PAP-62

File

Model Studies of Davis Aqueduct Turnouts

15.7 and 11.7

by

J. C. Schuster

Hyd - 442

PAP 62

rm DFC-11 PAP-62
52)
eau of Reclamation

INFORMATIONAL ROUTING

Ball

Memorandum

Denver, Colorado
October 6, 1954

Chief, Canals Branch
Attention: R. Sailer

Chief, Engineering Laboratories

Model studies of Davis Aqueduct Turnouts 15.4 and 11.7--Weber Basin Project, Utah

AUTHOR

Introduction

Some of the turnout structures on the Davis Aqueduct will operate at heads considerably in excess of 100 feet and will, therefore, require some means of dissipating the energy in the flow before it is released into open channels for delivery to the users. The preliminary design of the energy dissipator was similar to the box-with-baffle type developed by hydraulic model tests for the Franklin Canal drains and wasteways. However, there were marked differences in the operating conditions in these two cases. In the Franklin Canal structures a jet of water issuing from a partly filled conduit at fairly high velocity entered through the head wall of an open top box and impinged on an inverted L-shaped baffle. In the Davis Aqueduct turnouts a jet of water discharging from a partly opened valve in the box head wall at a much higher velocity impinged on the inverted L-shaped baffle (Figure 1A). The higher velocities, although of relatively smaller quantities, and the directional change of the valve jet with opening made it difficult to predict the performance of the Davis Aqueduct turnout structures. Hydraulic model studies were therefore made on two typical structures to investigate the adequacy of the design.

The Models

Models of two turnouts were built to a scale of 1 to 2.45 and were attached to a standard 6-inch gate valve and piping (Figures 1, 8, and 9). A discharge of 1.05 cfs at a velocity of 51 fps through the 6-inch valve approximately 12 percent open represented 10 cfs at 80 fps in the prototype. A second discharge of 0.47 cfs at a velocity of 67.4 fps represented 4.1 cfs at 105 fps. Prototype values will be used in the following paragraphs which report the results of the model tests.

Turnout 15.4

The floor of Turnout 15.4 was horizontal and the long leg of the baffle was vertical (Figure 1). In the preliminary design of this turnout, water from the valve was deflected by the inverted L-shaped baffle to the upstream head wall. A portion of the water

splashed from the head wall to overtop the baffle and fall into the downstream pool (Figure 2). The pool was turbulent but an exit velocity of approximately 3 fps over the end sill for a discharge of 10 cfs was acceptable. An increase in the depth and length of the pool to reduce the turbulence was discussed but the increase was not tested in the model.

The splash behind the baffle increased with an increase in velocity. The shape of the jet and the upward flow direction from the partially opened valve caused the water to splash over the side walls and the baffle (Figure 3). The flow conditions in the pool downstream from the baffle were satisfactory for a valve discharge of 4.1 cfs at a velocity of 106 fps, but the splash behind the baffle was objectionable because of the possibility of spray saturating the ground in the vicinity of the structure.

The splash was reduced to an acceptable minimum for the 4.1 cfs discharge when the height of the baffle was increased from 24 to 36 inches (Figures 1B and 4).

Flow conditions upstream of the baffle were improved for the 10 cfs discharge although a small amount of water was deflected upward on the head wall (Figure 5). However, the increased baffle height did not improve the pool flow conditions over those of the preliminary design; but, with the exit velocity still approximately 3 fps over the end sill the design was acceptable. The 36-inch baffle was recommended for the 15.4 turnout. Although not studied on this design, the two 8-inch wide deflectors at the side walls between the baffle and head wall, shown on Figure 1B, would prevent water overtopping the baffle.

Unsatisfactory flow conditions resulted when the passage under the baffle was closed and the water filled the space upstream of the baffle, submerged the valve, flowed over the top of the baffle, and plunged into the downstream end of the turnout (Figure 6). Severe turbulence occurred upstream of the baffle and in the pool. Flow conditions were acceptable for 4.1 cfs (Figure 7) but closure of the baffle was not recommended because of unsatisfactory flow conditions at larger discharges.

