DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT CORPS OF ENGINEERS
1222 SPRUCE STREET
ST. LOUIS, MISSOURI 63103-2833

REPLY TO
ATTENTION OF:

2 May 2018

Dear Sir or Madam:

The U.S. Army Corps of Engineers St. Louis District has prepared a draft report entitled "Upper Mississippi River Restoration Piasa and Eagle's Nest Islands Feasibility Study with Integrated Environmental Assessment Habitat Rehabilitation and Enhancement Project." You are receiving this letter because you may be interested in this project. However, no action is required on your part. The project is located in Jersey and Madison counties, Illinois, near Grafton, in Pool 26 between river miles 207.5 and 211.5. The draft report addresses the goal to restore and improve the quality and diversity of aquatic and island ecosystem resources within the study area. The report describes alternative solutions and presents a tentatively selected restoration plan. The report also serves to notify the public of the environmental effects of the project as required by law. These environmental effects are summarized in the report's Draft Finding of No Significant Impact(s) (FONSI), which is unsigned. A signed FONSI is required before project construction can occur. The FONSI will not be signed into effect until all comments received as a result of this public review have been carefully considered.

An electronic version of the draft report, titled "UMRR Piasa and Eagle's Nest Islands HREP Feasibility Study with Integrated EA" is available online at:

http://www.mvs.usace.army.mil/Portals/54/docs/pm/Reports/EA/PiasaEaglesNestIslandsHREP.pdf

You are welcome to comment on the content of the draft report. To submit a public comment please contact Dr. Kat McCain of our Environmental Planning Section, telephone 314-331-8047, or email at Kathryn.McCain@usace.army.mil. For general project inquiries, please contact Mr. Brian Markert of our Project Development Branch, telephone 314-331-8455, or email at Brian.J.Markert@usace.army.mil. Written comments may be sent to our address below:

US Army Corps of Engineers, St. Louis District
ATTN: Environmental Planning PD-P (McCain)
1222 Spruce St.
St. Louis, MO 63103-2833

The comment period runs from May 2, 2018 through June 1, 2018. A public open house will be held on May 23, 2018 from 5:00 to 7:00 pm at the Alton Motor Boat Club located at 11134 Harbor Dell, Godfrey, IL, 62035.

Sincerely,

Brian Johnson
Chief, Environmental Compliance Branch

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

PIASA AND EAGLE'S NEST ISLANDS

HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APRIL 2018
DRAFT for PUBLIC REVIEW

US Army Corps of Engineers ®
St. Louis District

POOL 26
MISSISSIPPI RIVER
MILES 207.5 – 211.5
MADISON & JERSEY COUNTIES, ILLINOIS
PROJECT SPONSOR: ILLINOIS DEPARTMENT OF NATURAL RESOURCES

ACKNOWLEDGMENTS

Piasa and Eagle's Nest Islands HREP USACE FY2018 Project Delivery Team members, with roles and experiences, are listed below:

Name	Role	Education	Years of Experience
Brian Markert	UMRR Program Manager	BS Agronomy and Forestry MS Public Lands Management MS Wildlife Biology	25
Kip Runyon	Project Manager	BS Biology MS Fisheries	21
Kat McCain Ph.D.	Plan Formulation; Environmental; Report Writer	BA Biology MS Wetland Ecology Ph.D. Restoration Ecology	8
Dawn Lamm	Hydraulic Design	BS Civil Engineering	20
Erin Guntren	Geographer	BA Anthropology MS Geography	7
Brad Krischel, P.E.	Hydraulic Design	BS Civil Engineering Professional Engineer	8
Jasen Brown, P.E.	Hydraulic Design	BS Civil Engineering	15
Mark Smith, Ph.D.	Cultural & Historic Resources	BA Anthropology MA Nautical Archaeology Ph.D. Archaeology	20
Roberta Hayworth	Tribal Coordination	MS Anthropology	23
Evan Stewart, CFM	Economics	BA Econ/Finance	3
Michelle Puzach	Cost Estimating	BS Architectural Engineering	6
Chuck Frerker	Regulatory	BS Zoology	26
Jim Lovelace	Real Estate	BS Human and Environmental Studies RE Appraiser	26
Rick Archeski	HTRW	BS Biology BS Electrical Engineering	36
Charlie Deutsch	Wildlife Biologist	BS Biology MS Biology	23
Lance Engle	Dredging Project Manager	BS Civil Engineering	18
Keli Broadstock	Office of Counsel	JD	11

WE'RE PROUD TO SIGN OUR WORK

Executive Summary*

Purpose of Report. The purpose of this draft Feasibility Report with Integrated Environmental Assessment, including the draft unsigned Finding of No Significant Impact, is to evaluate and document the decision-making process for the proposed Upper Mississippi River Restoration (UMRR) Habitat Rehabilitation and Enhancement Project (HREP) at Piasa and Eagle's Nest Islands. This report is being developed by the U.S. Army Corps of Engineers (Corps) with Illinois Department of Natural Resources (IDNR) serving as the non-Federal project sponsor. This report provides planning (including National Environmental Policy Act compliance), engineering, and sufficient construction details of the Tentatively Selected Plan (TSP) to allow final design and construction to proceed subsequent to document approval by the Mississippi Valley Division, U.S. Army Corps of Engineers.

Study Area Location. The *Piasa and Eagle's Nest Islands Habitat Rehabilitation and Enhancement Project* is located in Jersey and Madison counties, Illinois, near Grafton, in Pool 26 between Upper Mississippi River (UMR) river miles 207.5 and 211.5. The study area is comprised of 1,381 acres of side channel, main channel, island, and backwater habitat.

Problem Identification. Human activity over the past two centuries within the Upper Mississippi River (UMR) basin, floodplain, and channel has altered the hydrology and biotic communities historically present in the study area. These alterations have reduced the diversity and quality of aquatic (side channel and backwater) habitat, and reduced the acreage of island habitat. These stressors are likely to continue, as will the decline of the quality of aquatic and island habitat; however, this study provides an opportunity to improve the quality and diversity of important aquatic habitats.

Study Goal and Objectives. The goal of the study is to restore and improve the quality and diversity of aquatic and island ecosystem resources within the study area. The objectives identified to meet this goal are to:

1. Increase aquatic side channel habitat with depth and flow diversity
2. Increase connected backwater habitat with depth diversity for enhanced backwater fisheries habitat benefits
3. Restore diverse island mosaic

Plan Formulation, Evaluation, and Comparison. The following restoration measures were considered to achieve the study goal and objectives:

- No Action
- Excavate Piasa Chute
- Excavate Piasa Island Backwater
- Construct river training structures
- Construct islands

Hydraulic models (both numerical and small-scale physical) were used to generate feasible combinations of river training structures to maximize flow and depth without negatively impacting navigation and known mussel beds, and had stakeholder support. Forty-five hydraulic alternatives were tested. The measures retained from the hydraulics models were then combined with the other considered management measures. Due to the limited number of measures, the team generated project alternatives based on all possible combinations of measures. This resulted in 8 action alternatives and the No Action Alternative that were moved forward as the final array of alternatives. Cost and habitat benefits were estimated for each alternative. Habitat benefits were estimated using the Habitat Evaluation Procedures (HEP). Cost-effectiveness and incremental cost analyses were conducted to identify cost effective plans and reveal changes in cost for increasing levels of environmental outputs (i.e., average annual habitat unit). These analyses resulted in 3 "Best Buy" plans, including the No Action Alternative. Best buy plans are defined as those cost effective plans which provide the greatest incremental increase in output (benefits) for the lowest incremental increase in cost. These 3 alternatives were then compared and assessed on their ability to meet project objectives, NEPA compliance, and achieving the Corps Principles and Guidelines evaluation criteria of acceptability, completeness, effectiveness, and efficiency (ER 1105-2-100).

Plan Selection. The Tentatively Selected Plan (Alternative 4), shown in Figure ES-1, for the Piasa and Eagle's Nest Islands HREP consists of multiple measures to restore and improve the aquatic ecosystem structure and function by implementation of the following restoration measures:

- 200-ft wide braided channel excavation of Piasa Chute
- Excavation of the entrance of Piasa Island Backwater
- Construction of notched rock structure between Piasa and Eagle's Nest Islands
- Construction of islands

The Tentatively Selected Plan (TSP) is the National Ecosystem Restoration (NER) plan and a best buy alternative that yields 430.1 net average annual habitat units (AAHUs) at an average cost of $2,345 per AAHU (FY2018 federal discount rate of 2.75%). It best meets the study objectives and is deemed acceptable by the non-federal sponsor IDNR, as well as, from U.S. Fish and Wildlife Service (USFWS), non-governmental organizations (NGOs), and the general public. Implementation of the TSP would increase the quality and quantity of ecosystem resources and meet the needs for a large variety of native aquatic species. Establishing connectivity between Piasa Island Backwater and the main channel of the Mississippi River would contribute to overwintering fish habitat as well as feeding areas for migratory wildlife; providing bathymetric diversity and flow within Piasa Chute would provide important side channel habitat within Pool 26; and restoring historic islands would allow the study area to realize the highest benefit to fish and wildlife. The outputs are also consistent with the goals and objectives of the Upper Mississippi River Restoration Program.

All restoration measures and activities are located on federally managed lands and waters and as such, the project first cost will be 100% federal. Currently USACE and USFWS are in the process of adding the study area to the General Plan Lands Agreement between the USACE and the USFWS, subsequently to the Cooperative Agreement For Management of USACE General Plan Lands between the USFWS and IDNR (Appendix A, *Authorization and Agreements*). Per these agreements the Illinois Department of Natural Resources (IDNR) will manage the lands and waters as a national wildlife refuge to enhance fish and wildlife. Responsibility for the operation, maintenance, rehabilitation, replacement, and repair of the Piasa and Eagle's Nest Islands HREP would be the responsibility of IDNR.

Based on Fiscal Year 2018 price levels, the current estimated project first cost is $26,746,000 (including contingencies), which includes monitoring ($218,400) and adaptive management ($149,500) costs. The

total annualized cost is $1,008,546 (FY 2018 discount rate of 2.75%). IDNR would be responsible for the operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) at an estimated average annualized cost of $5,850 (including contingencies; FY 2018 discount rate of 2.75%).

The St. Louis District Engineer has reviewed the study outputs, a gain of 430.1 net AAHUs, and determined that the implementation of the TSP is in the Federal interest. Therefore, the District Engineer recommends construction approval for the Piasa and Eagle's Nest Islands HREP.

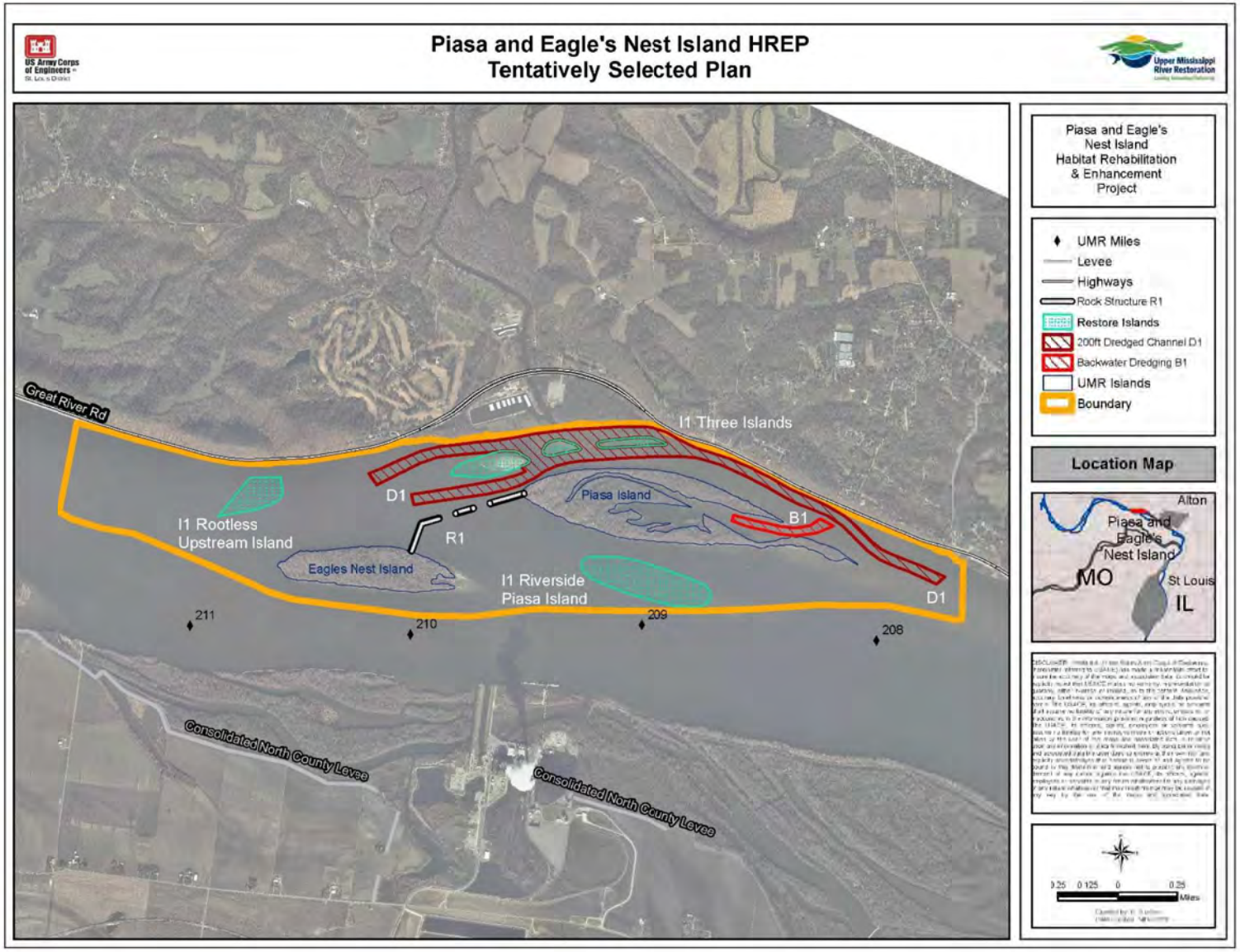

Figure ES-1. Proposed project measures of the Tentatively Selected Plan

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(* Denotes National Environmental Policy Act required Sections)

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PLATES

1 Study Background*

1.1 Study Purpose and Scope of Investigation

The scope of this study focuses on proposed project measures that would improve side channel, backwater, and island habitats and improve overall ecosystem resources in the vicinity of the Upper Mississippi River Restoration (UMRR) Piasa and Eagle's Nest Islands Habitat Rehabilitation and Enhancement Project (HREP), follows the Corps of Engineers' six-step planning process specified in Engineering Regulation (ER) 1105-2-100, and is consistent with agency management goals. The process identifies and responds to problems and opportunities identified; provides a flexible and rational framework to make decisions; and allows the interested public and decision makers to be fully aware of the basic assumptions employed, data analyzed, risks and uncertainties identified, and significant implications of each alternative plan, including the "No Action" alternative. The development and comparison of alternatives allow for the ultimate identification of the National Ecosystem Restoration (NER) plan. The NER plan reasonably maximizes ecosystem restoration benefits compared to costs, considering the cost effectiveness and incremental cost of implementing other restoration options, as well as, considering information that cannot be quantified, such as environmental significance, scarcity, socioeconomic impacts, and historic properties.

1.2 Authority

The UMRR was authorized in the Water Resources Development Act (WRDA) of 1986 (P.L. 99-662), Section 1103, the Upper Mississippi River Plan. Section 1103(e) of WRDA 1986 outlines the following undertakings:

(A) a program for the planning, constructing, and evaluation of measures for fish and wildlife habitat rehabilitation and enhancement (UMRR-HREP);
(B) implementation of long-term resource monitoring program (UMRR-LTRM); and
(C) implementation of a computerized inventory and analysis system.

The original authorizing legislation has been amended several times since its enactment. The 1990 WRDA, Section 405, extended the original UMRR HREP and UMRR-LTRM authorization an additional five years to fiscal year 2002. The 1992 WRDA, Section 107, amended the original authorization by allowing limited flexibility in how funds are allocated between the HREP program and the UMRR-LTRM element. The 1992 WRDA also assigned sole responsibility for operation and maintenance (O&M) of habitat projects to the Federal, State, or local agency owner that is responsible for management activities for fish and wildlife on such lands. The 1999 WRDA, Section 509, reauthorized UMRR HREP and UMRR-LTRM as a continuing authority with reports to Congress every 6 years and changed the non-Federal cost sharing percentage from 25 percent to 35 percent. The 1999 Water Resources Development Technical Corrections, Section 2, corrected paragraph deletions/additions. The 2007 WRDA, Section 3177, allowed for the inclusion of water quality research in the applied research program for development of remediation strategies on the Mississippi River. The full text of the original authorization, as amended, is located in Appendix A, *Authorization and Agreements*.

All proposed restoration measures and activities within the study area are located on federally managed lands and waters and as such, the project first cost will be 100% federal. Currently USACE and USFWS are in the process of adding the study area to the General Plan Lands Agreement between the USACE and the USFWS, subsequently to the Cooperative Agreement For Management of USACE General Plan Lands between the USFWS and IDNR (Appendix A, *Authorization and Agreements*). Per these agreements the Illinois Department of Natural Resources (IDNR) will manage the lands and waters as a

national wildlife refuge to enhance fish and wildlife. Responsibility for the operation, maintenance, rehabilitation, replacement, and repair of the Project would be the responsibility of IDNR.

1.3 Project Sponsor

The Non-Federal Sponsor is the Illinois Department of Natural Resources (IDNR). USFWS would serve as the Federal project sponsor.

1.4 Study Area Description

The Piasa and Eagle's Nest Island study area is approximately 1,381 acres of island, side channel, and backwater habitats located on the left descending bank of the Mississippi River, upstream of the city of Alton, Illinois in Madison and Jersey counties (Figure 1-1) between river miles (RM) 207.5 and 211.5. The study area lies within Pool 26, a 40-mile reach of the Upper Mississippi River System (UMRS)[1], beginning below Lock and Dam 25 (RM 241.4) near Cap au Gris, Missouri, and ending at Melvin Price Locks and Dam (RM 200.8) at Alton, Illinois. The study area encompasses Piasa Island and Eagle's Nest Island including Piasa Chute (the side channel between Piasa Island and the Illinois bankline), and the unnamed chute between Piasa Island and Eagle's Nest Island.

1.5 Purpose and Need

The Corps proposes a project at Piasa and Eagle's Nest Islands. The feasibility study purpose is to determine Federal interest in restoring ecosystem structure and function in the Piasa and Eagle's Nest Islands study area. The purpose of this Draft Feasibility Report with Integrated Environmental Assessment (EA), including the draft unsigned Finding of No Significant Impact (FONSI), is to evaluate the alternatives and provide a recommendation for the Piasa and Eagle's Nest Islands. The draft Feasibility Report and Integrated EA meet Corps of Engineers planning guidance and meet National Environmental Policy Act (NEPA) requirements. This report is being developed by the U.S. Army Corps of Engineers (Corps) with the IDNR serving as the non-federal project sponsor. This report provides planning, engineering, and sufficient construction details of the Tentatively Selected Plan (TSP) to allow final design and construction to proceed subsequent to document approval.

The need to restore side channel, island, and backwater habitats within the study area is based on the following factors:

- Through the *Upper Mississippi River System Habitat Needs Assessment* (Theiling, et al., 2000) restoring side channel habitat has been identified as a habitat need for Pool 26. Pool 26 has approximately 3% of the total aquatic and floodplain habitat classified as side channel habitat (Theiling, et al., 2000). Thus, existing side channel habitat is limiting within Pool 26 and the Project. In general existing side channels have shallow depth (e.g., < 5 feet) and limited structural diversity (e.g., cover, depth, and flow) due to sedimentation. Without action, side channel habitat would remain a limiting resource and would continue to decline impacting the survival and recruitment of various aquatic species, including riverine fishes and mussels. The sedimentation rate of 0.14 ft/year has been calculated for Piasa Chute. At this rate, without action, the average depth of Piasa Chute would decrease from 8.6 to 1.6 feet over 50 years (decrease of 83%), resulting in a loss of side channel habitat and quality of habitat.
- Through the *Upper Mississippi River System Habitat Needs Assessment* (Theiling, et al., 2000) restoring contiguous backwater habitat has been identified as a habitat need for Pool 26, and

[1] The UMRS, as defined by the UMRR authorizing legislation includes the Upper Mississippi River from Minneapolis, Minnesota, to Cairo, Illinois, and navigable portions of the Minnesota, St. Croix, Black, and Kaskaskia Rivers

are important habitats required for functional year-round habitat. Existing backwater habitat on Piasa Island is generally shallow, turbid, and has limited connectivity with the main channel due to sedimentation. Without action, the existing backwater habitat would continue to decline impacting the survival and recruitment of riverine fish species. Utilizing the UMRR-LTRM data from 1993 to 2013, the average depth of the Piasa Island Backwater is 1.25 to 3.5 feet. The St. Louis District has modeled a slough outside the Project (Simons, Simons, Ghaboosi, & Chen, 1988) but in close proximity (Brickhouse Slough, which separates Dresser Island at RM 206-209 from the Missouri shore) to Piasa and Eagle's Nest Islands. These estimates indicated the sediment deposition rate to be 0.5 inches per year. Using this rate for Piasa Island Backwater would suggest that the backwater would fill in completely in approximately 60 years; however, based on aerial imagery analysis comparing 1971 to present day, the backwater has persisted in similar surface area (but it has gotten shallower). The team assumed that areas <2 feet in depth currently would convert to land by year 50 which equates to a 37% loss of the existing backwater. However, it is known that sediment loads increase at higher pool elevations so if a series of more severe flood events were to occur, the life expectancy could be much less than that projected. The result of this sedimentation is a rapid conversion of water cover to land cover. This conversion translates to a quantitative loss of habitat for migratory and resident wildlife. In a similar manner, riverine fish are impacted by a loss of backwater spawning and rearing habitat.

- Through the *Upper Mississippi River System Habitat Needs Assessment* (Theiling, et al., 2000) restoring island habitat has been identified as a habitat need for Pool 26. Existing island habitat is approximately 5% of the existing aquatic and floodplain habitat in Pool 26 (Theiling, et al., 2000). Within the Project, island habitat has been degraded primarily as a result of direct inundation resulting from lock and dam construction. Without action, it is anticipated that historic islands would continue to be submerged reducing the availability of this habitat for aquatic and wildlife species.

