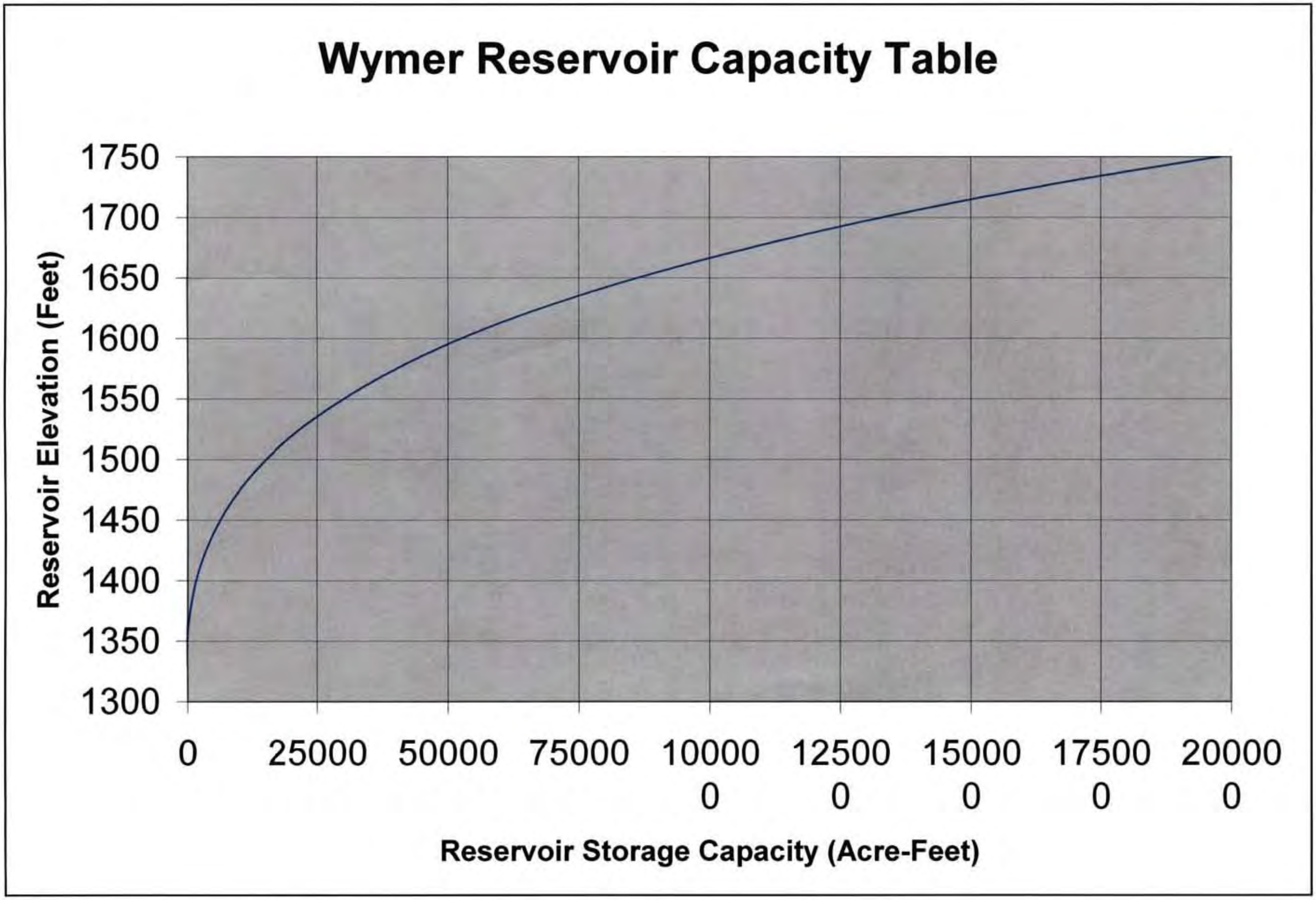
Legend

PROPOSED STRUCTURES

TYPE

- DAM
- DIKE 1
- DIKE 2
- EST. 1750 ft. CONTOUR

FIGURE #8



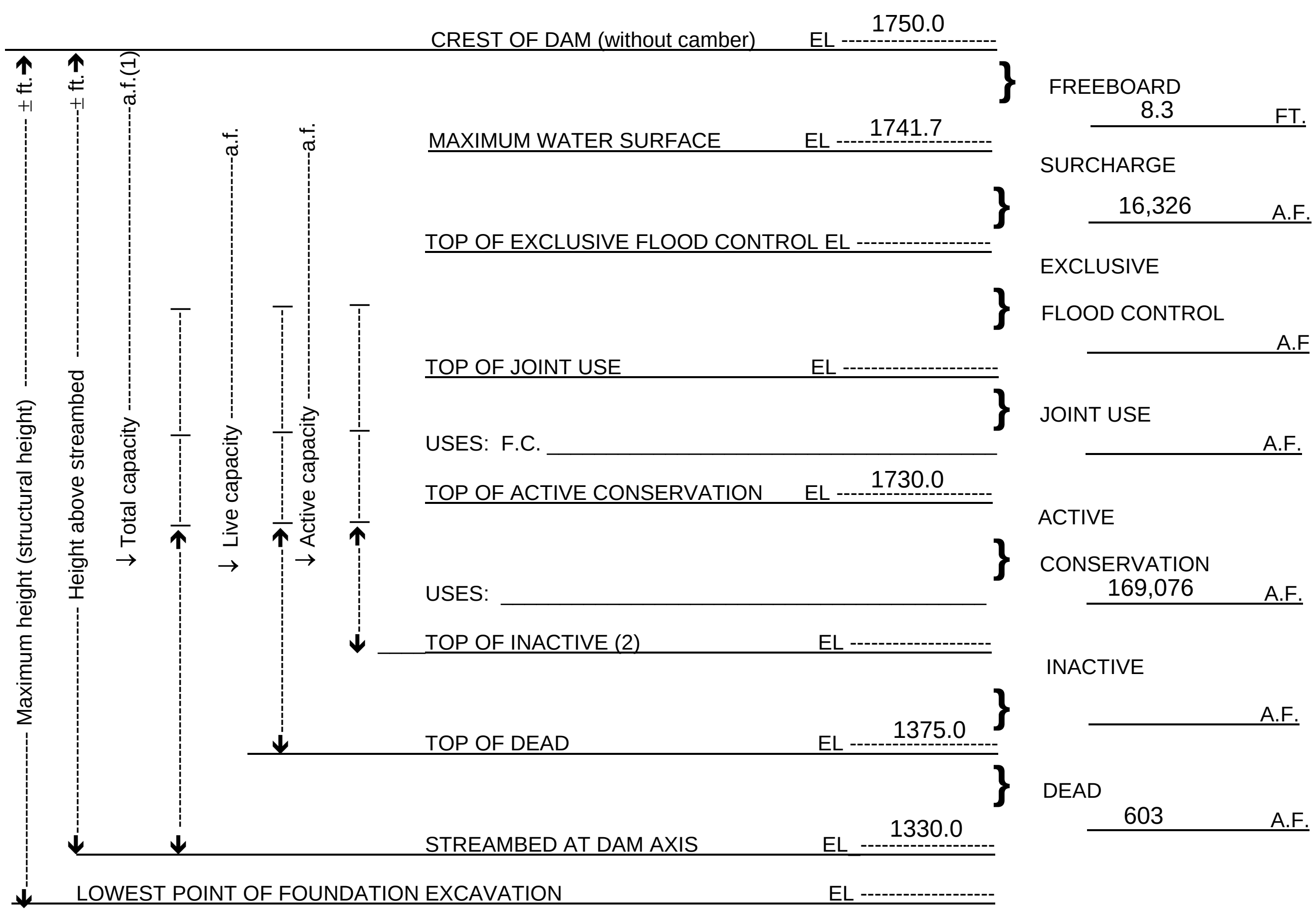
Wymer Reservoir Capacity Table
Reservoir Elevation (Feet)
1750
1700
1650
1600
1550
1500
1450
1400
1350
1300
0
25000
50000
75000
10000 0
12500 0
15000 0
17500 0
20000 0
Reservoir Storage Capacity (Acre-Feet)

Figure 9

7-1686 (5-06)
Bureau of Reclamation

RESERVOIR CAPACITY ALLOCATIONS

TYPE OF DAM Concrete Faced Rockfill	REGION PN	STATE WA
OPERATED BY	Wymer RESERVOIR	
CREST LENGTH FT. / CREST WIDTH FT.	Wymer DAM	
VOLUME OF DAM CU YD.	Yakima Basin Storage PROJECT	
CONSTRUCTION PERIOD	DIVISION	
STREAM Lmuma Creek	UNIT	
RES AREA 1346 ACRES AT EL 1730.0	Appraisal Design STATUS OF DAM	
ORIGINATED BY: *(Initials)* *(Code)* *(Date)*	APPROVED BY: *(Initials)* *(Code)* *(Date)*	



(1) Includes 603 a.f. allowance for 100- year sediment deposition between streambed and EL 1375.0 of which 603 a.f. is above EL 1330.0 .
(2) Established by ____.

REFERENCES AND COMMENTS:

1. The outlet works has two intake levels, one at invert elevation 1375.0 and one at invert elevation 1456.0 to allow for diversion during construction and a projected 100-year sediment load of 7,100 acre-feet.

2. The reservoir storage between elevation 1375.0 and 1456.0 (upper outlet works intake) is 6,512 acre-feet. Thus, initially the active capacity with the lower outlet works intake is 169,076 acre-feet. However, if sedimentation of the reservoir requires the lower outlet to be abandoned, the active capacity would be reduced to 162,564 acre-feet.

Figure 10

Instructions for Use of Form 7-1686

Reservoir Capacity Allocations

Up-to-date files of RCA sheets are maintained in the Technical Service Center, and in the regional offices as a convenient record of the official reservoir capacity allocations for authorized purposes. Inquiries concerning and recommended revisions to RCA sheets are to be sent to the Operation and Structural Safety Group, Technical Service Center, attention Code 86-68470.

Recommendations to revise RCA sheets are to be accompanied by supporting documentation and appropriate explanation. Such support should be in the form of copies of or references to filed reports, agreements, contracts, or official correspondence, which establishes physical, operational, or contractual basis for the recommended revisions. The responsible Technical Service Center code, indicated above, will circulate proposed revisions to the regional office and to other concerned groups in the Technical Service Center. After there is agreement between the regional office and the Technical Service Center on revision proposals, copies of the revised RCA sheet will be prepared and formally distributed by the Operation and Structural Safety Group to the regional office, the Washington office, and other Technical Service Center codes.

Reservoir capacity and elevation data on RCA sheets are to be in conformance with Bureau of Reclamation Reservoir Data Definitions as established by the Technical Service Center for inclusion in Reclamation Instructions. Insert in footnote 2, the appropriate notation "water supply," "F&W," "recreation," "compact," "powerplant," "structure protection," or "legislation" to indicate the condition which determines the top of inactive capacity. Authorized uses of joint use and active capacities should be indicated by inserting in the spaces provided FC for flood control, I for irrigation, M&I for municipal an industrial, P for power, F&W for fish and wildlife, WQ for water quality, and S for sediment.

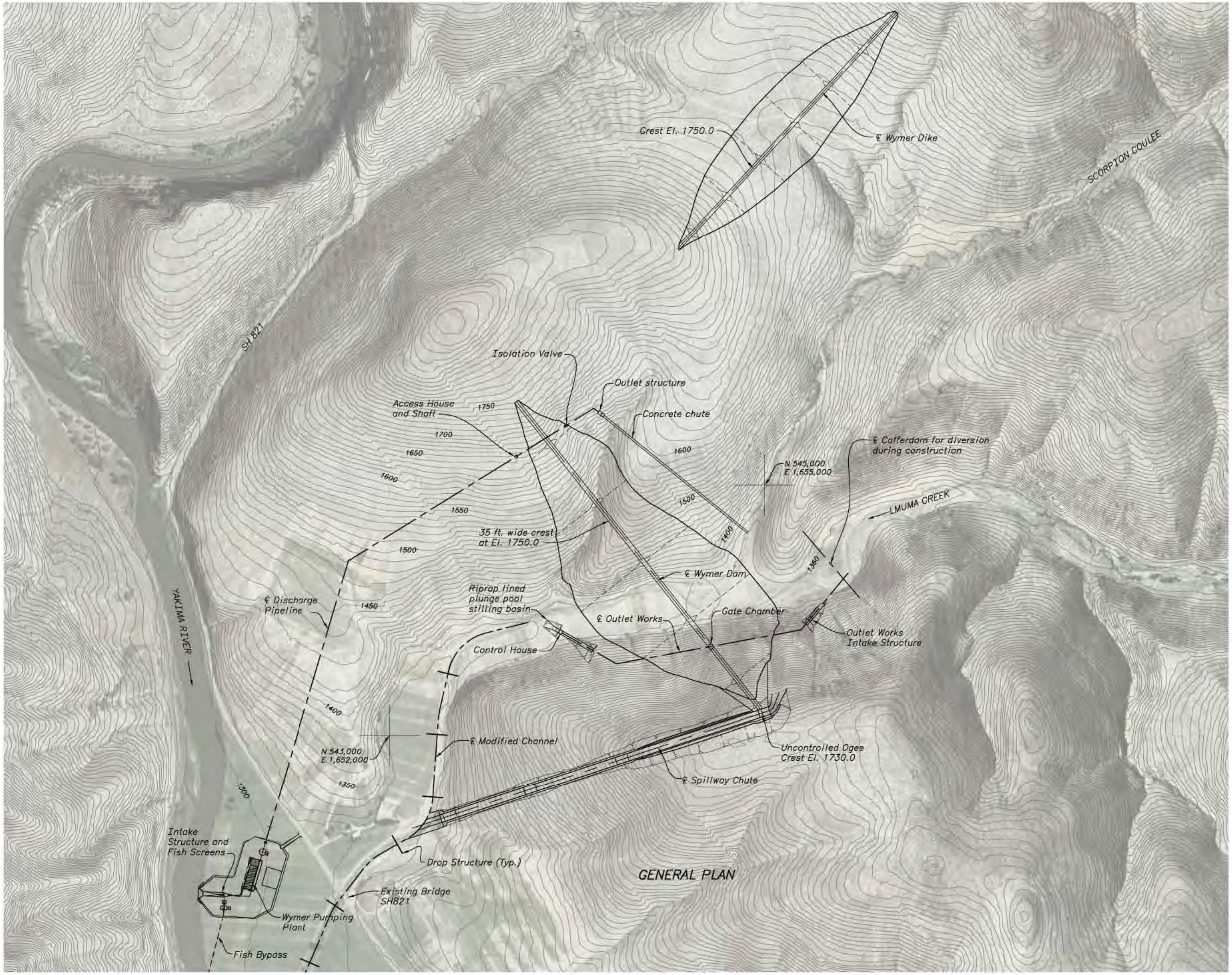
Capacities shown on RCA sheets may be computed using the official capacity table with volumes rounded as follows:

Capacity range - acre-feet	Use values rounded to nearest acre-feet
0-99	1
100-9.999	10
10,000-99,999	100
100,000-999,999	500
1,000,000 and over	4 significant figures

Under status of dam indicate planning, construction, or operational.

