# PROPOSED FLOOD PROTECTION AND DRAINAGE
# SALT RIVER, MISSOURI.

by

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A THESIS

Presented for the Degree of

B.S.

Bachelor of Science in Civil Engineering.

University of Missouri

Department of Engineering

1911

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The north fork of Salt River drains a long irregular basin in the north eastern part of the State of Missouri. It rises in Adair County and flows down thru the southwest corner of Know County, diagonally thru Shelby County from the northwest to the southeast and joins the south fork of Salt River at about the central line north and south of Monroe County.

It has a broad, flat valley ranging in width from one half to one mile and, owing to the many bends, it is more than twice as long as this valley thru which it flows. Because of these bends, the river channel has a slope much less than it would be if it followed the center of the valley. Almost every year it floods the greater part of the valley, doing thousands of dollars worth of damage to crops and stopping all travel on most of the roads that cross it.

In view of the importance of these facts, I have made this thesis an investigation of the feasibility and a plan for the flood protection and drainage of the valley.

The plan contemplates the improving of the channel of the river,and greatly increasing its capacity of discharge by shortening the line of flood-flow thru a medium of by-passes across the bends, and enlarging the intermediate stretches of river channel. It is designed to carry safely the volume of average floods,with the expectation of expanding the system when such a measure should become expedient by further channel enlargement and the enlarging of the canals or by-passes until they willhave the dimensions given for the canalsdesigned to carry the maximum flood. In this way,the discharging capacity of the system will so be increased as to take care of the extraordinary floods that come once in a dozen years or so.

## Data for Drainage Plans.

Before attempting to solve the drainage problem presented,as much data on rain-fall and runn-off as possible should be available,and a careful survey of the channel and valley should be made.

## Rainfall.

Daily records of the rainfall were procured from the local office of the United States Weather Bureau at Columbia,for the several points within

the

the drainage basin. From these records it was found that the year 1897 was an average year, having a precipitation of from 38 to 39 inches all over the basin. It was also found that the maximum rainfall occurred in the year 1898, ranging from 50.29 to 80.08 inches in different parts of the basin. Of these records we will use only the ones for Sublett, Adair County and Shelbina, Shelba County, since the portion of the river we wish to examine lies between these two points and we will consider only the months of May, june and July, 1908, the maximum rainfall of which we have a record occuring then.

Stream Discharge (run-off)

In order to determine this with a fair degree of accuracy a system of control levels should be run and gages set in the river every few miles, and daily gage readings taken. All of these gages should be marked to true elevations, so that every gage reading would be a record of the water at that station above mean sea level, and the ascertaining of river slopes and relation between the elevation of the river at any time and locality and elevation of lands in thesurrounding valley would be much simplified.

Continuous hydrographs should be kept for all of these daily gages, being curves with number of days for abscissas and heights of the gages for ordinates. Discharge measurements should be made with a current meter, subdividing the cross section of the stream into ten foot widths and measuring velocity at six-tenths of depth below surface of water in each such width.

In the absence of the above data on this stream I have taken ten different streams in Missouri and adjoining states having drainage basins of from 126 to 14,000 square miles, and which lie in the same climatological zone, and upon which run-off observations have been made for a number of years, as a comparison. From these observations the maximum discharge in cubic feet per second has been determined from which I calculated the maximum run-off in cubic feet per second per square mile of drainage basin. But owing to the smallness of the size of the basin, I am considering, it would be possible for a violent storm to cover its entire area at the same time and cause a flood much larger in proportion than in the case of the larger basins already investigated. Therefore

I have used a factor of safety of 5,or have designed my canals five times as large as would appear necessary from the comparison data,in order to provide for the maximum flood that might occur? In the design to provide for the ordinary flood I have used a factor of safety of 3,or have designed the canals three ~~two~~ times as large.

### Surveys.

In order to claculate the sizes of the by-passes and locate them where most needed,it would be necessary to make a traverse of the stream taking cross sections every two thousand feet and some times oftener,to find its length slope and the amount of water it would carry. The high water contour on each side of the valley should also be traced out in order to determine the amount of land receiving flood protection so the land owners might be taxed accordingly.

Since no such data is available at the present time,I have formed my estimate by using topographic maps of the United States Geological Survey. These maps are drawn to a scale of 1 in 125,000 and with a contour interval of 20 feet.

Daily precipitation for maximum year of 1898

North Fork Salt River Drainage Basin - area 225 square miles.

