UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

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Technical Memorandum No. 478

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HYDRAULIC LABORATORY REPORT HYD. 3.9

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HYDRAULIC MODEL STUDIES FOR THE DESIGN OF THE ISLAND PARK DAM SPILLWAY

By

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and
J. B. DRISKO, ASSISTANT ENGINEER

\- - -

Denver, Colorado
August 10, 1935

UNITED STATES

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

MEMORANDUM TO CHIEF DESIGNING ENGINEER

SUBJECT: HYDRAULIC MODEL STUDIES FOR THE DESIGN

OF

THE ISLAND PARK DAM SPILLWAY

------

by J. N. BRADLEY, ASSISTANT ENGINEER

and

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Under direction of

E. W. LANE, RESEARCH ENGINEER

TECHNICAL MEMORANDUM NO. 478

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Summary

As originally designed the Island Park Dam Spillway had sufficient capacity for the maximum designed discharge but a very irregular water surface together with a considerable amount of splashing and noise existed in the converging chute connecting the overflow channel with the 13-foot constant diameter tunnel.

This undesirable action in the chute was corrected by adding dentated steps on the downstream face of the overflow crest to break up the roll in the channel, a more gradual transition between the channel and converging chute, and by changing the cross-section of the chute to a horseshoe shape down to the irrigation outlets. The transition from the horseshoe to circular section was incorporated in the downstream end of the chute and this extended some distance into the horizontal tunnel.

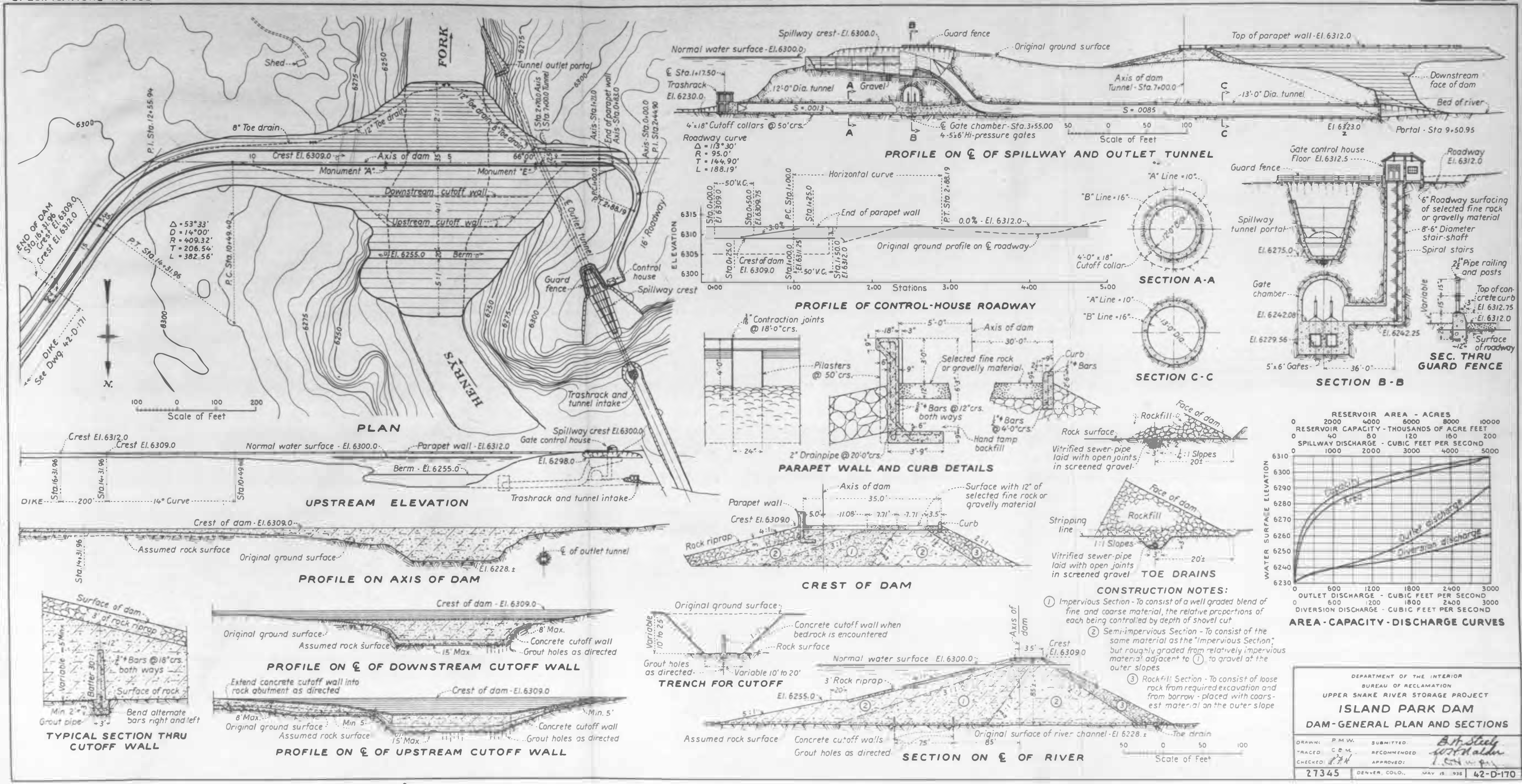
In the revised design, the water surface in the chute was quite regular and the noise and splashing was reduced to a minimum.

The Project

Island Park Dam will be located on Henry's Fork about 25 miles north of Ashton, Idaho. The dam will be of the earth fill type having a height of approximately 82 feet above the river bed and will create a reservoir having a capacity of 110,000 acre feet. This storage will provide a supplementary supply of water for the irrigated lands located in the Upper Snake River Valley between Idaho Falls and Ashton. A general plan of the dam is shown on figure 1.

The spillway in connection with the dam (see figures 1 and 2) will consist of a free overflow crest approximately 257 feet long, somewhat resembling a side channel spillway except that, in this case, the water will spill into the channel from both sides and also over the upstream end. The greater part of the channel floor is on a slope of 0.1097 which automatically increases its cross-sectional area in a downstream direction. Beginning at the downstream end of the channel, a converging horseshoe shaped chute will drop the water 57 feet into a 13-foot diameter circular tunnel 495 feet long having a slope of 0.0085. A transition at the upstream end of this tunnel will transform the horseshoe section into the circular section. The downstream end of the circular tunnel will lead to an open trapezoidal channel which in turn will discharge directly into the river below the dam. As the river bed and canyon walls consist of a stable rock formation, it will not be necessary to construct a stilling pool or structure to

FIG. 1


PLAN
UPSTREAM ELEVATION
PROFILE ON AXIS OF DAM
TYPICAL SECTION THRU CUTOFF WALL
PROFILE ON ℄ OF DOWNSTREAM CUTOFF WALL
PROFILE ON ℄ OF UPSTREAM CUTOFF WALL
PROFILE ON ℄ OF SPILLWAY AND OUTLET TUNNEL
PROFILE OF CONTROL-HOUSE ROADWAY
SECTION A-A
SECTION C-C
SECTION B-B
SEC. THRU GUARD FENCE
PARAPET WALL AND CURB DETAILS
CREST OF DAM
TOE DRAINS
TRENCH FOR CUTOFF
SECTION ON ℄ OF RIVER
AREA-CAPACITY-DISCHARGE CURVES
HENRYS FORK
Scale of Feet
CONSTRUCTION NOTES:
1 Impervious Section - To consist of a well graded blend of fine and coarse material, the relative proportions of each being controlled by depth of shovel cut
2 Semi-impervious Section - To consist of the same material as the "Impervious Section" but roughly graded from relatively impervious material adjacent to 1 to gravel at the outer slopes
3 Rockfill Section - To consist of loose rock from required excavation and from borrow - placed with coarsest material on the outer slope
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
UPPER SNAKE RIVER STORAGE PROJECT
ISLAND PARK DAM
DAM-GENERAL PLAN AND SECTIONS
DRAWN: P.M.W.
TRACED: C.E.M.
SUBMITTED:
RECOMMENDED:
APPROVED:
27345
DENVER, COLO., MAY 15, 1936
42-D-170

serve a similar purpose at the end of the tunnel. The spillway will have a maximum capacity of 5,000 c.f.s. for a head of approximately 3.5 feet on the crest.

In order to divert water from the reservoir to the river below the dam during the greater part of the year when the spillway will not be in operation, the original diversion tunnel will be utilized as shown in figures 1 and 2. It will intersect the spillway tunnel in the form of two rectangular conduits. These will have a maximum capacity of 2,500 c.f.s. which is equal to one-half of the spillway capacity.

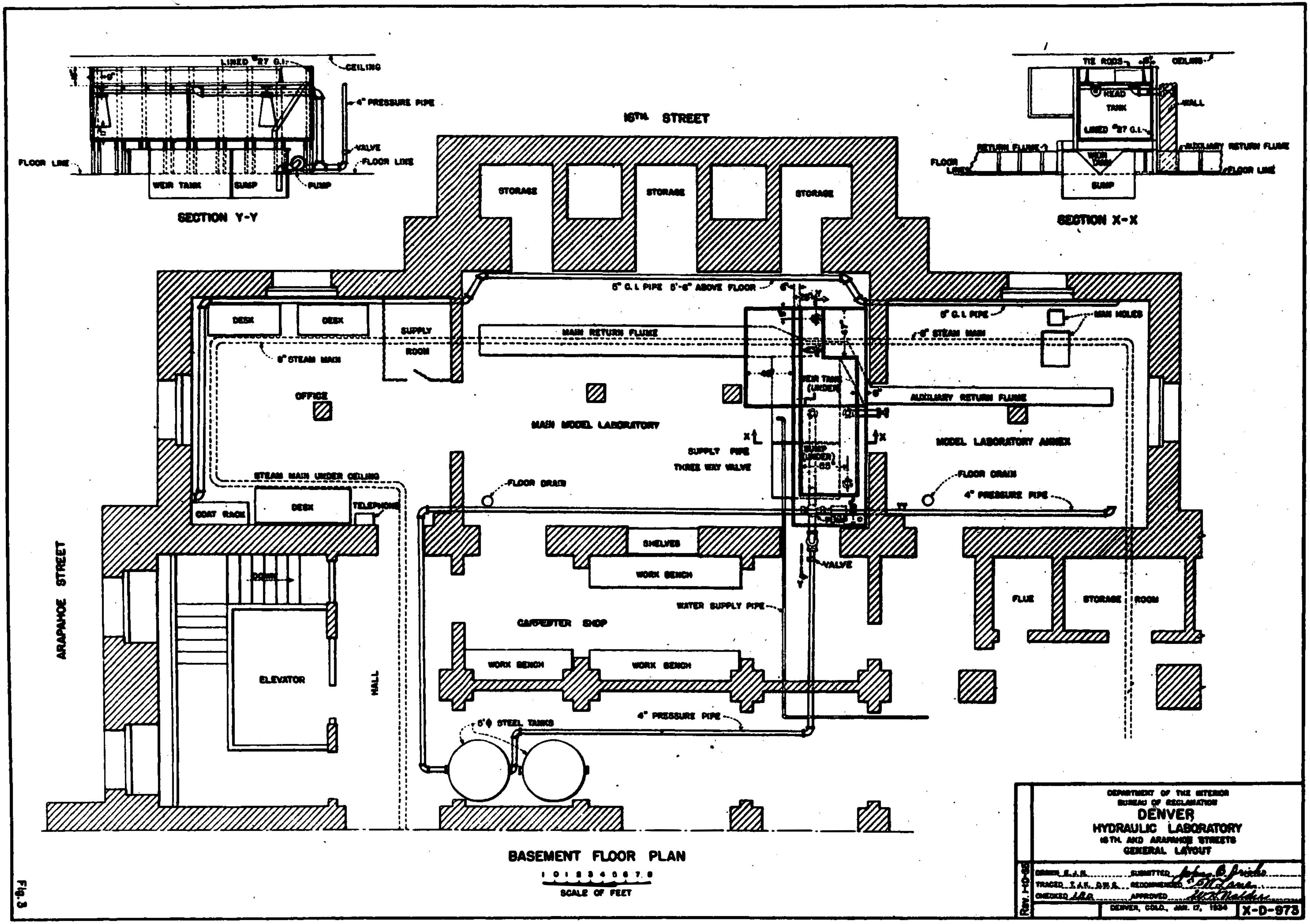
The Laboratory

A model of the Island Park Spillway was constructed and tested in the laboratory located in the basement of the Old Custom House in Denver. A plan of the laboratory is shown in figure 3.

Water for supplying the models is measured over a 90° V notch weir located in the end of a weir tank 6 by 12 by 4 feet deep, which is partially below the laboratory floor. From here a 6-inch centrifugal pump having a capacity of 3 c.f.s. raises the water up into a constant level tank located as high as the ceiling of the laboratory will permit. A stationary skimming weir makes it possible to maintain a constant head of water on this tank. The water flows from the constant level tank through calibrated gate valves, and large expanding cones into two head reservoirs, located directly below the constant level tank. Water is then supplied to the models directly from these head reservoirs. With this arrangement, two models can be operated simultaneously. The overflow section of the Island Park model was constructed in one of these head reservoirs. After passing through the model, the water collected in a sheet metal flume and flowed back to the weir tank. In this way, the water was continuously remeasured and recirculated. The head on the measuring weir was observed by two hook gages.