Under comments and references, list source material used in determining reservoir water surface elevations and capacities. Care should be taken to specifically identify sources for future reference purposes. Whenever possible, original sources should be used and references to summaries such as the Project Data Book should be avoided. Typical sources of information and data include capacity tables, construction drawings and specifications, final construction reports, legislation, flood control regulations, flood routing drawings, definite plan reports, etc. The nature and duration of special conditions or restrictions with regard to dam, appurtenant structures, or operations, which affect capacity allocations should be noted.

FIGURE 12



400 0 400 800 1200
SCALE OF FEET

NOTE

1. Vertical datum referenced to NGVD29.

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

2007-08-08

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN STORAGE STUDY

WYMER DAM AND RESERVOIR APPRAISAL STUDY

GENERAL PLAN

DESIGNED B. K. GOPLEN

REVIEWED R. W. LAFOND P.E.

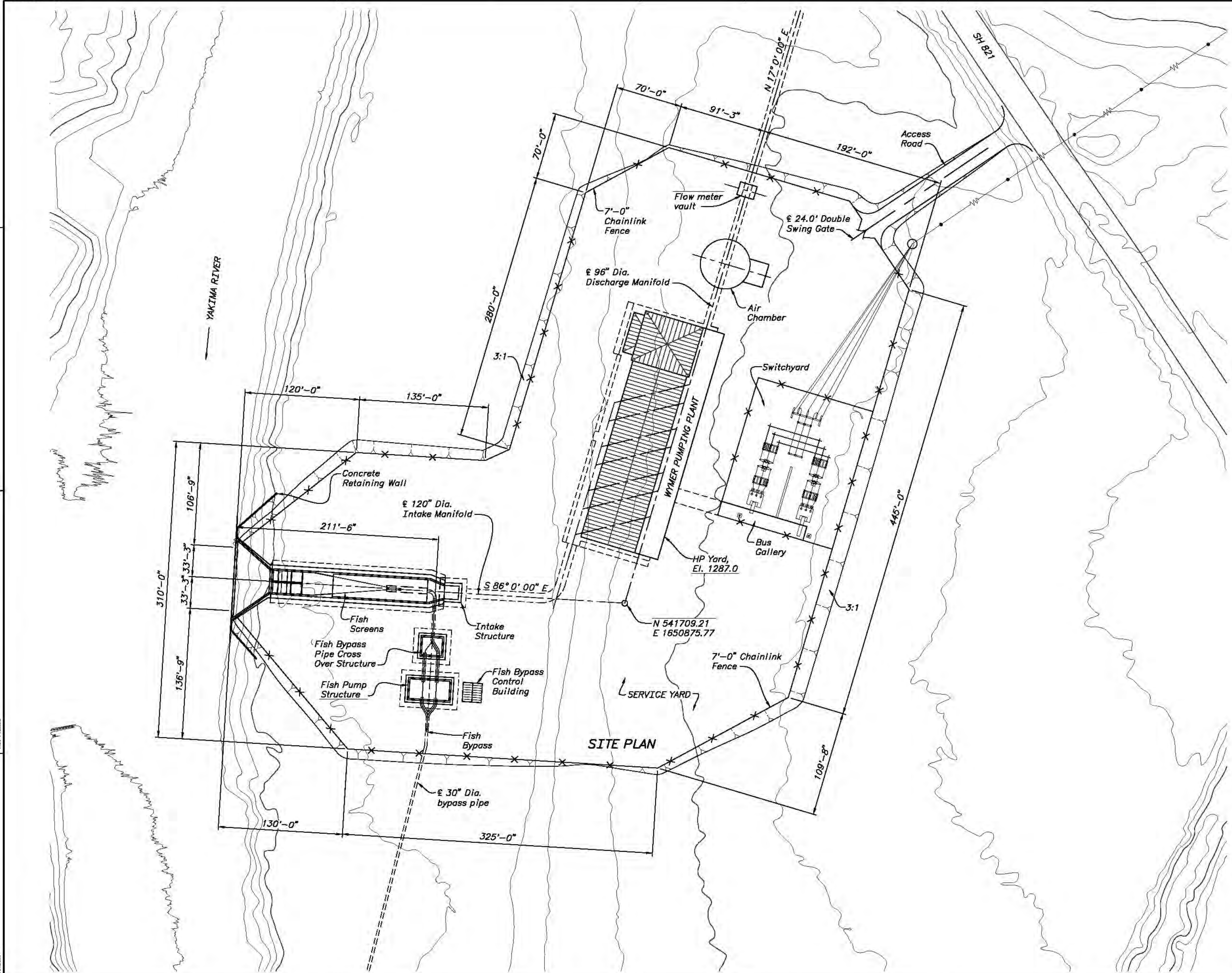
DENVER, CO SHEET 1 OF 1 APRIL 11, 2007

FIGURE 12

DATE AND TIME PLOTTED MAY 10, 2007 11:01
PLOTTED BY

CAD SYSTEM AutoCAD Rel. 16.1s
CAD FILENAME

FIGURE 13



NOTES

1. Vertical datum referenced to NGVD29.
2. Contour intervals are at 2.0 ft.

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

2007-08-08

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN STORAGE PROJECT

WYMER DAM AND RESERVOIR APPRAISAL STUDY

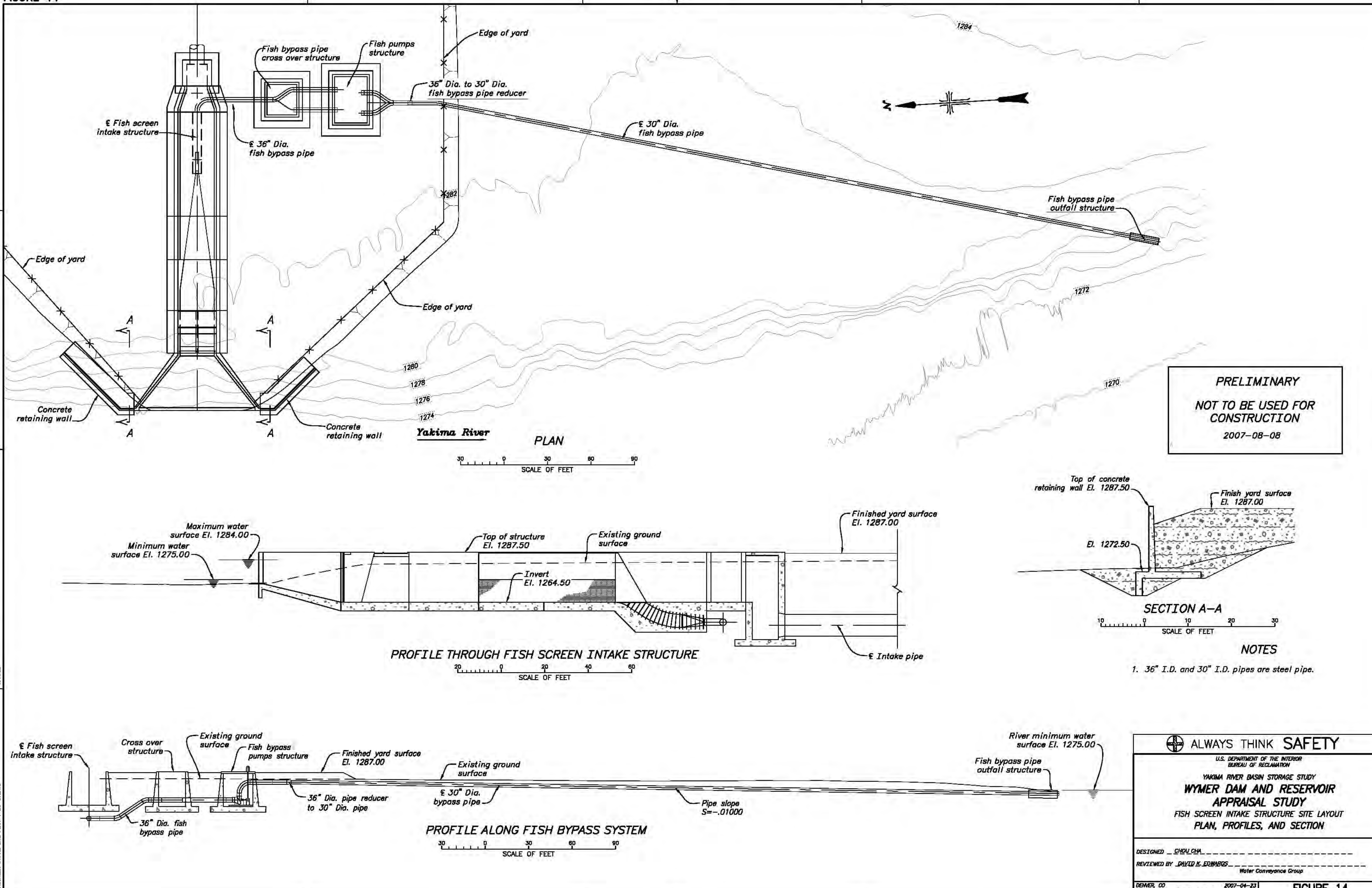
INTAKE AND PUMPING PLANT SERVICE YARD
SITE PLAN

DESIGNED B. K. GOPLEN

REVIEWED R. W. LAFOND P.E.

