U.S. DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

PACIFIC NORTHWEST REGION

YAKIMA RIVER BASIN WATER ENHANCEMENT STUDY

●

PRELIMINARY REPORT

for

SWAUK CREEK DAM

LAKE CLE ELUM TUNNEL

LAKE CLE ELUM PUMPING PLANT

MARCH 1984

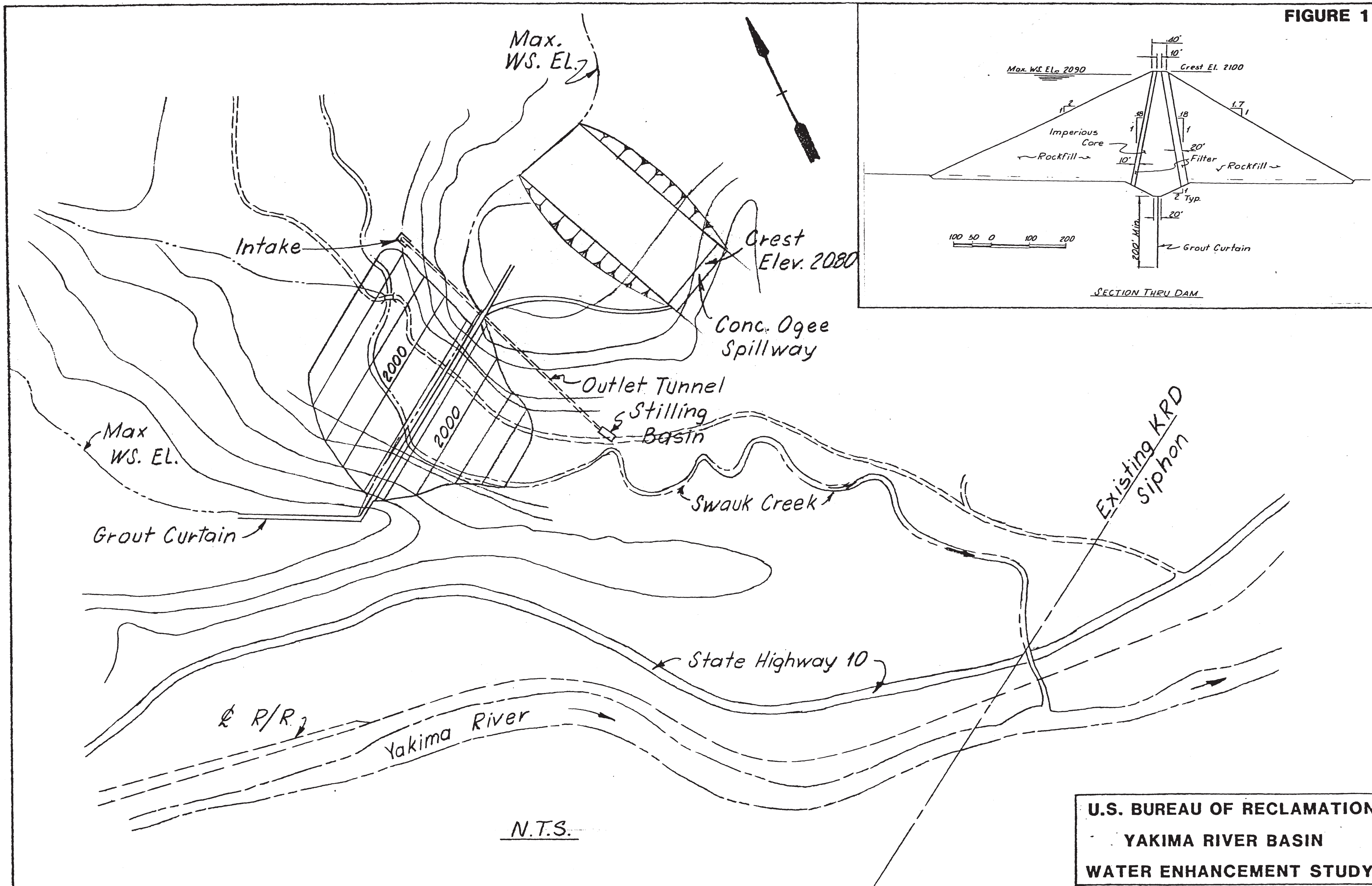
Submitted by

INTERNATIONAL ENGINEERING

A MORRISON-KNUDSEN COMPANY

NORTHWEST DISTRICT OFFICE
1451 HARTMAN STREET
P.O. BOX 4057
BOISE, IDAHO 83711

FIGURE 1



U.S. BUREAU OF RECLAMATION
YAKIMA RIVER BASIN
WATER ENHANCEMENT STUDY

SWAUK CREEK
PROPOSED ROCKFILL DAM
PLAN & PROFILE

MKO INTERNATIONAL ENGINEERING COMPANY, INC.
A MORRISON-KNUDSEN COMPANY

TABLE OF CONTENTS

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NORTHWEST DISTRICT OFFICE
P.O. BOX 4057 / 1451 HARTMAN STREET / BOISE, IDAHO 83704
PHONE: (208) 375-5232

April 4, 1984

Mr. Gary Kitterman
Bureau of Reclamation
Attn. Code 780
Box 043, 550 West Fort Street
Boise, Idaho 83724

Re: Report on Swauk Creek Dam and Lake Cle Elum
Low Level Outlet
IECO Project No. 4202

Dear Gary:

Enclosed are 10 copies of the completed report on Swauk Creek Dam, Lake Cle Elum Tunnel and Lake Cle Elum Pumping Plant. The revisions which you requested after reviewing the draft report have been incorporated.

This completes the work under Task Order 3 AB-10-05790-00040. We appreciate the opportunity to work with you on this study and will be pleased to provide any additional assistance required.

