DES MOINES RIVER
FLOOD PLAIN INFORMATION

DES MOINES, IOWA

PREPARED FOR THE STATE OF IOWA

IOWA NATURAL RESOURCES COUNCIL

BY

CORPS OF ENGINEERS, U. S. ARMY

ROCK ISLAND DISTRICT

APRIL, 1970

DES MOINES RIVER
FLOODING
DES Moines, IOWA

LOCAL MAIL

To _____

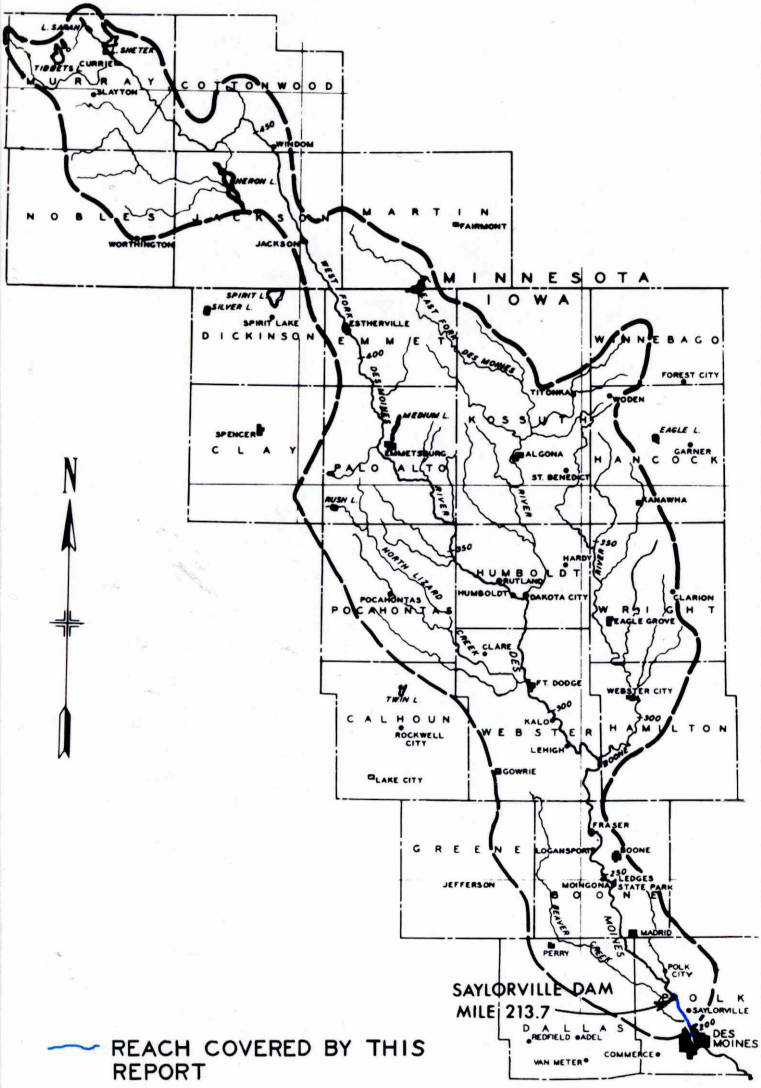
Department

Attention _____

191-0048

DES MOINES RIVER FLOODING DES MOINES, IOWA

APRIL 1970



HOW TO AVOID

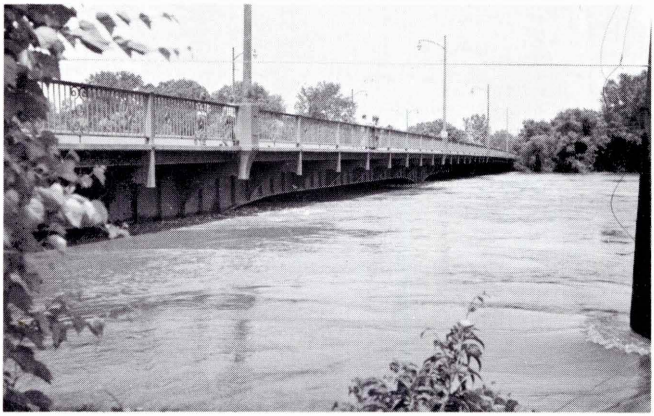
DAMAGE

PAST FLOOD SCENES

Looking west at Center Street dam — June 24, 1954 flood.

Looking southeast on Maine Street from University Avenue — June 26, 1947 flood.

Looking northeast at the D.M. & C.I. R.R. bridge downstream of Second Avenue — June 24, 1954 flood.



Looking north at the Second Avenue bridge — June 24, 1954 flood.

Looking south on Sixth Avenue from New York Avenue — June 26, 1947 flood.

Looking south on Sixth Avenue from New York Avenue — June 24, 1954 flood.

INTRODUCTION

This brochure is a summary of the Flood Plain Information Report for the Des Moines River at Des Moines, Iowa. The report was prepared to enable State and local governments to evaluate the flood hazard and to distribute flood information for the protection of existing and possible future public and private developments in the flood plain.

Historically, man has tried to reduce flood damages by constructing levees and floodwalls, flood control reservoirs, channel improvements, and other flood control works. Despite the expenditure of billions of tax dollars for costly flood control works, flood damages have been steadily increasing across the nation due to the continued development of flood-prone areas without recognizing the flood hazards.

Increases in flood damages and flood hazards to life and property have led to flood plain management as a means to protect existing and future developments from flood damage. Implementation of a flood plain management program requires two basic tools: (1) a logical and comprehensive land-use plan which recognizes the flood hazards and which is geared to the land needs and economy of the local community, and, (2) the legal tools to carry out the intent of the plan. Cooperative action by local, State and Federal Governments and private interests is essential.

The information contained in the Flood Plain Information Report evaluates the flood situation in the study reach and provides the basis for local flood plain management programs. For flood plain management to receive the necessary public support, it is important that residents of the community know the past history of flooding, the purposes and benefits of flood plain management, and the ways that regulations can be coordinated with the overall plan of development for the area.

PAST FLOODS

The highest known flood on the Des Moines River in the city of Des Moines occurred on June 24, 1954. The maximum gage height recorded at the U.S.G.S. Second Avenue gage was 30.16 feet. The maximum discharge was 60,200 cubic feet per second.

Other large floods on the Des Moines River occurred in April 1965, May 1903, June 1947, April

1960, May 1944, July 1902, March 1951, and April 1962 in the order of flow magnitude.

Photographs in this brochure show typical flood scenes at and near Des Moines during the June floods of 1954 and 1947 and the flood of April 1965. Physical damages, hazards to life, health, and property, and the inconveniences imposed by the floods are shown by the photographs.

The June 24, 1954 flood is an example of an infrequent flood which has occurred in the upper Des Moines River Basin. However, floods of greater magnitude should be considered for land use planning in the flood plain since studies of Des Moines River floods indicate that larger floods will occur in the future.

FUTURE FLOODS

An Intermediate Regional Flood was determined from an analysis of flood records in the upper Des Moines River Basin and in similar basins in the same geographic location as Des Moines. The modified stage for this flood would be 3.6 feet lower than the June 24, 1954 flood at the County Road W bridge (Fisher) — Mile 211.40.

A Standard Project Flood represents the reasonable upper limit of expected flooding. This flood, based on floods which have occurred on the upper Des Moines River Basin and on similar streams, would be significantly greater than experienced floods. The stage for a flood of this magnitude would be 6.1 feet higher than the June 24, 1954 flood at Mile 211.40.

Photographs in the brochure indicate the elevations of the Intermediate Regional and Standard Project Floods in relation to the June 24, 1954 high water at several locations in and near the city of Des Moines.

REDUCTION OF FUTURE FLOOD DAMAGE

The overall plans of the local community for industrial, commercial, and residential areas, for streets and utilities, and for parks, schools, and recreational areas, can be coordinated with the need for flood plain areas to carry flood water. The development plan must first recognize the flood hazard and establish the required floodway limits

based on technical data provided in the report and on the desired flood magnitude. When the required floodway limits are determined, the specific development for areas in the floodway and on the floodway fringe may be selected. Examples of development which may be planned for the floodway include those of low damage potential with no obstruction to flood flows such as parking lots, drive-in theaters, golf courses and parks. These facilities can be coordinated with more valuable developments on adjacent high ground. In the floodway fringe, these more valuable developments may be protected by floodproofing measures such as waterproofing walls and floors, filling to raise floor levels above flood elevations, installing removable waterproof bulkheads at entrances and low level openings, installing check valves in sewer lines, and placing electrical facilities above expected flood elevations.

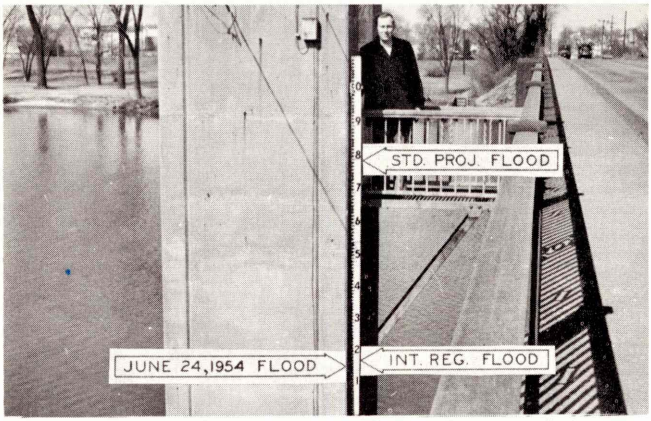
State and local governments, as representatives of the local community, have the responsibility to implement flood plain management programs through the use of legal tools. The available legal tools include zoning, subdivision regulations, and building codes which may be modified to include flood plain regulations. The actual flood plain regulations written into the local codes and ordinances must be definitive enough to provide general public understanding of the problem and the choices of action which the regulations provide. Regulations also must be specific so that criteria, such as minimum first floor elevations, type of construction or encroachment limits, are known for the specific area in question. There are, basically, two main objectives of regulation. First, is to assure and guarantee the retention of an adequate floodway for the river, and, secondly, to encourage sound land use consistent with the flood hazard and community land use needs. Community interest and action are, therefore, required to reduce the future direct costs of flood fighting, flood damage cleanup, and the need for expenditure of tax dollars for expensive flood control works.

This brochure has been prepared by the Corps of Engineers from the data in the report, "Flood Plain Information — Des Moines River, Des Moines, Iowa."

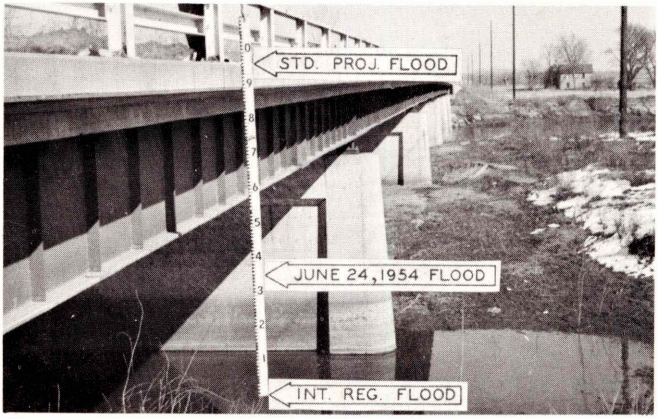
The Rock Island District of the Corps of Engineers will provide, upon request, limited technical assistance in interpreting the information contained herein.

RELATIVE FLOOD HEIGHTS

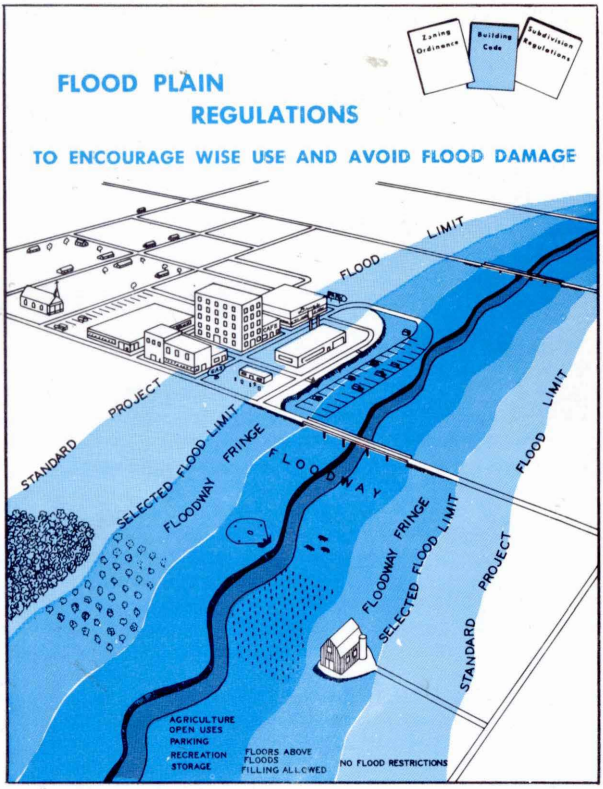
North walk on the left end of Center Street dam.

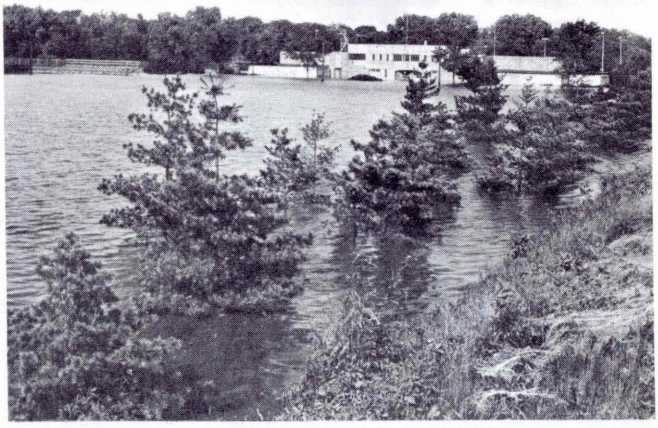


Stream gage on the upstream side of the Second Avenue bridge.

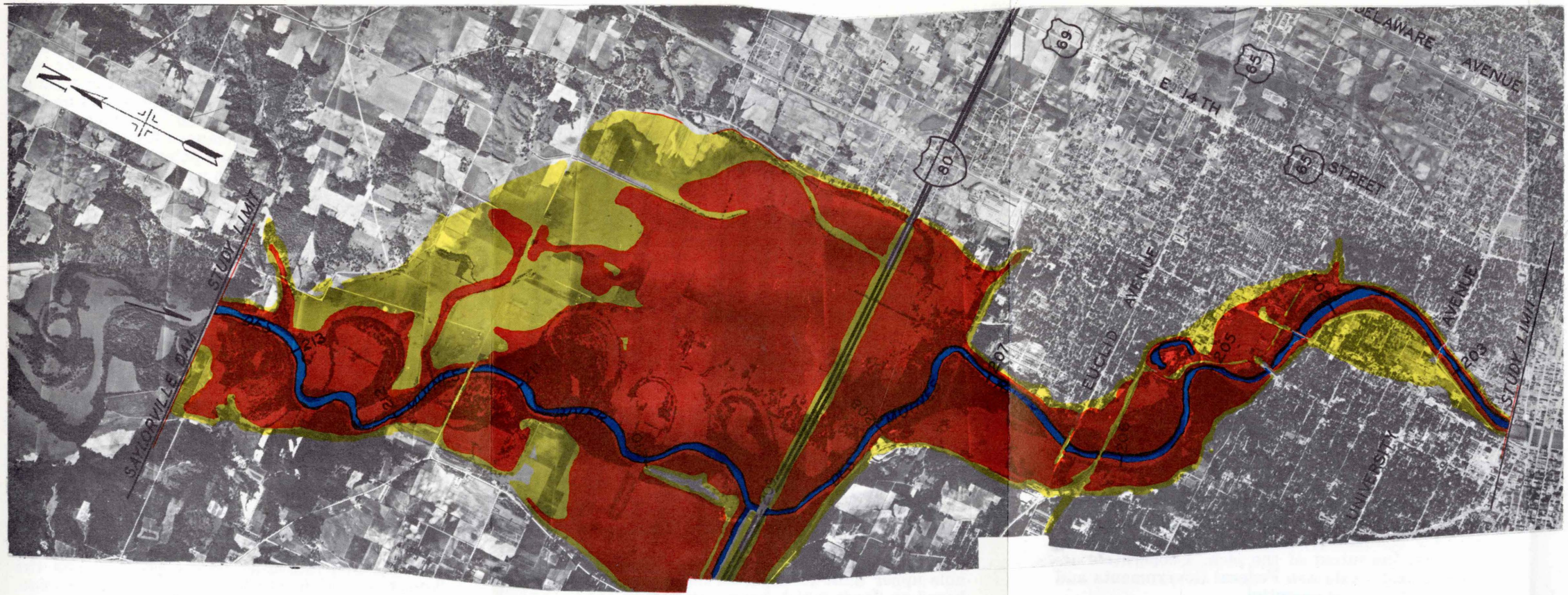


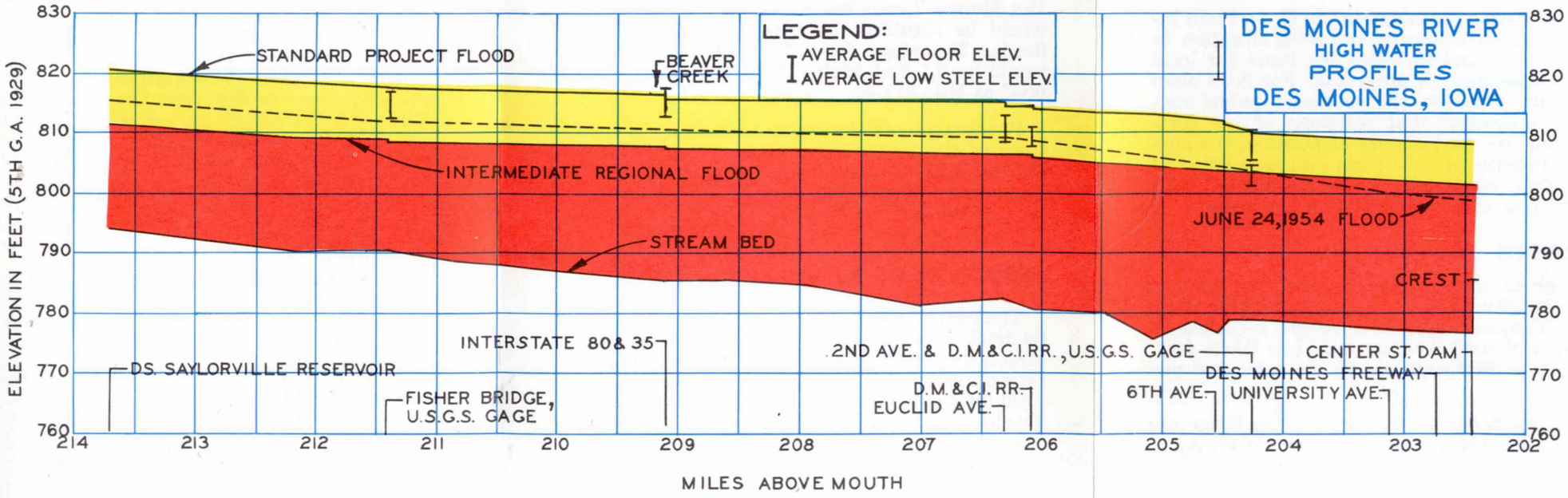
Downstream side of Fisher bridge, mile 211.40.





Looking west from Second Avenue at the swimming pool and playground near Franklin Avenue — June 24, 1954 flood.


N
SAYLORVILLE DAM
STUDY LIMIT
80
69
35
E. 14TH
DELAWARE AVENUE
3
ST. REET
EUCLID AVENUE
UNIVERSITY AVENUE
STUDY LIMIT
212
207
205
203


LEGEND:
AVERAGE FLOOR ELEV.
AVERAGE LOW STEEL ELEV.
DES MOINES RIVER
HIGH WATER
PROFILES
DES MOINES, IOWA
STANDARD PROJECT FLOOD
BEAVER CREEK
INTERMEDIATE REGIONAL FLOOD
JUNE 24,1954 FLOOD
STREAM BED
CREST
ELEVATION IN FEET (5TH G.A. 1929)
MILES ABOVE MOUTH
DS. SAYLORVILLE RESERVOIR
FISHER BRIDGE, U.S.G.S. GAGE
INTERSTATE 80 & 35
D.M.&C.I. RR. EUCLID AVE.
2ND AVE. & D.M.&C.I.RR., U.S.G.S. GAGE
6TH AVE.
DES MOINES FREEWAY
UNIVERSITY AVE.
CENTER ST. DAM
830
820
810
800
790
780
770
760
214
213
212
211
210
209
208
207
206
205
204
203
202

STANDARD PROJECT FLOOD

INTERMEDIATE REGIONAL FLOOD

CHANNEL

AERIAL MOSAIC OF JUNE 1954 FLOOD

DES MOINES RIVER

DES MOINES, IOWA

½ 0 1 2

APPROX. SCALE IN MILES

Looking northeast at the D.M. & C.I. R.R. and Beaver road bridges over Beaver Creek — April 10, 1965 flood.

CONTENTS

CONTENTS (continued)

TABLES

PLATES

FIGURES

INTRODUCTION

GENERAL

This report evaluates the flood situation along the Des Moines River flood plain starting from Center Street dam in the city of Des Moines to the downstream side of the Saylorville Dam in Polk County, Iowa. The report was prepared at the request of the Board of Supervisors of Polk County through the Iowa Natural Resources Council. The following agencies shared the cost of procuring topographic maps: Iowa Natural Resources Council, Polk County, city of Des Moines, and the Central Iowa Regional Planning Commission.

The report is based on rainfall, runoff, past and recent flood height information, and other technical data defining the occurrence and size of Des Moines River floods. Two significant phases of the flood problem in the study reach are covered in the report. First, it reviews the history of flooding in the Des Moines River, then, it estimates the possible occurrence of future floods, the Intermediate Regional and Standard Project Floods.

The Intermediate Regional Flood has an average frequency of occurrence of once in 100 years, although it may occur in any year. The magnitude of this flood was determined from a statistical analysis of known floods in the Des Moines River modified by the operation of Saylorville Reservoir. The Standard Project Flood represents the reasonable upper limit of expected flooding. Although a rare event, the conditions producing the Standard Project Flood could occur at any time. Analysis showed that the maximum reservoir outflow for this type of flood would be considerably larger than the largest known flood in the Des Moines River. For this reason, logical and practical flood plain development must be made compatible with the flood potential of the Des Moines River. Appropriate evaluation must be undertaken of the possible recurrence

of past floods and the occurrence of the Intermediate Regional and Standard Project Floods.

The maps, profiles, and cross sections in this report indicate the extent of flooding which could occur on the Des Moines River flood plain. This information will provide a basis for planning the most practical use of the flood plain consistent with the flood hazard. Likewise, the probable depth of flooding by the Intermediate Regional or the Standard Project Flood may be determined at any location. With this information, structure design criteria may be established or flood proofing measures may be undertaken to eliminate or minimize flood damages.

This report does not include plans for the solution of flood problems. However, it does provide the basis for further study and planning by the local community to minimize vulnerability to flood damages. Local, state, and Federal planning programs may guide developments by managing flood plain use through zoning and subdivision regulations, construction of flood protection works, or a combination of the two approaches.

State regulation of the flood plains of Iowa rivers and streams is provided primarily through administration of Chapter 455A of the Iowa Code by the Iowa Natural Resources Council. This statute assigns to the Resources Council the duty and authority to establish and enforce an appropriate comprehensive statewide program for the control, utilization, and protection of the surface and ground water resources of the state. Prior approval of the Resources Council is required for any structure, dam, obstruction, deposit, or excavation to be erected, made, used, or maintained in or on the floodway or flood plains of any river or stream. Similarly, works of any nature for flood control may not be constructed or installed unless and until the proposed works are approved by the Resources Council. Chapter 455A was amended by the Sixty-First

General Assembly of Iowa, 1965, to authorize the Resources Council to establish and enforce regulations for the orderly development and wise use of the flood plains of any river or stream within the state. The Resources Council is directed to determine the characteristics of floods which reasonably may be expected to occur. In addition, the Resources Council may establish encroachment limits, protection methods and minimum protection levels appropriate to flood characteristics of the stream and reasonable use of the flood plains. Policies and procedures for administration of this Act are being formulated by the Resources Council.

In addition, the authority of local governing bodies to zone land for protection from floods is included in the standard objectives listed in the state enabling statutes, Chapter 358A and Chapter 414 of the Iowa Code 1966, as amended. (See also Chapter 455A of the 1966 Code.)

The Zoning Ordinance of the City of Des Moines adopted in July 1965 provides for flood plain districts limiting the use of areas subject to flooding. It is incorporated in Section 2A-23 quoted hereunder.

"2A-23. 'U-1' DISTRICT REGULATIONS. (Flood Plain Districts) Statement of Intent. The "U-1" district is intended to encompass certain areas of the city which are subject to flood hazard. This district is created in order to protect the public health and welfare, to lessen the burdens imposed upon the community by rescue and relief efforts occasioned by the occupancy of areas subject to flooding, and to minimize the danger to life and property which results from development undertaken without full realization of such danger. It is further the intention of this ordinance that no reclassification of any lands zoned "U-1" be undertaken, unless and until suitable measures have been taken to insure that the flood hazard no longer exists, and that these measures have the

approval of the city, state, or federal agencies, where required by existing legislation.

A) Principal Permitted Uses. Only the uses of structures or land listed in this section shall be permitted in the "U-1" district.

1. Agriculture, truck gardening and nurseries, and the usual accessory buildings, provided that no permanent dwelling units shall be erected thereon unless the tract contains ten (10) or more acres.
2. Forests and forestry.
3. Publicly owned parks, playgrounds, golf courses, and recreational uses.
4. Any use erected or maintained by a public agency.
5. The uses hereinafter listed shall be permitted subject to approval by the City Council after public hearing, and after report and recommendation by the Plan Commission. In its determination upon the particular uses at the location requested, the City Council shall consider all of the following provisions:
    1. That the proposed location, design, construction, and operation of the particular use adequately safeguards the health, safety, and general welfare of persons residing or working in adjoining or surrounding property;
    2. That such use shall not impair an adequate supply of light and air to surrounding property;
    3. That such use shall not unduly increase congestion in the streets, or public danger of fire, safety, and flood;
    4. That such use shall not diminish or impair established property values in adjoining or surrounding property; and,

5. That such use shall be in accord with the intent, purpose, and spirit of this ordinance and the Comprehensive Plan of the City of Des Moines.

The uses subject to the above provisions are as follows:

a. Amusement enterprises, such as race track, carnival, circus, rides and shows, etc.

b. Mining and extraction of minerals or raw materials.

c. Airports and landing fields.

d. Private playgrounds, golf courses, and recreational uses.

e. Public utility structures and equipment necessary for the operation thereof.

f. Transmitting stations.

g. Dumping of non-combustible materials for land fill purposes.

h. Sanitary and combustible land fill.

i. Outdoor advertising signs and billboards.

B) Permitted Accessory Uses.

1. Accessory buildings and uses customarily incident to any of the above uses.

2. Bulletin boards and signs appertaining to the lease, hire, or sale of a building or premises, or signs appertaining to any material that is mined, grown, or treated within the district; provided however, that such signs shall be located upon or immediately adjacent to the building or in the area in which such materials are treated, processed or stored.

C) Bulk Regulations. The following minimum requirements shall be observed in the "U-1" district.

1. Front yard: 50 feet

2. Side yards: Two side yards, not less than 50 feet each

3. Rear yard: 50 feet
4. Maximum height: No limitation.
5. Maximum number of stories: No limitation."

Upon request, the Rock Island District of the Corps of Engineers will provide limited technical assistance to Federal, State, and local agencies in interpretation and use of the information contained in this report.

SUMMARY OF THE FLOOD SITUATION

The report covers approximately 11 miles of the Des Moines River flood plain from mile 202.45 upstream to mile 213.7. River mileage is measured from the mouth of the Des Moines River.