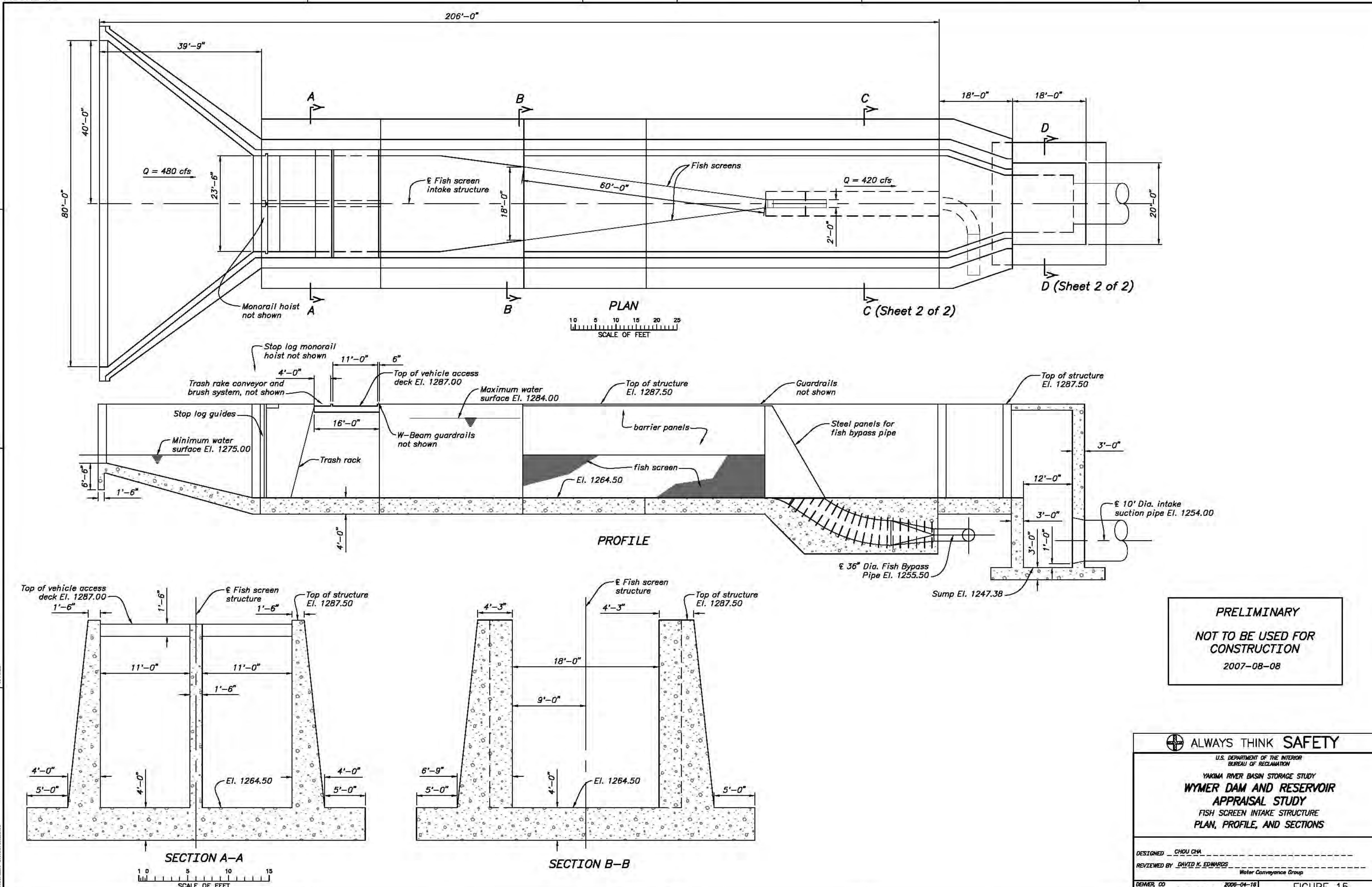
SHEET 1 OF 1 | FIGURE 13

FIGURE 14



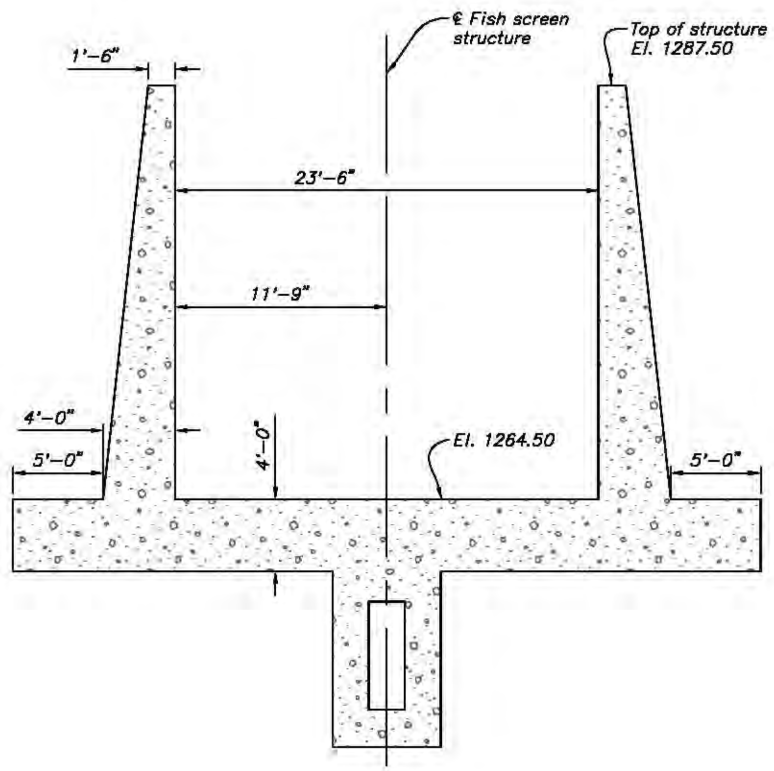
Edge of yard
Fish bypass pipe cross over structure
Fish pumps structure
36" Dia. to 30" Dia. fish bypass pipe reducer
℄ Fish screen intake structure
℄ 36" Dia. fish bypass pipe
℄ 30" Dia. fish bypass pipe
Fish bypass pipe outfall structure
1284
1282
1272
1270
1280
1278
1276
1274
Edge of yard
Edge of yard
A
A
A
A
Concrete retaining wall
Concrete retaining wall
Yakima River
PLAN
SCALE OF FEET
PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION
2007-08-08
Maximum water surface El. 1284.00
Minimum water surface El. 1275.00
Top of structure El. 1287.50
Existing ground surface
Finished yard surface El. 1287.00
Invert El. 1264.50
℄ Intake pipe
PROFILE THROUGH FISH SCREEN INTAKE STRUCTURE
SCALE OF FEET
Top of concrete retaining wall El. 1287.50
Finish yard surface El. 1287.00
El. 1272.50
SECTION A–A
SCALE OF FEET
NOTES
1. 36" I.D. and 30" I.D. pipes are steel pipe.
℄ Fish screen intake structure
Cross over structure
Existing ground surface
Fish bypass pumps structure
Finished yard surface El. 1287.00
Existing ground surface
℄ 30" Dia. bypass pipe
36" Dia. pipe reducer to 30" Dia. pipe
36" Dia. fish bypass pipe
Pipe slope S=-.01000
River minimum water surface El. 1275.00
Fish bypass pipe outfall structure
PROFILE ALONG FISH BYPASS SYSTEM
SCALE OF FEET
ALWAYS THINK SAFETY
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
YAKIMA RIVER BASIN STORAGE STUDY
WYMER DAM AND RESERVOIR APPRAISAL STUDY
FISH SCREEN INTAKE STRUCTURE SITE LAYOUT
PLAN, PROFILES, AND SECTION
DESIGNED CHOU CHA
REVIEWED BY DAVID K. EDWARDS
Water Conveyance Group
DENVER, CO
SHEET 1 OF 1
2007-04-23
FIGURE 14

FIGURE 15



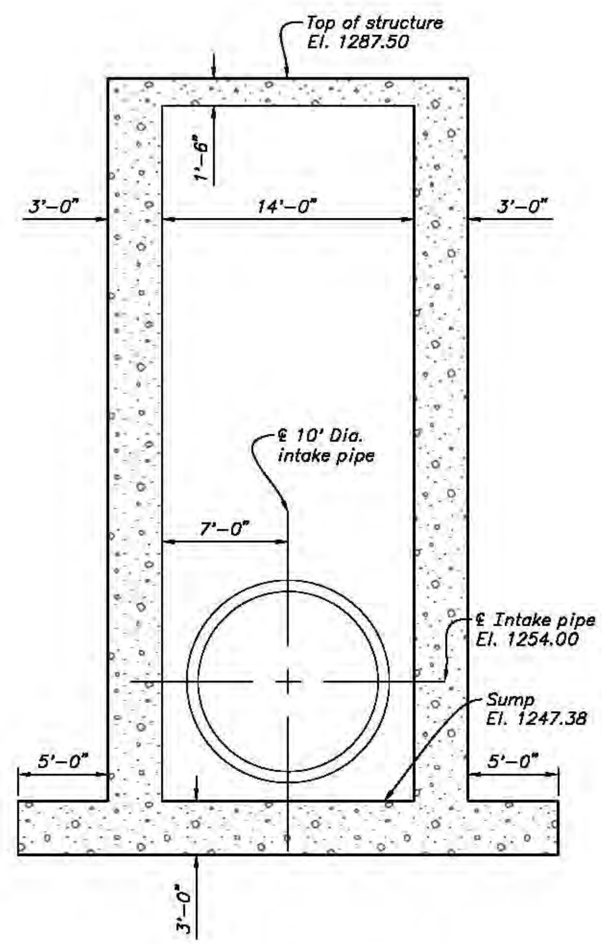
206'-0"
39'-9"
40'-0"
80'-0"
Q = 480 cfs
23'-6"
℄ Fish screen intake structure
18'-0"
60'-0"
Fish screens
Q = 420 cfs
2'-0"
18'-0"
18'-0"
20'-0"
Monorail hoist not shown
A
B
C
D
C (Sheet 2 of 2)
D (Sheet 2 of 2)
PLAN
SCALE OF FEET
Stop log monorail hoist not shown
4'-0"
11'-0"
6"
Top of vehicle access deck El. 1287.00
Trash rake conveyor and brush system, not shown
Maximum water surface El. 1284.00
Top of structure El. 1287.50
Guardrails not shown
Top of structure El. 1287.50
Stop log guides
16'-0"
W-Beam guardrails not shown
barrier panels
Steel panels for fish bypass pipe
Minimum water surface El. 1275.00
Trash rack
fish screen
El. 1264.50
3'-0"
12'-0"
6'-6"
1'-6"
4'-0"
℄ 10' Dia. intake suction pipe El. 1254.00
3'-0"
3'-0"
1'-0"
PROFILE
℄ 36" Dia. Fish Bypass Pipe El. 1255.50
Sump El. 1247.38
Top of vehicle access deck El. 1287.00
1'-6"
1'-6"
℄ Fish screen structure
1'-6"
Top of structure El. 1287.50
11'-0"
11'-0"
1'-6"
4'-0"
5'-0"
4'-0"
El. 1264.50
4'-0"
5'-0"
SECTION A-A
SCALE OF FEET
4'-3"
℄ Fish screen structure
4'-3"
Top of structure El. 1287.50
18'-0"
9'-0"
6'-9"
5'-0"
4'-0"
El. 1264.50
5'-0"
SECTION B-B
PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION
2007-08-08
ALWAYS THINK SAFETY
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
YAKIMA RIVER BASIN STORAGE STUDY
WYMER DAM AND RESERVOIR APPRAISAL STUDY
FISH SCREEN INTAKE STRUCTURE
PLAN, PROFILE, AND SECTIONS
DESIGNED CHOU CHA
REVIEWED BY DAVID K. EDWARDS
Water Conveyance Group
DENVER, CO
SHEET 1 OF 2
2006-04-18
FIGURE 15

FIGURE 16



SECTION C–C (Sheet 1 of 2)

1 0 5 10 15
SCALE OF FEET



SECTION D–D (Sheet 1 of 2)

