# PEORIA RIVERFRONT DEVELOPMENT
# (ECOSYSTEM RESTORATION) STUDY, ILLINOIS

## FEASIBILITY REPORT WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

## APPENDIX D
## HYDROLOGY AND HYDRAULICS

# D-1

# LOWER PEORIA LAKE - ILLINOIS RIVER
# RIVER MILES 162.2 - 166.0
# PEORIA POOL

# PEORIA LAKE HYDROLOGIC DATA

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Draft Final Report - October 2001

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# PEORIA LAKE HYDROLOGIC DATA

## HYDROLOGY

### FLOOD PROFILES

Flood profiles for the Illinois River were published in 1993 (Reference 1). The portion of the profiles that apply to Peoria Lakes are plotted and shown on plate D-1-1. The floods plotted include the 5-, 10-, 25-, 50-, 100-, 200-, and 500-year floods.

### ELEVATION DURATION

Elevation duration curves for year-round, March-September, and each month are shown on plates D-1-2 through D-1-15. This information is for the gage at the Peoria Boatyard, River Mile 164.6. This data well represents stages at the project site because of the flat slope of the water surface between the two sites. Duration curves give an historical representation of the percentage of time a particular water surface elevation has been equaled or exceeded.

### FLOW DURATION

The year-round flow duration curve is shown on plate D-1-16. This information is for Peoria Lock and Dam, River Mile 157.6. Duration curves give an historical representation of the percentage of time that a particular flow has been equaled or exceeded.

## CLIMATE

### PRECIPITATION

Data are based on observations recorded at the Moline, Illinois Airport by the National Weather Service. The average annual precipitation is 34.1 inches. Table D-1-1 portrays average monthly precipitation.

**TABLE D-1-1. Moline, Illinois Airport**
**Average Monthly Precipitation (inches)**

| Month | Average Precipitation | Month | Average Precipitation |
|---|---|---|---|
| January | 1.3 | July | 4.5 |
| February | 1.1 | August | 3.4 |
| March | 2.7 | September | 3.3 |
| April | 3.6 | October | 2.5 |
| May | 3.9 | November | 2.2 |
| June | 3.9 | December | 2.0 |

## TEMPERATURE

Data are based on observations recorded at the Moline, Illinois Airport by the National Weather Service. The average temperature is 49.6 degrees Fahrenheit. Table D-1-2 shows average monthly temperatures.

**TABLE D-1-2. Moline, Illinois Airport**
**Average Monthly Temperatures (degrees Fahrenheit)**

| Month | Average Temperature | Month | Average Temperature |
|---|---|---|---|
| January | 19.8 | July | 75.2 |
| February | 24.9 | August | 72.6 |
| March | 37.4 | September | 64.6 |
| April | 50.4 | October | 53.0 |
| May | 61.4 | November | 39.6 |
| June | 71.0 | December | 25.4 |

## BIBLIOGRAPHY

1. U.S. Army Corps of Engineers, Rock Island District "Illinois River Water Surface Profiles – River Mile 80 to River Mile 290", September 1993.

## LIST OF PLATES

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## LOWER PEORIA LAKE

## ILLINOIS RIVER
## RIVER MILES 162.2–166.0
## PEORIA POOL

## HYDRAULIC MICRO MODEL STUDY

## INTRODUCTION

A micro model river engineering study was conducted of Lower Peoria Lake of the Illinois River upstream of Peoria Lock and Dam, River Miles 162.2 to 166.4. The purpose of the study was to evaluate various combinations of island construction/channel dredging alternatives for the purpose of restoring the Lake Peoria ecosystem. Micro modeling was used to evaluate both the sediment transport and flow conditions in the reach.

The micro model study was conducted at U.S. Army Corps of Engineers Rock Island District's Le Claire Base. The model insert was constructed by Mr. Tom Kirkeeng, Hydraulic Engineer. Mr. Kirkeeng operated the micro model and prepared this report. Mr. Marvin Martens, Chief, Hydrologic Engineering Section, provided supervision. The micro model portion of the study was conducted under the guidance of the Applied River Engineering Center, St. Louis District, U.S. Army Corps of Engineers (AREC). Mr. Rob Davinroy and Mr. Dave Gordon of AREC provided this guidance. AREC approved the study proposal and reviewed and approved calibration and alternative runs.

