FLOOD CONTROL STUDIES IN THE CHARITON RIVER BASIN IN IOWA

THE IOWA STATE PLANNING BOARD
CHARITON RIVER BASIN COMMITTEE

BY
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DES MOINES, IOWA DECEMBER 27, 1937

A STATEMENT ON
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FOREWORD

The statements on the possibility of flood control by reservoirs contained herein were prepared for the Chariton Basin Planning Board to supplement data presented at a hearing held in Centerville, November 18, 1937, which hearing was held under the direction of the Corp of Engineers and the Soil Conservation Service pursuant to authority granted by the provisions of the Omnibus Flood Control Act of 1936 and as amended in 1937.

The data presented in this statement are the result of a study made of that part of the Basin for which topographic maps are available. No field work was undertaken in connection with this study, and for that reason the data presented must be taken as indicative only of the general condition existing there. For this reason it is felt that the data presented should be used only as a guide for further work and should not be used as a basis for publicity or justification for any particular project.

A STATEMENT OF FLOOD CONTROL

STUDIES IN THE CHARITON RIVER BASIN

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Iowa State Planning Board

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Description of the Area

The Chariton Basin in Iowa is an area of approximately 925 square miles located in six southern Iowa counties. In Table 1 is given the area of that part of each of the counties located in the basin.

Table 1

Chariton River Basin Land Area

County	Square Miles in Basin	Square Miles out of Basin	Total Square Miles
Appanoose	415	97	512
Clarke	28	400	428
Decatur	12	521	533
Lucas	135	297	432
Monroe	9	423	432
Wayne	325	199	524
TOTAL	924	1,937	2,861

This section of Iowa is located in the area covered by the Kansan glacial drift which was later covered by loessial deposits of more recent origin. In the eastern portion, erosion has carved deeply into the surface and produced a terrain which is rugged and characterized by streams on flat gradients in broad alluvial valleys. The loessial deposits were patchy and varied greatly in thickness. Erosion has removed much of this material and built up the fertile bottom land with this and the underlying glacial material. The western part is a comparatively level upland less deeply dissected than the eastern portion. Limestone and coal are found in the eastern half of the area with the limestone outcropping and the coal found in minable thickness and at reasonable depths. In the western half of the basin both these products are buried too deeply to be quarried or mined profitably.

The Flood Problem

Rainfall

Rainfall in the area has varied between relatively wide limits. Previous studies indicate that, at particular stations, a minimum recorded precipitation of 14 inches occurred in 1910 and that a maximum recorded precipitation of 52 inches was recorded in 1881. The annual average rainfalls in the basin for these years were 21.2 inches in 1910 and 45 inches in 1881. The mean annual precipitation for the period during which rainfall records have been obtained is 33.3 inches. Over a period of 40 years (1895-1934), although individual years have varied widely, the long-time rainfall trend has been downward at a rate of .05 to .12 inches per year with an average decrease of approximately .07 inches.[a]

Intense Storms

Intense storms in southern Iowa occur frequently and of the 33 most

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[a] "Iowa Precipitation Studies" - Iowa State Planning Board, November, 1935.

important storms in the northern United States[a], 5 were so oriented as to give a center of maximum precipitation in Iowa. Four of these five storms were located in southern Iowa. Studies of the intense 24-hour rainfall indicate that total 24-hour precipitation may occur at some point in the region with the frequencies indicated in Table 2. A study of the frequency data in-

Table 2

Rainfall Frequencies

24-Hour Precipitation (Inches)	Frequency (Years)
4.00 - 4.99	1.21
5.00 - 5.99	3.0
6.00 - 6.99	10.0
7.00 - 7.99	13.3
8.00 or more	20

dicates the expression

$$24 \text{ hour rainfall} = 3.8 \text{ Frequency}^{0.23}$$

is valid for frequencies up to about 20 years. Frequencies at a given point would be less (fewer occurrence in a given time) than those for the entire area.

