US 51 OHIO RIVER BRIDGE ENGINEERING AND ENVIRONMENTAL STUDY

River Hydraulics and Navigation Study

ITEM NOS. 1-100.00 and 1-1140.00

Prepared by:
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October 1, 2013

EXECUTIVE SUMMARY

The existing US 51 Bridge (also known as the Cairo Bridge) carries US 51, US 60, and US 62 traffic across the Ohio River between Wickliffe, Kentucky, and Cairo, Illinois. The scope of work for this study--US 51 Ohio River Bridge Engineering and Environmental Study (KYTC Item Numbers 1-100.00 and 1-1140.00)--is to perform preliminary engineering and environmental studies to replace or rehabilitate the existing bridge. The purposes of this document are to summarize existing conditions along the Ohio River relative to the existing structure and to describe potential concerns regarding new locations for replacing the structure.

The design team has coordinated with or obtained data from multiple agencies including:

- The United States Coast Guard (USCG)
- The United States Army Corps of Engineers (USACE)
- Flood Insurance Studies from the Federal Emergency Management Agency
    - Ballard County, Kentucky
    - Alexander County, Illinois
- The Kentucky Division of Water

Data, guidelines, or recommendations provided include:

- Horizontal and vertical clearance recommendations
- Navigational charts, guidelines, and restrictions
- Ohio River flood profiles

Data summarized in this document and in the Appendices (A-D) describe coordination activities with these agencies and data provided by these agencies. The information was used with this study and will also be useful when this project is advanced to future phases of preliminary engineering, environmental assessment, and ultimately final design and construction.

1. PROJECT OVERVIEW

The existing US 51 Bridge (also known as the Cairo Bridge) carries US 51, US 60, and US 62 traffic across the Ohio River between Wickliffe, Kentucky, and Cairo, Illinois. The existing US 51 Bridge is located at Kentucky Mile Point 7.372 along US 51 and at Ohio River Navigation Mile Point 980.4 near the confluence of the Mississippi and Ohio Rivers. The existing truss bridge opened to traffic in 1938 after construction was completed by the Cairo Bridge Commission. The bridge opened initially as a toll facility before tolls were removed on November 11, 1948, when the highway departments for Kentucky and Illinois took over maintenance responsibilities for the structure.

The scope of work for this study--US 51 Ohio River Bridge Engineering and Environmental Study (KYTC Item Numbers 1-100.00 and 1-1140.00)--is to perform preliminary engineering and environmental studies to replace or rehabilitate the existing bridge. More specifically, this study includes evaluation of the feasibility for constructing a new bridge for US 51 crossing the Ohio River. The purposes of this document are to summarize existing conditions along the Ohio River relative to the existing structure and to describe potential concerns regarding new locations for replacing the structure.

2. RIVER HYDRAULICS / NAVIGATION COORDINATION AND DATA COLLECTION

The design team has performed a number of activities including:

- coordinated with the United States Coast Guard (USCG) and the United States Army Corps of Engineers (USACE) to identify preliminary guidelines and criteria for development of preliminary engineering analyses and improvement strategies;
- reviewed available data associated with initial construction of the existing bridge including survey and boring data;
- reviewed Flood Insurance Study data from the Federal Emergency Management Agency for Ballard County, Kentucky, and Alexander County, Illinois;
- coordinated with the Kentucky Division of Water to identify supplemental information for the Ballard County Flood Study.

2.1. UNITED STATES COAST GUARD (USCG)

The design team coordinated with the United States Coast Guard on multiple occasions. This coordination culminated in two documents: a July 2, 2013, letter and follow-up correspondence on August 23, 2013. The July 2, 2013, correspondence provided comments regarding preliminary alternatives that had been provided by letter on May 15, 2013. The follow-up correspondence on August 23, 2013, clarified acceptable navigational openings and required vertical clearances specifically for the Combined Alternative 2 (2, 2A, and 2B). Correspondence on July 2, 2013, provided comments for Alternatives 1, 3, 3A, 4, and 5 in regard to the preliminary concepts provided to the USCG on May 15, 2013. Copies of USCG correspondence are included in Appendix A.

A brief summary of USCG comments and guidelines is highlighted below:

Alternative 1: The USCG expressed reservations regarding this alternative in the context of reductions in navigational channels associated with rehabilitation of existing piers.

> In response to this comment, the design team noted that more detailed study of pier rehabilitation techniques would be studied in future phases to identify techniques that minimized reductions to navigation channels.

Alternative 2, 2A, and 2B: August 23, 2013, correspondence from the USCG noted that the "*Combined Alternative 2 (2, 2A, and 2B) would be acceptable from a navigation standpoint. A navigation opening that provides a minimum horizontal clearance of 900 feet, a vertical clearance of at least 105.3 feet at the right descending pier and for 700 feet of the horizontal span, a vertical clearance of at least 113 feet measured above zero on the Cairo gage should satisfy reasonable needs of navigation."*

Alternatives 3 and 3A: The USCG recommended a 1,200-foot horizontal navigation opening for this alternative.

Alternatives 4 and 5: On July 2, 2013, the USCG noted that *"the middle pier on Alternative 5 needs to be shifted toward the left descending bank approximately 200 feet and the horizontal clearance increased to 1,000 feet vs. 900 feet. Both locations are in a less congestive area, and each would satisfy the reasonable needs for navigation and are recommended for further development."*

In the July 2, 2013, correspondence, the USCG further noted that all alternatives shall provide a vertical clearance of at least 105.3 feet above zero on the Cairo Gage. This provision was reiterated and further clarified in the August 23, 2013, correspondence.

2.2. UNITED STATES ARMY CORPS OF ENGINEERS (USACE)

The design team coordinated with the USACE by telephone on multiple occasions. Below is a summary of information provided by the USACE.

Required clearances are as follows:

- 2% flow = 321 Ohio River Datum (ORD) (+55 feet = 376.0 feet)
- Average June Pool = 298.1 ORD (+69 feet = 367.1 feet)

The USCG indicated that vertical clearance requirements for the Ohio River are 55 feet over the 2% flow and 69 feet above the normal pool, which is the average June flow in this situation.

The above information is presented in the context of Ohio River Datum. Below is a summary of datum per the Cairo USACE Gage.

- River Mile: 979.5
- Datum ORD: 270.9
- Datum NGVD 29 270.47
- Datum NAVD 270.87

The USACE also provided “Ohio River Navigation Charts--Cairo, Illinois, to Foster, Kentucky--June 2010.” These charts are included in Appendix B and indicate the following:

- Gage Elevation at Cairo Illinois: 270.9 ORD
- Low Steel Illinois Span – 105.3 feet above zero gage: 376.2 ORD
- Low Steel Center Span – 116.4 feet above zero gage: 387.3 ORD

An inspection of the 1936 bridge plans indicated relative consistency with 60 feet clearance and 327.3 feet high water elevation shown on the plans.

2.3. FLOOD INSURANCE STUDIES - FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

The design team located and reviewed two flood insurance studies developed by the Federal Emergency Management Agency (FEMA). These studies were:

- Flood Insurance Study, Ballard County, Kentucky, Unincorporated Areas, September 29, 1989
- Flood Insurance Study, Alexander County, Illinois, and Incorporated Areas, May 4, 2009

These studies provided a significant amount of data including:

- Floodway Schematics
- Summary of Discharges
- Floodway Data and Boundaries
- Flood Profiles for the Mississippi River and Ohio River
- Hydrologic Analyses
- Hydraulic Analyses
- Flood Insurance Rate Maps

Copies of these documents are included in Appendix C.

2.4. KENTUCKY DIVISION OF WATER COORDINATION

The Flood Insurance Study for Ballard County, Kentucky, referenced above was completed in September 1989. Given the relative age of this study, the design team also coordinated with the Kentucky Division of Water to determine if updated data were available that could be used to supplement information in the 1989 Flood Insurance Study for Ballard County, Kentucky. It was specifically noted that data presented in the 1989 study referenced only 100-year flood elevations. In response inquiries, the Division of Water provided the following information:

- HEC RAS Files
- Updated Flood Profiles
    - 10-year
    - 50-year
    - 100-year
    - 500-year

These are illustrated by the graphic below:

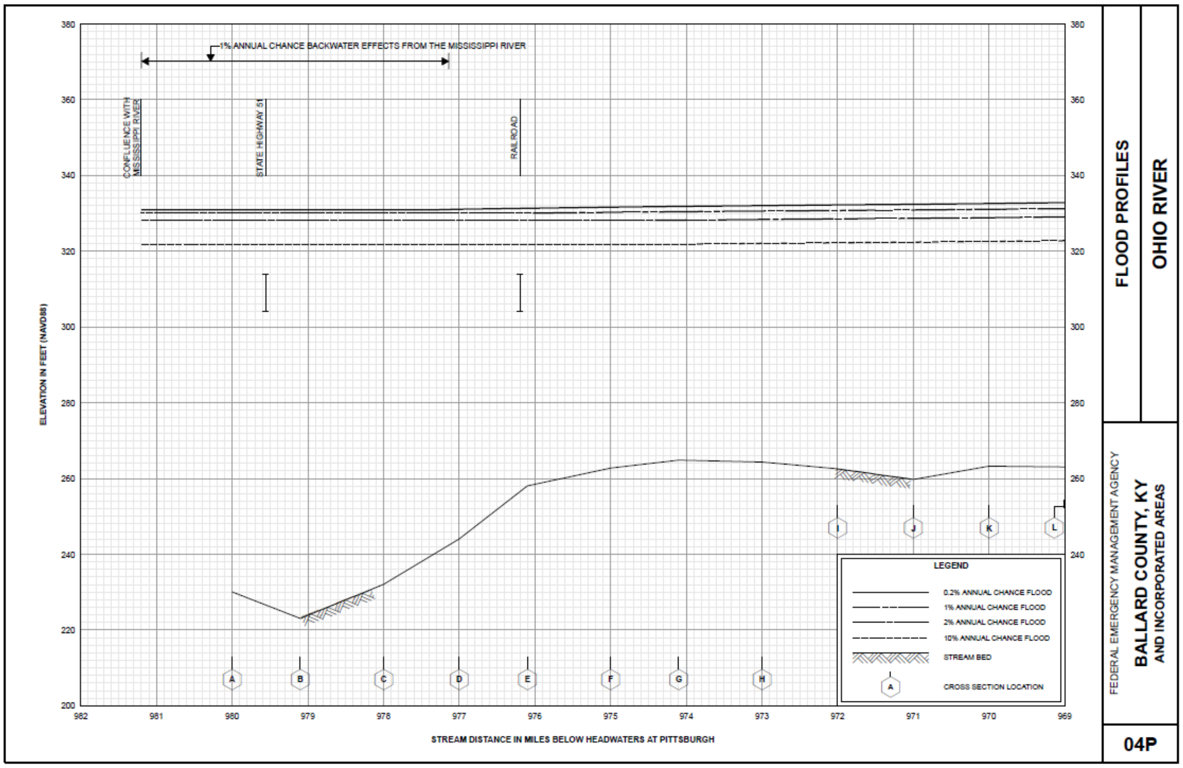

Figure 1: Flood Profiles Provided by Kentucky Division of Water

3. EXISTING PLANS

A review of the construction plans for the bridge (1936 by Modjeski, Masters, and Case, Inc. - Engineers) indicated the following:

Soil and Boring Data--US Government Precise Benchmark #182--Elevation 322.88 referred to Sandy Hook Datum. Elevations given referred to Sandy Hook Datum. Elevations along the upper Mississippi River and its many tributaries have been measured using many different datums. Three are still in active use: NAVD88, NGVD29, and the Fourth General Adjustment of 1912. Each vertical datum defines its own reference surface and will produce different heights. While many are aware of the NAVD88 and NGVD29 datums, few are as aware of the Fourth General Adjustment of 1912. With the Fourth General Adjustment of 1912, mean sea level was held at nine tide gage locations along the East, West, and Gulf coasts. One of these was Sandy Hook, New Jersey. Based on the notes in the plans, the elevation 322.88 feet is referenced to the Sandy Hook, New Jersey, tide gage. The article *Legacy height datums on the Mississippi and Illinois river systems by* Chris Pearson, NGS geodetic advisor for Illinois, and Dave Mick, Illinois Department of Natural Resources, provides a very good summary of height datums for the upper Mississippi River. A copy of this article is included in Appendix D. A portion of the plan sheet referencing the Sandy Hook Datum is illustrated in Figure 2 below.

4. SITE VISITS

The design team visited the site on multiple occasions. River hydraulics and navigation issues were noted and photographed. Below are illustrations of existing conditions and information identified during these site visits.

Photo No. 1: Vertical Control Mark *Cairo No. 4*

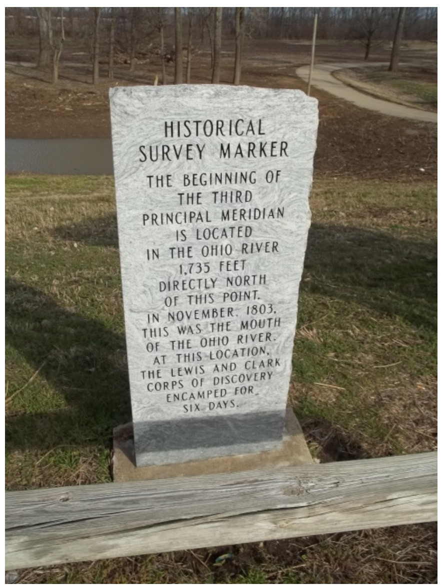

Photo No. 2: Historical Survey Marker Located on North Side of Ohio River

Photo No. 3: Barges on the Ohio River Upstream of US 51 Bridge

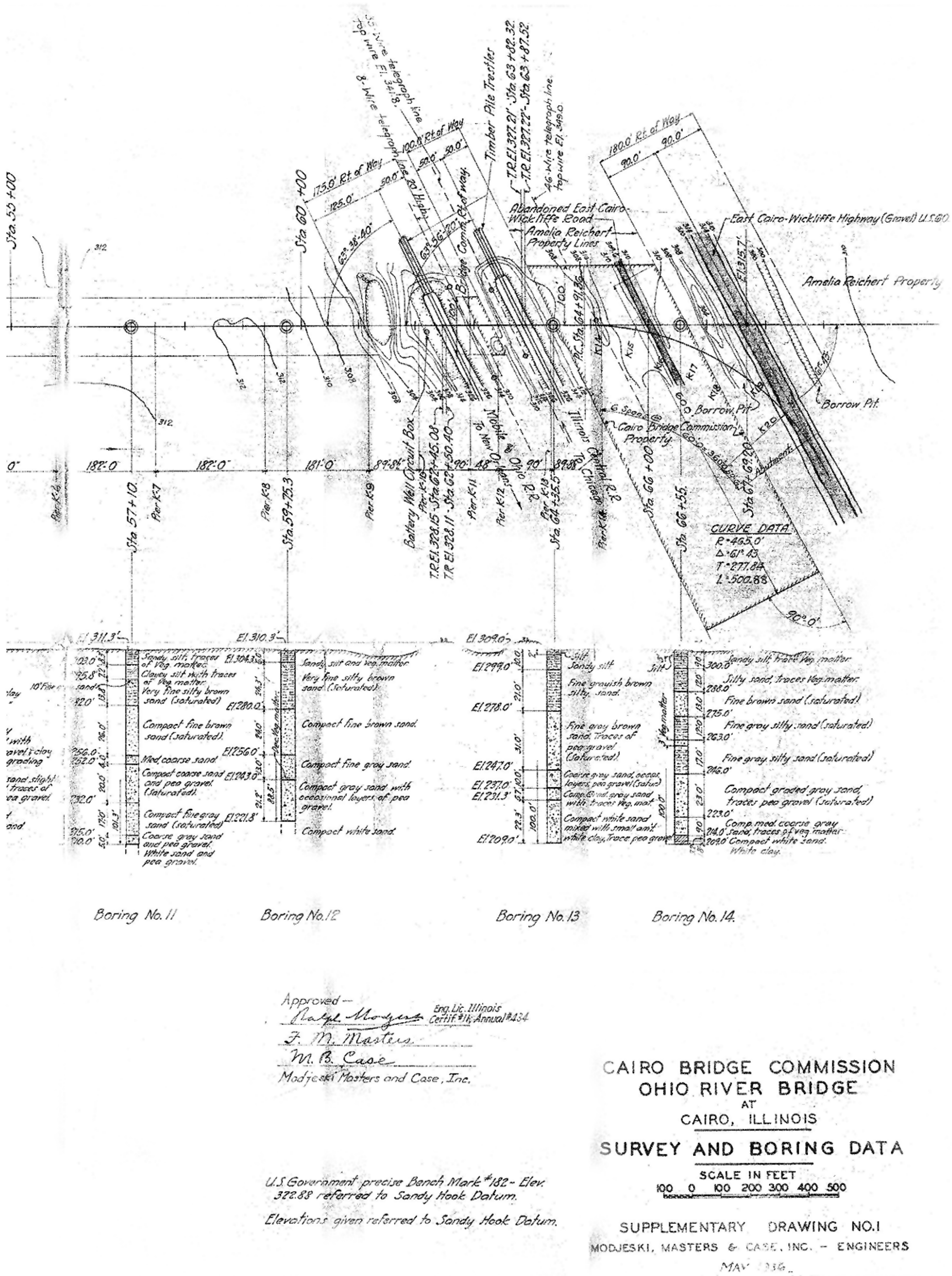

Figure 2: Survey and Soil Boring Plan Sheet, 1936

5. CONCULSIONs

Data summarized above and in the Appendices describe coordination activities with the agencies referenced. Information provided by these agencies was used with this study and will also be useful when this project is advanced to future phases of preliminary engineering, environmental assessment, and ultimately final design and construction.

APPENDIX A

UNITED STATES COAST GUARD

CORRESPONDENCE

U.S. Department of Homeland Security
United States Coast Guard

Commander
Eighth Coast Guard District

1222 Spruce Street, Room 2.102D
St. Louis, MO 63103-2832
Staff Symbol: dwb
Phone: (314)269-2382
Fax: (314)269-2737
Email: david.a.orzechowski@uscg.mil
www.uscg.mil/d8/westernriversbridges

16591.1/980.41 OHR
July 2, 2013

Mr. Michael P. McGregor, P.E.
Transportation Engineering Branch Manager
Kentucky Transportation Cabinet
Department of Highways, District 1 Office
5501 Kentucky Dam Road
Paducah, KY 42003

Subj: PROPOSED CAIRO HIGHWAY BRIDGE REPLACEMENT, MILE 980.41, OHIO RIVER

Dear Mr. McGregor:

This is in reply to your letter of May 15, 2013 regarding proposed alternatives for the subject bridge and provided the following response:

Alternative 1 – Reducing the Illinois and center navigational channels each by 30 feet is not conducive to the overall flow of navigation through a smaller horizontal navigational opening with the existing piers in place. This alternative is not recommended.

`Alternative 2 and 2B – These alternatives will not work where proposed pier placement is in the middle of the river with fleeting on both sides, also, during the state of high and low water, causes increased navigational issues for fleeting. These alternatives are not recommended.

Alternative 2A – No navigational issues. Proposed pier in the water acts like a protection for fleeting on the Illinois bank. This alternative would satisfy the reasonable needs of navigation and is recommended for further development.

Alternatives 3 and 3A – These alternatives are recommended based on proposed pier alignments, however, a 1200-foot horizontal navigation opening is recommended vs. 1000-feet.

Alternatives 4 and 5 – The middle pier on Alternative 5 needs to be shifted towards the left descending bank approximately 200 feet and the horizontal clearance increased to 1000 feet vs. 900 feet. Both alternative locations are in a less congestive area and each would satisfy the reasonable needs of navigation and are recommended for further development.

All alternatives presented shall provide a vertical clearance of at least 105.3 feet above zero on the Cairo gage.

I appreciate the opportunity to comment on the proposed bridge project. Should you have questions, please call Mr. David Orzechowski at above phone number.

Sincerely,

ERIC A. WASHBURN
Bridge Administrator, Western Rivers
By direction of the District Commander

U.S. Department of Homeland Security

United States Coast Guard

Commander
Eighth Coast Guard District

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16591.1/980.41 OHR
August 23, 2013

Mr. Michael P. McGregor, P.E.
Transportation Engineering Branch Manager
Kentucky Transportation Cabinet
Department of Highways, District 1 Office
5501 Kentucky Dam Road
Paducah, KY 42003

Subj: PROPOSED CAIRO HIGHWAY BRIDGE REPLACEMENT, MILE 980.41, OHIO RIVER

Dear Mr. McGregor:

Please refer to your letter dated August 15, 2013. The Combined Alternative 2 (2, 2A and 2B) would be acceptable from a navigational stand point. A navigation opening that provides a minimum horizontal clearance of 900 feet, a vertical clearance of at least 105.3 feet at the right descending pier and for the mid 700 feet of the horizontal span a vertical clearance of at least 113 feet measured above zero on the Cairo gage should satisfy the reasonable needs of navigation.

I appreciate the opportunity to comment on the proposed bridge project. Should you have questions, please call Mr. David Orzechowski at (314) 269-2382.

Sincerely,

ERIC A. WASHBURN
Bridge Administrator, Western Rivers
By direction

APPENDIX B

UNITED STATES ARMY CORPS OF ENGINEERS

OHIO RIVER NAVIGATION CHARTS

U.S. Army Corps of Engineers
Louisville District

Ohio River Navigation Charts

Cairo, Illinois to Foster, Kentucky

JUNE 2010

NAVIGATION CHARTS AND NOTICES

Navigation charts for the OHIO RIVER, within the limits of the LOUISVILLE DISTRICT, are available on our website at http://www.lrl.usace.army.mil for viewing and printing. Spiral-bound books are also available for purchase on the U.S. Government Printing Office website: http://bookstore.gpo.gov .

Notices to Navigation Interests, containing data on channel conditions and location of dredges, are issued as occasions demand. Request to be placed on the mailing list to receive these notices by writing to:

U.S. Army Corps of Engineers
Attn: CELRL-OP
600 Dr. Martin Luther King, Jr. Place
Louisville, KY 40202-0059

Charts of the Ohio River are as follows:
PITTSBURGH DISTRICT:
Mile 000.0 – 127.2

HUNTINGTON DISTRICT:
Mile 127.2 – 436.2

LOUISVILLE DISTRICT:
Mile 436.2 – 981.0

MILE POINTS

Mile points are shown on the charts at one mile intervals beginning with Mile 0 at Pittsburgh, PA (The Point).

BUOYS

Buoys used to mark channels in the Mississippi River System conform to the standard lateral system of buoyage on the Western Rivers of the United States. Generally, the unlighted buoys in the Ohio River are equipped with radar reflectors. All buoys are equipped with reflective material. Buoys on the left descending side of the channel reflect red. Buoys on the right descending side of the channel reflect green.

Buoys are set to mark maximum navigation channel available considering channel alignment, the prevailing river stage, and obstructions. Due to ever-changing environmental conditions, the location and number of buoys on-site do not necessarily coincide with these charts. The locations of printed buoys are approximate.

Buoys should always be given as wide a berth in passing as possible consistent with the length and width of vessel or tow and the width of the bend or crossing.

Buoys should always be used with caution. They may be carried off position by high water, accumulation of drift, ice, or sunk by collision or other causes. When carried off position, destroyed, or removed to prevent loss, buoys are replaced at the earliest opportunity.

Navigation lights and daybeacons are also shown in approximate locations. For additional information on lights, daymarks, daybeacons, and buoyage, see the U.S Coast Guard Light List, COMDTINST M16502, current edition.

FEDERAL MOORING BUOYS

Federal mooring buoys are for emergency use only, except where noted. These buoys shall not be used for recreational use or fleeting operations. Vessels using emergency buoys shall contact the nearest downstream lock upon mooring and again after departure.

DAMS

The height of the highest fixed points on the various parts of the locks and dams are shown in feet above the zero of the pass sill gage. Exceptions are noted on pages facing the page containing the dam to which they apply.

PERMITS – JURISDICTION

In the administration of laws enacted by Congress for the protection and preservation of navigation and the navigable waters of the United States, the U.S. Army Corps of Engineers exercises jurisdiction over the Ohio River and several of its tributary streams. Work or structures in, under, or over the Ohio River or any navigable tributary, between the limits of the ordinary high water lines on both banks of the stream require prior authorization. Inquiries regarding permits for such work or structures should be addressed to:

District Engineer
U.S. Army Engineer District, Louisville
Attn: CELRL-OP-F
600 Dr. Martin Luther King, Jr. Place
Louisville, KY 40202-0059

Inquiries may be made by telephone to:
(502)315-6733

VERTICAL CLEARANCE

Vertical clearances under bridges and aerial crossings are shown on back of charts preceding page showing respective features at project pool stage.

Existing clearances may be determined at open river stages, with reasonable accuracy, by method outlined in "EXAMPLE" below:

EXAMPLE - CSX R.R. Bridge (Chart 41)
(All Clearances are in feet)

RR Bridge Low Steel Elevation = 420.7
Evansville Gage "0" Elevation = 329.2

Current Gage Reading 43.0
Evansville "0" elevation 329.2
Water Surface elevation 372.2

RR Bridge Low Steel = 420.7
Water Surface el. = 372.2
Vertical Clearance = **48.5**

(Normal Pool Clearance)

Elevation of Low Steel = 420.7
Evansville Gage
Project Normal Pool Gage 12.8 = 342.0
Clearance at Normal Pool = **78.7**

(Using 1937 HW Readings)

Elevation of Low Steel = 420.7
1937 High Water (H.W.) 53.75
Current Reading - 43.00
(Distance in feet below H.W.)= 10.75
CSX R.R. Bridge:
1937 H.W. Clearance + 39.30
Current Clearance = **50.05**

1937 High Water (H.W.) Gage Reading		
GAGE		**READING**
Meldahl Lower Gage		75.50
Cincinnati, OH	Broadway	80.00
	U.S.W.B.	79.99
Markland Dam	Upper Gage	41.10
	Lower Gage	76.10
Madison, IN		72.30
McAlpine Dam	Upper Gage	52.15
	Lower Gage	85.44
Cannelton Dam	Upper Gage	34.00
	Lower Gage	60.40
Newburgh Dam	Upper Gage	40.00
	Lower Gage	58.00
Evansville, IN		53.75
Mt. Vernon, IN		59.15
John T. Myers Dam	Upper Gage	46.50
	Lower Gage	64.50
Smithland Dam	Upper Gage	39.90
	Lower Gage	61.90
Paducah, KY		60.50
Dam 52		62.30
Dam 53		64.00
Cairo, IL		59.50

WARNING
TO PLEASURE BOATERS AND FISHERMEN WHO NAVIGATE ON THE OHIO RIVER

Areas immediately upstream and downstream of the navigation dams in the Louisville District have been designated **Restricted Areas**. See the Legend Sheet for symbols that mark Restricted Areas and Danger Areas.

In recent years, there have been several **boating accidents** and **fatalities** as a result of vessels, particularly small fishing craft, operating too closely to navigation structures. Most of these accidents have occurred when boats approach too near the downstream side of a gated dam. Powerful reverse currents, commonly called **backlash**, draw boats in an upstream direction into the dam where there are capsized or smashed against the structure. Furthermore, an additional hazard exists in the vicinity of the lock discharge structures, which are located adjacent to the downstream river wall of the lock chamber. When the water in the locks is released during each locking operation, **sudden turbulent boils** are created which can capsize a boat venturing too near. This turbulence becomes more severe as the downstream pool falls to lower elevations.

On the upstream side of the dam, there is a **strong undertow** created by the flow of water through the gated section of the dam. Boats approaching too closely from the upstream side are in danger of being **lodged against the dam or capsized** by the undertow.

The nature of these river conditions emphasizes the serious danger to boaters and fishermen who operate their craft near either the upstream or downstream side of a dam. Vessel operators who enter these areas risk their lives and property and often preclude necessary gate operations of the locks and dams. Fishermen often fish in the tailwaters below the dam gates because the fishing is good. They must understand, however, that fishing from a boat in these **waters can be fatal**.

To supplement the **restricted areas**, the remaining area downstream of each dam, extending to the end of the long wall has been established as a **Danger Area**. All boaters and fishermen are urged to wear **Personal Floatation Devices (PFDs)** within this area, since these waters are frequently turbulent. Vessel operators should also heed the **warning sirens** which indicate that project personnel will be increasing flow from the dam or releasing water within the lock discharge areas. These sirens will be operated for a period of 30 seconds, after which, there will be a 3-minute delay prior to a release of water.

Navigators should become fully aware of the **Restricted and Danger Area boundaries** prior to operating their craft within the vicinity of a lock and dam facility. The **Restricted Areas** are shown in the current publication of the U.S. Army Corps of Engineers, Louisville District, “Ohio River Navigation Charts; Cairo, IL to Foster, KY.” Navigators should also observe all **warning signs** or **marker buoys** located within the area of each locks and dam structure. The marker buoys are illustrated with reflective orange bands and waterway symbols, and black wording on a white background. Buoys with the words “**KEEP OUT**” have, as their symbol, a cross enclosed within a diamond. Buoys designated as “**DANGER DAM**” are denoted with a diamond symbol.

The **regulations** pertaining to the **Restricted Areas** are contained within the U.S. Army Corps of Engineers’ “Regulations Prescribed by the Secretary of the Army for Ohio River, Mississippi River above Cairo, IL and their tributaries; Use, Administration, and Navigation” (Blue Book). These regulations are as follows:

33 CFR 207.300 “(s) Restricted Areas at Locks and Dams. All waters immediately above and below each dam, as posted by the respective District Engineers, are hereby designated as Restricted Areas. No vessel or other floating craft shall enter any such Restricted area at any time. The limits of the restricted areas at each dam will be determined by the responsible District Engineer and marked by signs and/or flashing red lights installed in conspicuous and appropriate places.”

Lockmasters will enforce adherence to these regulations and, if required, solicit **aid from local law enforcement** officers. In the interest of public safety, please tell other boaters or fishermen about the dangers of boating near lock and dam structures.

BE DAM CONSCIOUS!

REGULATIONS PRESCRIBED BY THE SECRETARY OF THE ARMY FOR THE OHIO RIVER ABOVE CAIRO, IL AND ITS TRIBUTARIES; USE, ADMINISTRATION, AND NAVIGATION

Section 7 of the River and Harbor Act of August 8, 1917

"That it shall be the duty of the Secretary of War to prescribe such regulations for the use, administration, and navigation of the navigable waters of the United States as in his judgment the public necessity may require for the protection of life and property, or of operations of the United States in channel improvement, covering all matters not specifically delegated by law to some other executive department. Such regulations shall be posted, in conspicuous and appropriate places, for the information of the public; and every person and every corporation which shall violate such regulations shall be deemed guilty of a misdemeanor and on conviction thereof in any district court of the United States within whose territorial jurisdiction such offense may have been committed, shall be punished by a fine not exceeding $500, or by imprisonment (in the case of a natural person) not exceeding six months, in the discretion of the court."

In pursuance of the law above quoted, the following regulations were prescribed to govern the use, administration, and navigation of the Ohio River above Cairo, IL and its tributaries.

Use, Administration, and Navigation

207.300 Ohio River, above Cairo, IL, and their tributaries; use, administration, and navigation.

a) Authority of Lockmasters

The lockmaster shall be charged with the immediate control and management of the lock, and of the area set aside as the lock area, including the lock approach channels. He shall see that all laws, rules, and regulations for the use of the lock and lock area are duly complied with, to which end he is authorized to give all necessary orders and directions in accordance therewith, both to employees of the Government and to any and every person within the limits of the lock or lock area, whether navigating the lock or not. No one shall cause any movement of any vessel, boat, or other floating thing in the lock or approaches except by or under the direction of the lockmaster or his assistants. In the event of an emergency, the lockmaster may depart from these regulations as he deems necessary. The lockmasters shall also be charged with the control and management of federally constructed mooring facilities.

b) Safety Rules for Vessels Using Navigation Locks

The following safety rules are hereby prescribed for vessels in the locking process, including the act of approaching or departing a lock:

I) Tows with flammable or hazardous cargo barges, loaded or empty

(i) Stripping barges or transferring cargo is prohibited.