1.6 Project Selection

The IDNR identified the study area for potential inclusion in the Corps' UMRR Program[2]. The River Resources Action Team (RRAT) is an interagency coordination team of state, federal and non-governmental organizations. The RRAT regularly meets to discuss and identify resource needs, stressors, ecosystem objectives, and identify potential future study locations within the Mississippi and Illinois Rivers located within the St. Louis District area of responsibility. After considering resource needs and deficiencies pool by pool, the RRAT recommended and supported the Piasa and Eagle's Nest Islands study area because it provides opportunities for significant island and aquatic ecosystem benefits; and the problems identified were considered to be within the Corps' Ecosystem Restoration Mission. A fact sheet[3] was developed and approved by the Mississippi Valley Division (8 September 2010).

[2] For more details on the UMRR program HREP planning and sequencing see: http://www.mvr.usace.army.mil/Portals/48/docs/Environmental/EMP/HREP/MVS/PiasaEaglesNestIslands/Piasa%20and%20Eagles%20Nest%20Approved%20Final%20Packet%2012-Oct-2010.pdf (accessed 6 Dec 2017)

[3] Available at: http://www.mvr.usace.army.mil/Portals/48/docs/Environmental/EMP/HREP/MVS/PiasaEaglesNestIslands/Piasa%20and%20Eagles%20Nest%20Approved%20Final%20Packet%2012-Oct-2010.pdf

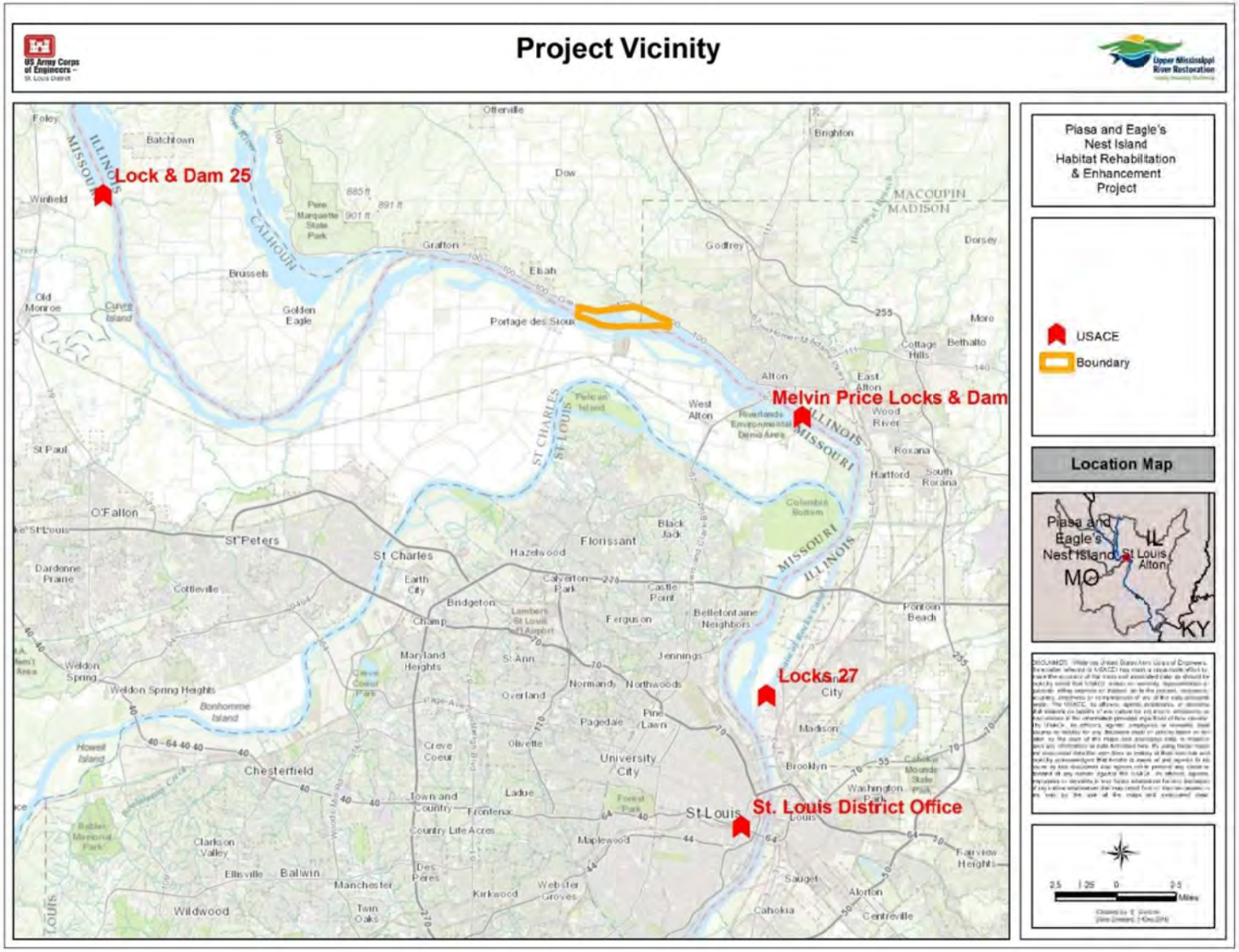


Figure 1-1. Piasa and Eagle's Nest Islands HREP Project Location and Vicinity

1.7 Resource Significance*

The Planning Guidance Notebook (2000) ER 11-5-2-100 defines significance in terms of institutional, public, and technical recognition.

1.7.1 Institutional Recognition

The formal recognition of the UMR Basin in laws, adopted plans, and other policy statements of public agencies and private groups illustrate the significance of the basin. The U.S. Congress recognized the UMR as a unique, "…nationally significant ecosystem and a nationally significant commercial navigation system…" in Section 1103 of the WRDA of 1986. Institutional recognition of this resource's significance was further recognized by Congress' initial and continued authorization of the Upper Mississippi River Restoration program for the planning, construction, and evaluation of features for restoration of fish and wildlife habitat in the UMRS.

1.7.2 Public Recognition

Ecosystem restoration and monitoring of the UMRS provide substantial benefits to the river communities, the UMRS region, and the nation. UMRR, throughout its 30+ year history, has created public outreach opportunities related to HREP planning, construction, and evaluation, and long-term monitoring and research. For example, *Our Mississippi* educational guide and quarterly newsletter of the U.S. Army Corps of Engineers highlight the work in the Mississippi River Basin. It is published in cooperation with other state and federal agencies and other river interests to move toward long-term sustainability of the economic uses and ecological integrity of the river system.

Additional public significance for the study area is through public outreach and conservation work being performed by the Great Rivers Land Trust. This organization is dedicated to the preservation and enhancement of natural resources in the St. Louis Metropolitan Region. The Great Rivers Land Trust has worked in the uplands to improve the Piasa Creek Watershed by reducing sedimentation in the 78,000 acre watershed located in portions of Jersey, Madison, and Macoupin counties in Illinois[4].

Furthermore, Piasa and Eagle's Nest Islands are locally recognized as public use areas for hunting, fishing, boating, and wildlife viewing. Several organizations, including Migratory Waterfowl Hunters Inc., Alton Motorboat Club, Alton Water Ski Club, and Illinois Federation for Outdoor Resources, are active within the study area and have been engaged in the planning process through public scoping.

1.7.3 Technical Recognition

Numerous scientific analyses and long-term evaluations of the UMRS have documented its significant ecological resources. Since the early 20th century, researchers, government agencies, and private groups have studied the larger river floodplain system and proposed ecosystem restoration in the UMRS. Numerous scientific analyses and long-term studies through the Corps' UMRR-LTRM[5] have documented significance of the resources in the UMRS.

In addition, technical resource agencies (federal, state, and non-profit) view the resources in Pool 26 as significant and are reflected in the ongoing habitat restoration efforts in the pool including the study at Piasa and Eagle's Nest Islands, and completed HREPs located at Dresser Island and Pools 25 & 26 Islands. In addition, Pool 26 is also a target for habitat restoration for the least tern, a federally listed bird species, through a floating habitat project managed by the Corps' Rivers Project Office. Furthermore, the habitat needs identified for the Piasa and Eagle's Nest Islands HREP are in line with The *Upper*

[4] Available online at: http://www.greatriverslandtrust.com/piasa-creek-watershed/ Accessed on 29 Sept 2016
[5] The Corps provides overall leadership responsibility and funding of UMRR-LTRM. The UMRR-LTRM is implemented by the U.S. Geological Survey in cooperation with Illinois, Iowa, Minnesota, Missouri, and Wisconsin.

Mississippi River System Habitat Needs Assessment (Theiling, et al., 2000) which technically recognized the need to restore island, side channel, and contiguous backwater habitats within Pool 26.

Furthermore, the study area is located in one of the six 50-mile study reaches of the UMRR-LTRM. Pool 26 was identified as a trend pool for the UMRR-LTRM to represent the conditions of the lower impounded reach (Pools 13-26) of the Upper Mississippi River. The UMRR-LTRM conducts monitoring of water quality, aquatic and floodplain vegetation, land cover and land use, and fish communities. More than 25 years of data have been collected within the study area through the UMRR-LTRM. These monitoring data are being used to detect and explain the long-term trends in the river resources, and to increase our understanding of the ecology and management of the UMRS. These data, along with observations made by the Corps, IDNR, and Illinois Natural History Survey (INHS) supported the planning, assessment, and future forecasting of proposed alternatives.

1.8 Proposed Federal Action*

This HREP focuses on proposed restoration measures that would improve ecosystem resources (side channel, backwater, and island habitat) within navigation Pool 26 of the Upper Mississippi River.

The federal action of selecting one of the alternatives for potential implementation will be determined by the U.S. Army Corps of Engineers, St. Louis District Engineer. The District Engineer will also determine, based on the facts and recommendations contained herein, whether this Environmental Assessment (EA) is adequate to support a Finding of No Significant Impact (FONSI) or whether an Environmental Impact Statement (EIS) will need to be prepared. This information will be updated with the TSP.

1.9 Scoping and Coordination*

Scoping is an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action. Scoping was conducted during the planning process using a variety of communication methods with the affected public, agencies, and organizations.

Scoping and coordination have been conducted with the following State and Federal agencies, and other interested parties:

- Illinois Department of Natural Resources
- Illinois Natural History Survey
- IL State Historic Preservation Office
- U.S. Fish and Wildlife Service
- U.S. Environmental Protection Agency
- Migratory Waterfowl Hunters, Inc.
- Alton Motorboat Club
- Alton Waterski Club
- Great Rivers Land Trust
- Missouri Department of Conservation
- Illinois Federation for Outdoor Resources
- City of Alton, Illinois
- Batchtown Sportsmen Club
- ARTCO Marine

The input received during scoping was incorporated in the process of making decisions for the study; however, the Corps must ultimately make the decision which direction the HREP will follow. Appendix B, *Coordination*, documents the coordination.

1.9.1 Coordination Meetings

Numerous coordination and stakeholder scoping meetings were held with study cooperators to discuss problems, opportunities, project goal and objectives, potential restoration measures, and expected outcomes with and without the proposed project. The following meetings demonstrated ongoing coordination:

Date	Entities
2014 Jan 24	Corps, IDNR, USFWS
2014 Sep 04	Corps, IDNR, USFWS, Migratory Waterfowl Hunters Inc., Illinois Federation of Outdoor Resources, Alton Motorboat Club, Alton Regional Convention and Visitors Bureau, Great Rivers Land Trust
2014 Oct 14	Corps, IDNR
2015 Mar 11	Corps, IDNR, USFWS, INHS, Migratory Waterfowl Hunters Inc., Illinois Federation of Outdoor Resources, Alton Motorboat Club, Alton Waterski Club, Great Rivers Land Trust, ARTCO Marine
2015 Aug 26	Corps, IDNR, USFWS, INHS, Migratory Waterfowl Hunters Inc., Alton Motorboat Club, Alton Waterski Club, Great Rivers Land Trust, Missouri Department of Conservation
2016 Sep 09	Corps, IDNR
2016 Oct 04	Corps, IDNR, USFWS, INHS, Migratory Waterfowl Hunters Inc., Alton Motorboat Club, Alton Waterski Club, Great Rivers Land Trust, City of Alton
TBD 2018	Public Open House

1.9.2 Public Review and Comments

In accordance with NEPA, the report with integrated environmental assessment and unsigned draft FONSI will be made available to interested members of the public during a 30-day public review period, yet to be scheduled. The report will be made available on the St. Louis District's website along with a letter mailed to interested members of the public addressing where to find the report, how to provide comments, and the date of the public meeting. Comments received during public review will be incorporated into the report where appropriate, and copies of written correspondence received will be provided in Appendix B, *Coordination.*

The study area is included in the Rivers Project Master Plan. The draft Rivers Project Master Plan was made available to the public from January to March 2013 with an Open House held at the National Great Rivers Museum on 22 January 2013 and the Clarksville Visitor Center on 23 January 2013. The final draft review and comment period was held from 24 March 2014 to 25 April 2014 with an Open House held at the National Great Rivers Museum in Alton, Illinois on 16 April 2014. Comments received applicable to the Project are included in Appendix B, *Coordination.*

1.9.3 Tribal Scoping

The United States government has a unique legal relationship with federally recognized American Indian tribes based on recognition of inherent powers of Tribal sovereignty and self-government.

Communication with federally recognized tribes was initiated with a USACE letter dated 2 December 2014. Copies of all tribal correspondence are provided in Appendix B, *Coordination*.

1.10 Prior Studies and Reports

The following references provide further detail on the UMRS, including Pool 26, in terms of formation over geological time; physical, environmental, and cultural characteristics; social and economic conditions; and multi-purpose management:

USACE. 2015. Rivers Project Master Plan Mississippi and Illinois Rivers[6]. The study area is included in the Corps Rivers Project Master Plan, which is a document that guides public use and natural resource management of the 48,792 acres of Federal public lands and 106,208 acres of water for environmental stewardship and recreation related purposes. The Rivers Project Master Plan includes land and waters from Cairo, Illinois upstream to the tail waters of Locks and Dam 22 at Saverton, Missouri.

Chick, J.H., L.A. Soeken-Gittinger, E.N. Ratcliff, E.J. Gittinger, B.J. Lubinski, and R. Maher. 2008. A Decade of Monitoring on Pool 26 of the Upper Mississippi River System: Water Quality and Fish Data from the Upper Mississippi River Restoration Environmental Management Program. Illinois Natural History Survey Bulletin 39(6): 323-420. This bulletin provides detailed information on water quality and fish monitoring from 1994 to 2004 in Pool 26 of the UMRS collected and analyzed by scientists at the Great Rivers Field Station, one of the six field stations associated with UMRR Long Term Resource Monitoring (LTRM).

Johnson, B.L., and K.H. Hagerty, eds. 2008. Status and Trends of Selected Resources of the Upper Mississippi River System. U.S. Geological Survey, La Cross, WI. Technical Report LTRMP 2008-T002. This report describes the UMRS and includes discussions on the historic and existing conditions, river monitoring and management, and ecosystem goals and indicators. It also discusses the status and trends of biological, physical, and chemical indicators of system health developed through UMRR-LTRM.

*Theiling, C.H., C. Korschgen, H. DeHann, T. Fox, J. Rohweder, and L. Robinson. 2000. Habitat Needs Assessment for the Upper Mississippi River System: Technical Report. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI. Contract report prepared for U.S. Army Corps of Engineers, St. Louis District, St. Louis, MO***.** This report summarizes the first Habitat Needs Assessment of the UMRS and is designed to help guide future ecosystem restoration projects. It describes and compares historical, existing, forecasted, and desired future conditions to identify habitat needs within the UMRS.

McGuiness, D. 2000. A River that Works and a Working River: A Strategy for the Natural Resources of the Upper Mississippi River System. Upper Mississippi River Conservation Committee (UMRCC), Rock Island, IL. This report describes the critical elements of a strategy for the OMRR&R of the natural resources of the UMRS and its tributaries including the setting of restoration goals and objectives. The report suggests nine objectives for successful resource management of the UMRS: 1) improve water quality, 2) reduce erosion, sediment, and nutrient impacts, 3) return natural floodplain, 4) restore seasonal flood pulse and periodic low flow conditions, 5) restore backwater connectivity, 6) manage sediment transport and deposition in floodplain and side channels, 7) manage dredging and channel maintenance, 8) sever pathways for exotic species, and 9) provide for passage at dams.

[6] Available online at: http://www.mvs.usace.army.mil/Portals/54/docs/recreation/rivers/MasterPlan/2015MasterPlan/2015%20Rivers%20Project%20Master%20Plan.pdf Accessed 4 January 2017

Upper Mississippi River Restoration Environmental Design Handbook. 2012. Corps, Rock Island District, Rock Island, IL. The design handbook of the UMRR evaluates project features and incorporates lessons learned throughout the lifetime of the program.

Upper Mississippi River Restoration Ecosystem Restoration Objectives. 2009. Corps. This report is the final product of a planning process initiated in 2008 for the purpose of identifying areas for new restoration projects and identifying knowledge gaps at a system scale. The Report serves as a backdrop for the formulation of specific restoration projects and their adaptive ecosystem management components.

*WEST Consultants, Inc. 2000. Upper Mississippi River and Illinois Waterway Navigation Feasibility Study – Cumulative Effects Study, Volumes 1-2. Prepared by WEST Consultants, Inc. for the U.S. Army Corps of Engineers, Rock Island District, Rock Island, IL***.** This report describes the cumulative effects of the Upper Mississippi River and Illinois Waterway Navigation Feasibility Study on channel morphology and ecology and develops predictions of geomorphic and ecological conditions for the year 2050.

2010 Report to Congress, Upper Mississippi River Restoration Environmental Management Program. Corps, Rock Island District, Rock Island, IL. This report is the most recent formal evaluation of the UMRR that evaluates the program; describes its accomplishments, including development of a systemic habitat needs assessment; and identifies certain program adjustments.

Piasa Creek Watershed Project[7]*.* Great Rivers Land Trust, in partnership with stated and federal agencies that reduced sedimentation in the 78,000 acre watershed located in portions of Jersey, Madison, and Macoupin counties in Illinois. Positive effects of the project include stormwater control, reduction of flash flooding, improved fish and wildlife habitat, and protection of sensitive ecosystems. The project has met and exceeded all of its goals to date. Interest and participation in the project has been embraced on a local, regional and national scale.

Upper Mississippi River Restoration Program Dresser Island Habitat Rehabilitation Enhancement Project. 1989. Corps, St. Louis District. This report is the final feasibility study documenting the Corps planning process and selection of a plan to restore a backwater habitat within Pool 26 in close proximity to the Piasa and Eagle's Nest Islands HREP.

Upper Mississippi River Restoration Program Pools 25 & 26 Islands Habitat Rehabilitation Enhancement Project. 2008. Corps, St. Louis District. This report is the final feasibility study documenting the Corps planning process and selection of a plan to restore island habitat within Pools 25 and 26.

Piasa Chute Investigation Upper Mississippi River Miles 208.0 - 216.0. St. Louis, Missouri: Brown (2007). U.S. Army Corps of Engineers, St. Louis District. This report investigates the hydraulic conditions of Piasa Chute.

Great River Resource Management Study: Mississippi River (Saverton, MO to Cairo, IL. 1982. This report addresses a multi-agency, interdisciplinary approach to planning for the management of the Mississippi River and related land resources from Saverton, Missouri to Cairo, Illinois.

[7] Available online at: http://www.greatriverslandtrust.com/piasa-creek-watershed/ Accessed 9 March 2017

2 Assessment of Existing Resources*

Section 2.1 assesses the existing conditions of resources within the study area and is organized by resource topic. This is not a comprehensive discussion of every resource within the study area, but rather focuses on those aspects of the environment that were identified as relevant issues during scoping or may be affected by the considered alternatives. The environmental consequences on these resources are described in Chapters 8 and 9.

2.1 Resource History of the Study Area

The study area consists of two islands (Piasa and Eagle's Nest Islands) and associated side channel and backwater habitats. The area is bounded on the north by the State Highway 100 and bluffs that run along the Mississippi River. The southern portion of the site is bounded by the alluvial floodplain located in Missouri. Most of this floodplain is cut-off from the river by levees. Prior to settlement, the area to the south of the study area was a mosaic of terrestrial and aquatic habitats. The area to the north of the study area was a mix of forest and upland prairie. The study area site itself was a dynamic area of continuous changing formations of islands, wetlands, sand bars, side channels, and backwaters with varying depths.

Since the mid-19th century, the U.S. Army Corps of Engineers has been charged by Congress to improve the Mississippi River for navigation through dredging, snagging and clearing, and channel constriction. The latter procedure began with authorization of the 4-foot channel in 1866, 4 ½-foot channel in 1878, and continued with a 6-foot channel in 1907. Between 1930 and 1940, the Corps constructed the Upper Mississippi River and Illinois Waterway 9-Foot Channel Project. Today, the 9-Foot Channel Project includes 37 locks and 1,200 miles of nine-foot deep navigable waterway in Illinois, Iowa, Minnesota, Missouri, and Wisconsin. Levee construction began on the UMRS in the 1880s. By 1890, much of the surrounding area to the study area, including a portion of Piasa Island itself, had been cleared for agriculture purposes. Approximately 30 acres of Piasa Island were under cultivation, while the remainder was forested (Figure 2-1). At that time, Eagle's Nest Island was mainly mud and sand flats, but by 1932 it was forested. There is no indication that Eagle's Nest Island was ever cultivated. While conversion of native habitat to agriculture affected the surrounding area, the impacts of constructing a stable and reliable navigation channel had greater impacts to the study area.

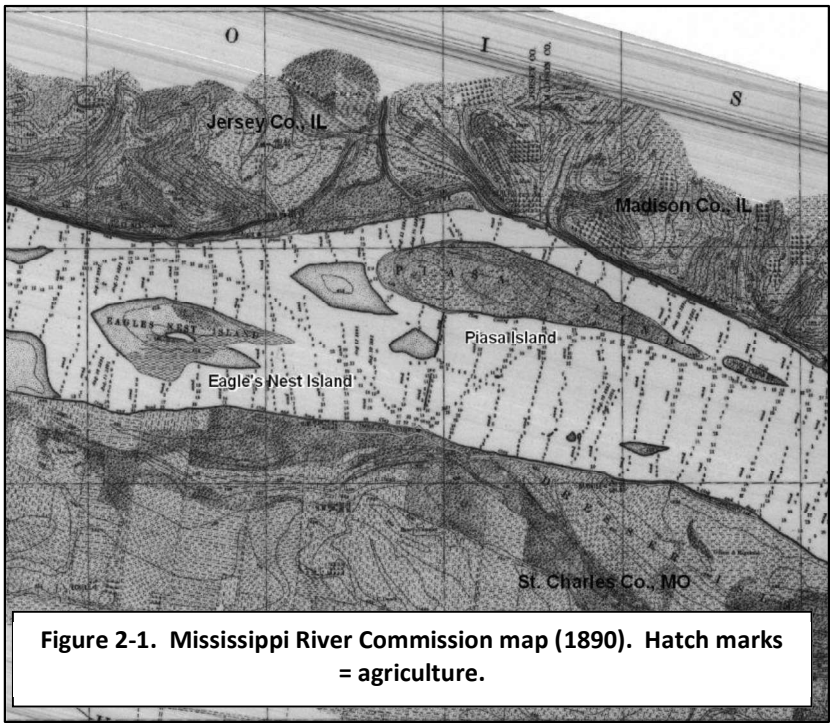


Figure 2-1. Mississippi River Commission map (1890). Hatch marks = agriculture.

