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WATER AND RELATED LAND RESOURCES MANAGEMENT STUDY. VOLUME III. --ETC(U)

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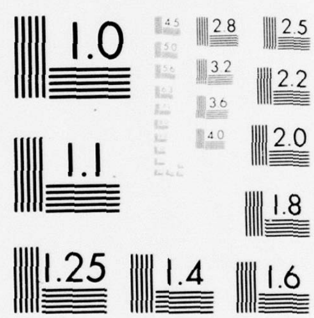

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VOLUME III
PLAN FORMULATION APPENDIX

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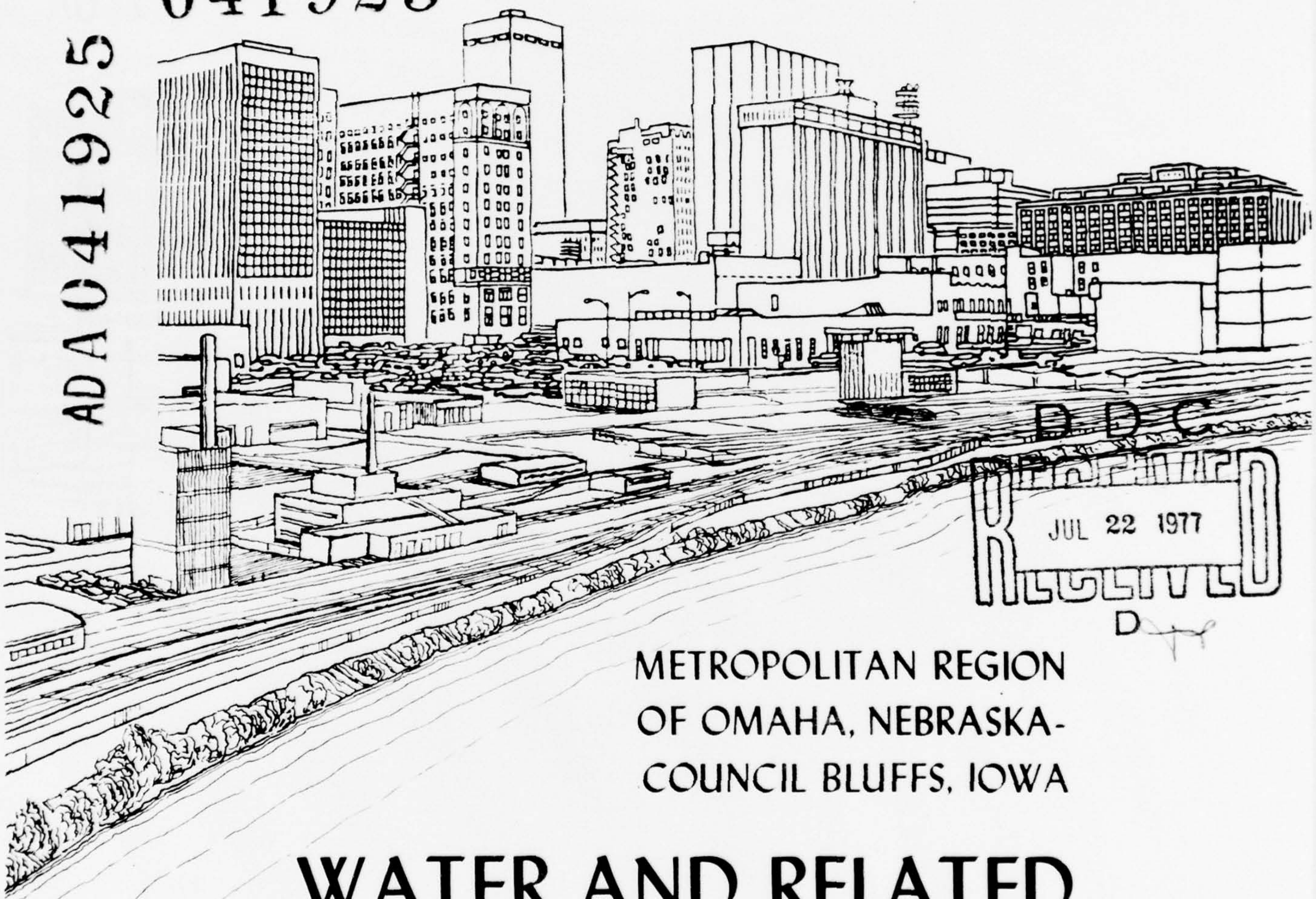
ANNEX D - FLOOD CONTROL

REVIEW REPORT ON THE MISSOURI RIVER AND TRIBUTARIES



METROPOLITAN REGION
OF OMAHA, NEBRASKA-
COUNCIL BLUFFS, IOWA

WATER AND RELATED LAND RESOURCES MANAGEMENT STUDY

ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE.

JUNE 1975

34

REVIEW REPORT FOR

(11) Jun 75

(12) 310 p.

Metropolitan

Omaha, Nebraska-

Council Bluffs, Iowa

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WATER AND RELATED LAND RESOURCES MANAGEMENT STUDY.

Volume III. Plan Formulation Appendix. Annex D. Flood Control.

ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE.

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REVIEW REPORT FOR METROPOLITAN OMAHA, NEBRASKA COUNCIL BLUFFS, IOWA WATER AND RELATED LAND RESOURCES MANAGEMENT STUDY

Volume III Plan Formulation Appendix

ANNEX A	ALTERNATIVE FUTURES
ANNEX B	WASTEWATER
ANNEX C	WATER SUPPLY
ANNEX D	FLOOD CONTROL
ANNEX E	RECREATION

PREPARED BY THE

OMAHA DISTRICT CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY

REVIEW REPORT FOR
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
WATER AND RELATED LAND
RESOURCES MANAGEMENT STUDY

Plan Formulation Appendix

Annex D Flood Control

PREPARED BY THE

OMAHA DISTRICT CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY

SECTION A

THE STUDY AND REPORT

FLOOD CONTROL AND FLOOD PLAIN MANAGEMENT

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SECTION A

THE STUDY AND REPORT

The Study and Report

PURPOSE AND AUTHORITY

1. The purpose of this annex is to present the results of studies made regarding existing and potential future flood problems in the Metropolitan Omaha, Nebraska-Council Bluffs, Iowa study area. The study information presented herein is intended to assist other agencies in making future planning decisions.

2. Authority for this study is contained in resolutions adopted by the Committee on Public Works of the United States Senate on 6 May 1971 and by the Committee on Public Works of the House of Representatives on 29 July 1971. These resolutions are worded as follows:

"Resolved by the Committee on Public Works of the House of Representatives and United States Senate, that the Board of Engineers for Rivers and Harbors is hereby requested to review the reports of the Chief of Engineers on the Missouri River and Tributaries, published as House Document Numbered 238, Seventy-third Congress, and other pertinent reports with a view to determining whether any modifications of the recommendations contained therein are advisable at the present time, with particular reference to providing a plan for the development, utilization and conservation of water and related land resources of the metropolitan region of Omaha, Nebraska - Council Bluffs, Iowa with due consideration for the metropolitan planning activities in the seven-county area, consisting of Cass, Douglas, Sarpy, and Washington Counties in Nebraska, and Harrison, Mills, and Pottawattamie Counties in Iowa. Such study to include appropriate consideration of the needs for protection against floods, wise use of flood plain lands, navigation facilities, regional water supply and waste management facilities systems, general recreational facilities, enhancement and control of water quality, enhancement and conservation of fish and wildlife, and other measures for environmental enhancement, economic and human resources development, and shall be harmonious components of comprehensive development plans formulated by various planning agencies and other interested Federal agencies."

SCOPE OF THE STUDY

3. This annex presents the results of studies of the unresolved flood problems in the Metropolitan Omaha, Nebraska - Council Bluffs, Iowa study area and potential alternatives for resolving these problems. It was determined early in the planning and screening process that the basins that had unresolved flood problems of any consequence were as follows: Boyer River in the vicinity of Missouri Valley, Iowa; Indian and Mosquito Creeks in the vicinity of Council Bluffs, Iowa; Papillion Creek and its tributaries; the Platte-Elkhorn River flood plain; and the Missouri River flood plain. Several alternative plans to resolve each basin's flood problems were investigated. All alternatives considered were also evaluated to determine their potential impact on area planning. Plans that appeared to have economic feasibility were studied in more detail, including cost and benefit estimates. The selection of the most feasible plan was made after considering all the factors, including those expressed by concerned planning agencies and other interested Federal agencies.

STUDY PARTICIPANTS AND COORDINATION

4. The Corps of Engineers had the principal responsibility for conducting and coordinating the study of the existing and future flood problems of the study area and for plan formulation and preparation of the report.

5. Coordination with other agencies included informal meetings to discuss alternative plans considered or to be considered, review of and comments of the draft of this report, review of the preliminary environmental statement for any selected plan, and participation in the formal public meetings.

6. Public meetings and workshops were held throughout the period of this study. A review of the meetings that were held is shown in Volume VI of this report.

The Report

7. This report presents the feasibility studies for flood control and flood plain management in the Metropolitan Omaha, Nebraska-Council Bluffs, Iowa study area. This annex has been separated into six sections to discuss the six major basins within the Metropolitan area. Each section includes a description of the resources and economy of the basin, the problems and needs, and formulation of the most suitable plan for meeting the needs of each basin. There are

other tributaries in the study area but flooding in these basins has been infrequent and mainly confined to agricultural lands. The frequency and damages caused do not justify construction of flood control measures. Flood plain regulation or zoning should be implemented in these basins to prevent increased flood damages. The remaining water resource problems, such as erosion and drainage, may be better handled by programs of the Soil Conservation Service.

Existing and Authorized Projects

8. A map showing existing and authorized projects of the Corps of Engineers within the study area is shown on plate A-1.

Prior Studies and Reports by The SCS

9. The Soil Conservation Service (SCS) has completed investigations throughout the study area. Plate A-2 shows the basins that were studied by the SCS; the status of these studies is shown on table A-1.

Table A-1
Recent SCS Studies, Iowa and Nebraska

Watershed	Status
IOWA	
Missouri River Direct Tributaries	
Soldier River	Nonfeasible
Rush Creek	Nonfeasible
Skunk Creek	Nonfeasible
Middle Soldier River	Nonfeasible
Davis-Battle Creek Watershed	PL 566 Const. Complete
Elk Creek	PL 566 Application
Cobb Creek	PL 566 Application
North Pigeon Watershed	PL 566 Construction
Simon Run Watershed	PL 566 Construction
Indian Creek Watershed	PL 566 Construction
Mosquito-Harrison Watershed	PL 566 Construction
Ryan-Henschal	PL 566 Construction
Twin Ponies Watershed	PL 566 Planning
Pony Creek Watershed	PL 566 Construction
Boyer River	
East Branch, Boyer River	Nonfeasible
Big Park Watershed	PL 566 Const. Complete
Dane Ridge Watershed	PL 566 Construction
Mill-Picayune Creek Watershed	PL 566 Construction
Harmony Creek Watershed	PL 566 Const. Complete
Allen-Steer	PL 566 Application
NEBRASKA	
Papillion Creek	PL 566 Construction

Environmental Setting

and Natural Resources

CLIMATE

10. The climate of the Metropolitan Omaha, Nebraska-Council Bluffs, Iowa study area is typically continental with relatively warm summers and cold, dry winters. The study area is affected by most storm centers, or "lows", that cause periodic and rapid changes in weather, especially during the winter months.

11. Temperature extremes of the study area have ranged from a high of $114^{\circ}F$ to a low of $-32^{\circ}F$. The mean annual precipitation ranges from 29 to 32 inches.

12. Normally, about 75 percent of the annual precipitation occurs between April and September. Local thunderstorms are frequent in the area. The mean annual snowfall is 32 inches. Climatological data through 1973 are shown in table A-2.

Table A-2
Climatological Data
Metropolitan Omaha, Nebraska-Council Bluffs, Iowa Study Area

Annual Mean Temperature	$52^{o}F$
Average Temperature, Summer Months	$75^{o}F$
Average Temperature, Winter Months	$26^{o}F$
Average Annual Rainfall	30.2 inches
Average Annual Snowfall	32.0 inches

GEOLOGY OF THE AREA

13. Bedrock geology of the study area consists of about 2,000 feet of sedimentary rock overlying an igneous and metamorphic Pre-Cambrian basement. Surface bedrock consists of limestones, dolomites, and shales of the Pennsylvanian system. Glacial till consisting of a mixture of clay, sand and gravels usually is found on top of bedrock. The till is a product of glacial action during the Nebraskan glacial stage. Loess in varying Thicknesses overlies the glacial till. Thick loess deposits occur in the bluffs bordering the Missouri River and its tributaries.

Future Land Use

14. Future development is expected to occur in the metropolitan area, basically within the four land use concepts presented in the Omaha Metro Studies for land use planning. These concepts are

listed as A, B, C, and D. Concepts A, C, and D concentrate population and employment growth in Douglas and Sarpy Counties. Concepts A and D represent continued sprawl, while Concept C represents redevelopment of the inner city. Concept B, while basically a "restricted growth policy", alternately distributes an additional 5 to 10 percent of future growth to the satellite cities outside of Douglas and Sarpy Counties.

GROWTH CONCEPT A

15. Growth Concept A is consistent with present trends in land use. In the absence of a firm growth policy, this concept would be the most likely growth alternative, with a continuing decay of the urban core.

16. Concept A is characterized by **low-density** growth with a residential development density of from 1 to 9 persons per acre. To develop this concept, the population allocations used in the Metropolitan Area Planning Agency's (MAPA) 1995 transportation plan were duplicated and extended to indicate what the growth pattern would look like in 1995 and 2020. Concept A's urban sprawl pattern is a compromise between the MAPA Comprehensive Land Use Plan adopted in 1971 and the Metropolitan Utility District's land use plan for water supply master planning developed in 1972. The MAPA plan estimated a density slightly lower than Concept A, whereas the latter plan estimated slightly higher densities. Concept A may be the most inefficient growth pattern where the use of land and the provision of public services are concerned. Residential, commercial, and industrial land required under Concept A would total about 72,000 additional acres by the year 2020. Most of this land is presently being used for agricultural production. The public

utilities and services, such as water, sewer, gas, electricity, telephone, and transportation, needed to serve this urban sprawl pattern would require major public expenditures. For many, Concept A represents the "American dream" of having a house on a lot large enough to afford some privacy. The growth pattern can be "planned" so that it may develop in an orderly fashion in contrast to the haphazard "leapfrogging" of today's urban growth. Plate A-3 presents potential land use with Growth Concept A.

GROWTH CONCEPT B

17. Concept B includes controlled expansion of urban Omaha, emphasis on encouraging higher-density residential development, revitalizing the urban core, developing satellite cities where communities presently exist around the fringes of the metropolitan area, and developing some new towns on the fringe of the metropolitan area. Small cities, and possibly some new communities, separated from Metropolitan Omaha by open country, characterize this concept. Population densities of from 10 to 15 people per acre were used in the major metropolitan area. In contrast, growth in the satellite communities and new towns would be at a planned high density of 30 persons per acre.

18. A satellite city is one which is self-sufficient, with adequate economic activity to provide job opportunities. In Concept B, the communities of Blair, Ft. Calhoun, Bennington, Elkhorn, Gretna, Springfield, and Plattsmouth, in Nebraska, and Missouri Valley and Glenwood, in Iowa would be satellite communities. Population projections for these "satellites" are shown in table A-3.

Table A-3
Population Projections
Concept B

City	1974	Rural Cities 2020	Satellite Cities 2020
Valley	1,595	3,325	6,000
Springfield	795	7,093	25,000
Gretna	1,557	13,208	35,000
Elkhorn	1,184	3,819	22,500
Blair	6,106	10,393	30,000
Ft. Calhoun	642	1,708	8,000
Bennington	683	3,144	22,500
Plattsmouth	6,371	8,057	20,000
Glenwood	4,421	6,312	10,000
Missouri Valley	3,519	6,059	10,000

19. New towns would include Deer Creek, located southeast of Fort Calhoun, Nebraska, and East Bellevue, located on the Iowa side of the Missouri River opposite Bellevue, Nebraska. A relatively low population of 7,000 was assigned to each of the New towns.

20. Land required for urban development with Concept B for year 2020 would be less than half of the 72,000 acres required for Concept A. Existing small communities close to Omaha could grow while having their own industry for a tax base and at the same time remain independent of Omaha.

21. The satellite cities concept would be difficult to implement. The growth of Omaha would have to be curbed; industrial employment opportunities would have to be directed toward the satellite cities. Most of the smaller communities are presently not prepared to accomodate the growth envisioned. New towns would require the establishment of governmental structures and the construction of all

the facilities needed to provide total services to a community. The problems associated with the construction of a new town would not be insurmountable, but they would pose numerous difficulties. Plate A-3 presents potential land use with Growth Concept B.

GROWTH CONCEPT C

22. Concept C is similar to Concept B but it does not include the satellite cities. This concept would be characterized by redevelopment of the older areas of Omaha and Council Bluffs, coupled with higher-density growth on the urban fringes. The urban area would be more compact than with Concept A. New and redeveloped areas under Concept C were projected to be double the density of Concept A. The satellite new towns of Deer Creek, and East Bellevue are not included. Existing smaller communities are assumed to grow at a rate projected by local and State agencies. A growth pattern similar to Concept C is being studied as an alternative to urban sprawl in MAPA's Transportation Planning for the year 2000. Additional land required for urban use would be on the order of 43,000 acres by 2020. Plate A-3 presents potential land use with Growth Concept C.

GROWTH CONCEPT D

23. Concept D is similar to Concept A, except that it assumes substantial finger-like development will occur along Interstate 80 to the southwest of Omaha and to the northeast of Council Bluffs along the proposed Omaha-Fremont Freeway to the northwest of Omaha, and along the Kennedy Freeway and the planned Highway 73-75 Expressway to the south of Omaha. Because Concept D envisions a sprawl pattern, the population densities used in developing it were similar to those used in Concept A. Additional land required for urban use is estimated to total 71,000 acres by the year 2020. Plate A-3 presents potential land use with Growth Concept D.

POPULATION PROJECTIONS

24. Table A-4 presents population projection comparisons for the seven-county area based on the growth concepts presented in the foregoing paragraphs.

Impact of Alternative Growth Concepts on Flood Plain Land Use

25. Future use of flood plain lands will be determined for the most part by local enforcement of Federal and State flood plain land use policies.

26. Flood plains of the Boyer River, Mosquito Creek, Indian Creek, the Missouri River, the Platte-Elkhorn Rivers, and Papillion Creek and tributaries will be subjected to different development pressures with the different alternative growth concepts.

BOYER RIVER

27. Flood problems in the Boyer River are subject to change at the downstream areas because Missouri Valley, Iowa, is partially located in the flood plain. Missouri Valley is promoting growth and could

Table A-4
Population Projection Comparisons For Seven-County Area
(Thousands)

	SMSA Counties				Non-SMSA Counties							
	Douglas	Sarpy	Pottawattamie	SMSA Total	Cass	Washington	Harrison	Mills	Study Region Total	Iowa	Nebraska	United States
1970 Census	390	66	87	543	18	13	16	13	603	2,825	1,483	203,212
1995 Concepts												
A	533	215	102	850	21	18	17	12	918	3,494	1,818	288,270
B	516	177	103	796	33	42	23	24	918			
C	581	167	102	850	21	18	17	12	918			
D	523	225	102	850	21	18	17	12	918			
2020 Concepts												
A	650	261	123	1,034	22	19	18	11	1,104	4,672	2,354	399,013
B	635	220	115	970	34	52	23	25	1,104			
C	686	229	119	1,034	22	19	18	11	1,104			
D	619	288	127	1,034	22	19	18	11	1,104			

be a satellite city of 10,000 population by year 2020 if Growth Concept B were to occur. Since the areas best suited for residential, industrial and commercial development are located in the flood plain, the growth of Missouri Valley would create pressures to develop flood plain lands located outside of the floodway; this would result in increased flood hazards in the fringe area.

MOSQUITO CREEK

28. Current and future flood problems in Mosquito Creek are prevalent at the downstream end of the basin in the suburbs of Council Bluffs, Iowa. The flood plain is directly in the path of future development. Pressure to develop the flood plain outside the floodway will exist under all four growth concepts. This pressure would be most intense with Concepts B and C, which would tend to limit expansion and increase the density of development in the area around the Mosquito Creek flood plain. Most of this future development will not occur for several years; now would be the best time to zone the floodway.

INDIAN CREEK

29. The Indian Creek flood plain passes through three distinct areas. The 3 miles of flood plain upstream from Council Bluffs are narrow and nearly fully developed with single-family residences. The next 3-mile area is a wide flood plain through high-density residential, commercial, and industrial development in Council Bluffs, Iowa. The downstream 3-mile area is protected by tieback levees of the Missouri River levee system. Since little land is currently available for development in the nonprotected reaches of the flood plain, the flood potential would not be subject to significant changes by new development. Since much of this flood

plain contains very old structures, redevelopment or replacement of these structures may, however, cause changes in the flood potential. This flood potential may increase or decrease depending upon the type of redevelopment. Growth Concepts B and C, which tend to restrict expansion and intensify land use within existing developed areas, could create pressures for more intensive use of the Indian Creek flood plain; this in turn may increase the flood potential in the future if the existing flood problem is not taken into consideration.

PLATTE-ELKHORN RIVERS

30. Flood problems in the combined Platte-Elkhorn Rivers flood plain are concentrated at Valley, Waterloo, Louisville, and King Lake, Nebraska. Since significant growth is not anticipated or projected for Waterloo, King Lake, or Louisville, flood problems in these areas are not expected to change noticeably in the future. Valley is a satellite city with a 2020 population of 6,000 in Growth Concept B. Valley is located entirely in the Platte River flood plain, therefore, any future development would intensify the flood problems.

MISSOURI RIVER

31. The Missouri River flood plain on the Nebraska side will be protected by Federal levees from the northern edge of Omaha, Nebraska downstream to the Platte River when levee unit R-616 is constructed. On the Iowa side, when levee units L-611-614 are completed, the flood plain will be protected from the northern edge of Council Bluffs downstream to Keg Creek. Upstream from Omaha, all alternative growth concepts include parks and open space in the flood plain.

PAPILLION CREEK AND TRIBUTARIES

32. Papillion Creek, Big Papillion Creek, Little Papillion Creek, and West Branch Papillion Creek flow through the center of the city of Omaha. The continued growth of Omaha will cause increasing pressures to develop the unzoned portions of the flood plains. Since the Little Papillion Creek flood plain is almost totally developed, future growth will not significantly affect the flood hazards. The downstream areas of the Big Papillion Creek flood plain and most of the West Branch and Papillion Creek flood plains remain undeveloped. All alternative growth concepts show Omaha growth across and beyond the flood plains of the Papillion Creek and its tributaries. Growth Concepts B and C are likely to create the most pressure to develop unzoned flood plain lands because the alternative growth concepts tend to restrict expansion and increase density in the developing areas.

Formulation and Evaluation Criteria

33. Formulation and evaluation of the plans of improvement for the study area, including all possible alternatives, were based on technical, economic, and intangible criteria, including beneficial and detrimental effects on the area's environment. Such criteria permit the selection of the plan of improvement which represents

the solution that best responds to the problems and needs of the area and which is justifiable.

TECHNICAL CRITERIA

34. The following technical criteria were adopted for use in developing a plan:

- Any plan of improvement shall provide urban-level flood protection;

- Any plan of improvement shall assume that the flood plain zoning will be implemented in accordance with the Flood Disaster Protection Act of 1973 (Public Law 93-234). Therefore, when considering alternatives, future development within the 100-year flood plain was considered to be compatible with the regulations;

- In determining the spillway width and surcharge depth required for any contemplated reservoir, a spillway design flood routing was made starting with a full pool in the reservoir and assuming zero outflow from the outlet works; and

- The plan should be consistent with local, regional, and State desires and land use plans.

ECONOMIC CRITERIA

35. The economic criteria which were applied in formulating plans are those specified by the "Principles and Standards". The following economic criteria were considered in formulating a plan:

• Average annual benefits must exceed average annual economic costs;

• Each separable unit of improvement must provide benefits at least equal to its costs;

• The scope of the development shall provide maximum net benefits; however, intangible considerations could dictate a project which would forego some of the net benefits;

• The benefits and costs shall be expressed in comparable terms to the fullest extent possible. All of the alternatives were based on September 1975 prices; annual costs were based on 50-year and 100-year periods of analysis and on an interest rate of 6 1/8 percent. Annual costs also include loss of land productivity, maintenance and operation, and major replacements. Interest during construction was not included where the construction period would be less than 1 year;

• If formulation shows that future development in the 100-year flood plain would occur without a project, the only benefit claimed was for elimination or reduction of flood proofing costs associated with the future development. No flood benefits were taken for future development within the 100-year flood plain; and

• Location or land enhancement benefits were taken where any potential Corps project would modify the flood plain to allow land use which, under preproject conditions, would be too hazardous.

ENVIRONMENTAL AND OTHER CRITERIA

36. The following environmental criteria and intangibles were considered in formulating a plan:

- Available sources of expertise were used to identify adverse effects which could not be avoided should any proposal be implemented;

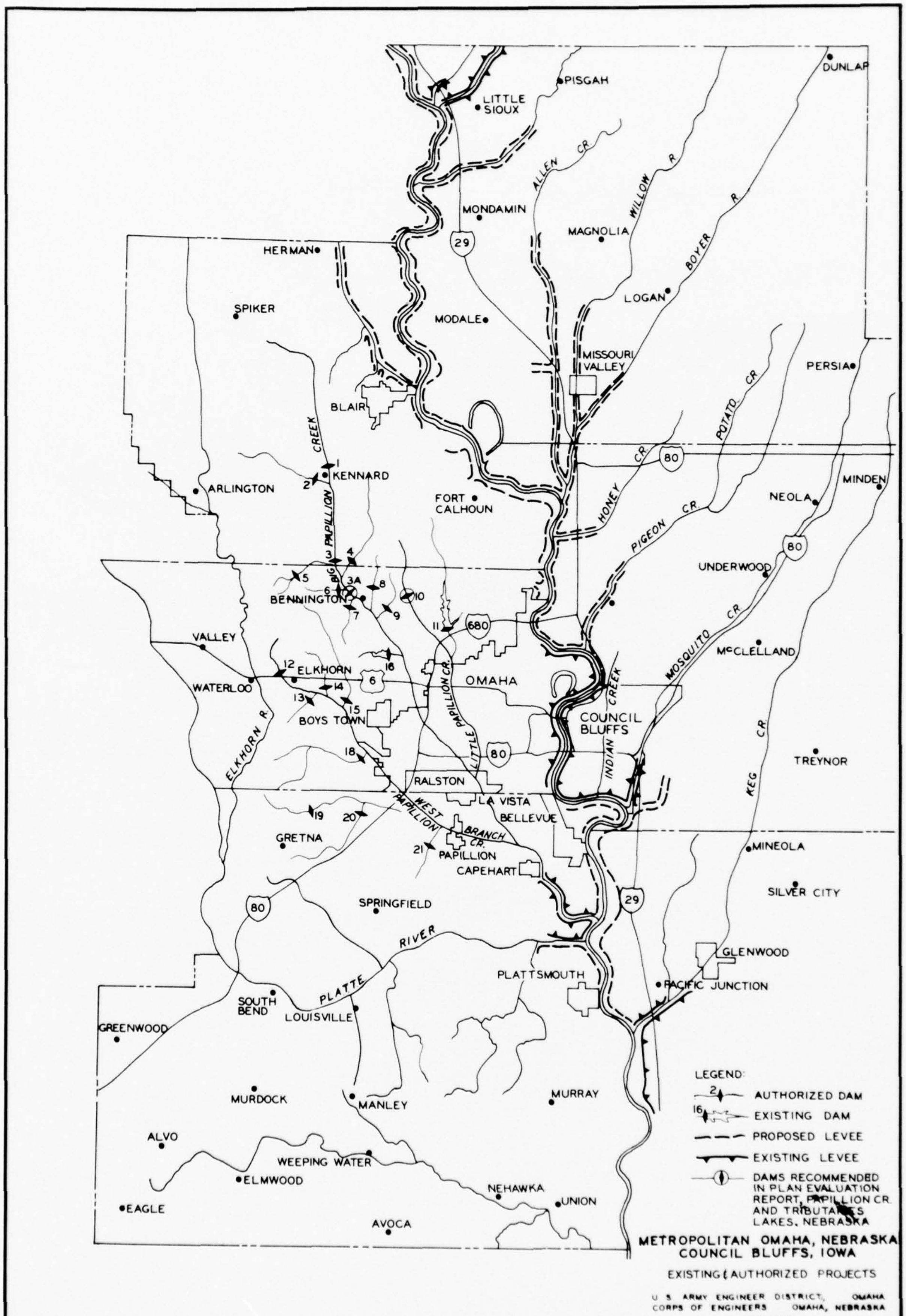
- The use of natural resources to effect implementation of a plan were minimized;

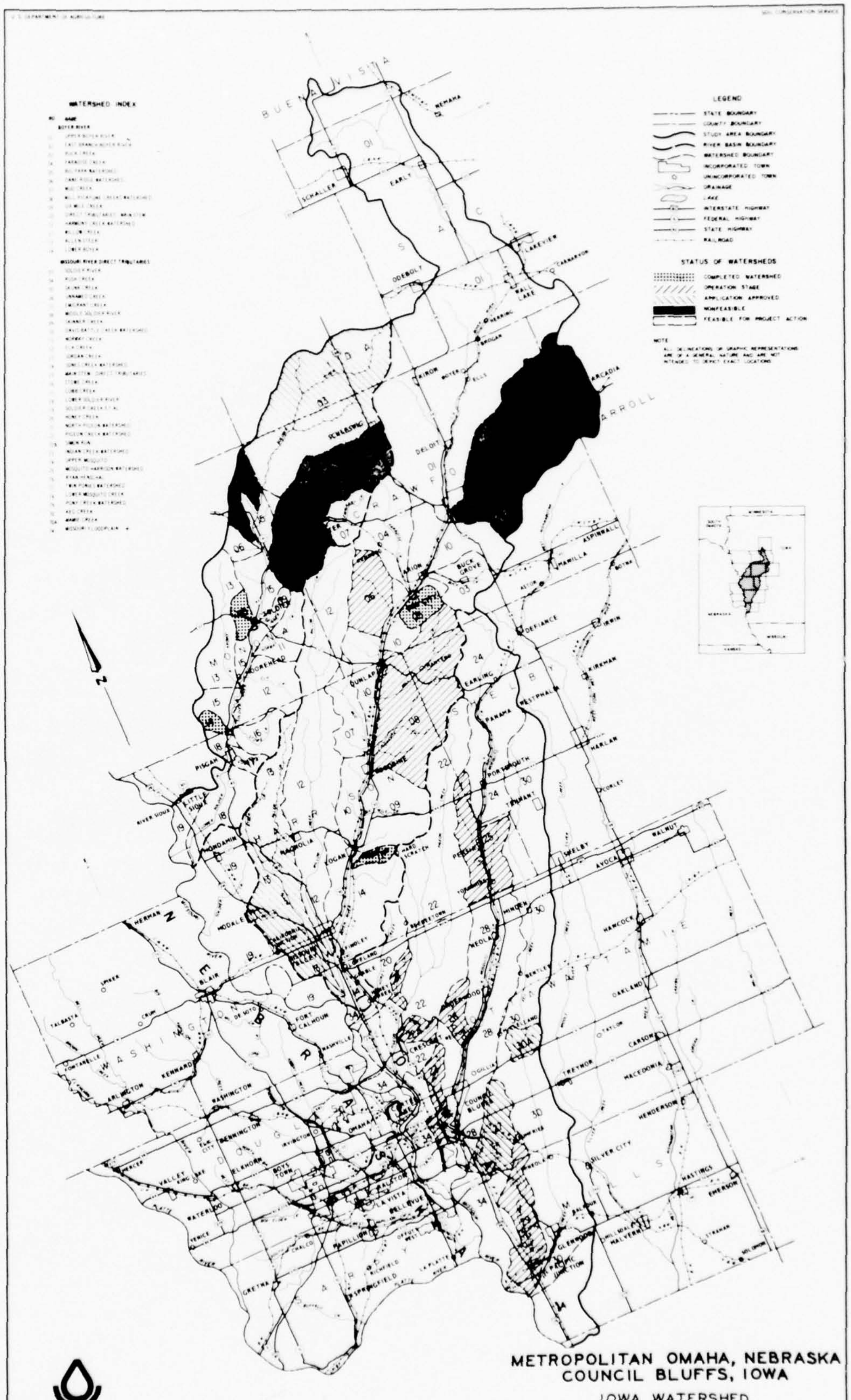
- Where detrimental environmental effects were found to be unavoidable, feasible mitigating features for such effects were included, where possible;

- Measures were considered which protect, preserve, or enhance environmental quality in the project area should any proposal be implemented;

- The public health, safety, and social well-being, including prevention of loss of life, were considered with each alternative studied; and

- Public meetings, field trips, meetings with small groups, and coordination with Federal and non-Federal agencies were used to determine general public acceptance of possible plans of improvement.


LITTLE SIOUX
PISGAH
DUNLAP
ALLEN CR
WILLOW R
BOYER R
MONDAMIN
MAGNOLIA
29
HERMAN
SPIKER
LOGAN
MODALE
MISSOURI VALLEY
PERSIA
BLAIR
CREEK
POTATO CR
80
HONEY CR
1
2
KENNARD
ARLINGTON
FORT CALHOUN
MINDEN
NEOLA
BIG PAPILLION
PIGEON CR
4
5
3A
6
8
10
BENNINGTON
7
9
UNDERWOOD
11
680
VALLEY
12
ELKHORN
16
6
14
13
15
WATERLOO
OMAHA
LITTLE PAPILLION CR.
INDIAN CREEK
MOSQUITO CR
McCLELLAND
COUNCIL BLUFFS
BOYS TOWN
ELKHORN R.
18
80
TREYNOR
KEG CR
RALSTON
LA VISTA
BELLEVUE
19
20
WEST PAPILLION
BRANCH CR.
GRETNA
21
PAPILLION
MINEOLA
CAPEHART
SPRINGFIELD
SILVER CITY
80
29
RIVER
PLATTE
GLENWOOD
PLATTSMOUTH
SOUTH BEND
PACIFIC JUNCTION
LOUISVILLE
GREENWOOD
LEGEND:
AUTHORIZED DAM
EXISTING DAM
PROPOSED LEVEE
EXISTING LEVEE
DAMS RECOMMENDED IN PLAN EVALUATION REPORT, PAPILLION CR. AND TRIBUTARIES LAKES, NEBRASKA
MURDOCK
MANLEY
MURRAY
ALVO
WEEPING WATER
ELMWOOD
NEHAWKA
UNION
EAGLE
AVOCA
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
EXISTING & AUTHORIZED PROJECTS
U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975



METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA

IOWA WATERSHED
DELINEATION MAP

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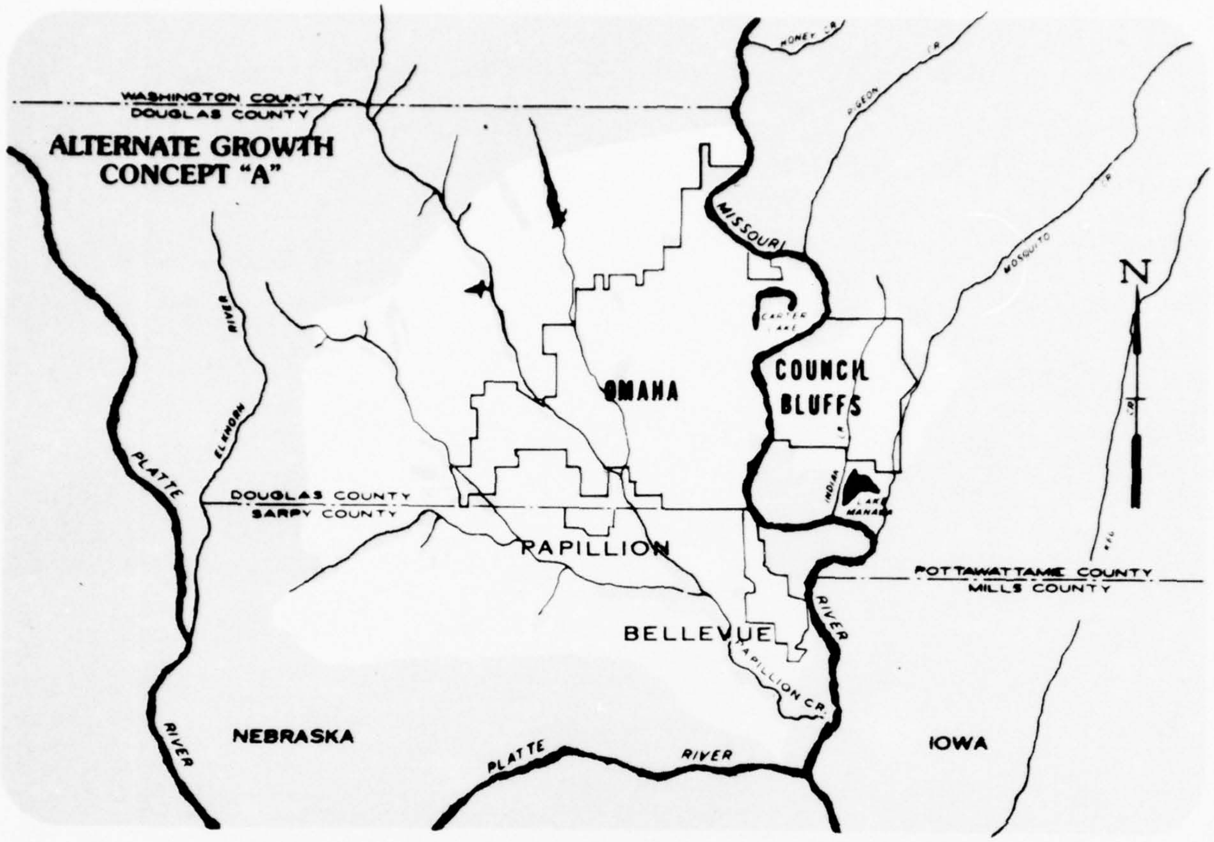
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

JUNE 1973


WASHINGTON COUNTY
DOUGLAS COUNTY
ALTERNATE GROWTH CONCEPT "A"
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OMAHA
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ELKHORN
RIVER
PLATTE
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SARPY COUNTY
PAPILLION
POTTAWATTAMIE COUNTY
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PLATTE
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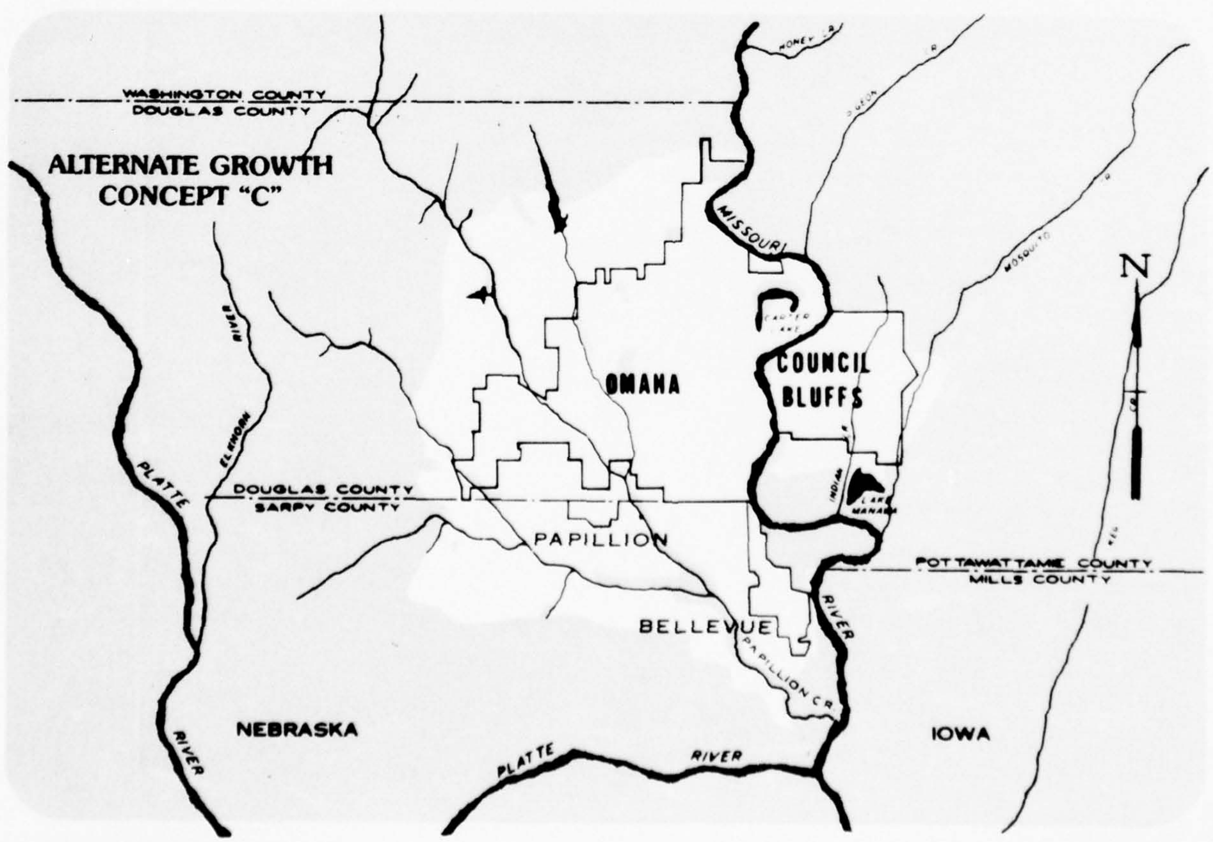
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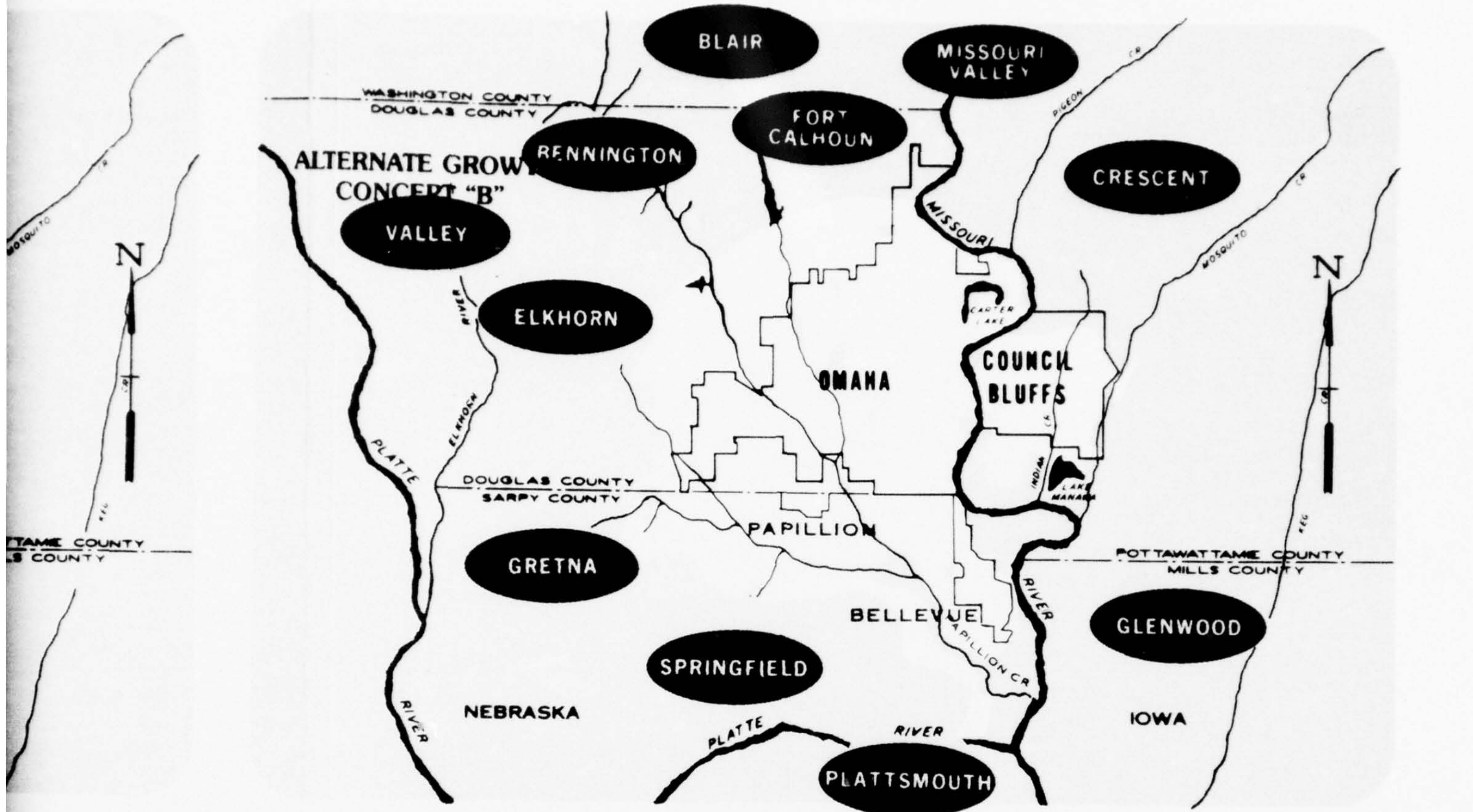

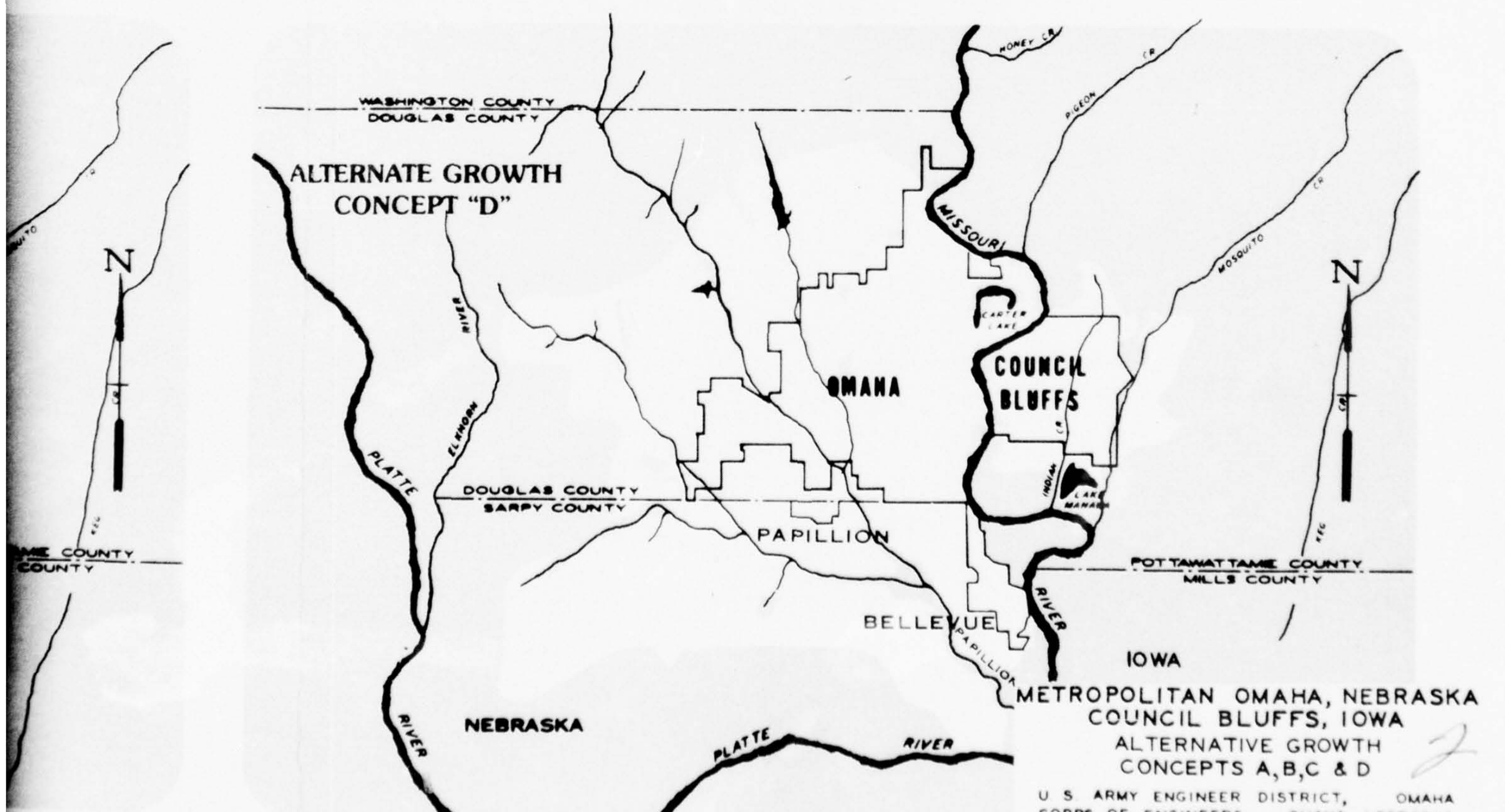

METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
ALTERNATIVE GROWTH
CONCEPTS A,B,C & D

U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

JUNE 1975

VOLUME III ANNEX D PLATE A-3

SECTION B

BOYER RIVER EVALUATION

BOYER RIVER EVALUATION

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SECTION B

BOYER RIVER EVALUATION

PART I

RESOURCES AND ECONOMY OF THE STUDY AREA

1. Flood problems are concentrated near the downstream portion of the Boyer River basin; the city of Missouri Valley, Iowa is located in this portion of the flood plain. The following discussion, therefore, deals primarily with the natural resources, human resources, and development and economy of Missouri Valley.

Environmental Setting and Natural Resources

BASIN DESCRIPTION

2. The Boyer River drains an area of 1,185 square miles and rises at the southern edge of Buena Vista County near Storm Lake, Iowa. The river flows in a southerly direction to a point west of Wall, Iowa in Sac County, and then in a southwesterly direction to its confluence with the Missouri River in northwestern Pottawattamie County, Iowa near the town of Missouri Valley. The basin is primarily agriculturally oriented. Numerous rural towns are scattered throughout the basin.