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# HYDRAULIC MICRO MODEL STUDY

## BACKGROUND

### LOCATION

Lower Peoria Lake is located on the Illinois River upstream from Peoria Lock and Dam (plate D-2-1 between River Miles 163.0 to 166.4 (plates D-2-2 to D-2-4). A USGS Quadrangle Map of the study area is shown on plate D-2-6.

### HISTORY

Though depths in Lower Peoria Lake have changed over the last 100 years, the plan view of the lake has not. Aerial views of the lake from 1903, 1930, and 1995 are presented in plates D-2-7, D-2-8, and D-2-9, respectively.

### SEDIMENT CHARACTERISTICS OF THE REACH

#### Dredging

While the off-channel areas have filled in over the years, the navigation channel in Lower Peoria Lake has been essentially self-maintaining. Dredging has not occurred frequently. The table below shows where dredging has occurred historically since inundation.

| Dredging Reach (River Mile) | Year Dredged | Amount Dredged ($yd^3$) |
|---|---|---|
| 161.0-163.0 | 1942 | 45,930 |
| | 1944 | 70,640 |
| | 1948 | 32,685 |
| | 1950 | 48,279 |
| | 1953 | 17,800 |
| | 1977 | 64,079 |
| | 1979 | 34,551 |
| 166.0-168.4 | 1946 | 187,863 |
| | 1948 | 31,041 |
| | 1969 | 41,217 |

## Bank Characterization

The 1988 Illinois Waterway Bank Erosion Study (Reference 1) performed an examination of bank conditions throughout the Illinois Waterway system.

Excerpts from 1988 bank erosion study are as follows:

> *Aerial reconnaissance*
> "The Illinois widened appreciably just upriver from Peoria Locks and Dam. Trees as much as 24 inches in diameter were growing within two to three feet of the water surface on the day of the inspection. Aquatic vegetation was seen growing within near bank shallow water areas. Banks within this downriver reach of the Peoria Pool had a very stable appearance and this stable appearance was very characteristic of the downstream portion of longer pools on the Illinois Waterway. A number of partially submerged barges were seen on the riverbank at approximately mile 159.3.
>
> Waterway location within Peoria Lake varied, with the channel located near the west side of the lake for some reaches and near the east side of the lake for other reaches. Rooted aquatic vegetation was established within many areas of the lake. The water in the lake appeared to be quite shallow and passage of pleasure craft and water skiers resuspend sediments. No appreciable reaches of failed or eroded lake shoreline or banks were observed during this inspection. There was no evidence of significant erosion on the many deltas that extended out into the lake. A number of tributary streams which entered the lake from the east have deposited deltas out into the lake. Typically these deltaic sediments were light-colored and appeared to be composed of granular alluvium. The delta at the mouth of Blue Creek, approximately mile 173.2, was typical of deltas formed by tributary streams. Wide areas of low relief were noted within these deltas. Exposed sediments appeared to be areas of recent coarse sand deposition."

## STUDY PURPOSE AND GOALS

The purpose of this study was to use a physical hydraulic micro model to define sedimentation trends and general flow impacts that could be expected to occur from various island construction configurations in Lower Peoria Lake. Four different island alternatives were tested in the model and compared to the base condition as well as to each other. The goal of the study was to determine the impact of island construction upon the flow and sediment transport characteristics in the upper portion of Lower Peoria Lake. Stability of constructed islands was not evaluated in the micro model portion of the feasibility study.

The area being considered for dredging and island construction is in vicinity of the McClugage Bridge in the upper northeastern portion of Lower Peoria Lake. The island (or islands) would be created within an area owned by the Illinois Department of Natural Resources. Most of the area being considered for island creation has water only 1 to 2 feet deep with a substrate of 4 feet (or greater in some areas) of soft mud and silt the consistency of pudding. Biological investigations of this area show that it has only marginal, if any, habitat value for most aquatic species.

