UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

- - - -

HYDRAULIC MODEL STUDIES FOR THE DESIGN OF ELEPHANT BUTTE DAM TAILRACE

By

R. A. Goodpasture, Junior Engineer

- - - -

Denver, Colorado
May 11, 1939

Denver, Colorado, May 11, 1939.

MEMORANDUM TO CHIEF DESIGNING ENGINEER
(R.A. Goodpasture)

Subject: Hydraulic model studies for design of Elephant Butte Dam tailrace.

1. Introduction. Construction of the power plant at Elephant Butte Dam necessitated the provisions of a tailrace which would allow efficient operation of the powerhouse and also serve as a stilling basin for the outlet works discharge. The proposed tailrace gave an arrangement whereby the outlets would discharge into the tailrace normal to its center line. Due to the uncertainty of behavior a study of the flow conditions was made in a hydraulic model. The model was built and tested in the hydraulic laboratory of the Colorado State College at Fort Collins, Colorado, through the cooperation of the officials of the Colorado State College Experiment Station.

2. The model. The model was constructed in an irregular-shaped metal-lined tank. The powerhouse shape was installed with openings representing the draft tubes. A small 90-degree V-notch weir was used to measure the powerhouse discharge. The outlets (four balanced valves and two sluices) through the dam were represented by tubes placed in the side of a permanent vertical tank. The relation of the available floor space and water supply in the laboratory made it necessary to reverse the model in plan. The photographs of the results have been reversed to show the model in the same position as the prototype.

3. Initial tests. The initial tests were made with a discharge of 3,100 second-feet for the outlets and 1,100 second-feet for the powerhouse. The outlets were operated in pairs; the two upper or two lower balanced valves being operated together. Operation of the sluices was eliminated from the program as being a condition which would never occur.

The original stilling basin was found to be inadequate. Accordingly the entire tailrace was lined and testing started to develop a satisfactory pool. The addition of a curved wall opposite the outlets and a low weir downstream from the powerhouse gave some improvement. The deeper pool formed by these additions forced the high velocity jets over the weir wall with but little improvement in the flow conditions downstream. Various locations for the curved wall together with different shaped weirs did not materially increase the efficiency of the pool.

4. Design 1. Correspondence with the project superintendent showed that while the maximum capacity of a pair of balanced valves was about 3,100 second-feet, the maximum discharge during the irrigation season would be 2,400 second-feet. However, since the outlets might inadvertently be opened too wide, it was decided to design the pool so that it would operate satisfactorily at the higher discharge for a short period of time.

Design 1 was the satisfactory stilling basin developed for use with the proposed tailrace (figure 1). Baffle piers and a tapered rectangular sill were used to break up the concentrated jets entering the pool. The auxiliary wall and sloping apron opposite the outlets had the effect of a side-channel spillway in turning the water downstream. This design operated satisfactorily with a discharge of 2,400 second-feet through either the upper or lower balanced valves. With a discharge of 3,100 second-feet the pool was rough but conditions downstream were not objectionable. The best flow conditions were always obtained with the powerhouse operating and the upper balanced valves discharging. Typical flow conditions are shown on figure 2.

5. Design 2. While design 1 gave a satisfactory stilling basin, objections were raised to the large amount of fill required to form the proposed tailrace. Discussion with the design department and study of photographs taken at the dam during construction of the powerhouse showed that there is a large pool downstream from the dam. Operation of the outlets over a period of years has stabilized the banks of this pool. Accordingly it was proposed to place an apron downstream from the outlets to protect the powerhouse foundation and utilize this pool.

The model tank was enlarged to represent the existing pool down to the control section. The horizontal apron at elevation 4198.0 fitted with the baffle piers and sill was retained. Observations showed that the apron should be extended to the end of the transformer house and that an auxiliary wall was necessary. This revised design (figure 3) operated satisfactorily at 2,400 second-feet with either the two upper or two lower balanced valves operating. The upper valves produced a satisfactory pool when discharging 3,100 second-feet. With the higher discharge, the two lower outlets produced an inefficient pool with undesirable scour at the end of the transformer house. Typical flow conditions for this design are shown on figures 4 and 5.

