UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

HYDRAULIC MODEL STUDIES OF OLYMPUS DAM SPILLWAY

Hydraulic Laboratory Report No. Hyd-278

ENGINEERING LABORATORIES BRANCH

DESIGN AND CONSTRUCTION DIVISION
DENVER, COLORADO

April 1, 1952

FOREWORD

Hydraulic model studies of Olympus Dam spillway, a part of the Colorado-Big Thompson Project, were conducted in the Hydraulic Laboratory of the Bureau of Reclamation at Denver, Colorado, during the period of January 14, 1947, to January 27, 1950.

The results obtained from this study were brought about through the cooperation of the staffs of the Concrete Dams Section of the Dams Division and the Hydraulic Laboratory.

During the course of the model studies, Messrs. J. J. Hammond, L. G. Puls, R. W. Whinnerah, and Max Ford of the Concrete Dams Section frequently visited the laboratory to observe the model tests and to discuss test results.

These studies were conducted by J. B. Dee, Jr., C. V. Adkins, G. L. Beichley, and W. E. Wagner, under the direct supervision of A. J. Peterka and J. N. Bradley.

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UNITED STATES
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Design and Construction Division
Engineering Laboratories Branch
Denver, Colorado
April 1, 1952

Laboratory Report No. Hyd-278
Hydraulic Laboratory
Written by: G. L. Beichley
Reviewed by: A. J. Peterka

Subject: Hydraulic model studies of Olympus Dam spillway

SUMMARY

Hydraulic model studies of Olympus Dam spillway, Figures 1 to 4 inclusive, were made on a 1:36 scale model, Figures 5 and 6, for the purpose of checking the hydraulic design by means of performance tests. Data and notes were taken on the flow in the spillway approach, the spillway itself, the stilling basin, and on flow in the river channel below the structure. Tests on the preliminary design showed it to be satisfactory except for the intermediate training wall extending through the stilling basin shown in Figure 2. The intermediate training wall had been extended through the basin to provide a separate stilling basin for small flows up to 4,000 second feet, which were to be regulated by a single gate. Such a training wall was found unnecessary as well as unsatisfactory and was therefore eliminated in the recommended design. Better operation with less construction cost was obtained by discharging through the center bay directly into the full width stilling basin with the intermediate wall removed.

Flow conditions in the approach to the spillway, page 4, were observed and found to be satisfactory. The spillway crest shape was calibrated and found to have a free discharge coefficient of 3.92 for the maximum flow, Figure 7. Therefore, it is efficient and capable of passing a free discharge of 22,700 second feet at maximum reservoir elevation 7475, which is 700 second feet more than anticipated by the designers. The crest shape was calibrated also for gate controlled flow, Figure 8, for use in the prototype operation. Tests showed pressures on the spillway crest, Figures 10 and 11, to be approximately atmospheric, or above, for all conditions of flow. Water-surface profiles of the flow over the spillway, Figures 12 and 13, showed the gate pin and under edge of the radial gate when fully open to be well above the upper nappe surface as desired.

For the maximum designed flow only minor wave action and destructive turbulence occured downstream from the spillway apron, Figures 14(a) and (b). Erosion in this area was not excessive and did not occur along the apron. As a result of this investigation, it is recommended that the preliminary design of the structure, but without the intermediate training wall, be used for prototype construction.

INTRODUCTION

Olympus Dam is a part of the Colorado-Big Thompson Project. It is located on the Big Thompson River near Estes Park, Colorado, Figure 1. The dam, Figure 2, consists of a concrete gravity-type spillway section at the right abutment and an earth embankment extending from the concrete section across the river channel to the left abutment. The total length is approximately 1,880 feet and the maximum height above riverbed is about 56 feet.

Flow over the spillway section, Figure 3, is controlled by five 20- by 17-foot radial gates, Figure 4. The gates seat on the face of the spillway at a point 7.401 feet downstream from the crest axis, measured horizontally, and 2 feet below crest elevation, measured vertically. Crest elevation 7460 is 15 feet below maximum reservoir elevation 7475. The crest length including piers is 120 feet. The effective length not including piers is 100 feet. The crest is designed to pass a controlled discharge of 20,000 second feet at maximum reservoir elevation, which corresponds to a discharge of 200 second feet per lineal foot of effective crest length. The flow drops a vertical distance of 42.87 feet in a horizontal distance of 55.37 feet measured from the axis of the crest to the upstream end of the stilling basin. The stilling basin has a sloping apron which is tangent to a 40-foot radius bucket at its upstream end. The apron slopes downward at the rate of 4 to 1 for a horizontal distance of 48.53 feet, at which point it joins the horizontal apron at elevation 7405. The horizontal apron continued 37.59 feet to the end sill. The end sill is 1 foot high and has an upstream slope of 1:5. The total length of the stilling basin is then 91.12 feet or 3.5 (d_2), where d_2 is 26 feet, the difference in elevation between the expected tail water elevation for 20,000 second feet and the elevation of the horizontal stilling basin floor. The spillway training walls are 120 feet apart and parallel for their entire length. They are 27 feet high measured from the horizontal apron of the stilling basin. The intermediate training wall shown in Figures 2 and 3 was a part of the preliminary design, but was eliminated in the design recommended and adopted for construction.

THE MODEL

The model shown in Figure 5 and by photographs in Figure 6 is a 1:36 scale reproduction of the spillway and surrounding area. It was constructed and tested in the Bureau of Reclamation Hydraulic Laboratory at the Denver Federal Center. The reservoir was reproduced for a distance of 288 feet upstream from the spillway and the lower river channel for a distance of 431 feet downstream from the stilling basin.

Topography in the reservoir area, except for the riverbed of the main channel approaching the spillway, was molded of concrete mortar placed on metal lath. The riverbed in the reservoir was constructed of wood since it was flat, and therefore less costly to build by that method. Model concrete surfaces simulating nonconcrete surfaces of the prototype such as topography were given a rough finish, while model concrete surfaces simulating prototype concrete surfaces were given a smooth finish.

The spillway crest, face, and apron were molded in cement mortar to sheet-metal templates.

Piezometers of 1/16-inch inside diameter copper tubing, located as shown in Figure 5, were placed flush and normal to the spillway face. The spillway training walls as well as the gate piers were made of wood and sanded smooth. The radial gates were made of 14-gate sheet metal, and all five gates were pivoted on a single length of 1/8-inch round rod that extended from one training wall to the other through all of the piers.

The topography surrounding the stilling basin was an erodible bed molded in sand as shown in Figure 6. The sand ranged in size from 1/32 inch to 3/32 inch in diameter. The erosion occurring in the loose sand was used to predict the erosion to be expected in the prototype.

Water was supplied to the model through a 12-inch pipe. The reservoir and tail-water elevations were measured with a hook-gage-in-well and point gage respectively. The tail water was controlled by an adjustable gate at the extreme downstream end of the model. The tail-water elevation for a given discharge was determined from the tail-water curve shown in Figure 2. Crest pressures were measured by means of eight piezometers placed as described above. Water-surface profiles were measured by means of a point gage sliding on a horizontal guide rail parallel to the spillway center line.

THE INVESTIGATION

The investigation was primarily concerned with the performance of the spillway discharging the maximum design flow of 20, 000 second feet, which corresponds to 200 second feet per lineal foot of crest length excluding pier thicknesses. With the maximum head on the crest of 15 feet the flow was to be controlled by the five radial gates. This flow created some of the more severe conditions throughout the structure. In the stilling basin the investigation was also concerned with a maximum flow of 4, 000 second feet regulated through one bay.

The investigation included the study of the flow through the spillway approach, over the spillway crest, through the spillway stilling basin, and of the flow leaving the stilling basin. The investigation was conducted under difficulties, as it was carried on intermittently during the transfer of the laboratory from the Customhouse to the Denver Federal Center and during the construction of the laboratory in the Federal Center.

Spillway Approach

Characteristics of the spillway approach are shown by the model views in Figures 6(b) and (c). Flow conditions were observed in this area for the entire range of discharges and found to be satisfactory.

Spillway Crest, Piers and Gates

The spillway crest is shown in Figure 3. It was calibrated in the model for both free flow and gate-controlled flow.

The free flow test data was used for determining the coefficient in the discharge equation:

$$Q = CLH^{3/2}$$

where Q is the discharge, C is the discharge coefficient, L is the length of the crest excluding the pier thicknesses, and H is the head or difference in elevation of the reservoir water surface and the crest. For maximum reservoir elevation 7475 the coefficient was determined to be 3.92 as shown in Figure 7 which proves the crest shape to be efficient. The discharge curve for the free crest was determined for one bay and is shown in Figure 8. From this curve the maximum capacity of the entire spillway was computed to be 22,700 second feet with maximum reservoir elevation 7475 which is slightly more than the 22,500 second feet anticipated by the designers, and therefore, satisfactory.

The gate-controlled calibration tests were made on the model with gate openings of 2, 4, 6, 8, and 10 feet. The discharge per bay was then plotted against reservoir elevation for each of the gate openings calibrated as shown in Figure 8. Discharge curves for other gate openings were interpolated and are also plotted in Figure 8. The interpolation was performed by first cross plotting from Figure 8 gate opening versus discharge for a range of reservoir elevations taken at 2-foot intervals between elevation 7464 and 7476, as shown in Figure 9. A discharge curve for any gate opening from zero to 10 feet could then be plotted from the curves of Figure 9.