(ii) All hatches on barges used to transport flammable or hazardous materials shall be closed and latched, except those barges carrying a gas-free certificate.

(iii) Spark-proof protective rubbing fenders ("possums") shall be used.

II) All Vessels

(i) Leaking vessels may be excluded from locks until they have been repaired to the satisfaction of the Lockmaster.

(ii) Smoking, open flames, and chipping or other spark producing activities are prohibited on deck during the locking cycle.

(iii) Painting will not be permitted in the lock chamber during the locking cycle.
(iv) Tow speeds shall be reduced to a rate of travel such that the tow can be stopped by checking should mechanical difficulties develop. Pilots should check with the individual lockmasters concerning prevailing conditions. It is also recommended that pilots check their ability to reverse their energies prior to beginning an approach.
Engines shall not be turned off in the lock until the tow has stopped and been made fast.
(v) U.S. Coast Guard Regulations require all vessels to have on board life saving devices for prevention of drowning. All crew members of vessels required to carry work vests (life jackets) shall wear them during a lockage, except those persons in an area enclosed with a handrail or other device which would reasonably preclude the possibility of falling overboard. All deckhands handling lines during locking procedures shall wear a life jacket. Vessels not required by Coast Guard Regulations to have work vests aboard shall have at least the prescribed life saving devices, located for ready access and use if needed. The lockmaster may refuse lockage to any vessel which fails to conform to the above.

c) Reporting of Navigation Incidents
In furtherance of increased safety on waterways the following safety rules are hereby prescribed for all navigation interests:
I) Any incident resulting in uncontrolled barges shall immediately be reported to the nearest lock. The report shall include information as to the number of loose barges, their cargo, and the time and location where they broke loose. The lockmaster or locks shall be kept informed of the progress being made in bringing the barges under control so that he can initiate whatever actions may be warranted.
II) Whenever barges are temporarily moored at other than commercial terminals or established fleeting areas, and their breaking away could endanger a lock, the nearest lock shall be so notified, preferably the downstream lock.
III) Sunken or sinking barges shall be reported to the nearest lock both downstream and upstream of the location in order that other traffic passing these points may be advised of the hazards.
IV) In the event of an oil spill, notify the nearest lock downstream, specifying the time and location of the incident, type of oil, amount of spill, and what recovery or controlling measures are being employed.
V) Any other activity on the waterways that could conceivably endanger navigation or a navigation structure shall be reported to the nearest lock.
VI) Whenever it is necessary to report an incident involving uncontrolled, sunken or sinking barges, the cargo in the barges shall be accurately identified.

d) Precedence at Locks
I) The vessel arriving first at a lock shall normally be first to lock through, but precedence shall be given to vessels belonging to the United States. Licensed commercial passenger vessels operating on a published schedule or regularly operating in the "for hire" trade shall have precedence over cargo tows and like craft. Commercial cargo tows shall have precedence over recreational craft, except as described in paragraph (f).

II) Arrival posts or markers maybe established above and/ or below the locks. Vessels arriving at or opposite such posts or markers will be considered as having arrived at the locks within the meaning of this paragraph. Precedence may be established visually or by radio communication. The lockmaster may prescribe such departure from the normal order of precedence as in his judgment is warranted to achieve best lock utilization.

e) Unnecessary Delay at Locks
Masters and pilots must use every precaution to prevent unnecessary delay in entering or leaving locks. Vessels failing to enter locks with reasonable promptness when signaled to do so shall lose their turn. Rearranging or switching of barges in the locks or in approaches is prohibited unless approved or directed by the lockmaster. This is not meant to curtail "jackknifing" or set-overs where normally practiced.

f) Lockage of Recreation Craft
In order to fully utilize the capacity of the lock, the lockage of recreational craft shall be expedited by locking them through with commercial craft, provided that both parties agree to joint use of the chamber. When recreational craft are locked simultaneously with commercial tows, the lockmaster will direct, whenever practicable, that the recreational craft enter the lock and depart while the tow is secured in the lock. Recreational craft will not be locked through with vessels carrying volatile cargoes or other substances likely to emit toxic or explosive vapors. If the lockage of recreational craft can not be accomplished within the time required for three other lockage of recreational craft shall be made. Recreational craft operators are advised that many locks have a pull chain located at each end of the lock which signals the lockmaster that lockage is desired.

g) Simultaneous Lockage of Tows with Dangerous Cargoes
Simultaneous lockage of other tows with tows carrying dangerous cargoes or containing flammable vapors normally will only be permitted when there is agreement between the lockmaster and both vessel masters that the simultaneous lockage can be executed safely. He shall make a separate decision each time such action seems safe and appropriate, provided:

I) The first vessel, or tow in, and the last vessel, or tow out, are secured before the other enters or leaves.
II) Any vessel or tow carrying dangerous cargoes is not leaking.
III) All masters involved have agreed to the joint use of the lock chamber.

h) Stations While Awaiting Lockage
Vessels awaiting their turn to lock shall remain sufficiently clear of the structure to allow unobstructed departure for the vessel leaving the lock. However, to the extent practicable under the prevailing conditions, vessels and tows shall position themselves so as to minimize approach time when signaled to do so.

i) Stations While Awaiting Access Through Navigable Pass
When navigable dams are up or are in the process of being raised or lowered, vessels desiring to use the pass shall wait outside the limits of the approach points unless authorized otherwise by the Lockmaster.

j) Signals
Signals from vessels shall ordinarily be by whistle; signals from locks to vessels shall be by whistle, another sound device, or visual means.

When a whistle is used, long blasts of the whistle shall not exceed 10 seconds and short blasts of the whistle shall not exceed 3 seconds. Where a lock is not provided with a sound or visual signal installation, the lockmaster will indicate by voice or by the wave of a hand when the vessels may enter or leave the lock. Vessels must approach the locks with caution and shall not enter nor leave the lock until signaled to do so by the lockmaster.

The following lockage signals are prescribed:

I) Sound Signals by Means of a Whistle

These signals apply at either a single lock or twin locks.

(i) Vessels desiring lockage shall on approaching a lock give the following signals at a distance of not more than one mile from the lock:

(a) If a single lockage only is required: One long blast of the whistle followed by one short blast.

(b) If a double lockage is required: One long blast of the whistle followed by two short blasts.

(ii) When the lock is ready for entrance, the lock will give the following signals:

(a) One long blast of the whistle indicates permission to enter the lock chamber in the case of a single lock or to enter the landward chamber in the case of twin locks.

(b) Two long blasts of the whistle indicates permission to enter the riverward chamber in the case of twin locks.

(iii) Permission to leave the locks will be indicated by the following signals given by the lock:

(a) One short blast of the whistle indicates permission to leave the lock chamber in the case of a single lock or to leave the landward chamber in the case of twin locks.

(b) Two short blasts of the whistle indicates permission to leave the riverward chamber in the case of twin locks.

(iv) Four or more short blasts of the lock whistle delivered in rapid succession will be used as a means of attracting attention, to indicate caution, and to signal danger. This signal will be used to attract the attention of the captain and crews of vessels using or approaching the lock or navigating in its vicinity and to indicate that something unusual involving danger or requiring special caution is happening or is about to take place. When this signal is given by the lock, the captains and crew of vessels in the vicinity shall immediately become on the alert to determine the reason for the signal and shall take the necessary steps to cope with the situation.

II) Lock Signal Lights

At locks where density of traffic or other local conditions make it advisable, the sound signals from the lock will be supplemented by signal lights. Flashing lights (showing a one-second flash followed by a two-second eclipse) will be located on or near each end of the land wall to control use of a single lock or of the landward lock of double locks. In addition, at double locks, interrupted flashing lights (showing a one-second flash, a one-second eclipse and a one-second flash, followed by a three-second eclipse) will be located on or near each end of the intermediate wall to control use of the riverward lock. Navigation will be governed as follows:

Red Light - Lock cannot be made ready immediately. Vessel shall stand clear.
Amber Light - Lock is being made ready. Vessel may approach but under full control.
Green Light - Lock is ready for entrance.
Green and Amber Lights - Lock is ready for entrance but gates cannot be recessed completely. Vessel may enter under full control and with extreme caution.
III) Radio Communication
VHF-FM radios, operating in the FCC authorized Maritime Band, have been installed at all operational locks, (except those at Lock 3, Green River). Radio contact may be made by any vessel desiring passage. Commercial tows are especially requested to make contact at least one half hour before arrival in order that the pilot may be informed of current river and traffic conditions that may affect the safe passage of his tow.

All locks monitor 156.8 MHz (Ch. 16) and 156.65 MHz (Ch. 13) and can work 156.65 MHz (Ch. 13) and 156.7 MHz (Ch. 14). Ch. 16 is the authorized call, reply and distress frequency, and locks are not permitted to work on this frequency except in an emergency involving the risk of immediate loss of life or property. Vessels may call and work Ch. 13, without switching, but are cautioned that vessel to lock traffic must not interrupt or delay Bridge to Bridge traffic which has priority at all times.

k) Rafts
Rafts to be locked through shall be moored in such manner as not to obstruct the entrance of the lock, and if to be locked in sections, shall be brought to the lock as directed by the lockmaster. After passing the lock the sections shall be reassembled at such distance beyond the lock as not to interfere with other vessels.

l) Entrance to and Exit from Locks
In case two or more boats or tows are to enter for the same lockage, their order of entry shall be determined by the lockmaster. Except as directed by the lockmaster, no boat shall pass another in the lock. In no case will boats be permitted to enter or leave the locks until directed to do so by the lockmaster. The sides of all craft passing through any lock shall be free from projections of any kind which might injure the lock walls. All vessels shall be provided with suitable fenders, and shall be used to protect the lock and guide walls until it has cleared the lock and guide walls.

m) Mooring
I) At Locks
(i) All vessels when in the locks shall be moored as directed by the lockmaster. Vessels shall be moored with bow and stern lines leading in opposite directions to prevent the vessel from "running" in the lock. All vessels will have one additional line available on the head of the tow for emergency use. The pilothouse shall be attended by qualified personnel during the entire locking procedure. When the vessel is securely moored, the pilot shall not cause movement of the propellers except in emergency or unless directed by the lockmaster. Tying to lock ladders is strictly prohibited.
(ii) Mooring of unattended or non-propelled vessels or small craft at the upper or lower channel approaches will not be permitted within 1200 feet of the lock.

II) Outside of Locks

(i) No vessel or other craft shall regularly or permanently moor in any reach of a navigation channel. The approximate centerline of such channels is marked as the sailing line on Corps of Engineers navigation charts. Nor shall any floating craft, except in an emergency, moor in any narrow or hazardous section of the waterway. Furthermore, all vessels or other craft are prohibited from regularly or permanently mooring in any section of navigable waterways which are congested with commercial facilities or traffic unless it is moored at facilities approved by the Secretary of the Army or his authorized representative. The limits of the congested areas shall be marked on Corps of Engineers navigation charts. However, the District Engineer may authorize in writing exceptions to any of the above if, in his judgment, such mooring would not adversely affect navigation and anchorage.

(ii) No vessel or other craft shall be moored to railroad tracks, to riverbanks in the vicinity of railroad tracks when such mooring threatens the safety of equipment using tracks, to telephone poles or power poles, or to bridges or similar structures used by the public.

(iii) Except in case of great emergency, no vessel or craft shall anchor over revetted banks of the river, and no floating plant other than launches and similar small craft shall land against banks protected by revetment except at regular commercial landings. In all cases, every precaution to avoid damage to the revetment works shall be exercised. The construction of log rafts along mattressed or paved banks or the tying up and landing of log rafts against such banks shall be performed in such a manner as to cause no damage to the mattress work or bank paving. Generally, mattress work extends out into the river 600 feet from the low water line.

(iv) Any vessel utilizing a federally constructed mooring facility (e.g. cells, buoys, anchor rings) at the points designated on the current issue of the Corps navigation charts shall advise the lockmaster at the nearest lock that from point by the most expeditious means.

n) Draft of Vessels

No vessel shall attempt to enter a lock unless its draft is at least three inches less than the least depth of water over the guard sills or over the gates sills if there be no guard sills. Information concerning controlling depth over sills can be obtained from the lockmaster at each lock or by inquiry at the office of the district engineer of the district in which the lock is located.

o) Handling Machinery

No one but employees of the United States shall move any lock machinery except as directed by the lockmaster. Tampering or meddling with the machinery or other parts of the lock is strictly forbidden.

p) Refuse in Locks

Placing or discharging refuse of any description into the lock, on lock walls or esplanade, canal or canal bank is prohibited.

q) Damage to Locks or Other Work

To avoid damage to plant and structures connected with the construction or repair of locks and dams, vessels passing structures in the process of construction or repair shall reduce their speed and navigate with special caution while in the vicinity of such work. The restrictions and admonitions contained in these regulations shall not affect the liability of the owners and operators of floating craft for any damage to locks or other structures caused by the operation such craft.

r) Trespass on Lock Property
Trespass on locks or dams or other United States property pertaining to the locks and dams is strictly prohibited except in those areas specifically permitted. Parties committing any injury to the locks and dams or to any part thereof will be responsible therefore. Any person committing a willful injury to any United States property will be prosecuted. No fishing will be permitted from lock walls, guide walls, or guard walls of any lock or from any dam, except in areas designated and posted by the responsible District Engineer as fishing areas. Personnel from commercial and recreational craft will be allowed on the lock structure for legitimate business reasons; e.g., crew changes, emergency phone calls, etc.

s) Restricted Areas at Locks and Dams
All water immediately above and below each dam, as posted by the respective District Engineers, are hereby designated as restricted areas. No vessel or other floating craft shall enter any such restricted area at any time. The limits of the restricted areas at each dam will be determine by the responsible District Engineer and marked by signs and/or flashing red lights installed in conspicuous and appropriate places.

t) Statistical Information
I) Masters of vessels shall furnish to the lockmaster such statistics of passengers or cargo as may be requested.
II) The owners or masters of vessels sunk in the navigable waters of the United States shall provide the appropriate District Engineer with a copy of the sunken vessel report furnished to the U.S. Coast Guard Marine Inspection Office in accordance with Code of Federal Regulations Title 33 Subpart 64.10-1.

u) Operations during High Water and Floods in Designated Vulnerable Areas
Vessels operating on these waters during periods when river stages exceed the level of "ordinary high water," as designated on Corps of Engineers navigation charts, shall exercise reasonable care to minimize the effect of their bow waves and propeller washes on river banks; submerged or partially submerged structures or habitations; terrestrial growth such as trees and bushes; and manmade amenities that may be present. Vessels shall operate carefully when passing close to levees and other flood protection works, and shall observe minimum distances from banks which may be prescribe from time to time in Notices to Navigation Interests. Pilots should exercise particular care not to direct propeller wash at river banks, levees, revetments, structures or other appurtenances subject to damage from wave action.

v) Navigation Lights for Use at All Locks and Dams

I) At locks at all fixed dams and at locks at all movable dams when the dams are up so that there is no navigable pass through the dam, the following navigation lights will be displayed during hours of darkness:

(i) Three green lights visible through an arc of 360° arranged in a vertical line on the upstream end of the river (guard) wall unless the intermediate wall extends farther upstream. In the latter case, the lights will be placed on the upstream end of the intermediate wall.

(ii) Two green lights visible through an arc of 360° arranged in a vertical line on the downstream end of the river (guard) wall unless the intermediate wall extends farther downstream. In the latter case, the lights will be placed on the downstream end of the intermediate wall.

(iii) A single red light, visible through an arc of 360° on each end (upstream and downstream) of the land (guide) wall.

II) At movable dams when the dam has been lowered or partly lowered so that there is an unobstructed navigable pass through the dam, the navigation lights indicated in the following paragraphs will be displayed during hours of darkness until lock walls and weir piers are awash.

(i) Three red lights visible through an arc of 360° arranged in a vertical line on the upstream end of the river (guard) wall.

(ii) Two red lights visible through an arc of 360° arranged in a vertical line on the downstream end of the river (guard) wall.

(iii) A single red light visible through an arc of 360° on each end (upstream and downstream) of the land (guide) wall.

III) After lock walls and weir piers are awash they will be marked as prescribed in paragraph (x) below.

IV) If one or more bear traps or weirs are open or partially open, and may cause a set in current conditions at the upper approach to the locks, this fact will be indicated by displaying a white circular disk 5 feet in diameter, on or near the light support on the upstream end of the land (guide) wall during the hours of daylight, and will be indicated during hours of darkness by displaying a white (amber) light vertically under and 5 feet below the red light on the upstream end of the land (guide) wall.

V) At Locks No. 1 and 2, Green River, when the locks are not in operation because of high river stages, a single red light visible through an arc of 360° will be displayed on each end (upstream and downstream) of the lock river (guard) wall at which time the lights referred to above will not be visible.

w) Navigation Lights for Use at Locks and Dams on the Green River

A single red light visible through an arc of 360° shall be displayed during hours of darkness at each end of the river wall or extending guard structures until these structures are awash.

x) Buoys at Movable Dams

I) Whenever the river (guard) wall of the lock and any portion of the dam are awash, and until covered by a depth, the limits of the navigable pass through the dam will be marked by buoys located at the upstream and downstream ends of the river (guard) wall, and by a single buoy over the end or ends of the portion or portions of the dam adjacent to the navigable pass over which project depth is not available. A red nun-type buoy will be used for such structures located on the left-hand side (facing downstream) of the river and a green can-type buoy for such structures located on the right-hand side. Buoys will be lighted, if practicable.

II) Where powerhouses or other substantial structures projecting considerably above the level of the lock wall are located on the river (guard) wall, a single red light located on top of one of these structures maybe used instead of river wall buoys prescribed above until these structures are awash, after which they will be marked by a buoy of appropriate type and color (red nun or green can buoy) until covered by a depth of water equal to the project depth. Buoys will be lighted, if practicable.

y) Vessels to Carry Regulations

A copy of these regulations shall be kept at all times on board each vessel regularly engaged in navigating the rivers to which these regulations apply. Copies may be obtained from any lock office or District Engineer’s office on request. Masters of such vessels are encouraged to have on board copies of the current edition of appropriate navigation charts.

EXTRACT FROM THE RIVER AND HARBOR ACT OF 1899

SECTION 15

That it shall not be lawful to tie up or anchor vessels or other craft in navigable channels in such a manner as to prevent or obstruct the passage of other vessels or craft; or to sink, or permit or cause to be sunk, vessels or other craft in navigable channels; or to float loose timber and logs, or to float what is known as sack rafts of timber and logs in streams or channels actually navigated by steamboats in such manner as to obstruct, impede, or endanger navigation. And whenever a vessel, raft, or other craft is wrecked and sunk in a navigable channel, it shall be the duty of the owner, lessee, or operator of such sunken craft to immediately mark it with a buoy or beacon during the day and a lighted lantern at night, and to maintain such marks until the sunken craft is removed or abandoned, and the neglect or failure of the said owner, lessee, or operator to do so shall be unlawful; and it shall be the duty of the owner, lessee, or operator of such sunken craft to commence the immediate removal of the same, and prosecute such removal diligently, and failure to do so shall be considered as an abandonment of such craft, and subject the same to removal by the United States as hereinafter provided for (30 St. 1152; 33 U.S.C. §409).

SECTION 16

That every person and every corporation that shall violate, or that shall knowingly aid, abet, authorize, or instigate a violation of the provisions of sections thirteen, fourteen, and fifteen of this Act shall be guilty of a misdemeanor, and on conviction thereof shall be punished by a fine not exceeding twenty-five hundred dollars nor less than five hundred dollars, or by imprisonment (in the case of a natural person) for not less than thirty days nor more than one year, or by both such fine and imprisonment, in the discretion of the court, one-half of said fine to be paid to the person or persons giving information which shall lead to conviction (30 Stat. 1153; 33 U.S.C §411). And any and every master, pilot, and engineer, or person or persons acting in such capacity, respectively, on board of any boat or vessel who shall knowingly engage in towing any scow, boat, or vessel loaded with any material specified in section thirteen of this Act to any point or place or deposit or discharge in any harbor or navigable water, elsewhere than within the limits defined and permitted by the Secretary of War, or who shall willfully injure or destroy any work of the United States contemplated in section fourteen of this Act, or who shall willfully obstruct the channel of any waterway in the manner contemplated in section fifteen of this Act, shall be deemed guilty of a violation of this Act, and shall upon conviction be punished as hereinbefore provided in this section, and shall also have his license revoked or suspended for a term to be fixed by the judge before whom tried and convicted. And any boat, vessel, scow, raft, or other craft used or employed in violating any of the provisions of sections thirteen, fourteen, and fifteen of this Act shall be liable for the pecuniary penalties specified in this section, and in addition thereto for the amount of the damages done by said boat, vessel, scow, raft, or other craft, which latter sum of the harbor or waterway in which the damage occurred, and said boat, vessel, scow, raft, or other craft may be proceeded against summarily by way of libel in any district court of the United States having jurisdiction thereof (30 Stat. 1153; 33 U.S.C. §412).

SECTION 19

(a) That whenever the navigation of any river, lake, harbor, sound, bay, canal, or other navigable waters of the United States shall be obstructed or endangered by any sunken vessel, boat, watercraft, raft, or other similar obstruction, and such obstruction has existed for a longer period than thirty days, or whenever the abandonment of such obstruction can be legally established in a less space of time, the sunken vessel, boat, watercraft, raft, or other obstruction shall be subject to be broken up, removed, sold, or otherwise disposed of by the

Secretary of War at his discretion, without liability for any damage to the owners of the same; PROVIDED, That in his discretion, the Secretary of War may cause reasonable notice of such obstruction of not less than thirty days, unless the legal abandonment of the obstruction can be established in less time, to be given by publication, addressed "To whom it may concern", in a
newspaper published nearest to the locality of the obstruction, requiring the removal thereof; AND PROVIDED ALSO, That the Secretary of War may, in his discretion, at or after the time of giving such notice, cause sealed proposals to be solicited by public advertisement, giving reasonable notice of less than ten days, for the removal of such obstruction as soon as possible after the expiration of the above specified thirty days' notice, in case it has not in the meantime been so removed, these proposals and contracts, at his discretion, to be conditioned that such vessel, boat, watercraft, raft, or other obstruction, and all cargo and property contained therein, shall become the property of the contractor, and the contract shall be awarded to the bidder making the proposition most advantageous to the United States; PROVIDED, That such bidder shall give satisfactory security to execute the work; PROVIDED FURTHER, That any money received from the sale of any such wreck, or from any contractor for the removal of wrecks, under this paragraph shall be covered into the Treasury of the United States (30 Stat. 1154; 33 U.S.C. §414).

(b) The owner, lessee, or operator of such vessel, boat, watercraft, raft, or other obstruction as described in this section shall be liable to the United States for the cost of removal or destruction and disposal as described which exceeds the costs recovered under subsection (a). Any amount recovered from the owner, lessee, or operator of such vessel pursuant to this subsection to recover costs in excess of the proceeds from the sale or disposition of such vessel shall be deposited in the general fund of the Treasury of the United States.

<u>SECTION 20</u>

(a) That under emergency, in the case of any vessel, boat, watercraft, raft, or similar obstruction, sinking or grounding, or being unnecessarily delayed in any Government canal or lock, or in any navigable waters mentioned in section nineteen, in such manner as to stop, seriously interfere with, or specially endanger navigation, in the opinion of the Secretary of War, or any agent of the United States to whom the Secretary may delegate proper authority, the Secretary of War or any such agent shall have the right to take immediate possession of such boat, vessel, or other watercraft, or raft, so far as to remove or to destroy it and to clear immediately the canal, lock, or navigable waters aforesaid of the obstruction thereby caused, using his best judgment to prevent any unnecessary injury; and no one shall interfere with or prevent such removal or destruction; PROVIDED, That the officer or agent charged with the removal or destruction of an obstruction under this section may in his discretion give notice in writing to the owners of any such obstruction requiring them to remove it; AND PROVIDED FURTHER, That the expense of removing any such obstruction as aforesaid shall be a charge against such craft and cargo; and if the owners thereof fall or refuse to reimburse the United States for such expense within thirty days after notification, then the officer or agent aforesaid may sell the craft or cargo, or any part thereof that may not have been destroyed in removal, and the proceeds of such sale shall be covered into the Treasury of the United States (30 Stat. 1154; 33 U.S.C. §415).

(b) The owner, lessee, or operator of such vessel, boat, watercraft, raft, or other obstruction as described in this section shall be liable to the United States for the cost of removal or destruction and disposal as described which exceeds the costs recovered under subsection (a). Any amount recovered from the owner, lessee, or operator of such vessel pursuant to this subsection to recover costs in excess of the proceeds from the sale of disposition of such vessel shall be deposited in the general fund of the Treasury of the United States.

U.S. Navigation Lights
Daybeacons
Mile Board 437.0

WATER WORKS LIGHT &
DAYMARKS 792.0
FL G4s SG(U), SG(D)

Buoys
- Can (Green)
- Nun (Red)
- Junction (Red/Green)
- Hazard (Lighted)

Arrival Point for Lockage AP

Spot Elevations +302
Mile Marker
Sailing Line
Secondary Sailing Line
Aerial Crossing
Submarine Crossing:
- Pipeline
- Cable

Commercial Docks:
- Cells
- Intake
- Diffusion Outfall Pipe
- Dolphin

Recreational Facilities:
- Launching Ramp
- Dock or Marina

Ordinary High Water Elevation: OHW 376.6

Miscellaneous:
- Coast Guard Station CG
- Tank
- Tower
- Ferry
- Crane

Regulated Navigation Areas: See Notes

Restricted Area No Vessels Allowed

Gages

Land Features:
- Revetment/Rip Rap
- Swamp
- Levee/Flood Wall
- Rock Wall
- Dike (Top Elev. Shown) DIKE Elev. 317

Wrecks:
- Visible Wreck
- Submerged Wreck
- Submerged Wreck (Depth Known) -6.5

Bottom Information:
- Land Above Project Pool
- Water, with Less Than 9' Depth at Project Pool
- Water, with 9' or More Depth at Project Pool
- Drying Height, Area that is Dry at Project Pool

Rock

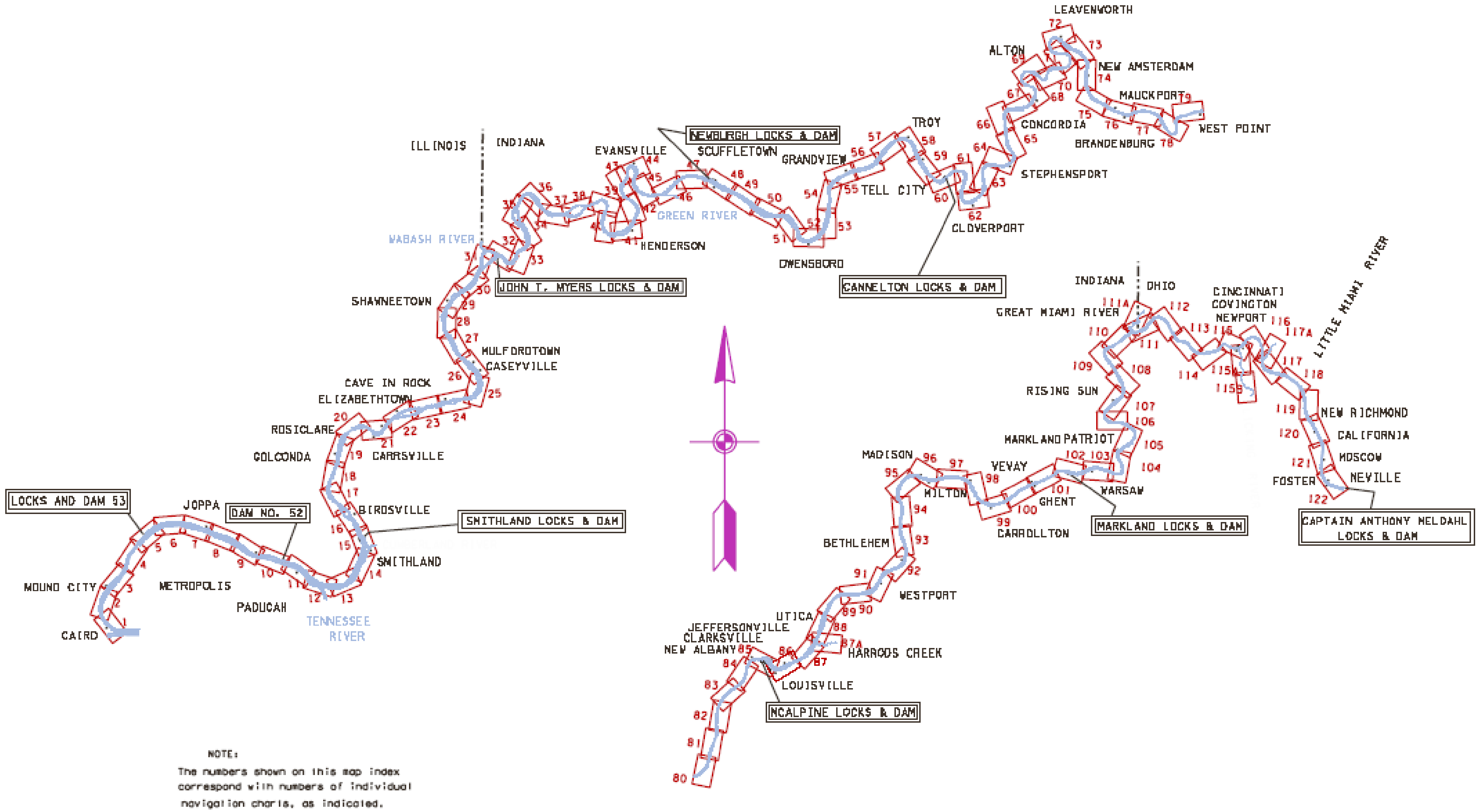
State Boundary

County Boundary

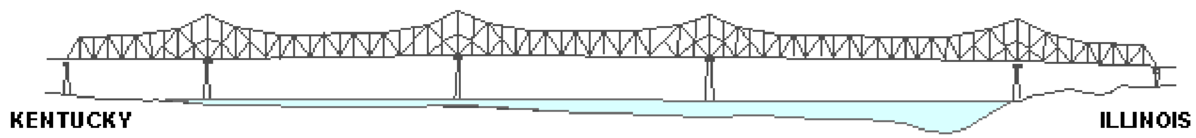
LEGEND
OHIO RIVER
LOUISVILLE DISTRICT

SHEET I

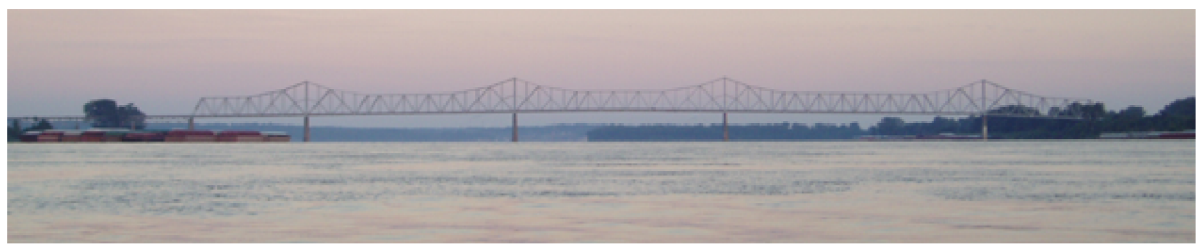
OHIO RIVER NAVIGATION CHARTS



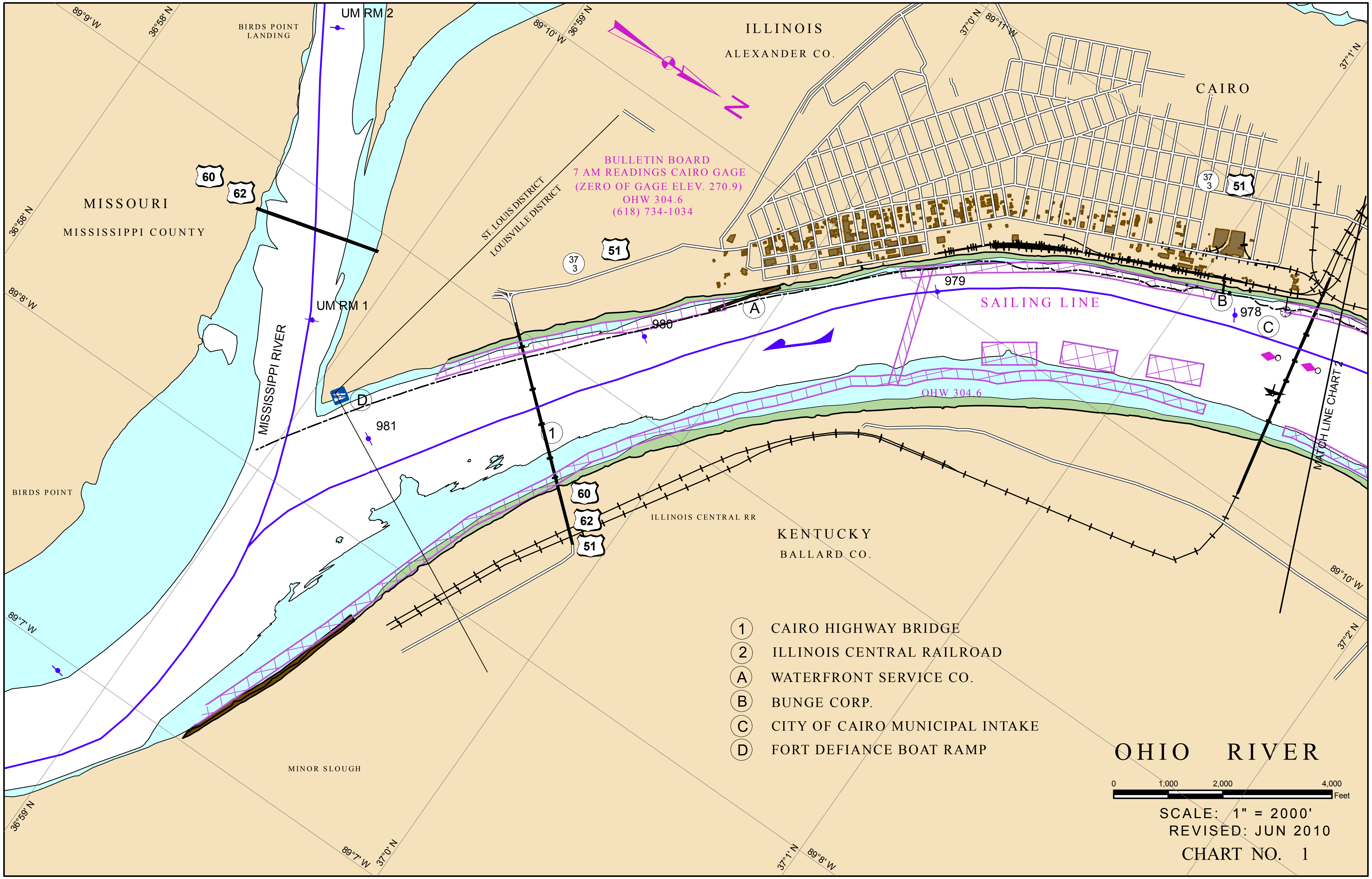
UNITED STATES ARMY CORPS OF ENGINEERS – LOUISVILLE DISTRICT
CHART INDEX - SHEET J