6. Conclusions. Design 2 is the least expensive solution to the stilling-pool problem and is therefore recommended. The upper pair of balanced valves always gave the better pool condition and accordingly should be used during a continuous flow for any period of time. The lower balanced valves should not be operated at discharges above 2,400 second-feet.

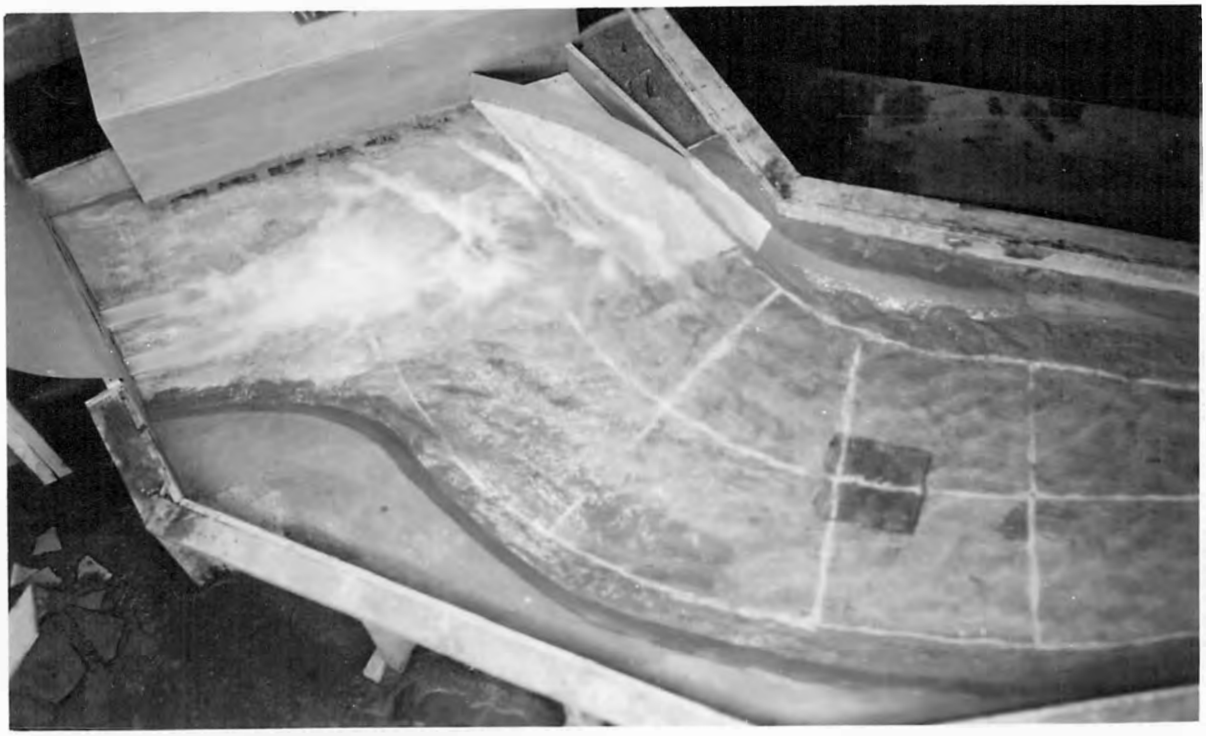
- - -

R.A. Goodpasture.