Pressures on the crest and spillway face were measured on a line parallel to the center line of spillway at a distance of 9.17 feet to the right of the center line of Pier No. 2, which is the one-third point of the bay width, as shown in Figure 5. It was believed that maximum subatmospheric pressures might occur with maximum reservoir elevation and small gate opening; therefore, pressures were measured for such an arrangement in the model. Pressures with gate openings of 1 foot and 2 feet, each with the reservoir at maximum elevation, are plotted in Figure 10. Subatmospheric pressures for these arrangements were found to be less than 1 foot of water. Crest pressures for free flow of maximum and one-half maximum discharge are plotted in Figure 11. Again, only very small subatmospheric pressures were encountered in both cases, indicating the crest shape to be entirely satisfactory.

Water-surface profiles of free flow over the spillway crest showed that the water surface cleared the under edge of the radial gates for the maximum design flow and that the gate pins were well above the water. The water surface around the piers of the spillway was depressed due to the contraction of the flow as shown in Figure 12. The depression was a little greater around the end piers; however, this draw-down condition offered no serious problems in itself and caused no ill effects farther downstream. Profiles of free flow along the center line of the second bay from the left, and along the right-hand face of Pier No. 2, are shown in Figure 13 for 22,700 and 11,550 second feet. These data were carefully recorded for future use in establishing general design procedures for gate-controlled spillways.

Since the spillway crest was efficient and capable of passing more than the anticipated flow with maximum reservoir elevation and since no subatmospheric pressures of any consequence or any other hydraulic difficulties were observed, no change in the spillway crest, piers or gates was recommended.

Spillway Stilling Basin

Preliminary design. The preliminary stilling basin is shown in Figures 2 and 3. Performance tests showed the stilling basin to dissipate the energy in the maximum design flow of 20,000 second feet very satisfactorily. Very little destructive turbulence existed beyond the end of the basin as shown in Figures 14(a) and (b). Figure 14(b) indicates that turbulence beyond the end of the apron increases somewhat with increased erosion.

Included in the preliminary design was an intermediate training wall, extending through the stilling basin from the second spillway pier from the left, to the downstream end of the apron. The purpose of this wall was to provide a separate narrow stilling basin for small spillway discharges usually passed through one gate, and not exceeding one-fifth of the maximum design flow of 20,000 second feet or 4,000 second feet. Model tests showed that the separate stilling basin was neither satisfactory nor necessary for the smaller flows. For a spillway discharge of 4,000 second feet passing through the left-hand bay into the narrow stilling basin, the discharge per foot of stilling basin width was as great as for 20,000 second feet passing through all five bays into the full-size stilling basin; yet the tail-water elevation was only as high as that for 4,000 second feet. Therefore, the jump moved downstream and was on the verge of sweeping out of the basin. Also, turbulence near the end of the small stilling basin was excessive. When using only one gate to pass flows up to and including 4,000 second feet, it was found better to pass the flow through the center bay into the full-width stilling basin. With this method the flow from the center bay spread out over a considerable width of the basin, thereby reducing the discharge per linear foot of stilling basin width.

Model scour tests on the preliminary design indicated that the stilling basin was effective in preventing excessive erosion downstream, particularly along the end of the spillway apron. In this most critical area no scour occurred during a 25-minute model test run with 20,000 second feet, and beyond the basin scour reached a depth of only 5 feet below the stilling basin floor, elevation 7405. The test in progress is shown in Figures 14(a) and (b). The scour pattern that resulted from this test is shown in Figure 14(c).

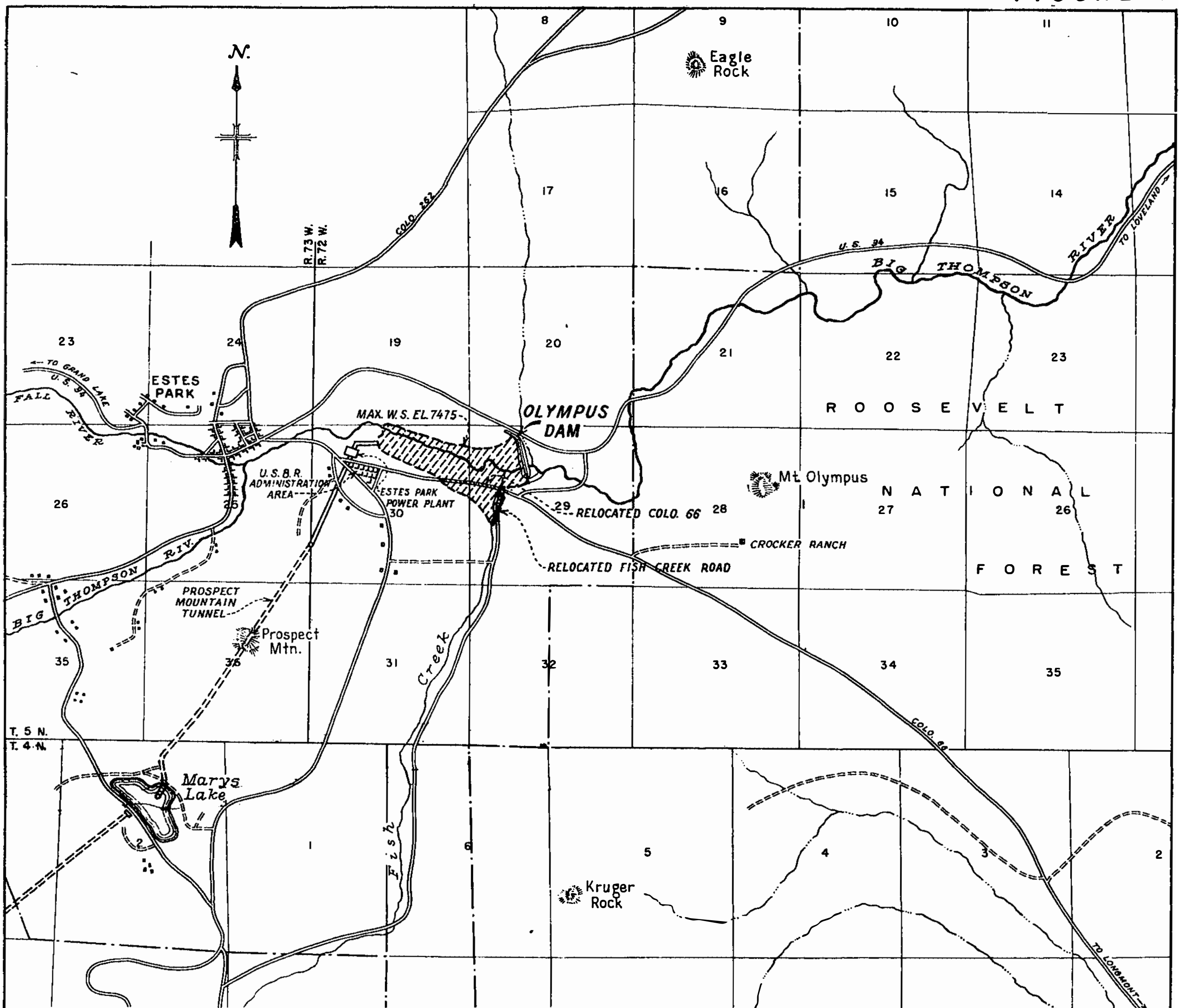
Recommended design. The intermediate training wall was removed, otherwise the recommended design was identical to the preliminary design, and testing continued. Like the preliminary design very little wave action or turbulence occurred beyond the end of the stilling basin for the maximum design flow.

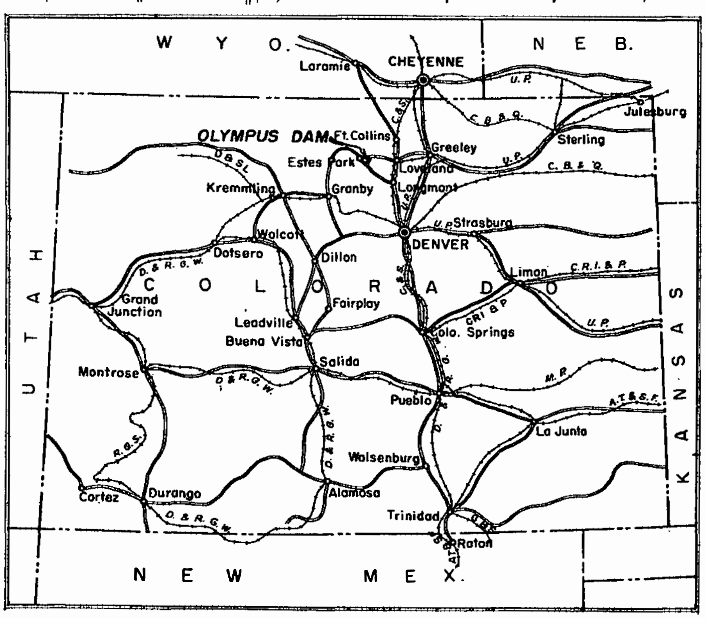
For flows up to 4,000 second feet it was found possible to safely regulate using only the center gate. Best operation occurred, however, when regardless of the discharge the flow was evenly divided between the five bays. Good performance was also obtained by using a symmetrical setting of the spillway gates; otherwise, the stilling basin was not fully utilized and unnecessary eddy action and erosion occurred. Erosion tests gave satisfactory results similar to those for the preliminary design. The tail-water elevation at which the hydraulic jump would sweep from the apron was checked for the maximum flow. It was found to be well below the expected tail water, indicating a safe and stable hydraulic jump.