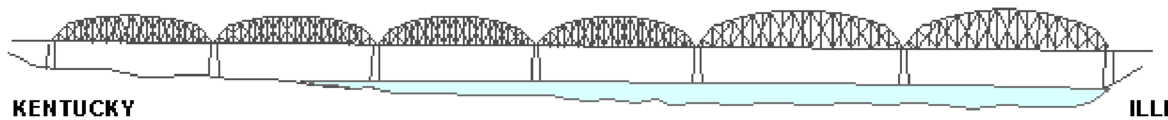
	CENTER SPAN		ILLINOIS SPAN	
	KY. PIER	ILLN. PIER	KY. PIER	ILLN. PIER
ELEVATION OF LOW STEEL	387.8'	387.4'	387.4'	376.2'
VERTICAL CLEARANCE AT POOL STAGE	116.9'	116.4'	116.4'	105.3'
HORIZONTAL CLEARANCE	630'		780'	



CAIRO HIGHWAY (US 60) BRIDGE (Ohio River Mile 980.4)

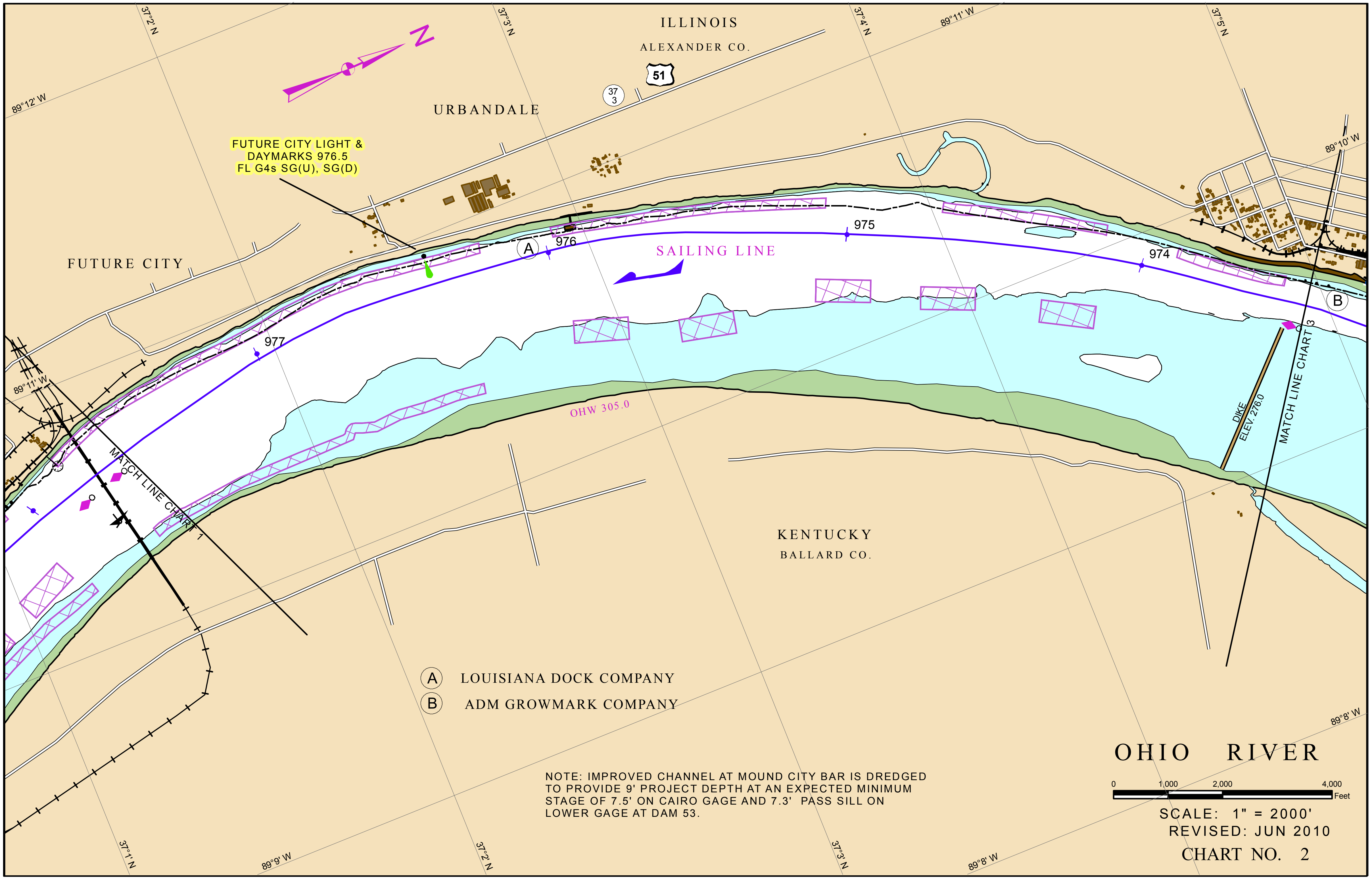


ILLINOIS
ALEXANDER CO.
CAIRO
MISSOURI
MISSISSIPPI COUNTY
BIRDS POINT LANDING
BIRDS POINT
MISSISSIPPI RIVER
UM RM 2
UM RM 1
ST. LOUIS DISTRICT
LOUISVILLE DISTRICT
BULLETIN BOARD
7 AM READINGS CAIRO GAGE
(ZERO OF GAGE ELEV. 270.9)
OHW 304.6
(618) 734-1034
SAILING LINE
OHW 304.6
981
980
979
978
ILLINOIS CENTRAL RR
KENTUCKY
BALLARD CO.
MINOR SLOUGH
MATCH LINE CHART 2
1 CAIRO HIGHWAY BRIDGE
2 ILLINOIS CENTRAL RAILROAD
A WATERFRONT SERVICE CO.
B BUNGE CORP.
C CITY OF CAIRO MUNICIPAL INTAKE
D FORT DEFIANCE BOAT RAMP
OHIO RIVER
0 1,000 2,000 4,000 Feet
SCALE: 1" = 2000'
REVISED: JUN 2010
CHART NO. 1



ELEVATION OF LOW STEEL	375.5'
VERTICAL CLEARANCE AT POOL STAGE	104.6'
HORIZONTAL CLEARANCE	500.5'

ILLINOIS CENTRAL RAILROAD BRIDGE (Ohio River Mile 977.7) Downstream View



Ⓐ LOUISIANA DOCK COMPANY

Ⓑ ADM GROWMARK COMPANY

NOTE: IMPROVED CHANNEL AT MOUND CITY BAR IS DREDGED TO PROVIDE 9' PROJECT DEPTH AT AN EXPECTED MINIMUM STAGE OF 7.5' ON CAIRO GAGE AND 7.3' PASS SILL ON LOWER GAGE AT DAM 53.

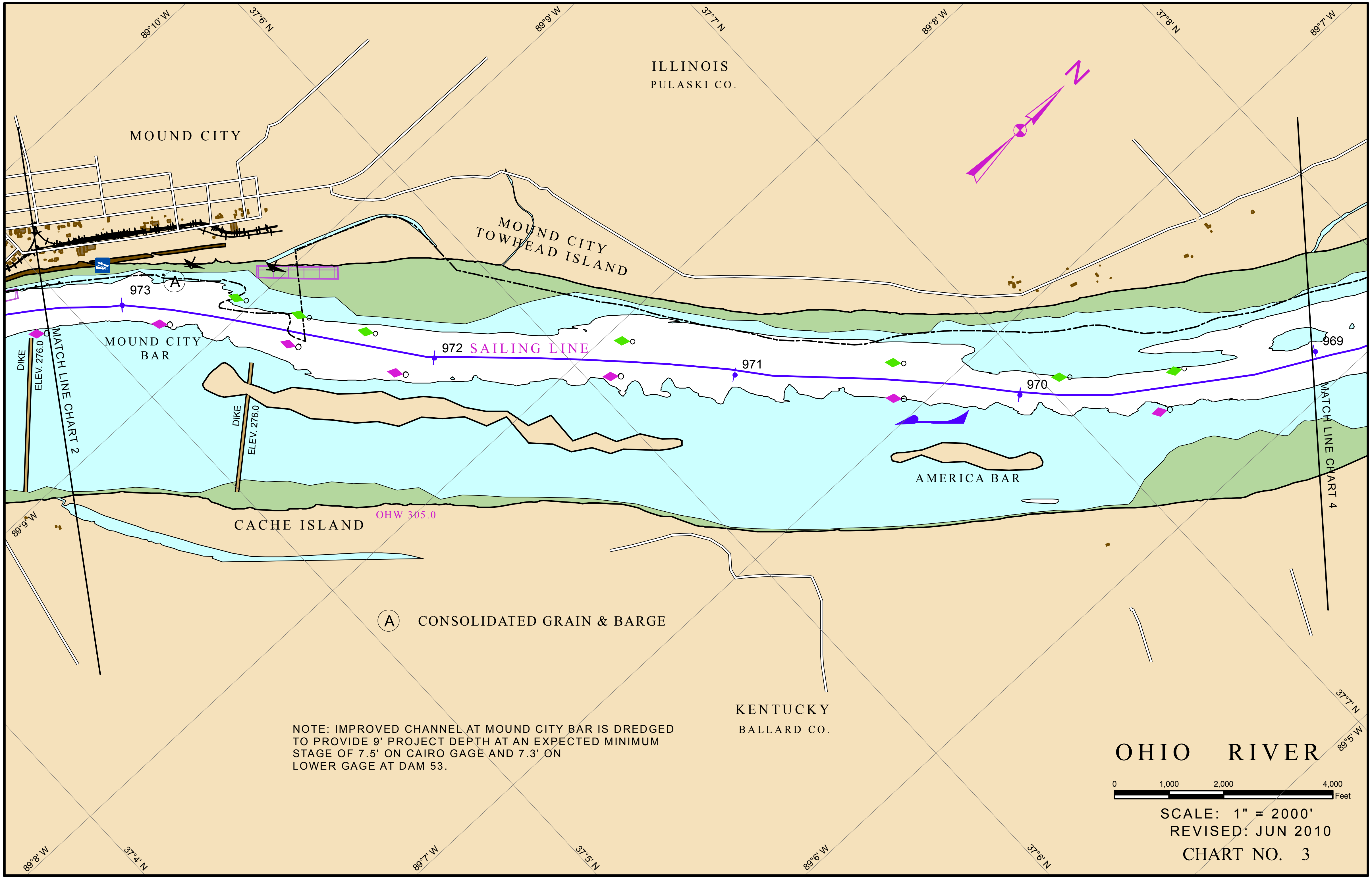
OHIO RIVER

0 1,000 2,000 4,000 Feet

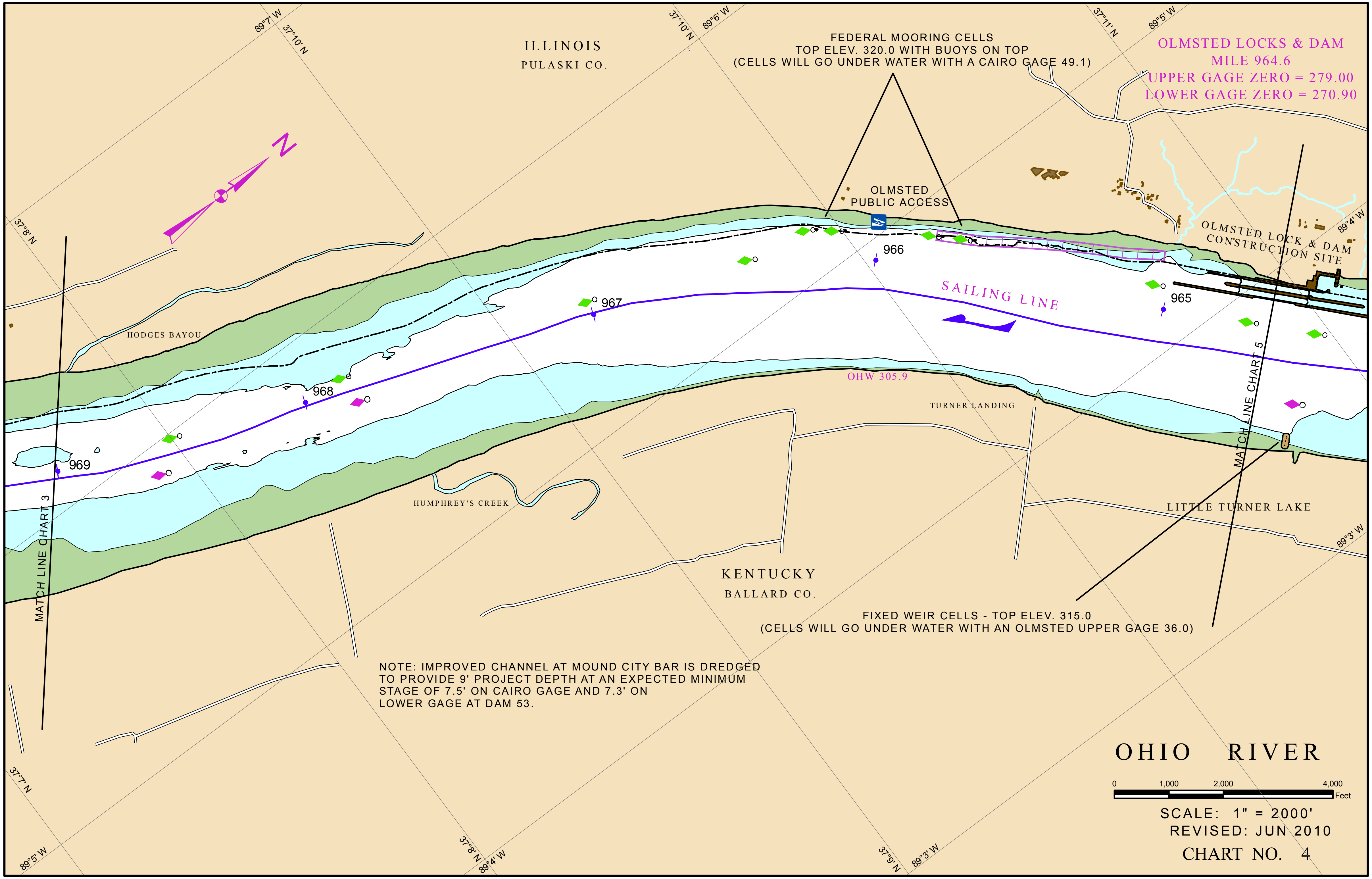
SCALE: 1" = 2000'

REVISED: JUN 2010

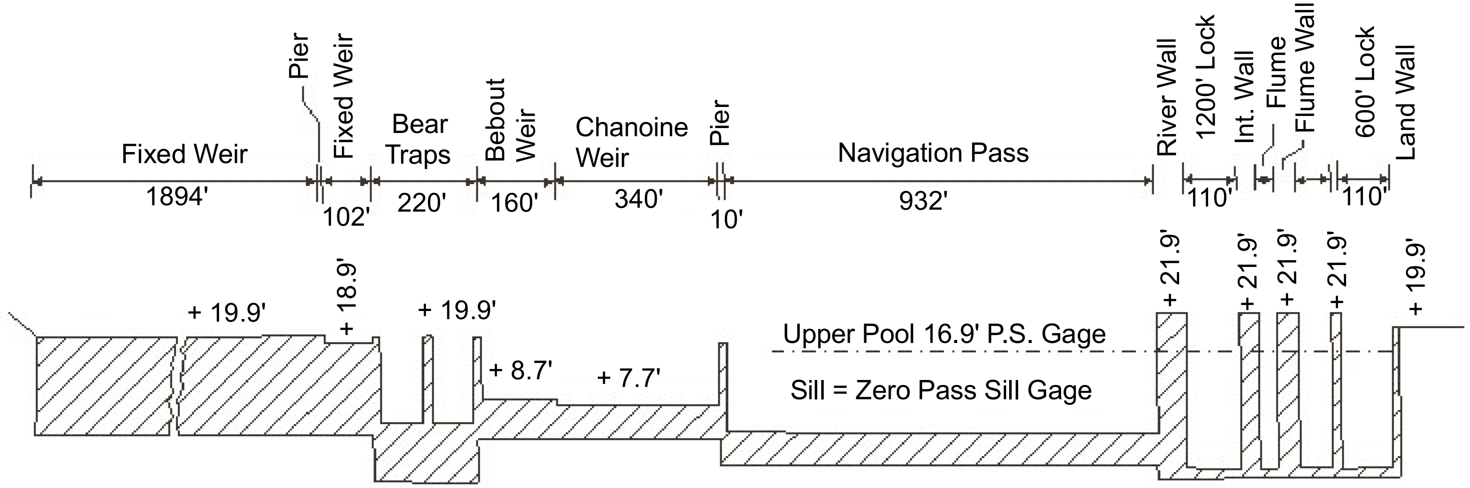
CHART NO. 2



ILLINOIS
PULASKI CO.
MOUND CITY
MOUND CITY TOWHEAD ISLAND
973
A
MOUND CITY BAR
972
SAILING LINE
971
970
969
DIKE ELEV. 276.0
DIKE ELEV. 276.0
MATCH LINE CHART 2
MATCH LINE CHART 4
AMERICA BAR
CACHE ISLAND
OHW 305.0
A CONSOLIDATED GRAIN & BARGE
KENTUCKY
BALLARD CO.
NOTE: IMPROVED CHANNEL AT MOUND CITY BAR IS DREDGED TO PROVIDE 9' PROJECT DEPTH AT AN EXPECTED MINIMUM STAGE OF 7.5' ON CAIRO GAGE AND 7.3' ON LOWER GAGE AT DAM 53.
OHIO RIVER
0 1,000 2,000 4,000 Feet
SCALE: 1" = 2000'
REVISED: JUN 2010
CHART NO. 3
89°10' W
37°6' N
89°9' W
37°7' N
89°8' W
37°8' N
89°7' W
89°9' W
89°8' W
37°4' N
89°7' W
37°5' N
89°6' W
37°6' N
37°7' N
89°5' W



ILLINOIS
PULASKI CO.
FEDERAL MOORING CELLS
TOP ELEV. 320.0 WITH BUOYS ON TOP
(CELLS WILL GO UNDER WATER WITH A CAIRO GAGE 49.1)
OLMSTED LOCKS & DAM
MILE 964.6
UPPER GAGE ZERO = 279.00
LOWER GAGE ZERO = 270.90
OLMSTED
PUBLIC ACCESS
OLMSTED LOCK & DAM
CONSTRUCTION SITE
HODGES BAYOU
966
967
965
968
969
SAILING LINE
OHW 305.9
TURNER LANDING
HUMPHREY'S CREEK
LITTLE TURNER LAKE
MATCH LINE CHART 3
MATCH LINE CHART 5
KENTUCKY
BALLARD CO.
FIXED WEIR CELLS - TOP ELEV. 315.0
(CELLS WILL GO UNDER WATER WITH AN OLMSTED UPPER GAGE 36.0)
NOTE: IMPROVED CHANNEL AT MOUND CITY BAR IS DREDGED
TO PROVIDE 9' PROJECT DEPTH AT AN EXPECTED MINIMUM
STAGE OF 7.5' ON CAIRO GAGE AND 7.3' ON
LOWER GAGE AT DAM 53.
OHIO RIVER
0 1,000 2,000 4,000 Feet
SCALE: 1" = 2000'
REVISED: JUN 2010
CHART NO. 4



BULLETIN BOARD

P.S.GAGE 16.9' = UPPER POOL
L. GAGE 2.9' = 9' DEPTH
ON LOWER MITER SILL

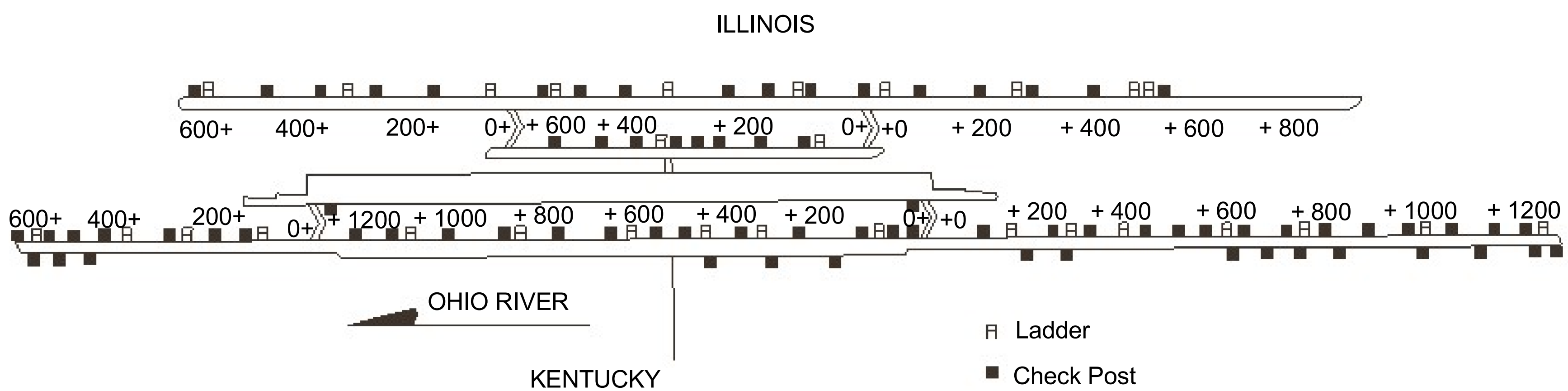
DAM NO. 53

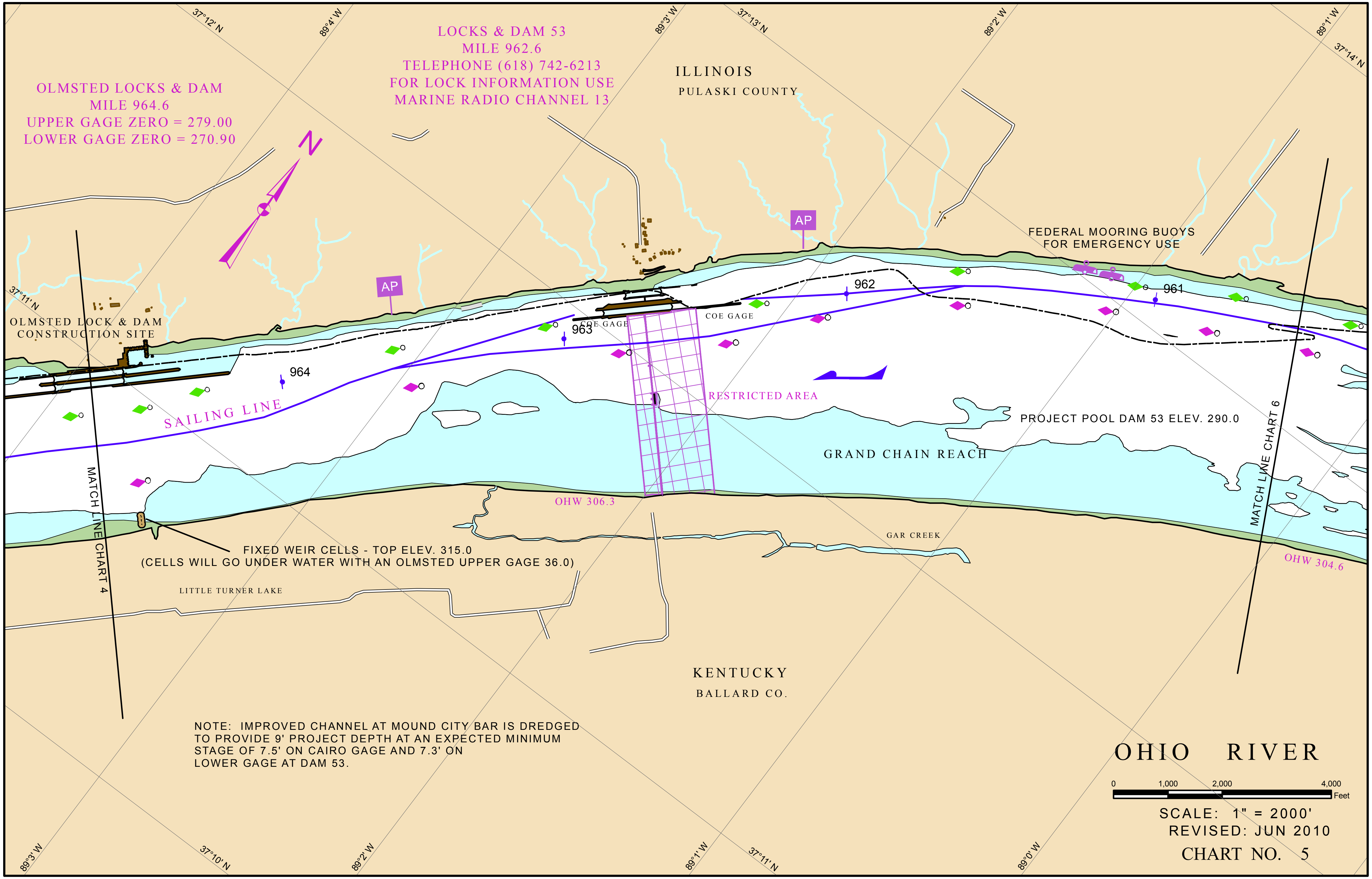
ELEVATION LOOKING DOWNSTREAM

(LOCK SIZE 600' x 110')

(LOCK SIZE 1200' x 110')

ZERO OF GAGE - DAM NO. 53	
UPPER SILL	ELEV 273.1
LOWER SILL	ELEV 273.1





OLMSTED LOCKS & DAM
MILE 964.6
UPPER GAGE ZERO = 279.00
LOWER GAGE ZERO = 270.90
LOCKS & DAM 53
MILE 962.6
TELEPHONE (618) 742-6213
FOR LOCK INFORMATION USE
MARINE RADIO CHANNEL 13
ILLINOIS
PULASKI COUNTY
FEDERAL MOORING BUOYS
FOR EMERGENCY USE
OLMSTED LOCK & DAM
CONSTRUCTION SITE
AP
964
963
962
961
COE GAGE
COE GAGE
SAILING LINE
RESTRICTED AREA
PROJECT POOL DAM 53 ELEV. 290.0
GRAND CHAIN REACH
OHW 306.3
OHW 304.6
GAR CREEK
MATCH LINE CHART 4
MATCH LINE CHART 6
FIXED WEIR CELLS - TOP ELEV. 315.0
(CELLS WILL GO UNDER WATER WITH AN OLMSTED UPPER GAGE 36.0)
LITTLE TURNER LAKE
KENTUCKY
BALLARD CO.
NOTE: IMPROVED CHANNEL AT MOUND CITY BAR IS DREDGED
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STAGE OF 7.5' ON CAIRO GAGE AND 7.3' ON
LOWER GAGE AT DAM 53.
OHIO RIVER
0 1,000 2,000 4,000 Feet
SCALE: 1" = 2000'
REVISED: JUN 2010
CHART NO. 5

MILE	LOCATION	OWNER or OPERATOR	TYPE of FREIGHT	SHELTER	MECHANICAL APPLIANCES	RAIL CONNECTION	REMARKS
943.0R	Metropolis, IL	TECO Barge Line	NONE	Workshop	Wharf Barge	NONE	Mid-stream Fueling Service
944.0R	Metropolis, IL	Delta Materials Co.,Inc	Sand & Gravel	NONE	Portable Hopper	NONE	
946.0L	West Paducah, KY	Shawnee Steam Plant	Coal	NONE	Covered Conveyors & Crane	IC RR	
947.5R	Metropolis, IL	Cook Coal Dock	Coal	Silos	Pipelines & Conveyor	Burlington- Northern RR	(33) Mooring Cells
952.3R	Joppa, IL	Joppa Steam Plant Electric Energy Inc.	Coal	NONE	Covered Conveyor & Crane	IC RR	
953.2R	Joppa, IL	LaFarge Cement Corporation	Cement & Crushed Rock	Silos	Pipelines & Conveyors	IC RR	9 Mooring Cells With Covered Storage Area
972.9R	Mound City, IL	Consolidated Grain & Barge Co.	Grain	NONE	Conveyor	IC RR	3 Cells
973.5R	Mound City, IL	ADM/Growmark Co.	Grain & Grain By-Products	Storage Tanks	Conveyor	IC RR	Loading Only
975.8R	Cairo, IL	L.D. Street Oil Co., Inc.	Gasoline, Kerosene, Diesel & Fuel Oil	Storage Tanks	Pipelines	IC RR	
976.0R	Cairo, IL	Louisiana Dock Co.	NONE	Office Barge	4 Permanently Moored Barges & Office Barge	NONE	5 Wood Pile Cluster
978.0R	Cairo, IL	Bunge Corporation	Grain	Storage Tanks	Conveyors	NONE	6 Mooring Cells
979.5R	Cairo, IL	Waterfront Services Company	Marine Supplies	Storage Barges	Floating Crane With Loading & Unloading From Ramp & Gangplank	NONE	Midstream Fueling, Fleeting & Tug Service Salvage Operation & Above Water Welding
	LICKING RIVER						
1.1R	Newport, KY	River Metals Recycling	Scrap Metal	NONE	Cranes	CSX	One Cell
1.2R	Newport, KY	River Metals Recycling	Scrap Metal	NONE	Crane	CSX	Two Errantly Moored Barges
2.1R	Wilder, KY	IOSCO Tubulars, Inc.	Scrap Metal	Warehouses	Gantry Crane	CSX	4 Small & One Large Cell
2.8L	Covington, KY	Marathon	Oil Products	Storage Tanks	Pipelines	CSX	3 Cells & Permanently Moored Barge

APPENDIX C

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

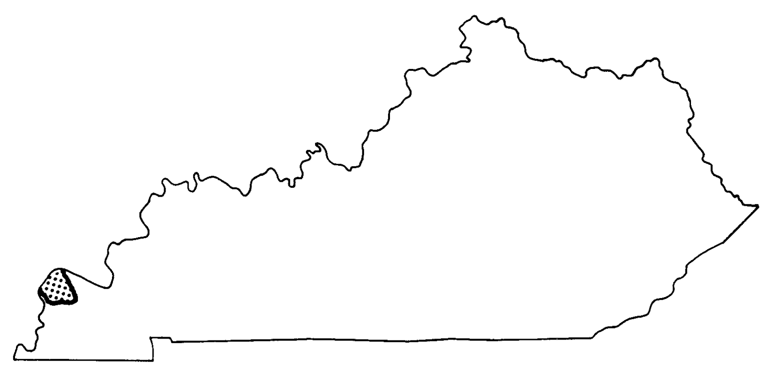
FLOOD INSURANCE STUDIES

BALLARD COUNTY, KENTUCKY

ALEXANDER COUNTY, ILLINOIS

FLOOD INSURANCE STUDY

BALLARD COUNTY, KENTUCKY
UNINCORPORATED AREAS



SEPTEMBER 29, 1989

Federal Emergency Management Agency

COMMUNITY NUMBER - 210268

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

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FLOOD INSURANCE STUDY

BALLARD COUNTY,
UNINCORPORATED AREAS,
KENTUCKY

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Unincorporated Areas of Ballard County, Kentucky, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the community that will be used to establish actuarial flood insurance rates and assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for Mayfield Creek were performed by the U.S. Army Corps of Engineers (COE), Memphis District.

