Memorandum

Denver, Colorado
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Chief, Dams Branch

ACTING Chief, Engineering Laboratories Branch

Model studies on Savage Rapids Dam--Grants Pass Project, Oregon

In connection with the rehabilitation of Savage Rapids Dam, certain information concerning pressures on two of the several overflow sections was required to proceed with the design. There being no applicable data available, a quick and inexpensive alteration to an already existing model was made to procure the information required.

OVERFLOW AND SLUICEWAY SECTION

The first problem required the pressures under the cantilever slab of the overfall section shown on Figure 1, for two conditions of flow, (1) for flow over the slab and (2) for flow over the slab and through the sluiceway simultaneously. The model was on a 1:48 scale and is shown on Figure 2A. The model demonstrated early in the tests that the pressure under the slab could be increased approximately 1 foot of water by cutting the slab back 2 feet as indicated by the dotted line on Figure 1. After the slab was cut back, the following pressures, prototype, were recorded:

Reservoir elevation (1)	Tail-water elevation (2)	Prototype pressure under slab ft of water (3)	Sluiceway (4)
960	947	+1.1	Closed
		-4.0	Open
964	950	+1.5	Closed
		-1.7	Open
970	954	+5.5	Closed
		+5.5	Open

With the sluiceway gate closed, the pressure under the slab was always positive. The magnitude of the pressure depended entirely on the tail-water elevation. With water flowing through the sluiceway and over the crest simultaneously, the pressure under the slab was either positive or negative depending on the operating condition. In general, an increase in the head on the crest, while holding the tail water constant, lowered the pressure

under the slab. Conversely, raising the tail water, holding a constant head on the crest, increased the pressure under the slab. The sluiceway was operated with gate completely raised or completely closed, the former constituting the most adverse condition. The slab was designed for a total pressure of 10 feet of water, so in no case contemplated will the positive pressure above the slab plus the negative pressure under the slab exceed this amount.

ARCH AND BUTTRESS SECTION

The second model represented a section of the arch and buttress portion of the dam. As rehabilitated, the section will appear as shown in Figure 3. The model, on a 1:32 scale, is shown on Figure 2B. As the overfall curve is rather sharp for the head involved, it was desired to know the magnitude of the pressures under the nappe. Steady subatmospheric pressures would not be particularly objectionable, but fluctuating pressures could cause the sheet of water to flutter or make and break contact with the downstream face of the dam. The latter could be objectionable from the standpoint of instability and noise. Six piezometers were installed in the model, as shown in Figure 3. Pressures observed for headwater at elevation 964 and tail water at elevation 950 are as follows:

	Prototype pressure in feet of water	
Piezometer (1)	Vent closed (2)	Vent open (3)
1	+3.2	+3.2
2	-1.1	-0.5
3	-5.3	-4.8
4	-7.5	-5.9
5	-4.0	-3.4
6	+1.8	+1.3

The first test was made with no air admitted under the nappe, and the pressures observed are shown in Column 2. The second test was made admitting air to the underside of the nappe through an existing 6-inch diameter air vent located in each large pier (Figure 3). These pressures, shown in Column 3, are only somewhat better than those in Column 2. Air passing through the vent did

not aerate the entire crest; rather, it merely was effective over a small portion on either side of the pier. This accounts for the small pressure differences.