In order to address complaints related to shallow water from steamboaters, a submergible dam was built in 1875-1877 between Piasa Island and the Missouri shore for the purpose of moving more water through the channel north of Piasa Island and deepening that channel for navigation. However, after dam construction, a continuous rock

ledge extending from the head of Piasa Island to the Illinois shore was discovered, which prevented the desired outcome to be achieved. The dam was abandoned and the decision was made to close the channel north of Piasa Island, and adopt the southern channel as the navigation channel. The dam was removed and additional dikes, including a dike from the Illinois shore to the head of Eagle's Nest Island, were constructed to direct flow into the southern channel (USACE, 1881). Over time, these historic dikes and closing structures led to increased sedimentation at the upstream end of Piasa Chute (i.e., the northern channel), and decreased depth diversity within the chute. Today, the navigation channel still runs south of both islands. The location of the historic rock ledge has not been discovered through additional surveys that were collected during this study; therefore, the Corps assumed this historic ledge would not influence existing conditions or projected future conditions. Additional hydrographic surveys would be collected during design to reduce the uncertainty related to this historic structure.

As part of the construction of Lock and Dam 26 and the creation of Pool 26, Piasa and the other islands in the study area were acquired by the federal government (Figure 2-2). Construction of Lock and Dam 26 was completed in 1939. The dam raised the water level in the vicinity of the study area inundating much of the wetlands and smaller islands surrounding Piasa and Eagle's Nest Islands. Figure 2-3 provides a series of aerial photographs of the study area from 1932 (pre-lock and dam), 1941 (post- lock and dam), 1979, and 2007. The gage data (Grafton gage located at RM 218.0) in 1932 was much lower as compared to the post-lock and dam photos which have more similar gage readings (Figure 2-3). These raised gage data post-lock and dam are expected due to the inundation. The raising of the water level frequently or permanently inundated parts of Piasa Island, which directly led to island loss and creation of more open water habitat. In addition, several of the smaller islands were permanently inundated.

Figure 2-2. 1942 Corps of Engineer map showing land acquisition (hatches indicate title vested in federal government)

Lock and Dam 26 was later replaced by the construction of Mel Price Locks and Dam (RM 200.5), located approximately 2 miles downstream of the original Lock and Dam 26. Mel Price became operational by 1990, and the original Lock and Dam 26 was removed.

2.2 Description of Current Management

The study area encompasses approximately 1,381 acres of side channel, backwater, and island habitat. Piasa Island and Eagle's Nest Island are the main forested islands within the study area. Piasa Chute and the unnamed chute between Piasa and Eagle's Nest Islands are the primary side channels within the study area.

Lands (i.e., the islands) within the study area are managed by the St. Louis Corps of Engineers' Rivers Project Office, in partnership with the Illinois Department of Natural Resources (IDNR). The Corps conducts forestry monitoring and management as well as conducts other wildlife monitoring surveys

(e.g., bat surveys) as needed. IDNR provides management support of Piasa Chute and the unnamed chute between Piasa and Eagles Nest Islands for migratory wildlife.

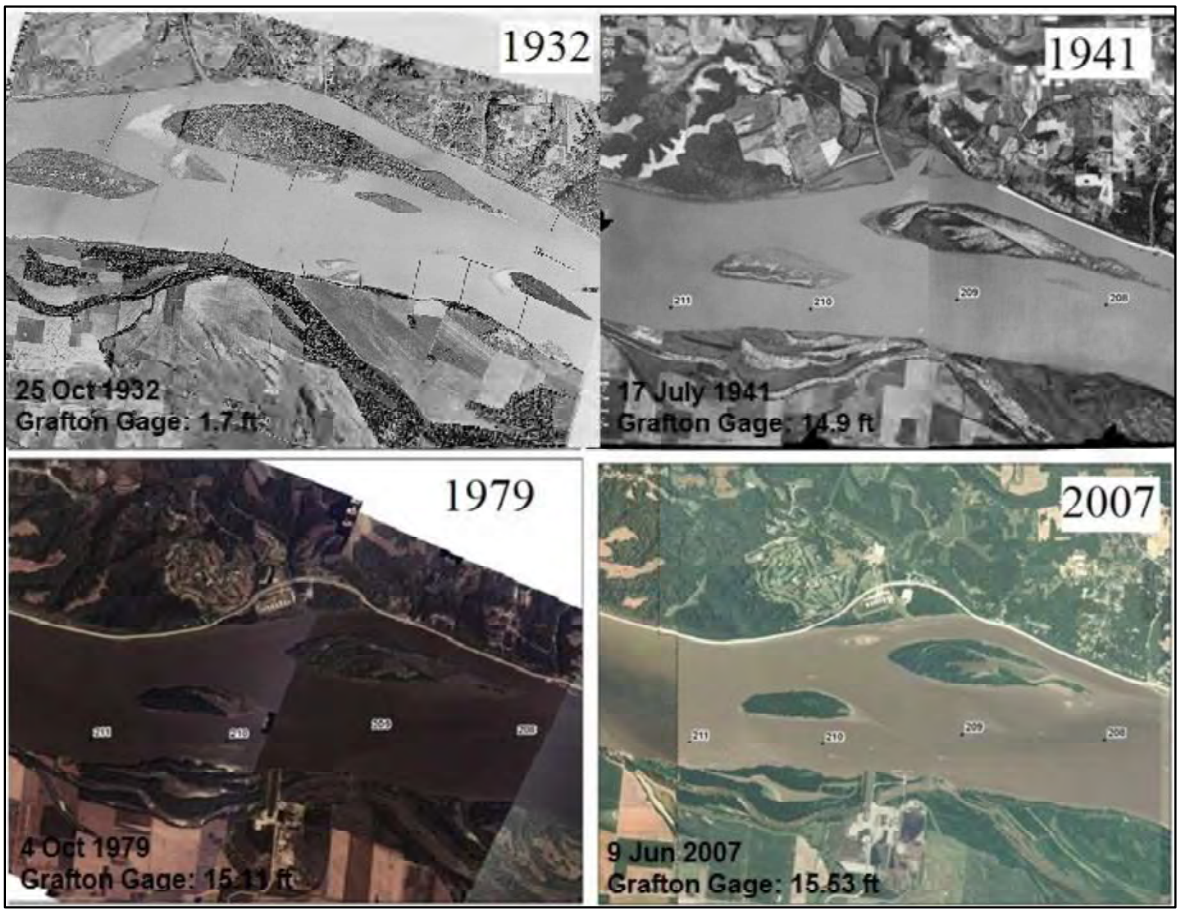


Figure 2-3. Historic aerial images of Study Area.

2.3 Hydrology & Hydraulics

The series of lock and dams on the UMRS are not for flood storage; the river still experiences flood pulses during the spring, but the historic summer extreme low-flow conditions have been eliminated (Wlosinski & Hill, 1995). Consequently, surface water elevations within the UMRS, including Pool 26, are higher than they were historically, especially at low discharges.

The Pool 26 of the Mississippi River is managed by Mel Price Locks and Dam (RM 200.5) Environmental Pool Management (EPM). EPM has been implemented since 1994 and attempts to create thousands of acres of wetland vegetation in the navigation pools, while still maintaining a safe and dependable navigation channel. During early implementation of EPM, the navigation pool water level was held approximately 1-2 feet lower for a period of 30-45 days typically between May and July. In more recent implementation, EPM has been targeting a 90+ day drawdown starting with a drawdown in March before centrachid spawn. The "drawdown" is then followed by a slow rise back to "full pool" in late August or early September. What usually results is an expanse of wetland vegetation, that when flooded, provides habitat for both fish and wildlife. The navigation pools are held either near the top of the operating range to improve fish spawning, held low to allow for maximum vegetation growth or somewhere in between depending on the determined needs and attainable river levels for that year. For Pool 26, the operating pool limits range from 412.5 to 418.56 feet NAVD 88 (Figure 2-4). Even with

EPM, the annual hydrograph for Pool 26 does show a spring rise followed by relatively stable water elevations the rest of the year. The average monthly water surface elevations for a historical period of record (1941-1980) and a more recent period of record (1981-2014) are shown in Figure 2-5. Additional hydrology and hydraulics information can be found in Appendix C, *Hydrology & Hydraulics.*

Sedimentation. Sedimentation rates in backwaters of Pool 26 have been estimated to be between 1 to 2 inches per year (GREAT III, 1982). From a more recent model conducted by the St. Louis District (Simons, Simons, Ghaboosi, & Chen, 1988) estimating total deposition of sediment in close proximity to the study area, the sediment deposition rate at Brickhouse Slough (located at RM 206-209 between Dresser Island and the Missouri shore) was calculated to be about 0.5 inches per year. Within the study area, additional investigations have been performed to better understand the fluvial processes leading to the shallowing of Piasa Chute and Piasa Island Backwater. The St. Louis District conducted an investigation to evaluate the existing conditions and the hydrographic survey records between River Miles (RM) 208.0 and 216.0 (Brown, 2007). The bathymetric analysis included surveys from 2004, 1998, 1987, 1983, 1977, 1971, and 1956. Overall, the main river channel upstream of Piasa Chute remained unchanged, which can be explained by its location within the navigation pool and having adequate width and depth. However, one change worthy of note is the scour hole (appx. 40 feet deep, 1 mile long, 1,000 ft wide) located 2 miles upstream of the entrance to Piasa Chute (RM 213.0-214.0) which switched back and forth from the right descending bank to the left descending bank between 1956 and 2004. Brown (2007) concluded that based on the scour hole's characteristics it can be considered to have direct consequences to the bathymetry of Piasa Chute. Recent hydrographic surveys of the study area were performed in 2012, 2013, 2014, and 2015. A line of scour near the north side of Eagle's Nest Island is present in the surveys (Plates 4, 5, and 6). This scour line suggests a substantial amount of energy entering the Piasa Chute exits between Piasa Island and Eagle's Nest Island, leaving less energy to pass through the remainder of Piasa Chute (Brown, 2007). In addition, the 2015 hydrographic survey discovered a large depositional area near RM 211 upstream of Eagle's Nest Island along the Illinois bankline (Plates 4, 5, and 6). Sediment grab samples determined this structure to be a mix of hardened clay and woody debris. This depositional area was observed through aerial photography (Figure 2-6; disregard the white cloud) and through field observations in 2015 during lower water conditions. This mass of material appears to influence the entrance conditions into Piasa Chute. Immediately downstream of this depositional area depth increases to approximately 10 feet (Plates 4, 5, and 6). Additional surveys have documented that the mass of material is migrating downstream.

The St. Louis District performed an ISOPACH analysis comparing 2006 to 2013 hydrographic surveys within Piasa Chute. This comparative analysis concluded that there has been net gain of material within Piasa Chute which has resulted in loss of depth and flow, and reduced habitat diversity (See Appendix C, *Hydrology & Hydraulics, and* Chapter 3 below for more details).

Acoustic Doppler Current Profiler (ADCP) data were collected in May 2015 (Plate 12) to document the flow (feet per second) within the study area. It appears that flow entering the Piasa Chute hugs the northern side of Eagle's Nest Island with slightly faster flows being closer to Eagle's Nest Island. Within Piasa Chute the flows are very slow. The ADCP data support the conclusion from Brown (2007) that the majority of flow entering the Piasa Chute exits between Eagle's Nest Island and Piasa Island, leaving less flow (energy) to pass through the remainder of the side channel and promoting deposition.

Within Piasa Island Backwater, further aerial imagery analysis and discussions with IDNR and USFWS have concluded that this backwater has lost depth over time which has led to reduced connectivity with the main channel.

Figure 2-4. Illustration of Environmental Pool Management for Pool 26 in relation to Melvin Price Locks and Dam and Piasa and Eagle's Nest Islands. Water surface elevations shown in feet NGVD 1929. Piasa –Eagle's Nest Islands land surface elevations range from 417.65 to 426.18 ft NGVD 29 (417.22 – 425.75 NAVD 88).

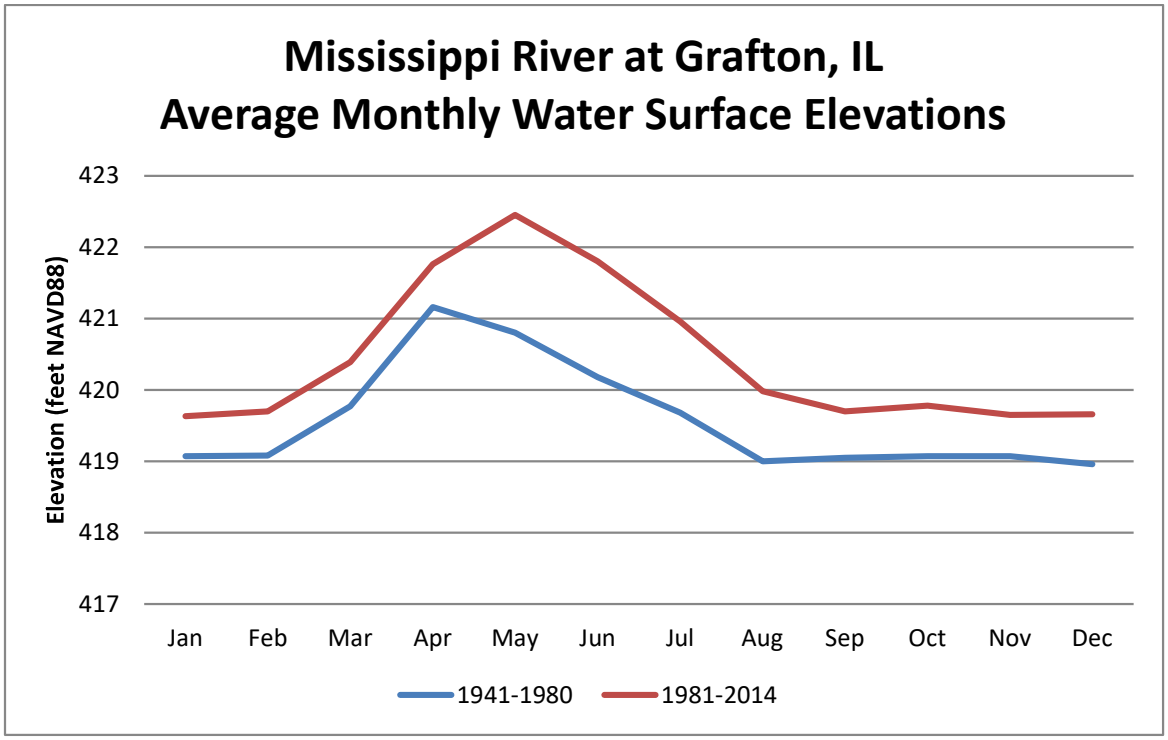


Figure 2-5. Average monthly water surface elevations for the Mississippi River at Grafton, IL (RM 218.0) from 1941-1980 and from 1981-2014.

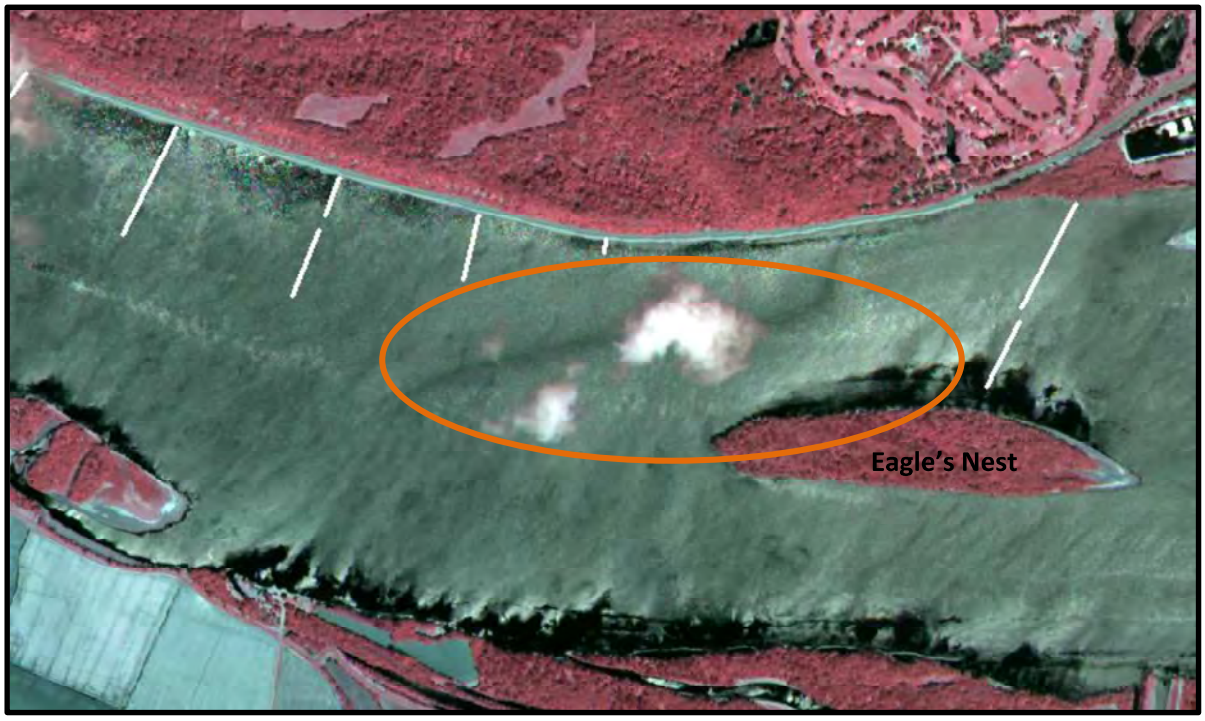


Figure 2-6. Aerial photo showing the depositional area (circled in orange) upstream of Piasa Chute near RM 211

2.4 Aquatic Resources

The study area contains approximately 1,196 acres of aquatic habitat, which includes side channel and main channel riverine habitats. The Piasa Chute complex, including the unnamed chute between the islands, is approximately 562 acres of side channel and 49 acres of backwater habitat.

2.4.1 Riverine Fisheries

Side channel habitat is an important component to support a healthy riverine fish assemblage; and restoring side channel habitat has been an identified need for Pool 26 through the *Habitat Needs Assessment* (Theiling, et al., 2000). In particular within Piasa Chute, the side channel has become degraded due to lack of flow and shallow conditions.

Within the UMR Pool 26 as a whole, fish population trends were examined using UMRR-LTRM fish data collected from 1994 to 2003 (Ratcliff, Lubinski, Gittinger, & Chick, 2013). During this time period, the UMRR-LTRM fish monitoring data revealed decreasing trends of common carp, with a detected spread of exotic species into Pool 26, including bighead and silver carp (Ratcliff, Lubinski, Gittinger, & Chick, 2013). The decrease in common carp has been linked to the increase of bighead and silver carp. Native fish species are negatively impacted by these Asian carp through competition for available food resources.

Riverine fish habitat under consideration for this study area includes the side channel habitat in Piasa Chute, approximately 562 acres. UMRR-LTRM data (stratified random sampling; UMRR-LTRM Fisheries Manual; for details see (Gutreuter, Burkhardt, & Lubinski, 1995)) collected within the study area from 1993 to 2013 were summarized for riverine fisheries habitat (Figure 2-7). For the side channel habitat (for all sampling gears; n = 258), a total of 17,969 fish of 59 species were collected. The most abundant species included channel catfish (20%) and gizzard shad (20%); both species are not indicators of quality aquatic habitat. Channel catfish are fairly tolerant to water quality issues and habitat loss, are omnivorous, and able to adapt to lentic or lotic environments (Hagerty & McCain, 2013). Gizzard shad are abundant and widely distributed forage fish species found in a variety of habitats within the UMRS. Overall the riverine fisheries assemblage within the study area is dominated by tolerant species of poor aquatic habitat with minimal utilization of the study area by riverine fishes that indicate good quality side channel habitat. No federally threatened or endangered species were collected during this time period.

2.4.2 Backwater Fisheries

Suitable backwater habitat (i.e., dissolved oxygen > 5.0 mg/L; winter temperatures > 1.0 ° C, > 5 feet depth; Hagerty & McCain, 2013) is needed to support a healthy backwater fish assemblage. The backwater fishery habitat under consideration for this study area includes the backwater located within Piasa Island, which is approximately 49 acres. Observations made by IDNR conclude that Piasa Island Backwater has decreased in depth and a sediment plug has formed at the mouth of the backwater reducing connectivity with the main channel. Based on water quality data collected by UMRR-LTRM (see Section 2.11 below), the average depth of the backwater ranges from 1.25 feet to 3.5 feet, which is not adequate to sustain a healthy backwater fish assemblage. Depths of greater than 5 feet are typically desired to maintain seasonal conditions (e.g., water temperature and dissolved oxygen concentrations) required to sustain backwater fish communities throughout the year. In addition, limited-to-no aquatic vegetation occurs within the backwater (see Section 2.4.4 for more details).

UMRR-LTRM data collected within the study area from 1993 to 2013 were summarized for backwater fisheries habitat, which included the UMRR-LTRM strata backwater offshore and backwater shoreline (Figure 2-7). For backwater offshore (for all gears; n=6), a total of 1,158 fish of 28 species were collected. The most abundant species collected included shortnose gar (23%) and freshwater drum

(10%). For backwater shoreline (for all gears; n = 99), a total of 6,122 fish of 50 species were collected. The most abundant species collected included freshwater drum (11%), gizzard shad (11%), and shortnose gar (10%). Freshwater drum and shortnose gar are pollution tolerant species, and are usually not indicators of quality backwater fish habitat. Indicators of quality backwater habitat were not abundant. No federally threatened or endangered species were collected during this time period.

In addition to UMRR-LTRM fish data collection, IDNR also sampled Piasa Island Backwater in April of 2010, 2011, and 2012 using hoop nets. In 2010, 8 nets were set resulting in 335 pounds of channel catfish sampled. In 2011, 35 nets were set resulting in 143 pounds of flathead catfish, 99 pounds of channel catfish, and 202 pounds of blue catfish. In 2012, 18 nets were set resulting in 48 pounds of flathead catfish, 250 pounds of channel catfish, and 40 pounds of blue catfish. Based on these snapshots in time, it appears that the more tolerant species of poor aquatic habitat, the channel catfish, is utilizing the backwater area more whereas the other two more desirable species showed a reduction.