Very truly yours,

George H. Talbott

George H. Talbott, P.E.
Project Manager

GHT:jrm

Enc: 10 copies of Report

SECTION 1

INTRODUCTION

This study was done by International Engineering Company (IECO) for the Pacific Northwest Region of the Bureau of Reclamation under Basic Ordering Agreement No. 3-AB-10-05790. There are three parts to the study. Eeah is covered in separate sections of this report. The three sections are as follows:

Section 2--Swauk Creek Dam - This study developed a conceptual design and estimated cost for a dam to provide irrigation storage on Swauk Creek.

Section 3--Cle Elum Lake Tunnel - A conceptual plan for using 100,000 acre-feet of dead storage has been developed using a 4.5 mile tunnel discharging into the Yakima River. A cost estimate for the plan is included.

Section 4--Cle Elum Lake Pumping Scheme - This very preliminary study develops three alternative concepts and discusses the relative merits of each. No cost estimates or quantitative comparisons are made.

The studies are based on existing data, reports, and other information provided by the Bureau of Reclamation. This data was analyzed by IECO and used to develop the concepts and cost estimated presented in the following sections of the report.

At the end of each section, conclusions are presented summarizing the findings of that particular study.

SECTION 2

SWAUK CREEK DAM STUDY

2.1 GENERAL DESCRIPTION

This study for a dam on Swauk Creek is a pre-feasibility or appraisal level study to develop an order-of-magnitude cost estimate for construction of the project.

2.1.1 Scope - The Bureau of Reclamation has developed a preliminary cost estimate for an earth-fill dam on Swauk Creek. In a report to the City of Ellensburg and the Roza Irrigation District, CH2M-Hill developed a cost for a dam at the same site, based on a rock-fill concept, to provide water for both irrigation and power generation.

This study has used the data and information from both studies to develop a concept and cost estimate for a dam at the Swauk Creek site. The Work Order requires a review of both previous studies and a cost estimate at approximately the same level of detail as the Bureau's study. Additional data, particularly pertaining to geology, has been provided by the Bureau's staff. Layout sketches are provided to illustrate the concept proposed.

2.1.2 Location - The proposed site is located on Swauk Creek about 1/2 mile from its confluence with the Yakima River in the NW 1/4 of Section 20, and the SW 1/4 of Section 17, T19 N, R17 E. The site is about five miles from the town of Cle Elum, and is accessible from Interstate 90 and State Highway 10. The City of Seattle lies 90 miles to the West and the City of Yakima is 55 miles to the east.

2.1.3 Geology - The site is in a U-shaped valley with a flat creek bottom about 500 feet wide, floored with alluvium with an estimated maximum depth of 50 feet. Flat lying basalt flow form the canyon walls. These are bold outcrops of lightly to moderately fractured basalt occurring on the left abutment which has slopes as steep as 50 degrees. The right abutment is on a slope of 35 degrees and is covered with slope wash estimated at 2 to 10 feet thick overlying the basalt.

There are no known faults in the area. There is evidence of a large landslide in the reservoir area about 2 1/2 miles upstream, but there are none at the damsite. The landslide would not affect the dam concept, and has not been evaluated in this study.

Impermeable and semi-permeable materials are not available in the area in the large quantities needed for an earthfill embankment. For this reason, a rockfill section was adopted. For purposes of costing the materials, it was assumed that the impervious core material would be brought in from a source 10 miles away in the valley. Sand and gravel for filters and concrete is available at Cle Elum, five miles distant. The basalt in the vicinity of the damsite is sound and would be used for the rockfill material. The rock will be taken from the spillway and tunnel excavation and a quarry which would be located at the site.

2.2 ASSUMPTIONS

The following assumptions were made in developing the criteria and the cost estimate.

2.2.1 Hydrology and Hydraulics - The flow data for the study was taken from both the Bureau's studies and the CH_2M-Hill report. The reservoir capacity of 80,000 acre-feet is approximately the same capacity used in both studies. A PMF of 50,000 cfs was adopted based on data contained in the CH_2M-Hill report, and was used in sizing the spillway. Based on discussions with Bureau staff, the spillway would not be used in operating the reservoir, and would be classed as an emergency spillway. An unlined spillway with a concrete ungated overflow section spilling into a natural drainage founded in the basalt bedrock is proposed. The outlet structure would serve as a diversion during construction and to control releases for reservoir operation. The size of the outlet was based on passing 2,000 cfs during construction and checked for capacity to pass 500 cfs for irrigation need at minimum pool elevation.

2.2.2 Structures - The study assumed a rockfill dam with a section as shown on Figure 1. The dam would be 300' high, as measured above streambed elevation, with a crest elevation of 2100' and 10' freeboard. Depth to rock was assumed to be 50' in the valley bottom and 10' on the abutments. A cutoff trench with a maximum depth of 50' would be excavated to bedrock. A single grout curtain would be provided to cut off seepage through openings in the bedrock. Grout take, which would be moderate, is estimated at 2 1/2 cubic feet of grout per foot of drill hole. The dam would have a crest width of 40' with no provision for a roadway.

The spillway would be located on the left abutment and would consist of an intake channel 400' wide excavated through the basalt rock. The material excavated would be used as rockfill in the dam. At the end of the intake channel, a concrete ogee overflow section 5' high would be constructed. This outlet would be an uncontrolled section without gates. The overflow section would discharge into a natural drainageway founded in bedrock. No provisions have been made for reshaping the natural channel since the spillway will be used only for emergency operations at very infrequent intervals. Some channel repair may be required if the spillway is used.

The outlet would be a 10' diameter concrete-lined tunnel excavated through the sound rock in the left abutment. The tunnel would be about 2,000' in length. A control shaft would be located near the centerline of the dam. The control chamber would have four 4' x 6' high pressure gates.

Two would be operating gates, backed up by two emergency gates. A trashrack would be provided at the intake, and the outlet would include a transition structure to return the water to the river of an acceptable energy level.

