Denver, Colorado, January 15, 1940.

MEMORANDUM TO CHIEF DESIGNING ENGINEER
(H. M. Martin)

Subject: Hydraulic model studies for the redesign of the spillway for Mormon Flat Dam, Salt River project, Arizona.

1. Summary. The Mormon Flat Dam spillway as constructed, 1923-1925, was found to be inadequate for the expected maximum flood flow of 150,000 cubic feet per second. In order to check alterations in the redesign of the spillway, a model of the dam, spillway, and pertinent topography was constructed to the scale of 1 to 90.

Alterations of the original design failed to increase the flood discharge over the spillway appreciably. Even with the addition of an auxiliary crest at elevation 1666.2 on the main arch of the dam, the prototype discharge at pond elevation 1672 was only approximately 85,000 cubic feet per second. The maximum prototype discharge that could be passed over the original gates was approximately 105,000 cubic feet per second, the approach channel having been deepened and widened and training walls to the piers having been installed.

The original spillway was blocked off and the nine gateways for the taintor gates were constructed on an ogee crest on the main arch of the dam at elevation 1643. An apron conducted the discharge from the crest radially inward and down over the powerhouse to the tailrace. The maximum flood of 150,000 cubic feet per second could be passed at pond elevation 1623.5 quite satisfactorily. However, it was decided to abandon this design because of difficulties in and the expense of construction.

The original design was again built into the model, and, after considerable observation, the gates were designed in echelon with respect to each other in plan and alinement. This spillway passed nearly the maximum flood flow of 150,000 cubic feet per second at pond elevation 1672. Difficulties in the design and construction of a scroll wall at the right side of the approach to gate 1 prevented the adoption of this plan.

The fourth and final spillway tested was a tapered, curved channel located in the area occupied by the original spillway. It consists of an ogee crest at elevation 1610.5 and a tapered, curved channel 416 feet in length from the crest, discharging over the

powerhouse roadway into the river. Several shapes of crests were investigated as to efficiency at several elevations. Also, several shapes of piers were tested to produce smooth flow down the channel. Two 50- by 50-foot stoney gates control the discharge.

2. The project. The Mormon Flat Dam is located in Maricopa County, south central Arizona, 40 miles downstream from the Roosevelt Dam on the Salt River. It is a concrete, variable radius, arch dam with a maximum height of 229 feet. It was built by the Salt River Water Users' Association under the general supervision of the Bureau of Reclamation and was completed in 1925. The flow of the river fluctuates widely, varying from a low flow of several hundred second-feet to a maximum flood of 150,000 second-feet. It was found that the spillway of the dam as originally designed and built was inadequate for the expected maximum flood flow. Pursuant to a contract between the Bureau of Reclamation and the Association, the Bureau reconstructed the spillway structure of Mormon Flat Dam. This involved the removal of a major part of the original spillway; installing two new 50- by 50-foot regulating gates, gate hoists, and motors; installing two 25 kv.-a gasoline-driven generators; removing and storing the nine radial gates of the original installation; grouting the foundation of the spillway gate structures; and constructing a new anchor block at the left abutment of the dam and a new road to the powerhouse.

3. The laboratory. The model of the Mormon Flat Dam was constructed and tested in the hydraulic laboratory of the Bureau of Reclamation in the basement of the Old Customhouse, Denver, Colorado, in 1935 and 1936.

Water for operating the model was measured over a 90-degree, V-notch weir in a tank 12 by 6 by 4 feet deep. The water was lifted from the sump of the weir tank to a constant-level tank by a centrifugal pump of 3-cubic-foot-per-second capacity. A skimming weir of approximately 32 feet long made it possible to maintain a constant head of water on the tank. The water was admitted from this tank through a calibrated gate valve into a head reservoir. The Mormon Flat Dam and spillway were built into this head reservoir. The water, after flowing over the spillway model, was returned to the weir tank through a sheet-metal flume, and recirculated.

4. Description of the model. The model of the dam and spillway was constructed to a scale of 1 to 90. The arch dam was represented in the model by a sheet of galvanized steel bent to the proper radius of the axis of the dam. The spillway crest sections were constructed of light-gage sheet metal and the piers were of redwood, in the original model. In alterations and revisions of the spillway crests, the crests were cast of neat cement between sheet-

metal templates. The topography, both upstream and downstream from the dam, was approximated by slopes installed in wood in the original model. Later, the topography was cast with sawdust concrete between sheet-metal templates set at the proper elevation and alinement. The depth of the forebay directly above the dam was limited to approximately 90 feet, prototype, below the parapet of the arch. This was necessary because of the lack of head room and limitations due to the weir tank below. The ogee sections for the auxiliary spillway on the main arch of the dam were of redwood. The reservoir elevation was recorded from hook gage readings in a stilling well connected to the forebay. The tail-water level was controlled by a hinged weir at the downstream end of the tail-water box, and the elevations were read on a gage connected to the tail-water box.

5. Discharge capacity and flow conditions. At a pond elevation of 1671, top of the parapet of the arch, and with the proposed auxiliary spillways (notches) closed off, the flood flow moved swiftly through the approach and banked on the upstream sides of the piers on the spillway crest. Nearly half of each gateway was void, due to the sudden change of direction of the approaching flood water. The excessive velocity, turbulence, and eddy loss reduced the effective head on the gates. This condition, along with the reduced effective crest length, limited the discharge to approximately 80,000 cubic feet per second at pond elevation 1671. The flow characteristics of the approach channel improved as the discharge decreased. The length of the spillway crest became more effective with the smaller velocities in the approach channel. Curve A, figure 1, indicates the discharge of the original structure.

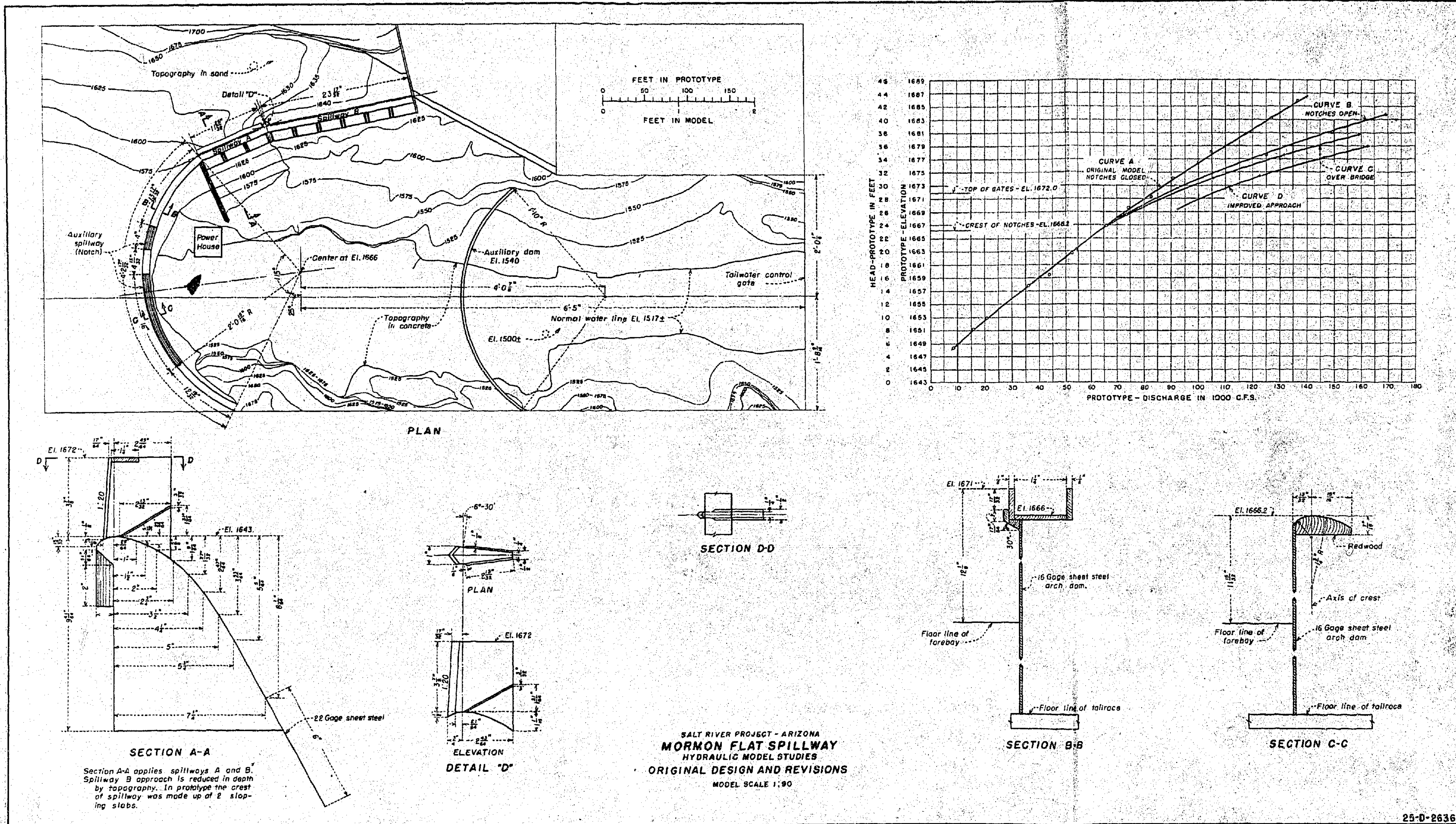
With the notches in the dam open, it was found that the flow to the ogee spillway was unaffected. The total effect of the notches on the required head for flood flows is shown on curve B, figure 1.

Several training walls in the approach were tried in an effort to reduce the head loss and to guide the flow to maintain a maximum effective crest length. The most effective training wall was that dividing the flow between gates 3 and 4, with a rounded entrance at the right side of gate 1. Other positions of training walls were relative ineffective.

The roadway over the dam and spillway was reproduced in the model. Curve C, figure 1, shows the discharge at reservoir elevations whose floods overtopped the dam and gates.

A restriction in the spillway approach channel near gates 1 to 3 was removed and the approach deepened. The resulting increased capacity is shown on curve D, figure 1.

