

THE REPAIRS ON THE JOINT HEAD DAM ON THE SALT  
RIVER IN ARIZONA.

BY

LUTHER R. TILLOTSON, -- 1916.

I N D E X

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## Bibliography.

The Joint Head Dam was directly under my supervision. The plans, as approved, were the result of the review by Mr. Hanna, the Supervising Engineer, Mr. Fitch, the Project Manager, Mr. Ward, the Construction Engineer, Mr. Cone, the Superintendent of Construction and Mr. Smart, the Foreman. The only theory of any importance referred to was Bligh's chapter on the talus of dams.



The Salt River Valley has been the scene of many irrigation projects. Numerous ruins of ancient temples, cities and canals are on the floor of the valley. History has no record of these projects which must represent a very old type of civilization. Very few of these ruins have been excavated and explored, though an Arizona engineer named Patrick, in the seventies, investigated and mapped all prehistoric ruins around Phoenix. The ruins which I saw, personally, were marked very plainly by mounds and ditches, still preserved by the mild Arizona climate, though a few show attempts at excavation. These old canal systems follow very markedly the present systems, though how water was obtained for them is not very plain. The causes of the decay of the systems and the people are not evident either, though it may be due to several of the difficulties of irrigation, but most probably to the silting up of the canals or their headworks.

When the great Mormon immigration came into the Salt River Valley, these hardy pioneers commenced to drift over the western deserts and establish

themselves in every irrigable spot. They investigated every water hole. This roving brought them into the Salt River Valley, containing much fertile land and an abundance of water in the Salt River. Their settlements were given the names of Tempe and Mesa. For a long time the Mormons, the Apache Indians and a few Mexicans were the principal inhabitants of this valley, so fertile and so hot. The Mormons simply built headers out into the stream and turned what little water they could onto the low flat lands south of the Salt River.

Later, W. J. Murphy, a contractor on the Santa Fe Railroad then building across Arizona, came into the Salt River Valley and built a dam on the site of the present Granite Reef structure. He called his company the Arizona Canal Company. He started the present Arizona Canal across the desert. Water, -however, was not plentiful, except on rare occasions when it usually came with such force as to take our all structures no matter how elaborate, and as the Granite Reef was principally timber and earth it usually went out pretty easily. Mr. Murphy start-

ed his work about 1883.

In the nineties, the United States Government commenced legislation looking towards the reclamation of arid land in the west. The first active work of the government to actually promote irrigation came in the Roosevelt administration and took the form of laws permitting water-users to organize for the purpose of allowing the government to make contracts with them whereby the government should be enabled to finance irrigation work. There were laws, however, dating from 1888, which looked forward to the government helping irrigation. The first undertaking of the government, under such an arrangement, was the Salt River Valley project. This was formed partially by water-users surrendering their rights and partially by purchase. The older canal companies, notably the Arizona Canal Company, were in financial difficulties. The washing out of the Granite Reef Dam wrecked their corporation, so the stepping in as a general proposition on the part of the United States government was to most of the water-users considered a great relief, though the Mor-

mon owners of the Tempe headers and the St. John ditch managed to stay out under organizations of their own. The government took over for active construction and operation practically all the various engineering schemes on the north and south sides of the Salt River around Phoenix. The general map, in the back of this cover, gives a very good idea of the whole scheme.

The first and main feature undertaken by the United States government was the Roosevelt Dam, seventy-eight miles northeast of Phoenix on the Salt River. This structure impounds the flood waters of the Salt and holds them in a reservoir to be used as needed in the valley below. The next structure undertaken was on the site of the old Granite Reef Dam. This new work is of concrete and serves to divert water sent down the Salt River bed from the Roosevelt Dam and the flood waters of the Verde River over the valley through the Arizona and consolidated canals.

Below the Granite Reef was an old structure of brush and dirt with stone walls for the intake

gates, known as the Joint Head Dam. Originally, the Grand Canal led from this structure. Its course was changed to the present one on the map. The Joint Head had about as precarious an existence as the Granite Reef. It had many disadvantages. The Dam existed in the main and lowest river channel. A high channel existed on the south side. Whenever a flood occurred in the Salt, the water would come down the south channel and threaten to change the river bed entirely, leaving the Joint Head Dam high and dry. The government rebuilt this dam of concrete, as shown. It further built dykes of earth over the arroyas south of the river which formed the high level river bed. A profile of these washed-out portions of the dykes is also shown on the plan of the structure. The Joint Head Dam is supplied with water exclusively let down from the Granite Reef, thus being purely a diversion dam to turn about a 1000 sec. ft. into the Salt Canal, the lowest canal of the government system on the north side of the Salt River. At the time Mr. W. Ward was made construction engineer of the project, I was employed by him

to have active charge of the work north of the Salt River and the Joint Head Dam repair work was part of my assignment. In February of 1914, the Joint Head structure had been compelled to withstand a flood estimated by the hydrographer of the project as 22000 sec. ft. The earth dykes south of the river had not withstood the flood and washouts had occurred, as shown on the accompanying plans. The dam was badly washed out downstream.

