Yakima River Basin Study

Wymer Dam and Reservoir Summary Technical Memorandum

U.S. Bureau of Reclamation
Contract No. 08CA10677A ID/IQ, Task 4.7

Prepared by

HDR Engineering, Inc.

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

State of Washington
Department of Ecology
Office of Columbia River

March 2011

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1.0 Introduction

This technical memorandum summarizes the findings of the Wymer Dam and Reservoir Appraisal Study that was completed in September 2007 and describes the challenges and possible next steps for this potential water storage project. The purpose of the 2007 study was to review past work and update the designs and costs to meet current standards and needs so the Wymer project could be compared to other potential Yakima River Basin storage alternatives.

No new or supplemental technical analysis has been performed for the Wymer project since 2007, but estimated project costs, updated to 2010 values, are included in a separate technical memorandum as part of the 2010 Yakima River Basin Study. All the features of the Wymer project, as described in the 2007 appraisal study, are included by reference in this memorandum. The executive summary from the 2007 report is included in Section 3.0 of this memorandum for background. Further analysis could develop a more well-defined configuration that could be integrated into a basin-wide water enhancement program.

2.0 Project Background

The primary purpose of the Wymer dam and reservoir project is to create additional water storage capability in the Yakima River Basin with the goals of:

- Improving anadromous fish habitat
- Improving the water supply for proratable irrigation water rights
- Meeting future municipal water-supply needs

The project would be an off-channel storage facility on Lmuma Creek, 8 miles upstream of the existing Roza Diversion Dam (see Figures 1 and 2).

2.1 1985 Feasibility Study

Reclamation completed a feasibility study of the Wymer project in 1985. Active reservoir storage was estimated at 174,000 acre-feet, and most of the stored water was to be pumped to the reservoir from the Yakima River via a pumping plant and pipeline. This active storage area is dependant on the ultimate outlet works configuration and the final water plan for the Wymer Reservoir. For these reasons, the active storage area has not been finalized and is subject to change. The 1985 concept included the following features:

- An unlined approach channel from Yakima River to the pumping plant
- A 5-unit, 400-cfs pumping plant
- An electrical switchyard
- A 96-inch-diameter discharge pipeline 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

Table ES-1 summarizes the major proposed features of the project, which had a field cost estimate of $206.2 million (April 1985 prices). In August 1985, the estimate was revised to a most-probable field cost estimate of $151.7 million (July 1985 prices) based on modifications of proposed features resulting from additional geologic data.

2.2 More Recent Studies

Various studies since 1985 relied on the quantities developed during the 1985 study and included cost indexing to bring costs to current levels.

Reclamation conducted other evaluations in 2004 and 2006, with emphasis on the feasibility of storing Columbia River water in the potential offstream Black Rock reservoir. These are described in the Executive Summary from the 2007 study in Section 3.0 below.

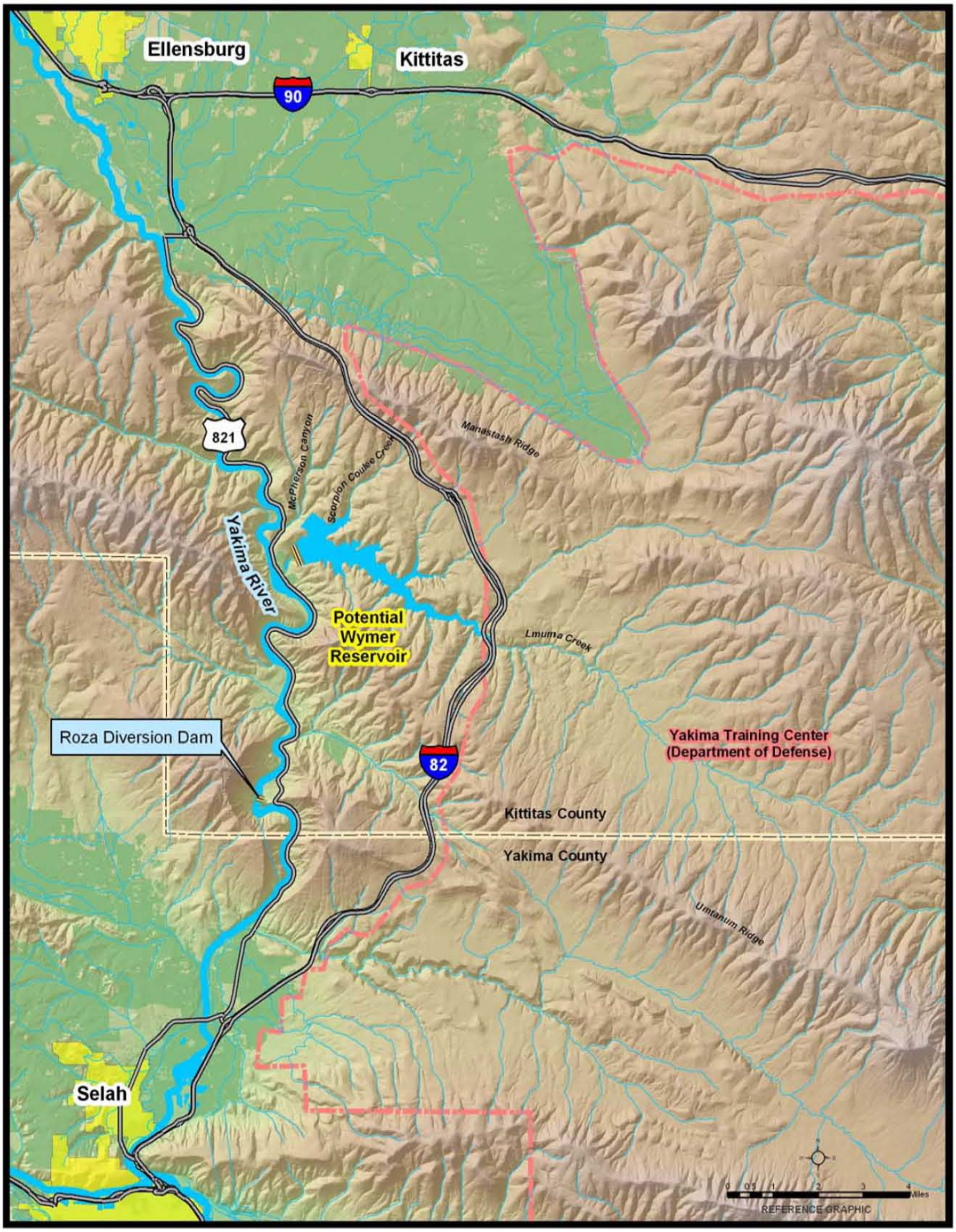

Figure 1. Potential Wymer Reservoir (USBR 2007)