The Original Model

A model of the Island Park spillway was made to a scale of 1:30. A drawing of the model is shown in figure 4. The overflow section was constructed by bending a piece of sheet metal around heavy metal ribs so that the resulting shape was true to scale and then soldering the sheet to the ribs. The two warped surfaces at the upstream end of the channel were moulded in place with plaster of paris. The metal ribs were mounted on small galvanized



SECTION Y-Y
CEILING
4" PRESSURE PIPE
VALVE
FLOOR LINE
WEIR TANK
SUMP
PUMP
16TH. STREET
SECTION X-X
TIE RODS
CEILING
HEAD TANK
WALL
AUXILIARY RETURN FLUME
RETURN FLUME
FLOOR LINE
STORAGE
STORAGE
STORAGE
DESK
DESK
SUPPLY ROOM
MAIN RETURN FLUME
8" STEAM MAIN
8" G.I. PIPE
MAN HOLES
OFFICE
MAIN MODEL LABORATORY
WEIR TANK (UNDER)
AUXILIARY RETURN FLUME
MODEL LABORATORY ANNEX
SUPPLY PIPE
THREE WAY VALVE
SUMP (UNDER)
STEAM MAIN UNDER CEILING
FLOOR DRAIN
FLOOR DRAIN
4" PRESSURE PIPE
COAT RACK
DESK
TELEPHONE
SHELVES
WORK BENCH
VALVE
ARAPAHOE STREET
DOWN
WATER SUPPLY PIPE
FLUE
STORAGE ROOM
CARPENTER SHOP
ELEVATOR
HALL
WORK BENCH
WORK BENCH
4" PRESSURE PIPE
5' STEEL TANKS
BASEMENT FLOOR PLAN
SCALE OF FEET
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
DENVER
HYDRAULIC LABORATORY
16TH. AND ARAPAHOE STREETS
GENERAL LAYOUT
SUBMITTED
RECOMMENDED
APPROVED
DRAWN
TRACED
CHECKED
DENVER, COLO., JAN. 17, 1934
X-D-973

Fig. 3

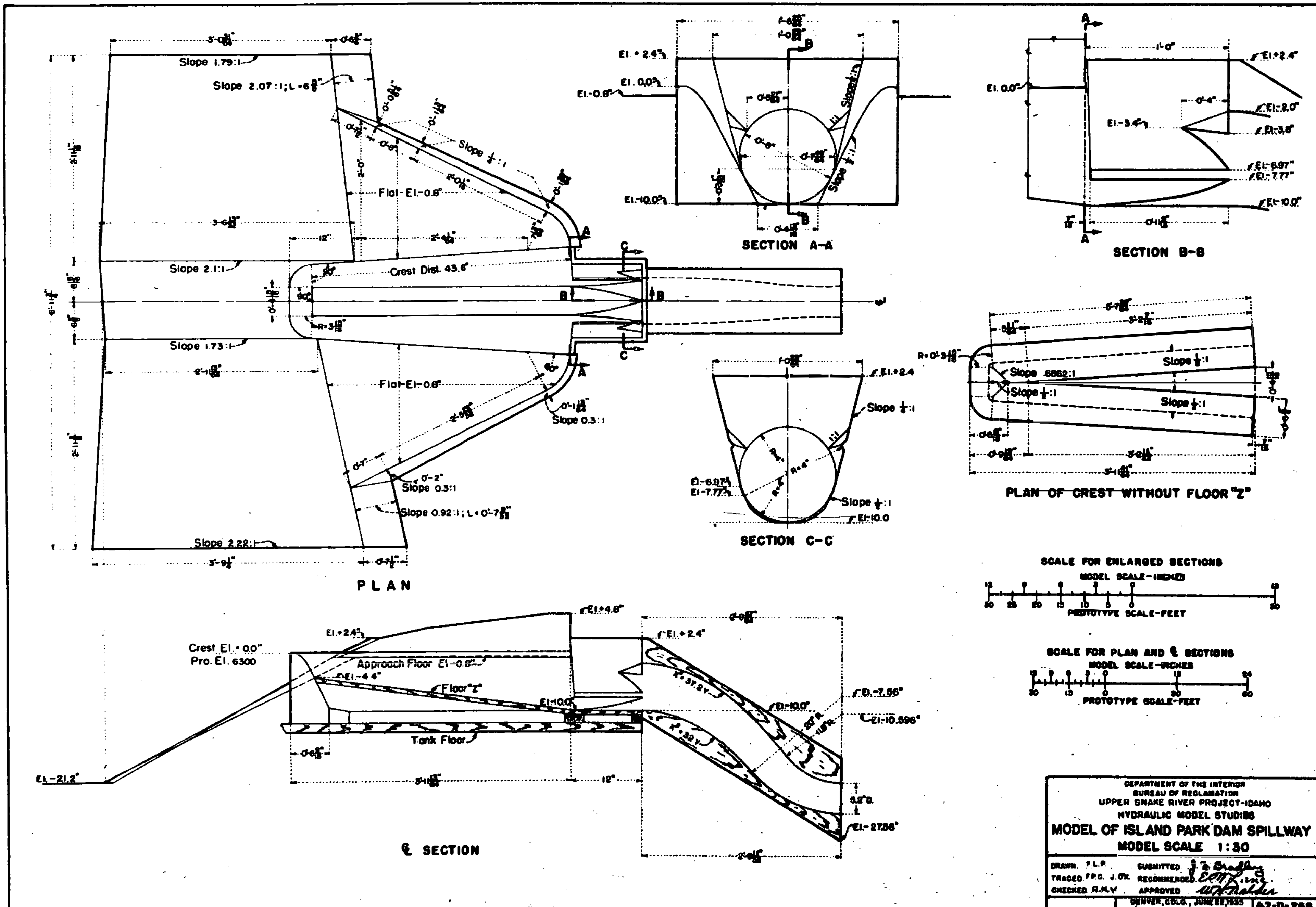

PLAN
Slope 1.79:1
Slope 2.07:1; L=6⅝"
Slope ½:1
Flat El-0.8"
Slope 2.1:1
Crest Dist. 43.6"
Slope 1.73:1
Slope 0.3:1
Slope 0.92:1
Slope 2.22:1
SECTION A-A
El.+2.4"
El. 0.0"
El.-0.8"
El-10.0"
SECTION B-B
El.+2.4"
El.-2.0"
El.-3.6"
El.-3.4"
El.-6.97"
El.-7.77"
El.-10.0"
SECTION C-C
El.+2.4
Slope ½:1
El.-6.97"
El.-7.77"
El-10.0
PLAN OF CREST WITHOUT FLOOR "Z"
Slope .6862:1
Slope ½:1
℄ SECTION
Crest El.=0.0"
Pro. El. 6300
El.+2.4"
El.+4.8"
Approach Floor El-0.8"
El-4.4"
Floor "Z"
El-10.0
Tank Floor
El.-21.2"
El.-7.66"
El.-10.0"
El.-10.896"
El.-27.36"
SCALE FOR ENLARGED SECTIONS
MODEL SCALE-INCHES
PROTOTYPE SCALE-FEET
SCALE FOR PLAN AND ℄ SECTIONS
MODEL SCALE-INCHES
PROTOTYPE SCALE-FEET
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
UPPER SNAKE RIVER PROJECT-IDAHO
HYDRAULIC MODEL STUDIES
MODEL OF ISLAND PARK DAM SPILLWAY
MODEL SCALE 1:30
DRAWN F.L.P.
TRACED F.P.G. J.O.K.
CHECKED R.H.V.
SUBMITTED
RECOMMENDED
APPROVED
DENVER, COLO., JUNE 22, 1935
42-D-268

FIGURE 4

iron angles and the whole made a very rigid and accurate model. The metal channel floor was constructed lower than specified so that an auxiliary wooden floor could be placed in various positions above it. The approach to the overflow crest which was made to scale was constructed of wood and covered with light sheet metal.

The converging chute which led from the downstream end of the overflow channel to the 13-foot circular tunnel was carved in a laminated block of wood. Pieces of 1- by 12-inch white pine boards were marked and sawed so that the greater part of the material to be removed was removed before the boards were assembled into a block. The pieces were then glued and screwed together so that the block was in two halves. Photograph A (plate II) shows the chute at this stage of construction. The remainder of the material to be removed was then dug out with the aid of gouges and templates to the final shape. The two halves were then bolted together. A portion of the top of the chute was made removable for observation purposes. The irrigation outlets were built into the lower end of the chute block. Photograph B (plate II) shows one half of the chute block completed with one of the irrigation outlets installed.

The 13-foot circular tunnel was rolled out of no. 24 gage sheet metal and the open cut at the downstream end was formed with the same material. A watertight box with an adjustable weir was constructed about the downstream portal as a means of regulating the tailwater depth.

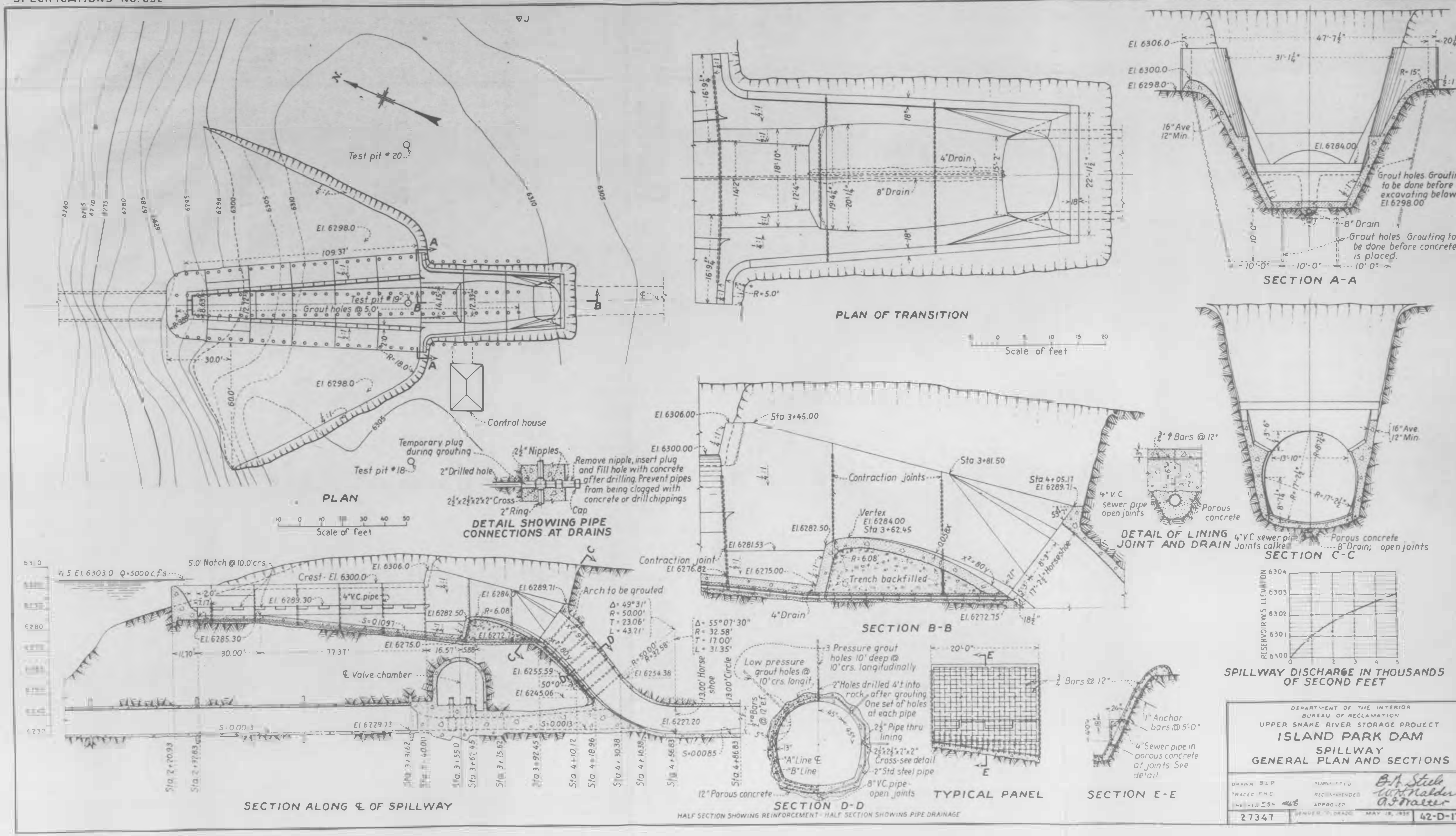
Water surface measurements on the model were made with a point gage. The head on the crest of the spillway was observed from a hook gage which operated in a stilling well connected to the head reservoir.

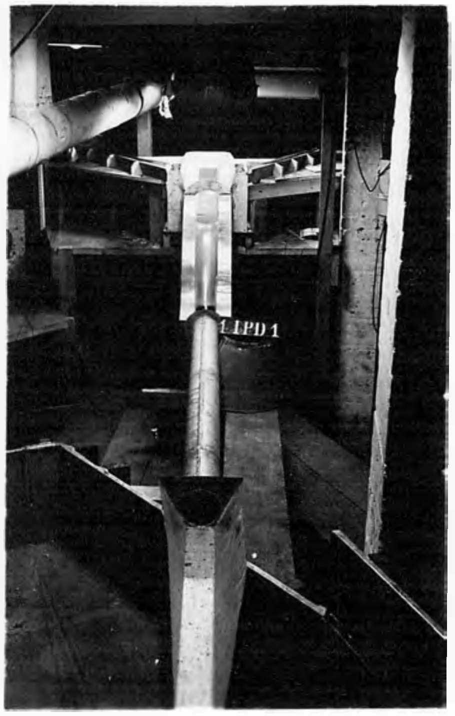
The Original Design

As originally designed, flow over the crest and in the overflow channel was quite satisfactory except for a certain amount of splashing at the upper end of the channel which was caused by the water flowing over the upstream end of the crest. Photograph C (plate I) shows the original channel in operation for the maximum discharge.