Dredging to construct the island(s) would range from 8 to 16 feet below flat pool and incorporate side channels and deep holes to provide depth diversity, overwintering habitat, and "edge" for fish species.  The islands would be constructed to approximately 10 feet above flat pool at their highest (elevation 450 MSL).  Additional structures, such as riprap along the island shore and jetties out into the water, will stabilize the islands and add additional habitat value.

## MICRO MODEL DESCRIPTION

### SCALES AND BED MATERIALS

Plate D-2-5 is a photograph of the Peoria hydraulic micro model that was used for this study.  The model encompassed the Illinois River between River Miles 162.5 to 166.0.  After entrance and exit conditions in the model were adjusted, the actual study reach was between River Miles 164.0 to 166.0.  The model employed a horizontal scale of 1 inch = 300 feet, or 1:3600, and a vertical scale of 1 inch = 20 feet, or 1:240, for a 15:1 distortion ratio.  This distortion supplied the necessary forces required to approximate sediment transport conditions in the prototype.  The bed material was granular plastic urea, Type II, with a specific gravity of 1.4.

### APPURTENANCES

The model was constructed using 1995 aerial photographs of the Illinois Waterway (plate D-2-9). The photograph's coordinate system was State Plane Zone Illinois West, NAD 83, feet.  The model was then placed in a standard micro model hydraulic flume.  The riverbanks of the model were constructed from dense polystyrene foam.  Rotational jacks located within the hydraulic flume controlled the slope of the model.

The model flow was simulated by a submersible pump and was monitored by an electromagnetic flow meter.  An electronic valve was used to regulate a steady state discharge that was used for all model runs.  Water stages were manually checked with a mechanical three-dimensional point digitizer.  Resultant bed configurations were measured and recorded with a 3-D laser digitizer. Surface current patterns were captured and recorded using time exposure photography.

## MICRO MODEL TESTS

### CALIBRATION

The first step in testing alternatives in the model is to calibrate the model.  The goal of model calibration is to match the bed forms of the model to the bed forms of the river.  When the model is calibrated, then alternatives can be reliably tested.

The reach of the model that was considered to be calibrated extended from River Miles 163.5 to 166.0 (plate D-2-6).

The calibration of the micro model involved the adjustment of water discharge, sediment load, slope, entrance condition, and physical modifications to nonerodible portions of the channel.

A constant flow of 1.60 gallons per minute (gpm) was used for all model simulations.

## PROTOTYPE SURVEYS

Bathymetric data from 1998-1999 is shown on plate D-2-10. This information was used to calibrate the micro model.

## BASE TEST

Plate D-2-11 shows the resultant bed configuration of the micro model base test. Plate D-2-12 shows the flow visualization of the micro model base test. This base test was developed from the simulation of a steady state flow in the micro model until bed stability was reached and a similar bed response was achieved as compared to the surveys of the river.

Once the favorable comparison of model tests and prototype survey was made, the model was considered calibrated. Alternatives were then modeled in the micro model to examine the impacts upon the bed forms and flow field.

## ALTERNATIVE TESTS

Four alternative designs were simulated in the micro model. These tests examined the flow response and impact to bed forms in the study reach from implementing each alternative. The two primary focuses to evaluate with each alternative were:

- Flow visualization
- Sediment filling trends of the dredged channels

Bathymetric survey data were collected at the end of each alternative test. Flow visualization photos were also taken of each alternative of the micro model working to estimate the effect upon the flow field.

**Alternative 1. Small Single Island Upstream of Bridge** A photograph of this alternative as it was implemented in the micro model is shown on plate D-2-13. The micro model bathymetry for Alternative 1 is shown on plate D-2-14. Sediment deposition trends as compared to the micro model base condition are shown on plate D-2-16. The flow visualization for Alternative 1 is shown on plate D-2-15. Results indicated the following trends:

Flow visualization shows that the impacted area extends downstream of the island and over to the left bank. No changes were noted in the right bank.