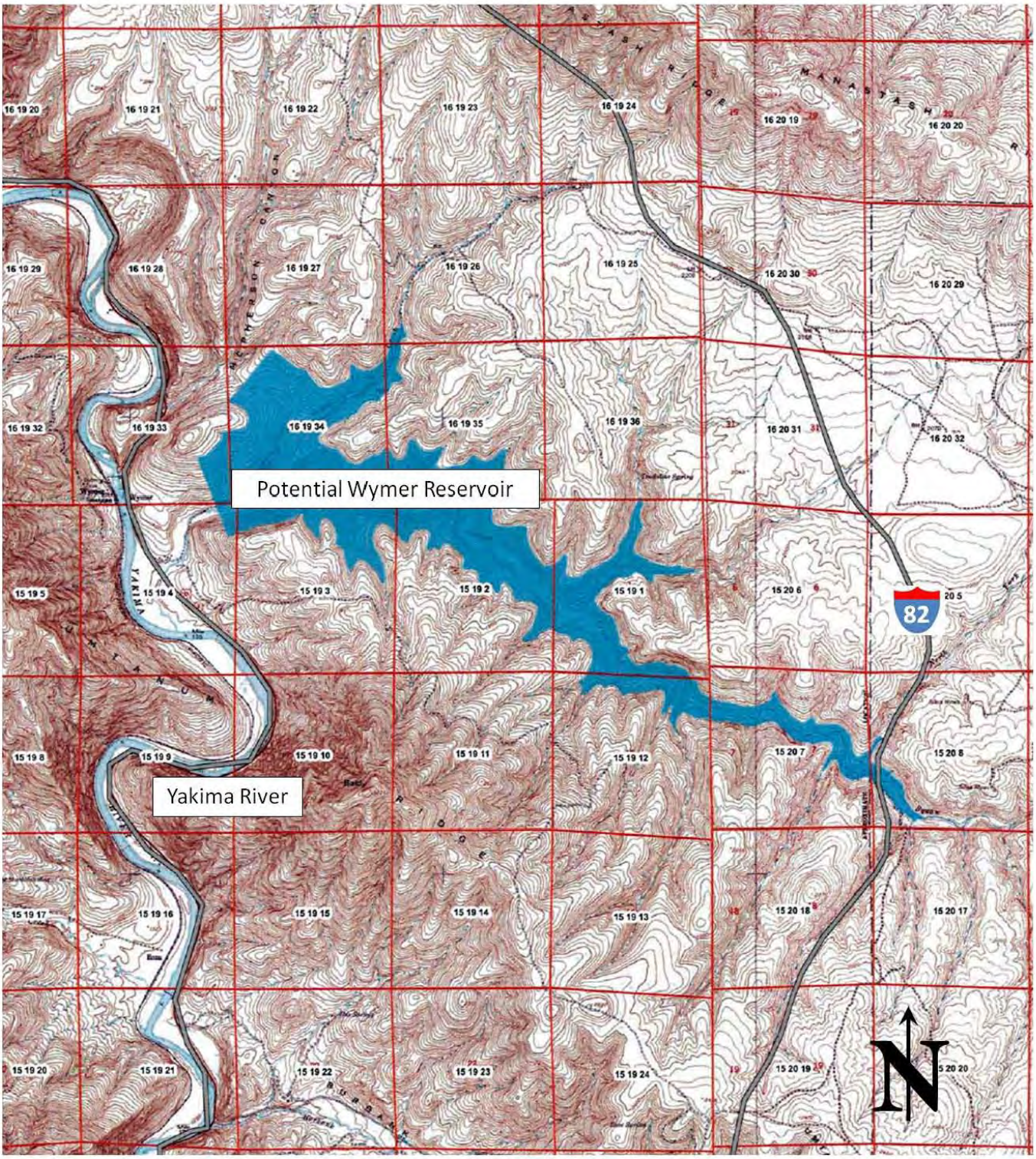

Figure 2. Potential Wymer Reservoir Location

3.0 Executive Summary from 2007 Wymer Dam and Reservoir Appraisal Study

(Printed verbatim from the 2007 feasibility report, with minor edits for clarity)

3.1 Background

In 2006, Reclamation prepared an appraisal assessment of a Wymer Dam and Reservoir. The 2006 evaluation used indexed costs for features that were originally designed and cost estimated in 1985. Following this evaluation, Reclamation's Denver Technical Service Center reviewed past work and updated the appraisal-level designs and costs to meet current standards and needs. This report documents the most recent updated appraisal assessment of the costs and features required to construct Wymer Dam and Reservoir.

3.2 Technical Findings

As currently proposed, Wymer reservoir has an active reservoir storage capacity of 169,076 acre-feet (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), 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. *(Note: Figure 12 has been attached to this memorandum from the 2007 Appraisal Study for completeness.)*

3.3 Conclusions

The following conclusions are based on the technical and cost analyses completed for the 2007 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 included in the 2007 Appraisal Report is in April 2007 price level dollars and includes mobilization, unlisted items, and contingencies. The field cost estimate does not include non-contract costs. *(Note: Costs updated to reflect 2010 prices are contained in a separate technical memorandum.)*

Table 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 dewater 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 based on NGVD29 datum.

3.4 Level of Study

The 2007 Appraisal Study 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 presented in the 2007 Appraisal Study 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.

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.

(End of Executive Summary from Wymer Dam and Reservoir Appraisal Study, September 2007)

4.0 General Considerations

The technical challenges to implementing the Wymer project are as follows:

- Identifying whether the pumping plant included in the 2007 appraisal study is needed
- Integrating the information from the 2007 appraisal study with other elements of a basin-wide plan
- Purchasing project land
- Determining the frequency and amount of water to be stored in, and withdrawn from, the Wymer reservoir
- Evaluating the potential for integrating hydropower with the reservoir facilities in light of current power revenue values
- Completing geotechnical investigations at the reservoir site and evaluation of current seismic design requirements
- Conducting a final assessment of potential impacts on the Highway 82 bridge foundations and piers

Further considerations for implementing this project may include:

- Address general concerns regarding the integration of the Wymer reservoir with the Yakima Basin Storage Study.
- Carry out the next phase of design to further solidify project costs.

5.0 Cost Estimates

Updated cost estimates for the Wymer project are presented in a separate Volume 2 technical memorandum: *Costs of the Integrated Water Resource Management Plan*.

6.0 References

1. Reclamation. 2007. Yakima River Basin Storage Study Wymer Dam and Reservoir Appraisal Report, Technical Series No. TS-YSS-16, U.S. Department of Interior, Bureau of Reclamation, September 2007.

7.0 List of Preparers

NAME	BACKGROUND	RESPONSIBILITY
HDR ENGINEERING, Inc.		
Leanne Greisen	Staff Engineer	Document Preparation
Stan Schweissing	Senior Engineer	QA/QC

Appendix A
Major Wymer Project Features (Reclamation 2007)