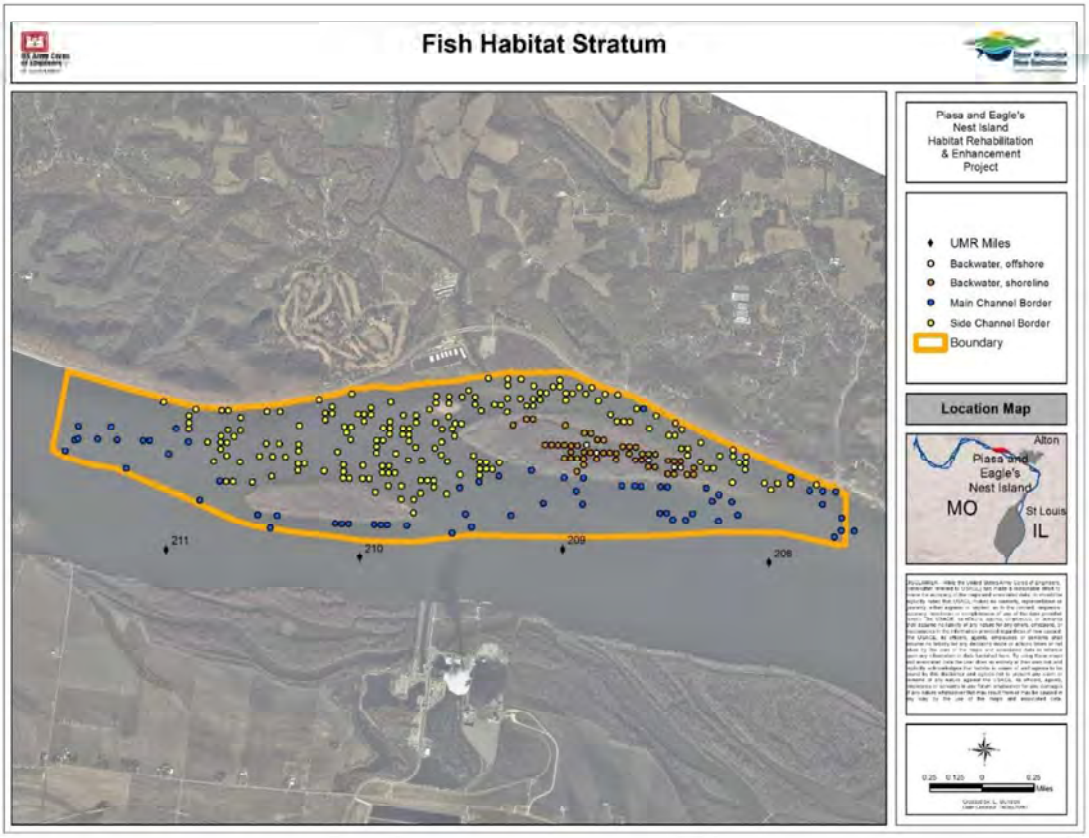


Figure 2-7. UMRR-LTRM stratified random sampling fish sampling sites (over all gears and strata) within the Study Area from 1993 through 2013.

2.4.3 Mussels

Mussels are filter-feeding animals that are important ecological components of the benthic community of the Upper Mississippi River; however, pollution, habitat modification (e.g., damming, dredging, siltation of backwater areas, navigation, floodplain development, commercial harvest), and infestation by the invasive zebra mussel (*Dreissena polymorpha*) of riverine systems has resulted in the decline of many native freshwater mussel species. The UMR historically harbored 50 freshwater mussel (unionid) species (Fuller, 1980). Thirty-four mussel species have been reported from Pool 26, 26 of which occurred in Pool 26 pre-impoundment (Ecological Specialists, 1999), 27 of which have been collected

within the past 30 years. Nine of the 34 species are presently listed in Illinois as threatened or endangered, including the federally endangered spectaclecase (*Cumberlandia monodonta*), which is considered "rare" in Pool 26. In addition four of the state listed species (*Cyclonaias tuberculata, Elliptio crassidens, E. dilatata,* and *Simpsonaia ambigua*) and the federally endangered fat pocketbook (*Potamilus capax)* have not been observed in Pool 26 in the past 30 years (Ecological Specialist Inc, 2014; Dennis, 1985).

In 1999, a reconnaissance study was conducted to identify significant mussel beds between Alton and Grafton, Illinois (Ecological Specialists, 1999). Areas were selected for investigation based on historical and recent mussel records. Areas were sampled upstream (RM 215.0 to 218.0) and downstream (RM 204.4 to 207.1) of the study area (RM 207.5 to 211.0). A summary of this reconnaissance study is provided here. The downstream site bordered the Great River Road with most of the bank being steep and rip rapped, with depth exceeding 19.6 feet within 82 feet of the bank. Only 25 mussels of six species were collected and most were *Amblema p. plicata*, *Megalonaias nervosa,* and *Quadrula.* The upstream site bordered the Great River Road, the bank was rip rapped, and the depth increased rapidly to 19.6 feet within 98.4 feet of the bank, but the habitat was variable and did provide some shallower areas. Mussels were found throughout this site, with mussels being most abundant between RM 216.0 and 216.7. Ninety mussels of 15 species were collected during the initial reconnaissance study. Additional monitoring was conducted between RM 216.5 to 216.7 with mussels being fairly abundant between depths of 23.9 to 24.9 feet in more consolidated sand and gravel substrate. A total of 1,050 live mussels of 22 species were collected with a significant population of *M. nervosa*.

In 2014, field sampling was conducted in May and June to identify and characterize the mussel communities within the study area (Ecological Specialist Inc, 2014)(Figure 2-8). Habitat was somewhat variable throughout the study area, but was generally characterized by relatively shallow water and soft substrate. Depth ranged from less than 2 inches to 21 feet, but the majority of the study area was less than 6.5 feet deep. Scattered mussels were present in several locations within the study area. A low-density mussel bed (1.92 individuals/m^2) was identified at the head of Piasa Island, and a moderate-density bed (5.56 individuals/m^2) was identified at the toe of Piasa Island (Figure 2-9). Both beds had low recruitment, species richness and diversity, and were overwhelmingly dominated by a few common thick-shelled species more tolerant of fluctuating water levels and siltation (Ecological Specialist Inc, 2014). Mussel abundance within the side channel was also low. A total of 2,151 mussels of 21 species were collected in the study area. *Amblema plicata* (59.2%), *Quadrula* (19.1%), and *Q. reflexa* (6.4%) together made up nearly 85% of the total catch. Only 3 other species (*Megalonaiais nervosa, Q. nodulata, and Quadrula p. pustulosa*) comprised greater than 1%. Two Illinois-threatened *Ellipsaria lineolata* were collected near the toe of Piasa Island. Coordination with Illinois Department of Natural Resources Incidental Take Authorization Coordinator occurred (Appendix B, *Coordination)*, and such handling of a state-listed species during the survey was performed under a permit held by the contractor. No evidence of federally listed species was observed, and suitable habitat for federally listed species is not present within the study area.

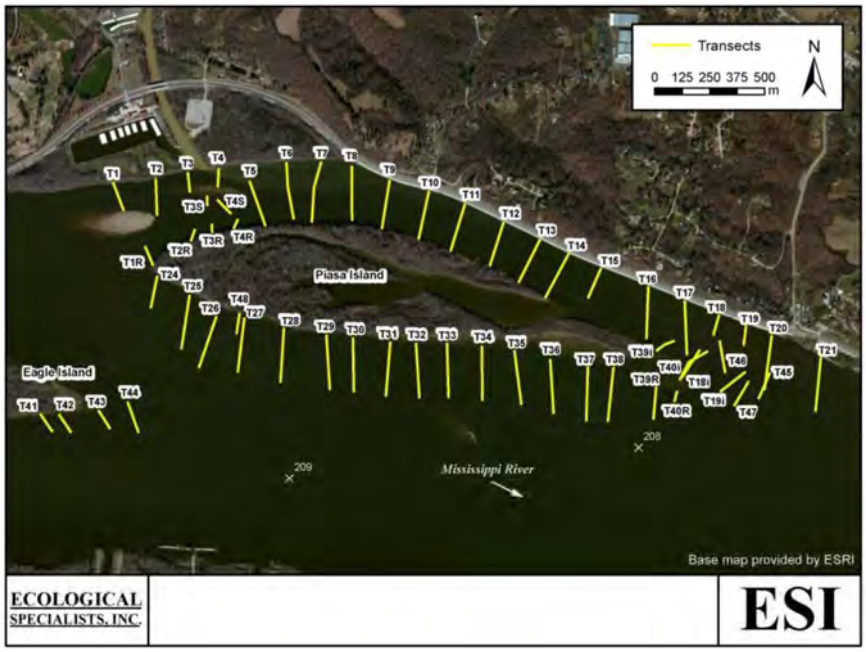


Figure 2-8. Semi-quantitative transects sampled within Piasa and Eagle's Nest Islands HREP, May-June 2014. Courtesy of Ecological Specialists, Inc. (2014).

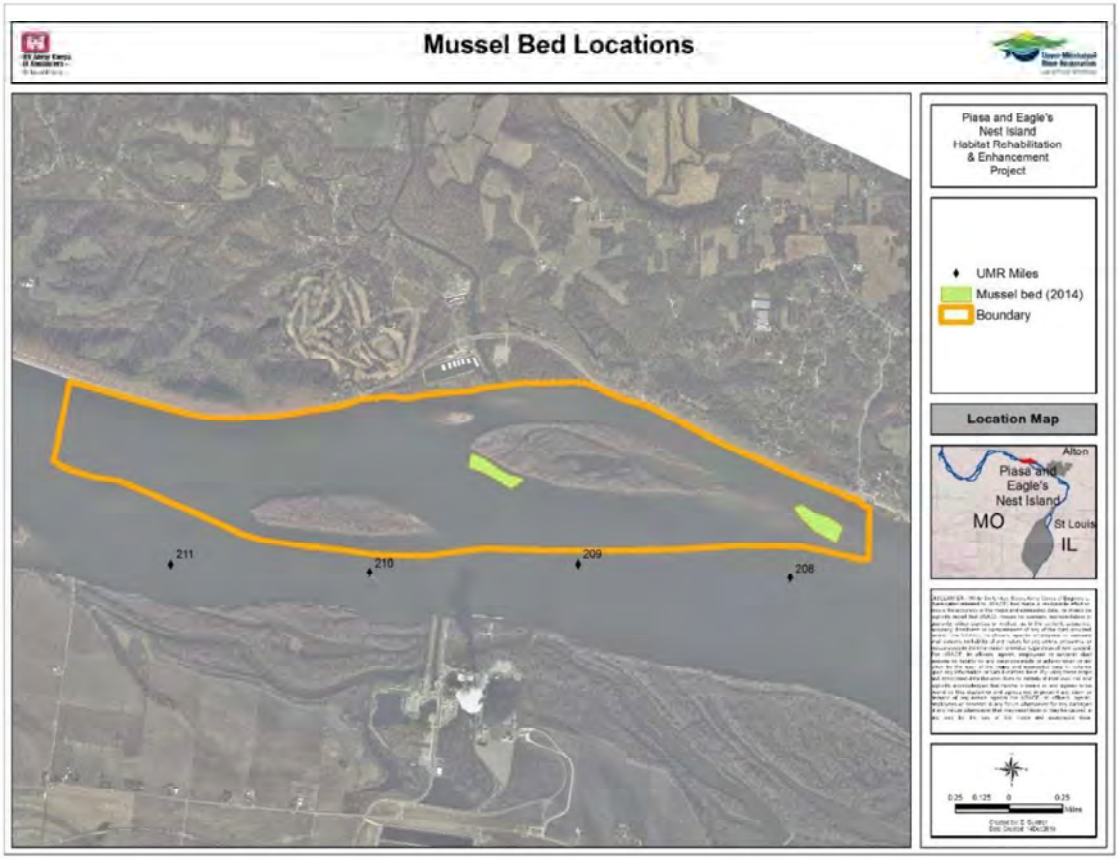


Figure 2-9. Location of mussel beds delineated during 2014 survey. See ESI (2014) for more details.

2.4.4 Aquatic Vegetation

Aquatic vegetation provides an important food source for migratory waterfowl and habitat for fish. The UMRR-LTRM conducts annual monitoring of aquatic vegetation using a stratified random sampling method (Yin, Winkleman, & Langrehr, 2000). Distribution and abundance of aquatic vegetation is mainly dependent on water depths and water clarity. The distribution of aquatic vegetation in the UMRS displays a distinct longitudinal pattern. Aquatic vegetation is common in shallow backwaters in the Upper Impounded Reach (Pools 4 and 8), but seldom detected in Pool 26 (Johnson & Hagerty, 2008). Aquatic vegetation data collected within the study area occurred from 1998 through 2004. The data were summarized by stratum, which included backwater contiguous (n=90), main channel border (n=38), and side channel (n=73). During this time period, a total of 37 plant species were detected across all strata, of which 2 species were detected in main channel border, 10 species detected in side channel habitat, and 33 species detected in the backwaters (which included woody, herbaceous, and aquatic vegetation). The backwater contiguous strata included emergent, floating, and submersed vegetation. The majority of samples regardless of strata contained no vegetation. In all three strata, common duckweed (*Lemna minor*) and common duck meal (*Spirodela polyrrhiza*) were detected most frequently, but still in relatively low abundance compared to other UMRR-LTRM study reaches. Due to low occurrence, aquatic vegetation sampling as part of the UMRR-LTRM was discontinued in Pool 26, Illinois River, and the Open River Reach after 2004. Even if water depths were adequate to support submersed aquatic vegetation in Pool 26, the low abundance of aquatic vegetation has been attributed to high turbidity (Johnson & Hagerty, 2008). Historically, aquatic vegetation was more expansive in the study area (e.g., Piasa Island Backwater), but it was still a minor component (IDNR, pers. comm). The loss of aquatic vegetation within the study area has been attributed to the flood of 1993 and other high water events.

2.5 Floodplain Habitat

Forested islands like Piasa and Eagle's Nest Islands are distinctive features within the floodplain landscape. Today, approximately 183 acres of island habitat occurs within the study area. Historically, Piasa and Eagle's Nest Islands consisted primarily of forest intermixed with emergent wetlands. Based on the *Habitat Needs Assessment for the Upper Mississippi River* (Theiling, et al., 2000) prior to European settlement Pool 26 was comprised of 46% emergent wetlands, 35% floodplain forest, 18% open water, and less than 1% marsh/swamp; while contemporary (1989) land cover composition has changed to 54% agriculture, 19% floodplain forest, 18% open water, 6% emergent wetlands, and less than 1% marsh/swamp) (Theiling, et al., 2000). Specifically for the study area, Figure 2-10 shows the changes of land cover composition from 1890 to 2010. Figure 2-11 illustrates the land cover changes within the study area from 1989 to 2000 to 2010. Most notably, the land cover changes within the study area include loss of sand bar habitat and aquatic vegetation with an increase in open water.

Previous studies also documented the forest community within the floodplain becoming dominated by flood tolerant tree species (e.g., cottonwood, willow, ash, and hackberry) (Yin, Wu, & Cosgriff, 2009; Romano, 2010). Within the study area, nearly the entire site is located within lower elevations (Figure 2-12). These low-lying areas are not suitable for optimal survival, growth, and sustainability of mast tree (i.e., nut producing tree) production (De Jager, Thomsen, & Yin, 2012), which are critical food sources for many species of resident and migratory wildlife. Recent forest inventory data (2010) conducted by the Corps at the study area determined the area to be dominated by silver maple (49%) and green ash (15%) which are flood-tolerant species. The study area has very little (less than 1%) nut-producing trees present (i.e., swamp white oak and overcup oak) which are less flood-tolerant, and primarily located on the west side of Piasa Island (Figure 2-13; elevations greater than 422.57 ft NAVD 88). Some larger American elms are present on the northwest side of Piasa Island.

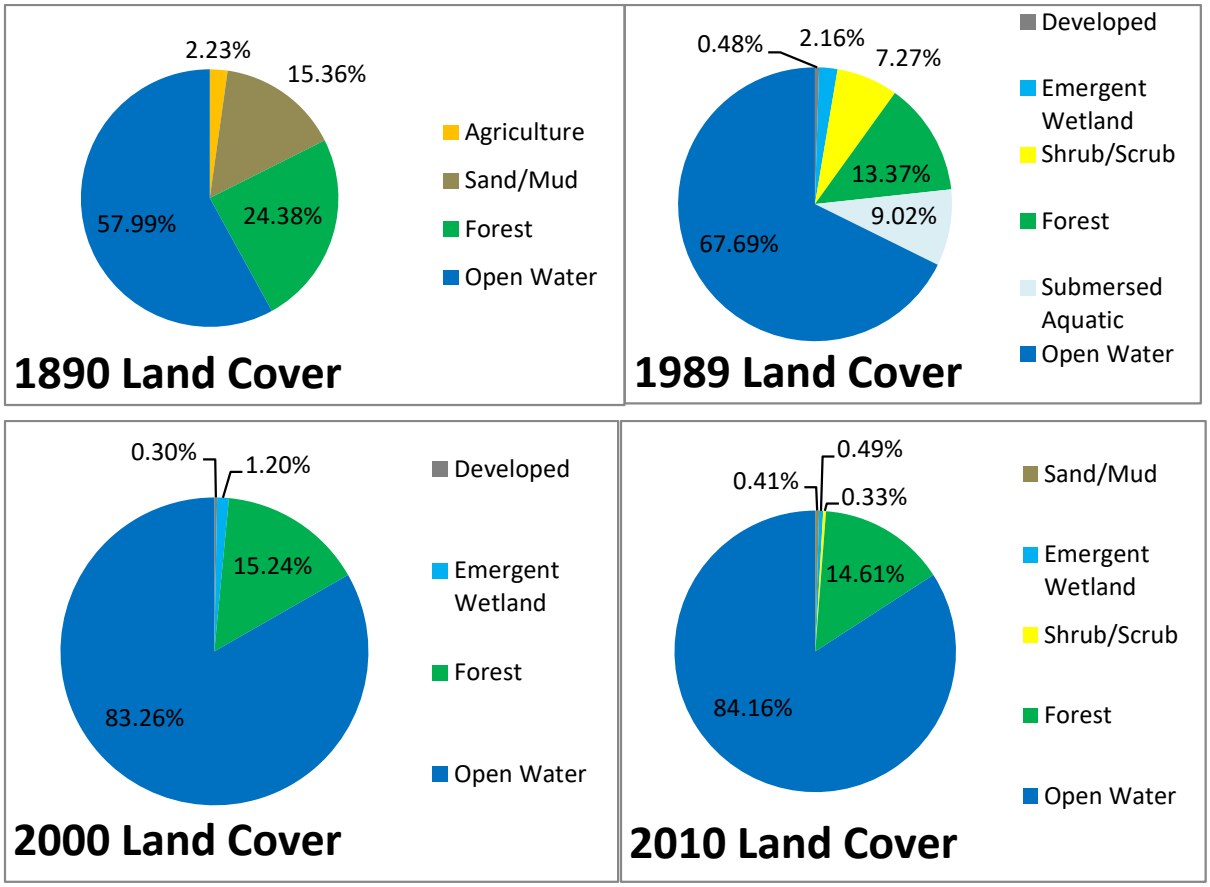


Figure 2-10. Land cover composition for the Piasa and Eagle's Nest Islands

Data courtesy of UMRR-LTRM; available for download at http://www.umesc.usgs.gov/mapping/resource_mapping_lcu.html

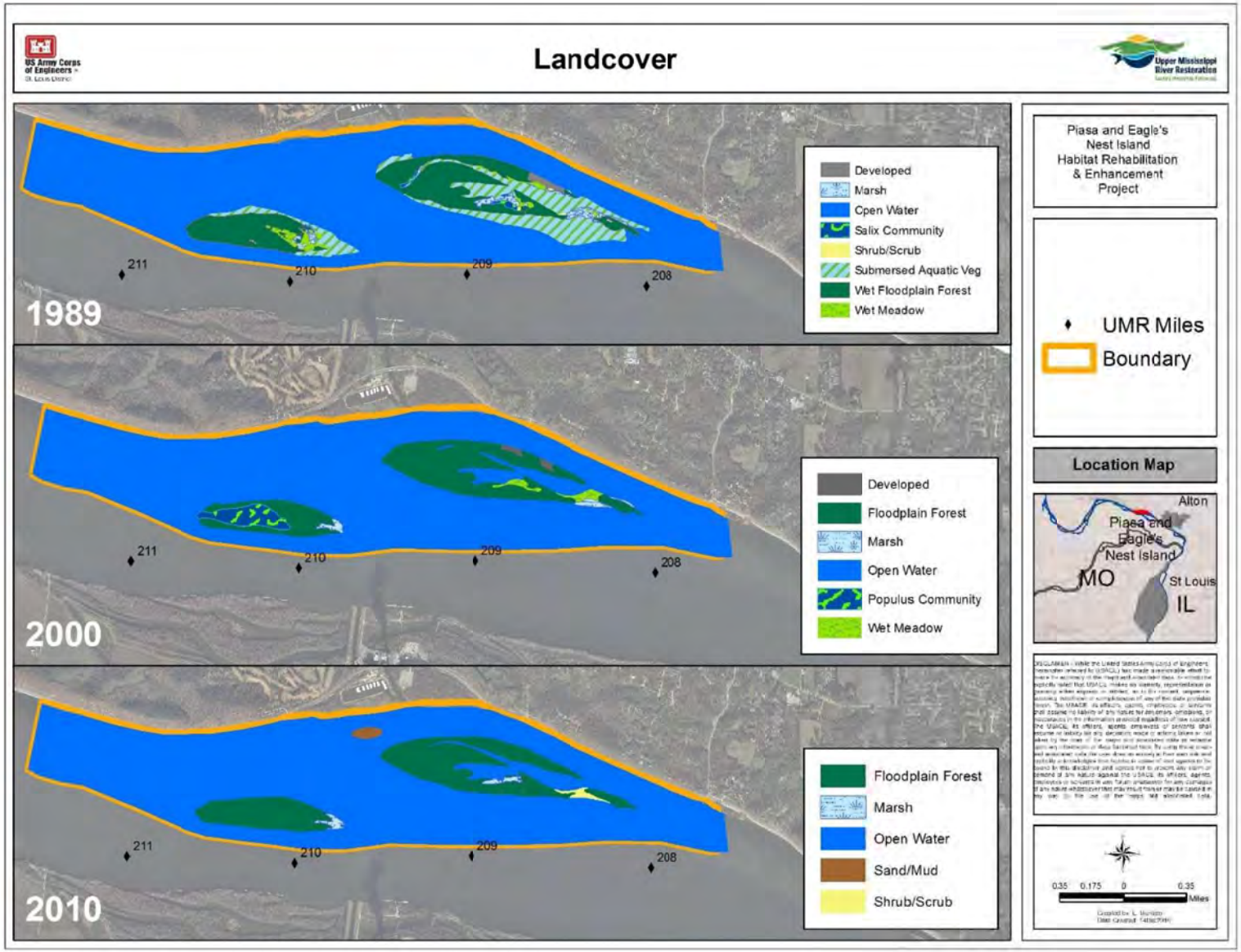


Figure 2-11. Land cover of Study Area from 1989 (top), 2000 (middle) and 2010 (bottom). Data courtesy of UMRR-LTRM.

