Special Flood Hazard Evaluation Report

Maumee River

Defiance and Paulding Counties Ohio

Prepared
for the Ohio
Department of Natural Resources

US Army Corps
of Engineers
Buffalo District

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This report documents the results of an investigation to determine the potential flood situation along the Maumee River for its entire length within the counties of Defiance and Paulding, Ohio. The report includes a history of flooding along the Maumee River and identifies those areas that are subject to possible future floods. Special emphasis is given to those floods through the use of maps and water surface profiles.

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SPECIAL FLOOD HAZARD
EVALUATION REPORT

MAUMEE RIVER
DEFIANCE AND PAULDING COUNTIES, OHIO

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MAUMEE RIVER DEFIANCE AND PAULDING COUNTIES, OHIO

INTRODUCTION

This Special Flood Hazard Evaluation Report, prepared at the request of the Ohio Department of Natural Resources, under the authority of Section 206 of the 1960 Flood Control Act, as amended, documents the results of an investigation to determine the potential flood situation along the Maumee River for its entire length within the counties of Defiance and Paulding, Ohio. The reach studied for this report begins at the Henry County line and continues upstream through Defiance County and Paulding County, to the Indiana State border, a distance of about 52 miles. Defiance is the only city within the study area: the remainder of the area along the river is predominately rural.

The total drainage area of the Maumee River is 6,608 square miles (see Figure 1). With its headwaters in Fort Wayne, Indiana, the Maumee River flows in a northeasterly direction through Ohio to Maumee Bay at Toledo. Two major tributary rivers, the Tiffin and the Auglaize, join the Maumee River at Defiance, Ohio. The Maumee River flows in a channel with large sweeping bends through flood plains that vary in width from a few hundred feet to about two thousand feet in width. Terrain varies from flat plains to moderately hilly uplands. Total fall of the river is 178 feet. Within the 52 mile study reach, the river has an average fall of 1.1 feet per mile.

Knowledge of potential floods and flood hazards is important in land use planning. This report includes a history of flooding along the Maumee River and identifies those areas that are subject to possible future floods. Special emphasis is given to those floods through the use of maps and water surface profiles. While the report does not provide solutions to flood problems, it does furnish a suitable basis for the adoption of land use controls to guide flood plain development and thereby prevent intensification of the flood loss problem. It will also aid in the development of other flood damage reduction techniques to modify flooding and reduce flood damages which might be embodied in an overall Flood Plain Management (FPM) program. Other types of studies, such as those of environmental attributes and the current and future land use role of the flood plain as part of its surroundings, would also profit from this information.

Additional copies of this report can be obtained from the Ohio Department of Natural Resources until its supply is exhausted and the National Technical Information Service of the U.S. Department of Commerce, Springfield, VA 22161, at the cost of reproducing the report. The Buffalo District Corps of Engineers will provide technical assistance and guidance to planning agencies in the interpretation and use of the data.

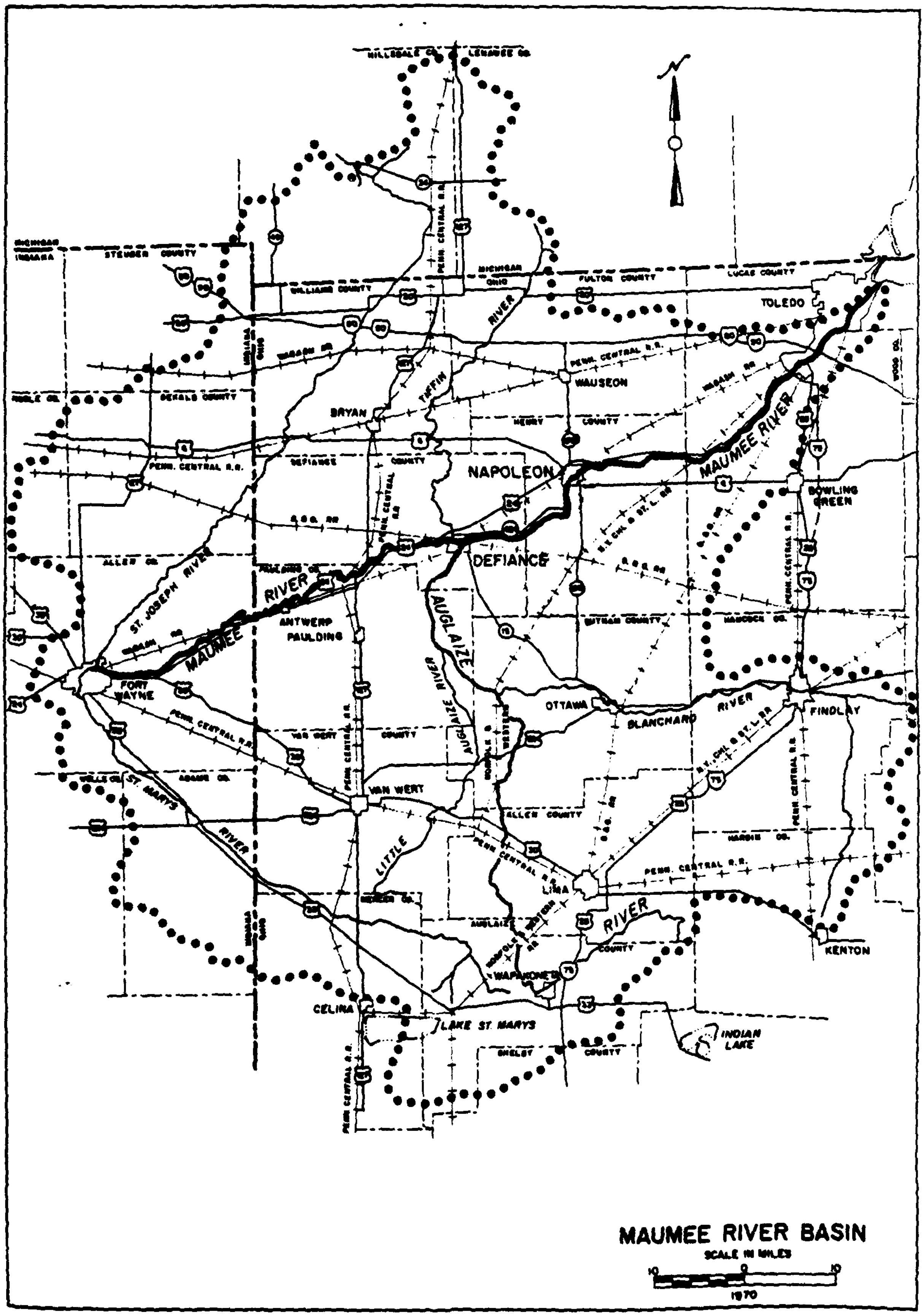

MAUMEE RIVER BASIN
SCALE IN MILES
1970
TOLEDO
WAUSEON
BRYAN
NAPOLEON
MAUMEE RIVER
BOWLING GREEN
DEFIANCE
ST. JOSEPH RIVER
MAUMEE RIVER
ANTWERP
PAULDING
AUGLAIZE RIVER
FORT WAYNE
OTTAWA
BLANCHARD RIVER
FINDLAY
VAN WERT
ST. MARYS RIVER
LITTLE
LIMA
RIVER
KENTON
WAPAKONETA
CELINA
LAKE ST. MARYS
INDIAN LAKE
TIFFIN RIVER
PENN. CENTRAL R.R.
WABASH RR
FULTON COUNTY
LUCAS COUNTY
WILLIAMS COUNTY
HENRY COUNTY
DEFIANCE COUNTY
PUTNAM COUNTY
HANCOCK CO.
VAN WERT COUNTY
ALLEN COUNTY
HARDIN CO.
SHELBY COUNTY
STEUBEN COUNTY
DEKALB COUNTY
ALLEN CO.
ADAMS CO.
WELLS CO.
PAULDING CO.
MERCER CO.
AUGLAIZE COUNTY
MICHIGAN
INDIANA
OHIO

FIGURE 1

PRINCIPAL FLOOD PROBLEMS

Records of river stages and discharges on the Maumee River have been maintained since 1898. Significant floods (those with peak discharges over 50,000 cfs) have occurred at least once in each decade since 1913. The main flood season for the Maumee River occurs during the winter and spring months. All of the highest known floods occurred during this period. However, intense local thunderstorms can occur in the summer and cause local flooding.

The greatest known flood to have occurred on the Maumee River was in March 1913. Records indicate that the 1913 flood discharge (138,500 cfs) was approximately 60 percent greater than the next highest known flood discharge. This occurred as a result of two intense frontal type storms which passed over Ohio from west to east between March 23 and 27. Rainfall averaged between 6 and 7 inches over the entire Maumee River Basin, with 6.5 inches recorded at Defiance (Reference 1).

Numerous major floods have occurred since the 1913 flood. The most recent flood (March 1982) was caused by rain and snowmelt in the upper Maumee River basin. Unseasonably warm temperatures combined with precipitation maintained high water levels and extended the period of flooding. Three lives were lost and 876 people were evacuated from Defiance and Paulding Counties. Additional damage in the two counties included 9.5 percent of farmland flooded and damage to 268 single-family dwellings, 44 businesses, as well as public buildings, sewer systems, roads, and bridges (Reference 2).

Floods of the same or larger magnitude as past floods are likely to occur in the future, as similar combinations of rainfall, snowmelt, and runoff can be expected to occur again within the study area.

Flood Magnitudes and Their Frequencies

Floods are classified on the basis of their frequency or recurrence interval. A 100-year flood is an event with a magnitude that can be expected to be equaled or exceeded once on the average during any 100-year period. It has a 1.0 percent chance of occurring in any given year. It is important to note that, while on a long term basis the exceedence averages out to once per hundred years, floods of this magnitude can occur in any given year or even in consecutive years and within any given time interval. For example, there is a greater than 50 percent probability that a 100-year event will occur during a 70-year lifetime. Additionally, a house which is built within the 100-year flood level has about a one in four chance of being flooded in a 30-year mortgage life.

Two United States Geological Survey (USGS) gages are located along the Ohio portion of the Maumee River. The gages are located at Waterville, downstream of the study area and Defiance, downstream of the Auglaize River. A third gage, located at Antwerp, seven miles downstream of the Indiana border, has been removed. Discharge frequency relationships were determined for these three sites.

The Maumee River, above its confluence with the Auglaize River, has a drainage area of 3,094 square miles. Just downstream of the Auglaize River confluence, the Maumee River drainage area is 5,545 square miles. Due to the large difference in drainage area upstream and downstream of the Auglaize River confluence, two separate discharge-frequency relationships were required at Defiance. A subtraction method of estimating discharges of the Maumee River above the Auglaize River was used to estimate peak discharges. These values were then used as input into the Flood Flow Frequency Analysis (FFFA) computer program (Reference 3) to determine the discharge-frequency relationship for the Maumee River above the Auglaize River.

The discharge-frequency relationships of the 4 sites were used to develop discharge-frequency vs. drainage area curves. Because only two points were available upstream of the Auglaize River, and two downstream, a simple straight line relationship between each set of points was used to represent intermediate areas. The equations for these lines are presented below.

For the reach between the Indiana-Ohio border and Defiance, Ohio, upstream of the Auglaize River:

$$Q100 = (21.14)(DA) - 15{,}807$$

For the reach downstream of the Auglaize River to the mouth:

$$Q100 = (19.108)(DA) + 2{,}046$$

where: Q100 = 100-year peak discharge in cubic feet per second
DA = drainage area for the study reach in square miles

Drainage areas were determined using the publication, Drainage Areas of Ohio Streams, prepared by USGS in cooperation with the Ohio Department of Natural Resources.

The drainage areas and 100-year peak discharges for reaches in Defiance and Paulding Counties are summarized in Table 1. The discharge-frequency values at the Ohio-Indiana stateline were coordinated with the Detroit District Corps of Engineers and were in agreement with values they had developed for the Maumee River within Indiana.

Table 1 - Peak Flows on the Maumee River

Location	Drainage Area (sq. mi.)	100-Year Peak Discharge (cfs)
Upstream of Wade Creek	5566	108,400
At USGS gage No. 04192500 near Defiance	5545	108,000
Upstream of Auglaize River	3094	49,600
Upstream of Tiffin River	2315	33,100
Upstream of Sulphur Creek	2281	32,400
Upstream of Platter Creek	2254	31,800
Upstream of Gordon Creek	2207	30,800
Upstream of Maria de Larme Creek	2170	30,100
Upstream of North Creek	2134	29,300
At USGS gage No. 04183500 at Antwerp	2129	29,200

Hazards and Damages of Large Floods

The extent of damage caused by any flood depends on the topography of the flooded area, the depth and duration of flooding, the velocity of flow, the rate of rise in water surface elevation, and development of the flood plain. Deep water flowing at a high velocity and carrying floating debris would create conditions hazardous to persons and vehicles which attempt to cross the flood plain. Generally, water 3 or more feet deep which flows at a velocity of 3 or more feet per second could easily sweep an adult off his feet and create definite danger of injury or drowning. As shown on Table 2, velocities exceed 3 feet per second for the 100-year flood. Rapidly rising and swiftly flowing floodwater may trap persons in homes that are ultimately destroyed or in vehicles that are ultimately submerged or floated. Since waterlines can be ruptured by deposits of debris and by the force of flood waters, there is the possibility of contaminated domestic water supplies. Damaged sanitary sewer lines and sewage treatment plants could result in the pollution of floodwaters and could create health hazards. Isolation of areas by floodwater could create hazards in terms of medical, fire, or law enforcement emergencies.

Flood Profiles and Flooded Areas

Analyses of the hydraulic characteristics of the Maumee River were carried out to provide estimates of the elevations of the 100-year flood. Cross sectional data for the river channel were obtained by field survey. Eleven bridges were surveyed to obtain elevation data and structural geometry. The field surveys were done in December 1987. Additional data in the overbank areas were obtained from USGS 7-1/2 minute topographic maps.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Plates 1-5). Selected cross section locations are also shown on the Flooded Area Maps (Plates 6-13).

The 100-year flood profile was generated using the COE HEC-2 step-backwater computer program (Reference 4). The backwater model was calibrated to the rating curves at both the USGS gage at the Independence Dam and the former USGS gage at Antwerp. The 100-year flood profile was drawn showing computed water surface elevations to an accuracy of 0.5 foot.

Channel roughness factors (Manning's "n") used in the computations were chosen by engineering judgement and based on field observations of the Maumee River and its flood plain. Roughness factors for the main channel varied from 0.025 to 0.046, while roughness factors for the overbank areas varied from 0.050 to 0.060. The contraction and expansion loss coefficients for the river were 0.2 and 0.4, respectively.

The starting water surface elevation for the Maumee River in Defiance County was taken from the flood profile at the Defiance-Henry County line as determined in the Special Flood Hazard Evaluation Report on the Maumee River in Henry County, Ohio (Reference 5).

The computed 100-year water surface profile for the Maumee River in Defiance and Paulding Counties is shown on Plates 1-5. The flood plain boundaries are shown on Plates 6-13. These boundaries were delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using USGS topographic maps and spot elevations obtained during the field surveys. Small areas within the flood plain boundaries may be above the flood elevations, but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

An encroachment floodway was also determined for the Maumee River based on equal conveyance reduction from each side of the flood plain. At the request of the Ohio Department of Natural Resources standards, the maximum increase in stage was limited to 1 foot, provided that hazardous velocities were not produced. Floodway widths were computed at cross sections and varied from 328 to 2,640 feet. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections and are shown in Table 2. The computed floodway is also shown on the Flooded Area Maps, (Plates 6-13). In cases where the floodway and the 100-year flood plain boundary are either close together or collinear, only the 100-year flood plain boundary is shown.

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if the bridges remain unobstructed from debris or ice and if channel and overbank conditions remain essentially the same as ascertained during this study.

All elevations are referenced from National Geodetic Vertical Datum of 1921 (NGVD). Elevation reference marks used in the study are shown on Plates 6-13; the descriptions of the marks are presented in Table 3.

Obstructions

During floods, debris collects on bridges, which could decrease the flow-carrying capacity of these structures and cause greater water depths (backwater effect) in upstream areas. Since the occurrence and amount of debris are indeterminate factors, only the physical characteristics of the structures were considered in preparing the water surface profiles. No reduction in the carrying capacity from clogging or jamming was considered. Similarly, the flooded area maps show the backwater effect of the existing bridge openings, but do not reflect increased water surface elevations that could be caused by debris which collect against these structures. In the winter, ice jams in the river could occur in the same manner. There is an island in the river downstream from Defiance which has, in the past, caused ice jams in the river and thereby increased flood stages.

UNIFIED FLOOD PLAIN MANAGEMENT

Historically, the alleviation of flood damage has been accomplished almost exclusively by the construction of protective works such as reservoirs, channel improvements, and floodwalls and levees. However, in spite of the billions of dollars that have already been spent for construction of well-designed and efficient flood control works, annual flood damages continue to increase because the number of persons and structures occupying floodprone lands is increasing faster than protective works can be provided.

Recognition of this trend has forced a reassessment of the flood control concept and resulted in the broadened concept of unified flood plain management

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE
A	301,420	890	16,891	6.4	667.3	667.3	668.2	.9
B	307,130	985	21,832	5.0	670.0	670.0	670.8	.8
C	313,150	695	14,187	7.6	671.7	671.7	672.6	.9
D	315,180	909	18,478	5.9	672.5	672.5	673.4	.9
E	319,220	801	18,993	5.7	675.1	675.1	675.7	.6
F	320,633	687	18,175	5.9	675.3	675.3	675.9	.6
G	323,940	670	17,730	6.1	675.7	675.7	676.3	.6
H	328,322	630	16,133	6.7	676.3	676.3	677.0	.7
I	332,528	859	19,188	5.6	677.3	677.3	678.0	.7
J	336,380	808	20,799	5.2	678.2	678.2	678.9	.7
K	340,381	507	11,359	4.4	679.1	679.1	679.9	.8
L	341,173	705	11,981	4.1	679.4	679.4	680.2	.8
M	342,466	460	11,459	4.3	679.8	679.8	680.6	.8
N	346,386	638	12,960	3.8	680.6	680.6	681.4	.8
O	347,970	1,232	18,485	2.7	680.9	680.9	681.7	.8
P	355,575	521	10,401	3.2	682.1	682.1	683.0	.9
Q	360,610	840	13,728	2.4	683.0	683.0	683.8	.8
R	363,230	434	8,390	3.9	683.4	683.4	684.2	.8
S	368,150	447	8,160	4.1	684.5	684.5	685.5	1.0
T	376,250	1,255	14,647	2.3	687.0	687.0	688.0	1.0
U	381,850	360	8,587	3.9	688.0	688.0	688.9	.9
V	389,700	1,407	18,888	1.8	689.5	689.5	690.4	.9
W	400,000	1,943	25,375	1.3	690.7	690.7	691.6	.9
X	406,000	1,772	26,223	1.3	691.4	691.4	692.3	.9
Y	409,900	2,058	25,087	1.3	691.6	691.6	692.5	.9
Z	416,600	807	11,124	2.9	692.2	692.2	693.1	.9

[1] Feet upstream from mouth.

TABLE 2

DEFIANCE AND PAULDING
COUNTIES, OHIO

FLOODWAY DATA

MAUMEE RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE
AA	421,300	1,179	14,801	2.2	693.1	693.1	694.0	.9
BB	425,219	1,829	21,669	1.5	694.2	694.2	695.1	.9
CC	430,000	1,396	19,792	1.6	694.5	694.5	695.4	.9
DD	433,480	1,252	11,833	2.6	695.1	695.1	696.0	.9
EE	439,220	590	8,796	3.5	696.6	696.6	697.5	.9
FF	444,810	913	12,460	2.5	697.9	697.9	698.8	.9
GG	450,000	1,091	14,594	2.1	699.0	699.0	699.9	.9
HH	456,500	408	7,431	4.1	700.3	700.3	701.0	.9
II	458,900	1,025	11,980	2.6	701.1	701.1	702.2	.9
JJ	465,400	1,026	11,257	2.7	702.3	702.3	703.3	1.0
KK	470,000	2,640	25,912	1.2	703.0	703.0	704.0	1.0
LL	477,149	1,016	14,709	2.1	704.1	704.1	705.1	1.0
MM	484,000	730	10,433	2.9	704.8	704.8	705.8	1.0
NN	490,000	328	6,133	4.9	706.4	706.4	707.2	.8
OO	495,000	516	8,699	3.5	708.2	708.2	709.1	.9
PP	500,800	854	10,193	3.0	709.9	709.9	710.8	.9
QQ	505,000	1,068	11,009	2.7	710.9	710.9	711.9	1.0
RR	509,650	1,011	10,160	2.9	712.2	712.2	713.2	1.0
SS	515,000	1,912	20,090	1.5	713.1	713.1	714.1	1.0
TT	522,300	717	9,667	3.0	714.6	714.6	715.6	1.0
UU	527,200	674	9,562	3.1	715.7	715.7	716.6	.9
VV	533,150	2,385	21,580	1.4	716.9	716.9	717.8	.9
WW	541,560	1,309	11,776	2.5	718.5	718.5	719.4	.9
XX	555,850	1,179	12,645	2.3	721.1	721.1	722.0	.9
YY	566,350	1,354	13,965	2.1	723.3	723.3	724.3	1.0
ZZ	572,000	733	9,303	3.1	724.3	724.3	725.3	1.0

1 Feet upstream from mouth.

TABLE 2

DEFIANCE AND PAULDING COUNTIES, OHIO

FLOODWAY DATA

MAUMEE RIVER

programs. Legislative and administrative policies frequently cite two approaches: structural and nonstructural, for adjusting to the flood hazard. In this context, "structural" is usually intended to mean adjustments that modify the behavior of floodwaters through the use of measures such as dams and channel work. "Nonstructural" is usually intended to include all other adjustments in the way society acts when occupying or modifying a flood plain (e.g., regulations, floodproofing, insurance, etc.). Both structural and nonstructural tools are used for achieving desired future flood plain conditions. There are three basic strategies which may be applied individually or in combination: (1) modifying the susceptibility to flood damage and disruption, (2) modifying the floods themselves, and (3) modifying (reducing) the adverse impacts of floods on the individual and the community.

Modify Susceptibility to Flood Damage and Disruption

The strategy to modify susceptibility to flood damage and disruption consists of actions to avoid dangerous, economically undesirable, or unwise use of the flood plain. Responsibility for implementing such actions rests largely with the non-Federal sector and primarily at the local level of Government.

These actions include restrictions in the mode and the time of occupancy; in the ways and means of access; in the pattern, density, and elevation of structures and in the character of their materials (structural strength, absorptiveness, solubility, corrodibility); in the shape and type of buildings and in their contents; and in the appurtenant facilities and landscaping of the grounds. The strategy may also necessitate changes in the interdependencies between flood plains and surrounding areas not subject to flooding, especially interdependencies regarding utilities and commerce. Implementing mechanisms for these actions include land use regulations, development and redevelopment policies, floodproofing, disaster preparedness and response plans, and flood forecasting and warning systems. Different tools may be more suitable for developed or underdeveloped flood plains or to urban or rural areas. The information contained in this report is particularly useful for the preparation of flood plain regulations.

a. Flood Plain Regulations.

Flood plain regulations apply to the full range of ordinances and other means designed to control land use and construction within floodprone areas. The term encompasses zoning ordinances, subdivision regulations, building and housing codes, encroachment line statutes, open area regulations, and other similar methods of management which affect the use and development of floodprone areas.

Flood plain land use management does not prohibit use of floodprone areas; to the contrary, flood plain land use management seeks the best use of flood plain lands. The flooded area maps and the water surface profiles contained in this report can be used to guide development in the flood plain. The elevations shown on the profiles should be used to determine flood heights because they are more accurate than the outlines of flooded areas. It is recommended that development in areas susceptible to frequent flooding adhere to the principles expressed in Executive Order 11988 - Floodplain Management whose objective is to "... avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains ... wherever there is a practicable alternative." Accordingly, development in areas susceptible to frequent flooding should consist of construction which has a low damage potential such as parking areas and golf courses. High value construction such as buildings should be located outside the flood plain to the fullest extent possible. In instances where no practicable alternative exists, the land should be elevated to minimize damages. If it is uneconomical to elevate the land in these areas, means of floodproofing the structures should be given careful consideration.

b. Development Zones.

A flood plain consists of two useful zones. The first zone is the designated "floodway" or that cross sectional area required for carrying or discharging the anticipated flood waters with a maximum 1-foot increase in flood level (Ohio Department of Natural Resources standard). Velocities are the greatest and most damaging in the floodway. Regulations essentially maintain the flow-conveying capability of the floodway to minimize inundation of additional adjacent areas. Uses which are acceptable for floodways include parks, parking areas, open spaces, etc.

