Chapter 6. The Illinois Waterway

This section describes the data collected from the Illinois Waterway and the analyses that were performed. Some of the background materials are taken from Bhowmik and Schicht (1980).

Background

The Illinois River and its main tributaries form one of the main waterways in Illinois and stretch from Milwaukee, Wisconsin, and South Bend, Indiana, to Grafton, Illinois. The tributaries of this river basically drain farmlands. Figure 6-1 shows the drainage basin of the Illinois River, which has a drainage area of 28,906 square miles.

The upper part of the Illinois River flows basically east to west and has a narrow channel. The riverbed has steeper slopes and the drop between Lockport and Starved Rock (upstream of Hennepin, Figure 6-1) is about 2.3 feet per mile. The river turns a south-westerly direction after passing De Pue. Below Starved Rock and until the mouth of the Illinois River, the channel becomes wider and meandering. The average slope is only about 1.6 inches per mile. Lubinski (1993) divides the Illinois River into the following two reaches:

- From confluence of the Kankakee and Des Plaines Rivers to Hennepin, Illinois. The river passes through a young geologic valley and has a relatively high gradient, narrow floodplain, and three navigation dams.

- From Hennepin, Illinois, to the Mississippi River. This section of the Illinois River is geologically older and wider than the upper reach. It was used by the Mississippi River before recent glacial activity redirected the Mississippi westward. It has a very shallow gradient, extensive levees, and two navigation dams.

Physiographically, the river basin is located in the till plains section of the central United States (Fenneman, 1928). Large-scale relief features are absent within Illinois; however, there are some local relief features which effectively change the physiography of the basin from one location to another.

Leighton et al. (1948) divided the State of Illinois into a number of physiographic divisions on the basis of the topography of the bedrock surface, glaciations, area of the drift, and other factors. The Illinois River flows through about five of these physiographic divisions characterized

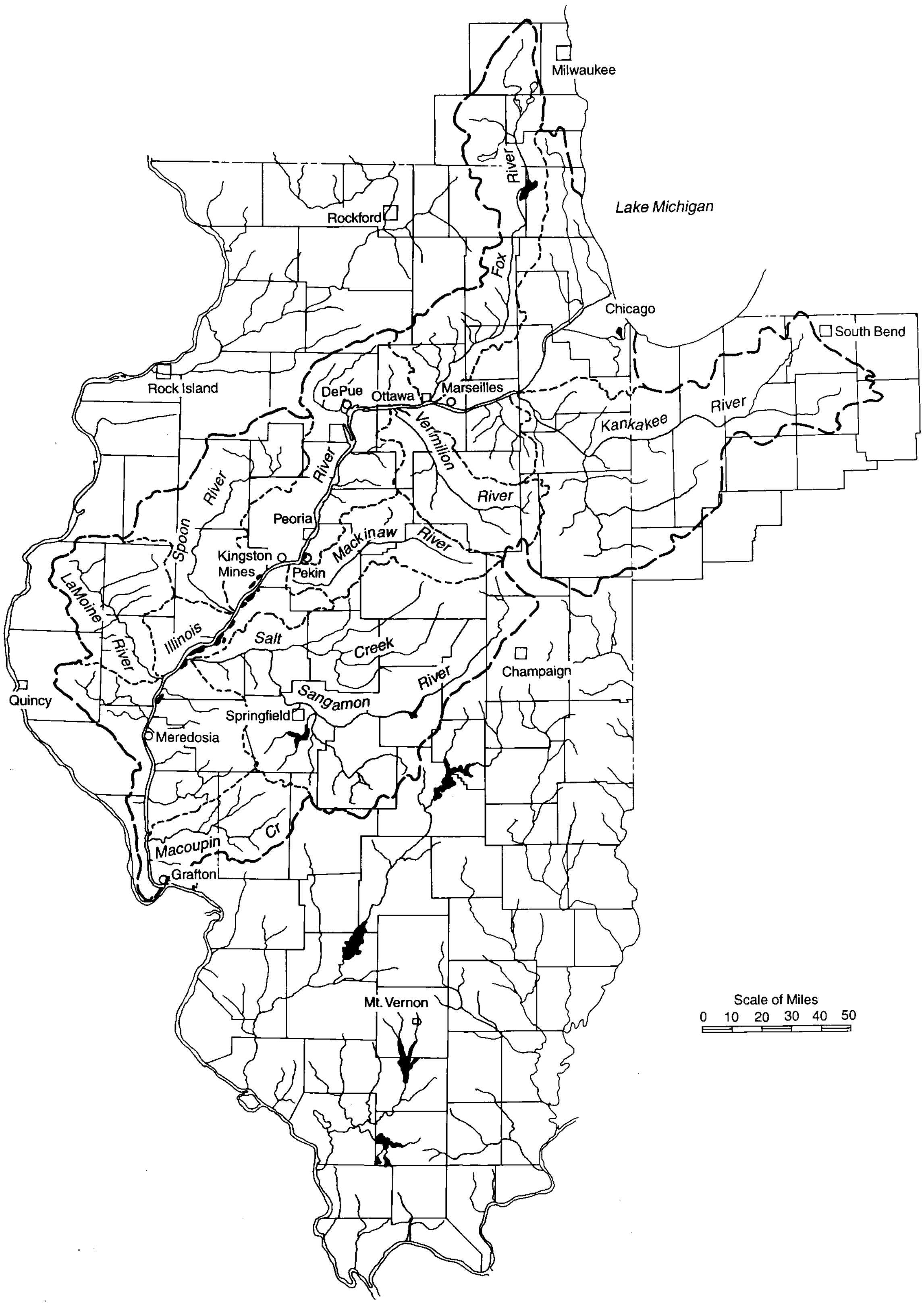


Figure 6-1. Drainage basin of the Illinois River

by broad till plains in the youthful stages of erosion. The alluvial soils near the river are most often layered and lensing alluvium.

The upper part of the river above the big bend near De Pue has a broad flat bottom valley with steep walls. Between De Pue and Peoria, the floodplains are rather narrow; downstream from Meredosia, the floodplain gradually narrows until the Illinois meets the Mississippi River near Grafton.

The Illinois River in its present form consists of a series of pools created by eight locks and dams. These locks and dams control the water surface profiles and the average depths of flow.

The U.S. Army Corps of Engineers maintains a 9-foot navigational channel along the length of the river for vessels that draw 9 feet of water. This major waterway has carried a large amount of barge traffic since the opening of the locks and dams in 1933. More than 46 million tons (1990 data, IPMP, 1994) of traffic traverse the river in a year. Tows operating on the river may have as many as 15 barges (each capable of carrying 1,500 tons) pushed by a 5,000 horsepower tow boat. A tow and barge configuration (nearly 105 feet wide and 1,100 feet long) can move at a speed in excess of 8 miles per hour with a draft of 9 feet and could move 1,100 cubic feet of water per second through its propeller (Adams, 1991).

Prior Erosion Studies

Three prior studies of bank erosion on the Illinois River have been done: Bhowmik and Schicht (1980), Warren (1987), and Hagerty (1988).

Bhowmik and Schicht (1980) Study. This study was conducted with the following objectives:

- To document present bank erosion areas.
- To develop present plan view of severely eroded banks at about 20 selected reaches.
- To make bank stability analyses for each reach.
- To attempt to assess the effect of the increase in the Lake Michigan diversion on bank erosion.
- To propose a monitoring system to document any future changes in bank conditions.
- To suggest future research areas that should be undertaken to better identify the causes of the bank erosion of the Illinois River.

A five-day boat trip on the Illinois River was taken from July 17-21, 1978, to document the severity of bank erosion. The trip started at Joliet and ended at Pere Marquette State Park near Grafton.

During the trip, severely eroded banks were photographed, and surficial soil samples from the eroded banks and the riverbed were collected at intervals of 3 to 4 miles. Figure 6-2 shows the location of the 24 river reaches, each on only one side of the river, selected during the field trip for initial analysis and further study.

Whenever a portion of the riverbank appeared to be severely eroded, the site was selected for data collection. Data collection included taking photographs and sampling bank and bed material. Surficial bank soil was photographed using a 2 foot by 2 foot grid with a fine mesh of 0.1 foot by 0.1 foot. Only the bank soils on the top layer of the bank were sampled. Subsequently, a surveying crew was engaged to survey the selected site, including detailed bank sections. Figure 6-3 shows the locations where bank and bed material samples were collected. Figure 6-4 shows sample plan forms that subsequently developed from a detailed survey by Bhowmik and Schicht (1980).

The bank slope is an important parameter in the stability analysis of any riverbank. For the 1980 Bhowmik and Schicht study, the surveying crew determined the bank slope at each selected reach for three to six sections. Data were plotted for each reach separately, with the bed of the river taken as the datum. The plot shows the lateral displacements of the bank with each foot of drop from the top of the bank. Figures 6-5 and 6-6 show two typical plots that were developed for Reaches 3 and 14, respectively. Data from Reaches 1-4, 7-9, 13, 15, 17-20, and 24 indicated that a single average bank slope determined from plots similar to figure 6-5 can be used as the representative bank slope for each one of these reaches. However, data analyzed from Reaches 5, 6, 12, 14, 22, and 23 indicated that either of two distinct slopes existed in the same reach, similar to one shown in figure 6-6, or different parts of the sample reach have different slopes. The bank slopes for all the reaches vary from 1V:3.5H to 1V:9H.