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

2007–08–08

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN STORAGE STUDY

WYMER DAM AND RESERVOIR APPRAISAL STUDY

FISH SCREEN INTAKE STRUCTURE

SECTIONS

DESIGNED CHOU CHA

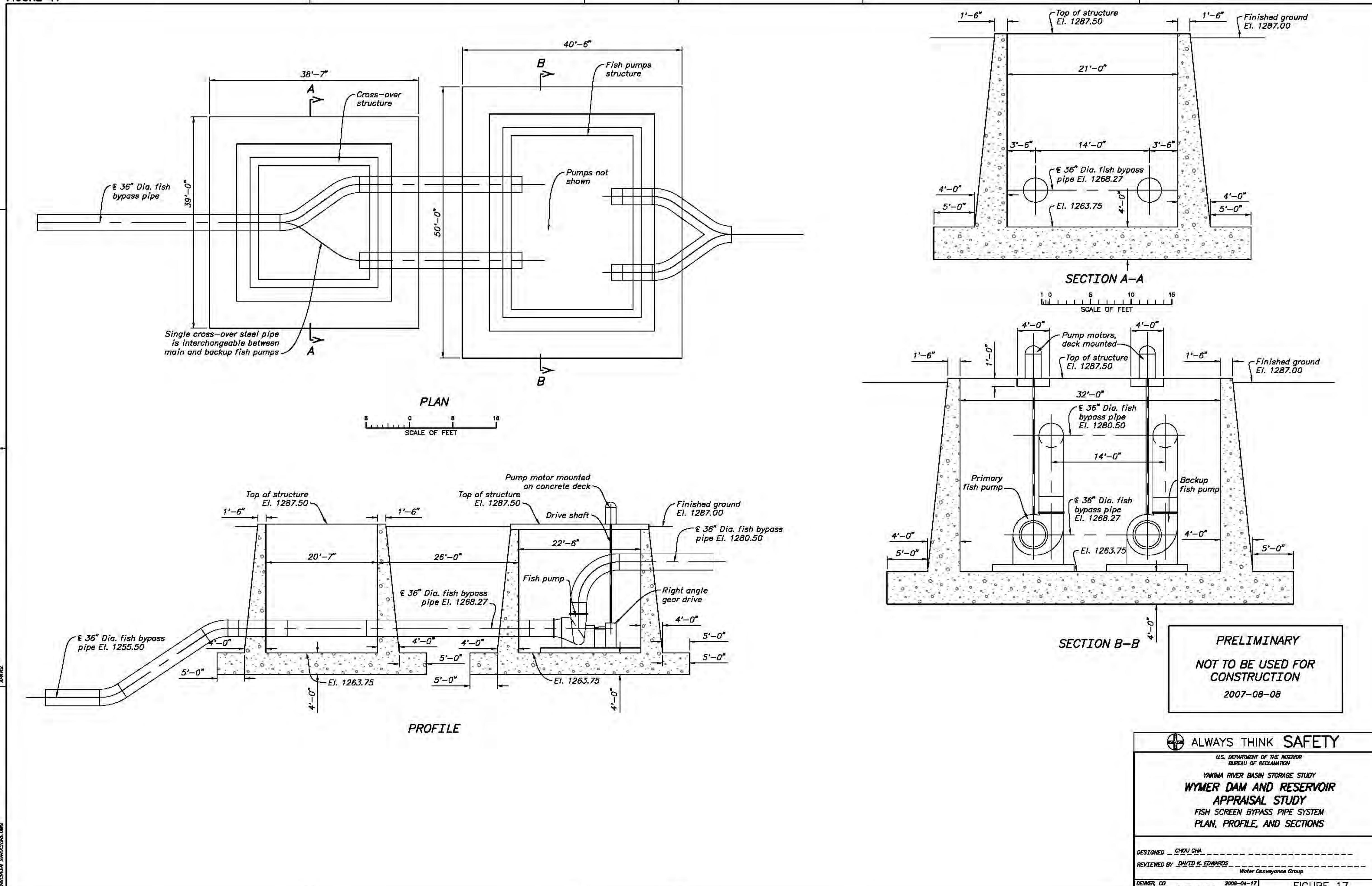
REVIEWED BY DAVID K. EDWARDS

Water Conveyance Group

DENVER, CO SHEET 2 OF 2 2006–04–18

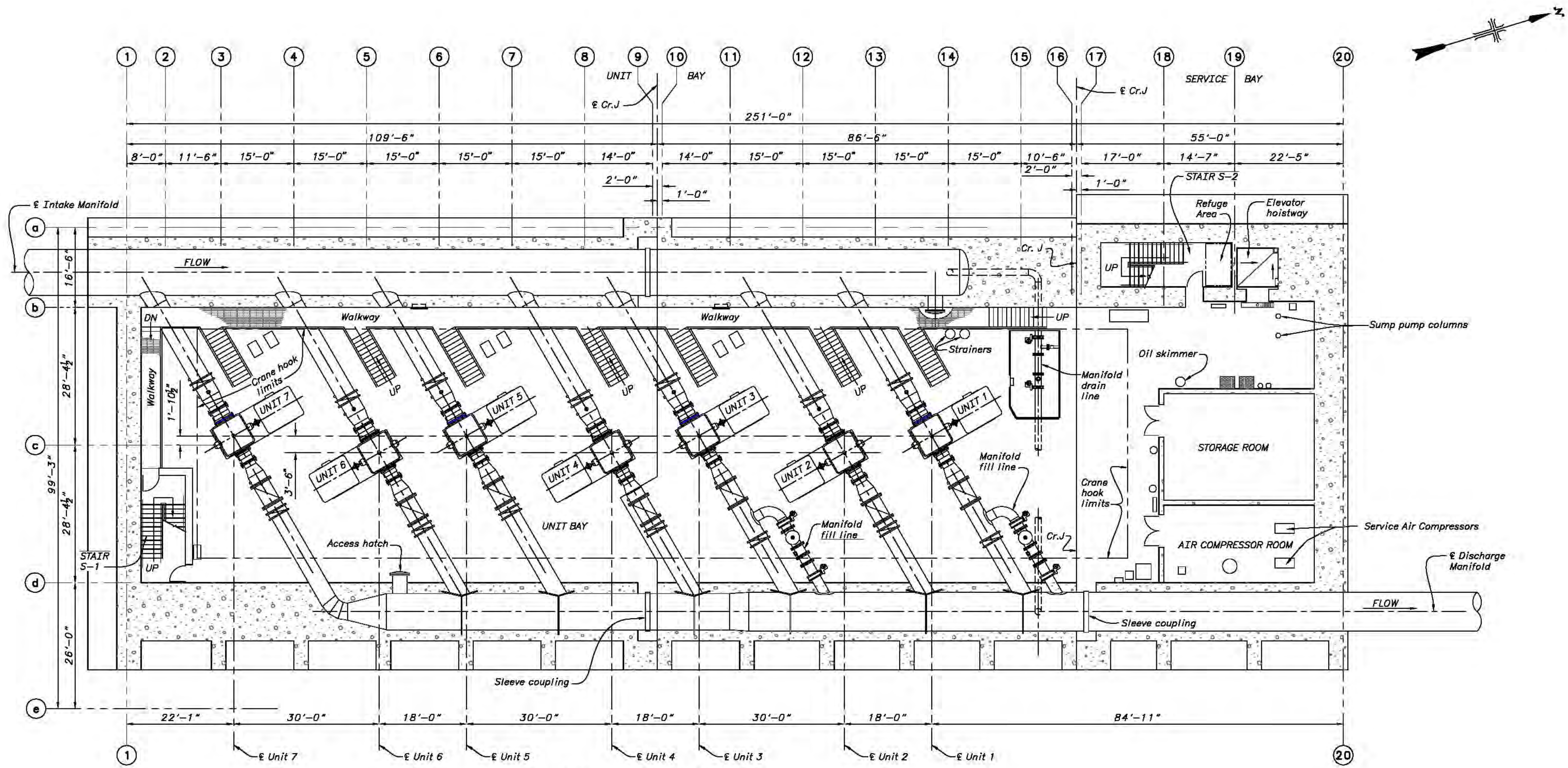
FIGURE 16

FIGURE 17



PLAN
38'-7"
40'-6"
39'-0"
50'-0"
Cross-over structure
Fish pumps structure
Pumps not shown
℄ 36" Dia. fish bypass pipe
Single cross-over steel pipe is interchangeable between main and backup fish pumps
A
B
SCALE OF FEET
PROFILE
Top of structure El. 1287.50
Pump motor mounted on concrete deck
Drive shaft
Finished ground El. 1287.00
℄ 36" Dia. fish bypass pipe El. 1280.50
℄ 36" Dia. fish bypass pipe El. 1268.27
℄ 36" Dia. fish bypass pipe El. 1255.50
Fish pump
Right angle gear drive
1'-6"
20'-7"
26'-0"
22'-6"
4'-0"
5'-0"
El. 1263.75
SECTION A-A
Top of structure El. 1287.50
Finished ground El. 1287.00
21'-0"
3'-6"
14'-0"
℄ 36" Dia. fish bypass pipe El. 1268.27
El. 1263.75
SECTION B-B
Pump motors, deck mounted
1'-0"
32'-0"
℄ 36" Dia. fish bypass pipe El. 1280.50
14'-0"
Primary fish pump
Backup fish pump
℄ 36" Dia. fish bypass pipe El. 1268.27
PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION
2007-08-08
ALWAYS THINK SAFETY
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
YAKIMA RIVER BASIN STORAGE STUDY
WYMER DAM AND RESERVOIR APPRAISAL STUDY
FISH SCREEN BYPASS PIPE SYSTEM
PLAN, PROFILE, AND SECTIONS
DESIGNED CHOU CHA
REVIEWED BY DAVID K. EDWARDS
Water Conveyance Group
DENVER, CO
SHEET 1 OF 1
2006-04-17
FIGURE 17

FIGURE 18



FLOOR – EL. 1250.00

NOTES

1. Vertical datum referenced to NGVD29.

PUMP DATA		
PUMP NUMBER	RATED CAPACITY * (cfs)	RATED HEAD (ft)
1 through 7	60 each	475
TOTAL	420	–

* Includes 5% wear factor

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

2007–08–08

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN STORAGE PROJECT

WYMER DAM AND RESERVOIR APPRAISAL STUDY

GENERAL ARRANGEMENT

FLOOR – EL. 1250.00

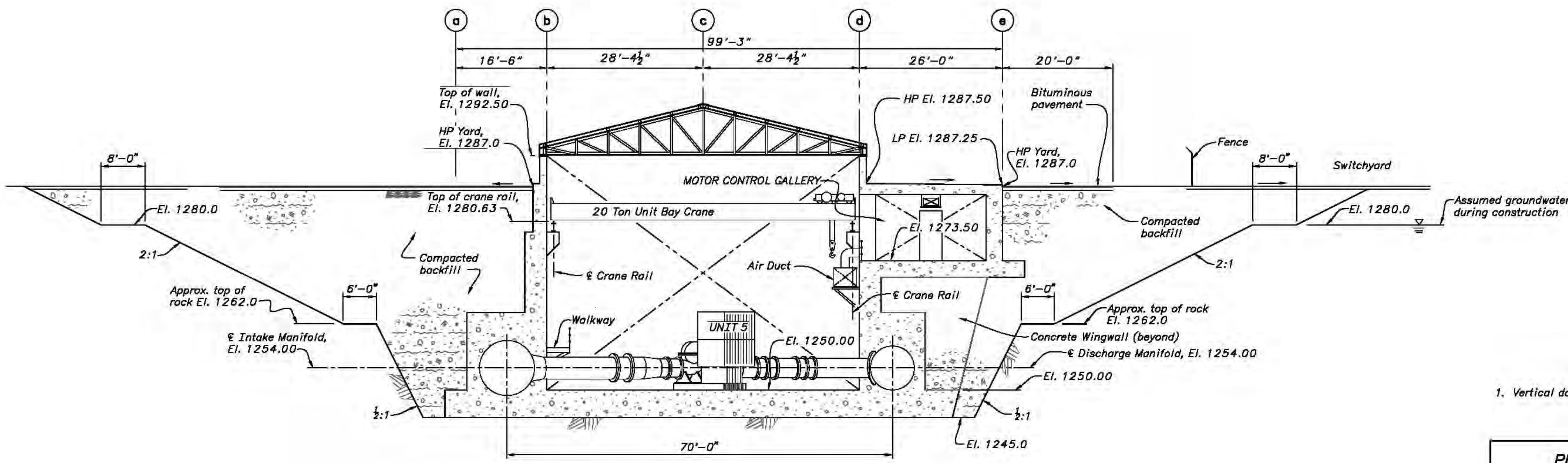
DESIGNED B. K. GOPLEN

REVIEWED R. W. LAFOND P.E.

SHEET 1 OF 1 | FIGURE 18

DATE AND TIME PLOTTED Not Plotted
PLOTTED BY Not Plotted
CAD SYSTEM AUTOCAD
CAD FILENAME UNKNOWN

FIGURE 19



TRANSVERSE SECTION THRU UNIT BAY

NOTES

1. Vertical datum referenced to NGVD29.

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

2007-08-08

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN STORAGE PROJECT

WYMER DAM AND RESERVOIR APPRAISAL STUDY

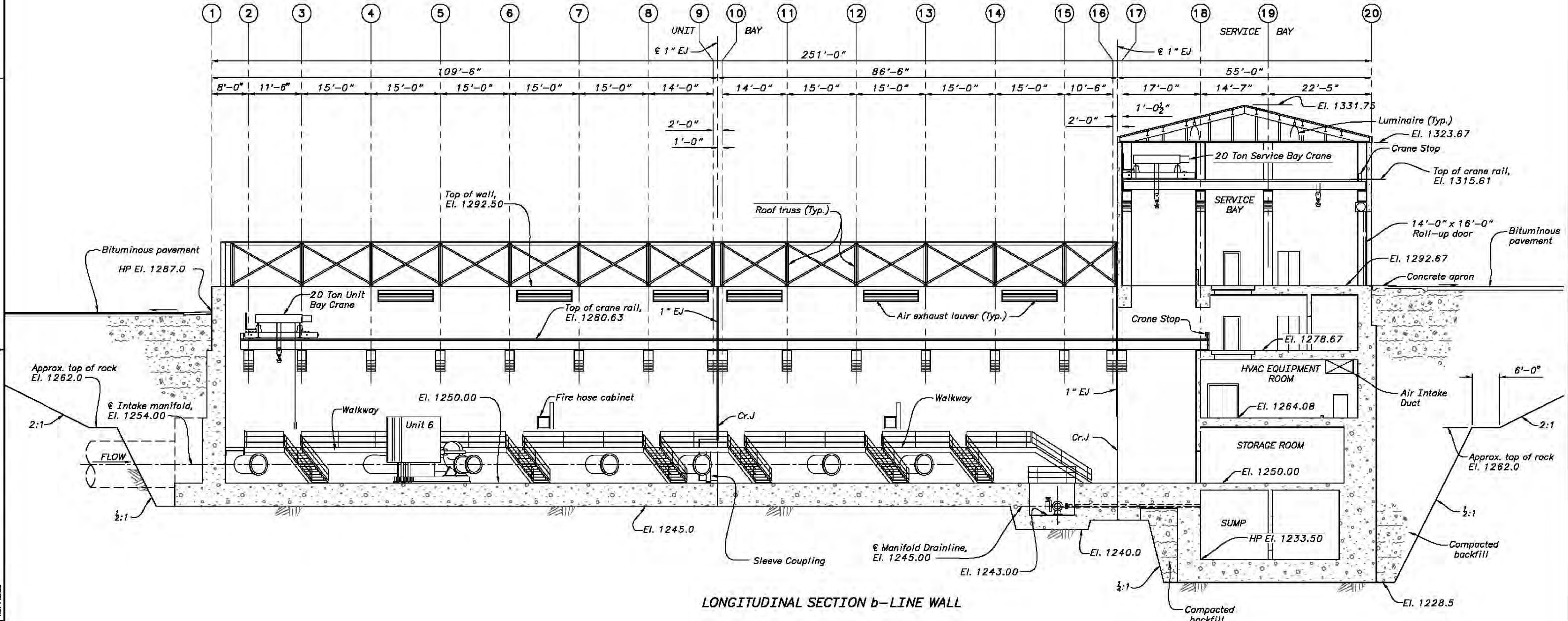
PUMPING PLANT – GENERAL ARRANGEMENT
TRANSVERSE SECTION THRU UNIT BAY

DESIGNED B. K. GOPLEN
REVIEWED R. W. LAFOND P.E.

SHEET 1 OF 1 | FIGURE 19

CAD SYSTEM AUTOCAD
CAD FILENAME UNKNOWN
DATE AND TIME PLOTTED Not Plotted
PLOTTED BY Not Plotted

FIGURE 20



LONGITUDINAL SECTION b-LINE WALL

NOTES

1. Vertical datum referenced to NGVD29.

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

2007-08-08

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
YAKIMA RIVER BASIN STORAGE PROJECT

WYMER DAM AND RESERVOIR APPRAISAL STUDY

PUMPING PLANT – GENERAL ARRANGEMENT

LONGITUDINAL SECTION b-LINE WALL

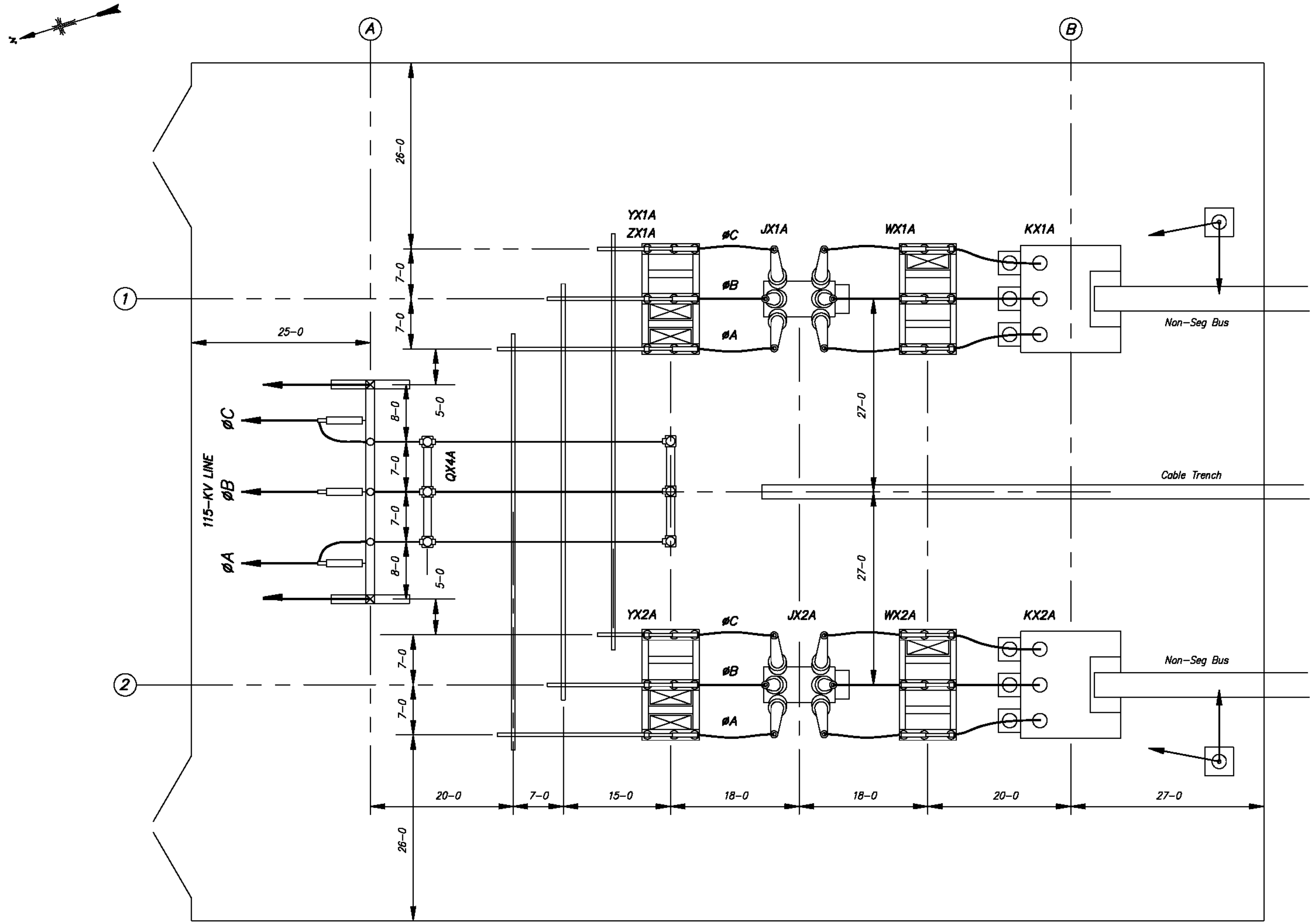
DESIGNED B. K. GOPLEN

REVIEWED R. W. LAFOND P.E.