Flow in the converging chute, on the other hand, was rough, irregular and noisy. Water flowing in the trapezoidal section connecting the overflow channel with the chute was unusually rough and considerable folding over of the water surface existed due to

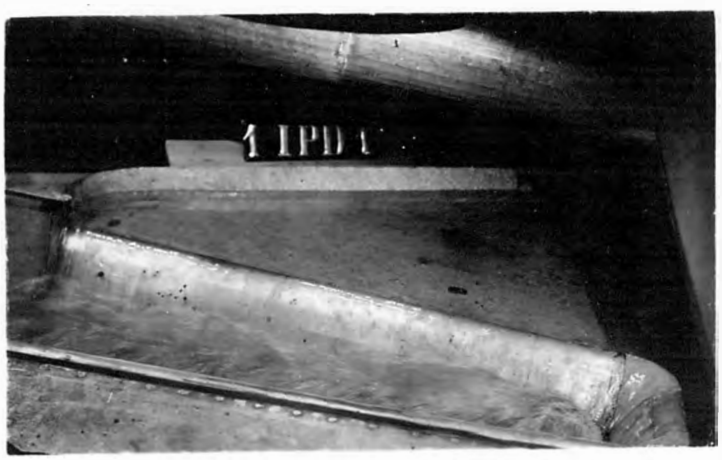
FIG. 2


PLAN
Test pit # 20
Test pit # 19
Test pit # 18
Grout holes @ 5.0'
El. 6298.0
109.37'
30.0'
60.0'
R=18.0'
Control house
Temporary plug during grouting
2½" Nipples
2" Drilled hole
Remove nipple, insert plug and fill hole with concrete after drilling. Prevent pipes from being clogged with concrete or drill chippings
2½"x2½"x2"x2" Cross
2" Ring
Cap
DETAIL SHOWING PIPE CONNECTIONS AT DRAINS
Scale of feet
PLAN OF TRANSITION
4" Drain
8" Drain
R=5.0'
SECTION A-A
El. 6306.0
El. 6300.0
El. 6298.0
El. 6284.00
16" Ave. 12" Min.
Grout holes Grouting to be done before excavating below El. 6298.00
8" Drain
Grout holes Grouting to be done before concrete is placed.
SECTION B-B
El. 6306.00
El. 6300.00
Sta 3+45.00
Sta 3+81.50
Sta 4+05.11 El. 6289.71
Contraction joints
Vertex El. 6284.00 Sta 3+62.45
El. 6282.50
El. 6281.53
Contraction joint El. 6276.82
El. 6275.00
Trench backfilled
4" Drain
El. 6272.75'
17'-2¼" Horseshoe
DETAIL OF LINING JOINT AND DRAIN
¾" Bars @ 12"
4" V.C. sewer pipe open joints
Porous concrete
SECTION C-C
16" Ave. 12" Min.
4" V.C. sewer pipe Joints calked
Porous concrete
8" Drain; open joints
SPILLWAY DISCHARGE IN THOUSANDS OF SECOND FEET
RESERVOIR W.S. ELEVATION
SECTION ALONG ℄ OF SPILLWAY
W.S. El. 6303.0 Q=5000 c.f.s.
5.0' Notch @ 10.0' crs.
Crest - El. 6300.0
El. 6306.0
El. 6289.30
4" V.C. pipe
S=0.1097
El. 6285.30
El. 6275.0
30.00'
77.37'
16.57'
El. 6282.50
R=6.08
El. 6284.0
El. 6289.71
El. 6272.75
Arch to be grouted
Δ=49°31' R=50.00' T=23.06' L=43.21'
Δ=55°07'30" R=32.58' T=17.00' L=31.35'
℄ Valve chamber
El. 6255.59
El. 6245.06
El. 6254.38
El. 6229.73
El. 6227.20
S=0.0013
S=0.00085
13.00' Horseshoe
13.00' Circle
SECTION D-D
Low pressure grout holes @ 10' crs. longit.
3 Pressure grout holes 10' deep @ 10' crs. longitudinally
2" Holes drilled 4' into rock after grouting. One set of holes at each pipe
2½" Pipe thru lining
2½x2½x2"x2" Cross-see detail
2" Std. steel pipe
8" V.C. pipe - open joints
12" Porous concrete
"A" Line ℄
"B" Line
HALF SECTION SHOWING REINFORCEMENT - HALF SECTION SHOWING PIPE DRAINAGE
TYPICAL PANEL
20'-0"
SECTION E-E
½" Bars @ 12"
1" Anchor bars @ 5'-0"
4" Sewer pipe in porous concrete at joints See detail
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
UPPER SNAKE RIVER STORAGE PROJECT
ISLAND PARK DAM
SPILLWAY
GENERAL PLAN AND SECTIONS
27347
42-D-172



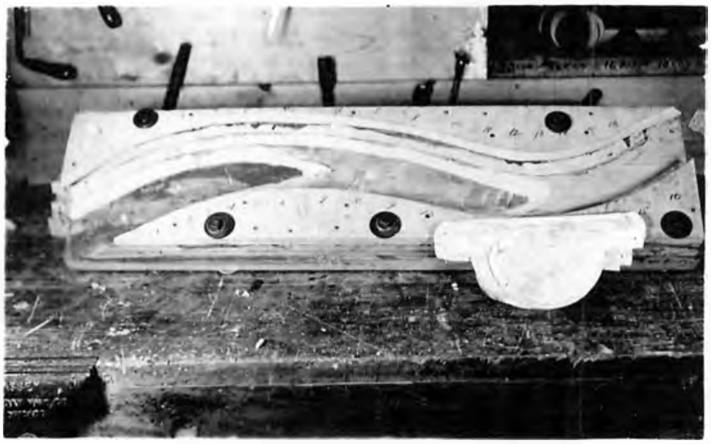
A. ORIGINAL MODEL

B. DISCHARGE 5,000 SECOND-FEET

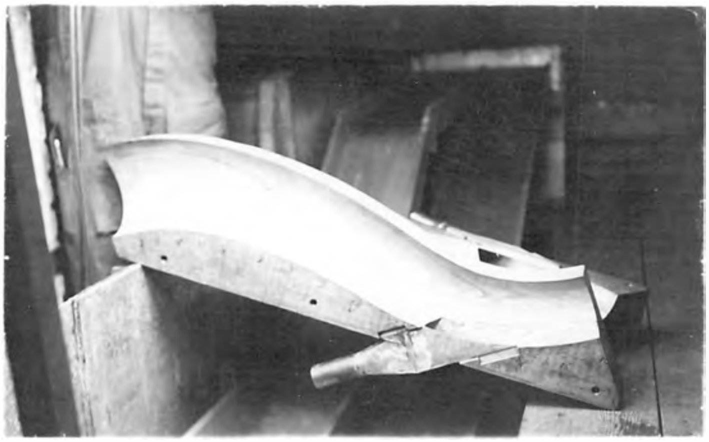


C. OVERFLOW CHANNEL WITH
DISCHARGE 5,000 SECOND-FEET

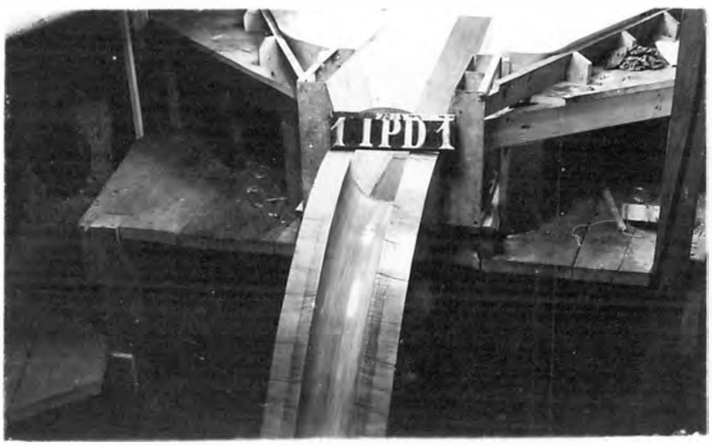
ORIGINAL DESIGN



A. METHOD OF CONSTRUCTION
OF CHUTE



B. ONE-HALF OF CHUTE COMPLETED



C. ORIGINAL CHUTE COMPLETED AND INSTALLED
CHUTE COVER HAS BEEN REMOVED

ORIGINAL DESIGN

the abrupt changes in section in this zone. A decided amount of splashing occurred at the lower end of the chute. This was caused by the irregular water surface in the chute and to some extent by the water striking the large irrigation outlets. Flow in the downstream portion of the 13-foot constant diameter tunnel was quite satisfactory.

A sketch of the original design of the overflow channel is shown in layout 1 (figure 7) and a drawing of the original chute is shown on figure 5. Photograph A (plate I) is a view of the complete model; photograph C (plate II) is a closer view of the overflow section showing a portion of the original circular chute; and photograph B (plate I) shows the original spillway in operation at the maximum discharge of 5,000 c.f.s. These pictures were taken with the chute cover removed. Note the splashing at the lower end of the chute in photograph B (plate I).

Preliminary Revisions on the Original Design

In an endeavor to improve the flow in the chute, rectangular sills of different heights were installed in various positions in the trapezoidal section connecting the channel with the chute. Sketch A (figure 9) illustrates one of these trials. These sills failed to improve the flow in the chute. The lower sills were ineffective, and the higher ones flooded the overflow channel.

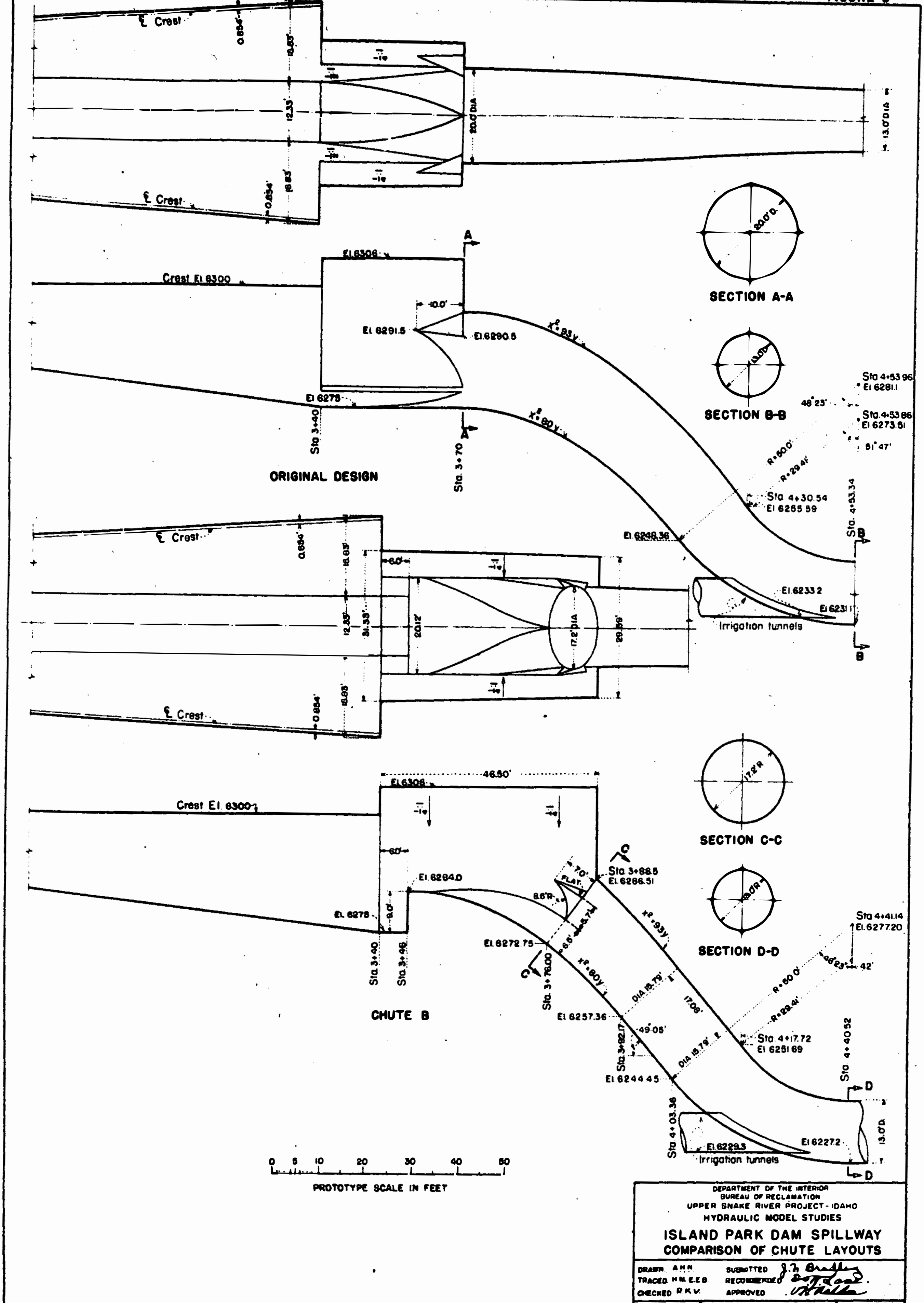
In another attempt to improve the flow, the entire chute was raised 6.25 feet as shown in sketch B (figure 9) without altering its horizontal position. This revision raised the water surface in the overflow channel and produced a noticeable improvement in the flow in the chute.

A portion of the trapezoidal channel section was then filled in with a piece of sheet metal as shown in sketch C (figure 9). The same slight improvement in flow conditions was noticeable with this layout which thus exhibited the possibility of moving the entire chute upstream and eliminating a portion of the trapezoidal channel section.

Chute B

The chute was next revised to agree with the sketch designated as "chute B" on figure 5. Notice that the chute now commences at station 3+46.0 and at this point it is 9 feet above the floor of the channel section. The slope of the invert down to station 3+92.17 is identical with the original. The shape of the chute from station 3+46.0 to station 3+76.0 however, was changed to that shown for chute

FIGURE 5



ORIGINAL DESIGN
CHUTE B
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
Crest El. 6300
El. 6306
El. 6291.5
El. 6290.5
El. 6275
Sta. 3+40
Sta. 3+70
El. 6284.0
Sta. 3+46
Sta. 3+88.5
El. 6286.51
El. 6272.75
Sta. 3+76.00
El. 6257.36
El. 6244.45
Sta. 4+17.72
El. 6251.69
Sta. 4+40.52
Sta. 4+41.14
El. 6277.20
Sta. 4+03.36
El. 6229.3
El. 6227.2
Sta. 4+30.54
El. 6265.59
El. 6248.36
Sta. 4+53.34
El. 6233.2
El. 6231.1
Sta. 4+53.96
El. 6281.1
Sta. 4+53.86
El. 6273.51
Irrigation tunnels
20.0' DIA
13.0' DIA
17.2' DIA
46.50'
R=60.0'
R=29.41'
0 5 10 20 30 40 50
PROTOTYPE SCALE IN FEET
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
UPPER SNAKE RIVER PROJECT - IDAHO
HYDRAULIC MODEL STUDIES
ISLAND PARK DAM SPILLWAY
COMPARISON OF CHUTE LAYOUTS
DRAWN A.H.R.
TRACED H.M. E.E.B.
CHECKED R.K.V.
SUBMITTED
RECOMMENDED
APPROVED
DENVER, COLO., JUNE 22, 1939
42-D-269

B on figure 5. As the 13-foot constant diameter tunnel was lowered approximately 4 feet and the upper portion of the chute was raised 9 feet, it was necessary to add a tangent section from station 3+92.17 to station 4+03.36. The remainder of the chute from the latter point downstream was the same as in the original design. Raising the chute portal 9 feet increased the depth of water in the overflow channel considerably. It was found however, that this was not objectionable as the overflow crest was not submerged and the added depth of water in the channel reduced the boil and splash at the upstream end. Flow in the chute, although an improvement over the original design, was still not acceptable. The water surface at the portal was higher along the sides than in the center with the result that a large fin from each side would fold in toward the center as the water started down the chute. This created a very irregular water surface together with a considerable amount of splashing and noise. Splashing was still prevalent at the lower end of the chute.