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FIGURE 12

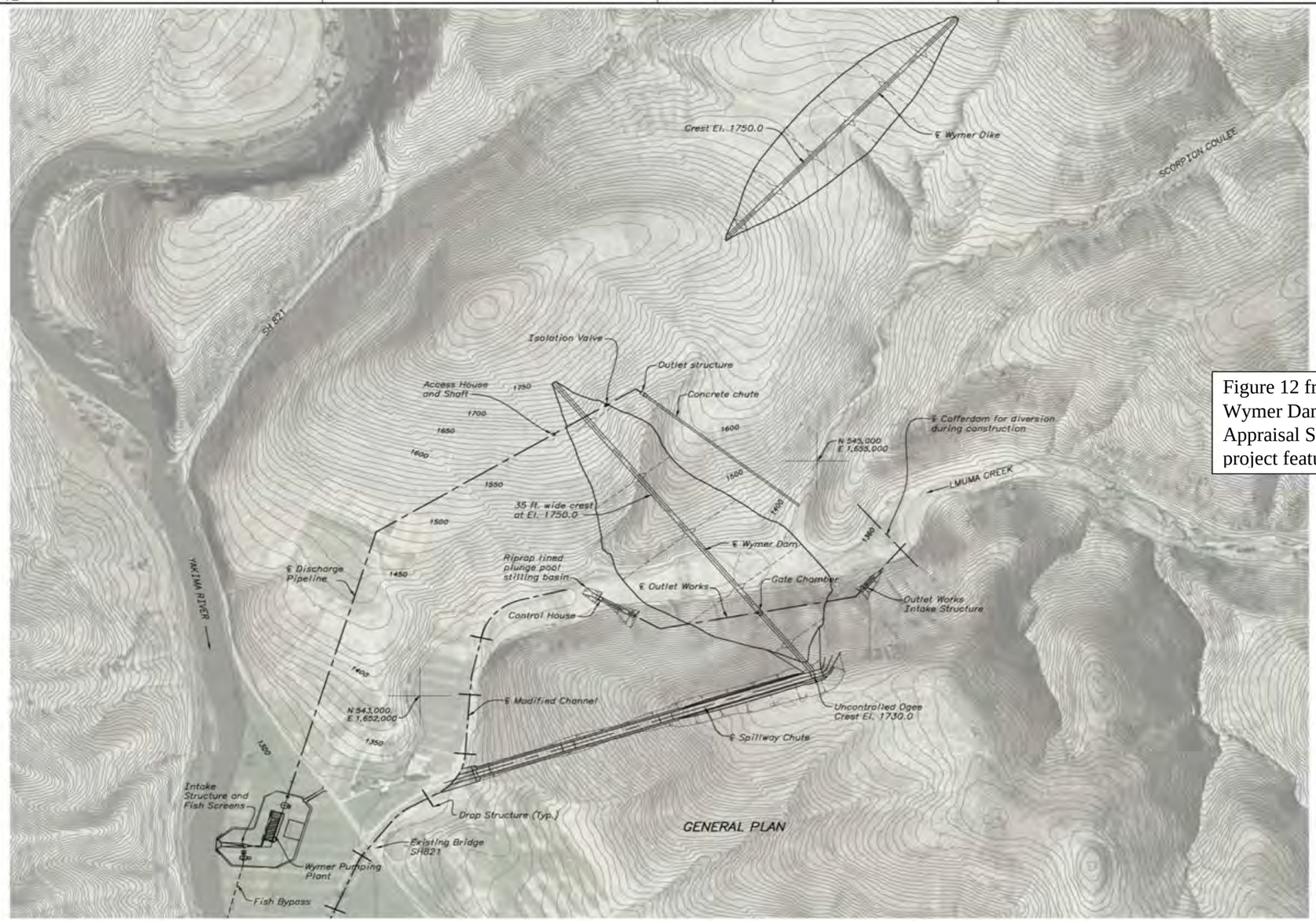

Figure 12 from Reclamation's 2007 Wymer Dam and Reservoir Appraisal Study shows major project features.

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. LAFORD P.E.

DENVER, CO APRIL 11, 2007 SHEET 1 OF 1

FIGURE 12

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

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

Appendix B
Geology Section from 2007 Wymer Dam and Reservoir Appraisal Study

Geology

(Printed verbatim from the 2007 feasibility report)

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:

1. Further characterization of foundation materials and properties at the main damsite and a saddle dike, including depth to bedrock.
2. Characterization of foundation materials and properties at the pumping plant site adjacent to the Yakima River.

3. Assessment of the Vantage sandstone, an interbed within the Columbia River basalts, with emphasis on reservoir seepage losses and slope stability.
4. Assessment of seepage losses and slope stability of the abutments.
5. 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

Pumping Plant Site: 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).

Damsite: 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.

Saddle Dike Site: 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.

Reservoir Basin: 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.

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Appendix C
Wymer Capacity Table (Reclamation 2007)

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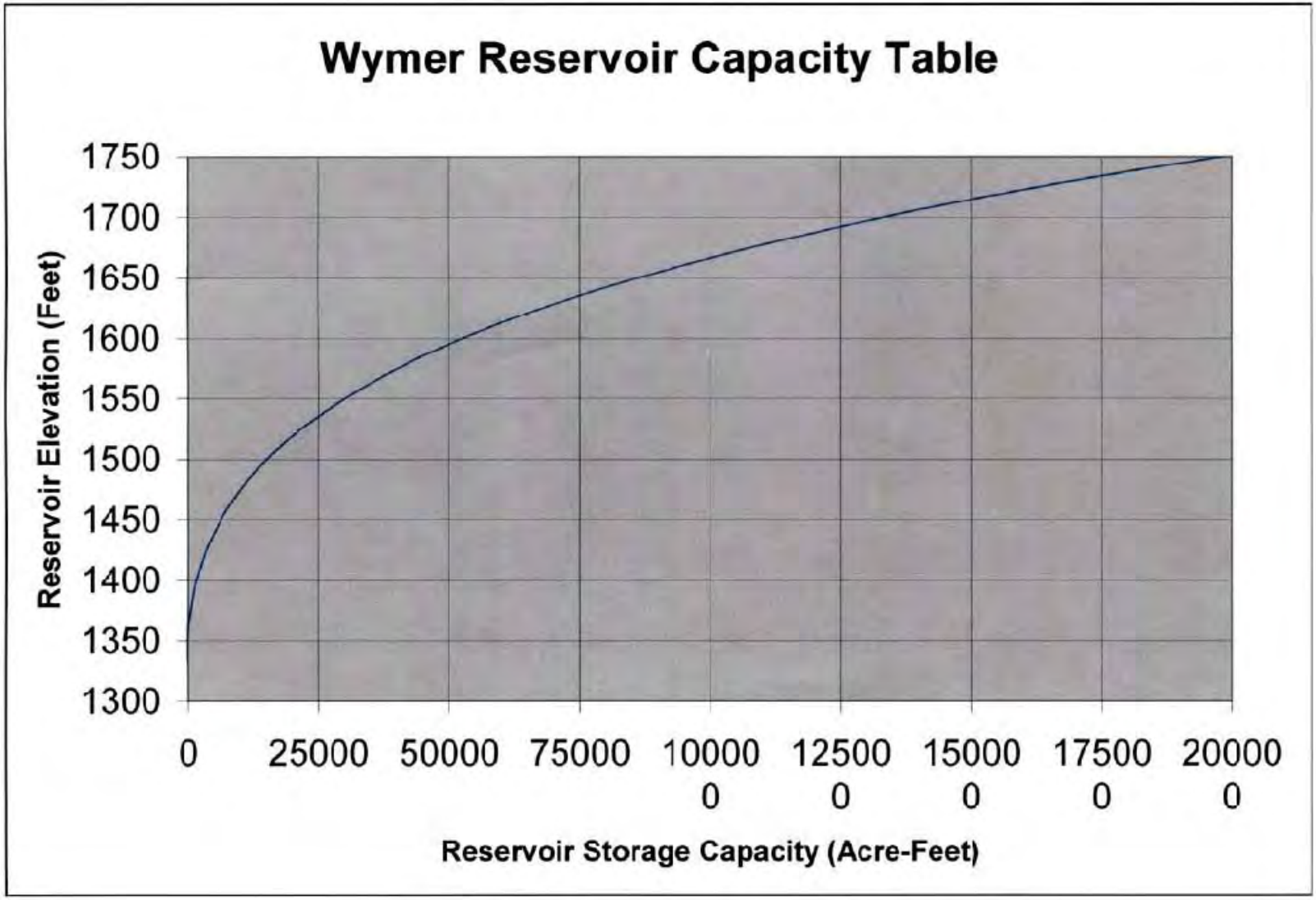
Wymer Reservoir Capacity Table
Reservoir Elevation (Feet)
1750
1700
1650
1600
1550
1500
1450
1400
1350
1300
0
25000
50000
75000
100000
125000
150000
175000
200000
Reservoir Storage Capacity (Acre-Feet)