Turnout 11.7

The inlet pipe and valve of Turnout 11.7 were at a 45° downward angle with respect to the horizontal pool and the baffle was at right angles to the axis of the valve (Figures 8A and 9).

Water from the valve was turned upstream against the head wall by the top leg of the baffle. A part of the water was deflected upward on the head wall and carried over the baffle into the downstream pool (Figure 10). Spray at the upstream corners of the turnout carried over the side walls. The pool downstream of the baffle was less turbulent than the pool of Turnout 15.4, but the turnout was not satisfactory because of excessive turbulence and spray.

A 15° rotation of the baffle about the uppermost edge improved the flow conditions at the head wall by deflecting the water downward but the turbulence in the downstream pool was increased. The design would not be satisfactory because of the pool turbulence; but the test indicated that it was desirable to have a baffle at a 90° angle to the valve jet, to have an opening of 1 foot at the bottom, and to have a downward slope of the lower surface of the top leg.

A 30° wedge was added to the lower surface of the top leg of the baffle (Figure 8B). This change improved the flow conditions at the head wall, but a part of the water from the baffle was turned downward into the valve jet to cause considerable spray. The length of the long leg of the baffle was increased by approximately 4-1/8 inches to compensate for the 30° wedge and the baffle raised to maintain a 1-foot clearance between the baffle bottom and the floor. The water was turned toward the head wall by the baffle and did not interfere with the valve jet (Figure 11).

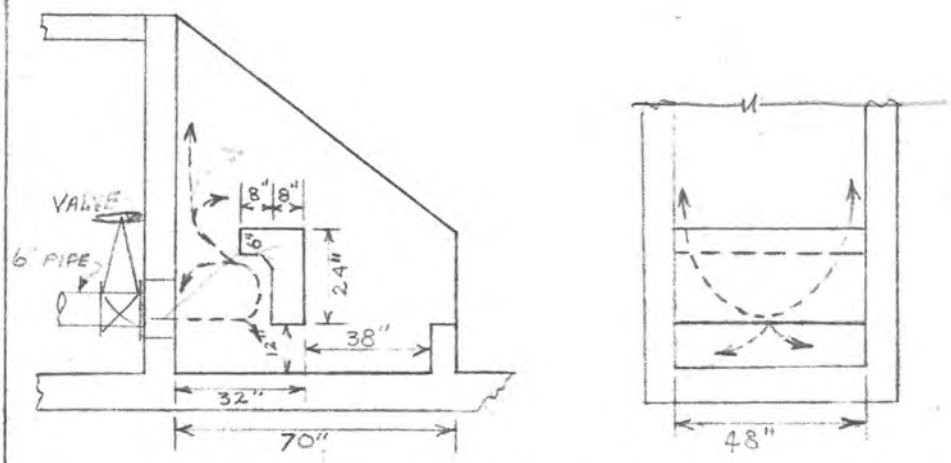
Spray in the turnout corners upstream of the baffle was objectionable and two 8-inch wide deflectors between the baffle and head wall were installed at each side of the turnout (Figure 8B). These deflectors confined all but a small amount of the water to the space behind the baffle (Figure 12). It was possible to confine this water by placing a splash board across the two deflectors (Figure 8B). It is believed that a space for aeration of 3-inch minimum width and 32 inches long (equal to the open distance between deflectors) should be provided between the splash board and the head wall, should the board be used in a field installation.

Flow conditions in the pool below the baffle were satisfactory for both the 10 and 4.1 cfs discharges (Figure 12). The 30° wedge on the top leg of the baffle and the two 8-inch wide side wall deflectors were recommended for the turnout. A splash board may be added to the field structure if objectionable spray occurs.