Chute C

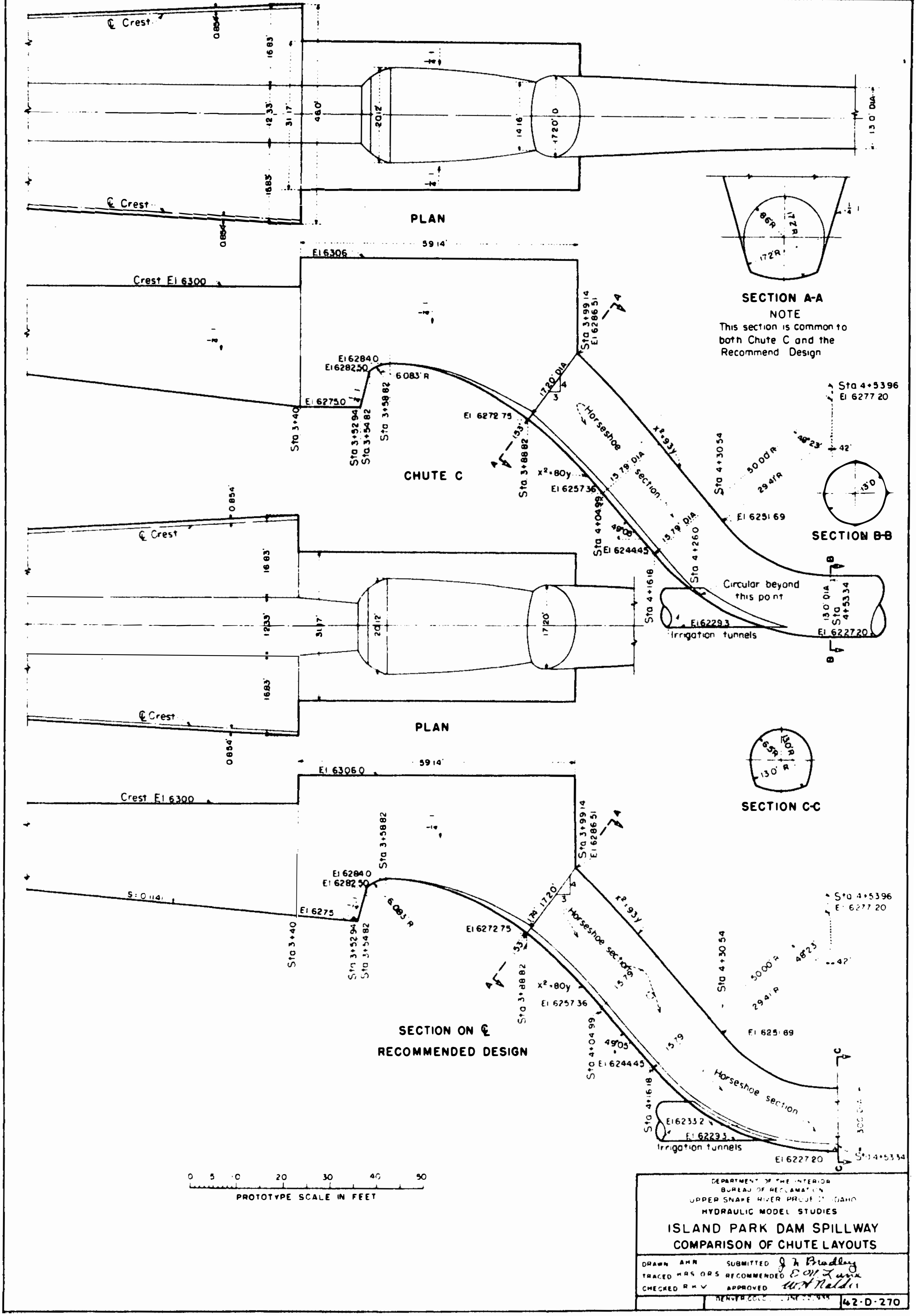
The chute was again revised so as to be horseshoe shape in section down to station 4+26.0 (see chute C, figure 6). The slope of the invert on the center line remained the same as for chute B. A transition from the horseshoe to circular section was made between stations 4+26.0 and 4+53.34. The 13-foot constant diameter tunnel remained circular throughout. Notice in this revision that the chute was moved 12.82 feet downstream and a rounded upstream face with a 1/4 to 1 slope was added. From information obtained from the previous tests, the channel connecting the overflow section with the chute was revised to a smooth converging transition as shown for chute C (figure 6) and photographs A and C (plate III).

Flow in the chute showed considerable improvement after this revision and a large part of the former noise was eliminated. Flow approaching the portal showed improvement over previous tests; however, it still lacked stability in this zone as a continual surge kept the water oscillating back and forth in a direction normal to the direction of flow as it entered the chute. This revision did not eliminate the splashing at the lower end of the chute. Photographs B and D (plate III) show views of the spillway operating at the maximum discharge with "chute C" installed.

Tests on the Overflow Channel

Various layouts were tried in an effort to improve the flow in the overflow channel which in turn was expected to rectify conditions to some extent in the chute. No actual measurements were

FIGURE 6


PLAN
CHUTE C
SECTION A-A
NOTE
This section is common to both Chute C and the Recommend Design
SECTION B-B
PLAN
SECTION C-C
SECTION ON ℄
RECOMMENDED DESIGN
℄ Crest
Crest El 6300
El 6306
59.14'
Sta 3+40
Sta 3+52.94
Sta 3+54.82
Sta 3+58.82
6083' R
Sta 3+99.14
El 6286.51
17.20' DIA
Horseshoe section
$x^2 = 80y$
$x^2 = 93y$
El 6272.75
Sta 3+88.82
El 6257.36
Sta 4+04.99
El 6244.45
Sta 4+16.18
Sta 4+26.0
Sta 4+30.54
El 6251.69
15.79' DIA
50.00' R
29.41' R
Sta 4+53.96
El 6277.20
Sta 4+53.34
El 6227.20
13.0' DIA
Circular beyond this point
El 6229.3
Irrigation tunnels
El 6233.2
Horseshoe section
0 5 10 20 30 40 50
PROTOTYPE SCALE IN FEET
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
UPPER SNAKE RIVER PROJECT IDAHO
HYDRAULIC MODEL STUDIES
ISLAND PARK DAM SPILLWAY
COMPARISON OF CHUTE LAYOUTS
DRAWN AHN
TRACED HRS ORS
CHECKED RHV
SUBMITTED J. N. Bradley
RECOMMENDED
APPROVED
42-D-270

A. REVISED SPILLWAY WITH DIVIDING WALL AND STEPS ON OVERFLOW SECTION

B. DISCHARGE 5,000 SECOND-FEET

C. REVISED SPILLWAY WITH DIVIDING WALL AND STEPS ON OVERFLOW SECTION

D. DISCHARGE 5,000 SECOND-FEET

taken during these tests as visual observations were sufficient in most cases. Some of the most representative of these layouts are shown in figures 7, 8, and 9 and a brief discussion of the results obtained with these follows. The channel as originally designed is shown as layout 1 on figure 7.

The dividing wall.

In an attempt to iron out the surges and stabilize the flow at the chute portal, a dividing wall was installed on the center line of the spillway in the throat of the chute as shown in layout 4 (figure 7). A very noticeable improvement was evidenced in that the oscillatory surging was reduced.

Steps on the overflow crest.

It was anticipated that small steps on the downstream face of the overflow crest would tend to break up the rolling motion in the channel and possibly improve flow conditions farther downstream. Layouts 2 and 3 (figure 7) illustrate two arrangements tried using steps with the dividing wall removed. The sills did improve the flow through the spillway. In layout 2 a portion of the channel floor was raised for the purpose of reducing the boil at the upstream end of the channel but this arrangement made it more pronounced than ever.

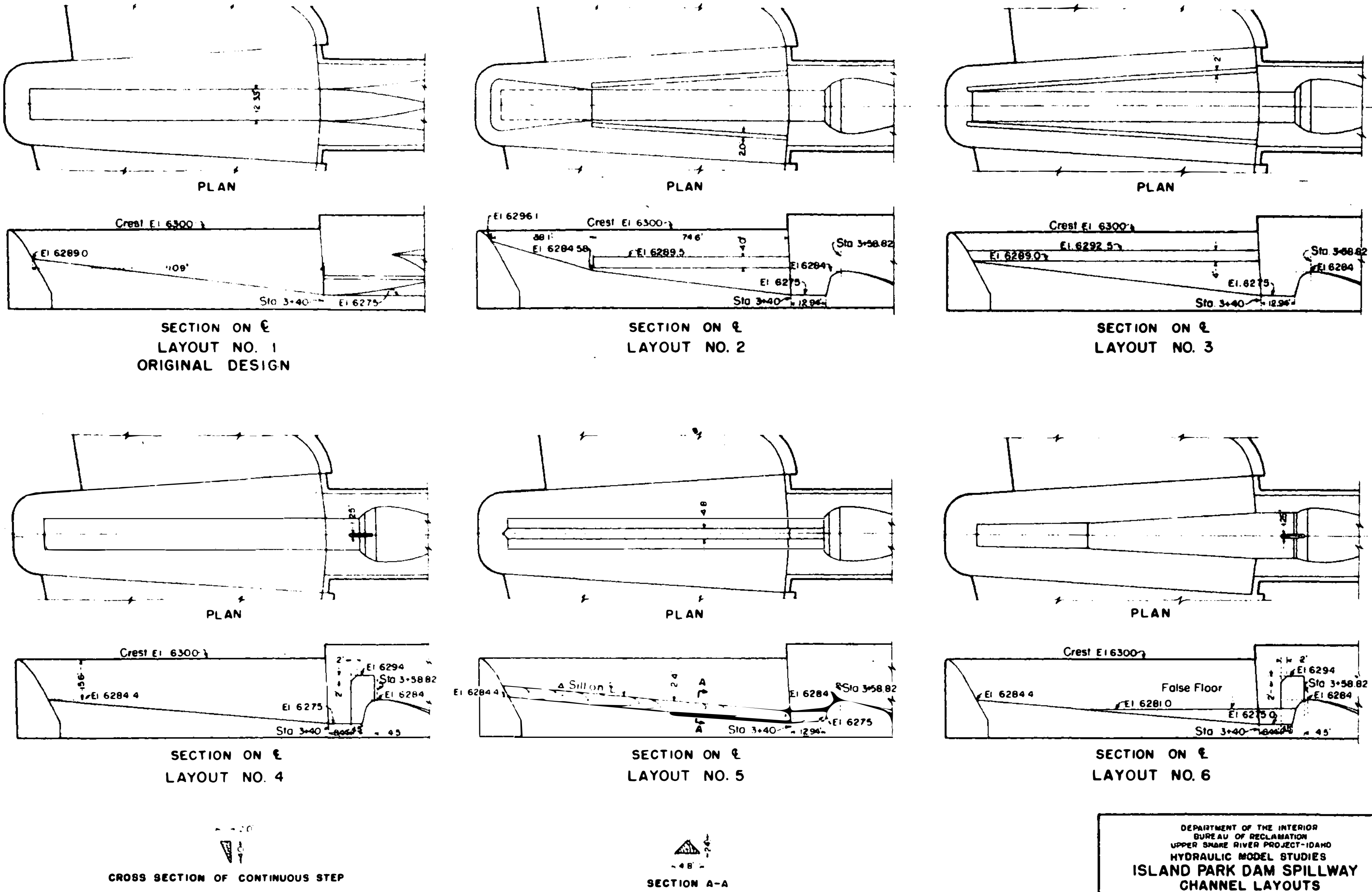
Sill on center line of channel.

In layout 5 (figure 7) the steps were removed from the overflow crest and a large triangular sill was installed on the center of the channel floor. The sill proved to be ineffective and no other variation of this was tried.

Steps and dividing wall.

In layouts 7 to 15, inclusive, on figure 8 and 9, various step arrangements were tried in combination with the dividing wall at the chute portal. Also, the slope and shape of the channel floor was varied throughout these tests. In general, the layouts in which the steps extended the full length of the crest produced the best flow conditions in the channel and down the chute. In other words, layouts 7, 8, and 14 were the best of the group with layout 14 the most satisfactory of the three. It should be noted that in some of the later layouts including number 14, the upstream 30 feet of channel floor was constructed level at elevation 6285.3. It was found that this revision reduced considerably the boil and splash caused by the water flowing over the upstream end of the crest.