FIGURE 1



SALT RIVER PROJECT - ARIZONA
MORMON FLAT SPILLWAY
HYDRAULIC MODEL STUDIES
ORIGINAL DESIGN AND REVISIONS
MODEL SCALE 1:90

25-D-2636

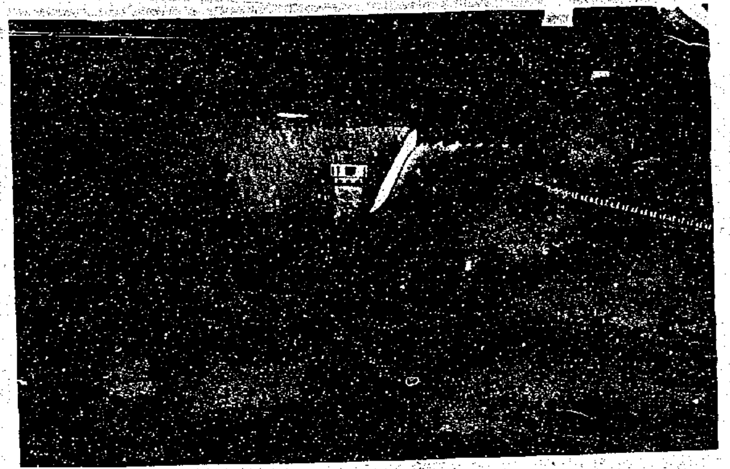
The curves on figure 1 indicate the progress made in the solution of the approach. Inasmuch as it was required that 150,000 cubic feet per second be passed over the spillway, the problem was left unsolved pending further considerations as to the improvement of the spillway approach.

6. Effect of various buckets and auxiliary dam. Various types and combinations of buckets were tried on the original ogee spillway to reduce the erosion and splash in the river below. None of the buckets tried was entirely satisfactory. An auxiliary dam was proposed for installation, about 1,500 feet downstream from the large dam, to control the tail water for the spillway and the powerhouse. In the tests of the buckets, it was found that the auxiliary dam was of little or no benefit in checking erosion and dissipating energy of the spillway discharge. Plate 1 shows the model of original structure before alterations were made.

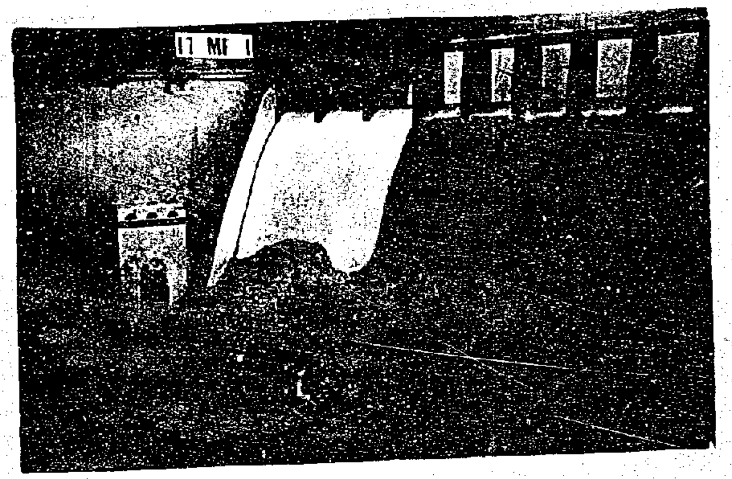
7. Tainter gate spillway on the dam. At this stage of the investigation it was decided to block off the original spillway and remove a portion of the arch dam parapet and the auxiliary spillways and to cast an ogee crest on the arch at elevation 1643. The gates of the original spillway were to be used in this installation. An apron consisting of a concrete slab supported by a structural-steel framework secured to the dam was intended to conduct the flood flow from the crest radially inward over the powerhouse and distribute it with a minimum of disturbance to the tailrace.

In the model, this spillway was cast in concrete. Three additional gates were added to the model to the left of the nine proposed on the design drawing. This was done to determine the best position for nine gates. As the investigation progressed, piezometers were placed in the crest and apron to determine the pressure distribution.

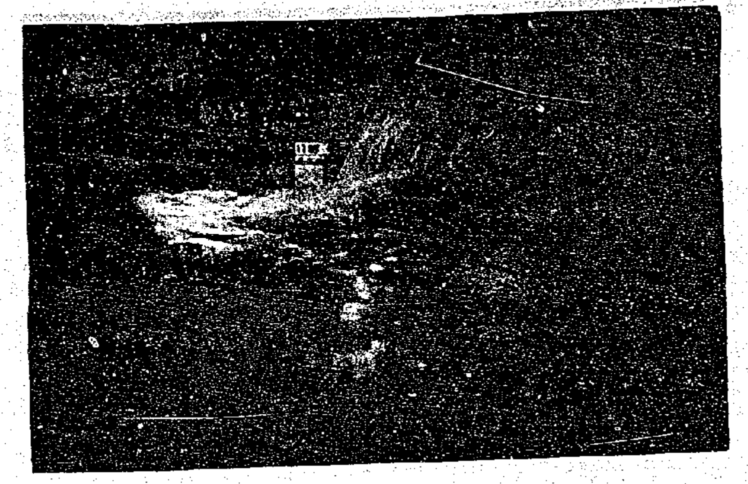
Various combinations or groups of gates revealed no great improvement over the nine proposed originally. The convergence of the flow from the gates formed a high "cockscomb" at the tip of the apron. The erosion in the tailrace was tremendous, due to the large vertical component of velocity. To relieve this situation the apron was leveled out, first at elevation 1561.25 and later at elevation 1583.46. The aprons directed the jet to give a spread over the tailrace. The higher apron was the more effective in eliminating boiling in the tailrace. This discovery suggested a revision in the design which involved the features as shown in figure 2. This model performed quite satisfactorily but was considered not feasible in the prototype because of the cost of construction, among other reasons.



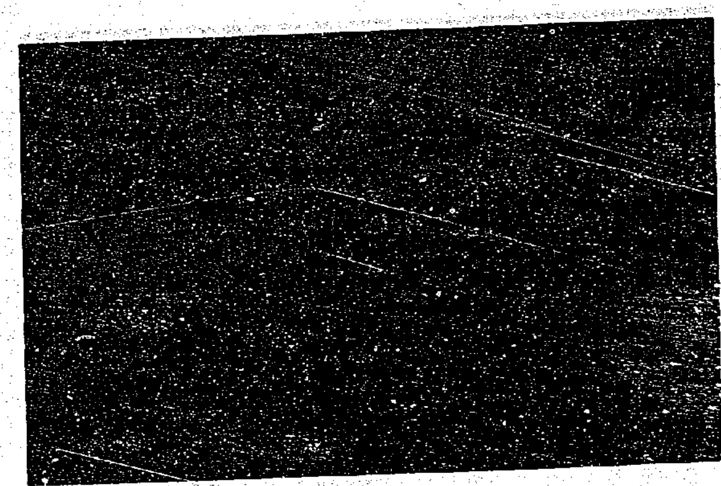
DAM AND SPILLWAY



SPILLWAY



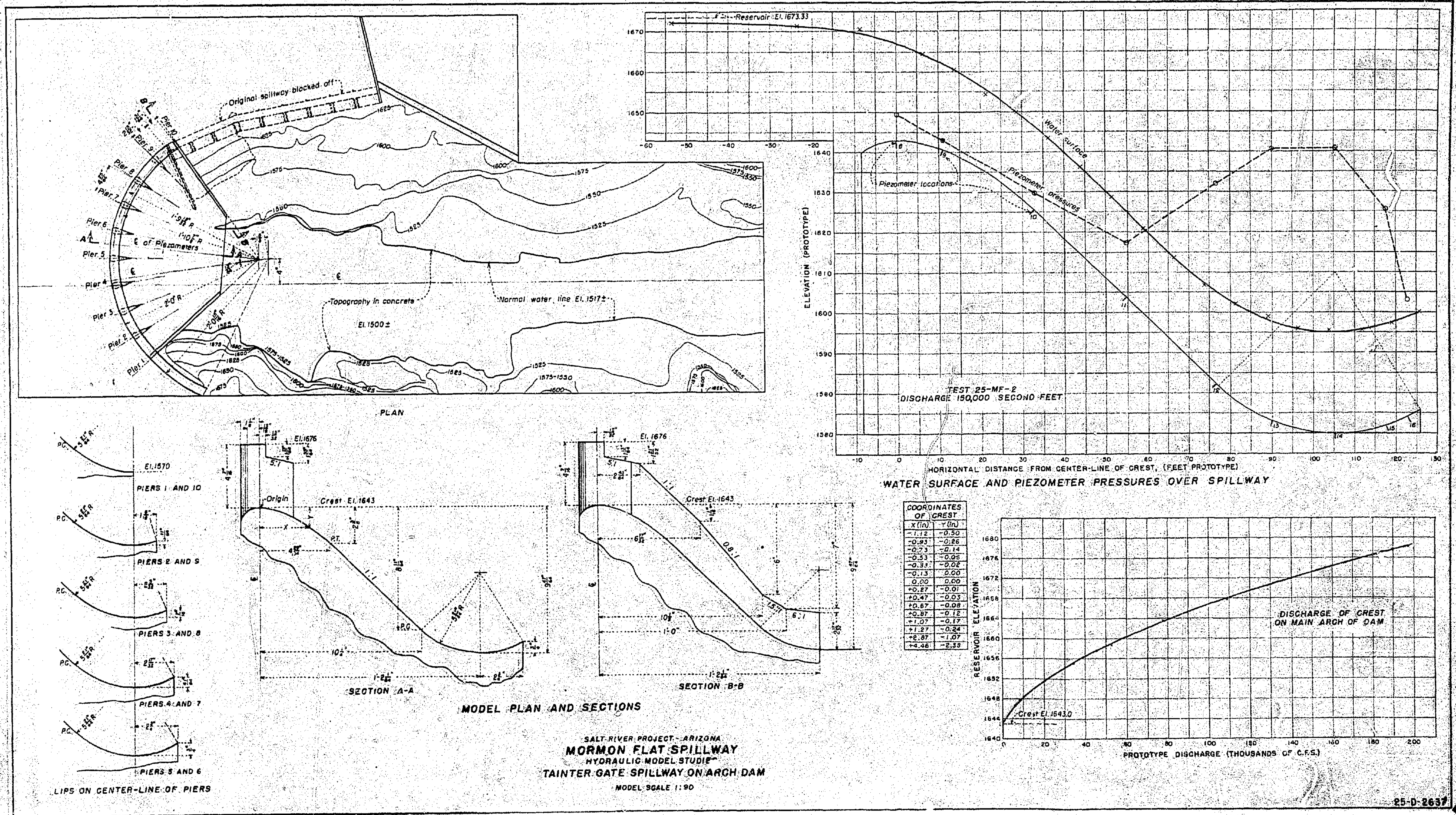
DISCHARGE 80,000 SEC.-FT.