Within the study reach, the United States Geological Survey has maintained a stream gaging station at the Second Avenue bridge, mile 204.28, from August 1941 to October 1961, then at the County Road "W" bridge, mile 211.40, from October 1961 to date. In addition, the Corps of Engineers collected daily wire-weight gage readings at the County Road "W" bridge from October 16, 1948 to September 30, 1953, then September 15, 1959 to September 30, 1961, primarily to obtain stage records for the tailwater of Saylorville Dam. County Road "W" bridge is also referred to as Fisher Bridge.

In addition to these gage records, newspaper files and historical documents were searched for information concerning past floods. From these investigations together with hydrologic studies on possible future floods, the local flood situation has been developed. The following paragraphs summarize the significant findings.

THE GREATEST RECORDED FLOOD FLOW on the Des Moines River within the study reach occurred on June 24, 1954. The discharge was 60,200 cubic feet per second with a peak stage of 30.16 feet at the Second Avenue gage. The corresponding discharge and stage at the County Road "W" bridge gage were 60,000 cubic feet per second and 24.50 feet, respectively.

ANOTHER LARGE FLOOD occurred on April 10, 1965. This flood was the second largest on record. The flow at the County Road "W" bridge gage was 47,400 cubic feet per second producing a stage of 24.02 feet. The peak stage for this flood at the Second Avenue gage was 28.7 feet.

OTHER LARGE FLOODS occurred on May 31, 1903, June 26, 1947, April 1, 1960, May 23, 1944, and July 10, 1902 in the order of flow magnitude. The descriptions of these floods appear in this report under the heading "Flood Descriptions".

THE INTERMEDIATE REGIONAL FLOOD by definition is a flood that has an average frequency of occurrence in the order of once in 100 years. The magnitude of this flood was determined from an analysis of past floods in the Des Moines River. With Saylorville Dam not operating, the flow for this flood would be 76,700 cubic feet per second at the County Road "W" gage. With the operation of the Saylorville Reservoir as a flood control feature the flow at County Road "W" would be 20,000 cubic feet per second at a stage of 20.9 feet. At the County Road "W" bridge, the modified stage of 20.9 feet would be 3.6 feet lower than the June 24, 1954 high water assuming a flow of 20,000 cubic feet per second from Beaver Creek.

STANDARD PROJECT FLOOD determination indicates that floods could occur on the Des Moines River between 5.2 and 9.0 feet higher than the June 1954 flood. The Standard Project Flood would be 6.1 feet higher than the June 1954 flood at the County Road "W" bridge with Saylorville Reservoir operating.

FLOOD DAMAGES from the occurrence of the Standard Project Flood would be substantial. Saylorville Reservoir, acting in conjunction with the Des Moines local flood protection works, will provide protection for that city from the recurrence of major known past floods and the occurrence of the Intermediate Regional Flood.

MAIN FLOOD SEASON for the Des Moines River is in winter and spring. Most of the larger floods have resulted from heavy general rains in combination with snowmelt during the winter and spring months. However, intense local thunderstorms may cause floods during other seasons.

VELOCITIES OF WATER during major floods vary widely, depending on location. During an Intermediate Regional Flood, channel and overbank velocities would range up to 5.2 and 1.1 feet per second, respectively. Velocities greater than three feet per second, combined with depths of three feet or greater, are generally considered hazardous.

FLOOD DURATION on the Des Moines River is relatively long. During the April 1965 flood, the water rose from an initial stage of 15.70 feet to a peak stage of 28.70 feet in 6 days and remained above flood stage of 23.00 feet for 7 days. During the June 1954 flood, the river rose to peak stage of 30.16 feet in 5 days and remained above flood stage for over 4 days. Plate 3 shows the recorded stage hydrographs at the Second Avenue gage for the floods discussed in this paragraph.

HAZARDOUS CONDITIONS would occur during large floods as a result of high velocities and deep flows. Floodwaters which overtop roads can cause hazardous conditions for anyone attempting to drive through inundated areas. Health problems often develop when wells become contaminated and when septic tanks become affected. The danger from underestimating the velocity and depth of floodwaters is a problem confronting residents within the flooded areas.

FUTURE FLOOD HEIGHTS during the occurrence of the Intermediate Regional and Standard Project Floods on the Des Moines River are shown in Table 1 together with the observed high water marks of the June 24, 1954 flood. The future flood heights are based on existing developments on the flood plain within the study reach assuming no clogging at bridges by debris or ice jams. Future developments, if allowed to encroach into the effective flow area of the flood plain, could cause higher water surface elevations than those shown in the table.

TABLE 1

RELATIVE FLOOD HEIGHTS

Mile	Identification [3]	June 1954 Flood Elevation [1] Feet	Intermediate Regional Flood Elevation [1] Feet	Intermediate Regional Flood Elevation [2] Feet	Intermediate Regional Flood Relation to 1954 Flood Elev. Feet	Standard Project Flood Elevation [1] Feet	Standard Project Flood Elevation [2] Feet	Standard Project Flood Relation to 1954 Flood Feet
202.45	US Center Street Dam	798.7	802.1	28.3	3.4	807.7	33.9	9.0
202.75	DS Des Moines Freeway		802.4	28.6		808.0	34.2	
202.75	US Des Moines Freeway		802.4	28.6		808.0	34.2	
203.12	DS University Avenue		802.7	28.9		808.4	34.6	
203.12	US University Avenue	800.0	802.7	28.9	2.7	808.4	34.6	8.4
203.65			803.4	29.6		809.0	35.2	
204.28	DS D.M.&C.I. RR		804.0	30.2		809.7	35.9	
204.28	US Second Avenue	803.8	804.0	30.2	0.2	810.2	36.4	6.4
204.46			804.2	30.4		810.4	36.6	
204.58	DS Sixth Avenue		804.3	30.5		810.8	37.0	
204.58	US Sixth Avenue	804.8	804.4	30.6	-0.4	811.2	37.4	6.4
204.75			804.6	30.8		812.0	38.2	
205.08			805.0	31.2		812.9	39.1	
205.47			805.2	31.4		813.4	39.6	
206.10	DS D.M.&C.I. RR		805.6	31.8		814.1	40.3	
206.10	US D.M.&C.I. RR		805.9	32.1		814.5	40.7	
206.30	DS Euclid Avenue		806.1	32.3		814.6	40.8	
206.30	US Euclid Avenue	808.7	806.2	32.4	-2.5	815.1	41.3	6.4
207.00			806.5	32.7		815.5	41.7	
208.00			806.8	33.0		815.9	42.1	
208.60			807.0	33.2		816.1	42.3	
209.10	DS Interstate 80 & 35		807.2	33.4		816.3	42.5	
209.10	US Interstate 80 & 35		807.5	33.7		817.1	43.3	
209.60			807.7	33.9		817.2	43.4	
210.80			808.1	34.3		817.8	44.0	
211.40	DS Fisher Bridge		808.3	34.5		818.0	44.2	
211.40	US Fisher Bridge	812.0	808.4	34.6	-3.6	818.1	44.3	6.1
212.20			808.9	35.1		818.7	44.9	
213.70	DS Saylorville Reservoir	815.5	811.0	37.2	-4.5	820.7	46.9	5.2

1/ Elevations are based on mean sea level, datum of 1929.

2/ Elevations are based on Des Moines city datum. Zero of Des Moines city datum = 773.8 feet above mean sea level, datum of 1929.

3/ DS - downstream; US - upstream.

GENERAL CONDITIONS AND PAST FLOODS

GENERAL

The Des Moines River is the largest stream in the interior of Iowa with headwaters in southwestern Minnesota and northwestern Iowa. The drainage area at the mouth is approximately 14,467 square miles. At the Second Avenue gage the drainage area is 6,245 square miles.

In the study reach, the Des Moines River flows generally from north to southeast. The average flood plain width as defined by the Standard Project Flood varies in the following locations: Second Avenue to Euclid Avenue - 3,000 feet, upstream from Interstate 80 and 35 - 15,000 feet, and at County Road "W" bridge - 10,200 feet.

Some residential, commercial, and industrial developments in Des Moines are on higher ground. However, there are some residential and commercial establishments on or immediately adjacent to the Des Moines River flood plain.

Des Moines has been damaged by 6 major floods and many minor ones during the past century. Major floods in 1851, 1903, 1944, 1947, 1954, and 1965 caused much property damage. Five hundred persons were displaced from their homes and 2 lost their lives during the June 1947 flood. Damages to the city amounted to $850,000 plus $150,000 spent for emergency flood fighting. The June 1954 flood forced 1,800 people to evacuate their homes and cost the city $1,193,000 in damages and another $375,000 for flood fighting.

The Stream and Its Valley

The Des Moines River flows for 535 miles in a southeasterly direction through the heart of Iowa, in farmland and through urban

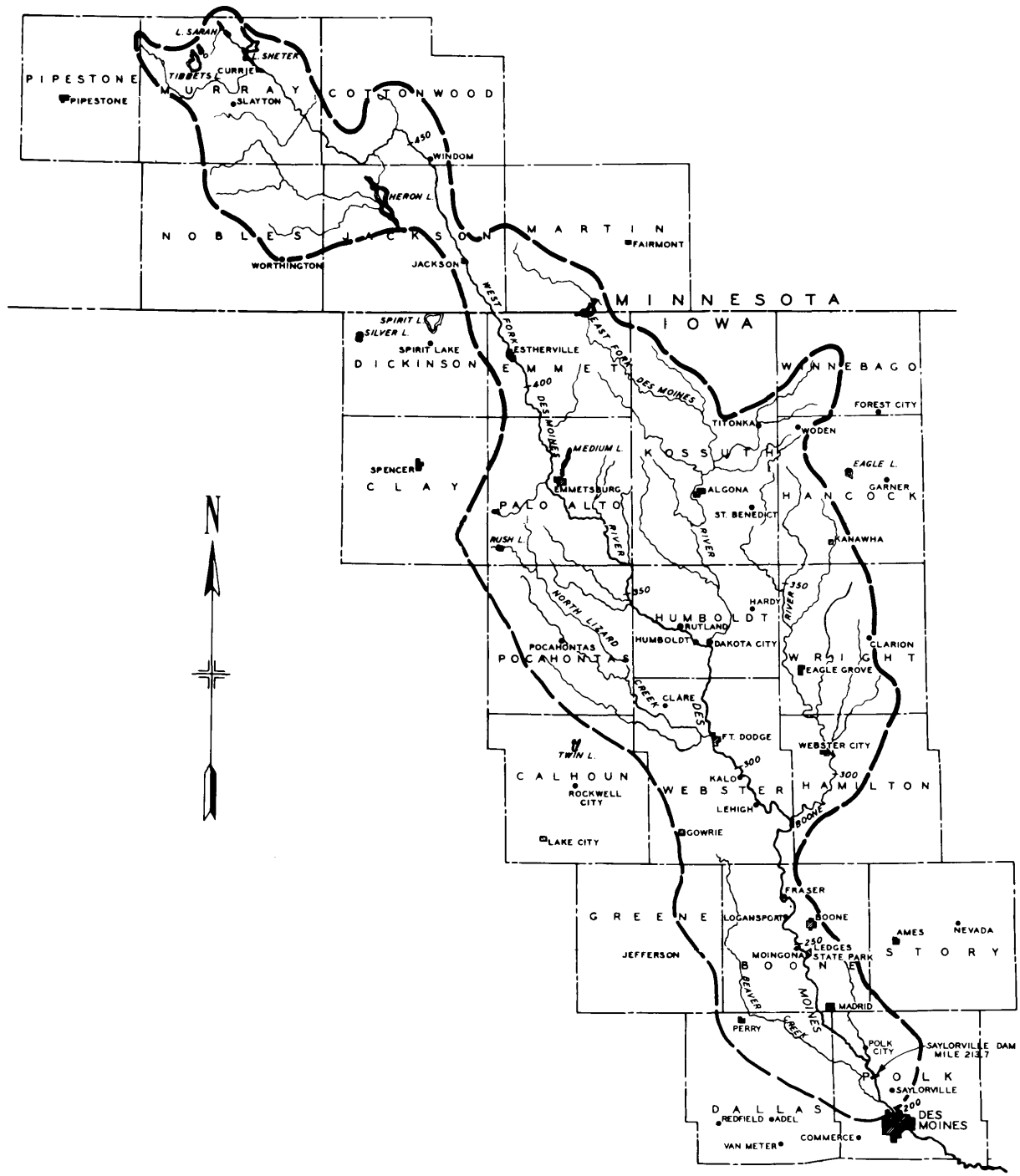
areas of Fort Dodge, Des Moines, Ottumwa and joins the Mississippi River near Keokuk, Iowa.

Tributaries of the upper Des Moines River include the West and East Fork Des Moines Rivers with a combined drainage area of 3,623 square miles at their confluence south of Dakota City, Iowa. Boone River, with headwaters in Hancock and Kossuth Counties, joins the Des Moines River near Webster City. Lizard Creek joins the Des Moines River at Fort Dodge.

Within the study reach, the principal tributary is Beaver Creek having a drainage area of 372 square miles at the mouth. It enters the Des Moines River on the right bank just upstream from Interstate 80 and 35.

Plate 1 shows the watershed, the stream drainage, and the reach covered by this report.

Pertinent drainage areas of the Des Moines River and its tributaries are given in Table 2.



CORPS OF ENGINEERS, U.S. ARMY
ROCK ISLAND, ILLINOIS, DISTRICT

DES MOINES RIVER WATERSHED

~~~ REACH COVERED BY THIS REPORT

10 5 0 10 20 30 40 50
SCALE IN MILES

APRIL 1970
~~~

TABLE 2

DRAINAGE AREAS IN DES MOINES RIVER WATERSHED

Stream	Location	Miles above Mouth	Drainage Area sq mi
Des Moines River	2nd Ave., Des Moines, Iowa	204.28	6,245
Beaver Creek	At mouth		372
Des Moines River	County Road "W" Bridge, near Saylorville, Iowa	211.40	5,841
	Near Boone, Iowa		5,511
Boone River	At mouth		906
Des Moines River	At Fort Dodge, Iowa		4,190
Lizard Creek	At mouth		437
West Fork Des Moines River	At mouth		2,308
East Fork Des Moines River	At Dakota City, Iowa		1,308

Settlement

The Des Moines River was discovered on June 25, 1673 by Father Marquette, missionary, and Louis Joliet, explorer and trader. Journeying westward along the Des Moines River from the Mississippi River, they came upon two Indian villages, from one of which, Moinguena, the name Des Moines was probably derived.

The earliest published record of exploration along the upper Des Moines is printed in a book written by Lt. Albert M. Lea, United States Dragoons, in 1835. Having descended the Des Moines River in a canoe from Raccoon River to Keokuk during the summer of 1835, he made these observations. "From the Raccoon River to the

Cedar, the Des Moines is from 80 to 100 yards in width, shallow, crooked, and filled with rocks, sand-bars, and snags, and is impetus in current at high water; yet it is certain that keelboats may navigate this portion of the river, being 96 miles, during a great part of the spring and fall; and it is not impossible that even steam-boats may run there."

The founding of Fort Des Moines started on May 20, 1843 when Captain Allen, with 52 dragoons, landed on the point between the Raccoon and the Des Moines Rivers. The men constructed a temporary wharf at the confluence of the two rivers. They erected the first building, a storehouse, at a point about 50 yards from the north bank of the Raccoon. They then erected a hospital about 300 yards west of the Des Moines River. Barracks for the men were constructed along a street line running northwest and southeast extending to the wharf. The officers' quarters were erected near the Des Moines River, a few yards north from the point, facing west, on a street running north and south, now known as Second Avenue.

On June 1, 1846 the town of Des Moines was platted and the first town lots were advertised for sale. The first limits of the town were set as far west as Eighth Street and as far north as Locust Street. The Des Moines River was the eastern boundary, and the Raccoon River the southern boundary.

At the same time another community had been developing on the land east of the Des Moines River. There were a tavern, a gristmill, a pottery, and a few settlers' homes already at that time.

There was much rivalry between the two settlements during the early days. It came to an end on January 28, 1857 when a law was passed creating the city of Des Moines, thus bringing together under one charter the east and west side communities.

During the growth and development of the city through the 1850's, Des Moines River was a precarious waterway for steamboats. River traffic declined only after the railroad came in.

The first railroad, the Des Moines Valley Railroad Company, reached Des Moines in August 1866. Many other railroad companies followed which directly or indirectly served Des Moines. Among these were: The Rock Island; the Mississippi and Missouri; the Des Moines, Indianola and Missouri; the Des Moines, Winterset and Southern; the Des Moines, Iowa Falls and Northern; the Minneapolis and St. Louis; the Northwestern; the Burlington; the Milwaukee; the Des Moines Northern and Western; the Des Moines Adel and Western; Des Moines Northwestern; the Great Western; and the Des Moines Union.

Today, major railroads serving the Des Moines area include the Chicago, Rock Island, and Pacific, the Norfolk and Western, the Chicago and North Western, and the Chicago, Milwaukee, St. Paul, and Pacific.

Flood Damage Prevention Measures

Saylorville Reservoir was authorized by the Flood Control Act of 1958. Authorized project purposes are flood control, low flow augmentation, and recreation. Remedial works to protect Polk City, Iowa include a barrier dam on Big Creek downstream and a diversion dam upstream from the town. Flows on Big Creek upstream from Polk City will be diverted directly into Saylorville Reservoir.

Project Status: Construction in progress.

The Flood Control Act of 1944 authorized construction of local flood protection works for the city of Des Moines. The project provides for construction of a system of levees and floodwalls, the repair and provision of gates on existing sewerage outlets, and appurtenant works.

Project Status: Construction in progress.

Flood Warning and Forecasting Services

The ESSA Weather Bureau, Department of Commerce, provides a general flood forecasting service for major river basins in Iowa, including the Des Moines River. The system involves the prediction of river stage at a particular gage or gages in the basin, based on observed precipitation, flow at upstream points, and anticipated weather conditions. The flood warnings and statements on flood conditions are transmitted to city officials as well as to newspapers and radio and television stations in the basin. These sources disseminate the information to residents of the flood plain in the form of flood warnings or general advisories. Such forewarning permits industrial plants, public utilities, municipal utilities, municipal officials, and individuals with property in the lowlands to take protective measures. Services available are generally of the three types described below:

1. Flash Flood. In relatively small areas, procedures utilizing radar or local flash flood reporting networks are the most practical means of implementing flood warnings. The WSR-57 facility at Des Moines, Iowa has effective range to cover the area. Commercial radio and television stations have 24-hour telephone warning service from the Weather Bureau at Des Moines. Radar coverage is used to provide general, but immediate, broadcast to identify areas of intense and persistent rainfall and potential flooding.

2. Major Flood Forecasts. Flood forecasts prepared by the Kansas City River Forecast Center for the Saylorville and Des Moines (Second Avenue) gages are issued through the Des Moines Weather Bureau Office. Forecasts are based on radar coverage, reports from about fifteen rainfall reporting stations, ten river stations, anticipated weather conditions, and hydrologic factors. The lead time may range from a few hours to several days.

3. Hydroclimatic Data. The basic data network in the basin above Des Moines, Iowa consists of sixteen stations, six of which automatically record precipitation intensity. Most of the data from the network is published. These records provide the basis for forecasts, as well as for the planning and design of protective works and their operation during floods.

Developments in the Flood Plain

Many structures in the flood plain of the Des Moines River have been damaged by past floods. In the study reach, damages due to the recurrence of past major floods and occurrence of the Intermediate Regional Flood will be lesser in extent primarily because of the operation of the Saylorville Reservoir. Some homes in the Beaver Creek area will be inundated together with a few farm houses upstream from Interstate 80 and 35. Parts of Riverview and Birdland Parks will also be inundated by the Intermediate Regional Flood.

The outflow from Saylorville Reservoir during the occurrence of the Standard Project Flood can overtop existing levees north of Second Avenue and flood many buildings, including residences and commercial and industrial establishments.

Plates 5 and 6 show the location of 14 sheets of the flooded area delineation maps, Plates 7 through 20. These delineation maps show the areas that will be flooded by the Intermediate Regional and the Standard Project Floods.

Bridges and Dam across Des Moines River

Seven highway and two railroad bridges, and Center Street dam span the Des Moines River within the study reach. The Center Street dam at mile 202.45 is now owned by the city of Des Moines. The city obtained the dam from the Iowa Power and Light Company.

Table 3 lists and describes the bridges and shows the relation of the average low steel elevation to the Intermediate Regional Flood crest elevation. Photographs of all these bridges and Center Street dam are shown in Figures 1 through 10.

Obstructions to Flood Flow

The high water profiles shown on Plate 21 indicate the effect of bridges on flood flows. For flows of the magnitude of the Intermediate Regional and Standard Project Floods, the bridges are not serious obstructions during the summer months. However, floods on the Des Moines River are most often the result of late winter and early spring snowmelt or snowmelt in combination with general heavy rainfall. The degree of obstruction may increase drastically when the ice cover breaks up. Increased flood crest elevations would result from the reduction of effective flow area by localized ice jams.

The current level of development in the flood plain of Des Moines River does not presently constitute a serious degree of encroachment. However, present trends and projected growth patterns indicate urban developments will encroach into areas subject to inundation by flows of the magnitude of the Intermediate Regional and Standard Project Floods. Careful flood plain management, including the establishment of encroachment limit lines, should be considered to assure preservation of an adequate floodway to accommodate the flow of the Intermediate Regional Flood without adverse effects on existing facilities.

TABLE 3

BRIDGES ACROSS DES MOINES RIVER

Mile	Identification	Type	Spans and Length in Feet	Intermediate Regional Flood Crest Elevation[1] Feet	Stream Bed Elev.[1] Feet	Floor Elevation[2] Left Feet	Floor Elevation[2] Right Feet	Low Steel Elev.[2] Left Feet	Low Steel Elev.[2] Right Feet	Underclearance: Average Low Steel Elev.[1] Feet	Underclearance: Above Inter. Regional Flood Feet	Underclearance: Below Inter. Regional Flood Feet
202.75	Des Moines Freeway	Steel Plate Deck Girder	7 - Total span = 860	802.4	777.5	-[3]	-	-	-	-	-	-
203.12	University Avenue	Reinforced Concrete Arch	6 - Total span = 750	802.7	778.0	847.9	825.0	839.3	816.4	827.4	24.7	
204.28	D.M. and C.I. RR	Steel Truss	4 - Total span = 583	804.0	779.3	804.6	804.6	801.6	801.6	801.6		2.4
204.28	Second Avenue	Steel Plate Deck Girder	5 - Total span = 520	804.0	779.3	811.8	808.8	806.4	804.2	805.3	1.3	
204.58	Sixth Avenue	Steel Plate Deck Girder	5 - Total span = 546	804.4	777.3	816.2	834.8	810.8	828.3	819.6	15.2	
206.10	D.M. and C.I. RR	Steel Truss	9 - Total span = 575	805.9	780.3	810.5	810.2	807.4	807.4	807.4	1.5	
206.30	Euclid Avenue	Steel Plate Deck Girder	6 - Total span = 550	806.2	782.8	812.4	812.7	807.9	808.2	808.1	1.9	
209.10	Interstate 80 and 35	Reinforced Concrete Deck Girder	7 - Total span = 700	807.5	785.6	818.2	818.2	813.7	813.7	813.7	6.2	
211.40	Fisher Bridge	Steel Plate Deck Girder	6 - Total span = 600	808.4	790.4	817.4	817.4	812.6	812.6	812.6	4.2	

1/ Elevations are based above mean sea level, datum of 1929.

2/ On arch bridges, tabulated low steel elevation is crown of the arch. Tabulated floor elevation corresponds to location at the crown of the arch.

3/ Low steel elevation is well above Standard Project Flood height.

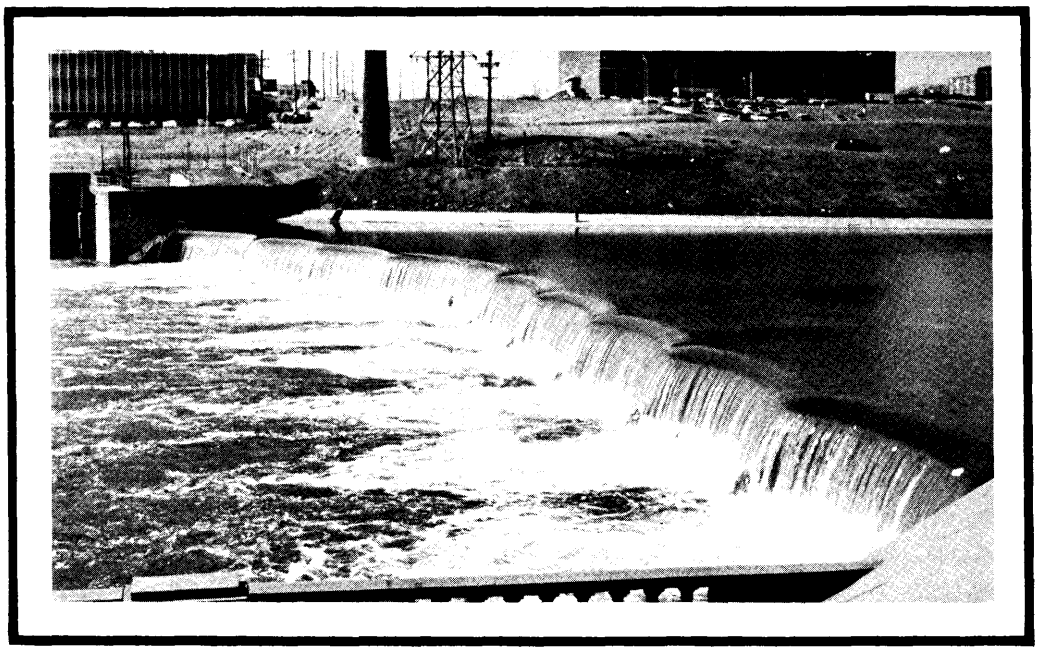


Figure 1. Looking west at Center Street dam - Mile 202.45.

Figure 2. Locking upstream at the Des Moines Freeway bridge - Mile 202.75.

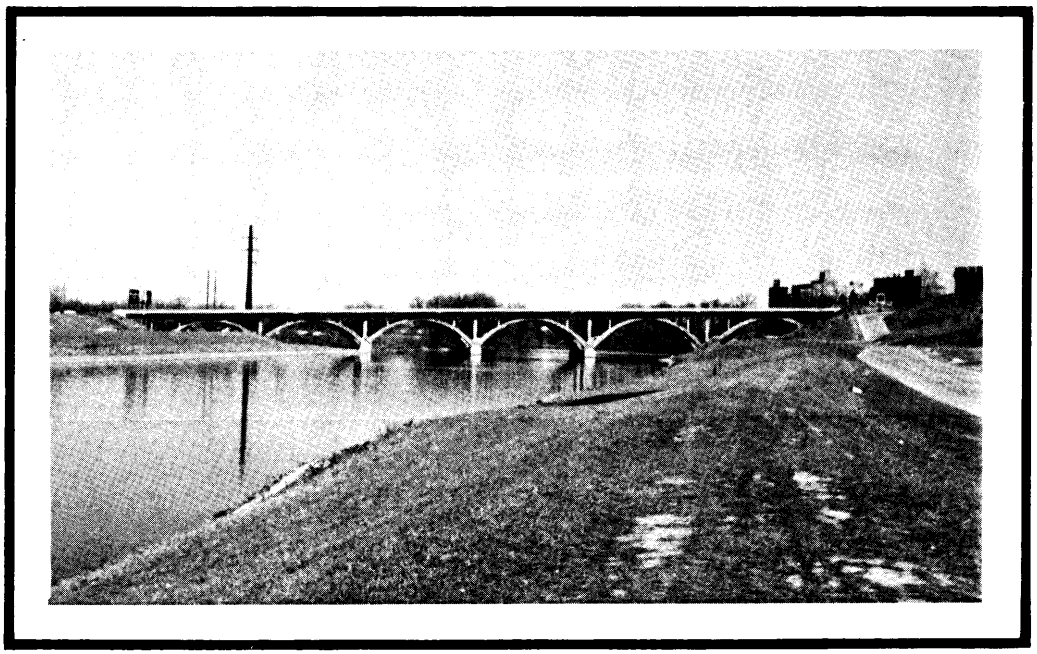


Figure 3. Looking upstream at the University Avenue bridge - Mile 203.12.

