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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

HYDRAULIC MODEL STUDIES OF THE INTAKE STRUCTURE FOR THE OUTLET WORKS OF LITTLE PANOCHE CREEK DETENTION DAM SAN LUIS UNIT, CENTRAL VALLEY PROJECT CALIFORNIA

Report No. Hyd-560

HYDRAULICS BRANCH
Division of Research

OFFICE OF CHIEF ENGINEER
DENVER, COLORADO

June 1, 1966

CONTENTS

ABSTRACT

A 1:15 scale model of the intake structure of Little Panoche Creek outlet works indicated certain modifications necessary to improve flow conditions. A vertical deflector at the crown of the elbow was dimensioned to act as a control so that the design flow of 900 cfs could be discharged at the design reservoir elevation. Vertical flow splitters, with a cross section similar to a truncated triangle, were placed between the horizontal structural beams of the trashrack-stoplog structure to allow aeration under the jets flowing over the stoplogs. This eliminated a flutter and rumble in the intake that occurred when the stoplogs were installed to within 6 to 18 in. of the beams. Pressures in the throat and elbow of the intake were near atmospheric or above at all flows. The design discharge was attained at the design reservoir elevation with stoplogs installed to any height up to 34 feet above the crest.

DESCRIPTORS-- *hydraulic structures/ *outlet works/ stop logs/ air demai capacity reduction/ control structures/ flow/ flow control/ *hydraulic models/ jets/ pipe bends/ unsteady flow/ *pulsating flow/ aeration/ guide vanes/ nappe/ discharges/ intake structures/ water pressures/ research an development
IDENTIFIERS--Little Panoche Creek Detention Dam, Calif/ Central Valley I Calif/ flow splitters/ California/ hydraulic design/ free flow

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Office of Chief Engineer		Report No.	Hyd-560
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HYDRAULIC MODEL STUDIES OF THE INTAKE STRUCTURE FOR THE OUTLET WORKS OF LITTLE PANOCHE CREEK DETENTION DAM--SAN LUIS UNIT, CENTRAL VALLEY PROJECT, CALIFORNIA

PURPOSE

The purpose of this study was to verify the hydraulic design of the vertical drop intake structure to insure a smoothly operating structure capable of discharging the required flows within the design reservoir elevations.

CONCLUSIONS

1. A 63-inch-long vertical deflector on the crown at the P. C. of the elbow smoothed the flow entering the elbow, Figure 5, and acted as a control so that the design flow of 900 cfs (cubic feet per second) was discharged at reservoir elevation 639.0.

2. Rib deflectors extending downstream from the end of the deflector on either side of the crown centerline of the elbow, prevented small discharges from spiralling over the crown and provided an air passage from the vertical deflector, Figure 5.

3. Pressures near the crest and in the throat of the intake were near or above atmospheric at all discharges, with and without stoplogs installed, Figure 6.

4. The design discharge of 900 cfs was attained at reservoir elevation 639.0 or 2.5 feet lower than the design elevation. The design discharge could be passed at the same reservoir elevation with stoplogs installed to elevation 624.0.

5. With stoplogs installed to within 6 to 18 inches from the bottom of the horizontal structural beams in the intake structure, considerable flutter and instability of the jet nappe occurred at discharges between 300 and 500 cfs. This instability could be a source of vibration in the prototype structure.

6. Providing aeration under the jet by splitting the flow passing over the top of the stoplogs stopped the flutter.

7. Vertical columns placed on top of the stoplogs eliminated the flutter, but were considered impractical because of possible construction and maintenance difficulties.

8. Vertical columns between the horizontal structural beams, although less effective, also reduced the flutter.

9. The most effective cross sectional shape for the vertical column was an equilateral triangle with one apex truncated. The base of the triangular section was placed on the downstream side of the beams with the apex facing upstream, Figures 3 and 9.

10. The pressures in the inlet were not materially affected by the flow splitters, Figures 6 and 10.

11. The addition of the recommended flow splitters increased the reservoir water surface elevation 0.6 foot at 900-cfs discharge.

ACKNOWLEDGMENT

The studies described in this report were accomplished through the cooperation of the Spillway and Outlet Works Section of the Dams Branch, Division of Design, and the Hydraulics Branch, Division of Research. Model photography was by W. M. Batts, Office Services Branch.

INTRODUCTION

Little Panoche Creek Detention Dam, a part of the San Luis Unit of the Central Valley Project, is an earthfill dam located on Little Panoche Creek about 20 miles south of Los Banos, California, Figure 1.

The purposes of the detention dam are to provide a sediment trap and prevent flooding of canals downstream from the dam. The dam is approximately 1,440 feet long at the crest and rises about 120 feet above the creek bed. The principal hydraulic features of the dam are a morning glory type spillway and an outlet works, both located near the right abutment, Figure 2.

The spillway inlet is a 30-foot-diameter morning glory structure with the crest at elevation 641.50. Its maximum discharge capacity is 3,220 cfs at reservoir elevation 670.40. The spillway inlet transitions into a 9.5-foot-diameter conduit leading to a Type II hydraulic jump stilling basin.

The outlet works consists of a 9-foot-square, vertical drop intake structure transitioning into a 6.5-foot-diameter circular conduit leading to a Type II stilling basin, Figure 2. The crest of the intake structure is at elevation 590.00; the design discharge is 900 cfs (100-year flood) at reservoir elevation 641.50, or the same elevation as the spillway crest. At maximum reservoir elevation 670.40, the outlet works design capacity is 1,040 cfs.

Provisions were made to place stoplogs in the intake structure as required to maintain a storage space for incoming sediment. As the reservoir fills with sediment, stoplogs will be placed on the crest of the intake structure to provide sufficient storage space to trap about 95 percent of the sediment. It is estimated that 1 foot of stoplogs must be added approximately every 3 years, or a total of 34 feet in the 100-year life of the structure.

The model studies described herein were concerned with flow conditions in the outlet works intake structure both with stoplogs removed and with stoplogs added to several representative elevations.

THE MODEL

The model, built to a scale ratio of 1:15, included the intake structure with the trashrack and stoplog superstructure, the vertical bend, and a short length of near horizontal conduit. The structure was mounted in the center of a 6- by 10-foot sheet metal lined box. The stilling basin was not included in this investigation. The intake structure and vertical bend were constructed of transparent plastic, heat formed over wood molds. The trashrack and stoplog superstructure, stoplogs, and guide vanes in the elbow were made from wood painted to resist swelling. The horizontal conduit and the flow deflector in the elbow were made from sheet metal, Figure 4.

Water was supplied to the model from the permanent laboratory water supply system. Model discharges were measured with volumetrically calibrated Venturi meters. Flow entering the model reservoir was stilled by passing it through a 6-inch-thick rock baffle. Reservoir elevations were measured by a water column connected to an inlet in the bottom of the model box about 3 feet (model) upstream from the intake structure. Pressures were measured by piezometers connected to open tube water manometers.

THE INVESTIGATION

Description

The intake structure is a 9-foot-square vertical drop inlet, Figure 3. The crest of the inlet is square in cross section and transitions to a 5-foot-diameter circular section in a drop of 13 feet. The 5-foot-diameter circular section continues for an additional drop of 3.5 feet to the P. C. of the vertical bend. The vertical bend, or elbow, turns the flow approximately 90° and diverges from a 5-foot-diameter to a 6-foot 3-inch diameter circular conduit. The 6-foot 3-inch diameter conduit continues on a near horizontal grade to the stilling basin.

The preliminary design included two types of appurtenances in the elbow to improve flow conditions. The first was a deflector on the crown side of the elbow starting at the P. C. and extending vertically downward. A 10-inch-diameter air-inlet pipe admitted air at the base of the deflector. The second appurtenance was two rib-vane-type deflectors placed along the crown of the tunnel on either side of the centerline. These vanes started at the end of the vertical deflector and extended along the elbow and 4 feet 6 inches into the horizontal conduit; their purpose was to prevent spiralling flow in the elbow and horizontal conduit.

A 51-foot-high reinforced concrete trashrack and stoplog structure is located on top of the intake structure. This structure consists of a 5-foot 6-inch square column at each corner reinforced with horizontal beams between columns at 10-foot intervals, Figure 3.

Elbow Studies

Vertical flow deflector. --The purpose of the vertical flow deflector was to provide smooth flow in the horizontal conduit by directing the flow to the invert of the elbow and to act as a control to establish a discharge reservoir elevation relationship. The air vent was placed under the deflector to insure full aeration and free flow conditions in the horizontal conduit. Ideally, a vertical deflector should extend sufficiently down into the bend to establish the desired flow conditions, but must still allow sufficient flow area to pass the design discharge at the design reservoir elevation, (900 cfs at elevation 641.5.)

The initial vertical deflector was 72 inches long, which reduced the flow area in the conduit elbow from 23.77 square feet to 15.51 square feet. This deflector provided excellent flow conditions in the elbow for all discharges tested, except near 500 cfs when the flow tended to spiral over the crown of the tunnel. The 900-cfs design discharge was not obtained until the reservoir reached elevation 663.0, indicating that the deflector constricted the tunnel and reduced the flow.