Sublett Station.

| | Jan. | Feb. | Mar. | Apr. | May. | Jun. | Jul. | Aug. | Sept | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | 1.80 | 1.25 | | | | | | |
| 2 | | | | | | | | .60 | | | | |
| 3 | | | | .85 | .40 | | | | | | | .40 |
| 4 | | | | | .60 | | | | | | .50 | |
| 5 | | | | | .70 | | | | .52 | | | |
| 6 | | | | | | | .65 | 1.90 | 1.18 | | | |
| 7 | | | | | | .26 | .69 | | | | | |
| 8 | | | | | | .05 | .15 | | | | .20 | |
| 9 | | .75 | | | 1.92 | | | | | | 1.15 | |
| 10 | .16 | | 1.00 | | .25 | .12 | | .12 | | | | |
| 11 | .25 | | | | | .39 | | | | | | |
| 12 | .10 | | .10 | .25 | | .14 | | | .37 | | | |
| 13 | | | | .60 | .25 | | | | .35 | | | |
| 14 | .20 | | | | 1.50 | | | | | | | |
| 15 | .20 | | | | 1.00 | .13 | | | | | | |
| 16 | | | | | | .23 | | .25 | | ..80 | | |
| 17 | | .25 | | .60 | .25 | | | | | 1.09 | | |
| 18 | | .30 | 3.45 | 1.10 | .50 | | | | | .20 | | .50 |
| 19 | .16 | .30 | | | 5.50 | | ..35 | | | | | 1.50 |
| 20 | | | | | 1.00 | | | | | | | |
| 21 | | | | .50 | 1.40 | | | | .52 | | 1.50 | .30 |
| 22 | .10 | | 1.50 | 2.75 | | .22 | | | 1.08 | | | |
| 23 | | | | | | | | | .05 | | | |
| 24 | | | | | | | 1.40 | | | | | |
| 25 | 1.50 | | | | | | | | 1.32 | 1.34 | .10 | |
| 26 | | | 3.00 | | | .50 | | | | | .20 | |
| 27 | | | 2.25 | | 1.70 | | 1.50 | | .34 | | | |
| 28 | | | | | | | | | | | | |
| 29 | | | | | | | .52 | | | | | |
| 30 | | | | | | | | | | | | |
| 31 | | | | | .45 | | .10 | | | | | |
| Tot. | 2.66 | 1.60 | 11.30 | 6.65 | 19.22 | 3.29 | 3.96 | 4.27 | 5.73 | 3.43 | 3.65 | 2.70 |

Daily precipitation for average year of 1897

North Fork Salt River Basin - area 225 square miles.

Sublett Station.

| | Jan. | Feb. | Mar. | Apr. | May. | June | July | Aug. | Sept | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .50 | .05 | | | | | | | | | | |
| 2 | 2.01 | | .18 | | | | .06 | | | | | .10 |
| 3 | 1.20 | | | | | | | .20 | | | | .65 |
| 4 | .40 | .41 | .63 | | | | | | | | .19 | .20 |
| 5 | | | | | | | .80 | | | | | |
| 6 | | | | | | .05 | | | | | | |
| 7 | | | | .10 | | | | | | | .05 | |
| 8 | | | | | .25 | | | | | | 1.02 | |
| 9 | | | | | | .10 | | | | | | |
| 10 | | | | | | | .51 | | | | | |
| 11 | | .23 | | | | | | | | .05 | | |
| 12 | .40 | | | .12 | .05 | | | | | | | |
| 13 | | | 1.00 | | | | | | | | | .37 |
| 14 | | .38 | | | | | | | | | | |
| 15 | | | | .23 | | | | | .76 | | .15 | |
| 16 | 3.02 | | | | | | | | .42 | | | .18 |
| 17 | | | .51 | | | | | | | | | .10 |
| 18 | | | | | | | | | | | | |
| 19 | | | .35 | | | .10 | | | | | | .08 |
| 20 | .06 | 1.00 | .20 | .08 | | | | | | | | |
| 21 | | | | .51 | | 1.20 | | .77 | | | | |
| 22 | | | | .48 | .10 | | | | | | | |
| 23 | .05 | | 1.52 | 3.12 | | | | | | | | |
| 24 | | | | .25 | | .23 | .58 | | | | | |
| 25 | .05 | .05 | | | | .38 | .22 | | | | | |
| 26 | | | | | .05 | .40 | | | | | | |
| 27 | | | | | .15 | | | | | | | .05 |
| 28 | | | | | | .48 | | | | | | |
| 29 | | | | | | .10 | | .05 | | | | |
| 30 | | | | | | .62 | | | | | | .05 |
| 31 | | | 2.75 | | | | | | | | | |
| Tot. | 7.28 | 2.12 | 7.14 | 4.89 | .60 | 3.66 | 2.17 | 1.02 | 1.18 | .05 | 1.41 | 1.78 |

Daily precipitation for maximum year of 1898

North Fork Salt River Drainage Basin - area 225 square miles.