Appendix D
Capacity Allocation Analysis

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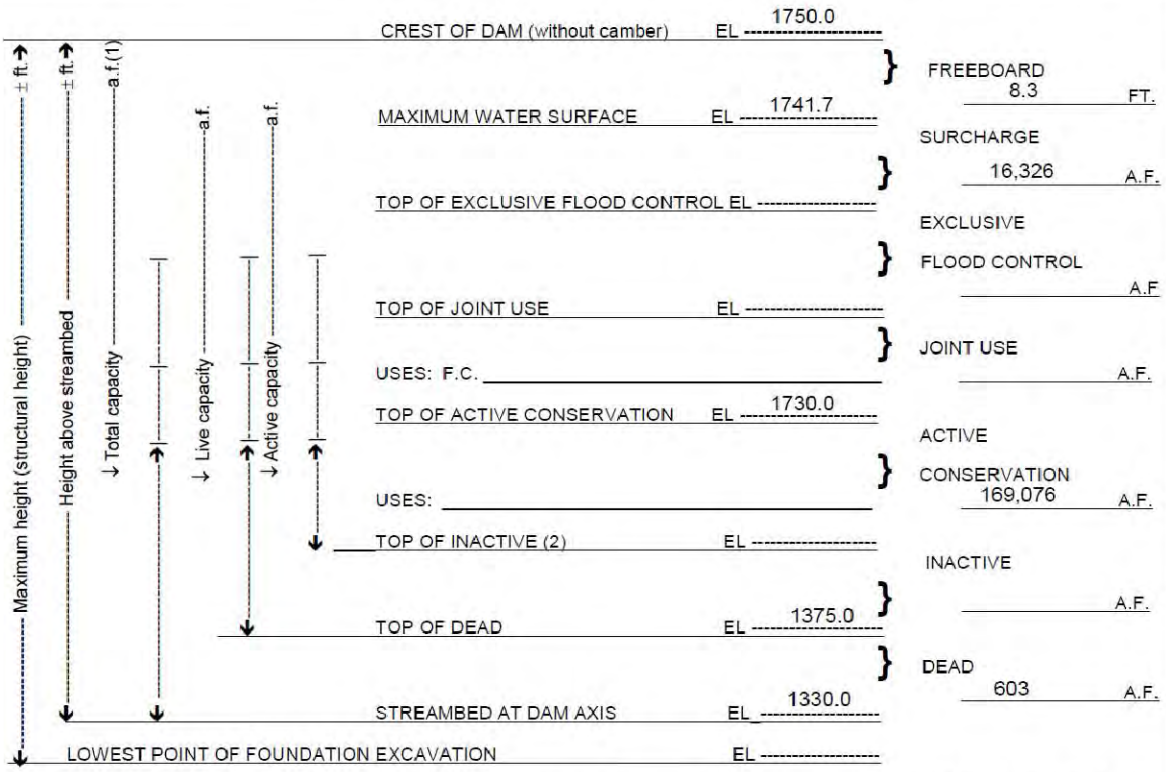
7-1686 (5-06)
Bureau of Reclamation

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.

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 date 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.

Appendix E
Selected Drawings (Reclamation 2007)

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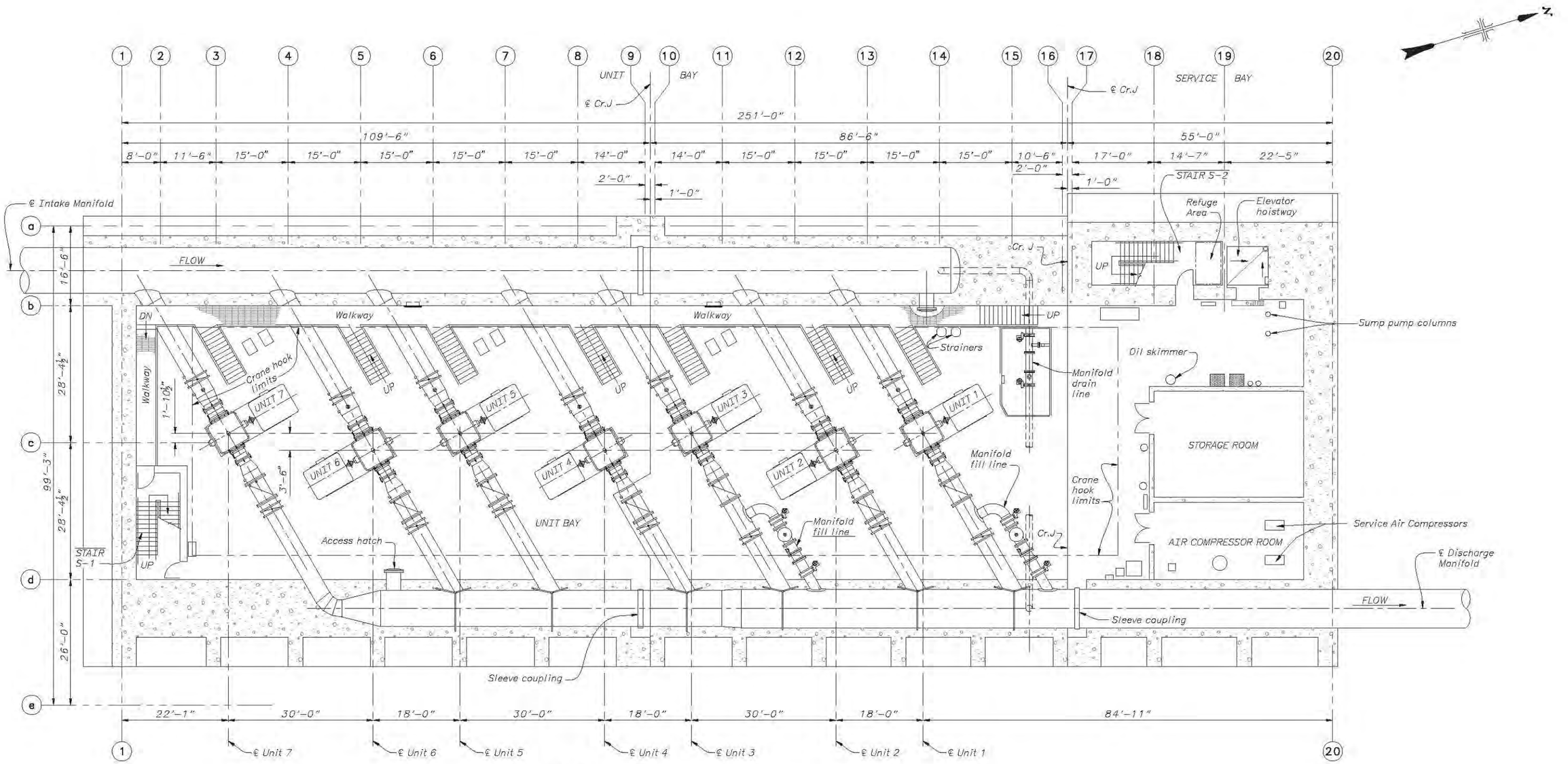
FIGURE 18