As a result of the stilling basin tests it is recommended that the preliminary stilling basin design without the intermediate training wall be adopted for the prototype structure. It was felt that it might have been possible to reduce the length of the basin and obtain equally satisfactory results, but because of the necessity of meeting deadlines in providing field drawings, no tests on shorter basins were made.

Interior - Reclamation - Denver, Colo.

FIGURE 1





INDEX MAP

0 ½ 1 2
SCALE OF MILES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLORADO-BIG THOMPSON PROJECT-COLO.

OLYMPUS DAM
LOCATION MAP

DRAWN: W.G.H. SUBMITTED: [signature]
TRACED: M.L.B. RECOMMENDED: [signature]
CHECKED: E.L.A. [initials] APPROVED: [signature] CHIEF ENGINEER
DENVER, COLORADO, FEB. 25, 1947 245-D-3788

FIGURE 2

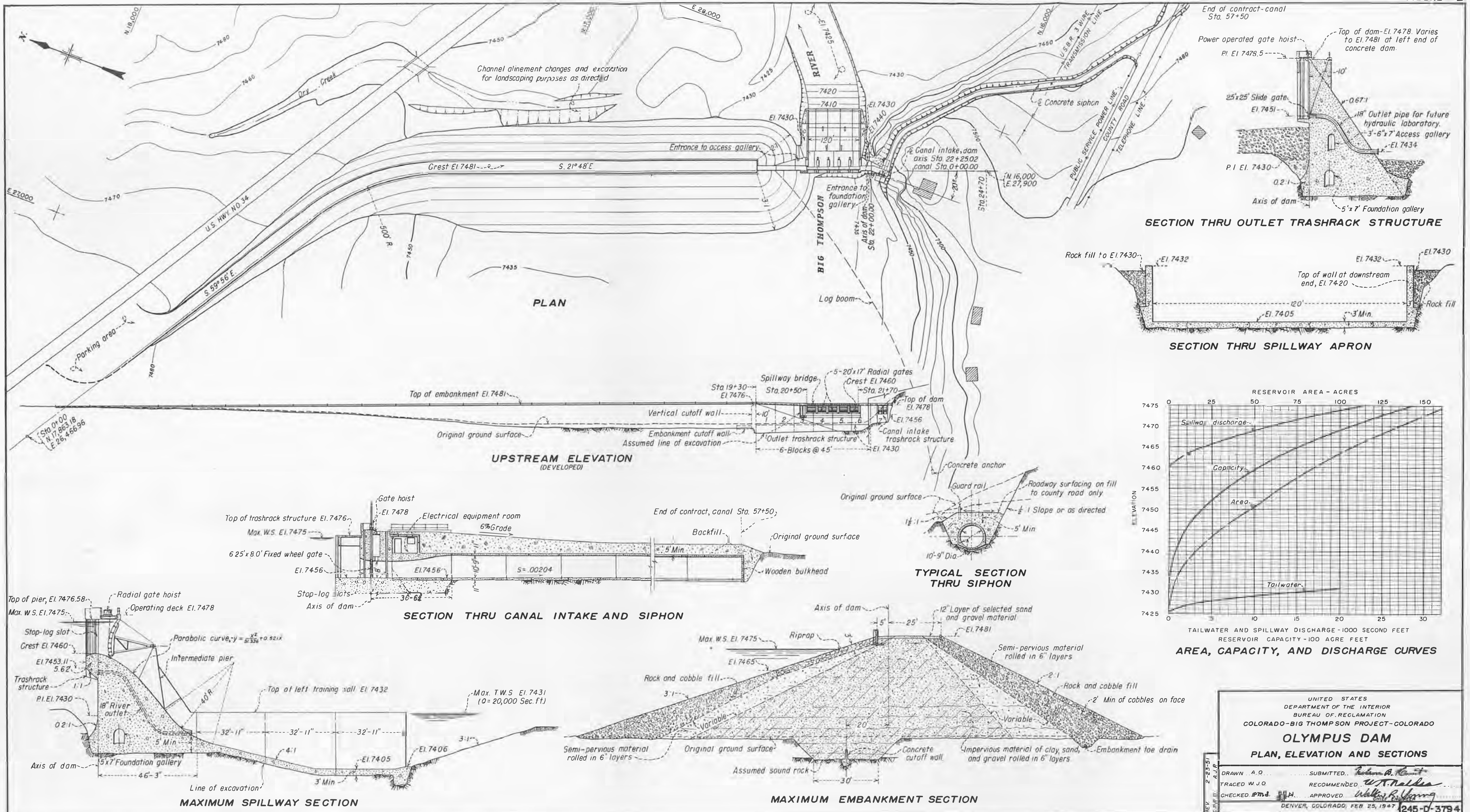
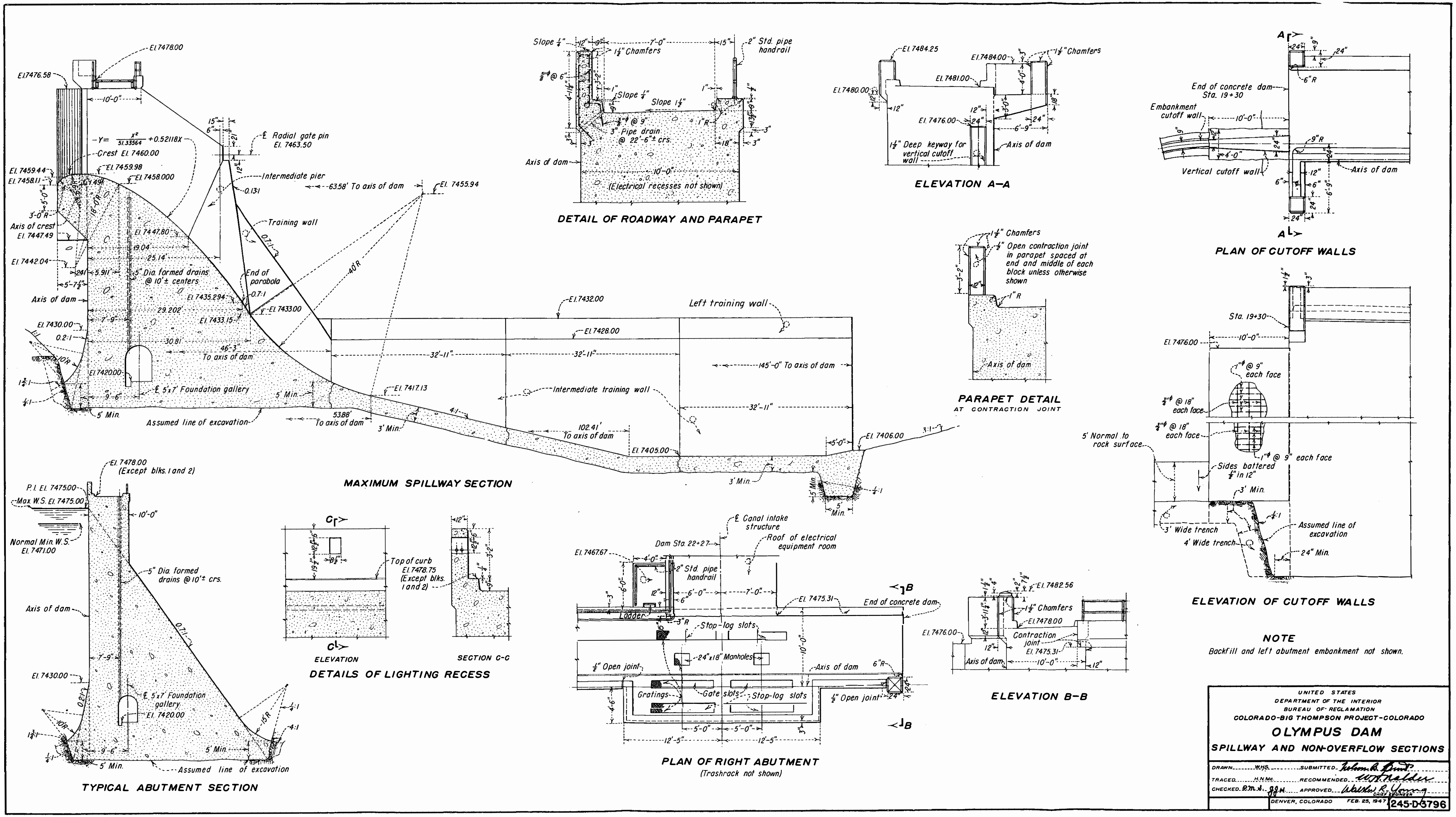