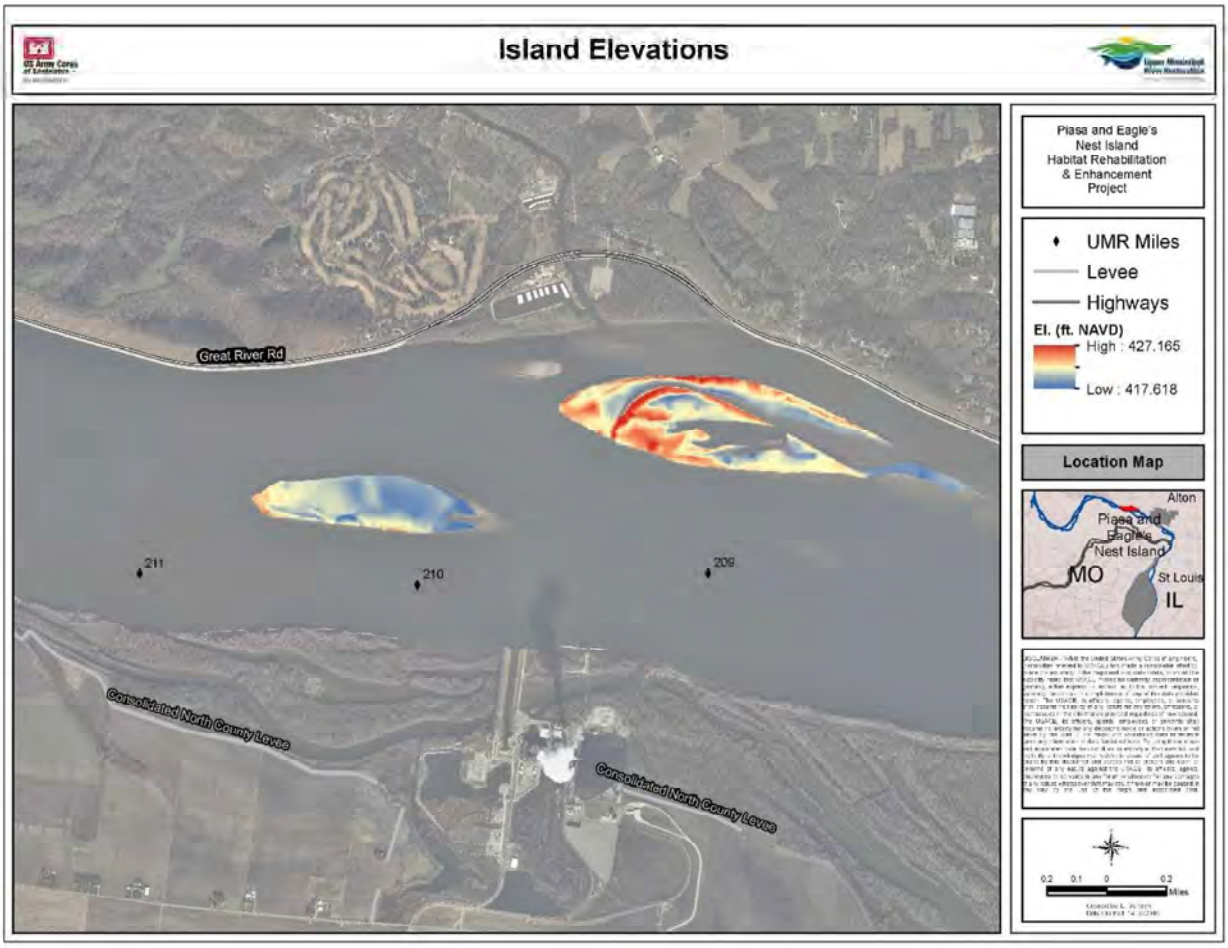


Figure 2-12. Elevation (feet NAVD 1988) for the Study Area

2.6 Geology and Soils

The geology and soils found at the Piasa and Eagle's Nest Islands are solely comprised of Darwin silty clay. The Darwin soils series[8] consists of very deep, poorly and very poorly drained, very permeable soils formed in clayey alluvium on floodplains. The soils are found on 0 to 2 percent slope and frequently flooded for long durations. The study area contains no soils designated as prime farmland (Farmland Protection Policy Act, 7 CFR Part 658).

In 2014, as part of the mussel survey (Ecological Specialist Inc, 2014), substrate was sampled. Within the study area, two sandbars were present at the head of Piasa Chute, and exposed sand was present along much of the Piasa Island bankline. Substrate was primarily composed of sand, silt, and clay in varying proportions. Silt and clay made up a larger percentage of the substrate near the banks, while loose sand became more common near the center of the side channel and riverward of Piasa and Eagle's Nest Islands. Gravel and woody debris were also present throughout much of the study area, although these constituents tended to make up only small percentages of the substrate.

[8] A soil series is a group of soils having identical profiles. All soils of a particular series have horizons that are similar in composition, thickness, and arrangement.

2.7 Wildlife & Migratory Birds

The study area and other floodplain conservation areas provide mid-migration habitat for the Mississippi Flyway, one of the major migratory bird flight corridors in North America. The Mississippi River and floodplain are the center of this flyway. This mid-migration habitat is recognized in the North American Waterfowl Management Plan as a habitat of major concern. About 20 species of ducks and geese stop during fall and spring migrations to rest, feed and seek sanctuary in the islands, wetlands and deep-water habitats of Pools 24, 25, and 26 and adjacent floodplain (Havera, 1985). Numerous wetland obligate reptiles, amphibians and mussels likely inhabit the study area. Approximately 50 species of mammals may inhabit the study area (Terpening, Nawrot, Sweet, & Damrau, 1975). Common species include opossum, raccoon, muskrat, mink, beaver, and white-tailed deer. In addition, approximately 285 species of birds including song birds, shorebirds and gulls, waterfowl, herons and egrets, and vultures and hawks are known to use or probably use the floodplain habitats of Pool 26 (Terpening, Nawrot, Sweet, & Damrau, 1975).

The Migratory Bird Treaty Act (MBTA) of 1918 regulates and protects most aspects of the taking, possession, transportation, sale, purchase, barter, exportation, and importation of migratory birds. As of March 31, 2010, the MBTA regulates and protects 1,007 species. Although there are numerous migratory birds that utilize Piasa and Eagle's Nest Islands, the following migratory birds are the most relevant in the area:

2.7.1 Bald eagle

The bald eagle typically utilizes large trees for roosting and building nests near water. The bald eagle is a common inhabitant within the study area during the winter months. The study area contains suitable habitat for eagle foraging, roosting, and nesting.

2.7.2 Great blue heron

The great blue heron (*Ardea herodias*) is a large wading bird which typically utilizes the shores of open water and wetlands where it forages for small fish as its primary food source. The species usually breeds in colonies, in trees close to open water or wetlands. A colony is often referred to as a rookery and can be as large as 500 nests. Heron rookeries are vulnerable in the UMRS because the availability of suitable nesting habitat is declining. The study area contains suitable habitat for heron foraging, roosting, and nesting. An active heron rookery is known to exist within Eagle's Nest Island, and likely has 300-400 active nests.

2.7.3 Neotropical migratory birds

Floodplain complexes and the habitat provided are highly important to migratory bird species such as neotropical migrants. The diverse array of floodplain habitat types, including island mosaics, typically tend to support higher abundances of species and individuals. In fact, Knutson et al. (1996) found relative abundance of all birds and total numbers of neotropical migratory birds were almost twice as high in the UMRS floodplain as in the adjacent uplands. The loss of island habitat has contributed to the reduction of floodplain habitat diversity over time, which in turn, degrades habitat for neotropical migrants.

2.8 Illinois Resources of Concern

The IDNR EcoCAT Natural Heritage Database was accessed on 14 October 2016 and lists 5 protected resources in the vicinity (i.e., Madison and Jersey counties of Illinois) of the study area. The resources include (1) Principia Hill Prairies East Illinois Natural Areas Inventory Site, (2) Principia Hill Prairies – East Natural Heritage Landmark, (3) Gray Bat (*Myotis grisescens*), (4) Indiana bat (*Myotis sodalis*), and (5) timber rattlesnake (*Crotalus horridus*).

The Principia Hill Prairies East resources are designated as a high quality natural community and a designated Natural Heritage Landmark. These sand hill prairies are located north of the study area in the uplands.

The Indiana bat and Gray bat are federally listed species discussed in Section 2.9, 8.9, and Biological Assessment (Appendix D).

Timber rattlesnake has a wide distribution within the continental U.S.; however, most populations have become isolated, especially towards the western and northern edge of their range. In Illinois, the species is primarily confined to the hilly regions in southern Illinois. Timber rattlesnakes have also been found along the forested river bluffs of the Mississippi River. This species has not been found within the study area.

2.9 Federally Threatened and Endangered Species

U.S. Fish and Wildlife Service provided a list of 8 federally threatened and endangered species that could potentially be found in the area (Jersey and Madison counties, Illinois) via a letter dated 14 October 2016 (updated 25 January 2017 and 16 January 2018; Appendix D, *Biological Assessment).* See Appendix D, *Biological Assessment,* for more details. The 8 species, federal protection status, and habitat can be found in Table 2-1. No critical habitat is located in the study area. USFWS provided a Draft Fish and Wildlife Coordination Act Report (dated 26 May 2017) for the study area which was reviewed and concurred by the Missouri Department of Conservation and the IDNR (see Appendix B, *Coordination*).

Table 2-1. Federally listed threatened and endangered species potentially occurring in the Study Area

Species	Status	Habitat
Least tern (interior population) (*Sterna antillarum*)	Endangered	Large rivers - nest on bare alluvial and dredge spoil islands
Indiana bat (*Myotis sodalis)*	Endangered	Hibernates in caves and mines; maternity & foraging habitat: small stream corridors with well-developed riparian woods; upland & bottomland forests
Northern long-eared bat (*Myotis septentrionalis*	Threatened	Hibernates in caves and mines; swarming in surrounding wooded areas in autumn. Roosts and forages in upland forests during spring and summer.
Decurrent false aster (*Boltonia decurrens*)	Threatened	Disturbed alluvial soils
Eastern prairie fringed orchid (*Platanthera leucophaea*)	Threatened	Moist, sandy floodplains and prairie wetlands along the Illinois River
Pallid sturgeon (*Scaphirhynchus albus*)	Endangered	Mississippi and Missouri Rivers
Eastern massasauga (*Sistrurus catenatus*)	Threatened	Open to forested wetlands and adjacent upland areas
Spectaclecase (*Cumberlandia monodonta*)	Endangered	Large rivers

2.10 Invasive species (Executive Order 13112)

Invasive Species Executive Order 13112 aims "to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause". To abide by this Executive Order, construction best management practices, such as cleaning equipment, would be in place and enforced to prevent the introduction of additional species to and transfer from the study area.

Two invasive plant species are known to occur within the study area: reed canary grass (*Phalaris arundinacea*) and Japanese hop (*Humulus japonicus*). Reed canary grass is an invasive cool-season, perennial grass that aggressively spreads in disturbed wetland environments and can persist in a wide range of flooding regimes. It can displace and suppress the establishment of native flora, especially the establishment and growth of woody species (Hovick & Reinartz, 2007). This species eventually dominates a site by establishing a dense monoculture which adversely affects ecosystem quality (Kercher, Hoover, & Klaas, 2004). Japanese hop is an herbaceous annual climbing vine native to East Asia that threatens floodplain forests and wetlands by forming a blanket of vegetation up to 4 feet thick, which smothers the existing vegetation. Both of these species have been found on both Piasa Island and Eagle's Nest Island. Other common invasive aquatic species likely to be present within the vicinity of the study area include: common carp (*Cyprinus carpio*), silver carp (*Hypopthalmichthys molitrix*), bighead carp (*H. nobilis*) and zebra mussel (*Dreissena polymorpha*).

2.11 Water Quality

Seasonal patterns and trends in annual averages of key water quality parameters were examined for Pool 26 from 1994 to 2004 (Soeken-Gittinger & Chick, 2013) through the UMRR-LTRM[9]. Soeken-Gittinger and Chick (2013) present detailed descriptions of the UMRR-LTRM water quality trend analysis on key water quality parameters sampled by UMRR-LTRM, so only key trends are provided here. The analysis demonstrated that Pool 26 is a highly productive river reach, with long-term averages of chlorophyll-*a*, total phosphorous, total nitrogen, and total inorganic solids being comparable to eutrophic lakes. In addition, discharge was strongly correlated with Secchi depth, turbidity, and total suspended solids with increased discharge having decreased Secchi, and increased turbidity and total suspended solids (Soeken-Gittinger and Chick 2013). Water quality monitoring within the study area has been accomplished through the UMRR-LTRM. Table 2-2 summarizes the water quality data collected through UMRR-LTRM from 1993 to 2013 on a seasonal basis for Piasa Chute and the Piasa Island Backwater.

The Mississippi River within the vicinity of the study area in Illinois (Assessment ID #: J-05) is listed in the Illinois 2016 303(d) list for impairment for mercury and polychlorinated biphenyls (based on fish consumption), and fecal coliform (for primary contact recreation)[10].

[9] Water quality sampling procedures are described in detail in the UMRR-LTRM Procedures Manual ((Soballe & Fischer, 2004)).
[10] Available online: http://www.epa.illinois.gov/Assets/iepa/water-quality/watershed-management/tmdls/2016/303-d-list/appendix-a2.pdf Accessed 16 November 2016

Table 2-2. Summary of UMRR-LTRM water quality data within Piasa Chute and Piasa Island Backwater

Location	Season*	Temp (°C) Average [min; max]	Dissolved Oxygen (mg/L) Average [min]	Water depth (ft)** Average [min; max]	Turbidity (NTU) Average	Velocity (ft/s) Average [min; max]	Suspended Solids (mg/L) Average
Piasa Chute	Win (n=40)	0.87 [0; 2.8]	13.84 [11.6]	6.28 [0; 16.08]	74.18	0.72 [0; 1.64]	107.04
	Spr (n=37)	15.02 [11; 18.5]	8.46 [6.8]	8.79 [0; 18.37]	90.22	1.80 [0; 3.94]	111.40
	Sum (n=36)	28.29 [24.9; 32.5]	6.37 [0]	8.46 [0; 13.78]	57.03	1.16 [0; 3.18]	73.41
	Fall (n=45)	16.53 [11.3; 21.5]	8.54 [5]	7.66 [1.31; 15.09]	45.40	0.72 [0; 2.53]	55.87
Piasa Island Backwater	Win (n=31)	1.31 [0; 4.8]	9.54 [0]	1.24 [0; 5.15]	6.45	--	19.80
	Spr (n=22)	13.63 [0; 19.0]	7.87 [0]	3.48 [0; 8.53]	43.00	0.2624 [0; 1.48]	61.59
	Sum (n=33)	24.08 [0; 35.0]	9.11 [0]	0.19 [0; 2.98]	44.03	--	73.91
	Fall (n=18)	16.53 [0; 24.3]	9.16 [0]	2.10 [0; 3.80]	43.00	0.0036 [0; 0.06]	55.64

*Winter = December-February; Spring = March –May; Summer = June-August; Fall = September-November
** Water depth as measured using a marked sounding pole, non-stretch sounding line, or a calibrated acoustic depth finder

2.12 Air Quality

The U.S. Environmental Protection Agency (USEPA) has identified standards for 7 pollutants: lead, sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, particulate matter less than 10 microns in diameter, and particulate matter less than 2.5 microns. Jersey County, Illinois currently meets all USEPA air quality standards while Madison County, Illinois is in nonattainment for lead (Granite City, IL) and particulate matter less than 2.5 microns and ozone (St. Louis metropolitan area)[11]. The study area is in a rural portion of Madison County and is not considered to be in the immediate vicinity of the urban areas in nonattainment; therefore it is considered to be in attainment.

2.13 Greenhouse Gas Emissions and Climate Change

Climate change is a fundamental environmental issue, and is a particularly complex challenge given its global nature and inherent interrelationships among its sources, causation, mechanisms of action, and impacts. Analyzing a proposed action's greenhouse gas emissions and how climate change may change an action's environmental effects can provide useful information to decision makers and the public. Climate change science is evolving, and is only briefly summarized here. In 1970 the Council on Environmental Quality estimated the level of atmospheric carbon dioxide to be 325 parts per million (ppm)[12]. Since 1970, the concentration of atmospheric carbon dioxide has increased at a rate of about 1.6 ppm per year (1970-2012) to approximately 400 ppm as of September 2016 (current globally averaged value)[13]. Based on the United States Global Change Research Program as well as other scientific records, it is now well established that rising global atmospheric greenhouse gas emission

[11] Available online at: https://www.epa.gov/green-book Accessed 16 November 2016
[12] Available online at: http://www.slideshare.net/whitehouse/august-1970-environmental-quality-the-first-annual-report-of Accessed 16 November 2016
[13] U.S. Department of Commerce, National Oceanic and Atmospheric Administration Earth Systems Research Laboratory, available at http://www.esrl.noaa.gov/gmd/ccgg/trends/global.html Accessed on 16 Nov 2016

concentrations are significantly affecting the Earth's climate[14]. A large body of scientific evidence indicates that increases in greenhouse gases (GHG) in the Earth's atmosphere are contributing to changes in national and global and climatic conditions (Melillo, Richmond, & Yohe, 2014). These changes include such things as average temperature, changes in precipitation patterns, and increases in the frequency and intensity of severe weather events. These changes have the potential to impact a wide sector of the human environment including water resources, agriculture, transportation, human health, energy, and aquatic and terrestrial ecosystems. Therefore, it is important to understand the potential impacts of federal actions on GHG emissions and climate change as well as the potential changes that may occur to the human environment that could affect the assumptions made with respect to determining the impacts and efficacy of the federal action in question.

2.13.1 Upper Mississippi River Region Climate Trends

The Corps is undertaking climate change preparedness and resilience planning and implementation in consultation with internal and external experts using the best available climate science and climate change information. The Corps is preparing concise and broadly-accessible summary reports of the current climate change science with specific attention to USACE missions and operations for the continental United States, Alaska, Hawaii, and Puerto Rico. Each regional report summarizes observed and projected climate and hydrological patterns cited in reputable peer-reviewed literature and authoritative national and regional reports. The following information on climate trends and future climate projections comes from the climate change and hydrology literature synthesis report for the Upper Mississippi River region (USACE, 2015).

Summary of Observed Climate Findings:

*The general consensus in the recent literature points toward moderate increases in temperature and precipitation, and streamflow in the Upper Mississippi Region over the past century. In some studies, and some locations, statistically significant trends have been quantified. In other studies and locales within the Upper Mississippi Region, apparent trends are merely observed graphically but not statistically quantified. There has also been some evidence presented of increased frequency in the occurrence of extreme storm event*s (Villarini, Smith, & Vecchi, 2013). *Lastly, a transition point in climate data trends, where rates of increase changed significantly, was identified by multiple authors at approximately 1970.*

Summary of Future Climate Projection Findings:

There is strong consensus in the literature that air temperatures will increase in the study region, and throughout the country, over the next century. The studies reviewed here generally agree on an increase in mean annual air temperature of approximately 2 to 6 ºC (3.6 to 10.8 ºF) by the latter half of the 21st century in the Upper Mississippi Region. Reasonable consensus is also seen in the literature with respect to projected increases in extreme temperature events, including more frequent, longer, and more intense summer heat waves in the long term future compared to the recent past.

Projections of precipitation found in a majority of the studies forecast an increase in annual precipitation and in the frequency of large storm events. However, there is some evidence presented that the northern portion of the Upper Mississippi Region will experience a slight decrease in annual precipitation. Additionally, seasonal deviations from the general projection pattern have been presented, with some studies indicating a potential for drier summers. Lastly, despite projected precipitation increases, droughts are also projected to increase in the basin as a result of increased temperature and ET rates.

A clear consensus is lacking in the hydrologic projection literature. Projections generated by coupling [Global Climate Models] *with macro scale hydrologic models in some cases indicate a reduction in future streamflow but in other cases indicate a potential increase in streamflow. Of the limited number of studies reviewed here, more results point toward the latter than the former, particularly during the critical summer months.*

[14] Intergovernmental Panel on Climate Change, 2014, available at www.ipcc.ch/report/ar5/index.shtml Accessed on 6 January 2015

2.13.2 Study Area Climate Trends & Greenhouse Gas Emissions

In terms of climate change, changes in the annual and long-term hydrologic cycles of the Mississippi River influence the study area. The two primary factors influencing hydrology in the vicinity of the study area include (1) snowmelt and precipitation events throughout the Upper Midwest, and (2) local and regional precipitation. In general, there is a seasonal pattern to the river's hydrology with peak flows typically occurring in the spring and early summer associated with rain and snowmelt followed by declining flows from early summer through early fall. In addition to the annual seasonal pattern of the river's hydrology, historical data shows an 11 to 15 year cycle of increasing discharge and flooding followed by declining flows and drought (Knox, 1984). Changes in hydrology (e.g., wet vs. dry periods) ultimately influence what floodplain habitats establish and persist.

In terms of the study area, existing greenhouse gas emissions is related to the site access for forestry inventory plot monitoring at Piasa Island. Approximately 7 gallons of fuel are used across the entire study area per year, or approximately 0.062 metric tons of carbon dioxide, which is equivalent to the annual greenhouse gas emissions from 0.013 of a passenger vehicle.[15]

2.14 Hazardous, Toxic and Radioactive Waste

A Phase I Environmental Site Assessment was conducted in accordance with the scope and limitation of ASTM Practice E 1527 (Appendix E, *HTRW*). The assessment revealed only the potential for low level recognized environmental conditions (RECs) that should not have any effect on the study area. There are no records indicating any spills, pesticide/herbicide use, or HTRW contamination. There had been several cabins on Piasa Island in the past, but only two remain. There was no indication of any spills or contamination around these cabins or on either island. Therefore no Phase II Environmental Site Assessment is necessary.