The majority of sediment that was deposited was located in the dredged channel on the main channel side of the constructed island as well as downstream of the island.

**Alternative 2. Larger Single Island Upstream of Bridge** A photograph of this alternative as it was implemented in the micro model is shown on plate D-2-17. The micro model bathymetry for Alternative 2 is shown on plate D-2-18. Sediment deposition trends as compared to the micro model base condition are shown on plate D-2-20. The flow visualization for Alternative 2 is shown on plate D-2-19. Results indicated the following trends:

Flow visualization was similar to Alternative 1. The impacted area extends downstream of the island and over to the left bank. No changes were noted in the right bank.

The majority of sediment that was deposited was located in the dredged channel on the main channel side of the constructed island as well as downstream of the island. Sediment deposition appeared to be less than that for Alternative 1.

**Alternative 3. Two Large Islands Downstream of Bridge** A photograph of this alternative as it was implemented in the micro model is shown on plate D-2-21. The micro model bathymetry for Alternative 3 is shown on plate D-2-22. Sediment deposition trends as compared to the micro model base condition are shown on plate D-2-24. The flow visualization for Alternative 3 is shown on plate D-2-23. Results indicated the following trends:

The flow visualization showed that the impacted area extended from an area upstream of the island pair to an area downstream of the island pair. The right side of the navigation channel experienced an increase in velocity directly across from the island pair.

Sediment deposition was evident at the upstream and downstream ends of the island pair. All dredged channels experienced some deposition and the greatest deposition appeared to be in the channel between the islands.

**Alternative 4. Single Large Island Downstream of Bridge** A photograph of this alternative as it was implemented in the micro model is shown on plate D-2-25. The micro model bathymetry for Alternative 4 is shown on plate D-2-26. Sediment deposition trends as compared to the micro model base condition are shown on plate D-2-28. The flow visualization for Alternative 4 is shown on plate D-2-27. Results indicated the following trends:

The flow visualization shows that slack water exists upstream of the island but less than for the island pair. Slack water area exists downstream of the island as well, but again, less than for the island pair. The right side of the navigation channel experienced an increase in velocity directly across from the island.

Sediment deposition was evident at the upstream end of the island, but less than that for the island pair. All dredged channels experienced some deposition. Some minor deposition was evident downstream of the island but less than for the island pair.

## RESULTS AND CONCLUSIONS

### SUMMARY OF RESULTS

- Flow visualization trends:

  For this study, the flow visualization analysis was qualitative rather than quantitative. Rather than predicting the aerial extent of the impacted area (quantitative), the flow visualization analysis consisted of comparing the alternatives to one another as well as to the base condition to predict trends (qualitative).

Alternatives 1 and 2 had similar impacts to the flow field as compared to the base condition. Alternative 1 appeared to have a slightly larger impact, possibly because Alternative 2 has a more streamlined shape. One would expect Alternative 1 to experience more sediment deposition than Alternative 2 for this reason.

Alternatives 3 and 4 also had similar impacts to the flow field. Both showed areas of reduced velocities upstream and downstream of the island(s). Alternative 3 had the greater impact of the two. This is expected because the two islands occupy a greater area than the single island. It is expected that Alternative 3 would experience more sediment deposition than Alternative 4 because of this larger impact.

- Sediment deposition trends

  As with the flow visualization analysis, the sediment deposition analysis was more qualitative rather than quantitative. Rather than using the results to predict depths of sediment deposition (quantitative), the sediment deposition analysis consisted of comparing the alternatives to one another as well as to the base condition to predict trends (qualitative).

  Alternatives 1 and 2 have similar attributes. Alternative 2 experienced less sediment deposition than in the constructed channels as compared to Alternative 1, especially in the riverward channel. As discussed in the flow visualization analysis, Alternative 2 consists of a more streamlined shape and provides for less change to the flow field. This may be a factor in the sedimentation deposition difference.