Cone fillets were installed at the downstream end of the crest



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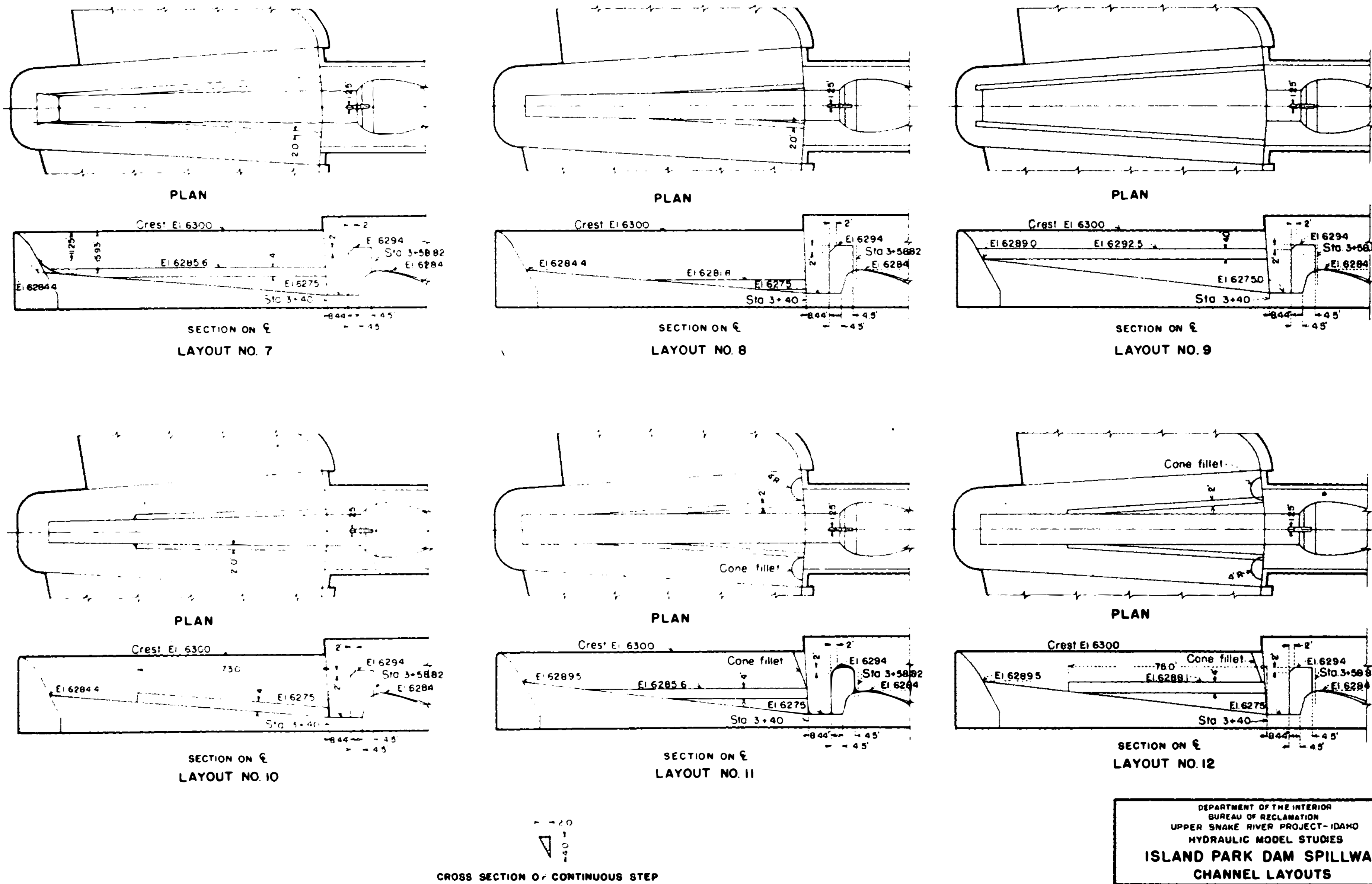
HYDRAULIC MODEL STUDIES

ISLAND PARK DAM SPILLWAY CHANNEL LAYOUTS

DRAWN A.H.N.	SUBMITTED J. B. Bradley
TRACED H.F.J.-J.O.K.	RECOMMENDED D. M. Lane
CHECKED R.K.V.	APPROVED W. H. Nalder
	DENVER, COLO. JULY 18, 1938

FIGURE 7



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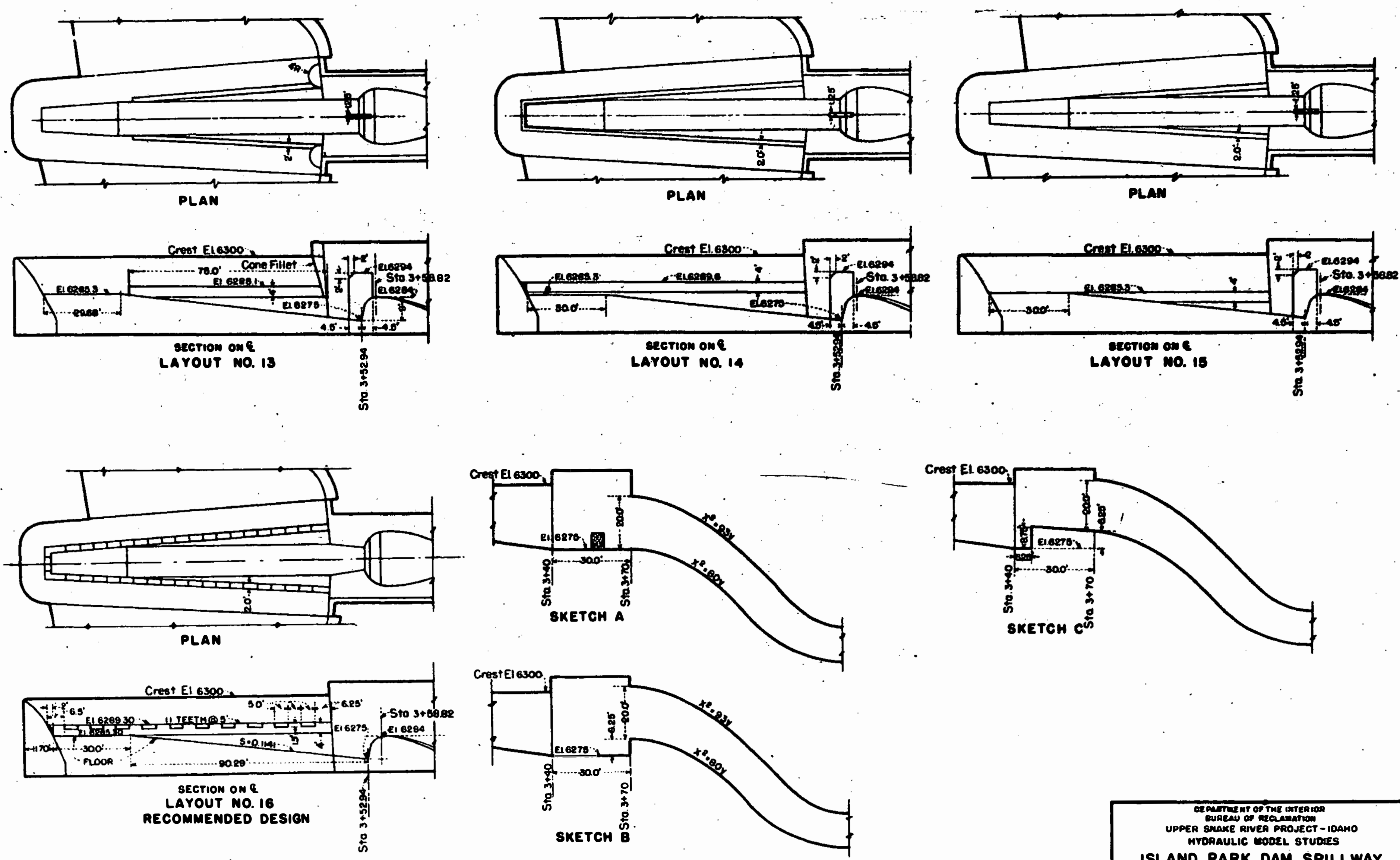
HYDRAULIC MODEL STUDIES

ISLAND PARK DAM SPILLWAY
CHANNEL LAYOUTS

DRAWN A.H.N.	SUBMITTED J. N. Bradley
TRACED E.E.B.	RECOMMENDED E.W. Lane
CHECKED R.K.V.	APPROVED W.H. Nalder
DENVER, COLO., JUNE 22, 1935	42-D-272

FIGURE 8



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HYDRAULIC MODEL STUDIES

ISLAND PARK DAM SPILLWAY
CHANNEL LAYOUTS

DRAWN A.H.R.	SUBMITTED J. N. Bradley
TRACED E.A.O. O.R.S.	RECOMMENDED D. ... Lane
CHECKED R.K.V.	APPROVED W. ... Nalder
DENVER, COLO., JUNE 22, 1953	42-D-273

FIGURE 9

in layouts 11, 12, and 13 for the purpose of eliminating the sharp corners in this location. These produced a negligible effect on the flow in the chute.

The Recommended Channel Design

A set of dentated steps was installed in various positions on the downstream face of the overflow crest and these were found to produce a very regular and symmetrical flow in the channel and in the chute. The best layout of this series was no. 16 (figure 9) in which the steps extended the full length of the crest. This layout was tried with and without the dividing wall installed and the results were practically identical for either case. The conclusion to be drawn from this is that the dividing wall was an aid in the poorer layouts where flow in the channel was irregular and lateral surges were present, but was of no noticeable value in the better layouts in which the flow was initially regular and symmetrical.

The Recommended Chute

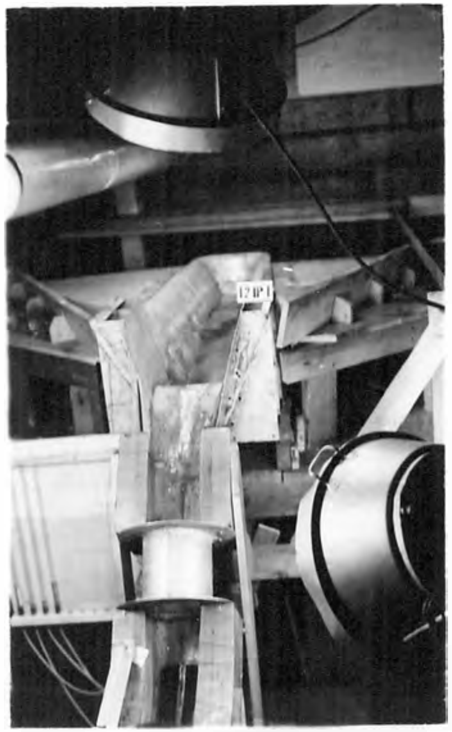
In spite of the improvement in flow in the upper part of the spillway, a certain amount of splashing was still present at the lower end of the chute. In a further effort to correct this undesirable condition, the horseshoe section was continued down to the end of the chute or station 4+53.34. The transition from the horseshoe to the circular section in this case was incorporated in the upstream end of the 13-foot constant diameter tunnel. This revision remedied the splashing and very satisfactory flow existed throughout the spillway. A drawing of the recommended chute is shown in figure 6 and the corresponding channel layout is shown as no. 16 on figure 9.

The photographs on plates V and VI show views of the recommended spillway. Photograph A (plate V) is a view of the spillway as recommended and photograph B shows it in operation at the maximum discharge. Photograph C on the same plate is a view looking down the chute and D shows the maximum discharge flowing through it. Photograph A (plate VI) is a closeup showing one of the dentated steps on the overflow crest; B shows the spillway in operation for a discharge of 600 c.f.s.; and C is a view showing this same discharge flowing down the chute.

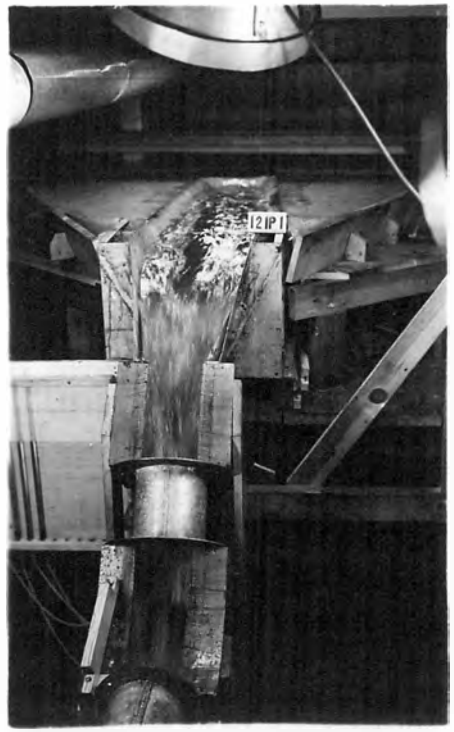
Attempted Revisions on the Recommended Spillway

Lowering of chute portal.

Toward the close of the testing, attempts were made to drop the



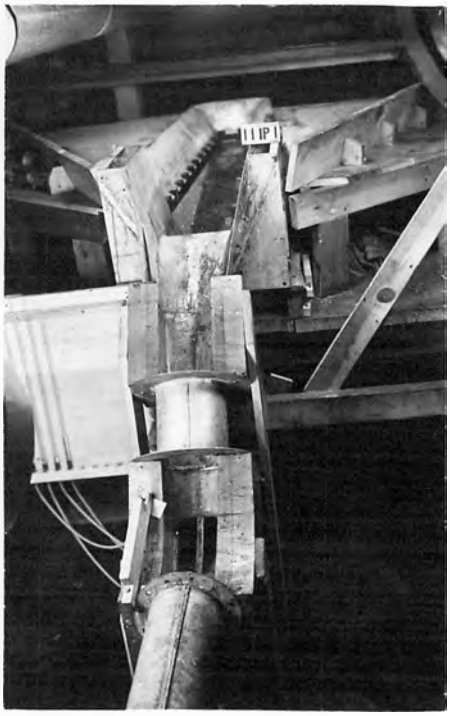
A. SPILLWAY



B. DISCHARGE 5,000 SECOND-FEET

C. DISCHARGE 5,000 SECOND-FEET

SAME AS RECOMMENDED DESIGN EXCEPT STEPS
ON OVERFLOW SECTION OMITTED



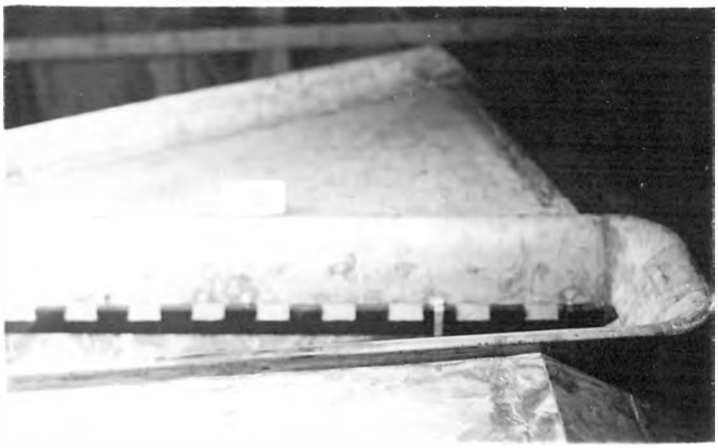
A. RECOMMENDED SPILLWAY

B. DISCHARGE 5,000 SECOND-FEET

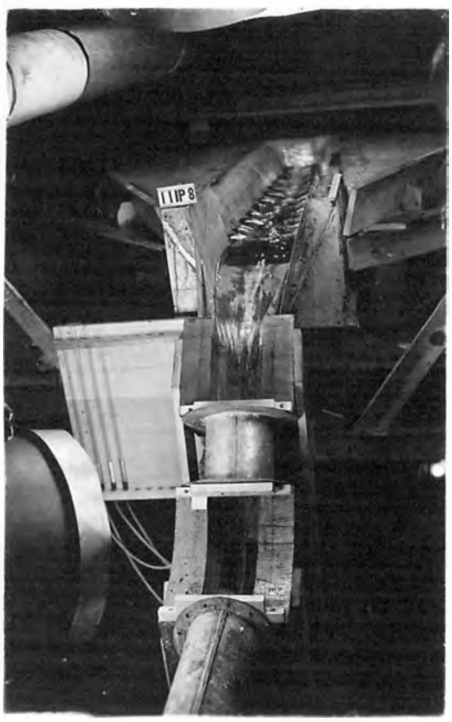
C. LOOKING DOWN CHUTE

D. LOOKING DOWN CHUTE WITH DISCHARGE 5,000 SECOND-FEET

RECOMMENDED DESIGN



A. OVERFLOW CHANNEL SHOWING
DENTATED STEP



B DISCHARGE 600 SECOND-FEET

C. FLOW CONDITIONS IN CHUTE WITH
DISCHARGE 600 SECOND-FEET

RECOMMENDED DESIGN

portal of the chute to two positions, namely, elevation 6281.7 and 6283.0. With the crest of the chute at elevation 6281.7 the flow was impaired. There was little difference in the flow when the crest of the chute was at elevation 6283.0 or 6284.0. The design department decided to leave the portal at elevation 6284.0.