HISTORICAL-ARCHEOLOGICAL FEATURES

3. The DeSoto Bend National Wildlife Refuge is located southwest of Missouri Valley on a cutoff meander of the Missouri River, and it is a major feeding and resting place for migrating geese and ducks. DeSoto Bend also contains remains of the historic steamboat "Bertrand" and its cargo; these remains represent mid-19th century socioeconomic aspects of the American Frontier.

NATURAL RESOURCES AND ENVIRONMENTAL CHARACTERISTICS

4. The Boyer River in the vicinity of Missouri Valley is characterized by a straightened channel lined with levees. No significant numbers of trees or shrubs occupy its steep banks. Row crops such as corn and soybeans have been planted up to the levees, and the vegetation on the riverside of the levees is primarily weeds and brome grass.

5. Game birds and animals inhabiting the basin include primarily cottontail rabbits and pheasants. Nongame species include fox, coyote, raccoon, muskrat, opossum, skunk, and the common species of moles, shrews, ground squirrels, field mice, and rats. Wildlife is very limited in this reach of the Boyer River because good habitat is absent.

Human Resources

STUDY AREA

6. Missouri Valley is the only town in Harrison County with a population of more than 2,500. There are three other towns located in the Boyer River basin in Harrison County which have populations between 1,000 and 2,000; these are Logan, Woodbine, and Dunlap.

7. Missouri Valley had a population of 3,519 in 1970. It is located in the Boyer River valley at the foot of the bluffs that line the eastern bank of the Missouri River in Harrison County. Missouri Valley serves as a trade center for an area that extends from Blair, Nebraska east to Portsmouth, Iowa and from Portsmouth south to Crescent, Iowa. Transportation to Missouri Valley is available by U. S. Highway 30, State Highway 183, and Interstate 29. Railroad transportation is provided by the Chicago and North Western Transportation Company. Daily bus service is also available.

POPULATION CHARACTERISTICS

8. The population of Missouri Valley declined significantly from 1940 to 1950. Since 1950, however, the population has remained relatively stable, as shown in table B1-1.

Table B1-1
Total Population, 1940 to 1970
Missouri Valley, Iowa

Year	Persons	Percent Change
1940	3,994	-
1950	3,546	-11.2
1960	3,567	0.6
1970	3,519	- 1.3

Source: U. S. Census of Population; 1940, 1950, 1960, 1970.

INCOME

9. The median income for Missouri Valley families was $7,965 in 1970; this compares to a median family income of $7,449 in Harrison County. About 14 percent of the families in both Missouri Valley and Harrison County had incomes of less than $3,000. Thirty-six percent of the families in Missouri Valley had incomes of $10,000 or more compared to 31 percent for Harrison County.

Development and Economy

10. The proximity of the Omaha metropolitan area is an important factor in providing opportunities for the growth of Missouri Valley. Easy accessibility to the metropolitan area via highway and rail is attractive to small- and medium-sized industrial enterprises that prefer a small town atmosphere relatively close to a major wholesale and transportation center in which to operate. Agricultural products, manufacturing, and chemical processing are examples of such industries.

11. Recent trends have also indicated that many families are migrating to smaller towns in order to avoid the increasing social stresses of living in an urban environment. These families are becoming more concerned with the "quality of life" afforded by small town living and are foregoing the conveniences afforded by the larger cities.

POPULATION PROJECTIONS

12. Missouri Valley is located in the OBERS Subarea 1023. OBERS projections indicate that the non-SMSA population of the subarea will decrease by 11 percent from 1970 to 2020. If Missouri Valley's population decreased at this rate, its 2020 population would be 3,130. Due to its immediate proximity to the metropolitan area, Missouri Valley's population would not be expected to decrease at the OBERS rate. This projection is, however, included in table B1-2 as a "low" projection.

13. Population projections for Missouri Valley were provided in a publication, "General Development Plan", prepared for the Missouri Valley Planning Commission in 1969. The projected populations were based on an expected employment increase in four categories; these are manufacturing; wholesale-retail trade; services; and transportation, communications, and utilities. The projections were also based on an increase of commuter families in Missouri Valley. The projections were given for 1980 and 1990 as shown on table B1-2. It is evident that if this growth rate continued through 2020, the Missouri Valley population would be between 5,000 and 6,000.

14. Table B1-2 presents the OBERS projections, the Missouri Valley Planning Commission's projections, and the projections for the four alternative growth concepts prepared by the Corps of Engineers.

Table B1-2
Population Projections
Missouri Valley, Iowa

	1995	2020
OBERS[1]	3,300	3,100
M.V.P.C.[2]	4,800	-
Concept A[3]	3,930	4,341
Concept B[3]	10,900	10,000
Concept C[3]	3,930	4,341
Concept D[3]	3,930	4,341

1 OBERS, Series E, Population Projections, Vol. 7.
2 Missouri Valley Planning Commission, General Development Plan, 1990 projection straightlined to 1995.
3 Corps of Engineers, Alternative Models Concept, Section C, "Population Projection Tables".

LAND USE

15. Land use in the Boyer River basin upstream from Missouri Valley is expected to remain stable through the foreseeable future. The area will continue to be used primarily for agriculture. Due to its proximity to the Omaha metropolitan area, the city of Missouri Valley possesses the potential for land use changes. About 54 percent of all land within the city limits of Missouri Valley is currently undeveloped.

16. About 50 percent of Missouri Valley is located in the Boyer River flood plain. Almost all of the land available for future commercial and industrial development is located in the flood plain. Pressure to develop the flood plain for residential, commercial, and industrial uses would increase with the growth of Missouri Valley. This would significantly increase flood damages. If Missouri Valley complies with the zoning requirements of Public

Law 93-234, these future flood damages would be significantly reduced. Development of the unregulated fringe areas of the flood plain, however, would result in increased flood damages.

PART II

PROBLEMS AND NEEDS

1. The purpose of this section is to summarize the water resource problems and needs relating to flooding, erosion, drainage, and irrigation in the Boyer River basin. This section also provides information on existing plans and improvements in the area. As an indication of relative flood hazard, figure B2-1 defines the flood potential by frequency of occurrence in years.

Prior Studies and Reports

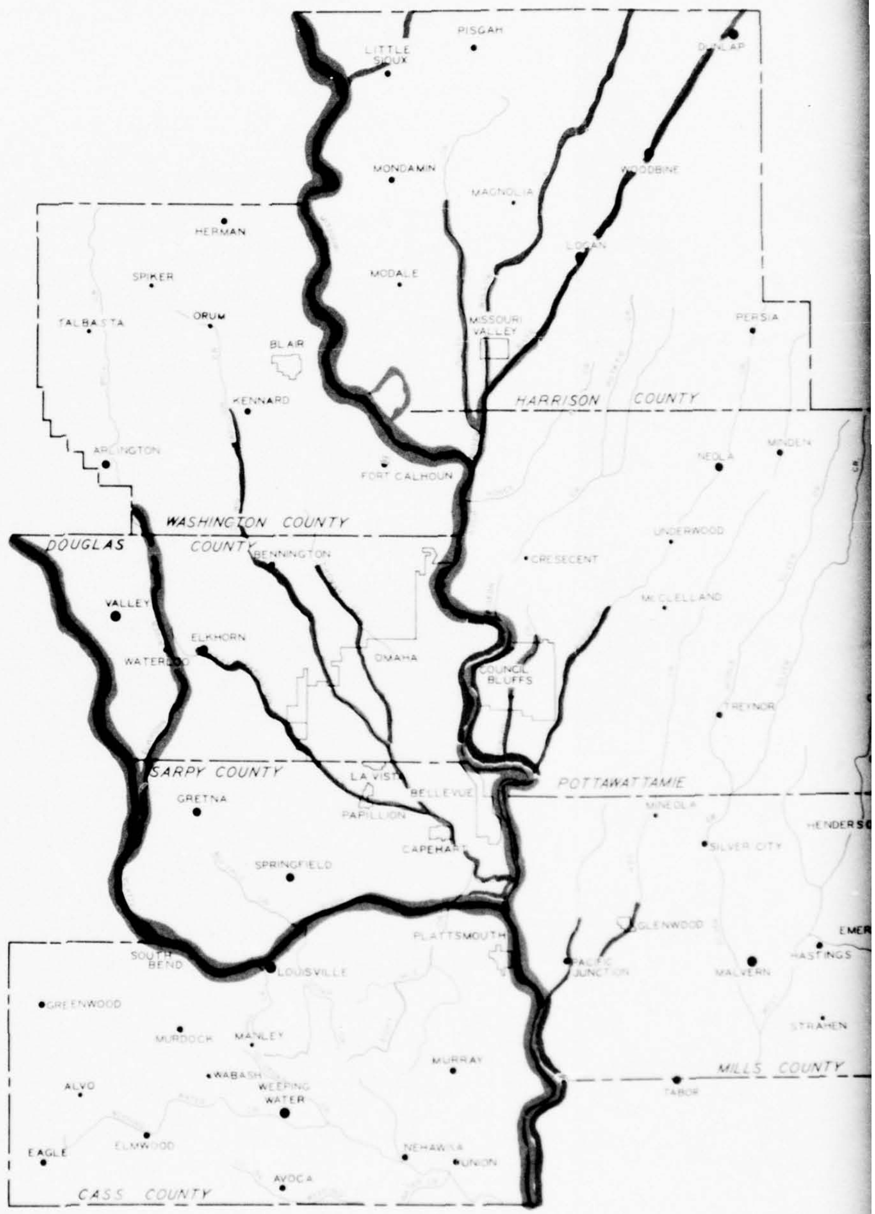
2. The Boyer River basin was studied and reports were written in 1935 and 1938. The 1935 report on the Missouri River, published as House Document 238, 73rd Congress, 2d Session, commonly referred to as the "308 Report", concluded that no potential existed, at that

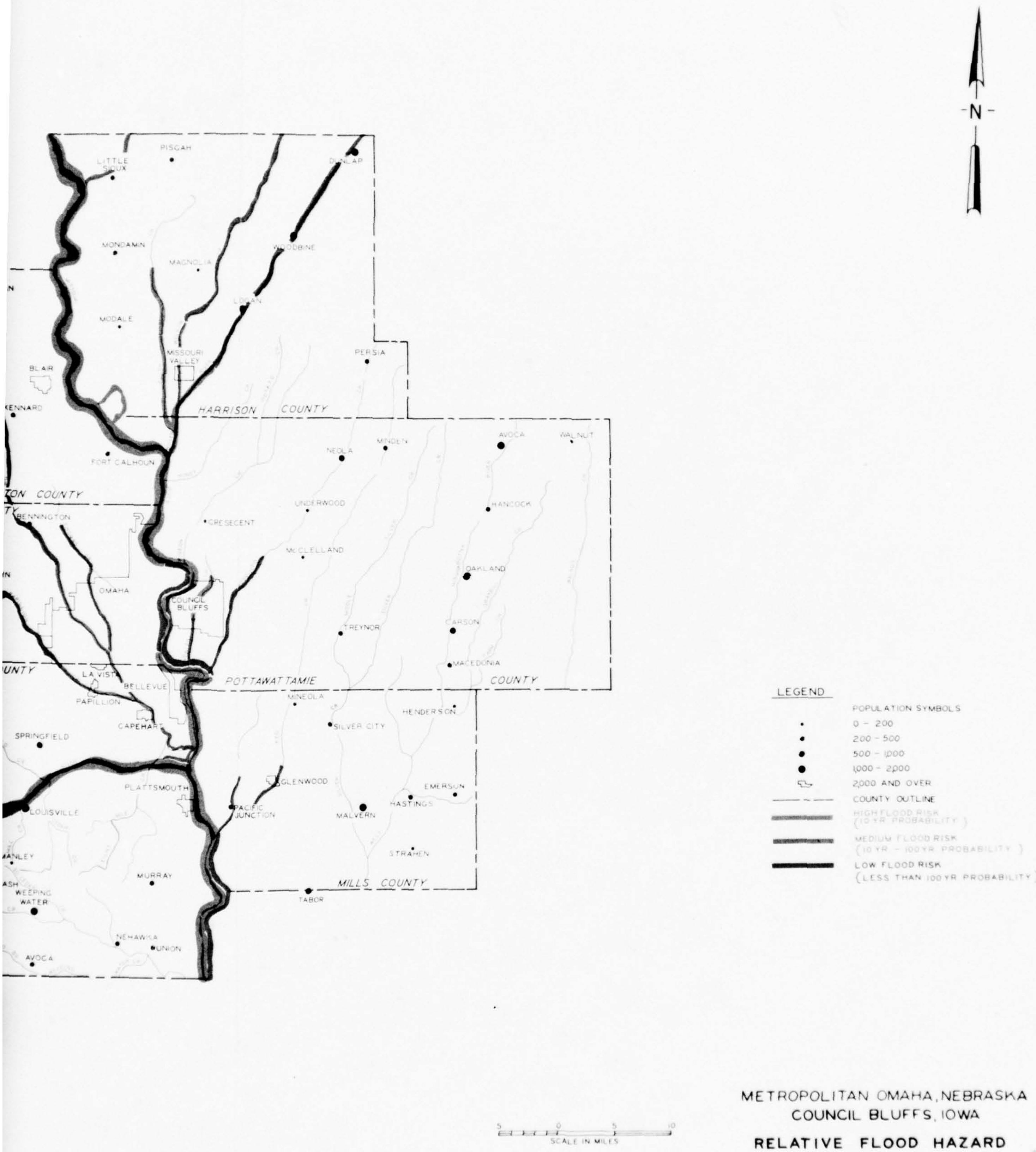
time, for construction of flood control reservoirs or navigation improvements and that no additional irrigation was needed in the Boyer River basin. The 1938 report investigated the flood problems in the Boyer River basin and concluded that further studies should be made for local protection projects at Missouri Valley and Denison, Iowa.

3. A report on the Boyer River at Missouri Valley and Denison was published as House Document 254, 78th Congress, 1st Session, 13 August 1943, entitled "Report on Survey of Boyer River, Iowa". This report concluded that a local protection project at Missouri Valley and at Denison would be economically feasible. Missouri Valley could not meet the local requirements, thus construction was recommended at Denison only.

4. A report on the Denison flood protection project entitled "Report on Project" was published in October 1948. The project recommended in 1943 had not been constructed by 1946; local interests had, at their own expense, excavated pilot channels on the East Fork of the Boyer River. This report made an investigation to determine if the above project was still necessary. The conclusion of the report was that the project should be deauthorized.

5. In 1965, the Committee on Public Works of the United States Senate requested that the Board of Engineers for Rivers and Harbors review the report on the Boyer River, Iowa, published as House Document 254, and other pertinent reports, to determine whether improvements in the interest of flood control and allied purposes were advisable at that time. The study by the Omaha District was deferred after Fiscal Year 1972 due to a need for extensive reformulation.


LITTLE SIOUX
PISGAH
DUNLAP
MONDAMIN
MAGNOLIA
WOODBINE
HERMAN
SPIKER
MODALE
LOGAN
TALBASTA
ORUM
MISSOURI VALLEY
PERSIA
BLAIR
KENNARD
HARRISON COUNTY
ARLINGTON
FORT CALHOUN
NEOLA
MINDEN
WASHINGTON COUNTY
DOUGLAS COUNTY
BENNINGTON
UNDERWOOD
CRESECENT
McCLELLAND
VALLEY
ELKHORN
OMAHA
WATERLOO
COUNCIL BLUFFS
TREYNOR
SARPY COUNTY
LA VISTA
BELLEVUE
POTTAWATTAMIE
GRETNA
PAPILLION
MINEOLA
SILVER CITY
CAPEHART
SPRINGFIELD
GLENWOOD
PLATTSMOUTH
SOUTH BEND
LOUISVILLE
PACIFIC JUNCTION
MALVERN
HASTINGS
GREENWOOD
MURDOCK
MANLEY
STRAHAN
MURRAY
MILLS COUNTY
ALVO
WABASH
WEEPING WATER
TABOR
EAGLE
ELMWOOD
NEHAWKA
UNION
CASS COUNTY
AVOCA



METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA

RELATIVE FLOOD HAZARD

U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

2

VOLUME III ANNEX D FIGURE B2-1

Existing Plans and Improvements

6. There are no Corps of Engineers projects in the Boyer River basin. Three levee units were authorized by the Flood Control Acts of August 1941 and December 1944 for the Missouri River, L-650, 651, and 670. These levees would have been constructed upstream along Allen and Willow Creeks and the Boyer River. The levees would have tied-off upstream from Missouri Valley, Iowa. Since project authorization, however, these levee units have been classified "inactive", subject to final approval of project benefits by the Secretary of the Army.

7. In Harrison County, Iowa, the Soil Conservation Service approved a Public Law 566 application for Allen-Steer Creek. Public Law 566 projects have been completed on Harmony Creek and one is currently under construction in the Mill-Picayune Creek watershed. The Public Law 566 projects were developed for flood prevention, conservation, and erosion control.

8. During the late 1940's and early 1950's, local interests straightened and enlarged the Boyer River and Willow Creek channels and constructed levees along the Boyer River from its mouth upstream to Logan, Iowa and along Willow and Allen Creeks to the bluff line. Upstream from Logan, the Boyer River was straightened to the vicinity of Wall Lake, Iowa by construction of pilot channels. The East Boyer River was straightened in a similar manner from its mouth to Vail, Iowa.

Flood Problem

9. The principal flood problem of the Boyer River basin is experienced in the vicinity of Missouri Valley. The flood problem threatens the city's economic stability and its future industrial and urban growth. The outline of the area flooded by the flood of record is shown on plate B2-1. There are approximately 300 homes, 66 businesses, an electric substation, a powerplant, the city waterworks, and sewage treatment lagoons located within the potential flood area.

10. The work by the local sponsoring agencies changed runoff characteristics in many places and the magnitude of the flood problem was increased in the downstream reaches. In addition, the construction work initiated a natural erosion process which enlarged and increased the capacity of the channels in the upstream reaches.

11. The bulk of the flood damages at Missouri Valley have been caused since the construction of levees along the Boyer River and Willow and Allen Creeks. Any levee failures along the right levee upstream from Missouri Valley result in the floodwaters ponding behind the levees at the junction of the Boyer River and Willow Creek levee units. This ponding then results in the flooding of Missouri Valley to record depths of approximately 5 feet.

RUNOFF CHARACTERISTICS

12. The flow in the Boyer River and its principal tributaries is classified as continuous throughout the major portion of their

lengths. In the past, floods on the basin streams have been the result of snowmelt, ice jams, general rains, intense localized rainstorms, or various combinations of these factors. Excessive general rainfall has only rarely been the primary factor in causing floods. Snowmelt and ice-jam floods are usually the result of the spring thaw being delayed by subnormal temperatures. A sudden return to normal seasonal temperatures, usually in late March, releases the winter's accumulation of snow in one surge.

13. In the areas upstream from Denison, Iowa, relatively steep channel slopes, rolling topography, and a trellis-type drainage pattern permit runoff to cause localized flooding, primarily during the late spring and summer months. There is little valley storage available in these reaches and floods are characterized by rapidly rising and falling stages with relatively short durations of overbank flow.

14. Between Denison and Logan, the enlarged channel created by the channel and levee improvements and the subsequent streambank erosion provide adequate discharge capacities to contain open-water flows of ordinary magnitude. Consequently, only minor open-water flooding has been experienced in this reach of the Boyer River since the improvements were completed. The minor tributaries entering in this reach are prone to overflow as a result of heavy local rainstorms.

15. The slope of the Boyer River channel is very mild in the reaches downstream from Logan and the resultant agradation process has had an adverse effect on the carrying capacity of the stream. Floods in these reaches of the Boyer River and on Willow and Allen

Creeks are most frequently the result of ice-jam conditions in the early spring. During the period of annual ice breakup, floating ice in these channels can accumulate against the unbroken ice on the Missouri River and obstruct the channels for miles upstream. Any subsequent flow then causes failure of the levees and large areas of the adjacent flat land are inundated to shallow depths. In general, the floodwaters have low velocities and, depending on the soil conditions, are slow to recede.

FLOOD HISTORY

16. During the 74-year period from 1902 to 1975, inclusive, more than 50 floods occurred in the Boyer River basin; these floods were caused by rainstorms, snowmelt, ice jams, and by combinations of these factors. The majority of the floods occurred during the first half of June, but since the completion of the channel improvement work by local interests, the principal flood threat is from ice jams during the early spring. It is probable that some flood events during the historical period were not reported, but undoubtedly these floods would be minor in magnitude and in damage. A gage height of 25.22 feet, the highest recorded stage at the Logan gage, was caused by the March 1965 ice-jam flood, and the maximum discharge of 23,600 c.f.s. at the Logan gage was produced by the June 1957 rainstorm flood. The most extensive damage, however, was caused by the flood of March 1949.

DISCHARGE PROBABILITY

17. The discharge-probability curve for the Boyer River was computed using the stream gage record of the U.S.G.S. station at Logan.

This gage was established in 1937. The probability curve was computed using the log-Pearson Type III distribution and was adjusted for Beard's expected probability and Langbein's partial duration. The resulting discharge-probability curve is shown on plate B2-2. Discharge-probability curves were also determined for the Boyer River upstream and downstream from the confluence with Willow Creek at Missouri Valley. These curves were developed by applying design runoff amounts to the synthetic unit hydrographs computed for the Boyer River at the two locations. The unit hydrographs at Missouri Valley were developed using a basin routing model and average Snyder's unit hydrograph constants determined from flood hydrographs at Denison and at Logan. The design runoff amounts for specific frequencies were determined from the ratios of the respective frequency curve peak discharge to the peak discharge of the unit hydrograph for the Boyer River at Logan. The resulting runoff amounts were then applied to the Missouri Valley unit hydrographs to determine the discharge-frequency curves shown on plate B2-2.

STANDARD PROJECT FLOOD

18. The standard project flood peak discharges for the Boyer River at Missouri Valley upstream and downstream from Willow Creek are estimated to be 60,000 c.f.s. and 62,250 c.f.s., respectively.

HISTORICAL DAMAGES

19. Information on floods which occurred in the Boyer River basin prior to 1943 was obtained from U. S. Weather Bureau records, prior survey scope reports, newspaper accounts of the flood events, and from personal contact with basin residents. It was necessary to

rely on these sources for historic flood information because of a lack of detailed streamflow records in the basin. For the more recent floods, the data were gathered by field reconnaissances conducted during or immediately following the flood occurrences. Damage estimates were based on detailed appraisals of the area inundated and the flood plain improvements damaged. Monetary values of damage estimates were based on the price levels and on the condition of improvements existing at the time of the flood event.

20. A major flood on the Boyer River, Willow Creek, and Allen Creek occurred on 5 March 1949. On 3 March, snowmelt runoff caused the ice in the Boyer River to break up, accumulate against the unbroken Missouri River ice, and form jams in the Boyer River and Allen Creek channels. Ice jams also formed at bridge crossings on Willow Creek in the vicinity of Missouri Valley. The ice-filled channels caused the floodwaters to rise and break the levees on the streams and to flood the town of Missouri Valley and the rural areas downstream as far as the mouth of the Boyer River. Flooding began on the night of 3-4 March and crested in Missouri Valley on 5 March, but water remained trapped behind levees and embankments in the flooded area for several days thereafter. Total flood damages were estimated at $1,522,600. Approximately 60 city blocks in that portion of Missouri Valley located east of Willow Creek were flooded. Sixty-four business establishments, 308 residences, an electric substation, the municipal powerplant and waterworks, and a Highway Commission maintenance garage were flooded to depths up to 5 feet. Approximately 980 persons residing in this area were made homeless for a week, and an additional 100 residents of Willow Park Addition were evacuated as a precautionary measure. The city's waterplant

was shut down for 72 hours, and the natural gas company was inoperative for 3 weeks. Two lives were lost during the flood. Total damages in Missouri Valley were $834,300. Table B2-1 shows historic flood data for floods in Harrison County. The damage estimates shown on the table are based on price levels and the condition of improvements existing at the time of the flood event.

Table B2-1
Historic Flood Data
Boyer River Basin, Harrison County

Occurrence Date Year	Month	Causative Factor	Relative Magnitude	Damage at Historic Price Levels
1920	Jun	Rainstorm	Minor	$ 800
1921	May	General Rain	Minor	2,500
1923	Jun	Rainstorm	Moderate	14,500
1924	Jun	General Rain	Moderate	24,500
1925	Jun	General Rain	Moderate	8,300
1926	Jan	Snowmelt	Minor	1,400
1936	Mar	Snowmelt and Ice Jam	Major	78,350
1937	Mar	Snowmelt and Ice Jam	Moderate	9,200
1937	Jul	Rainstorm	Minor	3,400
1938	Sep	Rainstorm	Moderate	30,000
1939	Mar	Ice Jam	Moderate	13,870
1939	Jul	Rainstorm	Minor	5,580
1944	Jun	Rainstorm	Major	56,050
1949	Mar	Snowmelt and Ice Jam	Major	1,522,600
1950	Feb	Snowmelt and Ice Jam	Moderate	61,000
1950	Jun	Rainstorm	Moderate	73,300
1957	Jun	Rainstorm	Major	259,000
1960	Mar	Snowmelt and Ice Jam	Minor	23,600
1965	Mar	Ice Jam	Major	849,800

AVERAGE ANNUAL FLOOD DAMAGES

21. Average annual damages in Harrison County for the Boyer River basin were computed by combining discharge-damage relationships with discharge-probability relationships to derive damage-frequency relationships. Integration of the damage-frequency relationships produced the average annual damages shown in table B2-2. Studies show that average annual flood damages are about $150,000 for the agricultural areas of Harrison County. At Missouri Valley, the average annual flood damages are about $200,000 and at Woodbine they are about $18,000. The flooding at Missouri Valley is caused by the combined flooding of the Boyer River and Willow Creek. Noncrop damages amount to $559,000 annually; these are primarily damages to highway bridges and railroad facilities located in the flood plain.

Table B2-2
Average Annual Damages
Existing Conditions

Reach*		Rural			
Community	Urban	Crop	Noncrop	Total	Total
1	$	$ 20,000	$ 88,500	$108,500	$108,500
2		38,000	122,900	160,900	
Missouri Valley	200,000				360,900
3		20,000	53,100	73,100	73,100
4		32,000	109,300	141,360	141,360
5		40,000	185,200	225,200	
Woodbine	18,000				243,200
TOTAL	$218,000	$150,000	$559,000	$709,000	$927,000

* - Reach
1 Allen and Steer Creeks
2 Boyer River mouth upstream to Missouri Valley
3 Willow Creek upstream from Missouri Valley
4 Boyer River Missouri Valley upstream to Logan
5 Boyer River Logan upstream to Harrison County line

Other Needs

EROSION

22. Sheet and gully erosion is in evidence throughout the basin and there is a need for increased land treatment. In addition, the construction of channel improvements along the Boyer River in the 1940's and 1950's initiated a natural erosion process which, over the past two decades, has enlarged the channel and increased its carrying capacity in the upstream reaches. Materials eroded throughout the basin are deposited within the leveed reach of the Boyer River as it crosses the Missouri River flood plain.

IRRIGATION

23. There is limited irrigation from surface flows and wells in the Boyer River basin. No additional irrigation need has been determined.

Improvements Desired

24. At a public meeting held in Missouri Valley on 30 October 1973, local interests expressed a desire for flood control. Several methods of flood control were suggested by those present.

The methods recommended included channel improvements, levees, reservoirs, and removing existing levees along Willow Creek and the Boyer River. Opposition was expressed to any plan of improvement which would include channel straightening as its principal feature.

PART III

FORMULATING A PLAN

1. This section presents a discussion of the possible solutions considered and the basis for selecting the final plan. In formulating a plan, it was imperative to consider all appropriate alternative plans. Such alternatives were then screened to arrive at the plan that best responds to the problems and needs of the area.

Possible Solutions

2. Several alternative measures to satisfy the problems and needs of the area are possible; however, some of these measures are not practical or economical. The possible solutions may be divided into the two broad categories of nonstructural and structural measures. Initially, both structural and nonstructural

alternatives, in addition to the alternative of "no action", were considered at Missouri Valley. In the case of "no action", it was assumed that there would be no Federal action and that Missouri Valley city officials would adopt flood plain zoning regulations in accordance with Public Law 93-234. Several alternative measures to satisfy the problems and needs of the area are possible. None of these solutions, however, are economically feasible. Nonstructural measures considered included insurance, flood plain zoning, flood proofing of both individual buildings and single land tracts, and permanent evacuation of flood plain areas. Possible structural measures included main stem reservoirs, channel improvements, ring levees, diversions, and several combinations of these. Also, a combination of nonstructural and structural measures is possible.

NONSTRUCTURAL MEASURES

FLOOD INSURANCE

3. Flood insurance, which does not prevent damages to existing development, should not be considered alone; it should be considered only as a supplement to flood plain management and structural solutions. The total cost of flood insurance includes the cost of average annual damages, the cost of administering the program, and actuarial costs; therefore, the cost of insurance exceeds the benefits that could be derived by the amount of the actuarial and administrative costs.

ZONING

4. With the passage of Public Law 93-234, it must be assumed that local interests will comply and the 100-year flood plain will be zoned. If the 100-year flood plain is zoned, it would affect an area that the city feels is its best site for future industrial development. At the present time, the Soil Conservation Service is working on a flood plain information report at Missouri Valley which will define the 100-year flood plain. In the flood plain fringes - outside the reserved floodway - buildings would be permitted, provided that they are adequately protected against damage from floods.

FLOOD PROOFING

5. Flood proofing is employed primarily for the reduction or elimination of flood damages to existing structures. Flood proofing includes, but is not limited to:

- Raising existing buildings;
- Providing individual dikes around existing structures;
- Providing permanent or temporary watertight covers for all openings;
- Protecting roads and utilities; and
- Anchoring floatable structures and facilities.

6. Flood proofing of existing structures in a potential flood zone could take any of the above-mentioned steps to provide adequate

protection against possible damage. Studies revealed that flood proofing existing structures would be economically infeasible for most of the structures in the flood plain. Approximately 200 of the existing residences in the flood plain are more than 30 years old. More than 125 of the homes in the flood plain are valued at less than $10,000 and would require major improvements in order to be flood proofed to withstand 5-foot flood depths. Therefore, flood proofing was found to be economically infeasible by a wide margin. Flood proofing future development in the Missouri Valley area would probably be feasible; however, such measures would be the financial responsibility of individuals who build in the flood plain.

EVACUATION

7. Permanent evacuation of flood plain areas is a means which can be used to reduce the flood damage potential. Total evacuation involves the complete removal of all buildings and damageable property in the flood plain. In the case of Missouri Valley, this would mean removal of the city offices, 66 businesses, an electric substation, a powerplant, the waterworks, and 300 homes, all located on the 100-year flood plain. Lands acquired in this manner are then used for parks or other public use purposes that would not interfere with floodflows or result in material damage from floods. The cost of the flood plain evacuation is estimated to be $12,000,000 and is not economically feasible.

STRUCTURAL MEASURES

RESERVOIRS

8. A system of flood control dams in the Boyer River basin was considered. The major problem with developing a system of dams is

the lack of good damsites. Upstream dams would help reduce floodflows. A preliminary economic study of possible damsites on the main stem and tributaries indicated that no projects were economically feasible. Relocation costs associated with any main stem damsite were the main cause for the projects not being economically feasible.

CHANNEL IMPROVEMENT

9. Consideration was given to providing channel improvements along the Boyer River and Willow Creek in the vicinity of Missouri Valley. The channels considered would provide 100-year flood protection. The existing levees would have to be removed and new bridges would have to be constructed. Because of the erosive action experienced along the channels of the Boyer River and Willow Creek, it would also be necessary to riprap the channel banks around bridges. The project would cost approximately $6,000,000. The channel project was not economically feasible.

RING LEVEE

10. Ring levees were considered in the immediate vicinity of Missouri Valley and the Willow Creek addition. The levees would provide standard project flood protection to both areas. The ring levees would be constructed closer to town than the existing private levees. The existing levees would not be used or removed, thus allowing them to serve their original purpose of protecting the agricultural lands in the area. When or if the existing levees failed, the ring levees would protect Missouri Valley and the Willow Creek addition. The total cost of the project would be about $7,500,000. This alternative was not economically justified.

OTHER STRUCTURAL ALTERNATIVES STUDIES

11. Other structural alternatives, such as a combination channel and levee, diversion of Willow Creek, and a channel improvement that would provide standard project flood protection, were studied. All of these alternatives were eliminated during preliminary screening because they were not economically feasible.

SUMMARY OF POSSIBLE SOLUTIONS

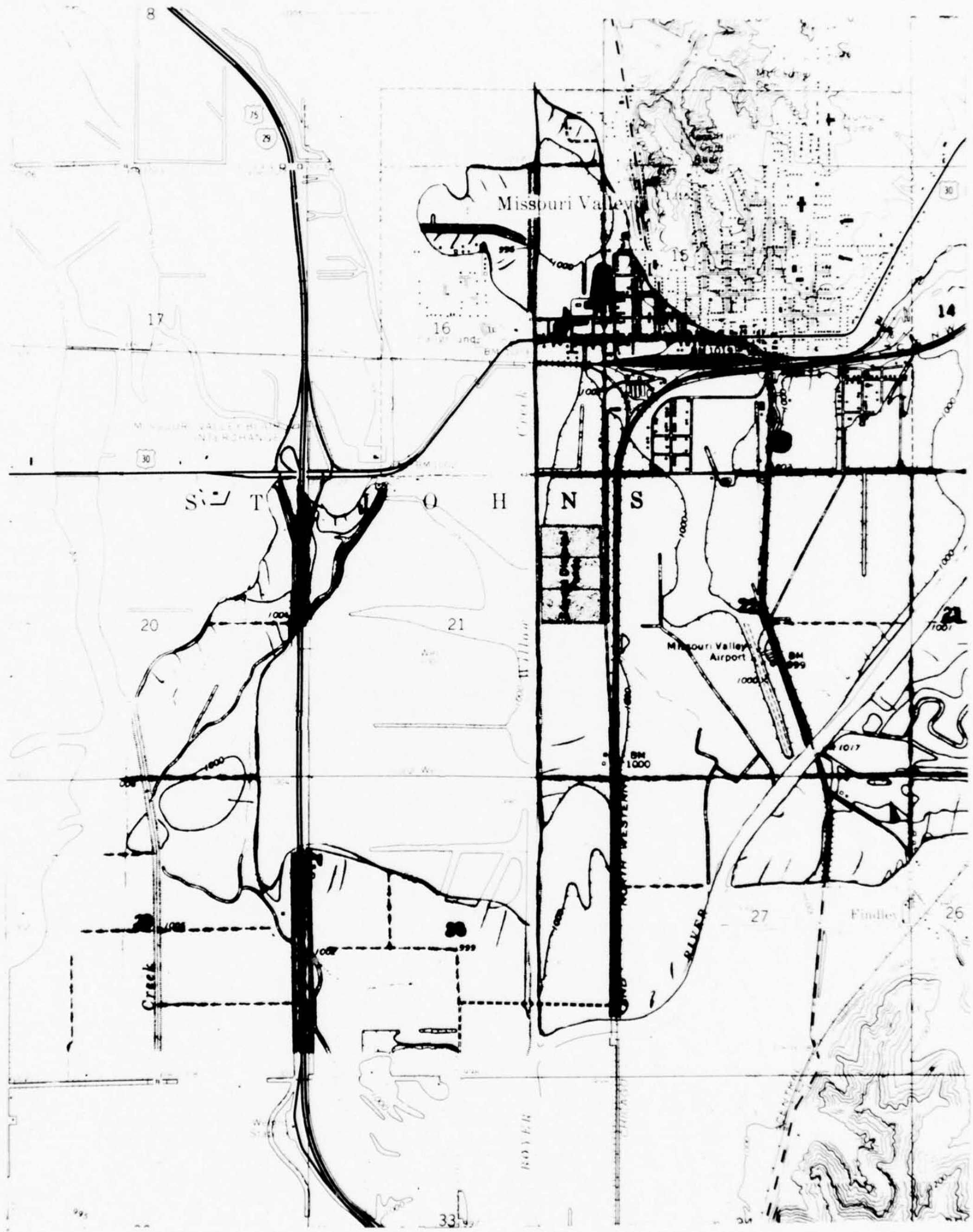
12. On the basis of previous discussions, particularly existing problems and needs and the alternatives that were considered, it was concluded that flood plain zoning should be adopted by Missouri Valley in accordance with PL 93-234. The limits of the flood plain will be published in the flood plain information report being prepared by the Soil Conservation Service. Although zoning would not stop the flooding of existing structures in the flood plain, it would help to eliminate or greatly reduce the damages that would otherwise occur to future development. Owners of existing structures in the flood plain should consider flood proofing on an individual basis or purchasing flood insurance.

Alternatives Considered Further

13. In view of the preceding analysis, the "no action" alternative, which includes flood plain zoning, appears to be the most favorable.

Selecting a Plan

14. In the Missouri Valley area, the flood plain should be zoned in accordance with Public Law 93-234. Owners of existing structures in the flood plain should purchase flood insurance.

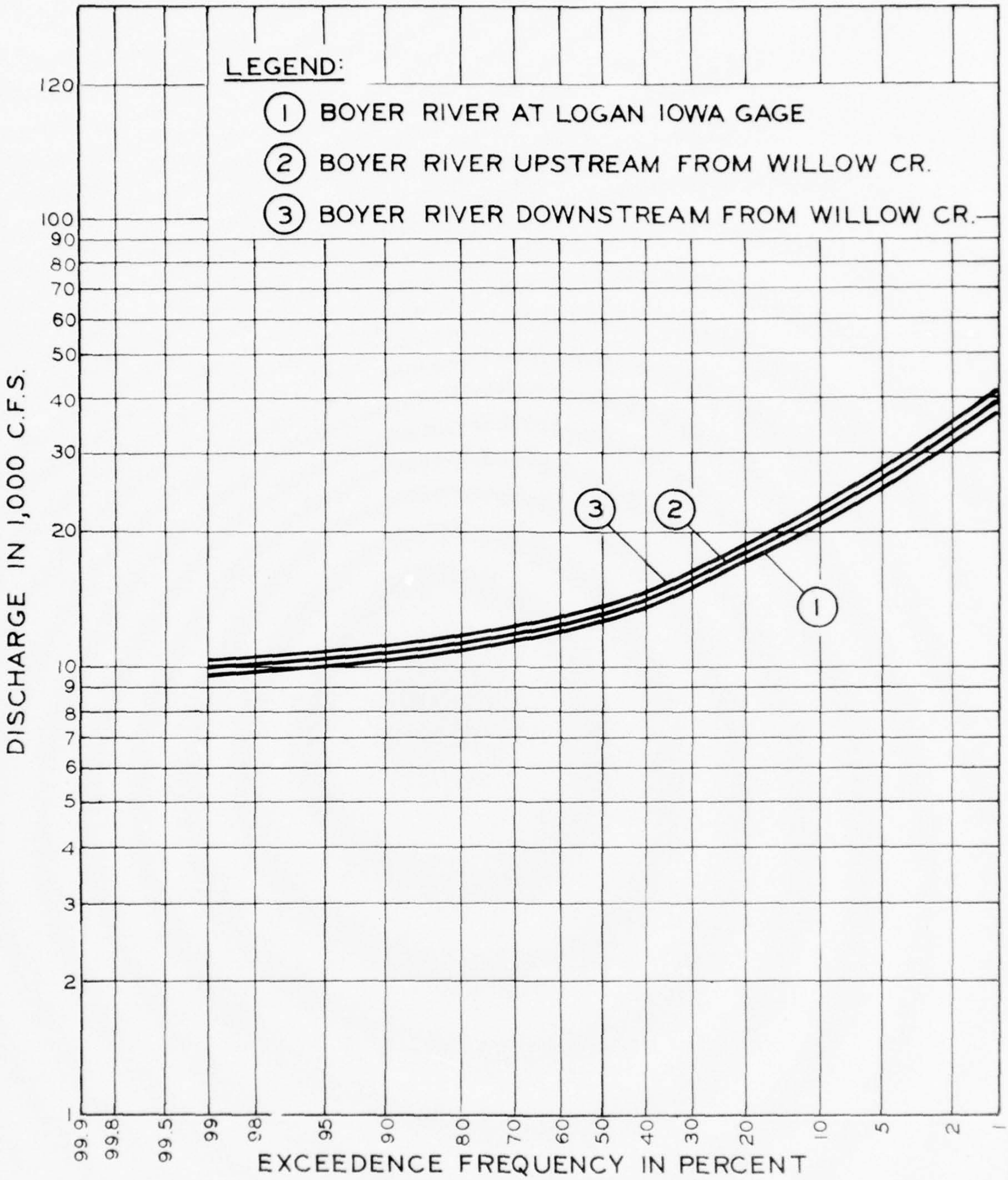


METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA

FLOOD OF RECORD – BOYER RIVER
MISSOURI VALLEY, IOWA

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

JUNE 1975



METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA

DISCHARGE FREQUENCY
BOYER RIVER BASIN

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

JUNE 1975

PLATE B2-2

SECTION C

MOSQUITO CREEK EVALUATION

MOSQUITO CREEK EVALUATION

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SECTION C

MOSQUITO CREEK EVALUATION

PART I

RESOURCES AND ECONOMY OF THE STUDY AREA

Environmental Setting and Natural Resources

BASIN DESCRIPTION

1. Mosquito Creek drains an area of 234 square miles and enters the Missouri River south of Council Bluffs, Iowa. The study area is located in the downstream portion of the basin where Mosquito Creek skirts the southeast edge of Council Bluffs.

2. Mosquito Creek is a minor left-bank tributary of the Missouri River. The basin is long and narrow, averaging about 5 miles wide and extending from the Missouri River southeast of Council Bluffs to Crawford County, a distance of about 55 miles.

3. U. S. highways and State routes in the study area include U. S. Highways 6, 30A, 59, 75, and 275; Iowa State Highways 64, 183, 92, 192, and 375; and Interstates 29 and 80. Railroad transportation is provided by Chicago and North Western Transportation Co.; Burlington Northern Inc.; Illinois Central Gulf Railroad; Norfolk and Western Railway Co.; Chicago, Milwaukee, St. Paul and Pacific Railroad; Chicago, Rock Island and Pacific Railroad; and the Union Pacific Railroad. Commercial air transport facilities are available at the nearby Omaha Municipal Airport, Eppley Airfield. The Council Bluffs airport accomodates private aircraft.

HISTORICAL-ARCHEOLOGICAL FEATURES

4. Council Bluffs has a rich historical heritage related to the railroads, Lewis and Clark, and the Mormon migrations. Several prehistoric findings have also been uncovered in Pottawattamie County; these findings include fossil bones and Indian artifacts.

NATURAL RESOURCES AND ENVIRONMENTAL CHARACTERISTICS

5. The Mosquito Creek basin is characterized by deeply cut streambeds with steep channel side slopes along the upstream

portions of the basin. Missouri River tieback levees have been constructed along both banks of the downstream portion of Mosquito Creek where it flows through the Missouri River flood plain into the Missouri River.

6. Vegetation for wildlife in the Mosquito Creek basin is primarily limited to areas along the watercourse. Species of woody vegetation found in the basin include cottonwood, box elder, mulberry, willow, green ash, silver maple, American elm, walnut, and cedar. Nettle, ragweed, chokecherry, gooseberry, honeysuckle, timothy, wild rye, brome, clover, and foxtail are shrub and grass species found in the basin.

7. Game birds and animals inhabiting the basin include white-tailed deer, bobwhite quail, cottontail rabbits, fox, squirrels, and pheasants. Nongame species include fox, coyote, raccoon, mink, weasel, muskrat, opossum, skunk, and the common species of moles, shrews, ground squirrels, field mice, and rats. Common resident birds include the yellow-shafted flicker, downy woodpecker, bluejay, black-capped chickadee, robin, cardinal, and American goldfinch. Woody vegetation along the watercourse attracts numerous species of warblers, orioles, sparrows, thrushes, hawks, and owls during spring and fall migrations. Numerous bird species such as the red-headed woodpecker, eastern phoebe, cardinal, catbird, robin, and brown thrasher find habitat in the basin suitable for nesting. Waterfowl are found occasionally. Although many species of birds are common to the basin, no rare, endangered, or unique species of birds are known to inhabit the basin.

8. The game populations in the basin have been decreasing the past few years due principally to decreasing habitat. During this same period, the number of hunters has been increasing, resulting in a very heavy hunting pressure. The posting of land by private owners to prohibit hunting has helped to reduce the hunting pressure and conserve existing game populations.

Human Resources

STUDY AREA

9. The study area contains the eastern edge of Council Bluffs. This area is undergoing increasing urban development.

POPULATION CHARACTERISTICS

10. Council Bluffs has experienced a steady population growth over the past 30 years as shown in table C1-1.

Table C1-1
Historic Population
Council Bluffs, Iowa

Year	Persons
1940	41,439
1950	45,429
1960	55,641
1970	60,348

Source: U. S. Census of Population; 1940, 1950, 1960, 1970.

INCOME

11. The 1970 census indicated that the median family income in Council Bluffs was $9,624 compared to $9,356 in Pottawattamie County and $10,204 in the Omaha-Council Bluffs SMSA. Families with incomes under the poverty level accounted for 8.3 percent of the families in Council Bluffs compared to 6.4 percent in Pottawattamie County and 6.8 in the SMSA.

Development and Economy

12. The study area contains many sites that would be attractive for residential development. Certain of these sites are currently being developed along established transportation corridors. The "Comprehensive Regional and Urban Area Plan" by the Council Bluffs Metropolitan Area Planning Commission has divided the study area into neighborhood zones and has projected populations for these zones. This report was used in projecting population and land use for the area.

POPULATION PROJECTIONS

13. Seven neighborhood zones are located in the study area and are shown in table C1-2. The projections are for 1985.

Table C1-2
Neighborhood Population Projections
1985 - Mosquito Creek Study Area

Number	Name	1985 Population
17	Bennet Avenue	3,460
18	Indian Hills	1,353
23	Glendale	1,692
24	Iowa Western	2,272
25	Mosquito Creek	2,083
26	Valley View	1,222
27	Longview	2,058
	Total	14,140

14. In addition to these neighborhood zones, a major residential-commercial development is being planned in the study area to the northeast of the Council Bluffs planning area. This development would nearly double the study area population.

LAND USE

15. The Mosquito Creek flood plain is relatively narrow and currently undeveloped. The neighborhood zones flank the flood plain. If these zones develop as planned, pressure to develop unzoned portions of the flood plain would increase. This would result in increased flood damages in the study area.

PART II

PROBLEMS AND NEEDS

1. The purpose of this section is to summarize the water resource problems and needs relating to flooding, erosion, drainage, and irrigation of Mosquito Creek within Pottawattamie County. This section also provides information on existing plans and improvements in the area. As an indication of relative flood hazard, figure B2-1 defines the flood potential by frequency of occurrence in years. The Corps of Engineers has not made any prior studies of the Mosquito Creek basin's water resource problems.

Existing Plans and Improvements

2. Approximately three-fourths of the Mosquito Creek channel was straightened and improved by local interests during the early 1900's.

3. A channel and levee flood control project was constructed by the Corps of Engineers along the downstream end of Mosquito Creek as a part of Missouri River Levee Unit L-624. A 3.8 mile section of the Mosquito Creek channel was enlarged; this alignment extends from the Missouri River upstream to Highway 375 near the bluffline. Missouri River tieback levees border both sides of the Mosquito Creek channel. The project was designed for a capacity of 12,000 c.f.s. from Mosquito Creek with the Missouri River at an elevation of 976 feet m.s.l.

4. A watershed work plan for that portion of the Mosquito Creek drainage area within Harrison County was prepared by the Soil Conservation Service in April 1965. The drainage area concerned covers 38.3 square miles. A total of 57 grade stabilization structures were planned; two are completed. Of the remaining 55 grade stabilization structures, 28 would have some detention storage. They would control all of the major gullies in the project area.

Flood Problem

5. The 1-percent or 100-year flood would inundate the entire Mosquito Creek valley floor along the downstream reach of the creek. The 100-year flood outline is shown on plate C2-1. Development in the Mosquito Creek flood plain is almost entirely agricultural; the only exception is a narrow belt of trees along the stream. The valley floor is devoted to cropland, with corn the

most important crop. Minor urban encroachment, consisting of a few buildings, has occurred at the towns of Portsmouth, Persia, Neola, and Underwood, Iowa. Other developments in the rural area include farmsteads, state highways, county roads, railroads, and bridges. The channel section in the vicinity of Persia and Portsmouth is as large as the channel section in the downstream portion of the basin. This, combined with the lesser drainage area, reduces the flood threat in Harrison County and upstream through Shelby County.

6. In the vicinity of Council Bluffs, Iowa, preliminary estimates indicate that only a few residences would be subject to the 100-year flood. Preliminary studies indicate that the standard project flood would inundate a large housing development in the vicinity of Franklin Avenue. In the event of levee failure in the Missouri River flood plain, Mosquito Creek could flood an area between Lake Manawa and Pony Creek, depending on the location of the break. This area includes agricultural land, an oil tank farm, a residential area around Lake Manawa, and a low-density commercial area along Highways 192 and 275.

STREAMFLOW RECORDS

7. Streamflow records for Mosquito Creek were collected from 1946 to 1969 from a water level recording gage located 2.5 miles southeast of Council Bluffs. The gage was operated and maintained by the Omaha District of the Army Corps of Engineers.

RUNOFF CHARACTERISTICS

8. Floods on Mosquito Creek are caused by thunderstorms. Thunderstorms with high intensity centers of limited extent are

common during the late spring and summer months and several severe rainstorms have occurred. These local thunderstorms produce flooding of considerable magnitude. Ice jam and snowmelt flood problems have not been serious on Mosquito Creek because flows are ordinarily small in the winter and very little ice is formed. In addition, the channel in the Missouri River bottom lands is straight and is, therefore, not conducive to the forming of ice gorges.

9. The long, narrow basin and comparatively mild channel gradient tend to reduce the potential for flooding. These factors, however, are counteracted by the efficient channel work that local interests created when they straightened the channel; the straightening resulted in steeper channel slopes. Flood peaks in the vicinity of Council Bluffs can occur in 4 to 10 hours after the start of heavy rainfall. The peaking time is longer when storm centers are farther upstream in the basin.