DISCHARGE 150,000 SEC.-FT.

ORIGINAL STRUCTURE

FIGURE 2

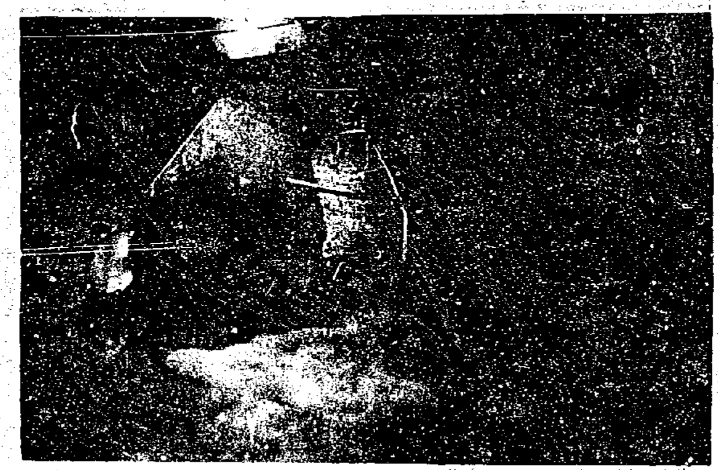


COORDINATES OF CREST	
X (in)	Y (in)
-1.12	-0.50
-0.93	-0.26
-0.73	-0.14
-0.53	-0.05
-0.33	-0.02
-0.13	0.00
0.00	0.00
+0.27	-0.01
+0.47	-0.03
+0.67	-0.08
+0.87	-0.12
+1.07	-0.17
+1.27	-0.24
+2.87	-1.07
+4.46	-2.33

SALT RIVER PROJECT - ARIZONA
MORMON FLAT SPILLWAY
HYDRAULIC MODEL STUDIES
TAINTER GATE SPILLWAY ON ARCH DAM
MODEL SCALE 1:90

FROM LEFT SIDE

NO FLOW, LOOKING UPSTREAM



DISCHARGE 150,000 SEC,-FT.

TAINTER GATE SPILLWAY ON ARCH DAM

The discharge capacity of this spillway is shown in figure 2. The pressures developed on the crest, apron, and bucket are also shown in figure 2.

Plate II shows the best development of the model. This is also shown in figure 2.

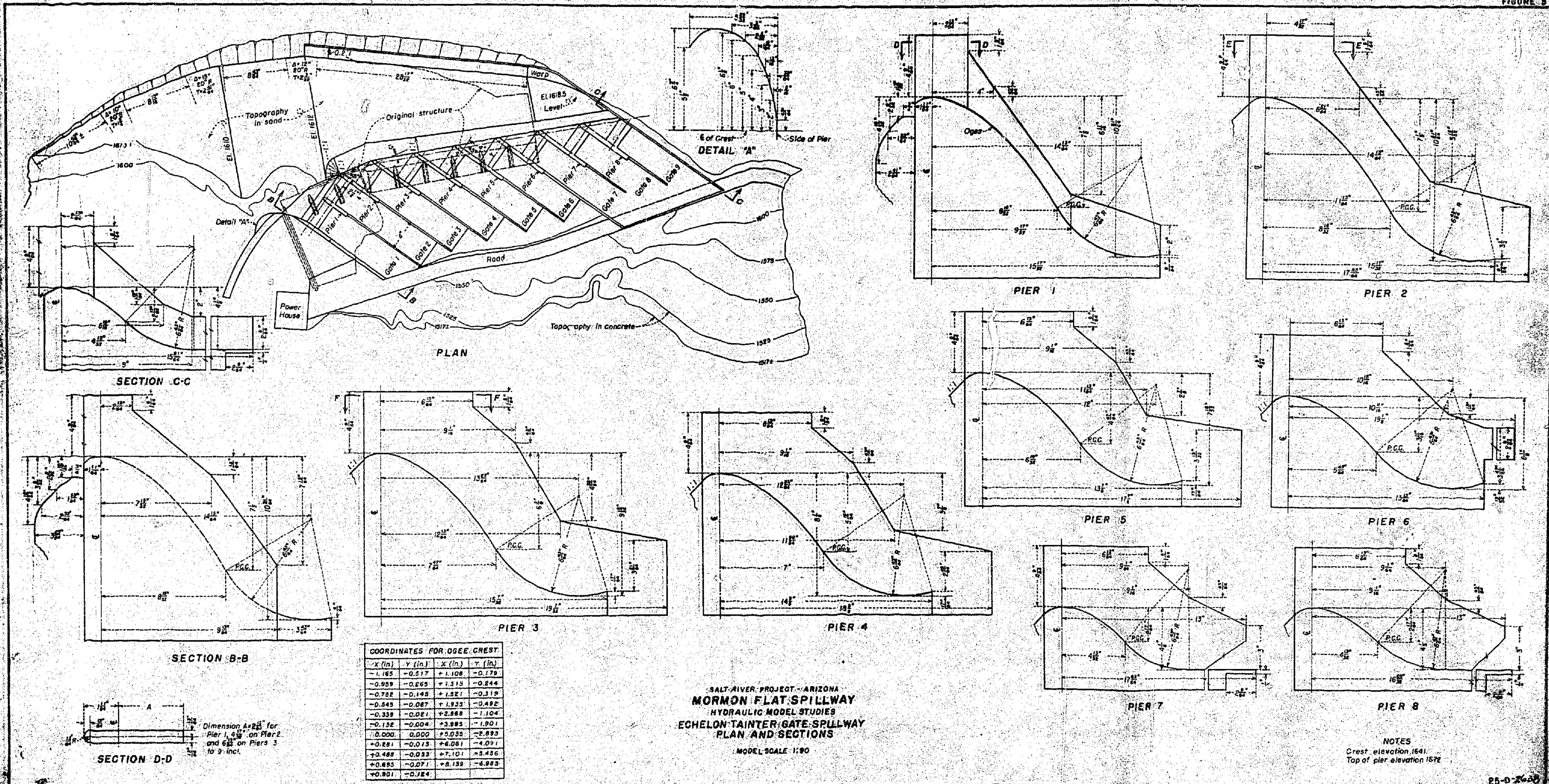
8. <u>The eschelon tainter gate spillway.</u> The tainter gate spillway on the dam being found impracticable, the original spillway was rebuilt and the approach channel was deepened and broadened as much as practicable within the limits of the field conditions. On the original spillway it was found that the inefficiency was due to two principal reasons: sudden change in direction of flow immediately preceding the crest, and excessive drawdown due to restricted channel.

Several calibration tests revealed that the greatest flood discharges that could be passed over the spillway by widening and deepening the approach channel were 120,000 to 130,000 cubic feet per second at pond elevation 1672.

This design was removed and the crest was reconstructed, the gates being in echelon with respect to each other in plan and alinement, much the same as shown in figure 3, except that gates 1 and 2 were also echeloned in alinement. The principal difficulty encountered in this type of spillway, situated as shown, was the tremendous drawdown on the scroll wall at the right of gate 1, affecting gates 1 and 2. The drawdown not only limited the discharge due to head loss and limiting the effective length of the crest of gates 1 and 2 but caused excessive overturning moment on the scroll wall. It was found to be impracticable to design for this condition. Various sizes and shapes of scrolls were tried in an effort to arrive at a solution within the limits of practical design.

After an exhaustive study of the drawdown problem at gates 1 and 2, it was decided to move the crest of gate 1 downstream in alinement with gate 2. The right wall of gate 1 was connected to the dam with various smooth-curved walls. Detail A, figure 3, shows the scroll wall giving the best flow conditions. The bench upstream from gates 1 and 2 was rounded off as indicated on section B-B, figure 3. The prototype discharge for the final echelon spillway as shown in figure 4 was 149,959 cubic feet per second at pond elevation 1672.00.

The aprons and buckets conducted the flood water quite smoothly over the roadway. Buckets 1 to 6 were given sufficient pitch to throw the floodwater over the roadway into the tailrace. Aprons 7 to 9 were cantilevered over the roadway to insure against the erosion of the road. Plate 3 shows the model in operation.



COORDINATES FOR OGEE CREST			
X (in.)	Y (in.)	X (in.)	Y (in.)
-1.165	-0.517	+1.108	-0.179
-0.959	-0.265	+1.315	-0.244
-0.752	-0.145	+1.521	-0.319
-0.545	-0.067	+1.935	-0.492
-0.339	-0.021	+2.868	-1.104
-0.132	-0.004	+3.985	-1.901
0.000	0.000	+5.035	-2.893
+0.281	-0.013	+6.061	-4.091
+0.488	-0.033	+7.101	-5.456
+0.695	-0.071	+8.139	-6.965
+0.901	-0.124		