For the second trial the deflector length was reduced to 57 inches, which increased the flow area to 18.12 square feet. The flow appearance was the same as with the initial deflector, but the design discharge was passed at reservoir elevation 633.0, about 8.5 feet below the design level.

The deflector was lengthened to 63 inches, decreasing the flow area to 17.18 square feet. Flow conditions in the elbow were satisfactory and the design discharge was obtained at reservoir elevation 639.0. Although this elevation was 2.5 feet below the design level, it was reasoned that since the trashracks were not installed in the model the head loss through the racks would probably require a higher reservoir elevation than indicated by the model, therefore, the 63-inch-long vertical deflector was chosen for the prototype structure. Figure 5C shows the excellent flow conditions when the flow is fully controlled by the vertical deflector. All subsequent tests were made with the 63-inch-long deflector installed in the model.

Rib deflectors in crown. -- Longitudinal deflectors on either side of the centerline along the crown of the elbow extended downward 16 inches and provided a 30-inch-wide by 16-inch-deep air passage along the crown, Figure 3. Their purpose was to provide a free air passage along the crown by preventing flow from spiralling over the top of the tunnel.

The longitudinal deflectors performed as anticipated and no changes were recommended. Figure 5B shows flow conditions in the elbow at about a 400-cfs discharge. The flow tended to spiral over the crown at this discharge, but the deflectors turned the flow downward toward the invert of the conduit.

Preliminary Intake Structure

Pressures.--Pressures were measured near the crest and in the throat of the intake structure by four piezometers placed on the invert side and one on the crown side, Figure 6. Initially, pressures were measured without stoplogs for discharges of 300, 400, 500, and 600 cfs; stoplogs which raised the effective crest 1, 4, and 9 feet were then installed, and pressures were obtained for the same discharges. Piezometers were also installed on the inside face of the intake near the top of the stoplogs at the 1-, 4-, and 9-foot heights, Figure 6.

Pressure measurements with no stoplogs in place indicated that the lowest pressures were equivalent to about 2 feet of water below atmospheric. Pressures of this magnitude were measured at the top of the inlet on the invert side and in the throat on the crown side for discharges between 300 and 500 cfs. When the intake was submerged for discharges greater than 500 cfs, all pressures were above atmospheric. One foot of stoplogs installed on the intake structure raised the pressures in the intake about 1 foot. Pressures near the top inside edge of the stoplog were about 1.0 to 2.5 feet of water below atmospheric for discharges of 500 cfs and less; for higher discharges the pressures were above atmospheric due to submergence.

All pressures were above atmospheric for discharges of 600 cfs or higher with 4 feet of stoplogs installed. With 9 feet of stoplogs the pressure in the top log was 1.6 feet below atmospheric with the 600-cfs discharge, which was just prior to submergence. All other pressures were above atmospheric. Pressures at all piezometers including those in the stoplogs were near atmospheric or lower at smaller discharges. When the discharge was greater than 600 cfs, there was full submergence and all pressures were above atmospheric. The pressures were never lower than about 2.7 feet of water below atmospheric.

Discharge capacity.--The discharge capacity of the intake structure was measured for reservoir elevations up to elevation 641.5. The design discharge of 900 cfs could be obtained at reservoir elevation 639.0. Reservoir elevations at 900-cfs discharge were also obtained with stoplogs installed to a height of 1, 4, 9, and 34 feet above the crest. The 900-cfs flow was discharged at reservoir elevation 639.0 for all of these conditions.

Aeration Studies

Considerable flutter and instability of the nappe occurred at discharges between 300 and 500 cfs with the stoplogs installed to a height of 34 feet above the crest, Figure 7. This flutter caused an audible rumble that could possibly be a source of vibration in the prototype structure, and the normally smooth water surface in the model reservoir showed small standing waves emanating from the structure.

There was a 1-foot space between the top of the uppermost log and the bottom of a structural beam at this stoplog level. The flutter occurred when orifice-type flow passed between the top of the stoplog and the bottom of the horizontal beam in addition to weir flow over the top of the beam. The weir flow prevented adequate aeration of the orifice flow which resulted in fluctuating pressures under the nappe and caused the nappe to flutter. The space between the weir and orifice nappes was areated through the stoplog slots and was at atmospheric pressure. The flutter did not occur when the distance between the stoplog and beam was more than 18 inches or less than 6 inches or when the tops of the stoplogs and beams coincided and all flow was over the top. The fluttering action ceased when air was admitted under the nappe of the orifice flow. Two alternative methods of eliminating the flutter were considered: (1) adjusting the placement of the stoplogs to avoid the critical spacing and (2) admitting air under the jet. Placing stoplogs to avoid critical spacing would require as much as 4 feet additional depth in the storage pool. This was considered to be excessive since all runoff from a storm is subject to downstream water rights and if almost normal runoff is not permitted the operators might be subject to litigation. Therefore, the first method was abandoned and methods of admitting air were investigated.

Structure modification.--The first method of admitting air under the orifice-flow jet was to chamfer the inside corners of the four columns of the structure. For structural strength, a 10-inch thickness of concrete was needed on the downstream side of the stoplog slot, thus an 8-inch, 45° chamfer was placed on the downstream corners of the columns. It was reasoned that the chamfers would provide adequate aeration under the jets. However, there was only slight improvement in the noisy fluttering condition for operation over the critical discharge range (300 to 500 cfs) since the flows merged and did not allow full aeration. However, the operation was considered sufficiently improved to incorporate the chamfers in the prototype structure, Figure 3.

Air vents.--Air conduits leading to the atmosphere were installed in the beams and stoplogs to admit air under the jets. The air conduits in the beams did not draw air which indicated that sufficient air was entering under the jet through the stoplog slots. The air conduits in the top stoplogs did draw air and reduced the flutter. However, it would be very difficult to construct an air vent system that could be changed whenever new stoplogs were added, so no further studies were made on this method.

Flow splitters.--The tests were directed toward developing a satisfactory method of splitting the flow passing over the beam or stoplog to allow air to enter under the jet. A vertical column centered between the beams or on top of the stoplogs split the flow as desired so detailed investigations were made to develop the most satisfactory shape and location for the column.

An 8- by 8-inch angle iron, 5 feet high was fastened to the top of each stoplog on the centerline of the opening on all four sides of the structure. The apex of the angle faced upstream and the end of each leg was even with the downstream edge of the stoplog. The angle split the flow, almost eliminated the flutter, and did not reduce the discharge capacity. Figures 8A and C show the flow conditions with this arrangement. The same angle fastened to the downstream face of the stoplog provided even better flow conditions. When the angle iron was reversed, so that the vertex was on the downstream side, there was complete aeration of the jets and the flutter action completely disappeared. A solid triangle-shaped column also provided good flow conditions when placed on top of the stoplogs with the vertex facing either direction.

Although this type of flow splitter was very effective, it would involve initial prototype construction difficulties and its use over the life of the structure would be impractical since the top stoplogs containing the splitters would have to be removed from the structure each time new logs were added.

The angles with their apexes up, were also placed horizontally across the structure over the intake on top of opposite stoplogs. This arrangement was very effective when the flow was between the beam and the top of the stoplog. However, when flow passed over the top of the beam, the nappe clung to the face of the stoplogs, indicating inadequate aeration. Although the angles spanning the structure reduced the flutter, flow conditions were not satisfactory.

Another method of splitting the flow was tested by making the top stoplogs and the beams higher in the center than on the sides, in the form of a peak. This modification did not split the flow sufficiently to permit aeration.

The next tests were made with flow splitters mounted on the beams rather than on the stoplogs. They become an integral part of the structure, and will not need to be moved when stoplogs are added. The initial trial was with flat plates fastened on the downstream side of the beams. Twelve-inch-wide by 1-inch-thick plates were placed on the centerlines of the openings, extending 30 inches above and 18 inches below the beam. Although the plates were very effective in splitting the flow and allowing full aeration under the jets, they reduced the discharge capacity.

Next, 8- by 8-inch angle irons with the vertex facing upstream, were placed vertically in the opening between the beams, Figures 8B and D. The flow did not split as well as when the angles were mounted on the stoplogs. The portion of the flow passing between the beam and the stoplog merged on the flat surface on top of the stoplog downstream from the angle, which prevented aeration under the nappe.

The next flow splitter was a vertical column with an equilateral triangle cross section 12 inches on a side. The column extended between beams in the center of the opening with a flat face upstream and the vertex even with the downstream edge of the beam. The performance was excellent with this flow splitter, and it provided full aeration under the nappe, no flutter in the jet, and no reduction in the discharge capacity.

A vertical column with a 12-inch-square cross section was also tested with equal, but not better, results.