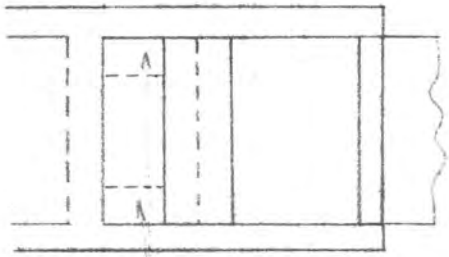
Copy to: W. H. Price
H. M. Martin
Files
✓J. W. Ball
J. N. Bradley

Walter H. Price

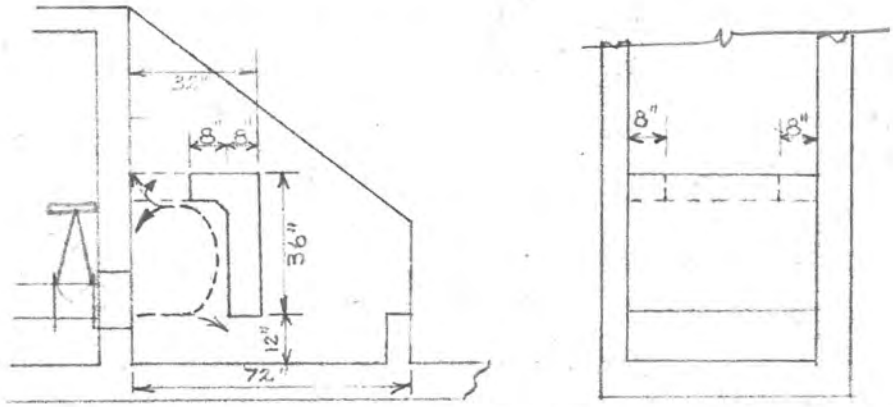
FIGURE 1



A. PRELIMINARY DESIGN--FLOW PATTERN



DEFLECTORS



B. RECOMMENDED DESIGN--36-INCH BAFFLE

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

DAVIS AQUEDUCT

TURNOUT 15.4
BAFFLE ARRANGEMENT

DRAWN CHECKED DATE

X-D-354

FIGURE No.

View from downstream

View from top

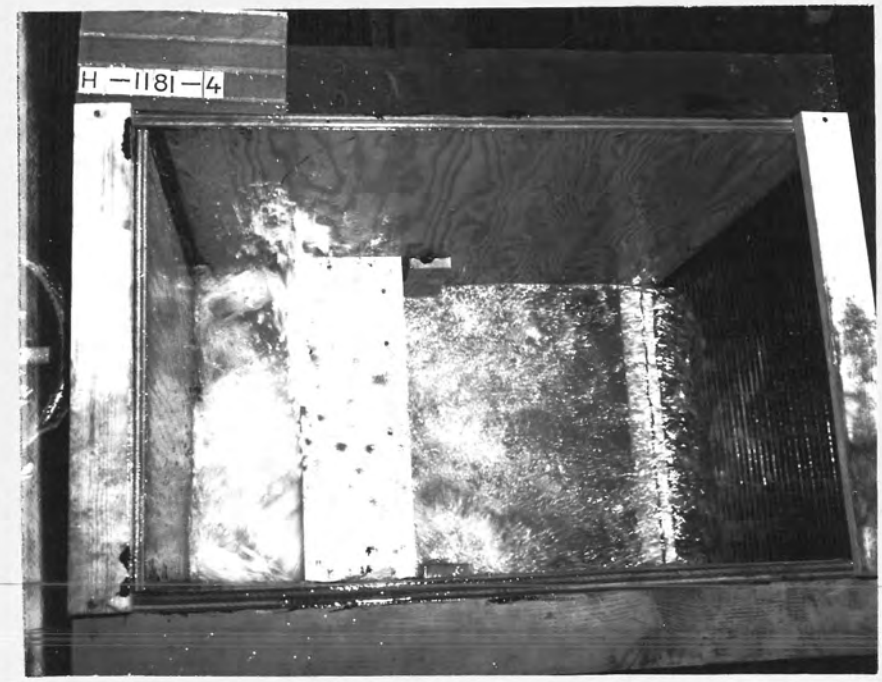
DAVIS AQUEDUCT

Turnout 15.4--Preliminary Design, Baffle 24 Inches High--1.0-foot Clearance at Floor, Discharge Representing 10 cfs at 80 fps