2.3 CRITERIA

The criteria used in this study is as listed below:

Maximum Pool	W.S. elev. 2090'
Freeboard	10'
Crest Length	1300'
Storage Capacity	
Surcharge	6,500 ac. ft.
Active	73,000 ac. ft.
Dead	500 ac. ft.
Total	80,000 ac. ft.
Dam Crest Elev.	2100'
Streambed Elev.	1800'
Dam Height	300'

Shell Slopes - upstream 2.0/1, downstream 1.7/1
Core Slope - .18/1 - both sides
Filter Zone Width - upstream 10', downstream 20'
Foundation Grouting - depth 75% of head, 25' min.
- spacing 25' c-c

PMF	50,000 cfs
Diversion flood	2,000 cfs
Max. Irrigation Release	500 cfs
Outlet tunnel lining	1' thick - entire length

2.4. COST ESTIMATE

Construction costs estimates were prepared for the major items described in paragraph 2.2.2. The estimate is presented in Table I. The costs were developed in accordance with standard procedures for appraisal-type estimates. Much of the data was taken from recent construction costs for similar projects or project features, especially in determining unit prices for major items of work. Information from IECO's and Morrison-Knudsen's files was used in developing these cost estimates.

The construction costs were estimated on the basis of computed quantities of work, to which unit prices were applied, as appropriate. The quantities were calculated on the basis of the sketches, which are presented as exhibits herein. The unit prices of the different items are based on March, 1984, prices and reflect the total cost of the work involved, including the cost of all labor, materials and equipment, as well as such indirect items as taxes and the contractor's overhead and profit. Lump sums were used for items for which the cost could not readily be established by the unit-price method. Included in the cost estimate is a contingency allowance of 25 percent to cover items not listed and possible increases in quantities. This allowance is considered to be reasonable in view of the generally conservative approach used in the estimates and designs. Costs for rights-of-way and relocations are not included.

2.5 CONCLUSION

This conceptual plan would develop 80,000 acre-feet of storage at an estimated construction cost of $46,341,000, or $579 per acre-foot. There is a potential for reducing the construction cost if the design, based on better data, can be further refined. A significant reduction could be made if a source of impermeable material is found near the site. For comparative purposes, the rockfill dam in the CH2M-Hill report was estimated at $27,385,000 (1980 prices) and an earthfill dam done by the Bureau of Reclamation was estimated at $74,385,000 (1982 prices).

TABLE 1

Item	Unit	Quantity	Unit Price	Amount
Clearing & Grubbing	Ac	26.1	2,000.00	$ 52,000
Diversion & Care of River	LS			250,000
Excavation - Cutoff	CY	41,000	5.00	205,000
Drilling Grout Holes	LF	23,500	12.00	282,000
Grouting	CF	6,650	6.50	43,200
Dental Concrete	CY	3,000	250.00	750,000
Impervious Core	CY	697,000	3.50	2,439,500
Filter Material	CY	326,000	9.50	3,097,000
Rock Shell	CY	3,880,000	3.75	14,550,000
Excavation - Spillway	CY	2,429,000	4.00	9,716,000
Concrete - Mass	CY	10,000	2.00	2,000,000
Reinforcing Steel	Lb	818,000	0.50	409,000
Excavation - Tunnel	CY	10,400	160.00	1,664,000
Concrete - Lining	CY	2,600	450.00	1,120,000
Trashrack	Lbs	42,500	1.50	63,800
Outworks - Gates	Lbs	137,200	2.50	343,000
Concrete - Structural	CY	1,300	300.00	390,000
Subtotal				$37,424,700
Contingencies (25%)				$ 9,356,300
TOTAL DIRECT COSTS				$46,781,000

SECTION 3

CLE ELUM LAKE
LOW LEVEL OUTLET

3.1 GENERAL DESCRIPTION

3.1.1 Scope - This study for a tunnel outlet alternative to drain the dead pool of Cle Elum Lake is a pre-feasibility or appraisal level study to develop an order of magnitude cost estimate for comparing alternatives.

No field work was done as part of this study, although discussions were held with USBR personnel who have visited the site. In addition, the existing studies prepared by the USBR have been reviewed.

3.1.2 Location - The proposed project is located at the existing Cle Elum Lake which is about 8 miles north of the town of Cle Elum. It is accessible from Interstate 90 and State Highway 903.

3.1.3 Existing Facilities - Cle Elum Lake was a natural lake at which the USBR built a dam in 1933 to increase the storage. At present, the lake can not be drawn down below elevation 2110, which is the invert of the existing outlet.

1.4 Geology - The geology of the area immediately south of Cle Elum Lake is shown in both plan and profile on Figure 2. The intake to the tunnel will be in hard to moderately hard sandstone. Tunneling in this material would require supports throughout its length. Groundwater will be encountered in large quantities at openings and faults. One major fault will be encountered in the sandstone.

Basalt will be encountered throughout most of the tunnel alignment. The basalt is hard and dense, suitable for tunnel boring. Supports will be required only at interflow zones and faults. The East Ridge Thrust Fault will be encountered by the tunnel and will entail some problems involving loose material and groundwater.

3.2 ASSUMPTIONS

The following assumptions were used in developing the preliminary design and cost estimate.

3.2.1 Reservoir Storage - The reservoir area capacity data was taken from information developed by the USBR. From this data it was determined that 100,000 AF of storage is available by drawing down the dead pool from elevation 2110 to 2055.

3.2.2 Hydraulics - The tunnel was designed such that the dead pool (100,000 AF) could be drained during a 75-day period. Using this criteria, the maximum discharge would be about 1,000 cfs, and at minimum pool the flow would be just over 300 cfs.