Recommended Design

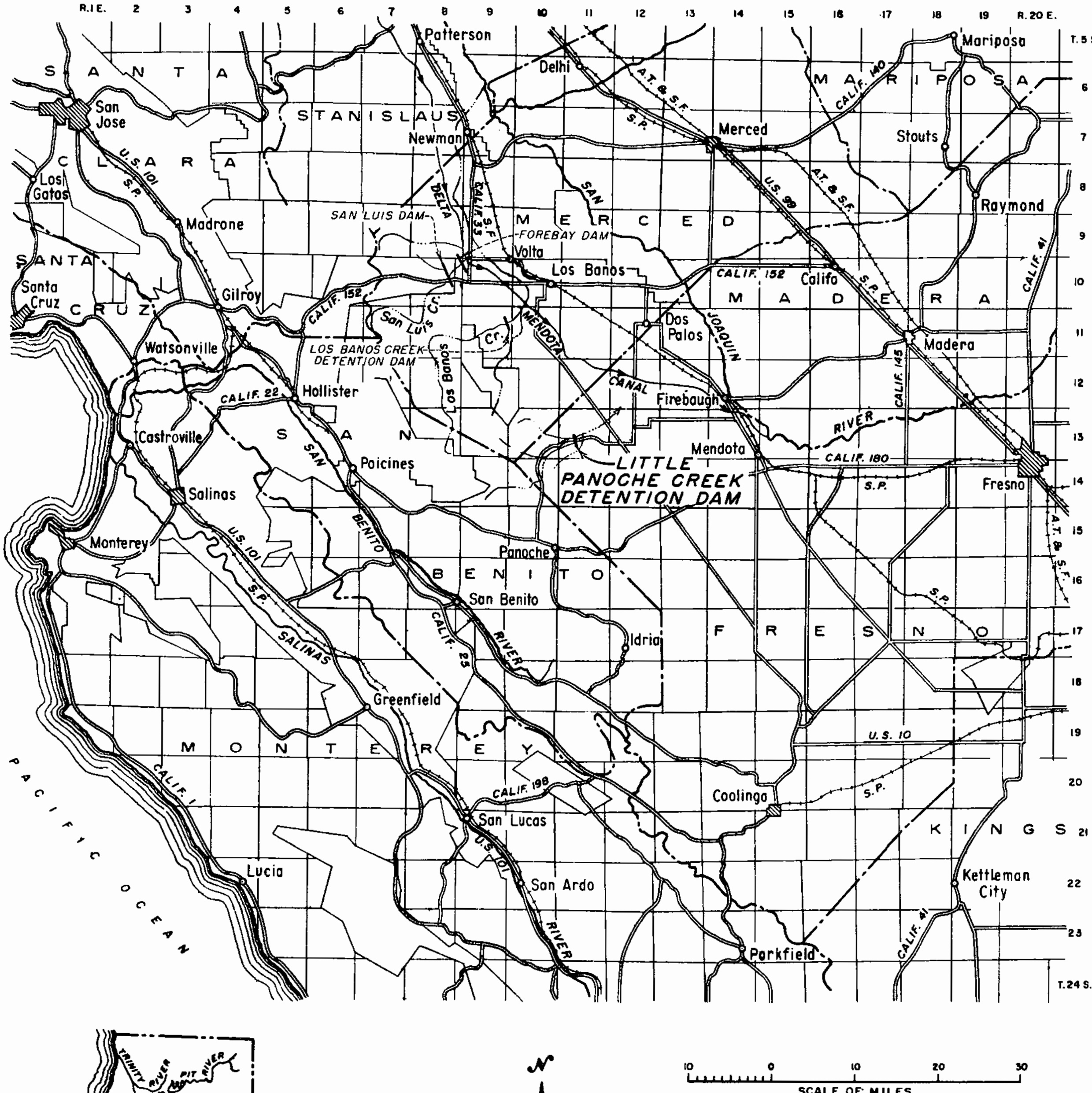
The recommended flow splitters were vertical columns mounted between beams, in the centers of the openings on all four sides of the structure, Figure 3. In cross section the splitters were equilateral triangles, 12 inches on a side. For structural reasons, the apex (facing upstream) was truncated to a 4-inch-wide flat surface and the other two corners had 1-inch chamfers. The 12-inch-wide base was even with the downstream or inside edge of the beam.

Observations were made with 6-, 12-, and 18-inch openings between the top of the stoplogs and the bottom of the two center beams that were 22.5 and 35 feet above the crest. Flow appearance and stability were excellent at all times. There was no indication of flutter in the jet or vibration of the structure, Figure 9.

There was a slight rumbling sound coming from the structure, with the 18-inch opening, but it was determined that it was caused by the air and water mixing during the vertical drop. The flow splitters were removed while the model was operating at 400-cfs discharge; immediately the rumble increased, the nappe of the jets started to flutter, and a noticeable vibration was set up in the structure; the vibration was sufficiently strong to cause standing waves to form on the water surface surrounding the structure. When the flow splitters were replaced, the smooth, quiet flow resumed.

Pressures.--Pressures were measured with the recommended flow splitters installed in the structure. The piezometer locations were identical to those tested in the preliminary design, Figure 10. The pressures were measured for four discharges with stoplogs installed to 1-, 4-, 9-, and 34-foot levels. The lowest pressure, equivalent to 1.70 feet of water below atmospheric was measured in the top stoplog with 34 feet of stoplogs installed, and at a discharge of 600 cfs, Figure 10.

Discharge capacity.--The addition of the recommended flow splitters slightly reduced the capacity of the structure. The design discharge of 900 cfs was obtained at reservoir elevation 639.6, Figure 11. This was about 0.6 foot higher than that observed without the splitters and about 1.9 feet below the design limitation of elevation 641.5. The 900-cfs discharge was obtained at reservoir elevation 639.6 for all levels of stoplogs. The maximum design discharge of 1,040 cfs was passed at reservoir elevation 664.0, or 6.4 feet lower than the elevation used for design purposes. The design and measured discharges agree well within acceptable limits of measurement and computation inaccuracies.



KEY MAP

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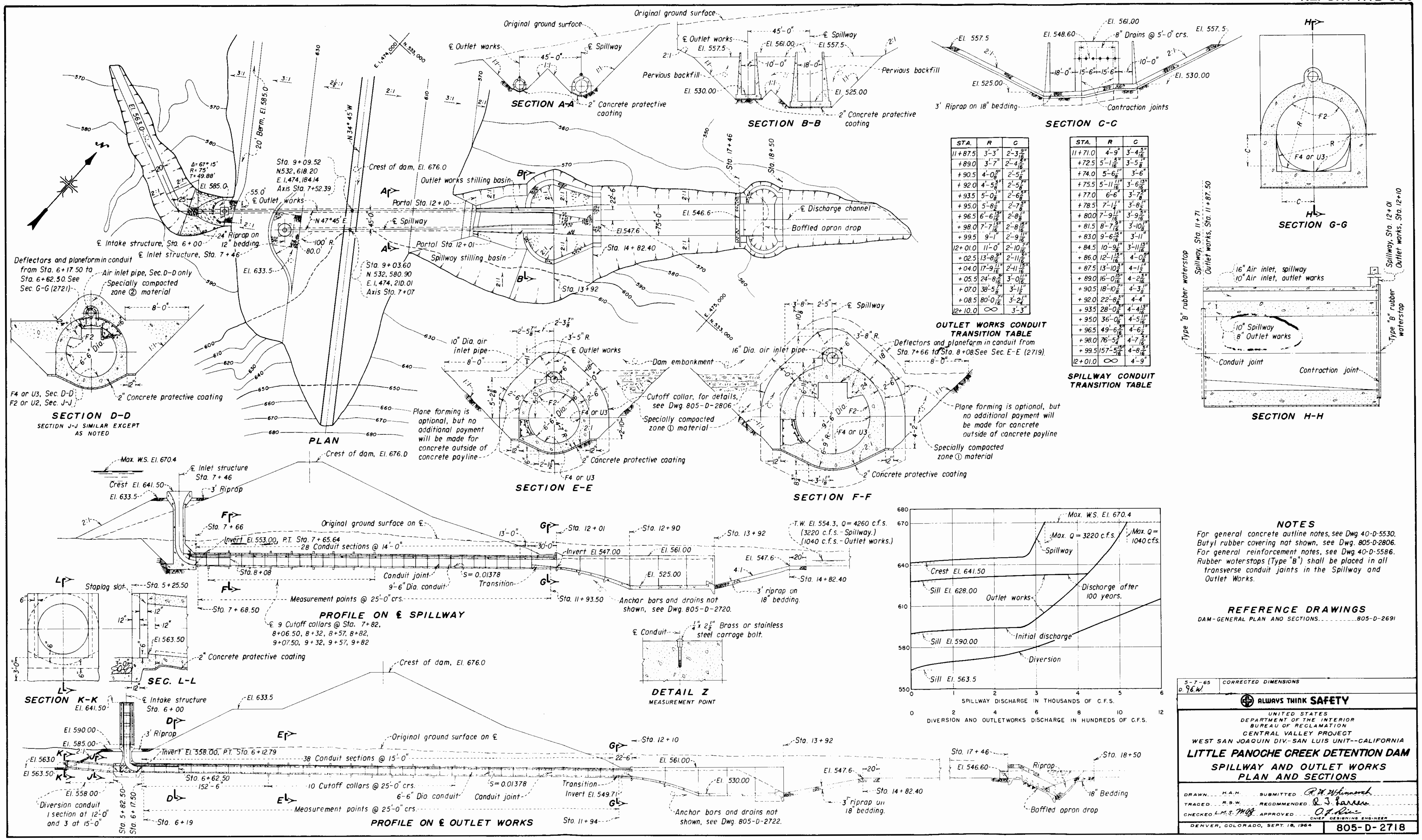
CENTRAL VALLEY PROJECT
WEST SAN JOAQUIN DIV. - SAN LUIS UNIT-CALIFORNIA