Transition in lower end of chute.

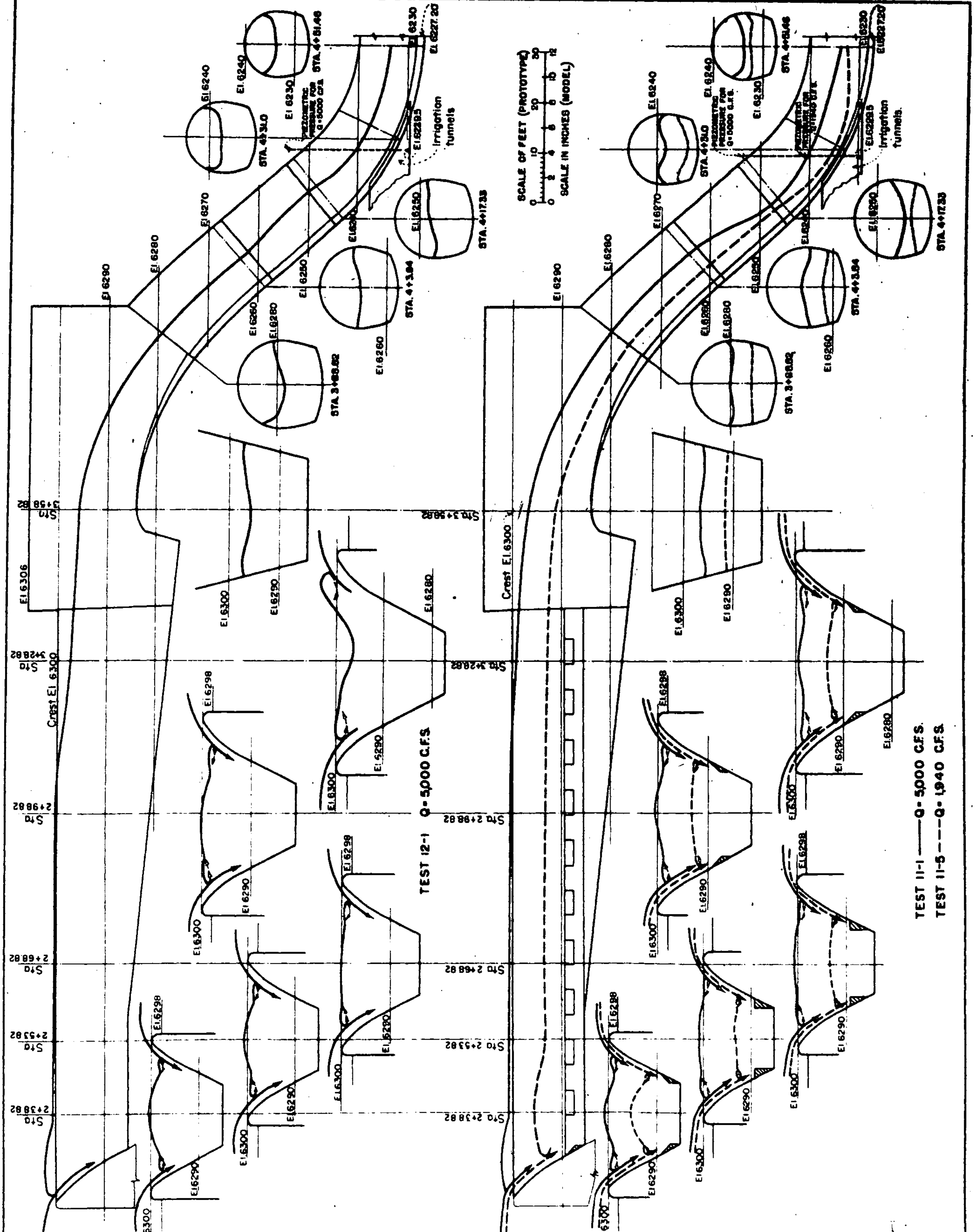
It was desired to commence the horseshoe-to-circular transition in the chute at station 4+41.56 (see figure 2) which is somewhat downstream from the one shown for chute C in figure 6. Note that the stationing is different on the two drawings. The lower end of the model was revised to simulate this design. This transition will work satisfactorily providing it is extended 30 or 40 feet into the horizontal tunnel. If made much shorter than this, splashing will undoubtedly occur in this region.

Water Surface Profiles

Water surface profiles and sections which were taken in the channel and down the chute on the recommended design are shown plotted on figure 10. In order to show that the steps on the overflow crest are indispensible for good flow conditions, the upper profile was obtained with the steps removed and the lower profile was measured with the steps installed. For the maximum discharge of 5,000 c.f.s., very little difference existed between the two in the shape of the water surface in the overflow channel. Naturally, the water surface was slightly higher in the layout with the steps installed. Flow down the chute however, varied considerably for the two. The sections in the chute for the test with the steps installed are much more regular and symmetrical than for those obtained from the test made with the steps omitted. The sections hardly do justice in showing the difference. The photographs on plate IV were taken during the tests with the steps removed and those on plates V and VI were taken of the recommended design with the steps installed. Notice the difference in the flow down the chute in photograph C (plate IV) and photograph D (plate V). The steps on the overflow crest make a remarkable improvement in the flow. It might have been possible to omit them had the slope of the chute been decreased. This, however, was not done for structural reasons. The sudden sag in the profile lines in the lower portion of the chute on figure 10 was produced by the unusually large irrigation outlets. A profile and some sections are also shown on the lower plot for a discharge of 1940 c.f.s.

Pressures in the Irrigation Outlets

Due to the unusual size of the irrigation outlets, more than



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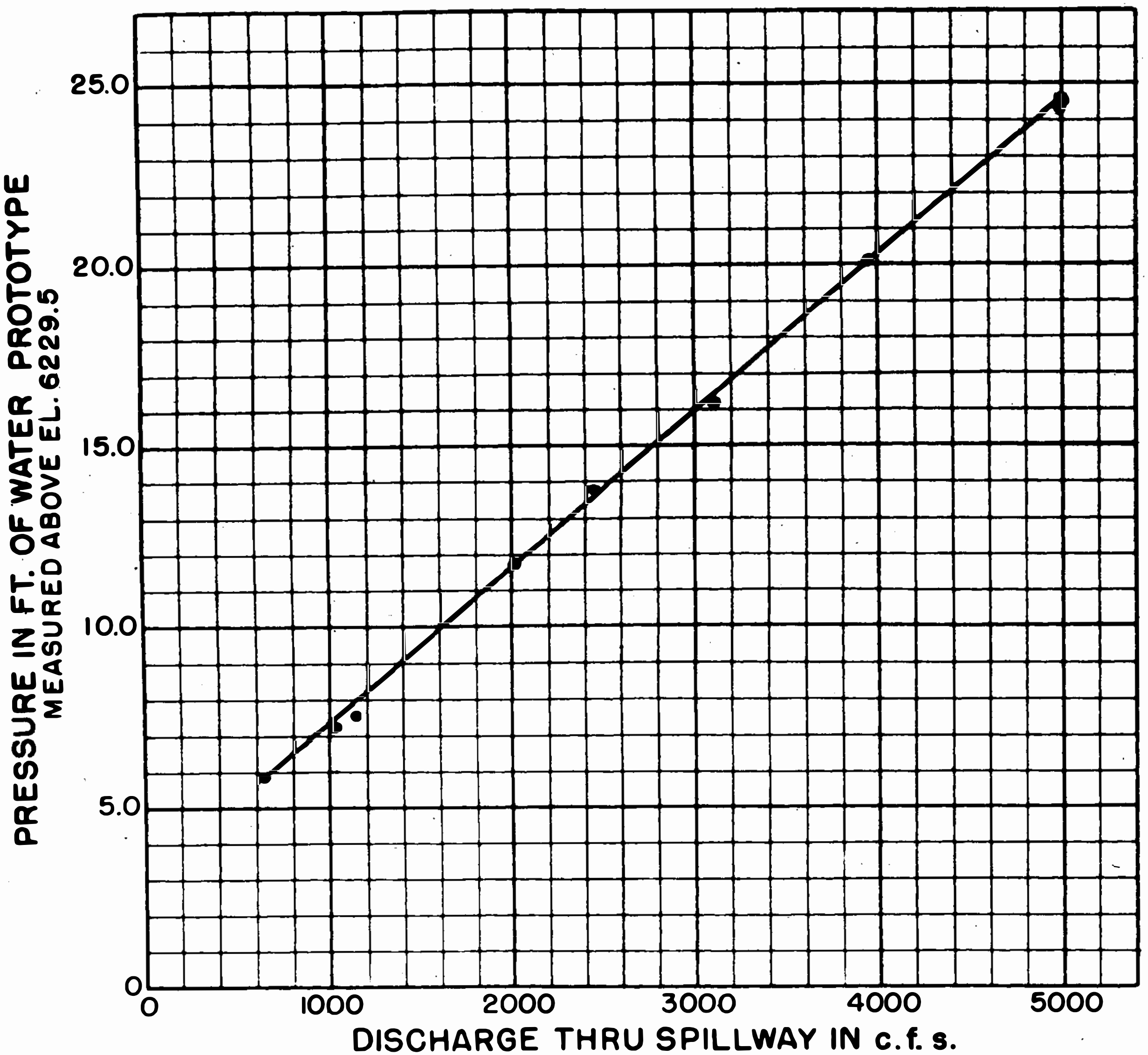
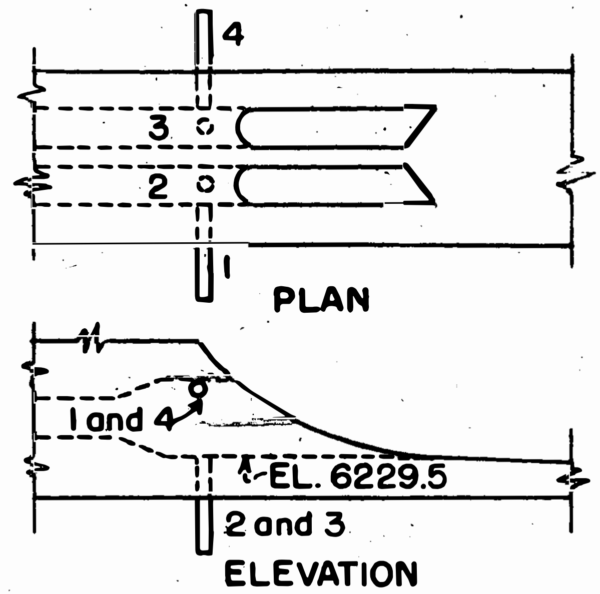
HYDRAULIC MODEL STUDIES

ISLAND PARK DAM SPILLWAY

WATER SURFACE PROFILES

DRAWN A.H.N. F.L.P.	SUBMITTED J. N. Bradley		
TRACED H.M. ORS	RECOMMENDED C.W. Lane		
CHECKED R.H.V.	APPROVED W. H. Nalder		
	DENVER, COLO. JUNE 22, 1935	42-D-274	





IRRIGATION TUNNELS
SHOWING LOCATION OF PIEZOMETERS

DEPARTMENT OF THE INTERIOR
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UPPER SNAKE RIVER PROJECT-IDAHO
HYDRAULIC MODEL STUDIES
ISLAND PARK DAM SPILLWAY
PRESSURES IN IRRIGATION TUNNELS

DRAWN A.H.N. SUBMITTED J. N. Bradley
TRACED D.W.S. RECOMMENDED E. W. Lane
CHECKED R.K.V. APPROVED W. H. Nalder

DENVER, COLO. 6-14-35 | 42-D-275

FIGURE 11

ordinary attention was paid to them.