3.2.3 Tunnel - The tunnel would be a pressure conduit from the intake to the gate control structure. This section would be about 3,000 ft. in length and would be a 10 ft. diameter concrete lined tunnel. From the gate shaft to the outlet structure, the tunnel would be a free-flowing (non-pressure) conduit with a length of 20,700 ft. and a diameter of 14 ft.

Approximately 19,200 ft. of the tunnel's 23,700 ft. length would be through basalt and could be constructed with a Tunnel Boring Machine (TBM). The remainder of the tunnel would be constructed through the sandstone by conventional methods .

It was assumed that 80 to 90% of length through the basalt would require rock anchors. It was also assumed that all the tunnel passing through the sandstone would require tunnel supports.

3.3. COST ESTIMATE

Construction cost estimates were prepared for the major items described under Part 3.2. The estimate is presented in Table 2. The costs were developed in accordance with standard procedures for appraisal-type estimates. Much of the data was taken from recent construction costs for similar projects or project features, especially in determining unit prices for major items of work. Information from IECO's and Morrison-Knudsen's files was used in developing these cost estimates.

The construction costs were estimated on the basis of computed quantities of work, to which unit prices were applied, as appropriate. The quantities were calculated on the basis of the sketches, which are presented as exhibits herein. The unit prices of the different items are based on March, 1984, prices and reflect the total cost of the work involved, including the cost of all labor, materials and equipment, as well as such indirect items as taxes and the contractor's overhead and profit. Lump sums were used for items for which the cost could not readily be established by the unit-price method. Included in the cost estimate is a contingency allowance of 25 percent to cover items not listed and possible increases in quantities. This allowance is considered to be reasonable in view of the generally conservative approach used in the estimates and designs.

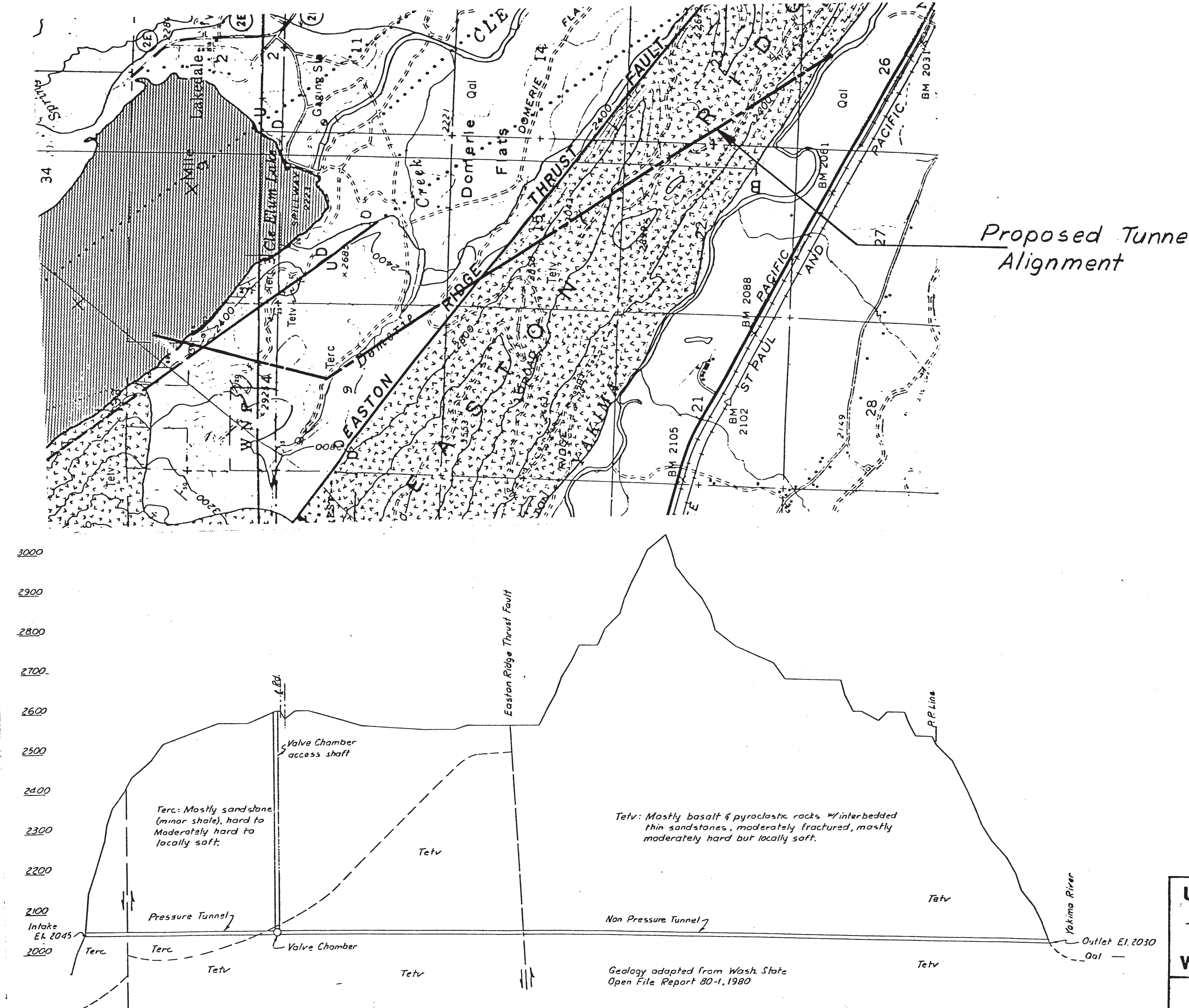
3.4 CONCLUSIONS

The estimated cost of $60,663,000 would provide 100,000 acre-feet of water at an average cost of $607 per acre-foot. On the basis of construction costs only, this plan is slightly more costly than the Swauk Creek, as described in Section 2. Over 20,000 feet of the tunnel alignment is in sound basalt which appears suitable for using a boring machine. Continued development of tunnel boring techniques could reduce the cost of this plan.