LITTLE PANOCHE CREEK DETENTION DAM
LOCATION MAP

DRAWN W.W.G. SUBMITTED R.J. Larsen
TRACED W.W.G. RECOMMENDED
CHECKED APPROVED
ACT. CHIEF ENGINEER

DENVER, COLORADO, SEPT. 22, 1964 | 805-D-2690

FIGURE 2
REPORT HYD-560



STA.	R	C
11+87.5	3'-3"	2'-3 9/16"
+89.0	3'-7"	2'-4 5/16"
+90.5	4'-0 5/8"	2'-5 1/8"
+92.0	4'-5 3/8"	2'-5 7/8"
+93.5	5'-0 1/8"	2'-6 5/8"
+95.0	5'-8 1/2"	2'-7 3/8"
+96.5	6'-6 13/16"	2'-8 1/8"
+98.0	7'-7 13/16"	2'-8 15/16"
+99.5	9'-1"	2'-9 11/16"
12+01.0	11'-0"	2'-10 7/16"
+02.5	13'-8 9/16"	2'-11 3/16"
+04.0	17'-9 11/16"	2'-11 15/16"
+05.5	24'-8 3/16"	3'-0 11/16"
+07.0	38'-5 7/8"	3'-1 1/2"
+08.5	80'-0 7/16"	3'-2 1/4"
12+10.0	∞	3'-3"

OUTLET WORKS CONDUIT TRANSITION TABLE

STA.	R	C
11+71.0	4'-9"	3'-4 5/16"
+72.5	5'-1 5/16"	3'-5 1/8"
+74.0	5'-6 1/8"	3'-6"
+75.5	5'-11 11/16"	3'-6 13/16"
+77.0	6'-6"	3'-7 5/8"
+78.5	7'-1 1/4"	3'-8 1/2"
+80.0	7'-9 11/16"	3'-9 5/16"
+81.5	8'-7 9/16"	3'-10 1/8"
+83.0	9'-6 15/16"	3'-11"
+84.5	10'-9 1/8"	3'-11 13/16"
+86.0	12'-1 15/16"	4'-0 5/8"
+87.5	13'-10 3/4"	4-1 1/2"
+89.0	16'-0 15/16"	4-2 3/16"
+90.5	18'-10 7/8"	4'-3 1/8"
+92.0	22'-8 3/8"	4'-4"
+93.5	28'-0 3/8"	4'-4 13/16"
+95.0	36'-0 7/8"	4'-5 11/16"
+96.5	49'-6 3/16"	4'-6 1/2"
+98.0	76'-5 3/4"	4'-7 5/16"
+99.5	157'-5 15/16"	4'-8 3/16"
12+01.0	∞	4'-9"

SPILLWAY CONDUIT TRANSITION TABLE

NOTES

For general concrete outline notes, see Dwg 40-D-5530.
Butyl rubber covering not shown, see Dwg. 805-D-2806.
For general reinforcement notes, see Dwg. 40-D-5586.
Rubber waterstops (Type "B") shall be placed in all transverse conduit joints in the Spillway and Outlet Works.

REFERENCE DRAWINGS

DAM-GENERAL PLAN AND SECTIONS..........805-D-2691

5-7-65 CORRECTED DIMENSIONS

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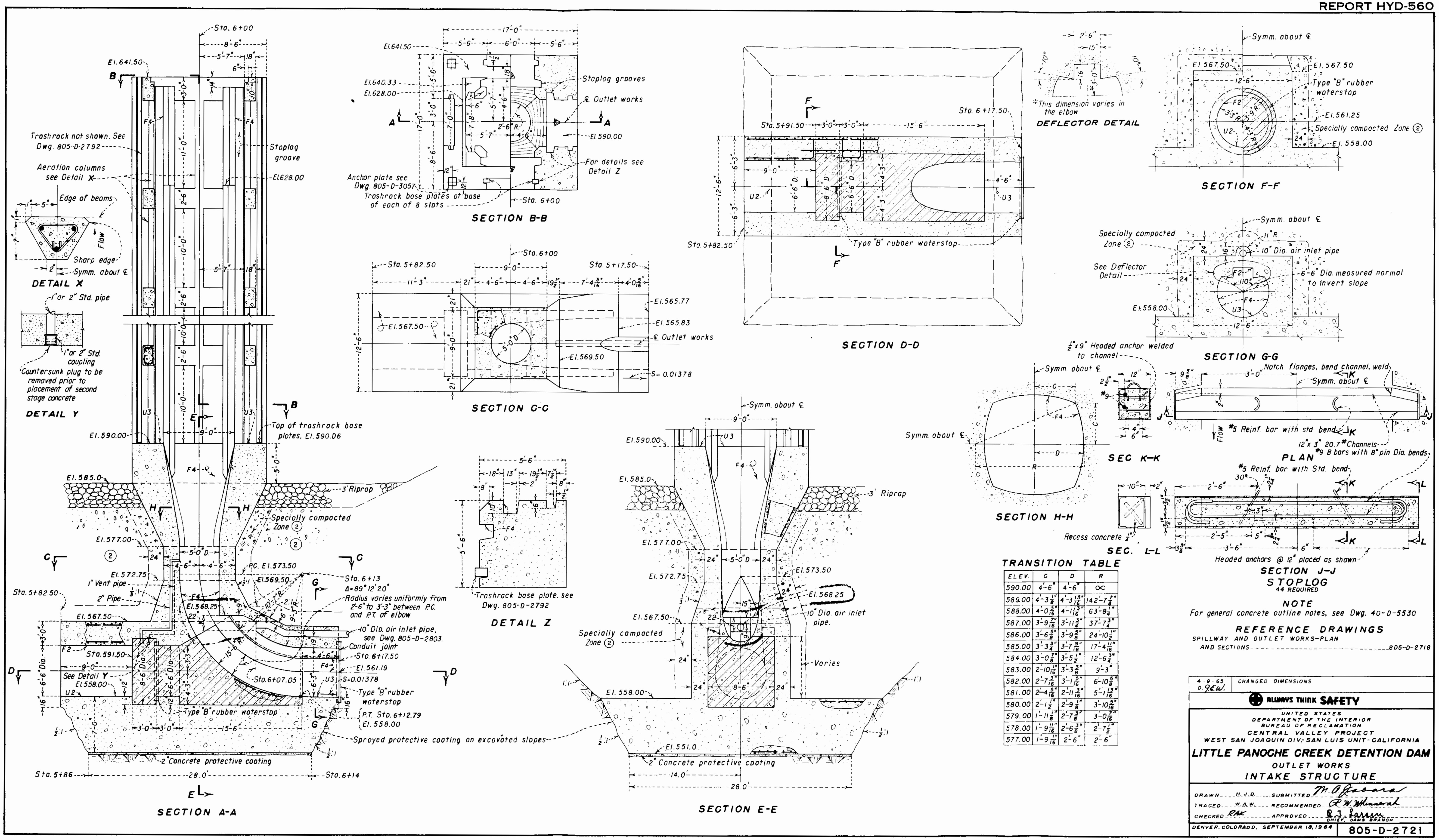
LITTLE PANOCHE CREEK DETENTION DAM
SPILLWAY AND OUTLET WORKS
PLAN AND SECTIONS

DRAWN H.A.H. SUBMITTED R.W. Hinnerk
TRACED R.S.W. RECOMMENDED R.J. Larsen
CHECKED L.M.S. APPROVED O.F. Rice, CHIEF DESIGNING ENGINEER
DENVER, COLORADO, SEPT. 18, 1964

805-D-2718



STOPLOG
44 REQUIRED

TRANSITION TABLE

ELEV.	C	D	R
590.00	4'-6"	4'-6"	∞
589.00	4'-3 1/8"	4'-3 15/16"	142'-7 7/8"
588.00	4'-0 5/16"	4'-1 13/16"	63'-8 1/4"
587.00	3'-9 7/16"	3'-11 3/4"	37'-7 3/4"
586.00	3'-6 5/8"	3'-9 5/8"	24'-10 1/2"
585.00	3'-3 3/4"	3'-7 9/16"	17'-4 11/16"
584.00	3'-0 7/8"	3'-5 1/2"	12'-6 3/4"
583.00	2'-10 1/16"	3'-3 3/8"	9'-3"
582.00	2'-7 3/16"	3'-1 5/16"	6'-10 5/8"
581.00	2'-4 5/16"	2'-11 3/16"	5'-1 13/16"
580.00	2'-1 1/2"	2'-9 1/8"	3'-10 5/16"
579.00	1'-11 1/8"	2'-7 3/8"	3'-0 7/16"
578.00	1'-9 11/16"	2'-6 3/8"	2'-7 1/2"
577.00	1'-9 1/16"	2'-6"	2'-6"