FLOOR – EL. 1250.00

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

* Includes 5% wear factor

NOTES

1. Vertical datum referenced to NGVD29.

PRELIMINARY

NOT TO BE USED FOR CONSTRUCTION

2007-08-08

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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
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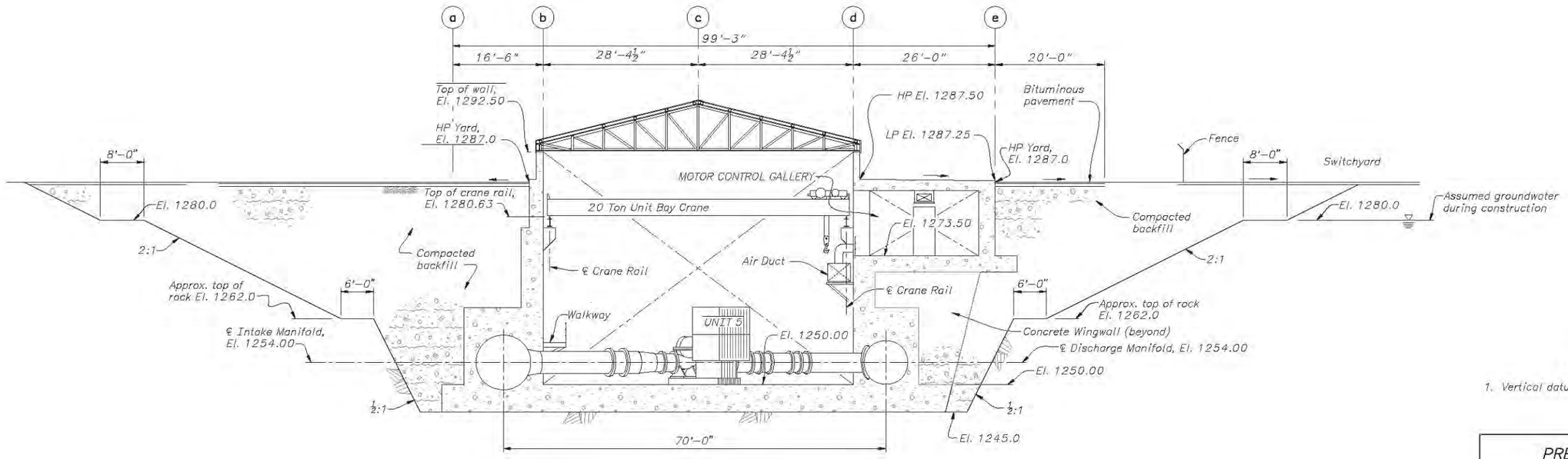
CAD SYSTEM
AUTOCAD
CAD FILENAME
UNKNOWN

FIGURE 19



TRANSVERSE SECTION THRU UNIT BAY

NOTES

1. Vertical datum referenced to NGVD29.

PRELIMINARY

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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

DATE AND TIME PLOTTED
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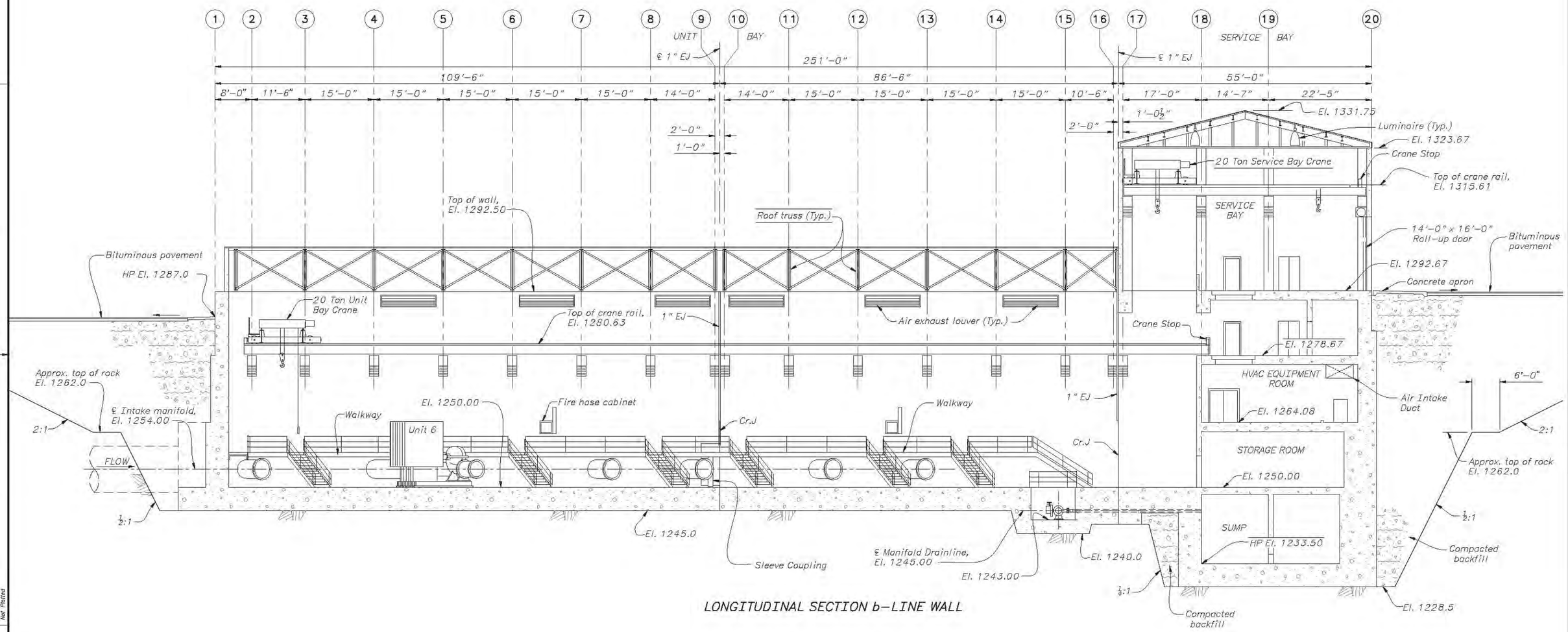
Not Plotted

CAD SYSTEM
AUTOCAD
CAD FILENAME
UNKNOWN

FIGURE 20



LONGITUDINAL SECTION b–LINE WALL

NOTES

1. Vertical datum referenced to NGVD29.

PRELIMINARY

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YAKIMA RIVER BASIN STORAGE PROJECT