Referring again to the five major storms[a], in Table 3 are shown the depths of precipitation over 1, 500, and 1,000 square mile areas for the duration of the storm.

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[a] "Storm Rainfall of Eastern United States" - Miami Conservancy District.

Table 3

TIME, AREA, DEPTH RELATIONS FOR FIVE IOWA STORMS*

M.C.D. Storm No.*	Date	General Location in Iowa	Area sq.mi.	1	2	3	4	5
51	July 14-16, 1900	N.W.	1	7.0"	13.0"	13.7"		
			500	6.8"	11.7"	12.2"		
			1000	6.8"	10.7"	11.4"		
72	Aug. 25-28, 1903	S.	1	11.2"	14.7"	15.5"	15.5"	
			500	10.6"	11.8"	12.2"	12.4"	
			1000	10.0"	10.8"	11.4"	11.7"	
83	June 9-10, 1905	S.E.	1	12.1"				
			500	10.9"				
			1000	10.0"				
240	Oct. 10-14, 1929	S.	1	5.1"	7.5"	7.7"	8.7"	9.8"
			500	5.0"	6.8"	7.4"	7.8"	8.9"
			1000	4.9"	6.5"	7.2"	7.5"	8.5"
256	June 11-15, 1930	S.E.	1	6.5"	9.6"	10.5"	10.6"	
			500	5.2"	8.5"	9.3"	9.3"	
			1000	5.0"	8.0"	8.6"	8.6"	

*Storm Rainfall of Eastern United States, Miami Conservancy District.

This table is of particular interest in that the depths for a 1,000 square mile drainage area are very close to those which would have been experienced in the Chariton Basin had these storms centered over the watershed and been properly oriented to give a maximum depth.

Types of Floods

Floods in the Chariton Basin are of three major types: Two of these result from intense rainfalls or heavy general rainfalls and melting snows combined and may occur over small areas anywhere in the basin or over the basin as a whole. The third is that found in the reach of the river extending from a point immediately above the Missouri State line upstream for a distance of 10 to 12 miles. It is caused by a combination of drainage activities and a restricted flood channel in Missouri rather than by excessive rainfall.

In the lower valley, channel straightening has decreased the regime channel length and materially increased the slope. Flood waters of bank full stages or less in the upper reaches of the stream are rapidly delivered by the straightened channel to the vicinity of Coal City at a rate far in excess of the capacity of the channel below this point. The adjacent valley, which acts as a detention basin, is inundated by flood waters in proportion to the duration and magnitude of the flood flow. The probable maximum total area subject to this type of flooding in the lower valley is approximately 12,000 acres.

The floods due to intense rainfall over small areas and to rainfalls of long duration over large areas have undoubtedly been increased for rainfalls of given magnitude through an increased runoff resulting from several factors. These may be listed as:

(1) Removal of absorbtive vegetative covering through lumbering, over grazing, and the breaking of sod for tilled crop production, etc.

(2) Drainage activities which have concentrated flood waters in the main channels and accelerated its movement.

(3) Sheet erosion which has exposed a more impervious subsoil and to changes in character of the soil due to agricultural use.

Flood Magnitudes

Unfortunately, no stream gaging stations have ever been operated on the Chariton River in Iowa. For this reason, reliable flood frequency studies are impossible at this time. However, floods of such magnitude as

Table 4
SWAMP AND BOTTOM LAND AREAS - CHARITON RIVER BASIN*
(Based on State and Federal Soils Survey)
(Acres)