~40' Head, proto

Figure 3

View from downstream



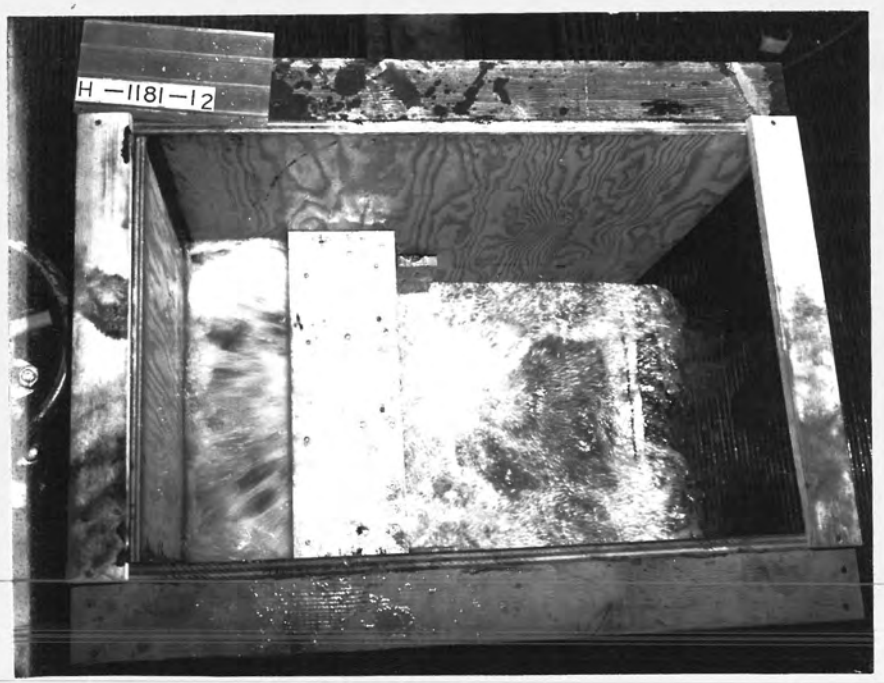
View from top

DAVIS AQUEDUCT

Turnout 15.4--Preliminary Design, Baffle 24 Inches High--1.0-foot Clearance, Discharge Representing 4.1 cfs at 106 fps

17.5' Head, Exp-3

View from downstream



View from top

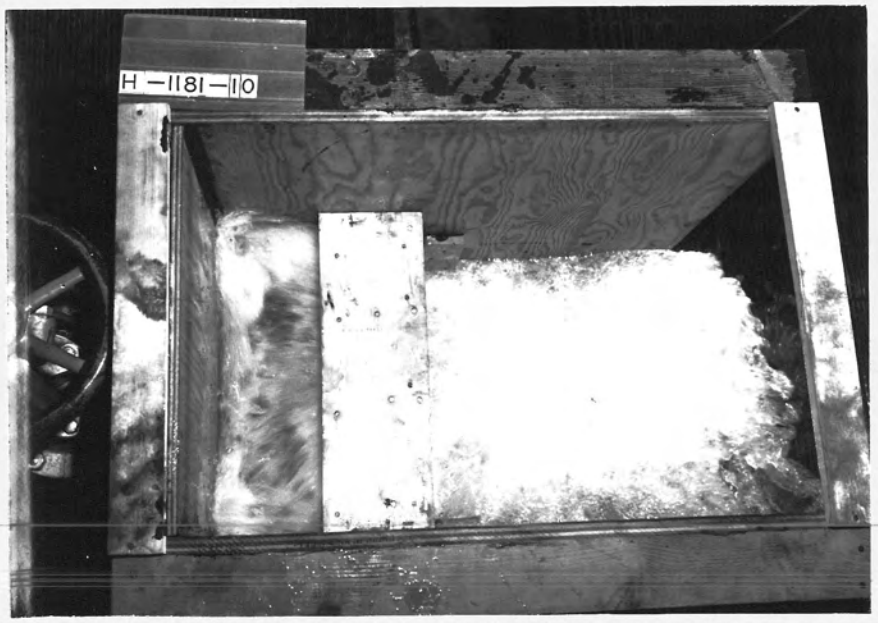
DAVIS AQUEDUCT

Turnout 15.4--Recommended Design, Baffle 36 Inches High--1.0-foot Clearance at Bottom, Discharge 4.1 cfs at 106 fps

170 Photographs

Figure 5

View from downstream



View from top

DAVIS AQUEDUCT

Turnout 15.4--Recommended Design, Baffle 36 Inches High--1.0-foot Clearance at Bottom, Discharge Representing 10 cfs at 80 fps

100' Head, proto.