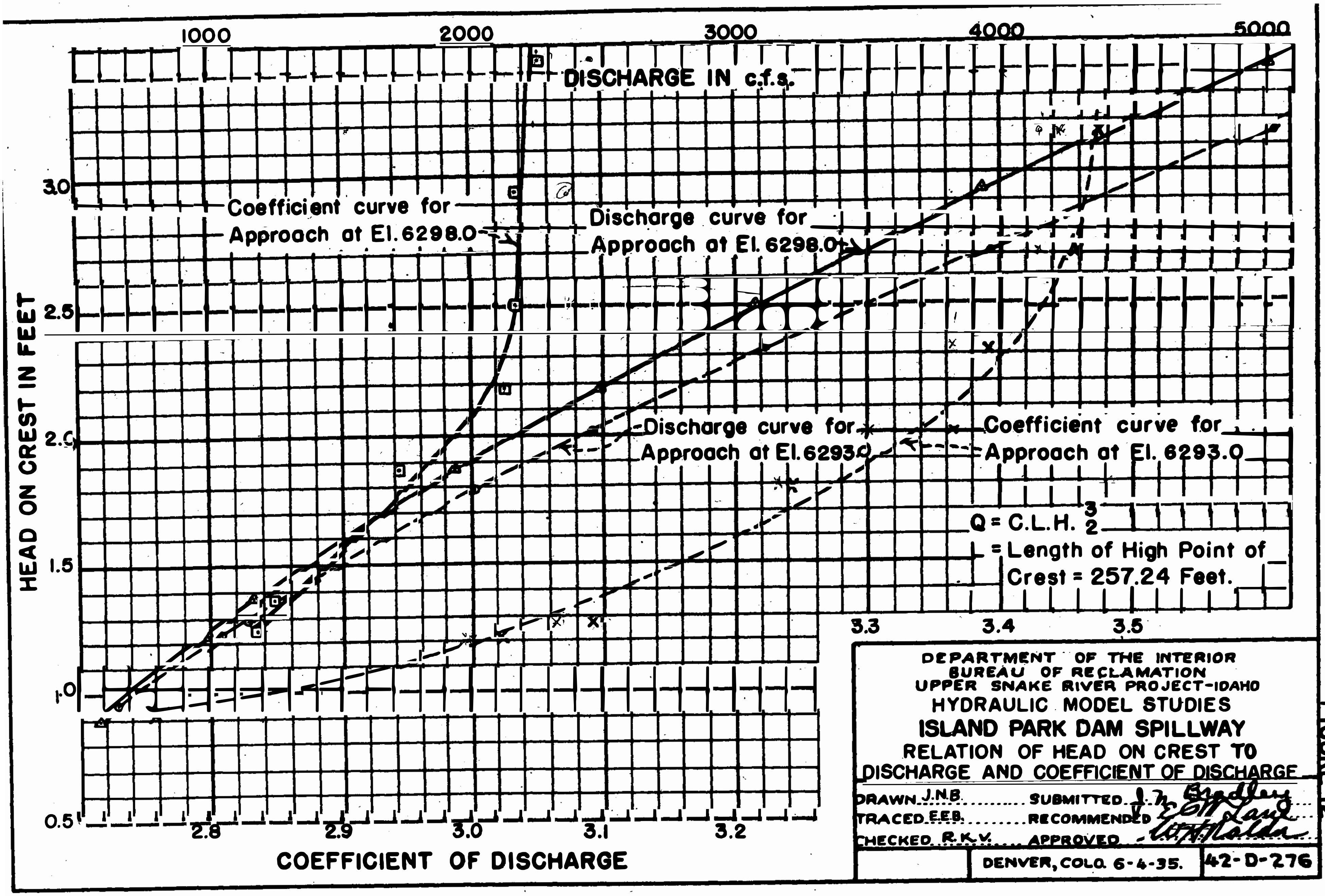
Piezometers were installed in the walls of the outlets, as shown in the sketch on figure 11, for the purpose of studying the pressures in these tunnels. The curve on figure 11 shows the results of tests made for the condition existing in the tunnels when the spillway was operating at various discharges with the outlet tunnels shut down. The average pressures in feet of water measured above elevation 6229.5 (converted into prototype values) are plotted with respect to the discharge through the spillway. The pressures observed for tests 12-1, 11-1, and 11-5 are also indicated on the plotted profiles on figure 10. The results definitely indicate that a pressure above atmospheric will exist in the irrigation outlets for all stages of flow through the spillway.

It will not be possible to pass much over 5,000 c.f.s. through the spillway as the 13-foot diameter tunnel will not carry much over this amount. If the spillway is operating at maximum discharge, flow through the irrigation tunnels must of necessity be cut off. Should the irrigation tunnels and spillway be operated together, the combined discharge can not much exceed 5,000 c.f.s.

The Head Discharge Relation and the Coefficient of Discharge

As originally designed, the approach to the overflow crest was to be excavated to 2 feet below the crest or elevation 6298.0 and the width of approach was to be as shown in figure 2. The head discharge relation obtained from runs made on this layout is plotted as a full line on figure 12. A head of 3.48 feet on the crest was required to get the maximum discharge of 5,000 c.f.s. over the spillway. The coefficients of discharge for the above runs were computed from the formula $Q = CLH^{3/2}$ where L is the length of the high point on the crest or 257.24 feet (measured on the model and converted to prototype). The coefficient curve for this layout is also plotted as a full line on figure 12. For maximum discharge, the coefficient of discharge is about 3.045.

During a series of experiments on approach studies, the head discharge relation was again determined for various discharges with the approach floor dropped to 7 feet below the crest or elevation 6293.0. One of the dotted lines on figure 12 shows this relation and the other is the coefficient of discharge curve for this layout. For a head of 3.0 feet on the crest there is a difference of 500 c.f.s. in the discharge using the approach floor at the two elevations. With the approach floor at elevation 6293.0, a head of only 3.20 feet is required on the crest for a maximum discharge and this gives a coefficient of discharge of 3.470.


1000
2000
3000
4000
5000
DISCHARGE IN c.f.s.
HEAD ON CREST IN FEET
3.0
2.5
2.0
1.5
1.0
0.5
Coefficient curve for Approach at El. 6298.0
Discharge curve for Approach at El. 6298.0
Discharge curve for Approach at El. 6293.0
Coefficient curve for Approach at El. 6293.0
$Q = C.L.H.^{\frac{3}{2}}$
L = Length of High Point of Crest = 257.24 Feet.
2.8
2.9
3.0
3.1
3.2
3.3
3.4
3.5
COEFFICIENT OF DISCHARGE
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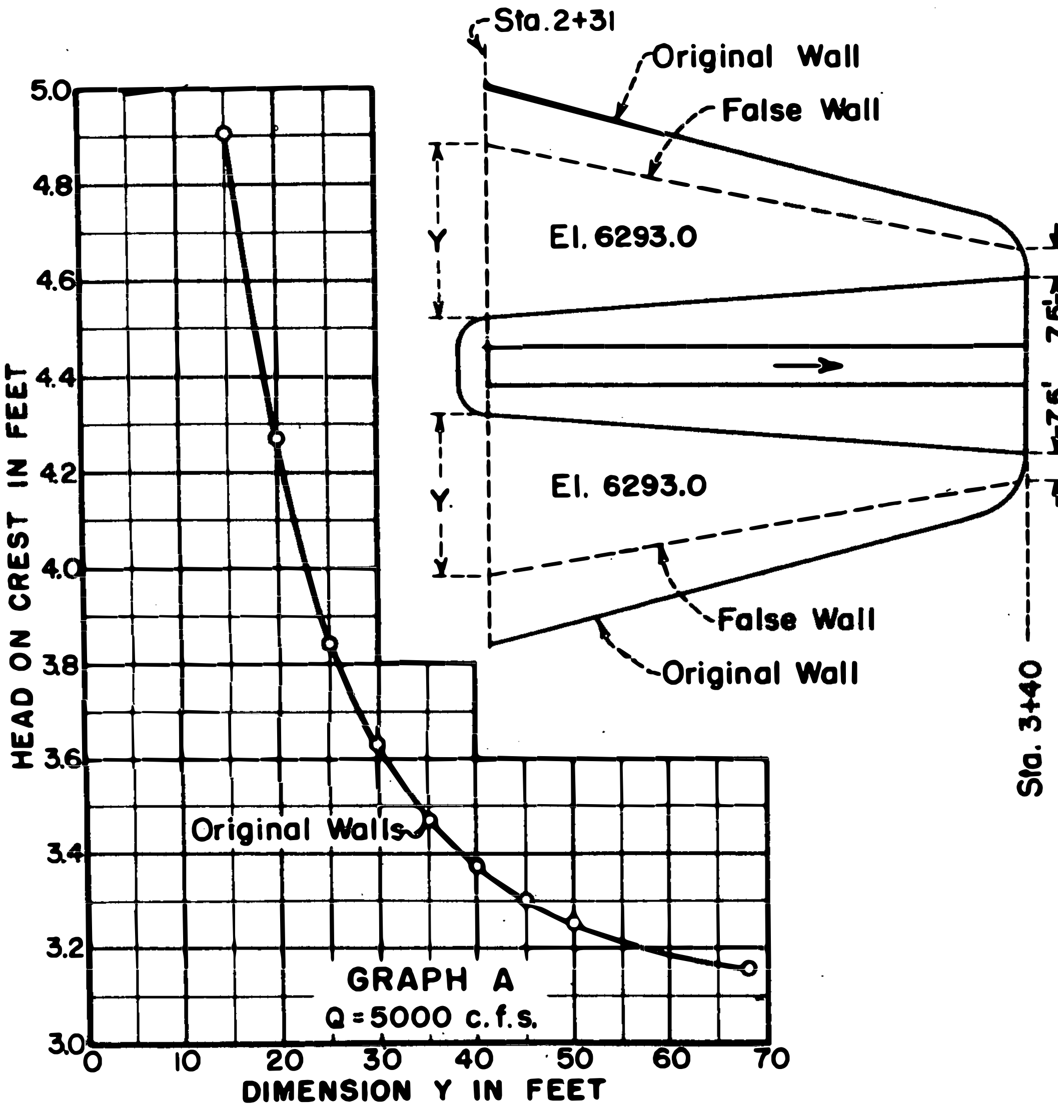
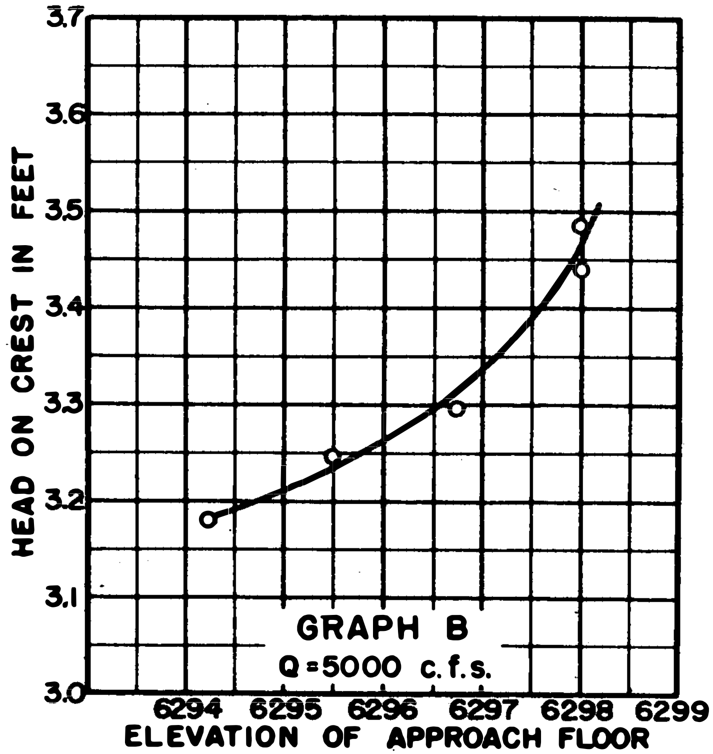
UPPER SNAKE RIVER PROJECT-IDAHO
HYDRAULIC MODEL STUDIES
ISLAND PARK DAM SPILLWAY
RELATION OF HEAD ON CREST TO DISCHARGE AND COEFFICIENT OF DISCHARGE
DRAWN J.N.B. SUBMITTED J. N. Bradley
TRACED E.E.B. RECOMMENDED E.W. Lane
CHECKED R.K.V. APPROVED
DENVER, COLO. 6-4-35.
42-D-276
FIGURE 12



CURVE SHOWING RELATION OF WIDTH OF APPROACH TO THE HEAD ON THE CREST.

APPROACH FLOOR WAS AT ELEV. 6293.0



CURVE SHOWING RELATION OF DEPTH OF APPROACH TO THE HEAD ON THE CREST.

APPROACH WALLS AS ORIGINALLY DESIGNED

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HYDRAULIC MODEL STUDIES
ISLAND PARK DAM SPILLWAY
RELATION OF WIDTH AND DEPTH OF APPROACH TO HEAD ON THE CREST

DRAWN J.N.B. SUBMITTED J.N. Bradley
TRACED J.O.K. RECOMMENDED E.W. Lane
CHECKED R.K.V. APPROVED [illegible]

DENVER, COLO. 6-14-35 42-D-277

FIGURE 13

The above comparison illustrates the importance of a well designed approach to a spillway of this type. As providing a minimum head on the crest was not important in this particular case and as the expense was much less for the higher approach, the floor was left at elevation 6298.0 in the final design as shown in figure 2.

Varying the Depth of Approach

In connection with the approach studies mentioned in the above paragraph, the head on the crest was observed for depths of approach varying from 2 to 7 feet below the crest using the original approach width. These runs were all made at the maximum discharge. The resulting curve is plotted as graph B on figure 13. The curve shows that the head on the crest decreases rapidly with an increase in the depth of approach.

Varying the Width of Approach

An attempt was made to narrow the width of the approach leaving the approach floor at elevation 6293.0. The curve shown in graph A on figure 13 was obtained using various widths of approach as shown in the sketch keeping the discharge constant at 5,000 c.f.s. This curve shows that narrowing the approach likewise produces a remarkable rise in the head on the crest even with the approach floor at elevation 6293.0.

These latter tests were of a somewhat supplemental nature, as the width and depth of the approach to the final spillway will remain the same as they were in the original design (see figure 2).

For a summary of all tests made on this spillway, see the appendix of this report.

Acknowledgments

The work in the hydraulic laboratories is under the general direction of E. W. Lane. The construction and testing of the Island Park model was under the supervision of J. B. Drisko. He was assisted by Junior Engineers H. M. Martin, L. R. Brooks, J. M. Buswell, and F. L. Pamizio. The office work was performed by A. H. Neal and R. K. Vierck.

APPENDIX
ISLAND PARK DAM SPILLWAY
Log of Tests

Test no.	Discharge in c.f.s.	Approach	Channel	Transition to chute	Check wall	Chute	Remarks
1-IP-1	5,000	Original El. 6298	Original Plate I	No upper fillets	None	Original Cir. sec. Plate II Figure 5	Fig. no. 4. Channel flow very rough and irregular. Marked boil at upstream end of channel. Water slopped out of transition at portal and of chute at point of reverse curvature. Irrigation tunnel outlets cause splash at entrance to straight tunnel. Unsatisfactory.
1-IP-2	5,000	Original	Original	Upper fillets placed	None	Original	Fig. no. 4. No improvement noted at portal or in chute
1-IP-3	5,000	Original	Original	Fig. 4	2.5'-8.75' high	Original	Fig. 9, sk. A. Check walls placed from sta. 3+40 - sta. 3+70. Checks 2.5' to 5' not effective. 8.75' check causes overflow at portal. Splashy condition in chute, better flow in channel.

APPENDIX (Continued)
ISLAND PARK DAM SPILLWAY
Log of Tests

Test no.	Discharge in c.f.s.	Approach	Channel	Transition to chute	Check wall	Chute	Remarks
1-IP-4	5,000	Original	Original	All fillets in place	6.25 ft. high	Original raised 6.25'	Fig. 9, sk. B. Splash in chute less but turbulence and splash in channel and approach is no better. Flow at portal poor.
1-IP-5	5,000	Original	Original	Made shallower	8.75 ft. high	Original raised 6.25'	Fig. 9, sk. C. Flow improved. Set up shows possibility of starting drop in transition closer to end of spillway channel.
1-IP-6	5,000	Original	Original	Fig. 5 Chute B	9.0 ft. high	Fig. 5 Chute B Cir.sec.	Fig. 5, chute B. Water surface in channel raised to within 2.5' of pond level. Boil at upstream end of channel reduced. Rough flow at portal and through chute. Splashy condition at outlet of irrigation tunnels.
1-IP-7	5,000	Original	Original	Reduced bottom width 5' adjusted fillets	9.0 ft. high	Fig. 5 Chute B	Flooded crest of spillway. No improvement in flow through transition and chute.