Altogether, 67 surficial bank material samples were collected from different locations (figure 6-3) along the Illinois River. All of the samples were analyzed by both sieve and pipette techniques to determine the particle size distribution. Plots were developed showing the percent

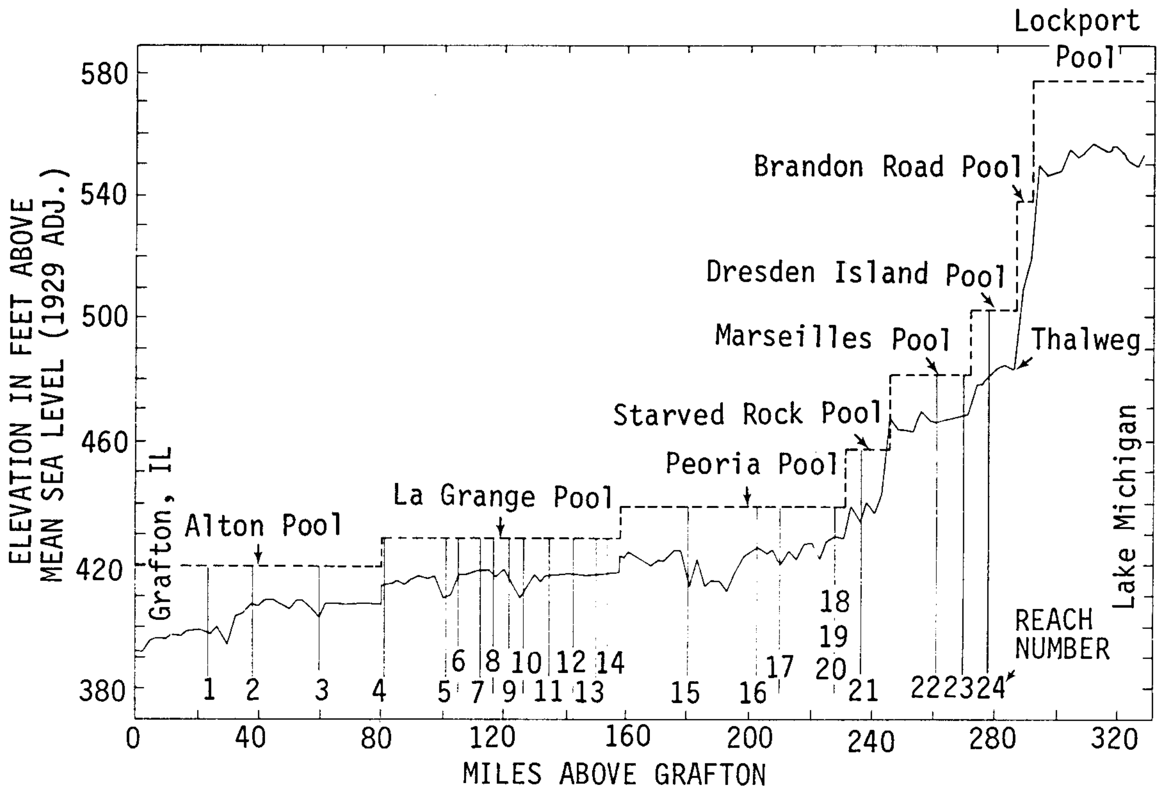


Figure 6-2. Profile of the Illinois River and the location of the reaches selected for further bank erosion investigations by Bhowmik and Schicht (1980)

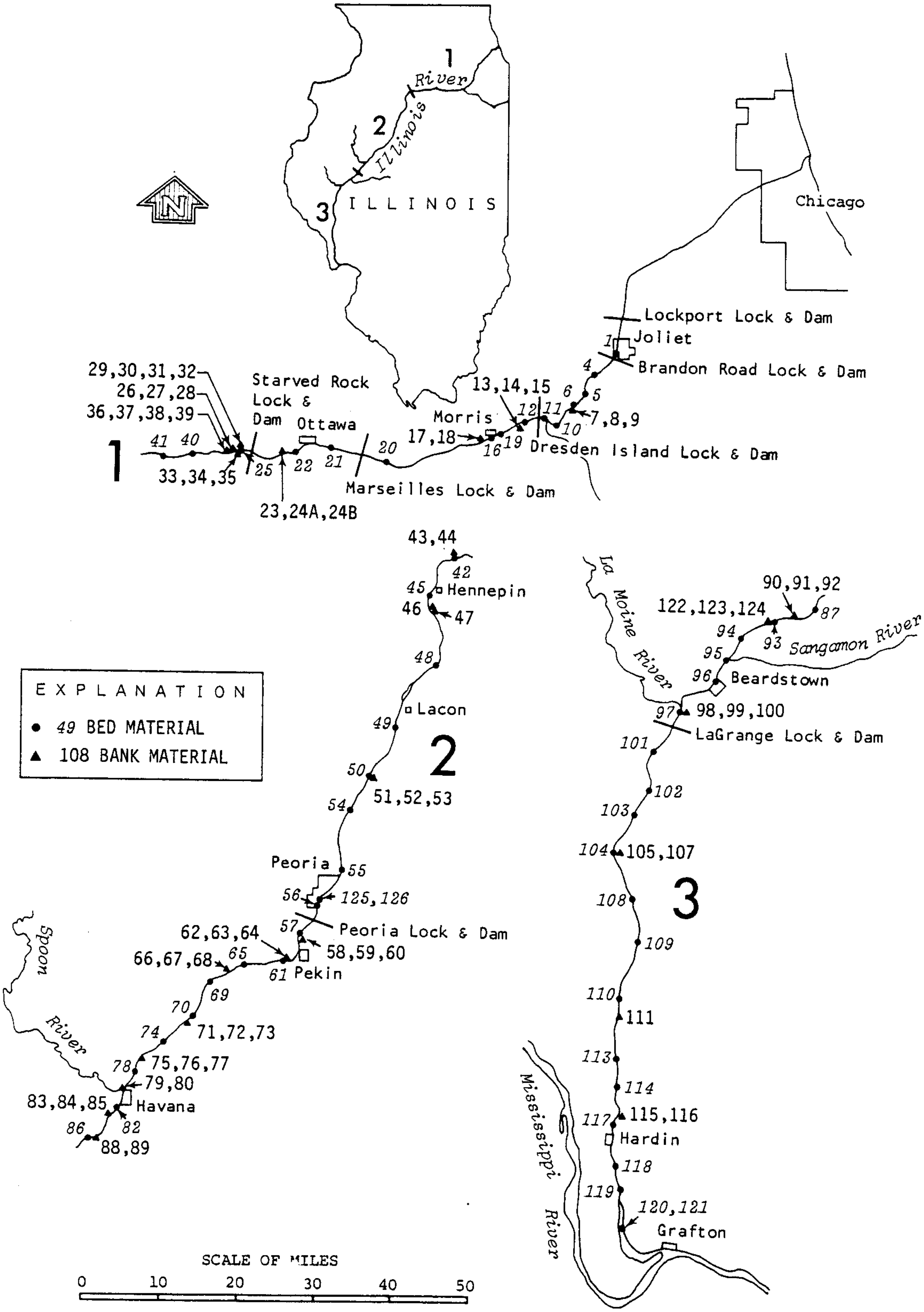


Figure 6-3. Locations where bed and bank material samples were collected by Bhowmik and Schicht (1980)