The second zone of the flood plain is termed the "floodway fringe" or restrictive zone, in which inundation might occur but where depths and velocities are generally low. Although not recommended if practicable alternatives exist, such areas can be developed provided structures are placed high enough or floodproofed to be reasonably free from flood damage during the Base (100-year) Flood. Typical relationships between the floodway and floodway fringe are shown in Figure 2. The floodway has been plotted on the Flooded Area Maps, Plates 6 through 13.

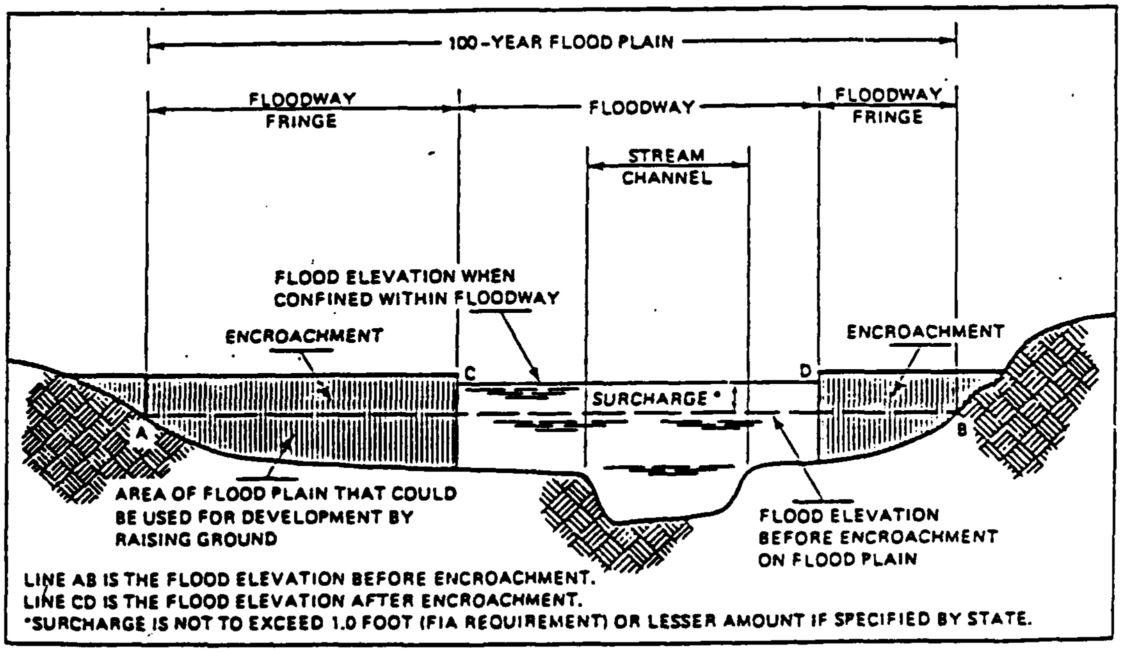


FIGURE 2 - Floodway Schematic

c. Formulation of Flood Plain Regulations

Formulation of flood plain regulations in a simplified sense involves selecting the type and degree of control to be exercised for each specific flood plain. In principle, the form of the regulations is not as important as a maintained adequacy of control. The degree of control normally varies with the flood hazard as measured by depth of inundation, velocity of flow, frequency of flooding, and the need for available land. Considerable planning and research is required for the proper formulation of flood plain regulations. Where formulation of flood plain regulations is envisioned to require a lengthy period of time during which development is likely to occur, temporary regulations should be adopted to be amended later as necessary.

Modify Flooding

The traditional strategy of modifying floods through the construction of dams, dikes, levees and floodwalls, channel alterations, high flow diversions and spillways, and land treatment measures has repeatedly demonstrated its effectiveness for protecting property and saving lives, and it will continue to be a strategy of flood plain management. However, in the future, reliance solely upon a flood modification strategy is neither possible nor desirable. Although the large capital investment required by flood modifying tools has been provided largely by the Federal Government, sufficient funds from Federal sources have not been and are not likely to be available to meet all situations for which flood modifying measures would be both effective and economically feasible. Another consideration is that the cost of maintaining and operating flood control structures falls upon local governments.

Flood modifications acting alone leave a residual flood loss potential and can encourage an unwarranted sense of security leading to inappropriate use of lands in the areas that are directly protected or in adjacent areas. For this reason, measures to modify possible floods should usually be accompanied by measures to modify the susceptibility to flood damage, particularly by land use regulations.

Modify the Impact of Flooding on Individuals and the Community

A third strategy for mitigating flood losses consists of actions designed to assist individuals and communities in their preparatory, survival, and recovery responses to floods. Tools include information dissemination and education, arrangements for spreading the costs of the loss over time, purposeful transfer of some of the individual's loss to the community by reducing taxes in flood prone areas, and the purchase of Federally subsidized flood insurance.

The distinction between a reasonable and unreasonable transfer of costs from the individual to the community can also be regulated and is a key to effective flood plain management.

CONCLUSION

This report presents local flood hazard information for the Maumee River in Defiance and Paulding Counties. The U.S. Army Corps of Engineers, Buffalo District, will provide interpretation and limited technical assistance in the application of the data contained in this report, particularly as to its use in developing effective flood plain regulations. Requests should be coordinated through the Ohio Department of Natural Resources.

GLOSSARY

BACKWATER	The resulting high water surface in a given stream due to a downstream obstruction or high stages in an intersecting stream.
BASE FLOOD	A flood which has an average return interval in the order of once in 100 years, although the flood may occur in any year. It is based on statistical analysis of streamflow records available for the watershed and analysis of rainfall and runoff characteristics in the general region of the watershed. It is commonly referred to as the "100-year flood."
DISCHARGE	The quantity of flow in a stream at any given time, usually measured in cubic feet per second (cfs).
FLOOD	An overflow of lands not normally covered by water. Floods have two essential characteristics: The inundation of land is temporary and the lands are adjacent to and inundated by overflow from a river, stream, 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, and rise of groundwater coincident with increased streamflow.
FLOOD CREST	The maximum stage or elevation reached by floodwaters at a given location.
FLOOD FREQUENCY	A statistical expression of the percent chance of exceeding a discharge of a given magnitude in any given year. For example, a <u>100-year flood</u> has a magnitude expected to be exceeded on the average of once every hundred years. Such a <u>flood</u> has a 1 percent chance of being exceeded in any given year. Often used interchangeably with <u>RECURRENCE INTERVAL</u>.
FLOOD PLAIN	The areas adjoining a river, stream, watercourse, ocean, lake, or other body of standing water that have 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 upstream from a known point along the approximate centerline of a stream of water that flows 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 a watercourse and those portions of the adjoining flood plain required to provide for the passage of the selected flood (normally the 100-year flood) with an insignificant increase in the flood levels above that of natural conditions. As used in the National Flood Insurance Program, floodways must be large enough to pass the 100-year flood without causing an increase in elevation of more than a specified amount (1 foot in most areas).
RECURRENCE INTERVAL	A statistical expression of the average time between floods exceeding a given magnitude (see FLOOD FREQUENCY).

Table 3 - Elevation Reference Marks in Study Area

Reference Mark	Description and Location (1)	Elevation (NGVD)
RM1	PK in northwest face of 32-inch Locust tree on State Rte 424 at Defiance-Henry County Line, Richland Township, Ohio	667.12
RM2	USGS brass disk set in top concrete headwall on north side of Independence Dam, Richland Township, Ohio	676.87
RM3	PK in south face of second telephone pole, east of Adams Ridge Road, on north side of State Rte. 424, Richland Township, Ohio	692.66
RM4	Chiseled □ in northwest corner at base of paratet of Domersville Road (State Rte. 281) bridge, Richland Township, Ohio	694.11
RM5	A spike in power pole located in the northwest corner at the intersection of Upton Road and Riverview Drive, Defiance, Ohio.	720.35
RM6	Bronze U.S. Army Corps of Engineers disk, set in concrete headwall, 25.9 feet south of centerline of East River Drive, 25 feet west from intersection of Carpenter Road and East River Drive, Defiance, Ohio	672.31
RM7	A chiseled X in top of east flange bolt of fire hydrant located at intersection of East High Street and East River Drive, Defiance, Ohio	693.64
RM8	Bronze U.S. Geological Survey disk, set in sand-stone block in southwest corner of County Office Annex Building at corner of Wayne Avenue and Second Street, Defiance, Ohio	691.31
RM9	North bonnet bolt on hydrant at southeast corner of intersection of Harding Street and West High Street, Defiance, Ohio	710.92
RM10	A chiseled X in top of north flange bolt of fire hydrant located on south side of intersection of Holgate Avenue and Davidson Street, Defiance, Ohio	691.18
RM11	Bronze U.S. Geological Survey disk, set in top of concrete post in Municipal Waterworks Yard on Baltimore Street, 44 feet west and 6 feet north of the southwest corner of the waste treatment plant, Defiance, Ohio	706.46

Table 3 - Elevation Reference Marks in Study Area (Cont'd)

Reference Mark	Description and Location (1)	Elevation (NGVD)
RM12	Chiseled □ on northwest corner of northwest wingwall of U.S. Rte. 24 bridge over Maumee River, Noble Township, Ohio	698.70
RM13	Boat spike in south face of third P&T pole, north side of Switzer Road, east of Dowe Road, pole No. 034BL/124550, Noble Township, Ohio	704.99
RM14	PK in northeast face of power pole No. 1657, at southwest corner of intersection of U.S. Rte. 24 and Ashwood Road, Delaware Township, Ohio	709.73
RM15	Top of concrete R/W marker at northeast corner of intersection of State Rte. 18 and Mulligans Bluff Road, 26 feet north and 18 feet east of intersection, Delaware Township, Ohio	714.68
RM16	Southwest corner of southwest wingwall of Chessie System bridge over Maumee River, east of the Bend Road, Delaware Township, Ohio	704.73
RM17	Northwest corner of northeast wingwall of the Bend Road bridge over Maumee River, Delaware Township, Ohio	689.25
RM18	Chiseled box in south corner of upper northwest wingwall of abandoned railroad bridge over Maumee River, Delaware Township, Ohio	706.39
RM19	Ohio Department of Transportation brass disk, set in northeast wingwall of U.S. Rte. 127 bridge over Maumee River, Delaware Township, Ohio	702.43
RM20	Northwest corner of northwest wingwall of County Road 105 bridge over Maumee River, Crane Township, Ohio	700.87
RM21	PK in face of power pole No. 334-123 on north side of U.S. Rte. 24 at Paulding-Putnam Electric Company substation, 0.7 mile west of County Road 105, Crane Township, Ohio	718.41
RM22	USC&GS brass disk, 149.5 feet south of intersection of U.S. Rte. 24 and County Road 105, 19 feet east of centerline of County Road 105, Crane Township, Ohio	718.03

Table 3 - Elevation Reference Marks in Study Area (Cont'd)

Reference Mark	Description and Location (1)	Elevation (NGVD)
RM23	Chiseled □ in northwest corner of northwest sandstone bridge abutment of County Road 73 bridge over Maumee River, Crane Township, Ohio	712.71
RM24	PK in east face of power pole No. 2J721181 at the northwest corner of the intersection of U.S. Rte 24 and County Road 73 (Bethel Church Road), Crane Township, Ohio	724.67
RM25	Railroad spike in power pole No. 202452J30, 50 feet north of centerline of U.S. Rte. 24 and approximately 68 feet west of west end Paulding County bridge No. 40652 over Zuber Cutoff, Carryall Township, Ohio	725.27
RM26	PK in north face of power pole No. 2J4120231, 7 feet west of the extension of Township Road 51, approximately 40 feet north of U.S. Rte. 24, Carryall Township, Ohio	728.46
RM27	USC&GS brass disk stamped "A 124 1946," set in concrete headwall, 1 mile east of Antwerp, on southeast side of U.S. Rte. 24, Carryall Townshio, Ohio	730.07
RM28	Brass disk stamped "H 122 1946," set in northeast corner of concrete wingwall, approximately 45 feet east of north end of State Rte. 49 bridge over Maumee River, 25 feet east of centerline of State Rte. 49, 62 feet south of power pole No. 355-134, Carryall Township, Ohio	723.50
RM29	Standard disk, stamped "R 300 1963," set in concrete monument on U.S. Rte. 24, 0.7 mile west of Post Office in Antwerp, 56.2 feet north of centerline of U.S. Rte. 24, 3.7 feet north of telephone pole, Carryall Township, Ohio	733.84
RM30	Standard disk, stamped "Q 300 1963," set in concrete monument, on U.S. Rte. 24, 1.7 miles west of Post Office in Antwerp, 45.6 feet north of centerline of U.S. Rte. 24, 36.2 feet west of County Road 250, Carryall Township, Ohio	732.47
RM31	Standard disk, stamped "P 300 1963," set in concrete monument at northwest corner of itnersection of U.S. Rte. 24 and County Road 11 (Ewing Road), 41.5 feet north of centerline of U.S. Rte. 24, 47 feet west of County Road 11, Carryall Township, Ohio	740.28

Table 3 - Elevation Reference Marks in Study Area (Cont'd)

Reference Mark	Description and Location (1)	Elevation (NGVD)
RM32	Standard triangulation disk, stamped "McCurdy 1947," set in concrete monument, on U.S. Rte. 24 at Ohio-Indiana State line, 3.6 miles west-southwest of Post Office in Antwerp, 77 feet east of the centerline of State-line Road, Harrison Township, Ohio	740.69

(1) Approximate location of reference marks are shown on the flooded area maps (Plates 6-13).

REFERENCES

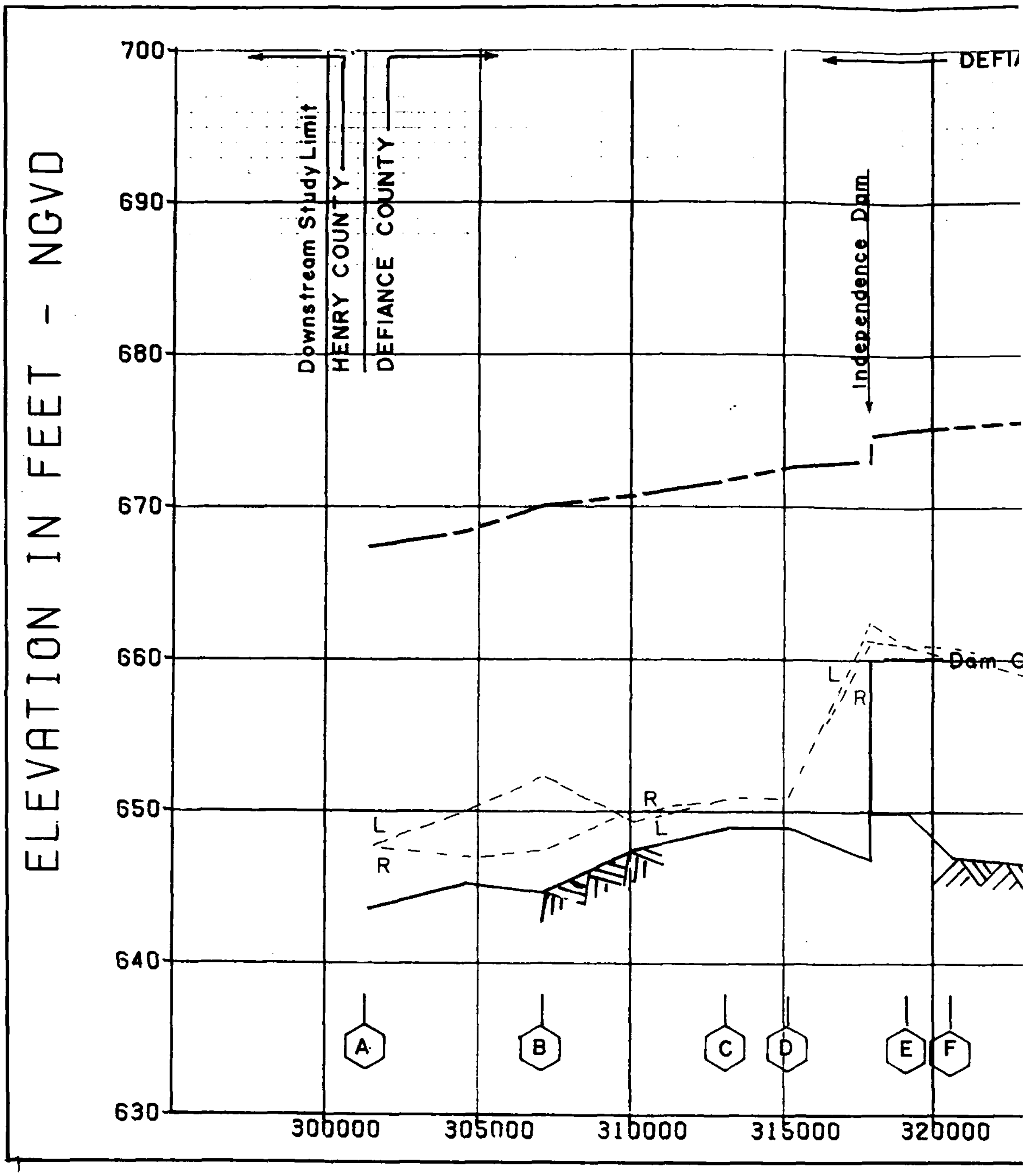
1. U.S. Army Corps of Engineers, Detroit District, Flood Plain Information Report, Maumee and Auglaize Rivers, Defiance, Ohio, 1970.

2. State of Ohio, Region V, Interagency Flood Hazard Mitigation Team, Flood Hazard Mitigation Report in Response to March 29, 1982, Disaster Declaration, April 26, 1982.

3. U.S. Water Resources Council, Hydrology Committee, Bulletin No. 17B, Guidelines for Determining Flood Flow Frequency, revised September 1981.

4. U.S. Army Corps of Engineers, Hydrologic Engineering Center, Computer Program 723-X6-L202A, HEC-2, Water Surface Profiles, Davis, California, August 1979, with updates.

5. U.S. Army Corps of Engineers, Buffalo District, Special Flood Hazard Evaluation Report, Maumee River, Henry County, Ohio, September 1987.



LEGEND

100-YEAR FLOOD

CHANNEL BOTTOM

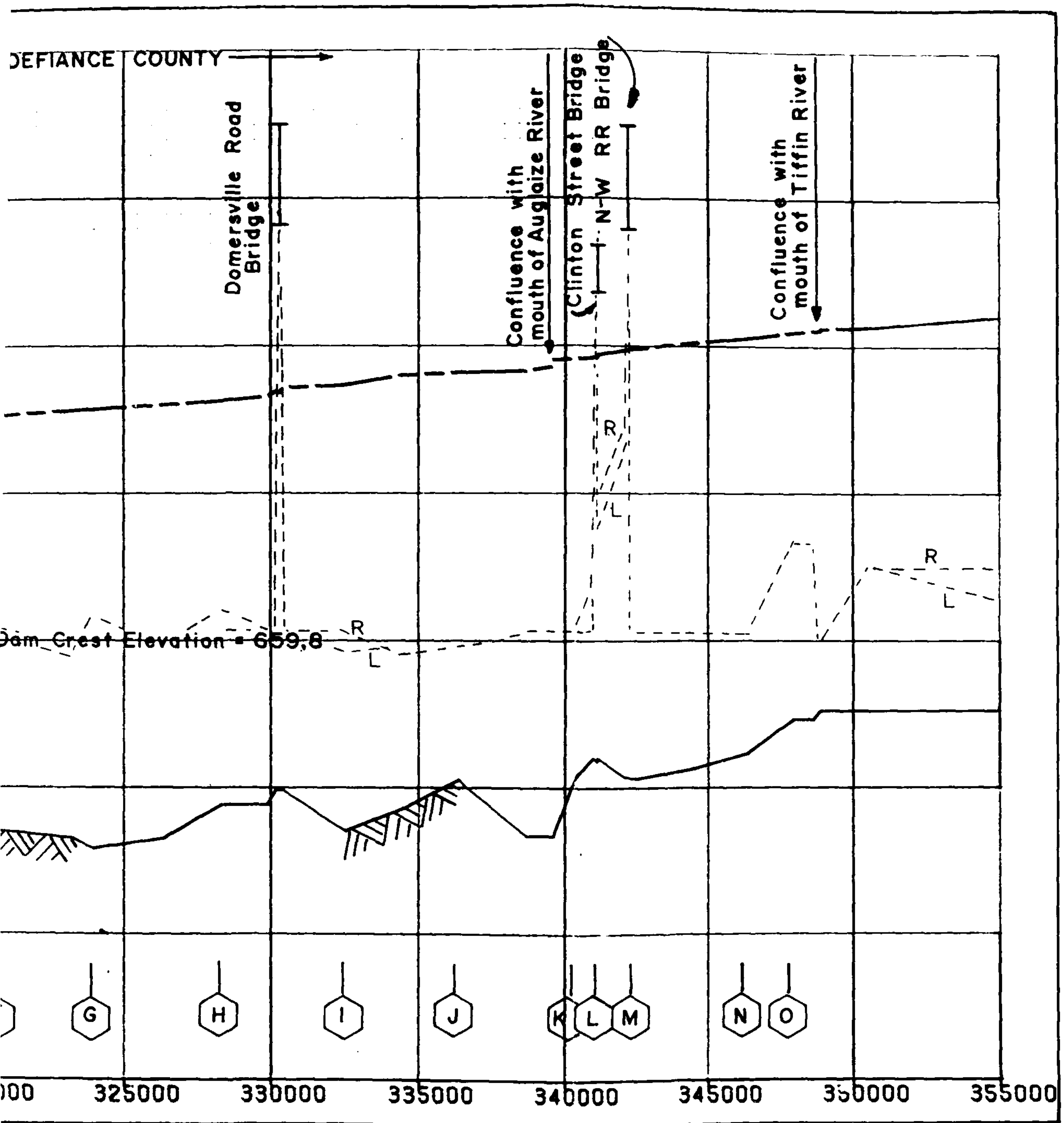
CROSS SECTION LOCATION

BRIDGE

NOTE: Distar
mouth

R RI

L LE



Distance is measured in feet from the mouth of Maumee River at Lake Erie.