WYMER DAM AND RESERVOIR APPRAISAL STUDY

PUMPING PLANT – GENERAL ARRANGEMENT

LONGITUDINAL SECTION b–LINE WALL

DESIGNED B. K. GOPLEN

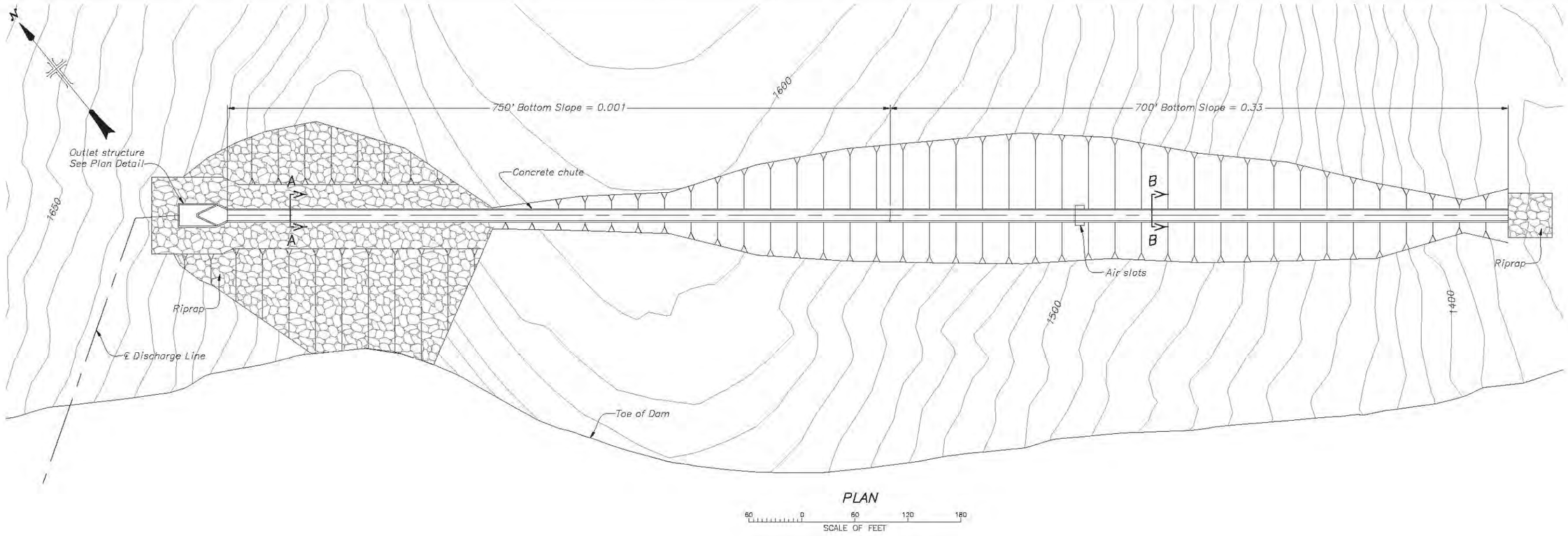
REVIEWED R. W. LAFOND P.E.

SHEET 1 OF 1 | FIGURE 20

DATE AND TIME PLOTTED
Not Plotted
PLOTTED BY
Not Plotted

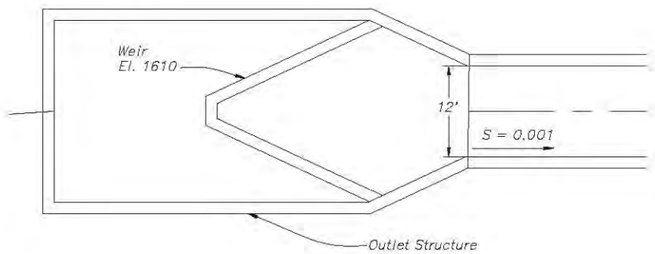
CAD SYSTEM
AUTOCAD
CAD FILENAME
UNKNOWN

FIGURE 25



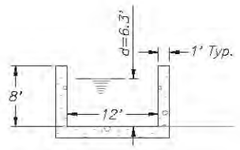
PLAN

60 0 60 120 180
SCALE OF FEET

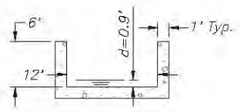


PLAN DETAIL

10 0 10 20 30
SCALE OF FEET



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

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NOTES

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

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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