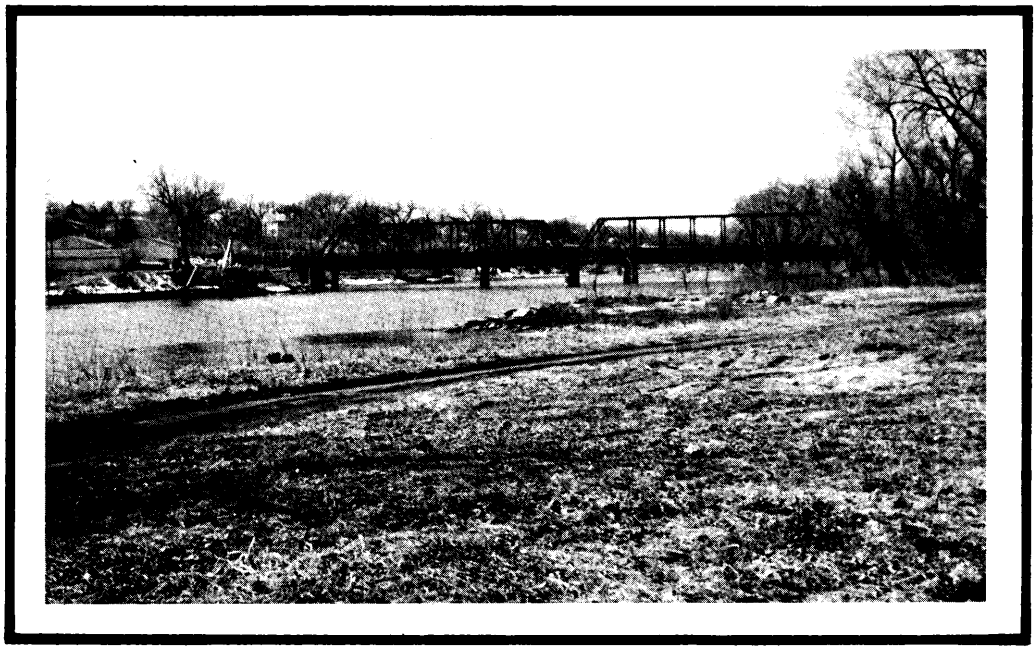


Figure 4. Looking upstream at the D.M.&C.I. RR bridge - Mile 204.28.

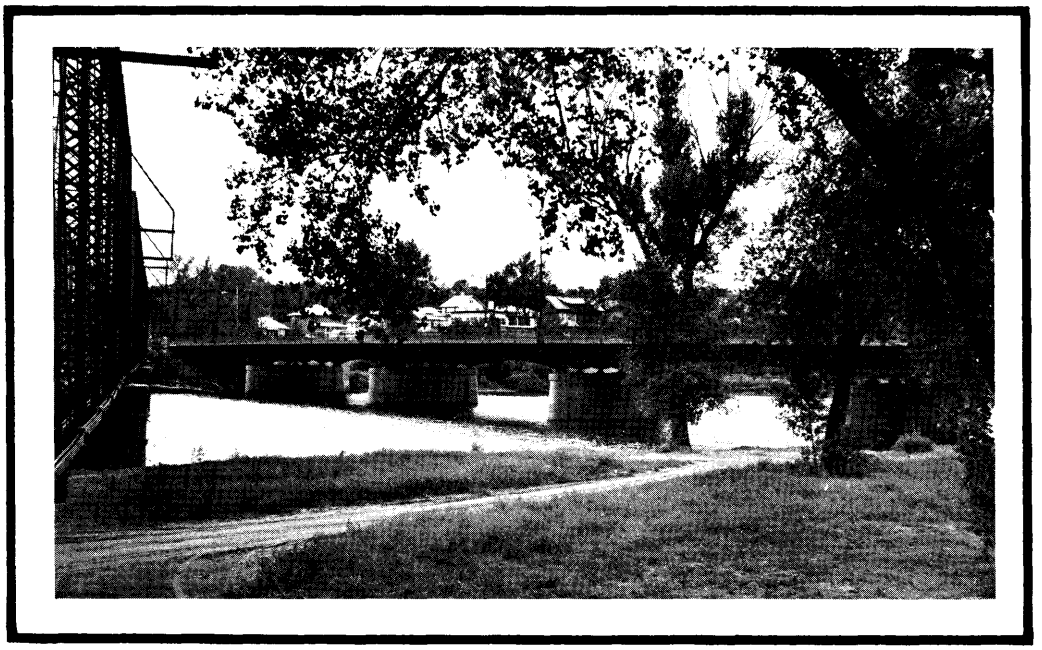


Figure 5. Looking southwest at the Second Avenue bridge - Mile 204.28.

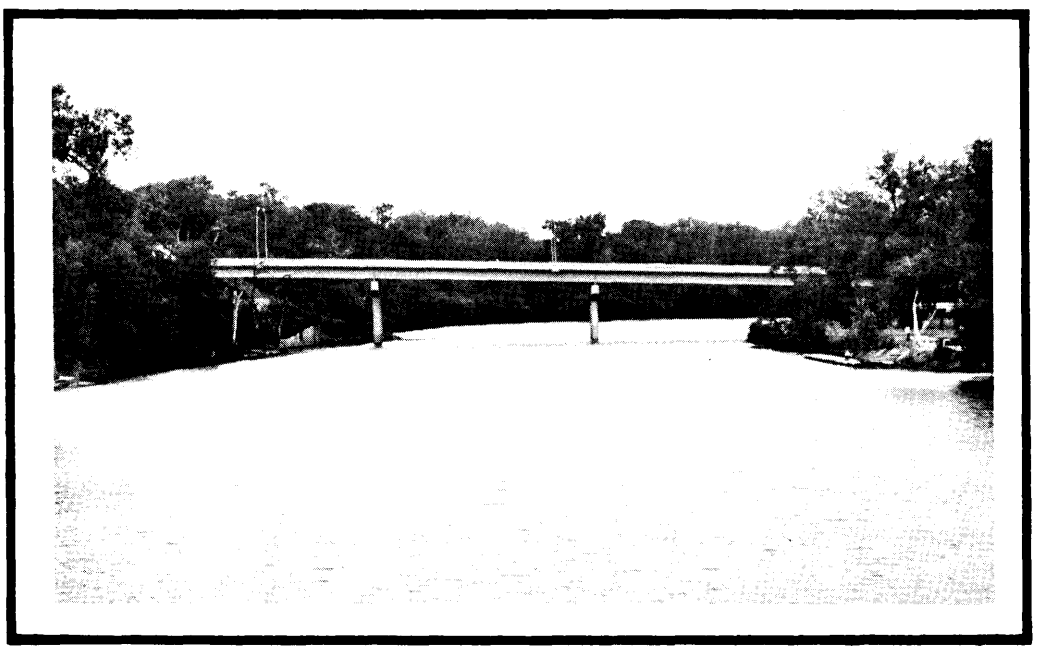


Figure 6. Looking upstream at the Sixth Avenue bridge - Mile 204.58.

Figure 7. Looking downstream at the D.M.&C.I. RR bridge - Mile 206.10.

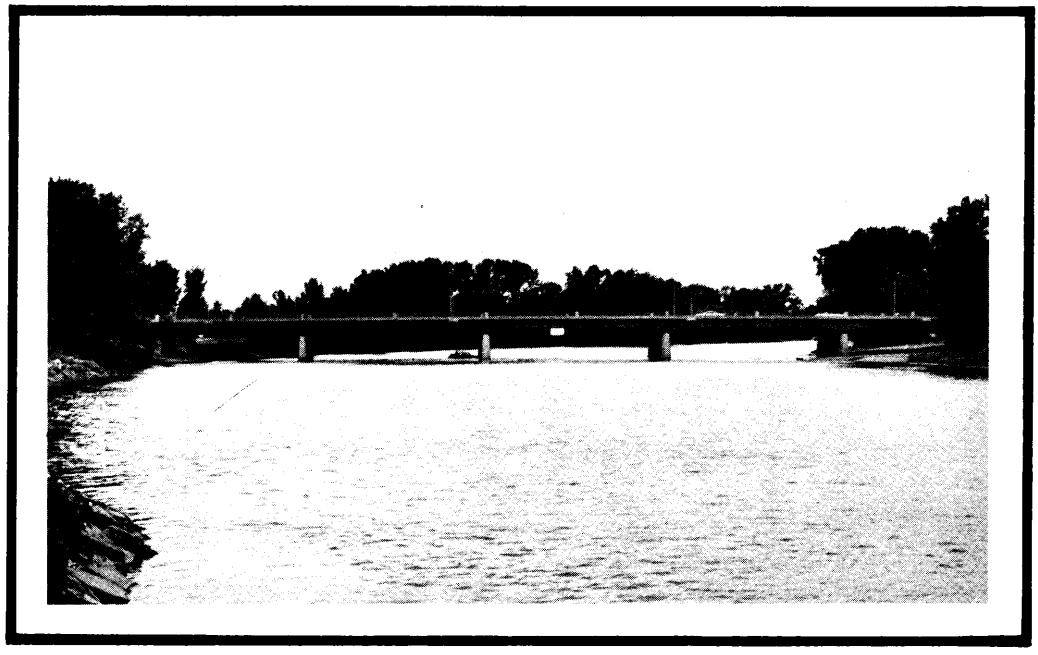


Figure 8. Looking downstream at the U. S. Highway 6 or Euclid Avenue bridge - Mile 206.30.

Figure 9. Looking northeast at the downstream side of the eastbound lane of Interstate 80 & 35 twin bridges - Mile 209.10.

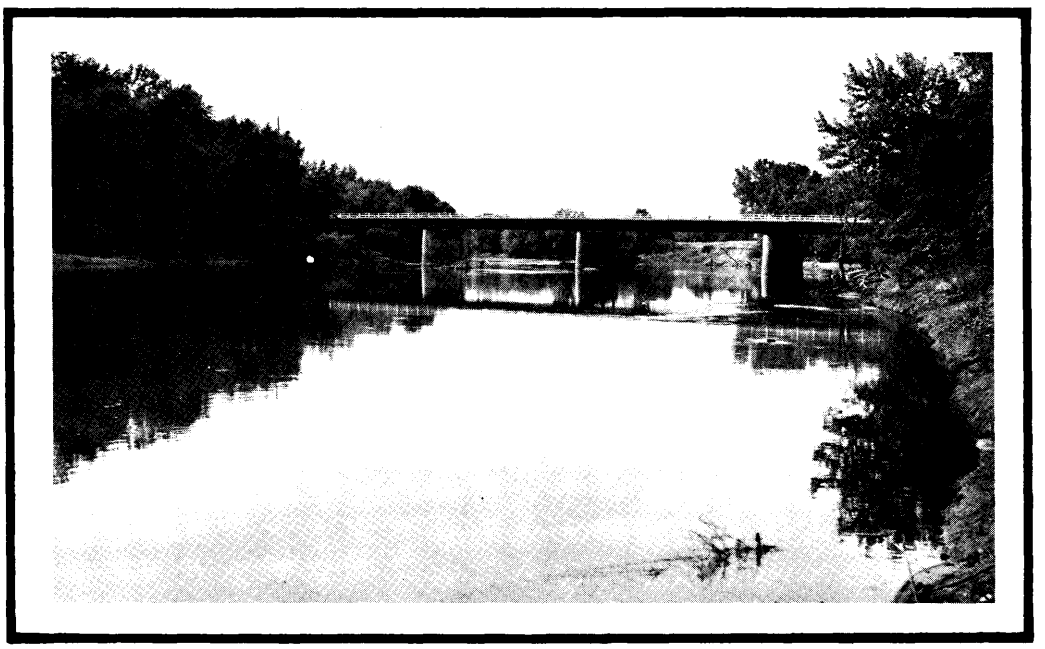


Figure 10. Looking upstream at Fisher Bridge - Mile 211.40.

FLOOD SITUATION

Flood Records

Records of river stages and discharges on the Des Moines River have been maintained since August 21, 1941 by the United States Geological Survey at Second Avenue bridge. On that date, the U.S.G.S. installed a continuous water stage recorder at the upstream side of the bridge. This gage was discontinued in October 1961.

On September 2, 1948 the Corps of Engineers installed a wire-weight gage at the upstream side of Fisher Bridge on County Road "W" - mile 211.40. Daily gage readings were collected until September 30, 1953 when the gage was discontinued. Again, on September 15, 1959 the Corps installed a wire-weight gage on the downstream side of the existing Fisher Bridge and daily stage records are available to date. The U.S.G.S. is now using this gage in lieu of the Second Avenue gage.

To supplement the records obtained at these gages, local residents were interviewed for information on dates and heights of floods. Newspaper files, historical documents, and records were searched. Valuable data were obtained from reports of field investigations made after floods. Through these investigations and records, a knowledge of floods on Des Moines River has been developed covering the past 67 years.

Flood Stages and Discharges

Tables 4A and 4B list crest stages and discharges for the known floods exceeding stages of 17.4 and 13.0 feet at the Second Avenue and County Road "W" (Fisher Bridge) gages, respectively. These stages correspond to a flow of 10,000 cubic feet per second, for partial duration series flow frequency analysis.

Table 5 lists the ten highest floods in order of flow magnitude. These floods occur in March, April, May, June, and July. Ice cover and snowmelt are generally at their greatest during late winter and early spring. This combination of conditions indicates the potential for ice jams at bridges, islands, channel bends, and other natural or manmade flow constrictions. The newspaper articles and past flood records on the Des Moines River describe the occurrence of ice jams. Ice jams result in ponding and increased water surface elevations upstream from the ice jam for a given flow.

Flood Occurrence

Plate 2 shows known crest stages and year of occurrence of known floods exceeding flood stages of 23.0 feet and 18.3 feet at the Second Avenue and the County Road "W" (Fisher Bridge) gages, respectively.

Duration and Rate of Rise

Plate 3 shows the recorded stage hydrographs for the June 24, 1954 and the April 10, 1965 flood hydrographs at the Second Avenue gage - mile 204.28, approximately. Plate 4 is the stage hydrograph for the April 1965 flood at the County Road "W" gage - mile 211.40.

From these hydrographs, the maximum rate of rise and duration above a particular stage may be estimated. During the flood of June 1954, the maximum rate of rise was 4 feet in a twelve-hour period and remained above flood stage of 23.0 feet for over 4 days.

TABLE 4A

FLOOD CREST ELEVATIONS ABOVE 17.4-FOOT STAGE

DES MOINES RIVER AT 2ND AVENUE, DES MOINES

The table includes all recorded floods from November 1941 to October 1961 above a stage of 17.4 feet (elevation 791.2) at the U.S.G.S. gaging station located on the right bank and 5 feet upstream from Second Avenue bridge in Des Moines. The gage is 1.8 miles upstream from Center Street dam, 2.8 miles upstream from Raccoon River, and 4.5 miles downstream from Beaver Creek. Drainage area at the gage is 6,245 square miles. The gage datum is at elevation 773.68 feet above mean sea level, datum of 1929.

Date of Crest	Gage Height		Discharge
	Stage feet	Elevation feet	cfs
February 24, 1943	19.02	792.70	9,500[1/]
May 23, 1944	24.40	798.08	34,000
June 17, 1944	23.40	797.08	29,100
March 18, 1945	19.50	793.18	15,500
April 19, 1945	18.50	792.18	12,500
April 27, 1945	19.50	793.18	15,400
May 25, 1945	19.60	793.28	15,800
June 4, 1945	20.46	794.14	18,700
August 20, 1945	18.30	791.98	12,100
March 16, 1946	18.00	791.68	10,900
May 29, 1946	19.78	793.46	16,900
June 21, 1946	17.80	791.48	11,000

TABLE 4A (Cont'd)

Date of Crest	Gage Height Stage feet	Gage Height Elevation feet	Discharge cfs
June 6, 1947	18.10	791.78	11,700
June 13, 1947	21.30	794.98	20,200
June 26, 1947	26.50	800.18	39,500
July 3, 1947	21.20	794.88	21,300
March 2, 1948	-	-	12,000±[1/]
March 19, 1948	21.21	794.89	20,300
March 8, 1949	19.43	793.11	15,300
March 30, 1949	18.40	792.08	12,400
March 9, 1950	17.73	791.41	10,600
June 22, 1950	17.67	791.35	10,600
March 1, 1951	19.00	792.68	12,000±[1/]
March 31, 1951	23.80	797.48	32,400
April 10, 1951	23.68	797.36	31,900
April 27, 1951	19.25	792.93	14,700
May 4, 1951	22.54	796.22	26,600
June 5, 1951	19.02	792.70	14,100
July 4, 1951	20.40	794.08	18,500
July 14, 1951	17.59	791.27	10,600
March 23, 1952	17.47	791.15	10,400
April 3, 1952	20.20	793.88	17,800
April 17, 1952	18.30	791.98	12,400
July 12, 1952	18.87	792.55	13,900
June 12, 1953	17.90	791.58	11,400

TABLE 4A (Cont'd)

Date of Crest	Gage Height		Discharge
	Stage feet	Elevation feet	cfs
June 13, 1954	19.06	792.74	14,300
June 24, 1954	30.16	803.84	60,200
August 29, 1954	19.92	793.60	16,800
May 26, 1959	17.42	791.10	10,200
June 3, 1959	19.72	793.40	16,100
April 1, 1960	25.25	798.93	36,200
May 7, 1960	18.61	792.29	13,100
May 27, 1960	19.25	792.93	14,600
March 31, 1961	22.55	796.23	26,700

1/ Estimated

TABLE 4B

FLOOD CREST ELEVATIONS ABOVE 13.0-FOOT STAGE

DES MOINES RIVER NEAR SAYLORVILLE, IOWA

The table includes all recorded floods from October 1961 to September 1969 above a stage of 13.00 feet (elevation 800.54) at the gaging station located on the downstream side of the midspan of County Road "W" bridge at mile 211.4. The drainage area at this gage is 5,841 square miles. Present gage zero is at elevation 787.54 feet above mean sea level, datum of 1929.

Date of Crest	Gage Height		Discharge
	Stage feet	Elevation feet	cfs
April 3, 1962	21.10	808.64	31,000
July 8, 1962	14.25	801.79	9,690
July 15, 1962	13.56	801.10	8,720
September 5, 1962	19.10	806.64	21,800
May 1, 1963	13.20	800.74	8,100
September 15, 1964	13.31	800.85	8,250
April 10, 1965	24.02	811.56	47,400
May 29, 1965	18.00	805.54	19,100
June 5, 1965	16.66	804.20	15,200
September 9, 1965	16.48	804.02	14,800
October 2, 1965	17.35	804.89	17,200
June 12, 1966	16.79	804.33	15,900
June 13, 1967	18.70	806.24	21,000
June 19, 1967	18.50	806.04	19,600
April 18, 1969	20.15	807.69	25,480

TABLE 5

HIGHEST TEN RECORDED FLOODS IN ORDER OF FLOW MAGNITUDE

DES MOINES RIVER AT DES MOINES, IOWA

Order No.	Date of Crest	Gage Height 2/ Stage feet	Gage Height 2/ Elevation feet	Discharge cfs	Gage Location 1/
1	June 24, 1954	30.16	803.84	60,200	2nd Avenue
2	April 10, 1965	24.02	811.56	47,400	County Road W
3	May 31, 1903	27.30	801.04	42,000	Walnut St Bridge
4	June 26, 1947	26.50	800.18	39,500	2nd Avenue
5	April 1, 1960	25.25	798.93	36,200	2nd Avenue
6	May 23, 1944	24.40	798.08	34,000	2nd Avenue
7	July 10, 1902	20.10	793.84	32,900	Walnut St Bridge
8	March 31, 1951	23.80	797.48	32,400	2nd Avenue
9	April 10, 1951	23.68	797.36	31,900	2nd Avenue
10	April 3, 1962	21.10	808.64	31,000	County Road W

1/ Gage location refers to the gage where discharge and gage height measurements were made.

2/ Gage height elevations are based on the following gage datum:
County Road W = 787.54 feet above m.s.l., 1929 datum.
Second Avenue = 773.68 feet above m.s.l., 1929 datum.
Walnut Street = 773.74 feet above m.s.l., 1929 datum.

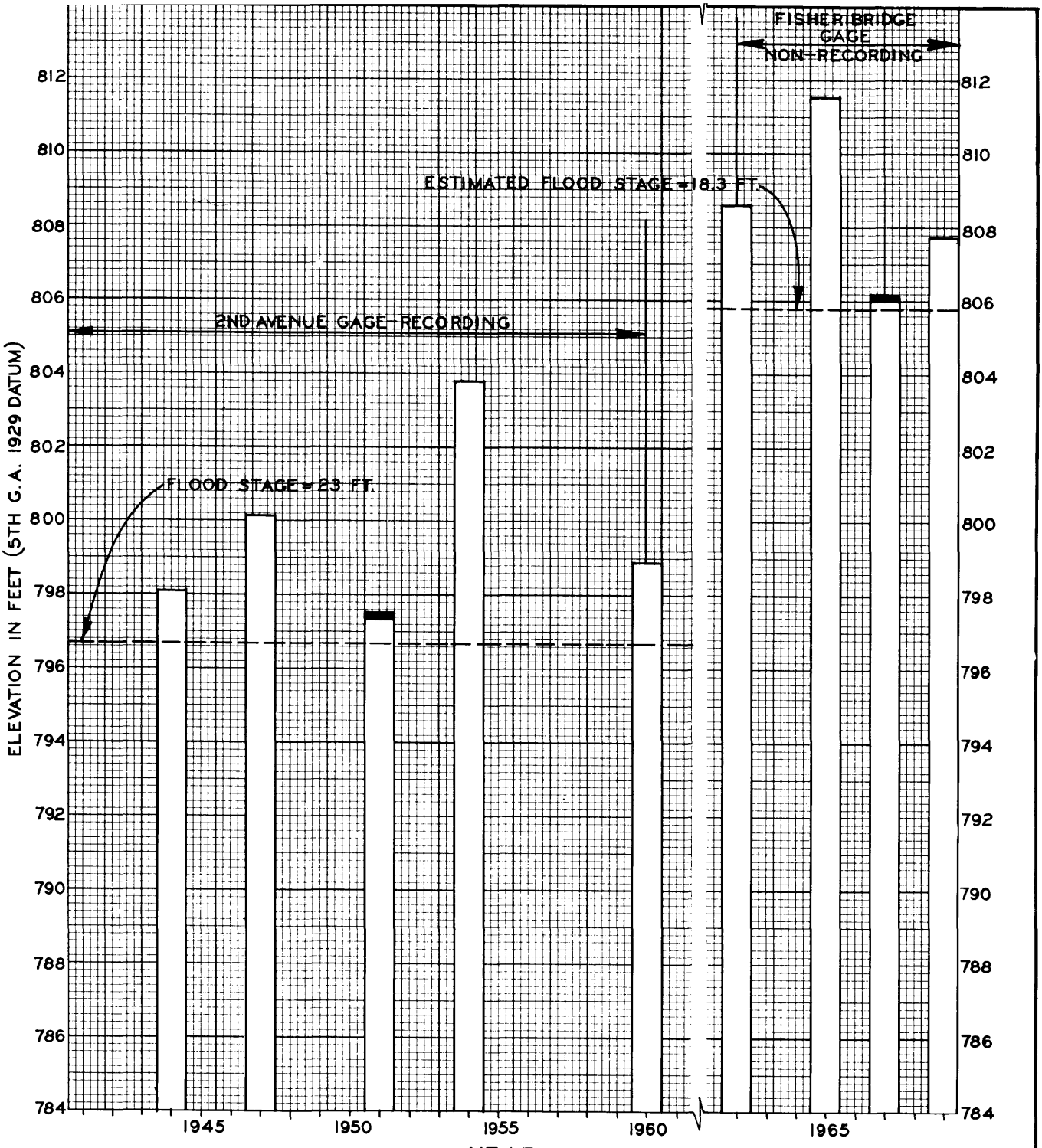
Velocities

With Saylorville Reservoir not operating, a recurrence of the June 24, 1954 flood would result in velocities of 7.8 and 1.5 feet per second in the channel and overbanks, respectively, at mile 204.46. These velocities are representative of open river conditions for flows of the magnitude of the June 24, 1954 flood, but would be greater at flow constrictions.

Flooded Areas, Flood Profiles, and Cross Sections

Plates 7 through 20 show the approximate areas along the Des Moines River that would be inundated by the Intermediate Regional and Standard Project Floods. The actual limits of these overflow areas on the ground may vary from those shown on the maps. The contour interval, scale of the maps, and changes in the topography since mapping was completed do not permit precise plotting of flooded area boundaries. However, the water surface profile elevations for the June 24, 1954, the Intermediate Regional, and the Standard Project Floods shown in Plate 21 may be used at specific locations.

Plates 22 and 23 show cross sections that are typical of the sections obtained for Des Moines River in the reach investigated. The locations of cross sections are shown on Plates 7 through 20.



STREAM GAGES AT:

1. 2ND AVENUE (1941 - 1961) - GAGE ZERO AT ELEV. 773.68
2. FISHER BRIDGE (1962 - PRESENT) - GAGE ZERO AT ELEV. 787.54.

NOTES:

1. VARIATION IN SHADING ON BAR GRAPH INDICATES MORE THAN ONE FLOOD DURING THE YEAR. FOR EXAMPLE, IN 1951 THERE WERE 2 FLOODS ABOVE FLOOD STAGE; GAGE HEIGHTS WERE 23.68 AND 23.80 FEET OR ELEVATIONS 797.36 AND 797.48 FEET, RESPECTIVELY.
2. THE ESTIMATED FLOOD STAGE OF 18.3 FEET AT FISHER BRIDGE IS EQUIVALENT TO THE 23.0 FOOT FLOOD STAGE AT 2ND AVENUE GAGE.