RIGHT BANK

LEFT BANK

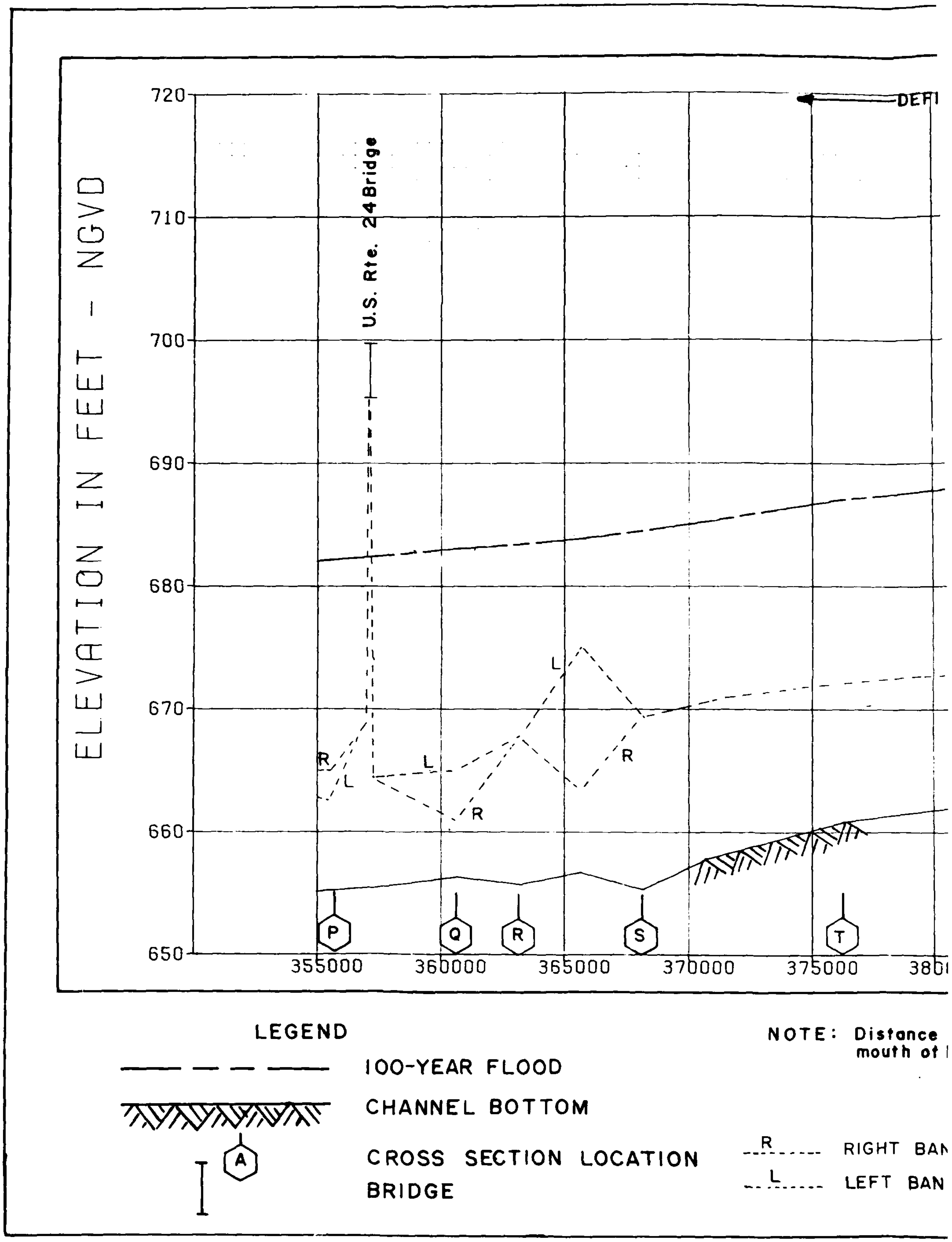
U. S. Army Engineer District, Buffalo
SPECIAL FLOOD HAZARD EVALUATION

FLOOD PROFILE

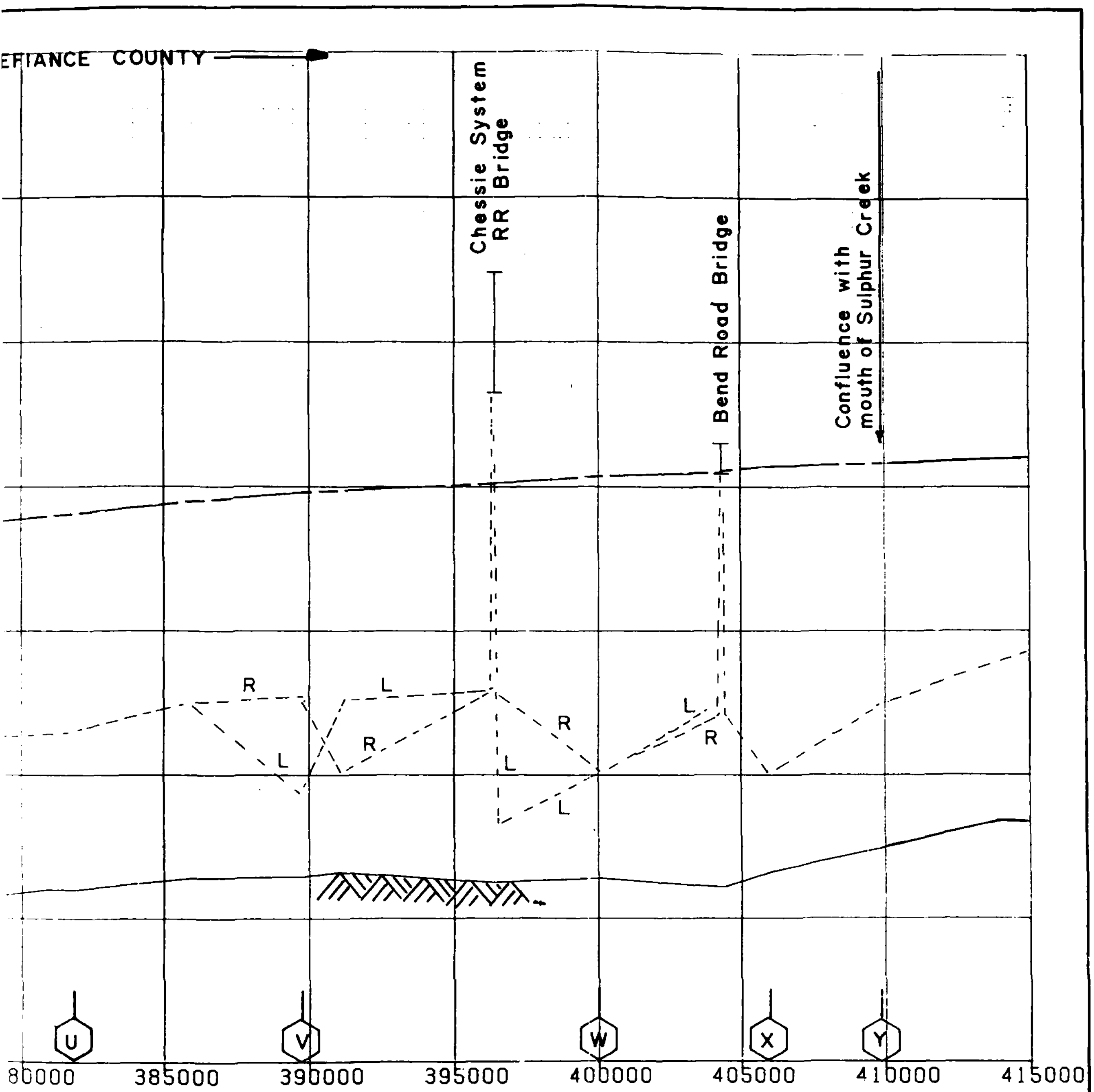
MAUMEE RIVER

DEFIANCE AND PAULDING COUNTIES, OHIO
STATION 3014+20 - 3550+00

PLATE I SEPT. 1988



ELEVATION IN FEET - NGVD
720
710
700
690
680
670
660
650
355000
360000
365000
370000
375000
U.S. Rte. 24 Bridge
DEFI
L
R
P
Q
R
S
T
LEGEND
100-YEAR FLOOD
CHANNEL BOTTOM
A
CROSS SECTION LOCATION
BRIDGE
NOTE: Distance
mouth of
R
RIGHT BAN
L
LEFT BAN



ce is measured in feet from the
of Maumee River at Lake Erie.

BANK

ANK

U. S. Army Engineer District, Buffalo
SPECIAL FLOOD HAZARD EVALUATION

FLOOD PROFILE

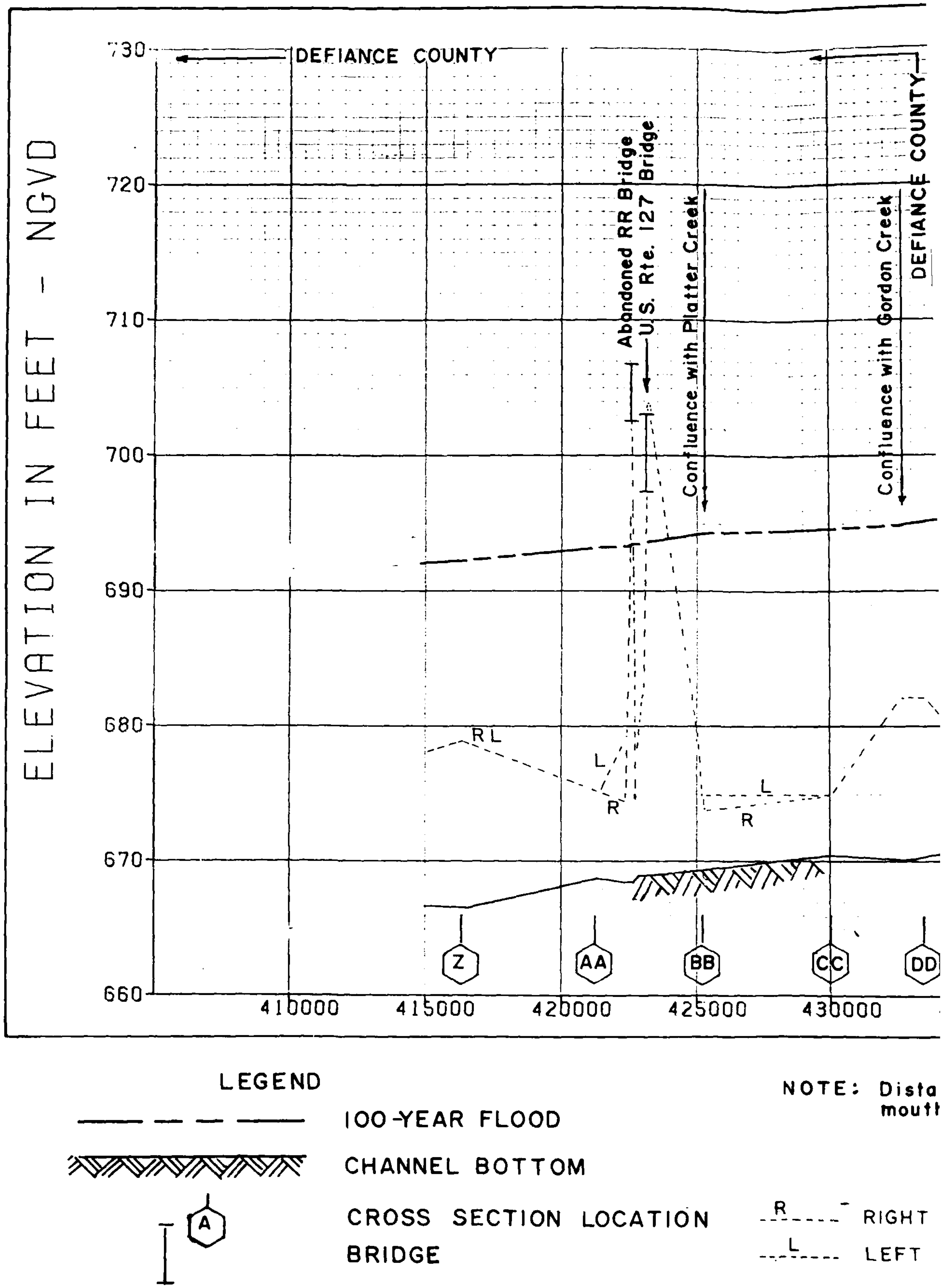
MAUMEE RIVER

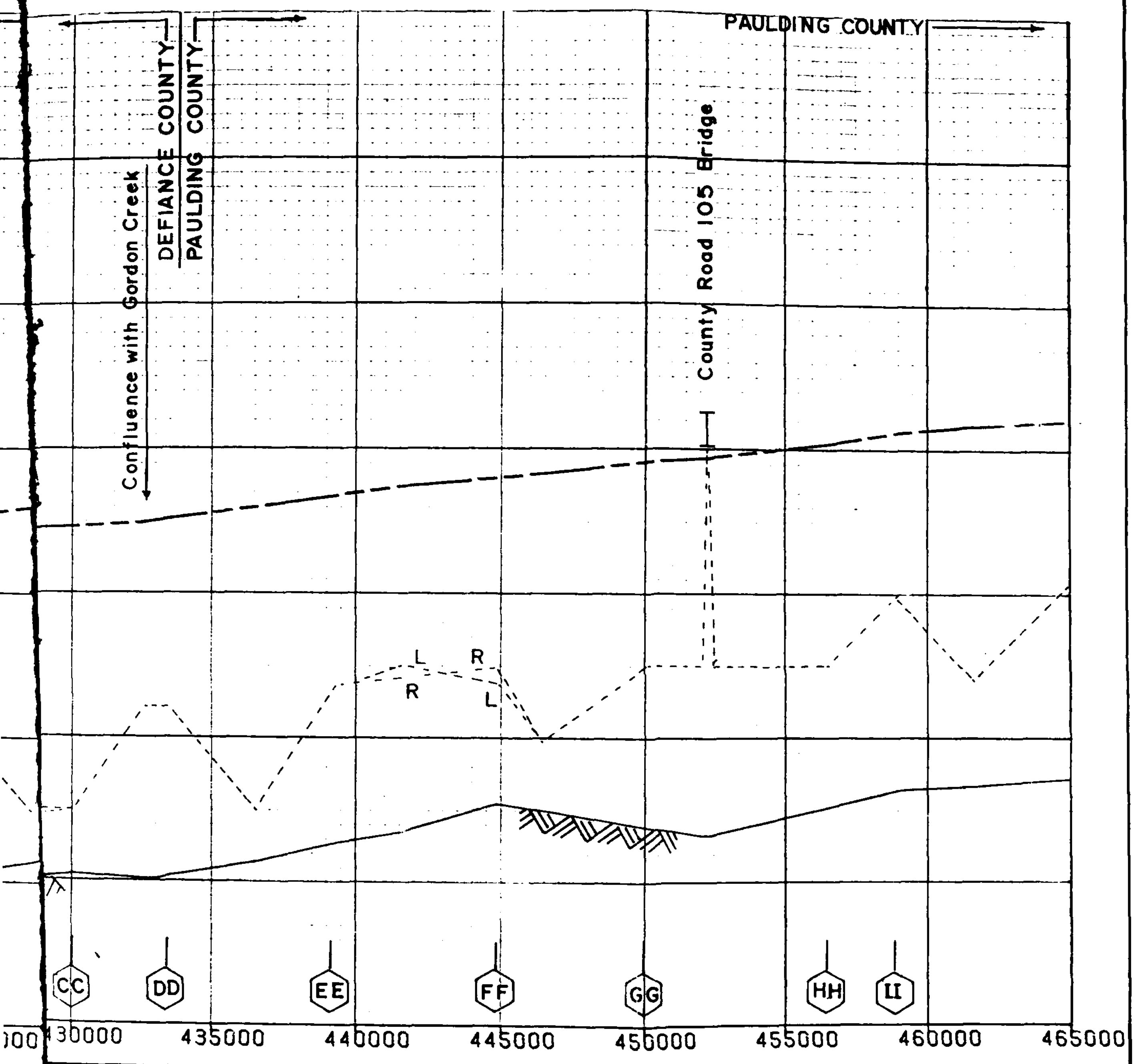
DEFIANCE AND PAULDING COUNTIES, OHIO

STATION 3550+00 – 4150+00

PLATE 2 SEPT. 1988

2


ELEVATION IN FEET - NGVD
730
720
710
700
690
680
670
660
410000
415000
420000
425000
430000
DEFIANCE COUNTY
DEFIANCE COUNTY
Abandoned RR Bridge
U.S. Rte. 127 Bridge
Confluence with Platter Creek
Confluence with Gordon Creek
R L
L
R
L
R
Z
AA
BB
CC
DD
LEGEND
100-YEAR FLOOD
CHANNEL BOTTOM
CROSS SECTION LOCATION
BRIDGE
A
NOTE: Dista
moutl
R
RIGHT
L
LEFT



NOTE: Distance is measured in feet from the mouth of Maumee River at Lake Erie.

-- RIGHT BANK

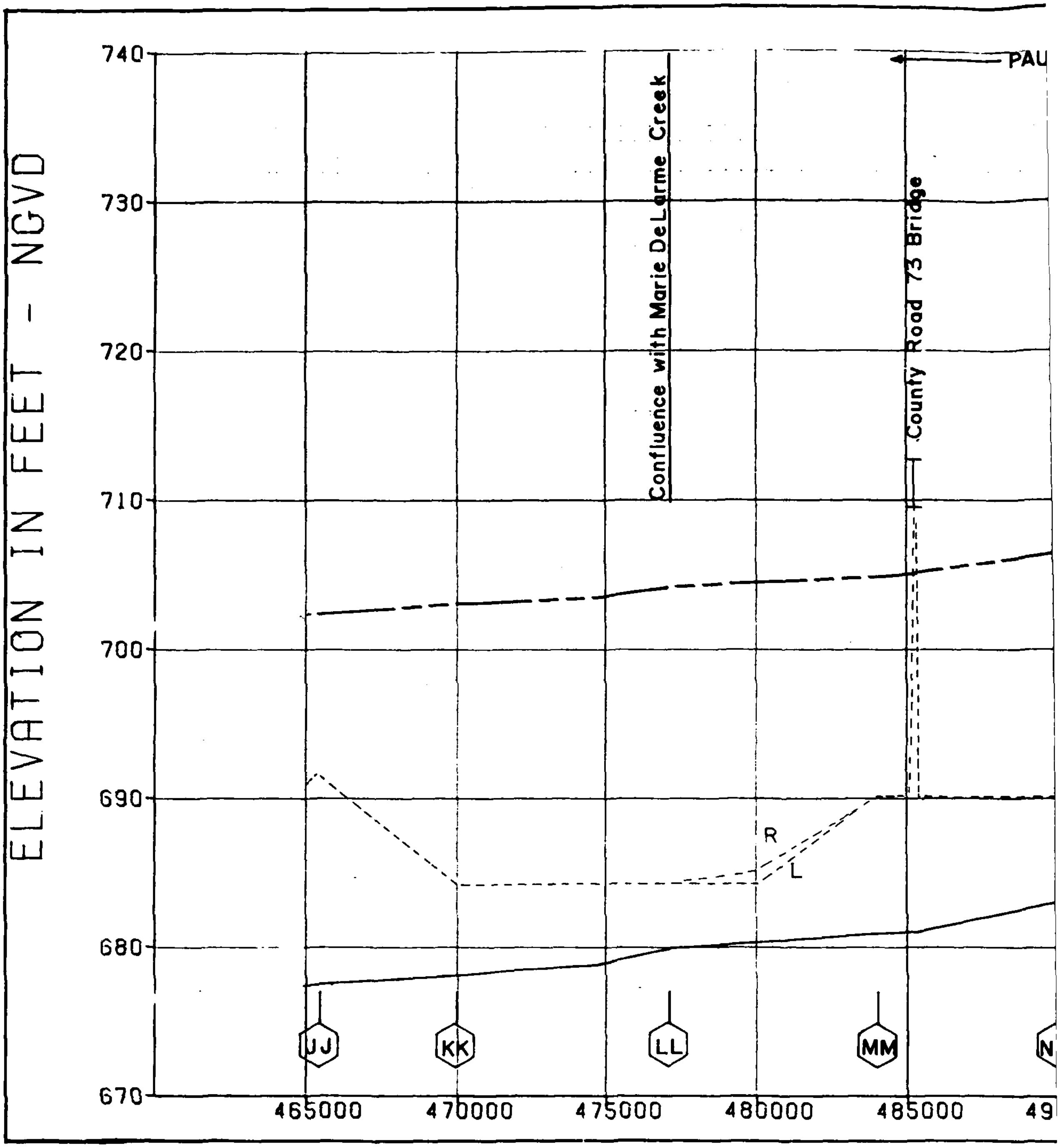
-- LEFT BANK

U. S. Army Engineer District, Buffalo
SPECIAL FLOOD HAZARD EVALUATION

FLOOD PROFILE
MAUMEE RIVER
DEFIANCE AND PAULDING COUNTIES, OHIO
STATION 4150+00 – 4650+00

PLATE 3 SEPT. 1988

2



LEGEND

100-YEAR FLOOD

CHANNEL BOTTOM

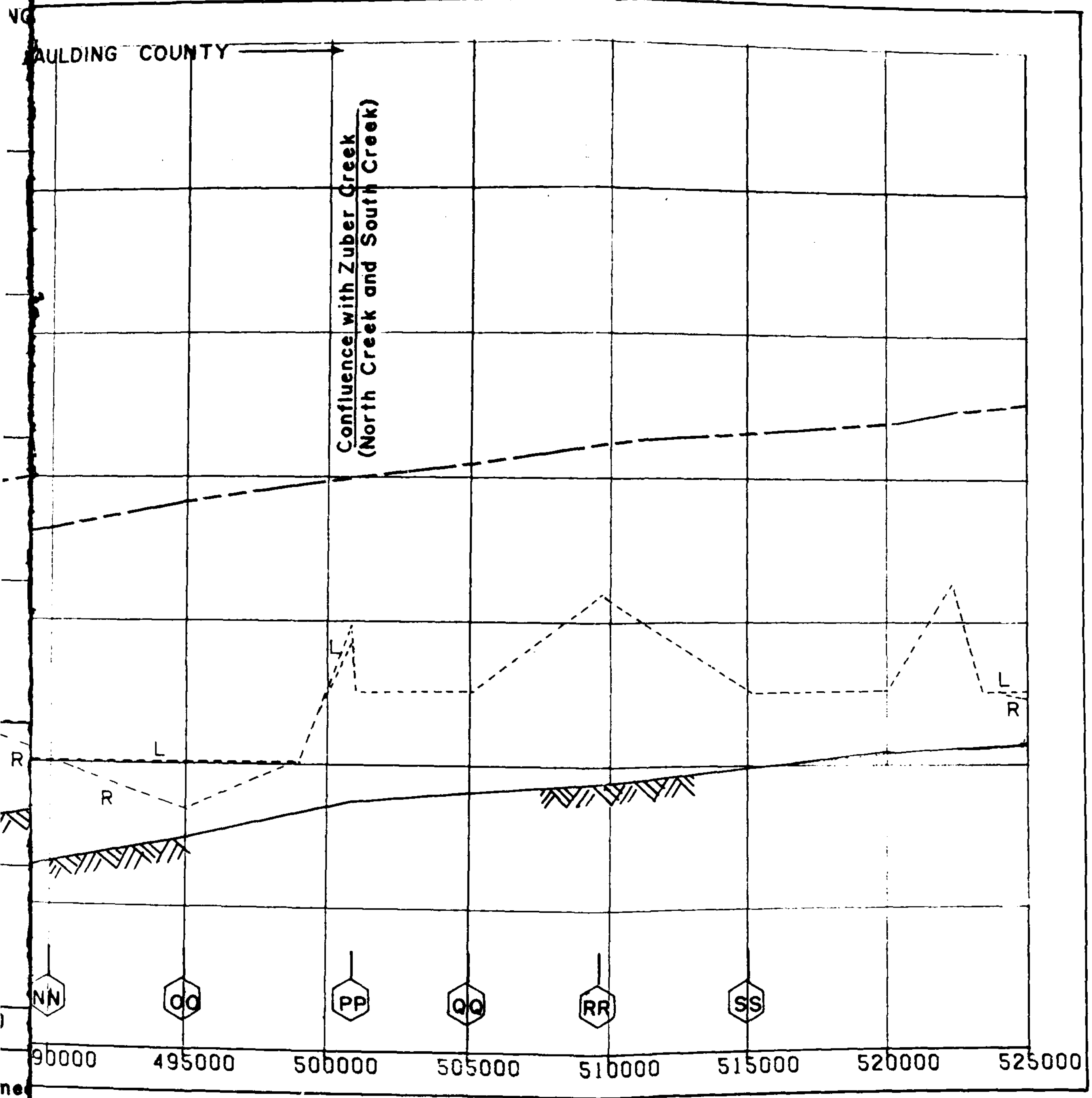
CROSS SECTION LOCATION

BRIDGE

NOTE: Distanc
mouth

R R

L L



ce is measured in feet from the
of Maumee River at Lake Erie.