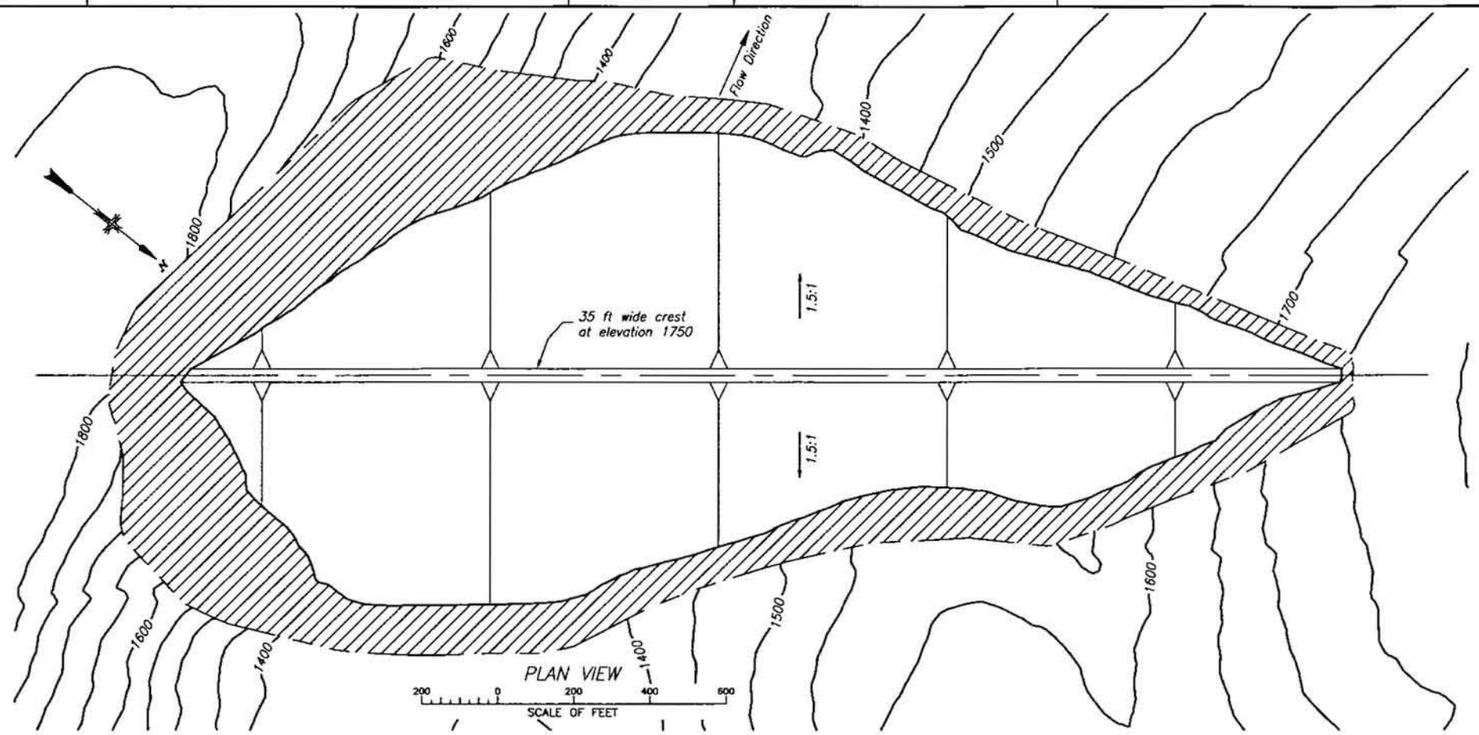
DENVER, CO APRIL 11, 2007
SHEET 1 OF 1

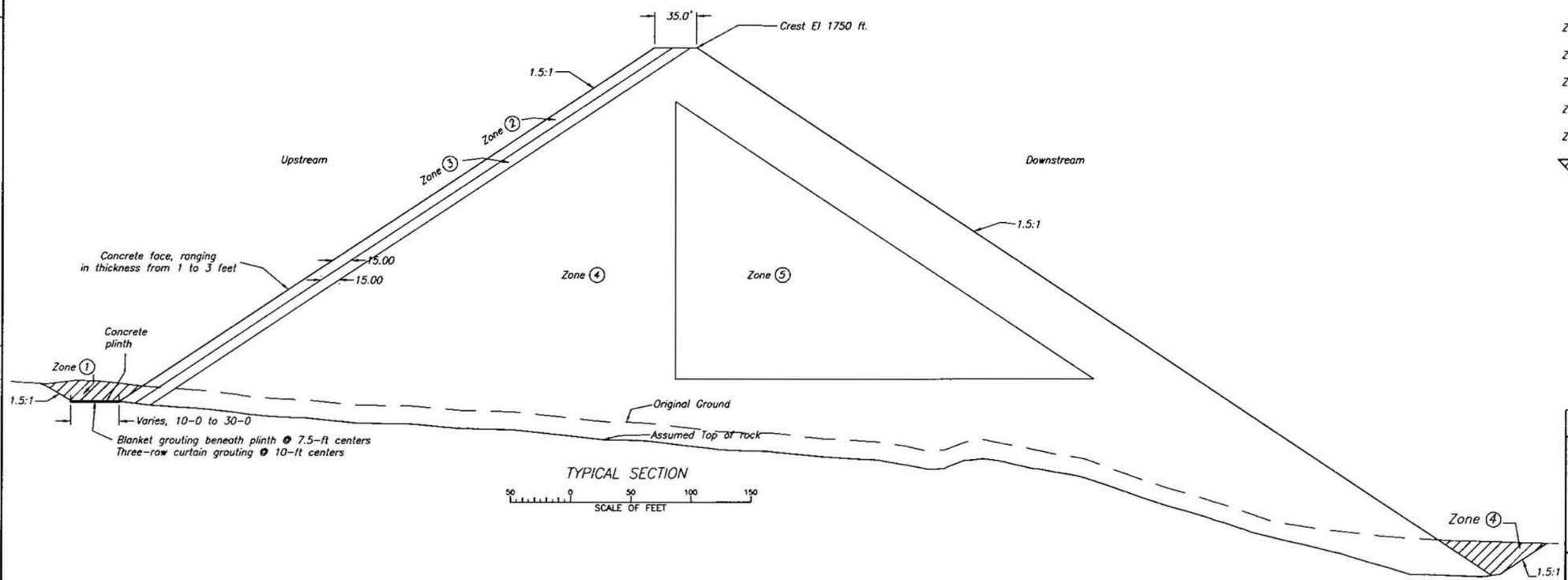
FIGURE 25

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





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

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2007-08-08

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BUREAU OF RECLAMATION

YAKIMA RIVER BASIN STORAGE STUDY

WYMER DAM AND RESERVOIR APPRAISAL STUDY

CONCRETE FACE ROCKFILL DAM PLAN AND SECTION

DESIGNED

REVIEWED BY

Technical Engineering Group

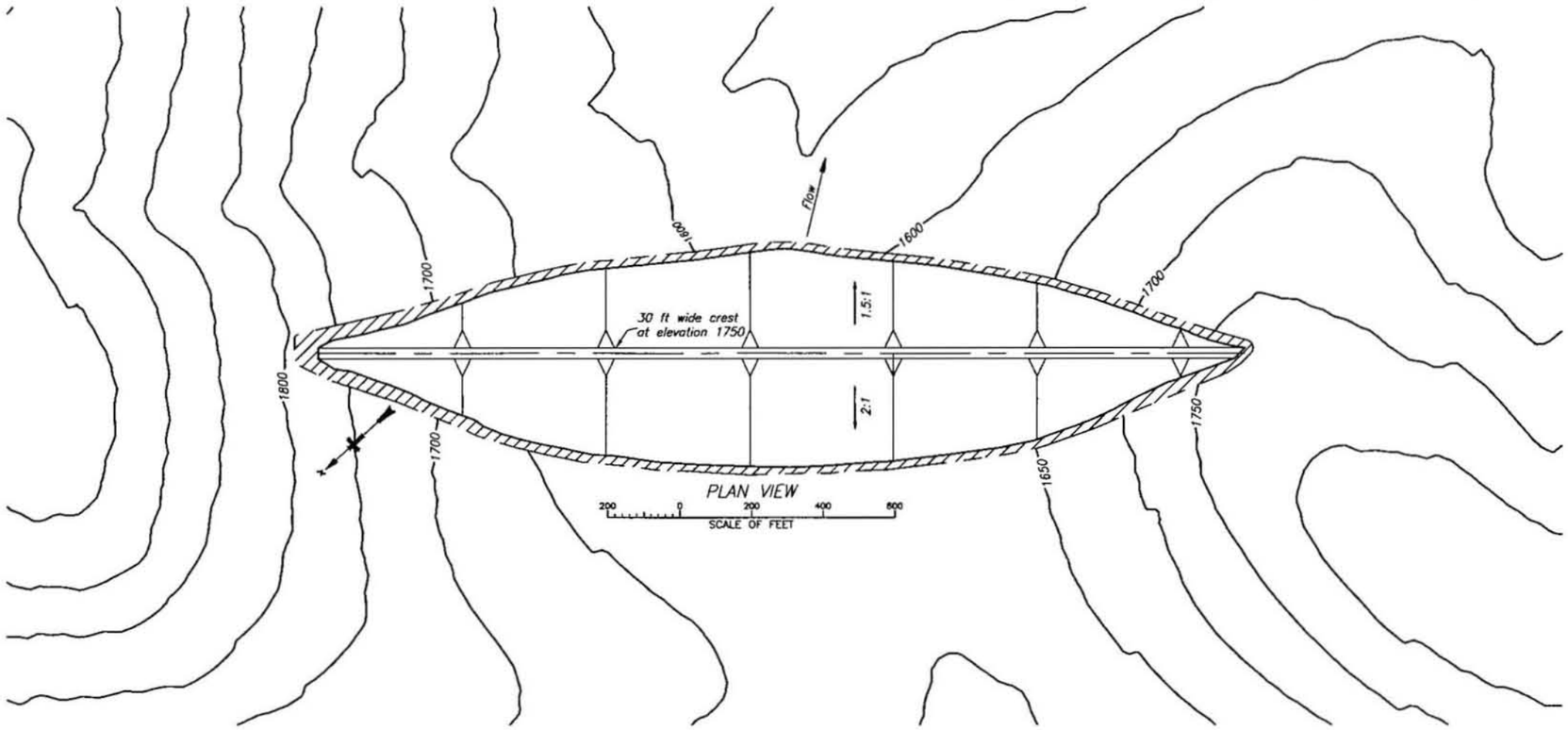
DENVER, COLORADO 2007-08-01
SHEET 1 OF 1