NOTE

For general concrete outline notes, see Dwg. 40-D-5530

REFERENCE DRAWINGS

SPILLWAY AND OUTLET WORKS-PLAN AND SECTIONS 805-D-2718

4-9-65 D. 9.E.W.	CHANGED DIMENSIONS

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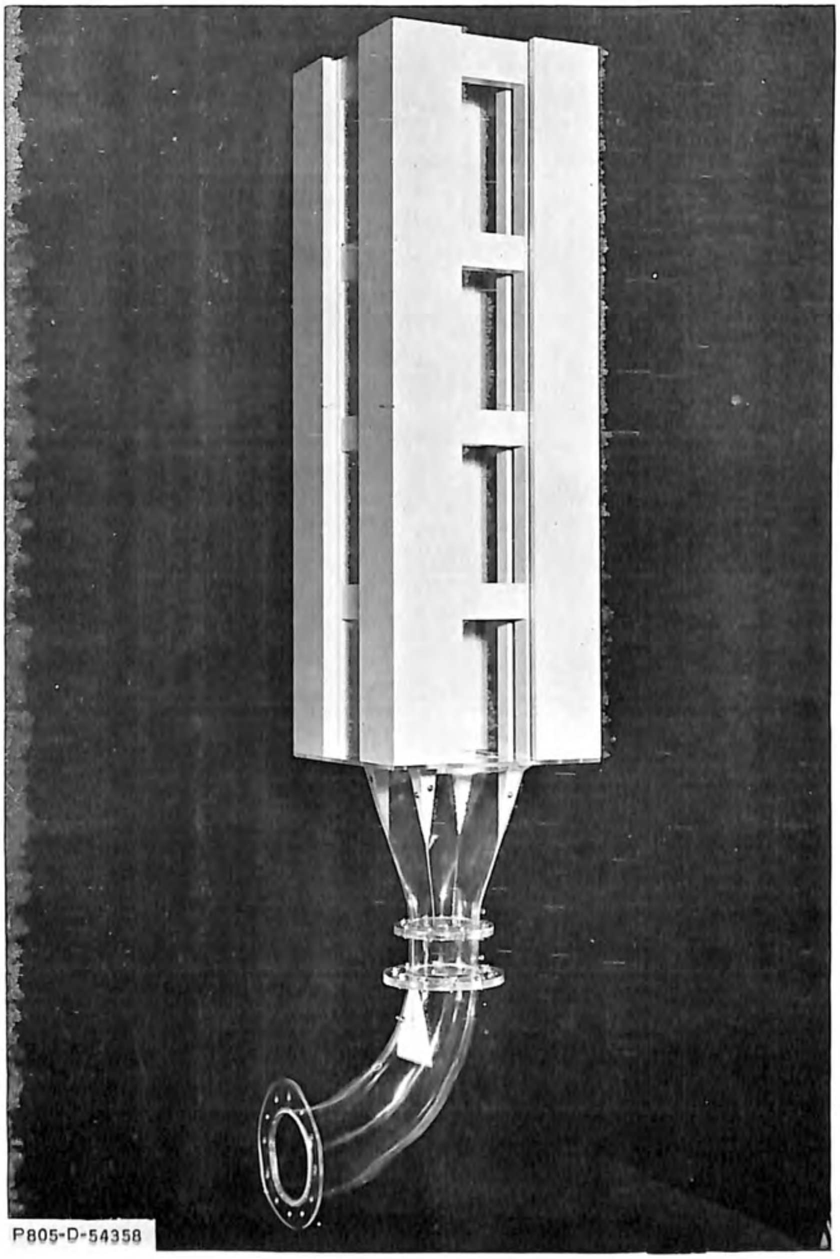
WEST SAN JOAQUIN DIV.-SAN LUIS UNIT-CALIFORNIA

LITTLE PANOCHE CREEK DETENTION DAM
OUTLET WORKS
INTAKE STRUCTURE

DRAWN H.J.D. SUBMITTED M. A. [signature]
TRACED W.A.W. RECOMMENDED R. W. [signature]
CHECKED RAK APPROVED R. J. [signature] CHIEF, DAMS BRANCH

DENVER, COLORADO, SEPTEMBER 18, 1964 | 805-D-2721

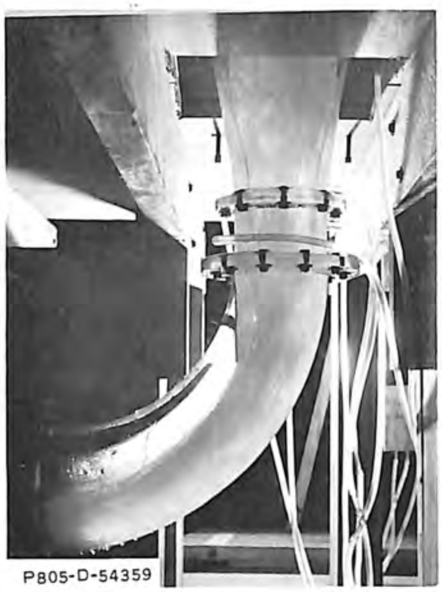


Note: Rib deflectors in crown of elbow not installed.
Vertical deflector in place.

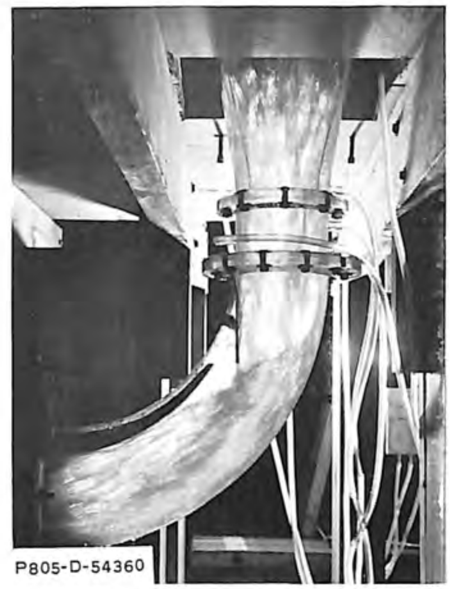
LITTLE PANOCHE CREEK DETENTION DAM
Outlet Works - Intake Structure