RIGHT BANK

LEFT BANK

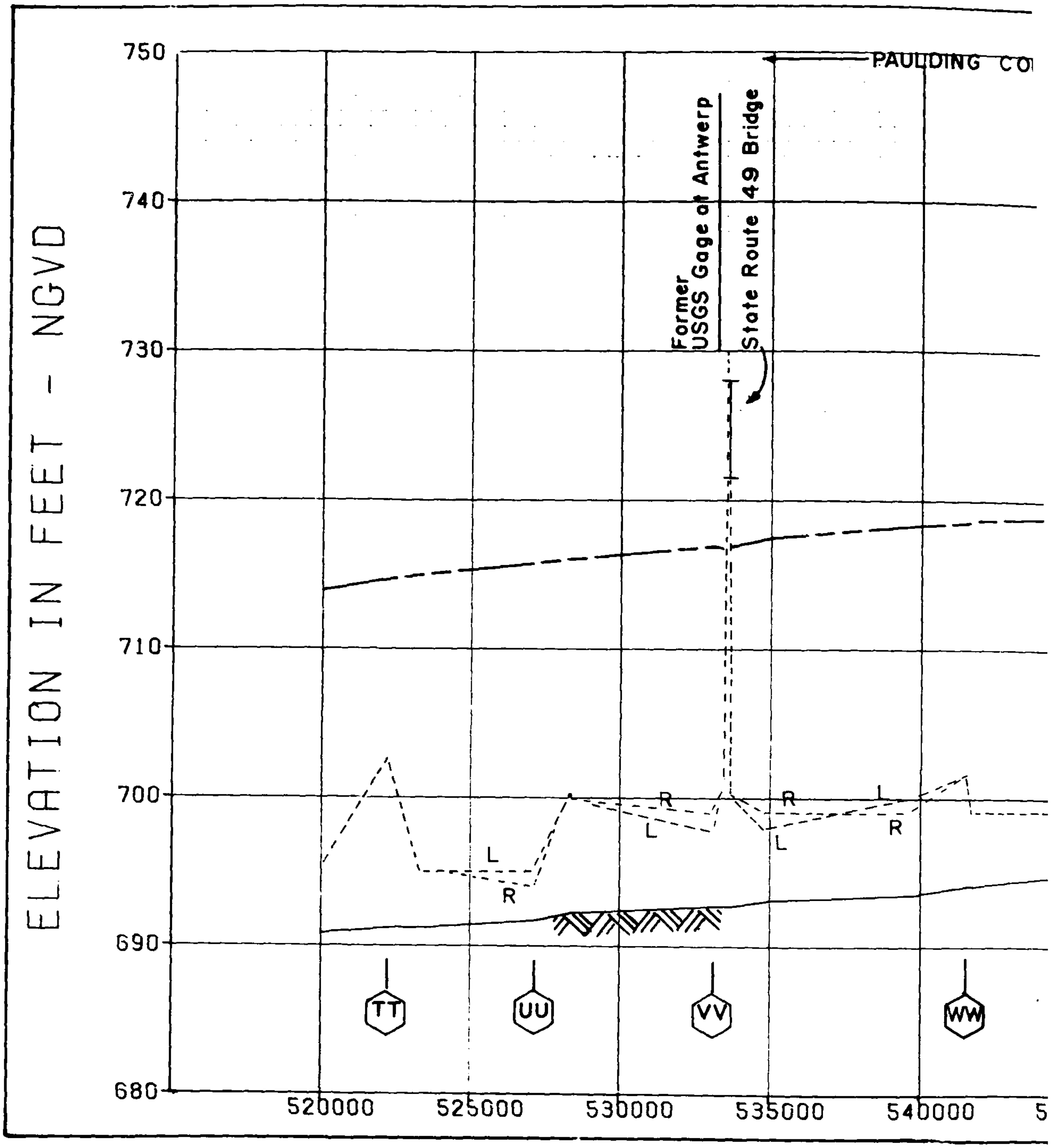
U. S. Army Engineer District, Buffalo
SPECIAL FLOOD HAZARD EVALUATION

FLOOD PROFILE

MAUMEE RIVER

DEFIANCE AND PAULDING COUNTIES, OHIO
STATION 4650+00 – 5250+00

PLATE 4 SEPT. 1988



LEGEND

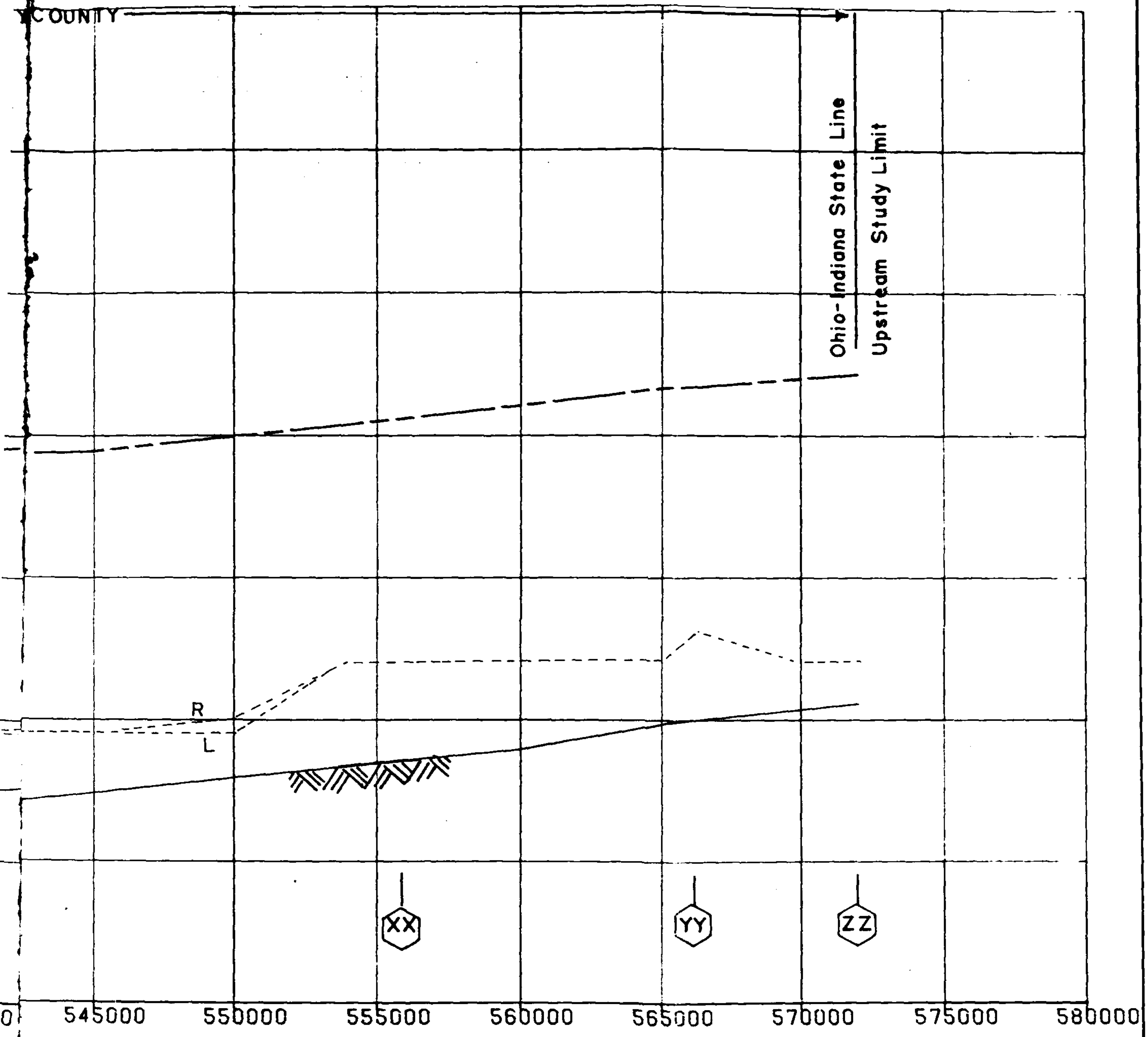
100-YEAR FLOOD

CHANNEL BOTTOM

CROSS SECTION LOCATION

BRIDGE

NOTE: D
m



E: Distance is measured in feet from the mouth of Maumee River at Lake Erie.

R .... RIGHT BANK
L .... LEFT BANK

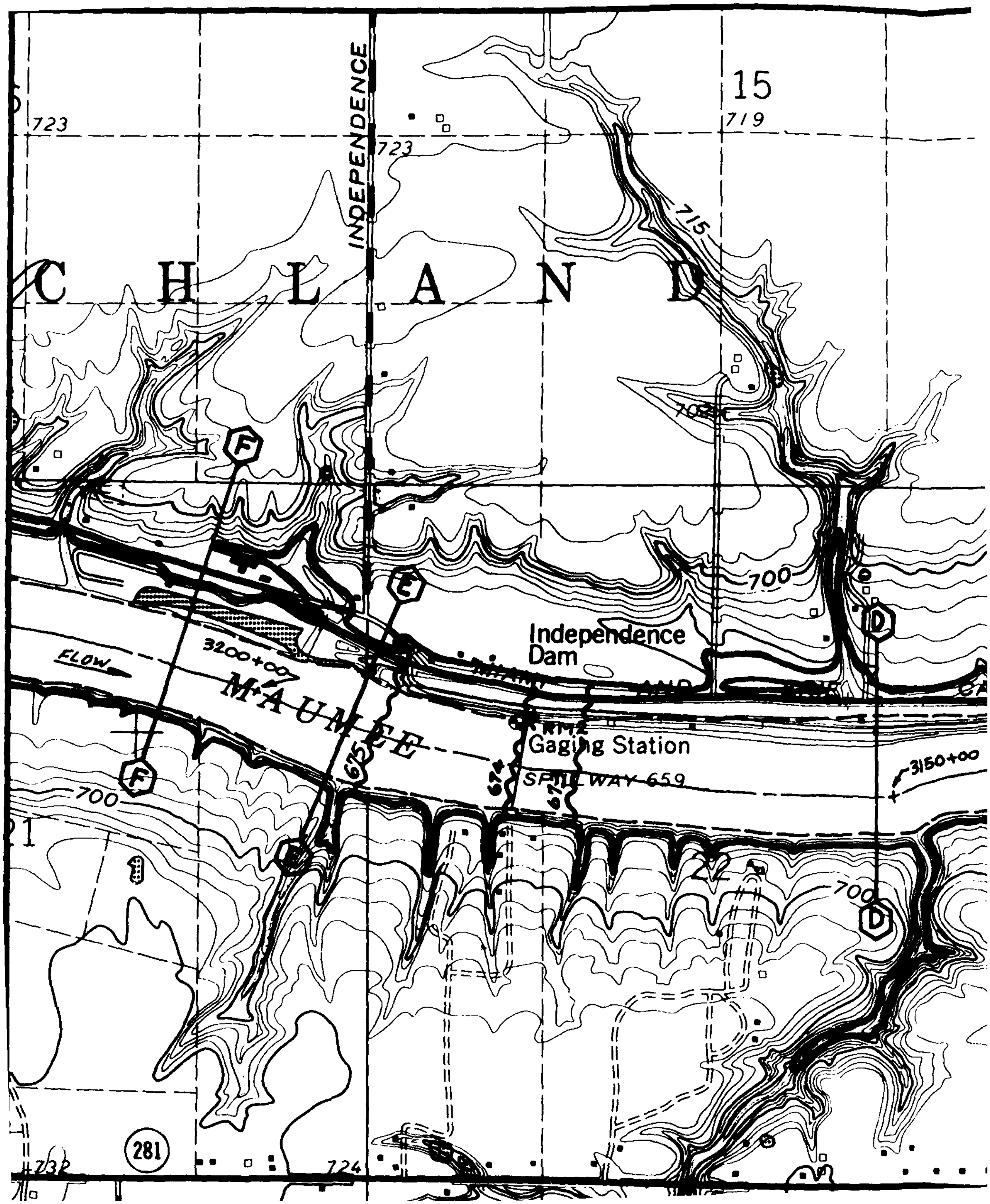
U. S. Army Engineer District, Buffalo
SPECIAL FLOOD HAZARD EVALUATION

FLOOD PROFILE

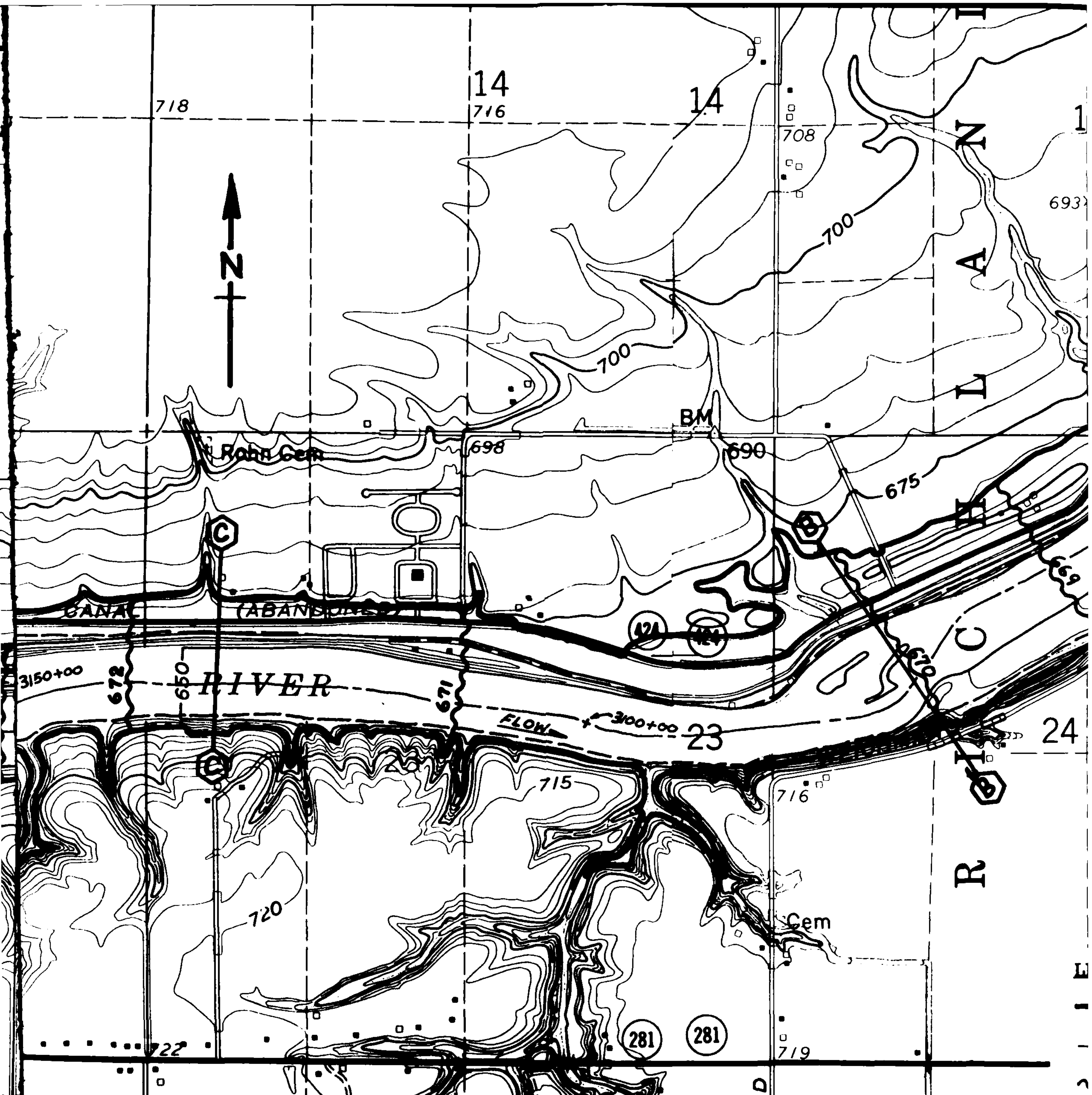
MAUMEE RIVER

DEFIANCE AND PAULDING COUNTIES, OHIO
STATION 5250+00 – 5720+00

PLATE 5 SEPT. 1988



15
723
719
723
INDEPENDENCE
715
C H L A N D
702
F
E
D
700
Independence
Dam
FLOW
3200+00
MAUMEE
Gaging Station
SPILLWAY 659
3150+00
675
674
700
22
281
724

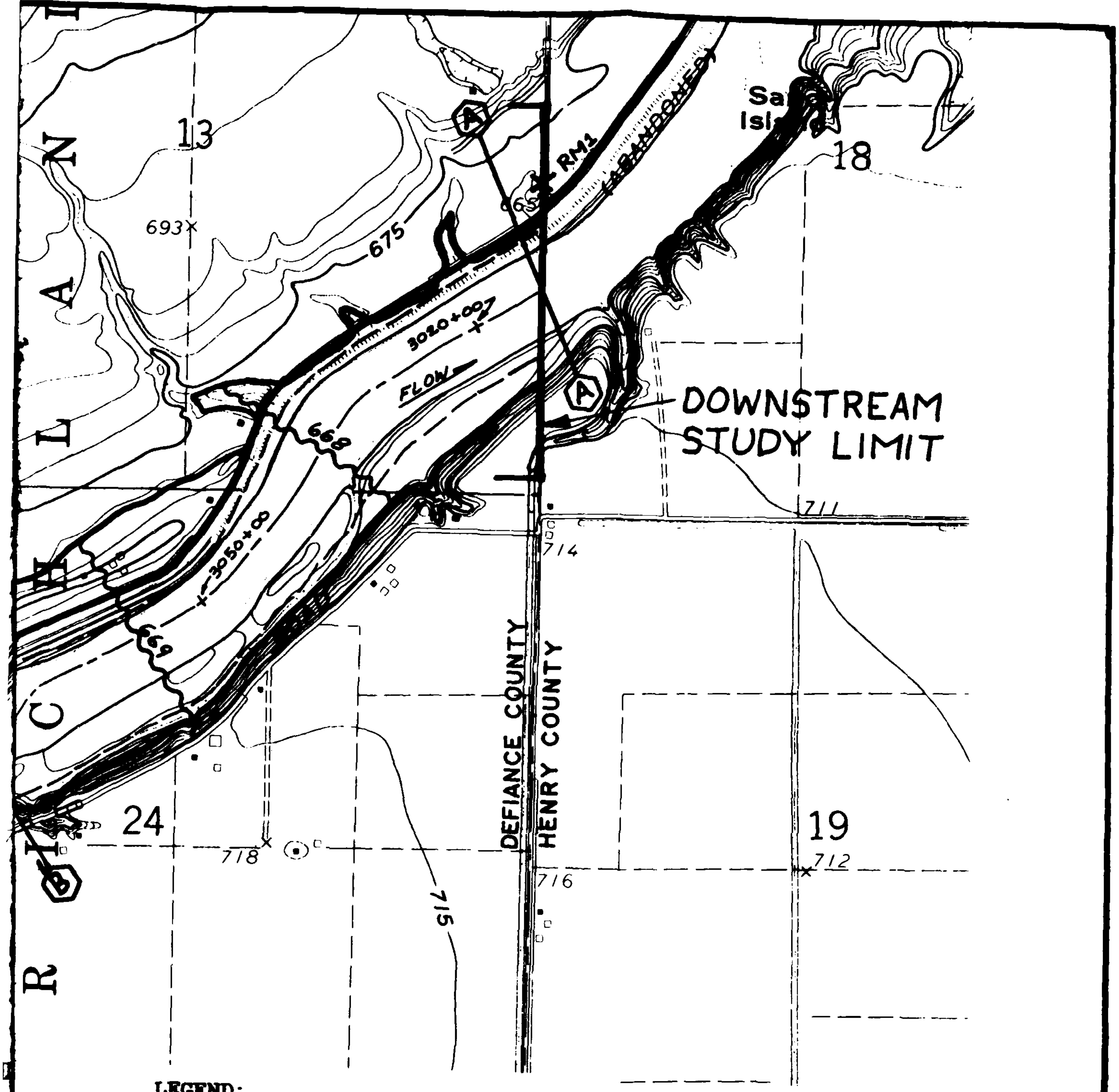


SCALE

1000' 0 1000' 2000'

NOTE:

DISTANCE IS MEASURED IN FEET FROM MOUTH OF MAUMEE RIVER AT LAKE ERIE.



FROM
E ERIE.

LEGEND:

100-YEAR FLOOD BOUNDARY

FLOODWAY BOUNDARY

670 BASE FLOOD ELEVATION

(A)—(A) CROSS SECTION LOCATION

× RM1 ELEVATION REFERENCE MARK

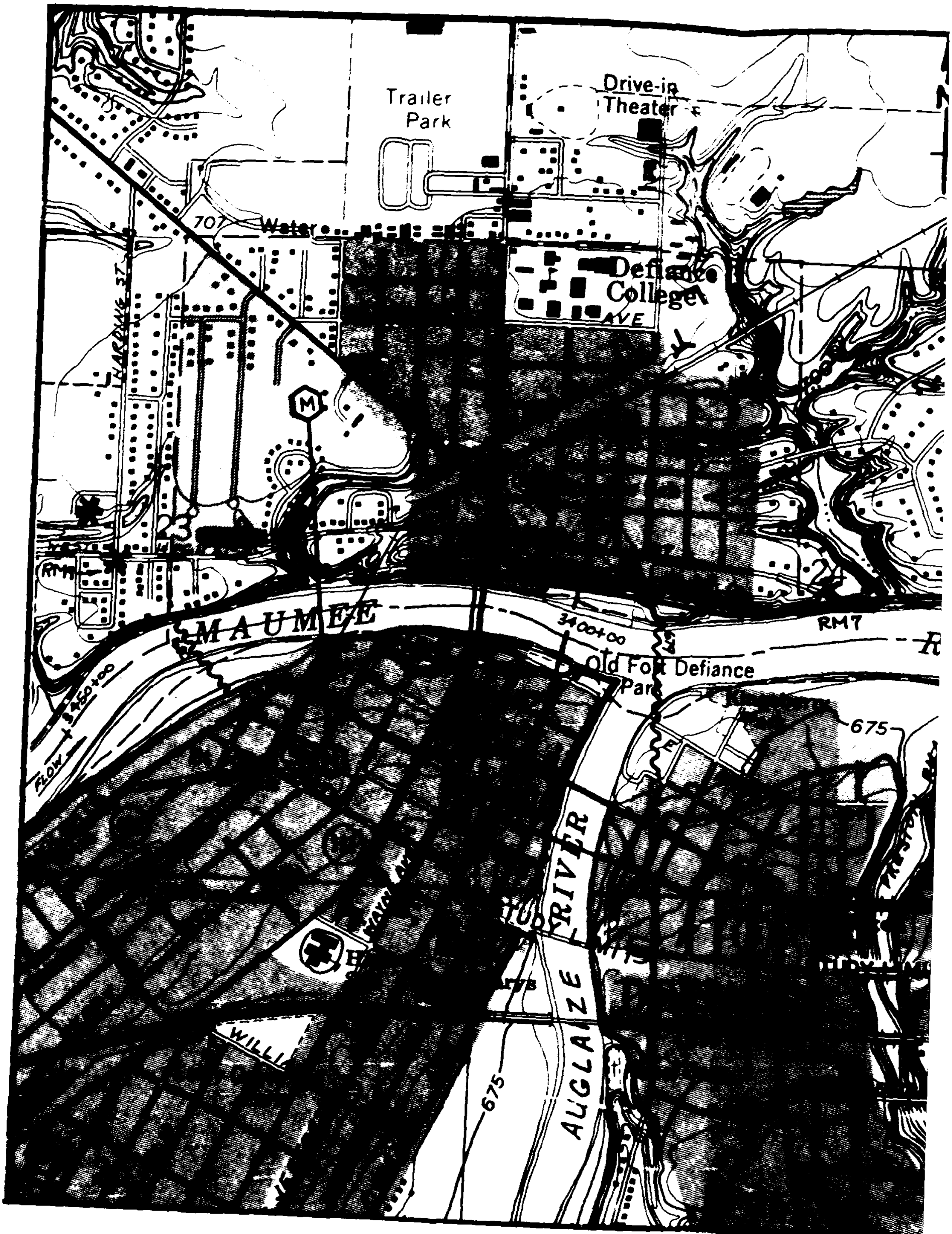
U. S. Army Engineer District, Buffalo
SPECIAL FLOOD HAZARD EVALUATION