PLAN
Channel alinement changes and excavation for landscaping purposes as directed
Dry Creek
U.S. HWY. NO. 34
Parking area
Entrance to access gallery
Crest El. 7481
S. 21°48'E
S. 59°56'E.
500' R.
BIG THOMPSON RIVER
Entrance to foundation gallery
Axis of dam Sta. 22+00.00
Canal intake, dam axis Sta. 22+25.02 canal Sta. 0+00.00
N.16,000 E.27,900
Concrete siphon
Log boom
PUBLIC SERVICE POWER LINE
COUNTY ROAD
TELEPHONE LINE
U.S.B.R. 3 WIRE TRANSMISSION LINE
End of contract-canal Sta. 57+50
E 27,000
E 28,000
N. 18,000
N. 16,000
UPSTREAM ELEVATION
(DEVELOPED)
Top of embankment El. 7481
Original ground surface
Vertical cutoff wall
Embankment cutoff wall
Assumed line of excavation
Sta 0+00 N.17,863.18 E.26,466.96
Sta. 19+30 El. 7476
Spillway bridge
Sta. 20+50
5-20'x17' Radial gates
Crest El. 7460
Sta. 21+70
Top of dam El. 7478
El. 7456
Outlet trashrack structure
Canal intake trashrack structure
6-Blocks @ 45'
El. 7430
SECTION THRU OUTLET TRASHRACK STRUCTURE
Power operated gate hoist
Top of dam-El. 7478. Varies to El. 7481 at left end of concrete dam.
P.I. El. 7478.5
25'x25' Slide gate
El. 7451
18" Outlet pipe for future hydraulic laboratory.
3'-6"x7' Access gallery
El. 7434
P.I. El. 7430
Axis of dam
5'x7' Foundation gallery
SECTION THRU SPILLWAY APRON
Rock fill to El. 7430
El. 7432
El. 7430
Top of wall at downstream end, El. 7420
120'
El. 7405
3' Min.
Rock Fill
SECTION THRU CANAL INTAKE AND SIPHON
Gate hoist
El. 7478
Electrical equipment room
Top of trashrack structure El. 7476
Max. W.S. El. 7475
6% Grade
6 25'x8.0' Fixed wheel gate
El. 7456
S=.00204
Stop-log slots
Axis of dam
End of contract, canal Sta. 57+50
Backfill
Original ground surface
Wooden bulkhead
5' Min.
TYPICAL SECTION THRU SIPHON
Concrete anchor
Original ground surface
Guard rail
Roadway surfacing on fill to county road only
1/2:1 Slope or as directed
5' Min
10'-9" Dia.
AREA, CAPACITY, AND DISCHARGE CURVES
RESERVOIR AREA - ACRES
ELEVATION
Spillway discharge
Capacity
Area
Tailwater
TAILWATER AND SPILLWAY DISCHARGE - 1000 SECOND FEET
RESERVOIR CAPACITY - 100 ACRE FEET
MAXIMUM SPILLWAY SECTION
Top of pier, El. 7476.58
Radial gate hoist
Max. W.S. El. 7475
Operating deck El. 7478
Stop-log slot
Crest El. 7460
Parabolic curve
Intermediate pier
El. 7453.11
Trashrack structure
P.I. El. 7430
18" River outlet
Top of left training wall El. 7432
Max. T.W.S. El. 7431 (Q=20,000 Sec. ft)
32'-11"
El. 7406
El. 7405
5'x7' Foundation gallery
Axis of dam
46'-3"
Line of excavation
3' Min
MAXIMUM EMBANKMENT SECTION
Axis of dam
12" Layer of selected sand and gravel material
El. 7481
Max. W.S. El. 7475
Riprap
El. 7465
Semi-pervious material rolled in 6" layers
Rock and cobble fill
2' Min of cobbles on face
Variable
Semi-pervious material rolled in 6" layers
Original ground surface
Concrete cutoff wall
Impervious material of clay, sand, and gravel rolled in 6" layers
Embankment toe drain
Assumed sound rock
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLORADO-BIG THOMPSON PROJECT-COLORADO
OLYMPUS DAM
PLAN, ELEVATION AND SECTIONS
DRAWN A.O.
TRACED W.J.O.
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
DENVER, COLORADO, FEB. 25, 1947
245-D-3794

FIGURE 3



DETAIL OF ROADWAY AND PARAPET
(Electrical recesses not shown)
ELEVATION A-A
PLAN OF CUTOFF WALLS
End of concrete dam Sta. 19+30
Embankment cutoff wall
Vertical cutoff wall
Axis of dam
PARAPET DETAIL
AT CONTRACTION JOINT
1½" Chamfers
½" Open contraction joint in parapet spaced at end and middle of each block unless otherwise shown
Left training wall
Intermediate training wall
Training wall
Intermediate pier
℄ Radial gate pin El. 7463.50
Crest El. 7460.00
5" Dia formed drains @ 10' ± centers
℄ 5'x7' Foundation gallery
Assumed line of excavation
MAXIMUM SPILLWAY SECTION
TYPICAL ABUTMENT SECTION
Max. W.S. El. 7475.00
Normal Min. W.S. El. 7471.00
DETAILS OF LIGHTING RECESS
ELEVATION
SECTION C-C
PLAN OF RIGHT ABUTMENT
(Trashrack not shown)
℄ Canal intake structure
Roof of electrical equipment room
Stop-log slots
24"x18" Manholes
Gratings
Gate slots
End of concrete dam
ELEVATION B-B
ELEVATION OF CUTOFF WALLS
3' Wide trench
4' Wide trench
NOTE
Backfill and left abutment embankment not shown.
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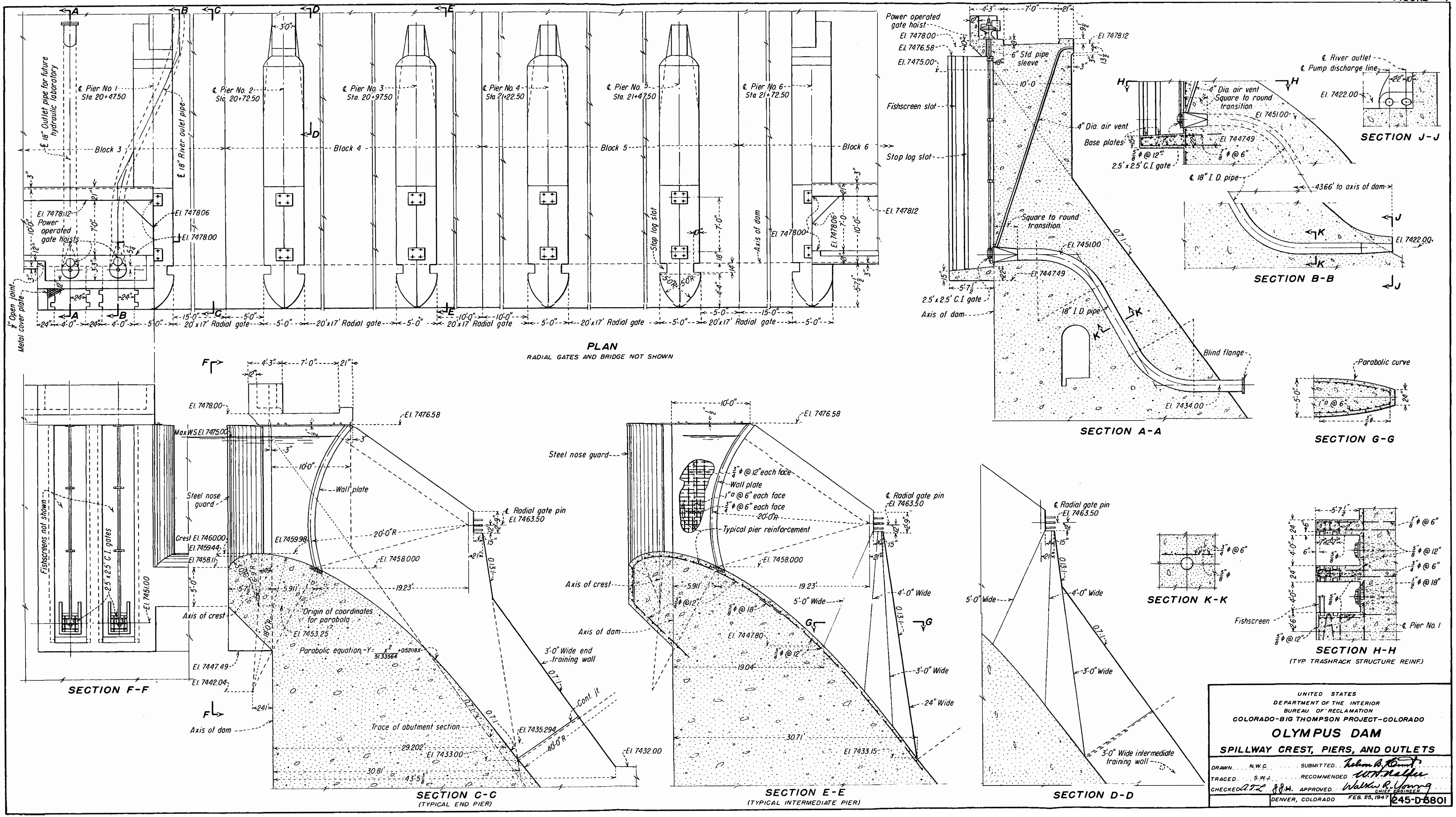
BUREAU OF RECLAMATION
COLORADO-BIG THOMPSON PROJECT-COLORADO
OLYMPUS DAM
SPILLWAY AND NON-OVERFLOW SECTIONS
DENVER, COLORADO FEB. 25, 1947
245-D-3796