Shelbina Station.

| | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | 1.06 | 1.25 | | | | | | |
| 2 | | | | | | | | | | | | |
| 3 | | | | 1.00 | .09 | | | | | | | .10 |
| 4 | | | | | .15 | | | | .20 | | | |
| 5 | | | | | .48 | | | | | | .90 | |
| 6 | | | | | .09 | | | | | | | |
| 7 | | | | | | .26 | 4.25 | | 2.20 | | | |
| 8 | | | | | | .05 | .05 | | | | | |
| 9 | | 1.20 | .10 | | .17 | | | | | | | |
| 10 | 1.70 | | 2.00 | | .24 | .12 | | | | | .80 | |
| 11 | | | .50 | | .62 | .39 | | | | .80 | | |
| 12 | | | | | | .14 | | | 1.30 | | | |
| 13 | | | | 1.10 | | | | | | | | |
| 14 | .20 | | | | 1.54 | | | | .20 | | | |
| 15 | | | .30 | | .26 | .13 | | | .30 | | | |
| 16 | | | | | .28 | .23 | | | .50 | | | |
| 17 | | | | .50 | | | | | | 1.50 | | |
| 18 | | .30 | .50 | | .33 | | | | | | | |
| 19 | | .50 | .10 | | 1.39 | | | | | | | .90 |
| 20 | .30 | | | | | | .50 | | | | | |
| 21 | | | | | .22 | | | | 1.80 | | .10 | |
| 22 | .80 | | .90 | .20 | | .22 | | | | | | .20 |
| 23 | | | | | | | | | | | | |
| 24 | | | | | | | | .50 | .20 | | | |
| 25 | | | | .50 | | | | | | 1.30 | | |
| 26 | | | | | | .50 | | | | | 1.00 | |
| 27 | | | 2.80 | | .32 | | .11 | | .60 | | | |
| 28 | | | | | | | .93 | | | | | |
| 29 | | | | | .20 | | .36 | | | | | |
| 30 | | | | .10 | | | .76 | | | | | |
| 31 | | | | | | | | | | | | |
| Tot | 3.00 | 2.00 | 7.20 | 3.40 | 7.43 | 3.29 | 6.96 | .50 | 7.30 | 3.60 | 2.80 | 1.20 |

Daily precipitation for average year of 1897

North Fork Salt Drainage Basin - area 225 square miles.

Shelbina Station.

| | Jan. | Feb. | Mar. | Apr. | May. | June | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | |
| 2 | | | .61 | | | | | | | | | |
| 3 | 5.70 | | | | | | | | | | | |
| 4 | | .50 | 1.10 | | | | 1.02 | | | | | |
| 5 | | | | | | | | .21 | | | .13 | 1.03 |
| 6 | | | | | | | | .19 | | | | |
| 7 | | | | | | | | | | | .72 | |
| 8 | | .05 | | 1.32 | | | | | | | .32 | |
| 9 | | | .56 | | .37 | | | | | | .28 | |
| 10 | | | | | | | | | | | .10 | .38 |
| 11 | | | | | | | | | | .20 | | |
| 12 | .78 | | | | .12 | | | | | | | |
| 13 | | | | | | | | | | | | .21 |
| 14 | | .48 | .10 | | | .27 | | .10 | | | | |
| 15 | | | | | | | | | | | | .30 |
| 16 | 1.13 | | | | | | | | .58 | | | |
| 17 | | | .48 | | | | | .25 | | | | |
| 18 | | | | | | | | | | | | |
| 19 | | | .71 | | | | | | | | | |
| 20 | .50 | | .05 | | | | .21 | | | | | |
| 21 | | | | | | | | .88 | | | | |
| 22 | | | | | .52 | 2.31 | | | | | | .21 |
| 23 | | | .54 | 1.51 | | | | | | | | |
| 24 | | | | | | 2.13 | 1.00 | | | | | |
| 25 | | | | | | | 1.57 | .10 | | | .68 | |
| 26 | | | | | .10 | 1.23 | | | | | .10 | |
| 27 | | | | | .38 | .27 | | | | | | |
| 28 | | | .24 | | | | | | | | | .10 |
| 29 | | | .05 | 1.50 | | | | | | | | |
| 30 | | | .23 | | | .48 | | | | | | |
| 31 | | | 1.10 | | | | | | | | | |
| Tot. | 8.11 | 1.03 | 5.77 | 4.44 | 1.49 | 6.69 | 2.80 | 1.73 | .58 | .20 | 2.23 | 2.23 |