TABLE 2

Item	Unit	Quantity	Unit Price	Amount
Excavation	CY	168,313	150.00	$25,247,000
Portal	LS			100,000
Lake Tap	LS			1,000,000
Rock Anchors	LF	16,320	15.00	244,800
Supports	CF	4,500	400.00	1,800,000
Concrete - Lining	CY	39,968	450.00	17,985,600
Concrete - Intake	CY	750	350.00	262,500
Reinforcing Steel	Lbs	2,111,000	.75	1,583,300
Control Gates	Lbs	100,000	2.50	250,000
Trashrack	Lbs	38,000	1.50	57,000
Subtotal				$48,530,200
Contingencies (25%)				$12,132,800
TOTAL DIRECT COST				$60,662,000

FIGURE 2



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YAKIMA RIVER BASIN

WATER ENHANCEMENT STUDY

CLE ELUM LAKE

PROPOSED TUNNEL

OUTLET WORKS

SECTION 4

CLE ELUM LAKE PUMPING SCHEME

4.1 General Description

The Cle Elum Lake Pumping Scheme would take water from the dead pool (El. 2110') and pump it into the existing outlet works. Approximately 100,000 acre-feet of yield would be available by pumping the dead pool down to El. 2055. During the drought year of 1977, the Kittas Reclamation District engaged the firm of Harstad Associates to study the feasibility of pumping from dead storage. This report concentrated on the concept of a floating pumping plant. A floating pumping plant was constructed on Cle Elum Lake, but was operated only a short time in 1977 to test the facility. The plant was never operated to obtain additional water from Lake Cle Elum, and was disassembled in 1982.

4.1.1 Scope - This study considered several alternative concepts for pumping water from dead storage. The advantages and disadvantages of each of these alternatives are discussed. No cost estimates or other quantitative comparisons are required for this study. The study develops conclusions on the feasibility of considering the pumping scheme as a source of supplemental water to the Yakima River Irrigation System.

4.1.2 Location and Access - Cle Elum Lake is located off Interstate 90 about midway between Yakima and Seattle. The area is assessible via State Highway No. 903. The Cle Elum Dam, built by the Bureau of Reclamation in 1931-33, has an active capacity of 437,000 acre-feet. A natural lake, forming the dead pool of over 100,000 acre-feet, existed prior to construction of the dam.

4.1.3 Geology - This proposal for pumping water from the dead pool would involve the area immediately surrounding the existing dam. The geologic conditions encountered in construction of the dam would apply to all the alternatives discussed in the following sections. The dam is founded on glacial terminal moraine and would contain typical till material. The material is relatively nonpermeable, but would contain assorted sizes of materials from glacial flour to large boulders. It would be difficult and expensive to tunnel through the material. Supports and lining would be required throughout. Excavation would be done by using a shield as the face is advanced. Lining would be placed to support the tunnel as it is advanced. Recent work in the existing outlet tunnel has confirmed the difficulty of working in this material.

4.2 ASSUMPTIONS

The report by Harstad Associates dated March 14, 1977, was based on a pumping capacity which would deliver 100,000 acre-feet from the lake in 75 days. This capacity of 750 cfs was adopted for this study.

For purposes of construction, it is assumed that the lake could be drawn down to the dead pool elevation of 2110'. It was also assumed that power would be available at the site for pumping. The dead pool would be pumped down from elevation 2110' to elevation 2055, for a total drawdown of 55' to obtain 100,000 acre-feet of water.

4.3 ALTERNATIVES

Three alternatives will be discussed for pumping from the dead storage. Other concepts were considered, but were judged unlikely to be acceptable for one or more reasons. For example, an alternative involving tunneling under the lake and constructing an inlet using a lake tap was dropped because the poor material underlying the lake would result in extremely high construction costs. Each of the three alternatives are described below.

4.3.1 Floating Pumping Plant - This concept was considered by the Bureau's Yakima River Study Team and was rejected as unacceptable because the facility installed in 1977 was not considered successful and also for environmental reasons. However, because it will probably be the simplest to construct and therefore the least expensive, it has been included in this study. The study by Harstad Associates developed this concept using a floating platform constructed on 6 ft. diameter pipe sections connected by crossbeams and saddles. The platform was anchored by cables to hold the platform in position. The discharge line proposed was two 6 ft. diameter steel pipes with a float system connected to the pump platform with 40 feet of flexible pipe. The pump system discharged into the existing outlet works at elevation 2110'. The concept was an emergency measure to provide water during the 1977 drought.

This concept could be constructed as a permanent type installation to pump from the dead pool. It would require a more stable and durable pumping platform, perhaps using rectangular steel barge sections joined together. A permanent anchoring system would be needed to hold the platform in position. The floating discharge line would also need a permanent anchoring system to keep it aligned with the pumping plant and the outlet structure. Also, a cradle system would be needed to support the pipe as it comes to rest on the bottom as the lake is pumped down.

While this concept could work, it has some major problems, in addition to the environmental objections which were mentioned previously. The system will have to be disconnected and held in storage, floating on the lake until needed again. All of the anchor system, pipe connections and cradles would remain in place, available when the system is reassembled for operation.

4.3.2 Vertical Turbine Pumps - This alternative would require excavating a vertical shaft near the upstream end of the outlet tunnel and connecting a horizontal shaft to the outlet tunnel. A concrete vertical shaft would be constructed, starting at elevation 2050' and extending to elevation 2240', maximum water surface. The lake would have to be drawn down while these facilities are constructed. Vertical turbine pumps, mounted in the vertical shaft, would discharge into the outlet tunnel through the horizontal connection at elevation 2110'. The pumps could be mounted either at the top of the vertical shaft or on a pump deck just above elevation 2110'. Either location would have difficult maintenance problems.