Figure 2

ELEPHANT BUTTE TAILRACE
1:30

Upper Balanced Valves Operating

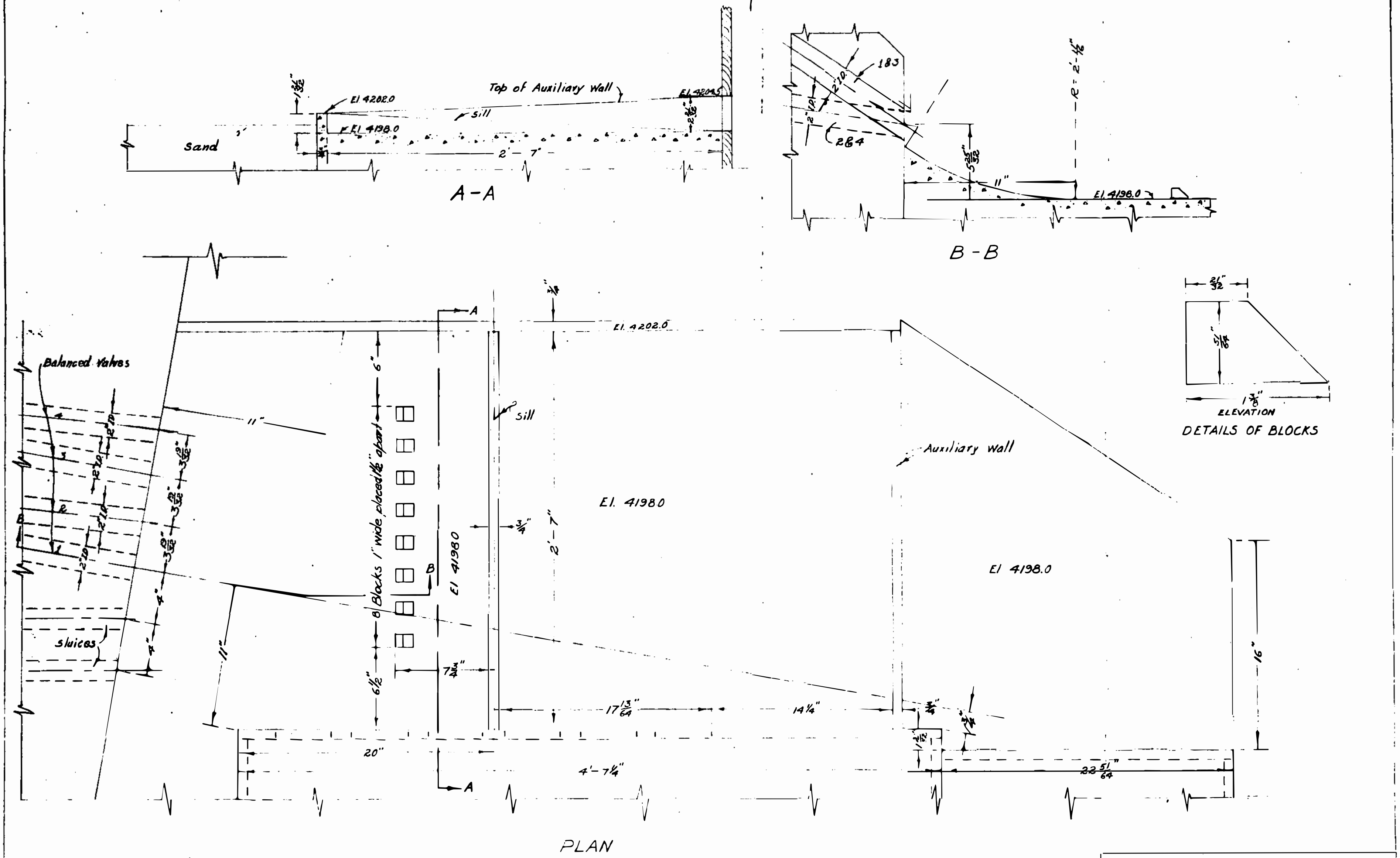


Lower Balanced Valves Operating

Power House Discharging 1,100 Second-Feet

Balanced Valves Discharging 2,400 Second Feet

DESIGN 1



12 9 6 3 0 1

Model Scale in Feet and Inches

NOTE: Model is left handed

DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT ~ NEW MEX & TEXAS

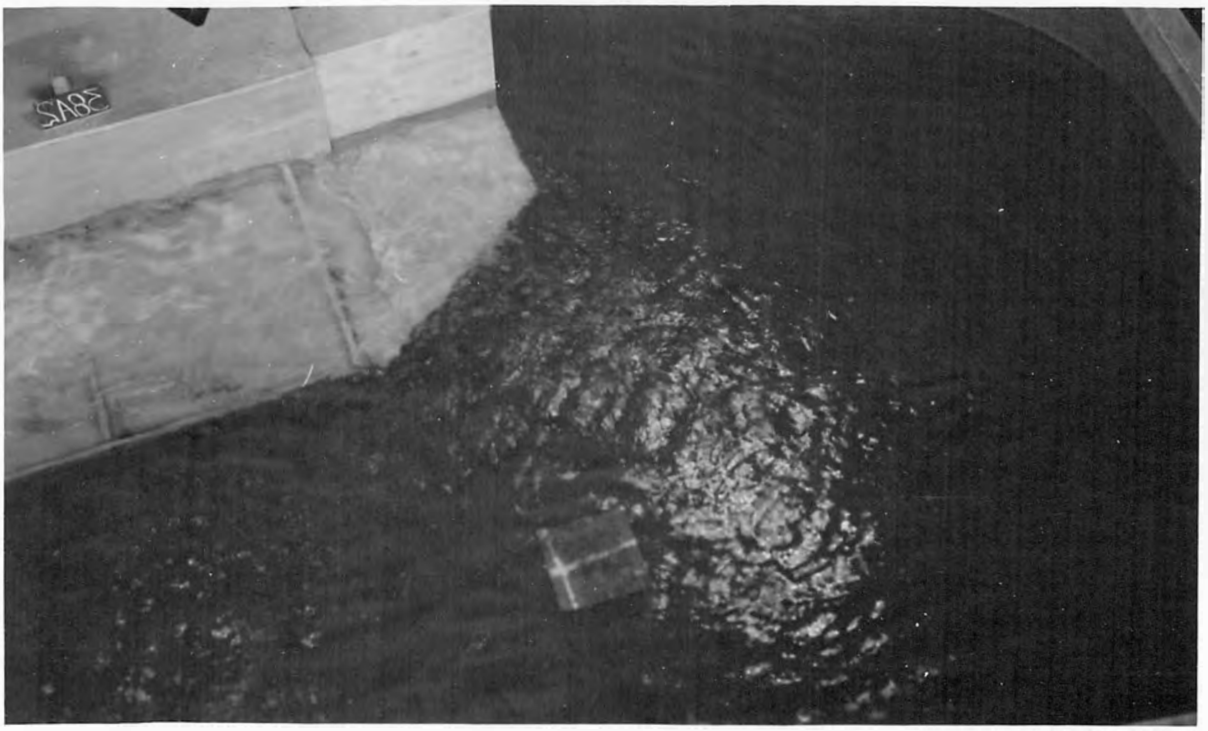
ELEPHANT BUTTE DAM
HYDRAULIC MODEL STUDIES
MODEL SCALE 1:30
STILLING BASIN ~ DESIGN 2

DRAWN R.A.G. SUBMITTED
TRACED RECOMMENDED
CHECKED APPROVED

DENVER COLO 4-27-39

FIGURE 3

ELEPHANT BUTTE TAILRACE
1:30



Upper Balanced Valves Discharging

Lower Balanced Valves Operating

Power House Discharging 1,100 Second-Feet

Balanced Valves Discharging 2,400 Second Feet

DESIGN 2

ELEPHANT BUTTE TAILRACE
1:30

Upper Balanced Valves Operating

Lower Balanced Valves Operating

Power House Discharging 1,100 Second-Feet

Balance Valves Discharging 3,100 Second-Feet

DESIGN 2