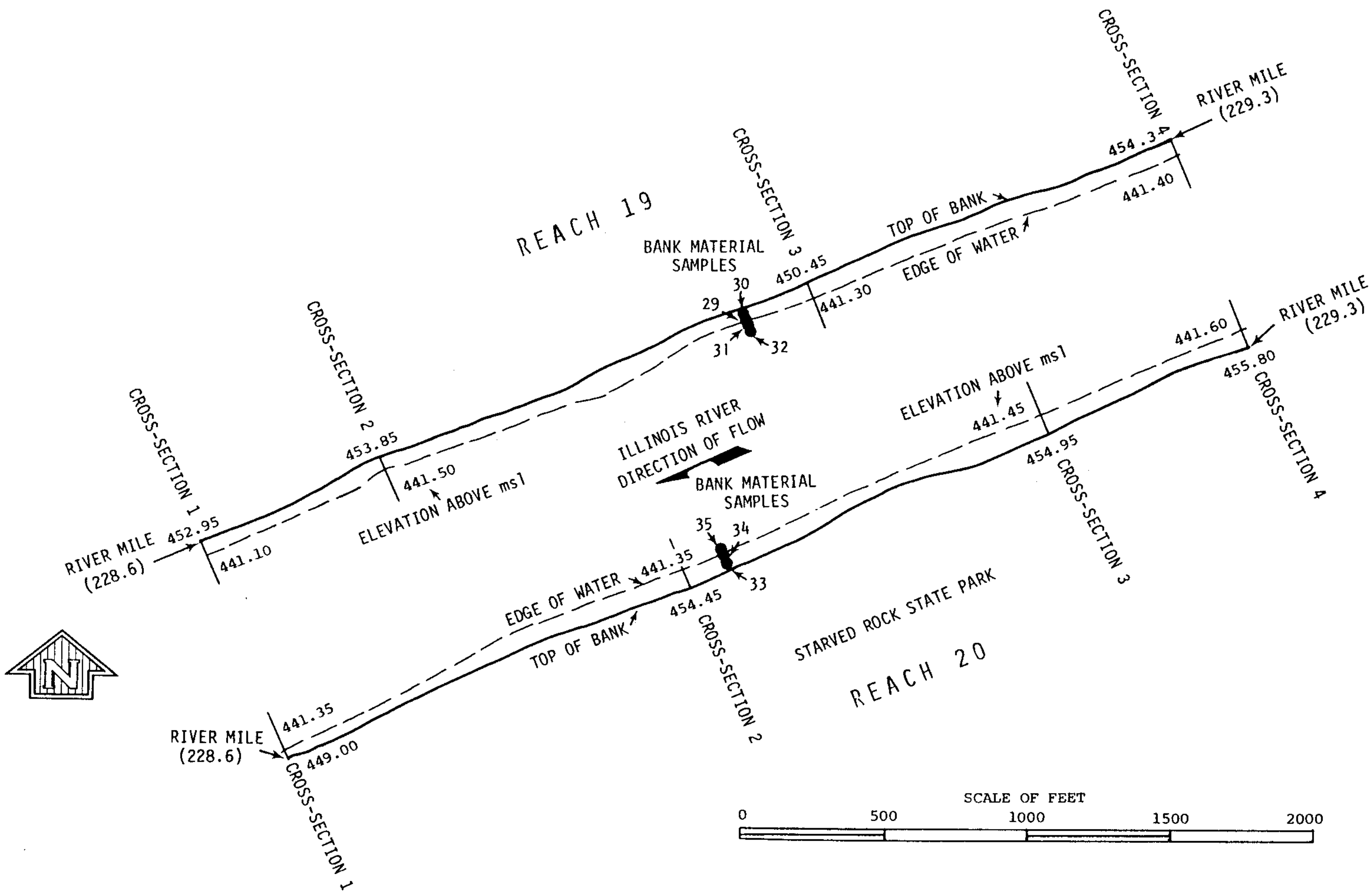


Figure 6-4. Typical plan profiles developed by Bhowmik and Schicht (1980) for the bank erosion study of the Illinois River

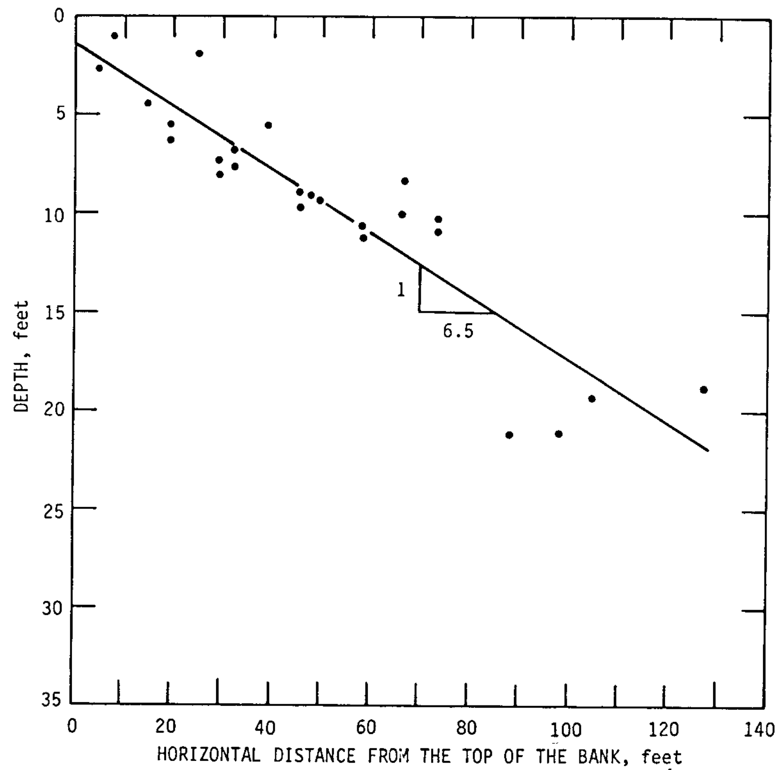


Figure 6-5. Typical plot showing the bank slope for Reach 3, after Bhowmik and Schicht (1980)

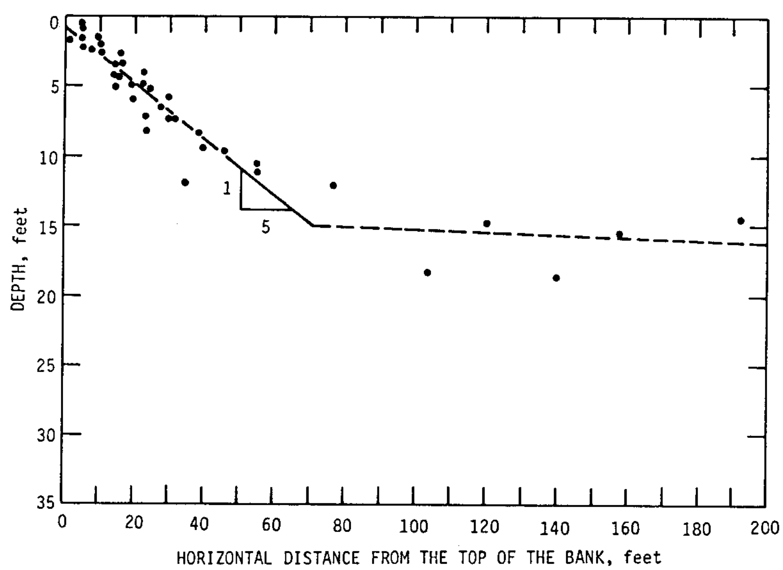


Figure 6-6. Typical plot showing the bank slope for Reach 14, after Bhowmik and Schicht (1980)

by weight versus the particle size for each one of the samples. These data were used to develop histograms of the surficial bank material. Other parameters generated from these analyses included σ and U, which are the standard deviation (σ) and uniformity coefficients (U) respectively. These two parameters indicate a measure of gradation of the particles. Higher values of σ and U indicate a well-graded material, whereas lower values of σ and U demonstrate more uniform materials. These two values are also shown in the histograms.

Figure 6-7 shows the histograms for the d_{50} and d_{95} sizes of the bank soils. For d_{50} sizes, it is obvious that 63 of the 67 bank soil samples have a median diameter smaller than 2 mm. The middle figure shows that out of these 63 samples, 38 have d_{50} values less than 0.1 mm. The top figure shows that 15 of the samples have d_{50} sizes within the range of 0.01 to 0.02 mm, indicating that these materials are in the clay to silty ranges.

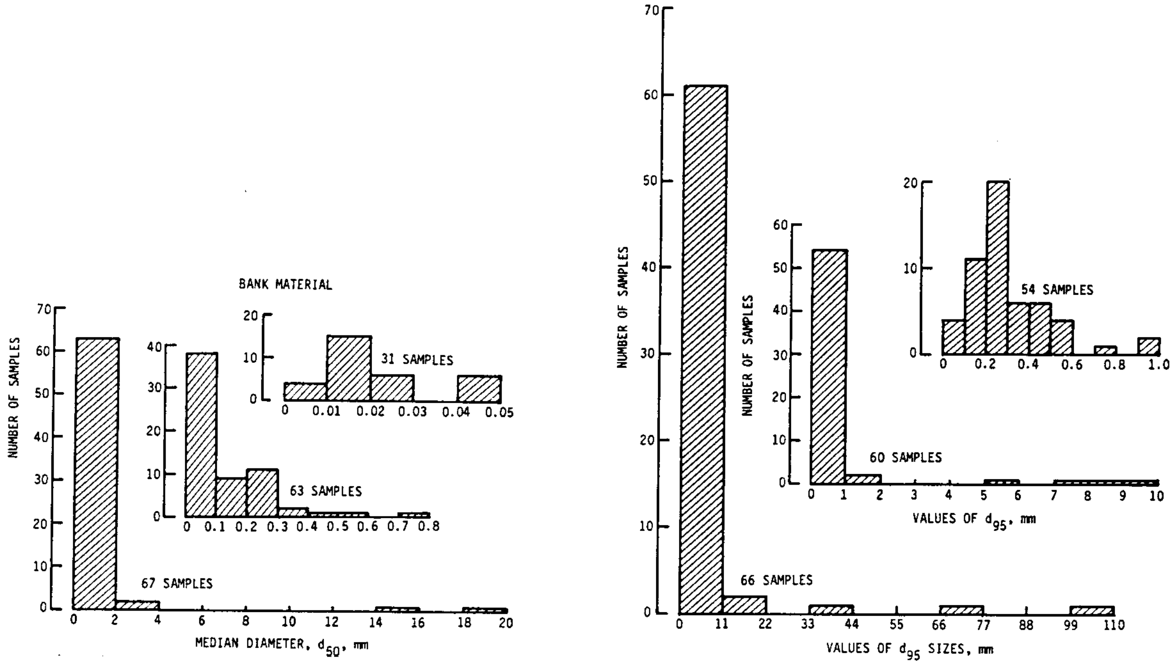
For d_{95} sizes, 60 out of 67 samples have d_{95} values less than 11 mm. Similarly, 63 out of 67 samples have d_{95} values of less than 1 mm and 20 of the samples have d_{95} values in the range of 0.2 to 0.3 mm, indicating that they are basically sandy materials.