SHEET 1 OF 1

FIGURE 20

Figure 21



EXPLANATION

KX1A, 2A – Main Power Transformers
JX1A, 2A – High Voltage Circuit Breakers
QX4A – Current Transformers
WX1A, 2A – Load-Side Disconnect Switches
YX1A, 2A – Line-Side Disconnect Switches

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

2007-08-08

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
YAKIMA RIVER BASIN STORAGE STUDY

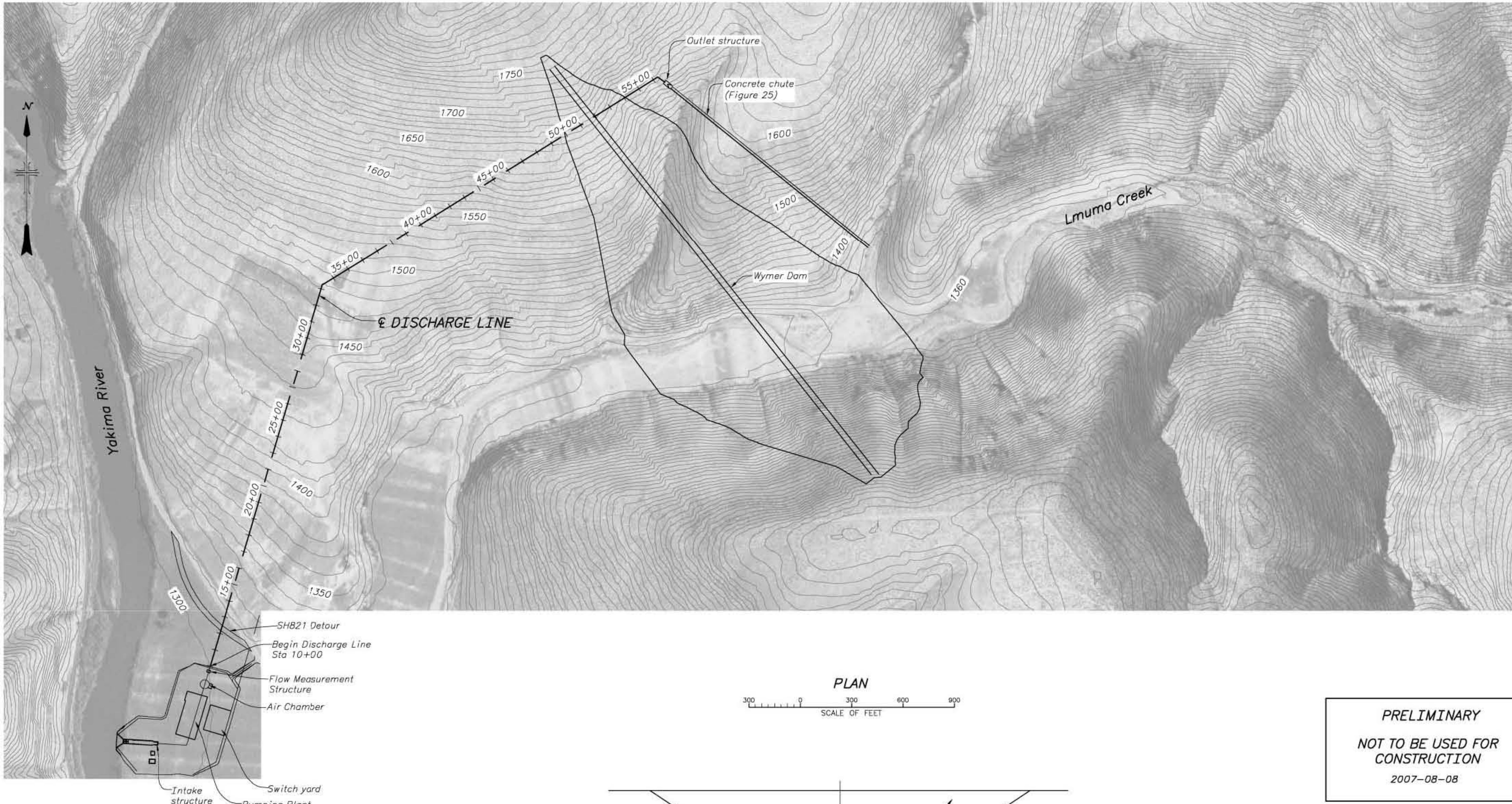
WYMER DAM AND RESERVOIR APPRAISAL STUDY

PUMPING PLANT – ELECTRICAL INSTALLATION
115-KV SWITCHYARD
PLOT PLAN

DESIGNED Douglas Crawford
REVIEWED James R. Zeiger

SHEET 1 OF 1

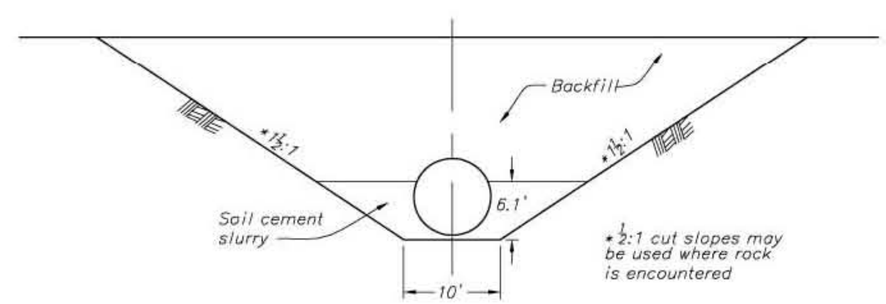
Figure 21



PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

2007-08-08



TYPICAL PIPE TRENCH SECTION

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN STORAGE STUDY

WYMER DAM AND RESERVOIR APPRAISAL STUDY

DISCHARGE LINE SYSTEM
PLAN AND SECTION

DESIGNED ANNE PAVOL

REVIEWED BY LINDA M. BOWLES

Water Conveyance Group

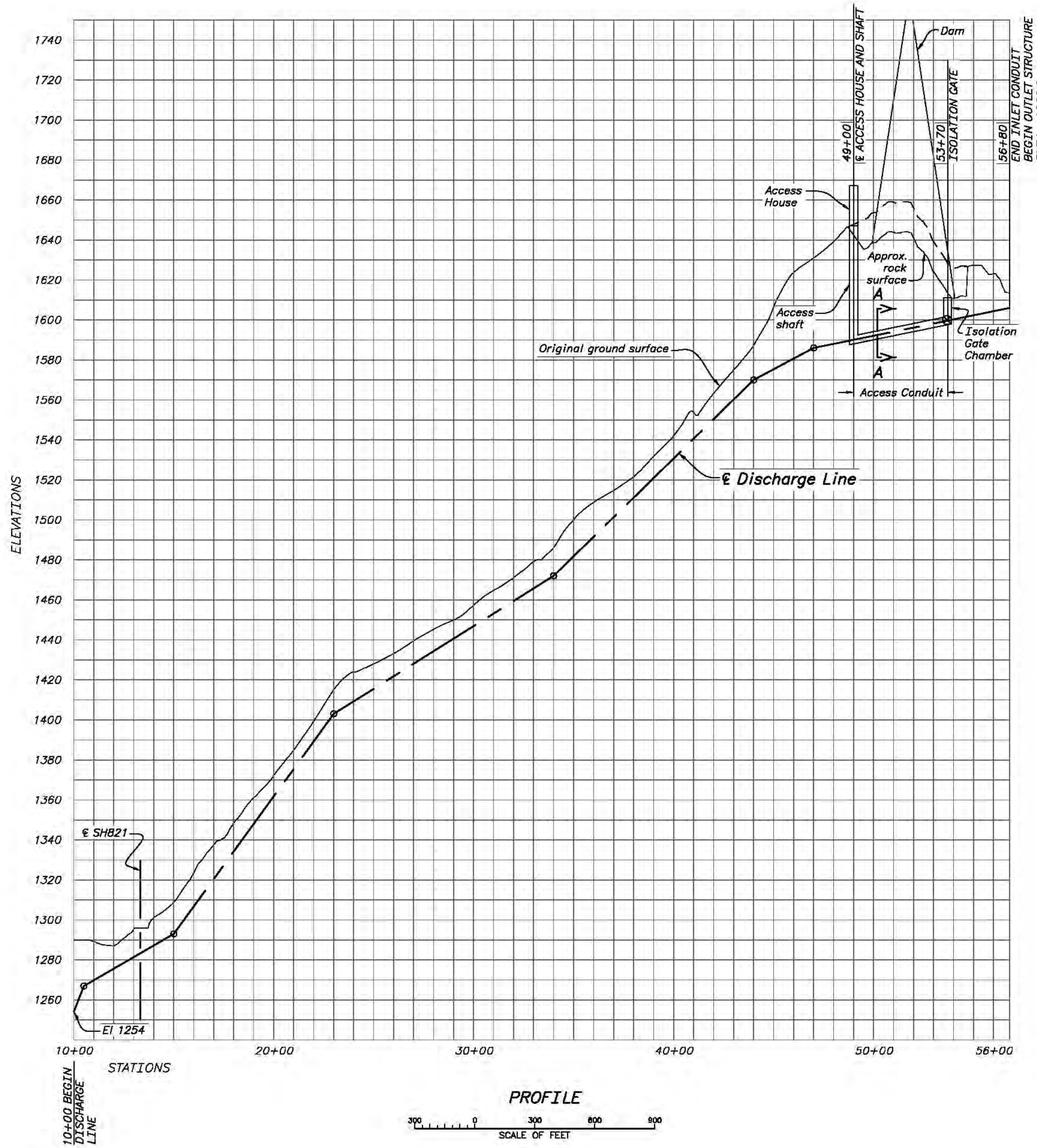
DENVER, CO SHEET 1 OF 1 APRIL 11, 2007

FIGURE 22

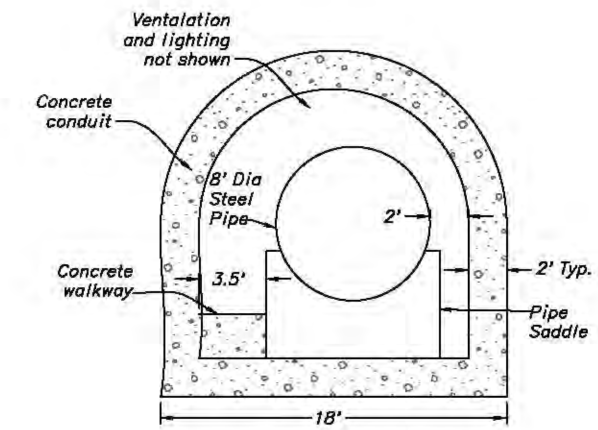
DATE AND TIME PLOTTED AUGUST 21, 2007 17:44 PLOTTED BY APAVOL

CAD SYSTEM AutoCAD Rel. 16.1s CAD FILENAME DISCHARGE FIGURE.DWG

FIGURE 23



PROFILE



SECTION A–A

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

2007–08–08

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN STORAGE STUDY
WYMER DAM AND RESERVOIR APPRAISAL STUDY
DISCHARGE LINE