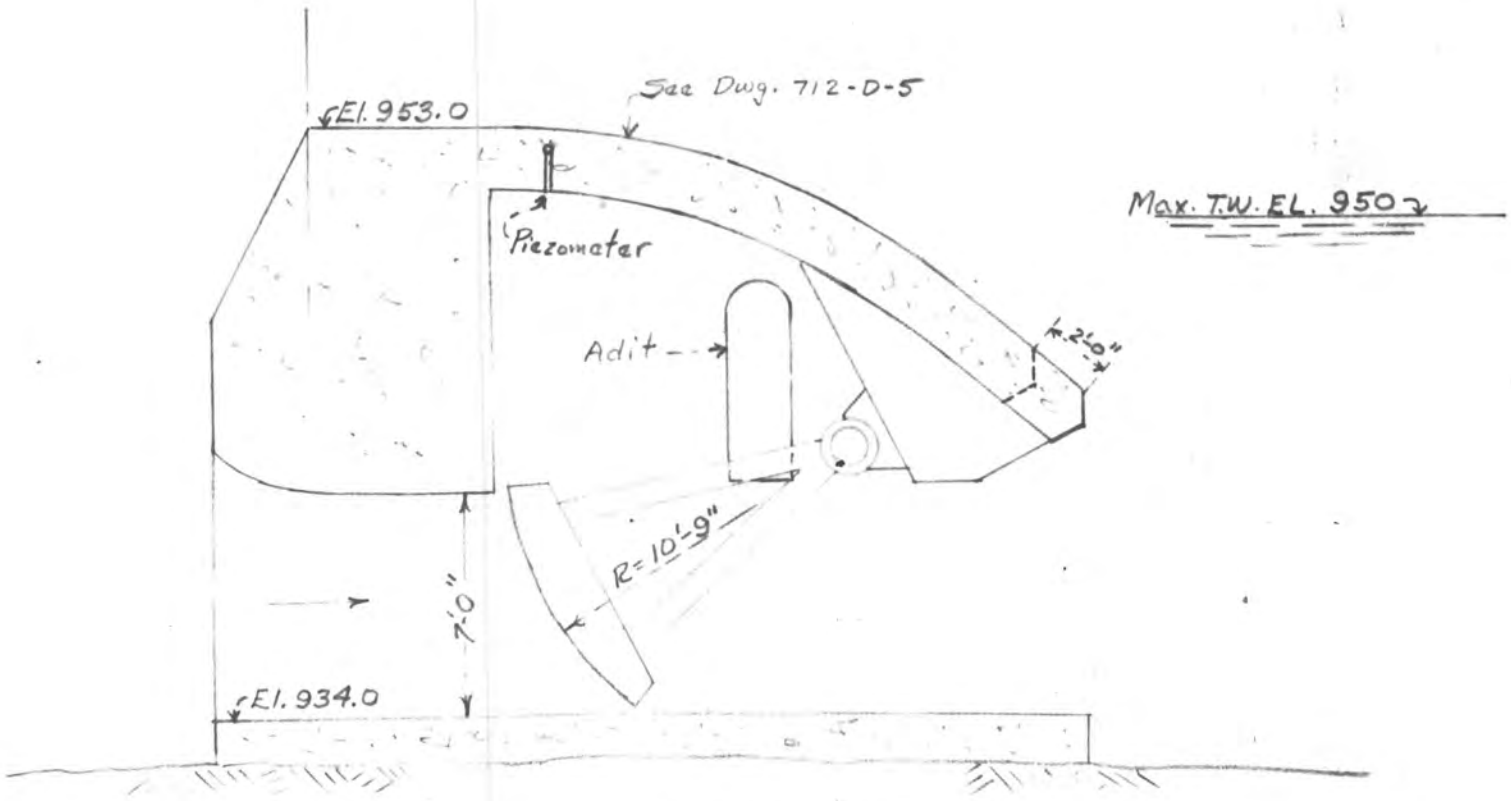
Several schemes were next tried to cause the lower surface of the nappe to break free from the overfall section so air could penetrate across the entire crest. The most satisfactory method consisted of installing a step, 2 feet wide, at the crest, as shown by alteration A on Figure 3. This change accomplished the desired purpose, and the air supplied through the 6-inch vent was sufficient to permit stable operation up to a reservoir elevation of 962. For higher heads, additional air was needed. To obtain more air, it was suggested that (1) a small deflector be placed above the entrance of each 6-inch air vent, as indicated by alteration B on Figure 3, to prevent water from entering the duct; and (2) install a second deflector, or merely a gob of concrete on the end of each intermediate pier, alteration C, Figure 3, to allow air to enter under the sheet of water at this point. The shape of the latter deflector can be made such that it will not retard the passage of debris.

Prototype pressures at the six piezometers for several combinations of the suggested alterations, with reservoir held at elevation 964, are listed in the following table:

	Prototype Pressure in feet of water		
Piezometer	Step A installed no aeration	Alterations A&B installed--Aeration through 6 in. vent	Alterations A B&C installed
(1)	(2)	(3)	(4)
1	+3.2	+3.2	+4.5
2			
3	-10.2	-2.7	-0.5
4	-8.5	-3.5	-0.5
5	-2.1	-1.0	-0.7
6	+2.3	-1.0	-0.5

The pressures in Column 2 were obtained with Step A installed and the 6-inch air vent closed. The pressures in Column 3 reflect the effect achieved by admitting air through the 6-inch air vent to a point immediately below the Step A. By placing the deflector C on each intermediate low pier additional aeration was permitted. The resulting pressures are shown in Column 4. By means of the three alterations mentioned aeration was satisfactory and effective up to

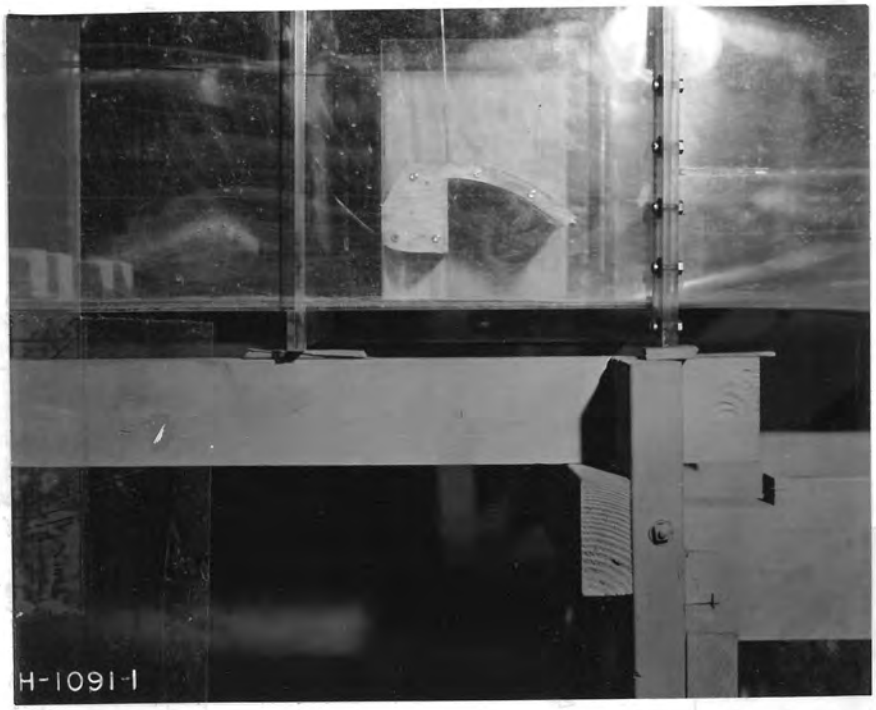
a reservoir elevation of 967. The tail water had little or no effect on the measured pressures for the arch and buttress section.