SALT RIVER PROJECT - ARIZONA

MORMON FLAT SPILLWAY

HYDRAULIC MODEL STUDIES

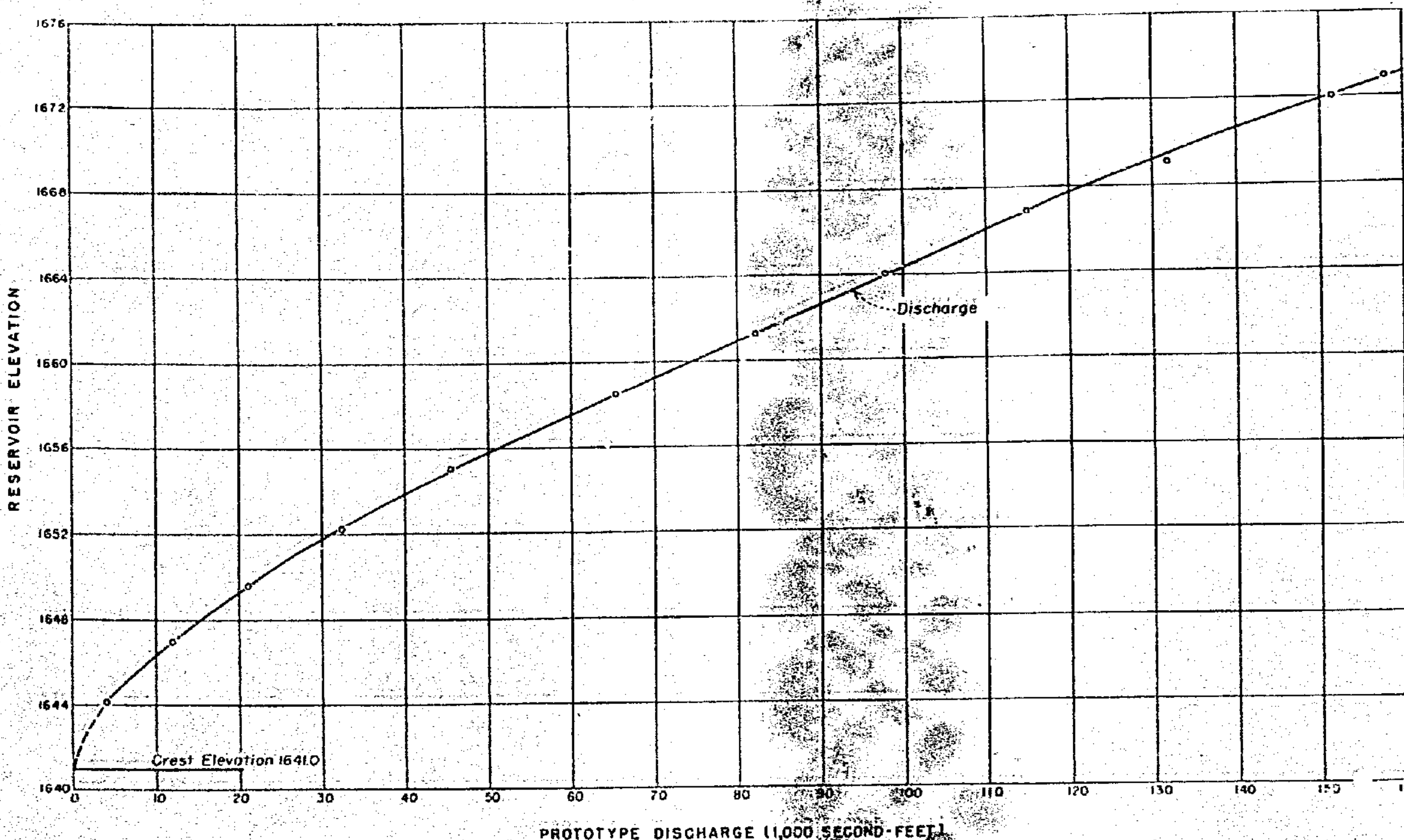
ECHELON TAINTER GATE SPILLWAY PLAN AND SECTIONS

MODEL SCALE 1:90

NOTES
Crest elevation 1641.
Top of pier elevation 1672.

25-D-2408

FIGURE 4



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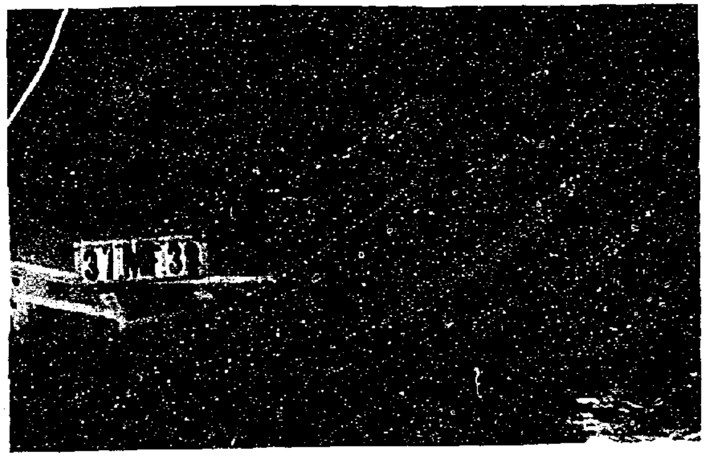
MORMON FLAT DAM
SPILLWAY
HYDRAULIC MODEL STUDIES
DISCHARGE - ECHELON SPILLWAY

DRAWN H.M.M. SUBMITTED
TRACED J.L.E.-H.S. RECOMMENDED
CHECKED H.M.M. APPROVED
DENVER, COLORADO - AUG. 4, 1939
25-D-2639

LOOKING UPSTREAM



DISCHARGE 150,000 SEC.- FT.

DISCHARGE 150,000 SEC.-FT.

9. Tapered curved spillway. It has been shown that the limiting condition in the design of the original and the echelon spillway was the change in direction of the approach channel which restricted the flow and caused rather unsteady flow conditions. The fourth and final design of the Morman Flat spillway was that of a curved, tapered channel controlled by two 50- by 50-foot stoney gates at the crest. The crest of the initial design was set at elevation 1611.0. Before the model of the initial design was completed, the crest was redesigned at elevation 1612.5, and the preliminary tests were made on the model thus altered. Figure 5 shows the initial model. The discharge at pond elevation 1671.0 was 144,000 cubic feet per second, approximately.

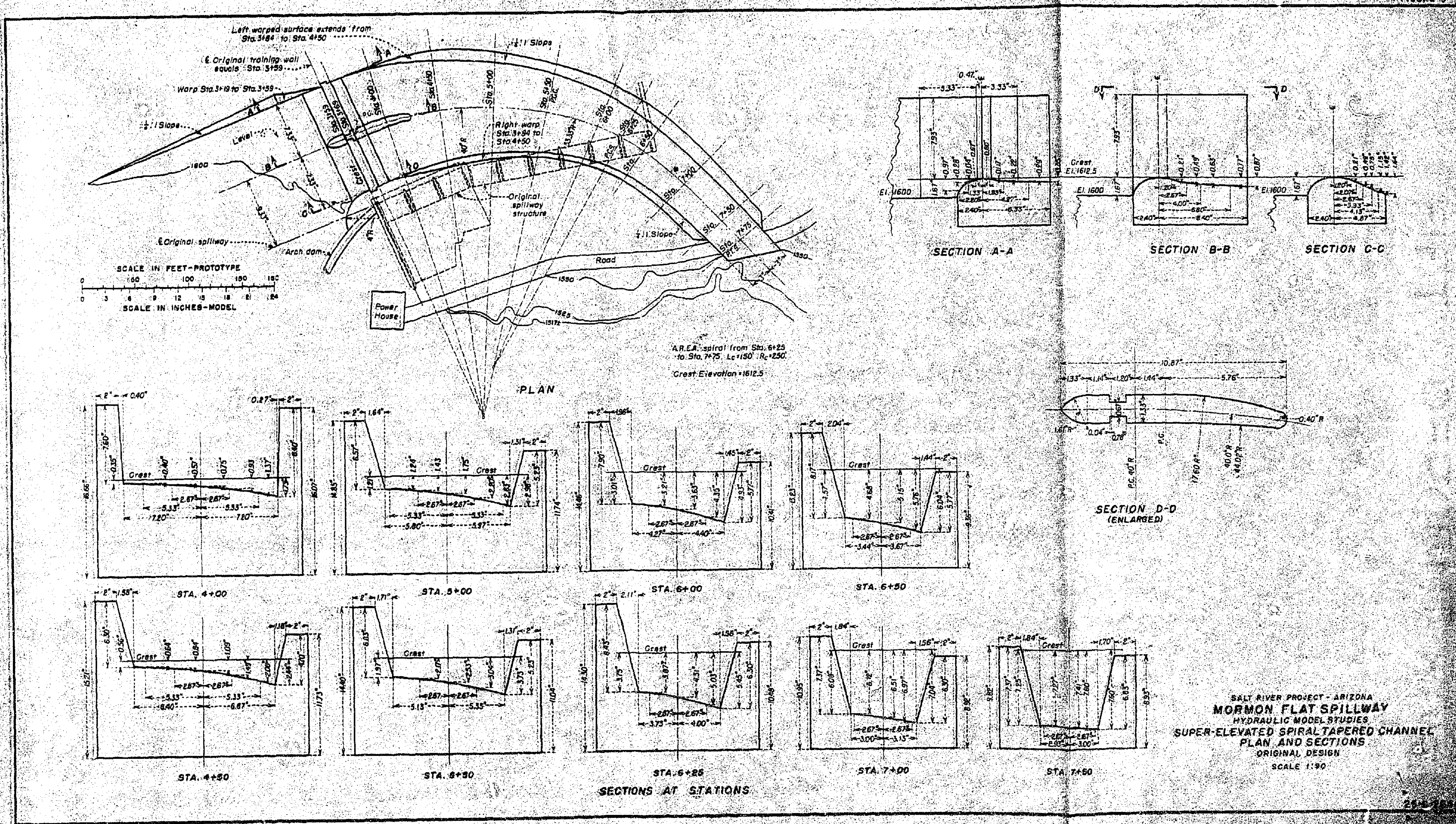
The crest was lowered to elevation 1611.0 and was a different shape than that used at elevation 1612.5. The discharge at pond elevation 1671.0 was approximately 145,000 cubic feet per second. As the shape of the crest used at elevation 1612.5 had a larger discharge coefficient than that used at elevation 1611.0, the former was used at elevation 1610.5. Figure 7 shows the relative capacities of the spillways set at the three different elevations.