FIGURE 4



PLAN
RADIAL GATES AND BRIDGE NOT SHOWN
Block 3
Block 4
Block 5
Block 6
℄ Pier No. 1 Sta. 20+47.50
℄ Pier No. 2 Sta. 20+72.50
℄ Pier No. 3 Sta. 20+97.50
℄ Pier No. 4 Sta. 21+22.50
℄ Pier No. 5 Sta. 21+47.50
℄ Pier No. 6 Sta. 21+72.50
℄ 18" Outlet pipe for future hydraulic laboratory
℄ 18" River outlet pipe
Power operated gate hoists
Stop log slot
Axis of dam
20'x17' Radial gate
1/8" Open joint
Metal cover plate
SECTION A-A
Power operated gate hoist
6" Std. pipe sleeve
Fishscreen slot
Stop log slot
4" Dia. air vent
Square to round transition
2.5'x2.5' C.I. gate
Axis of dam
18" I.D. pipe
Blind flange
SECTION B-B
4366' to axis of dam
SECTION J-J
℄ River outlet
℄ Pump discharge line
SECTION G-G
Parabolic curve
SECTION K-K
SECTION H-H
(TYP. TRASHRACK STRUCTURE REINF.)
Fishscreen
℄ Pier No. 1
SECTION F-F
Fishscreens not shown
2.5'x2.5' C.I. gates
SECTION C-C
(TYPICAL END PIER)
Steel nose guard
Wall plate
℄ Radial gate pin El. 7463.50
Origin of coordinates for parabola
Parabolic equation
3'-0" Wide end training wall
Trace of abutment section
Axis of crest
Axis of dam
SECTION E-E
(TYPICAL INTERMEDIATE PIER)
Typical pier reinforcement
SECTION D-D
3'-0" Wide intermediate training wall
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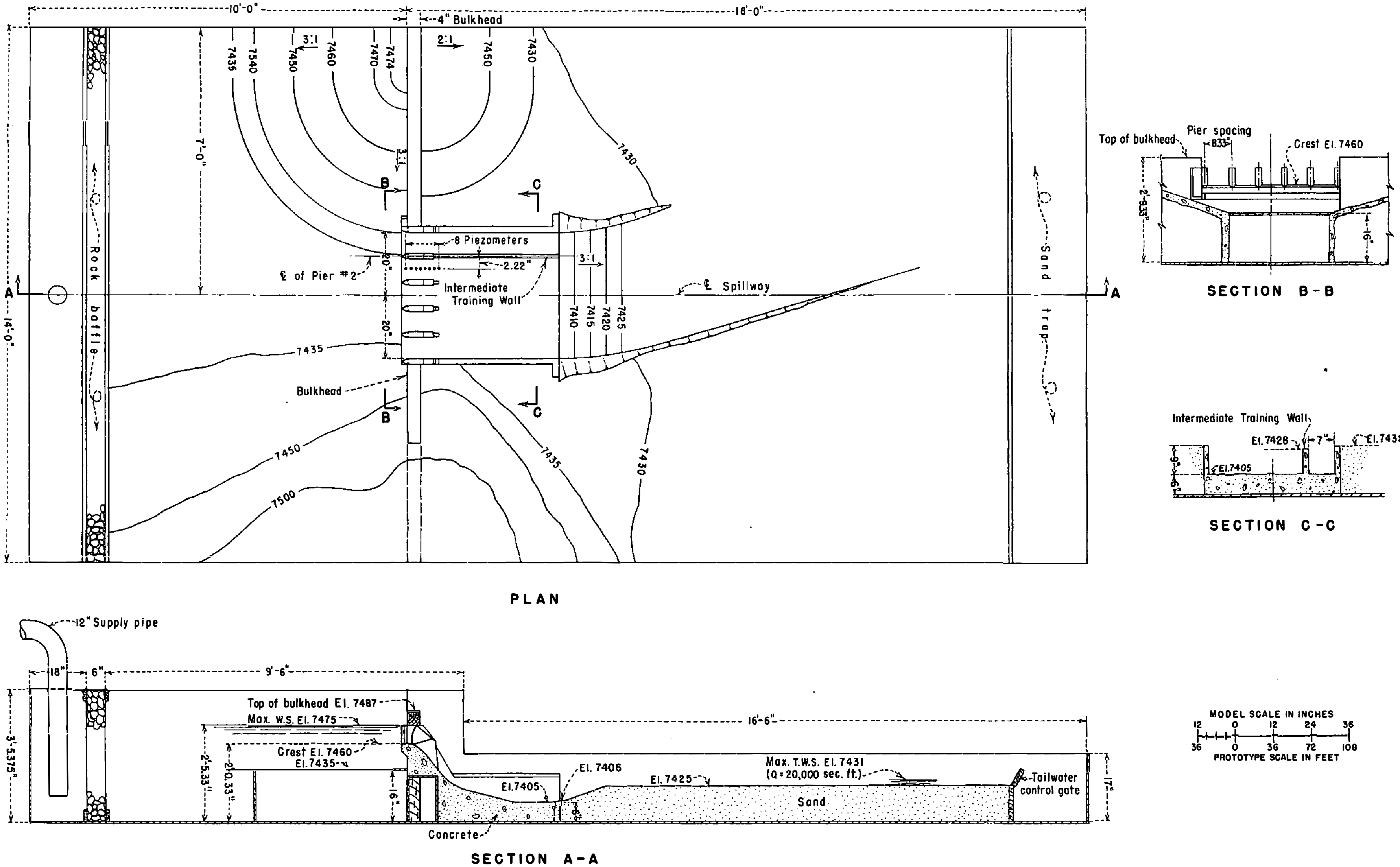
COLORADO-BIG THOMPSON PROJECT-COLORADO
OLYMPUS DAM
SPILLWAY CREST, PIERS, AND OUTLETS
DRAWN N.W.C. SUBMITTED
TRACED S.W.J. RECOMMENDED
CHECKED APPROVED Walker R. Young CHIEF ENGINEER
DENVER, COLORADO FEB. 25, 1947
245-D-3801