Flood profiles for the Mississippi River were also obtained from a COE, Memphis District report titled, "Mississippi River Frequency Flood Profiles" (Reference 1).

The hydrologic and hydraulic analyses for all other streams studied were performed by the COE, Louisville District, (the Study Contractor) for the Federal Emergency Management Agency (FEMA), under Inter-Agency Agreement No. EMW-86-E-2226, Project Order No. 15. This study was completed in January 1988.

1.3 Coordination

In August 1986, streams requiring detailed study were identified at a meeting attended by representatives of the Study Contractor, FEMA, and the county.

On November 2, 1988, the results of this Flood Insurance Study were reviewed and accepted at a final coordination meeting attended by representatives of the Study Contractor, FEMA, and the community.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the unincorporated areas of Ballard County, Kentucky. The area of study is shown on the Vicinity Map (Figure 1). The incorporated areas within the county were excluded from this study.

Flooding caused by overflow of the Mississippi River, the Ohio River, Sugar Creek, Sugar Creek Tributary, and Mayfield Creek was studied in detail.

Areas having low development potential or minimal flood hazards were previously studied using approximate analyses. The results were shown on the Flood Hazard Boundary Map for Ballard County, Kentucky (Reference 2) and are incorporated into this Flood Insurance Study.

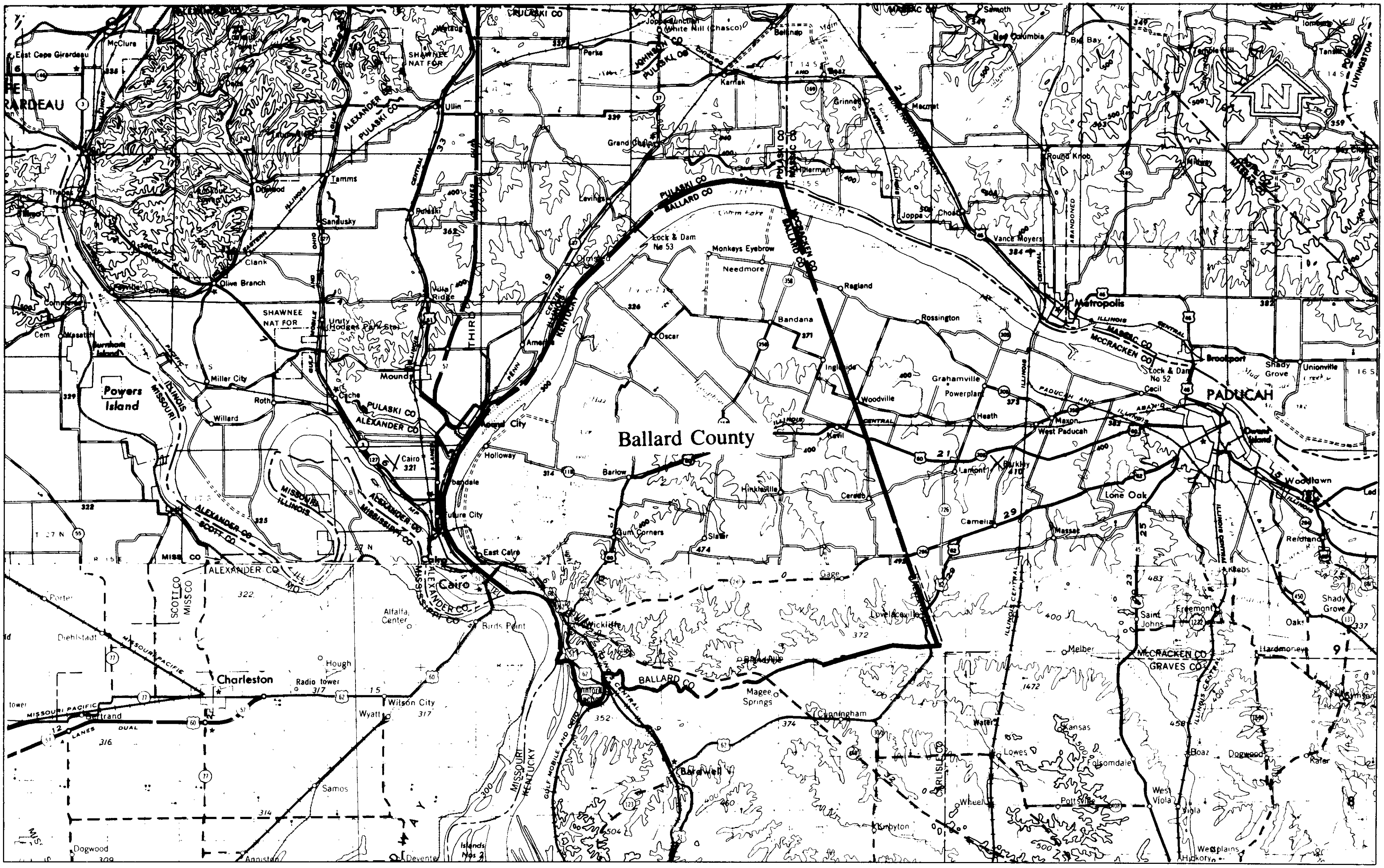
The areas studied were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through August 1989. The scope and methods of study were proposed to and agreed upon by FEMA and Ballard County.

2.2 Community Description

Ballard County is in the extreme western part of Kentucky in the Jackson Purchase Region. The county covers 259 square miles and is bordered by the Ohio River and Pulaski County, Illinois, on the north; McCracken County, Kentucky, on the east; Carlisle County, Kentucky, on the south; and Mississippi County, Missouri, and Alexander County, Illinois, on the west. Ballard County is served by U.S. Highways 51, 60, and 62; State Highways 118, 286, 358, and 440; and the Illinois Central Railroad. The 1980 population of Ballard County was reported to be 8,798 (Reference 3). The economy of the area is primarily supported by agriculture.

The climate of Ballard County is classified as humid continental, characterized by large annual and daily variations in temperature caused by the passing of cold or warm fronts and their associated centers of high and low pressure. The annual mean temperature is 59.6 degrees Fahrenheit (°F). Summers are moderately warm and humid, and winters are reasonably cold and cloudy. The extreme temperatures of record are 104°F in July 1954, and 5°F in January 1963.

As is characteristic of continental climates, precipitation in Ballard County varies widely from year to year; however, it is normally abundant and well distributed throughout the year. Fall is typically the driest season. The mean annual precipitation is 45.23 inches and the mean number of days with precipitation of .01 inch or more is 114. The average annual snowfall is 9.0 inches.



FEDERAL EMERGENCY MANAGEMENT AGENCY

BALLARD COUNTY, KY
(UNINCORPORATED AREAS)

APPROXIMATE SCALE
6 0 6 12 18 MILES

VICINITY MAP

FIGURE 1

2.3 Principal Flood Problems

Flood problems in Ballard County are caused mainly by the overflow of the Ohio and Mississippi Rivers. A large portion of the county is within the floodplains of those two major rivers. Significant floodplain areas are located along the rivers within the community.

2.4 Flood Protection Measures

While there are no flood protection facilities within the study area, flood stages along the Ohio and Mississippi Rivers in Ballard County are affected by numerous floodwater storage projects in the Ohio, Upper Mississippi, and Missouri River Basins. The navigation system on the Mississippi River and lower Ohio River is not regulated by locks and dams. The regulated portion of the Ohio River system commences at Lock and Dam 53, near Monkey's Eyebrow, Kentucky. Lock and Dam 53 is a navigation dam and has no effect on flood stages.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that is expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1-percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each riverine flooding source studied in detail affecting the community.

Natural discharge-frequency curves for the Ohio River were developed using COE methods (Reference 4). Modified discharge-frequency curves for the Ohio River were developed by routing 12 representative floods for the Ohio River modified by an upstream reservoir system. That system included reservoirs completed or near completion in 1976.

The discharges for Sugar Creek and Mayfield Creek were obtained from the COE "Mayfield Creek, Kentucky, Feasibility Report" (Reference 5).

The discharges for Sugar Creek Tributary and Sugar Creek above Sugar Creek Tributary were determined using square root drainage area proportion.

Peak discharge-drainage area relationships for the 100-year floods of each flooding source studied in detail in the community are shown in Table 1.

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQ MILES)	PEAK DISCHARGE (CFS*) 100-YEAR
MISSISSIPPI RIVER		
at Wickliffe, Kentucky	917,400	1,895,000
OHIO RIVER		
at Cairo, Illinois	203,943	1,275,000
MAYFIELD CREEK		
at confluence with Mississippi River	440	32,618
SUGAR CREEK		
at mouth	7.86	5,350
just upstream of confluence of Sugar Creek Tributary	2.88	3,240
SUGAR CREEK TRIBUTARY		
at mouth	4.07	3,850

*cubic feet per second

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Water-surface elevations for the 100-year flood were computed using the HEC-2 computer program (Reference 6). Cross-section data for the streams studied were obtained from field survey and topographic maps at a scale of 1:24000 with contour intervals of 5 and 10 feet (Reference 7).

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles and on the Flood Insurance Rate Map.

Roughness coefficients (Manning's "n") for the water-surface computations were assigned on the basis of field inspection of the channels and floodplains and are listed below.

STREAM	CHANNEL	OVERBANK
Ohio River	0.027-0.028	0.100
Sugar Creek	0.055	0.050-0.070
Sugar Creek Tributary	0.055	0.050

The starting water-surface elevation for Sugar Creek was determined by the slope-area method. The starting water-surface elevation for Sugar Creek Tributary was obtained from the Sugar Creek profile at the confluence of Sugar Creek Tributary.

The water-surface elevations for Mayfield Creek were obtained from the COE feasibility report (Reference 5).

The starting water-surface elevation of the Ohio River was obtained from rating curves developed at Cairo. One rating curve was based on historic floods on the Ohio River while Mississippi River elevations were low. The other rating curve was based on historic floods on the Ohio River while flooding was also occurring on the Mississippi River. The starting water-surface elevation was input into the HEC-2 run on the Ohio River using the latter rating curve. The flood profile was then drawn using the backwater elevation of the Mississippi River, intersecting with the profile from the HEC-2 program output.

The profiles for the Mississippi River (Reference 1) were developed by the COE, Memphis District, using a physical and an analytical model.

Flood profiles were drawn showing the computed water-surface elevations for floods of the selected recurrence intervals.

The hydraulic analyses for this study are based on the effects of unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the map and described in the exhibit labeled Elevation Reference Marks.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study provides 100-year flood elevations and delineations of the 100- and 500-year floodplain boundaries and 100-year floodway to assist communities in developing floodplain management measures.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:24000 with contour intervals of 5 and 10 feet (Reference 7).

The 100-year floodplain boundaries are shown on the Flood Insurance Rate Map. On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, AH, AO, A99, V, and VE) Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 100-year floodplain boundary is shown on the Flood Hazard Boundary Map for Ballard County (Reference 2).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces the flood-carrying capacity, increases the flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways for this study were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. 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, Floodway Data. The computed floodways are shown on the Flood Insurance Rate Map. In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
SUGAR CREEK								
A	0.23	530	2188	2.4	351.8	345.9[2]	346.9	1.0
B	0.77	400	1638	3.3	351.8	350.5[2]	351.5	1.0
C	1.17	385	1503	3.6	354.9	354.9	355.9	1.0
D	1.22	407	1585	3.4	355.4	355.4	356.4	1.0
E	1.26	293	1260	4.2	355.9	355.9	356.9	1.0
F	1.30	124	539	9.9	356.8	356.8	357.1	0.3
G	1.45	134	817	4.0	360.0	360.0	361.0	1.0
H	1.50	241	816	4.0	361.3	361.3	362.2	0.9
I	1.63	302	1466	2.2	362.2	362.2	363.2	1.0
SUGAR CREEK TRIBUTARY								
A	0.10	299	1256	3.1	359.5	359.5	360.5	1.0

[1]MILES ABOVE MOUTH
[2]ELEVATIONS WITHOUT CONSIDERING BACKWATER EFFECT FROM MAYFIELD CREEK

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

BALLARD COUNTY, KY
(UNINCORPORATED AREAS)

FLOODWAY DATA

SUGAR CREEK—SUGAR CREEK TRIBUTARY

Along streams where floodways have not been computed, the community must ensure that the cumulative effect of development in the floodplain will not cause more than a 1.0-foot increase in the base flood elevations at any point within the community.

The area between the floodway and the 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 2.

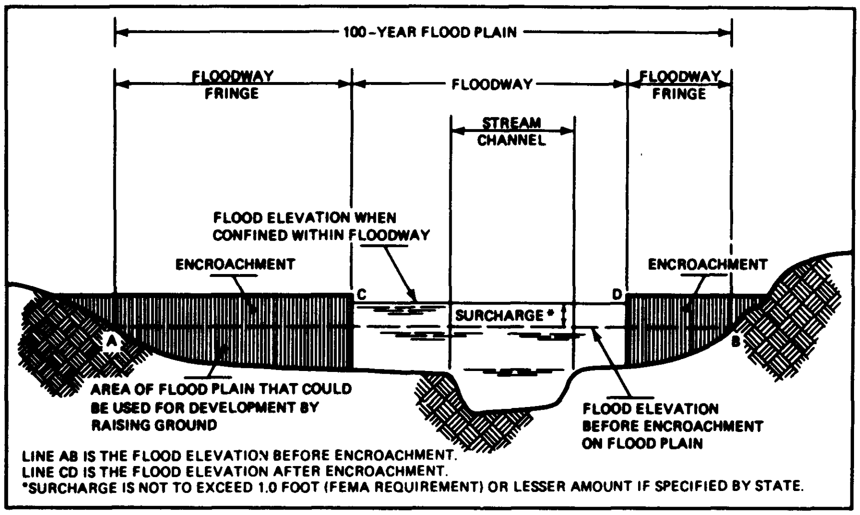


FIGURE 2 - Floodway Schematic

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by detailed methods. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 100-year floodplain, areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 100-year floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols the 100- and 500-year floodplains, the floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

7.0 OTHER STUDIES

The Ohio River profiles (Reference 8) used for this study were determined after the publication of the Flood Insurance Study for McCracken County, Kentucky (Reference 9) and, therefore, the elevations for the Ohio River contained in the Flood Insurance Study for McCracken County are not in agreement with the elevations in this study.

Flood Insurance Studies published for Alexander and Pulaski Counties, Illinois (Reference 10 and 11) and Mississippi County, Missouri (Reference 12) are in agreement with this study.

This Flood Insurance Study supersedes the previously printed Flood Hazard Boundary Map for Ballard County (Reference 2).

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, 1371 Peachtree Street, NE., Suite 736, Atlanta, Georgia 30309.

9.0 REFERENCES AND BIBLIOGRAPHY

1. U.S. Army Corps of Engineers, Memphis District, Mississippi River Frequency Flood Profiles, October 1978, unpublished.

2. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Ballard County, Unincorporated Areas, Kentucky, April 1977.

3. U.S. Department of Commerce, Bureau of the Census, 1980 Census of Population, Number of Inhabitants, Kentucky, Washington, D.C., February 1982.

4. U.S. Army Corps of Engineers, Sacramento District, Statistical Methods in Hydrology, Leo R. Beard, January 1962.

5. ————, Memphis District, Mayfield Creek, Kentucky, Feasibility Report, 1985-1986.

6. ————, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Computer Program 723-X6-L202A, Davis, California, April 1984.

7. U.S. Geological Survey, 7.5 Minute Series Topographic Maps, Scale 1:24000, Contour Intervals 5 and 10 Feet: LaCentor, Kentucky, 1975; Blandville, Kentucky, 1975; Wickliffe, Kentucky-Missouri, 1970; Wyatt, Missouri-Illinois, 1976; Cairo, Illinois-Kentucky, 1978; Bandana, Kentucky-Illinois, 1966; Olmsted, Illinois-Kentucky, 1967; Barlow, Kentucky-Illinois, 1975.

8. U.S. Army Corps of Engineers, Cincinnati District, Ohio River Profiles, January 1981.

9. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, McCracken County, Unincorporated Areas, Kentucky, June 1980.

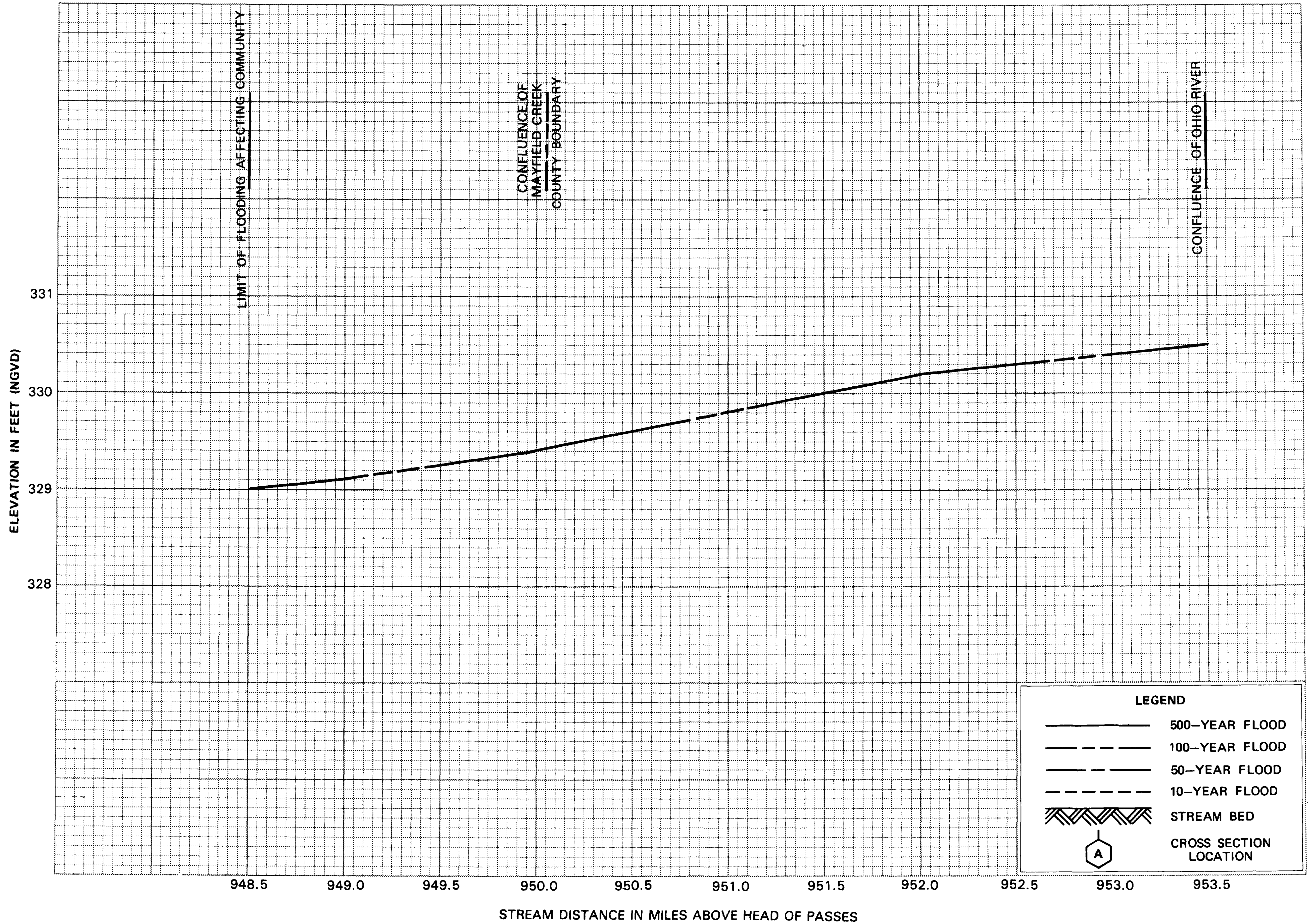
10. ————, Flood Insurance Study, Alexander County, Unincorporated Areas, Illinois, January 1986, revised November 1987.

11. ————, Flood Insurance Study, Pulaski County, Unincorporated Areas, Illinois, March 1985.

12. ————, Flood Insurance Study, Mississippi County, Unincorporated Areas, Missouri, January 1989.

ELEVATION REFERENCE MARKS

REFERENCE MARK	FLOOD INSURANCE RATE MAP PANEL	ELEVATION (FEET NGVD)	DESCRIPTION OF LOCATION
1	0075	329.20	disk stamped "R 128 1947" set in northeast end of southeast abutment of U.S. Route 51 bridge over Miner Slough
2	0175	329.21	disk stamped "P 128 1947" set in southwest end of northwest abutment of U.S. Route 51 bridge over Flat Pond
3	0175	328.54	disk stamped "N 128 1947" set in northeast end of southeast abutment of U.S. Route 51 bridge over Flat Pond
4	0175	469.73	disk stamped "M 358 1957" set in top of concrete post located about 1.0 mile south along U.S. Route 51 from intersection of Fourth Street and U.S. Route 51
5	0175	346.66	disk stamped "Z 130 1947" set in northwest end of southwest abutment of U.S. Route 60 bridge over Cane Creek
6	0100	341.28	disk stamped "C 389 1968" set in top of copper rod encased in 6-inch iron pipe located 75 feet east of centerline of U.S. Route 60, about 1.6 miles north of intersection of U.S. Route 60 and State Route 1368
7	0205	357.11	chiseled square on curb of southwest corner of State Route 1837 bridge over Sugar Creek
8	0205	364.07	chiseled square on curb of southeast corner of U.S. Route 62 bridge over Sugar Creek



FLOOD PROFILES

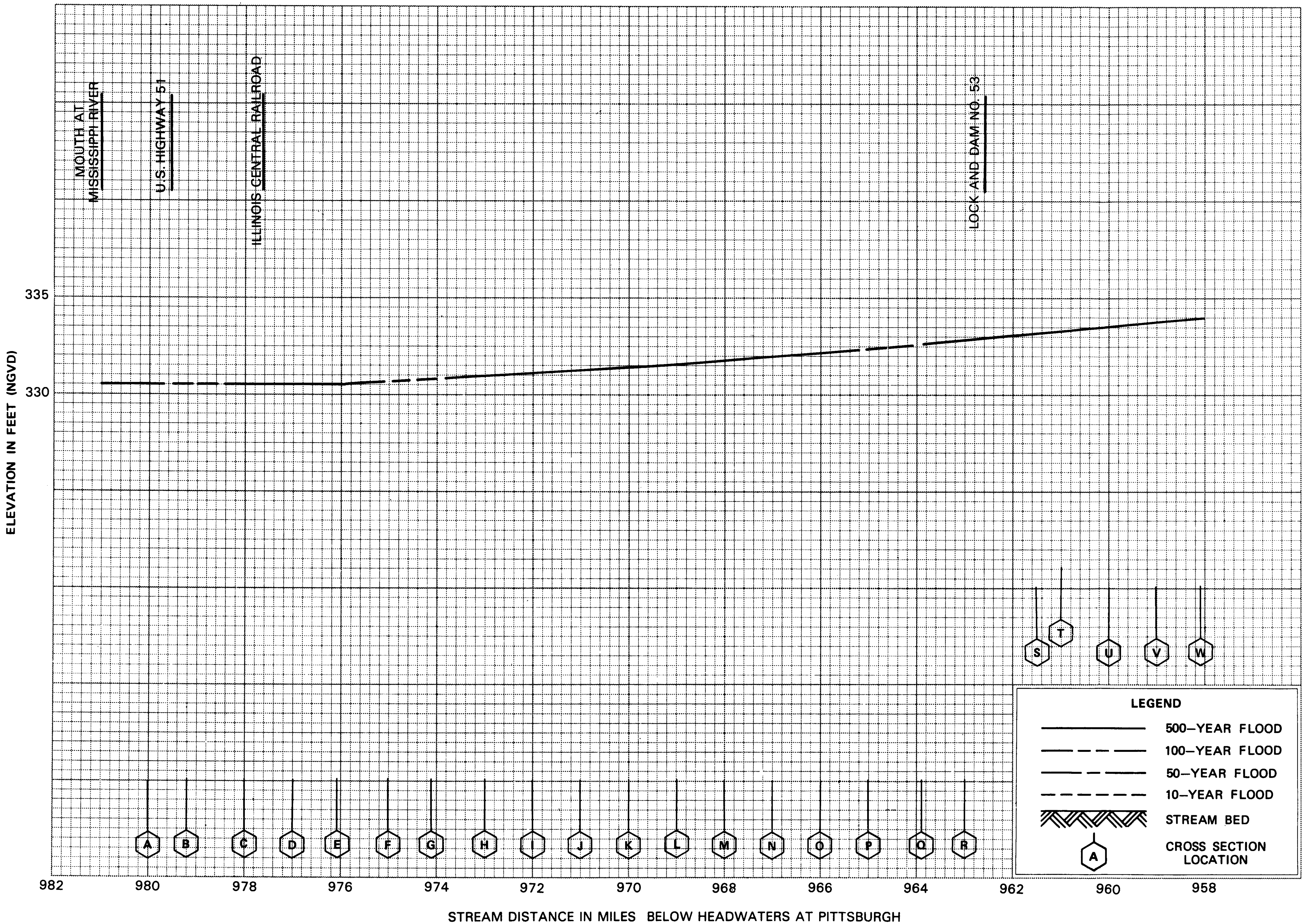
MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

BALLARD COUNTY, KY

(UNINCORPORATED AREAS)

01P



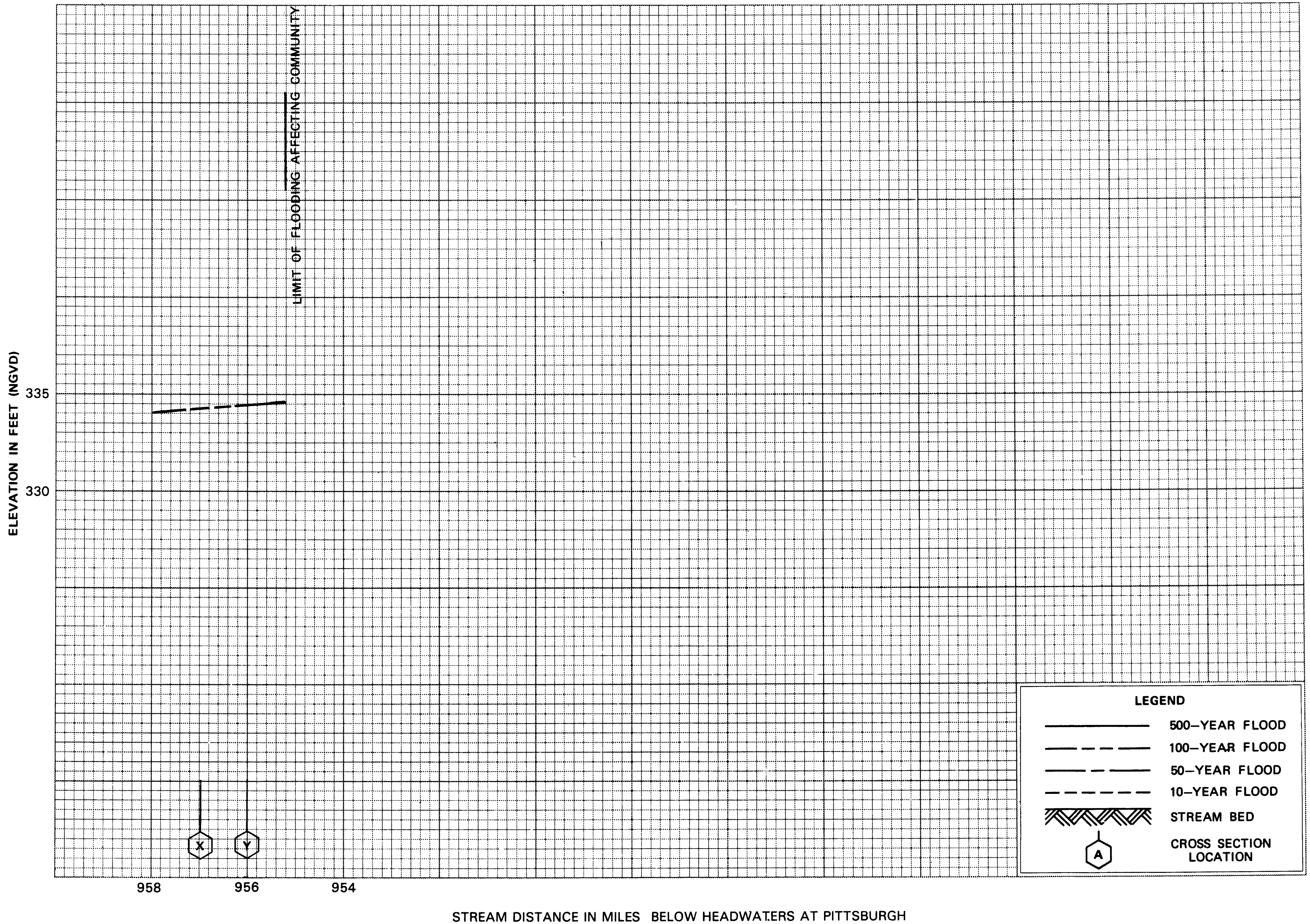
FLOOD PROFILES

OHIO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

BALLARD COUNTY, KY
(UNINCORPORATED AREAS)