A work order had been issued to the previous construction engineer, authorizing him to proceed with the work; but his plans were so poorly prepared, due to an insufficient engineering office, and apparently based on such poor information, due probably to the economy on the part of the government in not hiring a sufficient engineering department, it was thought best to secure more accurate data before attempting to proceed with construction. It was thought best to secure soundings below the structure and to obtain a line of levels over the dykes, to enable the showing of washouts on a profile of the dykes and also to permit of computation

of quantities. A great pool was caused by the flood below the dam and it was this hole which threatened the structure. Soundings were obtained by sending a man with a level rod out on a rope stretched across the pool below the dam. The water level being known, the rod could be let down and by reading the rod at the surface when it rested on the bottom the data on depth could be obtained. Readings were taken every five feet up and down stream and every fifteen feet length-wise of the dam apron. The readings were taken out for 105 feet from the face of the apron downstream where the pool ended. The soundings indicated that the hole at the deepest point was about at the foot of the downstream drop wall.

It is obvious from the drawings that the intake gates were placed in the wrong position as it is generally conceded that intake gates and wing walls to sluice gates should be at right angles, to the axis of the dam. In this case, the intake and sluicing arrangements were placed on a skew to take advantage of the old structure of stone already in place and which would have been quite an item of

expense to remove. It was further discovered that the sluicing gate was lower by three inches than the crest of the weir of the dam. From our data and observations it was evident that in the rush of water over the dam, the lower sluice gates and skewed wing combined to throw the water passing over the gate and that also coming against the wing wall on an angle creating a whirl in front of the dam which brought about the dangerous condition of the structure. It was further determined that, had the river bed been properly filled up with boulders below the dam apron instead of being left as constructed, the effects of much of this could have been avoided, as there would have been no step-off below the structure. The soundings gave an unusual chance to check Bligh's formula for length of dam aprons. Our soundings showed the constant to be fifteen for our particular structure, although the Granite Reef Dam was only designed with a constant of nine. The soundings indicated that the energy of the water commenced to give out at thirty-five feet. The formula by Bligh was further checked by assuming that the



water in falling over the end of the apron followed the same path in reverse in striking the water that it did when falling freely. Plotting distance against time, under this assumption, we have a parabola and the point where the parabola is nearly flat is the point where the energy gives out, which checks thirty-five feet very closely for this particular work. The holes in the earth dykes indicated that the dykes should have been a little higher which was accordingly recommended and the dykes built after the plan as shown. The upstream face of the dyke was brushed with branches cut in clearing the borrow pit excavation at a depth of two feet from the face. It seemed to be the experience of the foremen in the Reclamation Service that brushing any closer permitted small branches to protrude, which provided a way for water to follow into the earth giving an opportunity for destructive action. The soil was of such a light nature, the slope on the upstream side of the dykes was increased to two to one. This also gave the weight of the water an opportunity to hold down the dam.

It was thought best to pump the water out below the dam, driving a cofferdam for the downstream drop wall of the new apron and place the toe of the wall well into the sand and gravel which composed the stream bed. The new apron was only made 20' X 120' which was as long as the washout. The balance of the hole was filled with granite boulders hauled from the Tempe Powerhouse waste excavation about three miles away. The cement came from the Phoenix Warehouse and was the Cowboy brand of El Paso manufacture. The local cement plant was not running. The sand and rock came from the river bed and was really obtained by screening gravel from the dam site. The pump was a ten inch centrifugal run by alternating motor obtaining its current from the Salt River Valley high tension line from Arizona Falls to Phoenix. This necessitated a transformer installation, to step the current down from eleven thousand to two thousand, two hundred volts. The pump was run by electricity in a rather peculiar fashion. The outlet pipe was placed over the dam and the water pumped upstream. The waste gates of the Salt Canal

were lifted and the water wasted into the canal.