10. The Mosquito Creek channel is quite uniform throughout most of its length in the hill area. It is generally trapezoidal in section. Bottom widths range from about 30 to 60 feet, top widths from 100 to 150 feet, and depths from 25 to 35 feet. The gradient is about 5 feet per mile. The minimum channel sections are estimated to have a capacity of about 15,000 c.f.s., which would carry a 5-percent to 7-percent probability discharge in the downstream one-half of the basin. Flows are carried from the bluffline of the Missouri River to the Missouri River by a leveed floodway which has a length of 3.6 miles and a slope of 2 feet per mile. Floodflows at the bluffline are contained within the channel to the mouth, unless levee failures occur because the floodflows exceed the channel capacity.

11. An average 1-hour unit hydrograph for Mosquito Creek was derived from streamflow records of five storms at the Mosquito Creek gage location. This unit hydrograph has a peak discharge of 18,000 c.f.s. and Snyder's hydrograph coefficients of $C_t = 0.79$ and $C_p = 0.86$. These 1-hour coefficients were used to compute the unit hydrographs for areas within the Mosquito Creek basin varying in size from 10 to 240 square miles.

DISCHARGE-PROBABILITY

12. The discharge-probability curve for the Mosquito Creek gage location is shown on plate C2-2. This curve was developed using the log Pearson Type III distribution with 21 years of stream discharge records. Expected probability and partial duration adjustments were applied to the frequency curve.

STANDARD PROJECT FLOOD

13. The standard project flood peak discharge for the gage location is estimated to be 54,000 c.f.s.

HISTORICAL DAMAGES

14. The only floods on Mosquito Creek, which were recorded and for which damage surveys were made, occurred on 12 and 22 June 1947. The first recorded flood, of moderate magnitude, occurred on 12 June 1947. The floodwaters on Mosquito Creek broke the right-bank levee east of Lake Manawa, spread westward to near the east end of the lake, and thence spread southward to the Missouri River. Flooding began at 1 p.m. on 12 June. Near flood stage occurred for about

6 hours, after which recession was rapid. No stages or discharge measurements were taken for this flood as it was of only moderate magnitude. Approximately 1,000 acres of croplands were flooded to a shallow depth. This was sufficient, however, to cause severe damage to crops. Some damages resulted to fences and to county roads. No farmsteads were flooded and there was no loss of human life or of livestock.

15. The storm of 22 June 1947 caused severe flooding on the Nishnabotna River and other streams in the Council Bluffs area. The storm produced about 2.5 inches of rain over most of the basin. The rainfall over that portion of the area between Underwood and Council Bluffs, however, was considerably heavier, averaging between 3 and 4 inches. As a result of this excessive rainfall over the downstream part of the basin, a sharp peak with a flow of 7,500 c.f.s. occurred about 4 p.m. The stream then receded slightly before rising to another crest of 7,500 c.f.s. at 10 p.m.

16. During the 22 June flood, overbank flow occurred along the downstream reaches of Mosquito Creek in the vicinity of Highway 275. In the hilly portion of the basin, overbank flow extended from 500 to 1,500 feet in width, and in some places covered the entire valley floor. In the flat Missouri River flood plain, the waters spread as much as a mile from the Mosquito Creek channel. A crest stage of 18.7 feet was recorded on 22 June near Weston, Iowa. The gaging station on Mosquito Creek had been installed only a few years, hence no adequate records existed for comparing this flood with floods of previous years. Local residents stated, however, that the flood of 22 June was considerably higher than the flood of 12 June but appeared relatively moderate as compared with floods experienced on this stream many years before.

17. A total area of approximately 2,200 acres of land was inundated on 22-23 June. This area included only a small portion of the area inundated on 12 June. Considerable damages resulted to crops and fences, to seven county and highway bridges spanning the channel, and to 2 miles of county roads. The levees along Mosquito Creek sustained a 100-foot break and considerable erosion damage. Within the limits of Manawa Park village, 20 business places were damaged. The yards of 84 residences were flooded, 20 homes had basements filled, 10 homes had water on the first floors, and 5 families, totalling about 20 people, moved out. Mud was deposited in the streets and alleys of the village of Manawa. A large oil and gasoline bulk storage plant and distribution system for pipelines into Iowa, Nebraska, and Missouri was also flooded; this caused cessation of all activities for 45 hours and caused a tremendous indirect loss, as well as considerable direct damage, to the installation.

18. A summary of damages resulting from the floods on Mosquito Creek during 22-23 June 1947 is presented in table C2-1.

19. A summary of the average annual and potential flood damages is given in table C2-2. The table includes the reach from the mouth upstream to the town of Portsmouth.

Table C2-1
Flood Damages-Mosquito Creek
22-23 June 1947

Area Flooded:

1,500	Acres Cropland
600	Acres Hay and Pasture
10	Acres Municipal
90	Acres Waste and Rights-Of-Way
2,200	Acres Total

Damages:

Municipal		
Village of Manawa and Park		$ 12,300
Agriculture		67,300
Transportation		
Railroads	$1,000	
Highways	2,000	
County Roads	17,400	20,400
Levees and Channel Erosion		27,000
Oil Storage and Distribution Plant		8,300
Indirect and Miscellaneous		
Oil Storage and Distribution Plant		743,000
Others		10,000
Total Damages, Mosquito Creek		$888,300
Indicated Land Damage In Flood Plain Based On Soil Conservation Service Data		$366,600

Table C2-2
Flood Damage Summary
Mosquito Creek

	Flood Damage	
	Upstream from Highway 375	Downstream from Highway 375
1-Percent Flood	$1,860,000	0
Standard Project Flood	7,400,000	$8,350,000
Average Annual	59,150	66,720

Other Problems and Needs

20. Gully erosion is the major problem in the basin. Studies were made by the Soil Conservation Service for the central portion of the Mosquito Creek basin in Harrison County. The gullies in this area ranged in width from 10 to 100 feet and in depth from 4 to 30 feet. In addition to land voiding, depreciation of adjacent lands, and increased cost of farm operations, damage also occurs to fences, roads, bridges, and culverts.

21. Excessive sheet erosion has occurred on many of the sloping cropland areas of the basin. Land treatment measures installed in recent years have corrected this problem on portions of the cropland area. The present rate of sheet erosion in the central Mosquito Creek basin, averaged over the entire upland area, was estimated to be 9.6 tons per acre per year.

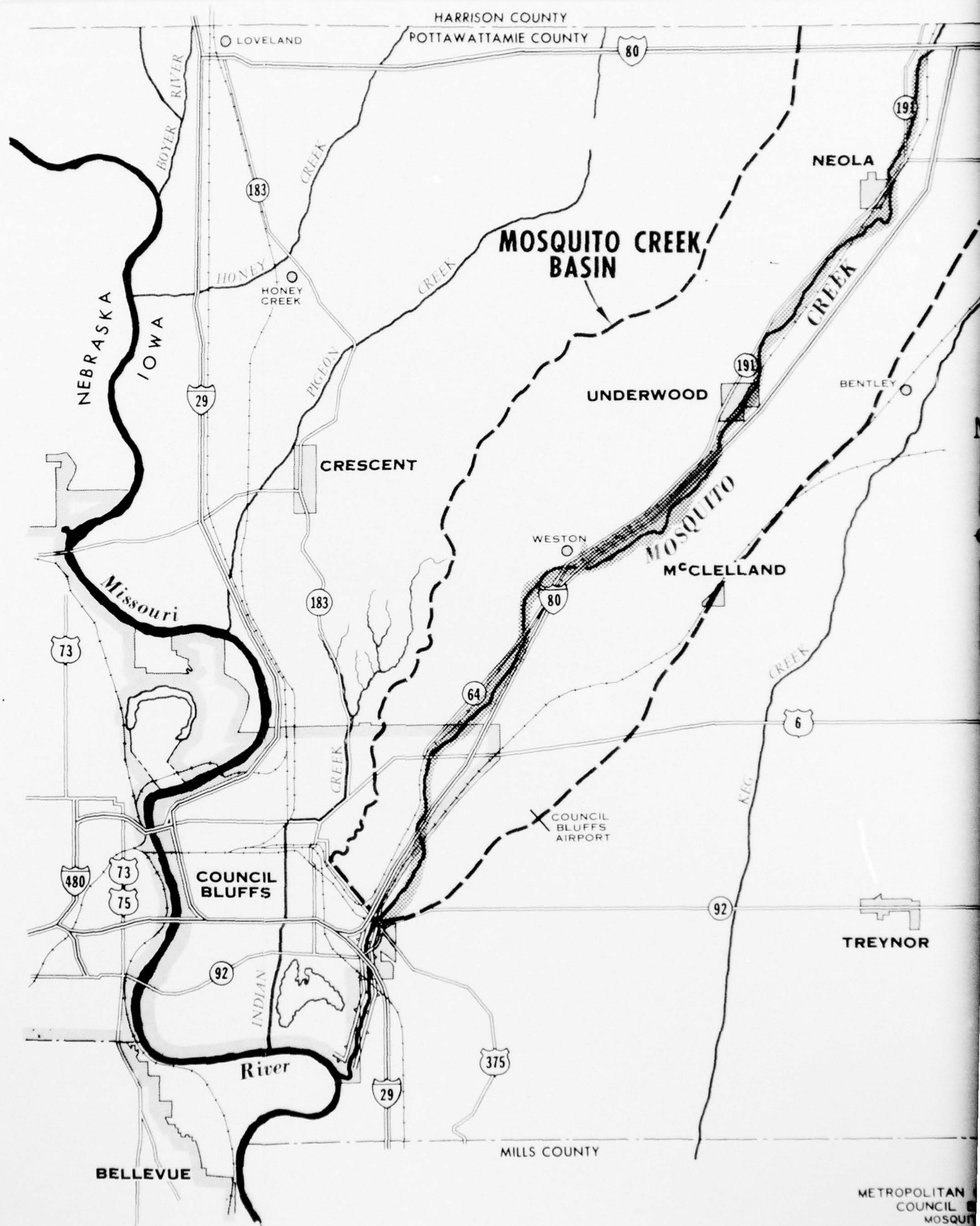
22. Sediment deposition from gully and sheet erosion causes filling of some of the lateral outlet channels that cross the Mosquito Creek bottom lands. These deposits have been removed periodically and quite frequently in certain portions of the channels.

23. The main channel of Mosquito Creek was straightened to reduce drainage and flood problems. Deepening and widening by erosion then took place. The channel banks are now covered with vegetative growth and the main channel appears to be stabilized. Some drainage problems exist along Mosquito Creek in the Missouri River flood plain due to the flat topography.

24. Soil Conservation Service land treatment and structural measures in the Mosquito Creek basin in Harrison County, according to SCS estimates, would eliminate direct gully erosion damage and would reduce sheet erosion by 35 percent or 6.3 tons per acre per year.

Improvements Desired

25. No public meetings have been held specifically for the Mosquito Creek basin. The flood plain is almost entirely agricultural. Available local land use plans show that the Mosquito Creek flood plain should be preserved as open space for the purposes of recreation or agricultural production.



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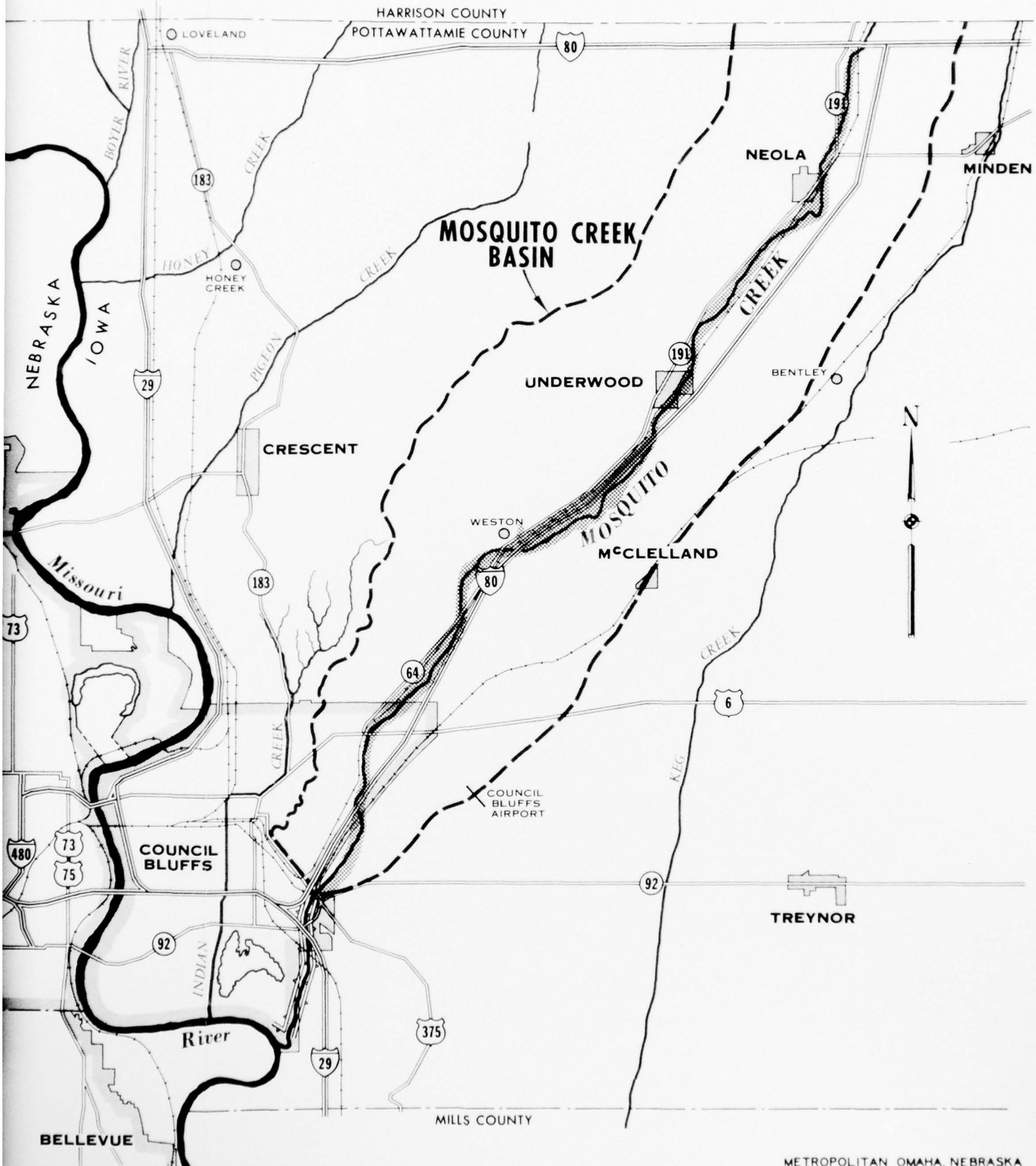

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MOSQUITO CREEK
FLOODED AREA
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CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975

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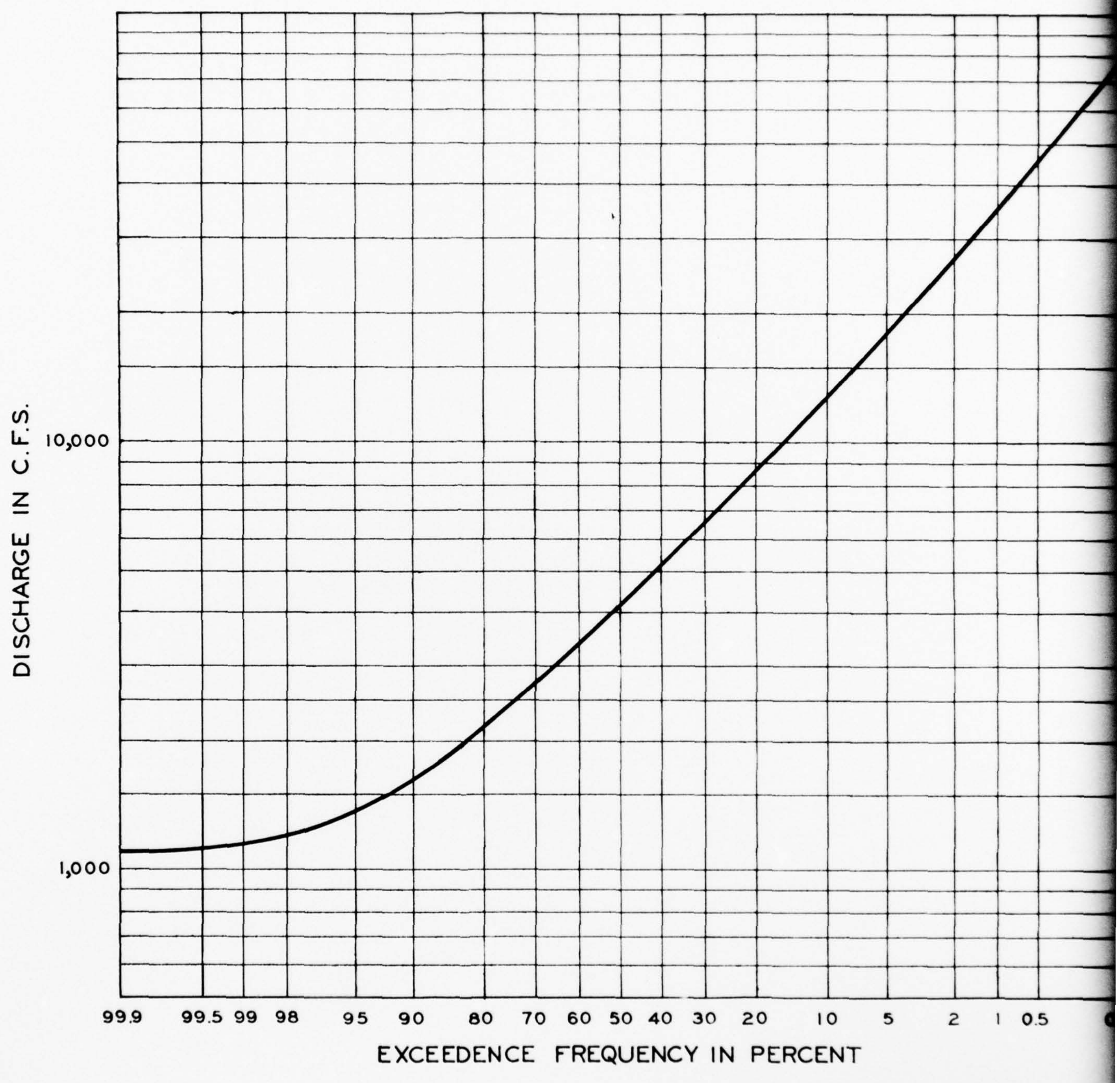

DISCHARGE IN C.F.S.
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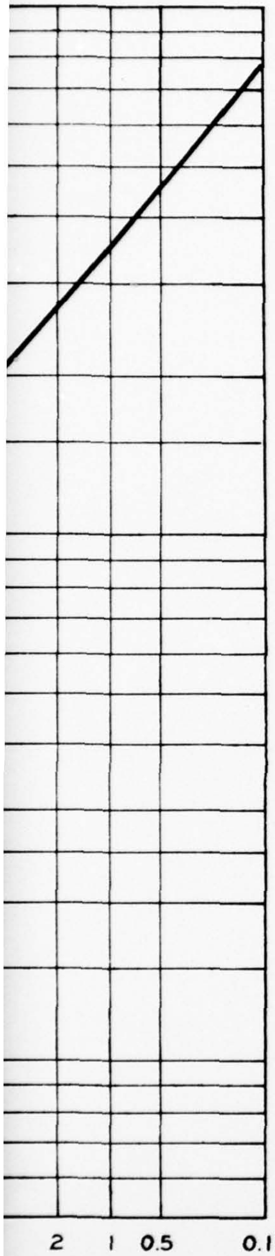

MOSQUITO CREEK WATERSHED
COUNCIL BLUFFS IOWA
CORPS OF ENGINEERS GAGE
DRAINAGE AREA-238 SQ. MI.
DISCHARGE FREQUENCY CURVE

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975

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PART III

FORMULATING A PLAN

1. This section presents a discussion of the possible solutions considered and the basis for selecting the final plan. In formulating a plan, it was imperative to consider all appropriate alternative plans. Such alternatives were then screened to arrive at the plan that best responds to the problems and needs of the area.

Possible Solutions

2. Several alternative measures to satisfy the problems and needs of the area are possible; however, some of these measures are not practical or economical. The possible solutions may be divided into the two broad categories of nonstructural and structural measures. Nonstructural measures include insurance,

zoning, building code regulations, flood proofing of both individual buildings and single land tracts, and permanent evacuation of flood plain areas. Possible structural measures include reservoirs, channel and levee improvements, diversions, and combinations of these. Also, a combination of nonstructural and structural measures is possible. Nonstructural measures are not intended to reduce or eliminate flooding, but are intended to regulate the use and development of the flood plain, thus lessening damaging effects of large floods.

NONSTRUCTURAL MEASURES

FLOOD INSURANCE

3. The flood insurance program provides compensation for people located in participating areas. It does not reduce damages to existing development. The program primarily involves improvements located below the 1-percent flood level in urban areas. Only buildings can be insured. On Mosquito Creek very few urban buildings are located within the 1-percent flood area. The bulk of flood damages at the 1-percent flood level are to crops and bridges. Thus, the program would have little benefit in the basin. Most of Mosquito Creek lies in a rural area which is not subject to regulation.

ZONING

4. Zoning could prevent damage to future developments in the flood plain, but would not protect existing development. Most of the Mosquito Creek flood plain is undeveloped and rural in nature. Zoning would be beneficial and best enforced in the Council Bluffs area.

FLOOD PROOFING

5. Flood proofing to protect against the 100-year flood would reduce damages to residential and nonresidential buildings, but would be expensive and socially objectionable. In addition, most of the urban development that would be affected by the standard project flood is already above the 100-year flood elevation. Rural damages would not be decreased. Existing development would not be required to flood proof under flood insurance program regulations, and future flood proofing would be the financial responsibility of individuals who build in the flood plain.

FLOOD FORECASTING

6. Peaking times on Mosquito Creek are from 4 to 10 hours. Effective flood forecasting would reduce the risk to human life, but little property could be evacuated. Crops and transportation facilities would not be benefited.

EVACUATION

7. Permanent evacuation of the 1-percent flood plain areas would reduce the rural damage potential. Most of the existing urban properties are located between the 1-percent flood and standard project flood zones. In Pottawattamie County, 18 residences, and 5 commercial buildings would have to be relocated. Also, 3,700 acres of agricultural land would have to be purchased. Bridges and transportation routes would not be protected. At an estimated cost of more than $8,000,000, evacuation would be infeasible. In addition, 3,700 acres of agricultural land would be removed from production.

NO ACTION

8. Under the no action alternative, it is assumed that the flood insurance program would be adopted by local officials. Future urban development would, therefore, be limited to the fringe of the 100-year flood area. Existing development would not be protected.

STRUCTURAL MEASURES

LARGE DAMS

9. A single, large dam on Mosquito Creek was considered at various sites along the stream, as shown on plate C3-1. The locations were: 1 mile upstream from Portsmouth; near the Pottawattamie-Harrison County line; just upstream from Underwood; and just upstream from Chataqua. A dam located at these locations would control 65, 116, 164, and 211 square miles, respectively, of the 234 square miles upstream from the bluffline. Each reservoir studied would have the capacity to store the standard project flood. The cost of these reservoirs ranged from about $8,000,000 to more than $14,000,000. All were economically infeasible. The alternative reservoir sites would require from 2,000 to 4,000 acres of land and the flood control pools would extend 7 to 10 miles upstream, thus occupying a considerable area along the stream.

10. A combined network of the four large dams, shown on plate D-6, was also considered. The dams would be located at the sites described previously and would control areas of 65, 51, 48, and 47 square miles, for a total of 211 square miles. An excessive portion of the flood plain would be taken up by the dams and reservoirs. In the 41-mile reach along Mosquito Creek between

the mouth and the Portsmouth damsite, the flood control pools would occupy a length of about 21 miles. The combined cost of the dam system was estimated at $30,000,000. This alternative was also found to be economically infeasible.

SMALL DAMS

11. To avoid the major relocations associated with the large dam, a system of small dams was considered. To control all of the significant side tributaries of Mosquito Creek, a network of 58 small dams would be required. Individual dams would control areas ranging from 0.2 to 12.6 square miles, with an average of 2.5 square miles and a total controlled area of 145 square miles. The total system would cost about $57,000,000 and is economically infeasible.

DIVERSION

12. Upstream from the vicinity of Weston, Iowa a diversion south to Keg Creek or north to Pigeon Creek is technically feasible. The diversion would require a dam on Mosquito Creek and about 5 miles of deep-cut channel. In addition to the expense of the diversion, the flood hazard would be increased on adjacent streams.

CHANNEL IMPROVEMENTS

13. Enlargement of the Mosquito Creek channel to carry the 1-percent flood was considered as shown on plate C3-2. The project would extend from Highway 375, at the head of the existing tieback levees, upstream to the town of Persia, a length of about 31 miles. The land required would be about 400 acres, which is less than that needed for the reservoir projects. The channel improvement would cost about $18,000,000 and would involve lengthening about 30 bridges. This alternative is also economically infeasible.

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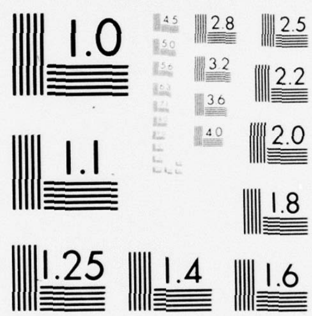
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LEVEES

14. A levee project to contain the 1-percent flood was evaluated. Because of the narrow flood plain, borrow for the levees would have to be taken from excavation of the channel. The location of the levee project would be the same as that of the channel project. The levee would require more land than the channel project; about 700 acres would be needed along the main stem and some additional land would be needed for tieback levees. By combining channel excavation and levee embankment, considerably less excavation would be required for the levee project. The levee project was found to be economically infeasible, with an estimated cost of about $19,000,000.

COMBINATIONS

15. In view of the lack of feasibility of the individual projects, estimates for the various possible combinations were not made.

SUMMARY OF POSSIBLE SOLUTIONS

16. Nonstructural measures would greatly reduce future increases in flood damage caused by unwise flood plain development. Existing damages, however, would not be reduced. Damageable development below the 1-percent flood level is mostly rural in nature.

17. All of the structural alternatives evaluated were economically infeasible by wide margins. A summary of costs for the alternatives considered is presented in table C3-1. All projects have a benefit-cost ratio of about 0.1 or less. Because none of the projects meet the economic criteria, an effect assessment and the "Principles and Standards" comparison covering social and environmental aspects were not made.

Table C3-1
Summary of Alternatives-Mosquito Creek

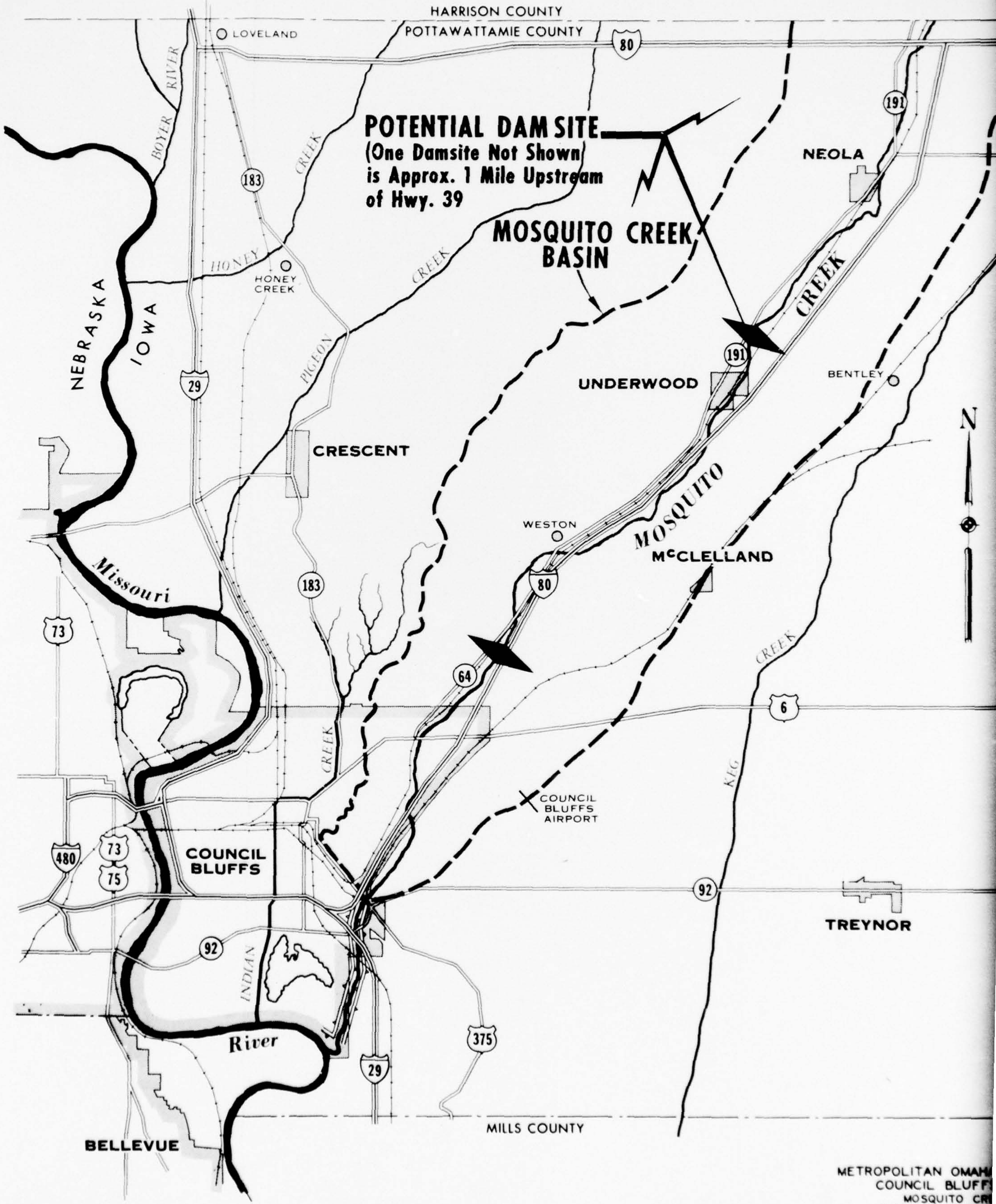
Alternative	First Cost
100-Year Evacuation	$ 8,820,000
Large Dam	
Portsmouth Dam	7,800,000
County Line Dam	9,450,000
Underwood Dam	11,970,000
Chataqua Dam	14,400,000
4-Dam System	29,750,000
58 Small Dams	57,430,000
100-Year Channel	18,210,000
100-Year Levees	19,190,000

Alternatives Considered Further

18. In view of the preceding analysis, the no action alternative appears to be the most favorable for further consideration.

Selecting a Plan

19. The rural portion of the Mosquito Creek basin could best be protected by projects of the type constructed by the Soil Conservation Service. In the Council Bluffs urban area, the Mosquito Creek flood plain presents an opportunity for flood plain management because most of its flood plain is undeveloped.



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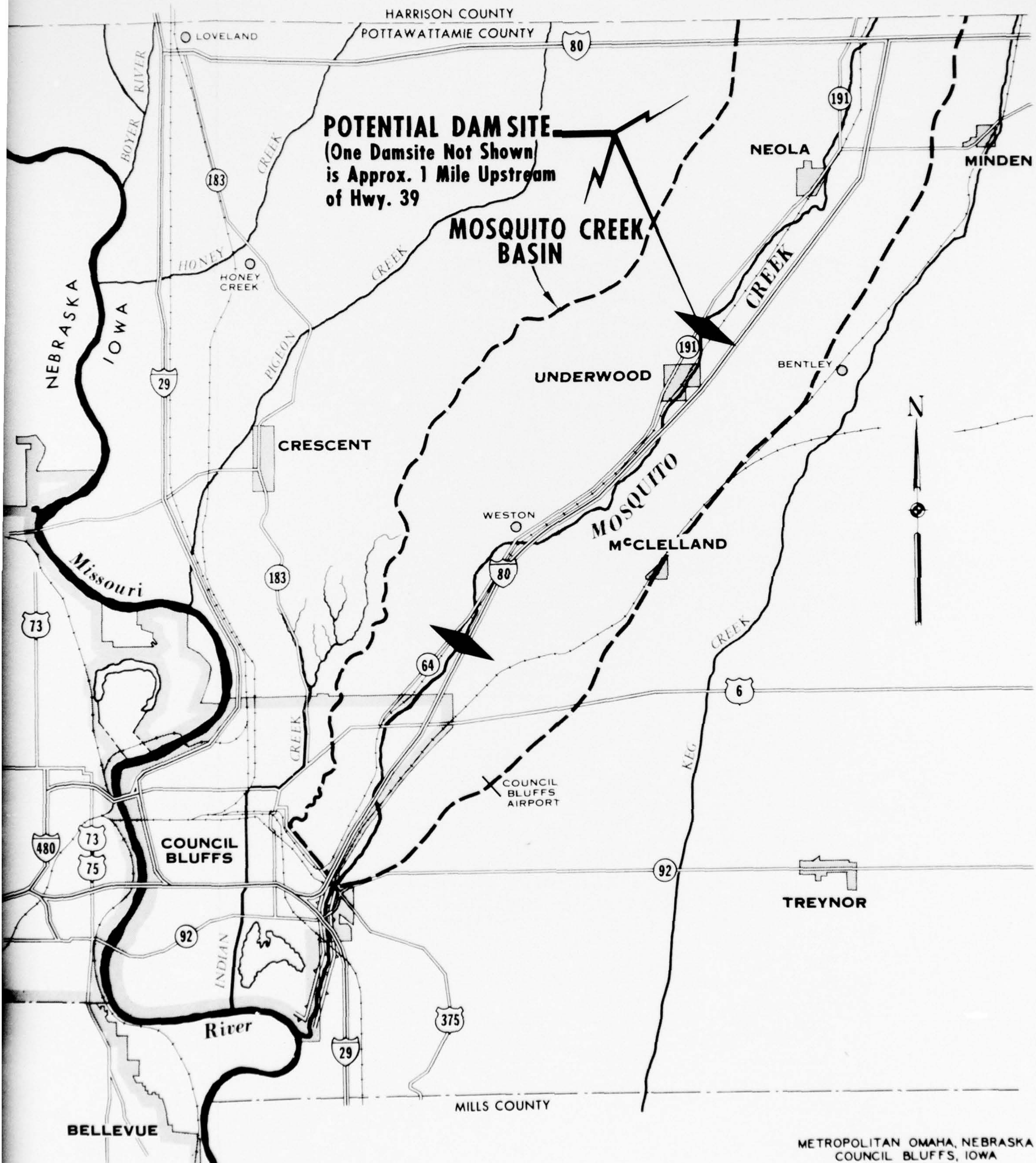

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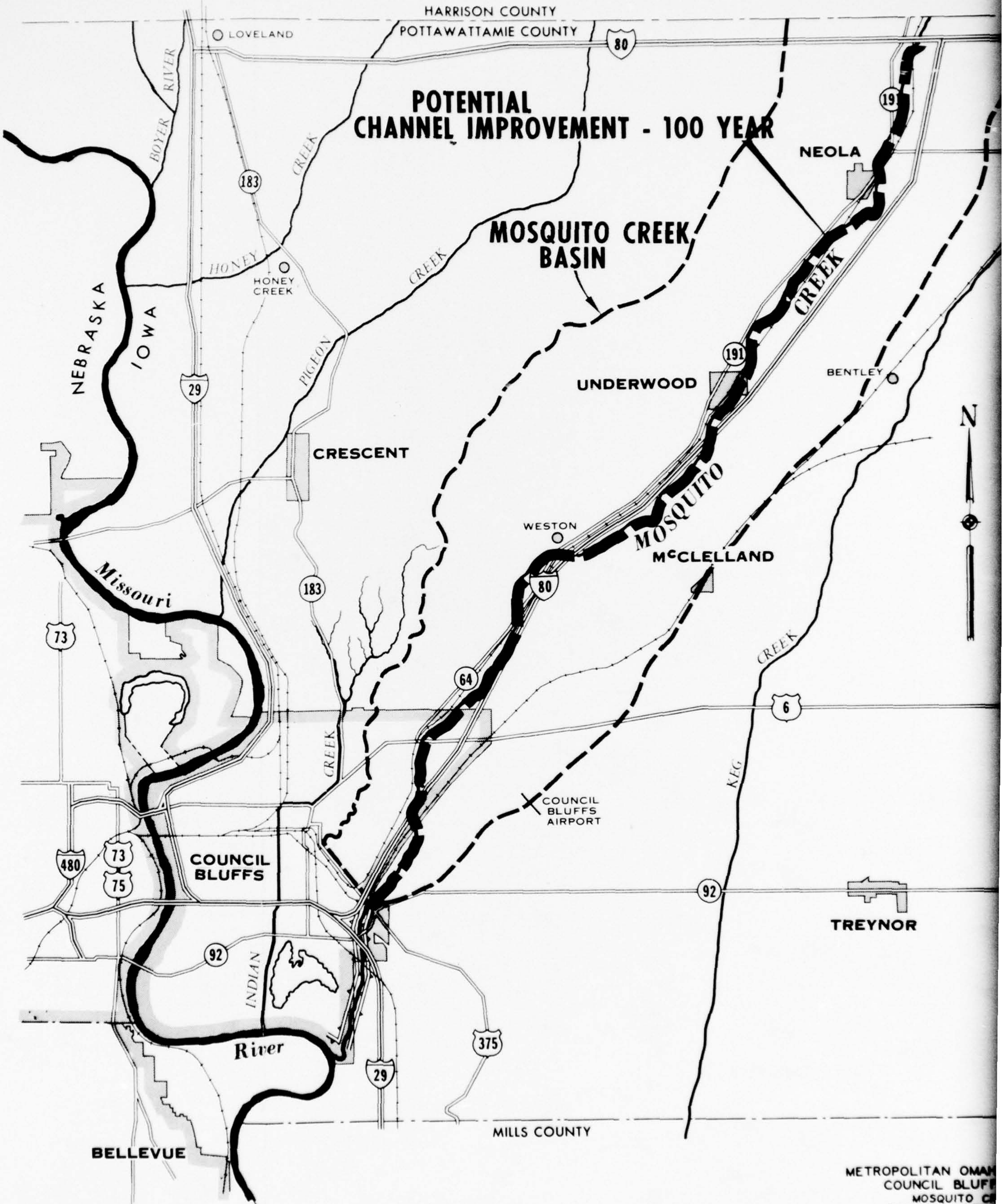
MOSQUITO CREEK
ALTERNATIVE DAM SITES
U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975

VOLUME III ANNEX D PLATE C3-1


POTENTIAL
CHANNEL IMPROVEMENT - 100 YEAR
MOSQUITO CREEK BASIN
HARRISON COUNTY
POTTAWATTAMIE COUNTY
MILLS COUNTY
LOVELAND
HONEY CREEK
NEOLA
UNDERWOOD
BENTLEY
CRESCENT
WESTON
McCLELLAND
COUNCIL BLUFFS AIRPORT
COUNCIL BLUFFS
TREYNOR
BELLEVUE
NEBRASKA
IOWA
Missouri
River
BOYER RIVER
HONEY CREEK
PIGEON CREEK
MOSQUITO CREEK
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INDIAN CREEK
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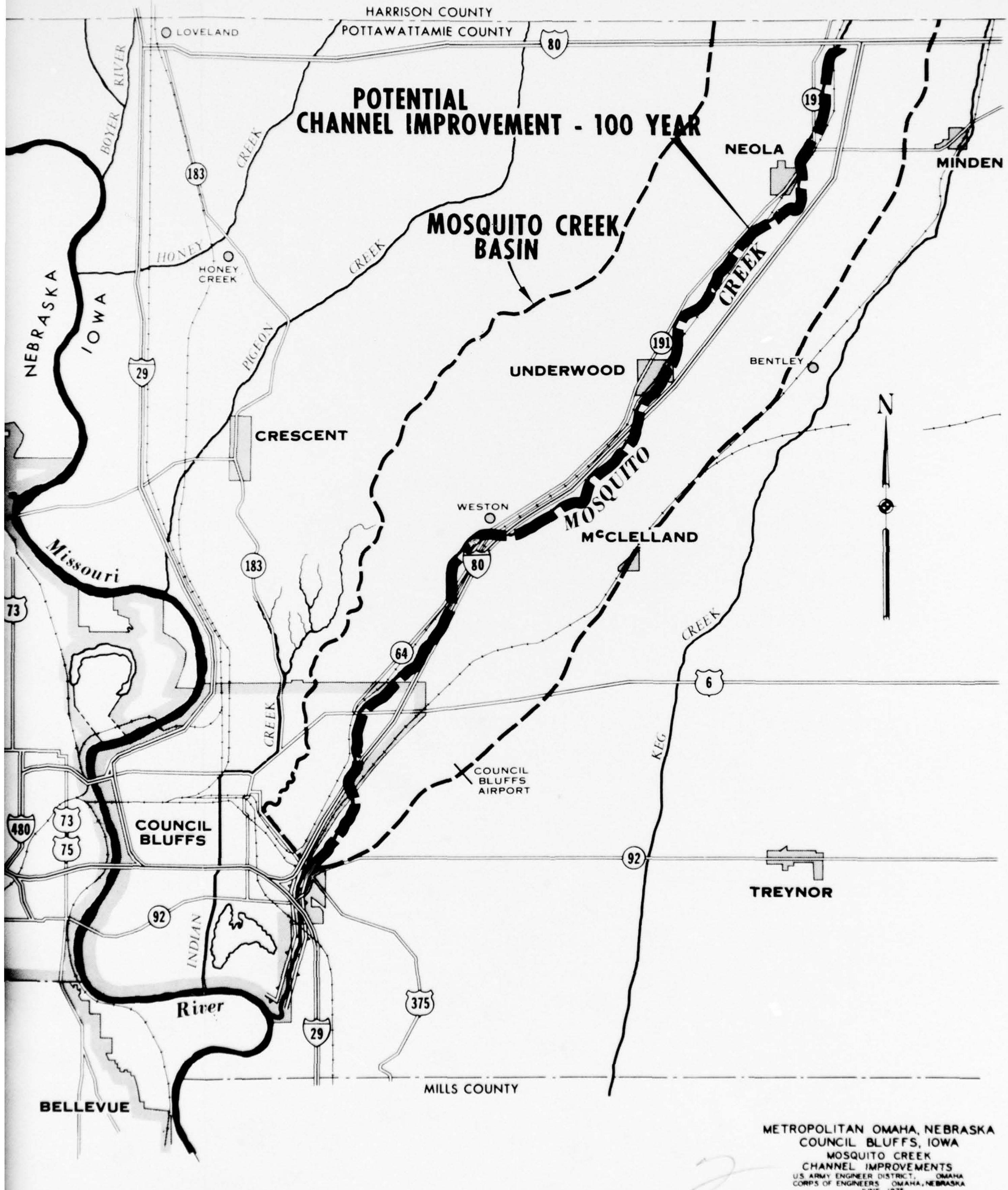
JUNE 197
VOLUME III ANNEX



METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
MOSQUITO CREEK
CHANNEL IMPROVEMENTS
U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975

VOLUME III ANNEX D PLATE C3-2

SECTION D

INDIAN CREEK EVALUATION

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SECTION D

INDIAN CREEK EVALUATION

PART I

RESOURCES AND ECONOMY OF THE STUDY AREA

Environmental Setting and Natural Resources

BASIN DESCRIPTION

1. Indian Creek drains an area of about 15 square miles. The downstream two-thirds of the basin is the study area. This area is subject to land use changes due to the growth of Council Bluffs, Iowa.

2. Indian Creek is a minor left-bank tributary of the Missouri River lying entirely within Pottawattamie County. The stream originates about 4 miles north of the city limits of Council Bluffs and flows in a southerly direction through the city. The basin is about 11 miles long, varies from 1 to 5 miles in width, and has a total area of approximately 15 square miles.

3. U. S. highways and State routes in the study area include U. S. Highways 6, 30A, 59, 75, and 275; Iowa State Highways 64, 183, 92, 192, and 375; and Interstates 29 and 80. Railroad transportation is provided by Chicago and North Western Transportation Co.; Burlington Northern, Inc.; Illinois Central Gulf Railroad; Norfolk and Western Railway Co.; Chicago, Milwaukee, St. Paul and Pacific Railroad; Chicago, Rock Island and Pacific Railroad; and the Union Pacific Railroad. Commercial air transport facilities are available at the nearby Omaha Municipal Airport, Eppley Airfield. The Council Bluffs airport accomodates private aircraft.

HISTORICAL-ARCHEOLOGICAL FEATURES

4. Council Bluffs has a rich historical heritage related to the railroads, Lewis and Clark, and the Mormon migrations. Several prehistoric findings have also been uncovered in Pottawattamie County; the findings include fossil bones and Indian artifacts.

NATURAL RESOURCES AND ENVIRONMENTAL CHARACTERISTICS

5. The Indian Creek basin is characterized by deeply-cut streambeds with steep channel side slopes along the upstream portions of the basin. At the northern edge of Council Bluffs, Indian Creek enters an open concrete channel. Indian Creek flows are carried by a covered underground concrete channel beginning at East Broadway and continuing through the Council Bluffs business district. Near the West Broadway viaduct between 10th and 14th Streets, the underground channel emerges; Indian Creek then flows south in a concrete-lined channel. At 16th Avenue the concrete channel ends, and streamflows are carried between Missouri River tieback levees to the Missouri River.

6. Vegetation for wildlife within the Indian Creek basin is primarily limited to areas along the watercourse and outside the city of Council Bluffs. Species of woody vegetation found in the basin include cottonwood, box elder, mulberry, willow, green ash, silver maple, American elm, walnut, and cedar. Nettle, ragweed, chockecherry, gooseberry, honeysuckle, timothy, wild rye, brome, clover, and foxtail are shrub and grass species found in the basins.

7. Game birds and animals inhabiting the basin include whitetail deer, bobwhite, quail, cottontail rabbits, fox squirrels, and pheasants. Nongame species include fox, coyote, raccoon, mink, weasel, muskrat, opossum, skunk, and the common species of moles, shrews, ground squirrels, field mice, and rats. Common resident birds include the yellow-shafted flicker, downy woodpecker, bluejay, black-capped chickadee, robin, cardinal, and American goldfinch. Woody vegetation along the watercourse attracts numerous species of warblers, orioles, sparrows, thrushes, hawks, and owls during spring and fall migrations. Numerous bird species such as the red-headed woodpecker, eastern phoebe, cardinal, catbird, robin, and brown thrasher find habitat in the basin suitable for nesting. Waterfowl are found occasionally in the basin. Although many species of birds are common to the basin, no rare, endangered, or unique species of birds are known to inhabit the basin.

8. The game populations within the basin have been decreasing the past few years, principally due to decreasing habitat. During this same period, the number of hunters has been increasing, resulting in a very heavy hunting pressure. The posting of land by private owners to prohibit hunting has helped to reduce the hunting pressure and conserve existing game populations.

Human Resources

STUDY AREA

9. The study area contains the northern and central portion of Council Bluffs. The northern portion is undergoing increasing urban development, while the central portion is completely developed.

POPULATION CHARACTERISTICS

10. Council Bluffs has experienced a steady population growth over the past 30 years as shown in table D1-1.

Table D1-1
Historic Population
Council Bluffs, Iowa

Year	Persons
1940	41,439
1950	45,429
1960	55,641
1970	60,348

Source: U. S. Census of Population; 1940, 1950, 1960, 1970.

INCOME

11. The 1970 census indicated that the median family income in Council Bluffs was $9,624 compared to $9,356 in Pottawattamie

County and $10,204 in the Omaha-Council Bluffs SMSA. Families with incomes under the poverty level accounted for 8.3 percent of the families in Council Bluffs, compared to 6.4 percent in Pottawattamie County and 6.8 percent in the Omaha-Council Bluffs SMSA.

Development and Economy

12. The northern portion of the study area contains many sites that would be attractive for residential development. Certain of these sites are currently being developed along established transportation corridors. The "Comprehensive Regional and Urban Area Plan" by the Council Bluffs Metropolitan Area Planning Commission has divided the study area into neighborhood zones and projected populations for these zones. This report was used in projecting population and land use for the area.

POPULATION PROJECTIONS

13. Eight neighborhood zones are located in the study area in addition to the existing fully developed areas. Approximately 10,000 persons are currently located in the developed central portion of the study area. This figure is expected to remain constant. Projections for the undeveloped portion of the study area are presented in table D1-2 by neighborhood zones.

Table D1-2
Neighborhood Population Projections
1985-Indian Creek Study Area

No.	Name	1985 Population
11	Harrison	3,668
14	Madison	3,978
15	Pusey	2,405
16	Lincoln	3,073
19	Hoover	2,795
20	Lewis & Clark	2,440
21	Lake Central	510
22	Gunn	2,825
	Subtotal	21,694
	Developed Portion	10,000
	TOTAL	31,694

LAND USE

14. The flood plain through the northern portion of the study area is extremely narrow. Development in the neighborhood zones, however, is already encroaching into the flood plain. As these neighborhoods continue to develop, flood damages will increase.

15. The flood plain in the central portion of the basin is very wide. This portion is fully developed and the flood damage potential is extensive. There is essentially no room for further development in this portion of the flood plain. Many of the homes and businesses in the area are older, dilapidated homes. Redevelopment efforts in the area without flood proofing or protection would result in higher flood damages than are currently present.

PART II

PROBLEMS AND NEEDS

1. The purpose of this section is to summarize the water resource problems and needs relating to flooding, erosion, drainage, and irrigation of the Indian Creek basin. This section also provides information on existing plans and improvements in the area. As an indication of relative flood hazard, figure B2-1 defines the flood potential by frequency of occurrence in years.

2. A letter report submitted by the Kansas City District Engineer in June of 1933 resulted in the authorization of improvements for flood control on Indian Creek. This project, however, was constructed by the city of Council Bluffs with the aid of a Federal grant under the emergency work relief program.

3. After some difficulties were experienced near the outlet of the improved channel, the Board of Engineers for Rivers and Harbors in a report published as House Document 577, 76th Congress, 3d Session, recommended extension of the improved channel of Indian Creek to the Missouri River, at a cost of $18,000. This extension

was authorized by the Flood Control Act approved 18 August 1941, but the plan was superseded by a plan presented in House Document 475, 78th Congress, 2d Session, authorized by the Flood Control Act approved 22 December 1944. This plan recommended the realignment of the downstream portion of Indian Creek to provide a new location for its mouth.