Maximum Daily Precipitation in Cu. Ft. For 8 days May 14 to 21 inclusive. Drainage basin in Adair County. area 150 square miles. (Sublett Data)

| May | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|
| | $5225 \times 10^5$ | $3485 \times 10^5$ | | $871 \times 10^5$ | $1740 \times 10^5$ | $19165 \times 10^5$ |

| May | 20 | 21 |
|---|---|---|
| | $3485 \times 10^5$ | $4879 \times 10^5$ |

Same precipitation in cubic feet per Sec.

| May | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|
| | 6050 | 4033 | | 1008 | 2016 | 22180 |

| May | 20 | 21 |
|---|---|---|
| | 4033 | 5646 |

Same for Drainage Basin in Knox Macon and Shelby counties. area 75 square miles.

| May | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|
| | $2683 \times 10^5$ | $436 \times 10^5$ | $440 \times 10^5$ | $547 \times 10^5$ | $2439 \times 10^5$ | | | $383 \times 10^5$ |

Same precipitation in cubic feet per. sec.

| May | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|
| | 3104 | 504 | 564. | 672 | 2802. | | | 444. |

Maximum precipitation in cubic feet per sec. per square mile = 40

Suppose 50% of this would reach the river at the same time the discharge would be 20 cubic feet per sec. per square mile of basin drained.

(Note) The expression "second-feet per square mile means the number of cubic feet of water flowing from every square mile of drainage area for each second.

From water supply paper #99 & 98
For year 1903.

| Stream | Drainage area sq. miles. | Max. discharge in second feet | Max. Run off second feet per sq. mile. |
|---|---|---|---|
| Iowa River Ia. at Cedar Rapids | 3,317 | 19,450 | 5.87 |
| Desmoins River Ia. at Keosanqua Ia. | 14.291 | 97.140 | 6.74 |
| Gasconade River Mo. At Arlington Mo. | 2,725 | 15,820 | 5.80 |
| Elkhorn River Nebr. Norfolk Nebr. | 2,474 | 8,000 | 3.25 |
| Blue River Kans. at Manhatten Kans. | 9,490 | 68,770 | 7.23 |
| Saline River Kans. Salina Kans. | 3,311 | 7,895 | 2.43 |
| Meramec River Mo. at Eureka, Mo. | 3,497 | 14,039 | 4.01 |
| Otter Creek Okla. at Mountain park Okla. | 126 | 457 | 3.63 |
| Illinois River Ottawa Ill. | 10,094 | 46,900 | 4.57 |
| Illinois River Minooka Ill. | 6,476 | 36,810 | 5.70 |
| Average Run Off in second feet per square mile = | | | 5.00 |

Run off for Maximum Flood.

150 square miles in Adair Co. with a run off of 25 c.f.s. per square mile = 3750 c.f.s. = Q at head of ditch.

40 square miles in Knox Co. with same run off = 1000 c.f.s.

3750 + 1000 = Q at Shelby Co. line.

35 square miles in Shelby Co with same run off = 875 c.f.s.

4750 + 875 = Q at point where Bear Creek enters.

Run off for Average Flood.

150 square miles in Adair Co with a run off of 15 c.f.s. per square mile = 2250 c.f.s. = Q at head of ditch

40 square miles in Knox Co with same run off of = 600 c.f.s.

2250 + 600 = 2850 c.f.s. = Q at Shelby Co. line

35 sqare miles in Shelby Co. with same run off = 525 c.f.s.

2850 + 525 = 3375 c.f.s. = Q at point where Bear Creek enters.

The canals are designed with the same proportions and side slopes as are used by the United States Reclimation Service Engineers, in which depth times breadth equals $\frac{18}{33}$ of sectional area and side slopes are one and one-half to one. The velocity in each case is taken at five feet per second as a greater velocity will perhaps wash the banks to a harmful extent while a lower velocity will allow sediment to accumulate in the bottom of the canal.

The Hydraulic Radius "R" is found from the diagram by I.C.Church,C.E. giving the mean velocity of uniform motion of water in open channels from $V = C\sqrt{RS}$ where R = the hydraulic radius, S = the slope and C= Kutter's co-efficient.