During the time of construction, a very peculiar accident happened. The intake gates were sluiced one day at the Granite Reef Dam. The water from the sluicing reached the Joint Head at night. No warning being given, the gates to the Salt Canal were not open sufficiently and the water passed over the weir of the dam. At this time, the pool below the dam was empty. The water overflowing entered one of the relief openings, placed in the old apron to take care of any head that might be causing a pressure on the under side of the apron, and caused sufficient pressure to wash the backfilling under the apron out under the base of the old downstream drop wall, the new work not being in place. This left practically forty feet of the apron and fifteen feet of the drop wall unsupported. It was found necessary, therefore, to open the apron, extend the drop wall and re-backfill the structure, replacing the apron removed. This accident proved the advisability of placing relief openings horizontal and in the drop wall just below the apron slab to prevent

the recurrence of such a performance.

Construction work was started the first of May, and completed August first. The foreman was Mr. C. A. Smart, a man of long reclamation experience. The labor was principally all Mexican, although the carpenters were white men. The grading outfit were fresnoes, as the dirt was loose and easy worked. The camp was well kept and the food good. The entire work was prosecuted by force account, which seems to be the Reclamation Service's favorite way of doing work when they have the equipment.

The original work order was for \$5,000.00. Our revised estimate was allowed to stand as such, though the work gave every indication of running higher. The final cost was very close to \$6,000.00. The accident added no little to the expense. The largest item of cost was pumping, of course. The work went forward rapidly, with the one untoward incident only. After the work of sounding and estimating, the engineering work was principally supervision.

The work was constructed as shown on plan.

The sluice gate was raised in height two feet by bolting 2 X 12 timbers on top of the top plate in order to force all water over the weir. The wing wall was straightened with a baffle wall as shown. It was planned to place the holes shown in this baffle, thereby having the pressure in flood time equal on all sides. As eventually built, the acting chief engineer directed it be filled solid with gravel. The gravel was then covered over with cement. Otherwise, the accompanying plans were followed out. Since this time, the Salt River has again been in flood, but I have not received word as to what damage was done to the Joint Head Dam and dykes. The loss to some of the power canals, as the Grand, I understand was tremendous. The theory of the construction of the dykes was that it was cheaper to repair earth work than to go to the expense of concrete. They were very poor looking affairs, compared to the thirty-six thousand dollar concrete Joint Head Dam. The soil of the valley is very light, so it doesn't seem to warrant earth structures. The site of the Joint Head Dam is necessarily poor, as

the foundation is nothing but gravel which washes very easily. It gives no hopes of a permanent structure as, in excavating under the apron, numerous fine streams were discovered trickling through the back-fill which certainly must have either come through the concrete dam or been forced under the upstream apron by the head of water back of the dam. In either case, it is not a very satisfactory showing.

Our addition consisted of 156 cubic yards of concrete, and 2600 cubic yards of earth. The reinforcing was principally second-hand steel salvaged from the electrical equipment of the service, and amounted to 4000 pounds.