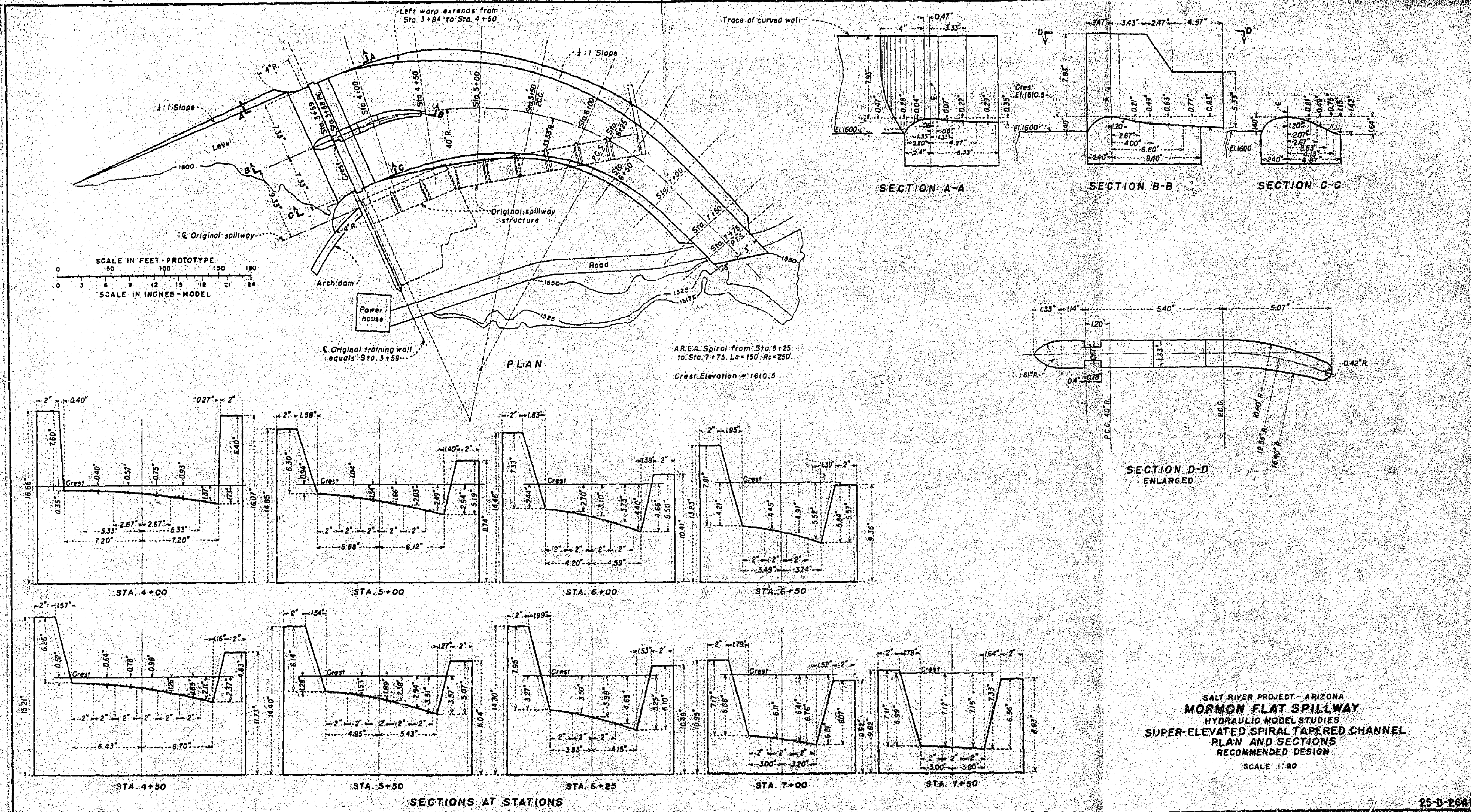
Along with the observations of discharge noted above, it was found that a cut-off wall to the left of and upstream from the gate section was necessary to prevent flow over the left gate abutment. The transition from the gate section to the 1:4 slope on the right side was too short and caused, in part, a sudden drawdown on the right side of the spillway channel from station 6+00 to station 6+50, banking on the left side. This was partially corrected by lengthening the right transition wall extending from station 3+84 to station 5+04. A revised pier also improved the water surface throughout the channel.

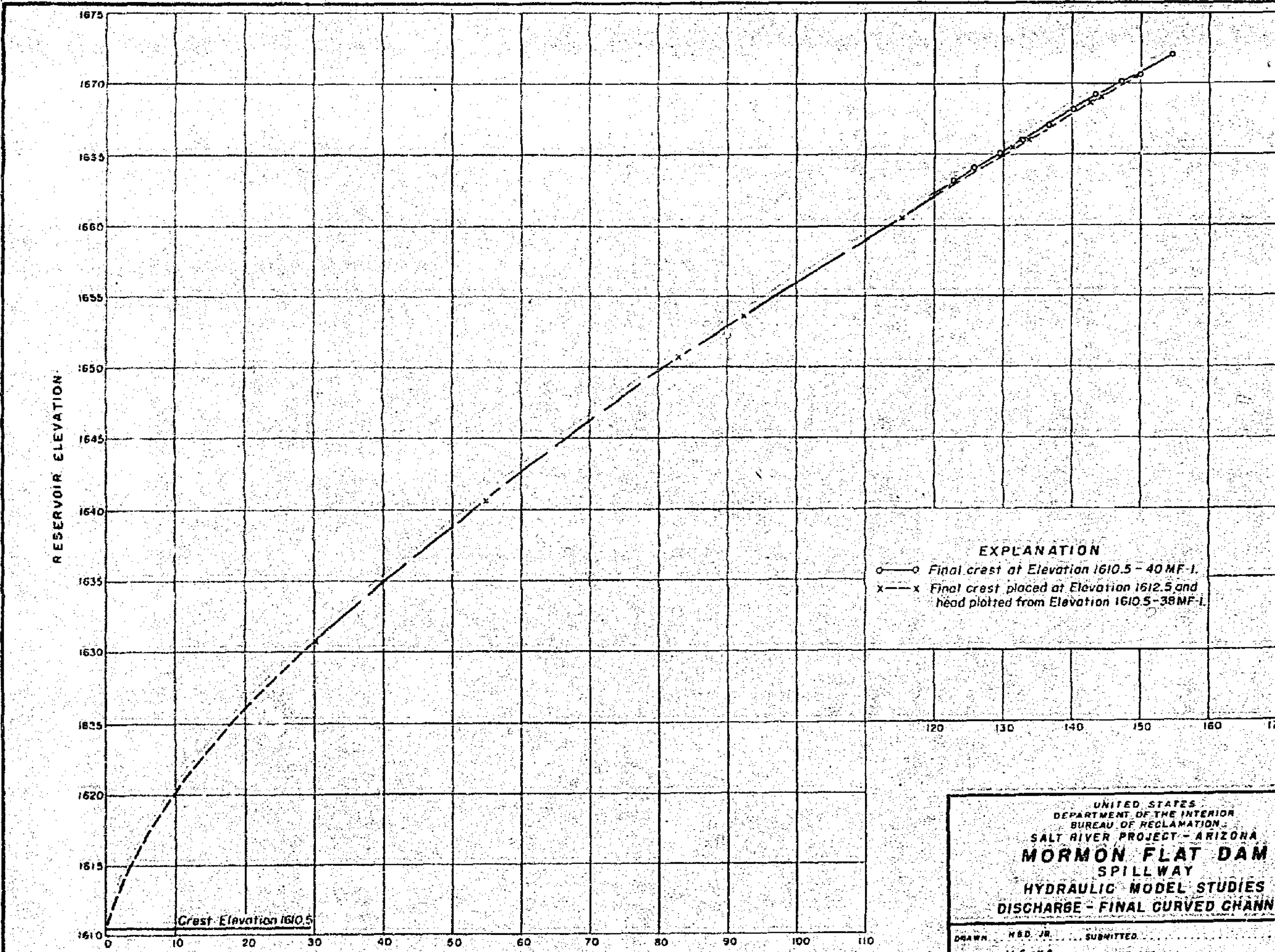
A rounded transition wall upstream of the gate section on the left side was found to improve the flow conditions through the gates and down the channel considerably.

All of the revisions described in the foregoing paragraphs are incorporated in the recommended design, the model drawing of which is shown in figure 6. Plates 4 and 5 show the recommended design as developed in the model. Figures 8 and 9 are the prototype plans of the final design, developed from the recommended design.

10. Streamlines. Velocity direction observations are shown in line diagram form in figure 10. The direction of velocity was determined by suspending short lengths of thread in the stream near the water surface and near the bottom of the channel.


Left warped surface extends from Sta. 3+84 to Sta. 4+50
℄ Original training wall equals Sta. 3+59
Warp Sta. 3+19 to Sta. 3+59
½:1 Slope
Level
Right warp Sta. 3+84 to Sta. 4+50
Original spillway structure
℄ Original spillway
Arch dam
Road
Power House
SCALE IN FEET-PROTOTYPE
SCALE IN INCHES-MODEL
A.R.E.A. spiral from Sta. 6+25 to Sta. 7+75. Lc=150' Rc=250'
Crest Elevation = 1612.5
PLAN
Crest El. 1612.5
El. 1600
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D (ENLARGED)
STA. 4+00
STA. 5+00
STA. 6+00
STA. 6+50
STA. 4+50
STA. 5+50
STA. 6+25
STA. 7+00
STA. 7+50
SECTIONS AT STATIONS
SALT RIVER PROJECT - ARIZONA
MORMON FLAT SPILLWAY
HYDRAULIC MODEL STUDIES
SUPER-ELEVATED SPIRAL TAPERED CHANNEL
PLAN AND SECTIONS
ORIGINAL DESIGN
SCALE 1:90


Left warp extends from Sta. 3+84 to Sta. 4+50
Trace of curved wall
½:1 Slope
Level
Crest
Original spillway structure
℄ Original spillway
SCALE IN FEET - PROTOTYPE
SCALE IN INCHES - MODEL
Arch dam
Power house
Road
℄ Original training wall equals Sta. 3+59
PLAN
A.R.E.A. Spiral from Sta. 6+25 to Sta. 7+75, Lc = 150' Rc = 250'
Crest Elevation = 1610.5
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
ENLARGED
STA. 4+00
STA. 5+00
STA. 6+00
STA. 6+50
STA. 4+50
STA. 5+50
STA. 6+25
STA. 7+00
STA. 7+50
SECTIONS AT STATIONS
SALT RIVER PROJECT - ARIZONA
MORMON FLAT SPILLWAY
HYDRAULIC MODEL STUDIES
SUPER-ELEVATED SPIRAL TAPERED CHANNEL
PLAN AND SECTIONS
RECOMMENDED DESIGN
SCALE 1:90
25-D-2661



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SALT RIVER PROJECT - ARIZONA