The existing intake channel would have to be deepened from elevation 2110' to elevation 2050, extending the channel 1500 feet into the lake. This could be done by digging or dredging the channel as the lake is drawn down.

This concept is shown on Figures 3 and 4.

4.3.3 Submersible Pumps - The alternative for vertical turbine pumps could be modified to accommodate submersible pumps. Discussions with manufacturers indicates that large pumps of over 50 cfs capacity are available in the submersible-type pumps. The pumps would be mounted on a floor below elevation 2110 in the vertical shaft, and like the previous alternative, would discharge into the outlet tunnel. This alternative would eliminate the need for a vertical concrete shaft described in the previous alternative from elevation 2110 to elevation 2240, a height of 130'. The submersible pumps would be under water and could not be serviced until the lake was drawn down to the dead pool level of 2110'.

5.1 CONCLUSIONS

Based on this very tentative study, the following conclusions have been reached:

- This study was done using the limited data available. A more detailed evaluation of the conceptual alternatives in this study would be required to compare pumping from dead storage with the low level outlet concept described in Section 3.

- The floating pumping plant concept may not be acceptable because the facility installed in 1977 was not accepted and also from the aesthetics-environmental point of view. However, it would probably be the least costly alternative.

- Installing a pumping plant using vertical turbine pumps would involve difficult and expensive construction methods, and would result in a plant that would be difficult to service and maintain. Also, the tall concrete vertical shaft and access bridge may not be aesthetically acceptable.

- Using submersible pumps would eliminate the need for a tall vertical shaft. While submersible pumps are available in these sizes, they have not been used in this type of installation where they will be under 130' of water. Their use in this type of installation in remote area raises serious questions regarding to their reliability. Finally, procuring and operating submersible pumps would be very costly.