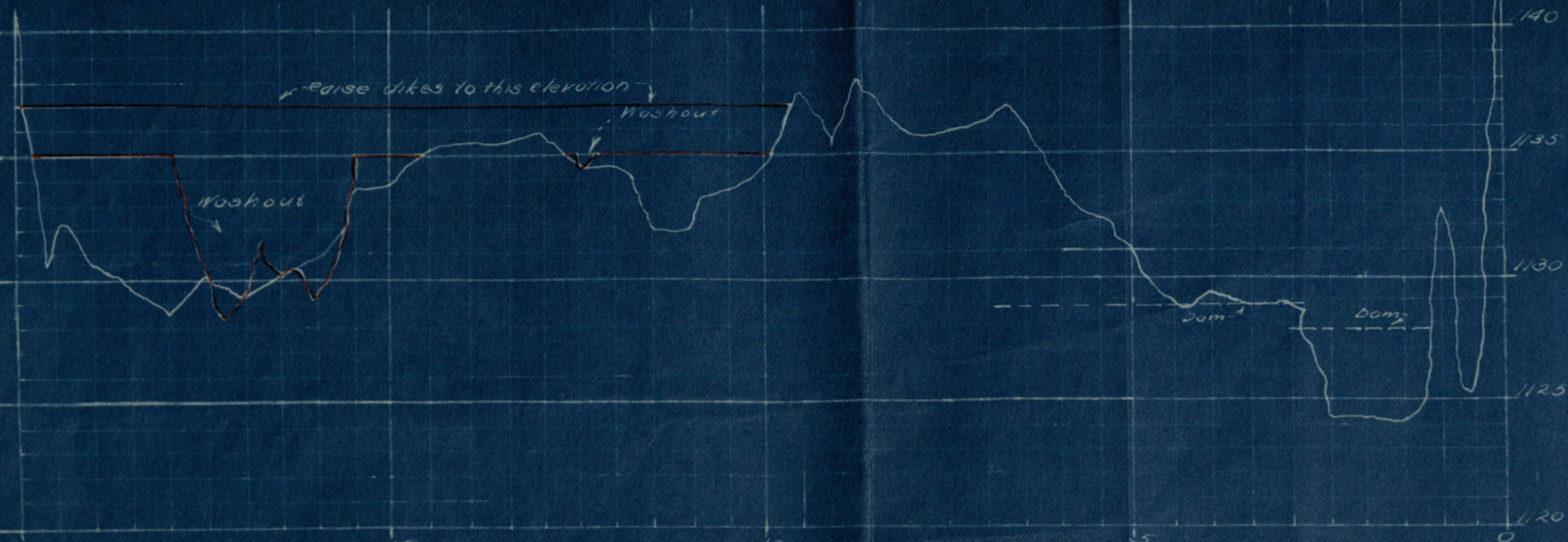




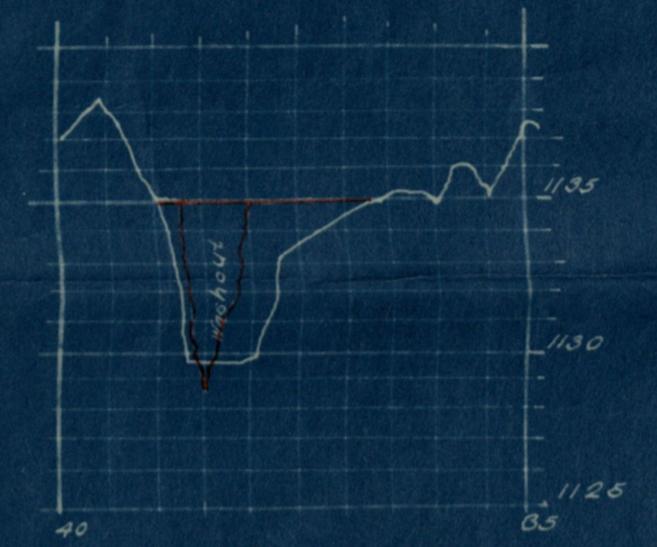
**LEGEND**  
 Canals operated by U.S.R.S. ———  
 Canals operated privately - - - - -  
 Transmission Lines ·····

**SITUATION MAP OF  
 JOINT HEAD DAM  
 IN THE SALT RIVER PROJECT  
 NEAR PHOENIX ARIZ.  
 LRT DEL MAY 10, 1916**





PROFILE FOR RAISING, REPAIRING AND STRENGTHENING DIKES



Puddle fill overlaid with Stone Riprap 3'0" deep

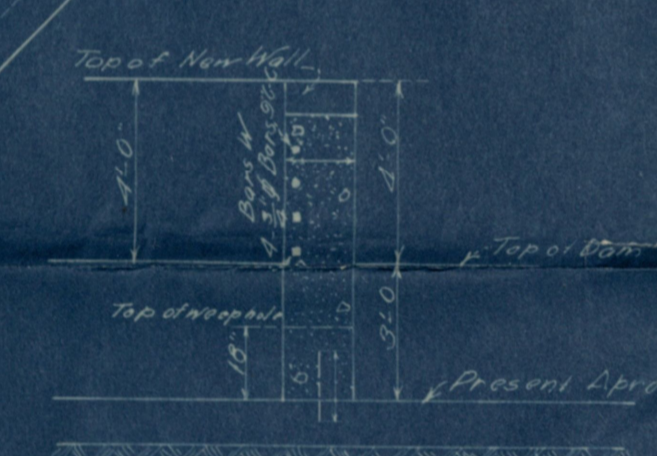
Transverse Bars in apron extension Bars S