CORPS OF ENGINEERS, U.S. ARMY

ROCK ISLAND, ILLINOIS, DISTRICT

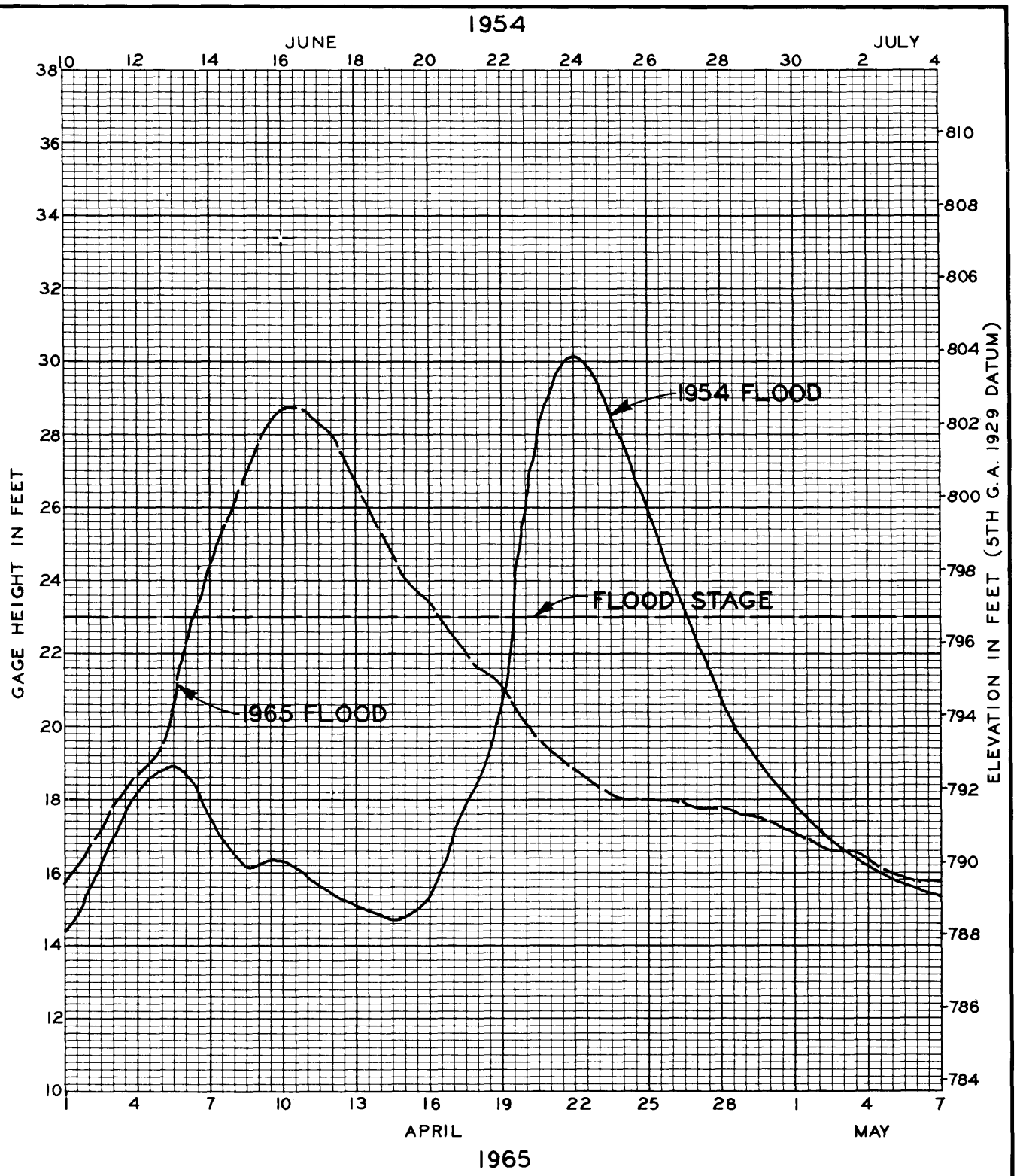
FLOODS ABOVE FLOOD STAGE

DES MOINES RIVER

DES MOINES, IOWA

APRIL 1970

PLATE 2



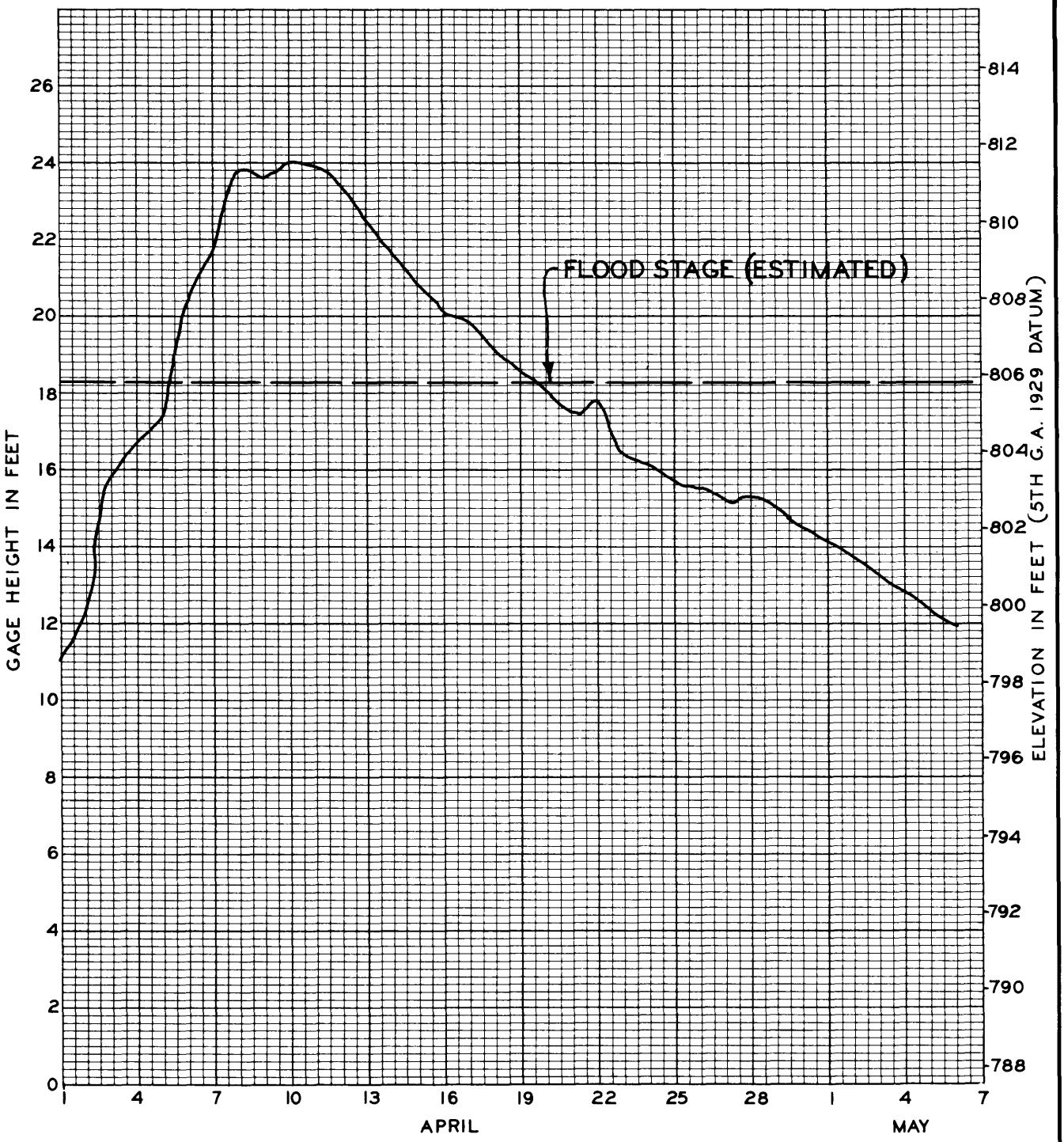
STREAM GAGE AT 2ND AVENUE BRIDGE – MILE 204.28

CORPS OF ENGINEERS, U.S. ARMY
ROCK ISLAND, ILLINOIS, DISTRICT

STAGE HYDROGRAPHS

DES MOINES RIVER
DES MOINES, IOWA
APRIL 1970

PLATE 2



STREAM GAGE AT FISHER BRIDGE - MILE 211.4 .

CORPS OF ENGINEERS, U.S. ARMY
ROCK ISLAND, ILLINOIS, DISTRICT

STAGE HYDROGRAPH

DES MOINES RIVER
DES MOINES, IOWA
APRIL 1970

FLOOD DESCRIPTIONS

Descriptions of large floods that have occurred on the Des Moines River in Des Moines, Iowa are based on field investigations, newspaper accounts, and historical records.

Flood of 1851

The "Book of Des Moines", written by Ilda M. Hammer in 1947 described the flood as follows:

"Early in May 1851, heavy rains began and continued until the middle of July. One writer says that in that year more than six feet of rain fell in less than five months. Great trees were uprooted by the flood waters and floated away downstream. Farms in the river bottoms were terribly damaged. Houses were destroyed; fences were torn out; cattle were drowned; crops already planted were washed away; and fields were left full of debris by the waters as they receded.

"What is now downtown East Des Moines was covered with water; a swift stream, almost another river, rushed along where the Chicago and Northwestern tracks and depot are. On the west side of the river, water covered the streets as far west as Third and Court Avenue."

Flood of July 1902

"The Register and Leader", a Des Moines newspaper, described the flood as follows:

"July 9--Twelve families were forced to leave their homes because of flooding. The Des Moines River is 13 feet 6 inches above normal at Locust Street bridge. It is the highest experienced since 1895.

"July 10--The Des Moines River rose 5.1 feet in 24 hours. Fifty families were driven from their homes. Great Western Railway have losses of $10,000.00.

"July 11--Des Moines River reached the highest 'known' mark yesterday since the flood of 1851. The water gage at 10 a.m. showed 21.3 feet which was 11 inches higher than the high water mark of 1892. After 10 a.m. the water began to recede at about an inch per hour. Practically everything is under water from Elm Street south to the Raccoon River. Losses will exceed $130,000.00. In all approximately 1,000 families have been forcibly dispossessed. One drowning occurred."

Flood of May 1903

"The Register and Leader" described the flood as follows:

"May 31--Along Grand Avenue the water stood two feet deep on the floors of business houses.--

"--The Queal Lumber yards extending for a block west from the Northwestern tracks on either side of Grand Avenue, were flooded to a depth of from two to six feet.

"--On Locust Street the water went into the first floors of all the business houses standing two feet deep in many of them and fully four feet deep in the street.

"The Turner and Brownlee boiler works, Eagle Iron Works, Dempster Manufacturing Company plant, plant of the Des Moines Manufacturing and Supply, and of a half dozen other factories on East Court Avenue were submerged, entailing considerable damage."

Flood of June 1947

"The Des Moines Register" described the flood as follows:

"Sunday, June 22--The Des Moines Weather Bureau Saturday night issued the following river report: 'Rains in the lower Raccoon watershed and along the lower Des Moines River averaged 1.5 inches in the eighteen hours ending Saturday evening.'

"June 23--Cloudbursts ranging up to six inches fell Sunday over the headwaters of the Des Moines and Raccoon Rivers and in other sections of western Iowa.

"S. E. Decker, of the Weather Bureau, said the new crest of the Des Moines and Raccoon Rivers will reach here in three to five days.

"June 24--The Des Moines Weather Bureau issued the following river bulletin: 'The flood in the upper Des Moines River valley will move downstream and will cause stages of about 23 to 24 feet at Boone Tuesday night and near 23½ feet at Des Moines Wednesday night or Thursday Morning.--'

"The present rise at Des Moines will crest at near 21½ to 22 feet during the night, after which a slight recession will occur before the upstream flood arrives.

"June 26--From 5 p.m. shortly before midnight, the flood stages of the Des Moines and Raccoon Rivers had crept up an average of two feet, and there was still another foot to go before the period of greatest danger arrives sometime between 6 and 10 a.m. this morning.

"At numerous critical points the levees were holding but shortly before midnight city workmen gave up in their efforts to bolster the Clark Street levee and water began surging through a break there. Police evacuated residents of 140 nearby homes.

"Early this morning, 500 persons had been given shelter at four refugee centers.--

"The Des Moines River at 11:20 p.m. had reached a stage of 25.98 feet at the Second Avenue bridge. A stage of 26½ feet is expected there when the flood reaches its crest at that point.

"Fisher Bridge at Sycamore Park, about 9 miles northwest of Des Moines, was blocked on both sides by the flooding river.

"More than 20 families left their homes in the bottomland area on North Twelfth Street Road, just north of the Des Moines city limits.

"Almost a mile of the road is under water from the railroad tracks at the edge of the city northward. A few boats were used to remove families, but most of them left before the water reached their homes.

"A man and his wife were marooned in their home near Fisher Bridge, and, with water already in the first floor, refused to leave when deputy sheriffs came by boat to take them away. They were in the second floor.

"June 27--Two men still were missing and the refugee centers still were faced with the problems of aiding almost 850 evacuees.

"At the Second Avenue bridge, the Des Moines River had fallen only a little. There the fall had been only 0.2 of a foot to 26.3 feet in a 14-hour period."

Flood of June 1954

"The Des Moines Register" described the flood as follows:

"Tuesday, June 22--Des Moines was warned Monday to prepare for the greatest flood in its history.--

"The river is expected to reach flood stage of 23 feet here Wednesday morning then continue rising until it is 4 to 5 feet over flood stage.

"By 10 p.m. Monday the river had reached 18.5 feet.

"Wednesday, June 23--Hundreds of Des Moines families began leaving their homes in low-lying areas Tuesday as the mightiest flood in the history of Des Moines River moved closer.

"At 8:30 p.m. Tuesday, the Des Moines River reached the 23-foot level or flood stage at the Second Avenue bridge. It is expected to crest at a record 29 to 30 feet here Thursday afternoon.

"By midnight the river had climbed to 24.63 feet, and muddy, swirling water was pouring into the city at one point and creeping over streets in others.

"Shortly before 1:00 a.m. today, water was one-foot deep over Sixth Avenue north of the bridge near Birdland Park.

"The water was within six inches of going across Euclid Avenue at the bridge east of Harding Road, and within a foot and a half of going over Second Avenue.--

"The Raccoon River crest was coming more slowly than expected. It will arrive shortly after the Des Moines crest.--

"North Twelfth Street Road, Pine Hill Road, Broadway Street, and the lower Beaver Road were among roads closed in the county.

"Thursday, June 24--The Des Moines River apparently crested at Second Avenue bridge at 29.98 feet at 1:00 a.m. today, and was holding at 2:30 a.m.

"Officials were relieved as the Weather Bureau said Raccoon River crest wouldn't come here until about 36 hours after the Des Moines River crest had passed.--

"Differences in arrival time of the crests apparently accounted for a 1954 flood phenomena.

"Thursday afternoon when the stage at Second Avenue bridge had pushed 1.3 feet above the 1947 flood mark of 26.5, the stage at Grand Avenue bridge was 1.8 feet below the 1947 mark there.

"Friday, June 25--By 1:00 a.m. the Des Moines River stage at Second Avenue bridge had dropped to 29.64 feet.--

"The only dike which failed was in the Guthrie Avenue levee system. Water moved in on that area Wednesday and flooded 50 homes.

"The entire yard of the Carbon Coal Company, 408 Sixth Avenue, was under water. Fourteen inches of water covered the second floor of the Thorpe Well Company, 2340 Sixth Avenue."

Flood of April 1960

The "Des Moines Tribune" described the flood as follows:

"April 1--The Des Moines River, swollen with the runoff from many central Iowa rivers and creeks, swirled through the Des Moines area Friday, spawning great lakes north and south of the city.

"The river was restrained in a straitjacket of levees through the central part of the city.

"But flood waters had driven an estimated 1,000 persons from homes that are not levee-protected.--

"The Weather Bureau said the Des Moines' crest apparently had been reached at the Second Avenue bridge at 1 p.m. The reading there then was 25.1 feet - 2.1 feet above flood stage.--

"Farm homes were flooded well north of Sycamore Park in the Des Moines River valley.--

"At Euclid, the river is half a mile wide and has spread within about 100 feet of Harding Road at several points.

"Birdland Park is dry, protected by the giant dikes built within the past few years.--

"In nearby Union Park, however, water from the river swirled close to Saylor Road through the park, but did not endanger homes in the area.

"Riverview Amusement Park, once a prime target for flood-waters, was protected by levees. Water was about 2 feet below the top of the levee."

Flood of April 1965

"The Des Moines Register" described the flood as follows:

"Wednesday, April 7--The Des Moines River rose to 23.10 feet at midnight, putting it a tenth of a foot over flood stage at the Second Avenue bridge.

"Thursday, April 8--The Des Moines River continued its slow, steady rise, while the Raccoon was holding steady. Both rivers were above flood stage.

"At midnight, the Des Moines stood at 24.83 feet, up about 8 tenths of a foot since midafternoon.--

"Water was seeping across University Avenue just west of the bridge today. City crews said it was 2-3 inches deep and that they expected the street would remain open to traffic.

"Water also flowed over Beaver Drive north of Interstate 35-80. The drive was closed.

"Friday, April 9--At midnight the Des Moines stood at 26.33 feet. So far, 168 persons in 29 families have been forced out from their homes.--

"Saturday, April 10--The Des Moines River is expected to crest at 28 feet Sunday morning at Second Avenue, about a half-foot higher than it was early today.

"An estimated 300 families in the Des Moines area were homeless Friday in what is expected to be the second highest flood on record.

"Water stood at about first floor level on half a dozen fairly new homes on Harding Road north of Euclid Avenue.

"Sunday, April 11--The river crested at 28.78 feet (Saturday), the second highest flood recorded here. Early today it was 28.67.

"Another trouble spot developed Saturday afternoon at the University Avenue bridge. Water moving into a low spot from the river onto University Avenue just west of the bridge, forced city officials to close the bridge to traffic. University was closed from Second Avenue to Pennsylvania Avenue.

"Second Avenue from Jefferson Avenue to Franklin Avenue also was closed by water seeping onto the roads from the sewers."

Figures 11 through 28 show typical flood scenes for floods which have occurred in the study reach.

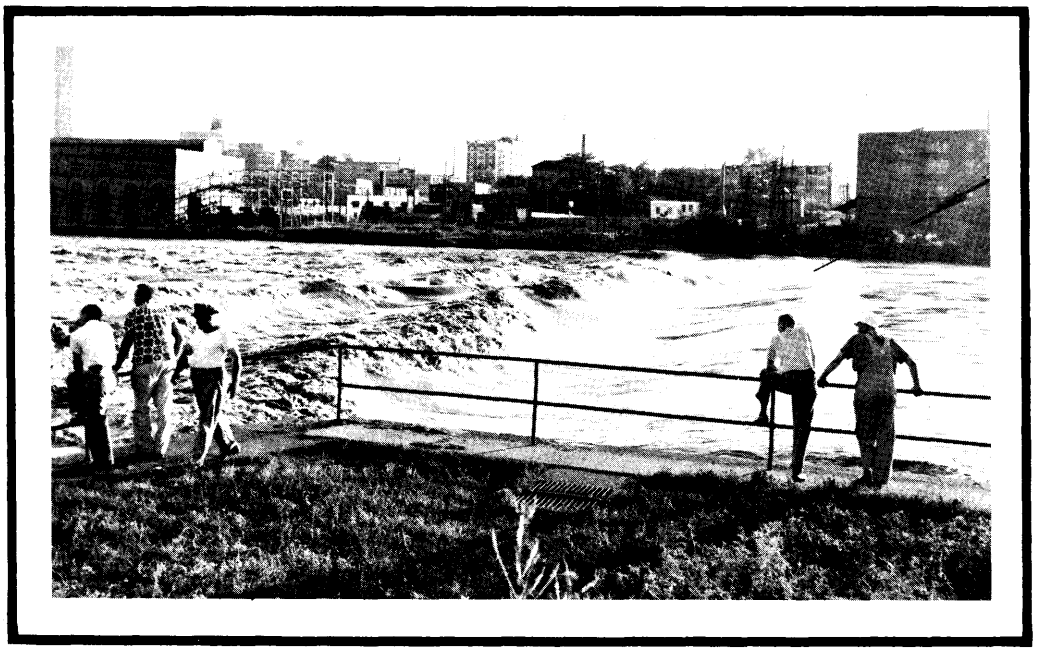


Figure 11. Looking west at Center Street dam - Mile 202.45, during the flood of June 1954.

Figure 12. Looking northeast on Maine Street from University Avenue - Mile 203.12, during the flood of June 1947.

Figure 13. Looking southeast on Maine Street from University Avenue - Mile 203.12, during the flood of June 1947.

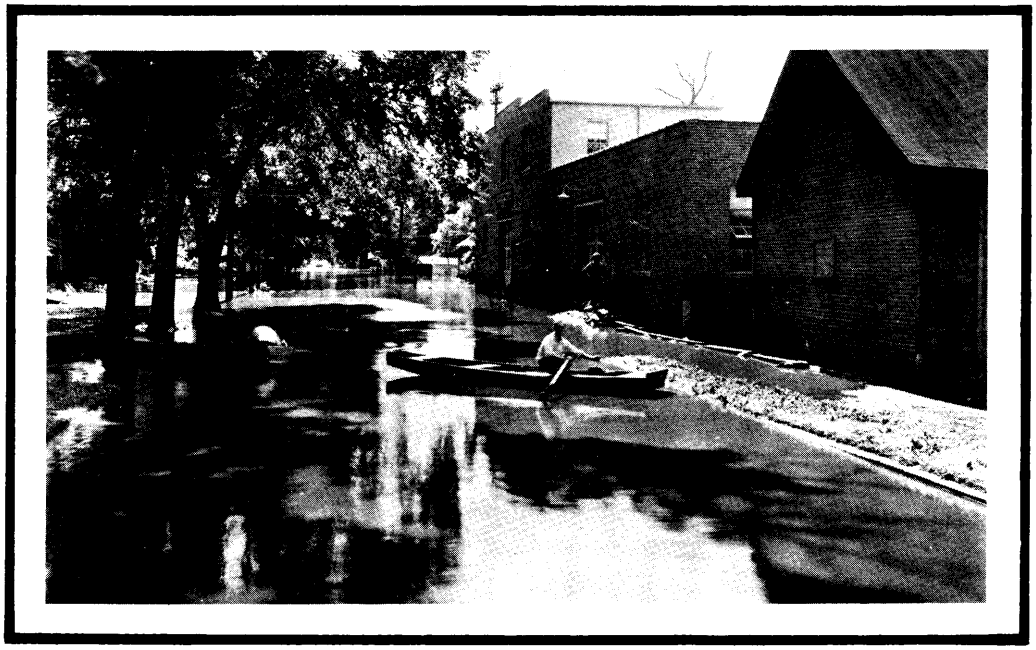


Figure 14. Looking east on College Avenue near the Northwestern Bell Telephone Company garage - Mile 203.6, during the flood of June 1947.

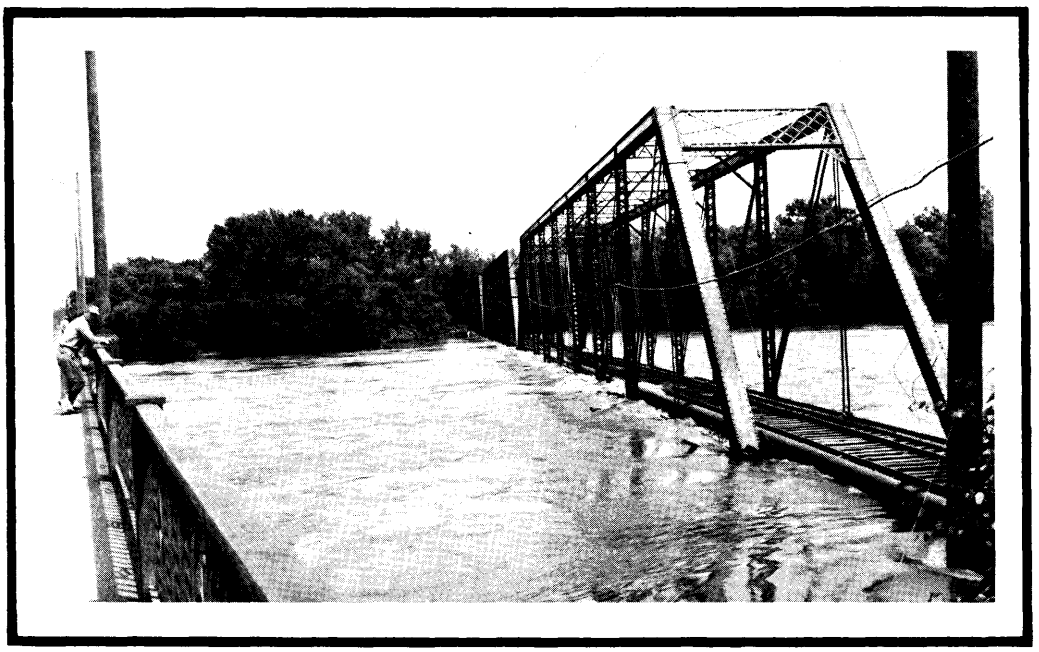


Figure 15. Looking northeast at the D.M.&C.I. RR bridge downstream of Second Avenue - Mile 204.28, during the flood of June 1954.

Figure 16. Looking north along the D.M.&C.I. RR bridge - Mile 204.28, during the flood of June 1954.

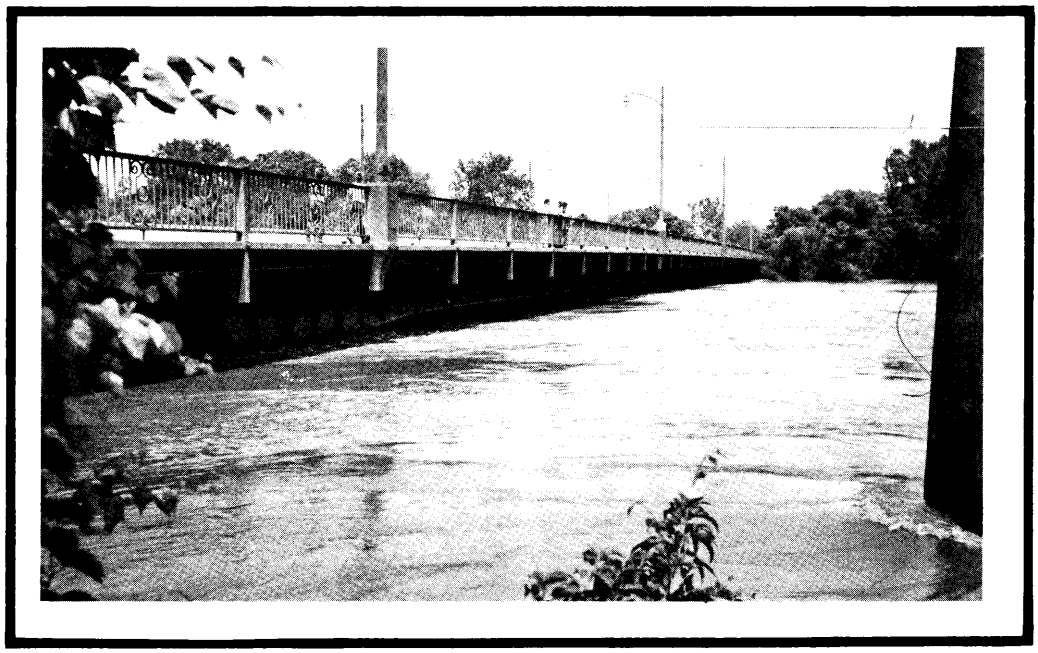


Figure 17. Looking north at the downstream side of Second Avenue bridge - Mile 204.28, during the flood of June 1954.

Figure 18. Looking north on Second Avenue toward Sheridan - Mile 204.28, during the flood of June 1954.

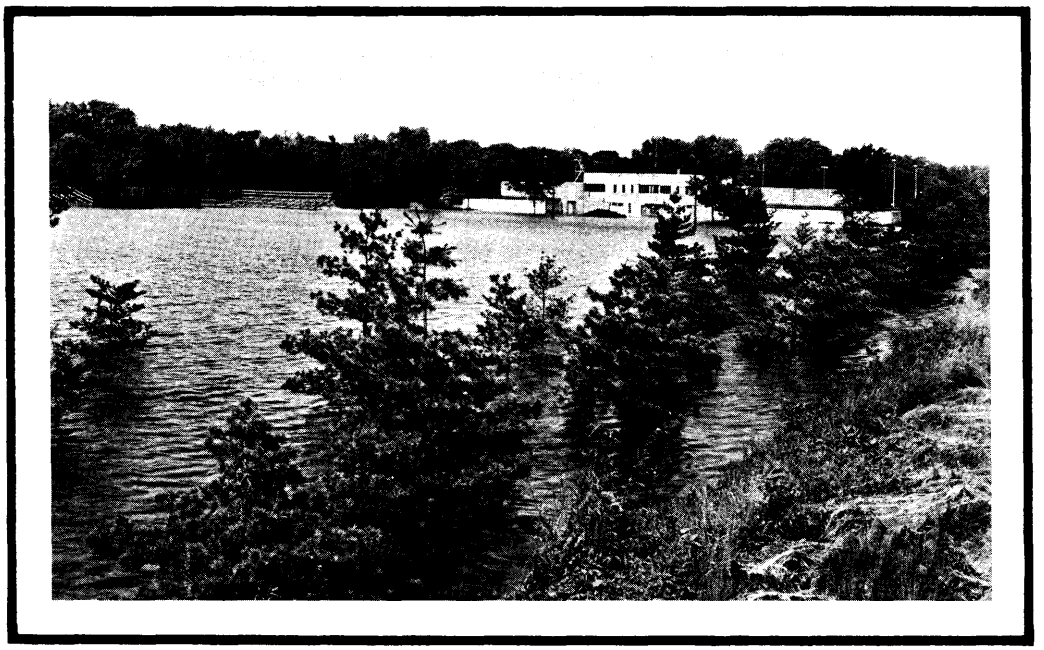


Figure 19. Looking west from Second Avenue at the swimming pool and playground near Franklin Avenue - Mile 204.40, during the flood of June 1954.

Figure 20. Looking south on Sixth Avenue from New York Avenue - Mile 204.28, during the flood of June 1947.

Figure 21. Looking west in the vicinity of Sixth Avenue and New York Avenue - Mile 204.58, during the flood of June 1954.