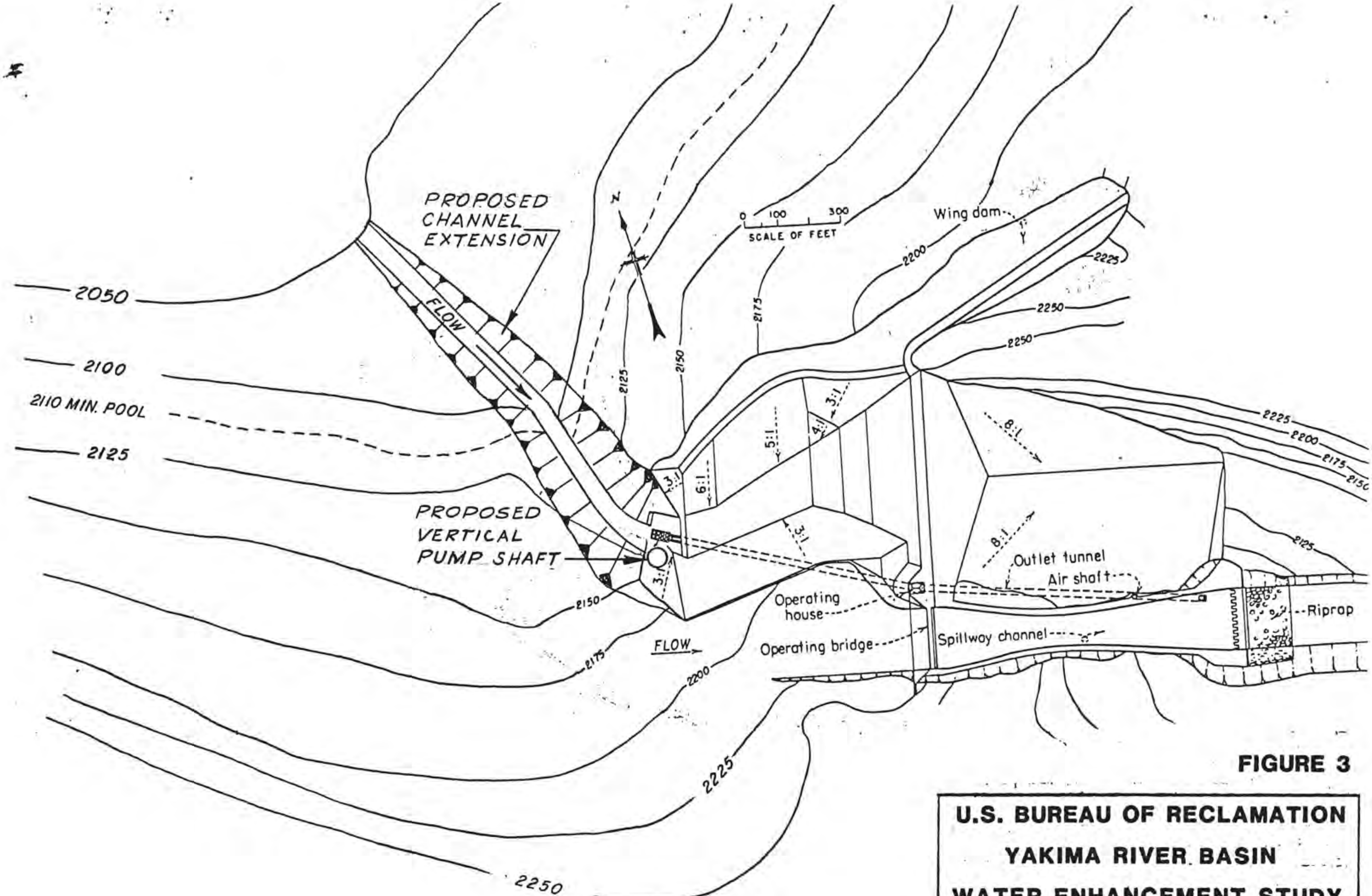

FIGURE 3

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WATER ENHANCEMENT STUDY

CLE ELUM LAKE
PROPOSED PUMPING
OUTLET WORKS

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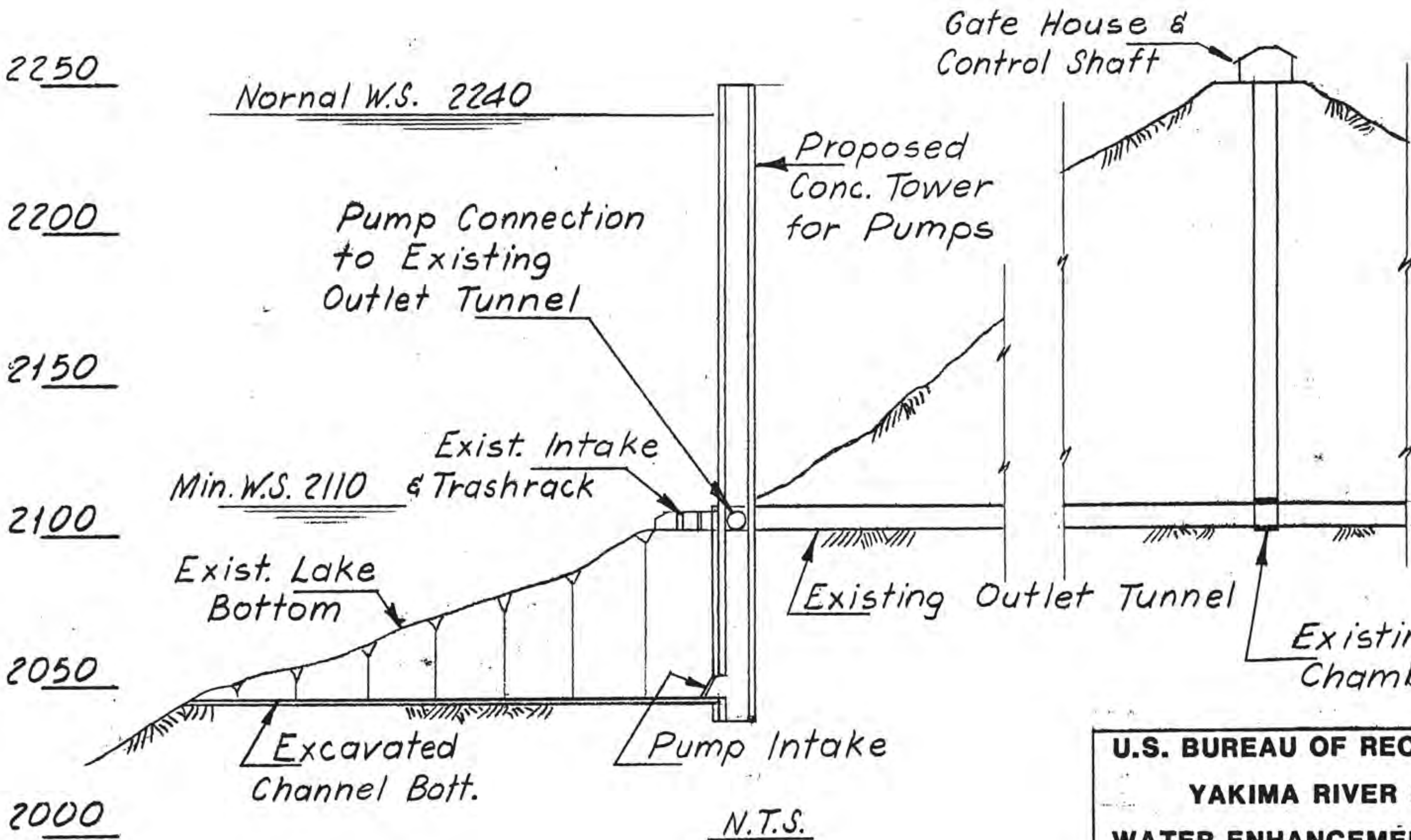