Area	Appanoose	Clarke	Decatur	Lucas	Monroe	Wayne	Total
Chariton River	21,274[a]	768		7,072[b]		384	29,498
Minor Chariton River Tributaries	9,734	287	185	300[b]	270	314	11,090
South Branch Chariton River and Minor Tributaries	1,122					7,322	8,444
Shoal Creek	2,812						2,812
Cooper Creek	1,361						1,361
Walnut Creek	1,721					491	2,212
Dick Creek						630	630
Nine Mile Creek						737	737
Wolf Creek				2,176[b]		612	2,788
Jackson Creek						2,680	2,680
Jordan Creek						401	401
Honey Creek				339[b]			339
Lost Branch Creek				358[b]			358
TOTAL	38,024	1,055	185	10,245[b]	270	13,571	63,350

Swamp & Bottom Land of all Streams / Total Area of Basin 10.7%

Swamp & Bottom Land of Chariton River Proper / Total Area of Basin 5%

(a) Of this area, 11,757 acres are located in the lower Chariton valley in the reach which has been straightened.

b Estimated.

*Data prepared by L. W. Murray, Field Engineer, Iowa State Planning Board.

to prevent successful farming in large parts of the bottom land have occurred with such frequency as to discourage any attempt to produce tilled crops. To remedy the situation with respect to flood records, the Appanoose County supervisors have made available funds for constructing a stream gaging station near Centerville on the Chariton River in cooperation with the Iowa Geological Survey.

Areas Flooded

In the absence of topographic maps or other reliable information on the extent of flood areas as a function of flood stage, an approximation of areas subject to inundation was arrived at by using the soil type as an index.

The Wabash soil series comprising the Wabash Loam, the Wabash Silt Loam, and the Wabash Silty Clay Loam are classified as bottom land soils either swampy or subject to overflow. Inasmuch as the swamp land in this region is overflow land, the Wabash soil series represents land subject to flooding.

The areas given in Table 4 were obtained by planimetering the areas shown on soil maps* on the Chariton main stem and its tributaries. Those acreages given for Lucas County were estimated by multiplying the total acreage of this soil series in the county by the ratio of the total area in the basin in Lucas County to the total area of the county.

Annual Flood Damage

No estimates of flood damage have ever been made on the Chariton Basin by the U. S. Weather Bureau of other agencies insofar as is known. Thus,

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*Soil Surveys of Appanoose, Clarke, Decatur, Monroe and Wayne Counties. U. S. Dep't. of Agriculture and Iowa Agricultural Experiment Station. Data prepared by L. W. Murray, Field Engineer, Iowa State Planning Board.

the only figures on actual crop damage that could be given would, of necessity, be hypothesized with the attendant questionable reliability.

A further disturbing factor in arriving at estimates of agricultural damage is the fact that in parts of the Chariton bottom lands no attempt is made to produce tilled crops because successive crop losses suffered have shown that successful crop production is unlikely. Evaluating losses due to non-attempted crop production is difficult indeed. However, in an attempt to arrive at an indication of the extent of agricultural benefits which might accrue from flood control, Table 5 was computed on the basis that one-third of the total bottom land (Wabash soil series) area might be protected from floods and its productivity increased by a decreased flood damage. The relationships expressed are all linear, and it is a matter of further study to determine what annual benefit per acre might be obtained by control measures.

Table 5

Flood Control Benefits to Agriculture*

Estimated Benefit per acre	Estimated Annual Benefit	Capitalized
$ .10	$ 2,112	$ 53,000
$ .25	$ 5,280	$ 132,000
$ .50	$10,560	$ 264,000
$ 1.00	$21,120	$ 528,000
$ 2.00	$42,240	$1,056,000
$ 3.00	$63,360	$1,584,000

*Based on the assumption that one-third of the bottom land would be benefited over a period of years by the annual amount shown in the first column. Thus, if one acre out of three were benefited to the extent of $3.00 per year then the expenditure warranted (at 4%) is $1,584,000.

Mention also, at this time, should be made of the point that whereas heretofore flood inundation has been considered beneficial to bottom land due to the deposition of a fertile humus and top soil washed from the uplands, this situation no longer exists in the Chariton Valley. Instead, the material deposited is an infertile subsoil which decreases rather than increases bottom land fertility.