Figure 6-8 shows the frequency distribution for the standard deviation (σ) and the uniformity coefficient (U). Although no definitive statement can be made as to the uniformity characteristics of these materials, they are basically well-graded materials, although some of the samples consist of uniform materials for almost 60 to 70 percent of their volume.

Data analyzed for the bank soils definitely indicate that wherever serious bank erosion existed on the Illinois River, the surficial bank soils are usually of fine-grained sands to silts.

Based on their investigation, Bhowmik and Schicht (1980, page 1) made the following observations. "Banks of the Illinois River have been eroding because of natural and man-made acts. In many places the erosion is very severe; in other places the banks are stable. The bank erosion of the river was investigated in detail to ascertain the probable effects of increased Lake Michigan diversion on bank stability or erosion. Hydraulic parameters were either computed or estimated, and the stability of the banks at all 20 locations was tested following accepted methods and techniques in hydraulics.

"The stability analysis based on hydraulic and gravity forces assuming noncohesive bank materials was done for discharges with and without additional Lake Michigan diversions for three typical water years. In general, the silty, sandy, and clayey materials of these severely eroded



a. Frequency distribution of the median diameter

b. Frequency distribution of the d_{95} sizes

Figure 6-7. Frequency distribution of the median diameter of the bank materials, after Bhowmik and Schicht (1980)

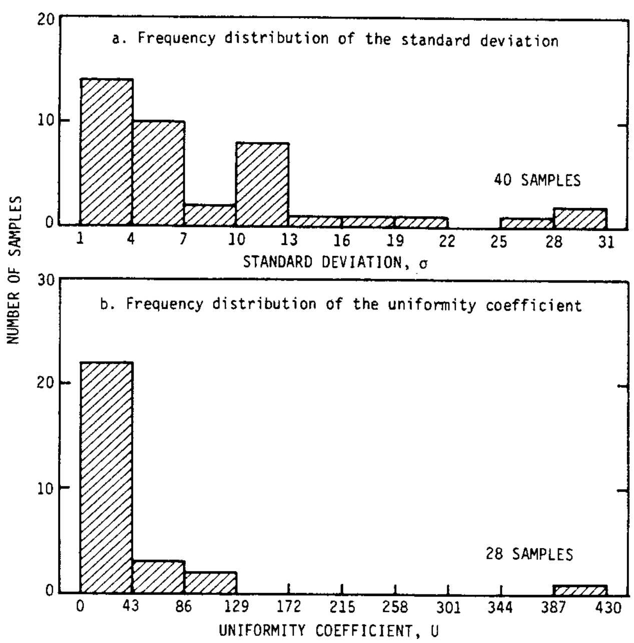


Figure 6-8. Frequency distribution of standard deviation (σ) and uniformity coefficient (U) of the bank material, after Bhowmik and Schicht (1980)

banks should be stable against the action of tractive force and flow velocity. However, preliminary computations indicated that the banks are unstable as far as the wind-generated wave action is concerned. It is possible that river-traffic-generated wave action also has a similar effect. A monitoring program is outlined, and a future research project related to the wave action on the banks is suggested." It should be noted that no geotechnical analysis was performed for this study.

Warren (1987). Warren (1987) based on historical observations, found the Illinois River had been geologically stable until the early 20th century. His summary stated: "Although it is difficult to judge the amount of bank erosion that occurred along the Illinois River under natural conditions, there is little question that erosion rates are much higher today. The modern channel is still straight, but a variety of artificial changes in the regime of the Illinois have both reinforced old causes and introduced new causes of erosion… some of the more important of these changes include the heightened water-surface elevation of the river; the increased frequency and magnitude of flooding along the river; the increase in wave action generated by vessel traffic and, perhaps, by wind; the introduction of drawdown as a new erosive force; and probably also the feedback between these various factors and the modern characteristics of cutbanks along the river. Together, these man-made causes and conditions have helped to create a severe erosion problem along many stretches of the Illinois River.

"A field study was conducted at five archaeologically important sites on the Illinois River. Rates of erosion were measured both horizontally and vertically over a period of approximately 6 months. At all but one site, banks were generally eroding. A statistical analysis using multi-regression of 14 variables related to site characteristics and erosion measurements was conducted. (None of the variables related to processes such as wind energy, or vessel waves, etc.) The average horizontal erosion rate at the five sites was 1 mm/day, with a high of 2.5 mm/day at one site and a low of -1 mm/day at another. Extrapolation of these rates indicates a 35-cm loss of bank deposits per year along the lower Illinois River. The author concluded that since erosion occurred on both sides of the river in both convex and concave channel areas, natural phenomena could not have caused the erosion; therefore, much of the erosion must be due to vessel traffic" (quoted from Maynord and Martin, 1996, page 50, on Warren's report).

Hagerty (1988) Study. Hagerty (1988) conducted an investigation on the conditions of banks along the IWW during June 1988. The purpose of this investigation was to observe bank conditions of the river, determine significant failure and erosion mechanisms on those banks, and describe the relative significance of each mechanism. Riverbanks were inspected by helicopter on a reconnaissance trip from St. Louis to Joliet (RM 286) and a bank inspection trip by boat from Joliet to Grafton. Hagerty (1988) summarized his observations about the channel morphology and surrounding structures after the helicopter overflight in his 1988 report and concluded (Hagerty, 1988, page 11):

- Significant bank erosion was not present along the IWW.
- Extensive reaches of high bare bank were not seen.
- Many long reaches with apparent bank stability were observed.
- Large bodies of water were noted adjacent to low bare banks with seepage marks.

The boat trip was conducted from June 8-14, 1988, from Joliet to Grafton, and the team marked and color-coded bank conditions on navigation charts. The team also stopped at erosion sites to inspect the occurrence and sequence of erosion and deposition. At each site the team assessed the mechanisms of erosion on the basis of soil exposed in dug bank trenches, information on the operation of the Illinois Waterway and dredging practices, the geologic formation of the river valley, and specific characteristics present on the bank and bench. The team inspected 20 sites previously inspected by Bhowmik and Schicht (1980) and selected 12 additional sites for evaluation. At each site, the team collected the following information:

- site photographs
- bank sections, and
- soil samples

Hagerty (1988) commented on the conditions found at each site. The soil samples were analyzed to determine the particle sizes. From the bank inspection, Hagerty derived the following conclusions: bank conditions vary significantly from pool to pool, but bank conditions are quite similar within long reaches of the waterway.

Based on observed bank conditions, sites with the potential for erosion were divided into five categories. The following passages are excerpted from Hagerty's 1988 report (pages 23, 24).

Figure 6-9 shows a sketch of a "Type 5 site: At this category site, the subaqueous bench was very gently sloping and extended far out under the water. Sediments had been deposited within shallow water near bank bench areas. Seasonal grasses and tree seedlings were often encountered on the lower bank at these sites. Somewhat steeper midbank areas often contained slumped alluvium and recently deposited sediments. This intermediate bank zone was 2 to 3 feet high and typically was sloped at 1 vertical on about 6 horizontal. Above the zone of recent sediment accumulation the variable bank slope increased slightly. Numerous trees and dense brush were found on the upper bank. These type 5 site conditions were indicative of relative bank stability" (page 23).

Figure 6-10 shows a "Type 4 site: The subaqueous bench on this type of site was very similar to that at a type 5 site, but did not extend as far channelward. The gently sloping lower bank was also narrower than at a type 5 site. Accumulations of failed soils and recently deposited sediments formed berms within the midbank. The midbank sloped from 1 vertical on 6 horizontal, to 1 vertical on 4 horizontal, and the height varied between 1 and 4 feet. These berms were deeply cut by runnels. Sparse seasonal grasses were growing in this area of the bank. The upper bank contained seasonal vegetation and willow above several nearly vertical faces 0.5 to 1.0 feet high" (pages 23-24).