4. In October 1948, the Omaha District of the Corps of Engineers forwarded a review report on Indian Creek. The report recommended diversion of Indian Creek by a dam at the north edge of the Council Bluffs city limits and an open-cut channel westward to the Missouri River. The report was returned to the District Engineer for restudy on 25 October 1954 by the Chief of Engineers because of objections by the Iowa Natural Resources Council. A review report on Indian Creek was made by the Omaha District in April 1961; it recommended a dam on Indian Creek at the north city limits of Council Bluffs. This dam would store the maximum probable flood, in conjunction with upstream erosion and sediment control measures that were to be constructed by the Soil Conservation Service. The Indian Creek dam was authorized by the Flood Control Act of 1962. The project was classified "inactive" on 2 July 1968. A 5-year limitation letter was issued on 12 December 1968. Project authorization expired on 12 December 1973.

Existing Plans and Improvements

5. Since 1856, the city of Council Bluffs has constructed various improvements in efforts to alleviate flood problems caused by Indian Creek. In 1936, under a Public Works Administration loan and grant, the city constructed an improved channel consisting of:

- An open concrete channel about 8,600 feet long from the north city limits to Frank Street;

- A covered concrete channel more than 7,300 feet long from Frank Street to Broadway and 13th Streets;

- An open concrete channel about 5,800 feet long from Broadway to 14th Street at 16th Avenue; and

- An open earth ditch about 16,000 feet long from 16th Avenue south and southwest to an outlet at the Missouri River near the Highway 275 crossing.

6. After difficulties were experienced with the open earth ditch, prior to 1946, the city closed off that part of the earth ditch south of the city limits and diverted the flow more directly west to the Missouri River in a ditch along 29th Avenue.

7. As part of the authorized Missouri River Levee Project, a flood protection plan was developed for the city of Council Bluffs. The outlet of Indian Creek was relocated by the Corps of Engineers

in 1949, so that the Indian Creek channel carries flows south from 29th Avenue to the Missouri River and passes on the west side of Lake Manawa. The new channel outlet was located 5.7 miles downstream from the old outlet in order to reduce the effect of backwater in the creek channel. Levees that were constructed on both sides of the channel tied into the Missouri River levees. The earth channel, from 16th Avenue to 29th Avenue, was cleaned out and enlarged to conform to the standards of the relocated channel. This outlet was designed for 6,000 c.f.s., which was the maximum expected to be delivered after the floodwaters spread out and attenuated within the city.

8. In 1944, the West Pottawattamie County Soil Conservation District was organized. Many of the farmers in the watershed are participating with the Soil Conservation Service and the District in framland treatment measures. In October 1948, the Soil Conservation Service completed a survey report of the upper watershed which recommended a program of runoff retardation and soil erosion prevention. A watershed work plan was prepared in February 1961. Structural measures consist of 15 structures, including six drop inlet structures, seven chute spillways, and two box inlets, along with structural waterways and general land treatment measures. Several of the structures have been completed and contracts were let in early 1975 for construction of the remaining structures. This project will do much to reduce erosion and sediment but will have little effect on major floodflows.

Flood Problem

9. Numerous damaging floods occurred prior to the construction of the present concrete channel in 1936. Since that time several larger discharges have occurred, but because of the increased channel capacity, less overflow occurred and flooding was not as extensive as would have been expected for some of the earlier floods. However the flood of 20 June 1942 was the largest ever experienced in Indian Creek and the flood of 22 June 1947 was nearly as great.

10. Available records indicate that at least 16 floods have occurred since 1883. Table D2-1 shows historic flood data.

Table D2-1
Historic Flood Damages
Indian Creek Basin

Year	Date	Comments
1883	5 and 6 June	Largest flood until 1903
1903	26 August	Over bridges from 6th Street to 15th Street
1909	5 July	75 blocks flooded west of 6th Street
1923	28 September	Highest stages of record in business district; heavy damage as far east as Bryant Street
1932	25 June	Over 2 inches of rain in less than 1/2 hour
1935	24 June	Greatest flood since 1923
1942	20 June	Largest flood of record
1947	22 June	148 city blocks flooded

Minor Damaging Floods

Year	Date	Year	Date
1898	9 June	1906	26 June
1898	6 July	1917	15 June
1901	27 September	1948	1 September
1903	24 August	1965	6 and 7 September

STREAMFLOW RECORDS

11. Streamflow records for Indian Creek have been collected since 1949 from a water level recording gage located at 2700 North Broadway in Council Bluffs. This gage is operated and maintained by the Omaha District of the Army Corps of Engineers and the gage has an automatic starting device to record all above normal flows. The channel in the vicinity of the gage is concrete and it provides a permanent control that is free of vegetation. The channel is straight for about 400 feet upstream from the gage and it is straight for about 300 feet downstream from the gage; therefore, at high stages the flow is fairly smooth. The U.S.G.S. established a wire weight gage in July 1954 on Mud Hollow Road at the north edge of Council Bluffs. This gage was replaced by a water stage recorder in April 1955 and it has provided a continuous record. Estimated peak discharges are available for three previous floods; these include 1942, with a peak discharge of 6,500 c.f.s.; 1947, with a peak discharge of 5,000 c.f.s.; and 1948, with a peak discharge of 4,000 c.f.s. On the basis of 7 years of record, the average annual runoff is about 970 acre-feet per year.

RUNOFF CHARACTERISTICS

12. The basin has an efficient channel and a steep channel gradient that results in a quick concentration of runoff. An examination of Indian Creek flood hydrographs indicates that the stream normally peaks within 2 hours from the beginning of each heavy burst of rainfall. The stream has experienced high discharges resulting from high-intensity, short-duration rainstorms. Due to the small drainage area, the volume of each flood is small compared to the peak discharge, and when the stream overflows its banks, the peak is dissipated on the flood plain within the city. Snowmelt

floods have not been a problem on this stream because of its small drainage area. Some of the rainstorm floods that have occurred in the basin are discussed in the following paragraphs.

13. As a consequence of the small basin area and the steep dissected terrain, Indian Creek floods are of the flash type, with fast peaking times and high discharges. Flood peaks are reached in 1 or 2 hours after the start of runoff. The upstream portion of the basin is hilly and runoff from this area, about 10 square miles, is responsible for flood peaks. The channel is deeply entrenched, with a steep gradient, and has been adequate for all floods of record in this area. In the upstream portion of the basin, the valleys are narrow and the overbank area is limited. A number of suburban homes, farms, and road crossings are located in the valley bottoms. All recorded flood damages have occurred within the city of Council Bluffs. An outline of the area estimated to be flooded by the 100-year flood is shown on plate D2-1. An open concrete channel begins at the Council Bluffs city limits. Upstream from Oak Street, the overbank area is narrow and predominantly residential. At Oak Street, however, floodwaters emerge onto Broadway, the principal business street. The valley continues narrow from Oak Street to Main Street. This reach is occupied by numerous small business establishments and some residential development. Between 2nd Street and Main Street, a major shopping center structure or superblock is under construction; it will occupy about 600 feet of the estimated 800-foot wide flood area. Normal flows would be carried by the covered concrete channel, but high flows from flooding would continue down the street to Main Street. Here the valley opens abruptly into the broad flat Missouri River flood plain. In many places, it is as much as 4 feet below the top of the channel walls. This flood plain acts

as a ponding area for the overflow and, as a result, all of the moderate floods inundate essentially the same area. Flood depths in this area are relatively shallow. The broad flats west of 8th Street quickly dissipate the floodflow and downstream from 29th Avenue, the creek seldom exceeds bankfull stage.

UNIT HYDROGRAPH

14. A 15-minute unit hydrograph was developed from the storm of 30 April 1951 on Indian Creek. This event was selected because the rainfall was uniformly distributed over the basin and the runoff-producing portion of the storm was short and well isolated. The 30-minute and the 1-hour unit graphs were determined from the 15-minute unit graph. The 15-minute unit graph was checked by using it to reconstruct several other floods that had occurred in the basin.

DISCHARGE PROBABILITY

15. The discharge-probability curve for the Indian Creek gage location is shown on plate D2-2. This curve was developed by the Log Pearson Type III distribution using 16 years of gaging records and estimates for the maximum discharges from four historical floods that occurred in the years 1923, 1942, 1947, and 1948. Since the first flood occurred in 1923, the two largest historical events were plotted on the basis of a 50-year record. Expected probability and partial duration adjustments were applied to the annual series frequency curve.

STANDARD PROJECT FLOOD

16. The standard project flood peak discharge for the gage location is estimated to be 16,000 c.f.s.

HISTORICAL DAMAGES

17. An outline of the history of some past floods is presented to indicate the nature and magnitude of the flood hazard.

18. Velocities can be very high in the upstream reaches of the flood area. In the flood of 28 September 1923, there were many accounts of automobiles being washed downhill and demolished, and sections of pavement were ripped from the streets of Council Bluffs.

19. The flood of 20 June 1942 was the largest ever experienced on Indian Creek. This storm was local in nature, but it produced intense precipitation at scattered locations in eastern Nebraska and western Iowa. The Omaha Weather Bureau Station recorded 3.48 inches of precipitation from 11 p.m. on 19 June to 6 a.m. on 20 June. The storm was very intense with 1 inch occurring during a 15-minute period, 1.8 inches occurring in 30 minutes, 2.44 inches occurring in 1 hour, and 2.74 inches occurring in 2 hours. The heavy downpour resulted in a peak discharge of approximately 6,500 c.f.s. near the north Council Bluffs city limits.

20. The floodwater stage was about 6 feet higher than the top of the closed conduit upstream from Frank Street, and floodwaters flowed on top of the conduit, overtopped the left bank of the channel, and flowed down the principal Broadway thoroughfare. Water in the closed conduit flowed with such pressure that the deck of the 7th Street Bridge was raised several feet. Water depths throughout

the area downstream from Bryant Street were shallow, in many places not over the street curb. Some damage also occurred in the upstream portions of the concrete-lined channel. A later resurvey of the area indicated that recurrence of the 1942 flood would inundate about 1,520 residences and 160 business establishments. Nearly all of the railroads and streets in the flooded area would require extensive cleanup to remove the thick deposits of silt, and sewer and utility service would be disrupted.

21. On 22 June 1947, the Indian Creek basin received 3.33 inches of rain in 12 hours; this caused the stream to leave its channel and flood more than 500 acres in the central part of Council Bluffs. The flood of June 1947 had an estimated discharge of 5,000 c.f.s., considerably less than the June 1942 flood. The downstream portion of the channel was badly silted, and as a result, the channel capacity was exceeded and the depth of flooding almost equalled that of 1942. After a detailed survey, damages from the 1947 flood were estimated and they are shown in table D2-2. The price level is that existing at the time of the flood.

Table D2-2
Damages-Flood of 22 June 1947

Residences - 665 lawns and basements	$108,300
106 flooded on first floor	89,000
Commercial concerns - 31	17,800
Streets, sewers, and water mains	45,500
Public utilities	4,000
Railroads	14,600
Miscellaneous	43,800
Total	$323,000

MAJOR FLOODS

22. Floods greatly in excess of the channel capacity upstream from the closed conduit would result in the excess flow running down Broadway through the heart of the business district. The stream valley along Broadway is very confining and a flood of standard project flood magnitude would send a floodwave at high velocity down the principal business thoroughfare. The flood depths would be increased due to backwater at the new shopping center. The peak would be reached about 1 hour after the stream overflowed its channel, giving very little warning of the impending disaster.

23. Such a flood would damage the larger commercial establishments of the city, located principally on Broadway and Main Streets. The overflow would spread out on the flatlands beyond Bryant Street. A standard project flood would cover an area greater than any historical flood. A major portion of this increase would be in the area to the west of Main Street, where the waters would spread to about 26th Street. The volume of floodwaters would be insufficient to cause extensive flooding west of this point. The hydraulic aspects of the flood problem on Indian Creek are complex and a flood plain information study is underway to obtain new cross sections and a current analysis of the flood hazard. Based on the standard project flood outline developed for the 1961 survey report on Indian Creek, it was estimated that damage would be sustained by about 770 commercial establishments, including most major retail outlets; 3,310 residences; and most of the railroads serving the city. An area of more than 2,000 acres, mostly in the flat Missouri River flood plain, would be inundated.

24. Urban damages in Council Bluffs result from the combined effect of inundation and excessive sedimentation. Inundation damage, in addition to that caused directly by the floodwaters, includes the loss of business for commercial or business firms, flood fighting, cost of cleaning up the extensive deposits of mud left by the receding waters, and other incidental damages caused by high water. Deposition in the channel downstream from the covered section where the slope flattens abruptly has, at times, decreased the available capacity by as much as 50 percent, materially affecting the flood frequency.

25. There have been no reports of loss of life attributable to floods on Indian Creek, but many narrow escapes have been reported. A flood of standard project flood magnitude would, however, result in a serious disaster. The sudden wave of water that would funnel through a heavily developed business and residential area would probably cause loss of life.

AVERAGE ANNUAL DAMAGES

26. Average annual flood damages were estimated using the flood plain simulator and recent surveys of economic development, current hydrology, and hydraulic profiles; it was assumed that the new shopping center on Broadway was in place. A sensitivity analysis was run using assumed channel capacities of 3,500 c.f.s., 4,800 c.f.s., and 6,000 c.f.s. for the reach downstream from the conduit entrance. This is a reflection of uncertainties in sedimentation, channel maintenance, channel conditions, and hydraulic factors. Average annual flood damages are presented in table D2-3.

Table D2-3
Average Annual Flood Damages
Indian Creek

	3,500 c.f.s.	4,800 c.f.s.	6,000 c.f.s.
Residential	$ 446,956	$287,607	$190,244
Shopping Center	471,572	319,896	222,107
Commercial	477,188	308,816	215,336
Warehousing	2,615	1,946	1,475
Manufacturing	317	57	0
Transportation	36,191	22,981	15,262
Recreation	220	131	89
Agriculture	14	6	3
Total	$1,435,073	$941,440	$644,516

Other Problems and Needs

27. The soils in the basin are loess, which is a windblown silt. The steep slopes, rapid permeability, and low clay content of most of these soils make them susceptible to severe erosion. The Soil Conservation Service estimated sediment production from the basin north of the Council Bluffs city limits at about 84 acre-feet per year. This results from both gully and sheet erosion.

28. Numerous laterals of large gullies in the basin are advancing into upstream areas. The gullies range from 20 to 60 feet in depth and from 40 to 200 feet in width. Gully erosion causes damage to some areas and isolation of other areas, these areas cannot be

profitably farmed. Average annual rates of land damage and land depreciation were estimated to be 11.6 acres and 11.1 acres, respectively. With the SCS watershed project fully installed, the rate of loss to gully erosion is expected to be reduced from about 23 acres per year to approximately 2 acres per year. Continuation of sheet erosion also brings about a gradual decline in farm productivity. The rate of sheet erosion over the entire upstream portion of the basin was estimated at 14 tons per acre per year. Sheet erosion will be reduced about 45 percent by land treatment measures. Channel slopes upstream from Council Bluffs are sufficient to keep the sediment load moving, but the reduced velocities through the city and on overbank areas can cause heavy sediment deposition loads in the downstream reaches during floods. This aggravates the flood problem and reduces the channel capacity. Occasional channel cleanouts have been necessary because of sediment. The channel slope downstream from the covered section of the channel approximates 2.9 feet per mile, which compares to an average upstream slope of 21.5 feet per mile. Despite the fact that the channel through the heart of the city is lined, the water-carrying capacity during past floods has varied depending upon the sedimentation and maintenance. The Soil Conservation Service projects would substantially reduce sediment. The Corps of Engineers' deauthorized dam would also help to reduce the sediment load.

29. During floods, drainage problems occur due to sewer backup and overland runoff in the reach of the Indian Creek channel located in the flat Missouri River flood plain.

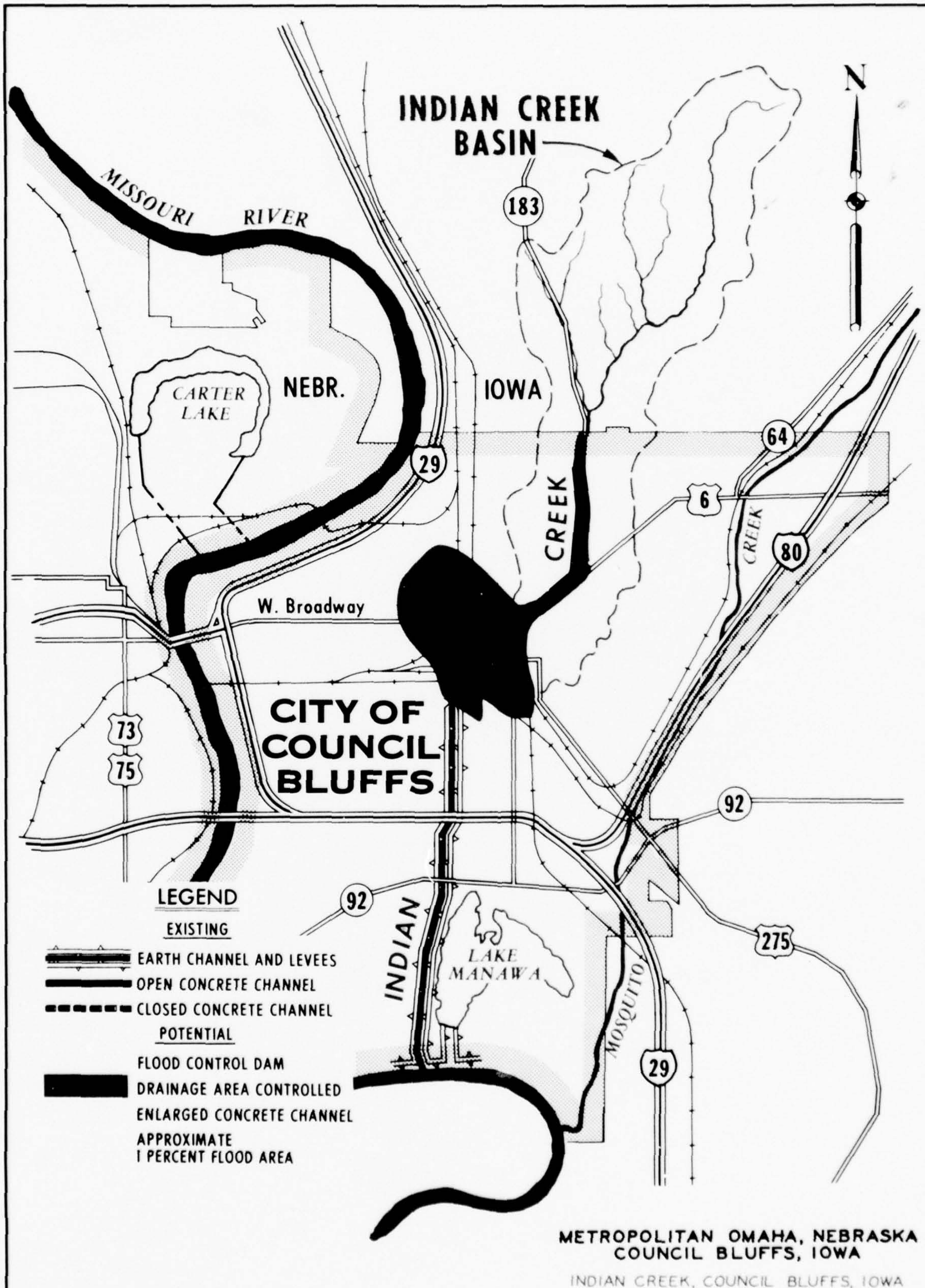
Improvements Desired

30. A public meeting was held in Council Bluffs on 1 October 1947. Farmers in the upstream portion of the basin cited losses due to gully and soil erosion and expressed strong support for soil conservation measures. It was the general consensus of those present that the existing channel was inadequate to accommodate both floodflows and the heavy silt loads of the stream and that it would be desirable to keep the water and silt from entering the city by means of a diversion or detention project. The city of Council Bluffs presented a report prepared by its consulting engineers; the report recommended investigation of a tube to divert the floodflows from the creek into the Missouri River north of the city limits and consideration of small detention reservoirs in the upstream portion of the basin. The construction of a tunnel was recommended because most of the silt and a large portion of the floodwaters originate outside of and upstream from the city. Considerable emphasis was placed on the city's problem in trying to keep silt out of the channel.

31. A meeting was held on 19 September 1955 with members of the Council Bluffs City Council, the City Attorney, the Board of the Chamber of Commerce, and others to explore ways to reactivate the Indian Creek investigation. As a result of this meeting, the study was reactivated. The restudy resulted in the Corps of Engineers recommending that a large detention reservoir be constructed on Indian Creek. On 21 November 1959, at a meeting with the City Manager and City Council and other interested parties, the Corps of Engineers' proposed improvements were presented. Those

present approved of the proposed plan and on 7 December 1959 the City Council adopted a resolution providing the necessary assurances. Another meeting was held on 3 March 1961 to discuss local assurances needed if the project were to be constructed. It was agreed by those present that the 1959 resolution of the Council Bluffs' City Council still reflected the views of local interests. Concurrence of the Council Bluffs' City Council in this conclusion is contained in a City Manager's letter dated 27 March 1961.

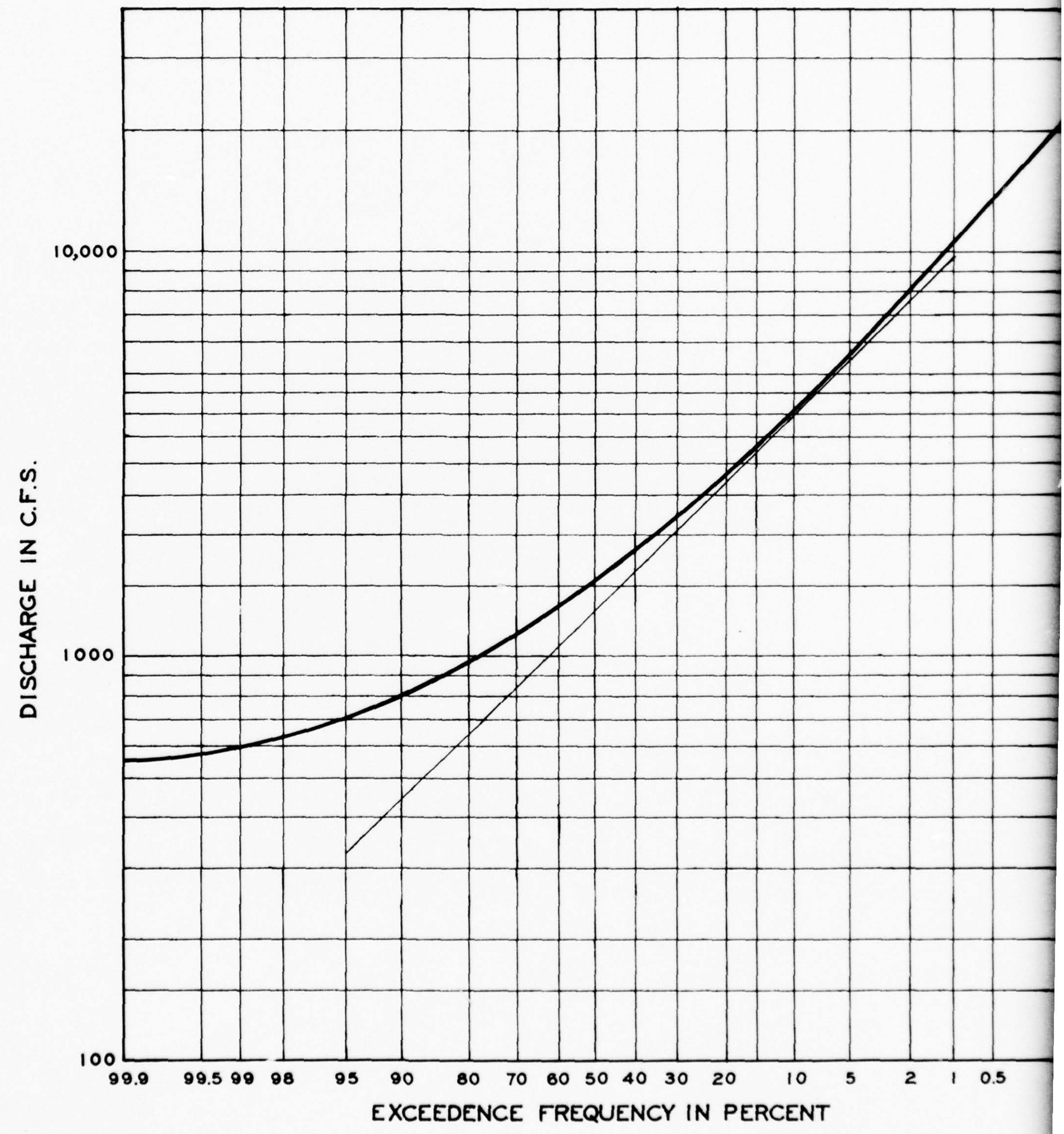
32. On 1 June 1963, the City Council of Council Bluffs again furnished a resolution providing assurances of local cooperation. In November 1965, an election was held on a $1 million bond issue to provide funds for the local share of the construction costs for the large dam. The bond issue was narrowly defeated. Since that time, the large dam project was classified inactive and on 12 December 1973 it was deauthorized.



METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA

INDIAN CREEK, COUNCIL BLUFFS, IOWA
FLOODED AREA

U S ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975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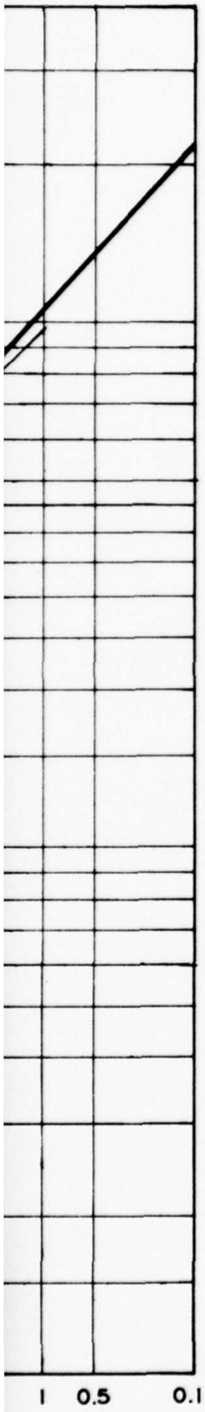


INDIAN CREEK
AT
COUNCIL BLUFFS, IOWA
U.S.G.S. GAGE D. A.-695 SQ. MI.
DISCHARGE FREQUENCY CURVE
EXISTING CONDITIONS

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

JUNE 1975

PART III

FORMULATING A PLAN

1. This section presents a discussion of the possible solutions considered, and the basis for selecting the final plan. In formulating a plan, it was imperative to consider all appropriate alternative plans. Such alternatives were then screened to arrive at the plan that best responds to the problems and needs of the area.

Possible Solutions

2. A wide range of alternatives was considered in the initial stage of formulation. Comparative data for alternatives are

displayed in table D3-1. Flood control benefits only were considered. In view of the likelihood of unfavorable recommendations, detailed studies for recreation benefits were not considered necessary, although recreation is discussed qualitatively. The small size of the drainage area would also require careful consideration of whether a pool could be maintained.

NONSTRUCTURAL MEASURES

FLOOD INSURANCE

3. The flood insurance program provides subsidized low premiums for those people located in participating areas. Insurance does not reduce damages to existing development. Existing property owners in a designated flood hazard area are not required to purchase insurance unless they apply for a loan from a Federally-regulated source to purchase, rebuild, or repair a building that is located in the flood plain. The total cost of flood insurance includes the costs of the average annual flood damages, the cost of administering the program, and actuarial costs. Therefore, the cost of insurance exceeds the benefits that could be derived by the amount of the actuarial and administrative costs.

ZONING

4. Zoning is a legal measure that State, county, or local governmental agencies could implement and enforce to effectively reduce the future flood damage potential of an area; zoning should be in accordance with a planned program of development and land use. Zoning ordinances should designate the channel and a floodway which would be required for the passage of floodwater, in accordance with the degree of flood protection desired. Ponding areas for floodwaters could also be developed, provided that

Table D3-1
Comparative Data for Alternatives*

Alternative	Investment	Annual Flood Control Benefits	Benefit Cost Ratio	% Flood Damage Reduction	Land Required Acre	Relocations Residential Units
Large Dam	$ 13,600,000	$816,000	0.95	87	1,013	129
Large Dam and 1% Channel	21,100,000	888,000	0.7	94	1,021	129
10 Small Dams	10,600,000	595,000	0.8	63	1,365	35
4 Small Dams	6,700,000	595,000	1.3	63	1,007	22
4 Small Dams and 1% Channel	23,200,000	881,000	0.6	94	1,015	3
1% Channel	25,300,000	838,000	0.5	89	8	13
Diversion	19,800,000	816,000	0.6	87	641	116
Evacuation	216,000,000	885,000	0.1	94	1,118	1,267
Flood Proofing	17,600,000	671,000	0.6	71	None	None
Flood Plain Management	No initial cost	109,000	0.8	12	None	None

*Sensitivity analyses were made based on assumed "no project" channel capacities of 3,500 c.f.s., 4,800 c.f.s. and 6,000 c.f.s. Above data are for 4,800 c.f.s.

adequate measures were taken to insure that no additional flooding or damages occur elsewhere as a result of these ponding areas. Limiting elevations should be established, below which development would not be permitted. A "fringe" area is an area in the flood area, but outside the floodway. It is the area which, if completely obstructed would not raise the 100-year flood level by more than 1 foot. The "fringe" areas outside of the floodway could be zoned for different types of development such as residential, commercial, agricultural, recreational, or open space if such developments are floodproofed above the 100-year flood. Zoning measures insure the safekeeping of property for the health, welfare, and safety of the general public.

5. The Corps of Engineers is currently conducting studies which will result in a flood plain information report for the city of Council Bluffs. This would enable the city to accurately define the flood hazard area for zoning purposes. The area subject to flooding is already highly developed, however, and zoning regulations would only change the nature of future development.

FLOOD PROOFING

6. Flood proofing is employed primarily for the reduction or elimination of flood damages to existing structures. Flood proofing includes but is not limited to:

- Raising existing buildings;

- Providing individual dikes around existing structures;

- Providing permanent or temporary watertight covers for all openings;

- Protecting roads and utilities; and

- Anchoring floatable structures and facilities.

7. Flood proofing of the many existing structures could require any of the above-mentioned steps to provide adequate protection against possible damage. Present flood insurance program regulations require protection against damage to an elevation 1 foot above the 1-percent flood in those areas where new construction is permitted. Studies indicate that complete flood proofing would have marginal feasibility at best. Due to the very short time of flood warning, permanent-type measures would be needed. Flood proofing would not protect bridges or utilities. In addition, flood proofing could create problems with financial responsibility and convenience of access and might also be socially and esthetically objectionable. Existing development would not be required to flood proof under flood insurance program regulations. Flood proofing future developments would be the financial responsibility of individuals who build in the flood plain.

FLOOD FORECASTING

8. Information on impending floods, disseminated by local civil defense and law enforcement agencies, newspapers, and radio and television stations, could also be used to reduce flood damages. To be effective, flood forecasting should be combined with local plans for temporary evacuation and flood proofing. In view of the very short peaking time, 1 to 2 hours on Indian Creek, little property could be evacuated from the flood area. It is also doubtful that the hazard to human life in this area could be eliminated by flood forecasting.

EVACUATION

9. Permanent evacuation of the 1-percent flood plain area would greatly reduce the flood damage potential. Such a measure could involve removal of all buildings and property in the flood plain. Lands acquired in this manner could be used for parks or other purposes that would not interfere with floodflows or result in material damage from floods. The flood plain in Council Bluffs, however, occupies the core area of the city and is highly developed. Acquisition and removal of about 1,200 residences and 300 commercial and apartment buildings would be necessary. The cost of buildings and land and relocation expenses is estimated to be in excess of $200,000,000. From a flood control standpoint, evacuation is infeasible by a wide margin.

NO ACTION

10. It is assumed that the flood insurance program would be adopted with attendant regulations. Owners of existing development under present regulations would not be required to purchase flood insurance or to flood proof. Most of the Council Bluffs flood area appears to be in a "fringe" area where new development can be built at any elevation. If new development is not flood proofed, the owners would be required to purchase flood insurance and to pay the higher unsubsidized actuarial rate. Therefore, it is assumed that new development would be flood proofed and would not be damaged by the 1-percent flood. The effect of flood insurance under this assumption would be to encourage "long-range" flood proofing. For benefit analysis, it was assumed that the overall value of new development would be similar to existing development, discounting inflation. As each existing development is replaced in the future, the new development would be flood proofed. At the end of the next 100-year period, all existing

development would be flood proofed. The average annual cost of this alternative is estimated at $145,000 and has benefit-cost ratios ranging from 0.4 to 1 to 1.3 to 1, depending on the Indian Creek channel capacity that is assumed. The relative effectiveness of this alternative is low. Discounted over a 100-year economic life, flood damages would be reduced by 10 to 14 percent, compared with a 60- to 90-percent reduction when structural measures are used. The no action alternative assumes only flood proofing to the 1-percent flood elevation to eliminate the requirement for flood insurance. Any purchase of flood insurance (mandatory or voluntary) would produce added costs without added benefits at the National level.

STRUCTURAL MEASURES

LARGE DAM

11. A large dam and dry reservoir on Indian Creek just north of the Council Bluffs city limits, shown on plate D3-1 was considered. The dam would be capable of storing the maximum probable flood and would control 7 of the 10 square miles of hilly area that contributes to flood peaks. The cost of the dam and dry reservoir was estimated at more than $13,000,000. This project and all other projects were evaluated using a sensitivity analysis of varying channel capacities. This was accomplished because of the history of sedimentation and consequent variations in channel conditions and to take into account the hydraulic complexities of flood routing in the Indian Creek flood area. In the reaches through the highly developed portion of the city, channel capacities of 3,500 c.f.s., 4,800 c.f.s., and 6,000 c.f.s. were assumed. The benefit-cost ratios were 1.4 to 1, 0.99 to 1, and 0.7 to 1, respectively.

SMALL DAMS

12. A system of 10 small dams in the upstream portions of the basin, located approximately coincident with authorized Soil Conservation Service structures, was also considered. This system is shown on plate D3-2. These dams would control 5.4 square miles of the 10-square mile hill area. These dams were located upstream from the large damsite to avoid most of the relocations that would be needed with the large dam. They would store the standard project flood and the maximum probable flood. Because the flood storage needed was much less than the site capacities, the dams were designed with perched spillways and earthwork balance. The total estimated cost would be about $22,000,000.

13. Since the site capacities were not used, some of the upstream dams might be considered superfluous. A system of the four small dams located farther downstream was also investigated. This system is shown on plate D3-3. These dams would control the same drainage area at an estimated cost of about $10,600,000 and would still provide the same degree of flood protection as the 10-dam system.

14. Because of the excessive site capacity and the large volume of earthwork required, even with an earthwork balance design, lower dam embankments were considered. These would store the standard project and maximum probable floods without a spillway. Dams designed in this manner should cost the least of any dam system studied. Using this criteria, costs for a 10-dam and 4-dam system would be $10,600,000 and $6,700,000. Benefit-cost ratios for the 10-dam and 4-dam systems with perched spillways and the 10-dam and 4-dam systems without spillways, assuming 4,800 c.f.s. downstream channel capacity, are 0.4 to 1, 0.9 to 1, 0.8 to 1, and 1.3 to 1, respectively.

CHANNEL IMPROVEMENTS

15. A channel that would provide 100-year protection to Council Bluffs was investigated. A route along the existing channel appeared to offer the least amount of relocation and disruption. The channel would extend about 21,500 feet from the north city limits to 16th Avenue South. The existing concrete channel would be removed and replaced with an enlarged concrete channel. About 38 bridge crossings would be affected by the enlarged channel. Some enlargement of the earth channel and levee outlet to the Missouri River south of the city would also be necessary. A portion of the channel through the central business district would be placed underground. The estimated cost would be more than $25,000,000; benefit-cost ratios, corresponding to the assumed existing channel capacities of 3,500 c.f.s., 4,800 c.f.s., and 6,000 c.f.s., are 0.9 to 1, 0.6 to 1, and 0.4 to 1, respectively.

LEVEES

16. Levees would require more land area than channel improvements. The congestion of buildings and street and railroad crossings would require major disruptive relocations. To get past the new shopping center, the right-of-way of one of the only two streets bypassing the center would be required. The part of the channel through the built-up business district is covered. In view of the above, levees were not considered further.

DIVERSION

17. The most suitable diversion route appears to be westward to the Missouri River beginning from a diversion dam north of the city limits at the same location as the large dam. The dam embankment for the diversion would be lower than the large dam embankment; however, a large earth-cut diversion channel or spillway would be required through the ridge to the west of the channel.

A concrete drop structure would be located at the bluffline to reduce the discharge velocities entering the outlet channel that would cross the Missouri River flood plain. Several new bridges would be needed, including a crossing under Interstate 29. The estimated cost would be about $20,000,000 with benefit-cost ratios of 0.95 to 1, 0.7 to 1, and 0.5 to 1, depending on what the existing channel capacity was assumed to carry.

RESERVOIR AND CHANNEL COMBINATIONS

18. Combinations of the dams with a 100-year channel were evaluated. With the large dam in place, the concrete channel enlargement would begin in the vicinity of 11th Street and Broadway and extend about 6,200 feet along the existing Indian Creek alignment to 16th Avenue South, as shown on plate D3-4; 18 bridges would be affected. The underground portion of the channel and the adjacent buildings would not be affected by this project. The combined cost is estimated at about $21,000,000, with benefit-cost ratios of 1.08 to 1, 0.7 to 1, and 0.5 to 1 depending on the assumed existing channel capacity.

19. With the small dam systems, the channel enlargement would extend about 12,900 feet from Frank Street to 16th Avenue South and 24 bridges would be affected. This project would include the covered conduit portion of the channel through the business district. Estimated combined costs would range from $23,000,000 to $39,000,000 depending on the small dam system used. The 4-dam system with perched spillways, would have benefit-cost ratios of 0.8 to 1, 0.5 to 1, and 0.4 to 1. The 4-dam system without spillways would have benefit-cost ratios of 0.96 to 1, 0.6 to 1, and 0.4 to 1.

COMPARISON OF ALTERNATIVES

20. The responsiveness to stated problems and needs, conformity to the formulation criteria, and comparison with other possible solutions were considered in evaluating the alternatives.

21. Nonstructural measures, such as flood insurance and zoning, would affect future development but would not reduce damages to the many improvements in the flood plain. There would not be sufficient warning time for effective flood forecasting or temporary evacuation. Permanent evacuation of the flood area is very costly. Flood proofing would have marginal feasibility and would be socially and esthetically objectionable. In addition, flood proofing would create problems of financial implementation and inconvenience of physical access.

22. Some observations with regard to structural measures are:

- Levees are undesirable due to disruptive relocations and because the channel in partially enclosed.

- The small dams and the large dam have the lowest first cost.

- The small dams do not reduce the 1-percent discharge enough to sufficiently reduce the combined costs of the small dams plus a 1-percent channel.

- The 4-dam system is more economical than the 10-dam system.

- The 4 small dams combined with a 1-percent channel would provide 1-percent flood protection and eliminate the costs associated with flood plain regulation.

- The greatest number of permanent relocations would result from the large dam; the diversion project would necessitate the next greatest number of relocations.

- The least number of permanent relocations would result from the 1-percent channel, but this project would have a high cost and the greatest temporary disruption during construction.

- All of the structural projects would provide a substantial reduction in flood damages. The reduction would range from more than 60 percent for the small dams to more than 90 percent for the large dam combined with a 1-percent channel downstream.

- All of the structural projects would require local cooperation.

- The dams and the diversion project would have a beneficial effect on wildlife and the environment by restricting development in the project area.

- The 1-percent channel and the nonstructural alternatives do not provide recreation or preserve open space.

- The channel projects would be located in an urbanized area with an existing lined channel, and they would have little effect on the natural environment.

23. The small 4-dam system and the large dam appear to be the most economically feasible projects. If benefits increase or costs decrease during more refined studies, the large dam combined with a 1-percent channel, or the diversion project appear to be the next most feasible projects. The structural alternatives all require local cooperation. Of the nonstructural alternatives, flood plain management appears to be the most feasible. This is considered to be the "no action" alternative. The large dam was authorized by the Flood Control Act of 1962 but was deauthorized in 1973 because local cooperation could not be obtained. Without local cooperation, the no action alternative would have to be recommended.

24. The projects most favorable for further consideration are the 4-dam system, the large dam, and the no action alternative.

Alternatives Considered Further

25. The alternative plans selected for further study were compared and evaluated in accordance with the principles and standards as promulgated by ER 1105-2-200. Each alternative was compared with respect to its contribution to the planning objectives, its relationship to national economic development, environmental quality, social well-being, and regional development accounts; its response to associated evaluation criteria; and implementation responsibilities.

DESCRIPTIONS

26. The three plans selected for further evaluation are listed in tables D3-2 and D3-3. They include a single dam, four small dams, and flood plain management.

CONTRIBUTIONS TO PLANNING OBJECTIVES

27. The planning objectives for this area are:

- To minimize damages caused by floods;

- To reduce the current deficit in outdoor recreation opportunities; and

- To improve water quality.

FLOOD CONTROL

28. The structural alternatives considered would achieve substantial flood damage reduction. The flood plain management plan with assumed long-range flood proofing would provide a reduction of only 12 percent over the 100-year economic life. This is because the benefits occur in the future and are discounted to present worth. The relative efficiency of the alternatives in meeting the flood control objective is shown in table D3-2. Monetary flood damage reduction benefits can be found in table D3-3.

RECREATION

29. The primary contribution of each alternative to the recreation potential of the area was considered to be the amount of open space preserved or made available for outdoor recreation

Table D3-2
Summary Comparison of Alternative Plans

Item	Large Dam	4 Small Dams	Flood Plain Management
A. Plan Description	Dam and reservoir at site of deauthorized Indian Creek Dam and Reservoir	System of 4 small dams upstream from Council Bluffs	Adoption of regulations consistent with Flood Insurance Program
B. Significant Impacts Specified in Section 122 of P.L. 91-611	See Paragraph Page	See Paragraph Page	See Paragraph Page
C. Plan Evaluation			
1. By Planning Objectives			
a. Minimize flood damages (% reduction)	87	63	12
b. Reduce outdoor recreation opportunity deficit. (Acres recreation available)	992	935	0
c. Improve water quality (Indian Creek)	Minor sediment reduction	Same as 1-A	0
2. By National Accounts			
a. NED Net benefits	$42,000	$178,000	-$37,000
b. EQ-Open space preserved (net acres)	992	935	0

Table D3-2
Summary Comparison of Alternative Plans
(cont'd)

Item	Large Dam	4 Small Dams	Flood Plain Management
c. SWB			
(1) Residences protected from 100-yr. flood	893	577	0 short term 1,267 long term
(2) Residences displaced	129	22	0 (Future buildings flood proofed)
d. RD			
(1) Acres protected from 100-yr. flood-available for higher economic use	788	509	0
(2) Acres removed from local tax rolls	1,013	1,007	0
3. By Associated Evaluation Criteria			
a. Acceptability	See Paragraph Page	See Paragraph Page	See Paragraph Page
b. Sensitivity	See Paragraph Page	See Paragraph Page	See Paragraph Page
c. Effectiveness (Probability of flooding in central area of city)	40 to 110 yr.	20 to 40 yr.	No immediate protection Long term up to 100 yr.

Table D3-2
Summary Comparison of Alternative Plans
(cont'd)

Item	Large Dam	4 Small Dams	Flood Plain Management
d. NED Benefit-Cost ratio	1.05	1.4	0.8
e. Geographic scope	See Paragraph Page	See Paragraph Page	See Paragraph Page
D. Implementation Responsibility			
1. Congress and authorization required	**Yes**	**Yes**	**No**
2. Cost Sharing (annual)			
a. Capital costs ($1,000)			
Federal	417.5	206.5	0
Non-Federal	417.5	206.5	146
b. OM&R ($1,000)			
Federal	0	0	0
Non-Federal	25	50	0

Table D3-3
System of Accounts

Accounts	Footnotes	Large Dam	4 Small Dams	Flood Plain Management
1. National Economic Development				
a. Beneficial Impacts ($1,000)				
(1) Value of increased output of goods and services: Flood control	1,5,7,9	816	595	109
(2) Value of output from use of unemployed or underemployed resources in construction or installation:	1,4,7,10	86	46	0
(3) Total NED Benefits		902	641	109
b. Adverse Impacts ($1,000)				
(1) Project costs	1,5,7,9	860	463	146
(2) Net NED Benefits ($1,000)		42	178	-37
c. B/C Ratio		1.05	1.4	0.8
2. Environmental Quality				
a. Environmental Quality Enhanced: Creation of permanent open space (acres)	1,5,7,9	992	935	0
b. Environmental Quality Destroyed or Degraded: Acres in construction	1,5,7,9	21	72	0

Table D3-3
System of Accounts
(cont'd)

Accounts	Footnotes	Large Dam	4 Small Dams	Flood Plain Management
3. Social Well-Being				
a. Beneficial Impacts				
(1) Enhancement of health, safety, and community well-being: Number of families protected from 100-year flood	1,5,7,9	893	577	0 short term 1,267 long term
(2) Increases in equity of distribution of real income: Reduced average annual damages ($1,000)	3,5,7,9	816	595	109
(3) Educational, cultural, and recreational opportunities: Creation of permanent open space (acres)	2,5,8,9	992	935	0
b. Adverse Impacts				
(1) Deterioration in quality of life, health, and safety: Residual families in 100-yr. flood plain	1,5,7,9	374	690	1,267 short term 0 long term
(2) Injurious displacement of people and community disruption: Displaced families	1,5,7,9	129	22	Numerous building alterations

Table D3-3
System of Accounts
(cont'd)

Accounts	Footnotes	Large Dam	4 Small Dams	Flood Plain Management
4. Regional Development				
a. Beneficial Impacts				
(1) Value of increased income				
Net flood control benefits (annual):				
Flood plain		$816,000	$595,000	$ -37,000
Region		-356,500	-210,500	0
Nation		-417,500	-206,500	0
Total		$ 42,000	$178,000	$ -37,000
(2) Quantity of increased employment				
Jobs created during construction (man-yr.)		453	224	None immediately. Spread over 100-yr. project life
Permanent jobs created for operation and maintenance		2	3	0
(3) Acres in urban area protected from 100-yr. flood and available for higher economic life		788	509	0
b. Adverse Impacts				
Acres removed from local tax rolls		1,013	1,007	0

Table D3-3
System of Accounts
(cont'd)

Index of Footnotes:

Timing

1. Impact is expected to occur prior to or during implementation of the plan.
2. Impact is expected within 15 years following plan implementation.
3. Impact is expected in a longer time frame (15 or more years following implementation).

Uncertainty

4. The uncertainty associated with the impact is 50% or more.
5. The uncertainty is between 10% and 50%.
6. The uncertainty is less than 10%.

Exclusivity

7. Overlapping entry; fully monetized in NED account.
8. Overlapping entry; not fully monetized in NED account.

Actuality

9. Impact will occur with implementation.
10. Impact will occur only when specific additional actions are carried out during implementation.
11. Impact will not occur because necessary additional actions are lacking.

purposes. Cost estimates were based on dry dams with flood control benefits only. Detailed recreation studies were not made due to the preliminary level of the studies and the lack of local interest. The large dam and the 4-dam system would provide more than 900 acres each. The flood plain management alternative would not create significant outdoor recreation opportunities. The relative performance of these alternatives can be seen in table D3-2. Recreation is an opportunity that could be realized if a feasible project were recommended and a sponsor found.

WATER QUALITY

30. The two alternatives involving detention dams would produce minor water quality benefits on Indian Creek by withholding the amount of sediment that would be stored in the sediment pool. The flood plain management alternative would not benefit water quality. The average discharge of Indian Creek for 20 years of gaging records is only 1.62 c.f.s. and the stream is not readily accessible to the public.

RELATIONSHIP TO NATIONAL ACCOUNTS

31. Beneficial and adverse effects of each alternative are evaluated in four National accounts: National Economic Development (NED), Environmental Quality (EQ), Social Well-Being (SWB), and Regional Development (RD). The impacts are briefly summarized in table D3-2 and displayed in detail in table D3-3.

NATIONAL ECONOMIC DEVELOPMENT

32. The NED account is a measure of the value of change in the output of goods and services and in national economic efficiency. The changes considered are those due to the effect of each alternative.

33. Beneficial effects are the: (1) value of increased output of goods and services resulting from reduced flood damages; and (2) value of output from the use of unemployed labor in construction.

34. National efficiency is increased through the use of labor in construction which would otherwise be unemployed. Labor was assumed to account for one-half of the project costs. It was also assumed that 20 percent of the labor costs would go to those otherwise unemployed.

35. Adverse effects in the NED account include the total annual cost. The project costs were computed from recent unit prices for construction items or relocation of improvements.

36. Net NED benefits are the total monetary benefits minus the total monetary costs. All benefit and cost figures displayed in table D3-2 and table D3-3 were discounted at an interest rate of 6 1/8 percent and a 100-year economic life.

THE NED PLAN

37. Since national economic development is one of the two national water resources planning objectives, selection of an NED plan is required. The NED plan should be selected on the basis of maximum net NED benefits and the maximum benefit-to-cost ratio.

From the tables, it can be seen that the 4-dam system would provide the maximum net benefits and has a benefit-cost ratio of 1.4 to 1, followed by the large dam, which has a benefit-cost ratio of 1.05 to 1. It should be noted that if recreation were included, the benefit-cost ratio for some of the alternatives, including those previously eliminated, would be increased. Recreation development near a metropolitan area usually returns benefits in excess of costs.

38. The 4-dam system is the preferred NED plan with the large dam being the second choice.

ENVIRONMENTAL QUALITY

39. Beneficial effects on the environmental quality (EQ) account are contributions resulting from the management, preservation, or restoration of one or more of the environmental characteristics of the area. Due to the proximity to the urban area, the creation of open space is considered a beneficial effect. With residences and farms removed, this open space would become available for wildlife habitat and would support a number of game and nongame birds and animals. The open space also creates a greenbelt for urbanization.