02P



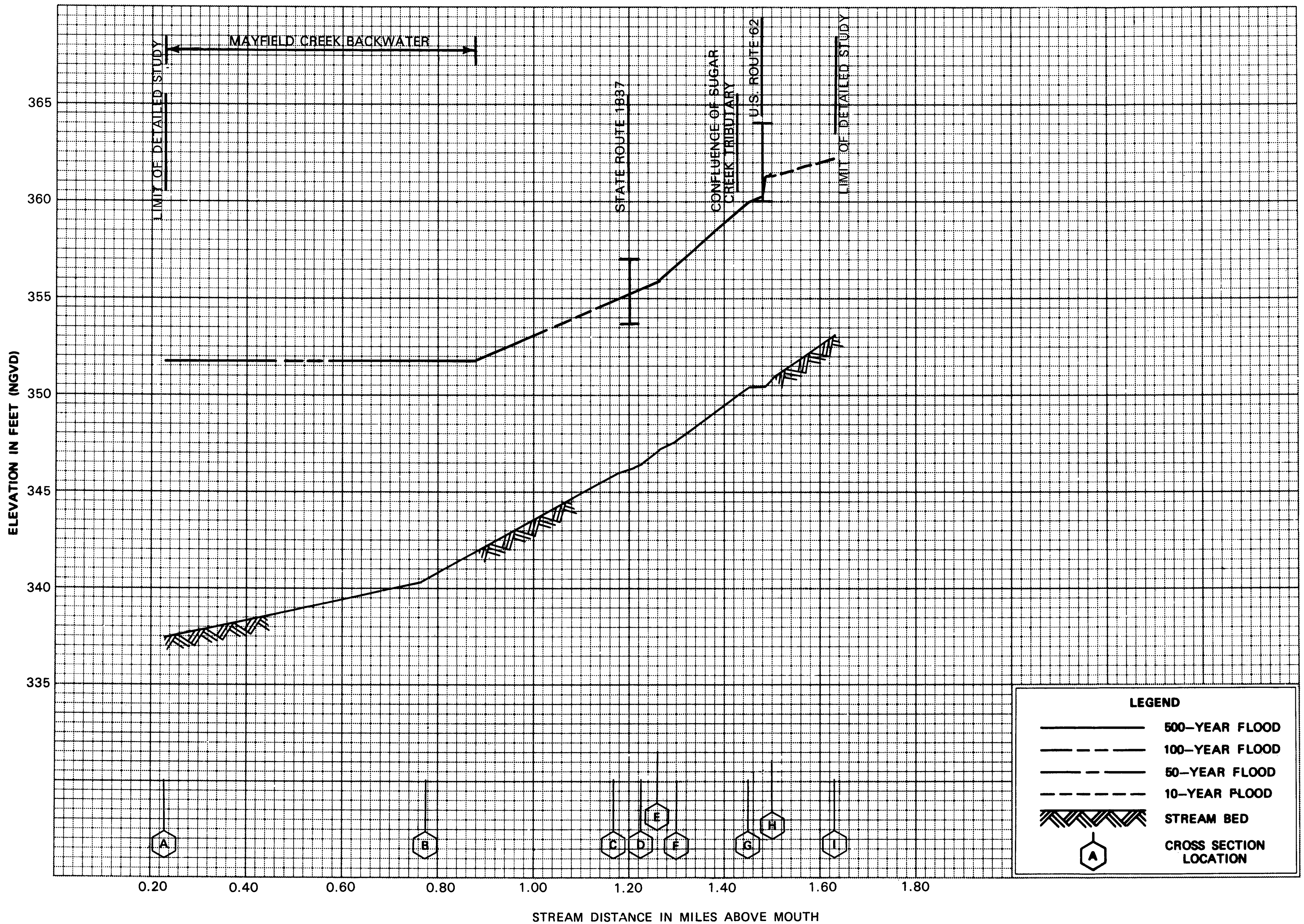
FLOOD PROFILES

OHIO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

BALLARD COUNTY, KY
(UNINCORPORATED AREAS)

03P



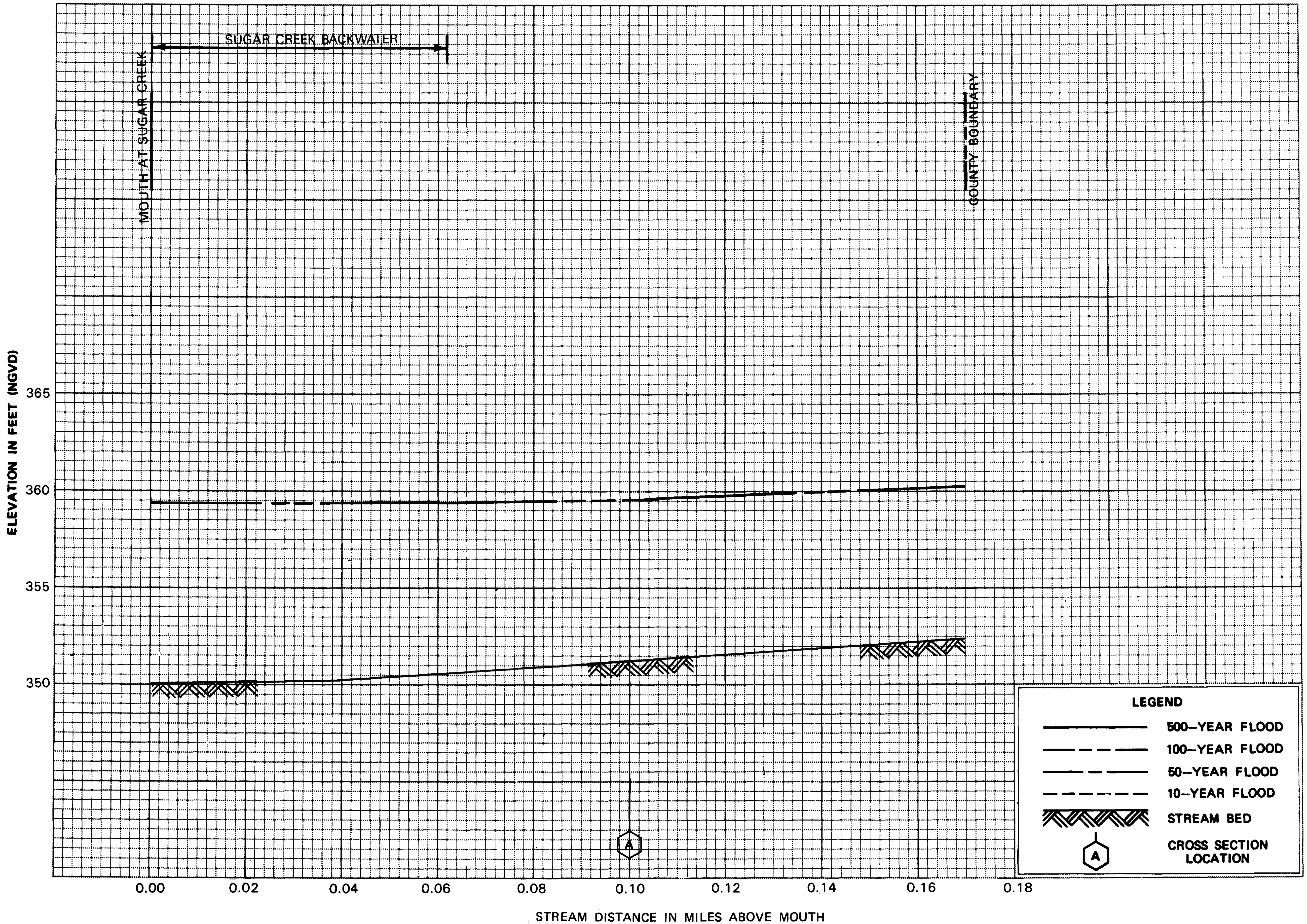
FLOOD PROFILES

SUGAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BALLARD COUNTY, KY
(UNINCORPORATED AREAS)

04P



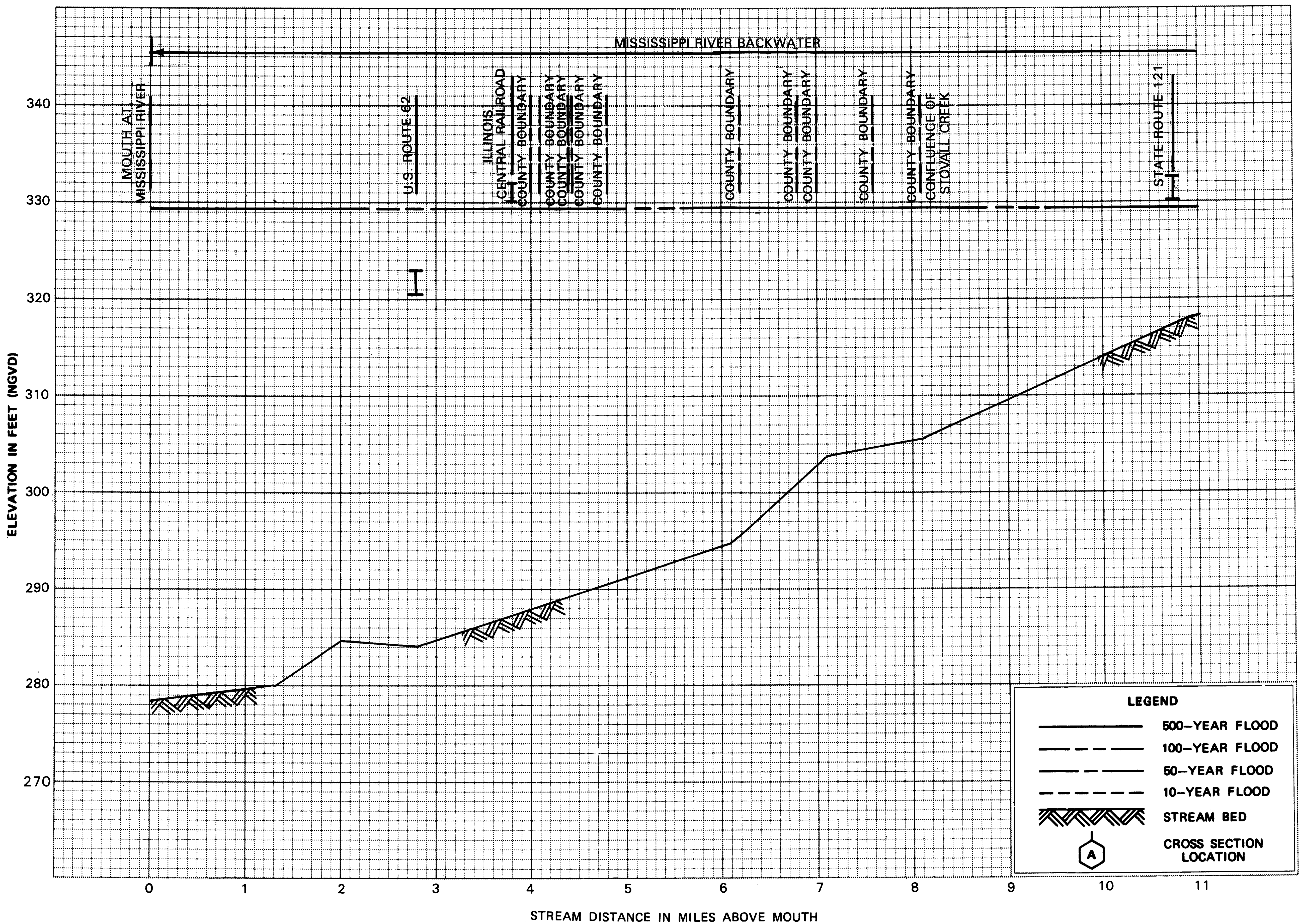
FLOOD PROFILES

SUGAR CREEK TRIBUTARY

FEDERAL EMERGENCY MANAGEMENT AGENCY

BALLARD COUNTY, KY
(UNINCORPORATED AREAS)

05P



FLOOD PROFILES

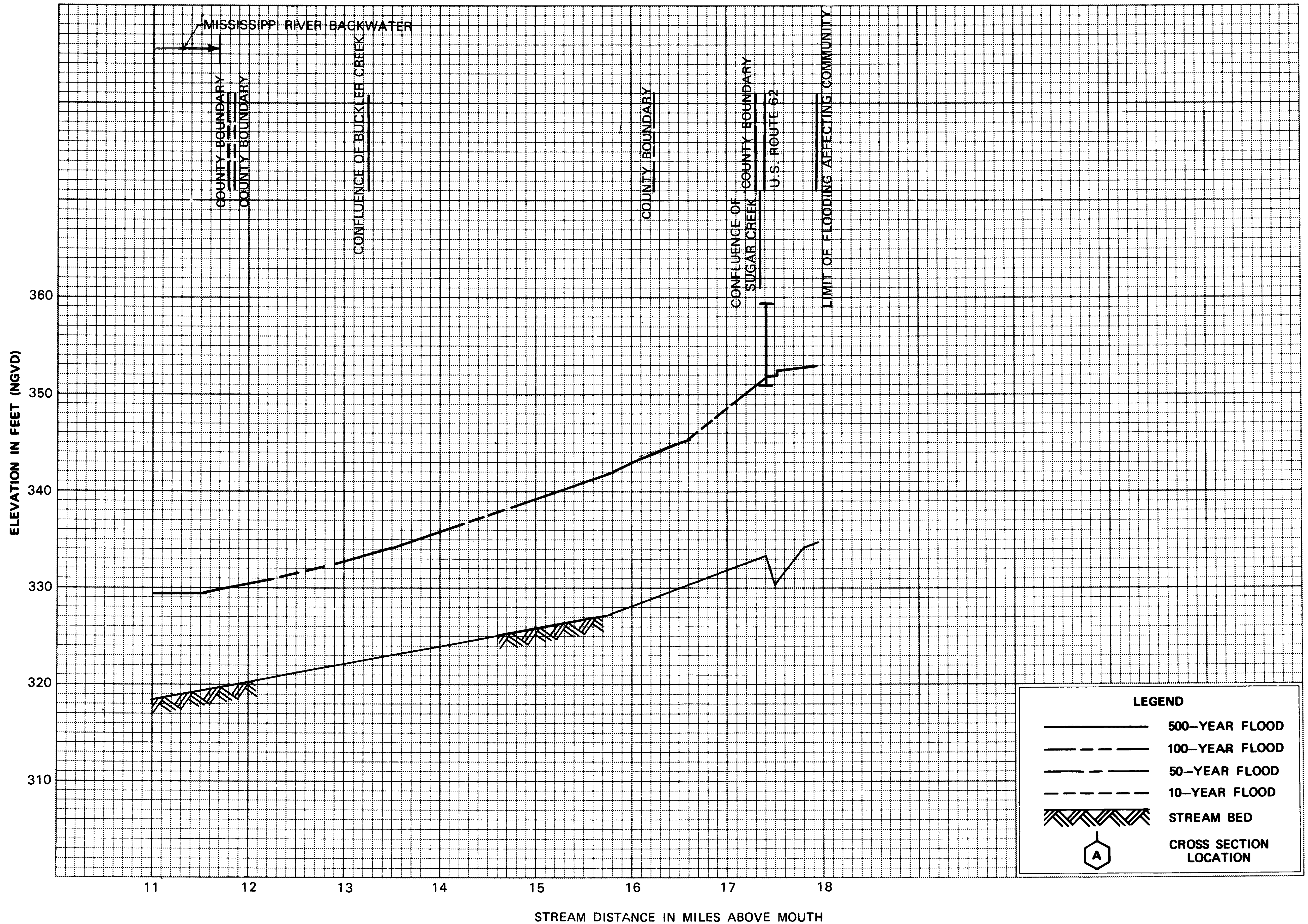
MAYFIELD CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BALLARD COUNTY, KY

(UNINCORPORATED AREAS)

06P



FLOOD PROFILES

MAYFIELD CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

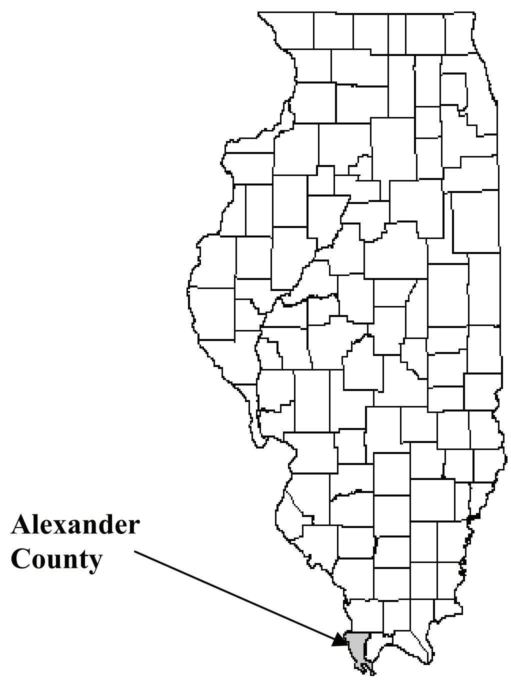
BALLARD COUNTY, KY
(UNINCORPORATED AREAS)

07P

FLOOD INSURANCE STUDY

ALEXANDER COUNTY, ILLINOIS
AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
ALEXANDER COUNTY (UNINCORPORATED AREAS)	170811
CAIRO, CITY OF	170004
EAST CAPE GIRARDEAU, VILLAGE OF	170916
MCCLURE, VILLAGE OF	170594
TAMMS, VILLAGE OF	170005
THEBES, VILLAGE OF	170006



May 4, 2009

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER

17003CV000A

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the Community Map Repository. It is advisable to contact the Community Map Repository for any additional data.

The Federal Emergency Management Agency (FEMA) may revise and republish part or all of this FIS report at any time. In addition, FEMA may revise part of this FIS by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS. It is, therefore, the responsibility of the user to consult with community officials and to check the Community Map Repository to obtain the most current FIS components.

Selected Flood Insurance Rate Map panels for this community contain information that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels (e.g., floodways, cross sections). In addition, former flood hazard zone designations have been changed as follows:

Old Zone(s)	New Zone
A1 through A30	AE
B	X
C	X

Initial Countywide FIS Effective Date: May 4, 2009

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FLOOD INSURANCE STUDY
ALEXANDER COUNTY, ILLINOIS AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and supersedes the FIS reports and/or Flood Insurance Rate Maps (FIRMs) and/or Flood Hazard Boundary Maps (FHBMs) in the geographic area of Alexander County, Illinois, including: the city of Cairo; the villages of East Cape Girardeau, McClure, Tamms and Thebes; and the unincorporated areas of Alexander County (hereinafter referred to collectively as Alexander County) and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood risk data for various areas of the county that will be used to establish actuarial flood insurance rates. This information will also be used by Alexander County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the NFIP are set forth in the Code of Federal Regulations at 44 C.F.R § 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgements

The sources of authority for this FIS are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The FIS includes the unincorporated areas of, and incorporated communities within, Alexander County. Information on the authority and acknowledgments for each jurisdiction included in this FIS, as compiled from their previously printed FIS reports, is shown below.

Pre-Countywide FISs

City of Cairo:	The hydrologic and hydraulic analyses for the FIS dated 1977 (Reference 1) for the city of Cairo were performed by the Memphis District, U.S. Army Corps of Engineers (USACE), at the request of the Federal Insurance Administration (FIA), U.S.

Department of Housing and Urban Development. The source of authority for the study is the National Flood Insurance Act of 1968, as amended. Authority and financing are contained in Interagency Agreement No. IAA-H-15-72, Project Order No. 18.

For the revised FIS dated February 17, 1988 (Reference 2) for the city of Cairo, the hydrologic and hydraulic analyses for the Revisions Description were obtained from the *Upper Mississippi River, Water Surface Profiles, River Mile 0.0 to River Mile 847.5* and the *Ohio River Profiles* (Reference 3, 4). The work was performed by the USACE, Rock Island District and Ohio River Division.

Flood elevations on the Upper Mississippi River and the Ohio River were obtained from USACE studies (Reference 3, 4) as well as from contiguous Flood Insurance Studies for the Unincorporated Areas of Alexander County, Illinois and Mississippi County, Missouri (Reference 5, 6, 7) which were based in part on USACE data. Internal drainage conditions were reported in a USACE memorandum (Reference 8).

Village of East Cape Girardeau: The hydrologic and hydraulic analyses for the FIS dated December 4, 1985 (Reference 9) for the village of East Cape Girardeau were obtained from the *Upper Mississippi River Water Surface Profiles Mile 0.0 to River Mile 847.5* (Reference 4). The analyses were performed by the USACE, Rock Island District. The study was completed in November 1979.

Village of Thebes: The hydrologic and hydraulic analyses for the FIS dated March 5, 1984 (Reference 10) for the village of Thebes were obtained from the *Upper Mississippi River Water-Surface Profiles Mile 0.0 to River Mile 847.5* (Reference 4). The analyses were performed by the USACE, Rock Island District. The study was completed in 1979.

Alexander County Unincorporated Areas: The hydrologic and hydraulic analyses for the FIS dated January 1986 (Reference 6) for Alexander County, Unincorporated Areas were obtained from the *Upper Mississippi River Water Surface Profiles Mile 0.0 to River Mile 847.5*, *Ohio River Profiles*, and *Floodplain Management Study, Olive Branch, Alexander County, Illinois* (Reference 3, 4, 11). The studies were completed November 1979, January 1981, and March 1983, respectively.

For the revised FIS dated November 19, 1987 (Reference 7) for Alexander County, Unincorporated Areas , the hydrologic and hydraulic analyses for this Revisions Description were obtained from a report entitled, *Cairo Drainage District, Goose Pond Pumping Station* (Reference 8), produced by the USACE, Memphis District. The Federal Emergency Management Agency (FEMA) reviewed and accepted these data for purposes of this revision.

The authority and acknowledgements for the villages of McClure and Tamms are not included because there were no previously printed FISs for those communities.

May 4, 2009
Countywide FIS

New hydrologic and hydraulic analyses for the Mississippi River were prepared by the USACE and reported in the *2004 Upper Mississippi River System Flow Frequency Study* (UMRSFFS)(Reference 12).

Planimetric base map information was derived from 2005 United States Geological Survey (USGS) digital orthophoto quarter quadrangles at a one-half meter ground resolution (Reference 13). Illinois State Geological Survey statewide ArcSDE raster mosaic of USGS digital raster graphs at a scale of 1:24,000 and the USGS National Elevation Dataset were also used in the digitization (Reference 14, 15).

The coordinate system used for the production of the digital FIRMs is Universal Transverse Mercator (UTM) North American Datum of 1983 (NAD 83) Geodetic Reference System 1980 (GRS80) spheroid.

This countywide FIS was performed under the Cooperating Technical Partners (CTP) Partnership Agreement No. EMC-2005-GR-7026 between the Illinois Department of Natural Resources (hereinafter referred to as IDNR) and the Federal Emergency Management Agency (FEMA), per the Mapping Activity Statement (MAS) No. IDNR05-01. The FIS was written, compiled, and edited under the direction of Patricia Hubbartt, IDNR.

1.3 Coordination

Coordination and outreach activities were performed to create a climate of understanding and ownership of the mapping process at the state and local levels. These activities were ongoing throughout the entirety of the project.

Pre-Countywide FISs

The purpose of an initial consultation coordination officer (CCO) meeting, or project team meeting, is to discuss the scope of the project. An intermediate CCO meeting, or scoping meeting, is meant to continue outreach and create a climate of understanding throughout the process. A final CCO meeting, or open house, is held with public officials and the general public to review the results of the study. The dates of the initial and final CCO meetings held for the pre-countywide studies for Alexander County's incorporated communities and unincorporated areas are shown in Table 1, "CCO Meeting Dates for Pre-Countywide Studies."

Table 1 - CCO Meeting Dates for Pre-Countywide Studies

Community	Initial CCO Date	Final CCO Date
Cairo	*	November 23, 1976
East Cape Girardeau	*	November 27, 1984
Thebes	*	September 26, 1983
Alexander County, (Unincorporated Areas)	*	January 24, 1985

* Initial Meeting Was Not Held

May 4, 2009
Countywide FIS

The project team meeting was held on January 3, 2006 in Olive Branch, Illinois, and attended by representatives of Alexander County, the city of Cairo, and IDNR. This meeting was intended to discuss various issues and concerns for the study area. A scoping meeting was held on February 7, 2006 in Olive Branch, Illinois, and was attended by representatives from Alexander County, the village of Tamms, USDA Natural Resource Conservation Service (NRCS), and IDNR.

A preliminary FIRM and FIS were prepared by merging effective FIS text, tables, and profiles with new study data. A Preliminary Summary of Map Actions (PSOMA) was also prepared for all affected communities. The PSOMA lists pertinent information regarding Letters of Map Change (LOMCs) that will be affected by the issuance of the FIRM (i.e., superseded, incorporated, and revalidated). Preliminary copies of the FIRM, FIS, and SOMA were distributed to community officials for public review and comment.

The results of the study were reviewed at the open house held on April 15, 2008 in Olive Branch, Illinois, and attended by representatives of Alexander County, the Southernmost Illinois Delta Empowerment Zone, and IDNR. All problems raised at that meeting have been addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Alexander County including the incorporated areas listed in Section 1.1.

The flooding information for the entire county, including both incorporated and unincorporated areas, is shown. The vertical datum was converted from the National Geodetic Vertical Datum of 1929 (NGVD 29) to the North American Vertical Datum of 1988 (NAVD 88).

Typically, areas studied by detailed methods are selected with priority given to all known flood hazards and areas of projected development or proposed construction. Approximate analyses are used to study those areas having low development potential or minimal flood hazards.

The streams, or portions of streams, listed in Table 2, “Limits of Revised or New Detailed or Limited Detailed Study,” have new or revised hydrologic and hydraulic analyses for this countywide FIS.

Table 2 - Revised or New Detailed or Limited Detailed Study

Flooding Source	Limits of Detailed Study
Mississippi River	From the confluence with the Ohio River at Fort Defiance to 6 miles upstream of State Route 146
Pigeon Roost Creek	From its mouth at Horseshoe Lake to 7,560 feet upstream of Pond Street

In the previous FIS Pigeon Roost Creek was referred to as Pigeon Creek.

The effective study for Pigeon Roost Creek was revised to account for changes in backwater boundary conditions and the removal of a railroad bridge. The revised study is a limited detailed analysis.

A new study completed by the U.S. Department of Agriculture, Natural Resources Conservation Service for ponding in the vicinity of Urbandale was incorporated into this new countywide FIS.

Flooding caused by overflow of the Mississippi River, the Ohio River, and Pigeon Roost Creek within the unincorporated areas of the county was studied in detail.

Flooding caused by the overflow of the Ohio and Mississippi Rivers was studied in detail within the incorporated areas of the city of Cairo. A special detailed analysis was conducted for flooding that occurs due to local runoff within the city of Cairo's levee system.

Flooding caused by overflow of the Mississippi River was studied in detail within the incorporated areas of the villages of East Cape Girardeau and Thebes.

A study was conducted by the IDNR State Water Survey (Reference 16) that used the UMRSFFS results to evaluate flooding on the Cache River.

The streams or portions of streams, listed in Table 3, "Limits of Detailed Study" were studied in detail and are incorporated into this FIS.

Table 3 – Limits of Detailed Study

Flooding Source	Limits of Detailed Study
Mississippi River	From the confluence with the Ohio River at Fort Defiance to 6 miles upstream of State Route 146
Ohio River	From the confluence with the Mississippi River at Fort Defiance to 0.3 mile upstream of the Illinois Central Gulf Railroad
Pigeon Roost Creek	From its mouth at Horseshoe Lake to 7560 feet upstream of Pond Street

Previous maps and reports for Alexander County are community-based. The maps and reports for adjacent communities may not reflect the same data. The conversion from community-based mapping to countywide mapping includes resolution and consolidation of data within the countywide FIS, as well as showing the full extent of the floodplains and floodways through mapped reaches on the countywide FIRM.

The conversion to countywide mapping may result in new or revised base flood elevations (BFEs) and floodway data for communities. The countywide FIRM may show detailed studies where previously approximate studies were shown, and/or may show flood hazard areas where previously no flood hazard areas were shown and/or may show floodway where previously no floodway was shown.

Also, special flood hazard areas were delineated for limited distances between study reaches using additional information from the model or interpolated for consistency.

Summary of Map Actions (SOMA)

FEMA issues determination letters for map changes (Letters of Map Change, or LOMCs). No letters issued by FEMA resulted in map changes (Letter of Map Revision [LOMR] and/or Special Response [SR]) of sufficient scale to be incorporated in the FIS revision.

2.2 Community Description

Alexander County is the southernmost county in Illinois and has the distinction of being the first county to be organized after the new state of Illinois was formed on December 3, 1818. Governor Shadrach Bond approved and signed the act of the Legislature in Kaskaskia on March 4, 1819 bringing the county into being. Most of the early settlers of Alexander County came from the Southern States (Reference 17). Today the county is bordered on the north by Union County, on the east by Pulaski County, Illinois and Ballard County, Kentucky, on the south by Mississippi County, Missouri, and on the west by Scott County and the city and county of Cape Girardeau, Missouri.

According to the U.S. Census Bureau, in 2000 the population of Alexander County was 9,590, and was estimated to be 8,635 in 2006 (Reference 18). The county is connected north to south by Illinois Routes 127 and 3. Interstate Highway 57 crosses the county north to south through its southeast corner.

The city of Cairo is the county seat of Alexander County and the largest city with a population of 3,632. Cairo is located at the junction of the Ohio and Mississippi Rivers at the extreme southern tip of Illinois. The city of Cairo covers an area of about twelve square miles, most of which is completely surrounded by levees and floodwalls. These levees and floodwalls were originally constructed by local interests and have been strengthened and raised from time to time by the USACE.

Alexander County has an area of 248 square miles. A significant part of the acreage consists of bottomland and low terraces along the Cache, Ohio, and Mississippi Rivers. These areas are used for farming which, in combination with forestry, contributes a major part of the total income to the county. Corn, soybeans, wheat, hogs, and beef cattle are the leading farm products. The distinctly steep and rocky uplands of Alexander County are used principally for woodland (Reference 17).

Within the State of Illinois, Alexander County ranks first in proportion of acreage covered by wetland (14.5 percent) and third in the percent of land covered by open water (7.5 percent). The county ranks seventh in acreage covered by forest/woodland (31.5 percent). The greatest percentage of land acreage is used for cropland (36.3 percent) (Reference 19).

The climate of Alexander County is classified as humid subtropical. Summers are hot and humid. Winter temperatures are mild on the average, but winter is occasionally interrupted by cold waves that bring severe weather for a few days at a time (Reference 20). The average annual temperature for Alexander County is 57 degrees (°) Fahrenheit. The coldest temperature on record is -20° Fahrenheit on January 12, 1918. The hottest temperature on record is 112 Fahrenheit on July 22, 1901. The average annual precipitation total for the County is approximately 48 inches. The average annual snowfall total is 14 inches. The largest snowfall on record was 20 inches on February 25, 1979 (Reference 21).

Alexander County is located at the southern tip of Illinois, at the confluence of the Mississippi and Ohio Rivers. The Mississippi River flows along the western and southern boundaries of Alexander County, and the Ohio River flows along the southeastern boundary of the county. Alexander County resides in the Mississippi River, Ohio River, and the Cache River drainage basins. The portion of the county that drains directly into the Mississippi River is drained by Old Clear, Horse, Sexton, Sammons and Miller Creeks. The drainage by these creeks is accomplished by short runs that descend rapidly from the hills in the Shawnee National Forest to the Mississippi River Bottomland to the west (Reference 22).

That portion of the county that drains to the Cache River is drained by Mill Creek, which descends from the hills in Union County and enters Alexander County from the north, to be joined by Cooper, Hartline, Jackson and Sandy Creeks that arise in the Shawnee National Forest hills and flow to the east. Hill Creek empties into the Cache River, which is further fed by Road Run and several creeks that flow through Pulaski County. Originally, the Cache River emptied into the Ohio River, but an outlet joining it to the Mississippi River was cut in the 1950s, so that now it empties into both rivers. Another significant riverine feature of Alexander County is Horseshoe Lake, an ox-bow lake created in an old Mississippi River cut-off meander (Reference 22).

Alexander County has a variety of landforms and relief. The range in elevation for the county is from 290 feet at the confluence of the Ohio and Mississippi rivers to 820 feet in the northern part of the county near the Union County line. Most of the northern part of the county lies in the Salem Plateau section of the Ozark Plateau Province, which forms a discontinuous upland along the southwestern margin of Illinois and is the eastern edge of an extensive upland in southern Missouri and northern Arkansas. This land is part of an area generally referred to as the “Illinois Ozarks”. This is the most rugged topographic area in the county with narrow ridge-tops and steep-sided rocky valley walls. These uplands are composed of chert (a dark colored flint-like material) and limestone covered with thick loess (a fine grained wind deposited silt), except on steep slopes where erosion has exposed many rocky outcrops (Reference 17).