Figure 6-11 shows a "Type 3 site: The type 3 site included a gently sloping lower bank bench and wide berm of recently deposited sediments and failed soils from upper bank collapse. Typically, this area of failed soil accumulations was 3 to 4 feet high on a slope of approximately 1 vertical on 4 horizontal. Above the berm a nearly vertical bare face 1 to 3 feet high was encountered. Pronounced runnels cut through middle bank berms. Tree roots were typically exposed within upper bank faces" (page 24).

Figure 6-12 shows a "Type 2 site: At this site, the subaqueous bench dropped off steeply. The lower bank subaerial bench was narrow. Recently deposited sediments and failed soil accumulations formed berms 1 to 3 feet high in the middle portion of the bank. These berms contained deep runnels and seasonal vegetation. Nearly vertical faces 4 to 6 feet high were encountered within upper bank areas" (page 24).

Figure 6-13 shows a "Type 1 site: At this site, the gently sloping subaqueous bench was narrow or absent. The subaqueous bench dropped steeply away from the gently slopping lower bank. Midbank benches and berms were narrow. Above these berms, the bank was nearly vertical with bare faces 6 to 9 feet high or higher. Cavities were encountered within and at the base of these upper bank faces. Vegetation on these sites was sparse, except for floodplain areas adjacent to the top of bank" (page 24).

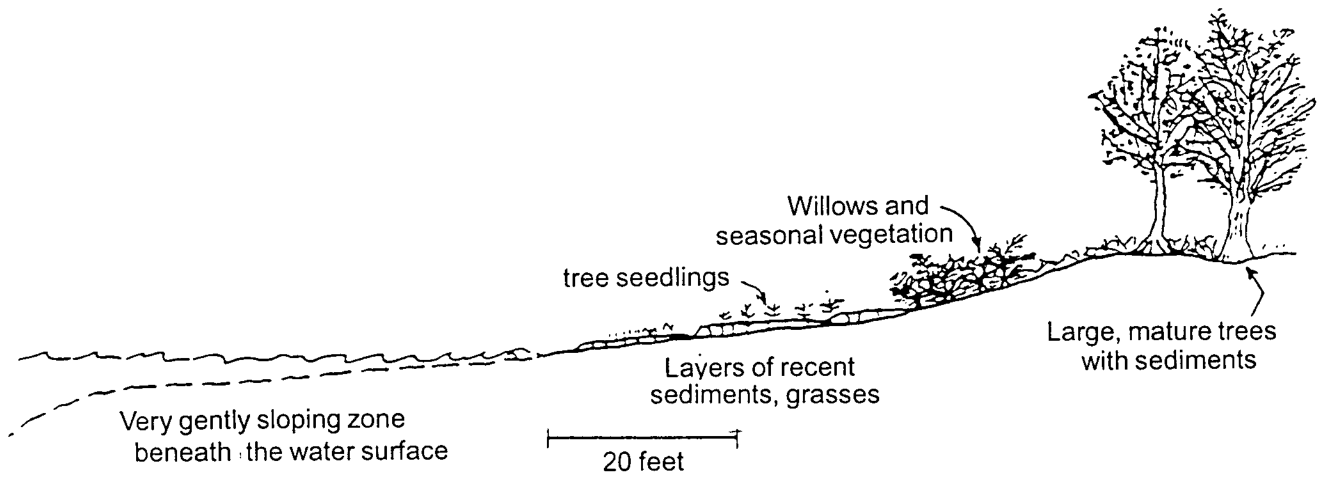


Figure 6-9. Type 5 site--relatively stable with significant deposition and relatively dense vegetation cover, after Hagerty (1988)

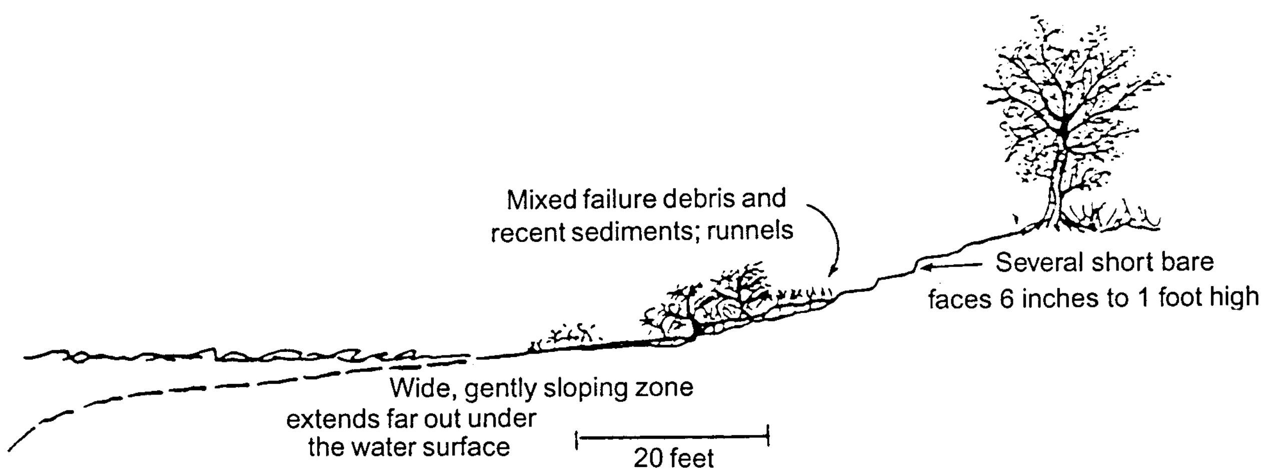


Figure 6-10. Type 4 site--site of only slight apparent erosion; deposition and accumulation of failure debris on middle and lower bank, with willows and seasonal vegetation cover, after Hagerty (1988)

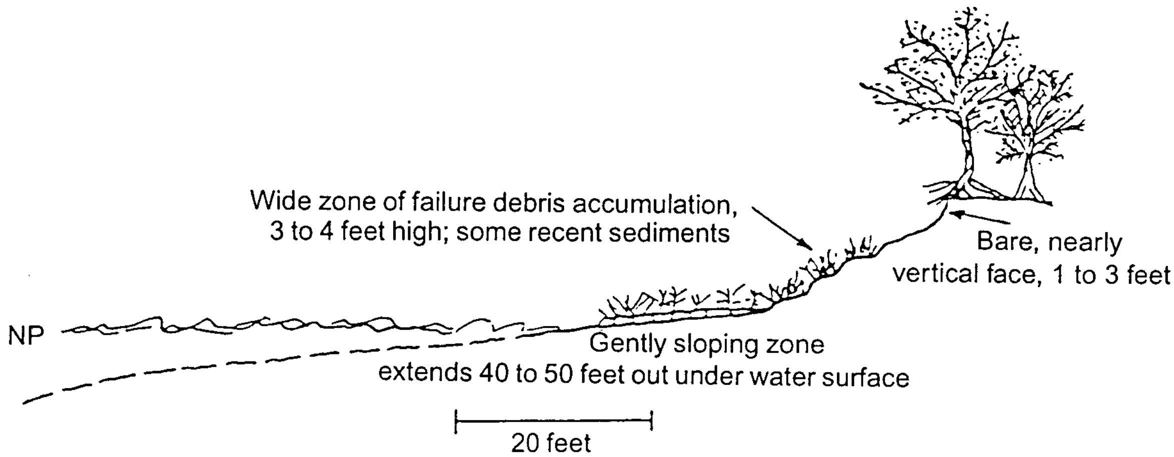


Figure 6-11. Type 3 site--site of moderate to slight erosion, with some sedimentation and moderate vegetation cover, after Hagerty (1988)

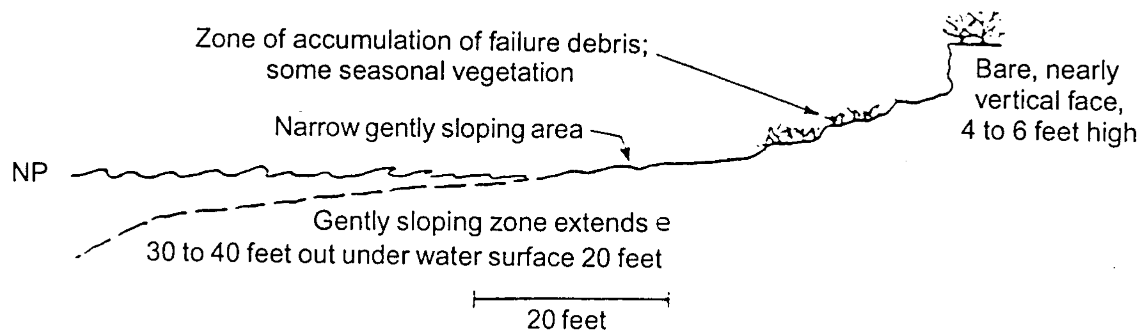


Figure 6-12. Type 2 site--apparently active site of moderate erosion very sparse cover of vegetation, after Hagerty (1988)