1:15 Scale Model

Figure 5
Report Hyd-560



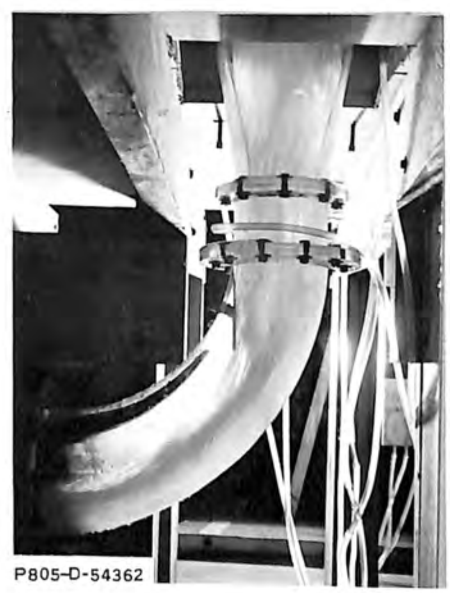
A



B

Q = 400 cfs

C



D

Q = 600 cfs

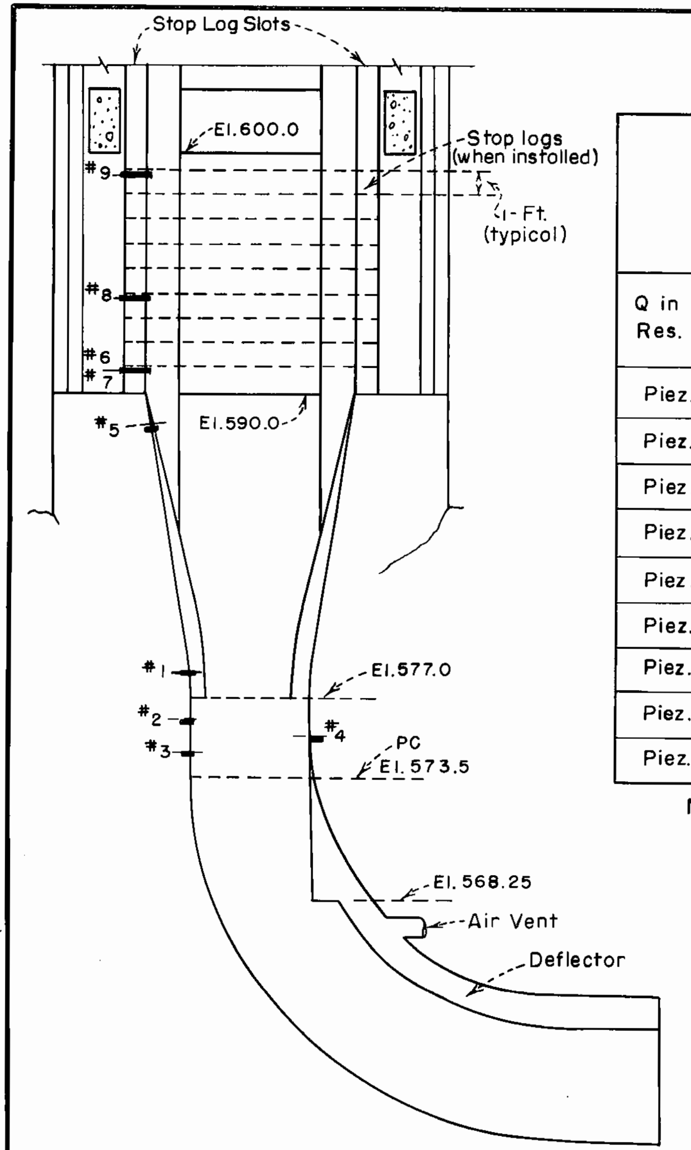
No stoplogs

Stoplogs to 34 feet

LITTLE PANOCHE CREEK DETENTION DAM
Outlet Works - Intake Structure

Flow in Recommended Elbow

1:15 Scale Model



SECTION
Through Centerline showing Piezometer locations.

	PRESSURES															
	TEST NO. 1 No Stop Logs				TEST NO. 2 1- Ft. of Stop Logs				TEST NO. 3 4- Ft. of Stop Logs				TEST NO. 4 9 - Ft. of Stop Logs			
Q in cfs	300	400	500	600	300	400	500	600	300	400	500	600	300	400	500	600
Res. El.	592.85	593.12	593.67	598.20	593.36	593.83	594.30	599.77	596.33	596.72	597.15	599.77	603.02	603.51	604.12	604.63
Piez. #1	-0.1	-0.8	+1.2	+5.5	+0.3	-0.7	+2.7	+6.3	0	-0.1	-1.2	+6.6	-0.6	-0.9	-1.9	+6.9
Piez. #2	0	+0.2	+3.1	+7.3	+0.3	-0.2	+3.5	+8.3	0	+0.1	-0.6	+8.6	-0.3	0	-0.3	+8.3
Piez. #3	-0.6	-0.8	+4.4	+8.9	-0.3	+0.1	+4.7	+9.9	-0.5	-0.1	+2.5	+10.0	-0.6	-0.6	-0.3	+9.4
Piez. #4	-1.9	-2.0	+1.3	+4.6	-0.6	-0.5	+0.6	+3.6	-0.5	-2.8	-1.2	+5.0	-1.4	-2.2	-1.9	+5.0
Piez. #5	-1.6	-1.8	-2.2	+6.6	-0.6	-0.9	-1.8	+8.3	-0.5	-0.9	-1.6	+9.4	-0.8	-1.6	-2.5	+7.8
Piez. #6	—	—	—	—	-1.9	-1.9	-2.5	+5.5	-0.6	-0.9	-1.9	+6.2	-0.9	-1.7	-2.7	+5.0
Piez. #7	—	—	—	—	-1.1	-1.3	-1.6	+6.1	-0.5	-0.6	-1.2	+7.2	—	—	—	—
Piez. #8	—	—	—	—	—	—	—	—	-0.5	-0.6	-1.2	+3.6	-0.5	-1.0	-1.9	+2.2
Piez. #9	—	—	—	—	—	—	—	—	—	—	—	—	-1.4	-1.7	-2.2	-1.6

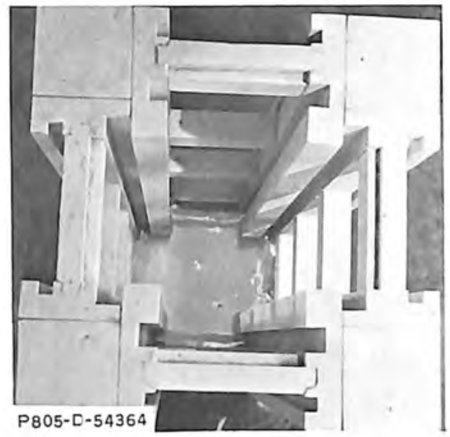
NOTES:

Pressures are in feet of water above (+) or below (-) piezometer opening.
Piezometers 6, 7, 8, and 9 are in Stop logs.
Piezometers are on centerline of opening except for No. 7 which is on left side of opening.

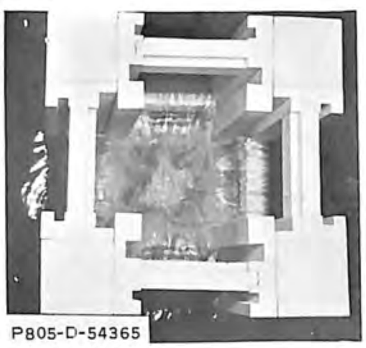
LITTLE PANOCHE CREEK DETENTION DAM
OUTLET WORKS INTAKE STRUCTURE
PRELIMINARY DESIGN

PRESSURE MEASUREMENTS
1:15 SCALE MODEL

Figure 7
Report Hyd-560



A No stoplogs B



C 34 feet of stoplogs D

Discharge = 400 cfs
Note depressed jet

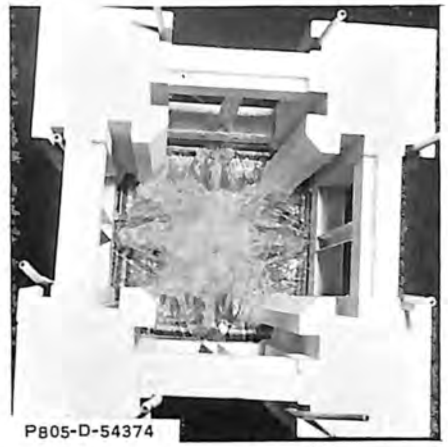
Discharge = 600 cfs

LITTLE PANOCHE CREEK DETENTION DAM
Outlet Works - Intake Structure

Flow in Preliminary Structure

1:15 Scale Model

A



B

Discharge = 270 cfs

C

D

Discharge = 400 cfs

Angle irons fastened to stoplogs

Angle irons fastened to beams

34 feet of stoplogs in place

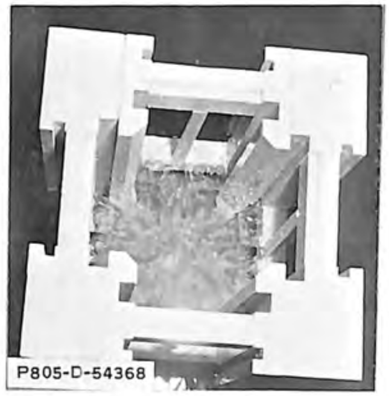
LITTLE PANOCHE CREEK DETENTION DAM
Outlet Works - Intake Structure