The co-efficient of roughness n = .030 for canals and rivers in in earth in moderately good order and regimen having stones and weeds occasionally.

The cost is taken at 15¢ per cubic yard which is a high estimate since the work would be of sufficient magnitude to justify the use of steam shovels and other modern methods of handling large quantities of material. The excavated material would be piled on the banks of the canal which would save the cost of laoding in wagons or dump cars.

DESIGN OF DITCH FOR MAXIMUM RUN OFF WHERE SALT RIVER ENTERS KNOX COUNTY.

Q equals 3750 cubic feet per second.

V equals 5 feet per second.

A equals $\frac{Q}{V}$ equals 750 square feet.

S equals .00075 per unit of length.

P equals wetted perimeter.

R equals $\frac{A}{P}$ equals 7 feet as given in Churche's diagram.

b equals 1.8 d

hence d x 1.8 d equals $\frac{18}{33}$ A.

d equals 15 feet.

b equals 27 feet.

B equals 72 feet.

Volume of excavation per 100 lin.ft. equals 2777 cu.yd.

Cost at 15¢ per cu.yd. equals $416.55 per 100 lin.ft.

DESIGN OF DITCH FOR MAXIMUM RUN OFF WHERE SALT RIVER ENTERS SHELBY COUNTY.



Q equals 4750 cubic feet per second.

V equals five feet per second.

A/equals $\frac{Q}{V}$ equals 950 square feet.

S equals .00075 per unit of length.

P equals wetted perimeter.

R equals $\frac{A}{P}$ equals 7 feet as given in Churche's diagram.

b equals 1.8 X d

hence d x 1.8 d equals $\frac{18}{33}$ A.

d equals 17 feet

b equals 31.6 feet

B equals 79 feet

Volume of excavation per 100 lin.ft.equals 3518 cu.yd.

Cost at 15¢ per cu.yd.equals $527.70 per 100 lin.ft.

DESIGN OF DITCH FOR MAXIMUM RUN OFF WHERE IS JOINED BY BEAR CREEK.

Q equals 5625 cubic feet per second.

V.equals 5 feet per second.

A equals $\frac{Q}{V}$ equals 1125 square feet.

S equals .00075 per unit of length.

P equals wetted perimeter.

R equals $\frac{A}{P}$ equals 7 feet as given in Churche's diagram.

b equals 1.8 x d

hence d x 1.8d equals $\frac{18}{33}$ A

d equals 18.5 feet.

b equals 33.5 feet

B equals 89 feet.

Volume of excavation per 100 lin.ft. equals 4166 cu.yds.

Cost at 15¢ per cu.yd. equals $527.70 per 100 lin.ft.

DESIGN OF DITCH FOR AVERAGE AVERAGE FLOOD
FLOW WHERE SALT RIVER ENTERS KNOX CO.

Q equals 2250 cubic feet per second.

V equals 5 feet per second.

A equals $\frac{Q}{V}$ equals 450 square feet.

S equals .00075 per unit of length.

P equals wetted perimeter.

R equals $\frac{A}{P}$ equals 7 feet as given in Churche's diagram.

b equals 1.8 d

hence d x 1.8 d equals $\frac{12}{33}$ A

d equals 11.7 feet.

b equals 21 feet.

B equals 56.1 feet.

Volume of excavation per 100 lin.ft. equals 1666 cu.yd.

Cost at 15¢ per cu.yd. equals $249.90 per 100 lin.ft.

DESIGN OF DITCH FOR AVERAGE FLOOD FLOW WHERE

SALT RIVER ENTERS INTO SHELBY CO.

Q equals 2850 cubic feet per second.

V equals 5 feet per second.

A. equals $\frac{Q}{V}$ equals 570 square feet.

S equals .00075 per unit of length.

P equals wetted perimeter.

R equals $\frac{A}{P}$ equals 7 feet as given in Churche's diagram.

b equals 1.8 d.

hence d x 1.8 d equals $\frac{18}{33}$ A.

d equals 13.16 feet.

b equals 23.7 feet.

B equals 63.3 feet.

Volume of excavation per 100 lin.ft. equals 2111 cu.yd.

Cost at 15¢ per cu.yd. equals $316.65 per 100 lin.ft.

DESIGN OF DITCH FOR AVERAGE FLOOD FLOW WHERE SALT RIVER IN JOINED BY BEAR CREEK.

Q equals 3375 cubic feet per second.