PROFILE AND SECTION

DESIGNED ANNE PAVOL

REVIEWED BY LINDA M. BOWLES

Water Conveyance Group

DENVER, CO SHEET 1 OF 1 APRIL 11, 2007

FIGURE 23

WYMER DISCHARGE LINE

APPRAISAL LEVEL
HYDRAULIC/TRANSIENT
SCHEMATIC
NOT TO SCALE

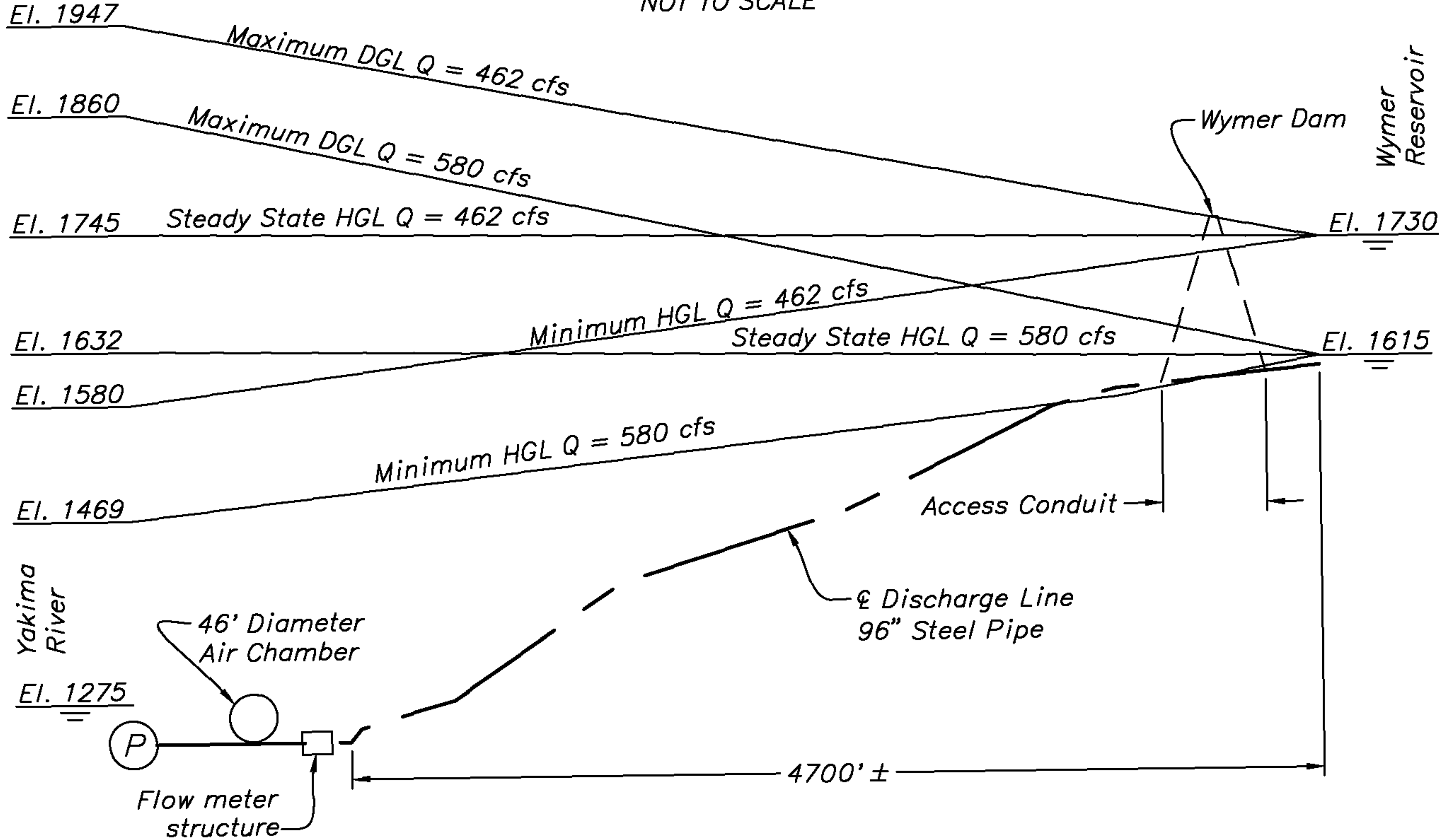
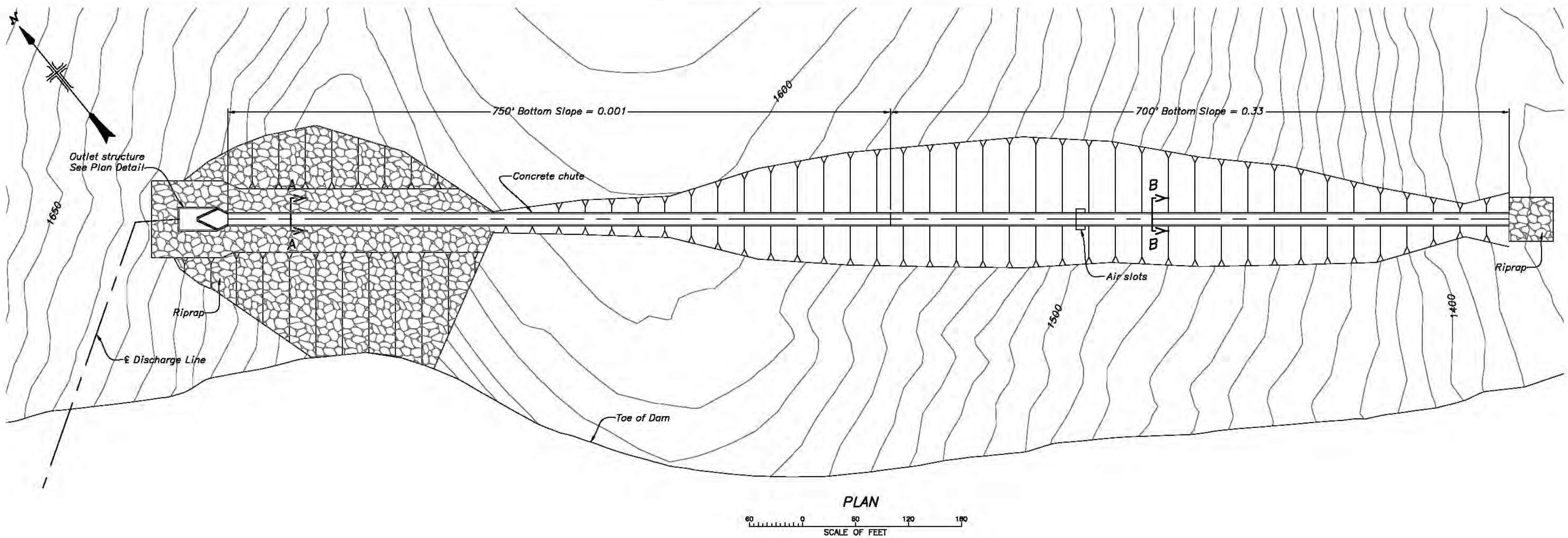
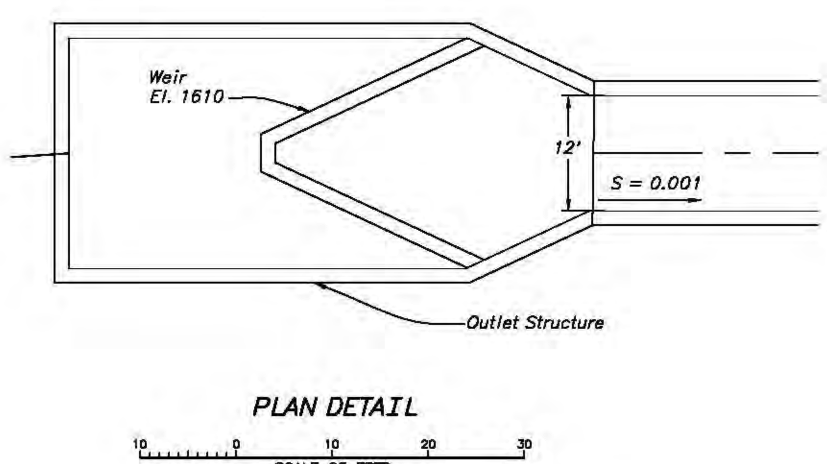


FIGURE 24

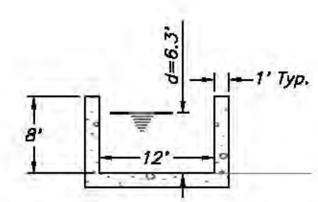
FIGURE 25



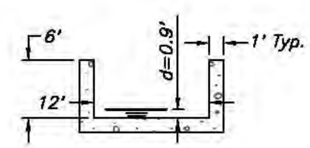
PLAN



PLAN DETAIL



SECTION A–A



SECTION B–B

HYDRAULIC PROPERTIES						
Q	V	n	s	b	d	H
580	7.7	0.013	0.001	12	6.3	8
580	55.0	0.013	0.33	12	0.9	6

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

2007-08-08

NOTES

1. Hydraulic Properties Table is for normal water depths at design flow 580 cfs.

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
YAKIMA RIVER BASIN STORAGE STUDY

WYMER DAM AND RESERVOIR APPRAISAL STUDY

DISCHARGE SYSTEM
OUTLET STRUCTURES
PLAN AND DETAIL

DESIGNED ANNE PAVOL
REVIEWED BY K.A. SAYER
Water Conveyance Group

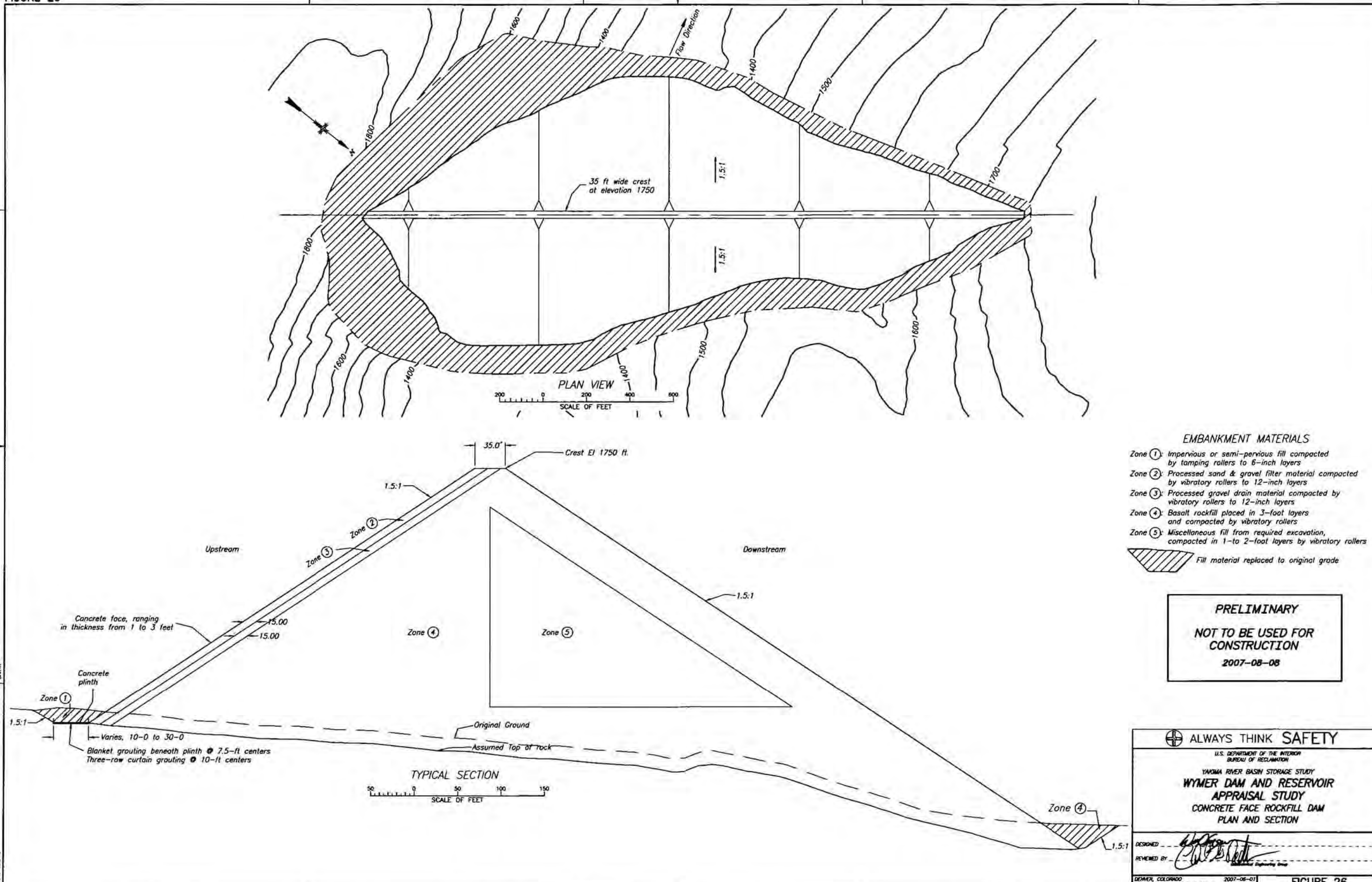
DENVER, CO SHEET 1 OF 1 APRIL 11, 2007

FIGURE 25

DATE AND TIME PLOTTED AUGUST 21, 2007 17:50 PLOTTED BY APAVOL

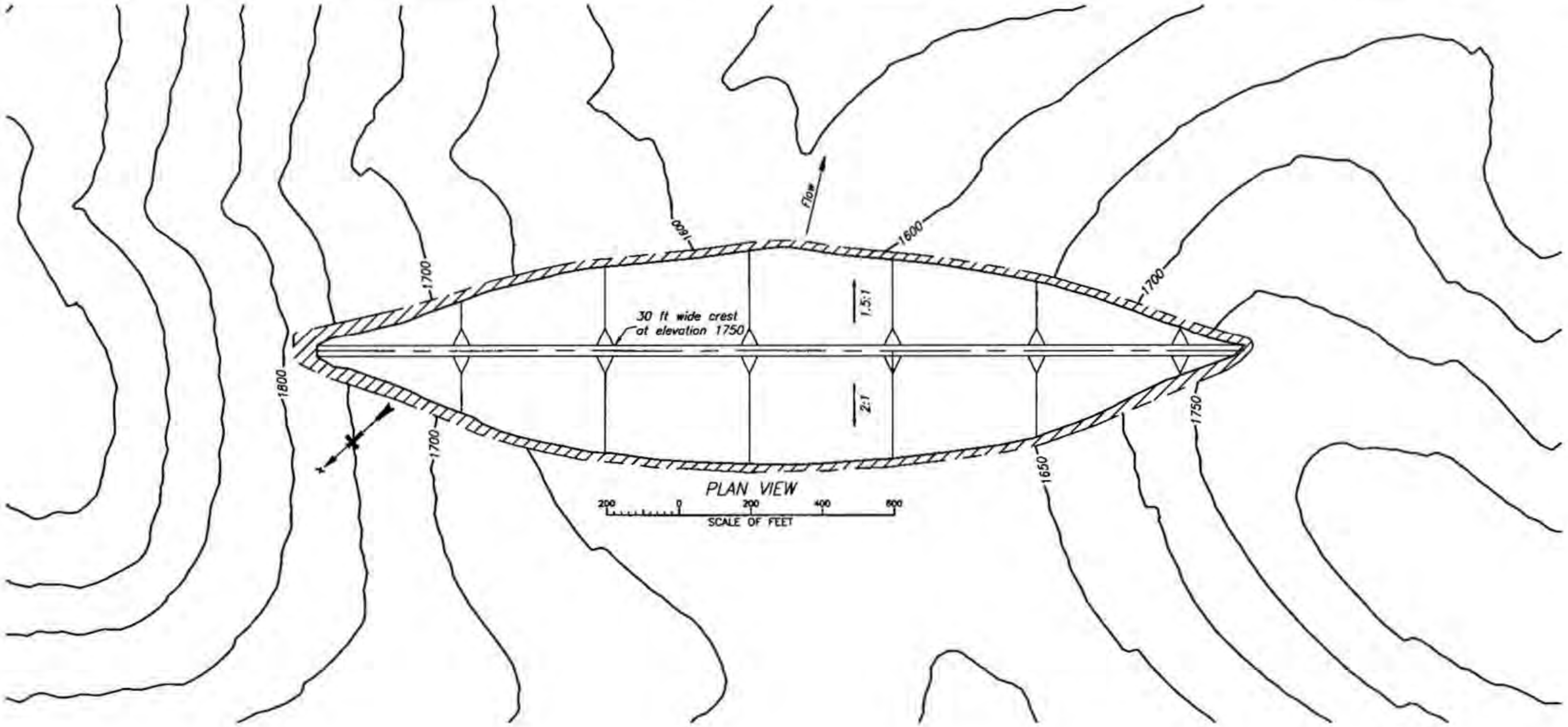
CAD SYSTEM AutoCAD Rel. 16.1s CAD FILENAME OUTLET FIGURE.DWG