There are no large towns located in the flood plains of the main river or its tributary; hence, there is no large urban flood damage in the basin. Several small villages, such as Sedan and Dean, are frequently flooded but the total damage is comparatively small. Minor damage may occur from intense storms in urban areas but this type of damage does not readily lend itself to control.

Possible Remedial Measures

Remedial measures for alleviating flood conditions may be classified into two general groups: Those works constructed to confine the flood flows to the existing channel by levees and channel enlargement or straightening, and those works constructed to withhold the flood waters from the channel and release them in such amounts as may be safely carried by the existing channel.

Channel Control Works

Of these two methods, mentioned above, the first has but little practical possibility in this area. In fact, a part of the flood problem is occasioned by just such attempts at flood control -- namely, channel straightening. It is doubtful if any channel straightening could be warranted on the Chariton except perhaps at isolated bends.

Table 6

POSSIBLE RESERVOIR SITES IN CHARITON BASIN*

Location	Drainage Area	Dam			Reservoir			Multiple Use
		Height (feet)	Length (feet)	Approx. Vol. (cu. yds.)	Area (acres)	Capacity (acre feet)	Capacity Inches on Watershed	
(1) Sec. 30, T. 71 N. R. 21 W., Wolf Cr.	67 sq.mi.	35	2100	383,000	1500	25,000	7.0	Irrigation flood control
(2) Sec. 36, T. 70 N. R. 21 W. (Northwest of Corydon)	4 sq.mi.	35	850	155,000	120	2,000	8.5	Recreational and flood control
(3) Sec. 36, T. 70 N. R. 21 W., Jordan Creek	16 sq.mi.	45	1100	345,000	530	12,400	14.5	Irrigation flood control
(4) Sec. 23, T. 71 N. R. 20 W., Honey Creek	11 sq.mi.	40	1000	248,000	395	7,900	13.9	Irrigation flood control
(5) Sec. 32, T. 70 N. R. 22 W., Nine Mile Creek	18 sq.mi.	40	1400	352,000	590	11,800	12.4	Irrigation flood control

*Quantities in the dam were estimated by scaling from a 1/48,000 scale topographic map; Dam section used has 10' freed board, 10' top width and 3 to 1 side slopes; quantities computed by $Q = \frac{(4h^2 + 7h)L}{27}$ ("h" is dam height, "L" is dam length at crest). Reservoir area was planimetered and capacity computed by $Q = \frac{2}{3} A(h-10)$. ("h" is dam height; "A" is reservoir area).

A thorough study of the flood plain area is needed to determine the relative feasibility of levee construction along the main stem of the Chariton River in its lower reaches as those heretofore constructed have not proved financially sound due to their limited nature. A few small levees of questionable adequacy have been constructed near Dean and Sedan.

Flood Detention Works

The Chariton River with its dendritic drainage system offers excellent possiblity for flood control by detention reservoirs on the smaller tributaries. A series of reservoirs controlling the runoff from drainage areas of 5 to 50 square miles can materially reduce floods on the main stream provided a number sufficient to control an appreciable percentage of the water-shed can be constructed.

Preliminary studies of U. S. Geological Survey maps have indicated that there are several sites for reservoirs which appear to be worthy of detailed study. The general locations of these reservoir sites are shown on the accompanying map. In Table 6 are shown certain data relative to these locations. Not all of the basin is covered by topographic maps; hence, only that part of the basin that is covered has been studied. Additional studies on remaining areas are needed to supplement the present studies.

Those reservoirs shown in Table 6 are considered as multiple use reservoirs designed primarily for flood control, supplemental irrigation and recreation. Others in the area might serve as possible water supply for municipal use. It is believed that the multiple use of these reservoirs is feasible and that the various uses will not materially interfere with one another. However, a detailed study is necessary to evaluate properly the benefits of the multiple use of these and other possible reservoirs.