The Interior Low Plateau Province is represented in northeastern Alexander County by the western part of the Shawnee Hills Section. The Shawnee Hills is a 400,000 hectare unglaciated east-west escarpment bisecting southern Illlinois. This area is underlain largely by limestone. A thick mantle of loess covers the ridge tops. In places there are outcrops of rock (Reference 17).

The flatlands that cover the southern half of the county are part of the Gulf Coastal Plain physiographic province. This province extends from the Gulf of Mexico. The alluvial plains of the Cache and Mississippi valleys and the hills between the Cache Valley and Ohio River are contained in this region (Reference 17).

Alexander County’s location in southern Illinois accounts for the fact that its topography is only in part and indirectly related to glaciation. Although the area was largely outside of the glaciated region, wind and water-borne materials were extensively deposited. As the glaciers withdrew, the great quantities of water derived from the melting ice threw the Mississippi and Ohio Rivers out of adjustment to their valleys and resulted in important changes in drainage. The broad valley now occupied by the Cache River was at one time the valley of a glacial Ohio River that has since shifted its course (Reference 22).

2.3 Principal Flood Problems

Major Ohio River flood events have occurred in Alexander County. The Ohio River flood of January-February 1937 caused the most damage in the county. The flood resulted from a series of rainstorms in late December 1936 and most of January 1937. Rainfall during January averaged more than 10 inches over the entire Ohio River basin and exceeded 22 inches at several points in the lower basin.

The City of Cairo is unique because of its geographic location with respect to flooding on the Ohio and upper Mississippi Rivers. The flood season on these two rivers may last as long as 6 months. Sometimes one river is flooding while the other river is relatively low. The Cairo river gage on the Ohio River has the property of reflecting the stage of that river which is relatively higher. The Cairo river stage is affected by such diverse influences as winter rains in Alabama, spring rains and snowmelt over Pennsylvania, and the late spring snowmelt on the upper Missouri River. In spite of the many floods that have occurred, the City of Cairo has not been inundated by any recorded floods of the Mississippi and Ohio Rivers. The City is surrounded by levees, which have been strengthened or restored as needed after every serious flood threat.

The river stages of record on the Ohio River at Cairo, Illinois are listed in Table 4, "Historical Flood Data." Information gathered for the table was collected from the *River Stages in Illinois* book (Reference 23).

Table 4 - Historical Flood Data

Ohio River at Cairo, Illinois - USACE Gage Number OH111

Datum of gage is 270.47 feet above NGVD 29

Flood Stage: 40.0 feet

Date	River Stage (feet)
February 3, 1937	59.51
April 3, 1975	56.50
April 2, 1927	56.40
March 11, 1997	56.21
February 15, 1950	55.90
April 1, 1973	55.67
May 28, 1995	55.67
February 19, 2002	55.00
April 18, 1979	54.60
April 17, 1994	54.20
May 14, 1984	54.00
April 10, 1993	48.77
February 25, 1989	46.52

The Cache River is subject to backwater flooding resulting from high river stages on the Mississippi River (Reference 16). Although some areas are protected by levees, much of the bottomland along the Mississippi River is inundated annually by seep water or backwater (Reference 24).

During the summer of 1993, the Upper Mississippi River experienced severe flooding from the middle of June until early August. Now known as "The Great Flood of 1993," this flood event is one of the costliest the U.S. has ever seen. The aerial extent, intensity, and long duration of the flooding make this one of the greatest natural disasters in U.S. history (Reference 25).

Rainfall totals surpassed 12 inches in many Midwestern states, including Illinois. Other portions of the Midwest recorded amounts exceeding 24 inches. Nearly 150 major rivers and tributaries flooded (Reference 25). Both the Missouri and Mississippi Rivers reached record heights, exceeding the 1-percent-annual-chance flood event. The high point of the Mississippi River was 49.58 feet at St. Louis on August 1, 1993, 19.58 feet above the flood stage. This stage surpassed previous records by 6 feet (Reference 25).

Severe damages occurred in 9 states including: Illinois, Iowa, Kansas, Minnesota, Missouri, North and South Dakota, Nebraska, and Wisconsin. Flooding occurred over 15,600 square miles, 50 people lost their lives, and 55,000 homes were damaged or destroyed (Reference 25). Levees were overtopped or broken and, farmland, towns, and transportation routes were destroyed. It has been estimated that there was between 10 and 15 billion dollars in flood damage including damage to homes, water and wastewater facilities, and the loss of crops.

In the Midwest, either water flooded 7.1 million acres of farmland or left them too wet to plant. $2.5 billion was lost in soybean and corn crops alone (Reference 25). Illinois had approximately 880,000 acres of its 20 million acres of corn and soybeans destroyed. The total crop damage in Illinois was approximately $610 million. Most of this damage was caused by floodwater from Illinois's 19 failed levees (Reference 26). Damage to the levees, terraces, and the drainage ditches alone was estimated to be $75 million. In addition, 16,300 residents had to evacuate their homes, 9,200 jobs were lost, and 2,900 personal water wells were flooded.

At the East Cape Girardeau Drainage and Levee District and the North Alexander County Drainage District, seepage and interior flooding were major problems. A majority of the drainage from the Clear Creek, Miller Pond, and Preston Drainage and Levee Districts flows toward these districts which have flap gated gravity outlets to Sexton Creek or the Mississippi River. The ponding of water in these 2 districts necessitated the raising of Illinois Routes 3 and 146 with enough rock to allow access to Cape Girardeau, Missouri. Temporary pumps were installed to help reduce the ponding of the water (Reference 23).

During the flood in 1993, the Len Small Levee near Miller City failed near mile 34 and approximately one-fourth (about 200,000 cfs) of the flood was carried through the breach. The failure started with about a 4-inch diameter flow, but as the failure continued approximately 2,500 feet of levee was eroded away. The levee still had about 5 feet of freeboard at the time of the failure. The floodwater continued overland to reenter the Mississippi River between river miles 14 and 16 (Reference 27). Damages occurred to 250 residences and 20,000 acres of farmland. Within 38 hours of the levee failure, water reached Olive Branch where flood depths of 4.5 feet occurred. The villages of Miller City and Willard were isolated. At Thebes about 15 residences were damaged from the flooding (Reference 23).

The greatest peak streamflow and river stages of record on the Mississippi River at Thebes, Illinois are listed in Table 5, "Historical Flood Data." Information gathered for the table was collected from the *River Stages in Illinois* book (Reference 23) and *USGS Real-Time Water Data – Illinois* (Reference 28).

Table 5 - Historical Flood Data

Mississippi River at Thebes, Illinois - USGS Gage Number 07022000

Datum of gage is 300.00 feet above NGVD 29

Flood Stage 33 feet

Date	Peak Streamflow (cfs)	River Stage (feet)
May 23, 1995	875,000	45.91
August 7, 1993	996,000	45.51
May 18, 2002	838,000	44.32
May 6, 1983	*	44.10
April 30, 1973	886,000	43.43
April 17, 1979	791,000	43.11
December 10, 1982	846,000	41.78
October 14, 1986	762,000	41.52
October 2, 1993	736,000	40.82
May 17, 1996	*	40.55
March 1, 1985	744,000	40.46
May 27, 1943	893,000	40.26
July 6, 1947	837,000	40.08
July 24, 1951	805,000	39.91
May 21, 1990	669,000	39.78
April 20, 1993	*	39.70
May 6, 1944	812,000	39.05
May 13, 1961	739,000	38.74
March 29, 1978	937,000	38.19
April 2, 1945	702,000	37.90
May 9, 1984	*	37.40
May 2, 1952	685,000	37.36
April 11, 1960	685,000	37.19
March 28, 1948	676,000	36.97

*Data not available

2.4 Flood Protection Measures

Levees that provide some degree of protection against flooding exist in the East Cape Girardeau, Illinois study area. However, it has been ascertained that the East Cape Girardeau and Clear Creek Drainage District and the North Alexander Drainage and Levee District Levee systems may not protect the community from rare events such as the 1-percent-annual-chance flood.

The city of Cairo has extensive levees, floodgates, and floodwall, which have been improved by the USACE to provide protection from flooding of the Ohio and Upper Mississippi Rivers. The Cairo Levee System provides the community with protection from flooding but may not protect the community from rare events such as the 1-percent-annual-chance flood.

Additional floodwater control is provided by the Birds Point–New Madrid Floodway. The floodway is a part of the authorized project in Missouri, and extends from opposite Cairo, Illinois to New Madrid, Missouri. The floodway consists of 130,000 acres of land and insures a wider passage for the floodwater during periods of excessive stream flow in the Mississippi Rivers. Its primary purpose is to protect Cairo by reducing the stages of extreme flood crests.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in Alexander County, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 1-percent-annual-chance flood in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potential based on conditions existing in Alexander County at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the county.

Pre-Countywide FISs

Each incorporated community within, and the unincorporated areas of, Alexander County, with the exceptions of the villages of McClure and Tamms, has a previously printed FIS report. Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community. Due to new detailed study data, pre-countywide study data on the Mississippi River has been superseded by the new study, the *Upper Mississippi River System Flow Frequency Study* (UMRSFFS) (Reference 12).

Information for the Ohio River discharge-frequency relationships is primarily taken from the *Ohio River Basin, Comprehensive Survey* (Reference 29). Frequency data for the Ohio River were supplied by the USACE, Ohio River Division. Natural maximum annual frequency curves were developed by the USACE in accordance with the method in *Statistical Methods in Hydrology* (Reference 30).

To determine modified flood peaks on the Ohio River, 12 historical floods plus 3 hypothetical ones of greater magnitude were used in the analyses of flow modification. The flows of these 15, considered representative of the basin, were modified by the operation of USACE reservoirs, completed or under construction. Frequency curves for the reservoir-modified discharges were developed for 20 locations on the main stem Ohio River.

May 4, 2009
Countywide FIS

Information on the methods used to determine peak discharge-frequency relationships for the streams studied as part of this countywide FIS is shown below.

The following information on the hydrologic analysis for the Mississippi River supersedes the hydrologic analysis for the Mississippi River for the revised FIS for Alexander County, Illinois unincorporated areas dated November 19, 1987.

The Mississippi River flood elevations were determined by the January 2004 *Upper Mississippi River System Flow Frequency Study* (UMRSFFS) (Reference 12). The UMRSFFS was developed by five Corps of Engineer Districts (St.

Paul, Rock Island, Omaha, Kansas City, St. Louis) and coordinated through representatives from seven federal agencies and seven states. The study addresses flooding of the Illinois River from Lockport to the mouth, the Missouri River below the Gavins Point Dam to the mouth, and the Mississippi River from St. Paul to the confluence with the Ohio River. Technical aspects of the study include impacts of levees, land use change, and climate variation. Hydrology was accomplished based on 100 years of records from 1898 to 1998 using a log-Pearson Type III distribution for unregulated flows at gages. In situations where historic records were not adequate to develop discharge frequency relationships or to verify the results, hydrologic modeling was used to create synthetic flows based on rainfall.

For the Urbandale study (Reference 31), runoff volumes were computed using Bulletin 70 (Reference 32) and the TR-20 model (Reference 22).

A summary of the drainage area-peak discharge relationships for all the streams studied by detailed methods is shown in Table 6, "Summary of Discharges."

Table 6 - Summary of Discharges

		Peak Discharges (cubic feet per second)			
Flooding Source and Location	*Drainage Area (square miles)*	*10-Percent-Annual-Chance*	*2-Percent-Annual-Chance*	*1-Percent-Annual-Chance*	*0.2-Percent-Annual-Chance*
MISSISSIPPI RIVER					
Thebes (Thebes gage)	713,200	709,000	895,000	950,000	1,142,000
Big Muddy	711,500	708,000	894,000	949,000	1,141,000
OHIO RIVER					
at Lock and Dam 53	203,100	925,000	1,175,000	1,275,000	N/A
PIGEON ROOST CREEK					
at State Route 3	3.5	N/A	N/A	2400	N/A

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are encouraged to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

Pre-Countywide FIS

Each incorporated community within, and the unincorporated areas of, Alexander County, with the exceptions of the villages of Tamms and McClure, has a previously printed FIS report. The hydraulic analyses described in those reports that have not been superseded by new study information are summarized below.

The profile information on the Ohio River was principally taken from the USACE, Rock Island District Ohio River Division, *Ohio River Profiles* (Reference 3).

A rainfall-runoff-storage analysis was used to determine various frequency flood elevations within the leveed areas of the city of Cairo. The hourly rainfall amounts used in this study were recorded at the city of Cairo for a period between 1940 and 1970. This rainfall was converted to runoff in cubic feet per second assuming 0.10 inches initial loss and a loss rate of 0.02 inches per hour thereafter. For the Elevation-Frequency relationships see Figure 1.

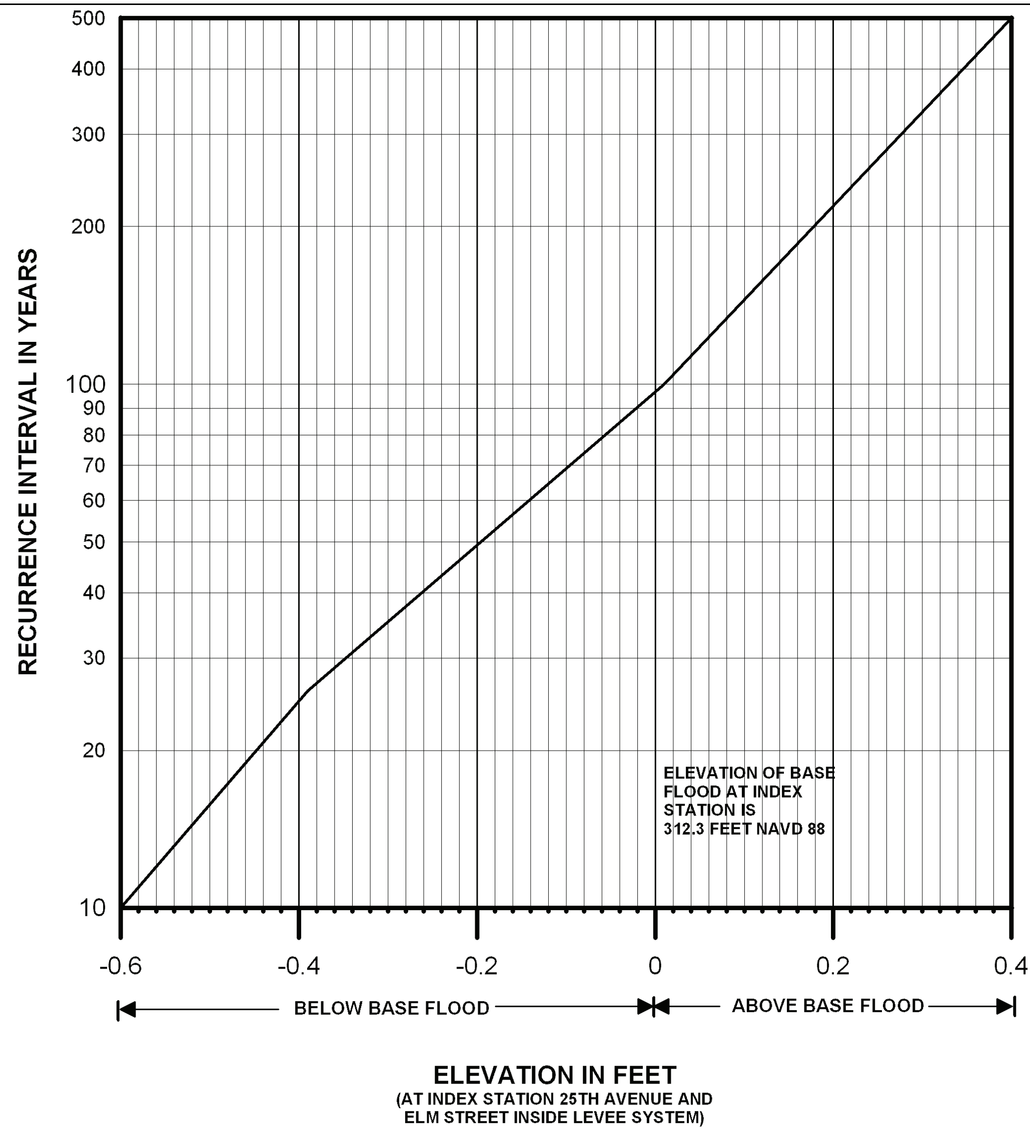

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALEXANDER COUNTY, IL
AND INCORPORATED AREAS

ELEVATION-FREQUENCY CURVE

INSIDE LEVEE SYSTEM

Cross sections for the Mississippi River were channel hydrographic surveys in conjunction with Scientific Assessment and Strategy Team (SAST) floodplain digital terrain data collected in 1995 and 1998. The UMRSFFS (discussed in Section 3.1) is based on an unsteady flow model (UNET). Levee failure was assumed at the top of existing levee grade based on an upstream and a downstream point. The UNET model was calibrated by both stage and discharge at gaging locations primarily by adjusting roughness coefficients and estimated lateral inflows. Some special considerations and techniques were required to address especially complex flow reaches and levee failure impacts.

The junction of the Mississippi River and the Ohio River is at River Mile 981.5 on the Ohio River. The stage–frequency values at the confluence adopted by the USACE Memphis District and used in the UMRSFFS is given in Table 7. A frequency event less than a 1 percent exceedence flood for the Ohio River is not available. The 0.2-percent-annual-chance flood was not computed between River mile 43.7 (near Thebes) and 0.0 (confluence with the Ohio River); therefore no shaded Zone X is shown.

Table 7 - Stage-Frequency at the Junction of the Mississippi and Ohio Rivers

Frequency	Elevation (feet NAVD 1988)
10%	323.4
2%	329.4
1%	330.7

The *Flood Elevation Study*, *Village of Urbandale, Alexander County, Illinois* (Reference 31), was used to map AE zones north and south of Urbandale. Flood elevations were determined from stage storage curves developed using the NRCS Technical Release 20 (TR20) hydrologic model (Reference 22).

The flow characteristics for Pigeon Roost Creek were determined by preparing a HEC-RAS v3.02 model using the input data from the WSP-2 model (Reference 33) initially prepared in 1982. The model was updated to reflect the removal of the Missouri Pacific Railroad Bridge. Given the age of the input data, the flood elevations simulated by the revised model may be considered a product of a limited detail study. A starting slope of 0.002 ft/ft was used. The floodplain along the lower portion of Pigeon Roost Creek is dominated by the Mississippi River floodwaters.

The results of the 2007 Cache River Study (Reference 16) indicate that backwater from the 1-percent-annual-chance flood on the Mississippi River still dominates the flooding along the Cache River in Alexander County.

The hydraulic analyses for this flood insurance study were based on unobstructed flow. The flood elevations shown on the Flood Profiles (Exhibit 1) are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

Locations of selected cross sections used in the hydraulic analyses are shown on the flood profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the FIRM (Exhibit 2).

Channel and overbank roughness factors (Manning's "n" values) used in the hydraulic models were chosen based on engineering judgment and field observations of the stream and floodplain areas. Table 8, "Roughness Coefficients (Manning's 'n' Values)," lists the channel and overbank roughness factors for all detailed studied streams.

Table 8 - Roughness Coefficients (Manning's "n" Values)

Stream	Channel "n"	Overbank "n"
Mississippi River (RM 0 – RM 54.78)	0.026-0.048	0.03-0.12
Ohio River	N/A	N/A
Pigeon Roost Creek	0.01-0.08	0.02-0.85

3.3 Vertical Datum

All FISs and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum in use for newly created or revised FISs and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the finalization of the North American Vertical Datum of 1988 (NAVD 88), many FIS and FIRMs are being prepared using NAVD 88 as the referenced vertical datum.

All flood elevations shown in this FIS and on the FIRM are referenced to NAVD 88. Structure and ground elevations in the community must, therefore, be referenced to NAVD 88. It is important to note that adjacent counties may be referenced to NGVD 29. This may result in differences in base flood elevations (BFEs) across the county boundary.

Effective information for this FIS was converted from NGVD 29 to NAVD 88 based on data presented in Figure 2 and Table 9a. Computations show a single average conversion factor of 0.351 feet (NGVD 29 + 0.351 = NAVD 88) for the county. The conversion factor was applied uniformly across the county, with the exception of the Mississippi River, and was used to prepare the Floodway Data Tables, Flood Profiles, and FIRMs.

The cross section specific conversion factor (cross section-by-cross section) method was applied to the Mississippi River for Alexander County. The cross section specific conversion factor method is applied to all reaches of the Mississippi River for consistency within the state.

The data presented in the *Upper Mississippi River System Flow Frequency Study* (Reference 12) were incorporated into this FIS and associated FIRMs. This information was converted to NAVD 88 based on data presented in Table 9b. A conversion factor was calculated using the latitude and longitude of each Mississippi River cross section. The conversion factor for each cross section was used to prepare the new Mississippi River Floodway Data Tables, Flood Profiles, and FIRMs.

For more information on NAVD 88, see *Guidelines and Specifications for Flood Hazard Mapping Partners Appendix B: Guidance for Converting to the North American Vertical Datum of 1988* (Reference 34) available at http://www.fema.gov/plan/prevent/fhm/dl_cgs.shtm or contact the Vertical Network Branch, National Geodetic Survey, Coast and Geodetic Survey, National Oceanic and Atmospheric Administration, Rockville, Maryland 20910 (Internet address http://www.ngs.noaa.gov).

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with the FIS report and FIRM for this county. Interested individuals may contact FEMA to access these data.

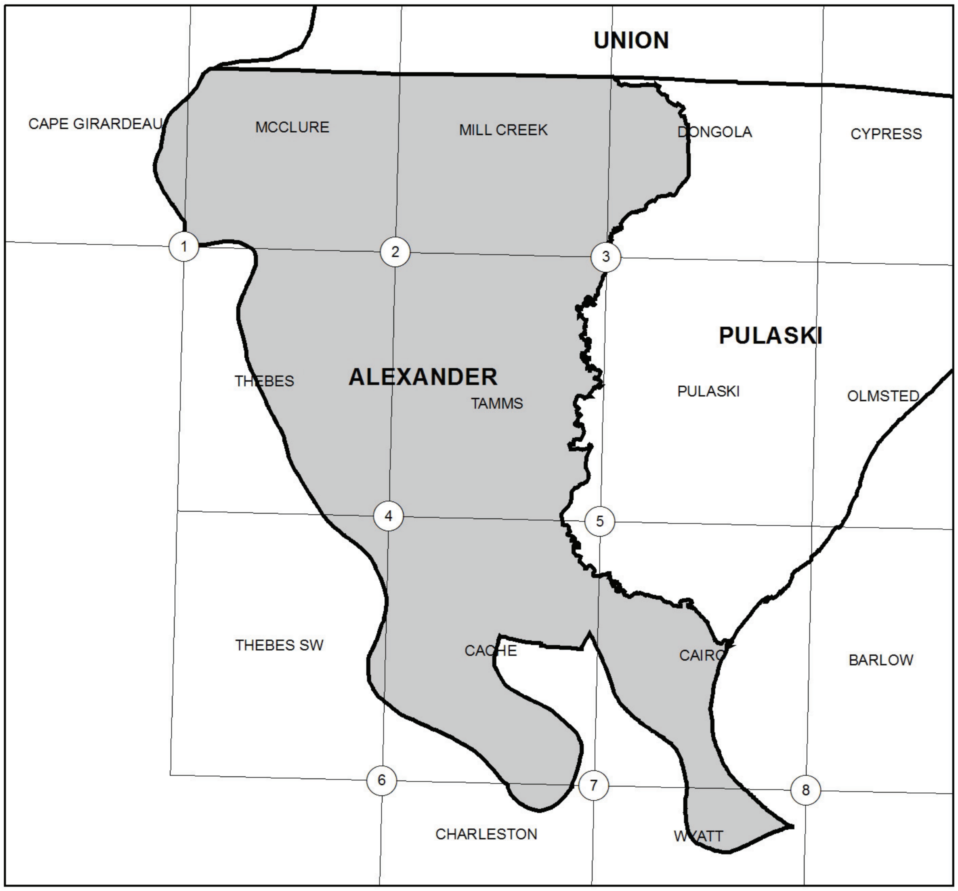

Figure 2 – Vertical Datum Conversion
USGS Quadrangle Corner Intersections
The change in elevation for each Point ID is listed in Table 9a.

Table 9a - Vertical Datum Conversions
Single Conversion Factor (countywide) Method
Alexander County

Point ID #	Quadrangle Name	Corner	NAD83 Latitude (dec. deg.)	NAD83 Longitude (dec. deg.)	NGVD 29 to NAVD 88 Elevation Change (feet)
1	Thebes	NW	37.250	89.500	0.423
2	Tamms	NW	37.250	89.375	0.305
3	Pulaski	NW	37.250	89.250	0.197
4	Thebes	SE	37.125	89.375	0.397
5	Tamms	SE	37.125	89.250	0.325
6	Cache	SW	37.000	89.375	0.377
7	Cairo	SW	37.000	89.250	0.387
8	Cairo	SE	37.000	89.125	0.397

Range of conversion values	0.197 to 0.423
Average conversion factor	**0.351**
Maximum variance from the average conversion (Within 0.25 foot tolerance)	0.154
Maximum variance from a no-conversion value	0.423

Table 9b - Vertical Datum Conversions
Cross Section Specific (cross section-by cross-section) Conversion Factors
Mississippi River

Cross Section ID	NAD83 Latitude (dec. deg.)	NAD83 Longitude (dec. deg.)	NGVD29 to NAVD88 Elevation Change (feet)
39.02	37.159	89.436	0.4
39.72	37.165	89.437	0.4
40.09	37.170	89.441	0.4
40.60	37.176	89.446	0.4
41.10	37.182	89.452	0.4
41.70	37.189	89.457	0.4
42.30	37.195	89.458	0.4
42.70	37.202	89.462	0.4
43.20	37.210	89.467	0.4
43.70	37.216	89.466	0.4
43.71	37.217	89.467	0.4
44.29	37.227	89.472	0.4
44.86	37.235	89.466	0.4
45.36	37.241	89.462	0.4
45.85	37.247	89.456	0.4
46.90	37.254	89.459	0.4
47.34	37.255	89.463	0.4
48.15	37.254	89.470	0.4
48.58	37.253	89.479	0.4
49.28	37.262	89.483	0.4
49.85	37.266	89.486	0.4
50.15	37.267	89.486	0.4
50.51	37.270	89.484	0.4
51.03	37.274	89.481	0.4
51.60	37.278	89.478	0.3
51.61	37.279	89.478	0.3
52.15	37.282	89.477	0.3
52.62	37.287	89.475	0.3
53.13	37.290	89.471	0.3
53.59	37.293	89.467	0.3
54.04	37.296	89.464	0.3
54.43	37.300	89.464	0.3
55.00	37.303	89.459	0.3
55.47	37.305	89.454	0.3
56.03	37.311	89.450	0.3
56.55	37.320	89.441	0.3
57.09	37.328	89.433	0.3
57.67	37.336	89.427	0.3
58.09	37.345	89.420	0.3

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages state and local governments to adopt sound floodplain management programs. Therefore, each FIS provides 1-percent-annual-chance flood elevations and delineations of the 1- and 0.2-percent-annual-chance floodplain boundaries and 1-percent-annual-chance floodway to assist communities in developing floodplain management measures. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data tables, and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community. For the flooding sources studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated on the basis of available topography.

The 1- and 0.2-percent floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AH, AO, and AE); and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent-annual-chance floodplain boundaries are close together or collinear, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

Where available along the Mississippi River, digital terrain data (DEM/DTM) provided by the USACE Rock Island and St. Louis Districts was used to delineate the floodplain (Reference 35). The DEM/DTM data described was used by the USACE for the upper and lower Mississippi River basin model study. The digital terrain data was supplemented with the USGS National Elevation Data as necessary (Reference 15).

The USACE DTM (Reference 35) data was also used to determine the floodplain boundary for the lower section of Pigeon Roost Creek and the lower section of the Cache River. USGS National Elevation Data (Reference 15) was also used to determine the floodplain boundary of Pigeon Roost Creek and the Cache River upstream of Sandy Ridge Road.

For the countywide FIS and FIRMs for Alexander County, new Base Flood Elevations were incorporated for the entire length of the Mississippi River, the Cache River (which is affected by backwater from the Mississippi River), Pigeon Roost Creek, and two ponding areas in the vicinity of Urbandale, IL.

The 2004 USACE *Upper Mississippi River System Flow Frequency Study* (UMRSFFS) (Reference 12) was incorporated into the countywide FIS report and FIRM for Alexander County. The new floodplain delineation encompasses the entire reach of the Mississippi River through Alexander County. The 0.2-percent-annual-chance flood was not computed between river mile 43.7 (near Thebes) and 0.0 (confluence with the Ohio River); therefore, no shaded Zone X is shown.

Conventional mapping that uses elevations at cross sections perpendicular to the channel as the basis for interpolating the floodplain boundary, cannot be employed in Alexander County along the reach of the Mississippi River from about river mile 39 (cross section 39.02) to the Interstate 57 bridge. River meanders, levee overtopping, backwater from the Ohio River, and alternate flow paths results in a pattern of flood elevations for the percent annual chance of inundation that do not follow the cross sections used for the floodway computation.

Below mile 39 (along cross section 39.02), the Mississippi River is no longer confined by bluffs. Local topography and land features and a sinuous path of the main channel and alternate flood flow paths result in a very complex flow pattern to the Ohio River confluence. In this reach, levees on the Illinois side of the river are not constructed to protect against the 1-percent-annual-chance flood.

Horseshoe Lake, an ancient meander of the Mississippi River, is east and slightly north of the Len Small Levee. Floodwaters can enter along the west side of Horseshoe Lake or through the southwest leg and exit over the dam at the southeast corner, creating a ponding area with low gradient. Flows also leave the main channel and flow over the peninsula between river miles 8 and 21, with most of this flow concentrated between river miles 21 and 9.

Another feature that affects flood flows is the Interstate 57 bridge at approximately river mile 7.5. This bridge restricts Mississippi River outflow to the Ohio River. Furthermore, backwater from flooding on the Ohio River creates a slack water area upstream of the bridge, in the horseshoe bend of the river from about river mile 10 to river mile 18.

The Base Flood Elevations (BFE) lines shown on the FIRM depict a composite picture of the flood risk. The steep decline in BFEs along the Illinois side of the Mississippi River from river mile 39 to river mile 26 is a function of the levee failure as observed during the 1993 flood. The BFE lines angle sharply, showing flow elevations in the main channel and over or through the levees. The effect of Horseshoe Lake is shown in the low water surface elevation gradient from the west to the east, with only a 1-foot drop in flood elevation. Northeast of Horseshoe Lake, wooded areas slow the flow, and the BFE lines are sculpted to depict this influence. Roads and topography further define the BFE lines, as exemplified by the curvature of BFE 335 south of Horseshoe Lake dam. Upstream of the Interstate 57 bridge, the BFEs show the slack water area at approximately mile 10 to 18, which was observed during the 1995 flood event.

Along Pigeon Roost Creek, changes in the backwater influence from the Mississippi River and the removal of a restrictive railroad bridge rendered the pre-countywide FIS and FIRM inaccurate. Using a copy of the original WSP-2 hydraulic model (Reference 33), a duplicate effective HEC-RAS hydraulic model was prepared and used together with the backwater elevations determined for the Mississippi River to prepare a revised profile for the FIS and the floodplain mapping. Given the age of the original data and issues with the original model, results represent only a limited detailed study.

The results of the 2007 study of the Cache River by the IDNR State Water Survey (Reference 16) indicate that backwater from the 1-percent-annual-chance flood on the Mississippi River still dominates the flooding along the Cache in Alexander County. The 1-percent-annual-chance flood elevations for the Mississippi River consistent with the UMRSFFS (Reference 12) are much lower than those presented on the pre-countywide maps. Base flood elevations shown for the Cache River reflect backwater from the Mississippi River and no profiles for the Cache River are included in the FIS.

The northern portion of the city of Cairo is within the levee system and subject to flooding along the Ohio River. For flooding conditions within this levied portion of the city, the boundaries of the 1-percent-annual-chance floods and the 0.2-percent-annual-chance floods were delineated using a topographic map at a scale of 1:6000 with a contour interval of one foot, and an aerial photograph of the city at the same scale with spot elevations.