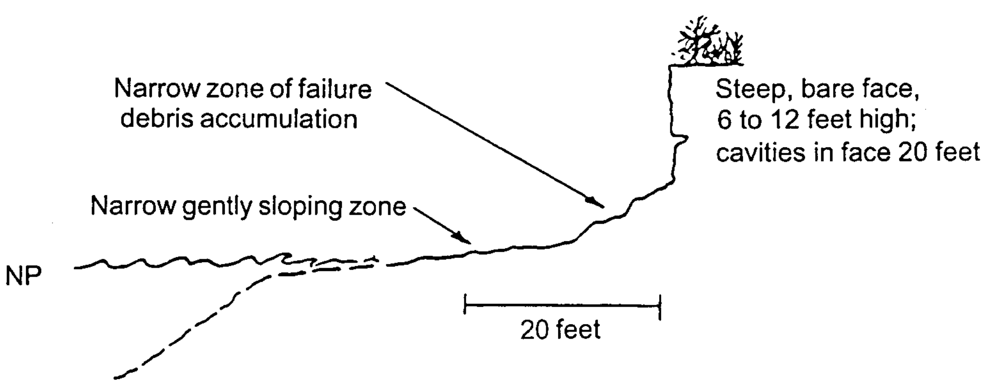


Figure 6-13. Type 1 site--apparently active site of most severe erosion little or no vegetation cover, after Hagerty (1988)

The bank conditions described by Hagerty (1988) can be summarized as:

Condition	*Left Descending Bank (%)*	*Right Descending Bank (%)*
Severely eroded	1.84	2.35
Moderately eroded	16.27	14.46
Artificial	17.47	21.09
Apparently stable	63.58	60.76
Bedrock outcrop	0.84	1.34

In a later report, Spoor and Hagerty (1989) stated: "Investigations conducted in 1988 along the Illinois Waterway indicated that bank failure and erosion are initiated by the flow of water out of the banks and removal of soil particles by piping/sapping…. Wave swash did not appear to be a significant mechanism for removal of inplace soils, although levee notching indicated erosion by a combination of waves and tractive forces during floods. Propeller turbulence was a cause of only very localized bed/bench scour…. Waterway bank erosion was not severe or widespread; even within the pools where erosion was most extensive, only 6 percent of the total bank length was severely eroded" (Maynord and Martin, 1996, page 51).

Hydrological Conditions during Field Surveys

Hydrological conditions prior to the three field studies could have influenced the studies: 1988 was a drought year, the Mississippi River experienced record floods during 1993, while the Illinois River had a major flood in 1995. These hydrological events are described here briefly using existing analyses. In the discussion, "water year" refers to the period from October of the previous year until the end of September of the current year. Bhowmik and Schicht's survey was conducted from July 17-21, 1978; Warren's study duration was from winter 1984 - 1985 (October 30, 1984 to February 14, 1985) to summer 1985 (May 31 to June 8) at five sites in the lower Illinois River valley, including Persimmon, Mortland Island, Woods Creek, Maude, and Napoleon Hollow; and Hagerty conducted the helicopter flight on June 6, 1988 and the field survey from of June 8-4, 1988.

Water Year 1978. "Streamflow was above normal as the 1978 water year began. The winter months produced record amounts of snowfall that exceeded the previous year's record snowfall…. Snowmelt in March produced some minor local flooding in central and southern Illinois. Heavy thunderstorms during June and July produced locally severe flooding in parts of northern Illinois. Total streamflow for the year was about normal in central and southern Illinois, but was below normal in northern Illinois" (USGS, 1979, page 2). These overall hydrologic conditions were indicative of the field conditions. Flows were above normal for the middle and lower portions of the Illinois River but were below normal for the northern part. However, the northern portion of the Illinois River had yearly high flows at the end of June due to the thunderstorms.

Water Year 1986. "For the sixth consecutive year, precipitation was above the 30-year average in Illinois. This is the longest above-average period in the last 120 years.… Long-term, average-annual precipitation ranged from 36 inches in the north to 44 inches in the south. However, below-normal precipitation occurred statewide during the months of January, March, April, and August. During December and June, precipitation was below normal in the southern half of the State.…Excessive runoff occurred at all three index stations (Figure 6-14). Runoff at the northern index station (Pecatonica River at Freeport) was 174 percent of its median for the period 1951-80, whereas that of the central index station (Sangamon River at Monticello) was 176 percent of its median. Runoff at the southern index station (Skillet Fork at Wayne City, IL) was 149 percent of the station's median.… The only months that had a deficit are January, April, May, and August at the central index station, and the months of January, March through June, August, and September at the southern index station" (USGS, 1987).

Water Year 1987. "Annual precipitation was below the 30-year average for the first time in several years. The long-term, average precipitation in the State ranged from 36 inches in the north to 44 inches in the south. During the 1987 water year, runoff was excessive in the north and deficient in the central and southern parts of the State. Runoff at the northern index station was excessive every month, except during March. Runoff was deficient at the central index station each month from January through September, except during February and August; runoff at the southern index station was deficient each month from December through September, except during July. Flow at the southern index station averaged only 9 percent of normal during June and September. During October, above-average rainfall occurred throughout the State. Heavy rains occurred in northeastern Illinois during the first 10 days of October following heavy rains in the last half of September. The areas most acutely affected by flooding were communities along the Des Plaines River and its tributary, Salt Creek at northern Illinois" (USGS, 1988).

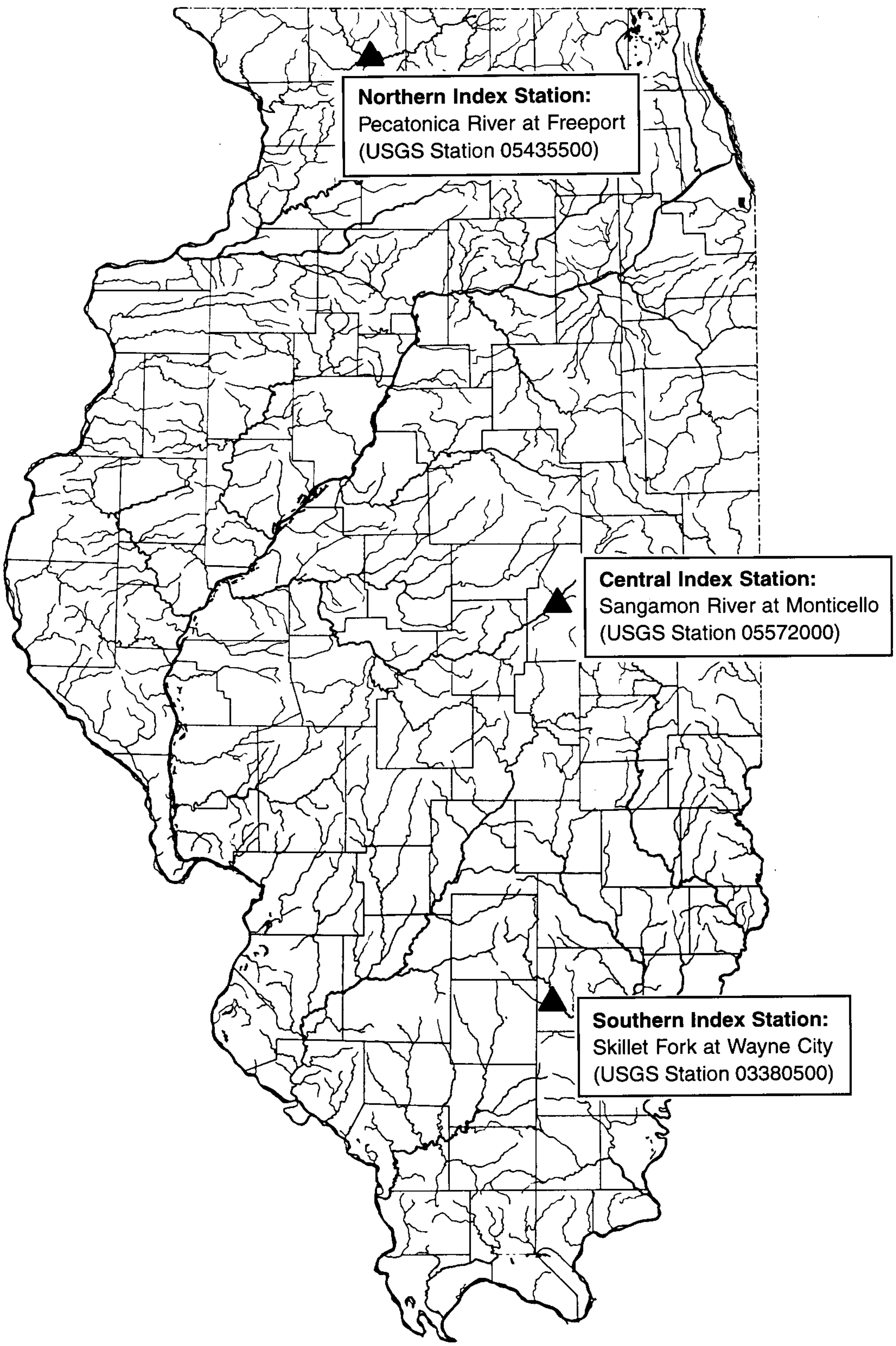


Figure 6-14. Locations of the USGS northern, central, and southern index stations

Water Year 1988. 1988 was a drought year in Illinois. During the 1988 water year, annual precipitation was below the 1951-80 average for the second consecutive year. "Runoff was normal in the northern part of the State, deficient in the central part, and excessive in the south. Runoff at the northern index station was excessive from December through February and normal for the remaining months. At the central index station, runoff was excessive in December and deficient in October and from May through September. Runoff at the southern index station was excessive from December through February and deficient in October, May, June, August, and September" (USGS, 1989).