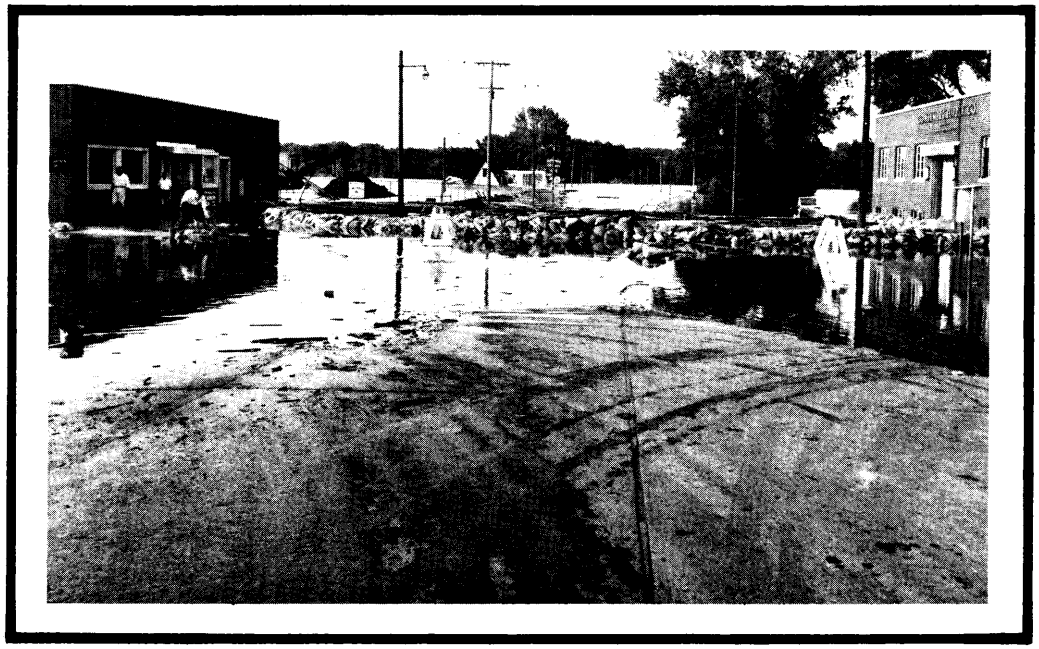


Figure 22. Looking south on Sixth Avenue from New York Avenue - Mile 204.58, during the flood of June 1954.

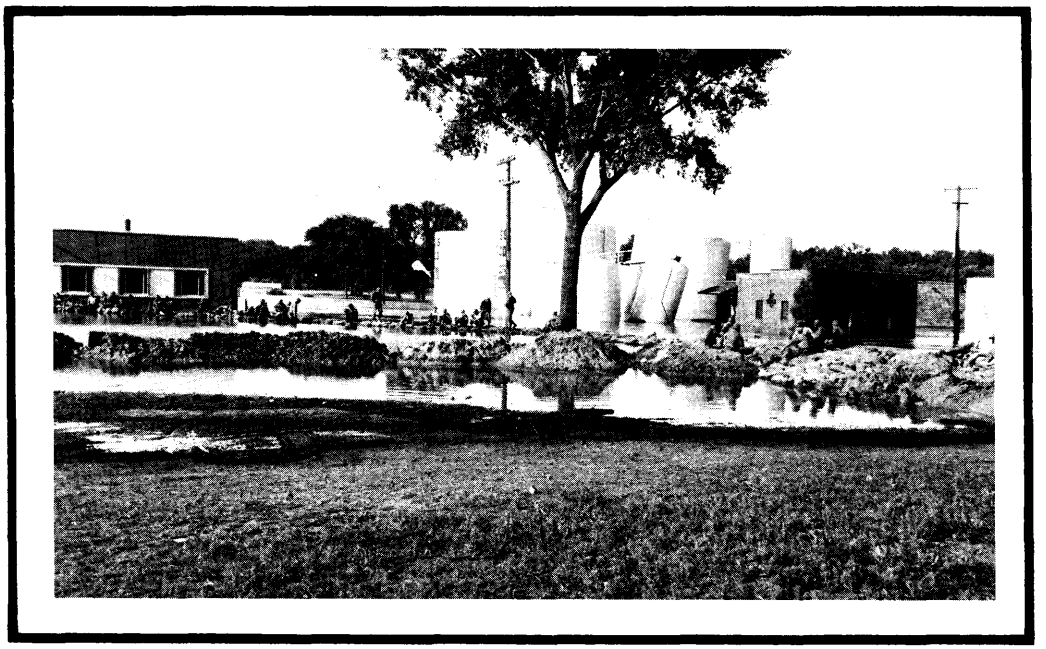


Figure 23. Looking southeast in the vicinity of New York Avenue and Sixth Avenue - Mile 204.58, during the flood of June 1954.

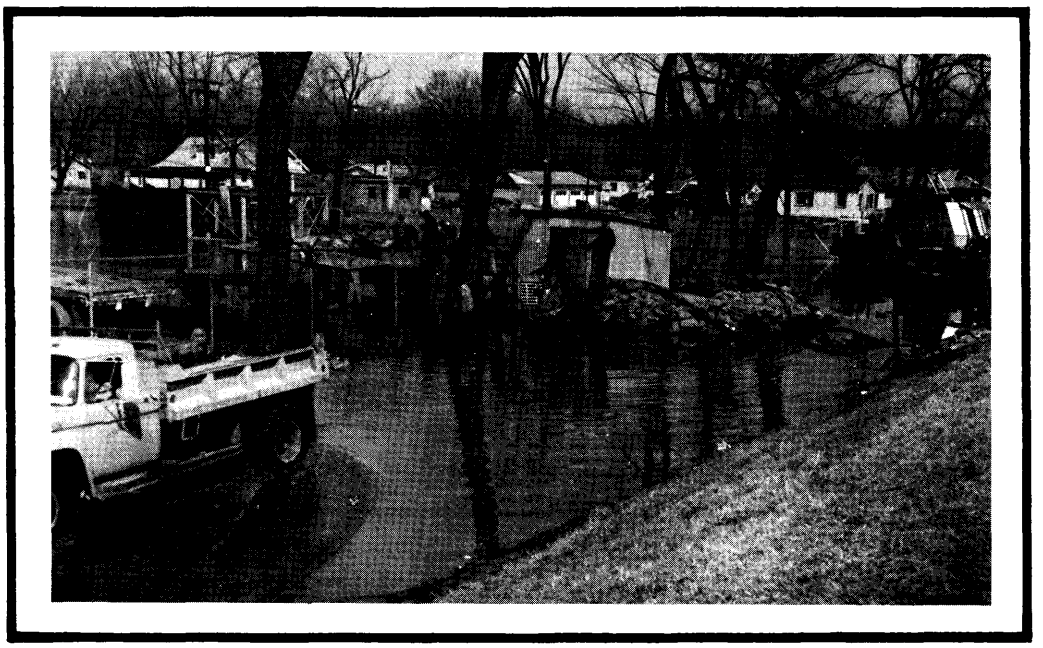


Figure 24. The Eagle Iron Works on Holcomb Avenue - Mile 204.70, during the flood of April 1965.

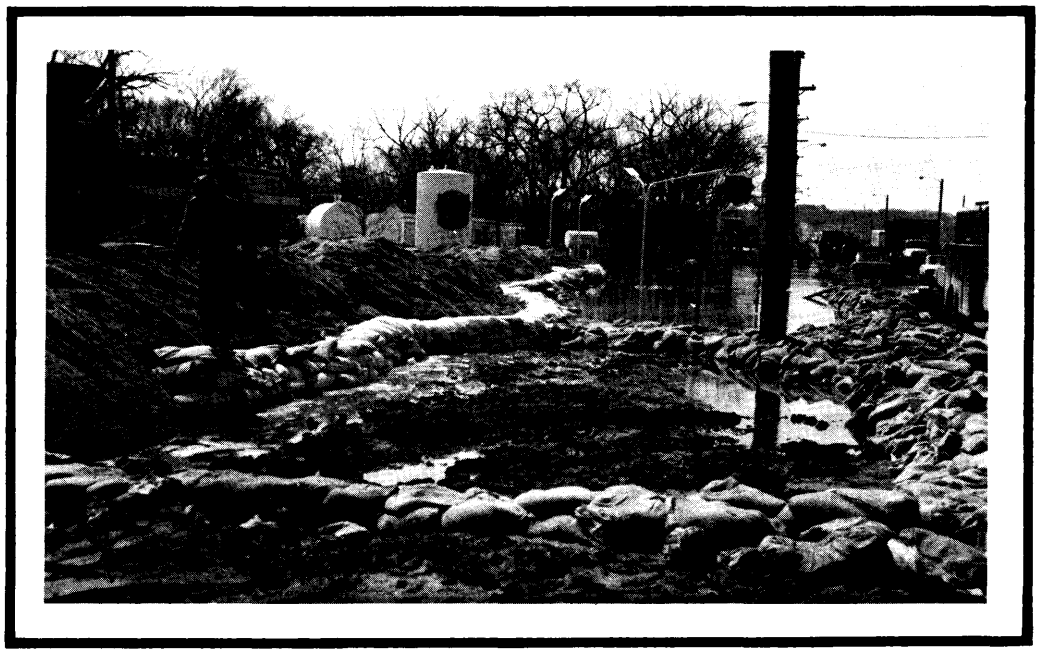


Figure 25. Emergency flood protection works along Euclid Avenue - Mile 206.30, during the flood of April 1965.

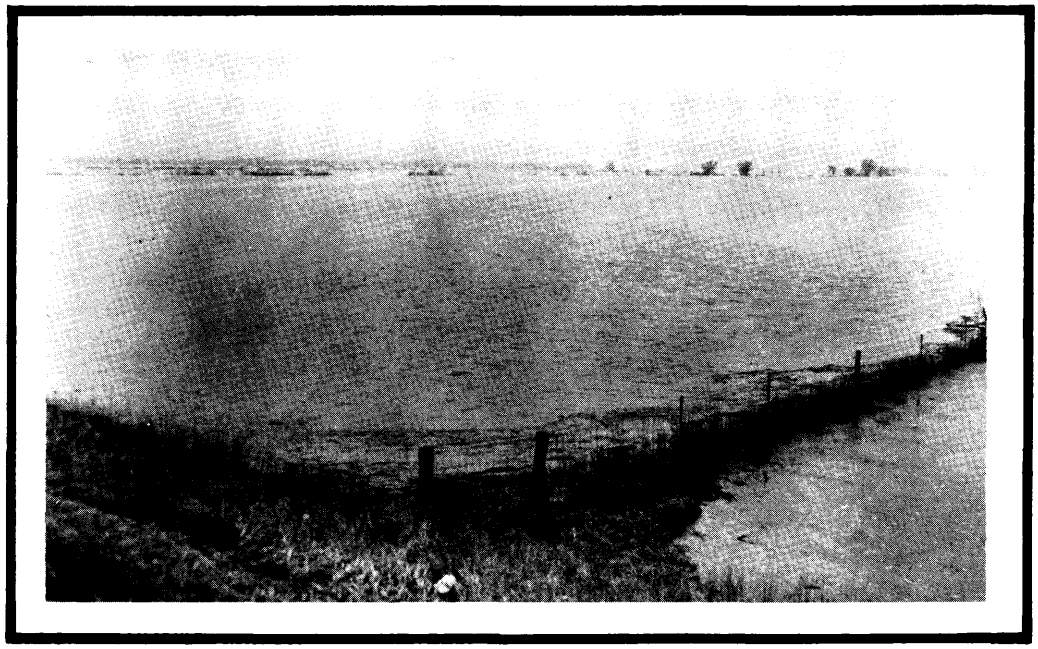


Figure 26. Looking northeast from the right bank of the Des Moines River upstream of Interstate 80 & 35 - Mile 209.10, during the flood of April 1965.

Figure 27. Looking northwest along the upstream side of Interstate 80 & 35 - Mile 209.10, during the flood of April 1965.

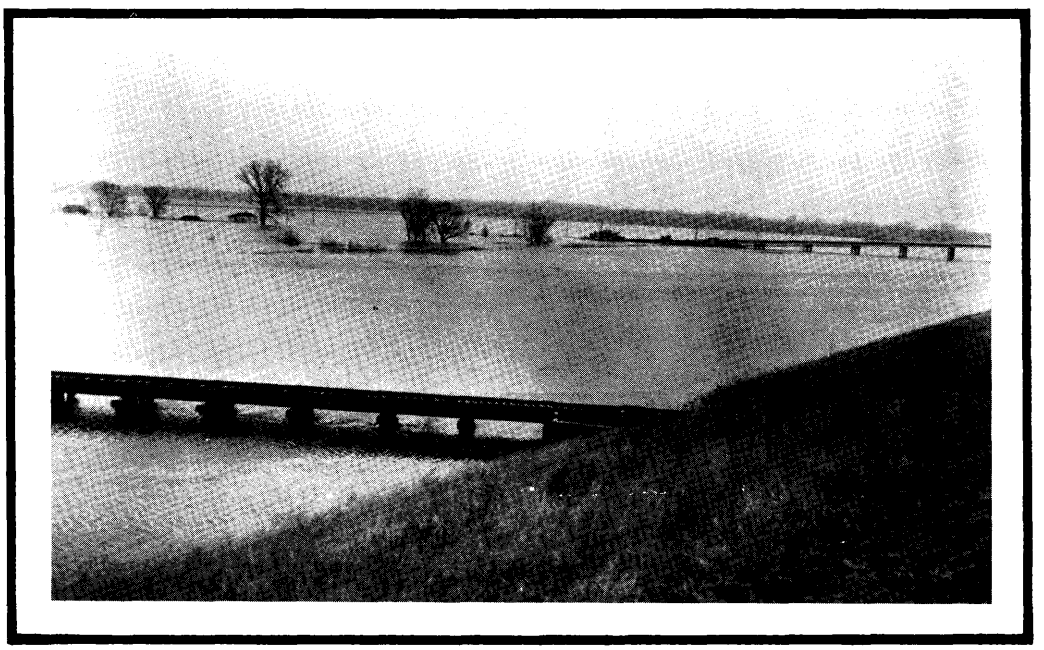


Figure 28. Looking northeast from the upstream embankment of Interstate 80 & 35 showing the D.M.&C.I. RR bridge (foreground) and the Beaver Road bridge (background) over the relocated channel of Beaver Creek - Mile 209.10, during the flood of April 1965.

FUTURE FLOODS

This section of the report discusses the Standard Project Flood and the Intermediate Regional Flood on the Des Moines River in the study area. The Standard Project Flood represents reasonable upper limits of expected flooding with Saylorville Reservoir operating along with the existing conditions of development and encroachment in the flood plain area. The Intermediate Regional Flood represents a flood that may reasonably be expected to occur more frequently.

Large floods from heavy general storms have occurred on streams in the general geographical and physiographical region of Des Moines. Similar heavy storms could occur over the Des Moines River and Beaver Creek watersheds. In this event, floods comparable to those on neighboring streams could occur on the Des Moines River and Beaver Creek. It is, therefore, desirable to consider storms and floods that have occurred in the region on watersheds whose topography, watershed cover, and physical characteristics are similar to those of the Des Moines River. Table 6 lists maximum known flood discharges that have occurred on watersheds in the region of Des Moines.

DETERMINATION OF INTERMEDIATE REGIONAL FLOOD

The Intermediate Regional Flood is defined as a flood having an average frequency of occurrence in the order of once in one hundred years, at a designated location, although the flood may occur in any year. Probability estimates are based on statistical analysis of streamflow records and the theoretical operation of Saylorville Reservoir. The Intermediate Regional Flood represents a major flood which could occur on the Des Moines River. Peak

TABLE 6

MAXIMUM KNOWN FLOOD DISCHARGES ON

STREAMS IN THE REGION OF DES MOINES, IOWA

Stream	Location	Drainage Area Sq. Mi.	Date	Peak Discharge Amount cfs	Peak Discharge Per Sq. Mi. cfs
Iowa River	At Wapello, Iowa	12,499	June 18, 1947	94,000	7.5
Mississippi River	Near Royalton, Minn.	11,600	April 16, 1965	37,700	3.2
Big Sioux River	At Akron, Iowa	9,030	March 31, 1962	54,300	6.0
Wisconsin River	Near Wisconsin Dells, Wisc.	7,830	September 14, 1938	72,200	9.2
Minnesota River	At Montevideo, Minn.	6,180	April 10, 1952	32,500	5.2
Des Moines River	Near Saylorville, Iowa	5,841	April 10, 1965	47,400	8.1
Des Moines River	Near Boone, Iowa	5,511	June 22, 1954	57,400	10.4
Cedar River	At Waterloo, Iowa	5,146	March 29, 1961	76,700	14.9
Skunk River	At Augusta, Iowa	4,303	April 3, 1960	51,000	11.8
Little Sioux River	Near Turin, Iowa	3,526	April 8, 1965	27,100	7.7
Raccoon River	At Van Meter, Iowa	3,441	June 13, 1947	41,200	12.0
Nishnabotna River	Above Hamburg, Iowa	2,806	June 24, 1947	55,100	19.6
Wapsipinicon River	Near De Witt, Iowa	2,330	June 27, 1944	26,000	11.2
Maquoketa River	Near Maquoketa, Iowa	1,553	June 27, 1944	48,000	30.9
Turkey River	At Garber, Iowa	1,545	February 23, 1922	32,300	20.9
Snake River	Near Pine City, Minn.	958	April 18, 1965	11,500	12.0
Boyer River	At Logan, Iowa	871	June 16, 1957	23,600	27.1
Nodaway River	At Clarinda, Iowa	762	June 13, 1947	31,100	40.8
Maple River	At Mapleton, Iowa	669	June 20, 1954	15,600	23.3
Upper Iowa River	At Decorah, Iowa	511	March 27, 1961	20,200	39.5

discharge of the Intermediate Regional Flood for selected locations within the study area are shown in Table 7.

TABLE 7

PEAK DISCHARGES ON DES MOINES RIVER

Location	Mile	Drainage Area	Discharges	
			Intermediate Regional Flood	Standard Project Flood
		sq mi	cfs	cfs
USGS Gage at 2nd Ave.	204.28	6,245	40,000	108,000[1/]
Upstream from mouth of Beaver Creek	209.60	5,873	20,000	97,000[1/]

[1/] Saylorville Reservoir regulation studies are currently in progress.

Tabulated flows indicate the general magnitude of Standard Project Flood outflows.

The Intermediate Regional Flood on the Des Moines River between Saylorville Reservoir and the Des Moines Local Protection Project comes from two sources, flood control releases from Saylorville Reservoir combined with natural flows from Beaver Creek. Estimated Intermediate Regional Flood outflow from Saylorville Reservoir will be 20,000 cubic feet per second combined with 20,000 cubic feet per second from Beaver Creek. Upstream from the mouth of Beaver Creek, the Intermediate Regional Flood crest elevations will be up to 4.4 feet lower than the June 1954 flood. Downstream from the mouth of Beaver Creek, the Intermediate

Regional Flood crest elevations will vary from 2.5 feet below to 3.4 feet above the crest elevations of the June 1954 flood.

DETERMINATION OF STANDARD PROJECT FLOOD

Only in rare instances has a specific stream experienced the largest flood that is likely to occur. Severe as the maximum known flood may have been on any given stream, it is commonly accepted that a larger flood can and probably will occur. The Corps of Engineers, in cooperation with the Weather Bureau, has made broad and comprehensive studies and investigations based on records of known storms and floods, and has evolved generalized procedures for estimating the flood potential of streams. These procedures have been used to determine a Standard Project Flood. It is defined as the largest flood that can be expected from the most severe combination of meteorological and hydrological conditions that is considered reasonably characteristic of the geographical region involved excluding extremely rare combinations.

Standard Project Flood estimates have been made for the design of Saylorville Reservoir. Estimates of the general magnitude of reservoir outflows for the Standard Project Flood in the study reach are shown in Table 7.

Frequency

The occurrence of the Standard Project Flood would be an extremely rare event; however, it could occur in any given year. This flood is a hypothetical event representing the critical flood volume and peak discharge that may be expected. Assignment of a frequency to this flood is considered impractical.

Possible Larger Floods

Floods larger than the Standard Project Flood are possible; however, the combination of factors necessary to produce such floods would seldom occur. The consideration of floods of this magnitude depends on the consequences should the flood occur. Extensive damage may be avoided by consideration of the Standard Project Flood in the regulation of flood plain development.

HAZARDS OF GREAT FLOODS

The damage caused by any flood depends, in general, on the area flooded, the height of flooding, the velocity of flow, rate of rise, duration of flooding, and amount and character of the flood plain development. Des Moines River floods develop by two sets of conditions. The melting of the winter accumulation of snow, with or without additional runoff from rainfall, produces the late winter and early spring floods. Late spring and early summer floods are the result of heavy general rainfall over the basin.

Ice jams occur on the Des Moines River and produce higher stages than would be obtained with open river conditions assumed for this report. However, ice jams are unpredictable and their occurrence is mentioned as a potential flood risk.

Areas Flooded and Heights of Flooding

The areas flooded along the Des Moines River by the Standard Project Flood and the Intermediate Regional Flood are shown in Plates 7 through 20. Depths of flow can be estimated from the water surface profiles shown on Plate 21 and the cross sections shown on Plates 22 and 23.

The water surface profiles were computed using stream characteristics determined from topographic maps and valley cross sections. The elevations shown in Plate 21 and the overflow areas shown in Plates 7 through 20 have been determined with an accuracy consistent with the purpose of this study and the accuracy of the basic data. For the Intermediate Regional Flood, the Raccoon River was assumed to discharge 60,000 cubic feet per second combined with 40,000 cubic feet per second from the Des Moines River.

The water surface profiles of the Standard Project Flood and the Intermediate Regional Flood depend in part upon the degree of destruction or clogging of various bridges during the flood. Because it is impossible to forecast these events, it was assumed that all bridge structures would stand and that no clogging by debris or ice would occur.

Figures 29 through 36 show the heights that would be reached by the Standard Project Flood and the Intermediate Regional Flood on the facilities existing on the Des Moines River flood plain.

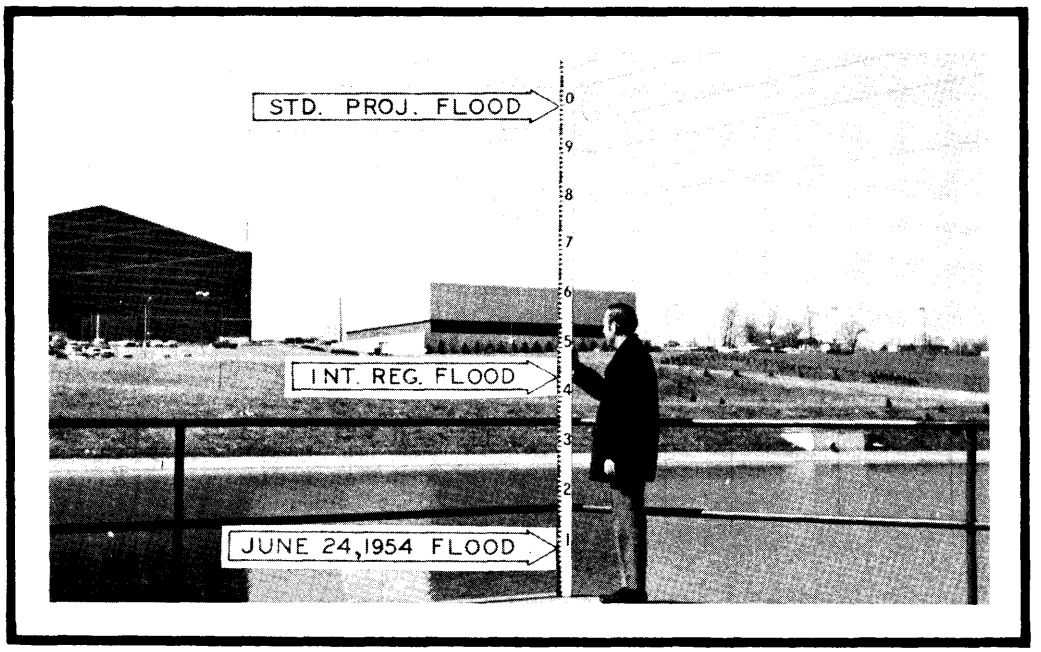


Figure 29. North walk on the left of Center Street dam - Mile 202.45.

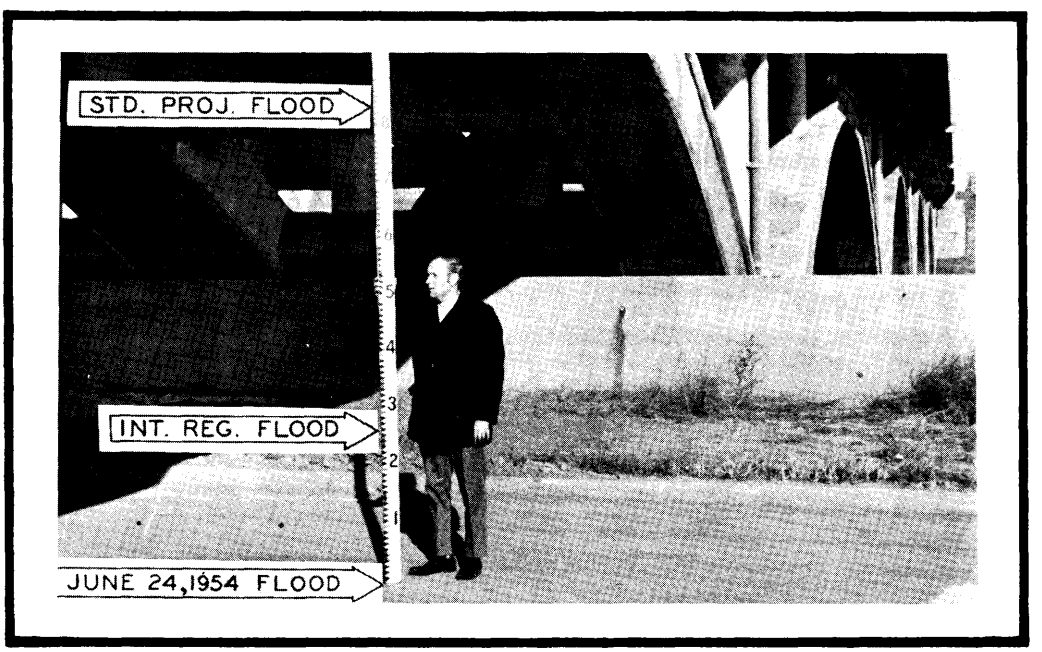


Figure 30. Centerline of roadway under the first arch span on the right bank of University Avenue bridge - Mile 203.12.

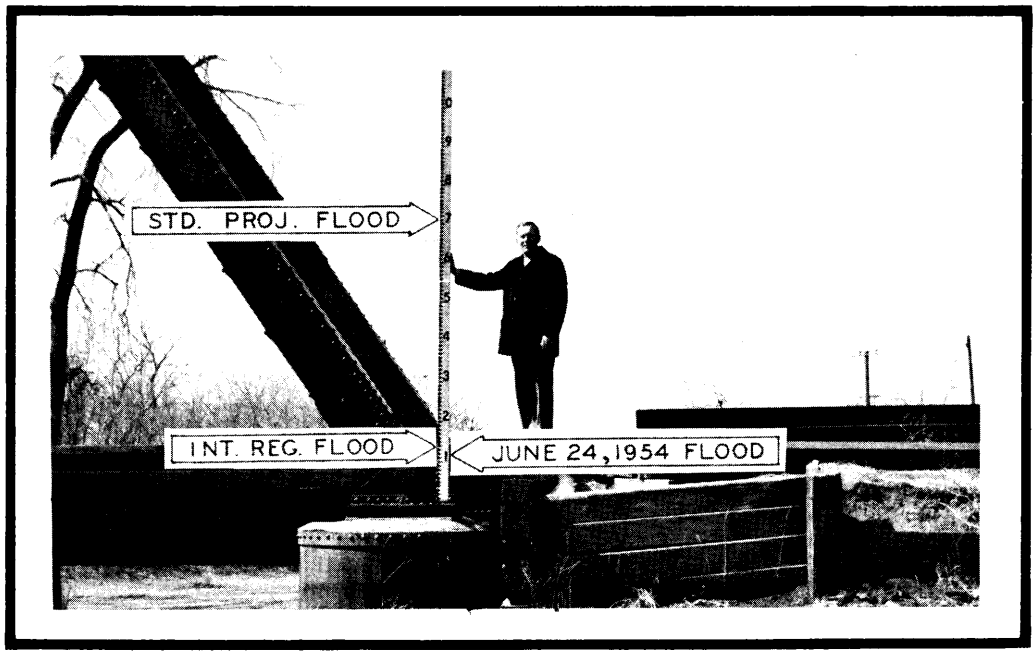


Figure 31. Downstream side of the left abutment of D.M.&C.I. RR bridge - Mile 204.28.