SLUICeway

CONCRETE EXTENSION TO APRON

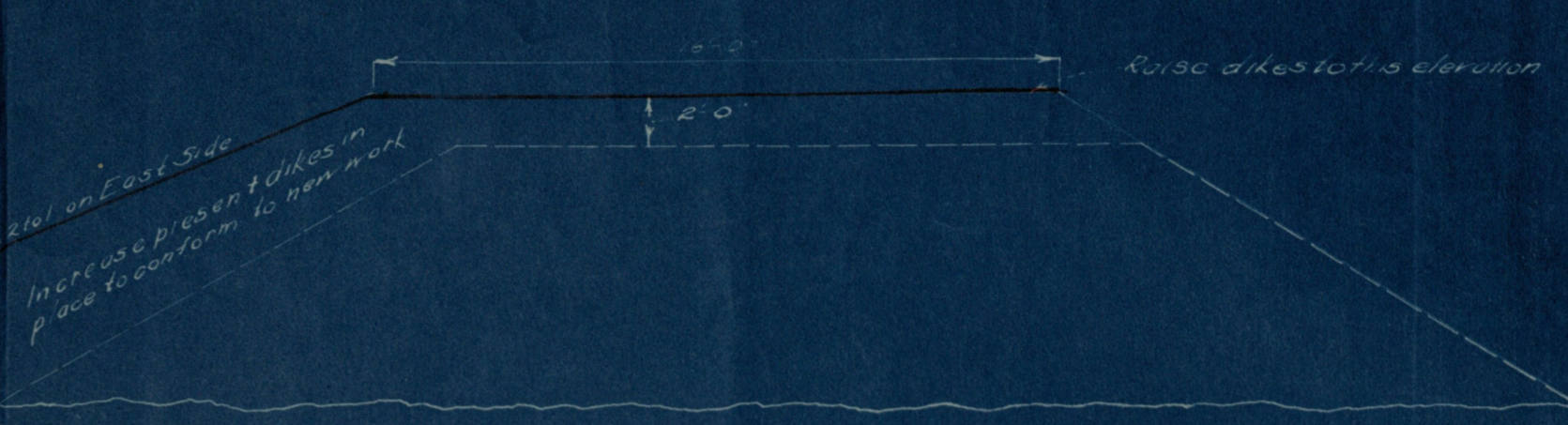
PRESENT CONCRETE APRON

WALL TO STRAIGHTEN WING WALL  
Scale 1/2" = 1'