OLYMPUS DAM SPILLWAY

MODEL LAYOUT - PRELIMINARY DESIGN

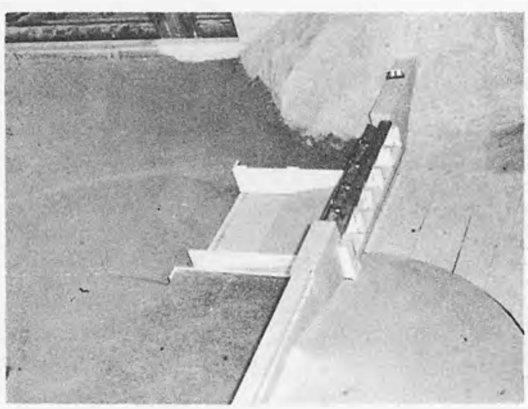
1:36 MODEL

FIGURE 5

Figure 6

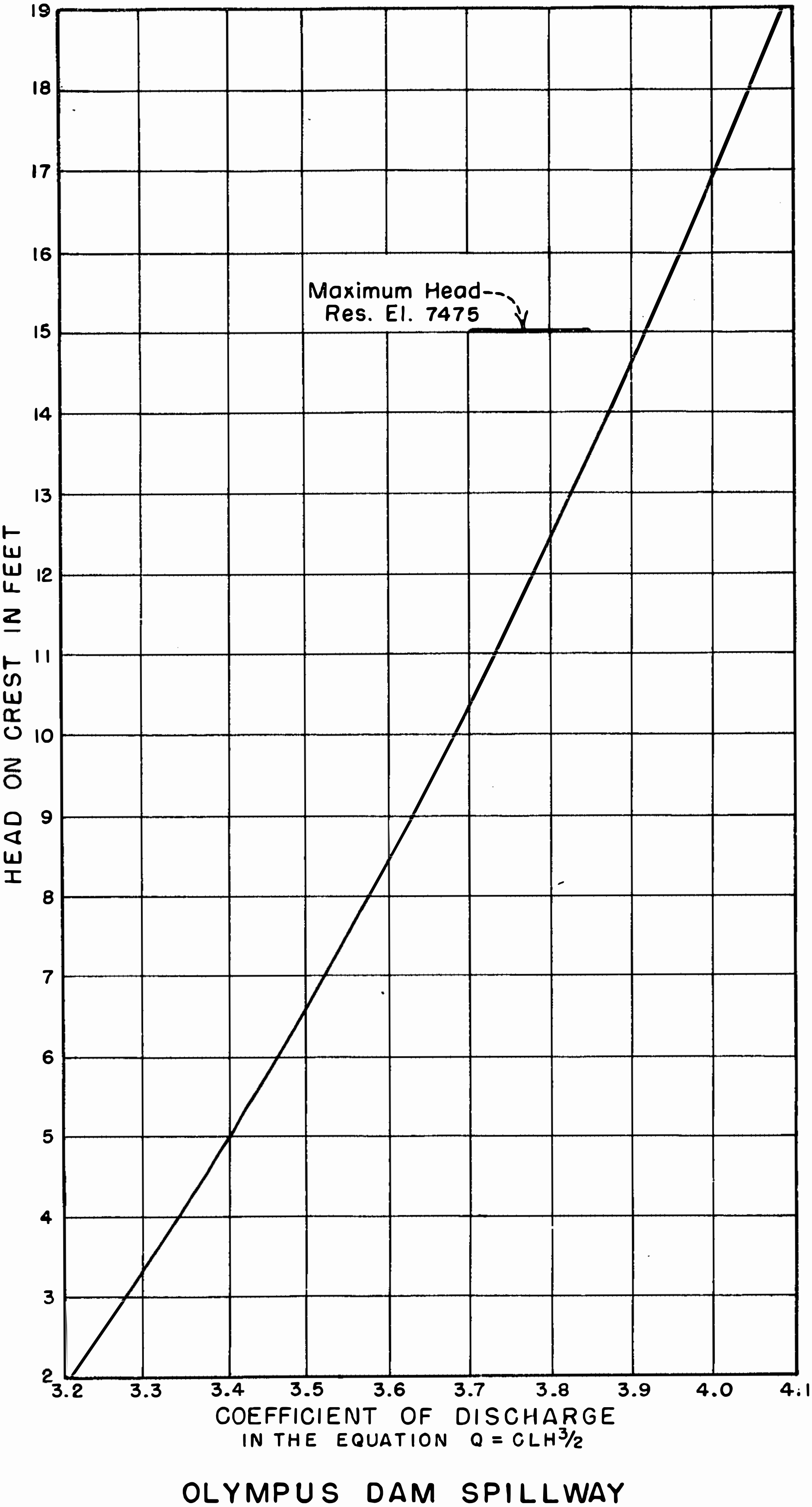
A. Downstream View

B. Upstream View



C. Side View

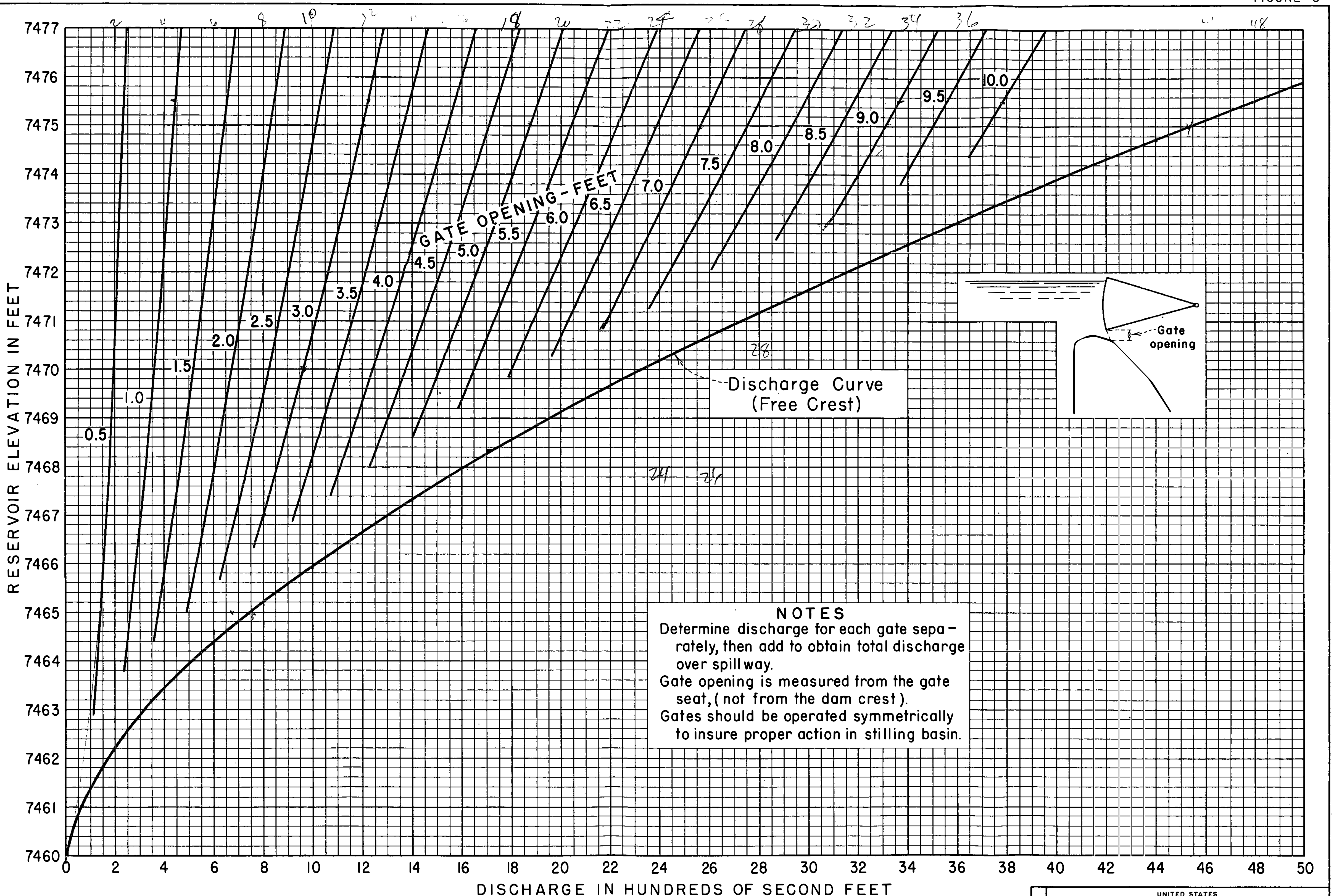
Olympus Dam Spillway
Model Views
1:36 Model



OLYMPUS DAM SPILLWAY

COEFFICIENT OF DISCHARGE CURVE

1:36 MODEL



NOTES

Determine discharge for each gate separately, then add to obtain total discharge over spillway.
Gate opening is measured from the gate seat, (not from the dam crest).
Gates should be operated symmetrically to insure proper action in stilling basin.

These curves were obtained from a 1:36 Scale Model

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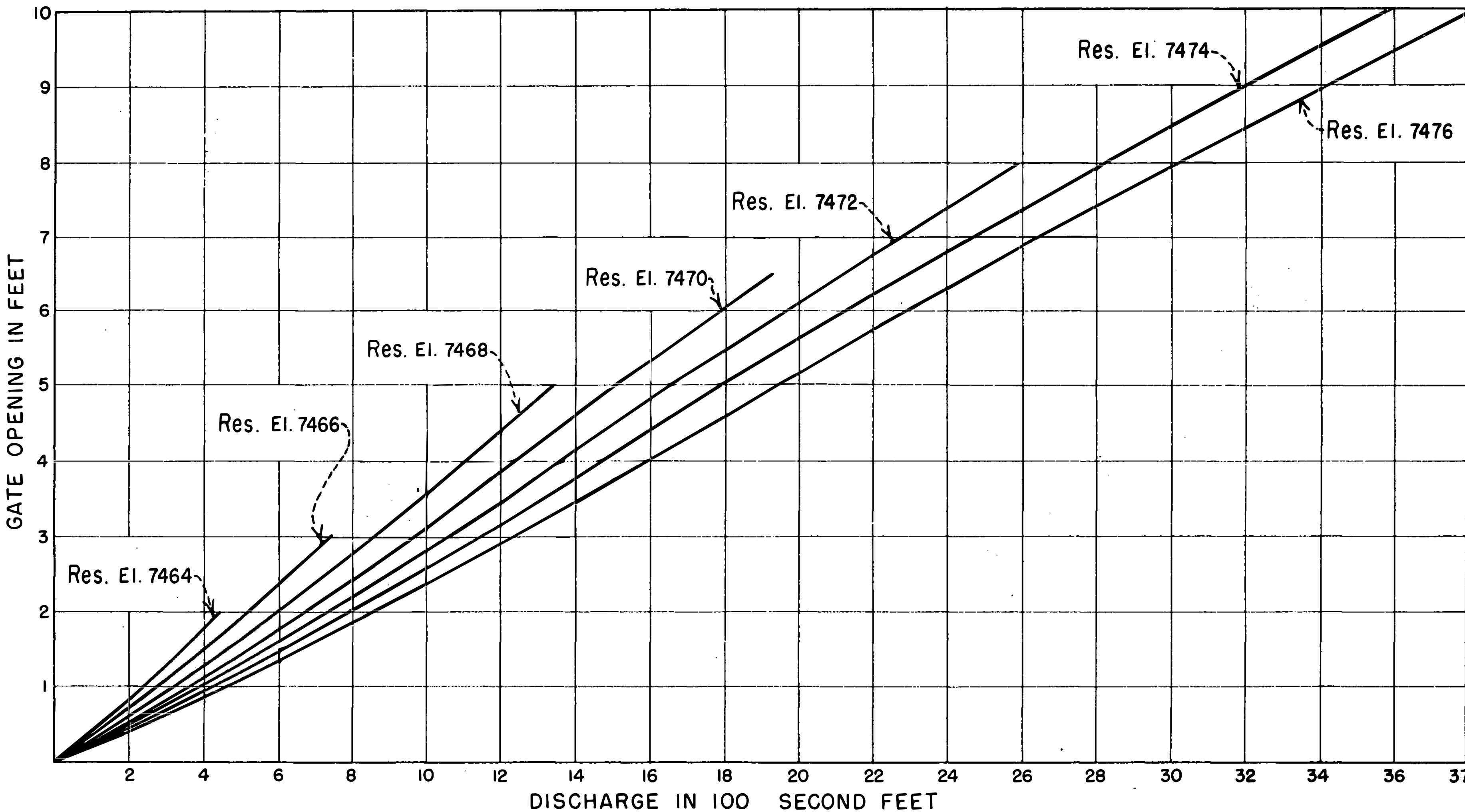
OLYMPUS DAM
SPILLWAY DISCHARGE CURVES FOR ONE 20' BY 17' RADIAL GATE