Figure 6

View from downstream

View from top

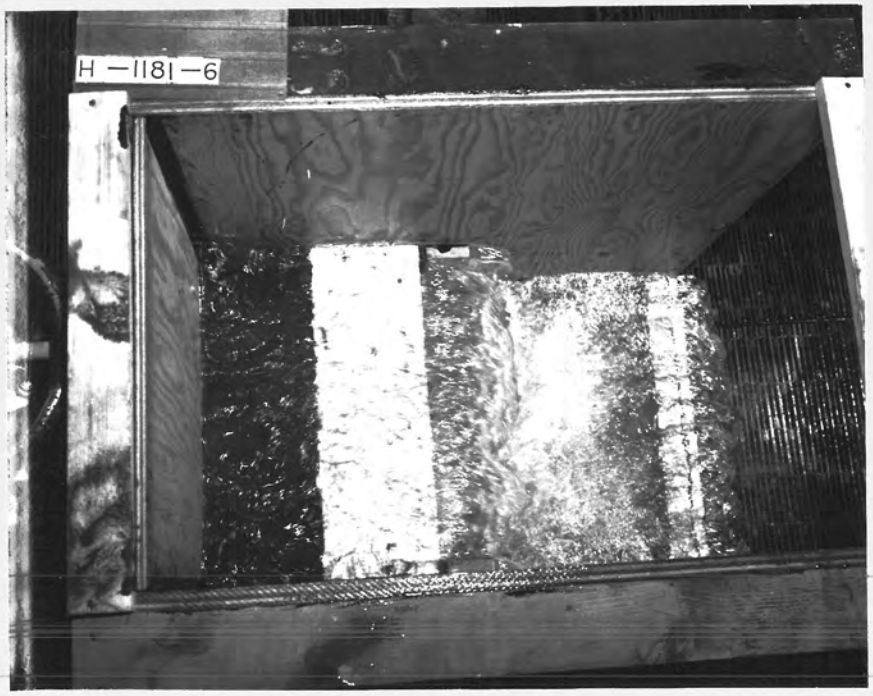
DAVIS AQUEDUCT

Turnout 15.4--Preliminary Design, No Passage Under Baffle
Discharge Representing 10 cfs at 80 fps