FIGURE 26



Flow Direction
1800
1600
1400
1500
1700
35 ft wide crest
at elevation 1750
1.5:1
1.5:1
PLAN VIEW
200 0 200 400 600
SCALE OF FEET
35.0'
Crest El 1750 ft.
1.5:1
Zone (2)
Zone (3)
Upstream
Downstream
1.5:1
Concrete face, ranging
in thickness from 1 to 3 feet
15.00
15.00
Zone (4)
Zone (5)
Concrete
plinth
Zone (1)
1.5:1
Varies, 10-0 to 30-0
Original Ground
Assumed Top of rock
Blanket grouting beneath plinth @ 7.5-ft centers
Three-row curtain grouting @ 10-ft centers
TYPICAL SECTION
50 0 50 100 150
SCALE OF FEET
Zone (4)
1.5:1
EMBANKMENT MATERIALS
Zone (1): Impervious or semi-pervious 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): Miscellaneous fill from required excavation, compacted in 1-to 2-foot layers by vibratory rollers
Fill material replaced to original grade
PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION
2007-08-08
ALWAYS THINK SAFETY
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
YAKIMA RIVER BASIN STORAGE STUDY
WYMER DAM AND RESERVOIR
APPRAISAL STUDY
CONCRETE FACE ROCKFILL DAM
PLAN AND SECTION
DESIGNED
REVIEWED BY
DENVER, COLORADO
SHEET 1 OF 1
2007-06-01
FIGURE 26

FIGURE 27



EMBANKMENT MATERIALS

Zone (1): Impervious or semi-pervious fill compacted by tamping rollers to 6-inch layers

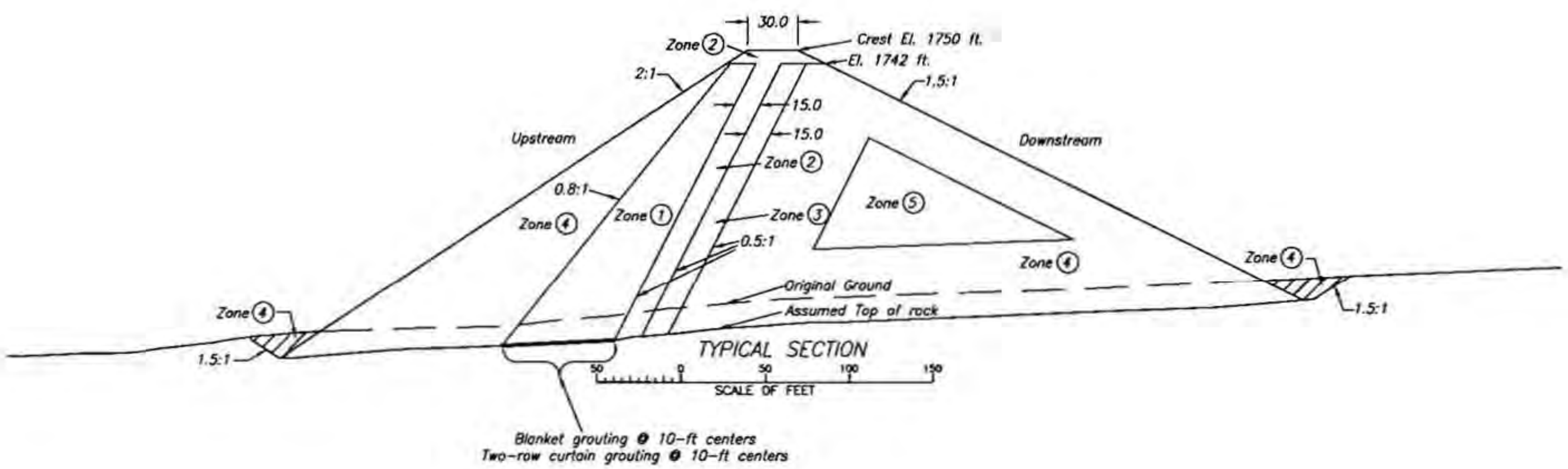
Zone (2): Processed sand & gravel filter material compacted by vibratory rollers to 12-inch layers

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): Miscellaneous fill from required excavation, compacted in 1-to 2-foot layers by vibratory rollers

Fill material replaced to original grade



PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

2007-08-08

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN STORAGE STUDY

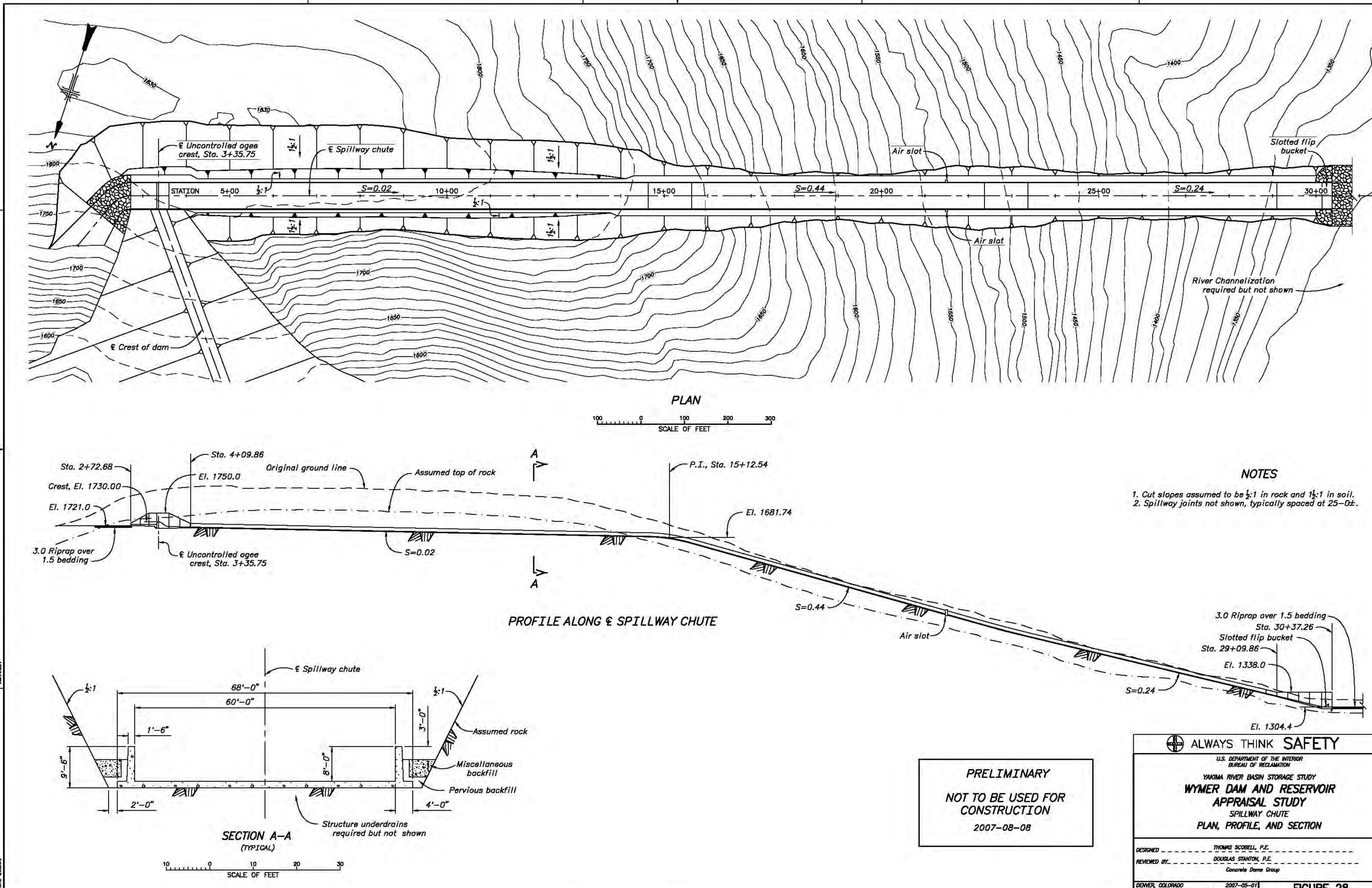
WYMER DAM AND RESERVOIR APPRAISAL STUDY

CENTRAL CORE ROCKFILL DIKE
PLAN AND SECTION

DESIGNED
REVIEWED BY

DENVER, COLORADO 2007-06-01
SHEET 1 OF 1

FIGURE 27



NOTES

1. Cut slopes assumed to be ½:1 in rock and 1½:1 in soil.
2. Spillway joints not shown, typically spaced at 25–0±.

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

2007–08–08

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN STORAGE STUDY

WYMER DAM AND RESERVOIR APPRAISAL STUDY

SPILLWAY CHUTE

PLAN, PROFILE, AND SECTION

DESIGNED THOMAS SCOBELL, P.E.

REVIEWED BY DOUGLAS STANTON, P.E.

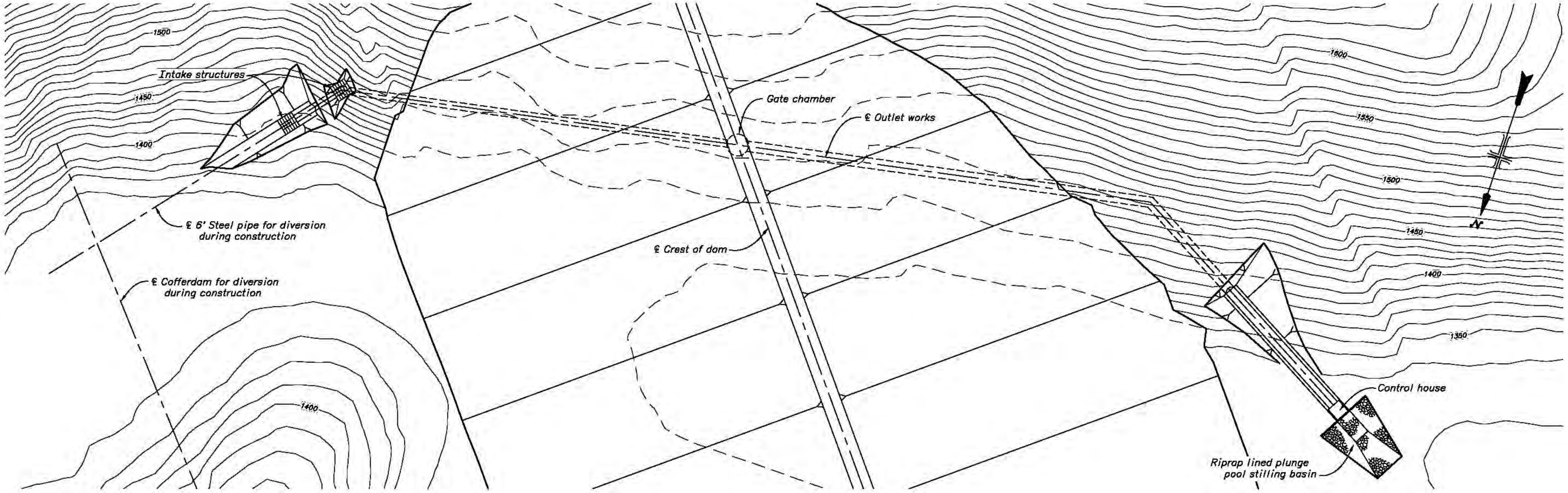
Concrete Dams Group

DENVER, COLORADO SHEET 1 OF 1 2007–05–01

FIGURE 28

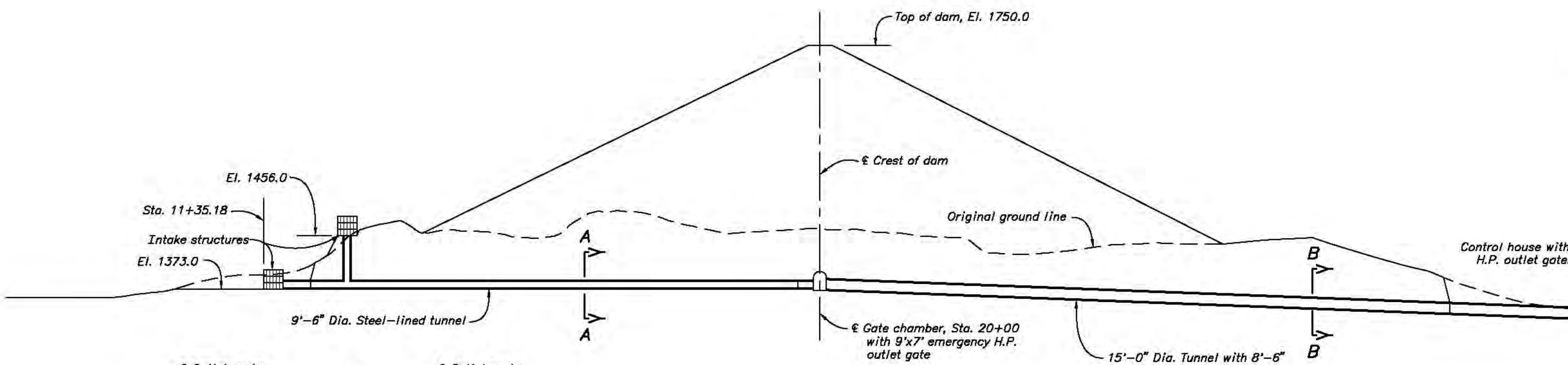
DATE AND TIME PLOTTED AUGUST 16, 2007 08:25 PLOTTED BY

CAD SYSTEM AutoCAD Rel. 16.1s CAD FILENAME



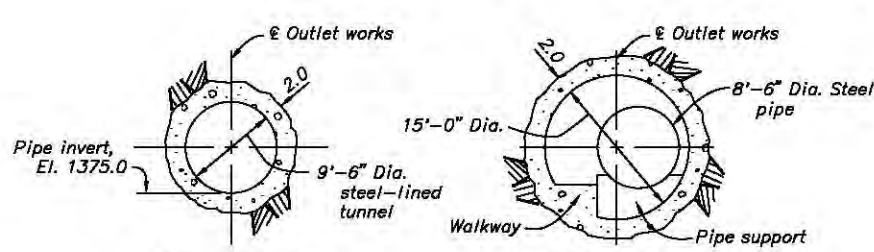
PLAN

100 0 100 200 300
SCALE OF FEET



NOTES

1. Cast-in-place reinforced concrete conduits required at upstream and downstream ends of tunnel.
2. Bulkhead required but not shown downstream of intake structure.