40. Adverse EQ effects are consequences of the alternatives that result in the deterioration of environmental characteristics. A primary indicator of this effect was considered to be the amount of land required for actual construction of the project. While the areas would be restored, a temporary disruption of the environment would take place. These EQ effects are noted in tables D3-2 and D3-3.

THE EQ PLAN

41. Environmental quality is one of the two coequal objectives of National water resources planning, and formulation of an alternative which emphasizes the contributions to this objective is required. The area of open space preserved was considered to be the most important indicator of contributions to environmental quality.

42. The large dam and the four small dams would contribute 992 and 935 acres of open space, respectively. The open space provided by the large dam would be situated closer to the urbanized area and would be concentrated in a larger block. No open space would be preserved by flood plain management.

43. In view of the foregoing, it appears that the large dam and 4-dam system can be considered as the EQ plans with little preference between them at this stage of analysis.

SOCIAL WELL-BEING

44. The social well-being (SWB) account table displays the significant adverse and beneficial impacts. The SWB account measures a set of "wants" satisfied by the alternatives. The recipient in the account is a household, the structure owner, or the structure renter in the Indian Creek basin. They would receive beneficial or adverse effects from the alternatives.

45. The beneficial SWB impacts are (1) the enhancement of health, safety, and community well-being, (2) an increase in the equity of distribution of real income, and (3) educational, cultural, and recreational opportunities.

46. The first beneficial impact is the enhancement of health, safety, and community well-being as measured by the number of families protected from the 100-year flood; that is, the number of homes in the area from which the 100-year flood hazard would be removed. This is related to the reduction in potential flood area. No homes would be protected initially by flood plain management, although over a period of 100 years, buildings would be flood proofed as they are replaced. Under the flood plain management assumption, all buildings in the flood plain would eventually be protected against a 100-year flood, although the flood areas would not be reduced.

47. The second beneficial impact is an increase in the equity of distribution of real income, which is assumed to be the reduction of average annual damages. The reduction in damages would be, in part, income to families and businesses in the flood plain. The families in the flood plain are primarily low income, therefore, this reduction becomes significant. These people are least able to absorb the economic losses incurred in a flood. Due to their low income, residents in the flood plain would have difficulties in locating acceptable housing within their affordable price range elsewhere.

48. The third beneficial impact is educational, cultural, and recreational opportunities. The metropolitan area has been found to be deficient with regard to recreational lands and opportunities. Under the single-dam and 4-dam alternatives, the government would purchase a certain number of acres. This land would remain permanent open space in an area undergoing urbanization and would be available for recreation use. No open space would be preserved by the flood plain management alternative.

49. Adverse SWB impacts are (1) deterioration in the quality of life, health, and safety, and (2) injurious displacement of people and community disruption.

50. The first adverse impact, deterioration of quality of life, health, and safety, is indicated by the residual families in the 100-year flood plain. These families would still be flooded by the 100-year flood remaining under each alternative. This is significant in the sense that if flood control were provided, the people in the flood plain would feel secure from most floods. Those people who would still be subject to the 100-year flood would have a false sense of security.

51. The second adverse impact, injurious displacement of people and community disruption, is indicated by the number of families that would be displaced by each alternative. Displacement is more injurious for the poor, elderly, and farm families who have a stronger attachment to their place of residence. Generally, the people of the Indian Creek basin have lower incomes and are older than the population of the Omaha-Council Bluffs SMSA.

52. Much of the land that would be taken for the alternatives which involve dams is wooded valley bottoms and steep hillsides. The area that would be taken by the large dam also includes suburban residential lots and roads. Only a part of the total lands that might be acquired would be cultivated farmland. In this basin, loss of farmland was not considered a material factor in deciding which alternative is chosen.

REGIONAL DEVELOPMENT

53. The regional development (RD) account displays pertinent beneficial or adverse effects and indicates whether they accrue to the flood plain, the region, or the Nation.

54. Beneficial effects due to flood damage reduction accrue to the flood plain residents.

55. The value of increased employment is regarded as a gain regardless of where it accrues. Estimates indicate the construction of the alternatives would have effects on the local unemployment rate. The structural alternatives would reduce potential flood areas and reduce the area subject to flood plain regulation. This would eliminate some potential costs for flood proofing and would lessen the pressure for locating elsewhere outside the city.

56. Adverse effects include costs and acres removed from local tax rolls. The costs of each alternative are divided in accordance with Federal cost-sharing policies. For a structural local protection project, such as those including dams, channels, or diversion, the non-Federal cooperating entity bears the costs of lands and relocations up to a maximum of 50 percent of the total project cost. For these alternatives, one-half of the investment and amortization charges accrues to the Nation and one-half accrues to the local cooperating body. All operation and maintenance costs are the responsibility of the local entity. Costs of long-term flood proofing would be the responsibility of those people located in the flood plain.

57. Table D3-2 summarizes the regional development account in terms of the local area. Table D3-3 displays a more detailed breakdown of beneficial and adverse effects. Net NED benefits for the flood plain are positive for the alternatives involving dams and negative for flood plain management for the reasons explained above. Net NED benefits for the Nation and the region are negative for all alternatives except flood plain management. Negative numbers for the structural alternatives represent a redistribution of income from the Nation and the local cooperating entity to the flood plain area. If recreation were included, more benefits would accrue to the region and the local cooperating entity.

58. Two employment effects are shown:

• Short-term employment generated in construction of the project. One-half of the construction costs are considered to go to labor. This figure was divided by an assumed average salary to derive the number of jobs generated.

• Long-term employment generated by operation and maintenance. The same method indicated above was used to derive this figure. One-half of the annual operational costs were assumed to go to labor.

RESPONSE TO ASSOCIATED EVALUATION CRITERIA

ACCEPTABILITY

59. All of the structural alternatives are objectionable because of local costs. Comments by city officials indicated that they

felt a bond issue would have little chance of success. Only about 15 persons other than Corps' personnel attended the public meeting held in Council Bluffs on 26 June 1975. Part of the lack of interest may be attributed to the interval of 28 years since the last major flood. Objections were raised to the small dam systems on the grounds that they would interfere with the Soil Conservation Service structures in the Indian Creek basin which are to be completed this year. Some flood plain regulations are already in effect. Flood plain maps of Council Bluffs were issued by the U. S. Department of Interior in 1974. These maps had enlarged the estimated flood plain to include most of the western part of the city. The enlarged outlines were protested.

SENSITIVITY

60. Variations in channel capacities were analyzed due to the history of channel sedimentation. A characteristic of all the alternatives is that the flood control benefits are very sensitive to assumed channel capacities. This is probably a reflection of the relatively shallow depths of flooding over most of the flood plain. Another factor adding to the uncertainty is the hydraulic complexities resulting from a combination of open and covered channels, and also overbank conditions varying from a steep, narrow valley, to a delta formation, to a nearly flat flood plain.

EFFECTIVENESS

61. A comparison of the effectiveness of each plan in reducing the frequency at which flooding begins is shown in table D3-2. The central area of the city refers to the area between the entrance of the covered channel near Frank Street to the end of the concrete channel at 16th Avenue. The greatest protection is provided by the large dam. The lowest degree of protection is provided by

flood plain management, followed by the 4-dam system. Flood plain management provides no immediate protection. Its effectiveness in the future depends on the trends of enforcement and changes in flood plain development. Another measure of effectiveness is the percentage reduction of average annual flood damages. This can be found in table D3-2 under the discussion of planning objectives.

NED BENEFIT-COST RATIO

62. Only flood control and employment benefits were evaluated. If recreation benefits were included, those alternatives offering recreation opportunities would have higher benefit-cost ratios. The 4-dam system had the highest benefit-cost ratio, followed by the large dam with values of 1.4 to 1 and 1.05 to 1 respectively.

GEOGRAPHIC SCOPE

63. The flood control benefits of these alternatives would be essentially localized to the city of Council Bluffs. Recreation benefits could be considered to apply to the metropolitan area. Except for flood plain management, the land required for the projects would lie outside of the city in Pottawattamie County.

IMPLEMENTATION RESPONSIBILITY

64. Cost-sharing for the alternatives is indicated in table D3-2. Recommendation by the Corps of Engineers and authorization by Congress would, however, require that an alternative meet the formulation criteria and be sponsored locally. Without authorization, projects such as flood proofing would be a local responsibility. The cost-sharing policy is discussed in the section on regional development.

SIGNIFICANT IMPACTS SPECIFIED IN SECTION 122 OF P.L. 91-611

ECONOMIC IMPACTS

65. Economic impacts specified are:

Tax revenues

Property values

Public facilities

Public services

Desirable regional growth

Employment/labor force

Business and industrial activity

Displacement of farms

66. The tax revenues lost would be in relation to the acres of land required for each alternative. The lands that would be required are shown in tables D3-2 and D3-3. For the structural alternatives requiring large amounts of land, the areas lost would be outside of the city.

67. Property values in the flood plain would probably increase with the addition of flood protection.

68. Public facilities and services would be benefited by flood control. The principal impact of this can be accounted for in project costs and flood control benefits.

69. The alternatives discussed are not expected to alter the growth rate of the area. The preservation of open space near the urban area, as measured in tables D3-2 and D3-3, should be socially and environmentally desirable.

70. The effects on employment have been tabulated in table D3-3 under regional development.

71. Business and industrial activity would be benefited by a decrease in flood damages and the lessening or elimination of flood plain restrictions. Flood plain management may influence some decisions to locate in the outer parts of the city away from the flood plain in the downtown area.

72. A few farmsteads would be displaced by the alternatives which involve dams. None would be displaced by flood plain management. The discussion of adverse impacts on the social well-being account considers loss of farmland.

ENVIRONMENTAL IMPACTS

73. The environmental impacts listed are:

Man-made resources

Natural resources

Water pollution

Air pollution

74. The only significant effects of the alternatives on man-made and natural resources would include land degraded by construction and materials used in construction. These effects are included in the preceding assessment tables and in the cost estimates.

75. The impact of the alternatives on water quality is found in the discussion of the water quality objective.

76. The alternatives which involve preservation of open space may be slightly beneficial in the sense that open and green space would be preserved near a source of air pollution. The space would assist in atmospheric dispersion. However, the impact of the alternatives on air pollution is not considered material to the decision making process.

SOCIAL IMPACTS

77. The social impacts required for consideration are:

Noise

Displacement of people

Esthetic values

Community cohesion

Desirable community growth

78. All alternatives that involve construction work would generate noise. The dams would be constructed outside the city. The only way to alleviate noise would be not to construct the alternative.

79. The numbers of residential units displaced by each alternative are shown in tables D3-2 and D3-3.

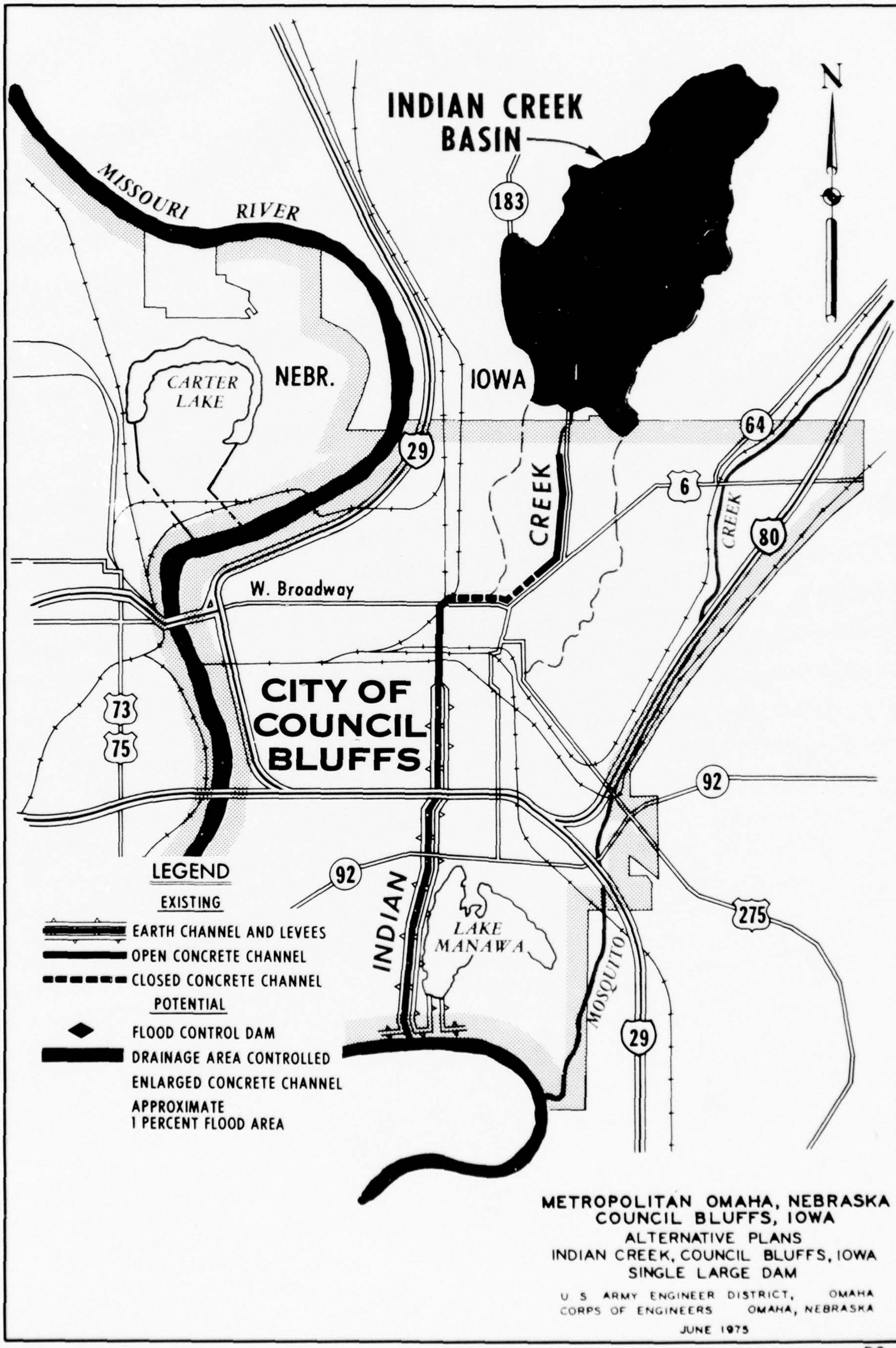
80. The alternatives involving dams would remove existing buildings in the project areas and create and preserve wooded open space near the urban area. This would be esthetically beneficial. In the vicinity of the dams there, would be an artificial appearance due to the embankments. Flood proofing of existing structures would present esthetic problems. Under the flood plain management alternative, it would presumably be easier to provide esthetic design for flood proofing of future structures.

81. The structural alternatives should benefit community cohesion in the sense that flood plain regulations could be reduced or eliminated. Countering this are objections to the local costs involved. Flood plain management, with attendant regulations, would cause a social and economic distinction between the central area of the city and other areas.

82. The impact of alternatives on desirable community growth is discussed previously under economic impacts.

Selecting a Plan

83. With sufficient assurances of local cooperation, more detailed studies could be made of solutions to the Indian Creek flood problem. At this time, the no action alternative of flood plain management and insurance is recommended. Detailed hydrologic and hydraulic studies for flood plain information purposes, under current conditions, have not yet been completed. Implementation of this program would be a local responsibility.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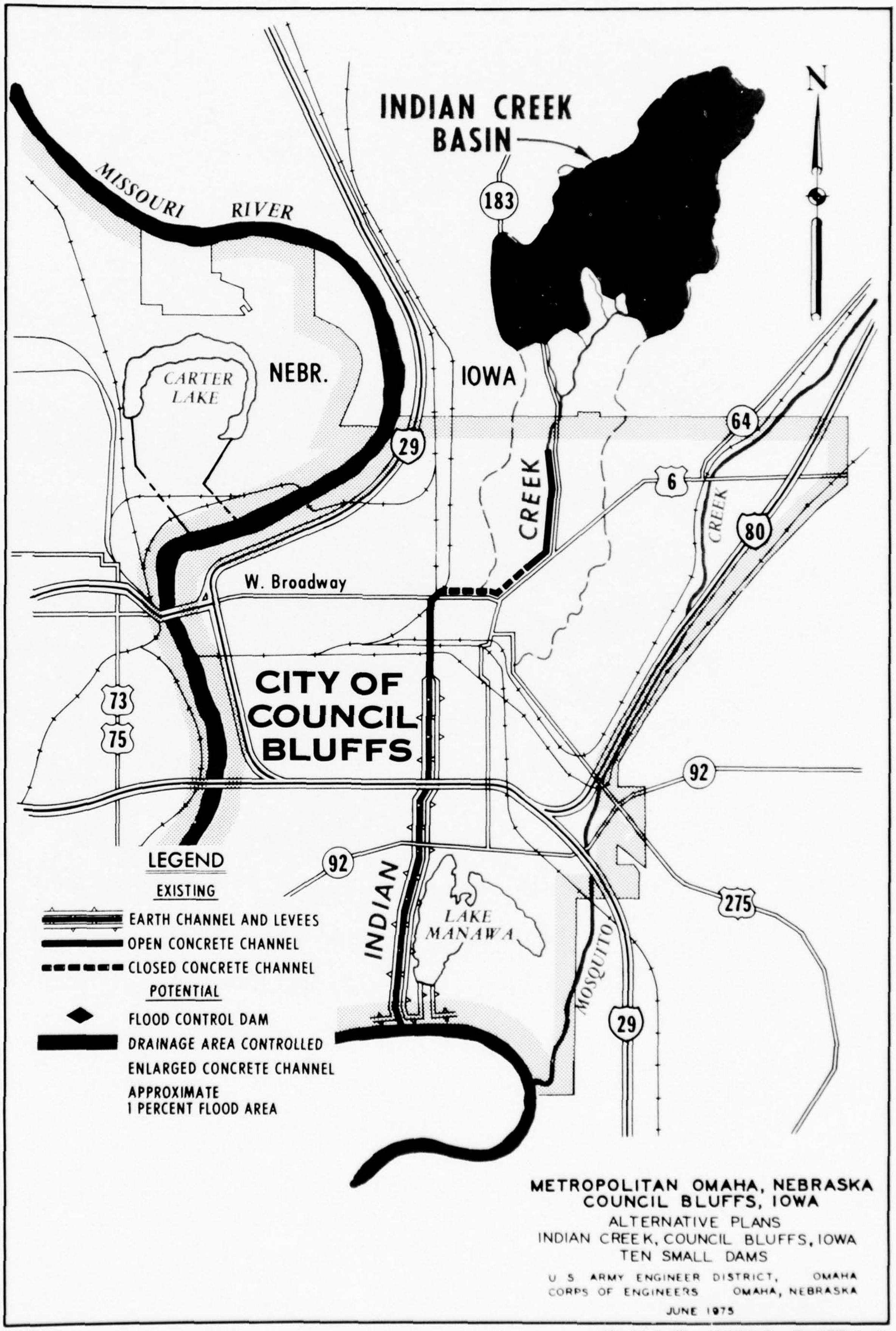
ALTERNATIVE PLANS
INDIAN CREEK, COUNCIL BLUFFS, IOWA
SINGLE LARGE DAM
U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975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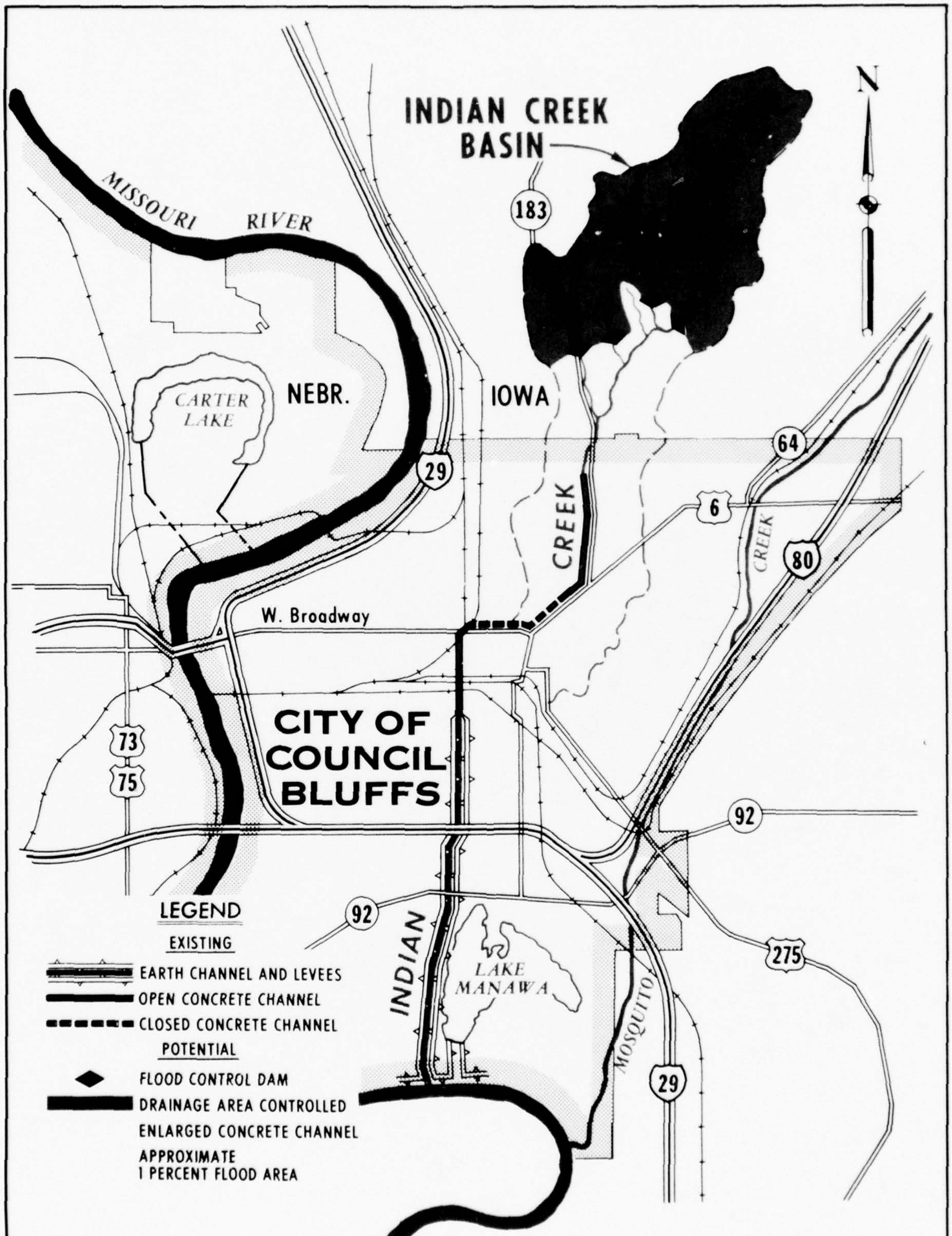
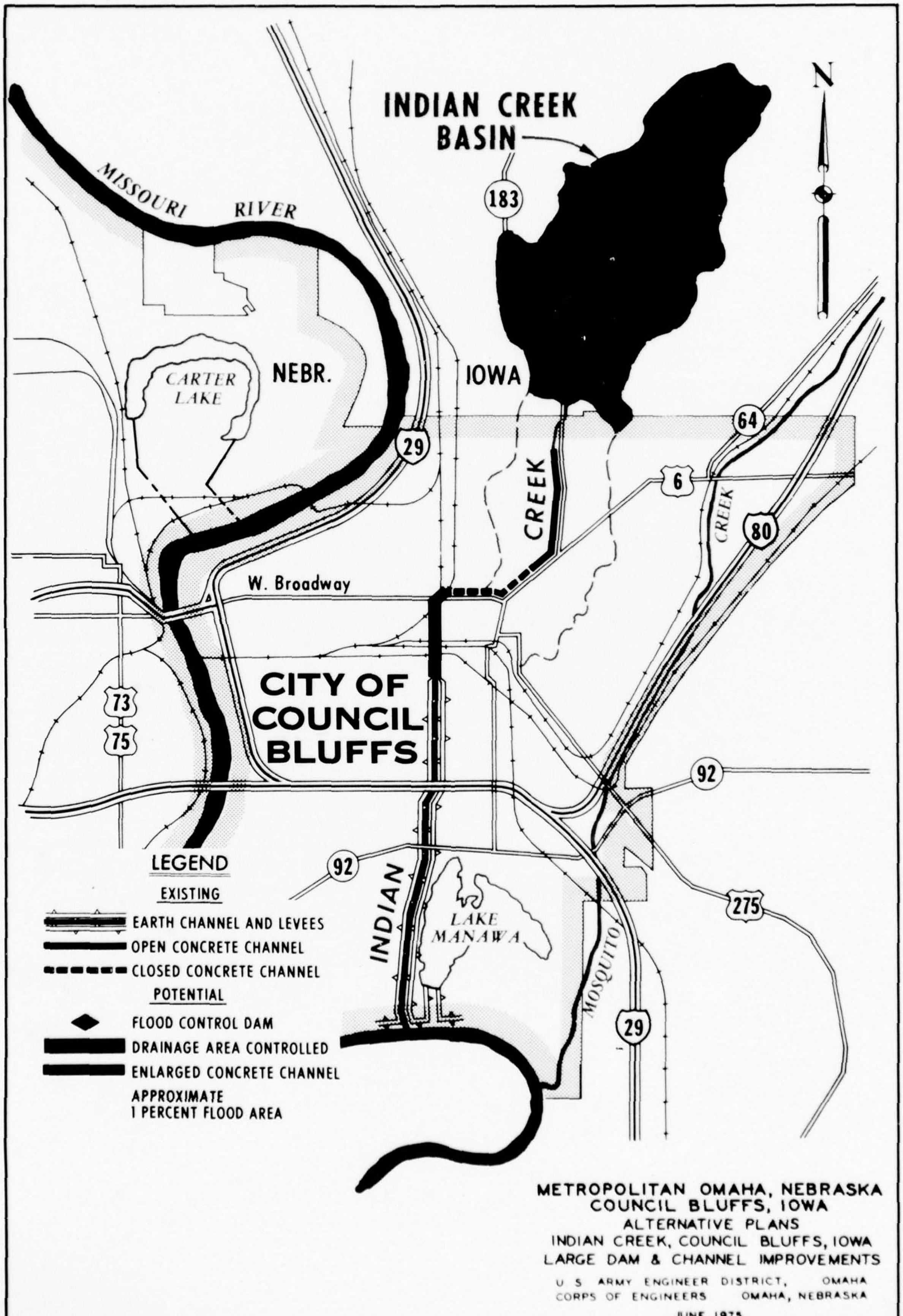


METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
ALTERNATIVE PLANS
INDIAN CREEK, COUNCIL BLUFFS, IOWA
FOUR SMALL DAMS

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

JUNE 1975



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ENLARGED CONCRETE CHANNEL
APPROXIMATE
1 PERCENT FLOOD AREA
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
ALTERNATIVE PLANS
INDIAN CREEK, COUNCIL BLUFFS, IOWA
LARGE DAM & CHANNEL IMPROVEMENTS
U S ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975

SECTION E

PLATTE-ELKHORN RIVER EVALUATION

PLATTE - ELKHORN EVALUATION

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SECTION E

PLATTE-ELKHORN RIVER EVALUATION

PART I

RESOURCES AND ECONOMY OF THE STUDY AREA

1. The reach of the Platte-Elkhorn River basin within the study area begins at the Dodge-Douglas County line for the Platte River and the Washington-Douglas County line for the Elkhorn River. The reach ends at the mouth of the Platte River. This reach bounds the Omaha metropolitan area on the west and south.

Environmental Setting and Natural Resources

BASIN DESCRIPTION

2. The Platte River is a major right-bank tributary of the Missouri River and it has a drainage area that extends 680 miles from the Continental Divide in the Rocky Mountains eastward to the

Missouri River. Within the study area, the principal tributary of the Platte River is the Elkhorn River.

3. The Elkhorn River is a major left-bank tributary of the Platte River; it enters the river about 5 miles upstream from Ashland, Nebraska.

4. The Platte-Elkhorn River study area includes parts of Cass, Douglas, and Sarpy Counties. The study area is primarily agricultural and is devoted to the production of feed grains and to the raising of livestock. The larger communities in the study area provide service to the surrounding rural areas. Omaha serves as the primary wholesale distribution center for the study area and contributes to the industrial potential of the basin. The study area is served by Interstate 80, U. S. Highways 6 and 275, and State Highways 64, 92, 85, and 66. Railroad transportation is provided by the Chicago and North Western Transportation Company, Burlington Northern Inc., and Union Pacific Railroad. Air transportation is provided at Eppley Airfield in Omaha.

HISTORICAL-ARCHEOLOGICAL FEATURES

5. There are no known significant archeological findings in the Platte-Elkhorn River study area. However, there are numerous small, local historical sites scattered throughout the area. Most of these sites represent the early pioneer period of eastern Nebraska.

NATURAL RESOURCES AND ENVIRONMENTAL CHARACTERISTICS

6. The Platte River in the study area averages about 1,900 feet in width. The channel is wide and shallow, with a sandy, unstable bottom

that is relatively devoid of the large holes and undercut banks needed to sustain a large fish population. Where holes do occur, the fish concentrate, but they are mostly nongame species. Fishery composition of the Platte River includes channel catfish, carp, buffalo fish, gizzard shad, carpsuckers, gar, and various minnows. Channel catfish and carp are the most sought-after species. The estimated average standing crop of fish in the Platte River is 75 pounds per acre. About 5 pounds per acre of the fish produced are catchable-sized catfish and carp.

7. The Elkhorn River in the study area averages about 325 feet in width. The Elkhorn River is a relatively productive stream. It has numerous pools and shallow areas; however, the fish population consists mostly of nongame species. The fishery composition is similar to that of the Platte River. The average standing crop of fish is about 200 pounds per acre; about 20 pounds per acre are catchable-sized catfish and carp, the main species sought by fishermen.

8. Cottonwood, American elm, green ash, and black willow stand along the banks of the Platte and Elkhorn Rivers and on the larger islands. There are numerous small woodland and shrub areas scattered throughout the agricultural land in the area. Upland-game habitat is provided by an interspersion of grainfields, brushy areas, and various-sized pastures.

9. The wooded river bottoms of the Platte and Elkhorn Rivers provide excellent white-tailed deer habitat. Because of cover requirements, deer mainly restrict their movements to within a mile of the river. Outside this area, escape cover and loafing areas are generally lacking on the agricultural lands and few animals are found.

10. Several species of fur animals are common in the project area, with muskrat, beaver, mink, and raccoon being the most important. Habitat for aquatic fur animals is outstanding, and there is a considerable amount of trapping.

11. Bobwhite quail and ring-necked pheasants are the most common game birds in the study area. They are especially abundant on agricultural lands that are interspersed with brushy areas and idle acreages. Cottontail rabbits and fox squirrels are common throughout the area and provide additional hunting.

12. The Platte River historically has been of major significance to waterfowl. In the spring, it is a staging area for ducks as they migrate northward. During the fall migration, duck use of the river also is high. The Dodge-Douglas-Saunders State Game Refuge includes about 40 miles of the Platte River and provides a major sanctuary for waterfowl. The refuge extends 20 rods from each bank along the 40-mile stream segment. This area winters about 25,000 mallards each year. In addition, there are 22 miles of the Elkhorn River and many sandpit ponds in the study area that provide waterfowl hunting.

Human Resources

STUDY AREA

13. The study area is located immediately outside the urbanized Omaha area. Overall growth of the study area is related to the growth of Omaha. The four incorporated rural towns of Louisville, Springfield, Valley, and Waterloo are located within the study area. King Lake, an unincorporated area, and an increasing number of independent recreation and scenic-oriented residential developments are also located in the study area.

POPULATION CHARACTERISTICS

14. Table E1-1 presents population data from 1940 to 1970 for the four incorporated towns in the study area. Published data for King Lake are not available. It is estimated that King Lake has a year-round population of approximately 500 and a summer population of approximately 800.

Table E1-1
Total Population
Platte-Elkhorn River Basin Towns
1940 to 1970

	1940	1950	1960	1970
Louisville	977	1,014	1,194	1,036
Springfield	370	377	506	795
Valley	-	1,113	1,452	1,595
Waterloo	381	382	516	455

Source: Nebraska Population Projections, Nebraska Bureau of Business Research, Sept. 1973; U. S. Census of Population: 1960, Nebraska.

INCOME

15. Income statistics for the study area are not available. The 1970 census data, however, indicated the percent of families with incomes of less than $3,000 were as follows: 12 percent-Cass County; 8 percent-Douglas County; and 5 percent-Sarpy County. Families earning more than $10,000 were as follows: 33 percent-Cass County; 53 percent-Douglas County; and 51 percent-Sarpy County.

16. Income in the study area towns can be expected to approximate county statistics. King Lake per capita income is generally lower. The new unincorporated residential areas contain a relatively higher income population.

Development and Economy

17. Growth of the Omaha metropolitan area will influence growth of the study area. The study area is not located within the projected urban area in any of the alternative growth patterns. The four urban towns, however, would be expected to grow as a result of the urban expansion because of commuter families moving into the towns and small commercial and industrial establishments locating in these towns to take advantage of the Omaha market. Increasing numbers of independent residential areas are expected to locate in the study area, especially near transportation facilities.

POPULATION PROJECTIONS

18. Two of the towns in the study area, Valley and Springfield, would be potential satellite cities under Concept B of the growth alternatives. Table E1-2 presents population projections for the alternative growth concepts.

Table E1-2
Population Projections
Platte-Elkhorn River Basin Towns
1970 to 2020

	1970	1995	2020
Concepts A, C, & D			
Louisville	1,036	890	813
Springfield	795	3,378	7,093
Valley	1,595	2,555	3,325
Waterloo	455	545	814
Concept B			
Louisville	1,036	890	813
Springfield	795	20,000	25,000
Valley	1,595	5,000	6,000
Waterloo	455	545	814

Source: Vol. 4, Alternative Futures Appendix.

LAND USE

19. The study area includes four smaller areas of particular concern in land use study. The first area is from Valley south to Highway 92 (Center Street). This area contains the communities of Valley, Waterloo, and King Lake. The second area starts 3 miles north of Highway 6 and ends 2 miles west of Interstate 80. The

third area is in the vicinity of Louisville, and the fourth area is in the vicinity of Highway 73-75.

20. These four areas are subject to significant land use changes because of their proximity to rural communities or to transportation links to the Omaha metropolitan area. All four of the areas contain unincorporated residential developments located in the flood plain. As these areas continue to be developed, flood damages will significantly increase because of the scope of development and the high value of these developments. The developers of these areas are beginning to provide flood protection, but the adequacy of this protection is not known.

21. All or parts of the communities of Valley, Waterloo, King Lake, and Louisville are located in the flood plain. Increased development of Waterloo outside of its protective levee will increase flood damages. Increased development of the other three communities would significantly increase flood damages.

PART II

PROBLEMS AND NEEDS

1. The purpose of this section is to summarize the water resource problems and needs relating to flooding, erosion, drainage, and irrigation in the Platte-Elkhorn River Study area. This section also provides information on existing plans and improvements in the area. As an indication of relative flood hazard, figure B2-1 defines the flood potential by frequency of occurrence in years.

Prior Studies and Reports

2. Studies of the flood and related water resources problems in the Platte River basin date from the Flood Control Act of 1928, which authorized the first extensive investigation. During that investigation, consideration was given to reservoir sites in the Platte

River basin which would provide flood control and navigation benefits on the Missouri and Mississippi Rivers. A reservoir on the Platte River 20 miles upstream from its mouth, referred to as the "Ashland Reservoir", was selected as most suitable for this purpose. Such a project would control about 90 percent of the drainage area of the Platte River. The project was not fully evaluated; however, as it was found that other potential reservoir projects within the Missouri River basin could provide similar benefits at a lower cost. The basic report concluded that the Platte River was not "subject to destructive floods" within the meaning of Section 10 of the 1928 Flood Control Act. With respect to navigation, the report also concluded that navigation on any portion of the Platte River was "entirely impracticable." The report stated that irrigation "is the most important phase of development to be considered in connection with the utilization of the water resources of the Platte River basin." A guideline plan of development was presented in the report. This plan provided for irrigation to an additional 1,230,000 acres in the basin. A potential irrigation development was indicated for the Platte River-Wood River area between Central City, Nebraska, and Silver Creek, Nebraska. The basic report found that hydroelectric power could probably be developed in conjunction with irrigation development. Although the Platte River discharges about 10 percent of the sediment carried by the Missouri River past Kansas City, bank erosion was considered to be a minor problem. The "Ashland Reservoir" storage, with a gross capacity of 1,400,000 acre-feet, would, according to the report, "be materially decreased by silt deposits in a comparatively short period."

3. A Corps of Engineers report, published in 1949 as House Document 396, 81st Congress, 1st Session, recommended construction of flood

control projects at West Point, Waterloo, Norfolk, Pierce, Battle Creek, and Tilden, Nebraska, all located within the Elkhorn River basin. The projects were authorized for construction by the 1950 Flood Control Act. The projects at West Point, Waterloo, Norfolk, and Pierce have been constructed. The other projects have been deauthorized.

4. In response to a resolution adopted in 1944 by the Committee on Flood Control, House of Representatives, the Omaha District made a study of flood problems in the Salt Creek basin in the vicinity of Lincoln, Nebraska. The report on the study recommended a system of 12 small dams, plus channel and levee improvements. The report was printed as House Document 396, 84th Congress, 2d Session, in 1957. The plan was authorized for construction by the 1958 Flood Control Act. The portion of the plan that provides flood protection for Lincoln has been completed. The remainder of the plan, which provides principally for rural flood protection, has been deauthorized.

5. King Lake and Louisville, Nebraska have been investigated, at the request of local interests, under the authority of Section 205 of the 1948 Flood Control Act. The conclusion of both studies was that the flood problems at each community were not significant enough to economically justify any structural measures to prevent flooding.

6. The Missouri River Basin Commission completed a Level "B" Study of the Platte River in Nebraska in September 1975. The final draft of the report is being formally reviewed and the final report will be completed early in calendar year 1976. The Corps is one of four Federal agencies, along with the State of Nebraska and the University

of Nebraska, involved in the study. The purpose of the study is to formulate a comprehensive plan that will satisfy multiple objectives, including alternatives as necessary, for conservation, development, and management of the water and related land resources of the Platte River basin in Nebraska. The study also identifies and recommends those action plans and programs within each subbasin required to fulfill the needs and desires foreseen in the next 15 to 30 years. The final draft of the report does not recommend any structural programs within the study area.

7. A study of the Platte River and Tributaries, Nebraska, authorized by four Congressional resolutions, will be resumed and will be completed by the end of Fiscal Year 1976. This study was deferred pending the results of the Level "B" Study in order to avoid duplication of effort; it will analyze the final results of the Level "B" Study. Appropriate elements of the plan of action will be formulated and economic feasibility studies will be conducted.

Existing Plans and Improvements

8. Within the Platte River basin in Nebraska, the Corps of Engineers has constructed eight local flood control projects and one emergency bank stabilization project. Only two of the projects are within the study area. A local protection project authorized by the Flood Control Act of 1950 was constructed for the town of Waterloo in 1966. It consists of a 21,680-foot ring levee which

protects the community from Elkhorn River and Platte River floods. At Cedar Island, a project was constructed to protect the Metropolitan Utilities District well field. The project was constructed in 1968 under authority provided by Section 14 of the 1946 Flood Control Act. It consists of 1,685 feet of stone-fill dike and 8,200 feet of toe-trench revetment. Within the Platte River basin, the Corps has 12 authorized projects which have not been constructed. None of the 12 projects are within the study area.

9. The Bureau of Reclamation has no projects along the main channel of the Platte River; however, it has two storage projects in the Loup River basin which modify Platte River flows. The Sargent Unit was constructed in 1959 to develop irrigation for 15,305 acres. The project consists of diversion dams, canals, and drains. The project also provides flood control in and near Sargeant, Nebraska. The Farwell Unit provides flood control and irrigation for 49,116 acres.

10. The Bureau of Reclamation also has an authorized project, referred to as the Nebraska Mid-State Division, which would if constructed, divert Platte River flows near Lexington into 23 interconnecting reservoirs with a combined capacity of 700,000 acre-feet. The project would distribute water to 140,000 acres and would permit coordinated surface-ground-water use and development.

11. The Soil Conservation Service has completed four watershed projects in the Platte River basin. One of the completed watershed projects is located within the study area; it is referred to as the Turtle watershed and is located in south Sarpy County.

12. Local flood protection levees have been constructed at many locations along the Platte River and its tributaries by organized drainage or irrigation districts and by cooperative action of local residents. The works constructed by organized districts generally provide a high degree of protection and are well maintained. Two of the major districts that have constructed flood protection levees are the Union Diking and Drainage District and the West Sarpy County Drainage District. Other improvements, although providing no direct flood control benefits, do, through irrigation and power diversions, effect incidental reduction in flood discharges.

13. The National Guard Camp near Ashland has been flooded frequently over the years and has sustained extensive damage to its buildings and grounds. In 1967, the National Guard constructed a low levee along the right bank of the Platte River to protect the buildings.

14. Where organized drainage or irrigation districts do not exist, landowners have undertaken protection of their property. Private improvements generally are not well constructed, provide protection only from the minor but more frequent floods, and receive either no maintenance or a minimum of maintenance. They are frequently overtopped or breached by floodwaters. Repairs to these structures have been made many times by the Corps of Engineers under Public Law 99.

Flood Problem

15. Available data indicate that flood conditions are experienced at some point in the Platte River basin every year. Most of these events are local and their effect on flows on the Platte River is minimal. The floods discussed in this report are those which have had a major effect on flows near the mouth of the Platte River. Floods along the downstream reaches of the Platte River can occur from snowmelt or rainfall. Past snowmelt floods have consistently been accompanied by ice jams which often have exerted a major influence on the flood conditions. The rainfall floods are generally the result of a prolonged wet period over a major portion of the basin. Single major storm events, however, such as occurred in June 1944 over the Elkhorn River basin, have produced major flooding along the Platte River downstream from the mouth of the Elkhorn River. Information on floods occurring prior to 1930 is limited, and available data indicate only where major flooding took place.

16. The flood of record outline for the Platte and Elkhorn Rivers, from Valley, Nebraska, downstream to the mouth of the Platte River, is shown on plate E2-1. On the Elkhorn River, the flood of record occurred in 1944. The area flooded averaged 1.5 miles wide through the study area. The most severe flood of recent years on the Platte River in the study area occurred in March-April 1960. This flood inundated an area 1.5 to 3 miles wide upstream from Interstate 80 and an area that averaged 1 mile wide downstream from Interstate 80. The area flooded covered about 50,000 acres.

17. Land use in the Platte River and Elkhorn River flood plains is predominantly agricultural. The remainder of the area contains gravel

pits, recreation lands, urban lands, and transportation rights-of-way. The communities of Valley, Waterloo, and Plattsmouth lie in this area and are flooded by the larger floods. The unincorporated community of King Lake is flooded by overflows from the Elkhorn River. The flood plain is traversed by several railroads, by numerous Federal and State highways, and by county roads; all are subject to flood damage.

18. Three primary factors, the construction of Interstate 80, the recreational potential of the Platte River and Elkhorn River, and urban growth, have caused significant land use changes within the flood plain. Omaha has been expanding westward towards the common Platte-Elkhorn River flood plain. Recent urban expansion into the flood plain in the form of recreational and scenic-oriented suburban residential developments, such as Ginger Cove, Riverside Lake Development, Buccaneer Bay, and Hanson's Lake, has increased the threat to human life. Although the four alternative growth patterns do not show extensive urban development in the flood plain, past history has shown that such development will occur if urban sprawl is not controlled.

19. In the absence of suitable flood protection or flood plain zoning measures, flood-prone areas will continue to experience severe and costly damages.

RUNOFF CHARACTERISTICS

20. The principal cause of flooding in the Platte River basin is the rapid concentration of runoff resulting from high-intensity rainfall in tributary basins. The hilly terrain of the numerous

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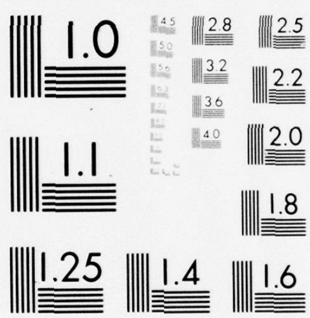


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

tributary streams and gulches produces rapid concentration of runoff, which in turn causes quick rises in streams. Flood stages in the tributary valleys usually subside within 24 hours. Flood stages on the Platte River are generally of longer duration, lasting from 2 to 3 days. Tributary streams originating in the upstream hilly portion of the basin produce greater flood velocities and more destructive floods than those produced on the Platte River. The highly erodible loess soil mantle of the lower Loup River and of the Platte River produces a heavy sediment load during floods. Consequently, the deposit of silt on flooded property serves to aggravate flood damages. Moreover, flood discharges tend to carry a heavy load of natural debris from wooded portions of the tributary basins. This debris frequently lodges at bridge crossings and at constricted channel sections, thereby causing higher stages and higher flood damages.

21. Snowmelt floods, aggravated by ice jams, have contributed to the flood problem of the basin. The rapid melting of a heavy snow accumulation, sometimes accompanied by heavy rainfall, has produced damaging floods. The snowmelt-ice-jam floods are primarily restricted to the Loup River and to the Platte River downstream from Columbus. In recent years, four floods in the Platte River basin have resulted from snowmelt conditions and have inflicted damages ranging from minor to severe throughout the basin.

22. Runoff from the Elkhorn River and its tributaries follows a characteristic annual pattern. During the winter months, there is little runoff and the streams are frozen. Springs floods are caused by rapid melting of the winter's accumulation of ice and snow, augmented by rainstorms in some cases. Occasionally, spring flooding

is caused or augmented by ice jams. Summer floods, as a result of heavy rainfall, are not unusual. Because of the broad fan shape of the area between Waterloo and the vicinity of Norfolk, nearly all of the flow contributing to the peak flow at Waterloo originates in this area.

DISCHARGE-PROBABILITY CURVE

23. A discharge-frequency curve for the Elkhorn River was computed from the flow records at Waterloo for the 45 years of record. The analytical method as described in "Statistical Methods in Hydrology," July 1952, by Leo R. Beard, was used. The annual series frequency curves adjusted for partial duration and expected probability are shown on plate E2-2.

24. Discharge-probability curves for the Platte River were determined from a regional study using the records from seven gaging stations located along the Platte River between Cozad and Louisville. This study indicated that desirable results were obtained when the square roots of the drainage areas were compared with mean floods and standard deviations at the gaging stations studied. The regional relationships and the discharge-probability curves are presented on plate E2-3.

STANDARD PROJECT FLOOD

25. The standard project flood on the Elkhorn River in the study area was computed in accordance with the method described in Civil Engineer Bulletin Nos. 52-8, using the average loss rate of 0.28 inch-per-hour and a 6-hour unit hydrograph. It was assumed that the area contributing to peak flow at Waterloo was the same as that for

the storm of 10-13 June 1944. The standard project flood would have a peak flow of 132,000 c.f.s., which is 1.32 times the design flow of 100,000 c.f.s.

26. The computed standard project flood for the Platte River at Fremont, Nebraska has a peak discharge of 200,000 c.f.s. The standard project peak discharge for the Platte River just upstream from the confluence with the Missouri River is estimated to be 243,000 c.f.s.

HISTORICAL DAMAGES

27. Rainfall in the Elkhorn River basin in June of 1944 caused severe flooding along the Platte River from the mouth of the Elkhorn River to the Missouri River. The estimated peak discharge was 107,000 c.f.s. at Ashland. The flood damages for this event totaled approximately $672,000.

28. The historic floods following the 1944 flood are shown in table E2-1.

Table E2-1
Historic Flood Records

Year	Cause	Damages
1947	Rainfall	$ 481,300
1948	Ice Jam	80,000
1949	Snowmelt and Ice Jam	92,000
1960	Snowmelt and Ice Jam	575,000
1962	Ice-jam Flood	No Estimate
1966	Ice Jam	268,250
1967	Rainfall	1,355,000

AVERAGE ANNUAL DAMAGES

29. Average annual flood damages on the downstream reaches of the Platte River are relatively low. The overall existing flood problems are minor, even though floods occur almost annually. The flood plain is rapidly developing, however, because of its obvious economic locational advantage and environmental attractiveness. Continued development in this area would result in potential damages far greater than those historically experienced. Although the four alternative growth patterns do not delineate extensive urban development in this flood plain, it is strongly suspected that uncontrolled, urban sprawl would allow such development. The construction of several urban developments within the combined Platte-Elkhorn River flood plain in the past 10 years is indicative of such an occurrence.

30. The crop and noncrop discharge-damage relationships for the study area and the corresponding discharge-probability curves were developed. Average annual damages were then computed using a tabular integration procedure. The average annual damages under existing conditions are $190,700 and are broken down as follows:

Crop	$ 44,400
Noncrop*	$146,300

* Urban damages are included in the noncrop damages.