DRAWN E. G. SUBMITTED Harold M. Martin
TRACED H. H. S. RECOMMENDED R. F. Blanks
CHECKED W. E. W. APPROVED J. J. H. W. H. Nalder CHIEF DESIGNING ENGIN'R

DENVER, COLORADO - FEBRUARY 14, 1950 245-D-5492

REV. AND REDRAWN 1-14-52 CLB JNB

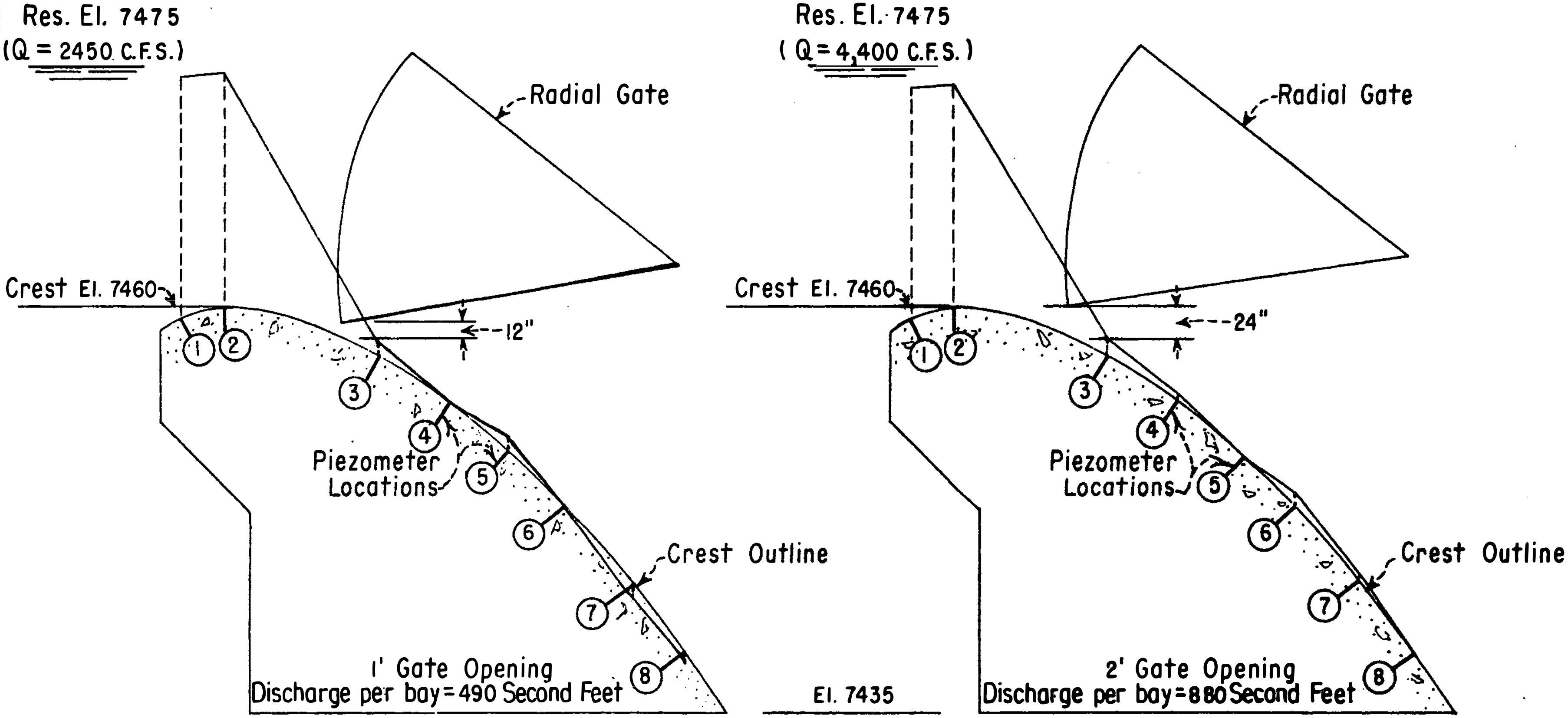


OLYMPUS DAM SPILLWAY

GATE OPENING VERSUS DISCHARGE

1 : 36 MODEL

FIGURE 9



NOTES

Piezometers are located on a line parallel to the centerline of the spillway one third of the bay width to the right of Pier No. 2.

Crest outline is zero pressure datum.

Pressures above atmospheric are plotted above the crest outline.

OLYMPUS DAM SPILLWAY
CREST PRESSURES – PARTIAL GATE OPENINGS
1:36 MODEL

SCALES
PRESSURE 1" = 10 FEET OF WATER
STRUCTURE 1" = 10'

NOTES

Piezometers are located on a line parallel to the centerline of the spillway one third of the bay width to the right of Pier No. 2.

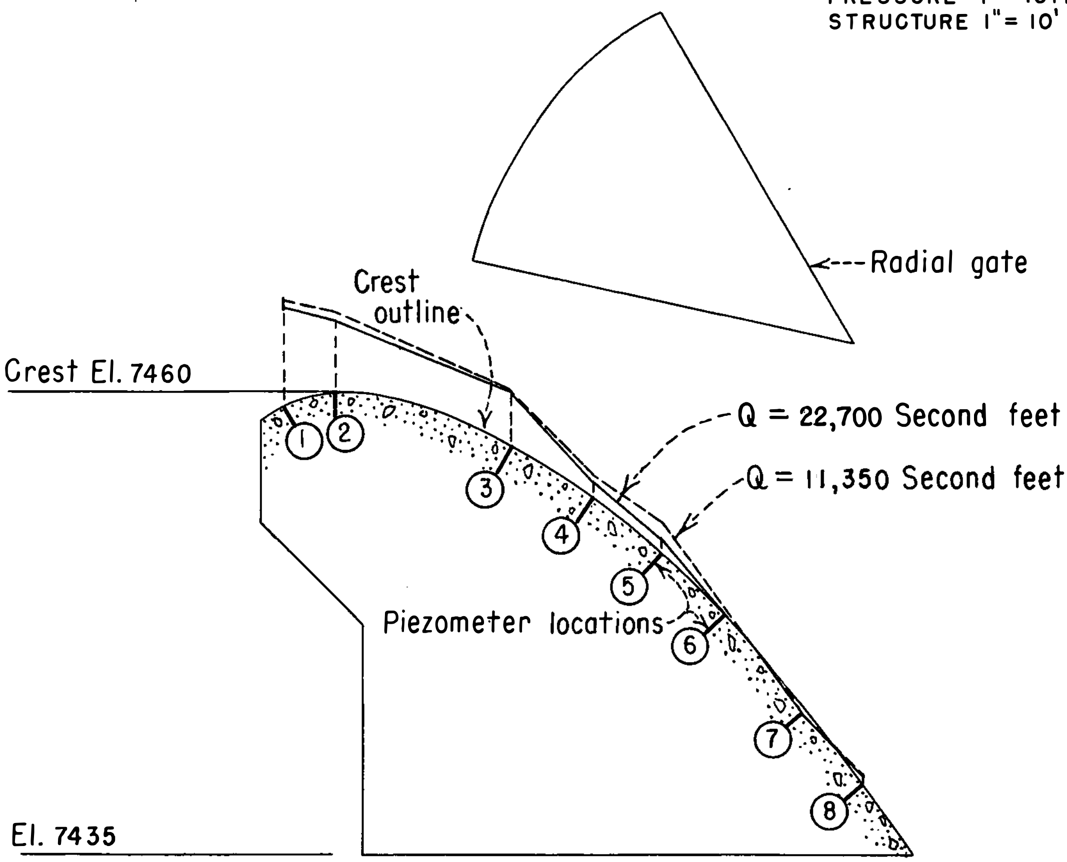
Crest outline is zero pressure datum.

Pressures above atmospheric are plotted above the crest outline.