V equals 5 feet per second.

A equals $\frac{Q}{V}$ equals 675 square feet.

S equals .00075 per unit of length.

P equals wetted perimeter.

R equals $\frac{A}{P}$ equals 7 feet as given in Churche's diagram.

b equals 1.8 d.

hence d x 1.8 d equals $1\frac{18}{33}$ A.

d equals 14.3 feet.

b equals 25.8 feet.

Bequals 68.7 feet.

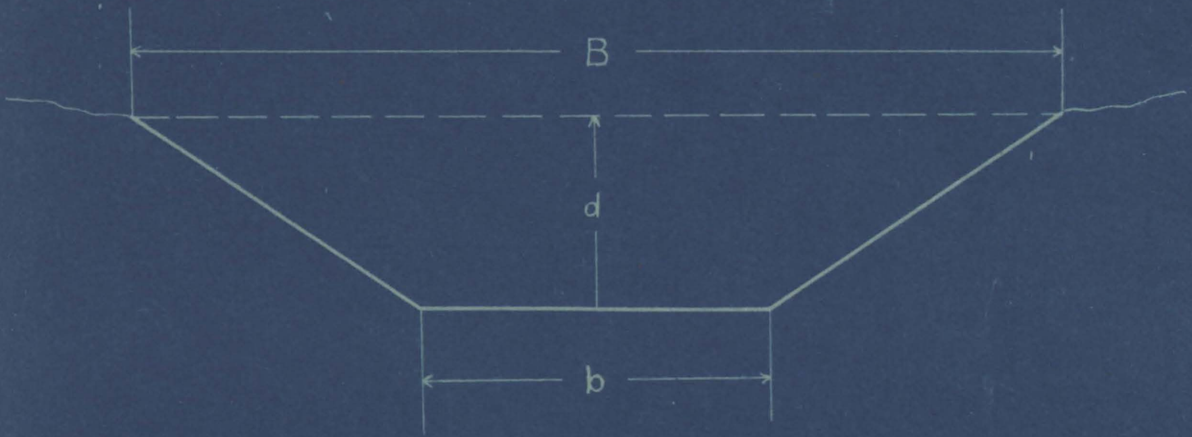
Volume of excavation per 100 lin.ft. equals 2500 cu.yd.

Cost at 15¢ per cu.yd. equals $375.00 per 100 lin.ft.

CROSS SECTION OF DITCH WHERE SALT RIVER ENTERS

KNOX CO.

DESIGNED FOR MAXIMUM RUNOFF




Area = 750 square feet.

B = 72 feet.

d = 15 feet

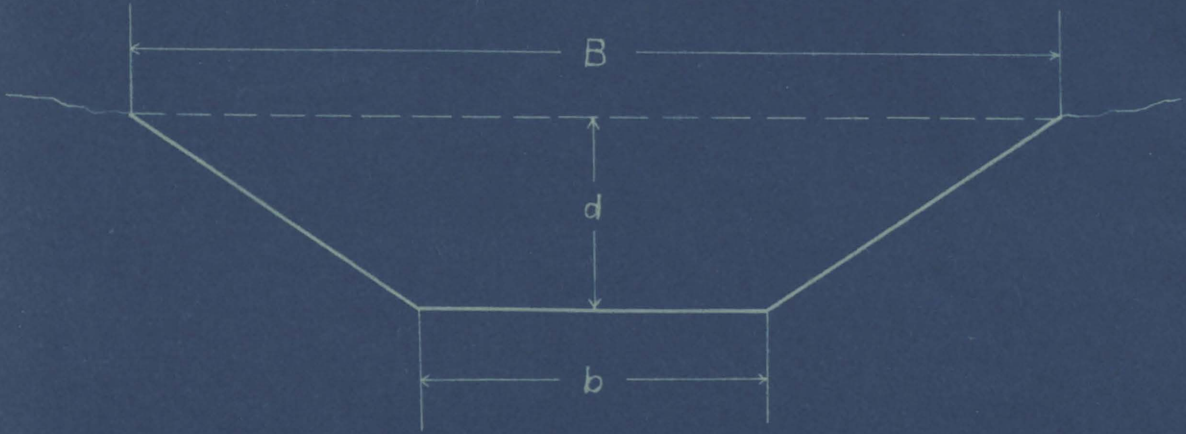
b = 27 feet.

Side slope 1 1/2 to 1.

CROSS SECTION OF DITCH WHERE SALT RIVER

ENTERS SHELBY CO.