APPENDIX (Continued)
ISLAND PARK DAM SPILLWAY
Log of Tests

Test no.	Discharge in c.f.s.	Approach	Channel	Transition in chute	Check wall	Chute	Remarks
1-IP-8	5,000	Original + uniform slope from pond bot. to approach bot.	Original	Bottom reduced 7.5' Fillets adjusted	9.0 ft. high	Fig. 5 Chute B	Flooded crest of spillway. Changes do not better flow through chute.
1-IP-9	5,000	AS 1-IP-8	Original	Circular	9.0' high	Fig. 5 Chute B	Invert as fig. 5, chute B. Cross-section of transition and chute circular from sta. 3+46 to 4+40.52, diam. from 20 ft. to 13 ft. Crest flooded out. Portal cond. good. Flow thru chute in two large folds intersecting half way down chute. Flow thruout fair.
2-IP-(1 & 2)	5,000	As 1-IP-8	Original + Δ sill at el. 6292.5	Horseshoe Fig. 6 Chute C	9.0 ft. high	Trap & circular Fig. 6 Chute C	2-IP-1. Fig. no. 7. Layout no. 3. Transition in chute so as to enter circular tunnel. Unsymmetrical flow in channel but quiet surface to chute. Flow thru chute poor and splashy at entrance to tunnel. 2-IP-2: Addition of dividing wall on ℄ at check wall straightens unsymmetrical flow from channel to give quieter flow thru

APPENDIX (Continued)
ISLAND PARK DAM SPILLWAY
Log of Tests

Test no.	Discharge in c.f.s.	Approach	Channel	Transition in chute	Check wall	Chute	Remarks
2-IP-(1&2) (cont.)							chute. Raising crest El. 1.9' does not improve flow thru chute.
2-IP-3a	5,000	As 1-IP-8	Original +△ sill at el. 6292.5	Fig. 6 Chute C	9.0 ft. high	Fig. 6 Chute C	Fig. 8, layout no. 9. Rough flow in chute probably due to steep gradient of chute. Flow improved over flow of 2-IP-1.
2-IP-3b -3c	5,000	As 1-IP-8	Original +△ sill at el. 6289.5	Fig. 6 Chute C	9.0 ft. high	Fig. 6 Chute C	(b) Dividing wall as (2-IP-3a). Flow in channel is more symmetrical. Flow thru model is quieter. (c) Cutoff 34.4 ft. from upstream end of △ sill & added circular fillets to trapezoidal section. Flow surface thru the transition & chute smoother than previous run. Flow at upstream end of channel poor.
2-IP-3d	5,000	As 1-IP-8	Fig. 7 Layout 2	Fig. 6 Chute C	9.0 ft. high	Fig. 6 Chute C	Cause larger fin at upstream end of channel. Poor flow conditions.

APPENDIX (Continued)
ISLAND PARK DAM SPILLWAY
Log of Tests

Test no.	Discharge in c.f.s.	Approach	Channel	Transition in chute	Check wall	Chute	Remarks
3-IP-1	5,000	As 1-IP-8	Fig. 7 Layout 4	Fig. 6 Chute C	9.0 ft. high	Fig. 6 Chute C	Bubbling action at U.S. end of channel improved slightly. Flow thru model shows no improvement.
3-IP-2	5,000	As 1-IP-8	Fig. 7 Layout 6	Fig. 6 Chute C	9.0 ft. high	Fig. 6 Chute C	Flow thru model unsymmetrical, rougher & noisier than previous run.
3-IP-3	5,000	As 1-IP-8	Fig. 8 Layout 10	Fig. 6 Chute C	9.0 ft. high	Fig. 6 Chute C	Flow shows no improvement. Sill not effective in this position.
3-IP-4a	5,000	As 1-IP-8	Floor as 3-IP-3 & △ sill at el. 6285.0	Fig. 6 Chute C	9.0 ft. high	Fig. 6 Chute C	Flow thru channel good, thru chute fair & still indicates that chute drops too quickly & turns too sharply at bottom.
3-IP-4b	5,000	As 1-IP-8	Fig. 8 Layout 7	Fig. 6 Chute C	9.0 ft. high	Fig. 6 Chute C	Fillet reduces bubbling action at upstream end of spillway channel-flow conditions fair throughout.

APPENDIX (Continued)
ISLAND PARK DAM SPILLWAY
Log of Tests

Test no.	Discharge in c.f.s.	Approach	Channel	Transition in chute	Check wall	Chute	Remarks
3-IP-5	5,000	As 1-IP-8	Fig. 7 Layout 5	Fig. 6 Chute C	9.0 ft. high	Fig. 6 Chute C	Sill not effective. Open irrigation tunnels cause splashy & finny surface at entrance to straight tunnel.
3-IP-6	5,000	As 1-IP-8	Fig. 8 Layout 8	Fig. 6 Chute C	9.0 ft. high	Fig. 6 Chute C	Sill too low on spillway face to be effective.
4-IP-1	5,000	As 1-IP-8	Fig. 8 Layout 11	Fig. 6 Chute C	9.0 ft. high	Fig. 6 Chute C	Channel flow unsymmetrical. Flow thruout not as good as 3-IP-4a.
4-IP-2	5,000	As 1-IP-8	Fig. 8 Layout 12	Fig. 6 Chute C	9.0 ft. high	Fig. 6 Chute C	Plate III Flow much improved but not as quiet flow conditions as with lower floor.
4-IP-3	5,000	As 1-IP-8	Fig. 9 Layout 13	Fig. 6 Chute C	9.0 ft. high	Fig. 6 Chute C	Flow in channel slightly unsymmetrical. Flow conditions thruout best yet.
4-IP-4	5,000	As 1-IP-8	Fig. 9 Layout 13 No sill	Fig. 6 Chute C	9.0 ft. high	Fig. 6 Chute C	Rougher & splashier flow thru channel & chute than previous run.

APPENDIX (Continued)
ISLAND PARK DAM SPILLWAY
Log of Tests

Test no.	Discharge in c.f.s.	Approach	Channel	Transition in chute	Check wall	Chute	Remarks
4-IP-5	5,000	As 1-IP-8	Fig. 9 Layout 13 + sill El. 6289.4	Fig. 6 Chute C	9.0 ft. high	Fig. 6 Chute C	Sill 2' x 4' full length of spillway. Best water surface thru model least amount of noise thru chute. Sill very effective in this position. Rough flow at entrance to straight tunnel, probably due to transition in bottom of chute.
5-IP-1	5,000	Flat approach area constant but excavated 5' deeper El. 6293	Fig. 9 Layout 14	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design complete horseshoe section	Water surface thru model best obtained. Irrigation tunnel openings have little effect on flow at max. Q, a bit splashy at low flows. Dividing wall removed with little effect on flow thru chute.
5-IP-2	5,000	As 5-IP-1	Fig. 9 Layout 14 No sill	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	Flow noisy. Splashy & rough water surface thruout model with roller type flow in channel. Dividing wall in or out has little effect on flow. Model works very good for 3/4 max. Q.
5-IP-3	5,000	As 5-IP-1	Fig. 9 Layout 15	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	Unstable roller in channel changing from side to side. Rough & noisy flow thru chute. Removal of dividing wall gives rougher flow at bot-

APPENDIX (Continued)
ISLAND PARK DAM SPILLWAY
Log of Tests

Test no.	Discharge in c.f.s.	Approach	Channel	Transition in chute	Check wall	Chute	Remarks
5-IP-4	5,000	As 5-IP-1	Fig. 9 Layout 15 Note remarks	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	No dividing wall. Two wing wall sloping 1-1/4:3, from bottom corner of approach to height of check wall & extending from check wall to 15' U.S. added. Flow no improvement over 5-IP-3
5-IP-5	5,000	As 5-IP-1	Fig. 9 Layout 14 Note remarks	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	Cut 30' from U.S. & 20' from D.S. Tip of sill very ineffective. Flow conditions are poor.
5-IP-6	5,000	As 5-IP-1	Fig. 9 Layout 14 Note remarks	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	Cut sill into 5' teeth, placed them on 10' centers with tops at El. 6289.4. Flow unstable in channel, rough thru chute. Teeth too low. Dividing wall removed with little effect.
5-IP-7	5,000	As 5-IP-1	As 5-IP-6 Note remarks	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	Addeda row of teeth above gaps of lower row with tops at El. 6293.4. Flow in channel very smooth. Flow thru chute fair. Dividing wall removed with little effect on flow thru chute.

APPENDIX (Continued)
ISLAND PARK DAM SPILLWAY
Log of Tests

Test no.	Discharge in c.f.s.	Approach	Channel	Transition in chute	Check wall	Chute	Remarks
5-IP-8	5,000	As 5-IP-1	As 5-IP-7 Note remarks	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	Removed lower row of teeth. Flow becomes rougher & splashier thruout model.
5-IP-9	5,000	As 5-IP-1	As 5-IP-2 Note remark	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	Raised floor 3.5' at check wall. Change not effective. Rougher flow than in 5-IP-2.
5-IP-10	5,000	As 5-IP-1	Fig. 9 Layout 16	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	Smooth surface in channel. Best flow conditions thru chute with minimum of noise & splash. Best results so far. Removal of dividing wall has little effect on flow conditions.
5-IP-11	5,000	As 5-IP-1	Fig. 9 Layout 16	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	With temporary sides it was found that approach channel could be narrowed very little without raising the pond level.
6-IP-(1-10)	5,000	As 5-IP-1	Fig. 9 Layout 16	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	With temporary walls channel of approach was narrowed & effect on pond level was noted. Flow thru channel & chute show little change. For changes in approach channel see fig. 13.

APPENDIX (Continued)
ISLAND PARK DAM SPILLWAY
Log of Tests

Test no.	Discharge in c.f.s.	Approach	Channel	Transition in chute	Check wall	Chute	Remarks
7-IP-(1-4)	5,000	As 5-IP-1	Fig. 9 Layout 16 Note remarks	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	Blocked off upstream end of horseshoe spillway. Very unsymmetrical flow thru channel with resulting poor flow thru chute. Probably due to unsymmetrical approach conditions to two sides of spillway.
8-IP-(1, 2 & 8)	5,000	As 5-IP-1	Fig. 9 Layout 16	Fig. 6 Rec. Design	9.0 ft. high	Fig. 6 Rec. design	See Fig. B Depth of approach lessened by 2.5' fills of sand on the flat. Very little effect on flow thru model. Increase in depth of approach give decrease in head.
8-IP-9	0-5,000	As 5-IP-1	Fig. 9 Layout 16	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	Irrigation tunnel openings made circular in plan. Flow at low discharges show very little improvement.
9-IP-10	0-5,000	As 5-IP-1	Fig. 9 Layout 16	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	With A Q of 2,500 c.f.s thru tunnels flow at bottom of chute improved for all discharges, especially the low Q. Recommend tunnels be less high & wider to take up full bottom width of horseshoe. A 1.25' lip tried above top of irrigation tunnels - Not effective.

APPENDIX (Continued)
ISLAND PARK DAM SPILLWAY
Log of Tests

Test no.	Discharge in c.f.s.	Approach	Channel	Transition in chute	Check wall	Chute	Remarks
9-IP-(1-8)	650-5000	As 5-IP-1	Fig. 9 Layout 16 D = 7.0'	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	See fig.11 and fig. 12 Measured Q, Hd. on crest. Pressure in irrigation tunnel with no flow thru tunnels. See fig. 11. Note pressure & not suction in tunnels.
10-IP-(1-5)	5,000	As 5-IP-1	Fig. 9 Layout 16	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	See sk. 11 Depth of approach lessened by 1.25' jumps from 7' to 2' with fine sand. The head discharge relations noted as in 8-IP(1, 2 & 8) runs. Increase in depth of approach gives decrease in head on crest.
11-IP-(1-8)	580-5000	Original	Fig. 9 Layout 16	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	Figure no. 10 Depth of approach = 2'. Head vs. discharge relations. Also profiles thru spillway & thru chute for this best run.
12-IP-1	5,000	Original	Fig. 9 Layout 16	Fig. 6 Rec. design	9.0 ft. high	Fig. 6 Rec. design	Figs. 10 & 12, plates 4, 5, & 6. Profile thru chute & spillway with sill on spillway removed to show poor flow conditions without sill at max. Q.

APPENDIX (Continued)
ISLAND PARK DAM SPILLWAY
Log of Tests

Test no.	Discharge in c.f.s.	Approach	Channel	Transition in chute	Check wall	Chute	Remarks
13-IP-(1-2)	5,000	Original	Fig. 9 Layout 16	Fig. 6 Rec. design	6.5 ft. high	Fig. 6 Rec. design Note remark	Chute & check wall dropped 2.5'. Sill & chute too low. Flow surface in channel lower & steadier than previous runs. Flow in chute with & without sill rougher than 11-IP series
13-IP-(3-4)	5,000	Original	Fig. 9 Layout 16	Fig. 6 Rec. design	7.75' high	Fig. 6 Rec. design	Raised check sill 1.25' leaving rest of model as (13-IP-1&2). Flow improved over previous run, not as good as 11-IP run, but flow in channel is steadier. Sill in place gave quieter flow thruout model.
13-IP-(5-6)	5,000	Original	Fig. 9 Layout 16 except for floor	As 13-IP-(3-4)	7.75' high	As 13-IP-(3-4)	Floor el. 6275.5 at check wall & el. 6285.5 at upstream end of spillway channel. Flow unsymmetrical thru channel & rough thru chute. Put in dentated step of layout 16 at el. 6289.3. Flow thruout model as good as the other best run 9-IP-series.
14-IP-1	5,000	Original	As 13-IP-(3-4)	As 13-IP-(3-4)	7.75' high	As 13-IP-(3-4) Note remarks	From horseshoe to circular transition placed at bottom of chute from sta. 4+40.84 to sta. 4+53.34. Transition does not create any serious trouble, but for smoother flow recommend that it be kept in straight tunnel beyond