FIGURE 26

DATE AND TIME PLOTTED
AUGUST 17, 2007 07:41
PLOTTED BY
SMITTA

CAD SYSTEM
AutoCAD Rel. 16.2s
CAD FILENAME
FIGURE 26.DWG

FIGURE 27



EMBANKMENT MATERIALS

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

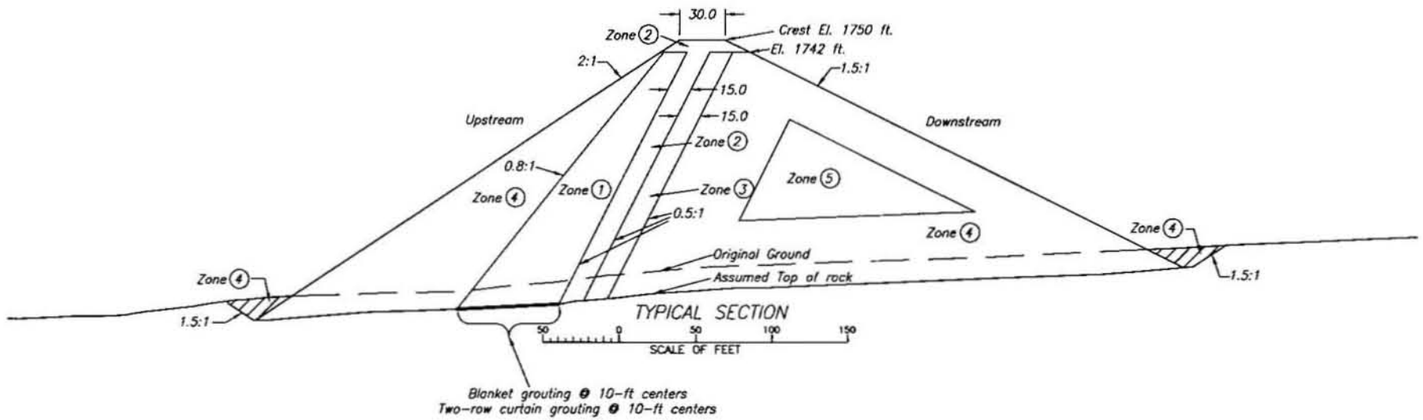
Zone (2): Processed sand & gravel filter material compacted by vibratory rollers to 12-inch layers

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

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2007-08-08

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BUREAU OF RECLAMATION

YAKIMA RIVER BASIN STORAGE STUDY

WYMER DAM AND RESERVOIR APPRAISAL STUDY

CENTRAL CORE ROCKFILL DIKE
PLAN AND SECTION

DESIGNED

REVIEWED BY

Geotechnical Engineering Group

DENVER, COLORADO
SHEET 1 OF 1

2007-08-01

FIGURE 27

DATE AND TIME PLOTTED
AUGUST 17, 2007 07:47
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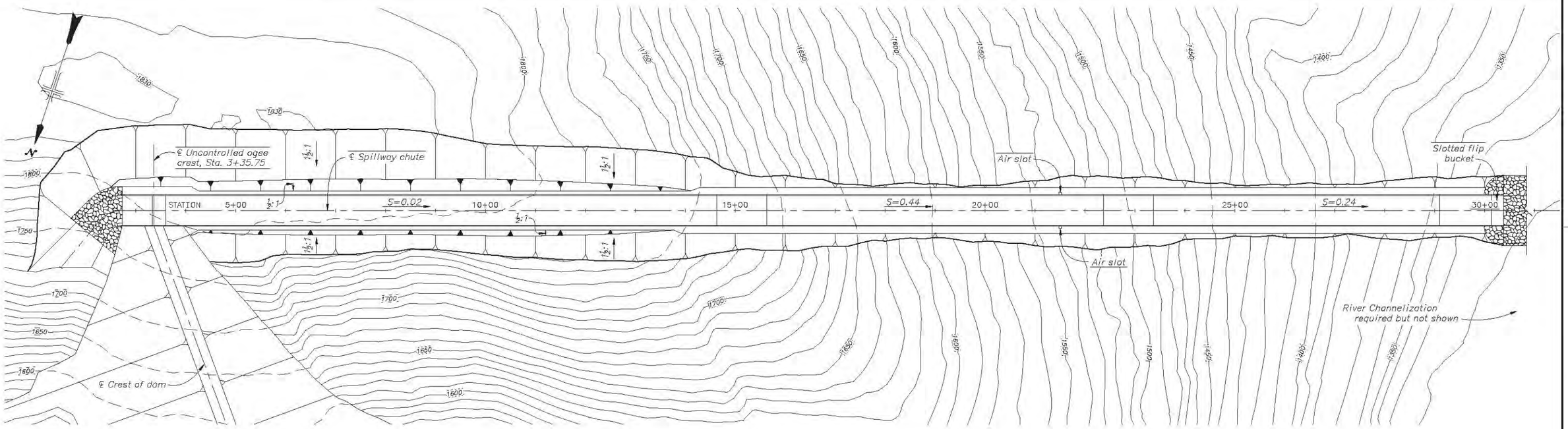
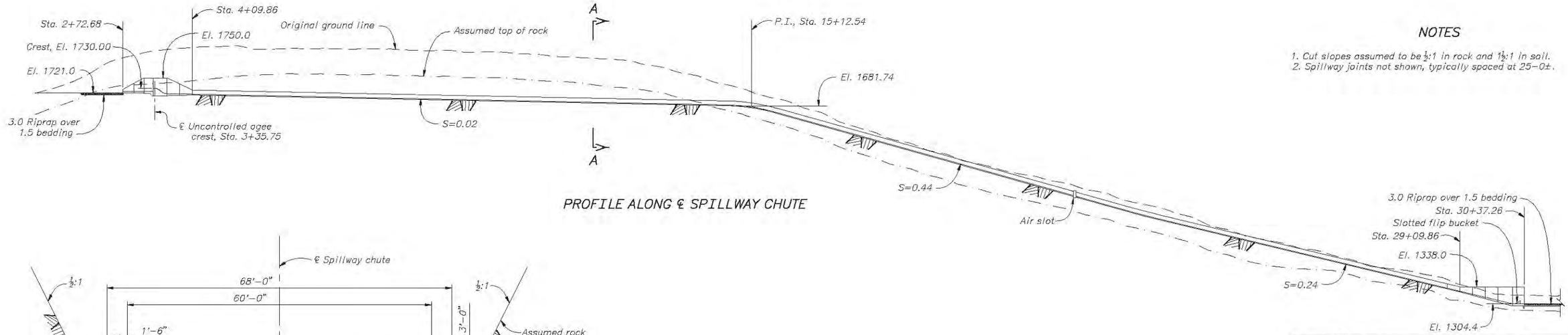
SMITA

CAD SYSTEM
AutoCAD Rel. 16.2x
CAD FILENAME
FIGURE 27.DWG

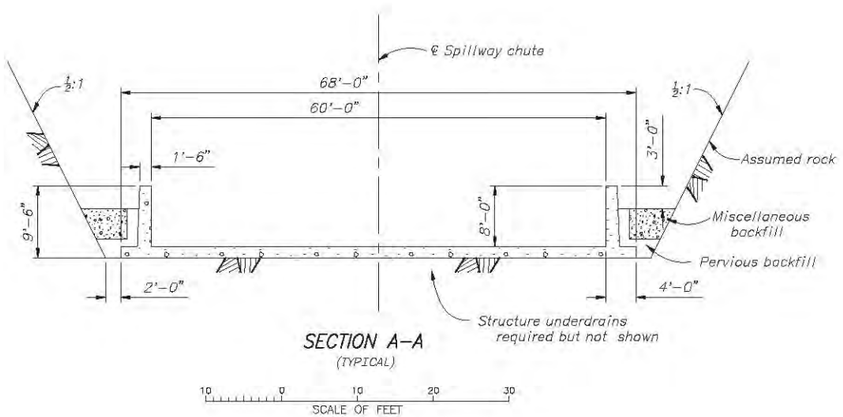


PLAN

100 0 100 200 300
SCALE OF FEET



PROFILE ALONG ℄ SPILLWAY CHUTE



SECTION A–A
(TYPICAL)

10 0 10 20 30
SCALE OF FEET

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

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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 2007–05–01
SHEET 1 OF 1

FIGURE 28

DATE AND TIME PLOTTED
AUGUST 16, 2007 05:25
PLOTTED BY
JMARKLEY

CAD SYSTEM
AutoCAD Rel 16.1s
CAD FILENAME
FIGURE 28.DWG