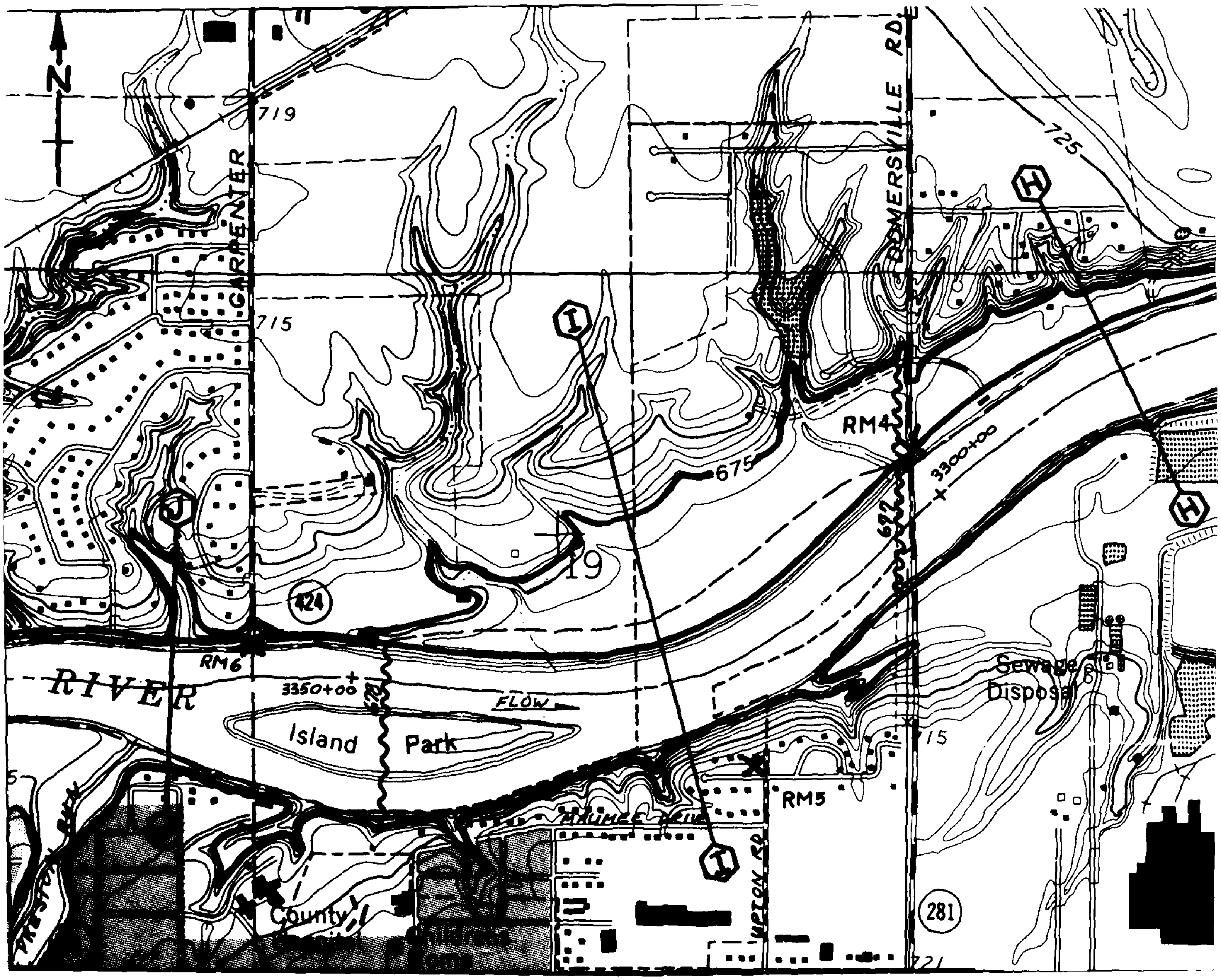
FLOODED AREAS

MAUMEE RIVER

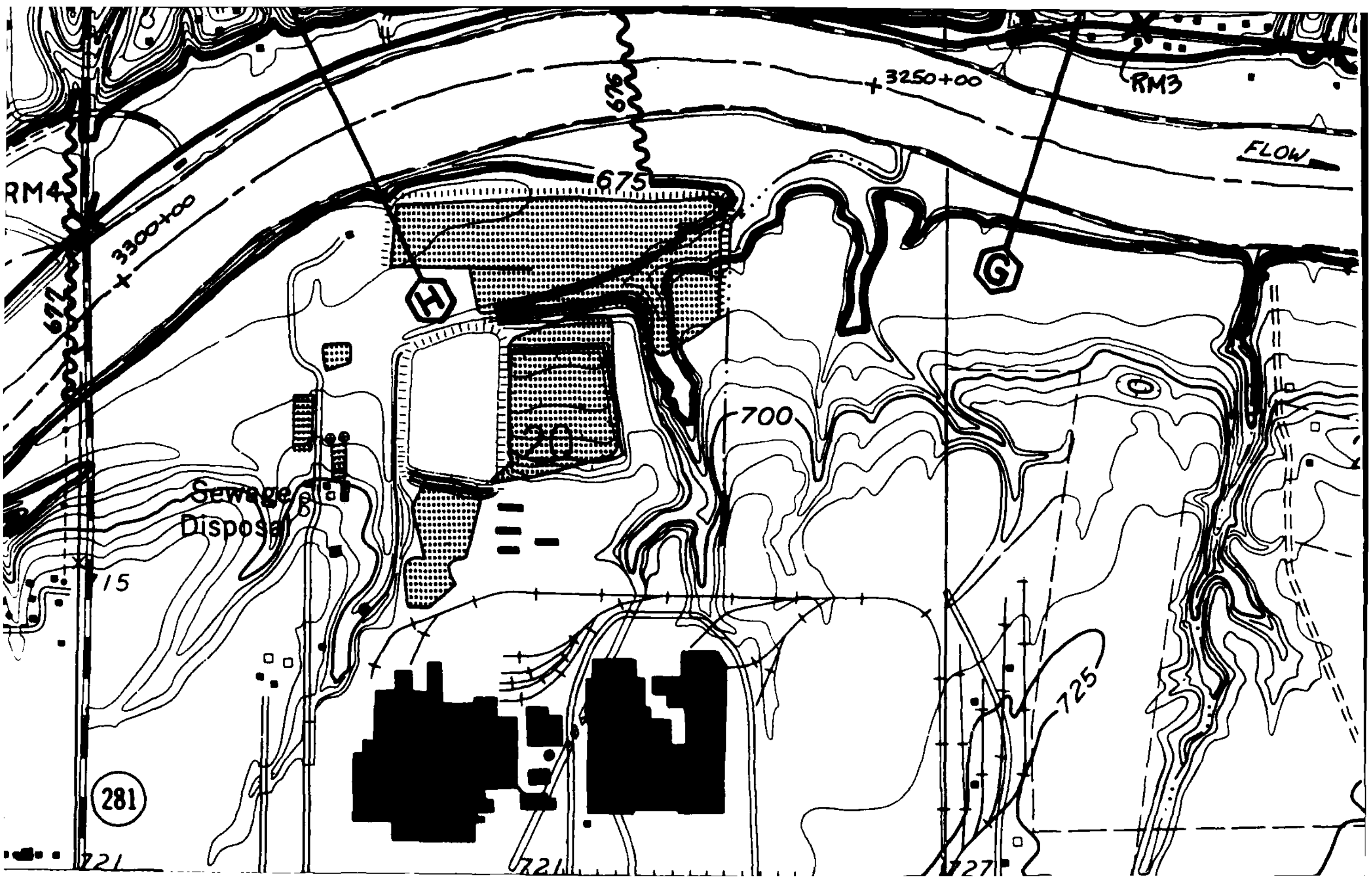
DEFIANCE AND PAULDING COUNTIES, OHIO
STATION 3014+20 – 3220+00

PLATE 6 SEPT. 1988

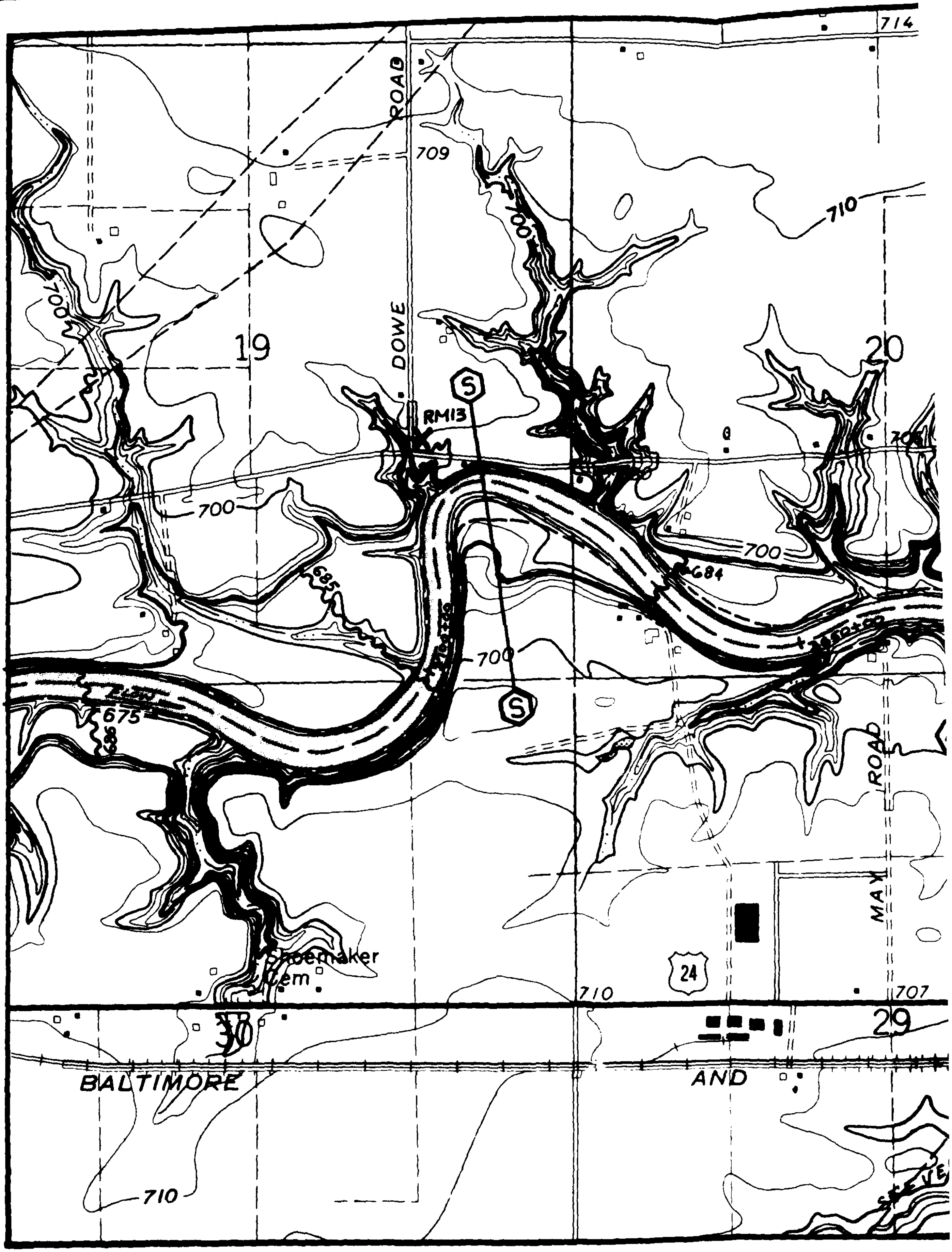

Trailer
Park
Drive-in
Theater
Water
Defiance
College
AVE
707
HARDING ST.
MAUMEE
RM7
3400+00
3450+00
FLOW
Old Fort Defiance
Park
675
RIVER
AUGLAIZE
675
WILLI



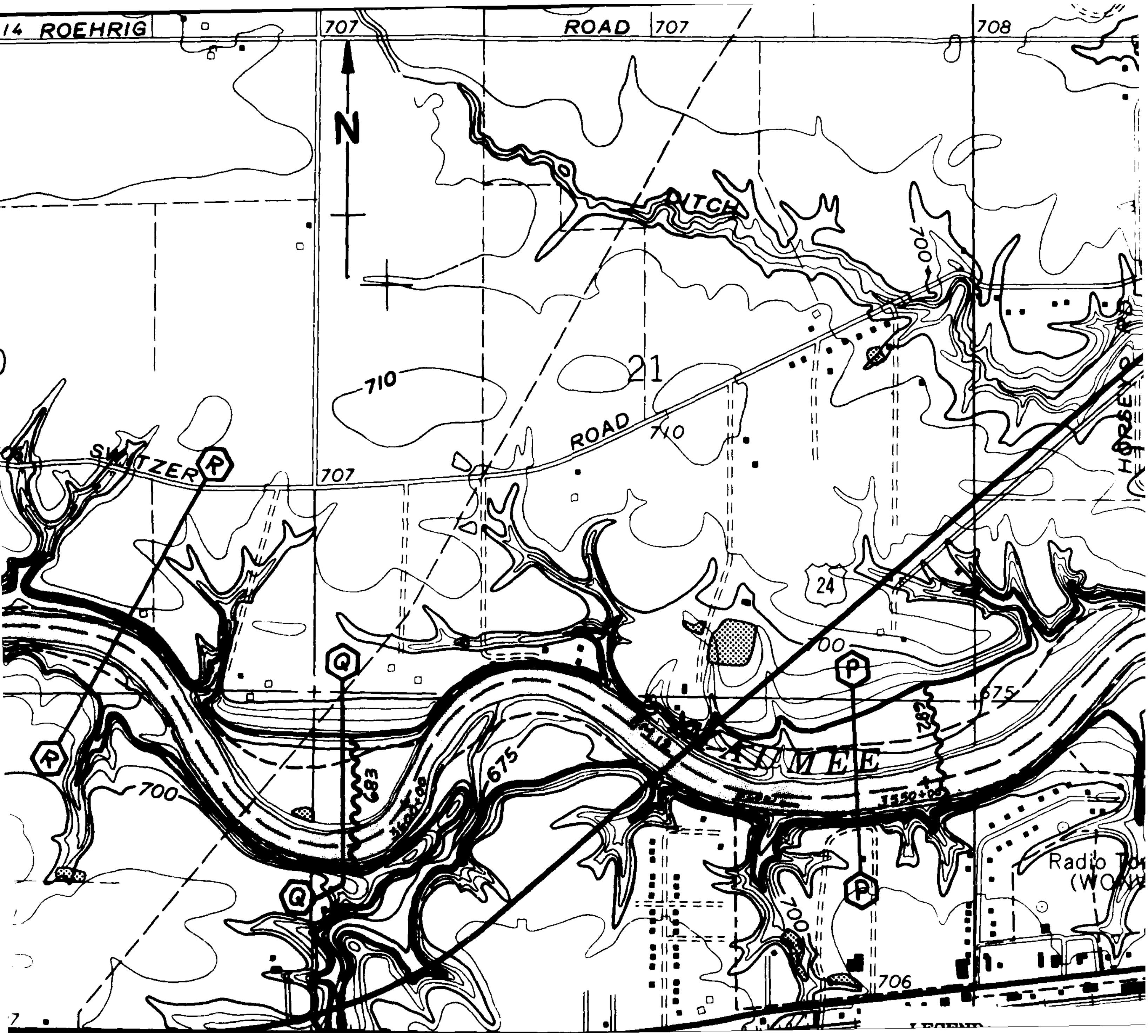
N
719
715
CARPENTER
DOWNERSVILLE RD.
725
H
I
J
RM4
RM5
RM6
675
3300+00
3350+00
692
19
424
RIVER
FLOW
Island Park
MAUMEE DRIVE
UPTON RD
715
Sewage Disposal
281
721
County



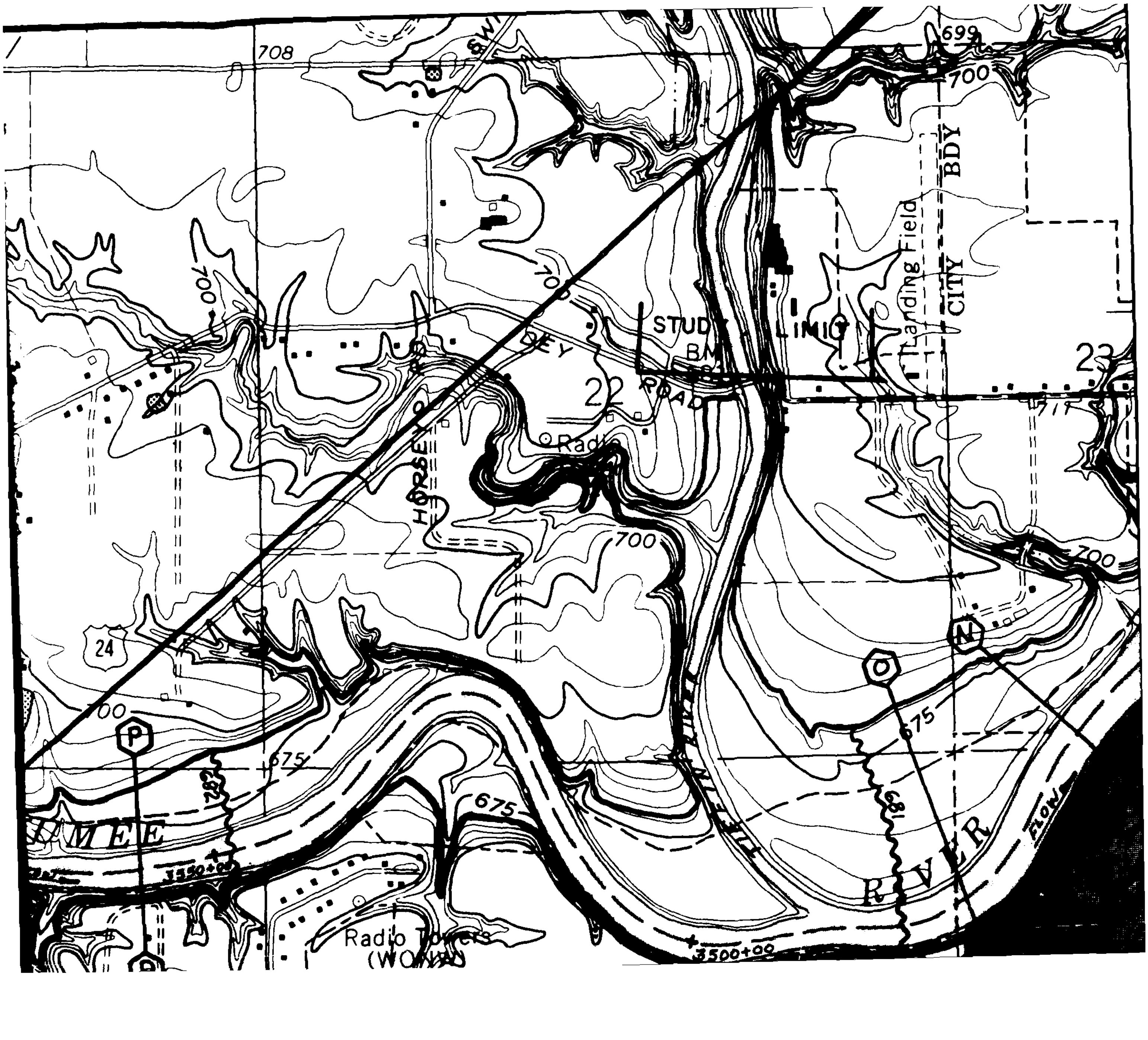
RM4
3300+00
692
676
3250+00
RM3
FLOW
675
H
G
700
20
Sewage Disposal
715
725
281
721
721
727



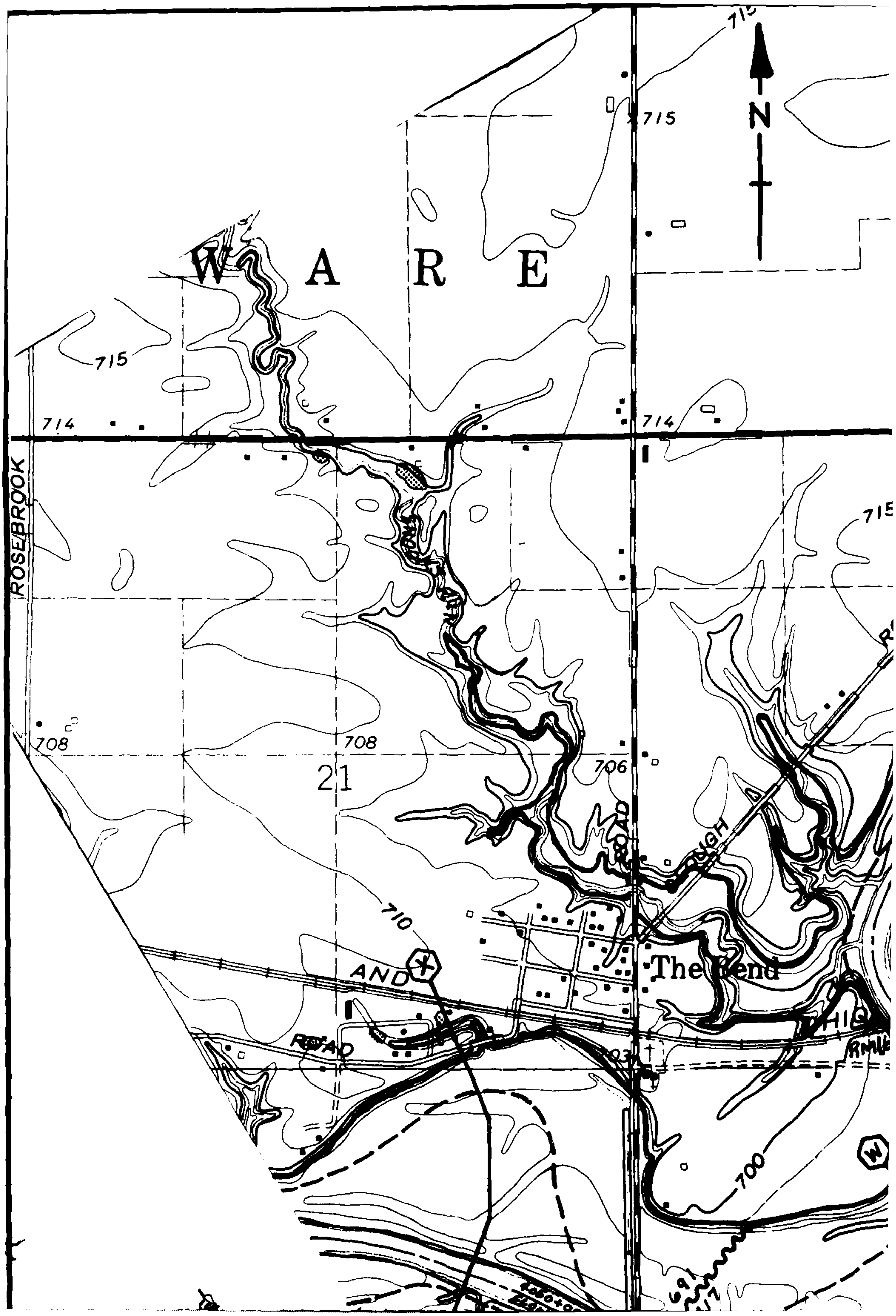
714
DOWE
ROAD
709
710
700
19
20
S
RM13
684
685
675
686
Shoemaker
Cem
24
710
707
29
30
BALTIMORE
AND
MAY
ROAD



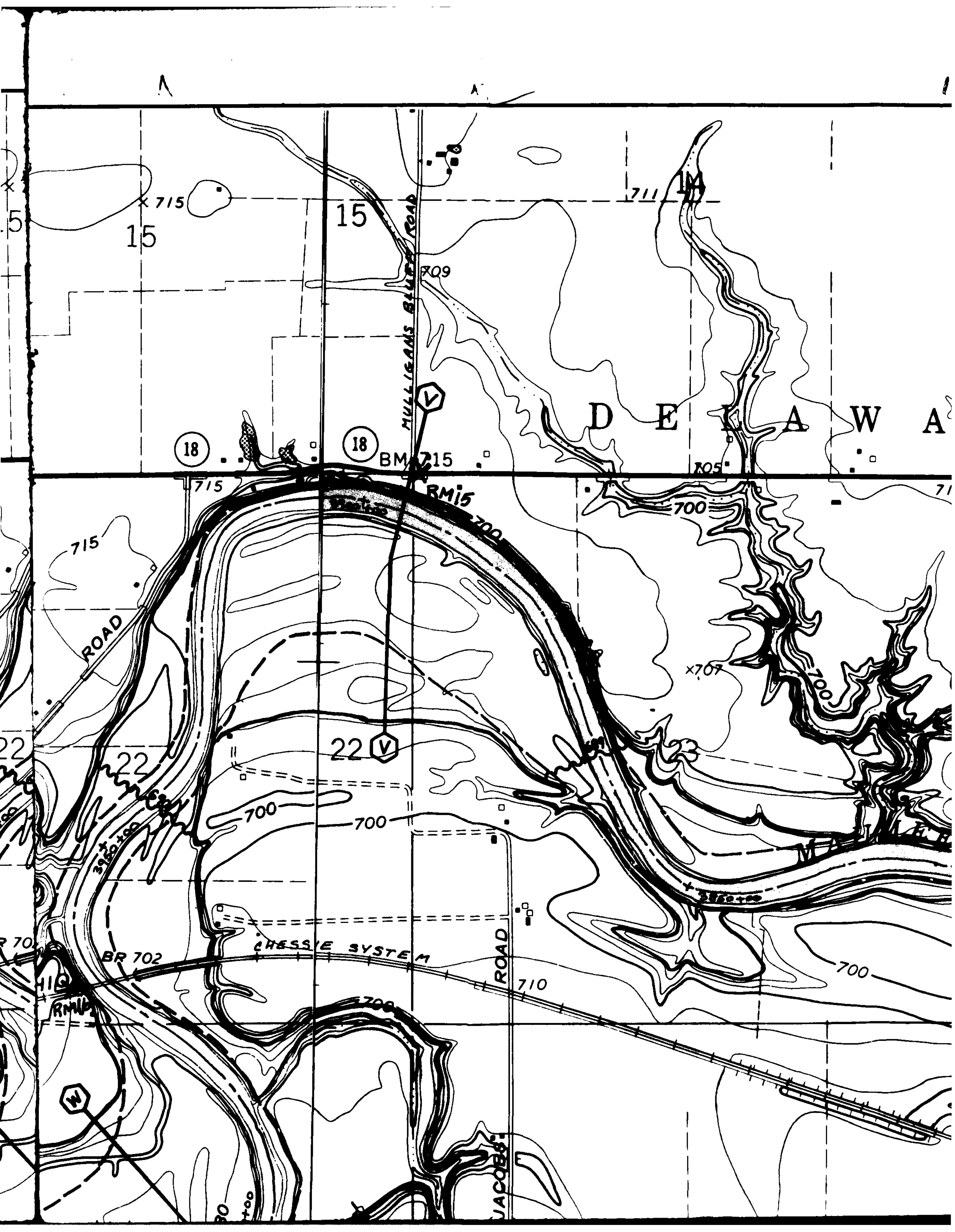
ROEHRIG
ROAD
707
707
708
N
DITCH
700
21
710
ROAD
710
SWITZER
R
707
24
Q
700
P
675
682
683
675
700
R
3550+00
Q
P
700
706
Radio To
(WO