Angle iron flow splitters in intake structure

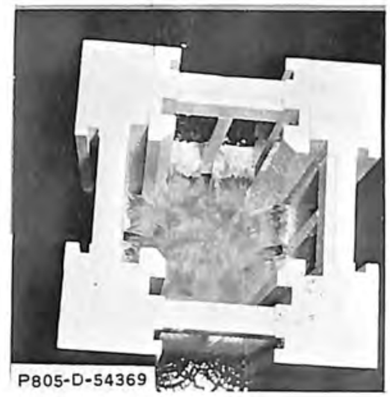
1:15 Scale Model

Figure 9
Report Hyd-560

250 cfs



400 cfs



600 cfs

34 feet of stoplogs installed
1-foot opening between stoplog and beam

250 cfs

400 cfs

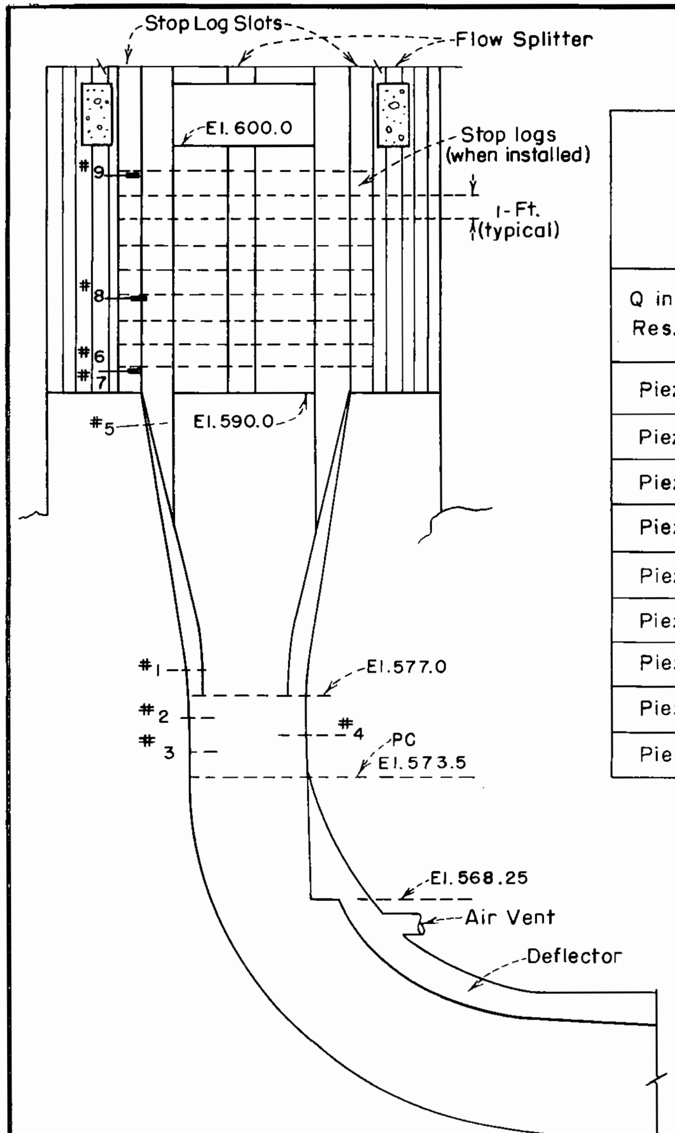
600 cfs

43 feet of stoplogs installed
Stoplogs extend above beam

LITTLE PANOCHE CREEK DETENTION DAM
Outlet Works - Intake Structure

Flow with recommended flow splitters

1:15 Scale Model



SECTION
Through Centerline showing Piezometer locations.

PRESSURES

	TEST NO. 1 1- Ft. of Stop Logs				TEST NO. 2 4- Ft. of Stop Logs				TEST NO. 3 9- Ft. of Stop Logs				TEST NO. 4 34-Ft. of Stop Logs			
Q in cfs Res. El.	300 593.8	400 594.2	600 599.5	900 639.6	300 596.6	400 597.9	600 599.5	900 639.6	300 603.0	400 603.7	600 604.7	900 639.6	300 629.2	400 629.9	600 630.8	900 639.6
Piez.#1	-.22	-.30	+5.8	+27.0	-.38	-.52	+6.0	+26.1	-.45	-.45	+7.0	+27.6	-.75	-1.0	+10.3	+26.8
Piez.#2	-.08	-.15	+7.7	+29.2	-.15	0	+7.8	+28.1	-.22	-.15	+8.8	+29.5	0	0	+11.0	+28.8
Piez.#3	-.52	-.45	+9.1	+29.8	-.75	-.60	+9.3	+29.1	-.82	-.62	+10.0	+30.8	-1.4	-1.0	+11.5	+30.3
Piez.#4	+1.20	+1.35	+9.2	+30.4	+1.72	+2.02	+9.3	+29.5	+1.12	+.75	+10.9	+40.0	+1.6	+2.6	+13.1	+30.2
Piez.#5	-.15	-.30	+8.4	+46.0	-.22	-.45	+9.2	+46.0	-.45	-.90	+11.4	+47.8	-.22	-.60	+14.8	+46.5
Piez.#6	-.30	-.45	+5.0	+41.4	-.90	-.90	+6.4	+42.5	-.45	-.90	+7.9	+45.8	-.30	-.60	+11.8	+44.4
Piez.#7	—	—	—	—	-.75	-.68	+3.1	+37.2	-.52	-1.0	+4.7	+42.4	—	—	—	—
Piez.#8	—	—	—	—	—	—	—	—	-.68	-1.1	-1.2	+35.7	+.08	-.22	+3.7	+36.5
Piez.#9	—	—	—	—	—	—	—	—	—	—	—	—	-.75	-1.1	-1.7	+9.4

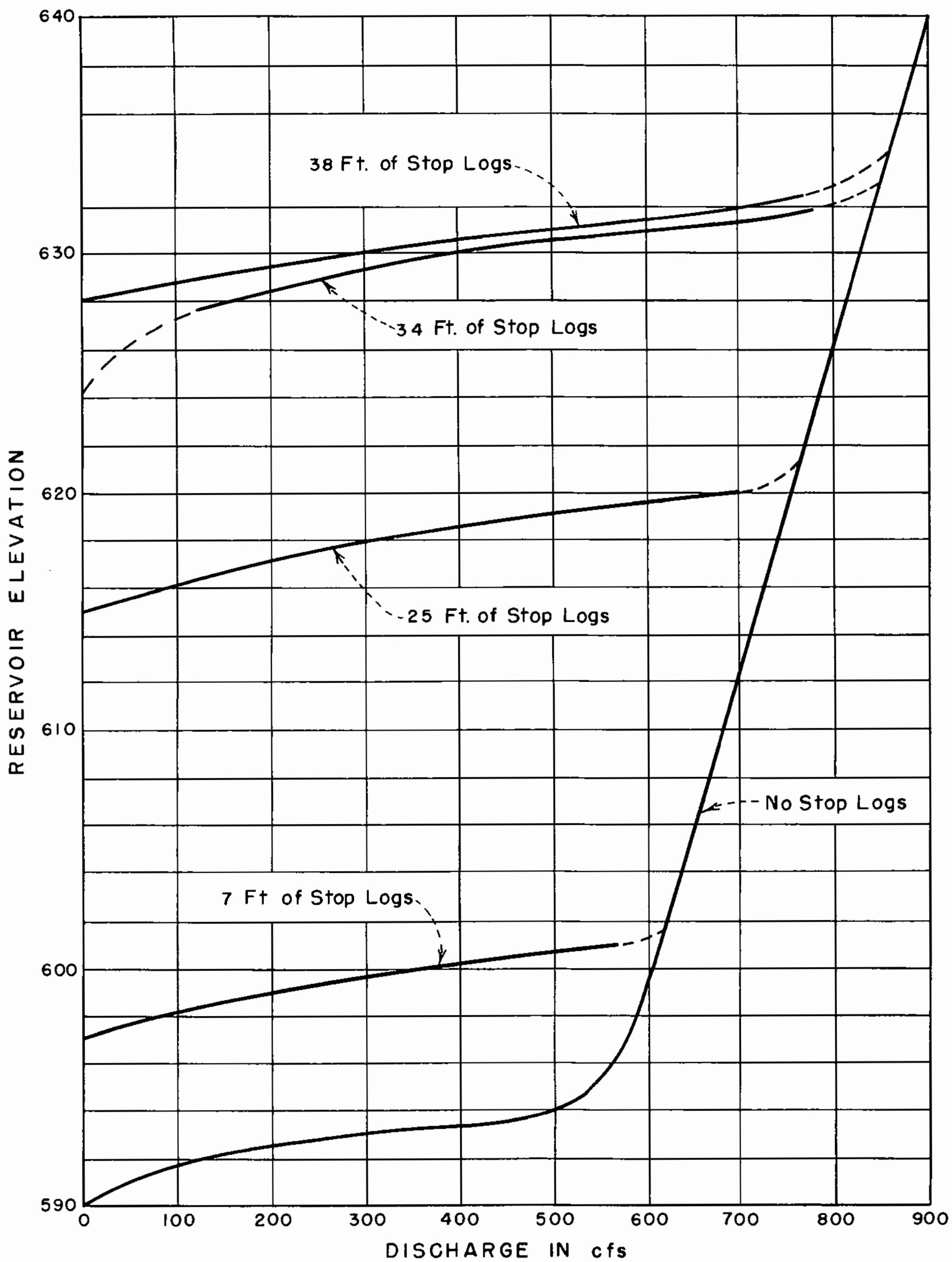
NOTES:
Pressures are in feet of water above (+) or below (-) piezometer opening.
Piezometers 6, 7, 8, and 9 are in Stop logs (#9 at 34 Ft. level).
Piezometers are on Centerline of opening.

LITTLE PANOCHE CREEK DETENTION DAM
OUTLET WORKS INTAKE STRUCTURE
RECOMMENDED DESIGN

PRESSURE MEASUREMENTS
1:15 SCALE MODEL

FIGURE 10
REPORT HYD-560

705



LITTLE PANOCHE CREEK DETENTION DAM
OUTLET WORKS INTAKE STRUCTURE
RECOMMENDED DESIGN

DISCHARGE CAPACITY
1:15 SCALE MODEL

CONVERSION FACTORS--BRITISH TO METRIC UNITS OF MEASUREMENT

The following conversion factors adopted by the Bureau of Reclamation are those published by the American Society for Testing and Materials (ASTM Metric Practice Guide, January 1964) except that additional factors (*) commonly used in the Bureau have been added. Further discussion of definitions of quantities and units is given on pages 10-11 of the ASTM Metric Practice Guide.

The metric units and conversion factors adopted by the ASTM are based on the "International System of Units" (designated SI for Systeme International d'Unites), fixed by the International Committee for Weights and Measures; this system is also known as the Giorgi or MKSA (meter-kilogram (mass)-second-ampere) system. This system has been adopted by the International Organization for Standardization in ISO Recommendation R-31.