2.15 Historical and Cultural Resources

The below is a brief description of the historical and cultural resources for Piasa and Eagle's Nest Islands. Additional narrative is provided in Appendix F, *Historical and Cultural Resources.*

Documentation of the Mississippi River Valley prehistoric and historical sequence is extensive and potentially the entire prehistoric cultural sequence may be present: Paleo-Indian (10,000–8,000 B.C.), Dalton (8,000–7,000 B.C.), Early Archaic (7,000–5,000 B.C.), Middle Archaic (5,000–3,000 B.C.), Late Archaic (3,000–1,000 B.C.), Early Woodland (1,000–200 B.C.), Middle Woodland (200B.C. –A.D. 400), Late Woodland (A.D. 400–900), Mississippian (A.D. 900–1350). The most numerous archaeological sites were occupied during the Hopewell-influenced Middle Woodland, Late Woodland, and Mississippian period (Rusch, McKay, & Karstens, 1999).

There is no known prehistoric occupation of the study area islands, but they have not been archaeologically surveyed yet. While Eagle's Nest Island formed predominantly in the historical period, Piasa Island predates Euro-American contact. Archaeological sites are abundant on the floodplain of the Mississippi and its tributaries, and it would not be unlikely that they exist, or once existed, on long-standing islands.

The first Euro-American claimant to what became known as Piasa Island was Toussaint Cerré. He petitioned for the island to the French lieutenant governor in January of 1800. In 1818 the western portion of Piasa Island was platted as three tracts. In 1841 the surveyor's office specifically mapped the island along with Little Piasa Island, which was located at the downstream end of the present day Piasa Island. Additional narrative is provided in Appendix F, *Historical and Cultural Resources*.

[15] http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results; accessed 27 May 2015

Shipwreck Inventory. No known documented historic or modern shipwrecks are located within the study area. The nearest known historic shipwreck is over 19 miles from the study area. The nearest known modern shipwreck is over 12 miles away. Additional narrative is provided in Appendix D, *Historical and Cultural Resources.*

National Historic Preservation Act. In accordance with Section 106 and Section 101 of the National Historic Preservation Act, and 36 CFR 800.4, the Corps St. Louis District's tribal coordination efforts were initiated in a letter sent to 28 tribes dated 2 December 2014. A letter report was sent to the Illinois State Historic Preservation Officer (SHPO) on 17 October 2016. The District received a letter from the IL SHPO on 2 November 2016 with no objection to the proposed project (Appendix B, *Coordination*).

2.16 Socioeconomic Resources

Water-based activities dominate recreation use, with boating, boat fishing, hunting, and wildlife viewing being the most popular activities. The Piasa Harbor Marina is in close proximity to the study area. The majority of the recreating public is drawn from the immediate bordering counties, and most visits are day trips.

The study area is located in Jersey and Madison counties of Illinois. Jersey County has a population of 22,985 based on the 2010 U.S. Census Bureau estimate[16]. Based on the 2010 population estimate for Jersey County, 49% were male, 97% white, and 8.0% of all individuals have income in the past 12 months below the poverty level. Based on the 2012 American Community Survey, the median household income in Jersey County is $53,692 with an average household size of 2.51. The main industries providing employment in Jersey County include educational services and health care and social services (27.6% of workforce), retail trade (13.1% of workforce), and manufacturing (12.0% of workforce). The unemployment rate for Jersey County is 5.7% as of September 2016[17].

Madison County has a population of 269,282 based on the 2010 U.S. Census Bureau estimate (http://factfinder2.census.gov; accessed on 30 September 2016). Based on the 2010 population estimate for Madison County, 48.9% were male, 88.2% white, and 13.8% of all individuals have income in the past 12 months below the poverty level. Based on the 2012 American Community Survey, the median household income in Madison County is $52,756 with an average household size of 2.46. The main industries providing employment in Madison County include educational services, and health care and social assistance (22.5% of workforce), manufacturing (12.3% of workforce), and retail trade (11.5% of workforce). The unemployment rate for Madison County is 5.9% as of September 2016[18].

2.17 Aesthetic Resources

Aesthetic resources of the site consist primarily of natural habitat found within the study area. This includes forest, wetlands, islands, and river habitat that serve as scenery for visitors. Three cabins on Piasa Island, duck blinds, a marina, a public boat ramp, a golf course, Illinois State Highway 100, and a power plant on the Missouri bank detract somewhat from the natural views.

2.18 Noise Levels

Noise levels surrounding the study area are varied depending on the time of day and season. The current human activities causing elevated noise levels in the vicinity of the study area include cars, trucks, boats, a power plant, boat marina and public boat ramp, and a golf course. The sound of firearms during hunting season is also prevalent. Illinois State Highway 100 is immediately north of the

[16] Available online: http://factfinder2.census.gov; Accessed on 30 September 2016
[17] Available online: http://research.stlouisfed.org Accessed on 16 November 2016
[18] Available: http://research.stlouisfed.org Accessed 16 November 2016

study area. This highway is a national scenic byway that sees on average 5,100 vehicles per day near the study area[19].

A typical vehicle can produce 60-90 decibels (dB) at a distance of 50 feet (USEPA, 1974). A local marina and public boat ramp exist in close proximity to the study area introducing noise from recreational boat traffic. A pleasure boat's noise range can typically be between 65-115 dB (USEPA, 1974). Barge traffic is frequent in the main channel south of the study area. While the engine noise from the barge would be similar to the vehicle noise from Highway 100, infrequent horn blasts may be in excess of 120 dB at one foot. Several duck blinds surround the islands and are a source of noise during hunting season. The noise from a typical 12 gauge shotgun is 130 dB. All of these may contribute to noise levels within the study area.

2.19 Environmental Justice (Executive Order 12898)

Under this Executive Order, a Federal agency "shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States." The standard unit of analysis for environmental justice is the census-designated Block.

Piasa and Eagle's Nest Islands themselves are located within 3 census blocks, with a population of 0. Due to the rural nature of the area, the census block analysis was extended beyond the study area to include census block group 010300-3 of Jersey County (13.82 sq miles) and census block group 402722-1 of Madison County (5.50 sq miles). For Jersey County, the population (1,543) within the census tract is approximately 96% white with a median household income of $47,938. As of 2008-2012, the per capita income of Block Group 010300-3 is $25,231, which is lower than the state average of $29,519 and is lower than the national average of $28,051. For Madison County, the population (2,891) within the census block group 402722-1 is approximately 95% white with a median household income of $67,747. As of 2008-2012, the per capita income of the Census Tract 402722 is $38,901, which is higher than the state and national averages[20].

[19] Available: http://www.gettingaroundillinois.com Accessed 16 November 2016
[20] Available: https://www.usa.com Accessed 30 September 2016

3 Future Without Project Condition Scenario

Forecasting the future is an essential part of the Corps planning process with the most important recurring forecasts being the future without project condition (FWOP) and future with project condition (FWP) scenarios. The FWOP is the "most likely condition expected to exist in the future in the absence of a proposed water resources project" (ER 1105-2-100 p. 2-8). The FWOP and FWP scenarios include "an inventory and forecast of critical resources (physical, demographic, economic, social, etc.) relevant to the problems and opportunities under consideration in the planning area" (ER 1105-2-100, p. 2-3). A major purpose of the FWOP scenario is "to identify the uncertainty that is most relevant for solving problems" and can be defined as a story we tell about the future if the planning partnership takes no action (Yoe, 2012). The No Action Alternative would not include any Corps project measures and no additional costs to the Corps would be generated.

The period of analysis was limited to 50-years in accordance with Corps Regulations (ER 1105-2-100, p. 2-11), even though project measures are anticipated to continue having beneficial effects beyond 50 years. The base year of 2025 was used and the period of analysis continued until 2075.

Assumptions are one of the most common ways to address uncertainty in a planning study. Several assumptions have been made in forecasting the FWOP scenario:

1) Water levels in Pool 26 would continue to be managed through Environmental Pool Management as they are now.
2) Corps, IDNR, or other stakeholders would not take actions in the future to solve the problem(s) as identified by the proposed Piasa and Eagle's Nest Islands HREP.
3) Corps would continue to provide wildlife and vegetation management within the study area as they do now on Piasa & Eagles Nest Islands.
4) IDNR would continue to manage fish and wildlife in and on the waters in the study area as they do now.
5) The navigation channel would be maintained in its current location.
6) No substantial increases to current operation and maintenance budget for the site would occur.
7) The Piasa Island Backwater would continue to lose depth and be disconnected from the Mississippi River.
8) The aquatic habitat within Piasa Chute would continue to degrade with sedimentation and reduced flow.
9) Sediment delivery from outside the study area would continue.

3.1 Sedimentation

Based on previous sedimentation rate calculations for Pool 26 (GREAT III, 1982) and for a backwater at RM 206-209 (Simons, Simons, Ghaboosi, & Chen, 1988), as well as aerial imagery analyses (Figure 3-1), the Corps Project Delivery Team assumed that areas currently less than 2 feet in depth within Piasa Island Backwater would convert to land by year 50, which equates to 37% loss of the existing backwater. The team decided this estimate better portrayed the existing and future conditions of the site since the 0.5 inches of sedimentation per year estimate (GREAT III, 1982) would have resulted in the entire backwater being gone by year 60; this seemed unreasonable since the backwater surface area has persisted since 1971, even though it has lost depth (Figure 3-1).

To determine sedimentation rate for Piasa Chute, the St. Louis District performed an ISOPACH analysis comparing 2006 to 2013 hydrographic surveys within Piasa Chute. This analysis calculates the net gain or loss by comparing two surveys taking into account water elevations. Figure 3-2 shows that within

Piasa Chute, there was a net gain of approximately 250,000 cubic yards of material with an average sedimentation rate of 0.14 feet per year during this time frame. If sedimentation rates of 0.14 feet per year continue over the 50-year period of analysis, then accumulation of as much as 7 feet may occur within Piasa Chute, resulting in complete loss of habitat value. Since side channel habitat has been an identified habitat need for Pool 26, losing Piasa Chute would be detrimental to the overall goal of restoring and enhancing side channel habitat to promote a healthy and resilient aquatic ecosystem.

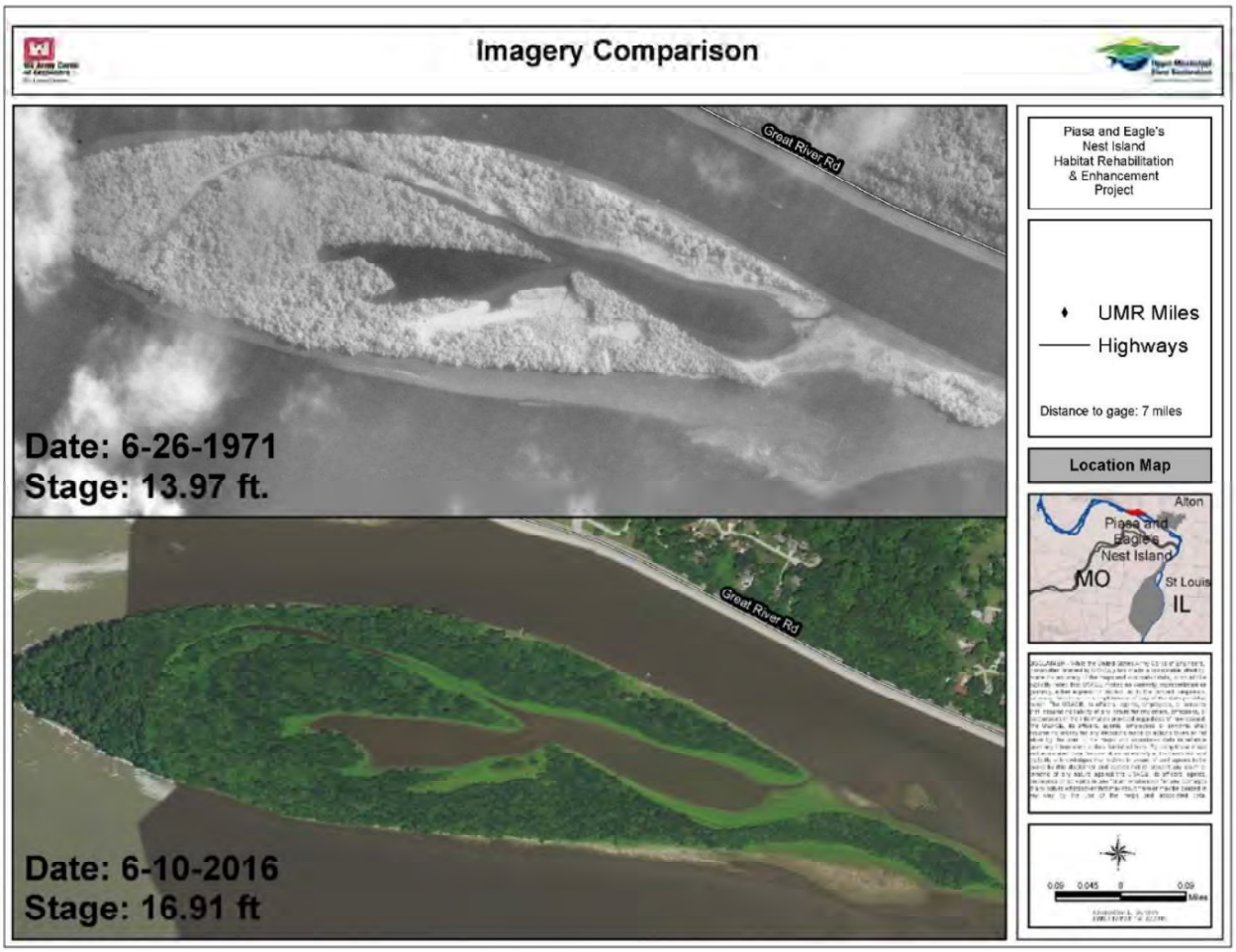


Figure 3-1. Aerial images of Piasa Island backwater from 1971 (top) and 2016 (bottom)

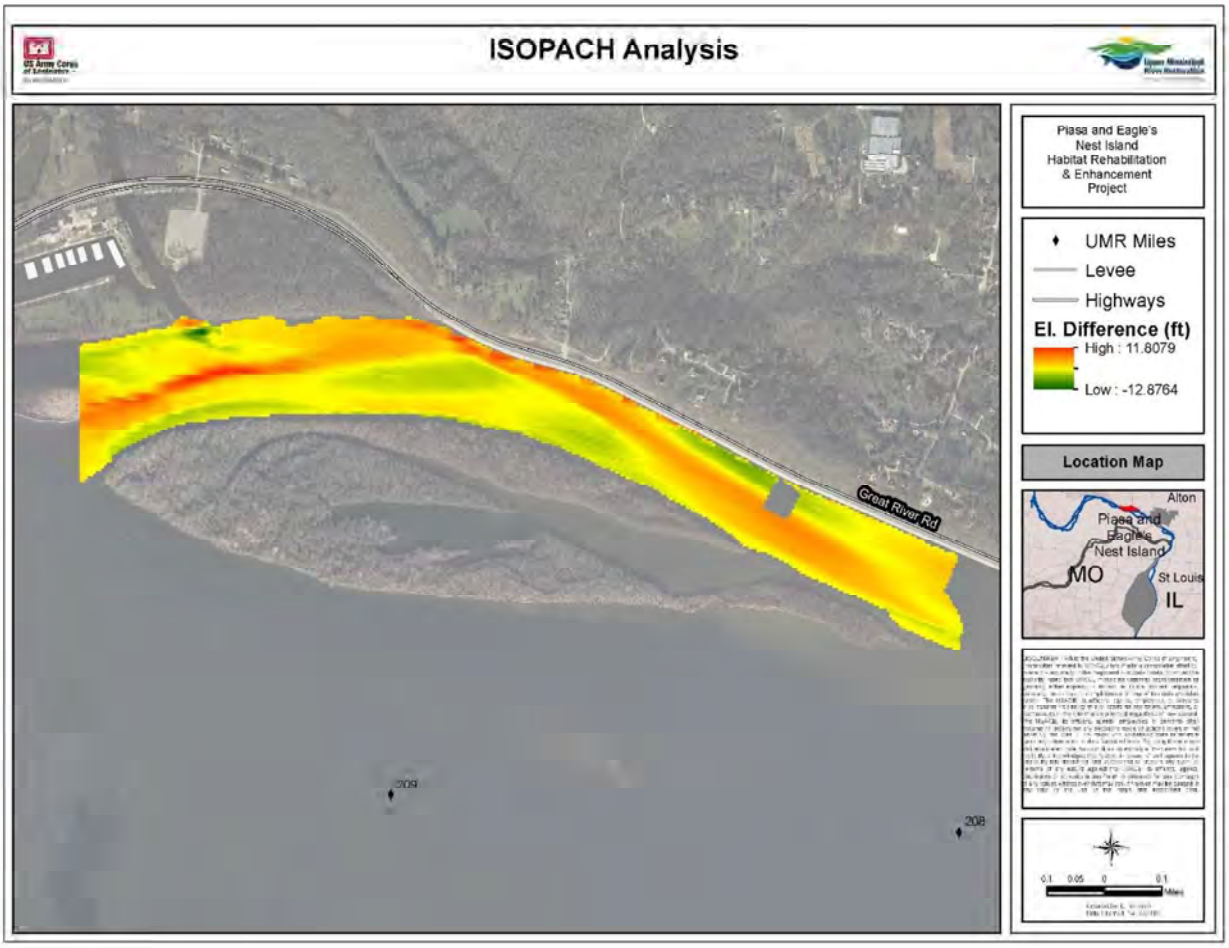


Figure 3-2. Isopach analysis comparing 2006 to 2013. Net gain of 247,265 cubic yards of material. Average sedimentation rate of 0.14 feet per year during this time. Warm colors illustrate accumulation of material (in feet), yellow shows no change, and green colors illustrate loss of material (in feet).

3.2 Aquatic Habitat

The future without project conditions for aquatic habitats discussed below are projections based on best available scientific and engineering data.

3.2.1 Backwater Habitat

Future conditions of various aquatic habitat types were predicted through the *Cumulative Effects Study of the Mississippi River* (West Consultants Inc, 2000). Contiguous backwater habitat and isolated backwater habitat in Lower Pool 26 were forecasted to decrease by 20% and 47%, respectively, by year 2050 (West Consultants Inc, 2000).

Under the previously described sedimentation rates, it is anticipated that the Piasa Island Backwater would continue to lose depth due to sedimentation. Utilizing the UMRR-LTRM data from 1993 to 2013, the average depth of the backwater is 1.25 to 3.5 feet. In the vicinity of the study area (Brickhouse Slough (RM 206-209, Missouri)), sedimentation rates have been estimated to be about 0.5 inches per year. Applying this sedimentation rate to Piasa Island Backwater would suggest this backwater would fill in completely in approximately 60 years; however, the Project Delivery Team did not concur with this forecasting of future without project conditions based on aerial imagery analysis of the study area. The

team assumed that areas currently less than 2 feet in depth would convert to land by year 50, which equates to a 37% loss of existing backwater.

Rearing and foraging habitat currently provided by the interior Piasa Island Backwater would be substantially reduced due to restricted access during average flows. The entrance of the backwater is expected to fill in and become disconnected from the Mississippi River during average flows. Consequently, summer habitat would either shift to another backwater complex or other side channel complex, if available, in Pool 26. Finally, overwintering habitat (areas with depths > 5 feet) would be reduced to zero within the next 50 years.

3.2.2 Side Channel Habitat

Based on UMRR-LTRM strata classes, the study area contains 562 acres of side channel habitat. Based on hydrographic surveys, the average depth is approximately 8.6 feet; however, there are large portions of the side channel that are shallow (< 5 feet) corresponding to elevations of 415.12 ft NAVD 88 and above (Plates 4, 5 and 6). Based on the ISOPACH analysis, the chute lost an average of 0.14 ft/year between 2006 and 2013. This sedimentation rate was used in forecasting the loss of depth during the period of analysis (2025-2075). During this 50 year period of analysis, Piasa Chute would be approximately 1.6 feet without the project. At this depth, along with subsequent forecasted changes to dissolved oxygen concentrations, water temperature, and velocities, the side channel habitat within Piasa Chute (562 acres) would be reduced to zero within the next 50 years.

3.2.3 Island Habitat

From 1890 to 2010, island habitat (based on land cover data) within the study area has been reduced by approximately 60% due to the conversion to open water as result of going to pool from locks and dam construction (Figure 2-10). Currently, Piasa Island is approximately 115 acres and Eagle's Nest Islands is 68 acres. The historic islands that once occurred within the study area are completely submerged as a result of locks and dam construction. Without the proposed project, it is expected this sand bar habitat would be available similar to what it is currently and dependent on pool water level management which is expected to continue to be operated in a similar fashion into the future. It is also anticipated that without the proposed project, the historic islands that once occurred within the study area would continue to be submerged and provide no habitat value for migratory wildlife, including the federally listed interior least tern.

4 Problems and Opportunities *

Chapter 4 identifies the Piasa and Eagle's Nest Islands study area resource problems and opportunities, specific objectives and constraints. The problem statements are concise characterizations of the broad issues that will be addressed with the study area. Following the problem statements, an array of opportunities are presented. Opportunities can be directly related to solving the problem at hand, but can also be ancillary to the identified problem. From the list of problems and opportunities, objectives for the study are drafted and study specific constraints are identified. The success of project planning is determined by the fulfillment of the objectives through identified alternatives.

Human activity over the past two centuries within the UMRS has altered hydrology, topography, and biotic communities historically present within the study area. These alterations have degraded aquatic resources (i.e., side channel and backwater), reduced island habitat, impaired ecosystem functions, and threatened the future sustainability of the river-floodplain ecosystem.

4.1 Conceptual Model

Development of a conceptual model aided the identification of resource problems, stressors, and illustrates the interactions amongst drivers (i.e., climate, flood/drought cycles, and land use), primary stressors (lock and dam operation and sedimentation), essential ecosystem characteristics, and potential management actions (Figure 4-1).

Essential ecosystem characteristics (EEC) are broadly defined categories of environmental features, are critical for sustaining ecological systems, and are valued by stakeholder interests (Nestler, Galat, & Hrabik, 2011). Five EECs have been identified for the UMRS: Geomorphology, Hydrology and Hydraulics, Biogeochemistry, Habitat, and Biota (Lubinski & Barko, 2003). The primary stressors for the study area are past and present lock and dam operation and river-borne sedimentation. Past and present lock and dam operation has directly impacted the Hydrology and Hydraulics and Habitat EECs though modified flow and connectivity and direct inundation of island habitat. The changes in hydrology, hydraulics and habitat then impact geomorphology (e.g., altering the bathymetry and sediment movement), biogeochemistry (e.g., dissolved oxygen and turbidity), and biota (e.g., fish, mussels, and migratory wildlife). Sedimentation directly impacts the Geomorphology, Hydrology and Hydraulics, and Habitat EECs by altering the connectivity, depths and velocities within the aquatic habitats which then affect the biogeochemistry and biota. The potential project measures were then identified to show how they interact with the various EECs.