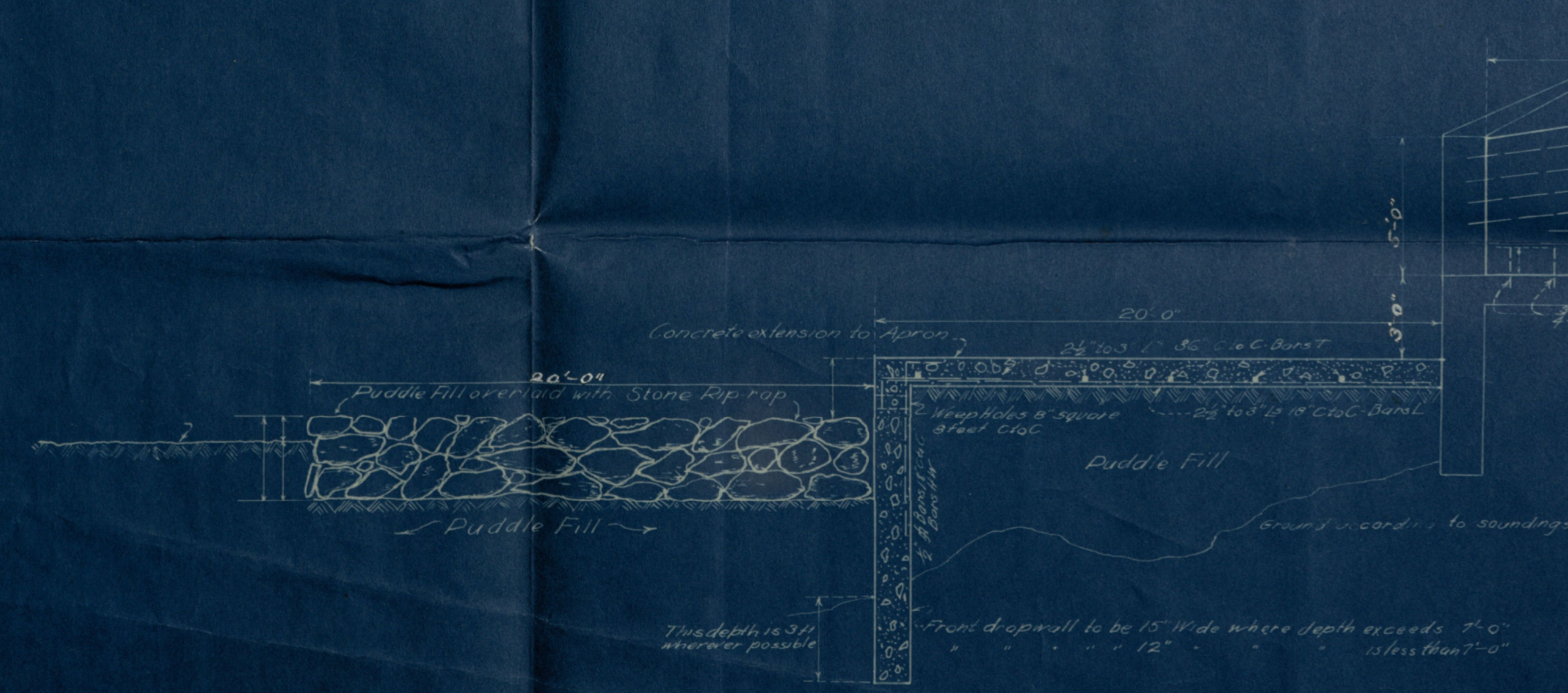


SECTION B-B  
Scale 1/2" = 1'

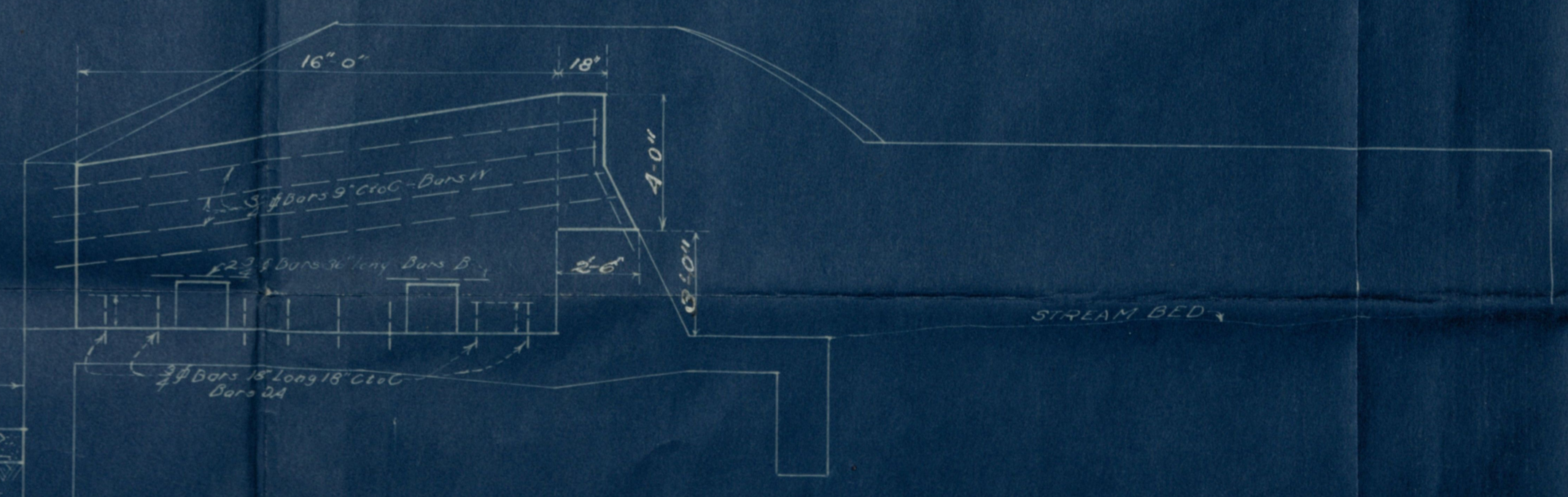
SECTION THRU STA 17+82.4  
Scale 3/8" = 1'



EXTENSIONS TO JOINT HEAD DAM  
Scale 1/20" = 1'



SECTION A-A  
Scale 1/2" = 1'



NOTE - All steel reinforcing bars as shown on this plan are structural shapes now owned by U.S.R.S.

United States Reclamation Service  
F. Williams, Superv. Eng. C.H. Fitch, Project Mgr.  
**DETAILS AND PLANS FOR EXTENSIONS TO JOINT HEAD DAM**  
Scale as noted

Phoenix, Ariz.

May 16, 1924

Note: This tracing made from blue print of tracing made under direction of U.S.R.S. and checked and revised by him.