Other Needs

EROSION

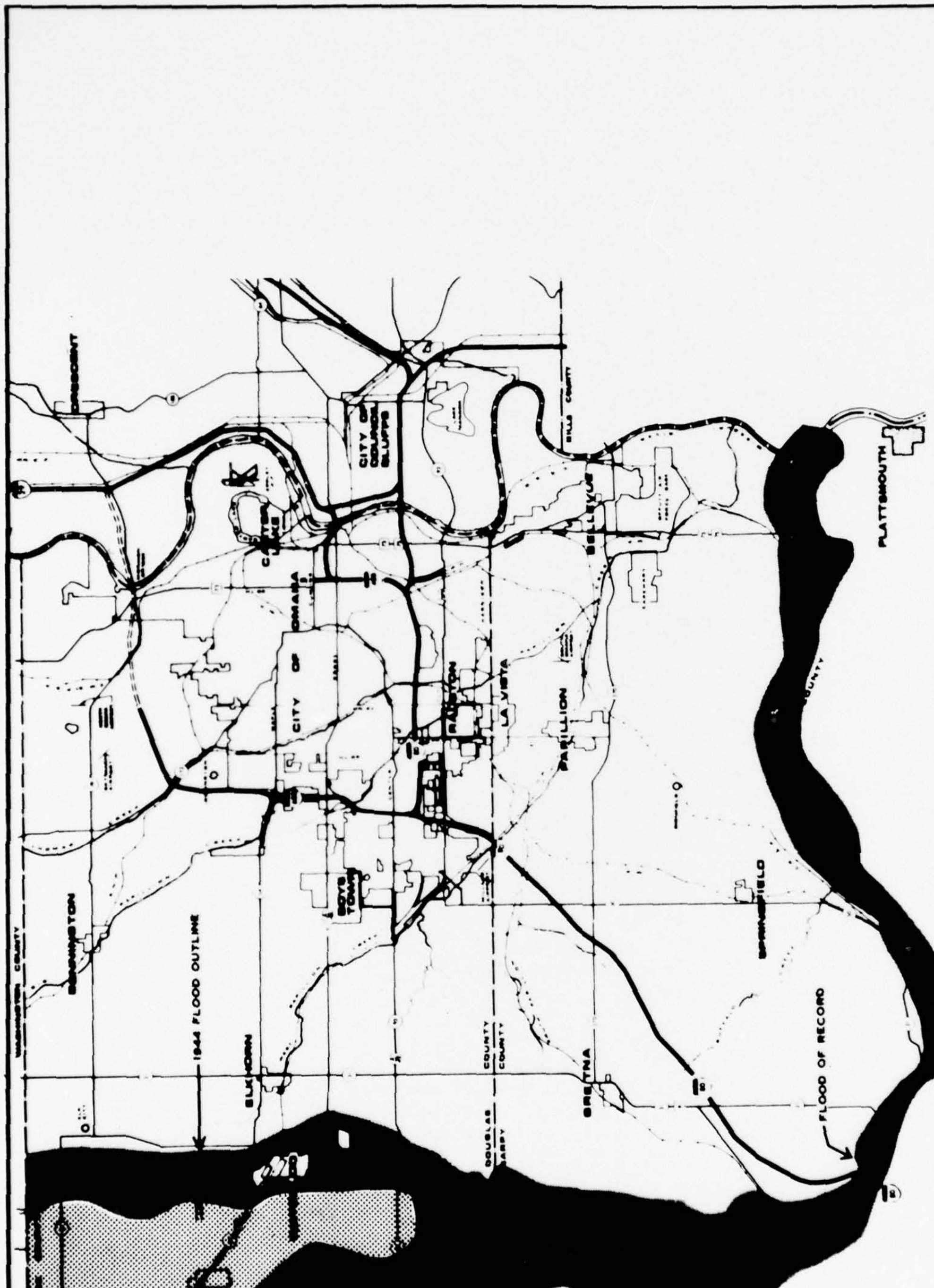
31. The erosion problem along the Platte-Elkhorn River flood plain could increase significantly during the next 50 years. Recreational and urban developments are occurring within the combined flood plain. The demand for river frontage for recreational purposes now exceeds the supply. The value of this frontage land is increasing at a rapid rate, and there is also a corresponding increase in the type and value of improvements being constructed on this land. Losses of irreplaceable esthetic and ecological values, however, may be an even greater loss. The erosion rate could increase due to development along the river; this could reduce the normal capability of the riverbank to revegetate and stabilize itself.

IRRIGATION

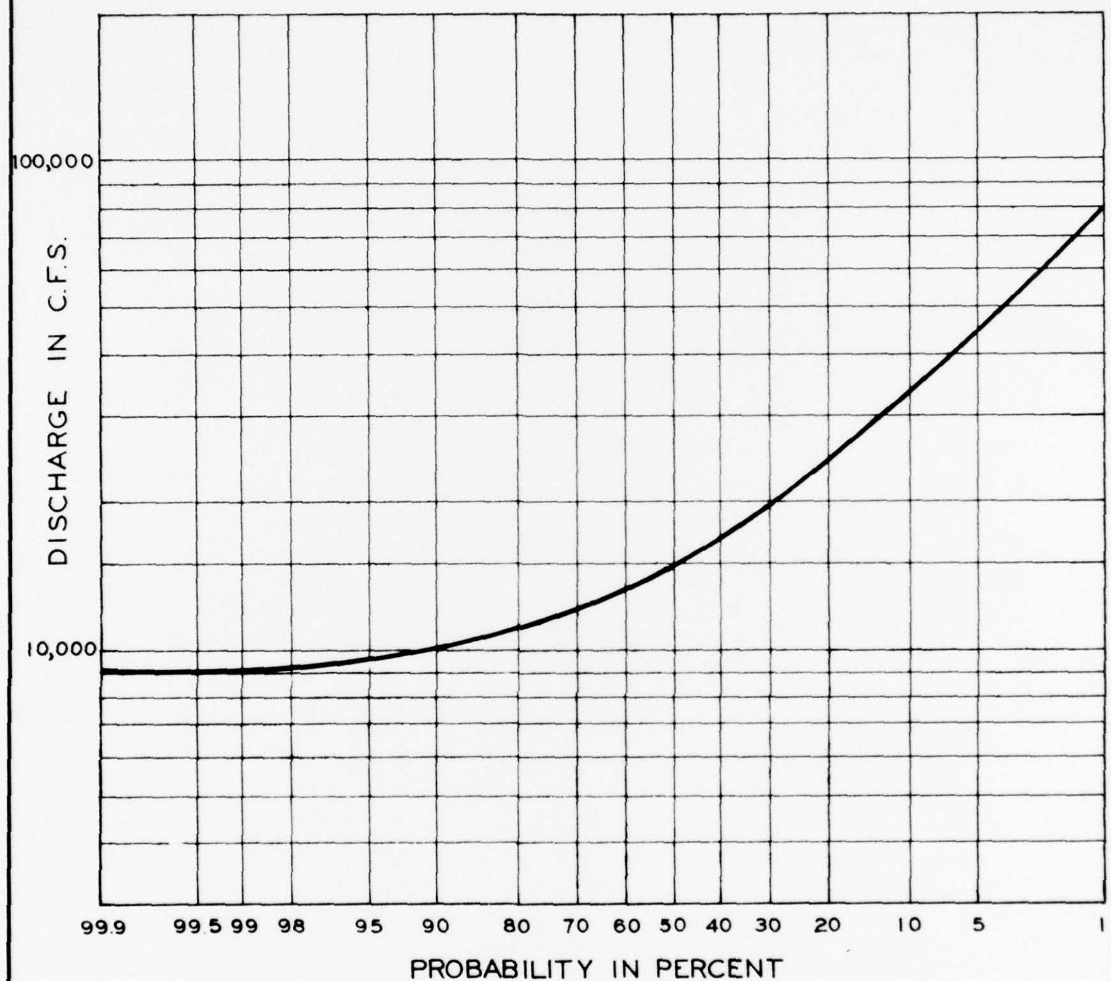
32. There is no need for the diversion of surface flows from the Platte or Elkhorn Rivers for irrigation within the study area. The precipitation and ground water table are sufficient for the growing of crops produced within the study area and dryland farming is the general practice.

Improvements Desired

33. Public meetings have been held regarding the water resource problems in the study area. The only flood problem area mentioned during these meetings was at Plattsmouth, Nebraska. The local interests felt that flood protection was needed for their municipal water and sewage treatment plants and for the surrounding flood plain. This same area is also subject to Missouri River flooding. During April of 1975, local interests from Hanson's Lakes, a development located upstream from U.S. Highway 73-75 along the north bank of the Platte River, requested flood protection for the area.



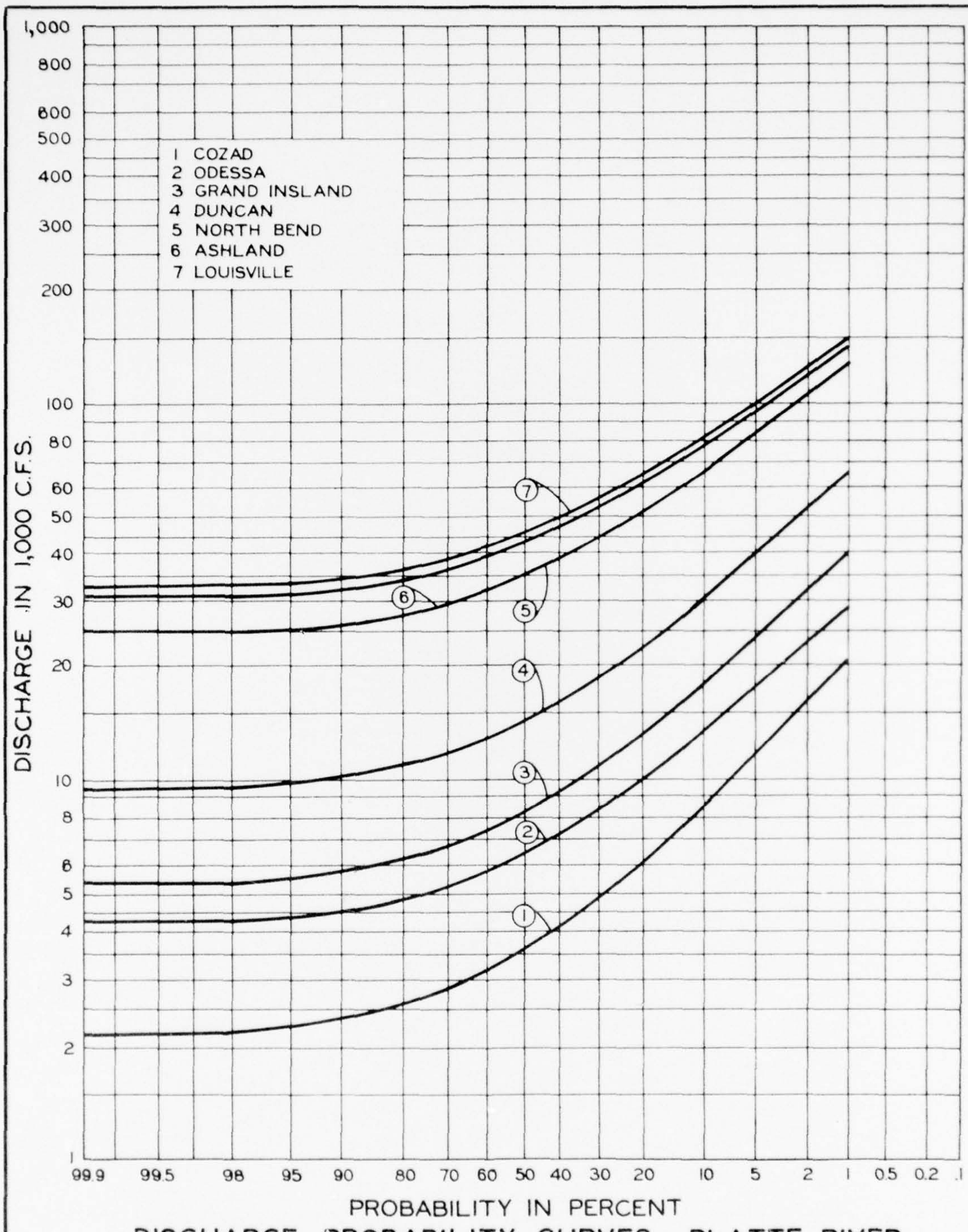
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
PLATTE - ELKHORN RIVERS
FLOOD OF RECORD
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975



DISCHARGE PROBABILITY CURVE
ELKHORN RIVER
AT
WATERLOO NEBRASKA
PERIOD OF RECORD - 45 YEARS

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

JUNE 1975



DISCHARGE PROBABILITY CURVES – PLATTE RIVER

NATURAL CONDITIONS

METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA

DISCHARGE PROBABILITY CURVES
NATURAL CONDITIONS

U S ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

JUNE 1975

PART III

FORMULATING A PLAN

1. This section presents a discussion on the formulation and evaluation criteria used, the possible solutions considered, and the basis for selecting the final plan. In formulating a plan, it was imperative to consider all appropriate alternative plans. Such alternatives were then screened to arrive at the plan that best responds to the problems and needs of the area.

Possible Solutions

2. Several alternative measures to satisfy the problems and needs of the area are possible; however, some of these measures are not practical or economical. The possible solutions may be divided into

the two broad categories of nonstructural and structural measures. Nonstructural measures include insurance, zoning, building code regulations, flood proofing of both individual buildings and land tracts, and permanent evacuation of flood plain areas. Possible structural measures include reservoirs, channel and levee improvements, diversions, and combinations of these. Also, a combination of nonstructural and structural measures is possible. Nonstructural measures emphasize regulation of the use and development of the flood plain, thus lessening damaging effects of large floods.

3. Initially, both structural and nonstructural alternatives, in addition to the alternative of "no action", were considered. With the "no action" alternative, it was assumed that there would not be any Federal action taken and that local officials would adopt flood plain zoning regulations in accordance with Public Law 93-234.

NONSTRUCTURAL MEASURES

FLOOD INSURANCE

4. Flood insurance would not prevent damages to existing development but it would provide compensation for those people located in participating areas. The total cost of flood insurance includes the cost of average annual damages, the cost of administering the program, and actuarial costs. Thus, the cost of insurance exceeds the benefits that could be derived by the amount of actuarial and administrative costs.

EVACUATION

5. Total evacuation would involve complete removal of all buildings and damageable property in the flood plain. This would mean buying

the unincorporated communities of King Lake and Venice, portions of the city of Valley, and the residential areas of Ginger Cove, Riverside Lake, Cedar Creek, Buccaneer Bay, and Hanson's Lake. In addition to this, there are hundreds of cabins located along the Platte and Elkhorn Rivers that would have to be purchased. Agricultural and transportation developments would remain in the flood plain and would not be protected. After preliminary analysis, this alternative was found to be infeasible because of high acquisition costs.

ZONING

6. Zoning would prohibit future development in the flood plain unless the structures are flood proofed. Zoning would not protect the existing development in the flood plain. With the passage of Public Law 93-234, it must be assumed that local officials will comply with its provisions and the 100-year flood plain will be zoned. If the 100-year flood plain is zoned now, it will limit future urban expansion and will preserve the existing environmental setting of the area and its use as an agricultural area.

FLOOD PROOFING

7. Flood proofing to protect against the 100-year flood would reduce damages to residential and nonresidential buildings, but would be socially objectionable and expensive. Under the current flood insurance program regulations, existing development would not be required to be flood proofed but all future development would have to be flood proofed if Federal money were borrowed. Many of the existing cabins and homes in the flood plain would require major improvements in order to be flood proofed. The cost of flood proofing was found to be economically infeasible by a wide margin. Future development in the flood plain would be required

to flood proof if the flood plain is zoned in accordance with flood insurance program regulations. The cost of flood proofing would be the financial responsibility of the individuals who plan to build in the flood plain.

STRUCTURAL MEASURES

8. Even though flooding occurs almost annually, the existing flood problems are relatively minor. Structural alternatives to solve the existing flood problems were considered and were all found economically infeasible by a wide margin and did not warrant detailed studies. Alternatives considered included a levee system which would provide 100-year flood protection at a cost of approximately $1,000,000 per river mile. The levee system would have paralleled both the Platte and Elkhorn Rivers within the study area. Channel improvement is another alternative, but it is opposed by local interests and would not be compatible with the habitat and environmental qualities of the rivers. Dams have been considered in the past both within and outside of the metropolitan study area; these studies indicated that there were insufficient damages to economically justify a dam or a dam system. Economic feasibility studies of Missouri River Agricultural Levee Unit R-610 were made at the request of Plattsmouth, Nebraska local officials. Preliminary studies indicated that the levee unit was not economically justified.

SUMMARY OF POSSIBLE SOLUTIONS

9. Nonstructural measures would reduce future damages caused by unwise flood plain development. Existing damages, however, would not be reduced. Based on the above analysis, it was concluded that

flood plain zoning should be adopted. At the present time, since a detailed outline of the 100-year flood is not available, the flood of record should be used. Owners of existing structures in the flood plain should consider flood proofing on an individual basis or purchase flood insurance.

Alternatives Considered Further

10. In view of the preceeding analysis, the no action or flood plain zoning appears to be the most favorable for further consideration.

Selecting a Plan

11. The study area is primarily rural in nature. The area presents an excellent opportunity for flood plain management. The cities already located within the flood plain should implement zoning to limit flood damages in the future.

SECTION F

MISSOURI RIVER EVALUATION

MISSOURI RIVER EVALUATION

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SECTION F

MISSOURI RIVER EVALUATION

PART I

RESOURCES AND ECONOMY OF THE STUDY AREA

1. The Missouri River study area is that portion of the Missouri River encompassed by the Metropolitan Omaha, Nebraska-Council Bluffs, Iowa Standard Metropolitan Statistical Area.

Environmental Setting and Natural Resources

BASIN DESCRIPTION

2. The study area encompasses approximately 1,500 square miles. In Nebraska, gently sloping hills extend from the western boundary of the metropolitan area to the bluffs along the Nebraska side of the Missouri River. Steeper bluffs, about 250 feet high, are located adjacent to the flood plain on the Iowa side. Between the

two bluff lines, the flat Missouri River bottom land averages about 5 miles wide. The Missouri River is about 600 feet in width in the area.

3. Approximately 10 percent of the total land in the study area is developed urban land. Ninety-one percent of the population of the study area lives in the urban area.

HISTORICAL-ARCHEOLOGICAL FEATURES

4. American Indian artifacts and remains comprise most of the important archeological finds in the study area. The Omaha-Council Bluffs SMSA has a rich and varied historical background related to the frontier life of 19th century America. Especially notable is the early key role which the area played as a transfer and crossing point on the Missouri River for pioneers and as a grouping point for Mormon migrations to Utah.

NATURAL RESOURCES AND ENVIRONMENTAL CHARACTERISTICS

5. Channelization of the Missouri River and construction of the main stem dams upstream have had a marked effect on ecosystems in and along the river.

6. The construction of the river into a narrow channel has increased velocities through the study area. The increased velocity over a primarily sand bottom has produced an unproductive zone. The rapid movement and force of the water plus the grinding effect of the sand particles make it very difficult for organisms to live on the bottom zone.

7. The river is continually scouring the bottom and maintaining a channel of good depth for navigation. The narrow channel and fast current do not permit the formation of mud flats or sandbars.

8. Vegetation typical of the flood plain forest includes an overstory composed of willow, cottonwood, elm, ash, hackberry, maple, black walnut, sycamore, elder, mulberry, and basswood. Shrub and herbaceous species form an understory composed of grape, Virginia creeper, dogwood, sumac, gooseberry, poison ivy, wild rose, coralberry, ragweed, nettles, hemp, asters, sunflower, fleabane, and wild strawberry.

9. The upland forests which are located on the Missouri River bluffs are characterized by an overstory of basswood, elm, ash, oak, and hickory and an understory of dogwood, gooseberry, sumac, wolfberry, and native grasses.

10. The Missouri River channel has never been conducive to the growth of aquatic vegetation. Swift turbid waters and shifting sand prevent vegetation from becoming established. Protected areas, however, such as backwaters, side chutes, cut-off lakes, and oxbow lakes do support aquatic vegetation. Cattail is the only aquatic plant in most protected areas and it grows in dense monospecific stands. Many isolated oxbow lakes and backwaters support cattail and some additional species, such as water lily and arrowhead.

11. Wildlife species in the study area reach depend upon the remaining habitat in the bottom lands and bordering uplands for their survival. Most of the forested marsh, backwater meadow, sandbar, and dune areas are located on or near the banks of the

Missouri River. White-tailed deer, mink, raccoon, fox, opossum, cottontail rabbit, squirrel, skunk, coyote, and small rodents are the most common terrestrial wildlife species in the study area. Other small mammals in the study area are shrews, ground squirrels, plains pocket gophers, mice, and moles. Abandoned buildings, bluff caves, and forests in the study area provide habitat for bats.

12. The study area is located near the western edge of the eastern deciduous forest which is the limit of the ranges of many eastern bird species. The appearance of some western bird species in the habitats of the flood plain is not unusual. For these reasons, the avifauna of the Missouri River flood plain is diverse and of biogeographical interest. The Missouri River is an avenue for bird movements, not only for the continent-spanning migratory flights of many species, but also for local movements during the winter and summer.

13. The species which use the study area for breeding include certain hawks, falcons, cuckoos, owls, goatsuckers, swifts, woodpeckers, flycatchers, jays, titmice, nuthatches, wrens, mockingbirds, thrashers, thrushes, gnatcatchers, waxwings, finches, and sparrows. Some species use the area only for migration. These include certain species of hawks, falcons, eagles, ospreys, owls, flycatchers, thrushes, vireos, warblers, grosbeaks, juncos, and sparrows.

14. Water- and wetland-dependent wildlife populations are declining in the study area due to the continuing loss of aquatic and semiaquatic habitat. The breeding species that are the most seriously affected include certain grebes, ducks, mergansers, herons, bitterns,

rails, coot, gallinules, plovers, sandpipers, woodcocks, snipes, terns, kingfishers, swallows, and blackbirds. Also affected to a serious degree are the winter and summer residents. These include certain ducks, mergansers, eagles, and herons. The least affected are the migrants. These include certain grebes, pelicans, cormorants, swans, geese, ducks, mergansers, eagles, bitterns, cranes, rails, avocets, plovers, sandpipers, gulls, terns, and blackbirds.

15. The species which are no longer common due to habitat reduction include the long-billed marsh wren, American bittern, least bittern, yellow-headed blackbird, least tern, and piping plover. As the acres of marsh and shallow water areas continue to decline, more species will become uncommon.

16. The more common reptiles and amphibians inhabiting the study area include the leopard frog, chorus frog, cricket frog, Great Plains toad, Rocky Mountain toad, gray tree frog, snapping turtle, western painted turtle, soft-shelled turtle, tiger salamander, northern water snake, bull snake, and the garter snake.

17. Fish habitat in the study area of the Missouri River is limited because of channel control programs. Four species, the carp, goldeye, river carpsucker, and the gizzard shad, are the most abundant. Other common fish are the channel catfish, flathead catfish, drum, gar, buffalo, and numerous minnows. Less common fish are the crappie, sauger, walleye, and paddlefish.

Human Resources

STUDY AREA

18. The Omaha-Council Bluffs SMSA is the key influence on future social and economic growth in the study area. The discussion of human resources will center around the SMSA. The 1970 population of the SMSA was 540,142. Omaha, the Douglas County county seat, had a population of 347,380 in 1970. Council Bluffs, the Pottawattamie County county seat, recorded a 1970 population of 60,348. The Omaha-Council Bluffs SMSA serves as a trade center and a key distribution point for eastern Nebraska and western Iowa. Interstates 80 and 29 serve the SMSA in addition to other State and Federal highways. The metropolitan area is served by eight railroads, six major airlines, and five barge lines.

POPULATION CHARACTERISTICS

19. The study area has experienced significant population growth over the last 30 years as shown in table F1-1. The table shows that the population of the study area has increased most significantly for the areas outside the corporate boundaries of Omaha and Council Bluffs. Population from 1940 to 1970 increased at a rate of 1.6 percent per year for Omaha, 1.5 percent per year for Council Bluffs, and 5.5 percent per year for the remainder of the SMSA.

Table F1-1
Historic Population
Missouri River Study Area
1940 to 1970

	1940	1950	1960	1970
Omaha	233,844	251,117	301.958	347,380
Council Bluffs	41,439	45,429	55,641	60,348
Rest of SMSA	49,824	69,849	100,274	132,414
Total	325,107	366,395	457,873	540,142

Source: Census of Population; 1940, 1950, 1960, 1970.

INCOME

20. Median family income in the SMSA in 1970 was $10,214 compared to $9,586 for the Nation. Census data indicated that 6.8 percent of the study area families had incomes below poverty level compared to 10.7 percent for the Nation.

Development and Economy

POPULATION PROJECTIONS

21. OBERS population projections for Water Resources Council Subarea 1023 and population projections for the four alternative growth concepts are presented in table F1-2.

Table F1-2
Alternative Population Projections
Omaha-Council Bluffs SMSA

	1995	2020
OBERS Projections	896,200	1,451,000
Concept A	850,900	1,034,500
Concept B	795,100	970,600
Concept C	850,900	1,034,500
Concept D	850,900	1,034,500

Source: OBERS Projections 1972; and Vol. III, Section C, Alternative Futures Appendix.

LAND USE

22. Upon completion of Federal levees L-611, L-614, and R-616 in the downstream Missouri River reaches of the study area, standard project flood protection will be provided throughout most of the study area from Omaha-Council Bluffs downstream. Land between the levees and the river would not be put to intensive urban uses. Existing development inside the levees consists mainly of cabins along the river. Land use plans indicate that the upstream portion of the study area will be open space. This upstream portion would not be protected by levees. Riverside areas would have park development and would not be urbanized.

PART II

PROBLEMS AND NEEDS

1. The purpose of this section is to summarize the water resource problems and needs relating to flooding, erosion, drainage, and irrigation in the Missouri River Study area. This section also provides information on existing plans and improvements in the area. As an indication of relative flood hazard, figure B2-1 defines the flood potential by frequency of occurrence in years.

Prior Studies and Reports

2. Many studies of the Missouri River have been made by the Corps of Engineers. Only those which concern the immediate study area are discussed in this report.

3. House Document 92, 46th Congress, 3rd Session, 1881, was the first report which set forth a comprehensive plan for navigation on the Missouri River. The report studied the entire length of the Missouri River.

4. House Document 594, 69th Congress, 2d Session, 1926, considered the feasibility of the improvement of the Missouri River for navigation upstream from Kansas City, Missouri. The report considered a channel "6 feet deep and of ample width for navigation".

5. House Document 238, 73rd Congress, 2d Session, covered the entire Missouri River basin and dealt with navigation, irrigation, power and flood control. The report recommended the storage of floodwaters in Fort Peck Reservoir and the release of these floodwaters during navigation season. Several systems of locks and dams were also considered for the area upstream from Sioux City, Iowa.

6. House Document 821, 76th Congress, 3d Session, entitled "Missouri River, Sioux City, Iowa to Kansas City, Missouri" considered flood control in the Omaha-Council Bluffs metropolitan study area. The report recommended that a Federal flood control project be adopted for the protection of agricultural lands and small communities between Sioux City and Kansas City. As a part of the general comprehensive plan for flood control approved in the Flood Control Act of 22 December 1944, local protection projects along the Missouri River were authorized for protection of the cities of Omaha, Nebraska and Council Bluffs, Iowa.

Existing Plans and Improvements

7. The construction of the Missouri River main stem dam system has reduced the magnitude of flood discharges along the Missouri River within the study area, thus reducing the frequency of flooding.

8. The Corps of Engineers has also constructed Missouri River levee units within the study area. Most of the units protect agricultural lands and small communities against floods. The completed projects and those that are funded for construction are shown on plate F2-1. All remaining, uncompleted units that have been classified "inactive" are also shown. Planning on levee units L-611-614 and R-616 was initiated in FY 1974 and is nearing completion. The combined Federal cost of these units is approximately $7,000,000.

9. As a part of the authorized Missouri River levee project, flood protection projects were constructed for Omaha, Nebraska and Council Bluffs, Iowa.

Flood Problem

10. The flood hazard on the main stem of the Missouri River has been dramatically reduced as a result of the constructed projects--

the main stem reservoirs, bank stabilization, and the Missouri River levee system. The flood problem on the Missouri River varies according to the flood-generating potential of tributaries downstream from the main stem reservoirs and the degree of protection afforded by levees. The flood area through the presently urbanized areas of Omaha and Council Bluffs is confined between the levees protecting these cities. Upstream and downstream from the leveed areas, the potential flood area from the major floods could extend from bluff to bluff.

11. The Missouri River levees, where completed, provide protection against a flood that is approximately the standard project flood event. A levee freeboard of 2 feet for agricultural areas and 5 feet for urban areas was used. There are numerous locally constructed agricultural levees along the river, some of which provide significant flood protection. Others provide a relatively low degree of flood protection and receive inadequate maintenance.

12. The Omaha District of the Corps of Engineers is making detailed studies to define the floodway along the Missouri River under current conditions. The study will show flood profiles relative to the streambed and both banks. Since the floodway study is still underway, no flood outline based on historic data was shown in this report. For more information regarding the floodway at specific locations, contact the Omaha District Flood Plain Planning Branch of the Corps of Engineers.

HISTORICAL DAMAGES

13. Since the completion of the main stem dam and the Missouri River levee system along the Missouri River within the study area, flood damages have been considered relatively minor. With the construction of levee units L-611-614 and R-616, the remaining areas that will be subject to flooding within the study area are primarily agricultural. The new levees would provide standard project flood protection to those areas protected by them. Most of the recent flooding within the study area limits has been downstream from Omaha in reaches where the authorized Missouri River levee system has not been constructed. The average annual damages have not been calculated for the Missouri River because the hydrology and hydraulics are currently being revised.

Other Needs —

Missouri River Flood Plain

DRAINAGE AND HIGH GROUND WATER

14. Drainage and high ground water problems exist adjacent to the Missouri River. Currently, the communities of Carter Lake and

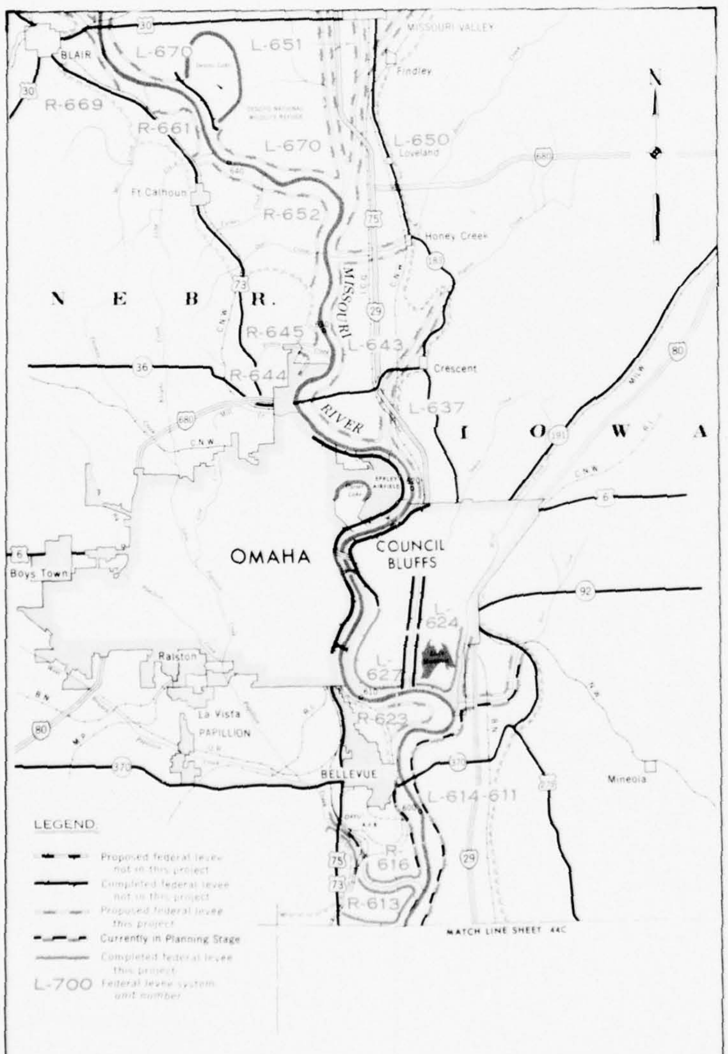
western Council Bluffs are adversely affected by these problems. Surface ponding in the two communities is evident during high water periods. High ground water levels and poor drainage are also problems in the vicinity of the community of Missouri Valley, Iowa, during high stages along the Boyer River, Missouri River, and Willow Creek. High ground water problems in some areas of the flood plain have been asserted to be caused by maintaining navigation flows in the Missouri River.

IRRIGATION

15. Irrigation districts exist along the Missouri River within the study area and there is some irrigation by wells. No additional irrigation needs were determined by this study.

Improvements Desired

16. Opposition to Missouri River levee R-616 has been expressed by landowners and cabin owners on the riverside of the proposed levee.



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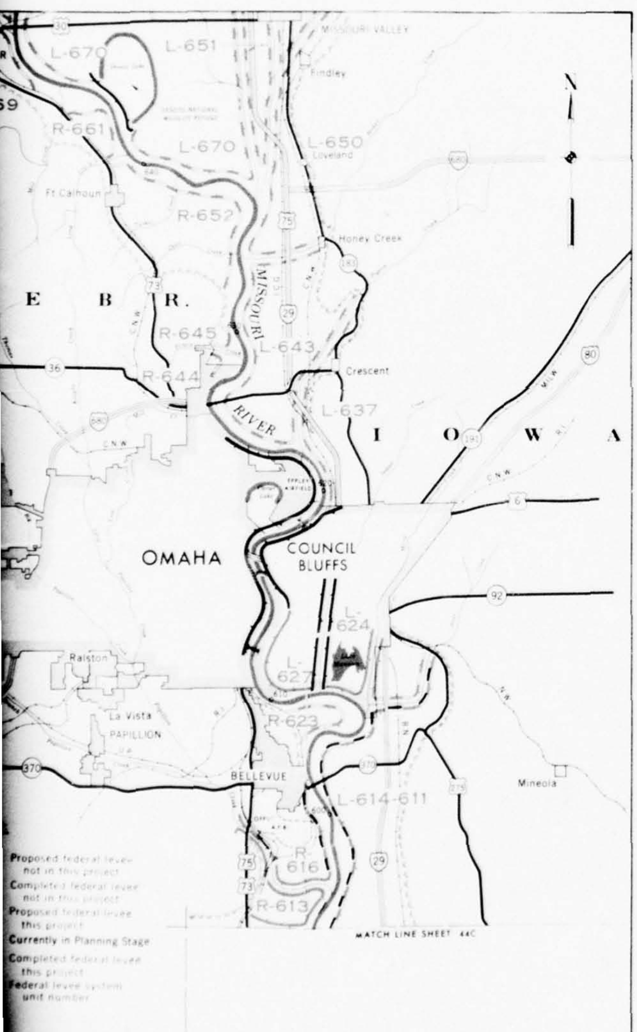

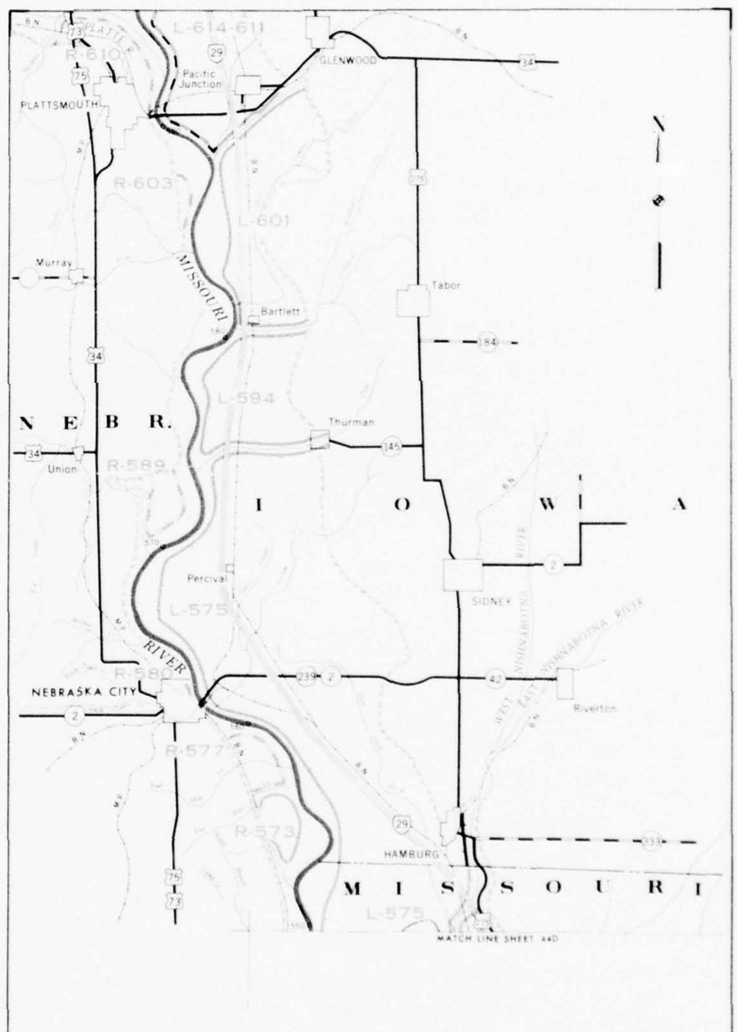

METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
AUTHORIZED MISSOURI RIVER
LEVEE SYSTEM

U S ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

JUNE 1975

VOLUME III ANNEX D PLATE F2-1

PART III

FORMULATING A PLAN

1. This section presents a discussion on the formulation and evaluation criteria used, the possible solutions considered, and the basis for selecting the final plan. In formulating a plan, it was imperative to consider all appropriate alternative plans. Such alternatives were then screened to arrive at the plan that best responds to the problems and needs of the area.

Possible Solutions

2. The residual flood problem in the Missouri River flood plain is minor, and most of the area still subject to flooding is agricultural. The authorized levee units could provide protection for

this area, if the flood problems were considered severe enough to economically justify their construction. Since the existing flood problem is minor, structural solutions were not found to be economically justified. Only nonstructural alternatives, therefore, were considered, including the alternative of "no action". Nonstructural measures considered included insurance, flood plain zoning, flood proofing of both individual buildings and single land tracts, and permanent evacuation of flood plain areas. In the case of "no action", it was assumed that there would be no Federal action but that county and city officials would adopt flood plain zoning regulations in accordance with Public Law 93-234.

NONSTRUCTURAL MEASURES

INSURANCE

3. Flood insurance, which does not prevent damages to existing development, should not be considered alone, but should be considered as a supplement to flood plain management. The cost of insurance exceeds the benefits that would be derived by the amount of the administrative and actuarial costs.

ZONING

4. The Omaha District, Corps of Engineers, currently has a floodway study underway. This study will show flood profiles relative to the streambanks and streambed. The flood profiles will provide a suitable basis for adoption of land use controls. The four future land use concept plans discussed in Alternative Futures, Annex A, of Volume III, show the Missouri River flood plain being used for parks, open space areas, and industrial development. With the passage of Public Law 93-234, it must be

assumed for the purposes of this study that local officials will comply and that the 100-year flood plain will be zoned. In the flood plain fringes--outside the reserved floodway--buildings could be constructed provided that they are adequately protected against flood damages.

FLOOD PROOFING

5. Flood proofing is employed primarily for the reduction or elimination of flood damages to existing structures. Flood proofing includes, but is not limited to:

- Raising existing buildings;

- Providing individual dikes around existing structures;

- Providing permanent or temporary watertight covers for all openings;

- Protecting roads and utilities; and

- Anchoring flotable structures and facilities.

6. Flood proofing of existing structures in a potential flood zone could take any of the above-mentioned steps to provide adequate protection against possible damage. Economic studies revealed that flood proofing of all existing structures located in the flood plain would be economically infeasible by a wide margin. On a building-by-building basis, some of the industrial complexes may find that flood proofing is warranted. Flood proofing of future development in the Missouri River flood plain

area would be feasible; however, such measures would be the financial responsibility of individuals who build in the flood plain.

EVACUATION

7. Permanent evacuation of the flood plain could be used to reduce the flood damage potential. Such a measure could involve removal of all buildings and property in the flood plain. Lands acquired in this manner could remain in agricultural use or be used for parks, greenbelts, open spaces, or other purposes that would not interfere with floodflows or result in material damage from floods. After preliminary analysis, this alternative was found to be infeasible due to high acquisition costs.

SUMMARY OF NONSTRUCTURAL MEASURES

8. With the current interest in developing the Missouri River flood plain, delineation of flood hazard areas and flood frequencies would provide information regarding the suitability of developing in certain areas. On the basis of the preceding discussions, particularly existing problems and needs, it was concluded that zoning was the best alternative. Although this approach does not solve the flood problem for the existing structures in the flood plain, it will help to eliminate or greatly reduce future increases in flood damages. Where landowners feel flood proofing is warranted, this should be adopted or they should purchase flood insurance.

Alternatives Considered Further

9. The "no action", or flood plain zoning alternative, appears to be the most favorable alternative.

Selecting a Plan

10. Local officials should zone the Missouri River flood plain in accordance with Public Law 93-234. This would limit increases in flood damages by restricting future development that would otherwise occur. Existing structures on the flood plain should be insured or flood proofed on an individual basis.

SECTION G

PAPILLION CREEK EVALUATION

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SECTION G

PAPILLION CREEK EVALUATION

PART I

RESOURCES AND ECONOMY OF THE STUDY AREA

1. The Papillion Creek study area lies entirely within Washington, Douglas, and Sarpy Counties in Nebraska. Douglas and Sarpy Counties constitute the Nebraska portion of the Omaha-Council Bluffs Standard Metropolitan Statistical Area.

2. Omaha, the Douglas County county seat, had a 1970 population of 347,380. The metropolitan area is served by Interstates 80 and 29, U. S. Highways 6, 73-75, and 275, and State Highways 36, 38, 50, 64, 85, 92, and 133. The Omaha area is served by eight railroads; they are the Burlington Northern Inc.; the Chicago, Milwaukee, St. Paul, and Pacific Railroad; the Chicago and North Western Transportation Co.; the Illinois Central Gulf Railroad; the Norfolk and Western Railway Co.; the Missouri Pacific Lines; the Chicago, Rock Island and Pacific Railroad; and the Union Pacific Railroad. The home office of the Union Pacific Railroad and the regional office for Burlington Northern Inc. are located in Omaha. In addition, about a dozen off-line railroads maintain offices in Omaha. Six major airlines operate daily from Eppley Airfield. Five smaller airports

are located on the outskirts of Omaha. Omaha is also served by five bus lines and five barge lines.

Environmental Setting and Natural Resources

BASIN DESCRIPTION

3. The Papillion Creek basin contains approximately 402 square miles. The basin is about 41 miles long and has a maximum width of 17 miles. The central portion of the basin is urbanized while the upper and lower portions are agricultural.

4. Three main tributaries form the Papillion Creek basin - the Little Papillion Creek, the Big Papillion Creek, and the West Branch Papillion Creek.

HISTORICAL - ARCHEOLOGICAL FEATURES

5. Papillion Creek and its tributaries flow through the historically rich Omaha-Council Bluffs SMSA. The area's heritage includes a a variety of events associated with the Spanish conquistadors, Lewis and Clark's explorations, Mormon migrations, the frontier era, and the American Indian culture.

NATURAL RESOURCES AND ENVIRONMENTAL CHARACTERISTICS

6. The central portion of the basin is an urban setting composed of the cities of Omaha, Ralston, Bellevue, and Papillion. Intensive farming is practiced throughout the remainder of the basin. Less than 1 percent of the land area remains in native tree, grass, and shrub cover. A significant portion of this area fringes the drainageways and comprises most of the basin's wildlife habitat. Species of woody vegetation found in the basin include cottonwood, box elder, mulberry, willow, green ash, silver maple, American elm, walnut, and cedar. Nettle, ragweed, chokecherry, gooseberry, honeysuckle, timothy, wild rye, brome, clover, and foxtail number among the shrub and grass species found in the basin.

7. Game birds and animals inhabiting the basin include whitetail deer, bobwhite quail, cottontail rabbits, fox squirrels, and pheasants. Nongame species include fox, coyote, raccoon, mink, weasel, muskrat, opossum, skunk, and the common species of moles, shrews, ground squirrels, field mice, and rats. Common resident birds include the yellow-shafted flicker, downy woodpecker, bluejay, black-capped chickadee, robin, cardinal, and American goldfinch. Woody vegetation along the creeks attracts numerous species of warblers, orioles, sparrows, thrushes, hawks, and owls during spring and fall migrations. Numerous bird species such as the red-headed woodpecker, eastern phoebe, catbird, and brown thrasher find suitable nesting habitat in the basin. Waterfowl are found occasionally in the basin but rarely on any of the Papillion Creek tributaries.

8. The game populations within the basin have been decreasing the past few years due principally to decreasing habitat. During this same period, the number of hunters has been increasing which results in heavy hunting pressure. The posting of land by private

owners to prohibit hunting has helped to reduce the hunting pressure and conserve existing game populations.

Human Resources

STUDY AREA

9. The three-county region of Washington, Douglas, and Sarpy Counties comprises the study area. Douglas and Sarpy Counties are primarily urban oriented while Washington County is primarily rural.

POPULATION CHARACTERISTICS

10. During the 1960-1970 period, population in the three-county region increased from 386,874 to 468,965, representing a net gain of 82,091 people. Douglas County accounted for approximately 56 percent of this growth, or 45,965; Sarpy County accounted for approximately 42.5 percent, or 34,919. The population growth in Washington County accounted for only 1.5 percent of the region's total population growth. Table G1-1 presents the 1960 to 1970 population changes for the study area.

Table G1-1
Population Changes 1960-1970
Papillion Creek Study Area

	1960	1970	Percent Change
Washington County	12,103	13,310	10.0
Kennard	331	336	1.5
Washington	44	76	72.7
Douglas County	343,490	389,455	13.4
Millard(1)	1,014	7,460	636.0
Omaha	301,598	347,328	15.2
Ralston	2,977	4,265	43.3
Bennington	341	683	100.3
Elkhorn	749	1,184	58.1
Sarpy County	31,281	66,200	111.6
LaVista	---	4,807	---
Papillion	2,235	5,606	150.8
Gretna	745	1,557	109.0

(1) Census included population in both Douglas and Sarpy Counties. Millard was annexed by Omaha in 1973.

Source: Census of Population: 1960, 1970.

INCOME

11. Table G1-2 presents 1970 income statistics for the study area and the percent of families in the study area with an income less than poverty level. Median family income for the Nation was $9,586; 10.7 percent of all families in the Nation had incomes less than the poverty level.

Table G1-2
Income Statistics
Papillion Creek Study Area

	Washington	Douglas	Sarpy	Omaha SMSA*
Number of Families	3,385	94,795	14,708	119,280
Median Income of Families ($)	8,808	10,419	10,209	10,214
Percent of Families with Income Less than Poverty Level	8.4	6.7	5.7	6.8

Source: Census of Population, General Social and Economic Characteristics 1970, and U. S. Summary.

* Includes Pottawattamie County, Iowa

Development and Economy

POPULATION PROJECTIONS

12. Table G1-3 presents population projections for OBERS Water Resources Subarea 1023 and the four alternative growth concepts, discussed in Section A of this Annex. The growth concepts are presented in more detail in Volume III, Annex A, of this urban study.

Table G1-3
Population Projections
Papillion Creek Study Area
(Thousands)

	1970	1995	2020
Water Resources Subarea			
1023	867.7	164.1	1,094.9

Source: OBERS, Series E, 1972, Volume 3.

	Douglas	Sarpy	Washington	*SMSA Total
1970, Census	389.5	66.2	13.3	542.6
1995, Concepts				
A	533.4	215.4	17.8	850.9
B	515.8	176.8	42.1	795.1
C	581.7	167.1	17.8	850.9
D	523.5	225.3	17.8	850.9
2020, Concepts				
A	650.2	260.7	19.3	1,034.5
B	635.0	220.2	52.2	970.6
C	686.5	228.5	19.3	1,034.5
D	619.3	288.2	19.3	1,034.5

Source: Volume III, Annex A, Alternative Futures Appendix

* Includes Pottawattamie Co., Iowa.

LAND USE

13. Urban land within the basin nearly doubled from 1956-1970. The trend toward urbanization is continuing. The most important urban growth sectors are in western Douglas County and northeastern Sarpy County. Population pressures in the Omaha metropolitan area have led to accelerated construction of both residential and commercial facilities in the basin.

14. As a "riverfront city", Omaha's central business district is on its eastern periphery bordering the Missouri River. Until 1970, the city's suburban development was characterized by low density, single lot development with convenience centers serving the neighborhoods. More recent growth has added a substantial number of high density apartment complexes to the western suburbs. These contribute to the heavy east-west vehicle traffic which is already taxing the capacity of the major traffic arteries.

15. The corporate limits of the city of Omaha extend into all of the major subbasins in the Papillion Creek system, and growth within the city's planning jurisdiction is progressing rapidly. New development is rather evenly distributed around the entire western periphery of the city of Omaha and is proceeding in the typical "skip over" pattern.

16. In the 1958-1967 period, the urban and built-up area of Sarpy County expanded by 46.8 percent to a total of 11,600 acres. According to the Nebraska Conservation Needs Inventory, Washington County experienced a 21 percent increase in urban land to a 1967 total of 7,500 acres.

17. In the 4-year period from 1966 to 1970, residential structures within the flood plain of Papillion Creek and its tributaries increased by 263 units to a total of 1,560 units with a total valuation of $27,274,000. In the same period, commercial establishments increased by 91 units to a total of 351 units with a valuation of $47,589,000. In 1970, 91.5 percent of the 21,500-acre Papillion Creek basin flood plain was used for agricultural purposes.

18. The major investment in flood plain development has been made in the Little Papillion subbasin and more than half of this is

represented by commercial properties in the city of Omaha. The Big Papillion Creek basin flood plain also encompasses a substantial amount of Metropolitan Omaha development. Table G1-4 summarizes 1970 flood plain development.

19. Implementation of flood plain zoning through the urban area will slow the development rate in the flood plain. As Omaha expands, however, pressure to develop the unzoned fringe portions of the flood plain would result in increased flood damages.

Table G1-4
Flood Plain Development, 1970

	Papillion	Big Papillion	West Papillion	Little Papillion	Papillion Creek Basin
Commercial					
Acres Developed	42	174	87	238	541
Percent of Total Acres	7.8	32.2	16.1	44.0	100.0
Residential					
Acres Developed	27	166	154	260	607
Percent of Total Acres	4.4	27.3	25.4	42.8	100.0
Transportation					
Acres Developed	10	174	90	130	404
Percent of Total Acres	2.5	43.1	22.3	32.2	100.0
Other Facilities					
Acres Developed	60	150	60	250	520
Percent of Total Acres	11.5	28.8	11.5	48.1	100.0
Agriculture					
Acres Developed	6,561	6,796	5,189	882	19,428
Percent of Total Acres	33.7	35.0	26.7	4.5	100.0
Total					
Acres Developed	6,700	7,460	5,580	1,760	21,500
Percent of Total Acres	31.2	34.7	26.0	8.2	100.0

PART II

PROBLEMS AND NEEDS

Prior Studies and Reports

1. The purpose of this section is to summarize the water resource problems and needs relating to floods, erosion damage, and irrigation in the Papillion Creek study area. This section also provides information on existing plans and improvements in the area. As an indication of the relative flood hazard, figure B2-1 defines the flood potential by frequency of occurrence in years.