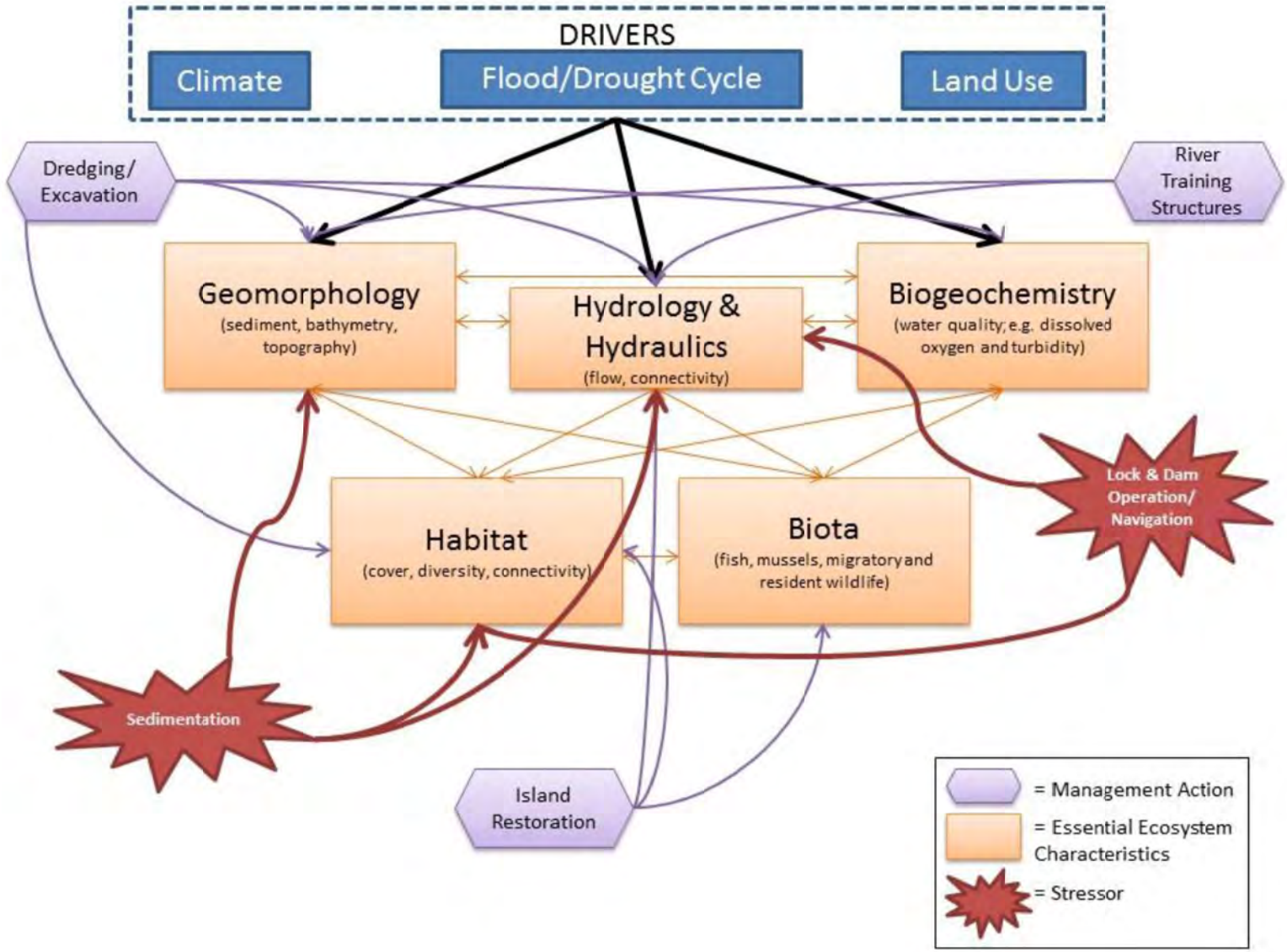


Figure 4-1. Conceptual Model for Piasa-Eagle's Nest HREP

4.2 Problems

Human-induced physical modifications of the UMRS began as early as 1832 with removal of woody snags to facilitate steamboat travel (Burke, Robinson, & Swanson, 1979). In 1913 the first lock and dam on the Mississippi River was built near Keokuk, Iowa. In 1933, the U.S. Army Corps of Engineers began construction of a lock and dam near Rock Island, Illinois. Since then, a total of 27 locks and dams have been built on the Upper Mississippi River. Lock and dam construction had the greatest effect in the lower half of each navigation pool (which is the reach of river between two dams) where the floodplain was inundated by the increased water surface elevation. Inundation caused an immediate change in the land-water distribution followed by a long-term change that included the gradual loss of land (e.g., islands). The physical changes created by lock and dam construction produced a significant change in the biological community in the lower reaches of the navigation pools. The original floodplain, which consisted of floodplain forest, wetlands, and isolated lakes, was converted into a large permanently submerged aquatic system that is often categorized as impounded. Impounded areas are generally characterized by large wind fetch, detectable water velocities, and few to no islands (USACE, 2012). Since impoundment, the patterns of river habitats have been greatly modified due to sedimentation of backwaters, island loss, and loss of side channels (Theiling, et al., 2000).

Specifically for Piasa and Eagle's Nest Islands HREP, the following problems and opportunities have been identified:

Problem 1: Loss of depth and flow in Piasa Chute. Side channel habitat is an important component of the UMRS. This type of habitat has declined due to the leveling effects of sedimentation, reduced sediment transport in off-channel areas, and reduced connectivity to the main channel during low river stages (USACE, 2001; Theiling, et al., 2000; Simons, Stevens, Lagasse, & Schumm, 1975) causing a degradation of aquatic habitat and geomorphic processes which are negatively affecting fishes and other aquatic assemblages. Within the study area, the side channel habitat has decreased in depth and flow resulting in degraded aquatic habitat.

Problem 2: Loss of backwater habitat. Backwater fisheries habitat is an important component of the Mississippi River ecosystem. Backwater habitat has declined in most of the UMRS due to the leveling effects of sedimentation related to the modifications of river hydrology (Gutreuter & Theiling, 1999). Many fishes that depend on lake-like backwaters (e.g., crappie and other sunfish) are an important ecological component of the UMRS; however, these species may be limited by the availability of suitable backwater habitat (Gutreuter & Theiling, Fishes, 1999). Within the proposed study area, the backwater located within Piasa Island has decreased in depth resulting in loss of connectivity with the main channel during most of the year. Fishes have restricted movement within the interior backwater since it has silted in and is experiencing woody vegetation encroachment (e.g., willows and cottonwoods). The entrance into the backwater is impeded due to sediment deposition limiting year-round fish movement between the main channel and the backwater. In addition, the fluctuations in water levels due to lock and dam operation may strand fish nests or expose small fish to predators, or in winter, eliminate temperature refuges (Gutreuter & Theiling, 1999).

Problem 3: Loss of diverse island mosaic. Habitat complexity and diversity afforded by island mosaics in the UMRS are highly valuable and have been declining. The habitat provided by island mosaics comprised of low flow sand bars, forested islands, and non-forested islands function to provide flow refugia critical to fish for foraging and nursery habitat, and resting habitat for migratory fish and wildlife species. Islands provide physical complexity across the floodplain-river ecotone; however, island habitat has been lost within the UMRS related to lock and dam construction. The reservoir-like impoundments of some navigation pools have led to island loss due to wind and wave erosion and direct inundation

(Gutreuter & Theiling, 1999). The study area is located in the lower portion of Pool 26; therefore, the physical changes related to lock and dam construction have led to island loss due primarily to inundation. Prior to lock and dam construction several smaller islands (e.g., "Little Piasa Island", "Sunflower Island", and other smaller unnamed islands) were present on the main channel side of Piasa and Eagle's Nest Islands (See Figure 2-3; Appendix D, *Historical and Cultural Resources*). Based on the land cover maps from 1890 to 2010 approximately 60% of the island habitat has been lost from the study area (Figure 2-10).

4.3 Opportunities

Opportunities exist to restore side channel, backwater, and island habitat, function, and process. Within the study area, there are opportunities for additional beneficial actions beyond solving the stated problems related to side channel, backwater, and island habitats.

Although not the primary focus of the study, there are opportunities of ancillary benefits[21]:

- Increase Public Use
    - Recreational boating
    - Recreation fishing and hunting
    - Photography
    - Environmental interpretation and education
- Potential navigation benefits due to increased flows (See Appendix C, *Hydrology & Hydraulics*).

4.4 Goals and Objectives

4.4.1 Overarching UMRR Program Mission and Vision

The UMRR program vision and mission statements were integral components of the strategic planning efforts of an interagency UMRR Coordinating Committee's efforts. The strategic plan sets a clear direction for the program in federal fiscal years 2015 to 2025. The overarching program mission is *to work within a partnership among federal agencies, state agencies, and other organizations; to construct high-performing habitat restoration projects; to produce state-of-the-art knowledge through monitoring, research, and assessment; and to engage other organizations to accomplish the Upper Mississippi River Restoration Program's vision.* The overarching program vision is as follows:

A healthier and more resilient Upper Mississippi River ecosystem that sustains the river's multiple uses.

4.4.2 Upper Mississippi River System (UMRS) Ecosystem Goals

The goal and vision statement imply conserving the UMRS's remaining structure and function while restoring the degraded components to realize a sustainable UMRS. Five system-wide objectives have been identified (Galat , et al., 2007) to:

- Manage for a more natural hydrologic regime
- Manage for processes that shape a physically diverse and dynamic river-floodplain system
- Manage for processes that input, transport, assimilate, and output material within the UMR basin river-floodplains
- Manage for a diverse and dynamic pattern of habitats to support native biota
- Manage for viable populations of native species within diverse plant and animal communities

[21] Ancillary opportunities are identified but are not formulated to or included as screening criteria for alternative selection. Ancillary benefits will still be realized, but per Corps Guidance (1105-2-100) are not included.

4.4.3 UMRR Reach Objectives

Reach planning for the UMRS was undertaken to support an anticipated $100 million per year ecosystem restoration program authorized in WRDA 2007, but it was subsequently expanded to apply to all UMRS ecosystem restoration programs, including the UMRR. Reach planning relied on state and federal partners to refine ecosystem restoration objectives based on the longitudinal differences that exist over the 1,100 river miles of the UMRS (USACE, 2009). The UMRS was divided into four floodplain reaches to identify reach specific objectives in order to maximize the benefits of individual projects within a given reach. The study area is located within the Lower Impounded Reach and was identified as a high priority ecosystem restoration subarea within the reach. Of the fourteen reach objectives identified for the Lower Impounded Reach, the geomorphology objective of "restoring hydro-geomorphic processes that create, maintain, and improve bathymetric diversity, islands, sandbars, shoals, and mudflats" relates directly to the proposed project at Piasa and Eagle's Nest Islands.

4.5 Study Goal and Objectives

The overarching UMRR program goal and reach objectives, the conceptual model, as well as input from state and federal agency natural resource managers and interested stakeholders, were used to guide the development of the Piasa and Eagle's Nest Islands study goal and objectives.

4.5.1 Study Goal

To restore and improve the quality and diversity of aquatic and island ecosystem resources within the study area

4.5.2 Study Objectives

Based on the study goal, specific study objectives were established and are listed below. These objectives are interrelated and together will assist in meeting the overall study goal. The guidance for developing study objectives is provided in Corps planning guidance ER 11-5-2-100 and specifies that objectives must be clearly defined, must provide information on the effect desired, and must include the subject of the objective, the location where the effect will occur and the timing and duration of the effect. For the purpose of the Feasibility Report, the location for all objectives is generally defined as the study area. The timing and duration of the objectives is assumed to be the 50-year period of analysis. The objectives for the Piasa and Eagle's Nest Islands HREP are as follows:

1. Increase aquatic side channel habitat with depth and flow diversity
2. Increase connected backwater habitat with depth diversity for enhanced backwater fisheries habitat benefits
3. Restore diverse island mosaic

The relationship between objectives and the performance evaluation criteria of that objective is summarized in Table 4-1. It should be noted that not all criteria must be met in order to achieve the objective; the criteria are indicators of ideal conditions.

Table 4-1. Piasa and Eagle's Nest Islands Objectives and Performance Criteria

Objective	Performance Criteria[2]	Rationale
1. Increase aquatic side channel habitat with depth and flow diversity	• Increased bathymetric diversity within Piasa Chute, as measured in acres deeper than 8 feet • Increased velocity[1] within Piasa Chute • Increased abundance of lotic species within study area • Reduced sediment deposition within Piasa Chute • Maintain and or improve existing mussel beds	The performance criteria described are meant to provide bathymetric and velocity diversity within Piasa Chute. Increased velocities are expected to reduce sediment deposition and improve fish usage by more lotic species while not negatively affecting the existing mussel beds in the study area.
2. Increase connected backwater habitat with depth diversity for enhanced backwater fisheries habitat benefits	• Increased fish abundance of backwater/slack water species within Piasa Island Backwater • Increased access to Piasa Island Backwater as measured by % year connected • Increased bathymetric diversity within Piasa Island Backwater, as measured in acres deeper than 5 feet • Improved dissolved oxygen within Piasa Island Backwater	The performance criteria described are meant to provide high quality backwater fisheries habitat by improving depth, temperature, dissolved oxygen, and connectivity with the Mississippi River.
3. Restore diverse island mosaic	• Increase acres of island habitat and percent wetted perimeter over existing conditions	This performance criterion described is meant to restore island habitat that historically occurred within the study area.

[1]Existing velocity is 1-2 ft/sec. Model outputs suggest post-project velocity could double to 2-3 ft/sec.

[2]See Monitoring and Adaptive Management Appendix for more detail.

4.6 Planning Constraints

A constraint is a restriction that limits the extent of the planning process for a particular study. It should focus on things that alternative plans should try to avoid. All studies have common constraints, including the following:

1. *Laws and Regulations* **–** Measures would be designed and constructed to be consistent with Federal, state, and local laws.
2. *Impacts to Cultural Resources* - Measures would not detrimentally affect historical and archaeological sites located within the study area.
3. *Flood Heights* - Restoration measures should not detrimentally increase flood heights or adversely affect private property or infrastructure.
4. *Aesthetics* – Measures should be designed to minimize negative impacts to aesthetics.
5. *Invasive Species* – Measures should be designed to minimize the spread and introduction of invasive species to and transfer from the study area.

In addition to those standard constraints, for this study area, the team identified the following study-specific constraints:

1. *Navigation* - Ensure measures do not negatively impact 9-foot navigation channel.
2. Avoid or minimize impacts to recreation.
3. Avoid impacts to adjacent landowners.

5 Considered Management Measures & Screening Criteria*

5.1 Measure Development & Screening

A management measure is a feature (a structural element that requires construction or assembly on-site) or an activity (a nonstructural action) that can be combined with other management measures to form alternative plans. Management measures were developed to address study area problems and to capitalize upon opportunities. Several measures were discussed during scoping, meetings with state and federal resources agencies, meetings with nongovernmental organizations, meetings with the project partner, and the Corps Project Delivery Team (PDT). A Hydraulic Sediment Response (HSR) model and Adaptive Hydraulics (AdH) Model were used to determine placement and configuration of proposed measures. Not all measures were moved forward, and some were eliminated from further consideration based on the screening criteria developed by the PDT as well as results from the models. The potential measures were initially screened based on their contribution to the study's goal and objectives, engineering considerations, local restrictions, and planning constraints. Symbols (e.g., D1, B1, I1, and R1) have been assigned to the measures retained for further evaluation to aide in the documentation of the planning process.

The following sections briefly discuss management measures that were considered during scoping. Table 5-1 summarizes the study goal, objectives, potential restoration measures, and how they link back to resource significance. Measures retained (Table 5-2) were combined into differentiated alternatives to reasonably maximize benefits (See Chapter 6, Alternative Plans). The following screening criteria were used to determine which management measures were retained and formulated into alternatives:

- Meets at least one study objective
- No negative effects to navigation
- Acceptable level of flow change over known mussel beds
- H&H model(s) results

Acres and/or distances were measured using ESRI ArcGIS software or surveyed data. Average depths and/or elevations were obtained by hydrographic surveys (Corps, St. Louis District) and LiDAR data. Shear stress and flow data were obtained from the Adaptive Hydraulics (AdH) numerical model using Surface Water Modeling Software (SMS). Estimates on quantities will be refined as the PDT proceeds with the analysis.

	OPPORTUNITIES	GOAL	OBJECTIVES	ALL POTENTIAL MEASURES CONSIDERED	SI
	Restore side channel to improve habitat conditions for a large variety of riverine fish species	To restore and improve the quality and diversity of aquatic and island ecosystem resources within the study area	Increase aquatic side channel habitat with depth and flow diversity	River training structures Dredging Woody structure	Enhancing the aq area would contri nationally signific commercial navig Significance).
	Restore connectivity to improve habitat conditions for a variety of riverine species requiring backwater habitat to complete important life history stages		Increase connected backwater habitat with depth diversity for enhanced fisheries habitat benefits	Dredging River Training Structures Moist Soil Management	Restoring the aqu fish and wildlife w fish, hunt, bird wa the restored area
	Restore historic islands within the study area to increase ecosystem structure and function		Restore diverse island mosaic	Revetment Bullnose chevron dike on head of islands Rock structures to restore historic islands Placement of excavated material to restore sandbar islands	Restoring sand ba migratory wildlife Least Tern, a fede (Technical Signific

ts suggest post-project velocity could double to 2-3 ft/sec.

	Considered Management Measure	Screening Criteria				
		Obj 1	Obj 2	Obj 3	No negative effects to navigation[1]	Acceptable level of flow change over known mussel beds[2]
	200-ft single dredge cut	X		X	X	Yes
	300-ft single dredge cut	X		X	X	Yes
	200-ft braided dredge cut	X		X	X	Yes
	300-ft braided dredge cut	X		X	X	Yes
ty	Minimum backwater dredging		X	X	X	Yes
	Maximum backwater dredging		X	X	X	Yes
	Three Islands			X	X	Yes
	Riverside Island			X	X	Yes
	Upstream Rootless Islands			X	X	Yes
	Upstream Rooted Island			X	X	Yes
	Eagle's Nest Protection			X	X	Yes
	Piasa Island Protection			X	X	NO
	Notch existing dikes	X				Yes
	Construct traditional dike, trail dike, SCED, chevron, weir, or combination thereof	X			X	Yes
	Construct sediment diversion structure	X				Yes
	Construct rock structure between islands	X				NO
	Construct notched rock structure between islands	X			X	Yes
	Construct Closing Structure		X			NO
	Convert Piasa Island Backwater to Moist Soil Management Unit				X	Yes
	Wood Pile Dikes	X			X	Yes
	Woody Bundles	X			X	Yes
	Best Management Practices				X	Yes
	Education and Outreach				X	Yes
	Water Level Management	X		X		Yes

iscussion with navigation industry and river engineers
0K cfs and discussion with natural resource partners, including mussel experts. The team deci ded what changes were at an acceptable level of risk. To reduce the level of uncertainty on impacts to
is study. If monitoring demonstrates a significant change (based on malacologist subject matt er expertise), then adaptive management features would be implemented.
ncrease or decrease of discharge through Piasa Chute

5.2 Piasa Chute Aquatic Diversity

Excavation has been proposed as a potential measure to provide suitable year-round habitat for fish. Excavation would also provide material required to increase island diversity within the study area, which is necessary to meet the study goal and objectives. Dredging would be required to restore aquatic diversity within Piasa Chute. Several dredging options and configurations within Piasa Chute were evaluated. Material removed from Piasa Chute would be hydraulically or mechanically dredged, or both, depending on contractor's equipment utilized for the proposed study area. Regardless of the dredging method selected, the removed material from Piasa Chute would be beneficially reused to construct the island restoration measures.

5.2.1 Types of Dredging

5.2.1.1 Hydraulic Dredging

Hydraulic dredging equipment would consist of a cutterhead dredge, along with pontoon or plastic pipeline to transport the excavated dredge material in the form of a slurry (Figure 5-1).

5.2.1.2 Mechanical Dredging

Mechanical dredging equipment would consist of a crane with clamshell bucket or a barge mounted excavator along with deck barges to transport the excavated dredge material in a more solid or cohesive condition (Figure 5-2).

Figure 5-1. Example of hydraulic cutterhead dredge and pontoon pipeline

5.2.2 Dredging Configurations

Within Piasa Chute, based on the hydraulic modeling outputs, four dredging configurations were evaluated to provide aquatic diversity and sufficient material to restore islands within the study area. Detailed results of the hydraulic modeling outputs are not provided here. For detailed discussion of how proposed configurations responded see Appendix C, *Hydrology and Hydraulics.* Each proposed configuration included a dredge cut depth to 10 feet below minimum pool (415.12 ft NAVD 88) which was selected to achieve an additional 5-6 feet of depth and flow within Piasa Chute. The considered dredge widths were selected based on standard dredging practice. Material excavated would be

transported to the island restoration sites. The Piasa Chute dredge cut configurations evaluated included:

Figure 5-2. Example of barge mounted excavator

5.2.2.1 200 foot Single Piasa Chute Dredge Cut

This measure consisted of a single dredge cut 200 ft wide through Piasa Chute. Our analysis compared different configurations to increase flow and minimize the risk of the side channel filling in the future. Based on the AdH models this configuration was ineffective at meeting objectives and therefore, not retained for detailed evaluation.

5.2.2.2 300 foot Single Piasa Chute Dredge Cut

This measure consisted of a single dredge cut 300 ft wide through Piasa Chute. Our analysis compared different configurations to increase flow and minimize the risk of the side channel filling in the future. Based on the AdH models this configuration was ineffective at meeting objectives and therefore, not retained for detailed evaluation.

5.2.2.3 200 foot Braided Piasa Chute Dredge Cut (D1)

This measure (D1) consisted of a braided channel dredge cut near Piasa Creek and a 200 foot wide dredge cut through Piasa Chute. This configuration took into account the potential effects from Piasa Creek and provides more opportunities to restore islands within the study area. Based on the AdH model results, this configuration did increase flow within Piasa Chute with minimal impact to overall flow entering the study area. Approximately 885,000 CY of material would be removed and transported within the study area to restore islands (I1). This measure was retained for detailed evaluation.

5.2.2.4 300 foot Braided Piasa Chute Dredge Cut (D2)

This measure (D2) consisted of a braided channel dredge cut near Piasa Creek and a 300 foot wide dredge cut through Piasa Chute. This configuration took into account the potential effects from Piasa Creek and provides more opportunities to restore islands within the study area. Based on the AdH model results, this configuration increased flow within Piasa Chute with minimal impact to overall flow entering the study area. Approximately 1,127,000 CY of material would be removed and transported within the study area to restore islands (I1). This measure was retained for detailed evaluation.