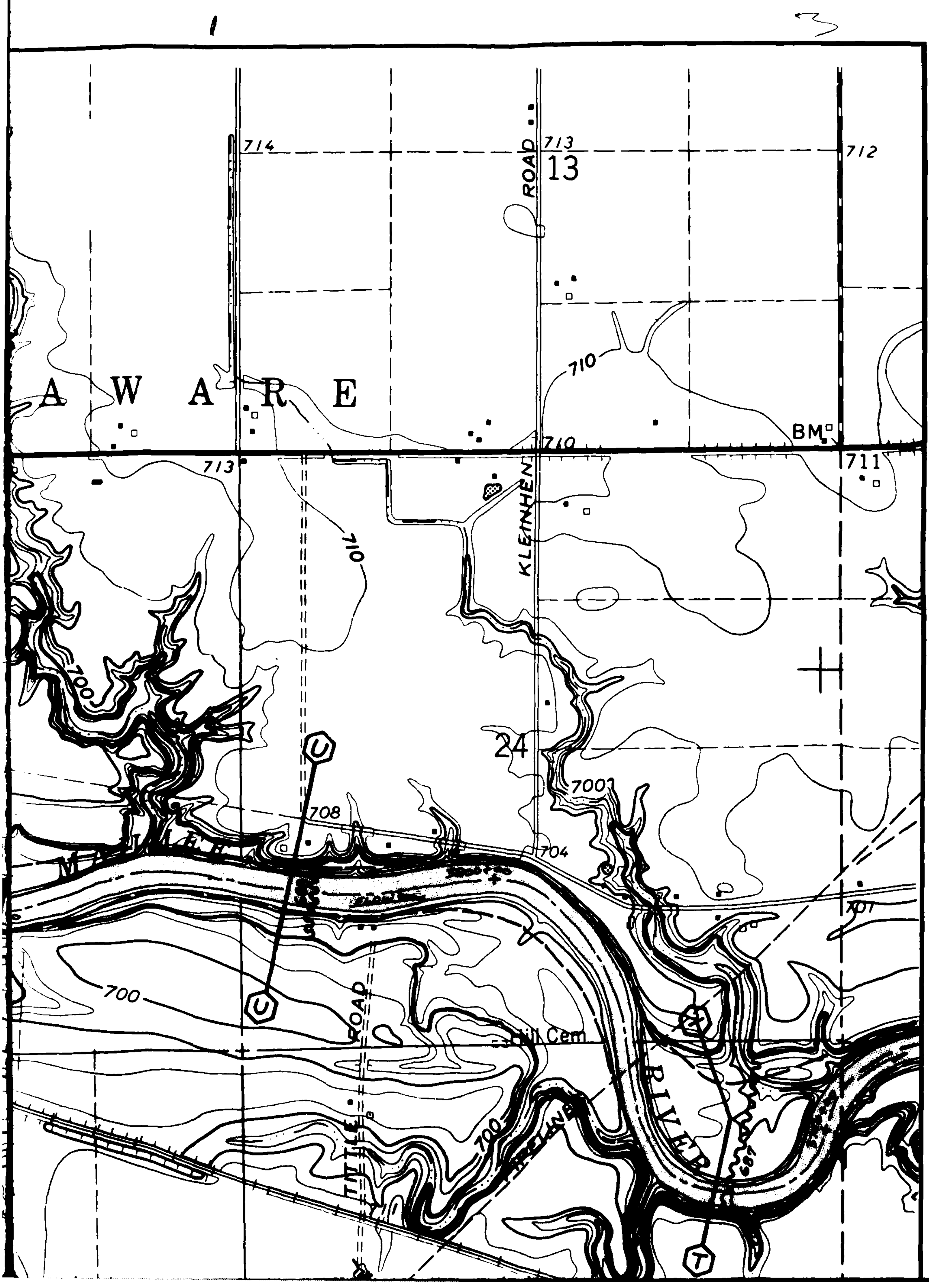
708
699
700
BDY
CITY
Landing Field
STUDY
LIMIT
BM
DEY
ROAD
22
23
711
Radio
HORSE
700
24
P
O
N
675
682
681
MEE
675
RIVER
FLOW
3550+00
3500+00
Radio Towers

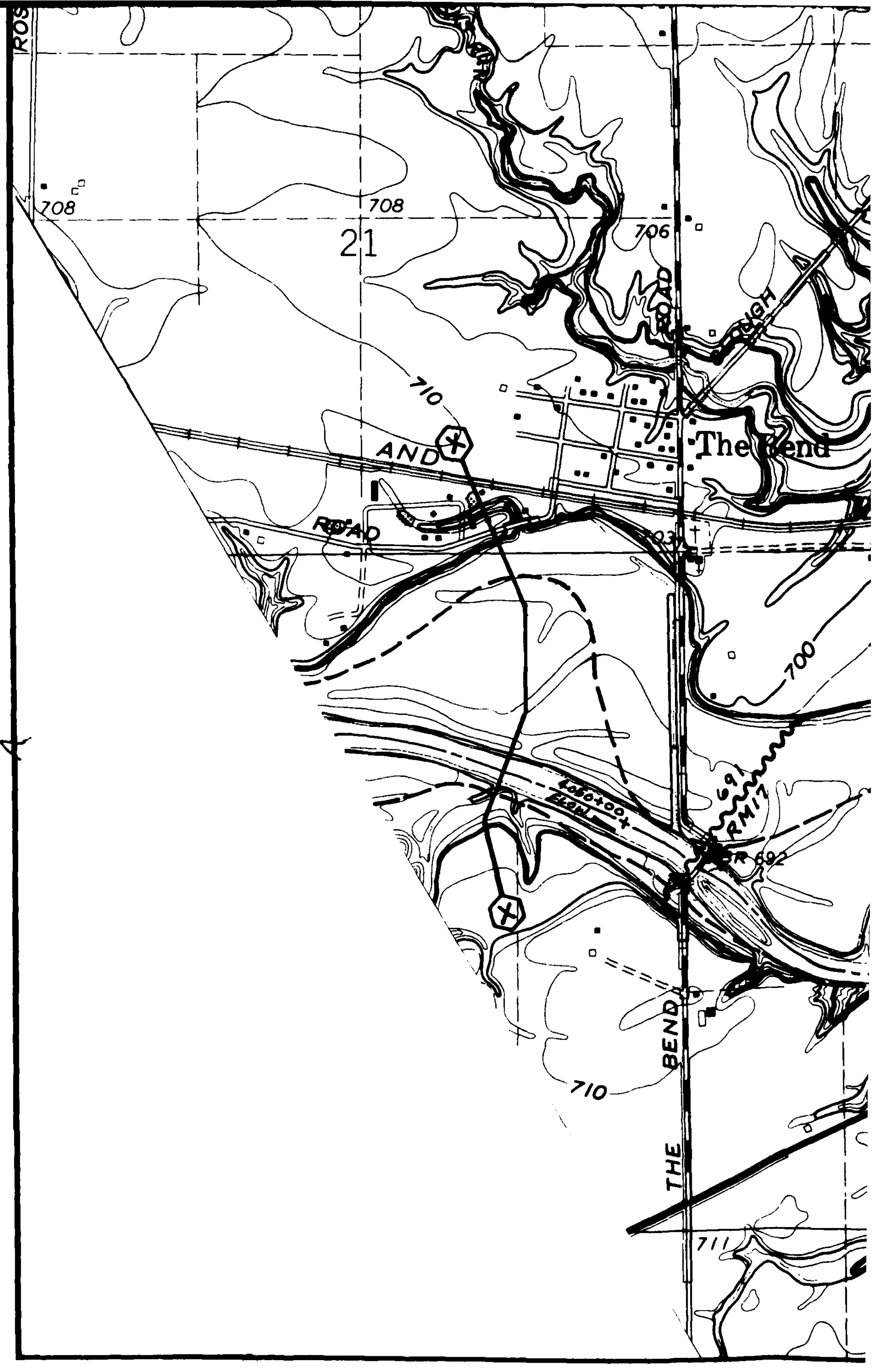


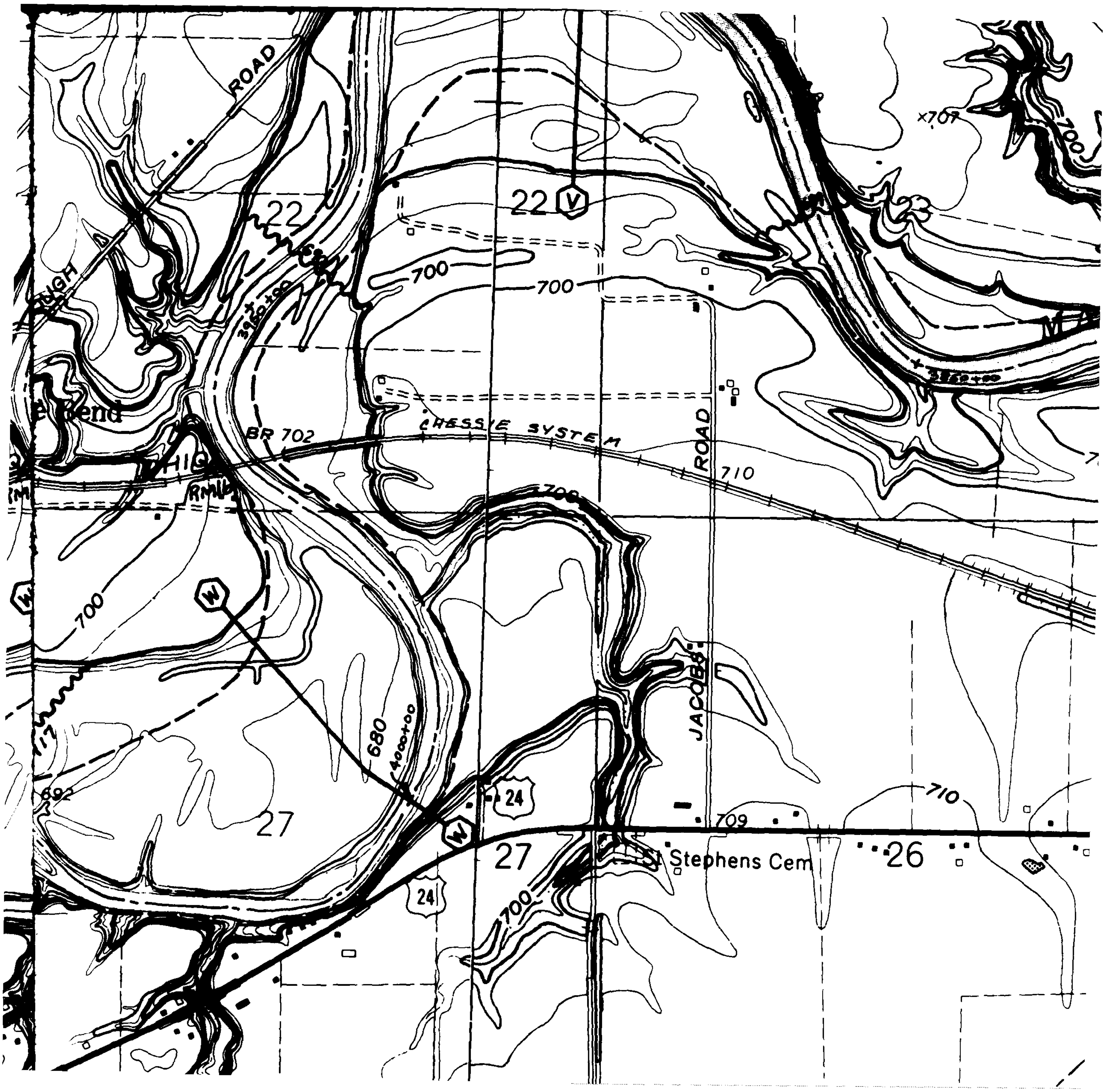
N
W A R E
715
714
ROSEBROOK
708
21
706
710
AND
ROAD
The Bend
703
700



15
15
715
711
14
MULLIGANS BLUFF ROAD
709
V
18
18
BM 715
715
BM15
705
D E L A W A
700
715
ROAD
707
700
22
22
22
V
700
700
CHESSIE SYSTEM
BR 702
ROAD
710
700
W
JACOBS

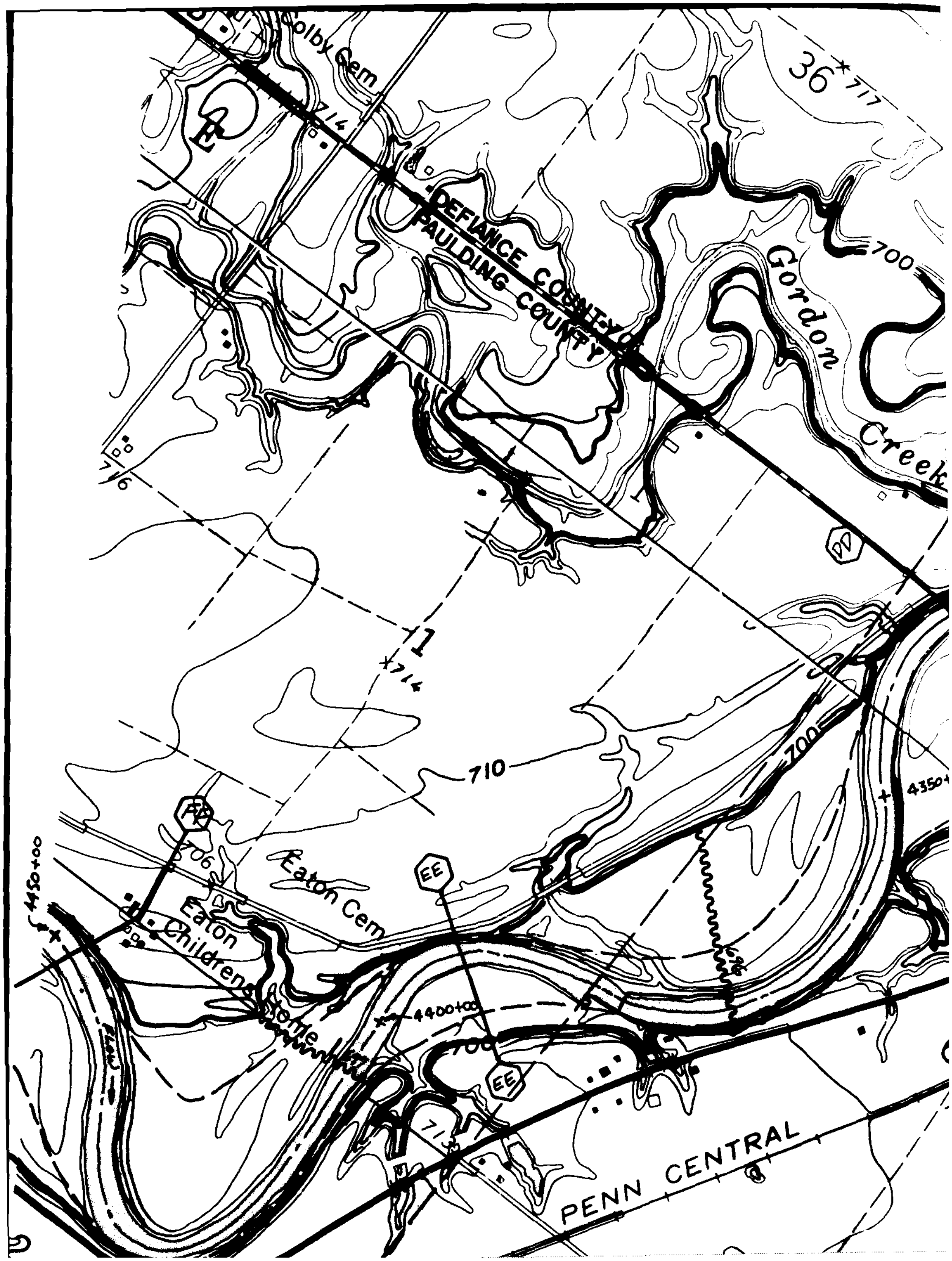

1
3
714
713
ROAD
13
712
710
A W A R E
BM
710
713
711
KLEINHEN
710
700
24
700
708
704
701
700
ROAD
Hill Cem
TITLE
700
RIVER
687


708
708
21
706
ROAD
710
AND
The Bend
ROAD
700
RM17
THE
BEND
710
711

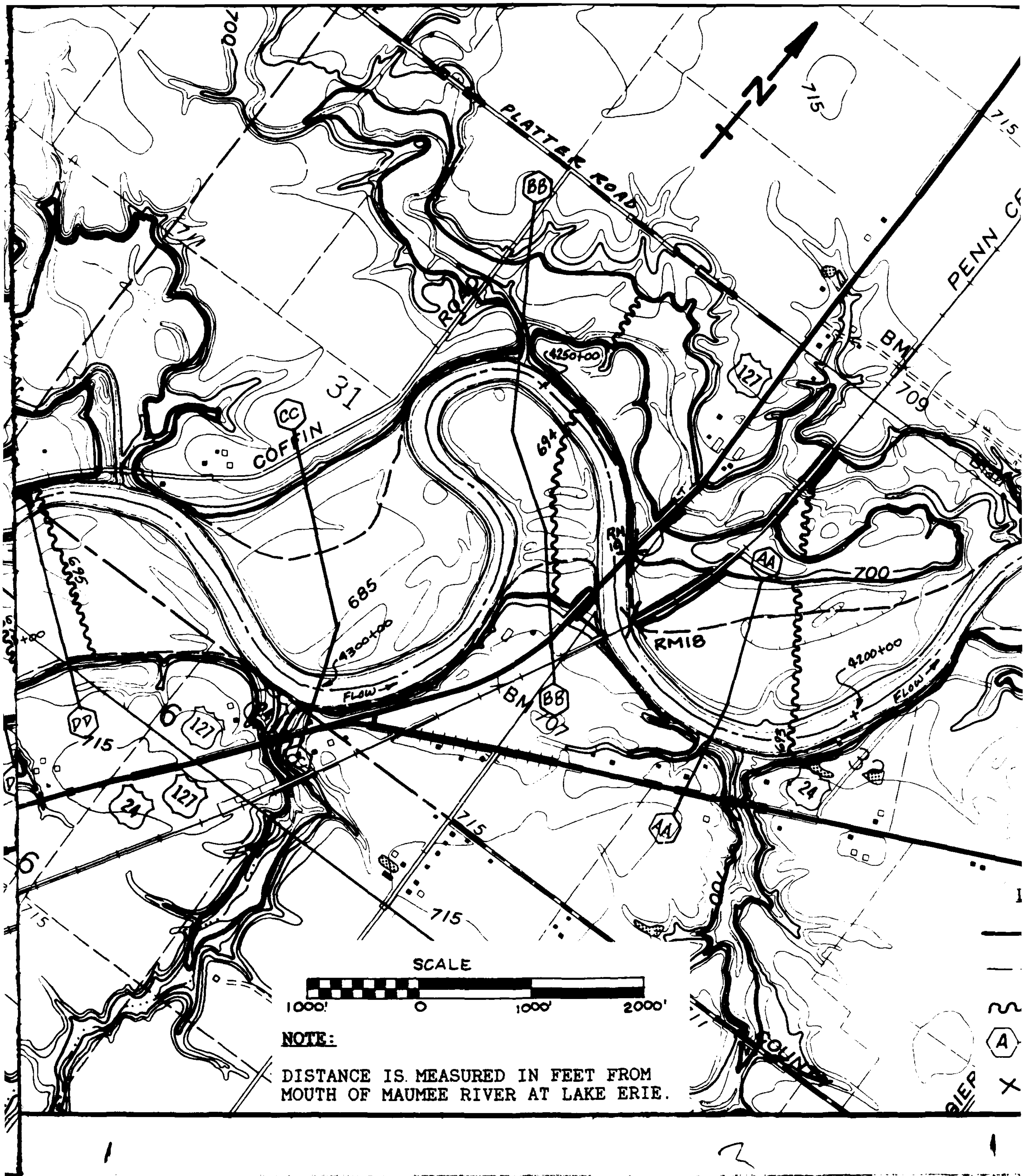


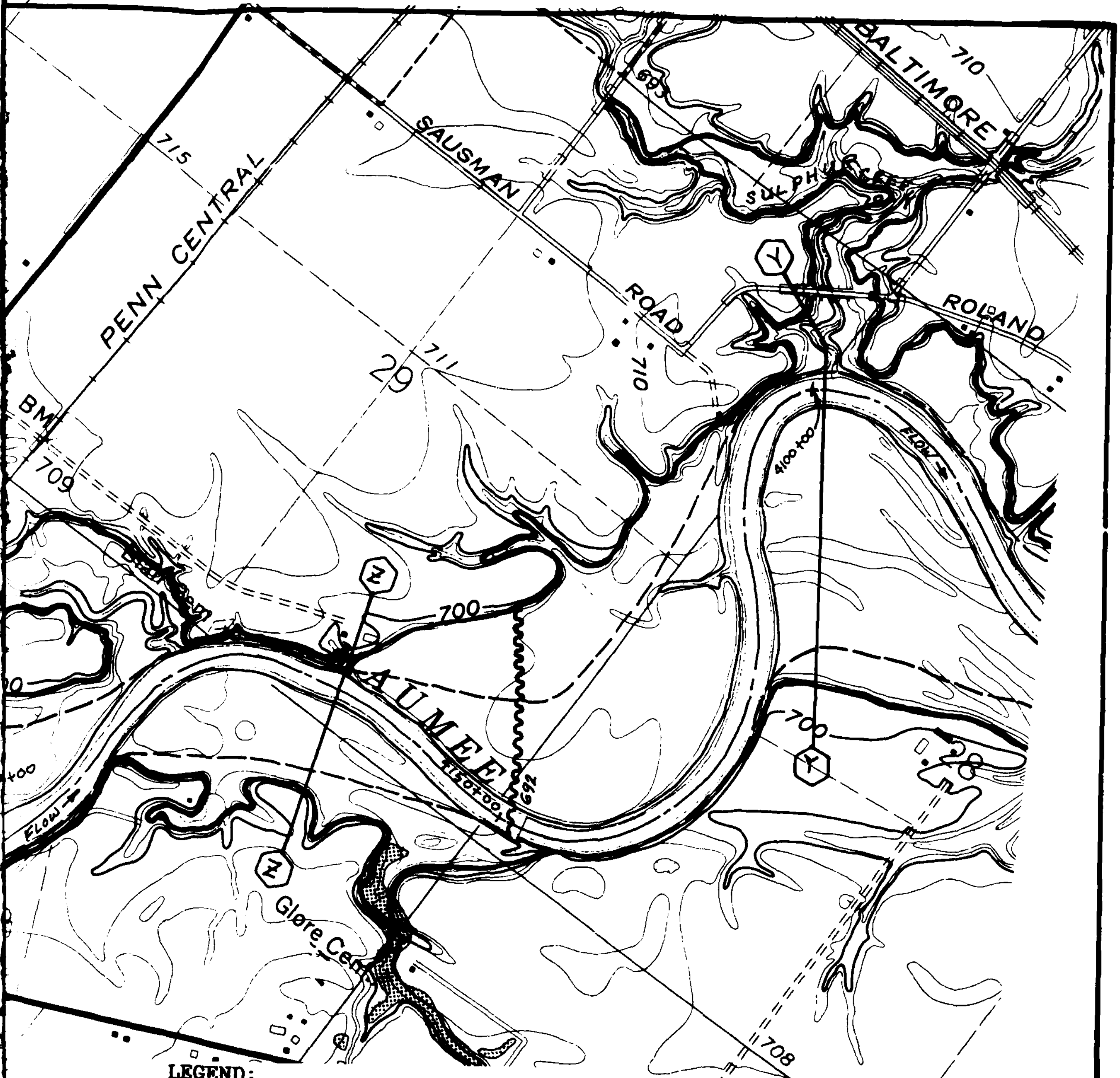
ROAD
22
22
V
700
700
CHESSIE SYSTEM
BR 702
ROAD
710
700
W
W
700
JACOBS
680
4000+00
24
W
709
710
27
27
St Stephens Cem
26
24
700
x707
700

KLE
24
708
700
704
701
700
ROAD
Cem
TITTLE
RIVER
700
712
U.S. Rte. 24
711



Colby Cem
36
717
714
DEFIANCE COUNTY
PAULDING COUNTY
Gordon
Creek
700
716
DD
714
710
706
FF
Eaton Cem
Eaton
Childrens Home
EE
4450+00
4400+00
700
EE
712
PENN CENTRAL


PLATTER ROAD
PENN CR
N
BB
CC
COFFIN
31
4250+00
127
BM
709
694
RM 19
AA
700
685
4300+00
RM18
4200+00
FLOW
BM 707
PP
715
6
24
SCALE
1000'
0
1000'
2000'
NOTE:
DISTANCE IS MEASURED IN FEET FROM
MOUTH OF MAUMEE RIVER AT LAKE ERIE.