The floodplains that have been mapped southeast of Tamms are a result of the backwater effects of the Mississippi River on the Cache River. Insufficient information was available to determine the Mississippi River backwater effects on Sandy Creek that is southwest of Tamms. The floodplain boundaries are shown with a Zone A designation beyond the limit of the current study.

For the streams studied by approximate methods, only the 1-percent-annual-chance floodplain boundary is shown on the FIRM (Exhibit 2).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, has the potential to reduce flood-carrying capacity, increase flood heights and velocities, and increase flood hazards in areas beyond the encroachment itself. For purposes of the NFIP, a floodway is used as a tool to assist local communities in floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe.

The floodway is the channel of a stream, plus any adjacent floodplain areas that must be kept free of encroachment so that the 1-percent-annual-chance flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. In Illinois, however, under the *Rivers, Lakes and Streams Act* (615 ILCS 5/23, 29 & 30 and 615 ILCS 5/18) (Reference 36) encroachment in the floodplain is limited to that which will cause only an insignificant increase in flood heights. The State of Illinois has adopted this more stringent criterion which limits the increase in flood heights to 0.1 foot, no more than a 10 percent reduction in floodplain volume, and no more than a 10 percent increase in average velocity. This has generally been interpreted as the least surcharge measurable, consistent with the encroachment option of the computer program utilized for the floodway determination. The floodways in this FIS are presented to local agencies as a minimum standard that can be adopted directly or that can be used as a basis for additional floodway studies.

The area between the floodway and the 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent-annual-chance flood by more than 0.1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 3, "Floodway Schematic."

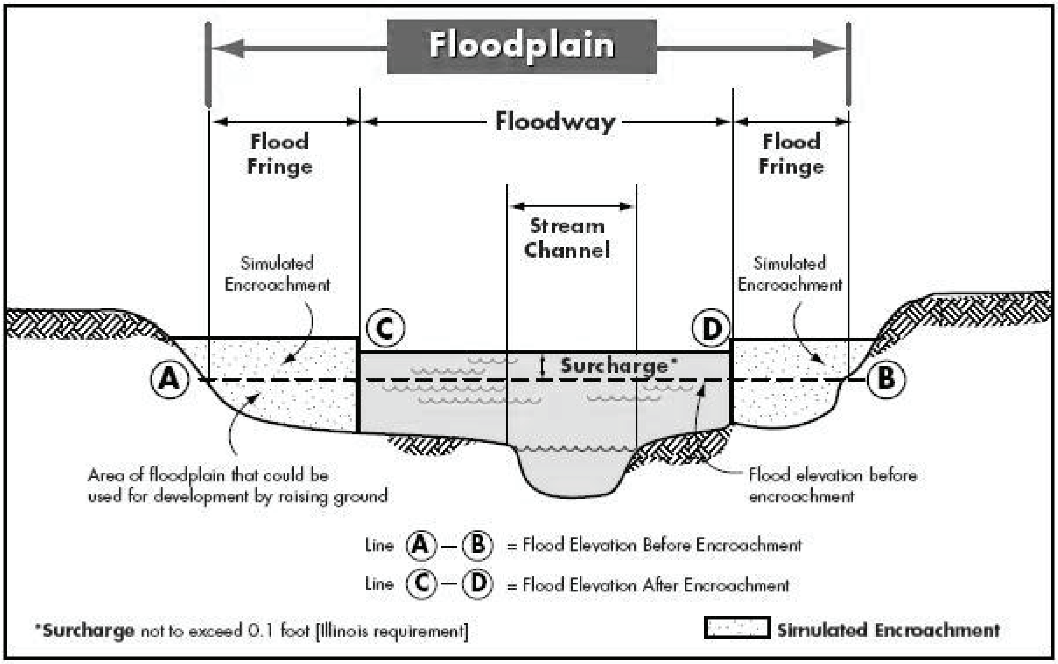

Figure 3 - Floodway Schematic

Due to the limitation of the UNET (as described in Section 3.2) with floodway encroachment modeling, floodway calculations for the Mississippi River are based on the June 2004 Upper Mississippi River Floodway Computation (Reference 37) performed by the St. Paul, Rock Island, and St. Louis Districts of the Corps of Engineers. The study extends from Cairo, Illinois to Hastings, Minnesota covering 815 miles.

The objective of the study was to produce a floodway consistent with the results of the UMRSFFS (Reference 12) (discussed in Section 3.1). A steady flow HEC-RAS model was built and calibrated to the 1-percent-annual-chance UMRSFFS profile only. The model was not calibrated to other frequency events or to “natural” conditions. This model was then used to compute the floodway.

When states on opposite banks defined the floodway based on differing allowable increases in elevation to the UMRSFFS 1-percent-annual-chance profile, two floodway computations were performed. Floodway computations were based on equal reduction in conveyance from both banks using first one state’s criteria and then the other state’s criteria. The floodway computation using the criteria of the state on the left bank was used to set the floodway boundary of the left bank. Likewise, the floodway computation using the criteria of the state on the right bank was used to set the right bank floodway. A third composite floodway run was performed using the floodway boundaries identified in the previous calculations for the left and right bank limits respectively. The appropriate floodway boundary on each bank was delineated and used in the HEC-RAS model resulting in a composite encroached 1-percent-annual-chance profile.

When a levee defined the floodway, the floodway boundaries were placed at the landside toe of the levee. Illinois has a more restrictive allowable rise than Iowa and Missouri, therefore, the composite floodway run produces a profile that exceeds the Illinois limit of 0.1 foot rise and is not reported in the FIS for Illinois counties.

As a result of this approach, the Floodway Data Tables for the Mississippi River are a special case. Floodway widths are reported in two columns, the width of the floodway within the state of Illinois and the total width of the composite floodway. Floodway section areas, floodway mean velocities, and the 1-percent-annual-chance floodwater surface elevations with floodways are not reported from the steady state hydraulic models. However, regulatory 1-percent-annual-chance floodwater surface elevations are reported from the UNET model.

Floodways have not been computed for the Ohio River or Pigeon Roost Creek.

Floodways restricted by anthropogenic features such as bridges and culverts are drawn to reflect natural conditions and may not agree with the widths listed in the floodway data table in the Flood Insurance Study. The floodway as shown on the FIRM should be used for regulatory purposes.

In Illinois, along streams where floodways have not been computed, the community must obtain state permit approval (when applicable) for development. This ensures that the cumulative effect of development in the floodplain will not cause an increase in the base flood elevations that creates a potential for flood damages.

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION[4]	DISTANCE [1]	WIDTH [2] (FEET) WITHIN ILLINOIS	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH [2] (FEET) TOTAL	REGULATORY FROM UNET MODEL	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Mississippi River									
39.02	39.02	4,442	N/A	N/A	5,934	342.6	N/A	N/A	N/A
39.72	39.72	2,952	N/A	N/A	4,283	343.1	N/A	N/A	N/A
40.09	40.09	2,636	N/A	N/A	3,771	343.3	N/A	N/A	N/A
40.60	40.60	2,230	N/A	N/A	3,237	343.7	N/A	N/A	N/A
41.10	41.10	1,881	N/A	N/A	3,335	344.0	N/A	N/A	N/A
41.70	41.70	1,713	N/A	N/A	3,097	344.4	N/A	N/A	N/A
42.30	42.30	2,377	N/A	N/A	3,435	344.8	N/A	N/A	N/A
42.70	42.70	1,684	N/A	N/A	3,005	345.1	N/A	N/A	N/A
43.20	43.20	1,227	N/A	N/A	3,083	345.5	N/A	N/A	N/A
43.70	43.70	1,716	N/A	N/A	2,741	345.8	N/A	N/A	N/A
43.71	43.71	1,673	N/A	N/A	2,644	345.8	N/A	N/A	N/A
44.29	44.29	1,360	N/A	N/A	2,226	346.3	N/A	N/A	N/A
44.86	44.86	1,185	N/A	N/A	2,242	346.8	N/A	N/A	N/A
45.36	45.36	1,014	N/A	N/A	2,162	347.2	N/A	N/A	N/A
45.85	45.85	2,438	N/A	N/A	3,816	347.6	N/A	N/A	N/A
46.90	46.90	2,727	N/A	N/A	3,965	348.5	N/A	N/A	N/A
47.34	47.34	3,588	N/A	N/A	4,699	348.8	N/A	N/A	N/A
48.15	48.15	5,612	N/A	N/A	6,641	349.4	N/A	N/A	N/A
48.58	48.58	2,752	N/A	N/A	7,529	349.8	N/A	N/A	N/A

[1] Miles above confluence with Ohio River
[2] Widths are reported as widths to state line and composite width
[3] Illinois width / width within Alexander County
[4] Portions of the Floodway Data are duplicated within the countywide FIS for Union County, Illinois
*Floodway Data Tables for the Mississippi River are a special case. See Flood Insurance Study Text for full explanation.
N/A = Data not available

TABLE10

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALEXANDER COUNTY, IL AND INCORPORATED AREAS

FLOODWAY DATA

MISSISSIPPI RIVER*

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION[4]	DISTANCE[1]	WIDTH[2] (FEET) WITHIN ILLINOIS	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	WIDTH[2] (FEET) TOTAL	REGULATORY FROM UNET MODEL	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Mississippi River (continued)									
49.28	49.28	2,169	N/A	N/A	8,169	350.3	N/A	N/A	N/A
49.85	49.85	2,041	N/A	N/A	7,463	350.7	N/A	N/A	N/A
50.15	50.15	2,546	N/A	N/A	6,997	351.0	N/A	N/A	N/A
50.51	50.51	2,536	N/A	N/A	5,158	351.2	N/A	N/A	N/A
51.03	51.03	3,639	N/A	N/A	4,738	351.7	N/A	N/A	N/A
51.60	51.60	2,952	N/A	N/A	3,839	352.0	N/A	N/A	N/A
51.61	51.61	2,938	N/A	N/A	3,829	352.0	N/A	N/A	N/A
52.15	52.15	3,028	N/A	N/A	3,936	352.4	N/A	N/A	N/A
52.62	52.62	3,249	N/A	N/A	4,388	352.7	N/A	N/A	N/A
53.13	53.13	2,764	N/A	N/A	3,825	353.1	N/A	N/A	N/A
53.59	53.59	2,047	N/A	N/A	2,929	353.4	N/A	N/A	N/A
54.04	54.04	3,010	N/A	N/A	3,589	353.7	N/A	N/A	N/A
54.43	54.43	3,701	N/A	N/A	4,553	353.9	N/A	N/A	N/A
55.00[4]	55.00	4,087/3,542[3]	N/A	N/A	5,196	354.3	N/A	N/A	N/A
55.47[4]	55.47	4,222/3,149[3]	N/A	N/A	6,021	354.6	N/A	N/A	N/A
56.03[4]	56.03	5,761/4,317[3]	N/A	N/A	9,292	355.0	N/A	N/A	N/A
56.55[4]	56.55	7,166/5,545[3]	N/A	N/A	11,995	355.3	N/A	N/A	N/A
57.09[4]	57.09	7,966/5,683[3]	N/A	N/A	13,717	355.7	N/A	N/A	N/A
57.67[4]	57.67	7,383/3,282[3]	N/A	N/A	14,459	356.1	N/A	N/A	N/A
58.09[4]	58.09	6,434/0[3]	N/A	N/A	13,529	356.3	N/A	N/A	N/A

[1] Miles above confluence with Ohio River

N/A = Data not available

[2] Widths are reported as widths to state line and composite width.

[3] Illinois width / width within Alexander County

[4] Portions of the Floodway Data are duplicated within the countywide FIS for Union County, Illinois

*Floodway Data Tables for the Mississippi River are a special case. See Flood Insurance Study Text for full explanation.

TABLE10

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALEXANDER COUNTY, IL AND INCORPORATED AREAS

FLOODWAY DATA

MISSISSIPPI RIVER*

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION (FEET NAVD 88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Ohio River								
*	*	*	*	*	*	*	*	*
Pigeon Roost Creek								
*	*	*	*	*	*	*	*	*

*Data not available

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALEXANDER COUNTY, IL AND INCORPORATED AREAS

FLOODWAY DATA

OHIO RIVER – PIGEON ROOST CREEK

5.0 INSURANCE APPLICATIONS

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. The zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by detailed methods. In most instances, whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at the selected intervals within this zone.

Zone AH

Zone AH is the flood insurance rate zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent-annual-chance floodplain, areas within the 0.2-percent-annual-chance floodplain, and to areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent-annual-chance flood by levees. No base flood elevations or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1- and 0.2-percent-annual-chance floodplains. Floodways and the locations of selected cross sections used in the hydraulic analyses and floodway computations are shown where applicable

The current FIRM presents flooding information for the entire geographic area of Alexander County. Previously, separate Flood Hazard Boundary Maps and/or FIRMs were prepared for each identified flood prone incorporated community and the unincorporated areas of the county. Historical data relating to the community maps prepared is presented in Table 11, "Community Map History."

7.0 OTHER STUDIES

Flood insurance studies have also been prepared for Union County and Pulaski County, Illinois, Ballard County, Kentucky, Mississippi County and Scott County, Missouri, and the City of Cape Girardeau, Missouri.(Reference 5, 24, 38, 39, 40, 41). A Flood Boundary and Floodway Map was prepared for the City of Cape Girardeau, Missouri (Reference 42).

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this FIS can be obtained by contacting FEMA, Federal Insurance and Mitigation Division, 536 South Clark Street, Sixth Floor, Chicago, Illinois 60605.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE(S)	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISION DATE(S)
Alexander County (Unincorporated Areas)	December 27, 1974	July 22, 1977	January 3, 1986	November 19, 1987
Cairo, City of	June 14, 1974	April 18, 1975	February 1, 1978	March 12, 1982 February 17, 1988
East Cape Girardeau, Village of	July 22, 1977	None	December 4, 1985	None
McClure, Village of	December 27, 1974 (Alexander County)	July 22, 1977 (Alexander County)	January 3, 1986 (Alexander County)	November 19, 1987 (Alexander County)
Tamms, Village of	May 10, 1974	June 11, 1976	May 25, 1984	None
Thebes, Village of	August 30, 1974	March 19, 1976	April 3, 1984	None

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALEXANDER COUNTY, IL AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

9.0 BIBLIOGRAPHY AND REFERENCES

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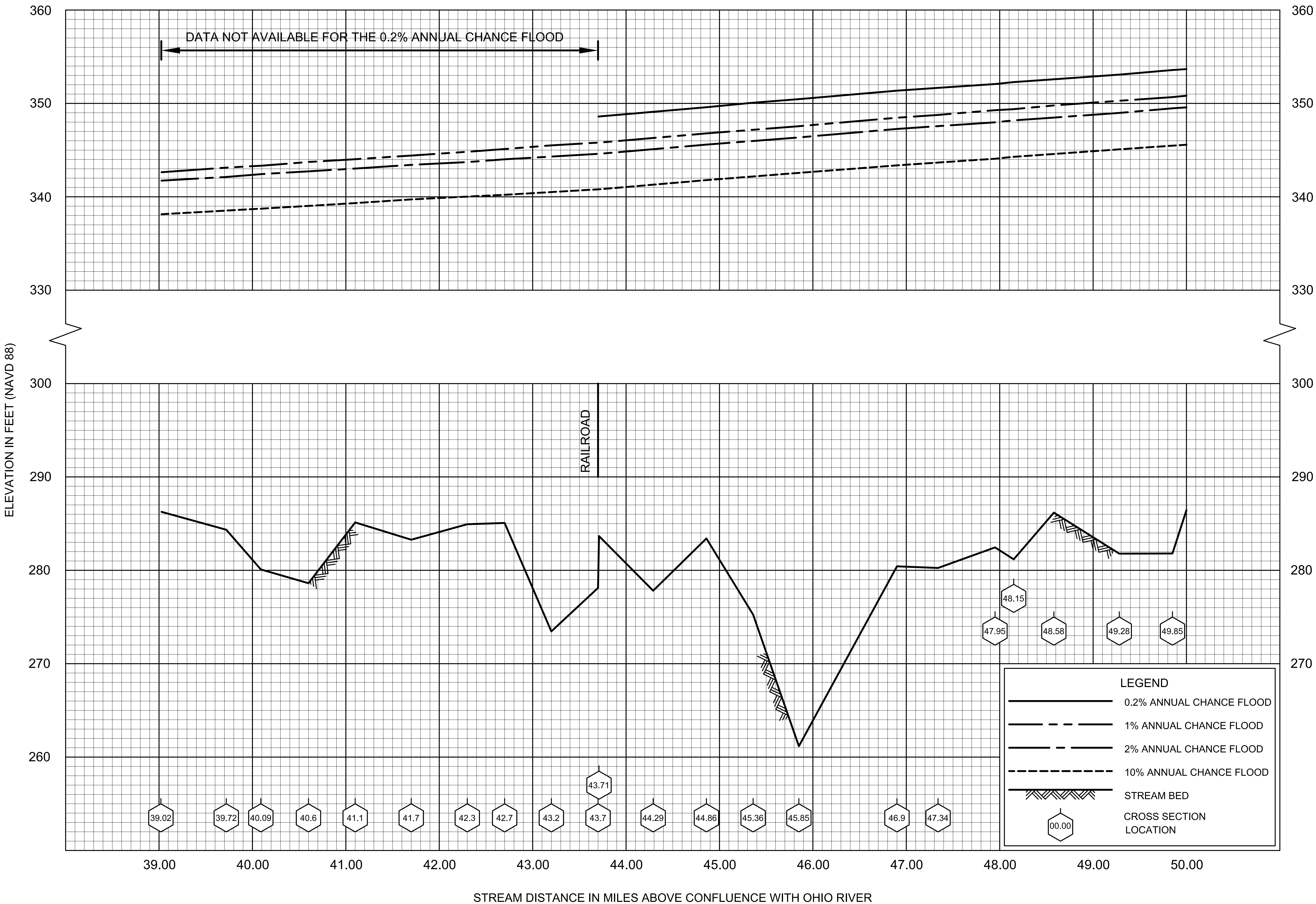


FLOOD PROFILES

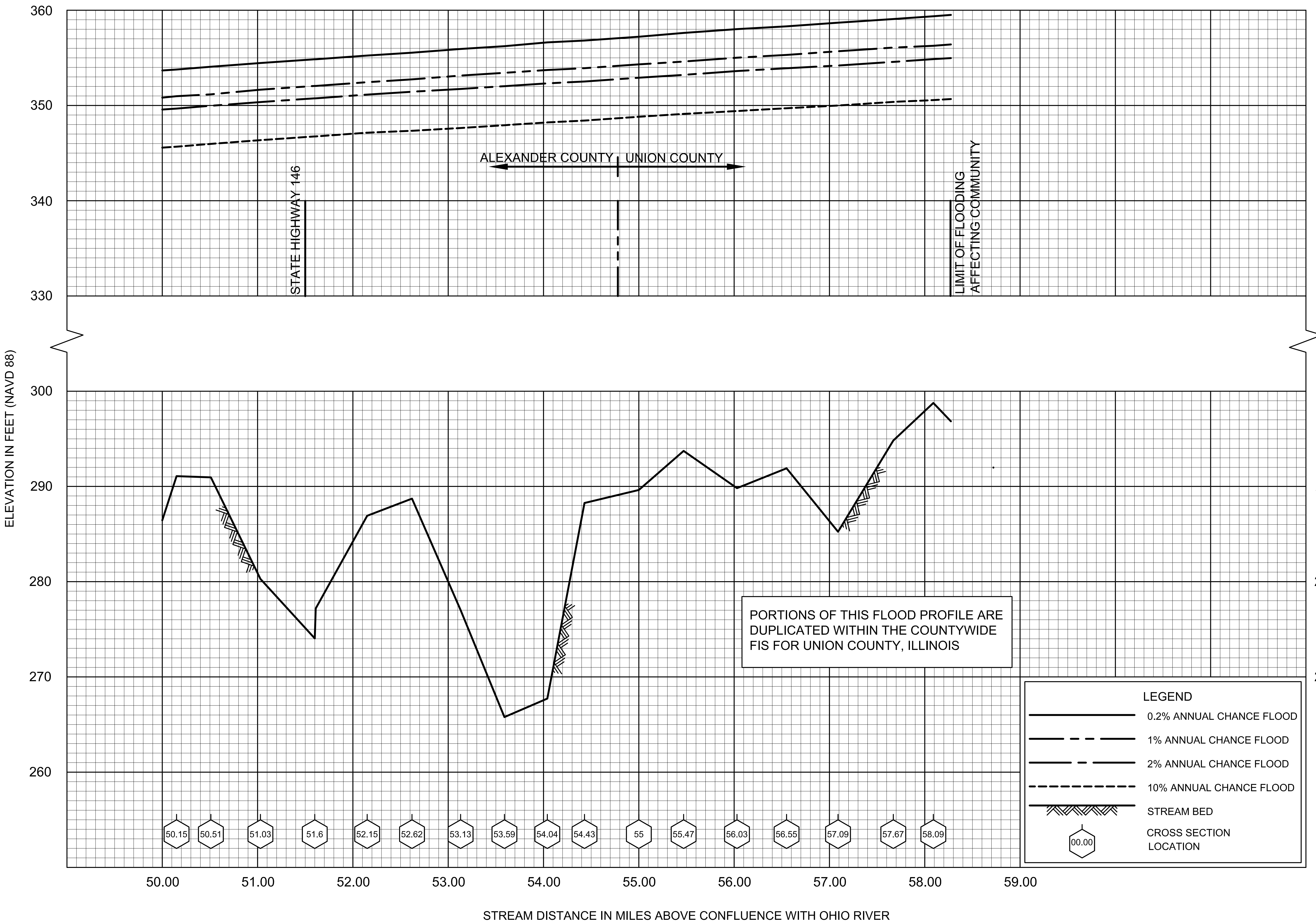
MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALEXANDER COUNTY, IL

AND INCORPORATED AREAS

01P



FLOOD PROFILES

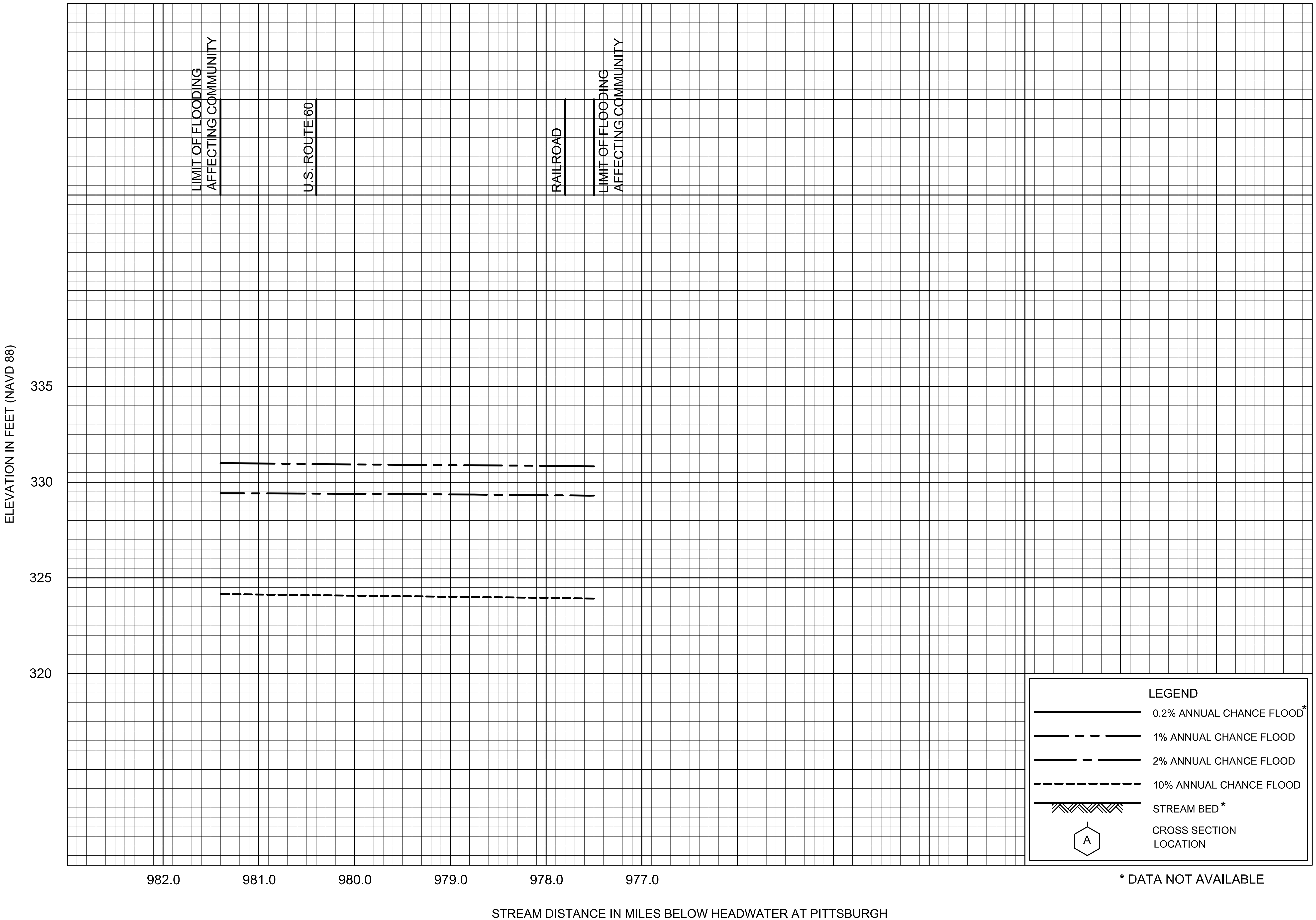
MISSISSIPPI RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALEXANDER COUNTY, IL

AND INCORPORATED AREAS

02P



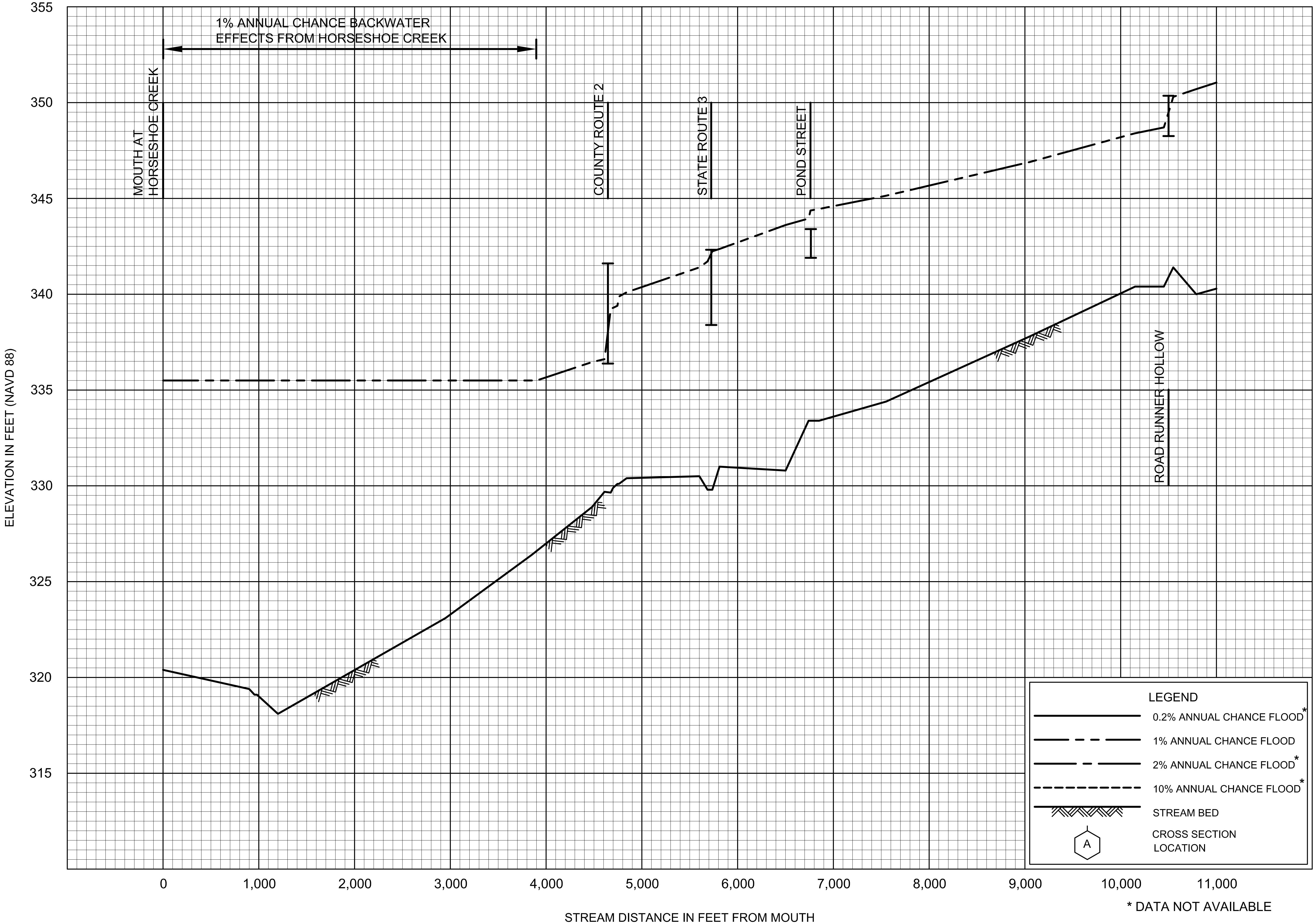
FLOOD PROFILES

OHIO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALEXANDER COUNTY, IL

AND INCORPORATED AREAS



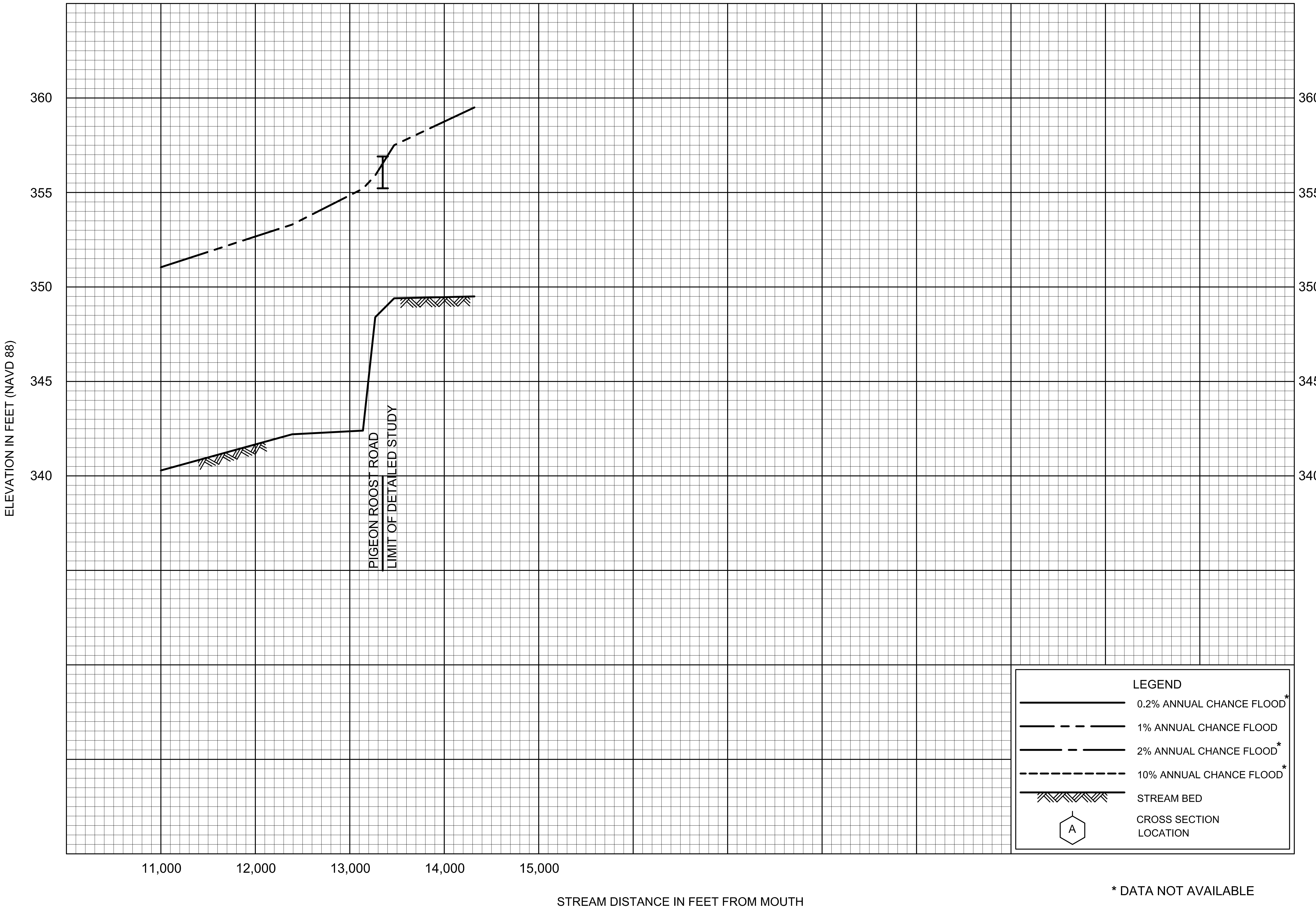
FLOOD PROFILES

PIGEON ROOST CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALEXANDER COUNTY, IL