The 1993 Flood. Although the main stem of the Mississippi River experienced new peak stages at many stations between Savanna, Illinois, and Thebes, Illinois, high stages on the Illinois River occurred mostly on its lower portion because of backwater effects from the Mississippi River and only Hardin experienced a new peak stage record. The following table is taken from a report by McConkey et al. (1994).

Illinois River Stations and Peak Stage Records

Gaging station	*River mile*	*Gage datum (feet)*	*Flood stage (feet)*	*1993 Peak stage*		*Feet over flood stage*	*Historical peak stage*		*Difference from record (feet)*
				(feet)	*(date)*		*(feet)*	*(date)*	
Henry	196.0	425.88	19.0	26.75	4/22	7.8	32.67	3/22/79	-5.9
Kingston Mines	144.4	428.00	20.0	21.41	4/23	1.4	26.02	5/25/43	-4.6
Meredosia	71.3	418.00	14.0	26.96	7/28	13.0	28.61	5/26/43	-1.7
Hardin	21.5	400.00	25.0	42.4	8/3	17.4	38.2	4/29/73	4.2

Water Year 1995. The 1995 survey was conducted from August 24-31 for the reach from Ottawa to Grafton, and from September 18-20 for the reach from Brandon Road to Ottawa, Illinois. "Average precipitation statewide was slightly above the 30-year average during the 1995 water year…. Average annual streamflows at the three index stations were above average (30-year average) at the central and southern Illinois index stations and below average at the northern Illinois index station. Flow was generally near normal for all three stations during most of the year. All three sites had excessive flows during May. Excessive flows also occurred at Monticello and Wayne City because of flood events during January, March, and August. Below normal flows occurred at Monticello and Wayne City during September…. Record-breaking floods occurred throughout central and southern Illinois during May 17-30, 1995. More than 12 inches of rain fell in parts of southern Illinois during May. Torrential rains (5-8 inches) fell throughout central and southern Illinois during May 16-19. The excess runoff caused flooding throughout central and southern Illinois"(USGS, 1996).

Flow conditions during the survey period were generally lower than the long-term averages. When the trip started on August 24, 1995 from Ottawa, the discharge at Marseilles was approximately equal to 90 percent of its long-term average value. At other stations downstream, flows were approximately 75 percent of the long-term mean discharges at each corresponding gaging station. When the crew started on Brandon Road Lock and Dam on September 18, the flows at the northern part of the Illinois River were low. The discharges at Marseilles station for that study period were approximately equal to 25 percent of the long-term mean discharge.

Historical Navigation Traffic

The locations of lock and dams on the Illinois River are also shown in figure 6-2. Data on the navigation traffic in terms of empty and loaded barges moving either upstream or downstream, from 1980-1995 were provided by the U.S. Army Corps of Engineers, Rock Island District. These data are presented in Appendix E. In general, the number of barges per year (either empty or fully loaded) increases in the downstream direction. Traffic associated with the Mississippi River should increase as one moves from the headwaters of the Illinois River toward its confluence with the Mississippi River.

Data showed a significant increase in the navigation traffic in 1993. During the 1993 flood, traffic on the Mississippi River was completely halted for more than a month (July 11 to August 22). High water stages on the Mississippi River may have diverted many barges to the IWW. On the other hand, traffic level in 1995 was lower than that in 1994. The IWW was closed 60 days for river rehabilitation work, and near record flooding on the mid- to lower Illinois River may have contributed to the decrease in traffic volume in 1995. Traffic in recent years appears to be increasing. Figure 6-15 shows the average annual navigation traffic for 1980-1994 for empty and loaded barges for all locks on the Illinois River.

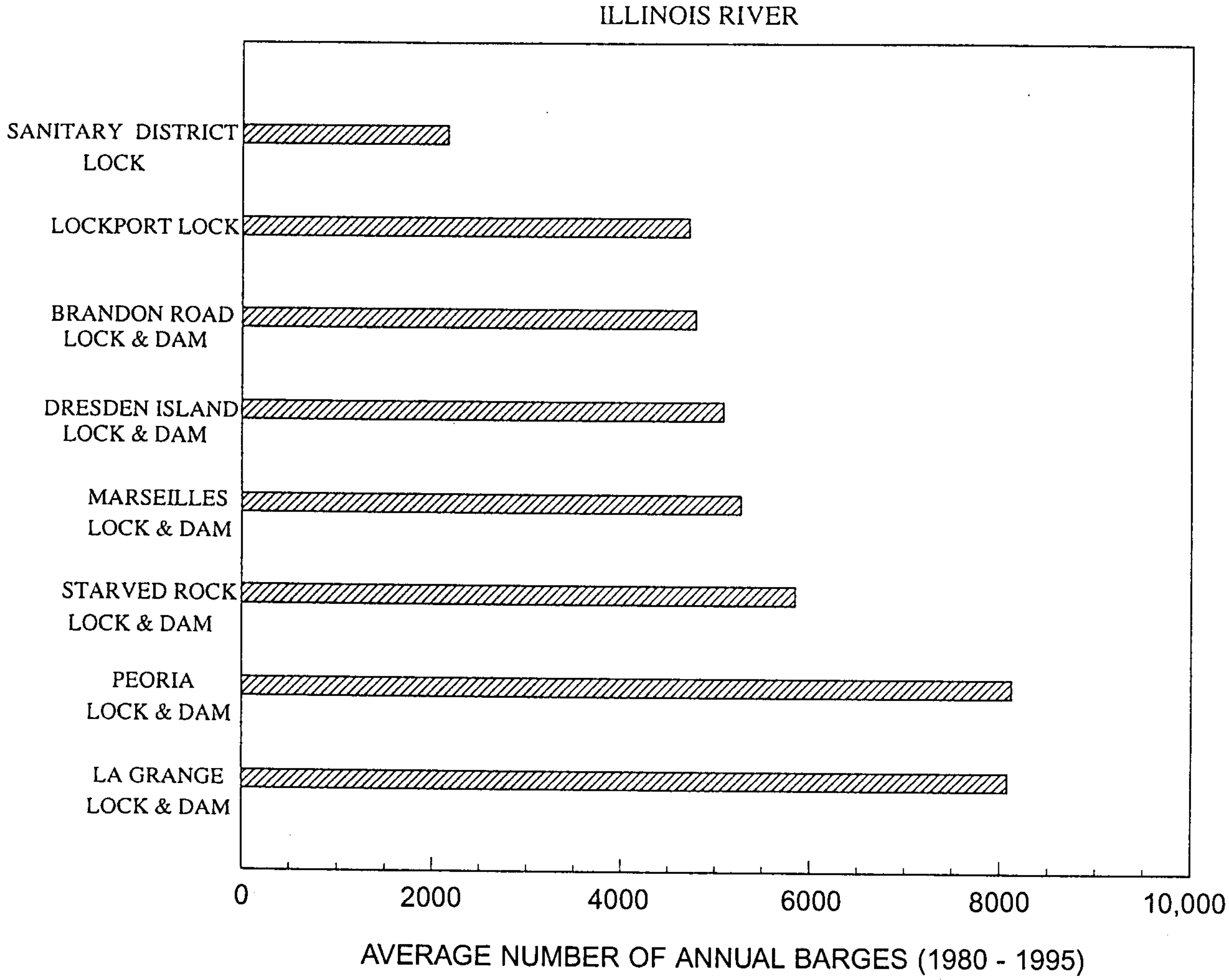


Figure 6-15. Average number of annual barges (empty, loaded, upstream bound and downstream bound) at various Lock and Dams on the Illinois River, 1980-1985. Data for Alton Pool were not available

Dredging History and Dredged Material Placement

Appendix D presents the dredging history, including dredge cut location, year dredged, dredged amount, and placement site, including the type of placement. Information included in this appendix was provided by the U.S. Army Corps of Engineers, Rock Island District.

Fleeting Areas and Mooring Sites

Appendix E also presents the terminal sites, fleeting locations, pool, fleeting capacity, name of operator and fleet destinations for the IWW and UMR, provided by the U.S. Army Corps of Engineers, Rock Island District.

Present Study

Site Locations

Twenty nine sites were selected for the present study. Figure 6-16 shows the locations of the present study sites and those selected by Bhowmik and Schicht (1980) and Hagerty (1988). Sites selected in 1995 are fairly equally distributed along the entire length of the river except in the Marseilles Pool and close to the Peoria Lock and Dam.