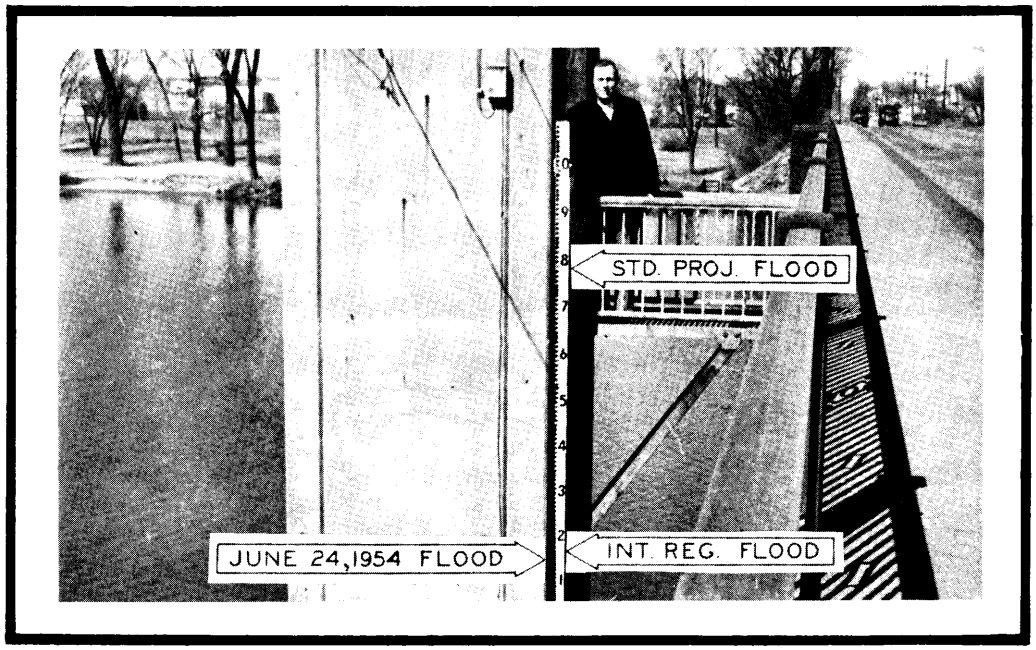


Figure 32. Stream gage on the upstream side of Second Avenue gage - Mile 204.28.

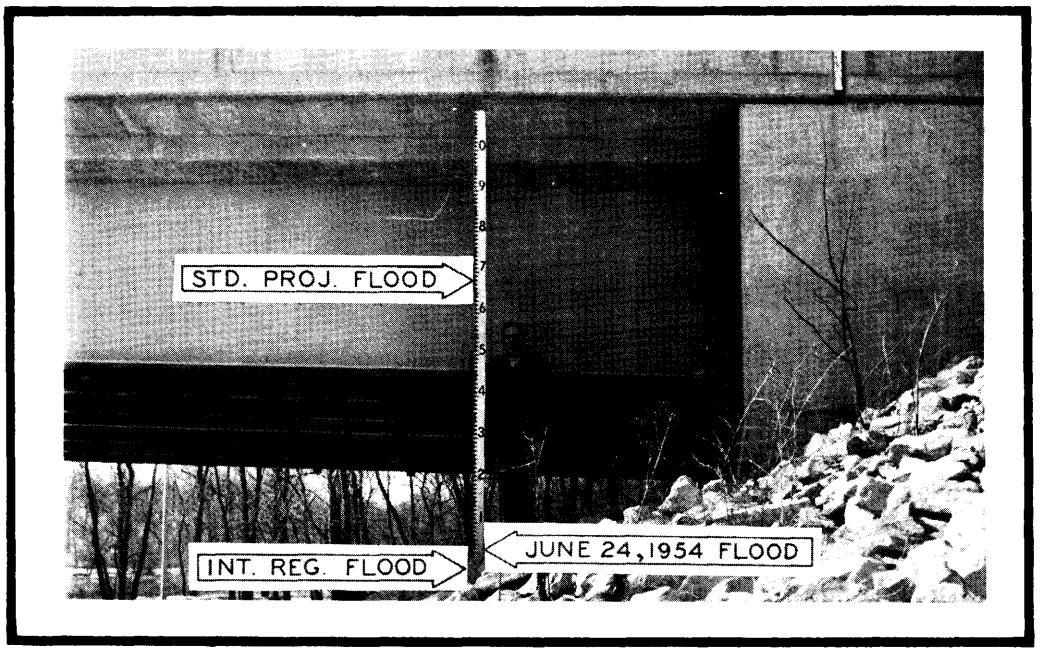


Figure 33. Downstream side of the left abutment of Sixth Avenue bridge - Mile 204.58.

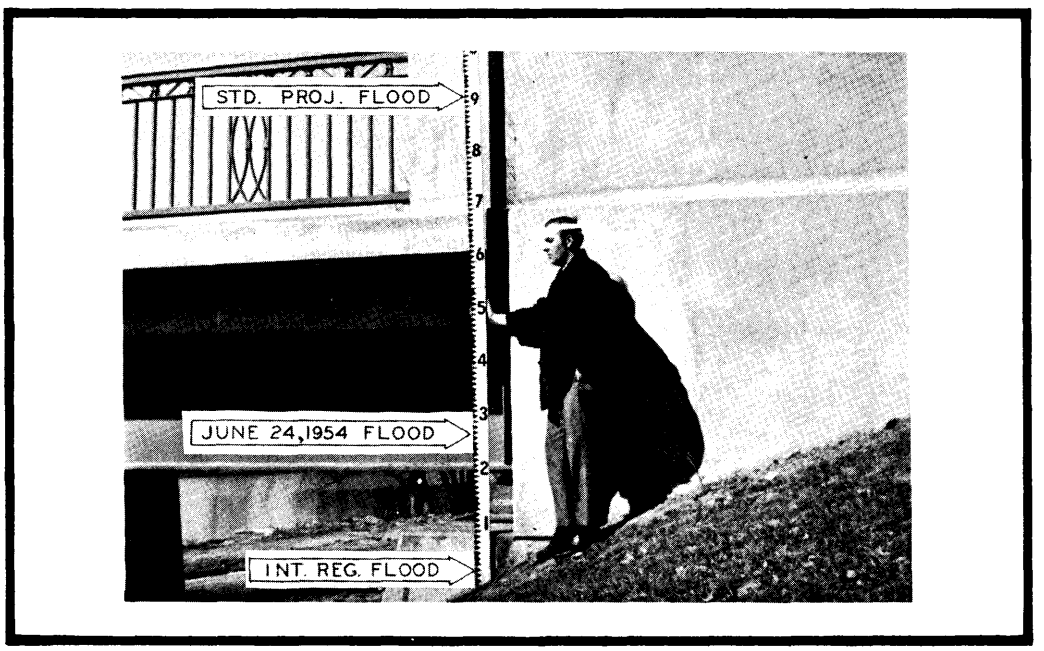


Figure 34. Downstream side of the left abutment of Euclid Avenue bridge - Mile 206.30.

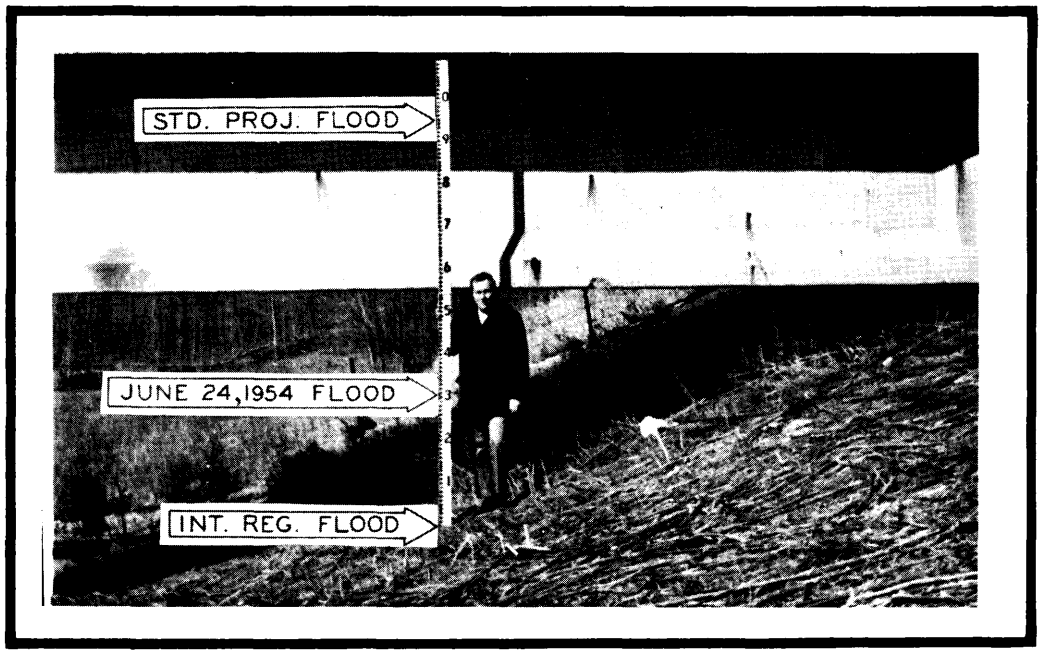


Figure 35. Downstream side of the left end of Interstate 80 & 35 westbound bridge - Mile 209.10.

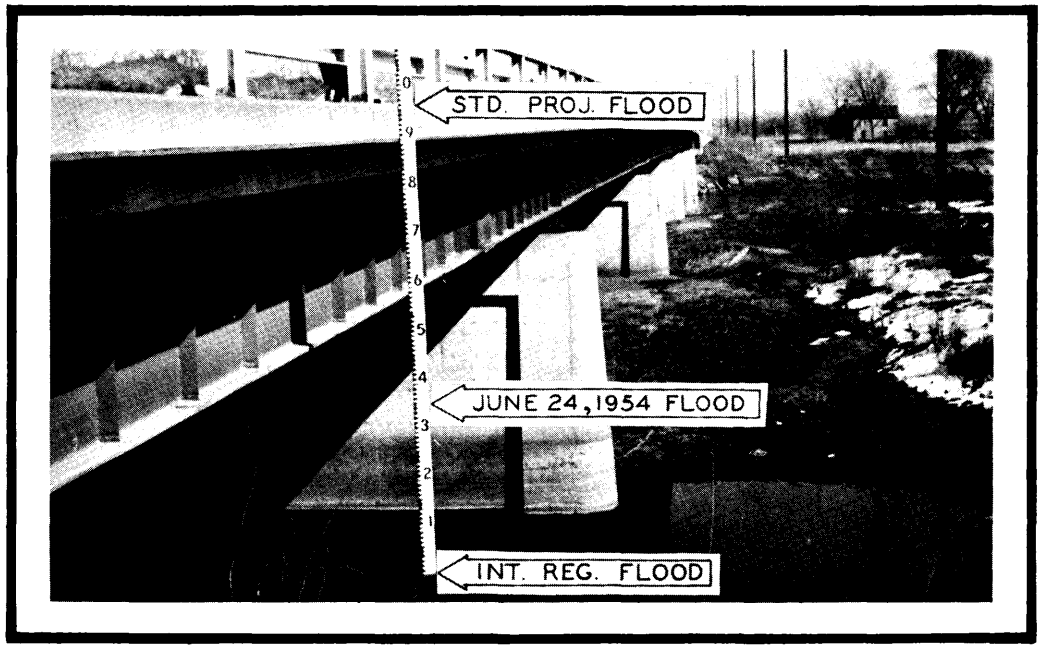


Figure 36. Downstream side of Fisher Bridge - Mile 211.40.

Velocities, Rates of Rise, and Duration

Water velocities during floods depend largely on the size and shape of the cross section, the condition of the stream, and the bed slope, all of which vary on different streams and at different locations on a single stream.

Table 8 lists the maximum velocities that would occur in the main channel and overbank areas of the Des Moines River during the Intermediate Regional and Standard Project Floods. Velocities listed are representative of open river conditions and may be higher at flow constrictions.

TABLE 8

MAXIMUM CHANNEL AND OVERBANK VELOCITIES ON DES MOINES RIVER

Flood	Location	Maximum Velocities	
		Channel ft per sec	Overbank ft per sec
Standard Project	Mile 204.46	10.0	2.9
Intermediate Regional	Mile 204.46	5.2	1.1

Table 9 lists the total rise above low water to the crest stages, the maximum rates of rise, and the durations above bank-full stage for the indicated floods on the Des Moines River.

TABLE 9

RATES OF RISE AND DURATION ON DES MOINES RIVER
ABOVE ESTIMATED FLOOD STAGE OF 18.3 FEET

Flood	Location	Height of Rise above Flood Stage feet	Time of Rise above Flood Stage hours	Maximum Rate of Rise ft/hr	Duration above Flood Stage days
Intermediate Regional	Stream gage at Co Rd "W" Bridge Mile 211.4	1.9 1/	15 1/	0.1 1/	2 1/
Standard Project	Stream gage at Co Rd "W" Bridge Mile 211.4	9.4	72	0.4	11

1/ Estimated

GUIDELINES FOR FLOOD DAMAGE REDUCTION

General

Man has been building on and occupying the flood plains of Iowa rivers and streams since the arrival of the pioneer settlers. The streams first provided transportation and water supply. Later, milldams were built and early highways and railroads were constructed along the gentle valley grades. Today the continuing growth of river cities results in ever increasing encroachment on the flood plains.

Streams in flood may carry thousands of times more flow than during low flow periods. These vast quantities of floodwater caused little damage until the works of man invaded the flood plain. Man has learned through bitter experience that floods periodically inundate portions of the flood plain, damaging or sweeping away roads, buildings, and homes. In addition to these property damages, floods often pose a severe threat to human life and health.

Historically, man has tried to reduce flood damages through structural measures to confine floods within the riverbanks. Many different types of control works have been constructed for this purpose. Dams and reservoirs have been constructed to store water for gradual release after the threat of flooding has passed. Channel improvements have been used to remove constrictions and improve flow characteristics so that future flood stages are reduced. Watershed treatment involves the regulation of the rate of runoff to the main stem and tributaries. Levees, dikes, and floodwalls have been constructed to confine the river to a definite course at stages which may be well above the adjacent flood plain. These methods are generally very costly and therefore are more often used in areas where development has already heavily

encroached on the flood plain, or where future plans call for extensive use of the flood plain. However, continued uncontrolled encroachment on the flood plain has taken place faster than construction of flood control works, with the result that development in flood hazard areas with their associated flood damages have been steadily increasing across the nation.

The increase in flood hazards and flood damages, despite the expenditure of billions of dollars of tax funds for the construction of flood control works, has led to a new approach to the reduction of these hazards and damages; namely the planned management and development of land adjacent to rivers by establishing land use patterns compatible with the flood hazards. The flood plain management plan, if fully integrated into the comprehensive land use and development plan of an area and implemented by means of appropriate zoning, subdivision and building regulations, can prevent the creation of new flood hazard areas. While flood plain areas can probably never be considered entirely flood free, comprehensive planning allows selection of the type of development desired consistent with the flood risk. A reasonable level of flood protection and flood damage prevention can be built into a project during initial construction.

Management of the flood plain can be carried out by a variety of means: encroachment lines, zoning ordinances, subdivision regulations, and modifications or additions to building codes. These methods will be described subsequently in some detail. However, it is not the purpose or intent of this report to recommend the specific technique to be used. Implementation of flood plain management techniques is the responsibility of State and local governments. This report is provided to furnish the State and local governments with an engineering basis for their appropriate action. The data in this report can be used in conjunction with

comprehensive land use plans to develop a reasonable and desirable plan for managing the Des Moines River flood plain in the study reach.

Fortunately, the need for flood plain planning on the Des Moines River has been recognized by local interests. This means that future damages in the study area can be reduced, at little or no cost to the taxpayer, by developing and enacting flood plain regulations. The flood data in this report, together with a planning program for future land use, will enable State and local interests to minimize flood damage risks.

Flood plain management may also include other methods which are helpful, particularly in special localized areas. These include park and open space developments, evacuation, urban redevelopment, flood proofing, tax reductions, and warning signs.

Encroachment Lines

A designated floodway is the area of channel and those portions of the flood plains adjoining the channel which are reasonably required to carry and discharge the floodwater or flood flow of a flood of a specific size without unduly raising upstream water surface elevations. Encroachment lines or limits are the lateral boundaries of this floodway. They are two definitely established lines, one on each side of the river. Between these lines no construction or filling should be permitted which could cause an impedance to flow. If possible, encroachment limits should be established before extensive development has taken place to avoid costly clearance of existing structures. Final choice of the magnitude of the flood, which will determine the size of the floodway, is a matter for State and local decision. In the final analysis, the flood magnitude is determined by consideration of local land use plans and comprehensive statewide flood control plans.

The data contained in this report can be used by State and local interests to determine the size of the regulatory flood, and to establish floodway encroachment lines or limits and land use districts. Problems or situations regarding encroachment at specific points in the study area should be referred to the appropriate State agency. In Iowa, the responsible agency is the Iowa Natural Resources Council at Des Moines.

Zoning

Zoning is a legal tool used by cities, towns, and counties to control and direct the use and development of land and property within their jurisdiction. Division of a municipality or county into various zones should be the result of a comprehensive planning program for the entire area, with the purpose of guiding its growth. The planning program as such has no legal status. Zoning, as described above, is a legal tool that is used to implement and enforce the details of the planning program. Its objectives are the conservation of property value and the achievement of the most appropriate and beneficial use of available land. Flood plain zoning is not a special type of ordinance, but merely another set of provisions which can be incorporated into a comprehensive zoning ordinance so that flood damage can be minimized. Zoning regulations may be used in lieu of encroachment laws or as a supplement to them. Thus, designated floodways may be zoned for the purpose of passing floodwaters and for other limited uses that do not conflict with that primary purpose. The ordinance may also establish regulations for the flood plain areas outside the floodway. These include designating elevations above which certain types of development must be constructed. The enabling statutes which authorize municipalities and counties in Iowa to adopt zoning regulations are Chapters 358A and 414, respectively, of the Iowa Code 1966, as amended.

Subdivision Regulations

A subdivision can be defined in a broad sense as a tract or parcel of land divided into two or more lots or other units for the purpose of sale or building development. Subdivision regulations are used by local governments to specify the manner in which land may be subdivided within the entire area under their jurisdiction. Regulations may state the required width of streets, requirements for curbs and gutters, size of lots, elevation of land, freedom from flooding, size of floodways, and other points pertinent to the welfare of the community. It has been found that responsible subdividers favor such regulations because they discourage land speculation and prevent unscrupulous competition from other subdividers who might develop flood hazard land with less than minimum desirable standards. Experience has also shown that various municipal costs are reduced during flood periods and that the annual maintenance required for streets and utilities is minimized. Subdivision regulations provide an efficient means of controlling development in areas which are presently undeveloped. By introducing such regulations early in these areas, planned flood plain development can take place without being hampered by nonconforming uses.

Building Codes

The primary purpose of building codes is to set up minimum standards for controlling the design, construction, and quality of materials used in buildings and structures within a given area, so that life, health, property, and public welfare are safeguarded. Since it may not be practical to prevent the location of any building in all areas subject to flooding, building codes can be used to minimize structural and consequential damages resulting from flood velocities and inundation. Some of the methods adaptable to building codes are:

(1) Prevent flotation of buildings from their foundations by specifying anchorage.

(2) Establish basement elevations and minimum first floor elevations consistent with potential flood occurrences.

(3) Prohibit basements in those areas subject to very shallow, infrequent flooding where filling and slab construction would prevent virtually all damage.

(4) Require reinforcement to withstand water pressure or high velocity flow and restrict the use of materials which deteriorate rapidly in the presence of water.

(5) Prohibit equipment that might be hazardous to life when submerged. This includes chemical storage, boilers, or electrical equipment.

Flood Plain Regulations

Flood plain regulation involves the establishment of legal tools with which to control the extent and type of future development which will be allowed to take place within the flood plain. The regulations must be definitive enough so that there is general public understanding of the problem and the choices of action which the regulations provide. Regulations must be specific enough so that criteria, such as minimum first floor elevations, type of construction, or encroachment limits, are known for the area in question. There are basically two main objectives of regulation. The first is to assure and guarantee the retention of an adequate floodway for the river - floodway being defined as the channel and those portions of the flood plains adjoining the channel, which are reasonably required to carry and discharge the floodwater or flood flow of a flood of a specific size without unduly raising upstream water surface elevations. Its size is based on sound economic and hydraulic criteria. Development and use of the areas lying on either side of the floodway, and which

may become inundated by the regulatory flood, should be planned and controlled. The second objective of regulation is to encourage sound land use consistent with the flood hazard and the community land use needs.

The water surface profiles shown on Plate 21, combined with the detailed information contained in this report, provide a basis for formulation of flood plain regulations.

GLOSSARY OF TERMS

Flood. An overflow of lands not normally covered by water and that are used or useable by man. Floods have two essential characteristics: The inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river or stream or an ocean, lake, or other body of standing water.

Normally, a "flood" is considered as any temporary rise in streamflow or stage, but not the ponding of surface water, that results in significant adverse effects in the vicinity. Adverse effects may include damages from overflow of land areas, temporary backwater effects in sewers and local drainage channels, creation of unsanitary conditions or other unfavorable situations by deposition of materials in stream channels during flood recessions, rise of ground water coincident with increased streamflow, and other problems.

Flood Crest. The maximum stage or elevation reached by the waters of a flood at a given location.

Flood Peak. The maximum instantaneous discharge of a flood at a given location. It usually occurs at or near the time of the flood crest.

Flood Plain. The relatively flat area or lowlands adjoining the channel of a river, stream or watercourse, or ocean, lake, or other body of standing water, which has been or may be covered by floodwater.

Flood Profile. A graph showing the relationship of water surface elevation to location, the latter generally expressed as distance above mouth for a stream of water flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific flood, but may be prepared for conditions at a given time or stage.

Flood Stage. The stage or elevation at which overflow of the natural banks of a stream or body of water begins in the reach or area in which the elevation is measured.

Floodway. The channel of the stream or body of water and that portion of the flood plain that is inundated by a flood and used to carry the flood flow.

Head Loss. The effect of obstructions, such as narrow bridge openings or buildings that limit the area through which water must flow, raising the surface of the water upstream from the obstruction.

Intermediate Regional Flood. A flood having an average frequency of occurrence in the order of once in 100 years, although the flood may occur in any year. It is based on statistical analyses of rainfall and runoff characteristics in the "general region of the watershed".

Left Bank. The bank on the left side of a river, stream, or watercourse, looking downstream.

Low Steel (or Underclearance). See "Underclearance".

Right Bank. The bank on the right side of a river, stream, or watercourse, looking downstream.

Standard Project Flood. The flood that may be expected from the most severe combination of meteorological and hydrological conditions that is considered reasonably characteristic of the geographical area in which the drainage basin is located, excluding extremely rare combinations. Peak discharges for these floods are generally about forty percent to sixty percent of the Probable Maximum Floods for the same basins. Such floods, as used by the Corps of Engineers, are intended as practicable expressions of the degree of protection that should be sought in the design of flood control works, the failure of which might be disastrous.

Thalweg. The line following the deepest part of the bed or channel of a stream.

Underclearance. The lowest point of a bridge or other structure over or across a river, stream, or watercourse, that limits the opening through which water flows. This is referred to as "low steel" in some regions.

AUTHORITY, ACKNOWLEDGMENTS, AND INTERPRETATION OF DATA

This report has been prepared in accordance with the authority granted by the Flood Control Act of 1960 (PL 86-645), as amended.

The cooperation and assistance given by the following agencies and numerous private citizens, in the accumulation of the information used in this report is greatly appreciated.

Central Iowa Regional Planning Commission
City of Des Moines
Iowa Natural Resources Council
Polk County Board of Supervisors
Public Library, City of Des Moines
U. S. Geological Survey
U. S. Weather Bureau (E.S.S.A.)

This report evaluates the flood situation caused by the Des Moines River and Beaver Creek between Saylorville Dam site and Center Street dam in Des Moines, Iowa. The Rock Island District, Corps of Engineers, upon request, will provide limited technical assistance in the interpretation and application of the data presented herein.

CORPS OF ENGINEERS

U. S. ARMY

NOTES:

1. PLATE NUMBERS CORRESPOND TO TOPOGRAPHIC MAP OF FLOODED AREAS.
2. STATIONING IS MEASURED IN MILES FROM THE MOUTH OF DES MOINES RIVER.
3. AERIAL MOSAIC OF JUNE 1954 FLOOD

FLOOD PLAIN INFORMATION REPORT
DES MOINES RIVER
MILE 208.9 TO MILE 213.7

INDEX SHEET
FOR
FLOODED AREA MAPS

½ ¼ 0 ½ 1

APPROX. SCALE IN MILES

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS

APRIL 1970

PLATE 6

CORPS OF ENGINEERS

U.S. ARMY

LEGEND

- STANDARD PROJECT FLOOD
- INTERMEDIATE REGIONAL FLOOD
- CHANNEL
- LEVEE
- 203.5 DISTANCE FROM MOUTH OF DES MOINES RIVER IN MILES.
- 3 LOCATION OF CROSS SECTION

NOTES:
1. ELEVATIONS BASED ON DES MOINES CITY DATUM.
2. DES MOINES CITY DATUM = 773.84 FEET ABOVE M.S.L., U.S.C.&G.S. DATUM 1929 G.A.

FLOOD PLAIN INFORMATION REPORT

DES MOINES, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA

DES MOINES RIVER

MILE 202.45 TO MILE 204.06

400 200 0 400 800 1200

SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS

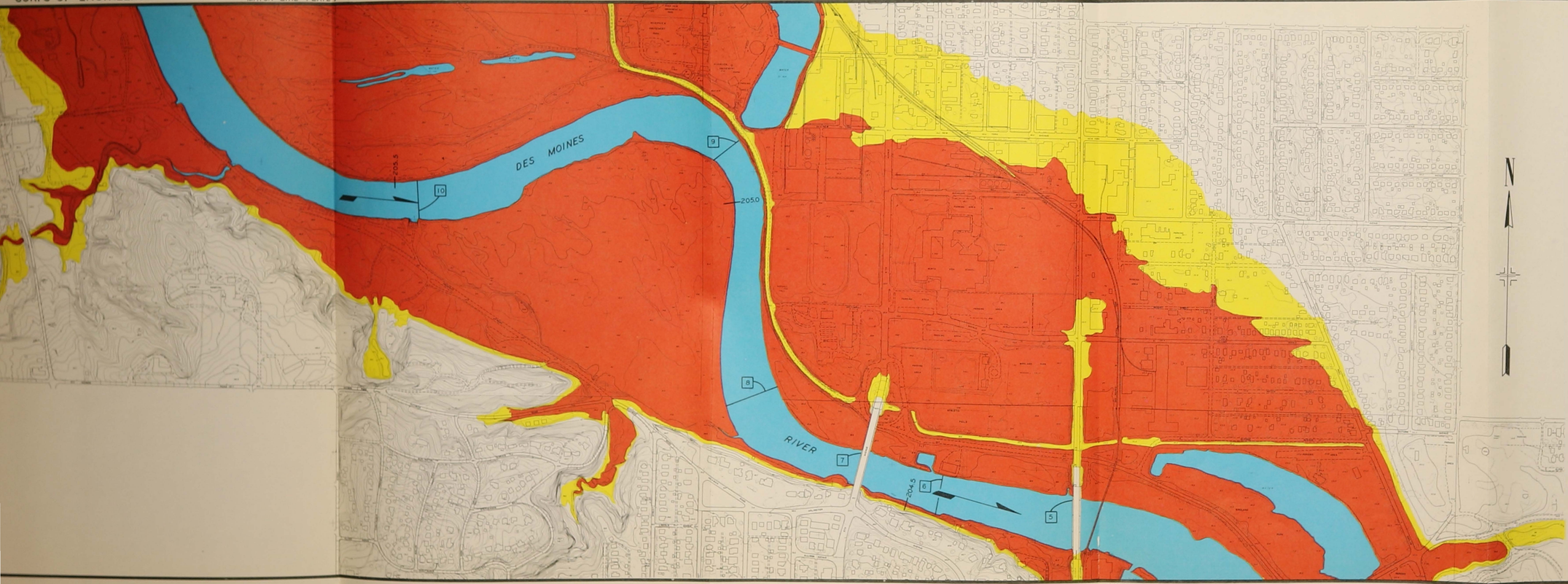
APRIL 1970

PLATE 7

CORPS OF ENGINEERS

MATCH LINE PLATE 9

U. S. ARMY



LEGEND.