  Alternatives 3 and 4 are located in the same area in Lower Peoria Lake. The constructed channel on the landward side of the island(s) experienced similar patterns for both alternatives. The riverward channels had less deposition under the two island alternative. Alternative 4 had more sediment deposition at the upstream end of the island(s). Deposition amounts downstream of the island(s) were also similar for Alternatives 3 and 4.

## INTERPRETATION OF MODEL TEST RESULTS

In the interpretation and evaluation of the results of the tests conducted, it should be remembered that the results of these model tests were qualitative in nature. Any hydraulic model, whether physical or numerical, is subject to biases introduced as a result of the inherent complexities that exist in the prototype. Anomalies in actual hydrographic events, such as prolonged periods of high or low flows, are not reflected in these results, nor are complex physical phenomena, such as the existence of underlying rock formations or other nonerodible variables.

The model study was intended to serve as a tool to the river engineer to guide in studying the general trends that could be expected to occur in the actual river from a variety of imposed alternatives. Measures for final design may be modified based upon engineering knowledge and experience, real estate and construction considerations, economic and environmental impacts, and any other special requirements.

# BIBLIOGRAPHY

1. Hagerty, D. Joseph, Dept. of Civil Engineering, University of Louisville, Report on Illinois Waterway Bank Evaluation, submitted to U.S. Army Corps of Engineers, Rock Island District, 25 June 1988.

**LIST OF PLATES**

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## FARM CREEK WATERSHED
## HYDROLOGY AND HYDRAULICS APPENDIX

**CLIMATE**

The basin's climate is typical of the American Midwest, with cold, dry winters and hot, wet summers. The transition season of spring tends to be very wet, while the fall season tends to be dry. Using Peoria as representative of the basin, average temperature for the year is 50.7 degrees Fahrenheit, with a peak maximum temperature of 113 degrees on July 15, 1931 and a low minimum temperature of -27 degrees on January 5, 1884. The average yearly precipitation is 36.25 inches, including an average snowfall of 26.2 inches per year. Peoria's climate is summarized in the table below.

**TABLE D-5-1. Peoria Climate**

| Month | Average Maximum Temp. (deg. F) | Average Minimum Temp. (deg. F) | Average Temp (deg. F) | Average Precipitation (inches) | Average Snowfall (inches) |
|---|---|---|---|---|---|
| **JAN** | 29.9 | 13.2 | 21.6 | 1.51 | 7.3 |
| **FEB** | 34.9 | 17.7 | 26.3 | 1.42 | 5.9 |
| **MAR** | 48.1 | 29.8 | 39.0 | 2.91 | 3.4 |
| **APR** | 62.0 | 40.8 | 51.4 | 3.77 | 1.2 |
| **MAY** | 72.8 | 50.9 | 61.9 | 3.70 | T |
| **JUN** | 82.2 | 60.7 | 71.5 | 3.99 | 0.0 |
| **JUL** | 85.7 | 65.4 | 75.5 | 4.20 | 0.0 |
| **AUG** | 83.1 | 63.1 | 73.1 | 3.10 | 0.0 |
| **SEP** | 76.9 | 55.2 | 66.1 | 3.87 | 0.0 |
| **OCT** | 64.8 | 43.1 | 54.0 | 2.65 | 0.1 |
| **NOV** | 49.8 | 32.5 | 41.2 | 2.69 | 1.9 |
| **DEC** | 34.6 | 19.3 | 27.0 | 2.44 | 6.4 |
| **Year** | 60.4 | 41.0 | 50.7 | 36.25 | 26.2 |

## PROJECT FEATURE ANALYSES

## FARM CREEK

### Location

Farm Creek is a tributary to the Illinois River in central Illinois. The project consists of two environmental ponds located just upstream of Washington, Illinois (20 miles east of Peoria). The project lies entirely in Tazewell County. The drainage area of Farm Creek just upstream of Washington is 5.2 square miles. The creek flows southwesterly and empties into the Illinois River at East Peoria. The location is shown on plate 1 of the main report.