FIGURE 4

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WATER ENHANCEMENT STUDY

LAKE CLE ELUM

PUMPING SCHEME

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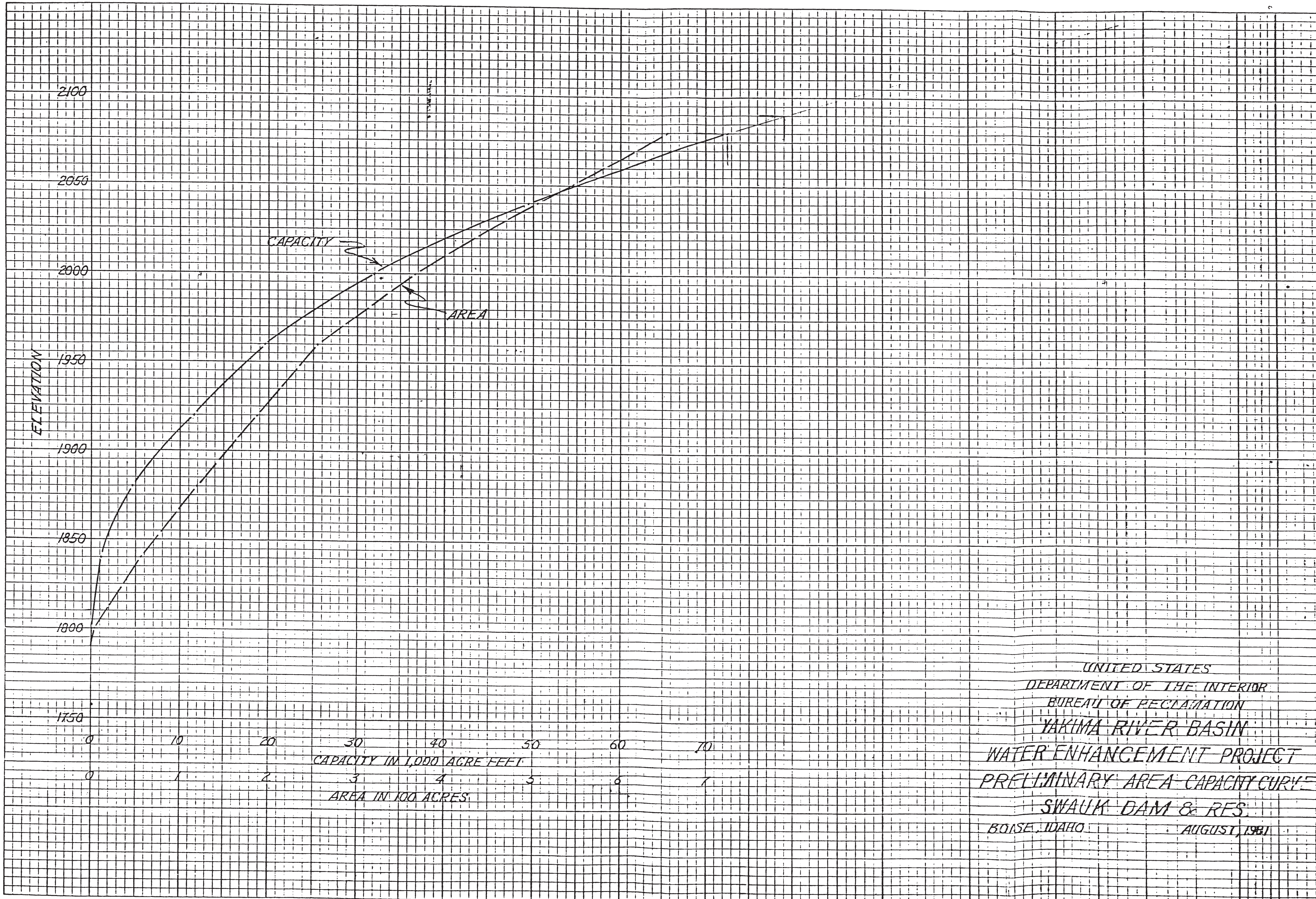
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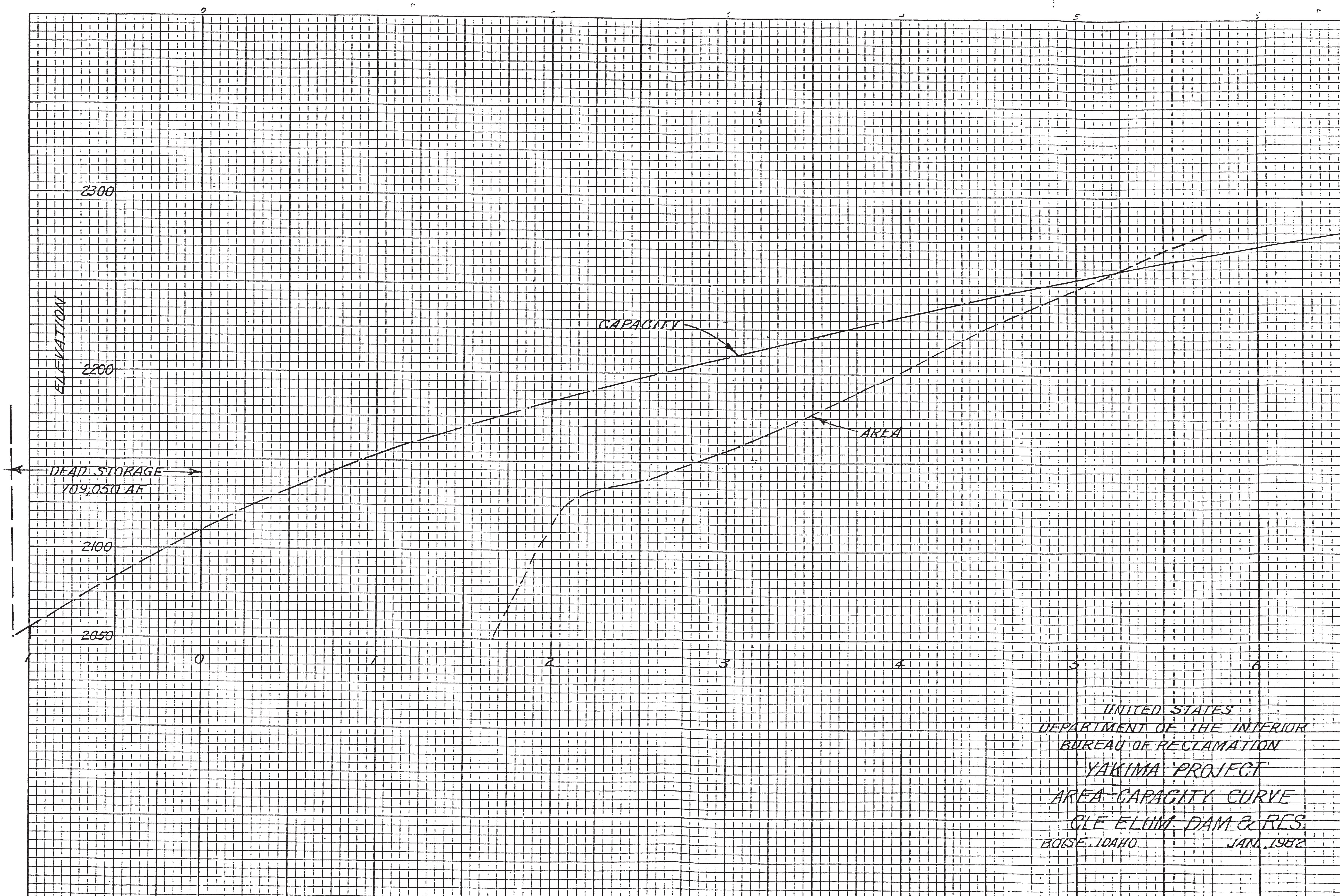
BOISE, IDAHO
AUGUST, 1981



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