- STANDARD PROJECT FLOOD
- INTERMEDIATE REGIONAL FLOOD
- CHANNEL
- 2050 DISTANCE FROM MOUTH OF DES MOINES RIVER IN MILES.
- [7] LOCATION OF CROSS SECTION

NOTES:
1. ELEVATIONS BASED ON DES MOINES CITY DATUM
2. DES MOINES CITY DATUM = 773.84 FEET ABOVE M.S.L. (U.S.C.&G.S. DATUM 1929 G.A.)

N

FLOOD PLAIN INFORMATION REPORT

DES MOINES, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA DES MOINES RIVER

MILE 204.06 TO MILE 205.96

400 200 0 400 800 1200

SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
APRIL 1970

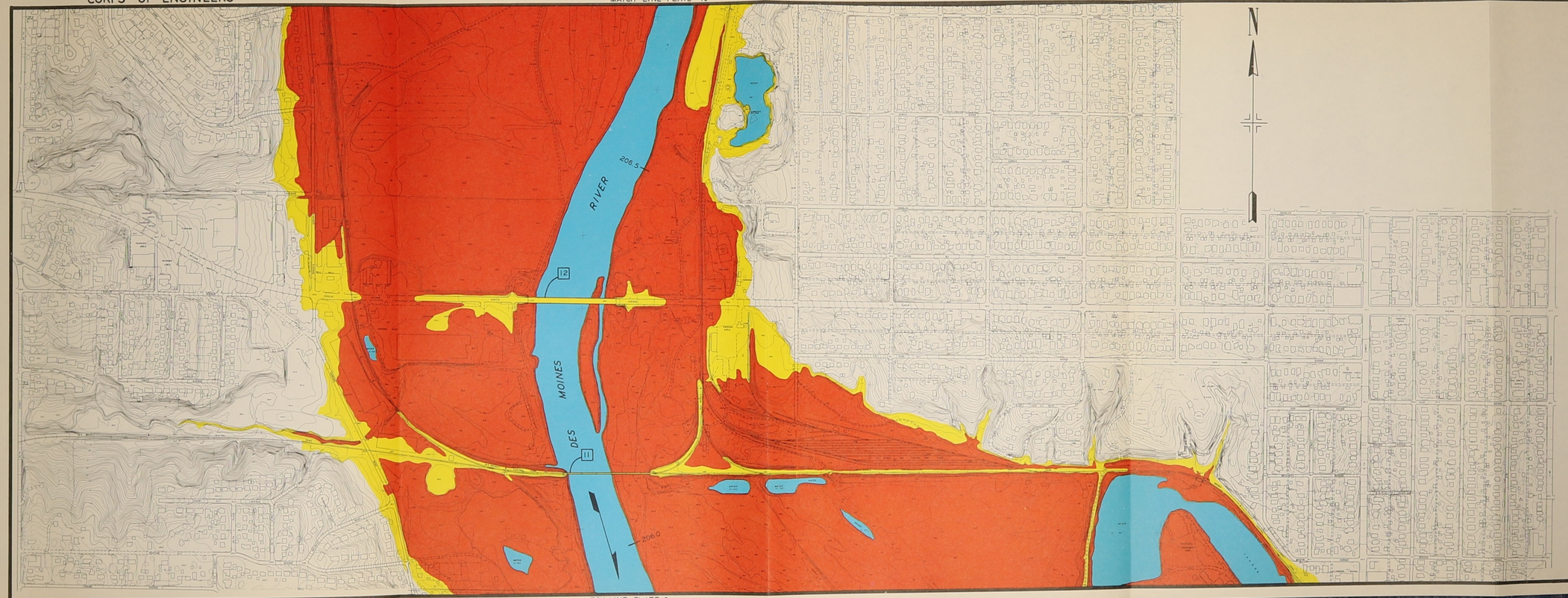
MATCH LINE PLATE 7

PLATE 8

CORPS OF ENGINEERS

MATCH LINE PLATE 10

U. S. ARMY



LEGEND

- STANDARD PROJECT FLOOD
- INTERMEDIATE REGIONAL FLOOD
- CHANNEL
- 206.5 DISTANCE FROM MOUTH OF DES MOINES RIVER IN MILES
- 11 LOCATION OF CROSS SECTION

NOTES:
1. ELEVATIONS BASED ON DES MOINES CITY DATUM.
2. DES MOINES CITY DATUM = 773.84 FEET ABOVE M.S.L., U.S.C.&G.S. DATUM 1929 G.A.

FLOOD PLAIN INFORMATION REPORT

DES MOINES, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA DES MOINES RIVER

MILE 205.96 TO MILE 206.77

400 200 0 400 800 1200

SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS

APRIL 1970

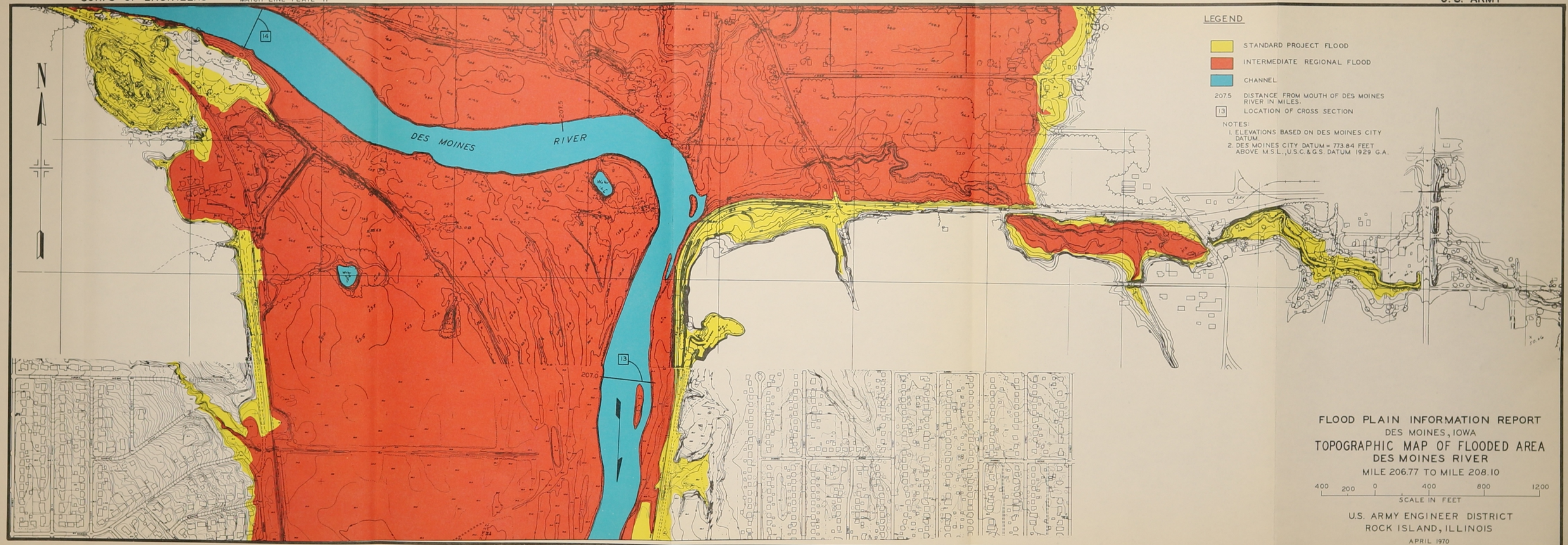
MATCH LINE PLATE 8

PLATE 9

CORPS OF ENGINEERS

MATCH LINE PLATE 11

U. S. ARMY



FLOOD PLAIN INFORMATION REPORT

DES MOINES, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA

DES MOINES RIVER

MILE 206.77 TO MILE 208.10

400 200 0 400 800 1200

SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT

ROCK ISLAND, ILLINOIS

APRIL 1970

MATCH LINE PLATE 9

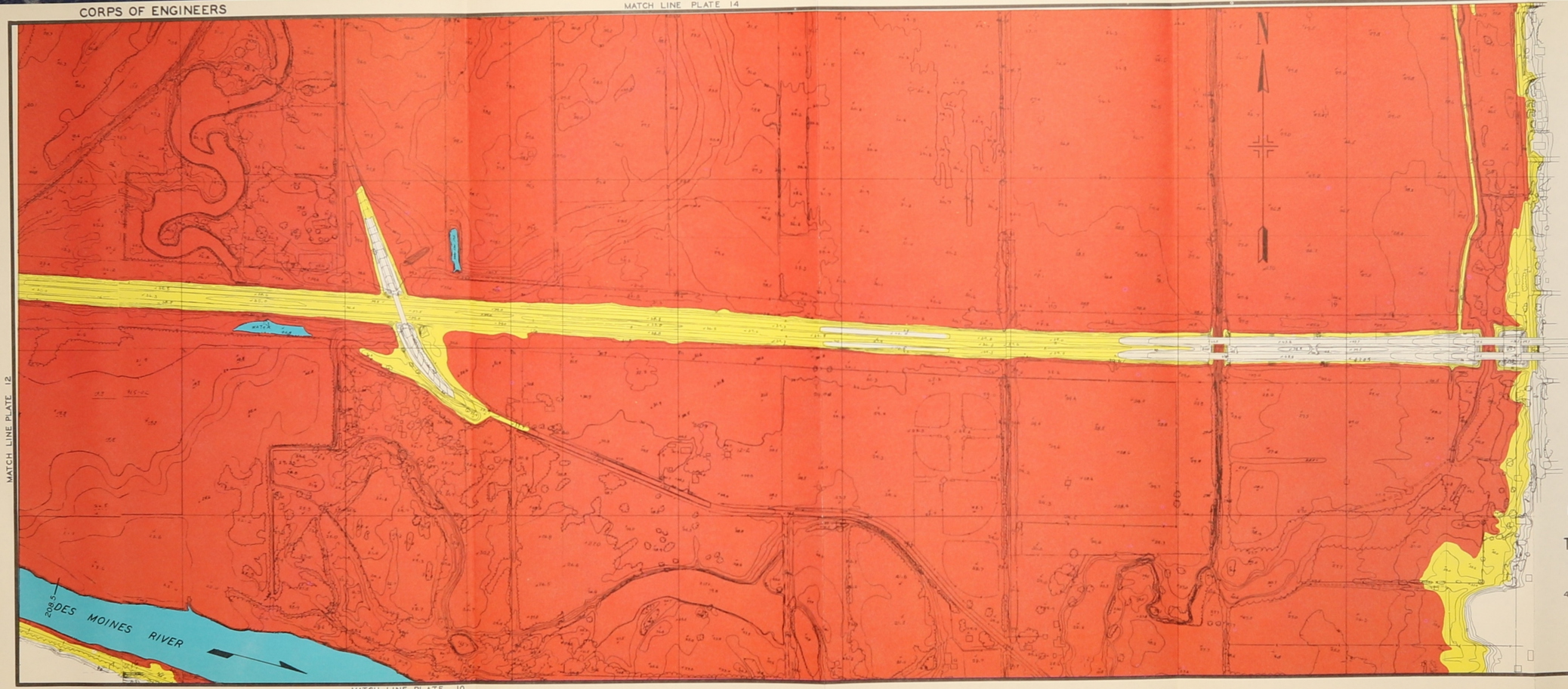
PLATE 10

CORPS OF ENGINEERS

U. S. ARMY

MATCH LINE PLATE 14

MATCH LINE PLATE 12



MATCH LINE PLATE 10

LEGEND

STANDARD PROJECT FLOOD

INTERMEDIATE REGIONAL FLOOD

CHANNEL

208.5 DISTANCE FROM MOUTH OF DES MOINES RIVER IN MILES.

NOTES:

1. ELEVATIONS BASED ON DES MOINES CITY DATUM.
2. DES MOINES CITY DATUM = 773.84 FEET ABOVE M.S.L., U.S.C.&G.S. DATUM 1929 G.A.

FLOOD PLAIN INFORMATION REPORT

DES MOINES, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA

DES MOINES RIVER

MILE 208.10 TO MILE 208.54

400 200 0 400 800 1200

SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT

ROCK ISLAND, ILLINOIS

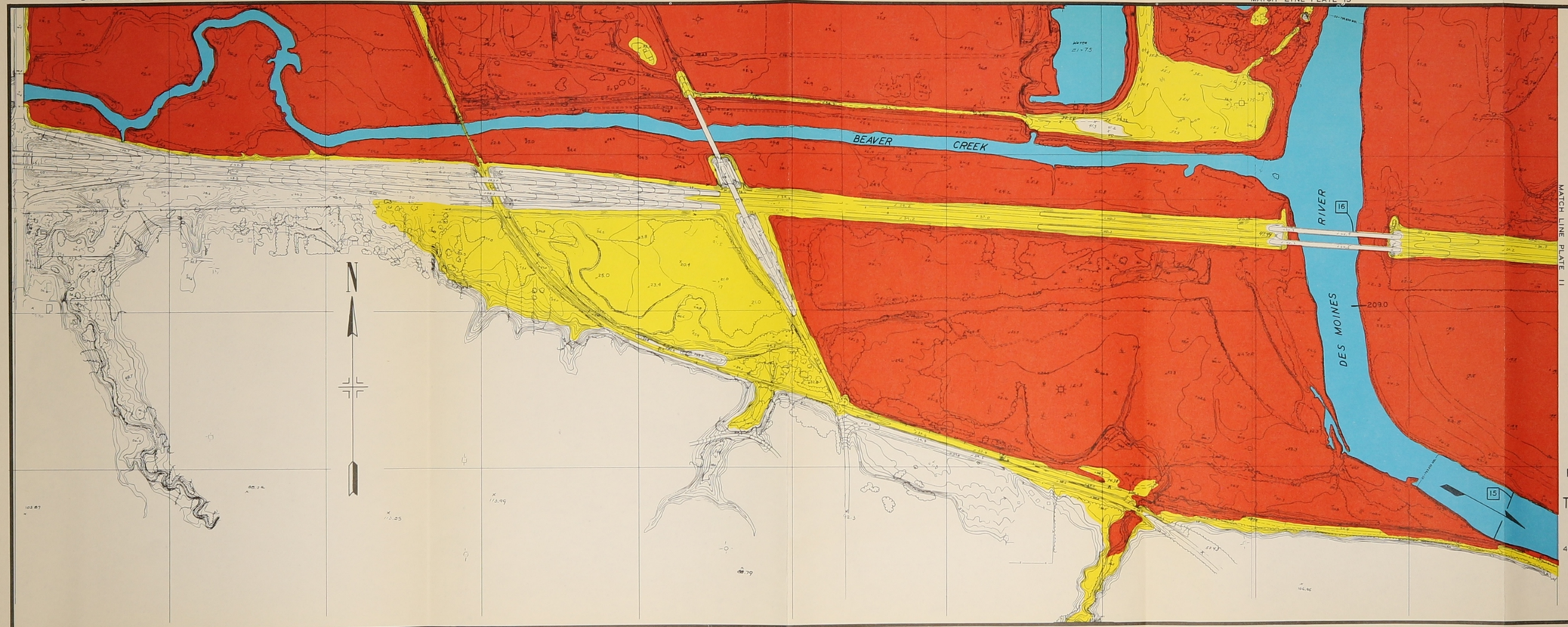
APRIL 1970

PLATE 11

CORPS OF ENGINEERS

MATCH LINE PLATE 13

U. S. ARMY



MATCH LINE PLATE 11

LEGEND

- STANDARD PROJECT FLOOD
- INTERMEDIATE REGIONAL FLOOD
- CHANNEL
- 2090 DISTANCE FROM MOUTH OF DES MOINES RIVER IN MILES.
- [16] LOCATION OF CROSS SECTION

NOTES:
1. ELEVATIONS BASED ON DES MOINES CITY DATUM.
2. DES MOINES CITY DATUM = 773.84 FEET ABOVE M.S.L., U.S.C.&G.S. DATUM 1929 G.A.

FLOOD PLAIN INFORMATION REPORT

DES MOINES, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA

DES MOINES RIVER

MILE 208.54 TO MILE 209.39

400 0 400 800 1200

SCALE IN FEET

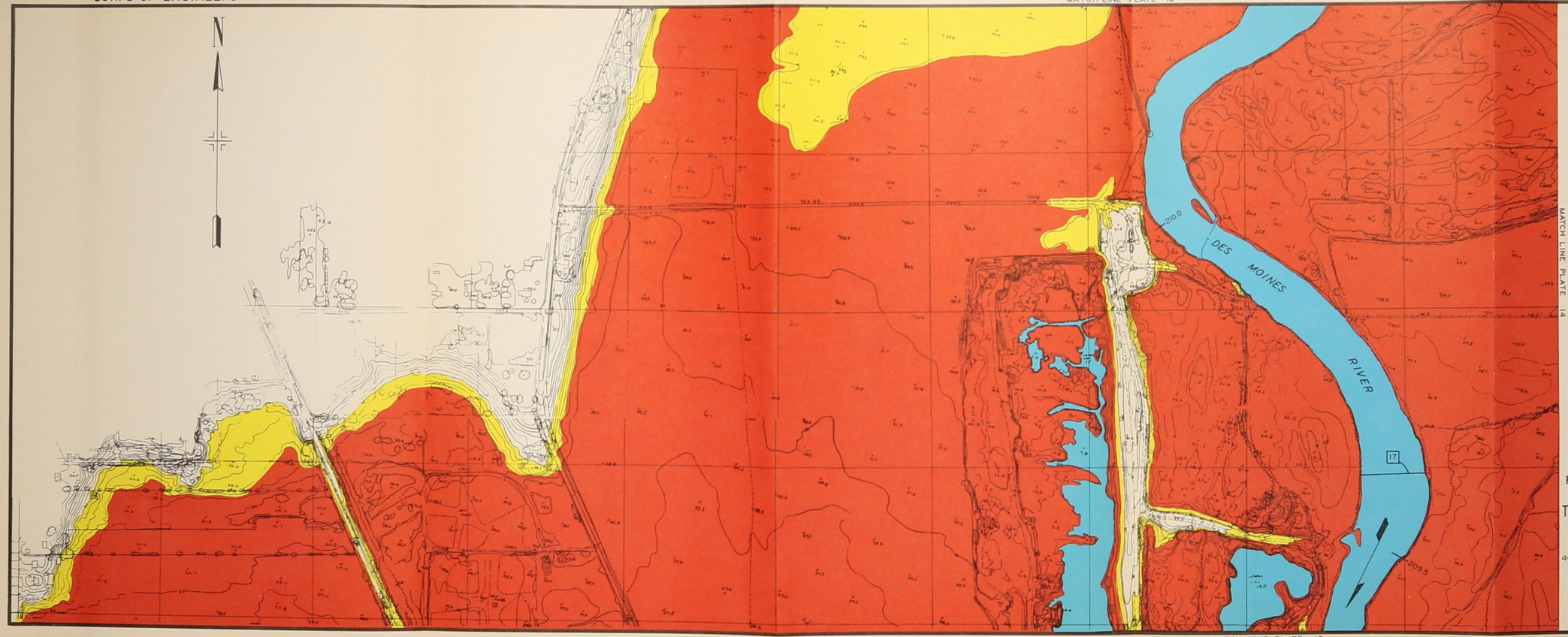
U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
APRIL 1970

PLATE 12

CORPS OF ENGINEERS

U. S. ARMY

MATCH LINE PLATE 15



MATCH LINE PLATE 14

MATCH LINE PLATE 12

LEGEND

- STANDARD PROJECT FLOOD
- INTERMEDIATE REGIONAL FLOOD
- CHANNEL
- 209.5 DISTANCE FROM MOUTH OF DES MOINES RIVER IN MILES.
- 17 LOCATION OF CROSS SECTION

NOTES:
1. ELEVATIONS BASED ON DES MOINES CITY DATUM.
2. DES MOINES CITY DATUM = 773.84 FEET ABOVE M.S.L., U.S.C.&G.S. DATUM 1929 G.A.

FLOOD PLAIN INFORMATION REPORT

DES MOINES, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA

DES MOINES RIVER

MILE 209.39 TO MILE 210.28

400 200 0 400 800 1200

SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS

APRIL 1970

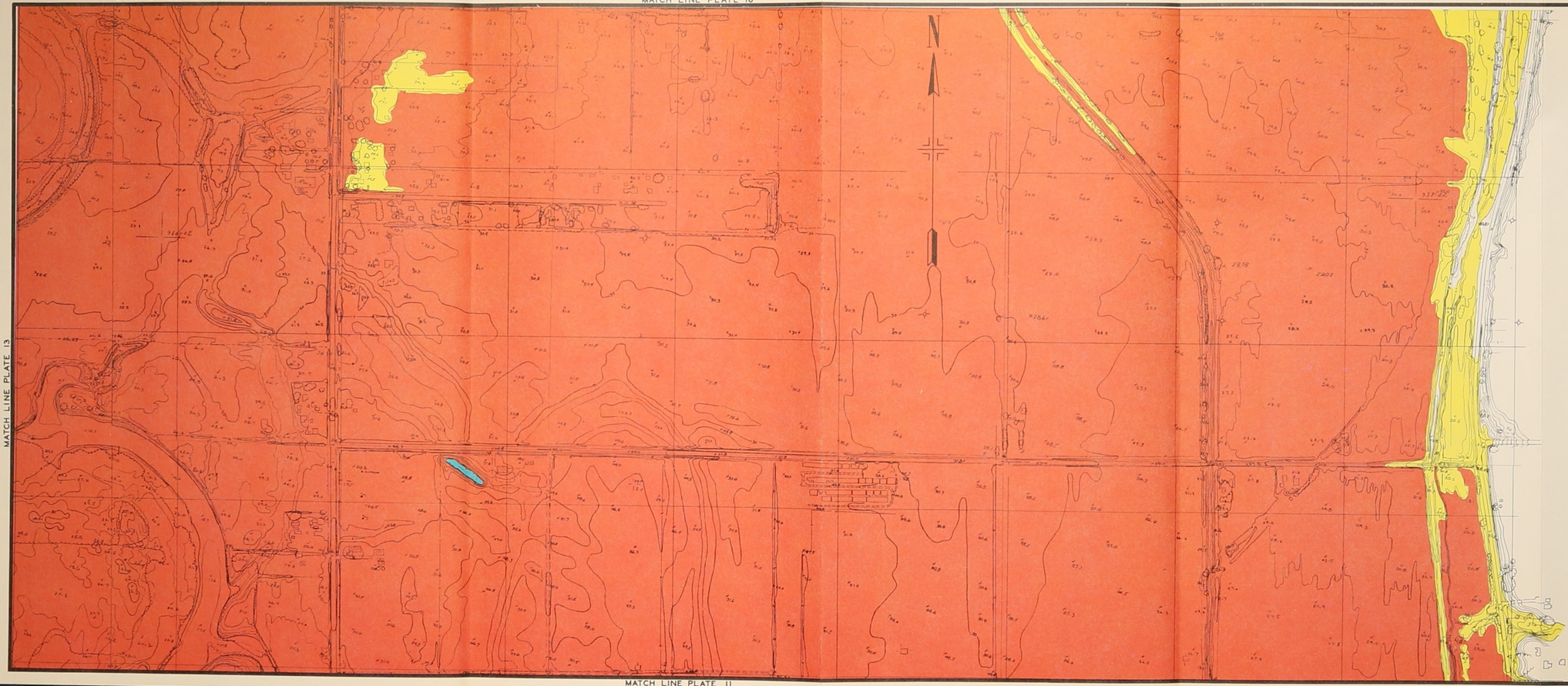
PLATE 13

CORPS OF ENGINEERS

U. S. ARMY

MATCH LINE PLATE 16

MATCH LINE PLATE 13



MATCH LINE PLATE 11

LEGEND

STANDARD PROJECT FLOOD

INTERMEDIATE REGIONAL FLOOD

NOTES:
1. ELEVATIONS BASED ON DES MOINES CITY DATUM.
2. DES MOINES CITY DATUM = 773.84 FEET ABOVE M.S.L., U.S.C.&G.S. DATUM 1929 G.A.

FLOOD PLAIN INFORMATION REPORT

DES MOINES, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA
DES MOINES RIVER

400 200 0 400 800 1200

SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS

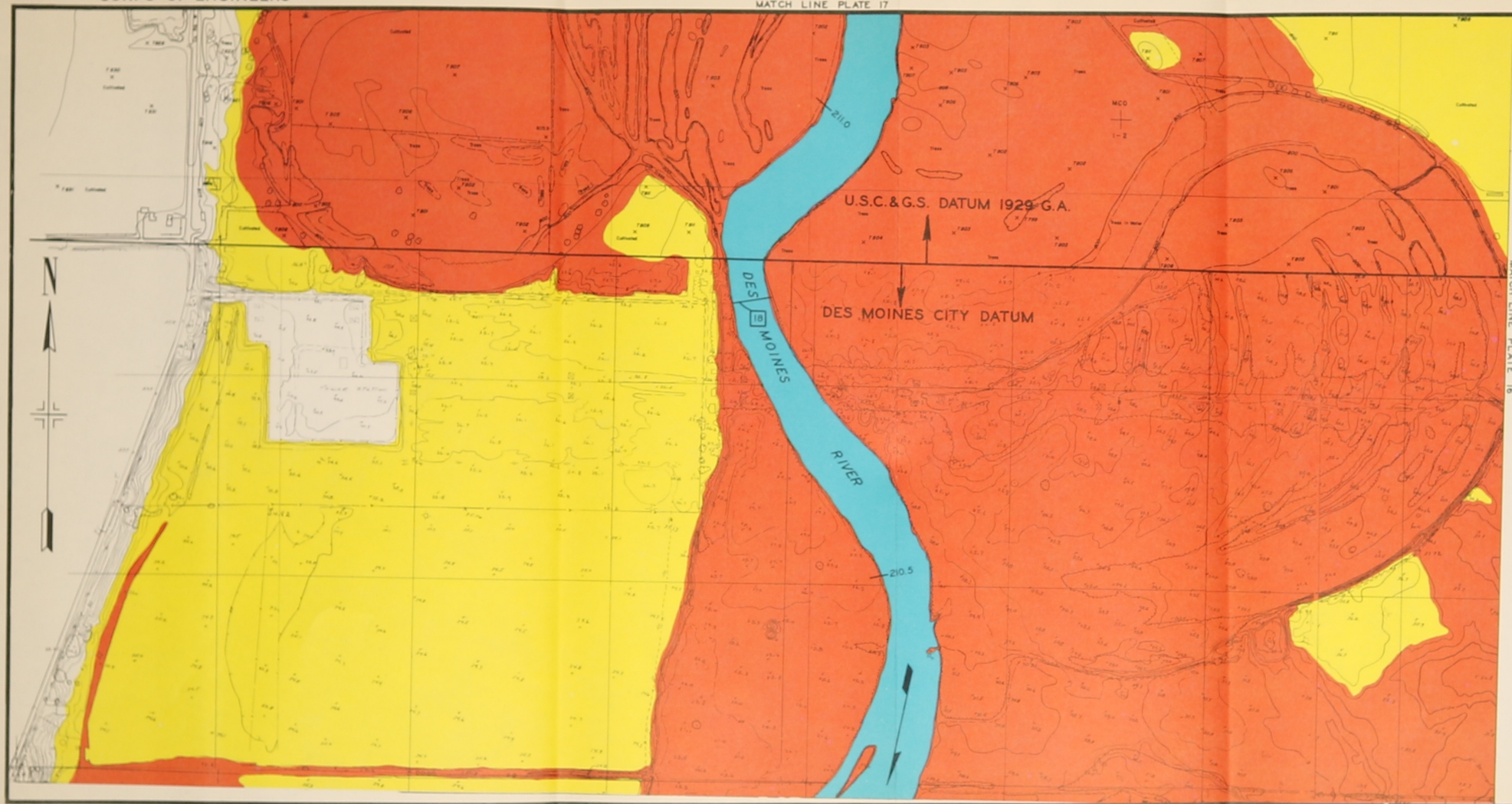
APRIL 1970

PLATE 14

CORPS OF ENGINEERS

MATCH LINE PLATE 17

U. S. ARMY



MATCH LINE PLATE 16

LEGEND

- STANDARD PROJECT FLOOD
- INTERMEDIATE REGIONAL FLOOD
- CHANNEL
- 211.0 DISTANCE FROM MOUTH OF DES MOINES RIVER IN MILES.
- [18] LOCATION OF CROSS SECTION

NOTES:

1. ELEVATIONS BASED ON DES MOINES CITY DATUM AND U.S.C.&G.S. DATUM 1929 G.A.
2. DES MOINES CITY DATUM = 773.84 FEET ABOVE M.S.L., U.S.C.&G.S. DATUM 1929 G.A.