2. A Preliminary Examination Report, dated 22 March 1948, was prepared in response to a Congressional resolution for a study of Little Papillion Creek. The report recommended a survey of the Papillion Creek basin in the interest of flood control.

3. As a result of the preliminary examination, a survey report, published as House Document 475, 87th Congress, 2d Session, 12 July 1962, was made. This report recommended channel improvements on

Little Papillion Creek for a distance of approximately 6.5 miles through Omaha, Nebraska. The report also found that protection of Offutt Air Force Base was economically justified. As a result, protection of Offutt Air Force Base was approved for construction as a military project. The channel improvements on Little Papillion Creek were authorized and the project has been completed.

4. A report on Papillion Creek and Tributaries, Nebraska was published as House Document 349, 90th Congress, 2d Session, 3 July 1968. The report was in response to a resolution adopted by the Committees on Public Works of the United States Senate and the House of Representatives on 22 June 1964 and 3 September 1964 requesting that the Board of Engineers for Rivers and Harbors "review the report of the Chief of Engineers on Papillion Creek and Tributaries, Nebraska, published as House Document 475, 87th Congress, and other pertinent reports, with a view to determining whether any modifications of the recommendations contained therein are advisable at this time." The report recommended the construction of a system of 21 dams and reservoirs at locations throughout the Papillion Creek basin to serve the purposes of flood control, recreation, fish and wildlife enhancement, and water quality control. The system of dams was authorized and two of the dams have been completed except for recreation functions.

5. Flood plain information reports have been published for Papillion Creek and for most of its major tributaries in the Omaha metropolitan area. The standard project flood outline and flood profiles are available from the flood plain information reports.

6. In September of 1975 a plan evaluation report was completed. The plan evaluation was made to determine the advisability and feasibility of modifying the authorized project. The evaluation

demonstrated that Dam 10, as authorized, is a feasible and necessary project element for solving the flood problems in the Little Papillion Creek flood plain.

7. In the West Branch Papillion Creek, the evaluation demonstrated that the changes since authorization have, indeed, significantly impacted on the feasibility of the authorized reservoir system in this drainage. As this evaluation progressed, it became obvious that a complete reformulation would be required to develop a feasible and cost-effective plan for this area. Since what may be done, or not done, in the West Branch area is not affected by the Big and Little Papillion Creek plan elements, and vice versa, it is considered prudent to defer, or postpone, further implementation of the authorized plan elements in the West Branch Papillion Creek until detailed reformulation studies are completed.

8. The study in the Big Papillion Creek portion of the basin proceeded through a screening procedure and numerous plan iterations, including all reasonable alternatives, to arrive at a selected plan for this area. It was found that construction of one relatively large dam and reservoir on Big Papillion Creek north of the city of Omaha would be the most cost-effective and economically, socially, and environmentally acceptable solution. Accordingly, the authorized plan in the Big Papillion Creek drainage should be modified to include construction of this one dam in lieu of nine dams further upstream that are authorized, but not yet constructed.

Existing Plans and Improvements

9. Stream channel improvements have been constructed in the Papillion Creek basin over the last 50 years by several short-lived drainage districts. The channels in upstream reaches were straightened and enlarged. This has resulted in increased flooding in the downstream portion of the basin. Local efforts to increase flood protection by further channel widening and by spoil bank levee construction in the downstream portion of the basin have not been successful. In 1961, the Corps of Engineers completed a survey investigation for flood control on Papillion Creek and its tributaries. That report recommended channel improvements on Little Papillion Creek from Maple Street to its confluence with Big Papillion Creek. The Little Papillion Creek channel improvement project was authorized for construction by the Flood Control Act of 1962. The project has been completed and provides protection for the highly developed areas along the Little Papillion Creek flood plain.

10. In 1964, under authority of Section 208 of the 1954 Flood Control Act, a channel snagging and clearing project was completed on the downstream 1 mile of Papillion Creek.

11. The Flood Control Act of 1968 authorized the construction of 21 reservoirs for flood control, water quality control, recreation, and fish and wildlife enhancement. Construction of the authorized system was initiated in 1972. Presently, Dams 16 and 11 are essentially complete except for the development of recreation facilities. In the West Branch basin, land acquisition has been essentially completed for Dam 20 and design of Dams 15 and 18 is also essentially completed. Plate G2-1 shows the authorized 21-dam system.

12. The Papio Natural Resources District is currently enlarging the channel and constructing levees along the downstream reaches of Papillion Creek. The completed portion extends from Missouri River Levee Unit R-613 upstream to near the confluence of Big and Little Papillion Creeks and is designed to complement the authorized system of 21 dams.

13. In 1973 the city of Omaha zoned the flood plains of the Papillion Creek basin within its jurisdiction. The zoning restricts development within the 100-year flood plain in accordance with Public Law 93-234 which established the National Flood Insurance Program.

Flood Problem

14. Past flood experience has shown that the flood problem in the basin is serious. Floods or threats of floods occur almost every year during the summer thunderstorm season, when about 40 percent of the annual precipitation occurs. In recent years floods occurred in 1959, 1960, 1964, and 1965. The Big Papillion Creek drainage area sustained flood damage in all 4 years. The Little Papillion Creek drainage area escaped the 1964 flood, but sustained heavy flood damages in 1960 and 1965. The 1964 flood, which was the basin's most damaging flood, centered over the West Branch drainage area and caused an estimated 5 million dollars in damage and the loss of seven lives. The 1959 flood also caused damage along the West Branch. The Papillion Creek valley has sustained damage from virtually every flood event due to the discharge concentration from the three major tributaries converging on this stream. Continued urbanization of the Papillion Creek basin will cause increases in future peak discharges, and future development within unrestricted

portions of the flood plain will also increase the damage potential.

15. The flood plains of the principal streams in the Papillion Creek basin drainage system generally average about one-half mile in width. Along Papillion Creek, and a few other locations, usually at the junction of two streams such as Little and Big Papillion Creeks, the flood plain broadens to about 1 mile. Land use in the flood plains includes major residential, commercial, industrial, agricultural, and military developments. Papillion Creek and its major tributaries can be considered in three distinctive geographic areas. These areas are the Little Papillion Creek, Big Papillion Creek, and West Branch Papillion Creek and Lower Papillion Creek. The Big Papillion Creek, for the purposes of evaluating the problems and needs of the Papillion Creek basin, includes the upper 5-mile stretch of the Papillion Creek between the confluence of the Big and Little Papillion Creeks and the confluence of Papillion Creek with the West Branch. The following paragraphs describe the principal areas subject to flood problems according to these three geographic areas.

LITTLE PAPILLION CREEK

16. Little Papillion Creek originates in Washington County and joins the Big Papillion Creek in Omaha between L Street and Q Street.

17. Upstream from the town of Irvington, where Knight and Thomas Creeks unite to form Little Papillion Creek, approximately 300 acres of agricultural land are subject to flooding. Downstream from Irvington, the creek flows through a highly developed flood plain which includes 1,521 residential units and 208 commercial and industrial establishments with an estimated value of over $130,000,000. In

addition to the residential and commercial properties, the flood plain has improvements in public transportation facilities that are valued at an estimated $14,000,000. A branch line of the Chicago and North Western Transportation Co. parallels the stream for most of its length. About 1 mile upstream from the mouth of Little Papillion Creek, the Union Pacific Railroad crosses the flood plain. In addition to Interstate 80 and several State highways, numerous paved and improved streets are located in the flood plain and numerous bridges provide crossings for the principal streets. With the constructed channel improvement project, construction of Dam 11, and the adopted flood plain regulations on the Little Papillion Creek to prevent encroachment on the remaining flood plain downstream from the dams, the construction of Dam 10 would complete the authorized plan on Little Papillion Creek to provide a high degree of flood protection.

BIG PAPILLION CREEK

18. Big Papillion Creek originates in Washington County and joins with the Little Papillion Creek to form Papillion Creek between L Street and Q Street near the town of Ralston. Also included in the Big Papillion Creek basin, as defined previously, is that portion of the Papillion Creek downstream to the mouth of the West Branch of Papillion Creek. The upstream reaches of the Big Papillion Creek flood plain are primarily rural in character. Portions of the towns of Kennard, Bennington, and Ralston--in addition to the city of Omaha--lie within the flood plain. The reach in Omaha, from Fort Street to Q Street, is extensively developed. Downstream from Q Street the flood plain is primarily rural in character. Improvements in the flood plain include residential, commercial, industrial, and public and private transportation

facilities, as well as recreation areas such as golf courses and parks. About 1,680 residential units and 249 commercial and industrial establishments are located in the flood plain. The value of these improvements is estimated at $59,000,000. Portions of Interstates 80 and 680 are located in the flood plain as are numerous State highways, county roads and streets, and railroad facilities. The value of public transportation facilities in the flood plain is estimated at $35,000,000. Currently there are 7,700 acres of land in the flood plain; about 870 acres are developed and the remaining 6,830 acres are in agricultural use or are undeveloped.

WEST BRANCH AND LOWER PAPILLION CREEK

19. The West Branch originates in Douglas County upstream from the town of Elkhorn and joins the Papillion Creek about 3 miles upstream from U. S. Highway 73-75 near Offutt Air Force Base. The Papillion Creek enters the Missouri River about 4 miles downstream from Highway 73-75. The West Branch and the Lower Papillion Creeks flow principally through an agricultural area. The flood plain varies from 0.5 mile to 1 mile in width. Approximately 7,000 acres are subject to flooding. Downstream from Highway 73-75 on the common flood plain of Papillion Creek, the Platte River, and the Missouri River are located: Offutt Air Force Base, the headquarters of the Strategic Air Command; an industrial plant which processes meatpacking waste materials; a chemical plant; and a new $100,000,000 waste-treatment plant which is under construction. Upstream from Highway 73-75, the towns of Millard and Papillion are in the West Branch flood plain. The remaining area is rural in character. Residential development in the flood plain consists of 303 living units; 160 are trailers and the remainder are homes or apartment units. There are 100 commercial and industrial establishments

located within the flood plains. The value of the residential, industrial, and commercial improvements, excluding Offutt Air Force Base and the waste treatment plant, is $20,000,000. The flood plain is crossed by Interstate 80, several State and county highways, and by city streets. Several railroads cross or parallel the stream in the flood plain. The value of transportation and public facilities within the flood plain is about $24,000,000.

RAINFALL FLOODS

20. The principal cause of flooding in the basin is the rapid runoff from high-intensity rainfall. The hilly terrain, with its numerous small tributary streams and gulches, provides rapid concentration of runoff, causing quick rises in stream stages. Flood stages normally subside within 24 hours or less. In recent years, the increasing amount of impervious areas, such as the streets and rooftops of urban developments, has resulted in an increase of both the amount and rapidity of runoff. This characteristic, together with the terrain and stream slopes of the hilly portions of the basin, can be expected to produce greater flood velocities and more destructive floods as urbanization of the basin progresses. With the greater exposure to flooding inherent in basin urbanization, the hazard to life and the magnitude of economic damage potentials can be expected to increase.

21. The highly erodible loess-soil mantle of the basin produces a heavy sediment load during floods. Consequently, the deposit of silt on flooded property serves to aggravate flood damages. Moreover, flood discharges tend to carry a heavy load of natural debris from wooded portions of the basin. This debris frequently lodges at bridge crossings and constricted channel sections and causes higher stages and increased flood damages.

SNOWMELT FLOODS

22. Historically, snowmelt runoff has not contributed significantly to the flood problems of the basin. Under certain conditions of excessive snow accumulation, and rapid spring melting accompanied by heavy rainfall, however, snowmelt runoff can be expected to produce damaging floods. Nevertheless, the probable frequency of snowmelt floods is not expected to contribute significantly to the flood damage potential of the streams in the basin.

HISTORICAL DAMAGES

23. Records of past flooding are incomplete and are not sufficient to give a good indication of the flood damage severity in the basin. Furthermore, with expanding urban development within certain portions of the basin, runoff characteristics have been altered and will continue to change in the future. A typical example of such change is the difference encountered in comparing the effects of the major Little Papillion Creek flood of 1943 with the effects that could be expected today from a flood generated from the same hydrologic conditions. Discharge measurements made in 1943 indicate that a peak discharge of about 9,000 c.f.s. occurred near the mouth of Little Papillion Creek. Approximately 660 acres were flooded in Omaha. The flooded area included 75 residences and 19 commercial establishments. A recurrence of this flood today would produce a peak discharge of about 15,000 c.f.s., would flood an area of approximately 1,000 acres, and would damage more than 300 homes and a great number of commercial and industrial establishments. The more recent flood of 1964 caused an estimated $5,000,000 in damages in the basin, of which 87 percent were urban damages.

24. Table G2-1 presents a summary of historic flood damages. The damage estimates shown are based on price levels and conditions of improvements existing at the time of the flood event.

Table G2-1
Historic Flood Data

Occurrence Date Year	Month	Causative Factor	Relative Magnitude	Damage, Historic Price Levels
*1929				
*1932				
*1936				
*1938				
*1941				
*1943			Minor	$ 200,000
1948	July	Rainstorm	Major	Not available
1950	July	Rainstorm	Moderate	Not available
1959	August	Rainstorm	Major	$1,090,000
1960	June	Rainstorm	Moderate	$ 671,000
1964	June	Rainstorm	Major	$4,962,000
1965	September	Rainstorm	Moderate	$ 529,000

* Information not available for these flood events.

AVERAGE ANNUAL DAMAGES

25. Potential flood damage to existing flood plain development was calculated for each tributary flood plain. Value, type, and elevation of the improvements subject to flooding were determined by field appraisals. Depth-damage relationships developed for the Omaha Flood Insurance Study were correlated with stage-frequency relationships to obtain damage-probability relationships. Integration of these relationships yields average annual flood damages. Table G2-2 presents the average annual damage potential for existing conditions by category for each tributary basin.

Table G2-2
Average Annual Flood Damages
Existing Conditions

	Category				
	Community	Commercial & Industrial	Whole-saling	Agri-culture	Total
Little Papillion	$ 77,000	$ 191,100	$ 21,600	$ 2,300	$ 292,000
West Branch & Lower Papillion	248,700	79,200	72,200	147,900	548,000
Big Papillion & Upper Papillion	373,000	790,400	61,600	80,000	1,305,000
Total	$698,700	$1,060,700	$155,400	$230,200	$2,145,000

Growth Patterns

GENERAL

26. The Omaha-Council Bluffs metropolitan area is referred to as the Standard Metropolitan Statistical Area (SMSA) and encompasses Douglas and Sarpy Counties in Nebraska and Pottawattamie County in Iowa. The Papillion Creek basin lies entirely within Washington, Douglas, and Sarpy Counties in Nebraska. Approximately 75 percent of the basin lies within Douglas and Sarpy Counties.

27. Prior to World War II, Omaha's growth was primarily north and south along the Missouri River, and Council Bluffs developed generally east and west along the main traffic arteries. Since World War II, development has occurred around the western fringe of Omaha and on the north and east of Council Bluffs, following development of major highways in these areas.

28. Further improvements in the transportation system, particularly the interstate system, have caused urban sprawl south and west of Omaha. Council Bluffs growth to the south and farther to the east has also been due to the development of the interstate system. Plate G2-2 presents the existing land use of the SMSA.

DOUGLAS COUNTY

29. The largest concentration of population in Douglas County is in the southeast portion, in and surrounding the city of Omaha. In 1915, the city of Omaha was bounded on three sides by the first circle of small towns. With Florence, Benson, Dundee, and South Omaha all adjoining Omaha, the city faced the possibility of no future expansion. As a result of a popular vote for consolidation by area residents, South Omaha and Dundee were annexed in 1915, and in 1917, Benson and Florence became part of the city. These annexations increased Omaha's total land area to 34.6 square miles. From 1918 through 1949 the rate of expansion declined, except for a 2-year period from 1925 to 1927; during this period, the city completed eight annexations containing more than 830 acres west and southwest of Omaha. The rate again rose as a result of the post-World War II housing boom. From 1951 to 1956 the city annexed 15 large areas; this added more than 7.6 square miles to the city's land area, bringing Omaha's total size to 45.6 square miles and the population

to 260,000. Since 1956 Omaha has completed more than 200 separate annexations. These annexations ranged in size from single lots to tracts as large as 3.1 square miles. These annexations have been predominately west and southwest in direction, and have moved Omaha's western boundary from its location east of 72nd Street, in 1956, to its present location at 156th Street. Although the annexed areas are primarily residential, containing a population of 80,000 people, they also contain considerable commercial and industrial development. Commercial and industrial development expanded in corridors along major thoroughfares and railroads.

SARPY COUNTY

30. The city of Bellevue, Offutt Air Force Base, and Capehart, located along the Missouri River, make up the major centers of population in Sarpy County. The cities of Papillion and La Vista, located in north-central Sarpy County, comprise another major concentration of urban population. The cities of Gretna and Springfield in the western part of the county also add to the urban population. Since 1940, Sarpy County has experienced the most rapid rate of growth of the three SMSA counties and is one of the Nation's fastest growing counties.

Future Flood Problem

31. Future development is expected to occur in the metropolitan area according to one of the four growth concepts developed as part

of the Omaha-Council Bluffs Urban Study. Three of the concepts envision population and employment growth concentrated in Douglas and Sarpy Counties. Of these three concepts, two represent continued sprawl while the third represents restoration and redevelopment of the inner city. The fourth concept, while basically a "restricted growth policy", also distributes an additional 5 to 10 percent of future growth to the satellite cities outside of Douglas and Sarpy Counties. The opinion of local planning agencies and the public is that future growth will occur according to one of the three concepts that concentrates growth in Douglas and Sarpy Counties. Under these growth concepts, the presently undeveloped portions of the Papillion Creek flood plains above the 100-year flood level are expected to continue to develop for residential, commercial, and industrial use. New development within the 100-year flood plain is currently being flood proofed with landfill. The demonstrated attraction of the flood plain and the fact that major recent improvements have been constructed on fill to the 100-year flood level indicate that the advantages of the flood plain are such that development in the nonrestricted portion of the flood plain will continue.

FUTURE AVERAGE ANNUAL DAMAGES

LITTLE PAPILLION CREEK

32. The Little Papillion Creek flood plain is presently about 80 percent developed and full development is expected to occur in the next 10 years. Dam 10 is the only remaining element of the authorized plan in the Little Papillion Creek basin that has not been constructed. The benefit-cost ratio for Dam 10 under existing conditions of development is 1.6 to 1 for flood control only. Since benefits based on future development are not required for justification, and the flood plain is extensively developed, no estimate of future flood control benefits was made on Little Papillion Creek.

WEST BRANCH PAPILLION CREEK AND PAPILLION CREEK

33. Land use in the West Branch Papillion Creek flood plain is basically agricultural. The amount of urban development is relatively small when compared to the Big and Little Papillion Creek flood plains. From the existing average annual damages, it is obvious that a significant amount of increased future average annual damages would be required to justify the authorized plan in West Branch Papillion Creek. Future average annual damages for West Branch and Papillion Creeks were not determined as part of this report. The future annual damage potential will be analyzed in a report to be completed in 1976 reviewing the authorized plan.

BIG PAPILLION CREEK

34. A future flood damage analysis was conducted only for Big Papillion Creek, including the 5 miles of Papillion Creek upstream from the West Branch. Under future conditions of development, the average annual damage potential in this reach would increase from $1,305,000 to $2,322,000 with Dams 11 and 16 controlling. With Dams 10, 11, 16 controlling, and with future conditions of development, the average annual damage potential in this reach would increase from $1,217,000 to $2,290,000. A detailed description of the flood damage analysis is presented in appendix A of the Plan Evaluation Report, September 1975, on Papillion Creek and Tributaries Lakes, Nebraska.

Other Problems and Needs

IRRIGATION

35. There are no organized irrigation districts within the Papillion Creek basin. Precipitation is normally adequate for the growing of crops and dryland farming is the general practice. A few farmers irrigate from wells or with water purchased from municipal services. A total of 18 water rights for pumping from streamflows within the basin has been approved by the State of Nebraska. Most of the rights date from the drought period of the 1950's. The total approved appropriations exceed the low flows that occurred in the drought period. Presently there is no demand for irrigation. Agricultural acreage within the basin is continuously declining due to urbanization.

NAVIGATION

36. Any project for navigation in the basin would require more water than can be supplied by the basin. The average annual flow of the basin, if uniformly discharged during the navigation season, would supply only 200 cubic feet per second of the 30,000 cubic feet per second required in the Missouri River at Omaha in the navigation season.

HYDROELECTRIC POWER

37. Due to the basin's limited water supply, the development of hydroelectric power is impractical.

WATER SUPPLY

38. Water supply for the growing Omaha metropolitan area is furnished from several different sources. The major portion of the Omaha area obtains its water from the Missouri River. Backed by six major reservoirs, the Missouri River supply is adequate to meet any forseeable demand of the urban area. In order to eliminate long supply lines, the Metropolitan Utilities District, a public utility which services Omaha and several nearby communities with water, recently began development of the ground water supplies of the Platte River valley south of Omaha. The extensive Platte River valley aquifer provides an excellent source of water. Some of the smaller communities, which use the Papillion Creek basin ground water as their source of supply, are expected to eventually join the metropolitan system. No condition is foreseen where it would be economical to develop a water supply from surface runoff in the Papillion Creek basin.

WATER QUALITY

39. At the present time, about 25 small sewage treatment plants are in operation within the basin. Most of these plants were built by sanitary districts and serve individual development areas. In general, the plants provide less than secondary treatment and discharge their effluent into the streams of the Papillion Creek basin. More than 5,000 acres of land in the Little Papillion Creek basin are served by combined storm and sanitary sewers that discharge overflow into streams of the basin. Pollution is a problem within the basin. This problem is recognized, and local interests have initiated construction of interceptor sewers to collect the sewage and conduct it to a large treatment plant near the mouth of Papillion Creek. A pollution problem will exist due to surface runoff and

combined overflows even with complete implementation of the new interceptor system within the Papillion Creek basin.

40. The authorized project includes water-quality control benefits based on improving the water quality in the downstream channels. This would be done by providing low-flow augmentation releases from eight of the reservoirs during nonwinter months. During pre-authorization studies, it was determined by the Federal Water Pollution Control Administration that water quality storage for municipal and industrial purposes was not required, but a need did exist for water quality control in the downstream channels.

41. Later, the Federal Water Pollution Control Act and its amendments specified that storage and water releases shall not be provided as a substitute for adequate treatment. Such low-flow releases can be provided, however, to improve the esthetics of the channels, and the water quality function has been retained for that purpose.

DRAINAGE

42. Many of the developed areas within the basin have inadequate facilities for handling stormwater runoff. The developments have obliterated natural drainage courses and local runoff is disposed of down streets and through limited-size culverts. Consequently, severe damage and loss of life has occurred. Provision of flood control works would be impractical for these areas. Flood plain information studies for some of these areas have been requested by local interests. These, when completed, will delineate the problem areas and suggest needed improvements. Drainage problems caused by high-water tables, in the past, were severe in the basin. Local interests have, over the years, largely solved this problem by channel straightening and deepening. The remaining areas with

high-water tables are of limited size. The problems are not sufficiently serious and widespread to constitute a serious basin problem.

RECREATION AND FISH AND WILDLIFE NEEDS

43. The Nebraska State Comprehensive Outdoor Recreation Plan defines recreation needs for water and land-based recreation and presents long-range plans to meet these needs. Region I as designated by the Nebraska State Comprehensive Outdoor Recreation plan includes Washington, Douglas, Sarpy, and Dodge Counties. This region has less than 2 percent of the State's land and 33.9 percent of the population. Region I has about 7,000 acres of land and 1,000 acres of water currently available for recreational use. The report states that there is currently a need for about 28,000 additional acres of nonurban land for high density recreation, general outdoor recreation, and natural environment areas. By 1990, it predicts a need for about 58,000 acres in Region I.

EROSION

44. Soils within the basin uplands are generally highly erodible loess and are subject to severe sheet and gully erosion. The Soil Conservation Service has an authorized plan consisting of land treatment and 52 grade-stabilization structures to further reduce erosion. The Service has assisted in the development of land-treatment measures in portions of the basin and is actively promoting further land-treatment measures. Implementation of the land-treatment and stabilization measures will greatly reduce the erosion problems of the basin.

Summary

45. The Papillion Creek basin contains no potential for navigation or hydroelectric-power production. There are no existing or anticipated water-supply problems, as highly dependable sources are readily available from the Platte and Missouri Rivers. Drainage problems caused by high water tables are insignificant. Interior drainage problems in developed areas are of major magnitude but are not susceptible to solution by construction of flood control works. Sheet and gully erosion problems are relatively serious. Corrective measures by the Soil Conservation Service will help reduce these problems. There is no demand for irrigation, and the possibility of such a demand developing becomes less as the basin urbanizes. In the Little Papillion Creek basin, Dams 10 and 11 and the existing channel improvement project would provide a high degree of flood protection. The West Branch and Papillion Creek basin will require an in-depth reformulation. In the Big Papillion Creek basin, where widespread and damaging floods destroy property and threaten life, there is also a need for water quality control, open space, and water-based recreational areas.

Flood Problem — Tributaries Not Affected By Authorized Plan

HELL CREEK

46. Hell Creek, shown on plate G2-3, is a left-bank tributary to West Papillion Creek in the western suburbs of Omaha. From its source north of Boys Town, the creek flows through Boys Town in a southeasterly direction, crosses Pacific Street west of 132nd Street and Center Street east of 130th Street, continues southeasterly passing under the Union Pacific Railroad main line tracks, and then passes east of the Western Electric Company plant and under Interstate 80 on its way to join West Papillion Creek near Giles Road and 114th Street. The mouth and the first mile of the creek are in Sarpy County. The remainder of Hell Creek is in Douglas County. The drainage basin contains 5.7 square miles, is 6.7 miles long, and averages less than 1 mile wide. The crest of the divide forming the basin boundaries averages 80 feet above the creek. The valley slopes are steep and contain numerous, small tributary drainages. The channel has been straightened and relocated for most of its length and the channel dimensions vary considerably. Near its mouth, the channel is 14 feet deep and has a top width of 60 feet, but in the upper reaches, the channel

is only 4 feet deep with a top width of less than 10 feet. The channel bed slope varies from 5 to 50 feet per mile while the average bed slope is 26 feet per mile. The channel banks are vegetated with weeds and small trees. The flood plain width varies, but in general it is about 500 feet wide. The flood plain has been reshaped and filled in the urban areas. The rural portion of the flood plain is nearly treeless and is used for farming.

47. Two major channel improvements have been completed. A concrete channel lining was installed in 1965. The lining extends approximately 3,200 feet from the Union Pacific Railroad crossing upstream to Westwood Lane. It has a trapezoidal shape--5.5 feet deep, 14 feet wide at the bottom, and 36 feet wide at the top. A second channel improvement was completed farther upstream in 1968. This improvement consists of twin 10-foot by 5-foot concrete box culverts which extend from Center Street to 0.5 mile upstream. Channel enlargement and bed degradation on Hell Creek near the mouth have required the installation of a stabilization structure to prevent undercutting of a culvert located under the Burlington Northern Inc. crossing. The channel bed downstream from the stabilization structure is 9 feet below the floor of the culvert. Excluding Boys Town, the basin development began in the early 1960's. The upstream reach of the basin includes Boys Town, two golf courses, and several areas which have been or are in the process of residential development. The middle portion of the reach, between L Street and the Union Pacific Railroad tracks, is occupied by commercial development and public utilities. Between L and Q Streets, the eastward residential expansion of Millard extends into the basin but ends on the slopes well above the Hell Creek flood plain. Additional residential development is in progress downstream from Q Street on the east side of the creek. This development is part

of a general urbanization process along Q Street between Interstate 80 and Ralston. The downstream reach of the basin is becoming urbanized as Metropolitan Omaha extends to the southwest. A total of 17 roads cross Hell Creek, two Union Pacific Railroad tracks and a Burlington Northern Inc. track also cross the creek. Major highways that cross the flood plain include U. S. Highway 6 on Dodge Street, U. S. Highway 275 and State Highway 92 on L Street, State Highway 38 on West Center Road, and Interstate 80. The 100-year flood overtops 11 of these roadways and is diverted across Interstate 80 at the Q Street overpass. Several of the other crossings also retard floodflows and flows rise a foot or more because of the bridge or culvert restriction.

DISCHARGE PROBABILITY

48. The 100-year and standard project flood peak discharges that were developed for the Omaha Metropolitan Region Flood Plain Information Report are shown on table G2-3.

Table G2-3
Hell Creek Basin
Summary of 100-Year and SPF Peak Discharges

Location	100-Year Discharge	SPF Discharge
Mouth	4,980	9,100
Pacific Street	1,180	2,240

HISTORICAL DAMAGES

49. Hell Creek experienced record flooding in June 1964. The flood event, estimated to be more than a 100-year flood, started on the headwaters near Boys Town and was continuous throughout

the entire length of the stream. The average width of flooding was 700 feet. In the reach upstream from the Union Pacific Railroad, floodwaters covered portions of two golf courses and some wasteland. Flood depths of 5 feet were experienced and 83 residences sustained damage, of which 11 were considered a total loss. About one-half of the homes sustaining damage had first floor flooding and the other one-half had basement flooding. The total damages sustained in the flood were $446,000. Flooding may have occurred prior to this time, but there is no record; the area was agricultural land in the early 1950's.

AVERAGE ANNUAL DAMAGES

50. The average annual damages under existing channel conditions and urban development are $15,000. The average flood damages under future conditions will not change significantly with implementation of flood plain zoning by the city of Omaha.

COLE CREEK

51. Cole Creek, shown on plate G2-3, is a left-bank tributary to Little Papillion Creek; it is located in northwestern Omaha. From its source near State Street, it flows southwesterly through Benson Park, continues across 72nd Street near Bedford Street, thence along Cole Creek Drive, and finally enters Little Papillion Creek just south of the Cass Street bridge over that creek. The basin drains a 6.1 square mile drainage area which is triangular in shape with the base of the triangle at the source. It is nearly 5 miles long and is 2 miles wide. The basin is hilly and contains numerous small tributary drains. The main channel dimensions vary widely. Near the mouth the channel averages 15 feet deep, is 60 feet wide at the top, and has a bed slope of 15 feet per mile. Near the upstream end the channel is about 5 feet deep, is 20 feet wide at the top,

and has a channel slope of 33 feet per mile. Cole Creek has been straightened and realigned at several locations. Trees and bushes line the channel banks along the downstream portions of the study reach. The flood plain averages 400 feet wide.

52. The concentrations of development vary in the study reach. From Cass to Blondo Streets, the areas along the creek are nearly fully developed. From Blondo Street to Military Avenue, open areas can be found which invite additional development. Benson Park and Golf Course occupies nearly 1 mile of the flood plain above Military Avenue. The remaining 0.8 mile of the study reach upstream from Benson Park is currently being developed. Developments are predominantly residential; there is some commercial development along Cole Creek Drive at Blondo Street. Overall, about 80 percent of the basin is urbanized. Cole Creek is crossed by the Chicago and North Western Transportation Company tracks and 15 streets. Major highways include State Highway 64, carried on Maple Street, and State Highway 38, carried on Military Avenue.

53. Because of the small size of the stream, many of the structures are culverts rather than bridges. The 100-year flood overtops all but two of the roads. The roads across Cole Creek obstruct the major floods moving down the valley. The flood depths are raised upstream from each road as a result of the constrictions. The largest obstructions occur at Maple Street, Blondo Street, and Military Avenue; the upstream stage of the 100-year flood is raised 7 feet or more at each of the bridges. The upstream stages are raised 3 feet at Ames Avenue and Parkview Lane and 2 feet or less for the remainder of the streets which cross Cole Creek.

DISCHARGE PROBABILITY

54. The 100-year and standard project flood peak discharges that were developed for the Omaha Metropolitan Region Flood Plain Information Report are shown in table G2-4.

Table G2-4
Cole Creek Basin
Summary of 100-Year and Peak Discharges

Location	100-Year Discharge	SPF Discharge
Mouth	5,150	9,930
Military Avenue	4,220	8,850
Burlington Northern Inc.	470	890

HISTORICAL DAMAGES

55. Flood records are very limited and only the 1965 flood has any written history. Other flooding has occurred, but specific flood damages on Cole Creek were not isolated from the Little Papillion Creek damages. On 6 September 1965, a thunderstorm developed over Papillion Creek basin and 6 inches of rain fell in a period of little more than 2 hours. Cole Creek was out of banks along much of the reach downstream from Benson Park. Lawns, sidewalks, and driveways were eroded and undercut. Also, a considerable amount of fencing was carried away by the floodwaters. Several basements were flooded and sewers and streets were seriously damaged. The total damages caused by the flood were $26,000 of which $24,000 was damage to public facilities.

AVERAGE ANNUAL DAMAGES

56. The average annual damages under existing conditions are estimated to be $21,000.

MUD CREEK

57. Mud Creek, shown on plate G2-4, is a left-bank tributary to Papillion Creek. It is located in southeastern Omaha and western Bellevue. The drainage boundaries contain about 7,000 acres of predominantly urban land. The upstream portion of the basin, located in southeastern Omaha, contains 3,500 acres of urban land which was developed with an extensive network of combined stormwater and sanitary sewers. Two large trunk sewers, namely the South Omaha and Monroe Street sewers, divert the combined sewage flows of the upstream portion of the Mud Creek basin and discharge the flow to the Omaha-Missouri River Sewage Treatment Plant. The hydrologic analysis for this portion of the Mud Creek basin, constituting the South Omaha and Monroe Street sewer service areas, has been discussed in the Harza report and the Urban Stormwater Hydrologic Study Supplement. The downstream reach of the Mud Creek basin contains 3,500 acres of partially urbanized land drained by a 24,000-foot natural channel that flows in a southerly direction paralleling the west side of U. S. Highway 73-75.

58. A commercial and industrial area northwest of Bellevue, extending along U. S. Highway 73-75 from Childs Road downstream to County Highway 370, is subject to flood damages. Development in the flood plain area includes motels, service stations, restaurants, a used car lot, a large manufacturer of reinforced concrete products,

and a few homes. In this reach, Mud Creek crosses under both the Union Pacific tracks and U. S. Highway 73-75 in three very sharp double 90-degree bends. The channel, in addition, is obstructed by some small brush and by a thick growth of weeds. Two discharge-probability curves were developed for this portion of the Mud Creek basin as a part of a prior Section 205 Reconnaissance Study. The following paragraph describes the development of the discharge-probability curves.

DISCHARGE PROBABILITY

59. An annual peak discharge-probability curve, shown on plate G2-5, was developed for two locations along the downstream reach of the Mud Creek basin. The probability curve labeled number (1) was computed for the subbasin located upstream from the intersection of U. S. Highway 73-75 and Kasper Street. This subbasin, shown on plate G2-4, has a 1,210 acre drainage area. The probability curve labeled number (2) was computed for the basin located upstream from the confluence with Papillion Creek. This portion of the basin, shown on plate G2-4, has a 3,500-acre drainage area. The curves were derived using the Rational Formula. The annual series curves were adjusted for partial duration and expected probability according to the procedures outlined in "Statistical Methods in Hydrology" by Leo R. Beard, January 1962.

STANDARD PROJECT FLOOD

60. The standard project flood peak discharge for locations (1) and (2) is estimated to be 5,400 c.f.s. and 8,400 c.f.s., respectively.

HISTORICAL DAMAGES

61. Local interests indicate that flooding occurs every 3 to 5 years. The most recent floods occurred in 1967 and 1971. The

1967 flood was caused by a high intensity rain. The nearest recorded reading for this rainstorm was at Offutt Air Force Base, where 4.85 inches of rain fell from 9 p.m. on 20 June 1967 to 1 a.m. on 21 June 1967. The floodwaters flowed across and along Highway 73-75 for about 4,000 feet. This flood had a discharge of approximately 2,600 c.f.s., measured at County Highway 370, and caused approximately $83,000 in damages. The flood was estimated to be approximately an 80-year flood.

62. The 1971 flood occurred on 10 May. The floodwaters flowed over Highway 73-75 at Childs Road, but did very little property damage. The discharge was estimated at less than 1,000 c.f.s. Some of this flooding occurred because the creek was partially blocked with an abandoned car body.

AVERAGE ANNUAL DAMAGES

63. The average annual damages under existing conditions are estimated to be $12,000.

BETZ ROAD DITCH

64. Betz Road Ditch, shown on plate G2-3, is located in northeastern Bellevue. It is a left-bank tributary to Papillion Creek. The total drainage area consists of 1.8 square miles of rapidly urbanizing area with the predominant land use development being residential and commercial. The basin is approximately 8,000 feet wide and 13,000 feet long.

DISCHARGE PROBABILITY

65. The discharge-probability curves that were developed for this study were derived by the Rational Formula and were adjusted for expected probability, based on 48 years of record as indicated

in the Weather Bureau publication TP-40. A 1-percent hydrograph was developed for the area upstream from Highway 370 by dividing the 1-percent peak discharge by the unit hydrograph peak discharge and applying the resulting runoff to the unit hydrograph. The hydrograph was routed through the highway structure (12-foot by 12-foot reinforced concrete box culvert) by a reservoir routing procedure and this resulted in a 1-percent peak discharge of 1,800 c.f.s.

STANDARD PROJECT FLOOD

66. The standard project flood peak discharges were developed for Betz Riad Ditch at the same locations selected for the discharge-probability curves. The standard project flood has a peak discharge of 3,000 c.f.s. downstream from Highway 370. This discharge was developed by reservoir routing the standard project flood hydrograph, computed for the area upstream from Highway 370, through the 12-foot by 12-foot reinforced concrete box highway structure.

67. The 1-percent and standard project flood peak discharges that are pertinent to Betz Road Ditch are presented in table G2-5

Table G2-5
Betz Road Ditch
Summary of 100-Year Flood
and SPF Peak Discharges

Location	1-Percent Peak (c.f.s.)	SPF Peak (c.f.s.)
Below Highway 370	1,800	3,000
Above Highway 370	2,680	6,100
Below Junction at Lloyd Street	2,400	5,900
Above Junction at Lloyd Street	1,600	3,800
Below Junction at Lincoln Road	1,370	3,000
South Branch above Lincoln Road	800	1,800
North Branch above Lincoln Road	570	1,200

HISTORICAL DAMAGES

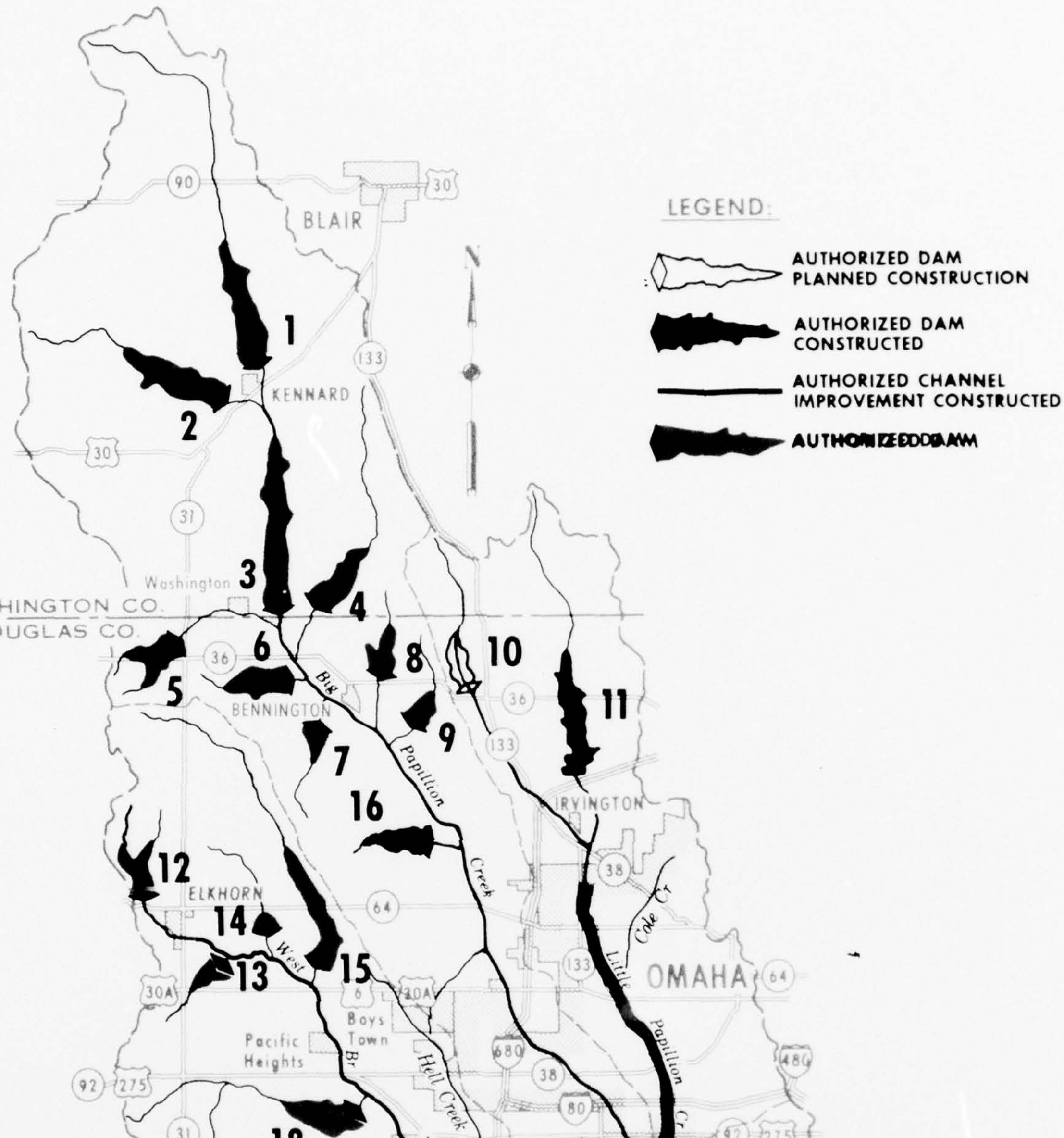
68. Betz Road Ditch experienced floods in 1967 and 1971. On 20 June 1967, more than 4.5 inches of rain fell within a 4-hour period. One life was lost when an automobile was swept off Harvell Drive between Kayleen Drive and Birchcrest Road by fastmoving floodwater. Autos were stalled at other points along Betz Road Ditch where streets and highways were inundated. On 11 May 1971, flooding again occurred along Betz Road Ditch. Rainfall totaling 6.57 inches in 6 hours was measured at Offutt Air Force Base. State Highway 131 was closed to traffic in the Birchcrest Road area. Autos were stranded in high water at the intersection of Betz Road and Twin Ridge Drive and along Harvell Drive near a shopping center. Water flowed over the bridge on Twin Ridge Drive in the spring of 1972 and the bridge on Englewood Drive was undermined.

69. Past flooding along Betz Road Ditch has been caused by localized, heavy rainfall occurring within a short time and producing flash floods. The probability of flash flooding has increased in recent years because of increased urbanization in the basin, which results in a faster rate of runoff during storms. Determination of properties subject to flooding was based on profiles from the flood plain information study, a 2-foot contour topography map prepared by photogrammetric methods from aerial photographs taken in April 1974, and field observations. The intermediate regional flood would cover an area generally averaging about 200 to 400 feet in width, although in some reaches, the flood area is limited to the channel area. Much of the flood problem is due to the inadequate capacity at culverts, and if obstructions are allowed to clog these openings, the flood damages will be even greater. It is estimated that significant damages begin at the 25-year flood level.

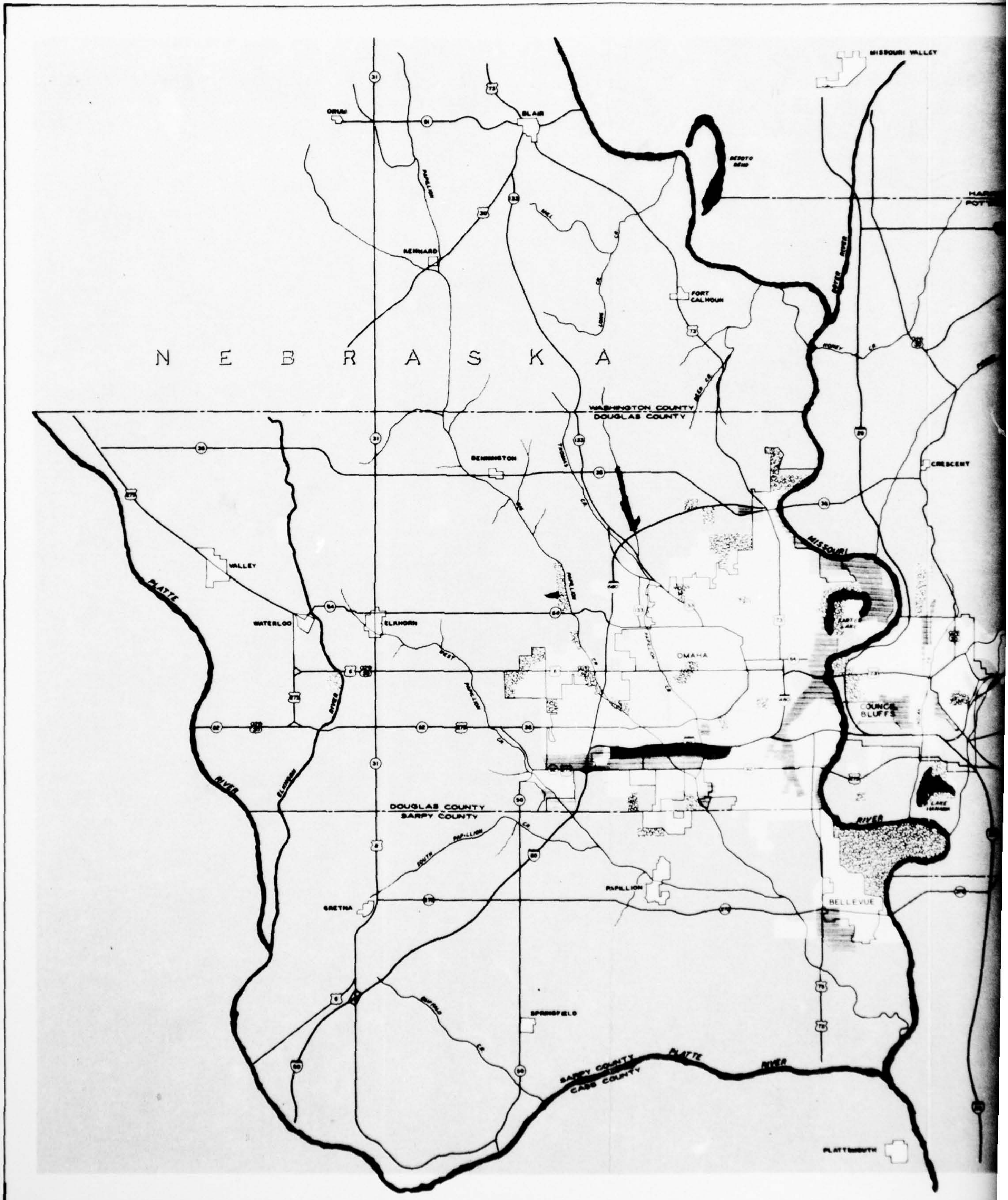
A total of 13 houses, five apartment buildings, a multiunit garage, and a parking lot for a shopping center are subject to damage by the intermediate regional flood. The probability of damage to motor vehicles has also increased because of heavier traffic in the area, due to increased population, and the shopping center area.

AVERAGE ANNUAL DAMAGES

70. Average annual flood damages along Betz Road Ditch were computed by the probability method. Using flood profiles from the flood plain information study, flood stages were compared with floor elevations of vulnerable structures. The analysis indicates that, in the absence of protective measures and based on current prices and existing levels of development, the average annual damages total $7,500.



METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
PAPILLION CREEK & TRIBUTARIES LAKES, NEBR.
AUTHORIZED PLAN
U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975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VALLEY
WATERLOO
ELKHORN
OMAHA
COUNCIL BLUFFS
PLATTE
RIVER
DOUGLAS COUNTY
SARPY COUNTY
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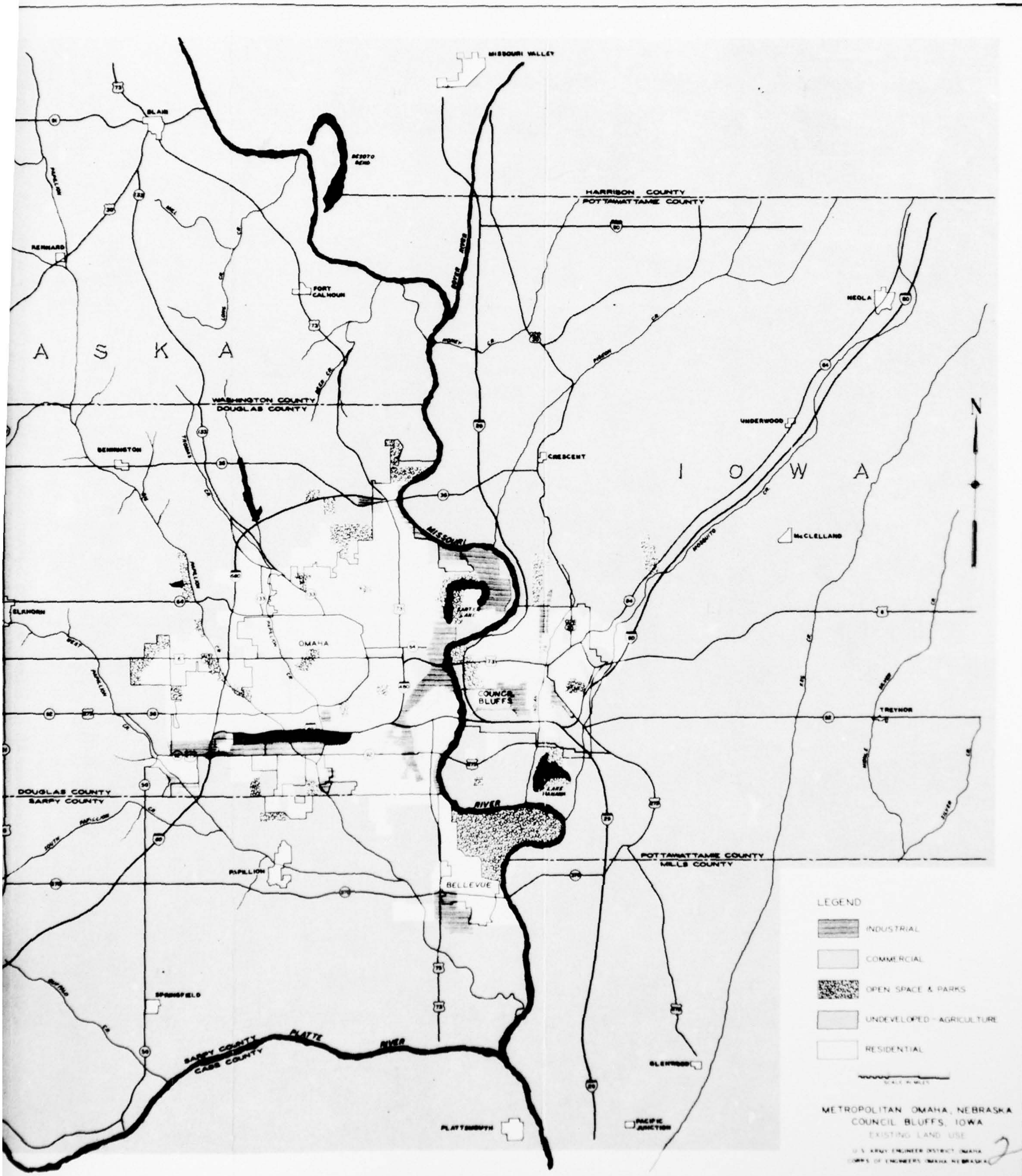
MISSOURI VALLEY
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WASHINGTON COUNTY
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UNDERWOOD
NEOLA
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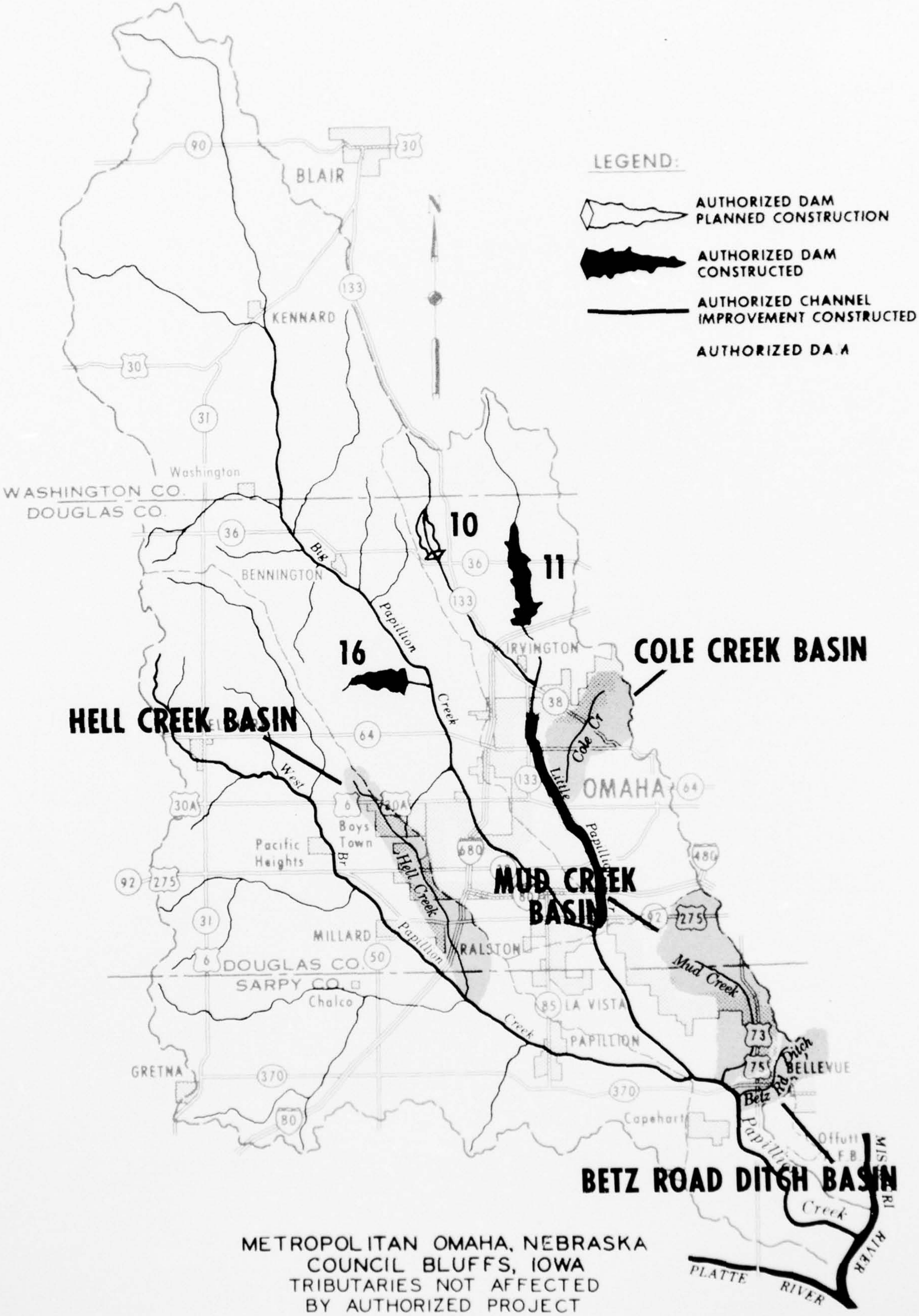
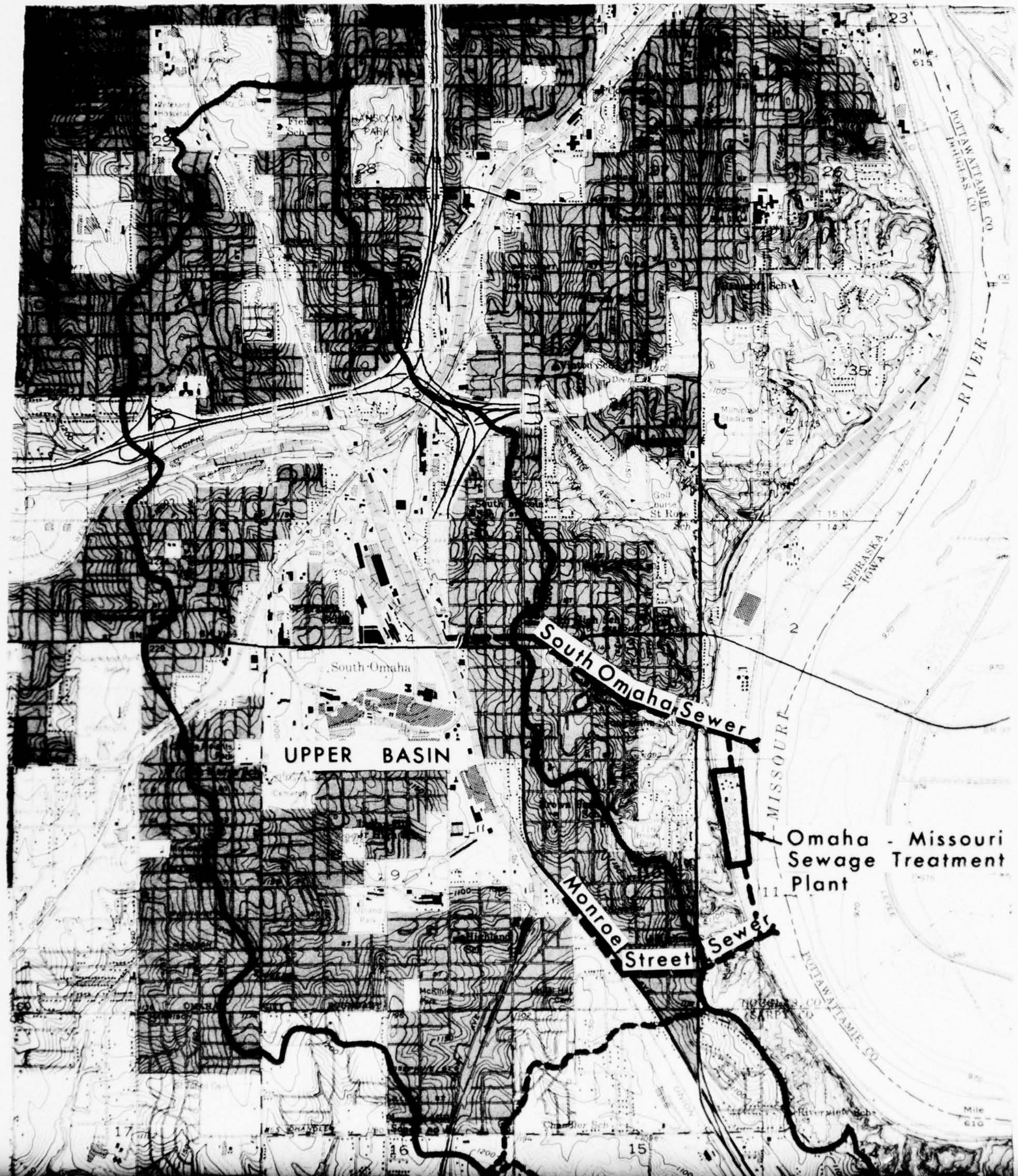
McCLELLAND
MISSOURI
ELKHORN
OMAHA
COUNCIL BLUFFS
TREYNOR
DOUGLAS COUNTY
SARPY COUNTY
RIVER
LAKE MANAWA
POTTAWATTAMIE COUNTY
MILLS COUNTY
PAPILLION
BELLEVUE
SPRINGFIELD
SARPY COUNTY
CASS COUNTY
PLATTE
RIVER
GLENWOOD
PLATTSMOUTH
PACIFIC JUNCTION
LEGEND
INDUSTRIAL
COMMERCIAL
OPEN SPACE & PARKS
UNDEVELOPED - AGRICULTURE
RESIDENTIAL
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
EXISTING LAND USE
U.S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS OMAHA NEBRASKA



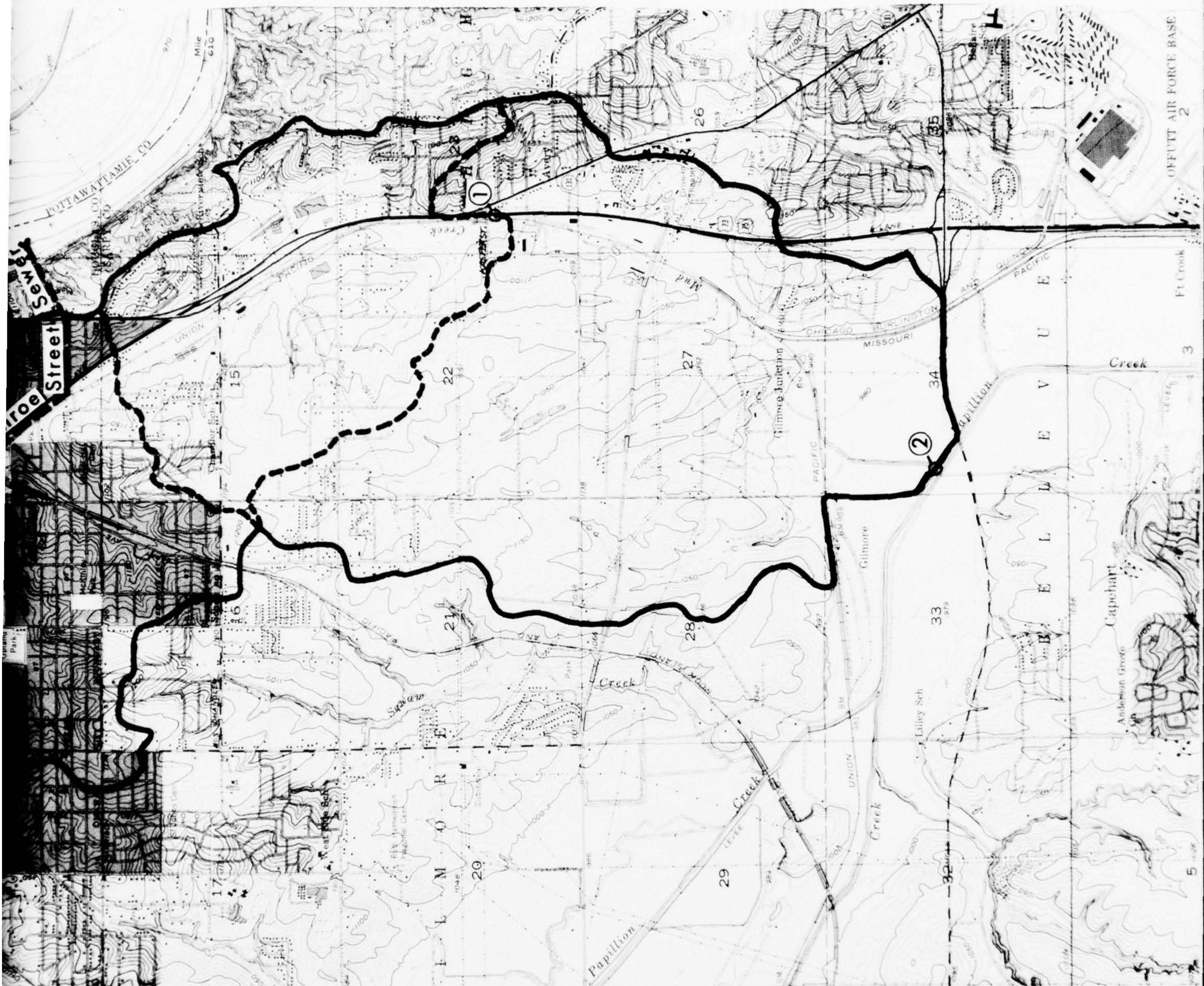
METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
TRIBUTARIES NOT AFFECTED
BY AUTHORIZED PROJECT

U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975

VOLUME III ANNEX D PLATE G2-3

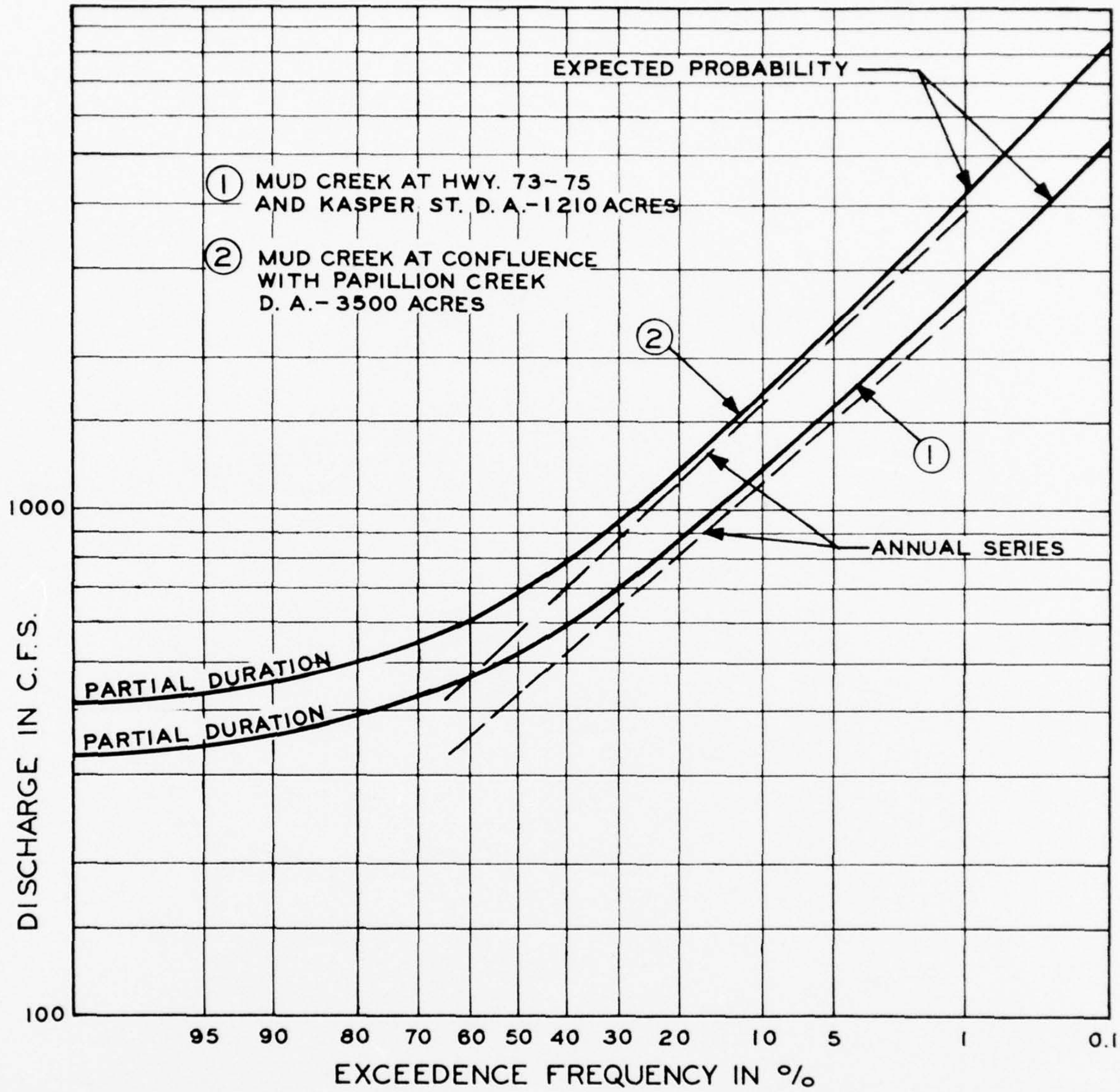


South Omaha Sewer
UPPER BASIN
Omaha - Missouri Sewage Treatment Plant
Monroe Street Sewer
MISSOURI
RIVER
South Omaha



METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
MUD CREEK
BASIN MAP

U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975



DISCHARGE PROBABILITY CURVE
MUD CREEK
AT
BELLEVUE, NEBRASKA

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975

PART III

FORMULATING A PLAN FOR THE AUTHORIZED SYSTEM

Little Papillion Creek

1. The plan for Little Papillion Creek includes Dams 10 and 11, the completed Little Papillion Creek channel improvement project, and flood plain regulation. In combination, these elements would provide 100-year or greater protection between the damsites and the mouth of Little Papillion Creek. Dams 10 and 11 would cause minor flood peak reductions on Papillion Creek from the mouth of Little Papillion Creek downstream to the West Branch; downstream from the West Branch, their effect would be negligible. The Little Papillion Creek basin is hydrologically separate and is, therefore, not affected by improvements made on Big Papillion Creek and West

Branch Papillion Creek. Dam 11 is operational for flood control and Dam 10 is the last structural element of the plan.

2. The Phase I General Design Memorandum for Dam 10 was completed in October 1973. It reaffirmed the need for flood control, recreation, and low flow releases to improve esthetics in the downstream channel and it reaffirmed the opportunity for fish and wildlife management. It also reaffirmed that there are no viable alternatives to the authorized plan on Little Papillion Creek because of the intense existing development in the Little Papillion Creek flood plain.

3. The current flood damage appraisal on the Little Papillion Creek shows that Dam 10 would reduce the average annual damage potential in the Little and Big Papillion Creek basins from $292,000 and $1,305,000, respectively to $182,500 and $1,217,000, respectively. Average annual flood control benefits attributable to Dam 10 are $197,500 under existing conditions of development. Dam 10 is economically justified under existing conditions for flood control only, or for multipurpose development. Since benefits based on future levels of development are not required for justification and since the flood plain is extensively developed, no estimate of future benefits was made. A summary of average annual benefits for Dam 10 is as follows:

Flood Control	
Existing Conditions	$197,500
Recreation	
General	84,000
Fish and Wildlife	7,900
Water Quality	1,400
Total Average Annual Benefits	$290,800

AD-A041 925 ARMY ENGINEER DISTRICT OMAHA NEBR F/G 8/6
WATER AND RELATED LAND RESOURCES MANAGEMENT STUDY. VOLUME III. --ETC(U)
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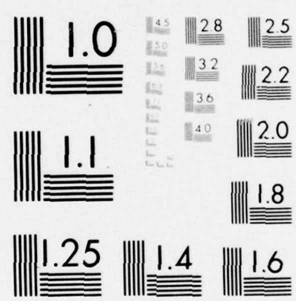


MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

4. Based on a first cost of $3,600,000 (October 1975 price levels), a summary of annual costs, based on an interest rate of 3.25 percent, is as follows:

Interest and Amortization	$122,000
Operation, Maintenance, and Replacement	43,000
Total Annual Costs	$165,000

5. Table G3-1 is an economic summary and table G3-2 shows pertinent data for Dam 10. A cost allocation using the separable costs-remaining benefits method shows that 78.0 percent of the first costs are allocated to flood control, 21.7 percent to recreation, and 0.3 percent to water quality.

6. Because Dam 10 is the last remaining structural element of the Little Papillion Creek portion of the authorized plan and it meets all the tests of economic feasibility, and because the Little Papillion Creek basin is hydrologically separate and, therefore, not affected by improvements on Big Papillion and West Branch Papillion Creeks, the plan reevaluation report recommended that construction of Dam 10 should proceed as soon as possible.

Table G3-1
Dam 10
Economic Summary

	Flood Control Only	Multipurpose Development
Costs		
Total investment cost	$3,290,000	$3,600,000
Average annual cost	128,400	165,000
Benefits (average annual)	197,500	290,800
B/C Ratio		
Existing conditions	1.5	1.8

Table G3-2
Dam 10
Pertinent Data

Drainage area, square miles	4.3
Lands	
Reservoir construction and operation, acres	510
Exclusive recreation	None
Total project, acres	510
Embankment	
Crest length, feet	1,450
Crest elevation, feet m.s.l.	1210.5
Height, feet	48
Volume of fill, cubic yards	416,000
Spillway	
Location	Left abutment
Crest elevation, feet m.s.l.	1202.0
Bottom width, feet	320
Length, feet	950
Outlet Works	
Elevation of multipurpose pool, inlet, feet m.s.l.	1188.5
Elevation of high level inlet, feet m.s.l.	1193.5
Conduit diameter, feet	4.0
Conduit length, feet	480
Reservoir	
Storage Volume (acre-feet)	
Sediment	1,140
Standard project flood	1,957
Surcharge	1,753
Total storage	4,850
Surface Area (acres)	
Multipurpose pool	125
Standard project flood pool	230
Surcharge	305
Elevations (m.s.l.)	
Multipurpose	1188.5
Standard project flood	1200.4
Maximum pool elevation	1207.2

West Branch Papillion Creek

7. The authorized project includes eight dams on the West Branch. At the time of authorization, these eight dams had a first cost of $10,559,000. Based on October 1975 price levels, the first cost is $48,700,000. Rapidly rising construction costs and extremely rapid increases in land costs due to the close proximity of the damsites to Omaha have been the main reasons for this increase.

8. The eight dams currently have an average annual cost of $1,500,000 for flood control only and $2,400,000 for multipurpose development. Considering the changes in flood plain regulation and the current first costs, a preliminary analysis shows that the average annual costs exceed the average annual benefits to existing development by more than 6 to 1. Future flood control benefits and recreational benefits would be required to justify the authorized project. Accordingly, a full scale reformulation of this element of the authorized plan was recommended by the Plan Evaluation Report of September, 1975. The reformulation will recognize the existing problems, their probable future magnitude, and include a full evaluation of alternative solutions. The evaluation of alternative solutions will include the potential for scaling of the authorized project, the relative merits of non-structural measures, structural measures not included in the authorized plan, or combinations of structural-nonstructural measures.

Big Papillion Creek

9. Currently, there are more than $100,000,000 worth of improvements in the Big Papillion Creek flood plain. Damage to at least some of these improvements is expected about once every 5 years, resulting in average annual damages of about $1,300,000. Accordingly, the primary planning objective is the reduction of these flood damages. Whenever a solution to the flood problem provides opportunities for outdoor recreation development, these opportunities are fully explored. The Omaha area is currently deficient in outdoor recreation opportunities, particularly those that are water related. Therefore, outdoor recreation is a valid planning objective. Similarly, opportunities for fish and wildlife management and water quality improvement are often apparent in solutions to flood problems.

10. Previous studies have consistently shown that the most effective solution to flood problems in the Big Papillion Creek flood plain consists of complete regulation by reservoirs located just upstream from Blondo Street. Existing roads, railroads, and other improvements, however, preclude the construction of reservoirs far downstream. Extensive investigations of many alternative damsites in previous studies resulted in the conclusion that optimum protection would be provided by construction of 11 dams. Thus, Dams 1-9 and Dams 16 and 17 were authorized by Congress. Dam 17 has been constructed by a development corporation. Except for recreation developments, construction of Dam 16 is complete; therefore, only Dams 1-9 were considered in the Plan Evaluation Report of September. 1975.

11. Three different factors influenced the review of the authorized project in the Big Papillion Creek basin. First, reduced expected future benefits because of recently enacted flood plain land use regulations and increased costs make Dams 5 through 9 economically infeasible. Secondly, recent abandonment of the railroad line which parallels Big Papillion Creek downstream from Dam 3 allowed consideration of Dam 3 at a new location approximately 2.5 miles farther downstream. Thirdly, some local interests requested that dry dams and channel improvements be evaluated and compared to the authorized plan. Therefore, the review evaluated the advisability of modifying the authorized project by eliminating some dams or by reconfiguration, with Dam 3 at a site farther downstream. Other structural and nonstructural alternatives were also considered.

12. Since the authorized project is intended primarily to reduce the flood problem, each modification of, or alternative to, the authorized project was first evaluated with respect to its effectiveness and economic efficiency in reducing the flood threat. Social, economic, and environmental effects were also analyzed. Secondly, since there is a significant deficiency in opportunities for outdoor recreation in the region, opportunities for outdoor recreation were developed with each modification or alternative. These associated outdoor recreation opportunities were developed considering economic optimization, public desires, and the capability of local governmental units to provide the required non-Federal cost-sharing. The amount of recreation development, in each case, was limited by the multiple-purpose opportunities provided. Whenever opportunities for management of fish and wildlife or water quality improvement were associated with the modifications or alternatives, these opportunities were developed.

13. Alternatives considered in the initial stages of the review included modifications to the authorized project, other structural alternatives such as diversion, channel improvement, and levees; and nonstructural alternatives such as evacuation, zoning, flood proofing, and flood insurance. Benefit and cost data for each alternative are displayed in tables G3-3 and G3-4.

NONSTRUCTURAL ALTERNATIVES

EVACUATION

14. Residential and business developments in the flood plain are currently valued at more than $59,000,000. Removal of these developments would cost approximately $78,000,000 and would result in a benefit-to-cost ratio of approximately 0.3. Evacuation would not reduce damages to transportation facilities or the danger to those using these facilities. Evacuation would involve the relocation of more than 600 residences and businesses. Such a massive relocation would cause considerable social and economic disruption. Social problems would include the effects of broken neighborhoods and social affiliations and the problems in finding a suitable residential location. Economic effects would include disruption in existing taxing districts and business losses caused by disruptions in the business-consumer relationship. Accordingly, evacuation is unacceptable, because it is uneconomical, ineffective, and would result in considerable economic and social disruption.

ZONING, FLOOD PROOFING, AND FLOOD INSURANCE

15. Zoning affects only future flood problems by restricting flood plain land use. Flood proofing of existing flood plain developments by levees or by raising structures would cost nearly as much as the value of the developments. This would result in a benefit-cost ratio of less than 0.2. Flood insurance does not

Table G3-3
Benefit and Cost Data for Flood Control Only

Alternative	Investment	Existing Conditions Annual Costs	Existing Conditions Annual Benefits	Existing Conditions Benefit-Cost Ratio	Future Conditions Annual Benefits	Future Conditions Benefit-Cost Ratio
Dams 1-3	$20,700,000	$ 776,000	$ 855,000	1.1	$1,600,000	2.1
Dams 1-4	24,800,000	935,000	924,000	1.0	1,700,000	1.8
Dams 1-9 (Authorized Project)	39,100,000	1,500,000	1,049,000	0.7	1,900,000	1.3
Dam 3A	25,600,000	917,000	1,037,000	1.1	1,822,000	2.0
Channel (Q St. to Blondo)						
100-year	22,100,000	828,000	725,000	0.9	725,000	0.9
Levee (Q St. to Blondo)						
100-year	27,500,000	1,010,000	750,000	0.7	750,000	0.7
SPF	33,700,000	1,200,000	810,000	0.7	810,000	0.7
Evacuation						
100-Year Flood Plain	78,000,000	2,643,000	760,000	0.3	760,000	0.3

Table G3-4

Benefit and Cost Data for Flood Control, Recreation, and Water Quality

Alternative	Investment	Annual Costs	Existing Conditions Annual Benefits	Existing Conditions Benefit-Cost Ratio	Future Conditions Annual Benefits	Future Conditions Benefit-Cost Ratio
Dams 1-3	$27,700,000	$1,483,500	$2,561,000	1.7	$3,300,000	2.2
Dams 1-4	33,200,000	1,765,800	2,930,000	1.7	3,706,000	2.1
Dams 1-9 (Authorized Project)	49,400,000	2,727,000	3,255,000	1.2	4,100,000	1.5
Dam 3A	32,500,000	1,616,100	2,806,000	1.7	3,591,000	2.2

reduce flood damages. It is simply a method of distributing financial losses over time and among a greater number of people. It is economically infeasible because flood damages remain the same and administrative and acturial costs are incurred.

16. Zoning, flood proofing, and flood insurance are, therefore, not appropriate measures for reducing the existing flood problem. These measures are effective, however, in reducing future flood problems. Flood plain zoning and flood proofing in accordance with the Flood Disaster Protection Act of 1973 for prevention of future flood problems and flood insurance for developments left unprotected are considered as nonstructural complements to all structural alternatives.

STRUCTURAL ALTERNATIVES

DIVERSION

17. Big Papillion Creek floodflows could be diverted into the Little Papillion Creek, West Branch Papillion Creek, or out of the basin into the Elkhorn River or the Missouri River. Diversion into either the Little Papillion Creek or West Branch Papillion Creek basins is completely unacceptable because it would create excessive flood damages and increase the threat to lives in these basins. Adequate reservoir storage for these diverted flows would not be available in either case. Diversion to the Missouri or Elkhorn Rivers is physically impossible because, in both cases, the diversion would cross a major drainage basin.

LEVEES

18. The major flood damage potential in the Big Papillion Creek flood plain extends from Blondo Street downstream to Q Street.

Standard project flood protection would cost approximately $34,000,000 and 100-year protection would cost nearly $28,000,000. Either plan of protection would provide a benefit-cost ratio of about 0.7. Levees were not considered further because they would not be economically feasible.

CHANNEL IMPROVEMENT

19. Channel improvement was considered from Bennington to the Missouri River, from Blondo Street to the Missouri River, and from Blondo Street to Q Street. Since there is little development in the flood plain from Bennington to Blondo Street, potential flood damage reductions in that reach would not be nearly as great as the costs of channel improvement. Channel improvement from Blondo Street to the Missouri River would cost approximately $39,000,000 and would result in a benefit-cost ratio of about 0.5. Channel improvement for the 100-year flood from Blondo Street to Q Street would cost approximately $22,000,000. This channel improvement would increase the 100-year peak discharge downstream from Q Street from 24,000 cubic feet per second to 27,000 cubic feet per second. This discharge increase would induce $65,000 average annual damages downstream. Although it would be the most economical of all channel improvement options, the benefit-cost ratio for channel improvement from Blondo Street to Q Street would be only 0.9 using a discount rate of 3.25 percent, and 0.5 using a discount rate of 6.125 percent. Also, the non-Federal share of the investment would be approximately $9,000,000. No local governmental body in the area where the channel would be improved has encouraged the selection of channel improvement as an alternative to the authorized project, or offered to provide the non-Federal cost-sharing. The city of Omaha and Sarpy County have publicly expressed opposition to channel improvement. Since all channel improvement alternatives are economically

infeasible and are not supported locally, channel improvement is not considered further.

MODIFICATIONS TO THE AUTHORIZED PROJECT

20. The authorized project for Big Papillion Creek includes Dams 1 through 9 and Dam 16. Construction of Dam 16 is complete except for the recreation portion of the project. The remaining nine dams were evaluated economically and hydrologically as next-added elements to Dams 10, 11, and 16 and as last-added elements to Dams 10, 11, and 16 and the other eight dams.

21. It was found that Dams 1 and 2 would be economically justified, as next-added and last-added elements. Dam 3 would also be justified, but only as an addition to Dams 1 and 2 because Dam 3 would not have adequate storage in itself. The remainder of the analysis considered Dams 1 through 3 as inseparable elements.

22. As single-purpose flood control projects, Dams 4, 5, 6, 7, 8, or 9 would not be economically justified as first-added elements to Dam 16 or as next-added elements to Dams 1, 2, and 3. Therefore, Dams 1, 2, and 3 represent the economically optimum portion of the authorized project for single-purpose flood control.

23. When recreation and water quality were included in the evaluation, Dam 4 would be incrementally justified as a first-added element to Dam 16 or as a next-added element to Dams 1, 2, and 3. As multi-purpose projects, Dams 5 through 9 would not be incrementally justified as first-added elements to Dam 16 or as next-added elements to Dams 1, 2, 3, and 4. Dams 1 through 4 represent the optimum portion of the authorized multiple-purpose project.

24. Dam 3 of the authorized system would have been located approximately 3.5 miles upstream from Bennington. Since adequate

storage would not be available at that site without inundating Kennard, construction of Dams 1 and 2 would be necessary upstream from Dam 3. Dam 3 originally could not be located farther downstream because of the Chicago and Northwestern Transportation Co. railroad line. Recently, however, the railroad line was abandoned, allowing consideration of Dam 3 at a site approximately 2.5 miles downstream from its original location. Dam 3, located at this new site, is designated Dam 3A. Since Dam 3A would have adequate storage capacity without excessive relocations and since Dams 1, 2, 4, and 5 would have been upstream from Dam 3A, these dams would be unnecessary. Dams 6, 7, 8, or 9 would not be economically justified as next-added elements to Dam 3A. Dam 3A would control the runoff from 106 square miles compared to 101 square miles for Dams 1 through 9 of the authorized system. Dam 3A would be economically justified as a multiple-purpose dam, or as a single-purpose dam for flood control only.

CONCLUSIONS

25. None of the alternatives except modification of the authorized project warranted further evaluation because, in addition to being economically infeasible, each alternative was found to be either ineffective in reducing flood damages or could not be implemented. Two modifications of the authorized project were found economically feasible. These modifications included construction of Dams 1 through 4 of the authorized 9-dam system or construction of Dam 3A in place of the authorized 9-dam system. The plan evaluation compared both alternatives and recommended Dam 3A rather than Dams 1 through 4 because, Dam 3A would provide a reduction in average annual flood damages of more than $1,800,000 compared to $1,700,000 for Dams 1 through 4. Dam 3A, shown on plate G3-1, would also

provide net economic benefits of $1,974,900 annually compared to $1,940,200 for Dams 1 through 4 and it had a benefit-cost ratio of 2.2 compared to 2.1 for Dams 1 through 4. Dam 3A would displace only 36 families compared to 46 for Dams 1 through 4. Dam 3A would require 5,150 acres of land including 4,300 acres of cropland while Dams 1 through 4 would require 7,250 acres including 6,100 acres of cropland. Dam 3A would result in a total loss of assessed value to local taxing districts of $625,000 compared to $1,018,000 for Dams 1 through 4. Dam 3A is the least expensive. It would cost $32,500,000 compared to $33,200,000 for Dams 1 through 4. Dam 3A would be inferior to Dams 1 through 4 only in that it would provide fewer recreation and fish and wildlife management opportunities because it requires less land. Table G3-5 and G3-6 present a summary comparison of the alternative plans and the system of accounts. A more detailed description of the alternatives considered further is presented in the Plan Evaluation Report of September, 1975.

Table G3-5
Summary of Alternative Plans

	Dams 1-4	Dam 3A
A. Plan Description		
Total acres	7,250	5,150
Multiple purpose (acres)	6,073	4,150
Exclusive recreation (acres)	1,177	1,000
Water surface (acres)	1,695	1,500
Land surface (acres)	5,555	3,650
Drainage area (sq. mi.)	86.8	106
B. Significant Impacts Specified in Section 122 of PL 91-611	Included in "Relationship to Four Accounts"	
C. Plan Evaluation		
1. Contributions to Planning Objectives		
a. Flood control		
Damage reduction		
Existing	$ 924,000	$1,037,000
Future	1,700,000	1,822,000
b. Recreation		
Reduction in current deficit		
Land (percent)	20	13
Water (percent)	9	8
c. Fish and wildlife		
Land (acres)	2,424	1,000
Water (acres)	1,695	1,500
d. Water quality		
Minimum flow (c.f.s.)	3	3
2. Relationship to Four Accounts		
a. National Economic Development (NED)		
Net benefits	$1,940,200	$1,974,900

Table G3-5
Summary of Alternative Plans
(Cont'd)

	Dams 1-4	Dam 3A
b. Environmental Quality (EQ)		
Wildlife lands (acres)	2,424	1,000
c. Social Well Being (SWB)		
Families displaced	46	36
Cropland acquired (acres)	6,100	4,300
Annual recreation days	1,333,000	1,175,000
Families protected	600	600
d. Regional Development (RD)		
Loss in assessed value of local taxing districts	$1,018,000	$ 625,000
3. Plan Response to Associated Evaluation Criteria		
a. Benefit/Cost	2.1	2.2
b. Flood damage reduction	$1,700,000	$1,822,000

D. Implementation Responsibility

Financial

	Dams 1-4	Dam 3A
Federal costs		
Investment	$29,000,000	$29,050,000
O, M, & R	91,000	50,000
Non-Federal costs		
Investment	$ 4,200,000	$ 3,450,000
O, M, & R	550,000	465,000

Table G3-6
System of Accounts

Accounts	Footnotes	Dams 1-4	Dam 3A
1. National Economic Development			
a. Beneficial Impacts			
(1) Value of increased output of goods and services.			
Flood control	3,5,9	$1,700,000	$1,822,000
Recreation	2,5,9	1,676,000	1,493,000
Fish and wildlife	2,5,9	324,000	270,000
Water quality	2,5,9	6,000	6,000
(2) Total NED benefits		$3,706,000	$3,591,000
b. Adverse Impacts			
(1) Project costs			
Int. and Amortiz.	1,5,9	$1,124,800	$1,101,100
O, M, & R	2,5,9	641,000	515,000
(2) Total NED costs		$1,765,800	$1,616,100
c. Net NED Benefits		$1,940,200	$1,974,900
B/C ratio		2.1	2.2
2. Environmental Quality			
a. Environmental Quality Enhanced			
Wildlife acres	*2,6,9	2,424	1,000
Water surface acres	*2,6,9	1,695	1,500
Improved esthetics	*2,6,9	4 lakes	large lake
Minimum stream flow	*2,6,7,9	3 c.f.s.	3 c.f.s.
b. Environmental Quality Degraded			
Degraded esthetics	*2,5,9	mudflats	mudflats
c. Environmental Quality Destroyed			
Natural channel inundated (miles)	2,5,9	20	10

Table G3-6
System of Accounts
(Cont'd)

	Footnotes	Dams 1-4	Dam 3A
Good wooded cover (miles)		3	1
Good grassy cover (miles)		11	5
Poor habitat (miles)		6	4
3. Social Well-Being			
a. Beneficial Impacts			
(1) Enhancement of quality of life, health & safety			
Families protected from 100-year or greater flood	*2,5,9	600	600
(2) Educational, cultural, and recreational opportunities			
Acres provided (present deficit)			
Picnicking (4,087 acres)	2,5,7,9	129	95
Camping (599 acres)		74	75
Fishing (6,303 acres)		1,695	1,500
Swimming (15 acres)		3	2
Boating (8,082 acres)		1,695	1,200
Waterskiing (4,380 acres)		1,172	900
Miles of hiking trails provided (25 miles)		28	22
Recreation days provided	2,5,7,9	1,333,000	1,175,000
b. Adverse Impacts			
Injurious displacement of people and community disruption			
Displaced farm families		46	17
Displaced urban families		0	19
Displaced total families	*1,6,8,9	46	36
Reduced cropland (acres)	*1,5,9	6,100	4,300
4. Regional Development			
a. Beneficial impacts			
(1) Value of increased income			

Table G3-6
System of Accounts
(Cont'd)

	Footnotes	Dams 1-4	Dam 3A
Net benefits:			
Flood plain	2,5,7,9	$1,700,000	$1,822,000
Region	2,5,7,9	1,307,700	1,181,100
Nation	2,5,7,9	-1,067,500	-1,028,200
Total	2,5,7,9	1,940,200	1,974,900
(2) Quantity of increased Employment			
Jobs created during construction (man yrs.)	*1,5,9	600	700
Jobs created for operation & maintenance	*2,5,9	4	4
(3) Desirable population distribution	*2,4,10	not quantified	
(4) Increased stability of regional economic growth	*2,4,10	not quantified	
b. Adverse Impacts			
(1) Undesirable population distribution	*2,4,10	not quantified	
(2) Decreased stability of regional economic growth			
Business reduction	*2,4,10	not quantified	
(3) Property tax			
Washington County			
Acres removed	*1,5,9	7,250	2,995
Assessed value loss	*1,5,9	$1,018,000	$ 428,000
percent	*1,5,9	1.5	0.6
Mill levy adjustment		0.1	0.05
Douglas County			
Acres removed	*1,5,9	0	0
Assessed value loss	*1,5,9	0	$ 197,000
percent		0	0.002
Mill levy adjustment	*1,4,10	0	0.0003

Table G3-6
System of Accounts
(Cont'd)

	Footnotes	Dams 1-4	Dam 3A
Kennard Fire District			
Acres removed	*1,5,9	5,889	2,920
Assessed value loss	*1,5,9	$ 766,000	$ 365,000
percent		10.5	5.0
Mill levy adjustment	*1,4,10	0.2	0.07
Arlington Fire District			
Acres removed	*1,5,9	111	0
Assessed value loss	*1,5,9	$ 16,000	0
percent		0.2	0
Mill levy adjustment	*1,4,10	0.002	0
Blair Fire District			
Acres removed	*1,5,9	321	0
Assessed value loss	*1,5,9	36,000	0
percent		0.3	0
Mill levy adjustment	*1,4,10	0.001	0
Bennington Fire District 1/			
Acres removed	*1,5,9	929	2,230
Assessed value loss	*1,5,9	$ 200,000	$ 260,000
percent		3.8	5.0
Mill levy adjustment	*1,4,10	0.04	0.05
Washington County School District #1			
Acres removed	*1,5,9	2,985	783
Assessed value loss	*1,5,9	$ 467,000	$ 97,000
percent		3.2	0.7
Mill levy adjustment	*1,4,10	2.3	0.5
Washington County School District #24			
Acres removed	*1,5,9	1,678	309
Assessed value loss	*1,5,9	$ 228,000	$ 35,000
percent		1.8	0.3
Mill levy adjustment	*1,4,10	0.9	0.1

Table G3-6
System of Accounts
(Cont'd)

	Footnotes	Dams 1-4	Dam 3A
Washington County School District #31			
Acres removed	*1,5,9	543	0
Assessed value loss	*1,5,9	$ 67,000	0
percent		6.9	0
Mill levy adjustment	*1,4,10	1.0	0
Washington County School District #R100			
Acres removed	*1,5,9	2,044	2,462
Assessed value loss	*1,5,9	$ 256,000	$ 296,000
percent		15.7	18.2
Mill levy adjustment	*1,4,10	3.9	4.7
Douglas County School[2] District #59			
Acres removed	*1,5,9	0	1,596
Assessed value loss	*1,5,9	0	$ 197,000
percent		0	3.7
Mill levy adjustment	*1,4,10	0	1.0
Douglas County School District #8			
Acres removed	*1,5,9	0	0
Assessed value loss	*1,5,9	0	0
percent		0	0
Mill levy adjustment	*1,4,10	0	0

1/ Does not include $198,000 assessed value loss due to Dams 16 and 10.

2/ Does not include $84,000 assessed value loss due to Dam 10.

Table G3-6
System of Accounts
(Cont'd)

Index of Footnotes:

<u>Timing</u>
1. Impact is expected to occur prior to or during implementation of the plan.
2. Impact is expected within 15 years following plan implementation.
3. Impact is expected in a longer time frame (15 or more years following implementation).

<u>Uncertainty</u>
4. The uncertainty associated with the impact is 50% or more.
5. The undertainty is between 10% and 50%.
6. The uncertainty is less than 10%.

<u>Exclusivity</u>
7. Overlapping entry; fully monetized in NED account.
8. Overlapping entry; not fully monetized in NED account.

<u>Actuality</u>
9. Impact will occur with implementation.
10. Impact will occur only when specific additional actions are carried out during implementation.
11. Impact will not occur because necessary additional actions are lacking.

<u>Section 122</u>
* Items specifically required in Section 122 and ER 1105-2-105.

Tributaries Not Affected

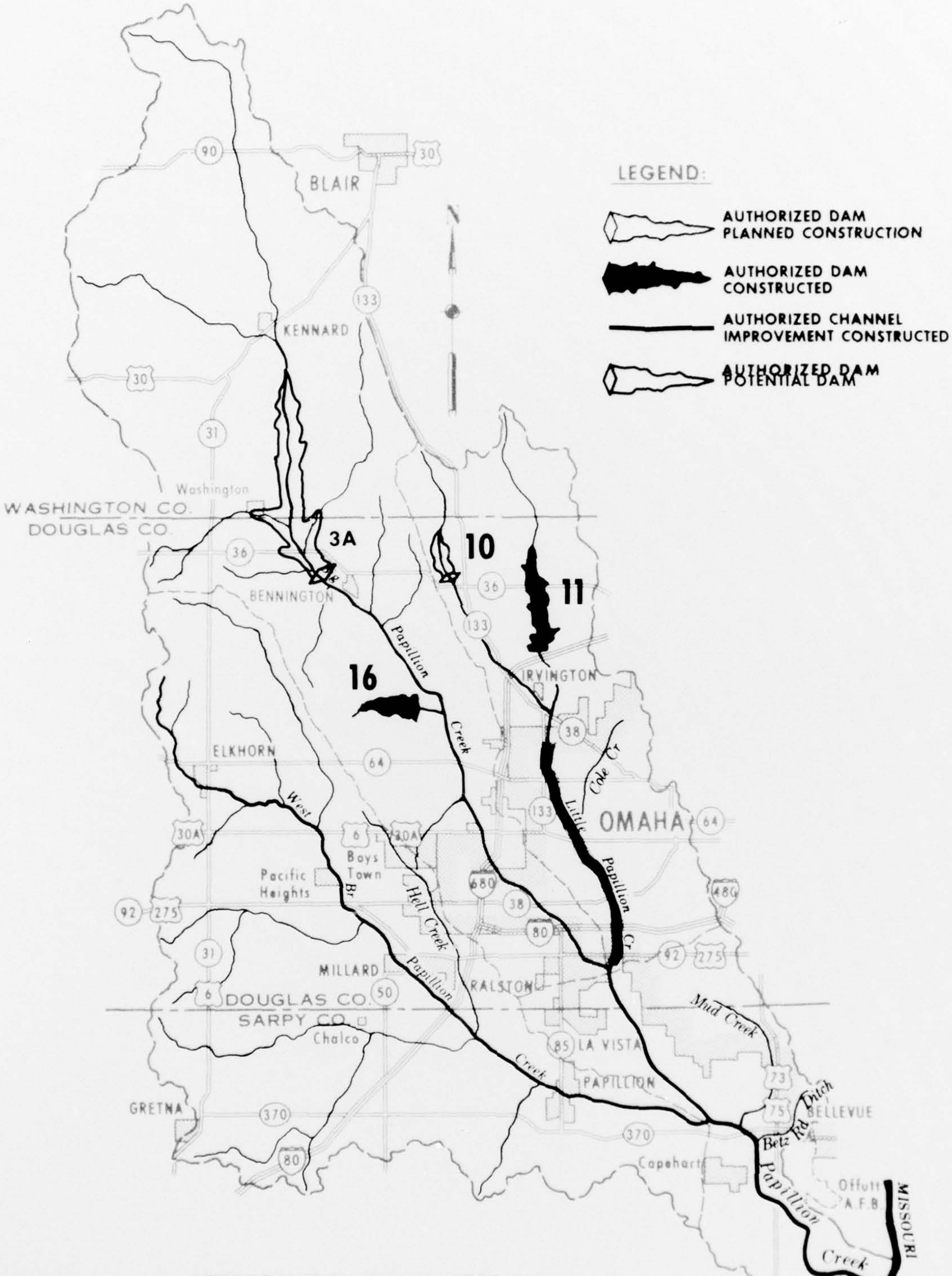
By Authorized Plan

HELL AND COLE CREEKS AND BETZ ROAD DITCH

26. Alternative structural measures of solving the flood problems of Hell and Cole Creeks and Betz Road Ditch that were given preliminary screening during the study included channel enlargement and levees. Clearing and snagging of trees and debris was also considered for Cole Creek. None of the structural alternatives that were investigated were found to be economically feasible. The city of Omaha zoned the 100-year flood plains of Hell and Cole Creeks in 1974. The city of Bellevue zoned the 100-year flood plain of Betz Road Ditch in 1975. All of these zoning actions are in accordance with Public Law 93-234. Nonstructural alternatives, in addition to zoning, that were studied included evacuation, flood insurance, flood proofing, and "no action". None of the nonstructural alternatives were found to be economically feasible. Flood plain regulations and insurance appear to be the most practicable program.

MUD CREEK

27. Alternative structural and nonstructural methods of solving the Mud Creek flood problem that were considered during the study included channel enlargement, levees, flood insurance, flood proofing, and "no action". The city of Bellevue zoned the 100-year flood plain in 1975 in accordance with Public Law 93-234. This limits future urban expansion in the flood plain but does not protect existing development. Preliminary studies indicate that a channel designed for an 8-year flood would be marginally feasible. Further detailed studies under Section 205 authority are planned in the future to determine project feasibility. At the present time, flood plain zoning regulations adopted by the city of Bellevue and flood insurance are the most practicable early actions for the Mud Creek flood problem.



METROPOLITAN OMAHA, NEBRASKA
COUNCIL BLUFFS, IOWA
BIG PAPILLION CREEK
DAMSITE 3A

U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA
JUNE 1975