100' Head, 0+75

Figure 7

View from downstream

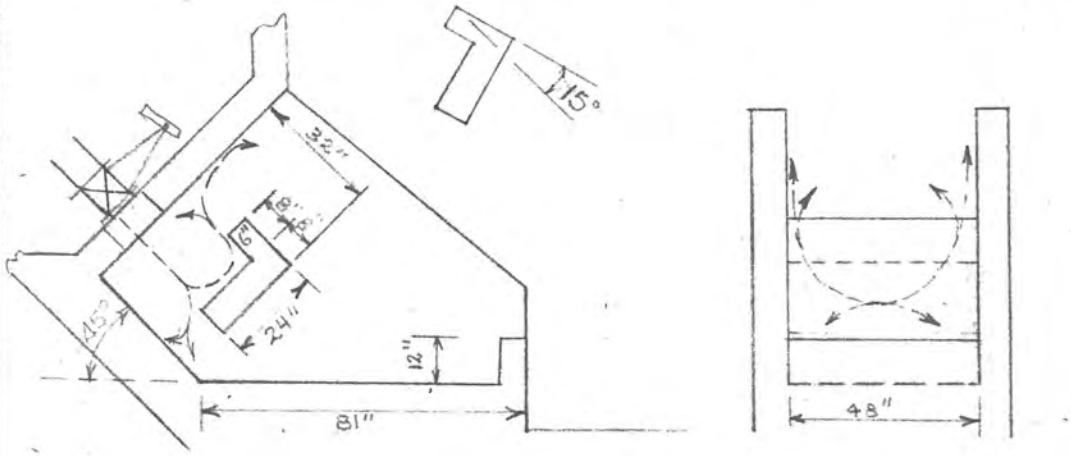


View from top

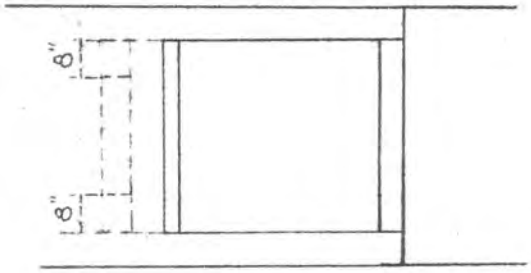
DAVIS AQUEDUCT

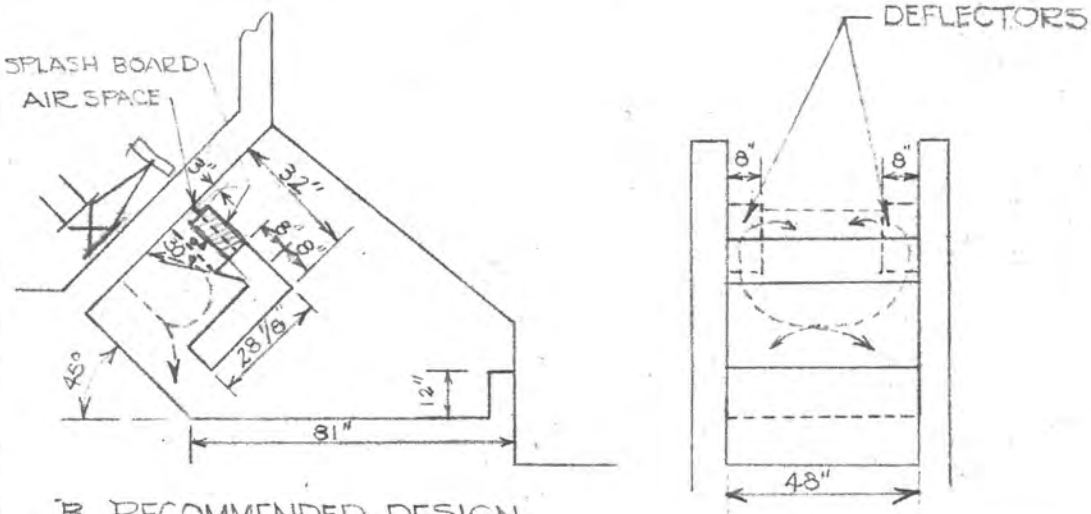
Turnout 15.4--Preliminary Design, No Passage Under Baffle
Discharge Representing 4.1 cfs at 106 fps

FIGURE 8



A. PRELIMINARY DESIGN-- FLOW PATTERN





B. RECOMMENDED DESIGN

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

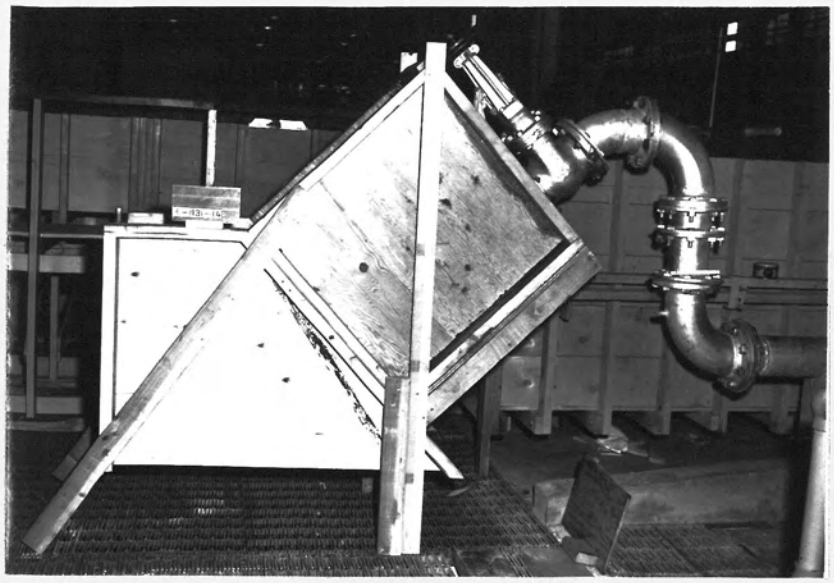
DAVIS AQUEDUCT

TURNOUT 11.7
BAFFLE ARRANGEMENTS

DRAWN CHECKED DATE

X-D-354

FIGURE No.