MORMON FLAT DAM

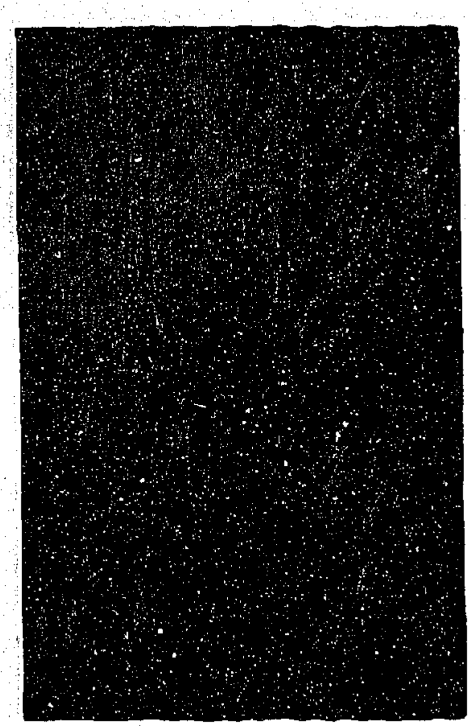
SPILLWAY

HYDRAULIC MODEL STUDIES

DISCHARGE - FINAL CURVED CHANNEL

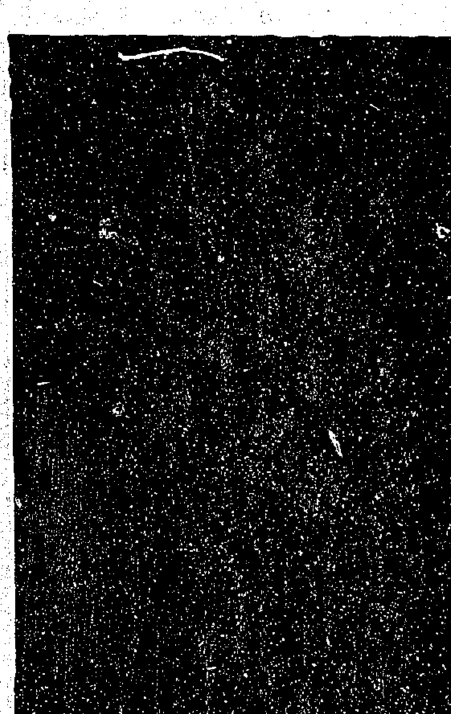
DRAWN H.B.D. JR. SUBMITTED
TRACED J.L.C.-H.S. RECOMMENDED
CHECKED APPROVED
DENVER, COLORADO - AUG. 4, 1939 25-D-2642

FIGURE 7

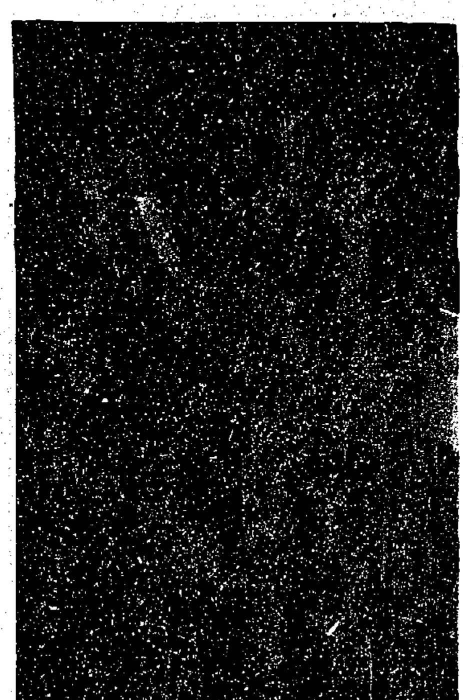


LOOKING UPSTREAM

LOOKING DOWNSTREAM

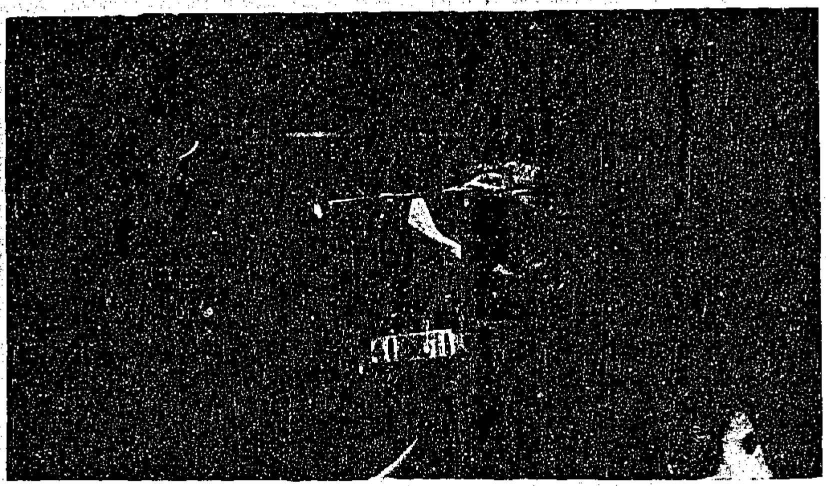


FROM RIGHT SIDE

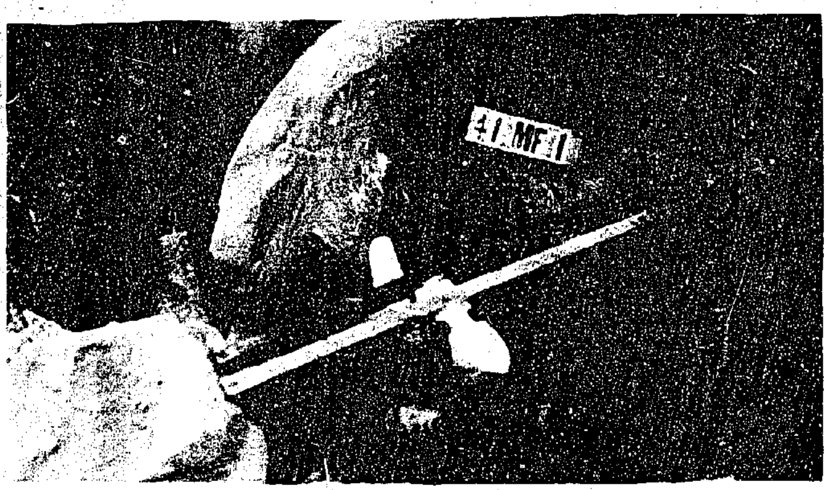


FROM LEFT SIDE

LOOKING UPSTREAM



LOOKING UPSTREAM



LOOKING DOWNSTREAM

TAPERED SPILLWAY
FINAL DESIGN

DISCHARGE 150,000 SEC.-FT.