LEGEND:

100 YEAR FLOOD BOUNDARY

FLOODWAY BOUNDARY

692 BASE FLOOD ELEVATION

(A)——(A) CROSS SECTION LOCATION

× RM 1 ELEVATION REFERENCE MARK

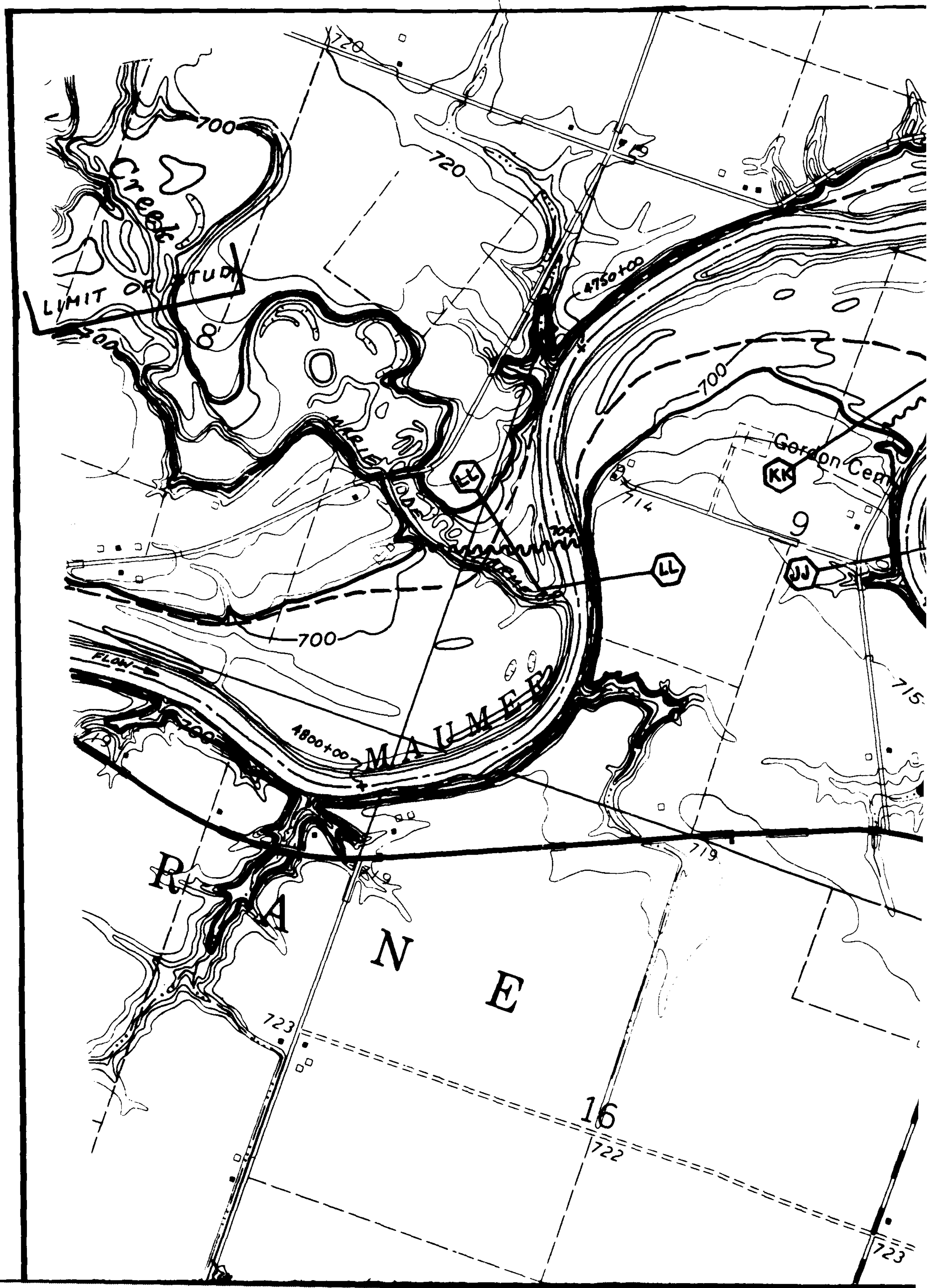
U. S. Army Engineer District, Buffalo
SPECIAL FLOOD HAZARD EVALUATION

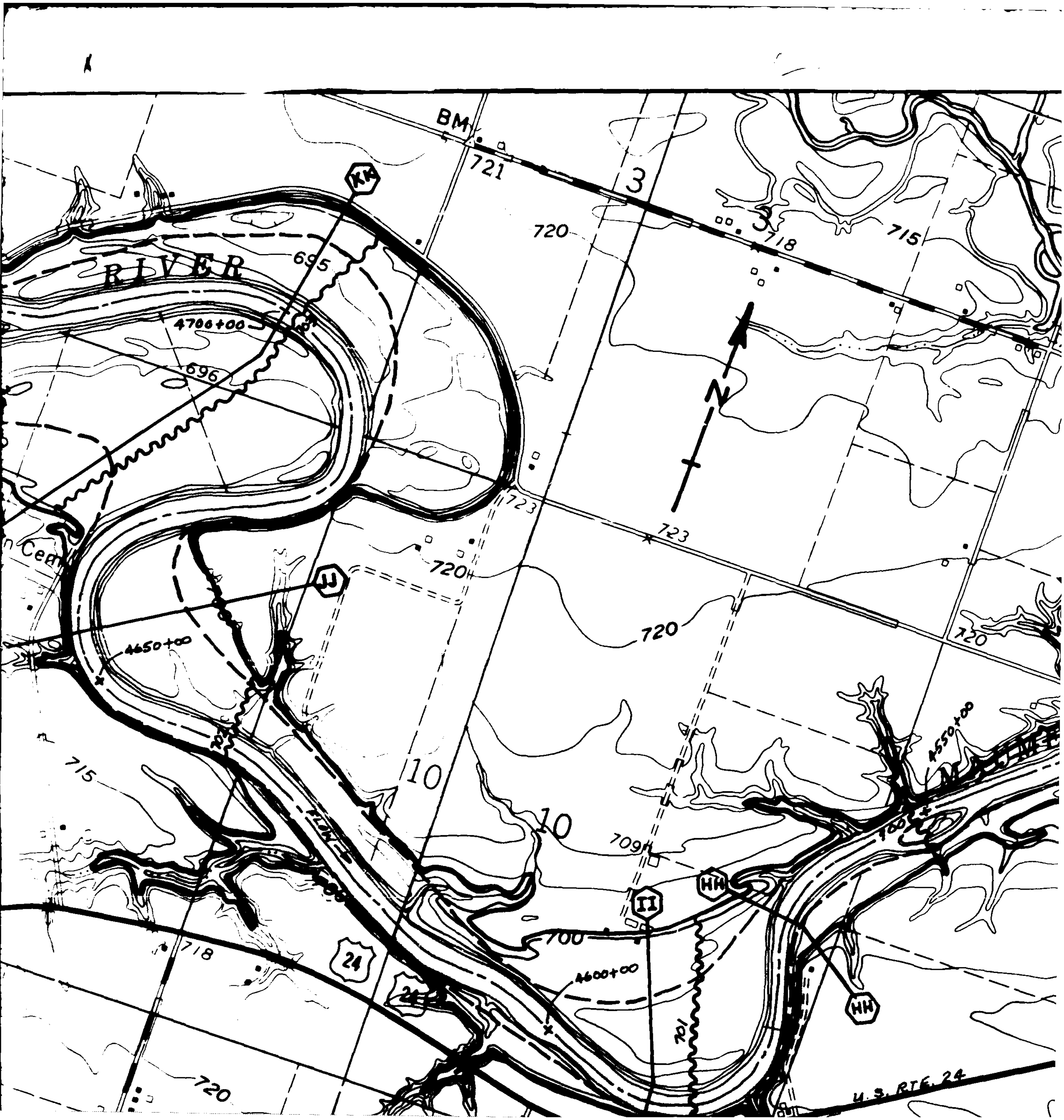
FLOODED AREAS

MAUMEE RIVER

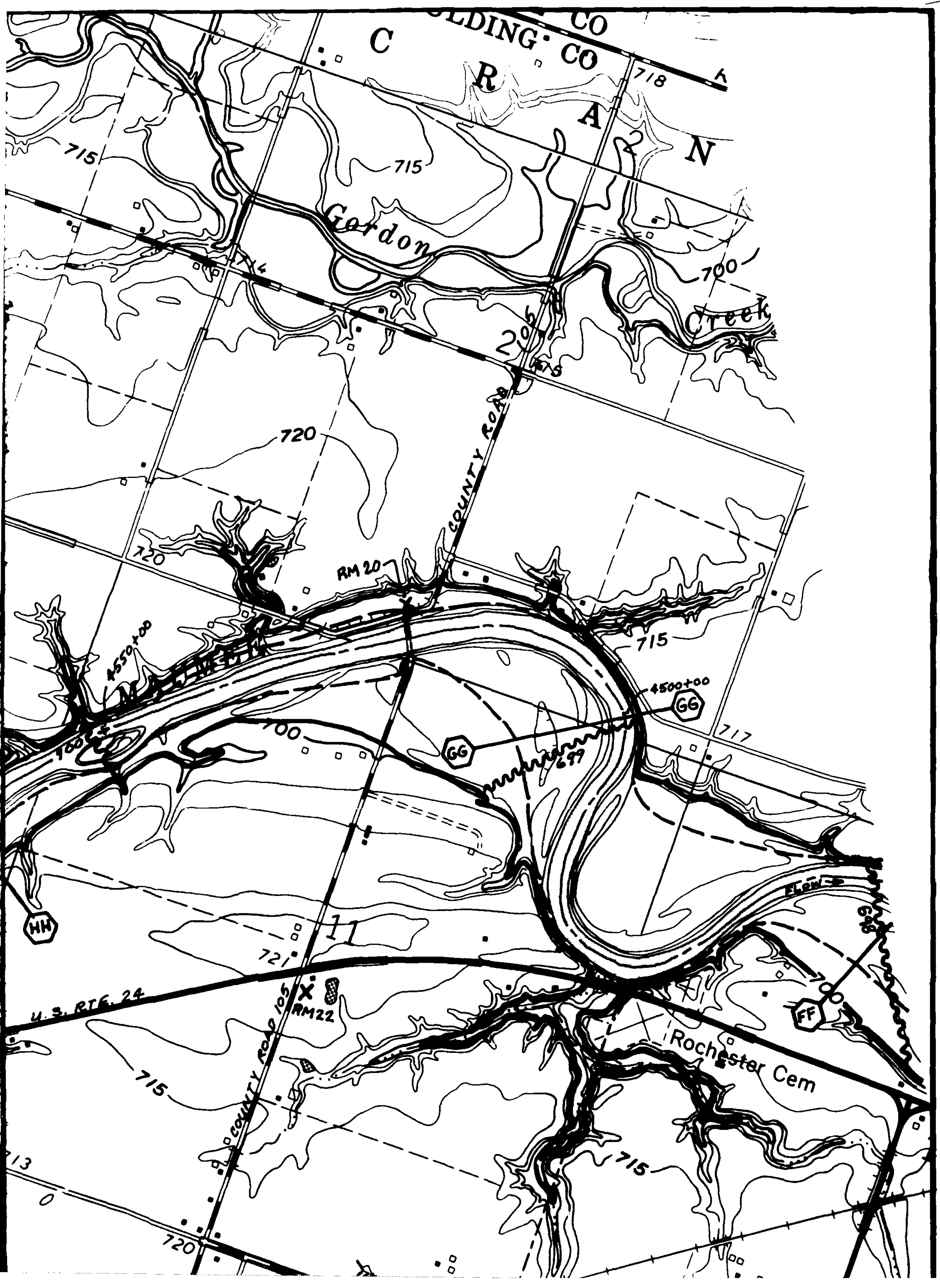
DEFIANCE AND PAULDING COUNTIES, OHIO
STATION 4075+00 - 4453+00

PLATE 10 SEPT. 1988

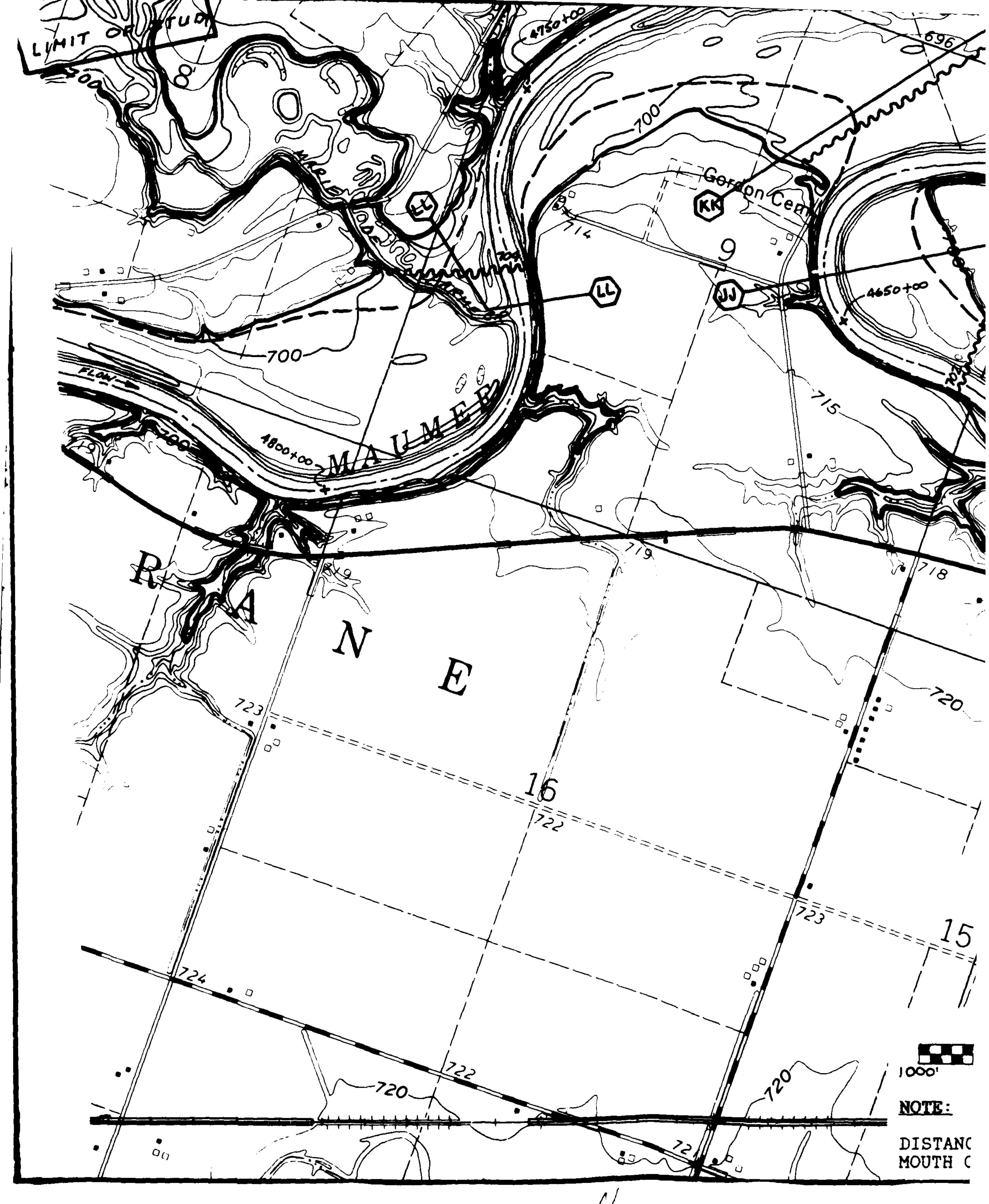

LIMIT OF STUDY
Creek
8
9
16
700
720
714
715
719
722
723
4750+00
4800+00
MAUMEE
FLOW
Gordon Cem
KK
LL
JJ
R A N E



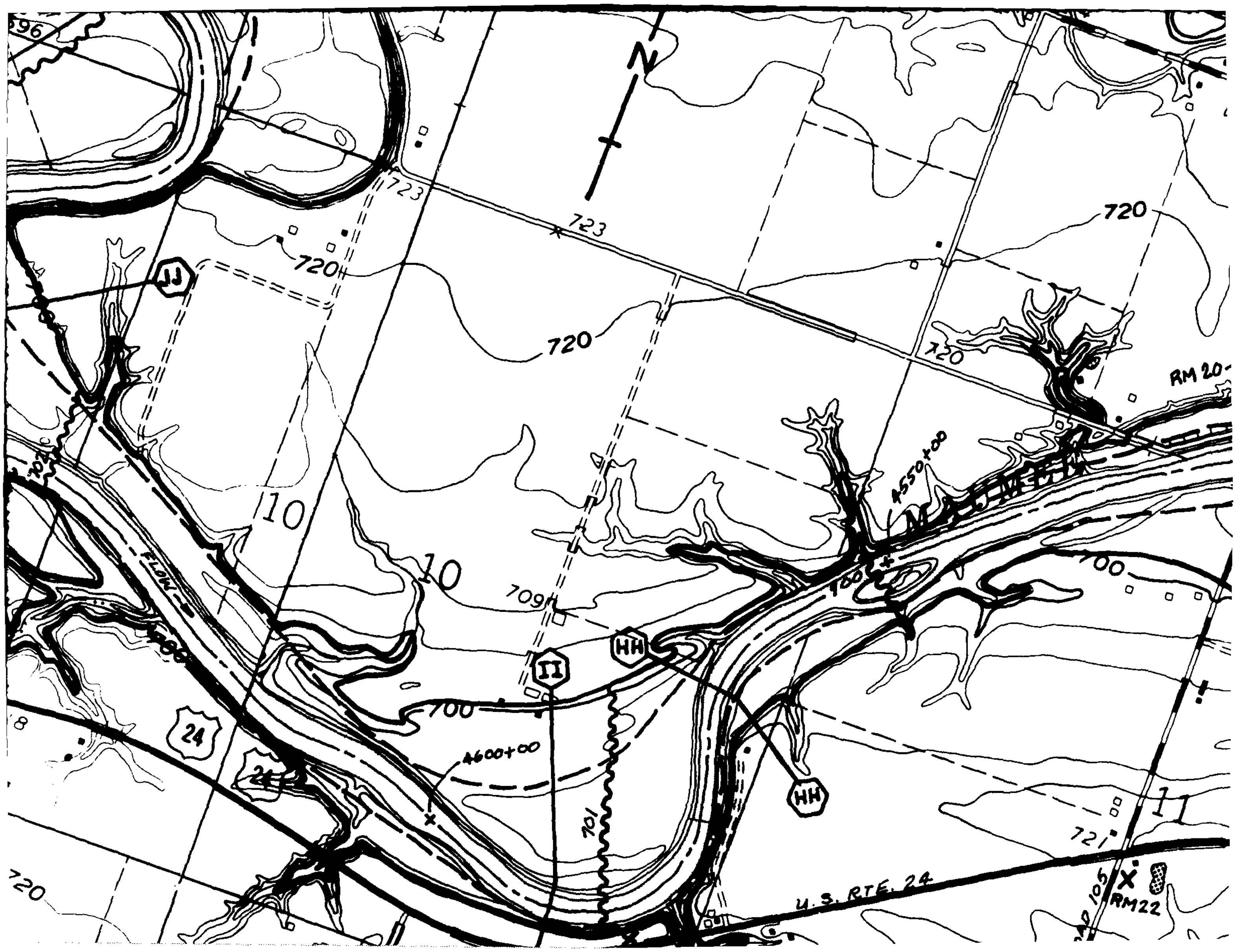
BM
721
3
720
718
715
RIVER
695
4700+00
696
723
723
KK
JJ
720
720
720
4650+00
715
10
10
709
4550+00
HH
II
HH
700
24
4600+00
718
720
701
FLOW
U.S. RTE. 24

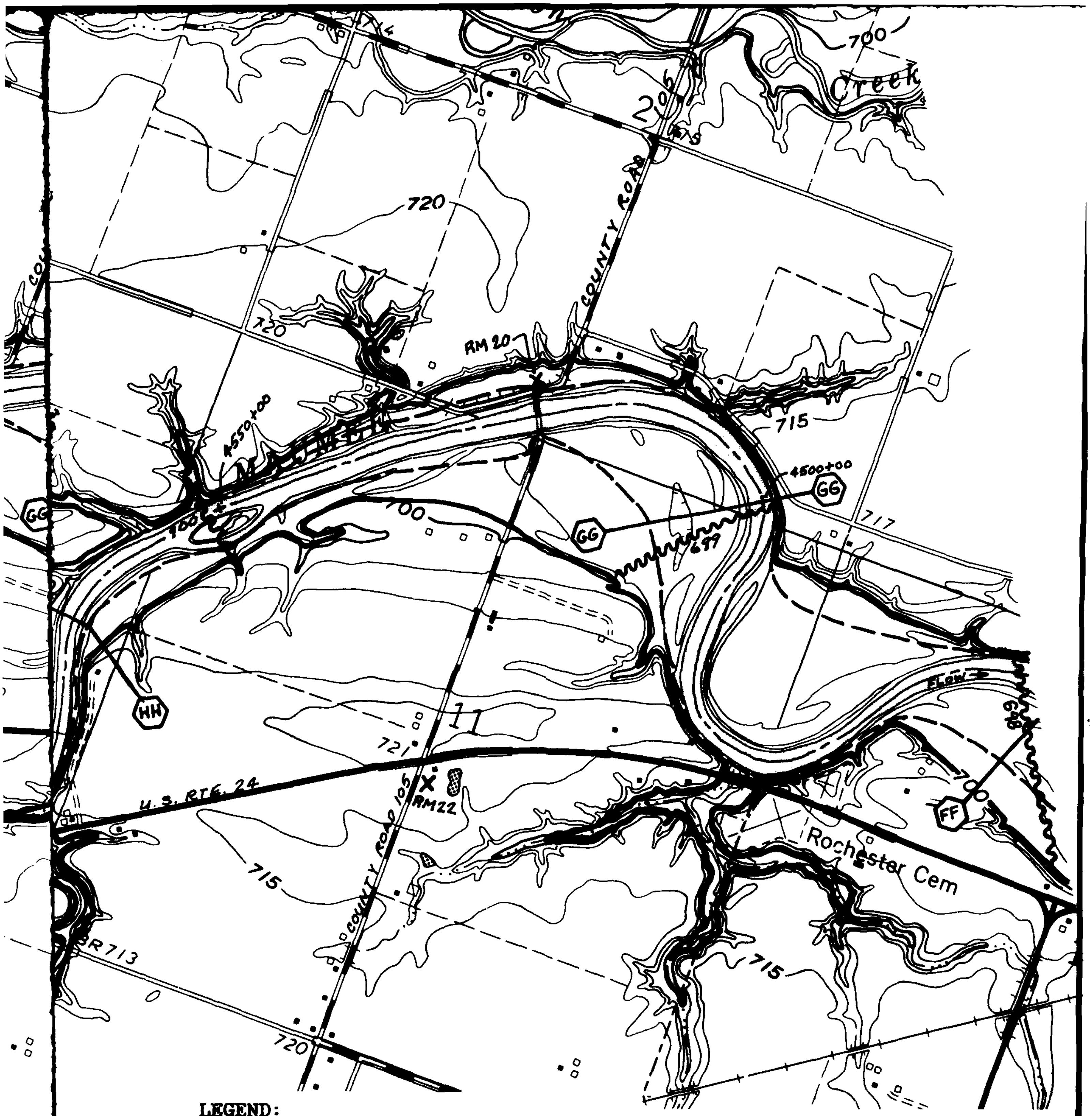


CO
CO
C
R
A
N
Gordon
Creek
715
718
700
720
COUNTY ROAD
RM 20
4550+00
4500+00
GG
717
699
HH
11
721
U.S. RTE. 24
COUNTY ROAD 105
RM22
Rochester Cem
FF
698
Flow
713



LIMIT OF STUDY
8
4750+00
696
700
Gordon Cem
KK
LL
9
714
JJ
4650+00
700
FLOW
MAUMEE
4800+00
715
R
A
N
E
719
718
723
720
16
722
723
15
724
722
720
720
1000'
NOTE:
DISTANC
MOUTH C


N
723
723
720
720
720
720
720
RM 20
4550+00
10
10
709
700
700
JJ
II
HH
HH
FLOW
4600+00
24
701
U.S. RTE. 24
721
11
RM22



LEGEND:

- 100 YEAR FLOOD BOUNDARY
- FLOODWAY BOUNDARY
- 700 BASE FLOOD ELEVATION
- (A)—(A) CROSS SECTION LOCATION
- × RM 1 ELEVATION REFERENCE MARK