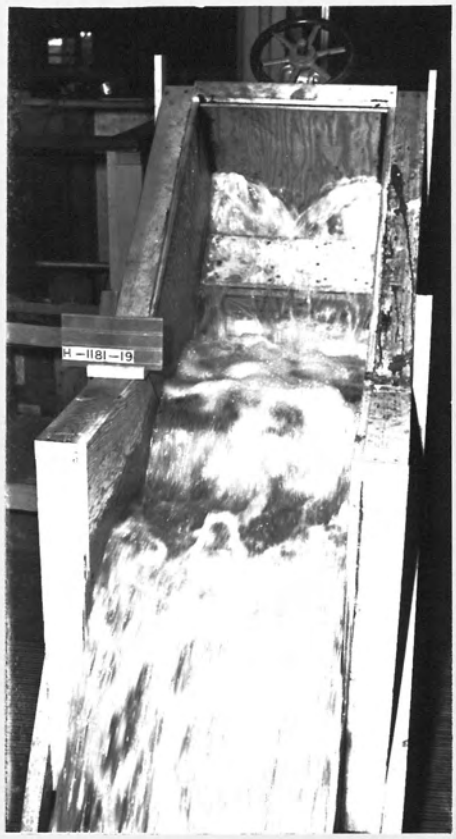


View from left side

View from downstream

DAVIS AQUEDUCT

1:2.46 Scale Model of Turnout 11.7



Discharge representing
10 cfs at 80 fps

101' Head

Discharge 4.1 cfs at 106 fps

145' Head

DAVIS AQUEDUCT

Turnout 11.7--Flow Conditions for Preliminary Design

Discharge representing
10 cfs at 80 fps

100' Head

Discharge representing
4.1 cfs at 106 fps

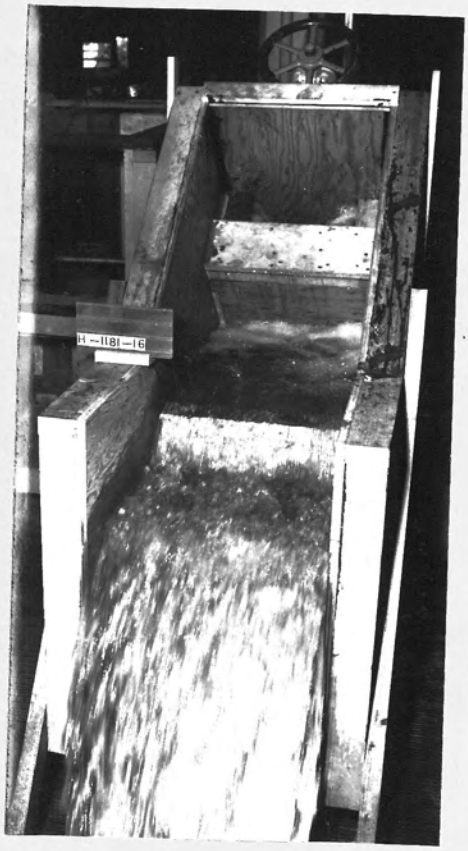
75' Head

DAVIS AQUEDUCT

Turnout 11.7--30° Wedge on Lower Surface of Top Leg of Baffle

Discharge representing
10 cfs at 80 fps

100' Head



Discharge representing
4.1 cfs at 106 fps

120' Head

DAVIS AQUEDUCT

Turnout 11.7--30° Wedge on Top Leg of Baffle, Two 8-inch
Deflectors at Side Walls, Recommended Design