AND INCORPORATED AREAS



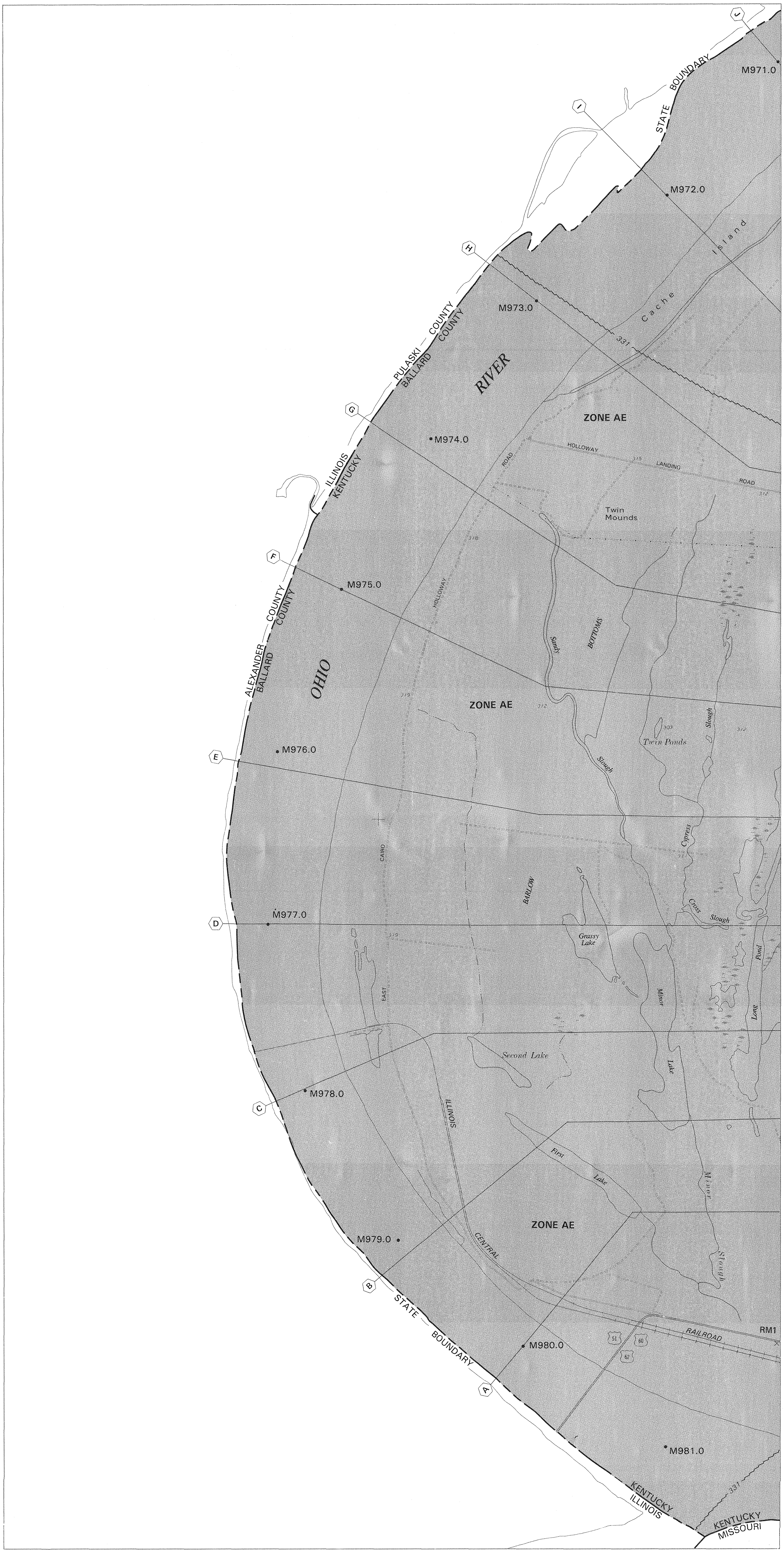
FLOOD PROFILES

PIGEON ROOST CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALEXANDER COUNTY, IL

AND INCORPORATED AREAS



LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

ZONE A No base flood elevations determined.

ZONE AE Base flood elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.

ZONE A0 Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE A99 To be protected from 100-year flood by Federal flood protection system under construction; no base elevations determined.

ZONE V Coastal flood with velocity hazard (wave action); no base flood elevations determined.

ZONE VE Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

ZONE X Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

ZONE X Areas determined to be outside 500-year flood plain.

ZONE D Areas in which flood hazards are undetermined.

Flood Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

513 Base Flood Elevation Line; Elevation in Feet*

D D Cross Section Line

(EL 987) Base Flood Elevation in Feet Where Uniform Within Zone*

RM7 X Elevation Reference Mark

•M1.5 River Mile

*Referenced to the National Geodetic Vertical Datum of 1929

NOTES

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size, or all planimetric features outside Special Flood Hazard Areas.

Certain areas not in the Special Flood Hazard Areas may be protected by flood control structures.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Emergency Management Agency.

Floodway widths in some areas may be too narrow to show to scale. Refer to Floodway Data Table where floodway width is shown at 1/20 inch.

Coastal base flood elevations apply only landward of the shoreline.

Elevation reference marks are described in the Flood Insurance Study Report.

Corporate limits shown are current as of the date of this map. The user should contact appropriate community officials to determine if corporate limits have changed subsequent to the issuance of this map.

For adjoining panels, see separately printed Map Index.

MAP REPOSITORY

County Courthouse, Wickliffe, Kentucky (Maps available for reference only, not for distribution.)

INITIAL IDENTIFICATION:

APRIL 8, 1977

FLOOD HAZARD BOUNDARY MAP REVISIONS:

FLOOD INSURANCE RATE MAP EFFECTIVE:

SEPTEMBER 29, 1989

FLOOD INSURANCE RATE MAP REVISIONS:

To determine if flood insurance is available, contact an insurance agent or call the National Flood Insurance Program at (800) 638-6620.

N

APPROXIMATE SCALE IN FEET

2000 0 2000

NATIONAL FLOOD INSURANCE PROGRAM

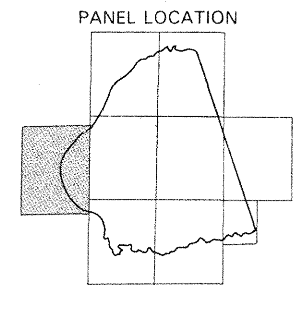
FIRM

FLOOD INSURANCE RATE MAP

BALLARD COUNTY, KENTUCKY
(UNINCORPORATED AREAS)

PANEL 75 OF 205
(SEE MAP INDEX FOR PANELS NOT PRINTED)

PANEL LOCATION



COMMUNITY-PANEL NUMBER

210268 0075 B

EFFECTIVE DATE:

SEPTEMBER 29, 1989

Federal Emergency Management Agency

LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

ZONE A	No base flood elevations determined.
ZONE AE	Base flood elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.
ZONE A0	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE A99	To be protected from 100-year flood by Federal flood protection system under construction; no base elevations determined.
ZONE V	Coastal flood with velocity hazard (wave action); no base flood elevations determined.
ZONE VE	Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

ZONE X	Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

ZONE X	Areas determined to be outside 500-year flood plain.
ZONE D	Areas in which flood hazards are undetermined.

Flood Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

513	Base Flood Elevation Line; Elevation in Feet*
D — D	Cross Section Line
(EL 987)	Base Flood Elevation in Feet Where Uniform Within Zone*
RM7X	Elevation Reference Mark
•MI.5	River Mile

*Referenced to the National Geodetic Vertical Datum of 1929

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N

APPROXIMATE SCALE IN FEET

2000 0 2000

NATIONAL FLOOD INSURANCE PROGRAM

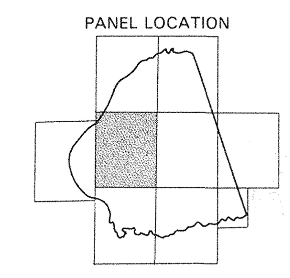
FIRM

FLOOD INSURANCE RATE MAP

BALLARD COUNTY, KENTUCKY
(UNINCORPORATED AREAS)

PANEL 100 OF 205
(SEE MAP INDEX FOR PANELS NOT PRINTED)

PANEL LOCATION



COMMUNITY-PANEL NUMBER

210268 0100 B

EFFECTIVE DATE:

SEPTEMBER 29, 1989

Federal Emergency Management Agency

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FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

ZONE X	Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

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	Flood Boundary
	Floodway Boundary
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	Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.
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SEPTEMBER 29, 1989

FLOOD INSURANCE RATE MAP REVISIONS:

To determine if flood insurance is available, contact an insurance agent or call the National Flood Insurance Program at (800) 638-6620.

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APPROXIMATE SCALE IN FEET

2000 0 2000

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

BALLARD COUNTY, KENTUCKY
(UNINCORPORATED AREAS)

PANEL 175 OF 205
(SEE MAP INDEX FOR PANELS NOT PRINTED)

PANEL LOCATION

COMMUNITY-PANEL NUMBER
210268 0175 B

EFFECTIVE DATE:
SEPTEMBER 29, 1989

Federal Emergency Management Agency

APPENDIX D

LEGACY HEIGHT DATUMS ON THE MISSISSIPPI AND ILLINOIS RIVER SYSTEMS

Legacy height datums on the Mississippi and Illinois river systems

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Abstract
In this paper we summarize the major vertical datums that are used along the Mississippi River and its tributaries in Illinois (Memphis datum, Mean Gulf Level and the 4th General adjustment of 1912) and show the approximate shifts between these systems and NAVD88. These height differences are not small. For example height differences of up to 8 ft are observed for Memphis datum.

Introduction

For most applications, there are only two vertical datums in common use in the United States. The North American Vertical Datum of 1988 (NAVD88), our current national height datum, is used for most high accuracy modern surveys and the National Geodetic Vertical Datum of 1929 (NGVD29) which is superseded but is still used for engineering applications and by numerous municipal governments. Very rarely do we encounter survey measurements in datums older than NGVD29. One major exception to this is the upper Mississippi River and its tributaries. Here, because of the great value of historical measurements of river levels, and because of the importance of maintaining continuity for diverse groups of users, pre 1929 datums remain important and, indeed, in some cases, are in common usage for water level measurements and bathymetric surveys.

In this paper we summarize the major vertical datums that are used along the Mississippi River and its tributaries in Illinois and show the approximate datum shifts between these datums and NAVD88. In conducting this study we have concentrated on mapping the local differences in heights recorded in the various legacy datums and NAVD88 (Zilkoski Richards and Young 1992) along corridors following the Mississippi and Illinois rivers, because this is where the legacy datums are most likely to be encountered by surveyors.

Datums in common use in the upper Mississippi River Valley.

In the Mississippi River Valley, the major legacy datums are:

1. Memphis Datum: Because no accurate datum for measuring heights existed in the Mississippi River Valley prior to the establishment of Mean Gulf Level and its propagation up the Mississippi River Valley after 1881, government surveys on the Mississippi conducted in latter part of the 19th centurary used an arbitrary datum established in Memphis, Tennessee.
2. Mean Gulf Level: This was the first sea level datum for the Mississippi. It was based on mean sea level determined by a tide gage in Biloxi, Mississippi established in 1881 by the Mississippi River Commission. These heights were then gradually propagated up the Mississippi by leveling parties
3. Fourth General Adjustment of 1912: The first datum based on geodetic quality leveling was established in 1900 by the U. S. Coast and Geodetic Survey (USC&GS) holding elevations referenced to local mean sea level

(LMSL) fixed at five tide stations (Boston MA, Sandy Hook NJ, Washington DC, New York, NY and Biloxi, MS). Readjustments of the leveling network were performed in 1903, 1907 and 1912. Only the Fourth General Adjustment of 1912 is widely used as a legacy datum in the Mississippi Valley today. It is the basis of all height and water level measurements conducted by the Rock Island office of the US Army Corps of Engineers (USACE) in Wisconsin and Illinois.

Relationship between Memphis Datum, Mean Gulf Level and NAVD88.

Because each vertical datum has its own unique adjustment procedures, each is warped in a complex way with respect to NAVD88. Local shifts between the datum surfaces can be estimated by identifying benchmarks that have heights determined in both systems and comparing them. Using this technique, McKibbin and Schmidt (1954) developed relationships between these surfaces and NGVD29 using USACE data. However no published datum shifts between the legacy datums and NAVD88 exist. In order to determine these relationships we went through McKibbin and Schmidt (1954) and identified all of the benchmarks in their study that have valid NAVD88 heights in the National Geodetic Survey (NGS) database (www.ngs.noaa.gov/cgi-bin/datasheet.prl).
Using this data and the legacy elevations provided by McKibbin and Schmidt (1954) we were able to determine height differences between these legacy datums and NAVD88. Figure 1 shows the benchmarks in Illinois where heights are available for one or more of these legacy datums and NAVD88. Note that our study is restricted to narrow corridors along the Illinois and Mississippi River Valleys. Because of this limited geometry, our study is unable to fully define the complex relationship or the tilts between these two datum surfaces. We were able to measure height differences between the legacy datums and NAVD88 for specific points along these corridors. Figure 2 shows the vertical shift between NAVD88 and Memphis Datum for points along the Illinois River. There appears to be no clear trend. All that can be said is that the shift is 7.7 +- 0.1 ft at the 95% level of confidence.

McKibbin and Schmidt (1954) do not list any individual benchmarks with heights in the Mean Gulf Level datum however they do list datum shifts between Mean Gulf Level and NGVD29 for specific localities along the Mississippi from Cairo, IL, to Prairie Du Chen, WI. We developed approximate datum shifts between Mean Gulf Level and NAVD88 by applying shifts calculated using the NGS program vertcon (www.ngs.noaa.gov/ PC_PROD/pc_prod.shtml#VERTCON) for the appropriate locality to the NGVD29 values. The height differences as a function of Mississippi River miles are shown in figure 3. It should be noted that the NGVD29 heights used by McKibbin and Schmidt (1954) will not reflect any post 1954 adjustments to NGVD29. Because the vertcon shifts applies to post 1954 adjustment values, it has the potential to introduce a slight bias into the height difference shown in figure 3. In order to estimate the effect that post any post 1954 adjustment of NGVD29 might have had on the height differences shown in figure 3, we compared NGVD29 heights from for 11 benchmarks along the Mississippi Valley from McKibbin and Schmidt (1954) located between river mile 209-513 with NGVD29 heights from superseded heights from the NGS database. Since, in every case but one, the two values agree within a hundredth of a foot, we feel that post 1954 adjustments to NGVD29 are unlikely to have significantly affected the height differences shown in figure 3. Note that the height difference between Mean Gulf Level and NAVD88 starts out as slightly negative near Cairo IL (mile 0) then reaches a fairly constant value of 0.2 ft over most of the northern part of the Mississippi River Valley in IL and southern WI.

Fourth General Adjustment of 1912

The Fourth General Adjustment of 1912 included 46,462 km of level lines and about 11,000 benchmarks (Berry 1976). Mean sea level was held at nine tide gages located on the East, West and Gulf coasts holding elevations referenced to local mean sea level (LMSL) fixed at nine tide stations (Boston MA, Sandy Hook NJ, Baltimore MD, Morehead City NC, Brunswick GA, Biloxi, MS, Galveston TX, San Diego CA and Seattle WA). Adjusted heights for benchmarks are reported in Bowie and Avers (1914).

The level data included in the adjustment of 1912 include a series of lines extending along the Mississippi river from Cairo, IL to St Paul MN. In order to determine a height difference between NAVD88 and the Fourth General Adjustment of 1912 along the Mississippi, we checked all of the points listed in Bowie and Avers (1914) and cross referenced these with the NGS database to identify marks with both NAVD88 and the Fourth General Adjustment heights. In all we investigated 563 marks from the list in Bowie and Avers (1914) and identified 119 in the NGS database. Of these 62 had adjusted NAVD88 heights and 57 had only VERTCON heights. Standard River miles for these benchmarks were determined using shape files supplied by the USACE (lagic.lsu.edu/metadata/losco/ **river**_mile_mark_**usace**/navgeog3dxmmk.html) and ESRI's ArcInfo software. Using this data we developed a chart of the height differences as a function of river miles for all of the 62 points with adjusted NAVD88 heights. The results are shown in Figure 5. Figure 4 shows a the Fourth General Adjustment-NAVD88 height difference for the Illinois River Valley.

In the Mississippi Valley (above St Louis) the relationship between NAVD88 and the Fourth General Adjustment (see figure 5) shows significant variation with distance in the relationship between the Fourth General Adjustment – NAVD88 height difference and river miles. However a simple 2nd order polynomial regression line (see figure 6) produces an acceptable fit.

$$D = -0.055329148 + 0.00314407R$$
$$- 3.25861084627033 \bullet 10^{-06} R^{2}$$

Where D is the the Fourth General Adjustment – NAVD88 height difference in ft and R is the position of the point in USACE River miles. The predicted datum conversion from this regression equation is shown in Figure 6 and the corresponding residuals are shown in figure 7.

Conclusion

Heights along the upper Mississippi River and its tributaries have been measured using many different vertical datums. While most of these are of historical interest, there are three that are still in active use, NAVD88, NGVD29 and the Fourth General Adjustment of 1912. Each vertical datum defines its own reference surface for heights. Each reference surface will produce a different height so as users of geographic data it is up to us to ensure that we know what reference surfaces all of our heights are referenced to. While surveyors are used to dealing with NAVD88 and NGVD29, few will be aware of the continued use of the Fourth General Adjustment or the existence of other legacy datums.

The difference between NAVD88 and NGVD29 are quite small in Illinois and indeed over most of the Mississippi River Valley, however the other legacy datums have much greater shifts. For example the height difference between the Fourth General Adjustment, (which is still in common use for recording river level heights) and NAVD88 is as much as 0.82 ft. The height difference for Memphis Datum, which is no longer used but which remains important due to the large amount of legacy data within this system, is over 7.5 ft. As a result, correctly identifying the datum associated with each height measurement is particularly important for workers in this region.

Acknowledgements

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Bowie W. and H. G. Avers 1914. *Fourth General Adjustment of the Precise Level Net in the United States and the Resulting Standard Elevations*, Special Publication No. 18, U.S. Coast & Geodetic Survey, Government Printing Office Washington, D.C.

McKibbon J. C. and M. O. Schmidt (1954) Datum Planes in Illinois Civil engineering Studies Surveying Series #1 Department of Civil Engineering University of Illinois; Urbana Illinois

Zilkoski, David B., John H. Richards, and Gary M. Young Results of the General Adjustment of the North American Vertical Datum of 1988 American Congress on Surveying and Mapping *Surveying and Land Information Systems*, Vol. 52, No. 3, 1992, pp.133-149

- Figure 1 Map showing location of benchmarks with NAVD88 elevations and elevations in one or more legacy datums. Triangles shows points along the upper Mississippi which have heights from the Fourth General Adjustment of 1912 reported in Bowie and Avers (1914) and have valid NAVD88 heights. Crosses show benchmarks along the Illinois River Valley which McKibbin and Schmidt (1954) list heights in the Fourth General Adjustment of 1912 and Memphis Datum and which also have valid NAVD88 heights from the NGS database.

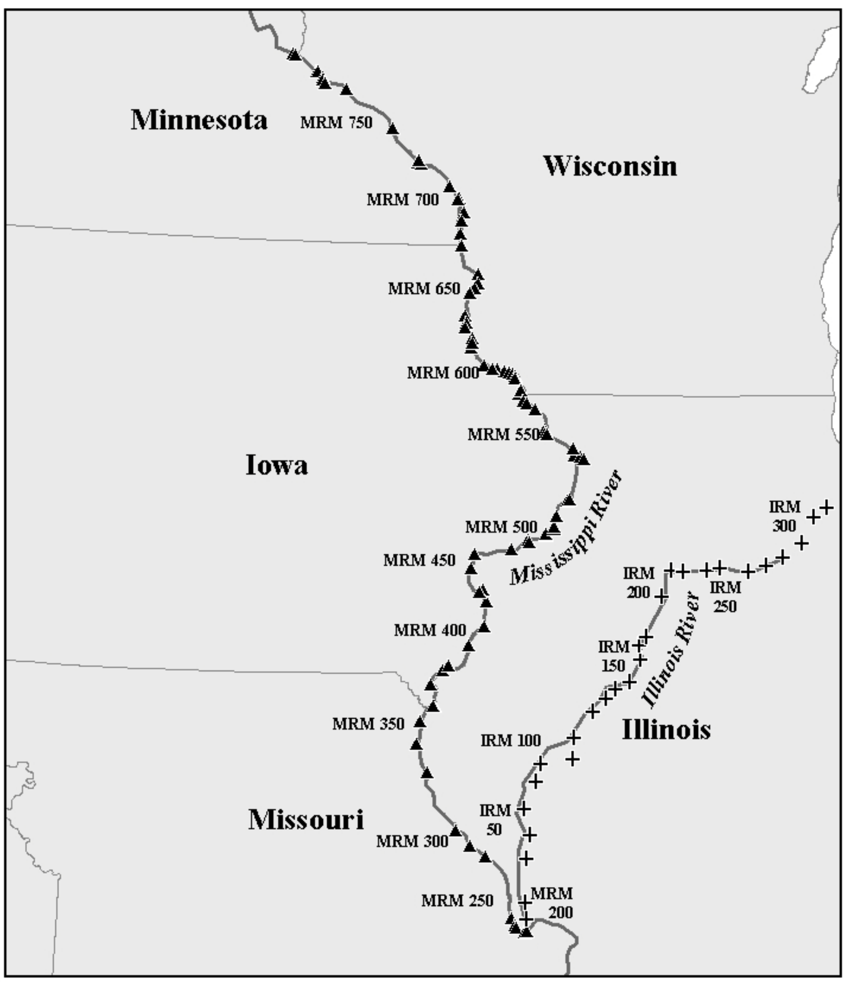

Figure 2 Height difference between Memphis Datum and NAVD88 for points along the Illinois River vs. standard river miles from the confluence with the Mississippi.

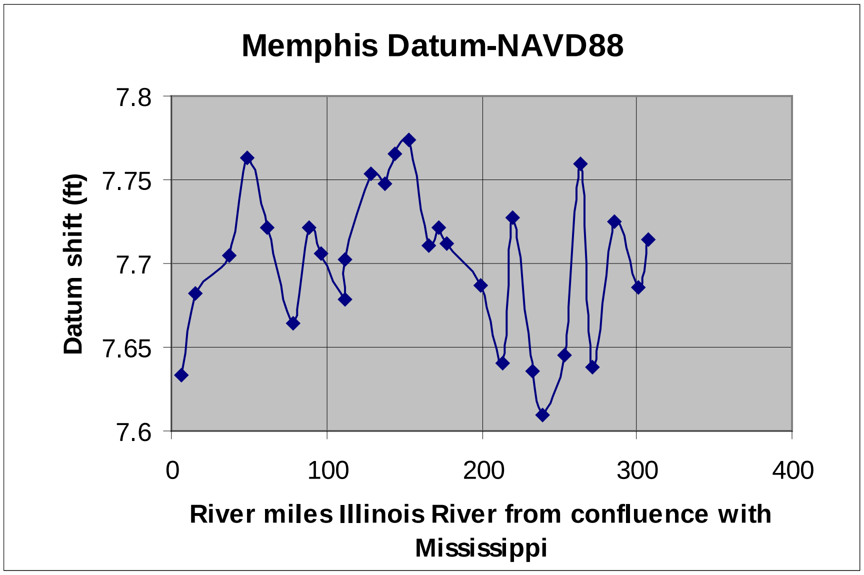

Figure 3 Approximate height difference between Mean Gulf Level and NAVD88 for points along the Mississippi River

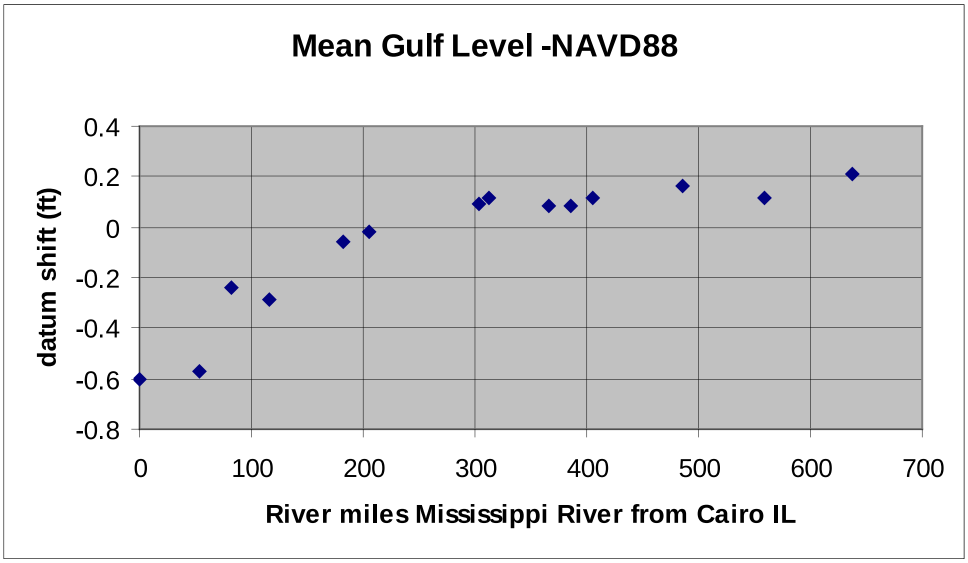

Figure 4 Shift between the 4th General adjustment and NAVD88 in the Illinois River Valley from the confluence with the Mississippi River to Willow Springs in suburban Chicago.

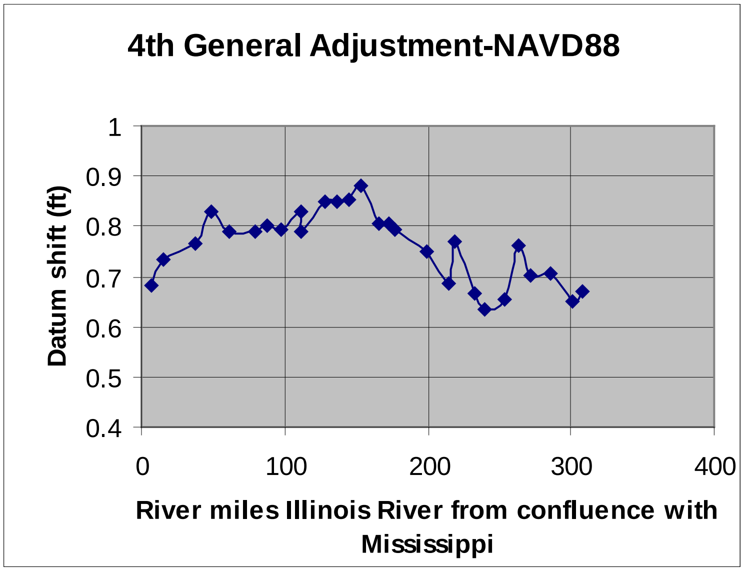

Figure 5

Shift between 4th General adjustment and NAVD88 in the Mississippi River valley between St. Louis and St Paul.

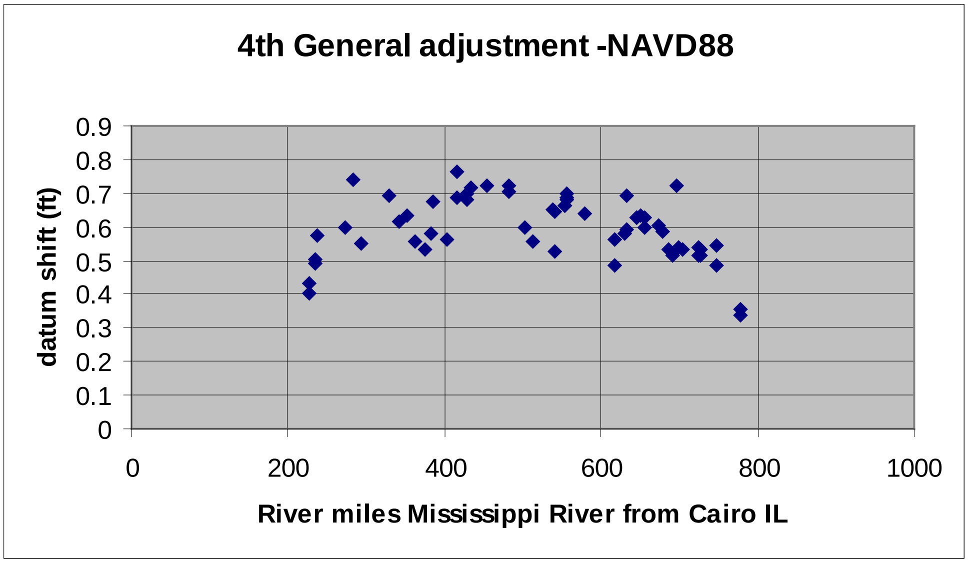

Figure 6

Order 2 regression for Mississippi Valley benchmarks between the 4th General adjustment - NAVD88 height difference vs. River Miles.

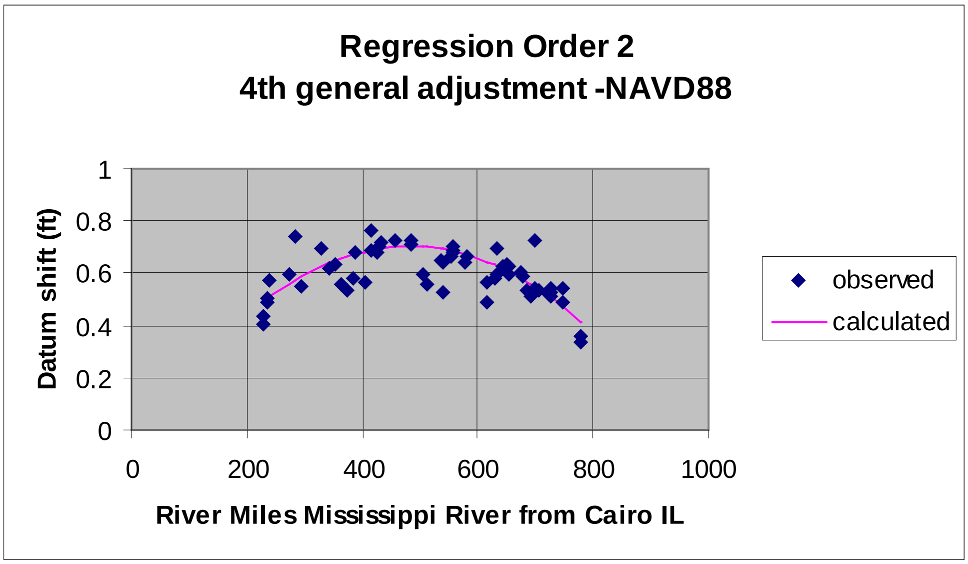

Figure 7

Residuals after removing Second-order regression