### Overview

This project consists of two environmental dams. The two ponds are located on adjacent unnamed tributaries flowing into the left descending bank of Farm Creek in the City of Washington. These two ponds were designed using the Natural Resources Conservation Service (NRCS) program *SITES*. This program follows NRCS guidelines. Dams are classified according to the damage that might occur to existing and future development should the dam suddenly release large quantities of water. The established classes are shown below.

**Class A:** Dams located in rural or agricultural areas where failure may damage farm buildings, agricultural lands, or township and local roads.

**Class B:** Dams located in predominantly rural or agricultural areas where failure may damage isolated homes, main highways, or minor railroads or cause interruption of use or service of relatively important public utilities.

**Class C:** Dams located where failure may cause the loss of life, serious damage to homes, industrial, and commercial buildings, important public utilities, main highways, or railroads.

NRCS guidelines call for using *Technical Release 60 (TR60)* if the dam is Class B or C, or if it is Class A and the product of storage (acre-feet) times the effective height (feet) of the dam is 3,000 or more or the effective height of the dam is 35 feet or higher. If the dam is a Class A structure and does not meet the above size restrictions, then NRCS NHCD-386 guidelines can be used.

The dams in this study are Class C dams because of their location just upstream of Washington, Illinois, with a mainline railroad track and houses downstream. Both dams will have to be designed to safely pass the probable maximum flood.

### Local Issue

These dams were designed to maximize habitat for a core group of species. From a hydrologic perspective, they do this by providing 1.5 to 2.0 feet of deepwater over as large an area as possible. The City of Washington is interested in as much flood protection as possible from this project. As such, earthen dams were designed and savings were calculated at downstream sites for flow reduction based on previous flood protection studies of the area.

The project site consists of two dams designed using the NRCS program *SITES* with the NRH-386 criteria. Because the dams are upstream of a main line railroad track and the City of Washington, these dams will need to have their auxiliary or emergency spillways designed to safely pass the probable maximum flow. For this study, they are designed to contain the 24-hour, 50-year storm event on city property and keep the 24-hour, 100-year storm within 1 foot vertical on the adjoining private property. The rainfall volumes for the design are 6.2 inches for the 24-hour, 50-year event and 7.0 for the 24-hour, 100-year event. Table D-5-2 summarizes the hydrology for the two dams.

**TABLE D-5-2. Farm Creek Dams - Hydrology**

| Pool | Drainage Area (acre) | Flow Length (feet) | Watershed Slope (%) | Curve Number | Time of Concentration (hour) |
|---|---|---|---|---|---|
| 1 | 505 | 12,100 | 1.59 | 82.5 | 2.88 |
| 2 | 156.5 | 6,600 | 1.19 | 82.5 | 2.05 |

The dams were designed to have a large area at the conservation pool inundated from 1.5 to 2 feet deep. The principal spillways were sized to keep the 24-hour, 50-year storm event on the city's property and the auxiliary spillway was sized to keep the 24-hour, 100-year storm event from flooding more than 1 foot vertical on the adjoining private properties. Table D-5-3 summarizes the dams' features.

**TABLE D-5-3. Dam Sizes at Project Site**

| Pool | Elevation Principal Spillway (feet, NGVD) | Outlet Size of Principal Spillway | Elevation of Auxiliary Spillway (feet, NGVD) | Spillway Length (feet) | Top of Dam (feet, NGVD) |
|---|---|---|---|---|---|
| 1 | 744 | 3 - 5'x2'box | 747.91 | 300 | 749.91 |
| 2 | 746 | 1 - 18" hooded conduit | 751.52 | 150 | 753.53 |

## Sedimentation

A local concern for the effective life of these environmental ponds is the biological waste that floats downstream during storms. The practice of no till farming that is used in the area has resulted in corn stalks floating down to culverts, where they drop out in the backwater just upstream and historically have added up to 4 feet of soil in a 10-year period. If this should happen to any of the environmental ponds, they would become ineffective at increasing the desired habitat after only 5 years, much shorter than the minimum 25-year life of the project.