SCALES

PRESSURE 1" = 10 FEET OF WATER

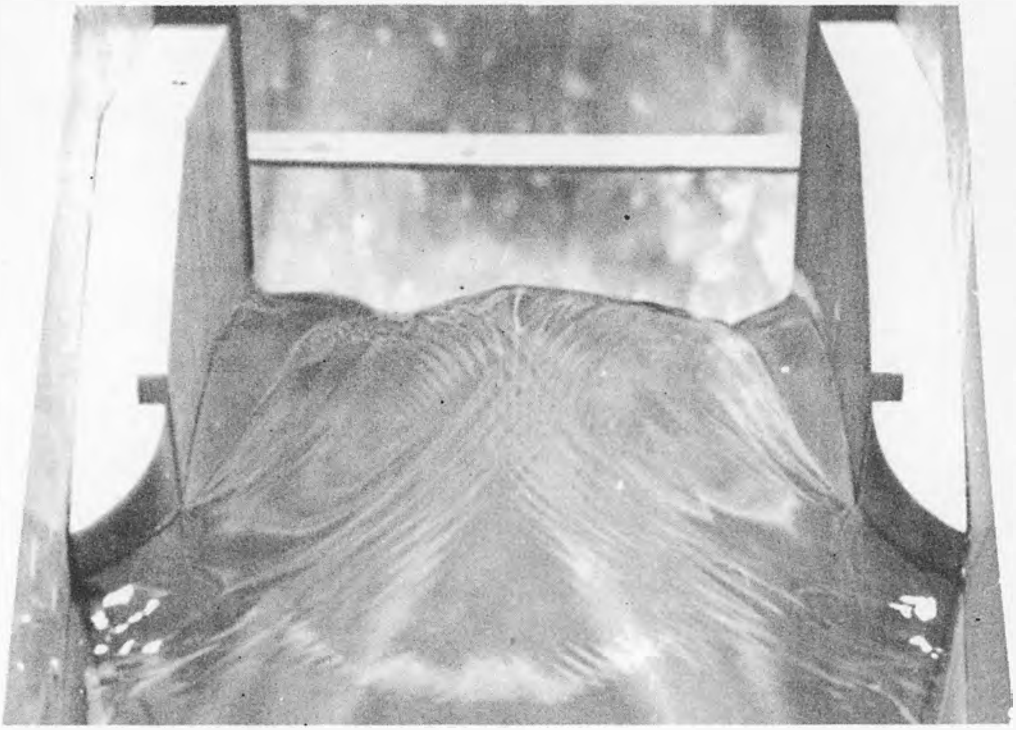
STRUCTURE 1" = 10'



OLYMPUS DAM SPILLWAY

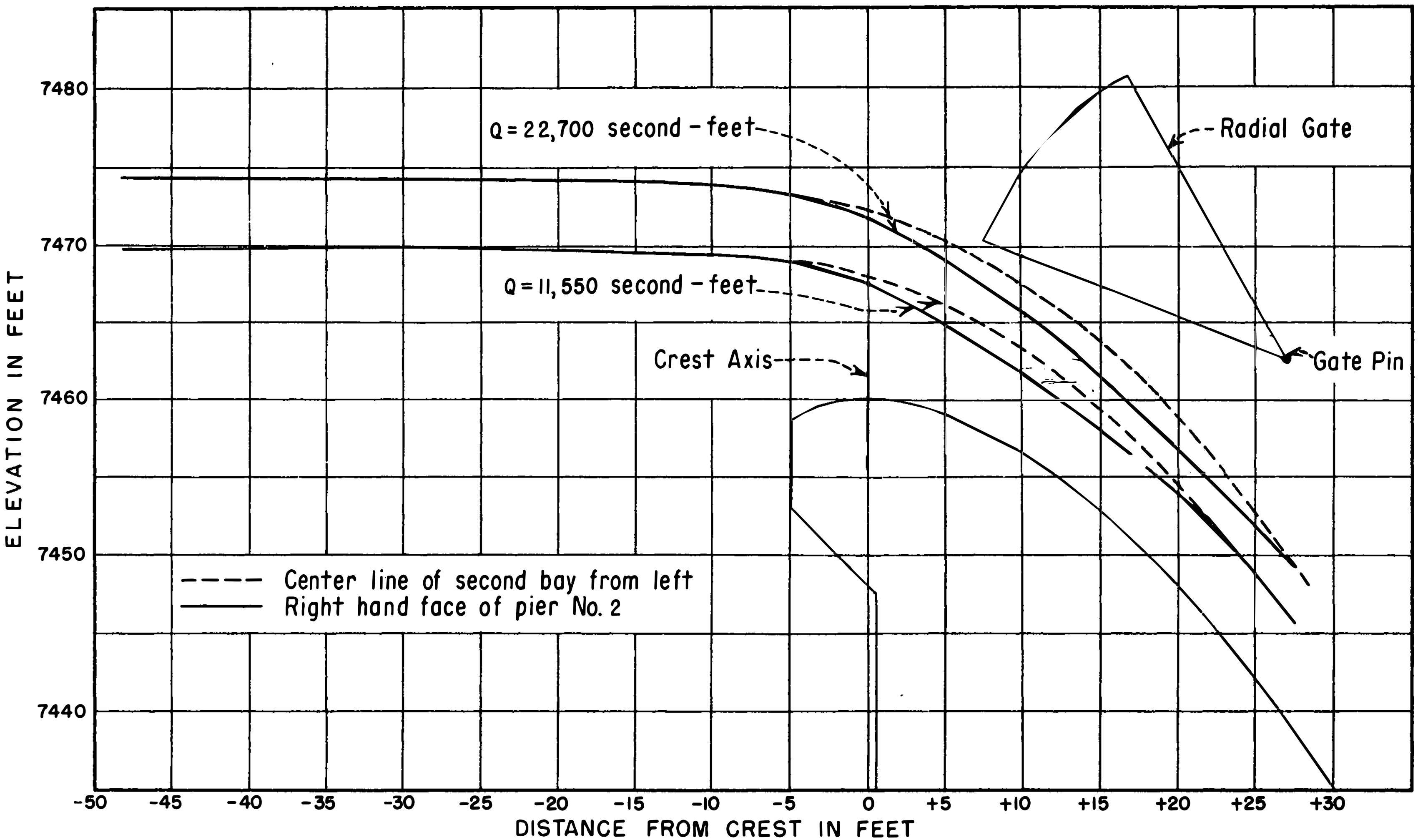
CREST PRESSURES—UNCONTROLLED FLOW

1:36 MODEL



Center Bay
Maximum Reservoir Elevation
Spillway Discharge 22, 700 Second-feet.

Olympus Dam Spillway
Water Surface Between Piers
1:36 Model

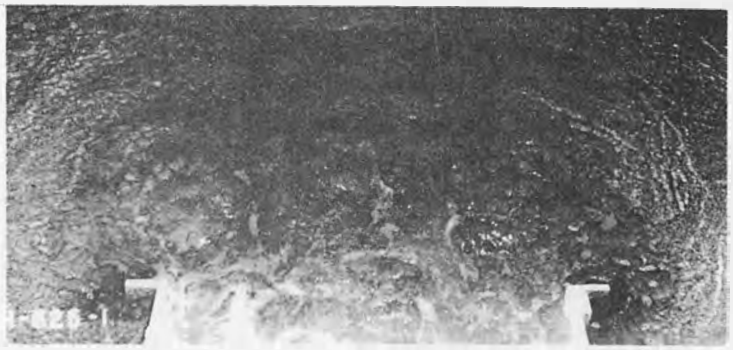


OLYMPUS DAM SPILLWAY

WATER SURFACE PROFILES OVER UNCONTROLLED CREST

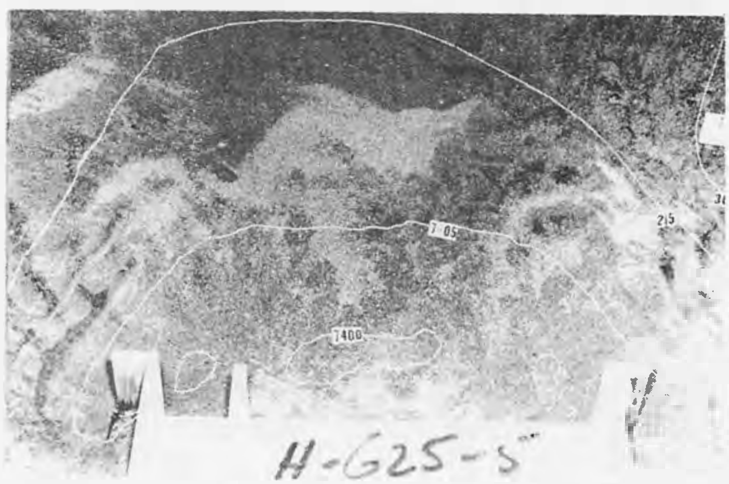
1 : 36 MODEL

FIGURE 13



a. Beginning of 25 minute Model Scour Test.

b. Scour Test in Progress after 14 minutes of Model Operation.



c. Scour Pattern after 25 minute Model Test Run.

Olympus Dam Spillway
Scour Test - 20,000 Second-Feet - Preliminary Design
1:36 Model