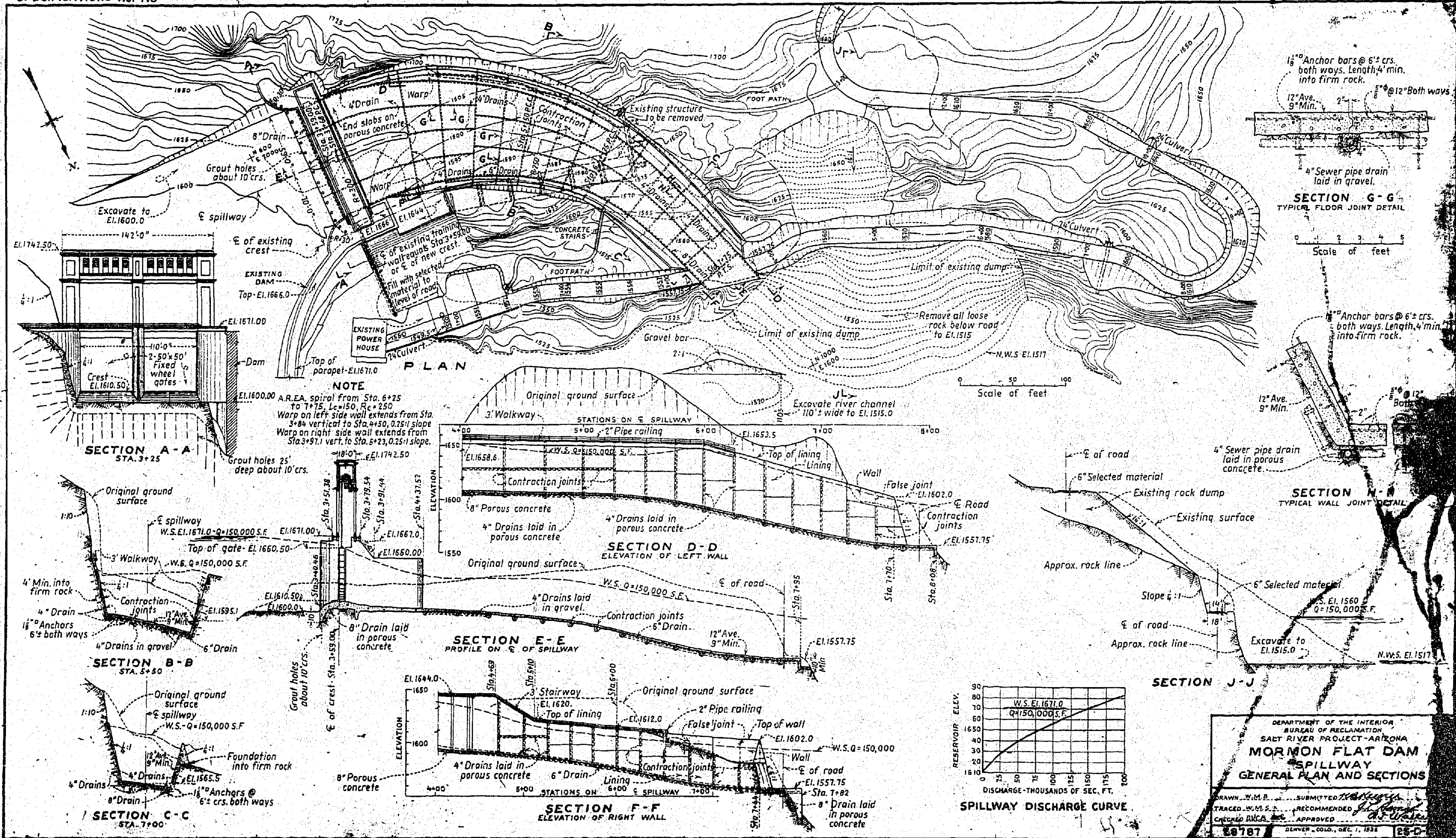
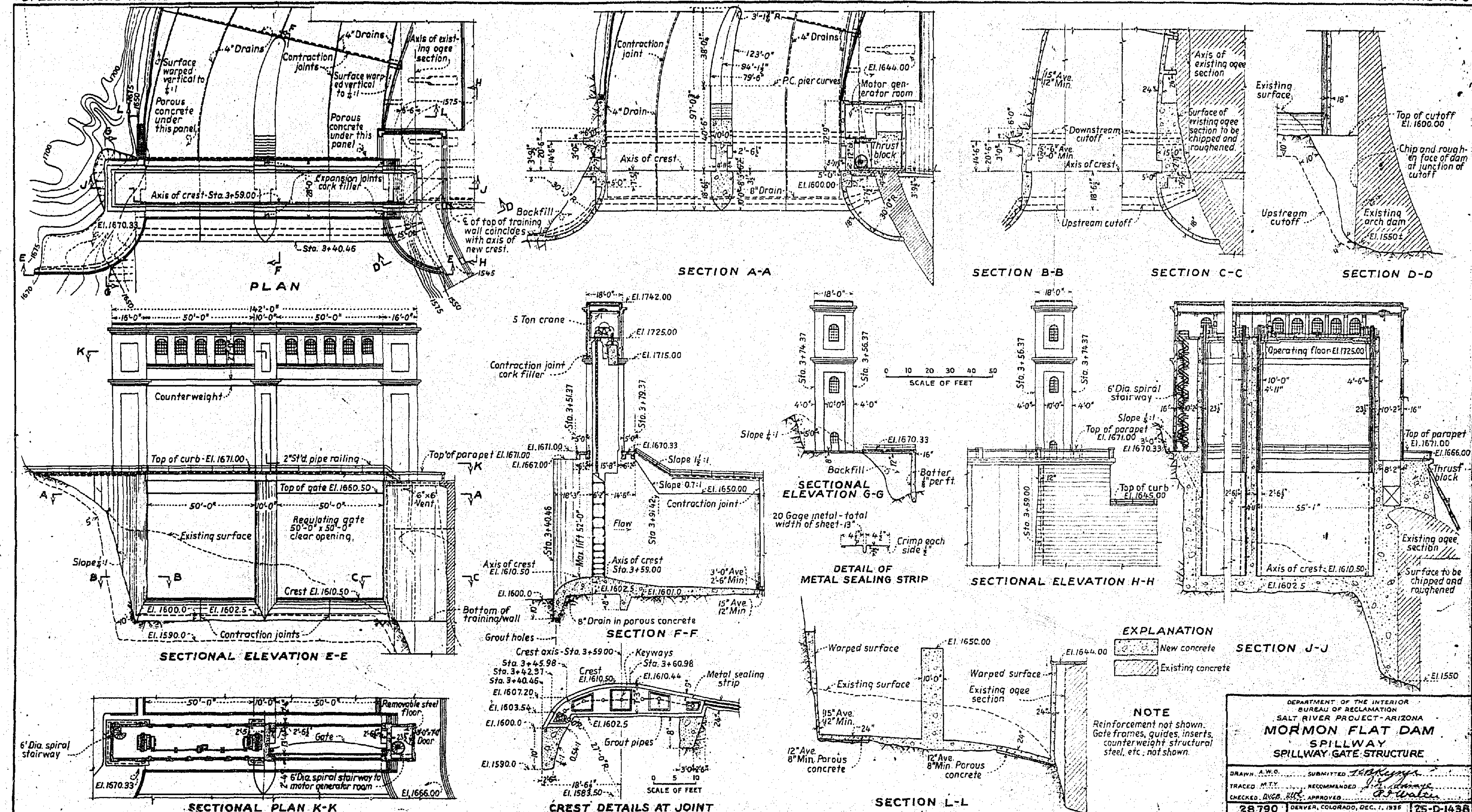

PLAN
Scale of feet
Excavate to El. 1600.0
℄ spillway
℄ of existing crest
EXISTING DAM
Top-El. 1666.0
Grout holes about 10' crs.
8" Drain
4" Drain
End slabs on porous concrete
Warp
Contraction joints
Existing structure to be removed
FOOT PATH
24" Culvert
CONCRETE STAIRS
FOOTPATH
EXISTING POWER HOUSE
Top of parapet-El. 1671.0
Limit of existing dump
Remove all loose rock below road to El. 1515
Gravel bar
N.W.S. El. 1517
Excavate river channel 110'± wide to El. 1515.0
℄ of existing training wall equals Sta. 3+59.00 or ℄ of new crest.
Fill with selected material to level of road
NOTE
A.R.E.A. spiral from Sta. 6+25 to 7+75, Lc=150, Rc=250
Warp on left side wall extends from Sta. 3+84 vertical to Sta. 4+50, 0.25:1 slope
Warp on right side wall extends from Sta. 3+97.1 vert. to Sta. 5+23, 0.25:1 slope.
SECTION A-A
STA. 3+25
El. 1742.50
142'-0"
El. 1671.00
110'-0"
2-50'x50' Fixed wheel gates
Crest El. 1610.50
Dam
El. 1600.00
Grout holes 25' deep about 10' crs.
SECTION B-B
STA. 5+50
Original ground surface
℄ spillway
W.S. El. 1671.0-Q=150,000 S.F.
Top of gate-El. 1660.50
3' Walkway
W.S. Q=150,000 S.F.
4' Min. into firm rock
Contraction joints
4" Drain
1⅛"ø Anchors 6'± both ways
4" Drains in gravel
6" Drain
SECTION C-C
STA. 7+00
4" Drains
8" Drain
1⅛"ø Anchors @ 6'± crs. both ways
Foundation into firm rock
SECTION D-D
ELEVATION OF LEFT WALL
STATIONS ON ℄ SPILLWAY
2" Pipe railing
Top of lining
Lining
Wall
False joint
℄ Road
Contraction joints
8" Porous concrete
4" Drains laid in porous concrete
SECTION E-E
PROFILE ON ℄ OF SPILLWAY
Original ground surface
W.S. Q=150,000 S.F.
℄ of road
4" Drains laid in gravel
Contraction joints
6" Drain
8" Drain laid in porous concrete
Grout holes about 10' crs.
℄ of crest-Sta. 3+59.00
SECTION F-F
ELEVATION OF RIGHT WALL
3' Stairway
Top of lining
2" Pipe railing
False joint
Top of wall
W.S. Q=150,000
Wall
℄ of road
8" Drain laid in porous concrete
8" Porous concrete
4" Drains laid in porous concrete
6" Drain
Lining
Contraction joints
SECTION G-G
TYPICAL FLOOR JOINT DETAIL
1⅛"ø Anchor bars @ 6'± crs. both ways. Length 4' min. into firm rock.
⅝"ø @ 12" Both ways
12" Ave. 9" Min.
4" Sewer pipe drain laid in gravel.
SECTION H-H
TYPICAL WALL JOINT DETAIL
4" Sewer pipe drain laid in porous concrete.
SECTION J-J
℄ of road
6" Selected material
Existing rock dump
Existing surface
Approx. rock line
Slope ¼:1
W.S. El. 1560 Q=150,000 S.F.
Excavate to El. 1515.0
N.W.S. El. 1517
SPILLWAY DISCHARGE CURVE
W.S. El. 1671.0 Q=150,000 S.F.
RESERVOIR ELEV.
DISCHARGE-THOUSANDS OF SEC. FT.
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
SALT RIVER PROJECT-ARIZONA
MORMON FLAT DAM
SPILLWAY
GENERAL PLAN AND SECTIONS
DRAWN W.M.B.
TRACED W.M.S.
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
DENVER, COLO., DEC. 1, 1936
28787

Fig 9


PLAN
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
SECTIONAL ELEVATION E-E
SECTION F-F
SECTIONAL ELEVATION G-G
DETAIL OF METAL SEALING STRIP
SECTIONAL ELEVATION H-H
SECTION J-J
SECTIONAL PLAN K-K
CREST DETAILS AT JOINT
SECTION L-L
Axis of crest-Sta. 3+59.00
Expansion joints cork filler
Contraction joints
Surface warped vertical to 1/4:1
Porous concrete under this panel
4" Drains
Axis of existing ogee section
Motor generator room
P.C. pier curves
Thrust block
Backfill
℄ of top of training wall coincides with axis of new crest.
Sta. 3+40.46
Downstream cutoff
Upstream cutoff
Surface of existing ogee section to be chipped and roughened
Existing surface
Top of cutoff El. 1600.00
Chip and roughen face of dam at junction of cutoff
Existing arch dam
Counterweight
Top of curb-El. 1671.00
2" St'd. pipe railing
Top of parapet El. 1671.00
Top of gate El. 1660.50
Regulating gate 50'-0" x 50'-0" clear opening
Crest El. 1610.50
Bottom of training wall
Contraction joints
5 Ton crane
Contraction joint cork filler
Flow
Axis of crest Sta. 3+59.00
8" Drain in porous concrete
Grout holes
20 Gage metal - total width of sheet - 13"
Crimp each side 1/8"
SCALE OF FEET
6' Dia. spiral stairway
Operating floor-El. 1725.00
Existing ogee section
Surface to be chipped and roughened
Removable steel floor
Gate
6' Dia. spiral stairway to motor generator room
Crest axis-Sta. 3+59.00
Keyways
Metal sealing strip
Grout pipes
Warped surface
Porous concrete
EXPLANATION
New concrete
Existing concrete
NOTE
Reinforcement not shown. Gate frames, guides, inserts, counterweight structural steel, etc., not shown.
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
SALT RIVER PROJECT-ARIZONA
MORMON FLAT DAM
SPILLWAY
SPILLWAY GATE STRUCTURE
DRAWN A.W.G.
TRACED M.T.Y.
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
28790
DENVER, COLORADO, DEC. 1, 1935
25-D-1438