The metric technical unit of force is the kilogram-force; this is the force which, when applied to a body having a mass of 1 kg, gives it an acceleration of 9.80665 m/sec/sec, the standard acceleration of free fall toward the earth's center for sea level at 45 deg latitude. The metric unit of force in SI units is the newton (N), which is defined as that force which, when applied to a body having a mass of 1 kg, gives it an acceleration of 1 m/sec/sec. These units must be distinguished from the (inconstant) local weight of a body having a mass of 1 kg; that is, the weight of a body is that force with which a body is attracted to the earth and is equal to the mass of a body multiplied by the acceleration due to gravity. However, because it is general practice to use "pound" rather than the technically correct term "pound-force," the term "kilogram" (or derived mass unit) has been used in this guide instead of "kilogram-force" in expressing the conversion factors for forces. The newton unit of force will find increasing use, and is essential in SI units.

Table 1

QUANTITIES AND UNITS OF SPACE

Multiply	By	To obtain
	LENGTH	
Mil	25.4 (exactly)	Micron
Inches	25.4 (exactly)	Millimeters
	2.54 (exactly)*	Centimeters
Feet	30.48 (exactly)	Centimeters
	0.3048 (exactly)*	Meters
	0.0003048 (exactly)*	Kilometers
Yards	0.9144 (exactly)	Meters
Miles (statute)	1,609.344 (exactly)*	Meters
	1.609344 (exactly)	Kilometers
	AREA	
Square inches	6.4516 (exactly)	Square centimeters
Square feet	929.03 (exactly)*	Square centimeters
	0.092903 (exactly)	Square meters
Square yards	0.836127	Square meters
Acres	0.40469*	Hectares
	4,046.9*	Square meters
	0.0040469*	Square kilometers
Square miles	2.58999	Square kilometers
	VOLUME	
Cubic inches	16.3871	Cubic centimeters
Cubic feet	0.0283168	Cubic meters
Cubic yards	0.764555	Cubic meters
	CAPACITY	
Fluid ounces (U.S.)	29.5737	Cubic centimeters
	29.5729	Milliliters
Liquid pints (U.S.)	0.473179	Cubic decimeters
	0.473166	Liters
Quarts (U.S.)	9,463.58	Cubic centimeters
	0.946358	Liters
Gallons (U.S.)	3,785.43*	Cubic centimeters
	3.78543	Cubic decimeters
	3.78533	Liters
	0.00378543*	Cubic meters
Gallons (U.K.)	4.54609	Cubic decimeters
	4.54596	Liters
Cubic feet	28.3160	Liters
Cubic yards	764.55*	Liters
Acre-feet	1,233.5*	Cubic meters
	1,233,500*	Liters

Table II

QUANTITIES AND UNITS OF MECHANICS

Multiply	By	To obtain
MASS		
Grains (1/7,000 lb)	64.79891 (exactly)	Milligrams
Troy ounces (480 grains)	31.1035	Grams
Ounces (avdp)	28.3495	Grams
Pounds (avdp)	0.45359237 (exactly)	Kilograms
Short tons (2,000 lb)	907.185	Kilograms
	0.907185	Metric tons
Long tons (2,240 lb)	1,016.05	Kilograms
FORCE/AREA		
Pounds per square inch	0.070307	Kilograms per square centimeter
	0.689476	Newtons per square centimeter
Pounds per square foot	4.88243	Kilograms per square meter
	47.8803	Newtons per square meter
MASS/VOLUME (DENSITY)		
Ounces per cubic inch	1.72999	Grams per cubic centimeter
Pounds per cubic foot	16.0185	Kilograms per cubic meter
	0.0160185	Grams per cubic centimeter
Tons (long) per cubic yard	1.32894	Grams per cubic centimeter
MASS/CAPACITY		
Ounces per gallon (U.S.)	7.4893	Grams per liter
Ounces per gallon (U.K.)	6.2362	Grams per liter
Pounds per gallon (U.S.)	119.829	Grams per liter
Pounds per gallon (U.K.)	99.779	Grams per liter
BENDING MOMENT OR TORQUE		
Inch-pounds	0.011521	Meter-kilograms
	1.12985×10^6	Centimeter-dynes
Foot-pounds	0.138255	Meter-kilograms
	1.35582×10^7	Centimeter-dynes
Foot-pounds per inch	5.4431	Centimeter-kilograms per centimeter
Ounce-inches	72.008	Gram-centimeters
VELOCITY		
Feet per second	30.48 (exactly)	Centimeters per second
	0.3048 (exactly)*	Meters per second
Feet per year	0.965873×10^{-6}*	Centimeters per second
Miles per hour	1.609344 (exactly)	Kilometers per hour
	0.44704 (exactly)	Meters per second
ACCELERATION*		
Feet per second^2	0.3048*	Meters per second^2
FLOW		
Cubic feet per second (second-feet)	0.028317*	Cubic meters per second
Cubic feet per minute	0.4719	Liters per second
Gallons (U.S.) per minute	0.06309	Liters per second

Multiply	By	To obtain
FORCE*		
Pounds	0.453592*	Kilograms
	4.4482*	Newtons
	4.4482×10^{-5}*	Dynes
WORK AND ENERGY*		
British thermal units (Btu)	0.252*	Kilogram calories
	1,055.06	Joules
Btu per pound	2.326 (exactly)	Joules per gram
Foot-pounds	1.35582*	Joules
POWER		
Horsepower	745.700	Watts
Btu per hour	0.293071	Watts
Foot-pounds per second	1.35582	Watts
HEAT TRANSFER		
Btu in./hr ft^2 deg F (k, thermal conductivity)	1.442	Milliwatts/cm deg C
	0.1240	Kg cal/hr m deg C
Btu ft/hr ft^2 deg F	1.4880*	Kg cal m/hr m^2 deg C
Btu/hr ft^2 deg F (C, thermal conductance)	0.568	Milliwatts/cm^2 deg C
	4.882	Kg cal/hr m^2 deg C
Deg F hr ft^2/Btu (R, thermal resistance)	1.761	Deg C cm^2/milliwatt
Btu/lb deg F (c, heat capacity)	4.1868	J/g deg C
Btu/lb deg F	1.000*	Cal/gram deg C
Ft^2/hr (thermal diffusivity)	0.2581	Cm^2/sec
	0.09290*	M^2/hr
WATER VAPOR TRANSMISSION		
Grains/hr ft^2 (water vapor transmission)	16.7	Grams/24 hr m^2
Perms (permeance)	0.659	Metric perms
Perm-inches (permeability)	1.67	Metric perm-centimeters

Table III

OTHER QUANTITIES AND UNITS

Multiply	By	To obtain
Cubic feet per square foot per day (seepage)	304.8*	Liters per square meter per day
Pound-seconds per square foot (viscosity)	4.8824*	Kilogram second per square meter
Square feet per second (viscosity)	0.02903* (exactly)	Square meters per second
Fahrenheit degrees (change)*	5/9 exactly	Celsius or Kelvin degrees (change)*
Volts per mil	0.03937	Kilovolts per millimeter
Lumens per square foot (foot-candles)	10.764	Lumens per square meter
Ohm-circular mils per foot	0.001662	Ohm-square millimeters per meter
Millicuries per cubic foot	35.3147*	Millicuries per cubic meter
Milliamps per square foot	10.7639*	Milliamps per square meter
Gallons per square yard	4.527219*	Liters per square meter
Pounds per inch	0.17858*	Kilograms per centimeter

GPO 845-237

ABSTRACT

A 1:15 scale model of the intake structure of Little Panoche Creek outlet works indicated certain modifications necessary to improve flow conditions. A vertical deflector at the crown of the elbow was dimensioned to act as a control so that the design flow of 900 cfs could be discharged at the design reservoir elevation. Vertical flow splitters, with a cross section similar to a truncated triangle, were placed between the horizontal structural beams of the trashrack-stoplog structure to allow aeration under the jets flowing over the stoplogs. This eliminated a flutter and rumble in the intake that occurred when the stoplogs were installed to within 6 to 18 in. of the beams. Pressures in the throat and elbow of the intake were near atmospheric or above at all flows. The design discharge was attained at the design reservoir elevation with stoplogs installed to any height up to 34 feet above the crest.

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Hyd-560
Rhone, T. J.
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USBR Lab Rept Hyd-560, Hyd Br, June 1, 1966. Bureau of Reclamation, Denver, 10 p, including 11 fig

DESCRIPTORS-- *hydraulic structures/ *outlet works/ stop logs/ air demand/ capacity reduction/ control structures/ flow/ flow control/ *hydraulic models/ jets/ pipe bends/ unsteady flow/ *pulsating flow/ aeration/ guide vanes/ nappe/ discharges/ intake structures/ water pressures/ research and development
IDENTIFIERS--Little Panoche Creek Detention Dam, Calif/ Central Valley Proj, Calif/ flow splitters/ California/ hydraulic design/ free flow

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