FLOOD PLAIN INFORMATION REPORT

DES MOINES, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA

DES MOINES RIVER

MILE 210.28 TO MILE 211.10

400 200 0 400 800 1200

SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
APRIL 1970

MATCH LINE PLATE 13

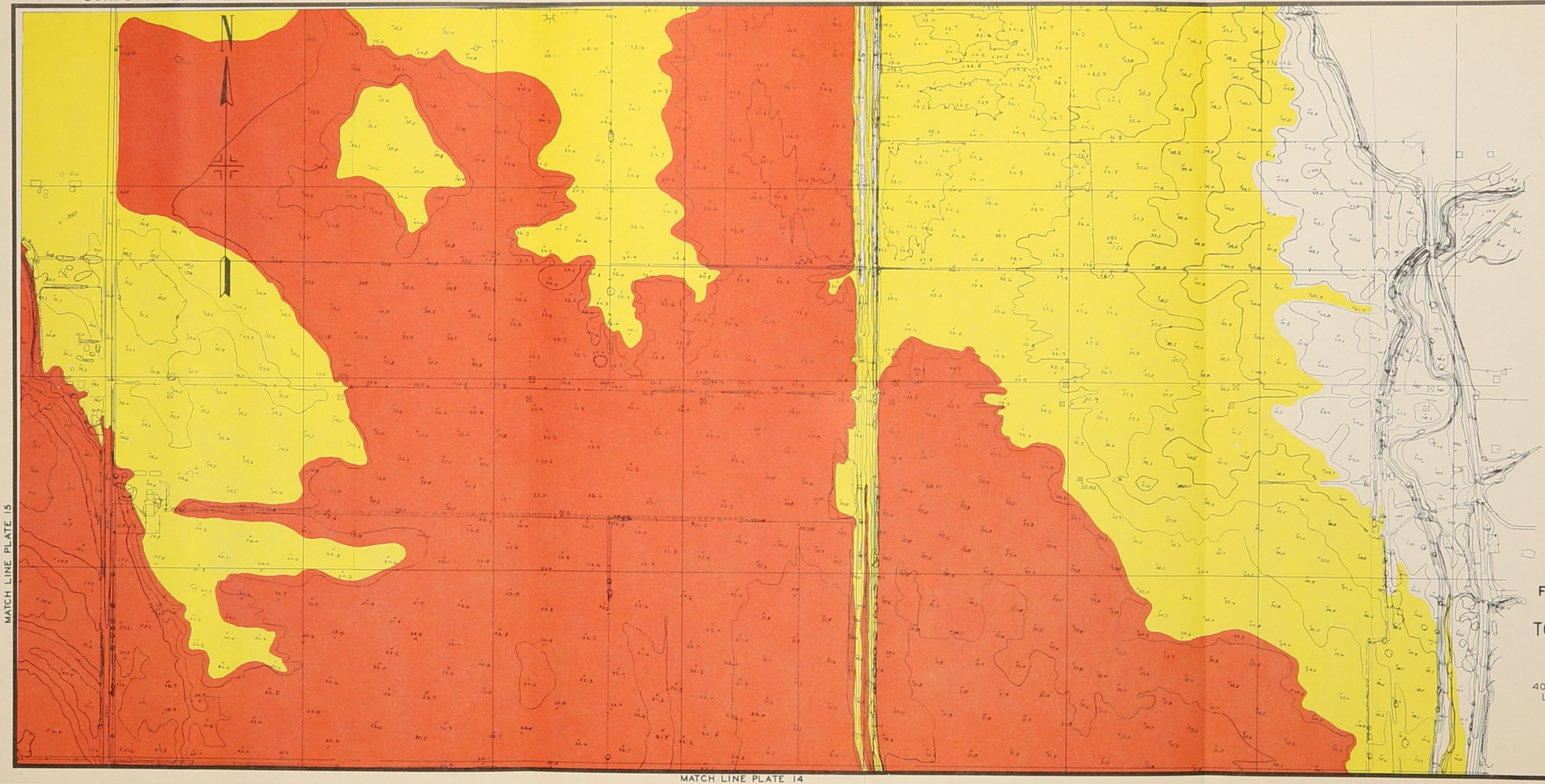
MATCH LINE PLATE 14

PLATE 15

CORPS OF ENGINEERS

MATCH LINE PLATE 18

U. S. ARMY



MATCH LINE PLATE 15

MATCH LINE PLATE 14

LEGEND

STANDARD PROJECT FLOOD

INTERMEDIATE REGIONAL FLOOD

NOTES:

1. ELEVATIONS BASED ON DES MOINES CITY DATUM.
2. DES MOINES CITY DATUM = 773.84 FEET ABOVE M.S.L., U.S.C.&G.S. DATUM 1929 G.A.

FLOOD PLAIN INFORMATION REPORT

DES MOINES, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA DES MOINES RIVER

400 200 0 400 800 1200

SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
APRIL 1970

PLATE 16

CORPS OF ENGINEERS

MATCH LINE PLATE 19

U. S. ARMY

LEGEND

- STANDARD PROJECT FLOOD
- INTERMEDIATE REGIONAL FLOOD
- CHANNEL
- 212.0 DISTANCE FROM MOUTH OF DES MOINES RIVER IN MILES.
- 20 LOCATION OF CROSS SECTION

NOTE:
1. ELEVATIONS BASED ON U.S.C.&G.S. DATUM 1929 G.A.

FLOOD PLAIN INFORMATION REPORT

DES MOINES, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA DES MOINES RIVER

MILE 211.10 TO MILE 212.22

400 200 0 400 800 1200

SCALE IN FEET

US. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS

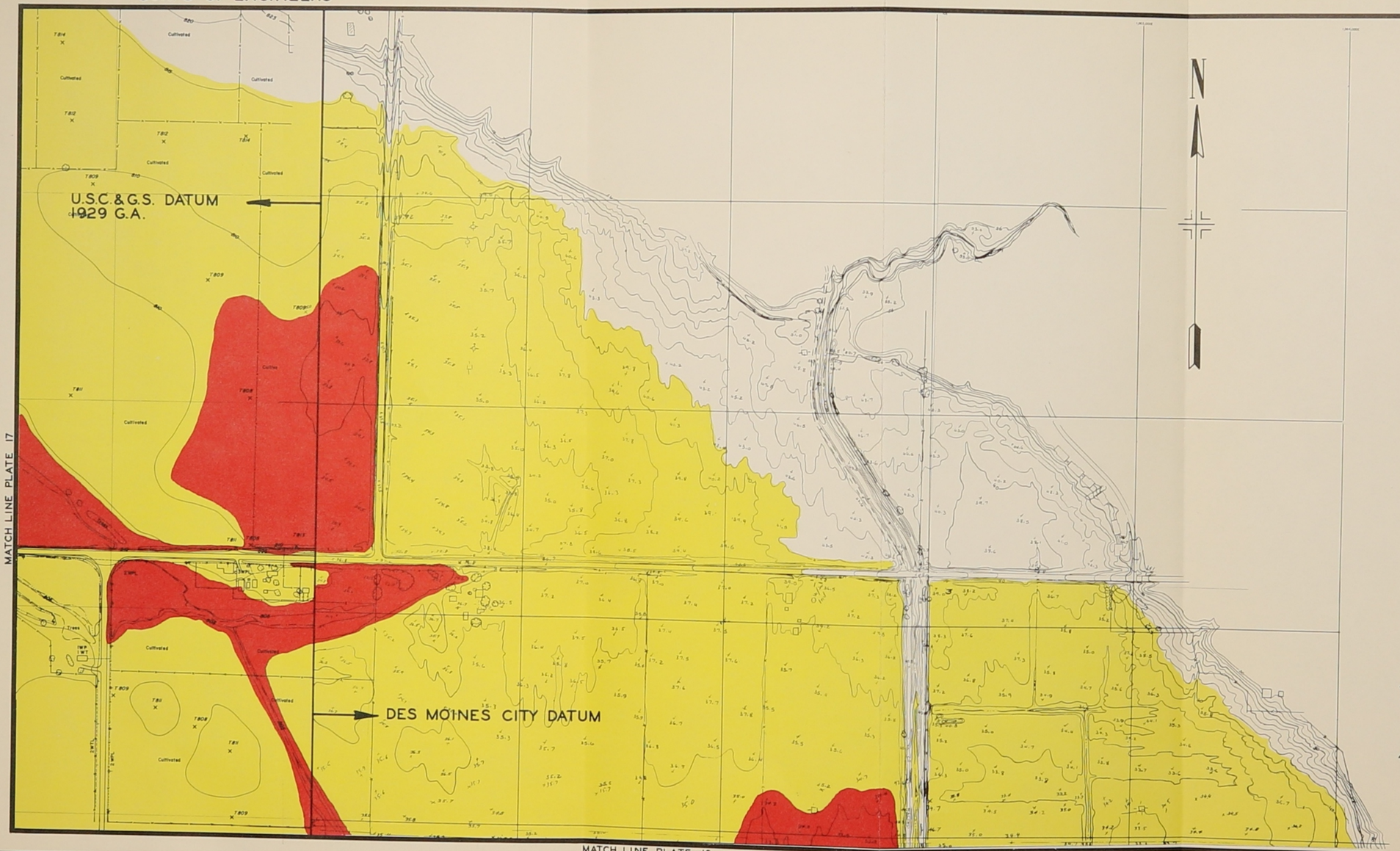
APRIL 1970

MATCH LINE PLATE 15

PLATE 17

CORPS OF ENGINEERS

U. S. ARMY



MATCH LINE PLATE 17

MATCH LINE PLATE 16

LEGEND

STANDARD PROJECT FLOOD

INTERMEDIATE REGIONAL FLOOD

NOTES:

1. ELEVATIONS BASED ON DES MOINES CITY DATUM AND U.S.C.&G.S. DATUM 1929 G.A.
2. DES MOINES CITY DATUM = 773.84 FEET ABOVE M.S.L., U.S.C.&G.S. DATUM 1929 G.A.

FLOOD PLAIN INFORMATION REPORT

DES MOINES, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA

DES MOINES RIVER

400 200 0 400 800 1200

SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS

APRIL 1970

PLATE 18

CORPS OF ENGINEERS

MATCH LINE PLATE 20

U. S. ARMY

MATCH LINE PLATE 17

LEGEND

STANDARD PROJECT FLOOD

INTERMEDIATE REGIONAL FLOOD

CHANNEL

2130 DISTANCE FROM MOUTH OF DES MOINES RIVER IN MILES.

NOTE:
1. ELEVATIONS BASED ON U.S.C.&G.S. DATUM 1929 G.A.

FLOOD PLAIN INFORMATION REPORT

DES MOINES, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA DES MOINES RIVER

MILE 212.22 TO MILE 213.19

400 200 0 400 800 1200

SCALE IN FEET

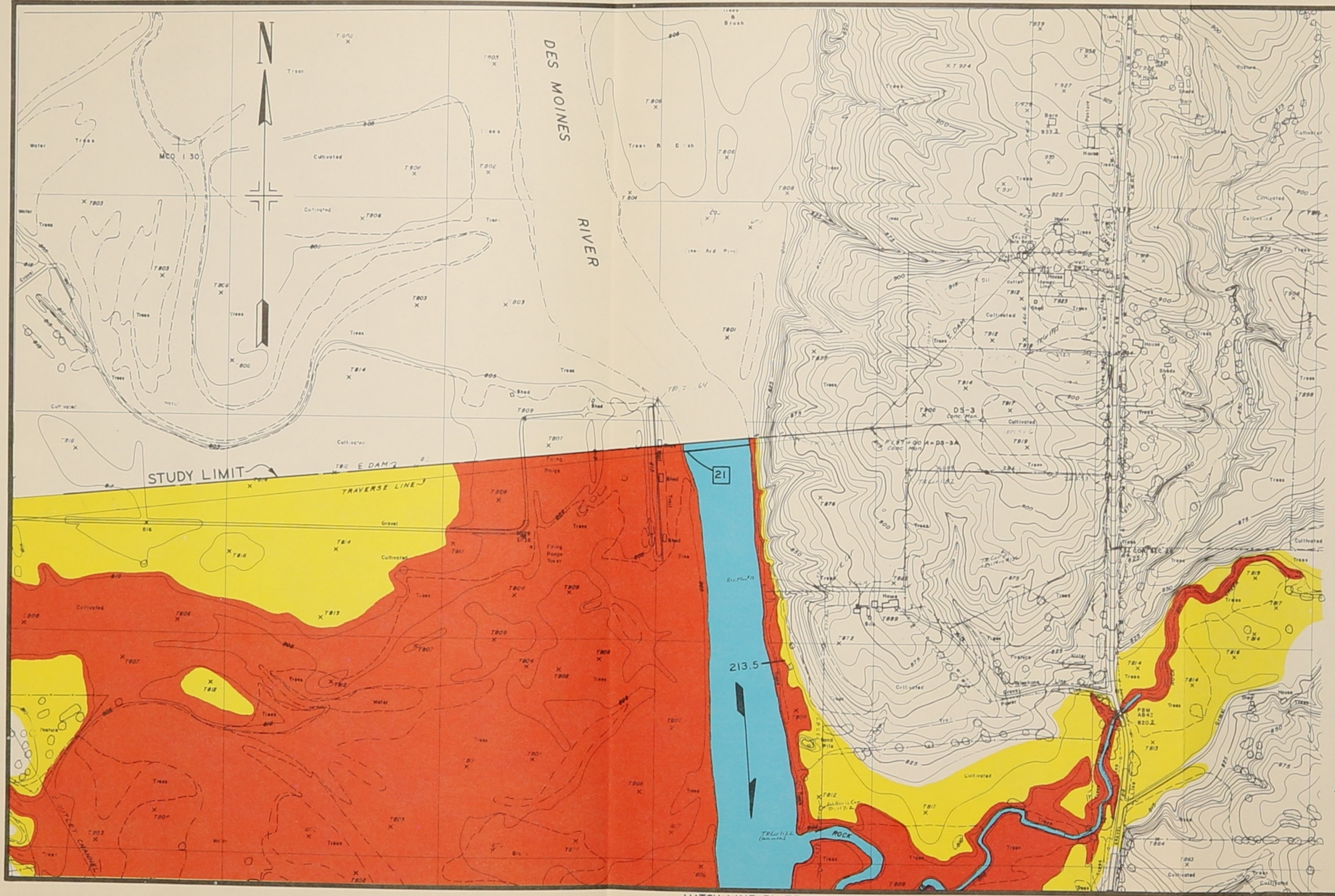
U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS

APRIL 1970

PLATE 19

CORPS OF ENGINEERS

U. S. ARMY



LEGEND

- STANDARD PROJECT FLOOD
- INTERMEDIATE REGIONAL FLOOD
- CHANNEL
- 213.5 DISTANCE FROM MOUTH OF DES MOINES RIVER IN MILES.
- 21 LOCATION OF CROSS SECTION

NOTE:
1. ELEVATIONS BASED ON U.S.C.&G.S. DATUM 1929 G.A.

FLOOD PLAIN INFORMATION REPORT

DES MOINES, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA

DES MOINES RIVER

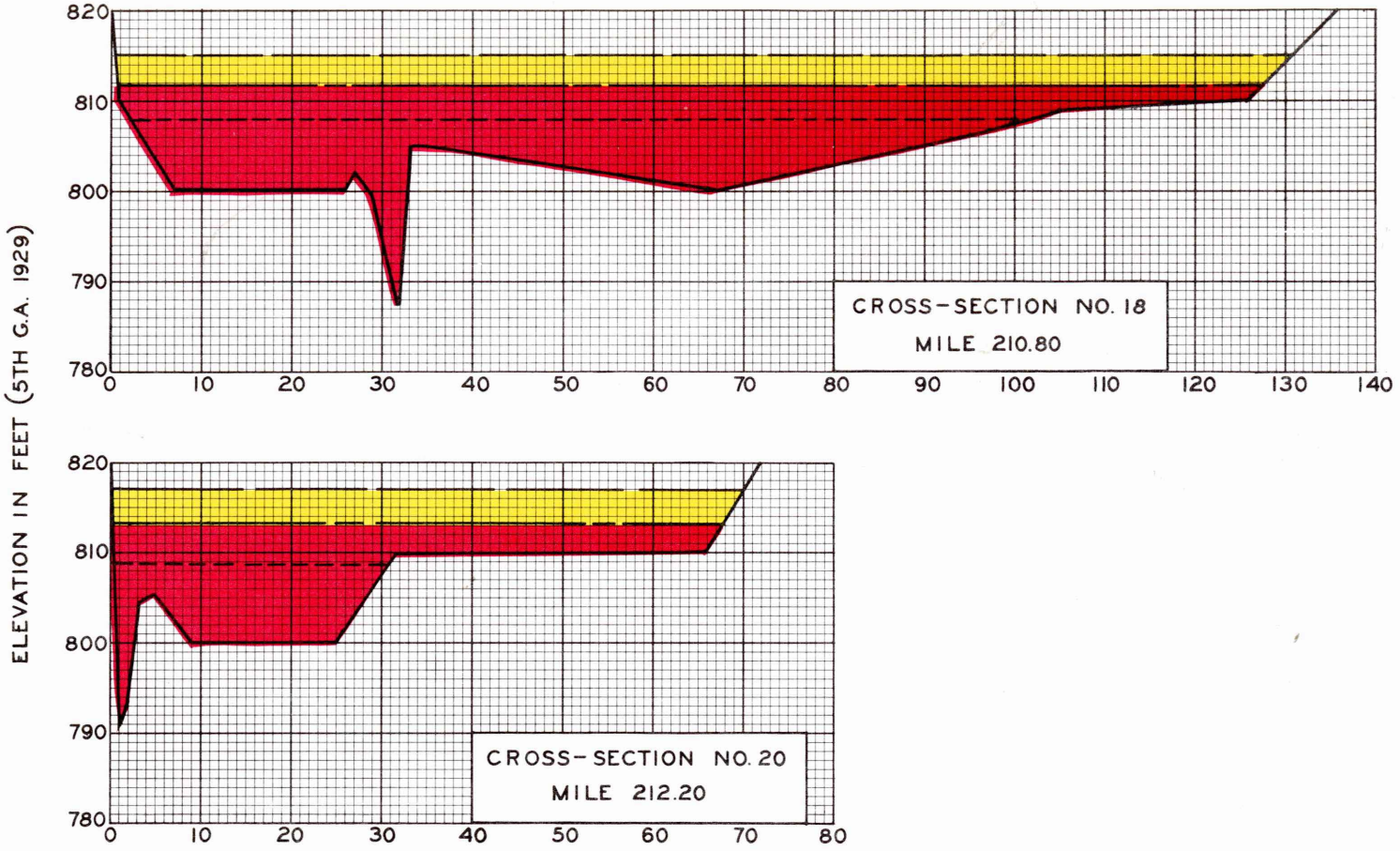
MILE 213.19 TO MILE 213.70

400 200 0 400 800 1200

SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
APRIL 1970

MATCH LINE PLATE 19



LEGEND:

STANDARD PROJECT FLOOD
INTERMEDIATE REGIONAL FLOOD
JUNE 24,1954 FLOOD
GROUND LINE

SECTION TAKEN LOOKING UPSTREAM

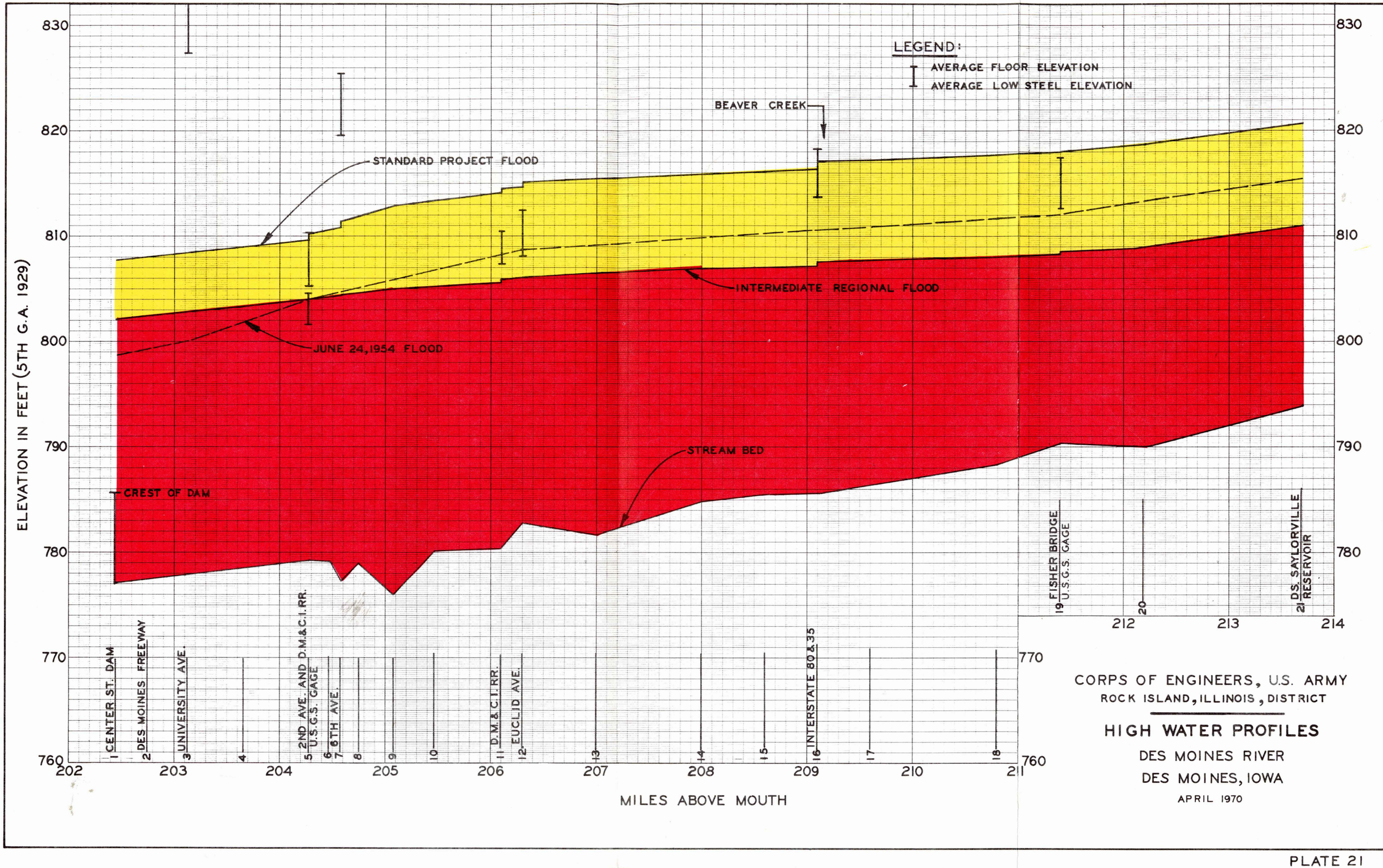
HORIZONTAL DISTANCE, HUNDRED FEET

CORPS OF ENGINEERS, U.S. ARMY
ROCK ISLAND, ILLINOIS, DISTRICT

CROSS SECTIONS
DES MOINES RIVER
DES MOINES, IOWA

APRIL 1970

PLATE 23

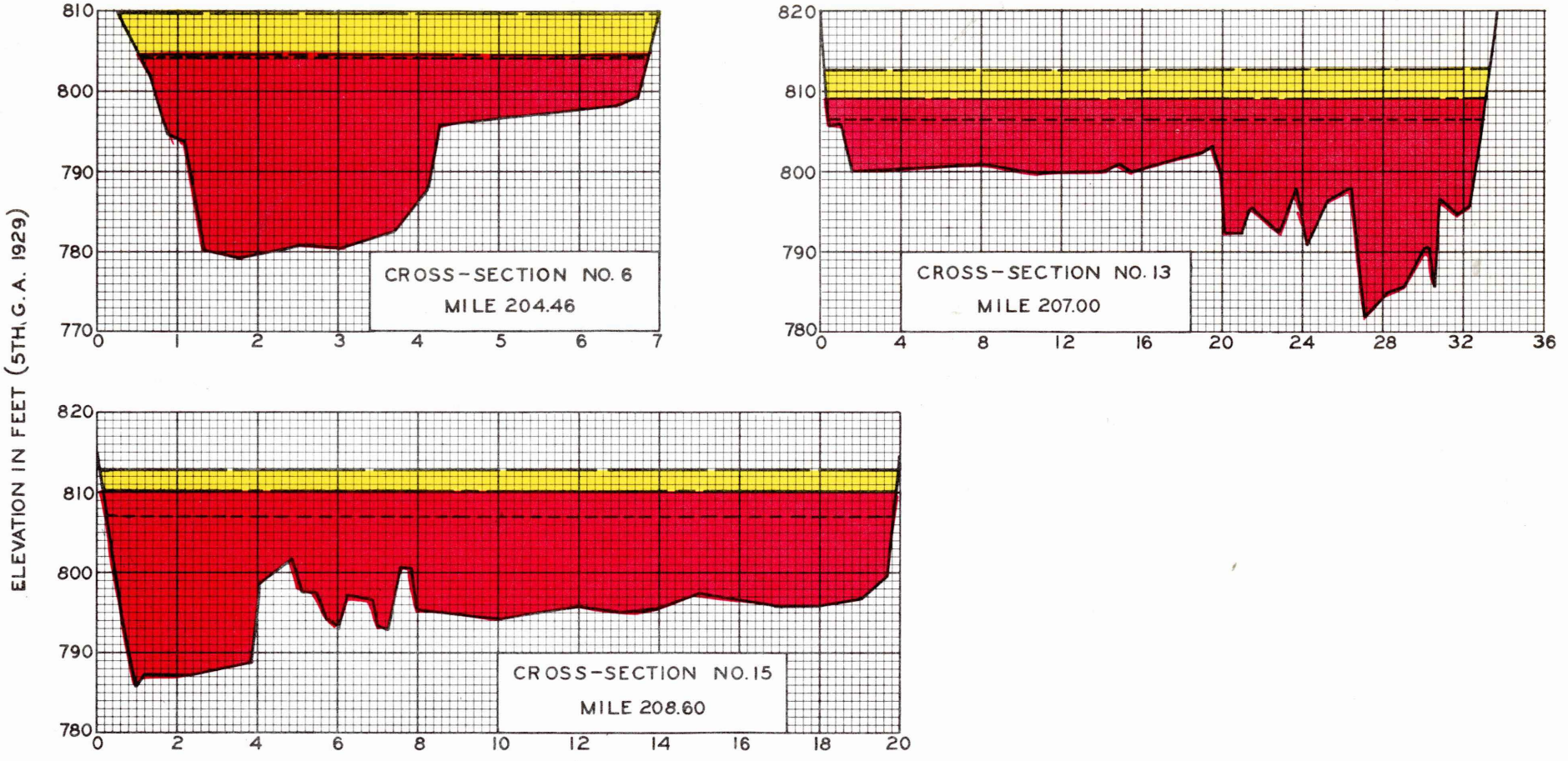


CORPS OF ENGINEERS, U.S. ARMY
ROCK ISLAND, ILLINOIS, DISTRICT

HIGH WATER PROFILES

DES MOINES RIVER
DES MOINES, IOWA
APRIL 1970

PLATE 21



CORPS OF ENGINEERS, U.S. ARMY
ROCK ISLAND, ILLINOIS, DISTRICT

CROSS SECTIONS
DES MOINES RIVER
DES MOINES, IOWA

APRIL 1970

PLATE 22