DESIGNED FOR MAXIMUM FLOOD.




Area = 950 square feet.

b = 31.6 feet.

d = 17 feet.

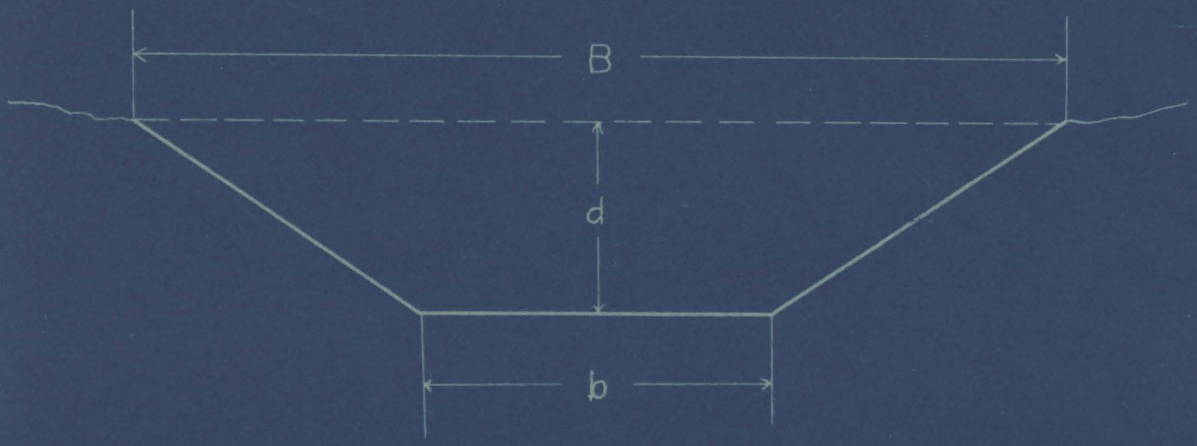
B = 79 feet.

Side slope 1 1/2 to 1.

CROSS SECTION OF DITCH WHERE SALT RIVER

IS JOINED BY BEAR CREEK

DESIGNED FOR MAXIMUM FLOOD.




Area = 1125 square feet.

B = 89 feet.

d = 18.5 feet.

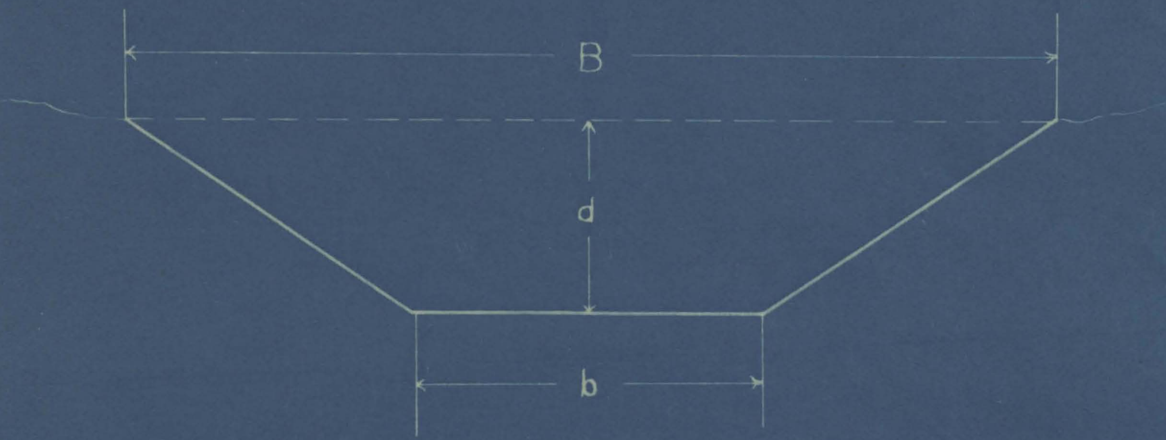
b = 33.5 feet.

Side slope 1 1/2 to 1.

CROSS SECTION OF DITCH WHERE SALT RIVER

ENTERS KNOX CO.

DESIGNED FOR AVERAGE FLOOD.




Area = 450 square feet.

B = 56.1 feet.

d = 11.7 feet.