SECTION A-A

SECTION B-B

10 0 10 20 30
SCALE OF FEET

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

2007-08-08

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN STORAGE STUDY

WYMER DAM AND RESERVOIR APPRAISAL STUDY

OUTLET WORKS

PLAN, PROFILE, AND SECTIONS

DESIGNED THOMAS SCOBELL, P.E.
REVIEWED BY DOUGLAS STANTON, P.E.
Concrete Dams Group

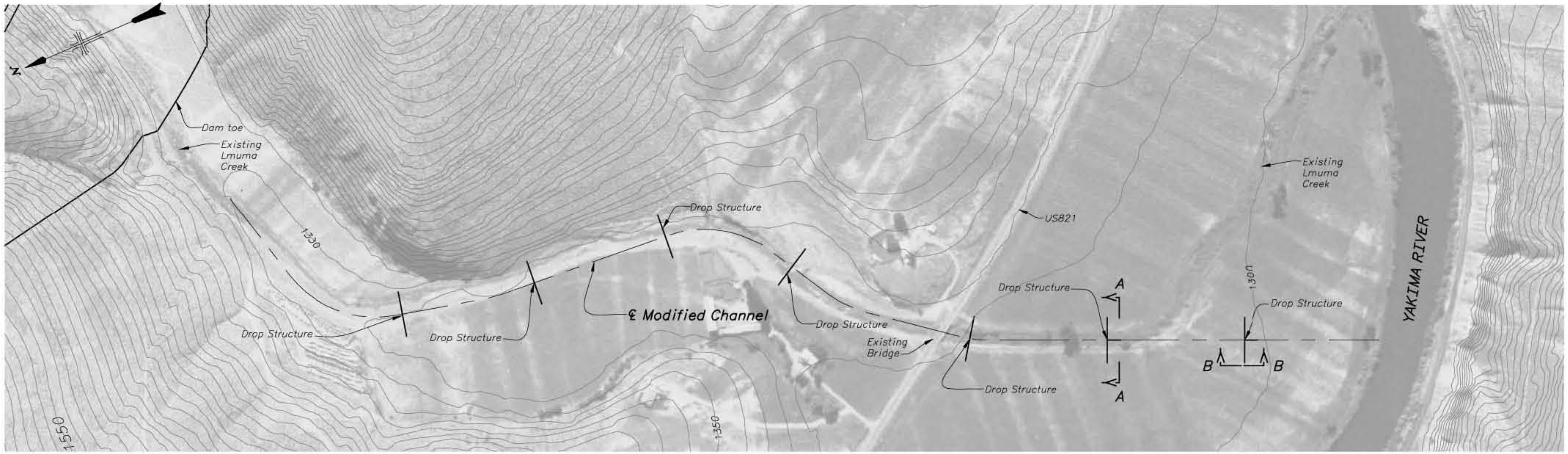
DENVER, COLORADO 2007-05-01
SHEET 1 OF 1

FIGURE 29

DATE AND TIME PLOTTED
AUGUST 16, 2007 08:27
PLOTTED BY
JMARKLEY

CAD SYSTEM
AutoCAD Rel. 16.1s
CAD FILENAME
FIGURE 29.DWG

FIGURE 30



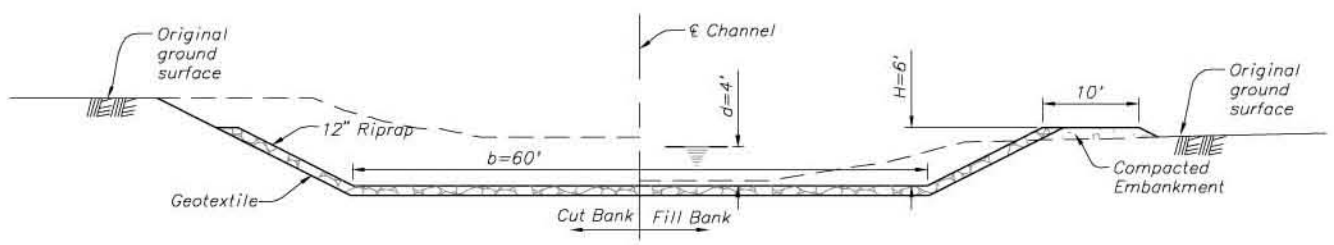
PLAN

200 0 200 400 600
SCALE OF FEET

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

2007-08-08



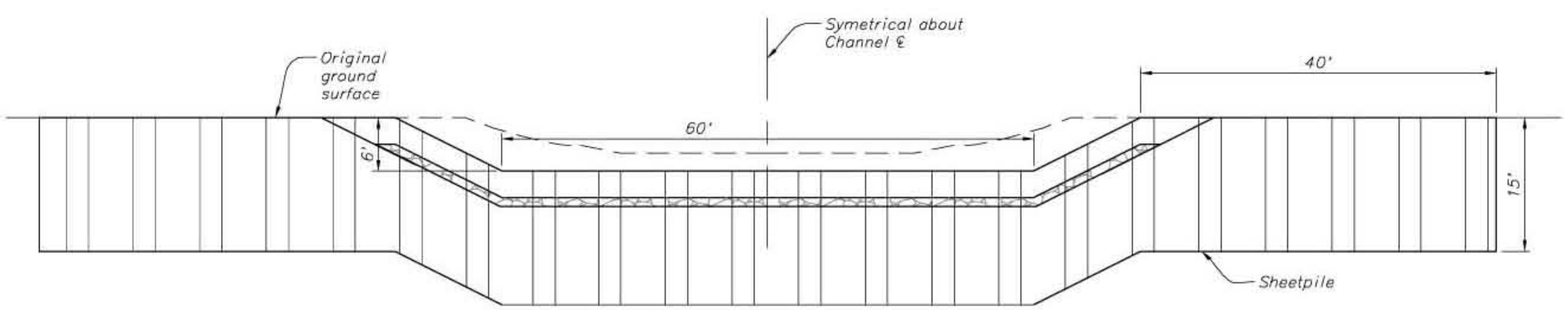
MODIFIED CHANNEL SECTION

10 0 10 20 30
SCALE OF FEET

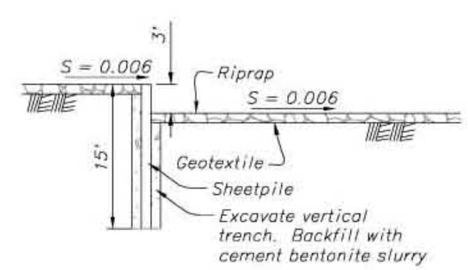
NOTES

1. Existing bridge is not to be disturbed
2. Assumed spacing of drop strucures = 500 feet

HYDRAULIC PROPERTIES							
Q	V	n	s	b	d	H	s:s
1600	5.9	0.045	0.006	60	4	6	2:1



TYPICAL DROP STRUCTURE (SECTION A–A)



TYPICAL DROP STRUCTURE (SECTION B–B)

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

YAKIMA RIVER BASIN STORAGE STUDY

WYMER DAM AND RESERVOIR APPRAISAL STUDY

OUTLET CHANNEL MODIFICATIONS

PLAN AND SECTIONS

DESIGNED ANNE PAVOL

REVIEWED BY K. A. SAYER

Water Conveyance Group

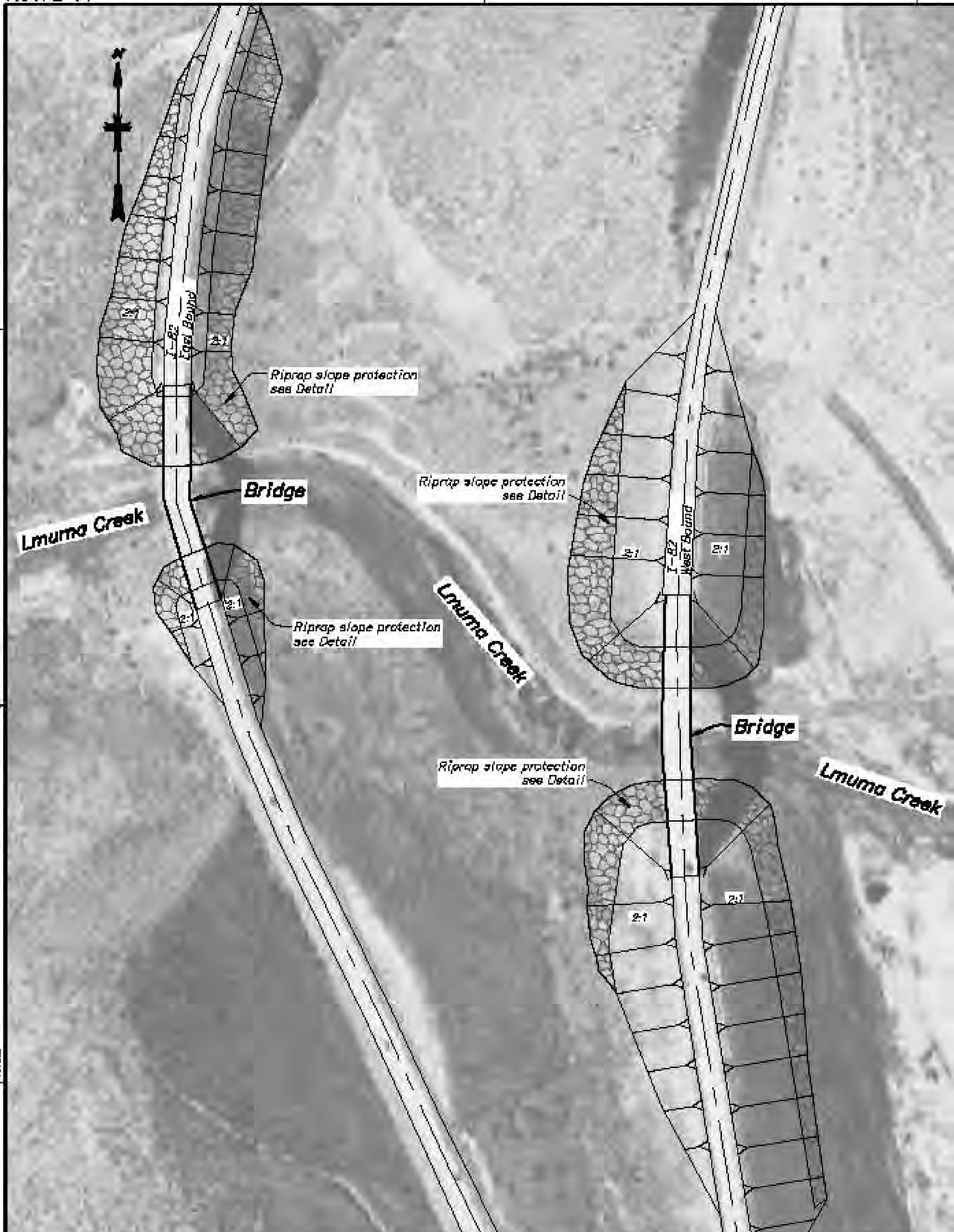
DENVER, CO SHEET 1 OF 1 APRIL 25, 2007

FIGURE 30

DATE AND TIME PLOTTED AUGUST 21, 2007 17:52 PLOTTED BY APAVOL

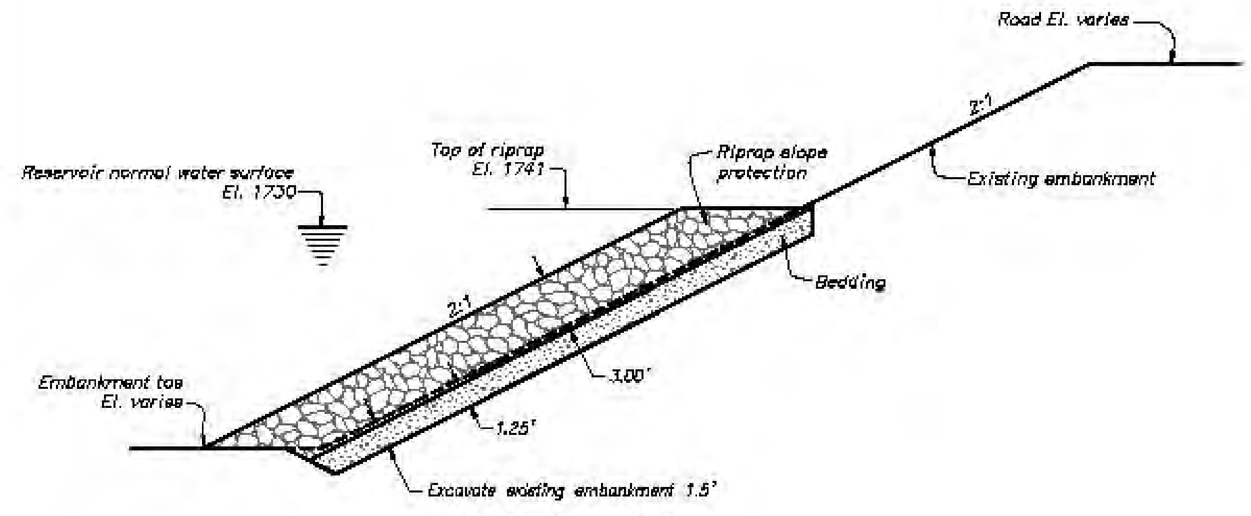
CAD SYSTEM AutoCAD Rel. 16.1s CAD FILENAME CHANNEL FIGURE.DWG

FIGURE 31



PLAN

SCALE OF FEET



RIPRAP DETAIL
NOT TO SCALE

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

2007-08-08

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
YAKIMA RIVER BASIN STORAGE STUDY

WYMER DAM AND RESERVOIR APPRAISAL STUDY
I-82 Slope Protection

PLAN AND DETAIL

DESIGNED ______
REVIEWED BY ______
Water Conveyance Group

DENVER, CO SHEET 1 OF 1 May 8, 2007

FIGURE 31