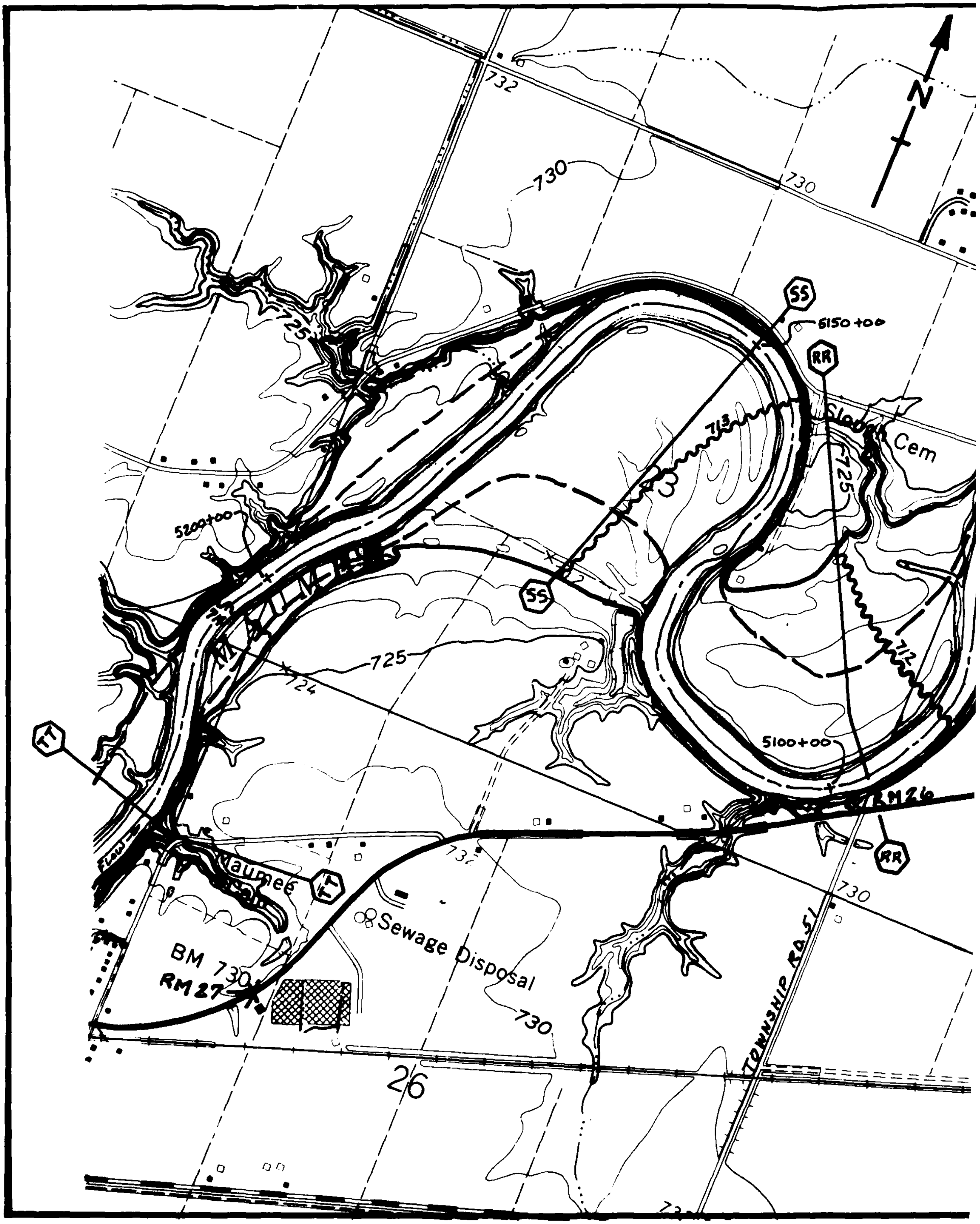
U. S. Army Engineer District, Buffalo
SPECIAL FLOOD HAZARD EVALUATION

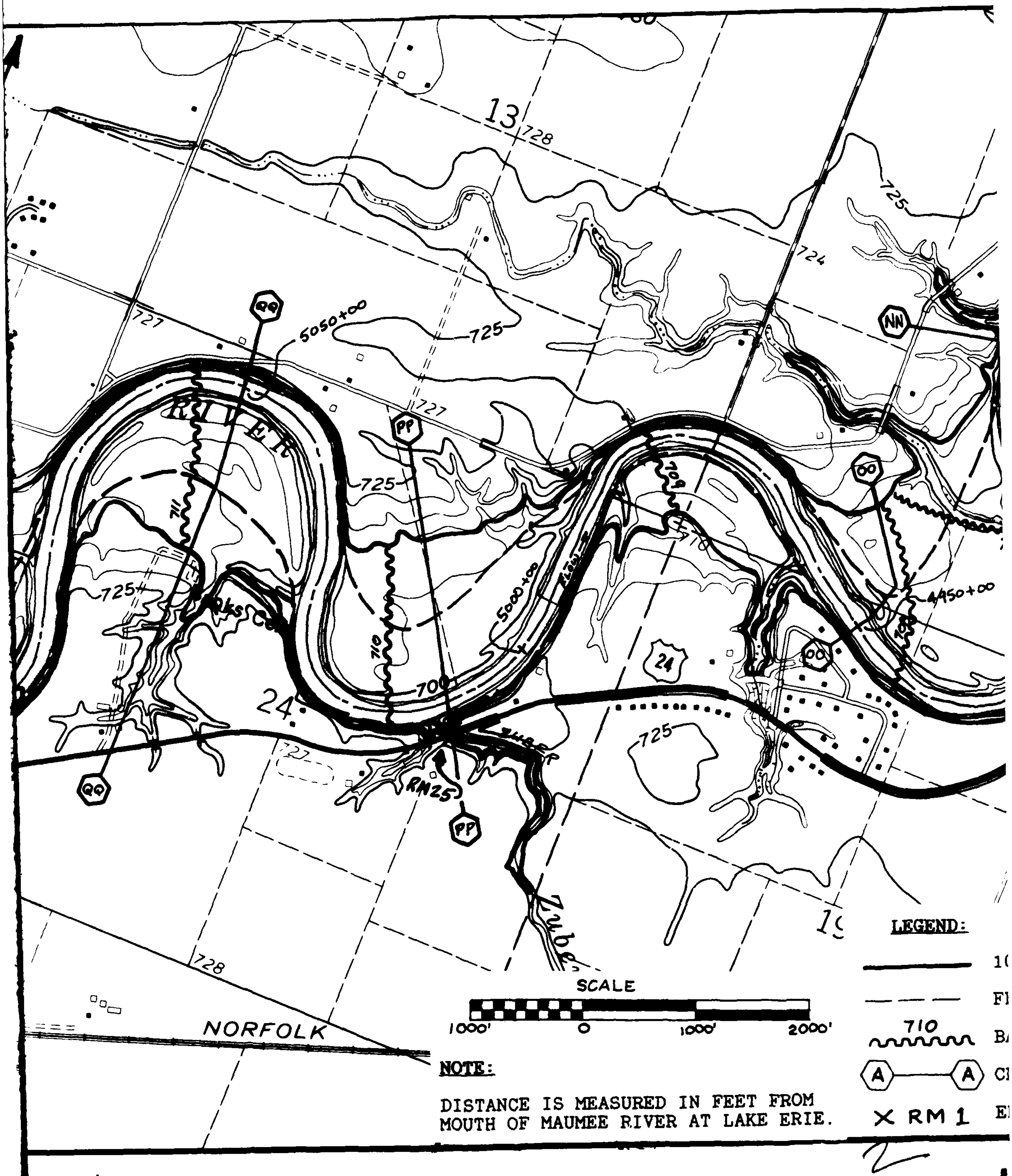
FLOODED AREAS

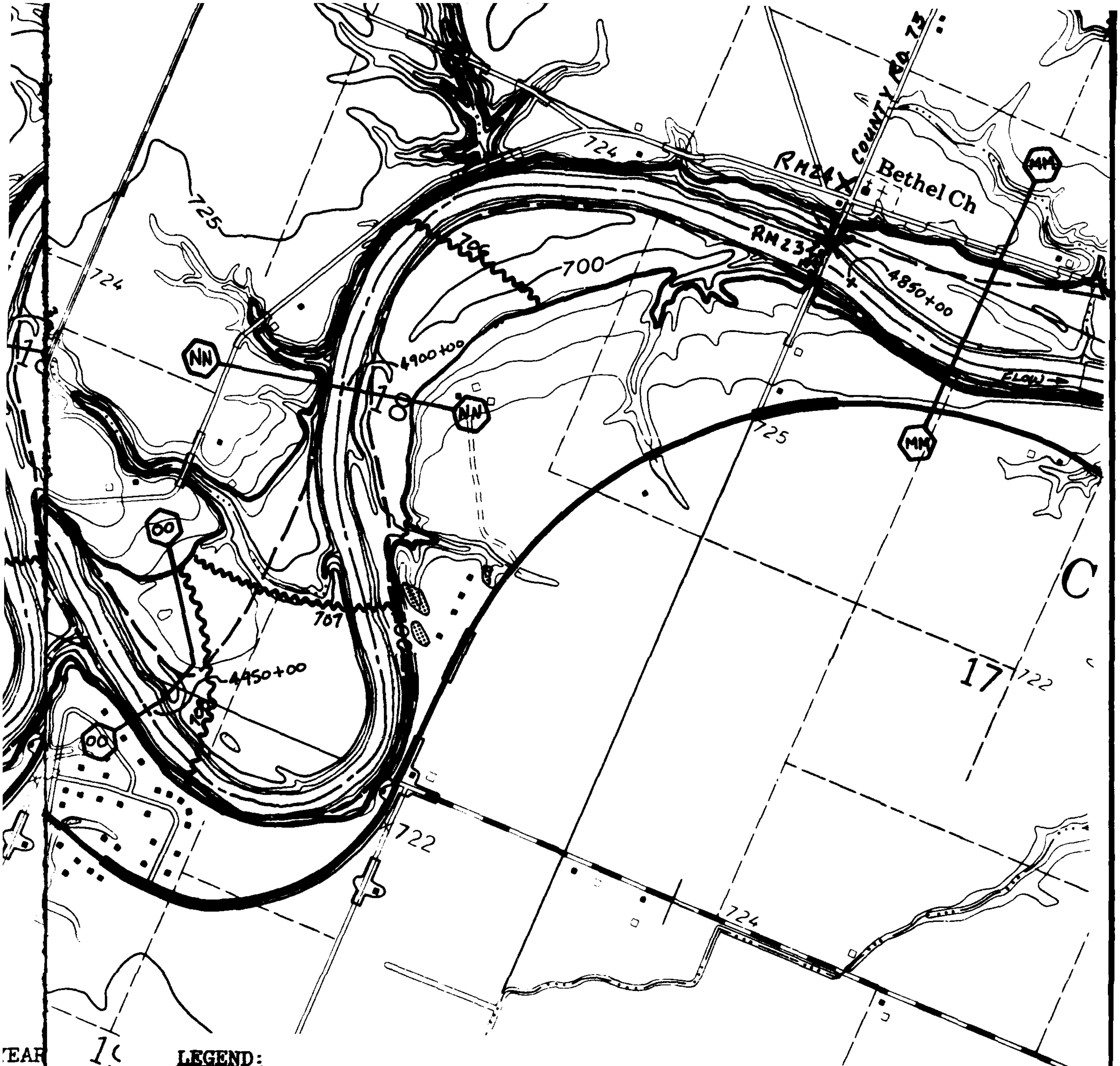
MAUMEE RIVER

DEFIANCE AND PAULDING COUNTIES, OHIO
STATION 4452+00 - 4828+00

PLATE 11 SEPT. 1988


N
732
730
725
713
Slocum Cem
5150+00
5200+00
5100+00
SS
RR
TT
724
712
RM26
Maumee
Sewage Disposal
BM 730
RM27
26
TOWNSHIP RD 51


13
728
725
724
727
725
5050+00
QQ
PP
NN
OO
RIVER
725
711
710
709
708
700
5000+00
4950+00
24
24
727
RM25
ZUBER
Zuber
725
728
NORFOLK
SCALE
1000'
0
1000'
2000'
LEGEND:
710
A
A
X RM 1
NOTE:
DISTANCE IS MEASURED IN FEET FROM
MOUTH OF MAUMEE RIVER AT LAKE ERIE.



LEGEND:

(solid heavy line)	100 YEAR FLOOD BOUNDARY
(dashed line)	FLOODWAY BOUNDARY
710 (wavy line)	BASE FLOOD ELEVATION
(A)——(A)	CROSS SECTION LOCATION
X RM 1	ELEVATION REFERENCE MARK

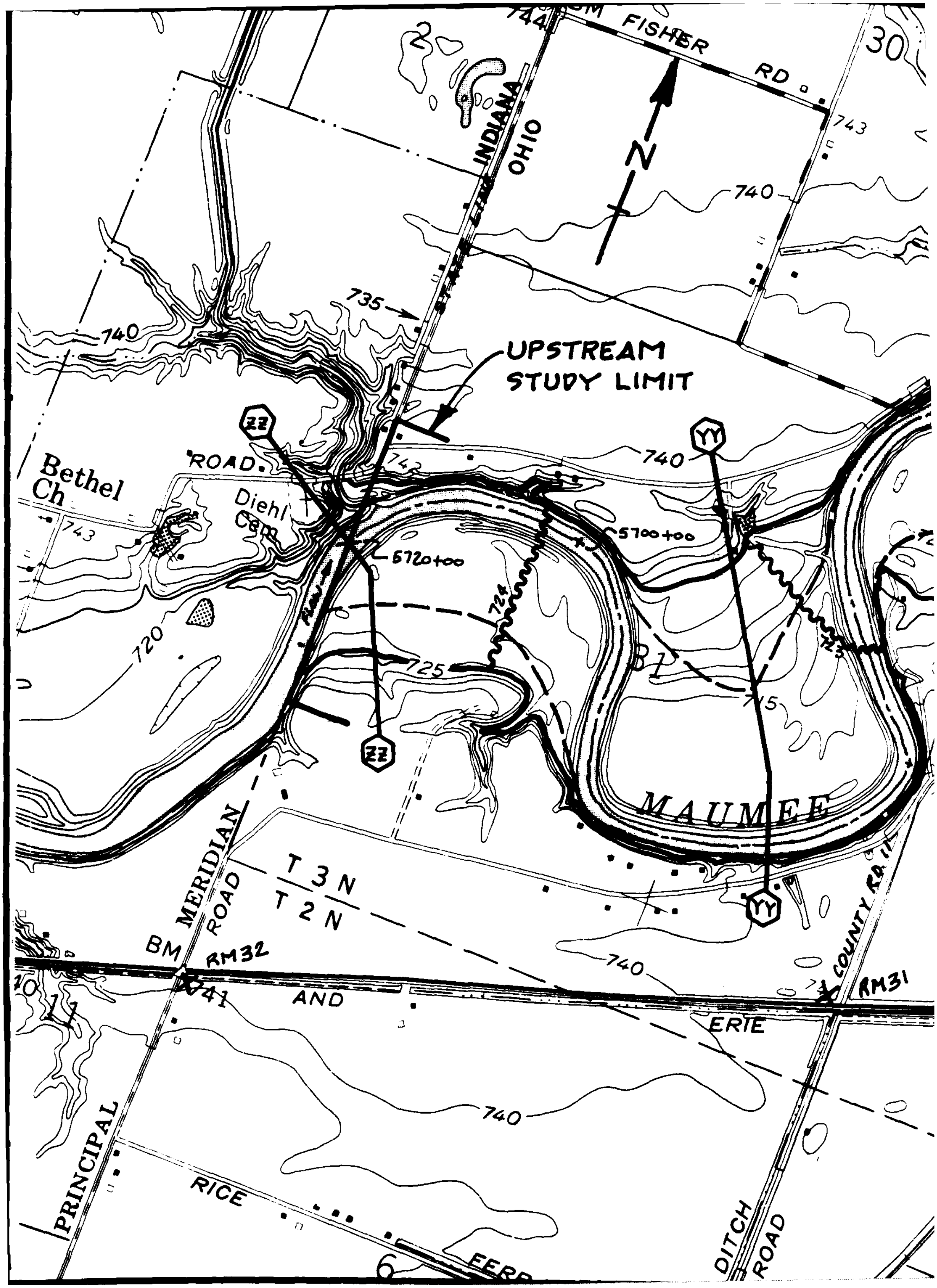
U. S. Army Engineer District, Buffalo
SPECIAL FLOOD HAZARD EVALUATION

FLOODED AREAS

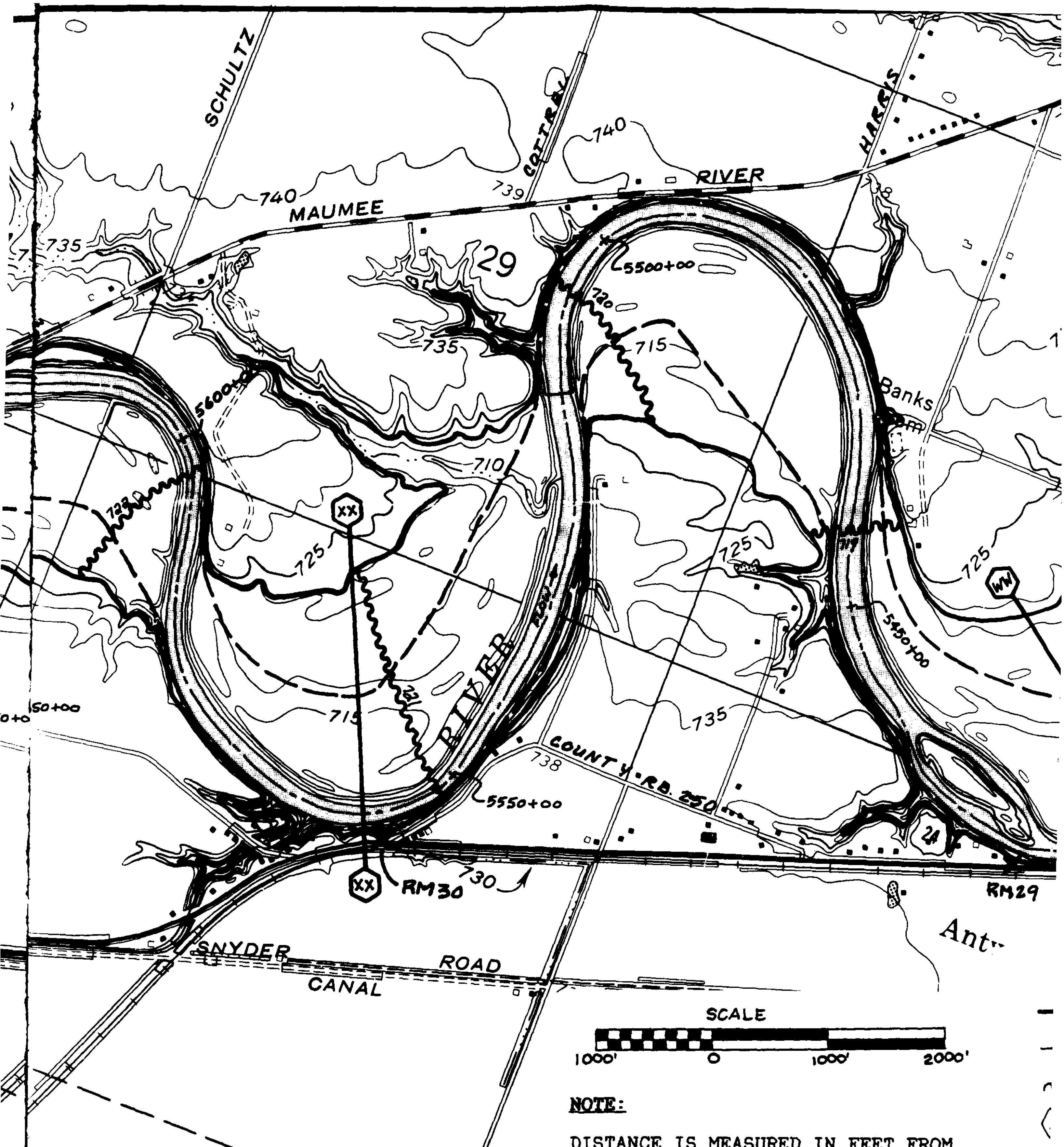
MAUMEE RIVER

DEFIANCE AND PAULDING COUNTIES, OHIO
STATION 4828+00 - 5229+00

PLATE 12 SEPT. 1988

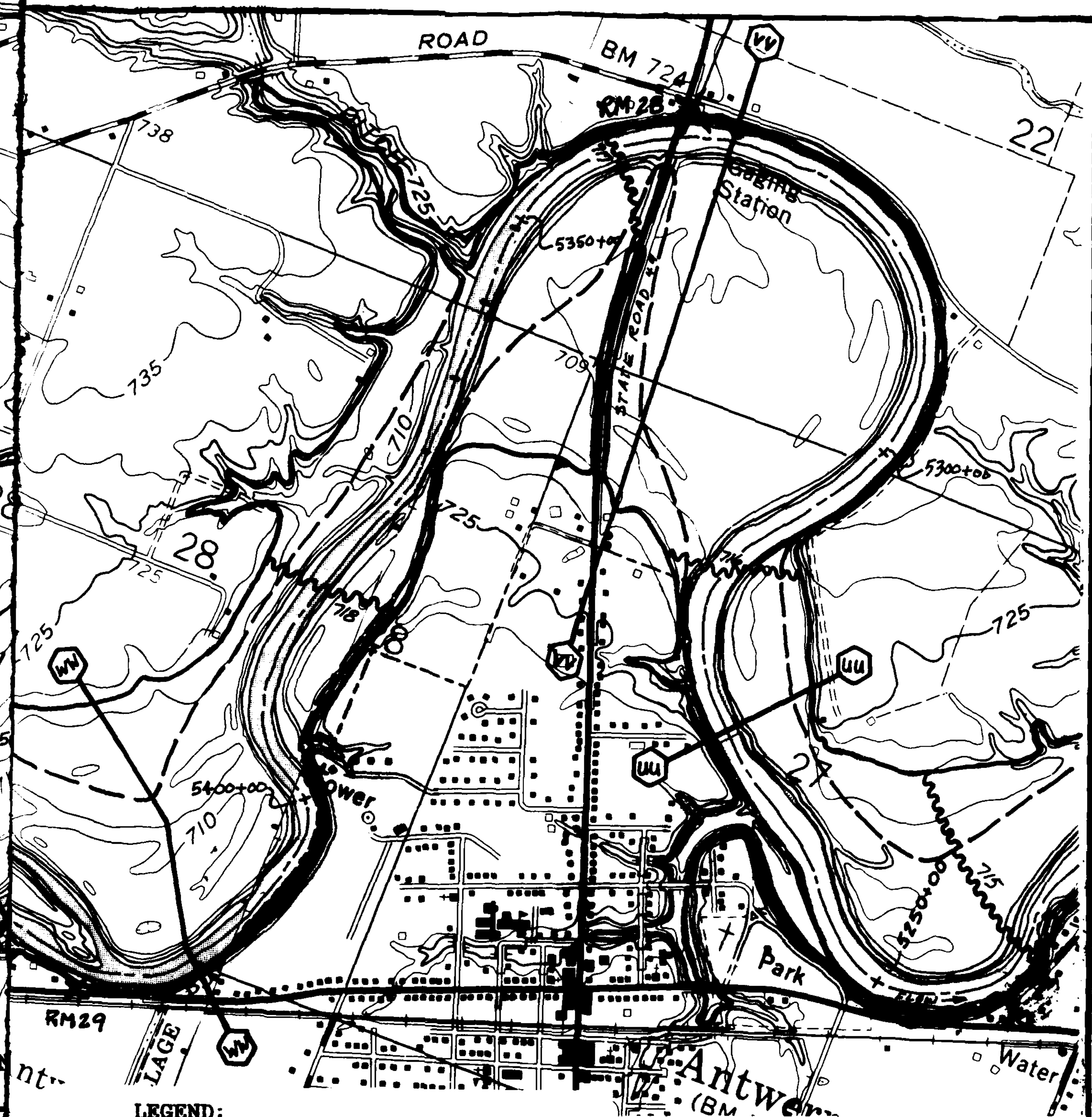


FISHER RD
30
2
744
INDIANA
OHIO
N
743
740
735
740
UPSTREAM
STUDY LIMIT
ZZ
YY
Bethel
Ch
ROAD
Diehl
Cem
743
742
740
5720+00
5700+00
724
723
720
725
715
MAUMEE
ZZ
YY
T 3 N
T 2 N
MERIDIAN
ROAD
BM
RM32
741
AND
ERIE
740
COUNTY RD. 11
RM31
10
11
740
PRINCIPAL
RICE
FERR
DITCH
ROAD
6



NOTE:

DISTANCE IS MEASURED IN FEET FROM MOUTH OF MAUMEE RIVER AT LAKE ERIE.



LEGEND:

———	100 YEAR FLOOD BOUNDARY
– – – –	FLOODWAY BOUNDARY
720 (wavy line)	BASE FLOOD ELEVATION
(A)—(A)	CROSS SECTION LOCATION
× RM 1	ELEVATION REFERENCE MARK

U. S. Army Engineer District, Buffalo

SPECIAL FLOOD HAZARD EVALUATION

FLOODED AREAS

MAUMEE RIVER

DEFIANCE AND PAULDING COUNTIES, OHIO

STATION 5229+00 – 5720+00

PLATE 13 SEPT. 1988

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