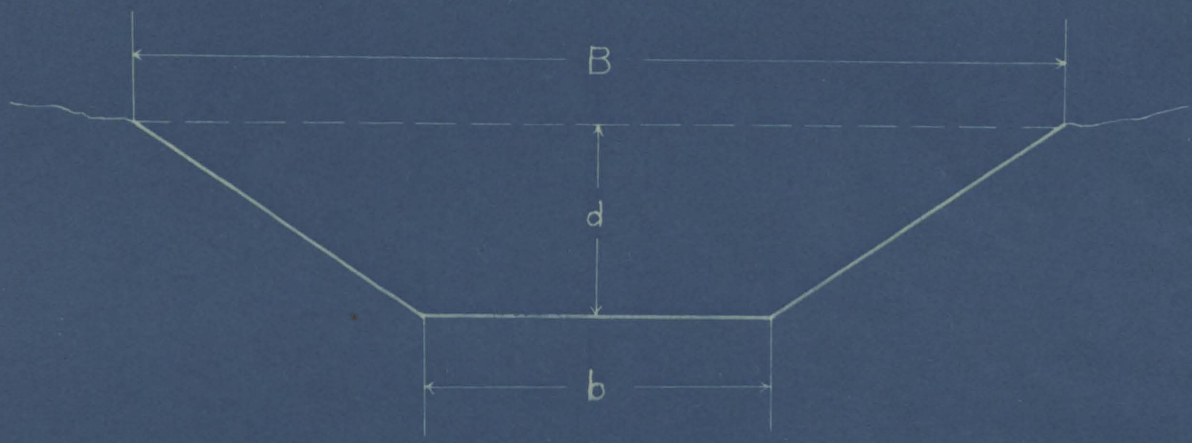
b = 21 feet.

Side slope 1 1/2 to 1.

CROSS SECTION OF DITCH WHERE SALT RIVER

ENTERS SHELBY CO.

DESIGNED FOR AVERAGE FLOOD.




Area = 570 square feet.

B = 63.3 feet.

d = 13.2 feet.

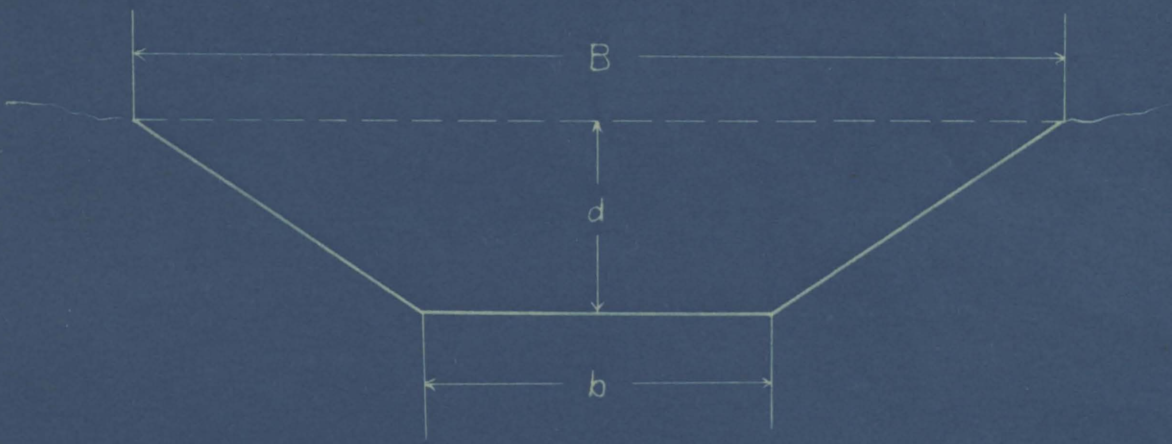
b = 23.7 feet.

Side slope 1 1/2 to 1.

CROSS SECTION OF DITCH WHERE SALT RIVER

IS JOINED BY BEAR CREEK.

DESIGNED FOR AVERAGE FLOOD




Area = 675 square feet.

B = 68.7 feet.

d = 14.3 feet.

b = 25.8 feet.

Side slope 1 1/2 to 1.

## SUMMARY.

In the preceeding estimate it is shown that a ditch of sufficient size to carry the maximum flood would have an average cost of $24,928 per mile,and the ditch which would carry the average flood would have a cost of $16,497 per mile. Since there would be at least 500 acres of land protected to the mile,the maximum ditch could be cut at a cost of $49.85 per acre and the average flood ditch $33.00 per acre.

The above estimate does not provide for the old river channel being used. By using the old channel where possible and constructing by passes on the same designs as the preceeding ditches,the above cost per acre would probably be lowered at least one- half or to $25.00 per acre for the maximum flood protection and $16.50 for the average flood protection. This amount could be more than paid for by the savings of less than three crops.