The importance of supplemental irrigation in southern Iowa has not been clearly appreciated in general. Experiences of farmers in the state who have attempted small scale irrigation have demonstrated the feasibility. During the past season, pumped irrigation areas produced corn yields 50 per cent greater than non-irrigated areas in the same fields at several points over the state. There is scarcely a year when the opportune application of irrigation water to irrigable lands will not increase crop yields in this region, even though normal rainfall is received. Benefits from irrigation would be in addition to flood control benefits shown in Table 5. It is this combined use of reservoirs that will make economically sound those structures which could not be justified on the basis of a more efficient single use.

A further beneficial use of these reservoirs is that of municipal water supply for those small municipalities not now having public supplies. The problem of municipal water supply in this basin is a serious one in that in this area are found the greatest number of towns over 250 population having no public water supply.

Justification for and Benefits from Detailed Studies

The people in this six-county area are attempting a program of rehabilitation of their agriculture and associated industries. An awakened sense of responsibility to future generations makes this a very desirable area for demonstrating the effectiveness and feasibility of certain governmental proposals for flood control, soil conservation and economic and social rehabilitation. The region is handicapped in securing the necessary Federal cooperation and assistance due to the absence of supporting factual data to substantiate the request for assistance.

For example, the fact of frequent flooding with attendant agricultural loss is generally known but various agencies collecting basic data on flood frequencies and magnitudes, extent of damages, etc., have neglected this area not because of insignificance of the problem but because in monetary magnitude it was smaller than on other and larger streams. The deficiency of data has been recognized, and at the present time a step toward remedying this deficiency has been taken by the Supervisors of Appanoose County, making available funds for constructing a stream gaging station, in cooperation with the Iowa Geological Survey, on the Chariton River near Centerville.

It is believed that detailed surveys, as authorized by the Omnibus Flood Control Act of 1936 (P.D. 738 - 74th Congress), are warranted for this area on the following points:

(1) Previous studies ("308" reports) by the Corps of Engineers have not included this portion of Iowa within their scope, and at no time past have studies been made of the economic feasibility of "constructive flood control and allied purposes."

(2) The absence of adequate basic data on flood magnitudes, frequen-

cies and extent of flood damage requires that studies of flood control and associated problems be undertaken by an agency having adequate technical background and the necessary funds to properly prosecute the work. The financial status of the political units in the basin is such as to preclude their financing the preliminary work.

(3) The detailed studies requested would show that the benefits accruing from the construction of multiple use reservoirs to be used primarily for flood control and supplemental irrigation are sufficient to warrant the construction as being on a sound economic policy. A portion of the storage capacity in some cases might be devoted to municipal water supply use.

(4) Further justification for a detailed study of the area is that of determining its suitability for use as a study area intermediate between the laboratory size model and the very large scale developments as exemplified by projects such as the Muskingum Valley project in Ohio. The Chariton Basin Planning Board and the Iowa State Planning Board are at present working on an expanded program for collecting meteorological and hydrological data in this basin as a part of a broad study of the area. This program supplemented by such additional data as might be required would provide a study area wherein might be tested the feasibility of present theories of flood control.

The Project

A detailed study by the Corps of Engineers as envisioned in this request would cover the following points:

1. Authentic data on the economic feasibility of

   A. A levee system in the Lower Chariton River Valley

   B. A system of comparatively small (5 to 50 square mile drainage area) multiple use reservoirs for

      (1) Flood control on the main River

      (2) Supplemental irrigation

      (3) Municipal water supply

      (4) Recreational use

      (5) Reducing erosion of and along river banks

   C. Effectiveness of a reservoir system in Iowa on the flood problem in Schuyler County, Missouri.

II. The development of a possible construction program for the Chariton Basin based on the studies given in Item I above should the development be found feasible.

III. The inauguration of a broad study program concerning the practical effectiveness of such construction in attaining a program of flood control and water conservation.