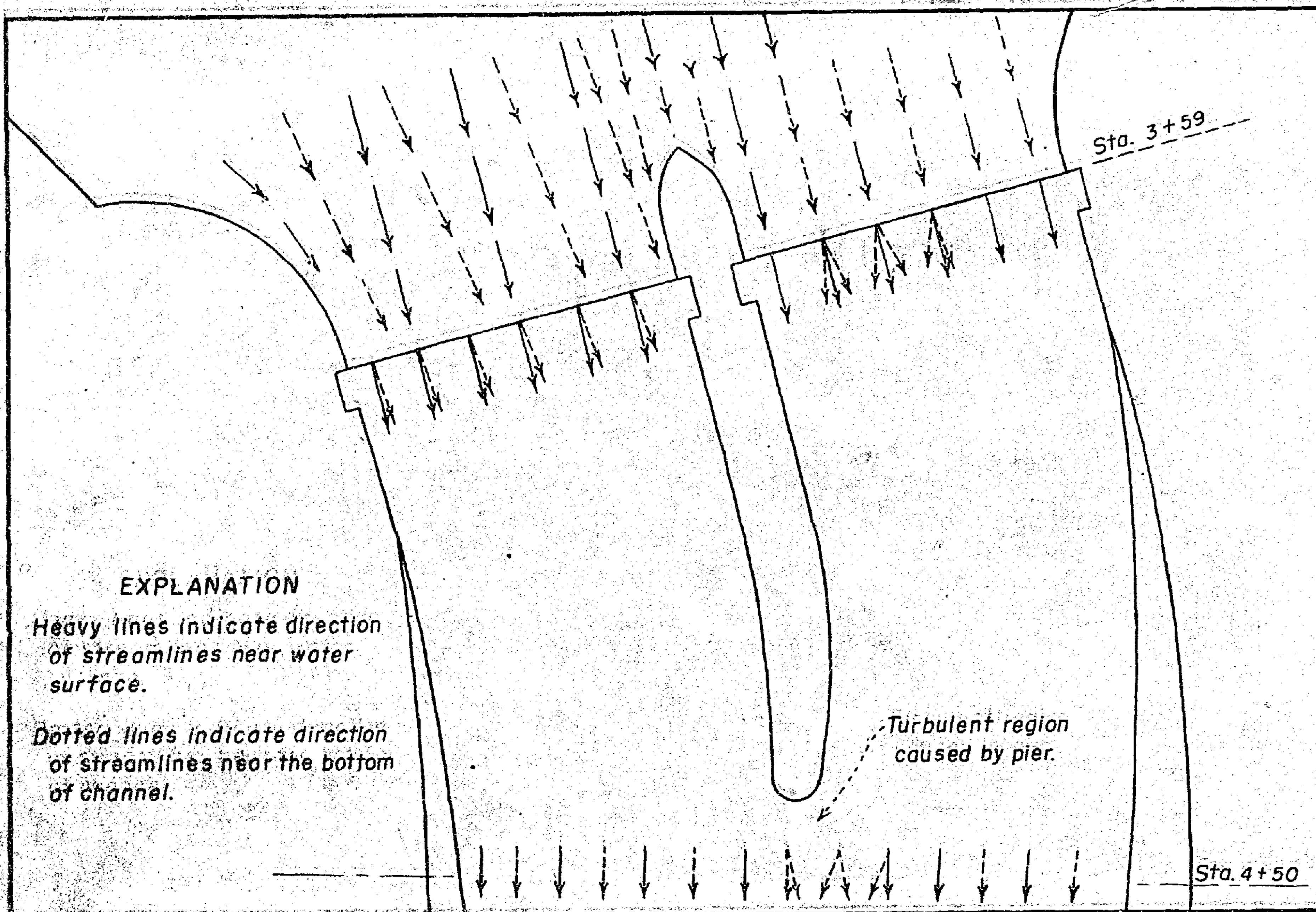

Sta. 3+59
Sta. 4+50
Turbulent region caused by pier.
EXPLANATION
Heavy lines indicate direction of streamlines near water surface.
Dotted lines indicate direction of streamlines near the bottom of channel.

FIGURE 10

The streamlines upstream from the left gate were normal to the crest. At the crest, the streamlines near the top and bottom were generally normal to the crest, except in a small area near the center of the gate where the velocity oscillated slightly in a direction from right to left.

Upstream from the right gate the flow on the bottom impinged on the pier at quite an appreciable angle and continued in the same general direction through the right gate. The flow at the top of the approach appeared to be almost normal to the crest except at the extreme right near the curved wall.

At station 4+50 the streamlines near the surface and near the bottom were nearly parallel to the center line except in the turbulent area immediately downstream from the pier. The streamlines throughout the remainder of the channel appeared to be ideally patterned.

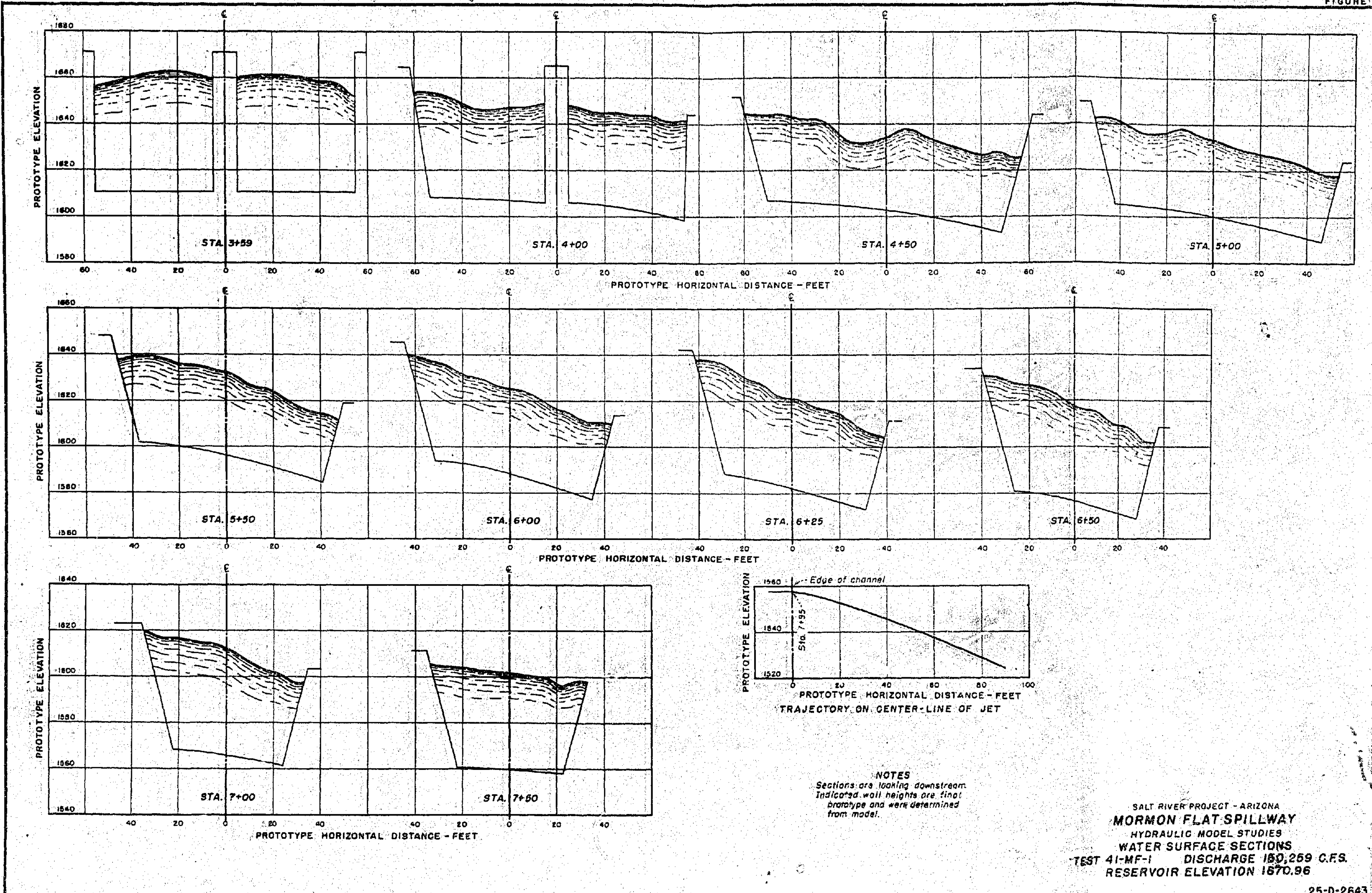
11. Water surface measurements. Water surface sections of the discharge of 150,259 cubic feet per second in the final design are shown in figure 11.

ACKNOWLEDGMENTS

The studies discussed in this memorandum were made by the Hydraulic Research Department of the Bureau of Reclamation, United States Department of the Interior, in its laboratory then located in the Old Customhouse, Denver, Colorado. These tests were initiated when E. W. Lane, Research Engineer, was in charge of the Hydraulic Research Department, and were completed under the charge of J. E. Warnock, Engineer. The construction and testing were under the general supervision of J. B. Drisko, Assistant Engineer, and D. P. Barnes, Engineer. The testing was begun by F. L. Panuzio, Assistant Engineer, and completed by H. G. Dewey, Jr., Assistant Engineer. The report was prepared by H. M. Martin, Associate Engineer, under the general supervision of G. J. Hornsby, Engineer.

All engineering work of the Bureau of Reclamation is under J. L. Savage, Chief Designing Engineer, and R. F. Walter, Chief Engineer. All activities of the Bureau are under the direction of J. C. Page, Commissioner.

FIGURE 11


PROTOTYPE ELEVATION
STA. 3+59
STA. 4+00
STA. 4+50
STA. 5+00
PROTOTYPE HORIZONTAL DISTANCE - FEET
STA. 5+50
STA. 6+00
STA. 6+25
STA. 6+50
STA. 7+00
STA. 7+50
Edge of channel
Sta. 7+95
TRAJECTORY ON CENTER-LINE OF JET
NOTES
Sections are looking downstream.
Indicated wall heights are final prototype and were determined from model.
SALT RIVER PROJECT - ARIZONA
MORMON FLAT SPILLWAY
HYDRAULIC MODEL STUDIES
WATER SURFACE SECTIONS
TEST 41-MF-1 DISCHARGE 150,259 C.F.S.
RESERVOIR ELEVATION 1670.96
25-D-2643