Sampling at Sites

After a site was selected, the limits of the site were delineated by placing temporary stakes on the bank. Then quarter points and midsection were located visually for further data collection. Figure 6-17 shows the sampling locations selected for site UP4 on the Illinois River. The primary section is the place where a detailed bank section was measured, and surficial and core samples were collected, and a river cross section was also measured. At the two quarter points, normally the bank sections were surveyed, some bank and core material samples were collected, and occasionally, a river cross section was measured.

Site Parameters

After the field trip, the team organized the field information and determined the length of each site based on the GPS coordinates measured in the field. Table 6-1 shows various parameters associated with all 29 sites on the Illinois River, including the site number, date and time when

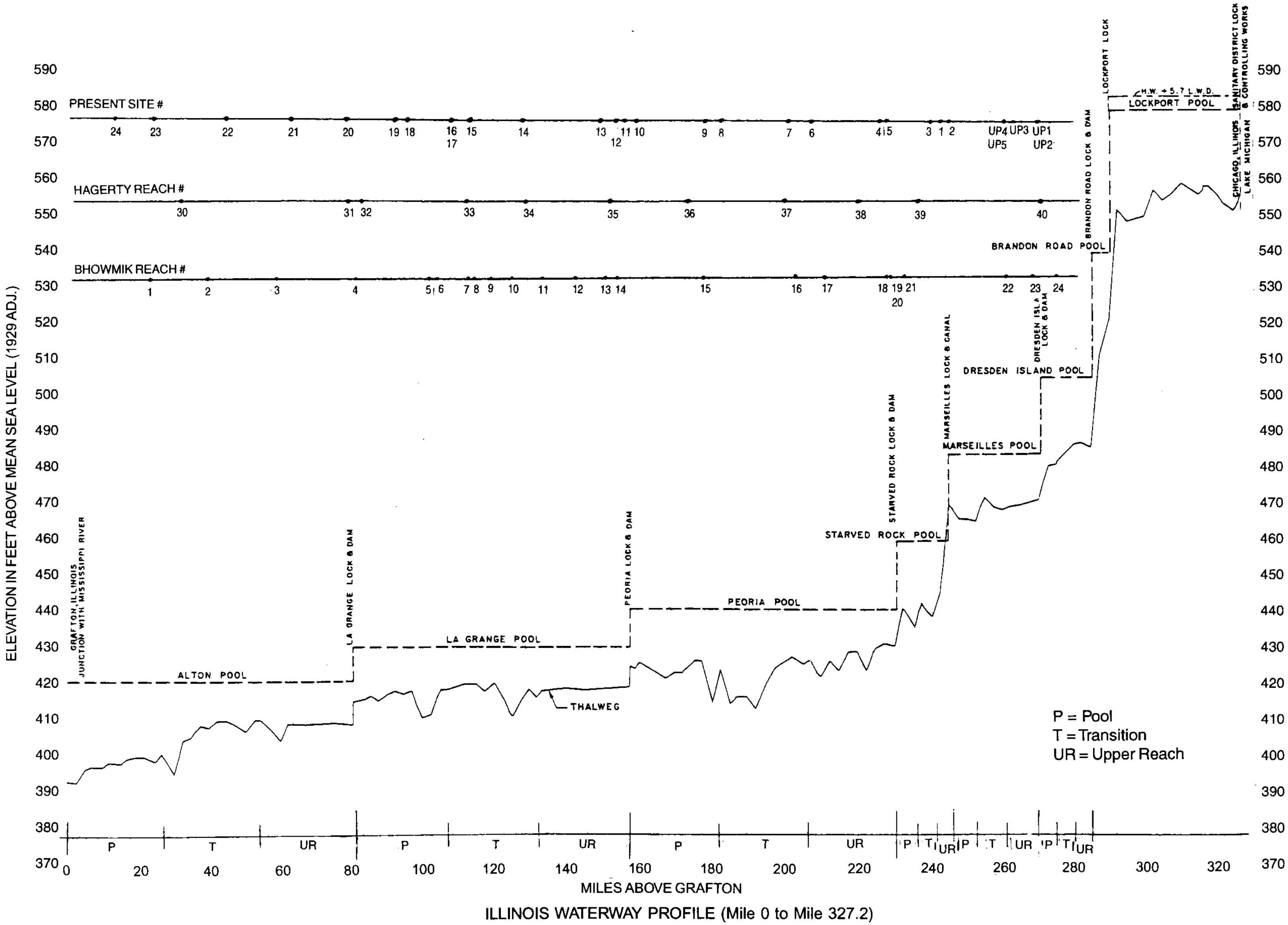


Figure 6-16. ILWW showing the relative location of sites selected for the present study and those selected by Bhowmik and Schicht (1980) and Hagerty (1988)

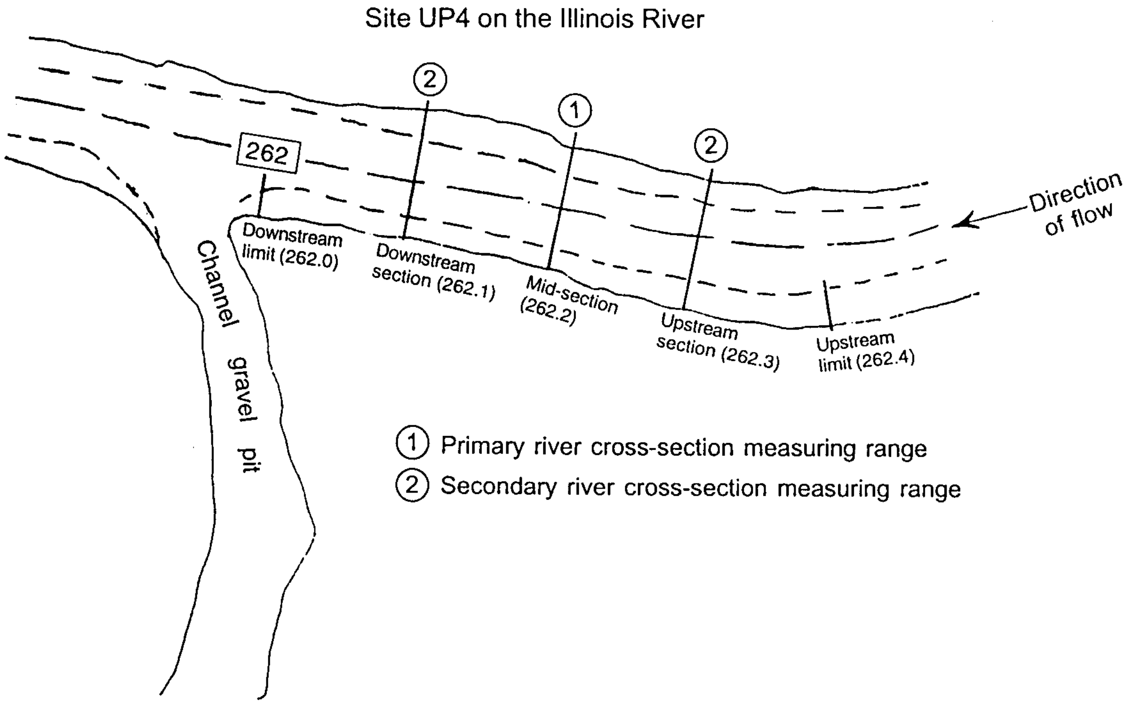


Figure 6-17. Typical sampling locations at a site

data were collected, river mile, location of the midpoint, upstream point and downstream point, right or left descending bank of the river where the site is located, length of the sites in miles, water surface stage when the data were collected, recurrence frequency corresponding to the stage, and ordinary high water level and normal pool level.

Generalized Bank Types

After examining the field data associated with these 29 sites, and comparing them in conjunction with failure mechanisms, six “Bank Types” have been grouped to facilitate the description of individual sites on the Illinois river (see Figures 6-18 through 6-23). It can be understood that the degree of failure mechanisms acting upon a bank will vary with the bank’s size, geometry, soil structure; and with the extent and slope of the corresponding bench. These mechanisms are subjected to the fluctuating water levels at that site. Therefore the most likely erosion processes are identified for each bank type and called “erosion potentials.” Table 6-2 shows the corresponding main features and erosion potential with these bank types.

General Characteristics of Selected Erosion Sites

River Widths and Maximum Depths. River cross sections were measured at the 29 sites. The top width, W_T, at the midpoint, during the field data collection period, varied from about 525 to 919 feet. The maximum depths, D_{max}, also at the midpoint, varied from about 12 to 21 feet. Figures 6-24 and 6-25 show the histograms of W_T and D_{max} measured at the midpoints at all the sites.

Bank Slopes. Three bank slopes were determined at each one of the bank sections measured at all the sites: scarp slope; berm slope; and bench slope. Figure 6-26 shows a definition sketch for these parameters. It can be seen that these slopes are best approximations to the field conditions. After the field data were checked and bank sections were plotted, the study team then selected the representative portion for each of these three features; and the slopes were determined.