SAVAGE RAPIDS DAM
SLUICEWAY AND OVERFLOW
SECTION

FIGURE 1

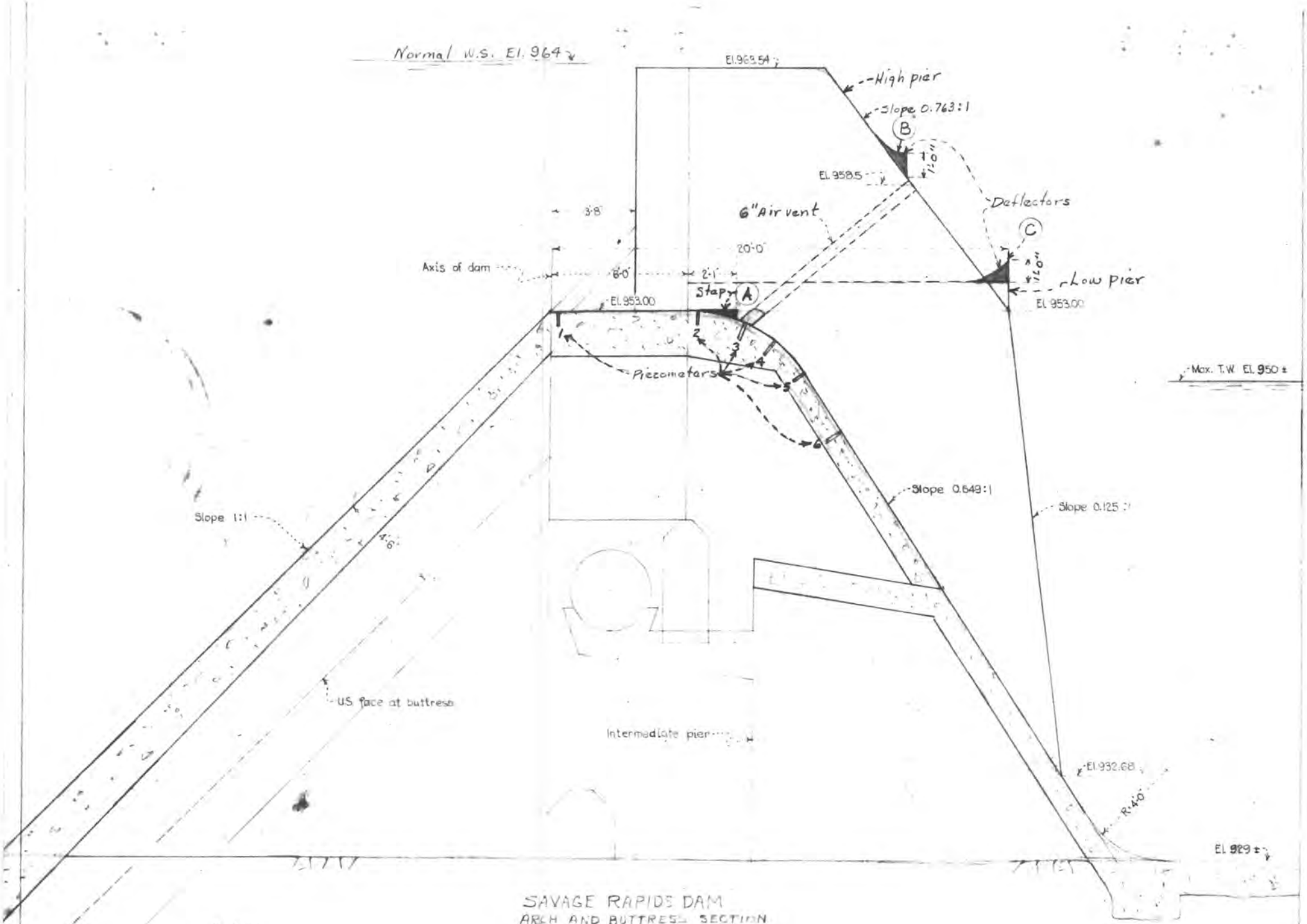
FIGURE 2



A Overflow and sluiceway model-scale 1:48

B Arch and buttress section model-scale 1:32

SAVAGE RAPIDS DAM



SAVAGE RAPIDS DAM
ARCH AND BUTTRESS SECTION
FIGURE 3