5.3 Piasa Island Backwater Connectivity

Excavation has been proposed as a potential measure to increase connectivity and to provide suitable year-round habitat for fish, which includes critical overwintering habitat for fish species. Excavation

would also provide material required to increase island diversity within the study area, which is necessary to meet the study goal and objectives. Dredging would be required to restore aquatic diversity within Piasa Island Backwater. This would be accomplished through the direct act of dredging (hydraulic, mechanical, or both). Two different configurations were evaluated:

5.3.1 Minimum Backwater Dredging (B1)

This measure (B1) consisted of dredging and/or mechanically excavating the entrance of Piasa Island Backwater to improve connectivity of the backwater to the river, increase depth, and minimize impacts to existing vegetation. Approximately 156,000 CY of material would be removed. This measure was retained for detailed evaluation.

5.3.2 Maximum Backwater Dredging (B2)

This measure (B2) consisted of dredging and/or mechanically excavating Piasa Island Backwater to improve connectivity of the backwater to the river and increase depth. The backwater would be dredged to 10 feet. Approximately 311,000 CY of material would be removed. This measure was retained for detailed evaluation.

5.4 Island Restoration

Island restoration has been proposed to increase island acreage and diversity within the study area. All proposed island locations included placement of rock to reinforce the material, shape, and location of the newly constructed islands. The material dredged from Piasa Chute and Piasa Island Backwater would be used to build the islands. Islands would be built to 420.57 feet, which is the prevailing height of Piasa Island. Several locations for islands were evaluated in the AdH model and locations were selected based on low shear stress and historic island locations (See Appendix C, *Hydraulics and Hydrology*). The following options were evaluated:

5.4.1 Three Islands, Riverside Piasa Island, and Upstream Rootless Island (I1)

This measure (I1) would restore island diversity within the study area in three areas: Three Islands, Riverside Piasa Island, and Upstream Rootless Island (Figure 5-3). Three Islands involves enhancing the existing three small islands that are exposed during pool drawdown within Piasa Chute. Riverside Piasa Island would restore the historic island that once existed on the riverside of Piasa Island. Upstream Rootless Island would be restored and would serve as a sediment trap and reduce sediment entering the study area. All dredged material from Piasa Chute and Piasa Island Backwater would be used to restore these islands, and all three locations would be required. Refer to Table 5-3 for more details. This measure was retained for detailed evaluation.

Table 5-3. Island Restoration Details

	Quantity			
Item	Three Islands	Riverside Piasa Island	Upstream Rootless Island	**Unit**
Dredged Material	177,000	631,000	233,000	CY
Island Diversity	26	43	8	AC
Stone Protection	60,700	29,900	56,000	TN

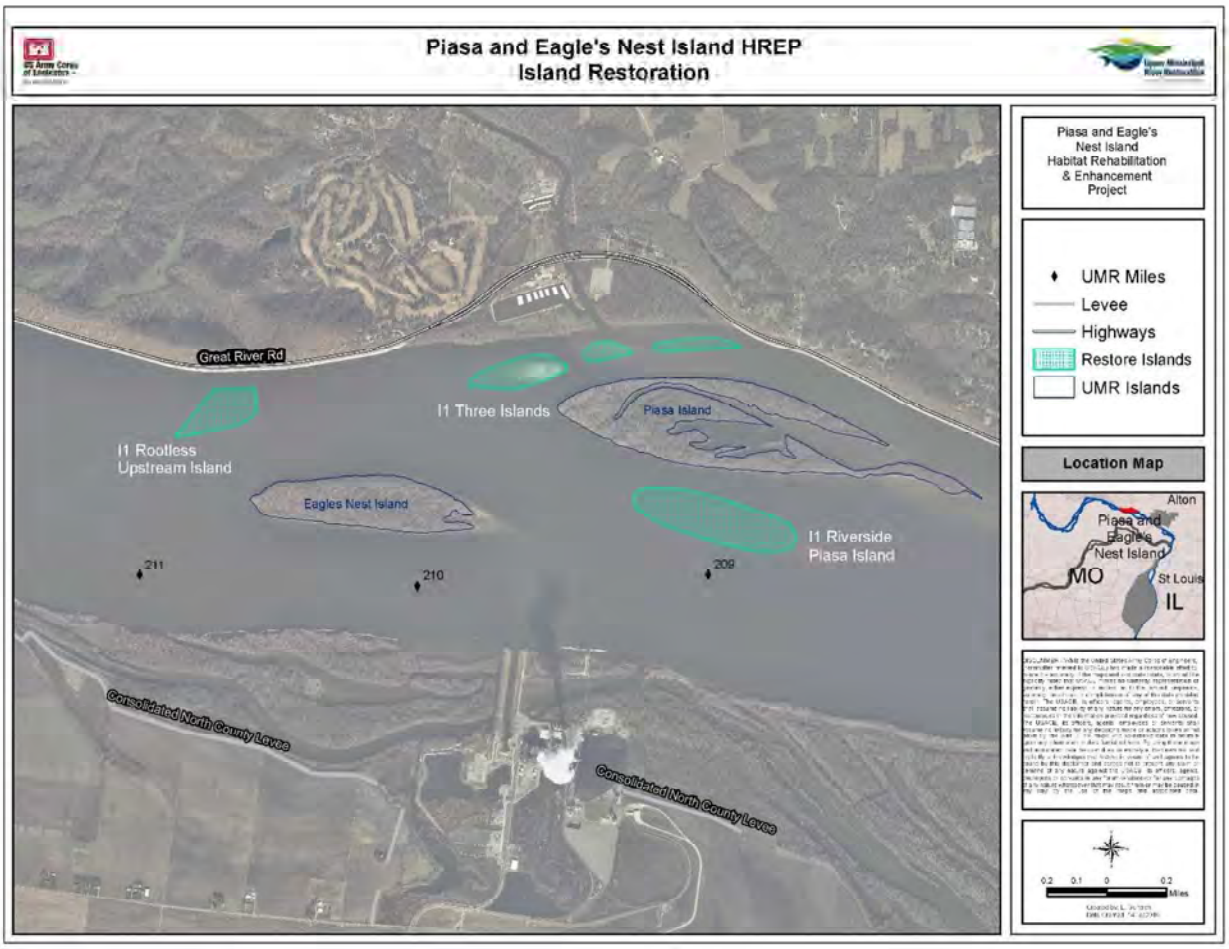


Figure 5-3. Location of proposed island diversity measures

5.4.2 Upstream Rooted Island

In lieu of the Upstream Rootless Island, as described in Section 5.4.1, another design was considered at a similar location. The Upstream Rooted Island differed by instead of leaving a small channel between the Illinois bank and the island, the island would be tied directly to the Illinois bank. This measure considered placing stone along the existing large depositional area and enhancing it as sandbar habitat using the dredged material. Upon further evaluation with the AdH model, this measure was not retained for detailed evaluation since it did not meet study objectives.

5.4.3 Eagle's Nest Island Protection

Various river training structures and revetment configurations were evaluated using the HSR model (See Appendix C, *Hydrology & Hydraulics*). However, during additional inventory of existing conditions and HSR model development, the perceived problem of erosion on Eagle's Nest Island was determined to be no longer a problem based on the additional data collection. Therefore, no measures were retained for detailed evaluation.

5.5 River Training Structures

River training structures have been proposed to improve aquatic habitat by modifying the flow and sediment response of the river. River training structures are generally constructed with rock. Chapter 7 of *Upper Mississippi River Restoration Environmental Design Handbook* (USACE, 2012) provides an overview of typical river training and side channel enhancement structure designs that have been used by the Corps. The following is just an overview of the types of river training structures that were evaluated through the HSR and AdH Models. For additional information see Appendix C, *Hydrology & Hydraulics)*.

Example of notched dikes (Mile 100 Islands)

Dike Notches: This measure would be accomplished by notching (i.e., removing) material in a particular location within an existing dike to increase flow diversity within the study area. Upon additional hydrographic surveys and HSR model outputs and limited opportunities to notch existing dikes, this measure was not retained for detailed evaluation because it did not meet study objectives.

Traditional Dike: Dikes, sometimes referred to as spur dikes, are structures placed in a river to redirect the river's own energy to provide a variety of effects. This measure would be accomplished by constructing a new dike to divert flow and promote sediment deposition along the islands. Upon further evaluation with the HSR and AdH Models, this measure was not retained for detailed evaluation because it did not meet study objectives.

Example of trail dike (RM 181.7L)

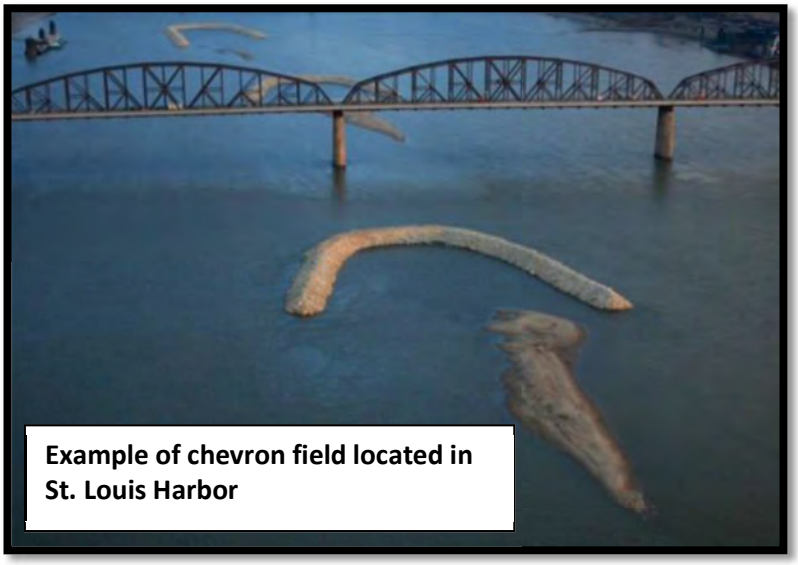
Trail Dike: This feature would be accomplished by constructing a trail dike off the end of a traditional dike parallel to the river flow. The purpose of this structure would be to encourage sediment deposition from the downstream end of the island along the trail dike while still maintaining flow in the main channel. Upon further evaluation with the HSR and AdH Models, this measure was not retained for detailed evaluation because it did not meet study objectives.

Side Channel Enhancement Dike (SCED): This feature captures additional flow into a side channel by the placement of an upstream angled structure at the entrance to the side channel. Upon further evaluation with the HSR and AdH Models, this measure was not retained for detailed evaluation because it did not meet study objectives.

Hard Points: Hard points are very short rock dikes that are used to stabilize side channel or slough banklines. These short dikes do not cause a significant buildup of sediment but do create scour holes and help reduce erosion by keeping flows directly off of the bankline. Upon further evaluation with the HSR and AdH Models, this measure was not retained for detailed evaluation because it did not meet study objectives.

Example of hard points at Duck Island (RM 195.3R)

Chevron: Chevrons are used to direct flow into the side channel and increase bathymetric diversity (i.e., scour holes and sand bar formation). In general, when a chevron is overtopped a scour hole forms within the apex and a sand bar island forms between the legs of the chevron. Upon further evaluation with the HSR and AdH Models, this measure was not retained for detailed evaluation because it did not meet study objectives.



Example of chevron field located in St. Louis Harbor

Low Elevation Weir (elevation 413.07 NAVD 88): This measure would consist of constructing a low elevation weir between the islands. Based on the AdH model outputs, this measure reduced overall flow entering the study area and minimally increased flow into Piasa Chute. In addition, this measure increased shear stress over the known mussel beds. This measure was not retained for detailed evaluation because it did not meet study objectives.

Sediment Diversion Structure: This measure consisted of constructing a low elevation weir from Eagle's Nest Island to the Illinois bankline. Based on the AdH model outputs, this measure actually reduced flow into Piasa Chute; therefore, this measure was not retained for detailed evaluation because it did not meet study objectives.

Rock Structure between Piasa and Eagle's Nest Islands: This measure consisted of constructing a rock structure between Piasa Island and Eagle's Nest Island to divert flow into the Piasa Chute. Based on the AdH model outputs, this measure reduced more flow within Piasa Chute than any other measure initially

evaluated; therefore, this measure was not retained for detailed evaluation because it did not meet study objectives.

Closing Structure (elevation 420.57 ft NAVD 88) to convert entire area to Backwater: Based on the AdH model outputs, this measure poses high uncertainty and risk of increasing surface water elevation, has a high risk of filling in the whole study area especially within Piasa Chute, would result in limited island restoration opportunity, potential impacts to navigation, and potential of flooding adjacent landowners based on H&H modeling results. Due to these concerns, this measure was not retained for detailed evaluation.

Notched Rock structure (R1): This measure (R1) consisted of constructing a rock structure between Piasa Island and Eagle's Nest Island to divert additional flow through Piasa Chute, but still maintain flow between the islands. Based on AdH Model outputs this measure restored additional bathymetric and flow diversity within the study area that is currently lacking with minimal changes in flow over the known mussel beds (See Appendix C, *Hydrology and Hydraulics*). Approximately 42,000 tons of graded A-stone would be used to construct this structure to an elevation of 420.57 NAVD 88. This measure was retained for detailed evaluation.

5.6 Moist Soil Management Unit

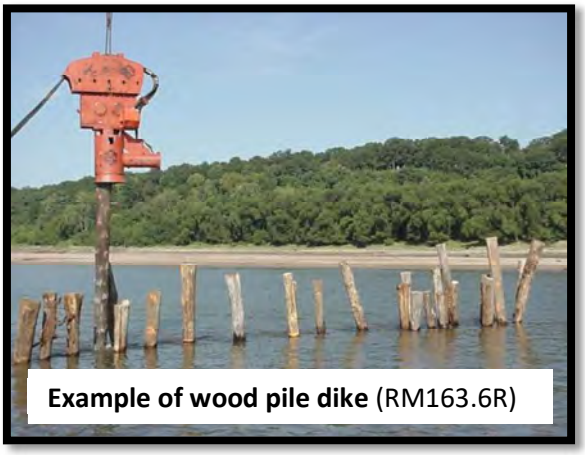
The team considered development of a moist soil management unit in the Piasa Island Backwater which would be constructed to restore aquatic and emergent vegetation. However, converting the existing backwater to an emergent wetland does not meet the objectives set forth by this study and was not evaluated further. In addition, the team determined the need to restore the existing backwater habitat would restore the ecosystem structure and function more fully compared to converting the existing habitat to something else. Converting the existing backwater to a moist soil unit would require more active management in order to achieve desired results and was deemed unacceptable. Due to these concerns, this measure was not retained for detailed evaluation.

5.7 Woody Structure

To help ensure a safe navigation channel, the U.S. Army Corps of Engineers began removing woody snags from the Mississippi River during the 1800s. Today, this practice is all but vanished. Naturally occurring large woody structure (i.e., > 10 cm diameter and 2 m in length) is an important component of many river systems. The value of woody structure is well known, including providing cover, forage, and reproduction sites for a multitude of fish species, providing attachment sites and habitat for

Examples of woody bundle during construction (left), and placement in the river (right; Calico Chute RM 148.3L)

macroinvertebrates, helping fuel productivity in the river by catching and retaining drifting organic material, and increasing habitat diversity by altering substrate and velocity patterns through increased roughness (Fischenich & Morrow Jr., 2000). The District performed a woody structure pilot study in the Middle Mississippi River (McCain, 2013) which recommended the continued use of wood pile dikes and woody bundles, as well as incorporating downed trees within the location of new proposed dikes. The following woody structure measures were considered:



Example of wood pile dike (RM163.6R)

5.7.1 Wood Pile Dikes

In lieu of a traditional rock dike, wood pile dikes could be built by driving rows of long wooden posts into the riverbed. River water flows through these structures, creating varying patterns in the riverbed. These piles act like a screen and catch additional organic matter, which increases favorable fish habitat. Due to the abundance of woody debris existing within the study area, this measure was not evaluated further.

5.7.2 Woody Bundles

Woody bundles consist of wood logs tied together and sunk in the water with an anchor. A set of woody bundles could be placed between existing or proposed constructed dikes or within an island bullnose. Due to the abundance of woody debris existing within the study area, this measure was not evaluated further.

5.8 Non-Structural Methods

Non-structural methods consisting of Best Management Practices, Education and Outreach, and Water Level Management have been proposed to help meet the objectives of the study area.

5.8.1 Best Management Practices

Best Management Practices (BMPs) are defined by the U.S. Environmental Protection Agency (USEPA) as non-regulatory guidance for agriculture issued to farmers to reduce non-point source pollution. By implementing these BMPs, the public has the capability to reduce sediment loads and increase the water quality of the Mississippi River significantly. The 8 basic types of BMPS are Conservation Tillage; Crop Nutrient Management; Pest Management; Conservation Management; Irrigation Water Management; Grazing Management; Animal Feeding Operation Management; and Erosion Sediment Control. Since this measure is outside of Corps authority, the District recommended it be evaluated by the responsible agencies/persons and was not further evaluated for the purposes of this study.

5.8.2 Education and Outreach

Education motivates people to think about the world, their relationship to it, and their ability to influence it. Without education the public may not be well-informed about public measures available to aide in the restoration of the environment. Education measures related to Piasa and Eagle's Nest Islands includes, but is not limited to, information on non-point source pollution, point source pollution, agricultural practices, invasive species, threatened and endangered species, floodplain, and wetlands. Education and Outreach programs are established through local, state, and Federal agencies as well as other public forums. Several education programs have been implemented by USDA and EPA regarding

BMPs and other agricultural practices. The IDNR offers a suite of conservation education programs, as well as stream and watershed management workshops. The USFWS has several migratory bird initiatives to include international migratory bird day festivals, partners in flight, and the junior duck stamp program. The Corps education programs are locally available to schools, civic groups, and local organizations through the St Louis district Rivers Project Office. The Great Rivers Land Trust, a non-profit group, is involved in a variety of community initiatives including wetland restoration, reforestation projects, riparian buffers, as well as the Piasa Creek Watershed Project and Piasa Harbor clean-up. These outreach programs are dedicated to educating people of all ages about the natural environment, promoting safety, and encouraging good stewardship. The interagency Project Delivery Team determined that there are several education and outreach vehicles in place; therefore, developing new outreach and education mechanisms for this project was not needed and this measure was not retained for further evaluation.

5.8.3 Water Level Management

This measure considered manipulation of Pool 26 water levels to increase depth of the side channel. However, since Pool 26 is under Environmental Pool Management and is expected to be into the future, this measure was considered unacceptable and was not retained for further evaluation.

6 Alternative Plan Formulation & Evaluation

The National Environmental Policy Act (NEPA) requires Federal agencies to evaluate a range of reasonable alternatives to a proposed Federal action. For this environmental assessment, the proposed Federal action is to improve or restore ecosystem structure and function within the Piasa and Eagle's Nest Islands study area. This section describes the measures that were retained and the formulation of the final array of alternatives. Due to the limited number of measures retained (Table 6-1) and dependency relationships, the team analyzed all possible combinations rather than identify individual alternative formulation strategies. The final array of alternatives includes 8 action alternatives and the No Action Alternative (Table 6-2). Each alternative was evaluated through an environmental benefit analysis to determine the magnitude of ecosystem benefits to be expected if the alternative was implemented.

The IWR Planning Suite II tool was developed to aide environmental and ecosystem restoration planning studies in performing cost-effectiveness and incremental cost analyses (CE/ICA) on alternatives. CE output determines which alternatives are the least costly for a given level of environmental output. ICA evaluates the efficiency of the cost-effective alternatives, to determine which provide the greatest increase in output for the least increase in cost. The incremental analysis of alternatives was accomplished following guidance by Corps' Institute of Water Resources and using methodology described in Robinson et al. (1995). The results of the incremental analysis were synthesized with other decision-making criteria (e.g., acceptability, completeness, effectiveness, efficiency, reasonableness of costs, stakeholder support) to help the planning team select and recommend a particular plan. Refer to Appendix H, *CE/ICA*, for the detailed results of the analysis.

Primary assumptions and constraints used to conduct the Piasa and Eagle's Nest Islands CE/ICA are as follows:

1. For all analyzed habitats (side channel, backwater, and island), the habitat outputs, as measured as Average Annual Habitat Units (AAHUs), were assumed to have equal value in comparing alternative plans.
2. The Island Diversity (I1) and Piasa Chute Dredge Cut (D1 or D2) are mutually dependent
3. The Island Diversity (I1) and the Piasa Backwater Dredge Cut (B1 or B2) are mutually dependent
4. Notched Rock Structure (R1) is dependent on Piasa Chute Dredge Cut (D1 or D2)

Table 6-1. Feasible Restoration Measures

Measure Code	Description
D1	200 ft Braided Piasa Chute Dredge Cut
D2	300 ft Braided Piasa Chute Dredge Cut
B1	Piasa Island Backwater Minimum Dredge Cut
B2	Piasa Island Backwater Maximum Dredge Cut
R1	Notched Rock Structure between Piasa and Eagle Nest's Islands
I1	Island Diversity: Three Islands, Piasa Riverside Island, and Upstream Rootless Island (dependent on D and B measures)

Table 6-2 Final Array of Alternatives

Alt #	Measures Included	Alternative Description
1	D0B0R0I0	No Action (defined as the alternative that the proposed federal action would not take place and there would be no change from current management direction or level of management intensity)
2	D1B1R0I1	Braided 200 ft Piasa Chute + Minimum Backwater Dredging + Island Diversity
3	D1B2R0I1	Braided 200 ft Piasa Chute + Maximum Backwater Dredging + Island Diversity
4	D1B1R1I1	Braided 200 Ft Piasa Chute+ Minimum Backwater Dredging + Notched Rock Structure + Island Diversity
5	D1B2R1I1	Braided 200 ft Piasa Chute + Maximum Backwater Dredging + Notched Rock Structure + Island Diversity
6	D2B1R0I1	Braided 300 ft Piasa Chute + Minimum Backwater Dredging + Island Diversity
7	D2B2R0I1	Braided 300 ft Piasa Chute + Maximum Backwater Dredging + Island Diversity
8	D2B1R1I1	Braided 300 ft Piasa Chute + Minimum Backwater Dredging + Notched Rock Structure + Island Diversity
9	D2B2R1I1	Braided 300 ft Piasa Chute+ Maximum Backwater Dredging + Notched Rock Structure + Island Diversity

[Note: the Project Alternative numbering does not coincide with the numbering used in the H&H Appendix].

6.1 Habitat Benefit Evaluation

A habitat benefit evaluation was conducted to evaluate environmental benefits of alternative plans for aquatic and island habitat improvements. The evaluation was conducted by a multi-agency team which included representatives from the IDNR, USFWS, and Corps. Island and aquatic benefits were quantified through the use of the Habitat Evaluation Procedures (HEP; (USFWS, 1980)).

Habitat Evaluation Procedures (HEP) is a habitat-based evaluation methodology used in project planning. The procedure documents the quality and quantity of available habitat for selected fish and wildlife species. The HEP is based on the assumption that habitat for selected species can be described by a Habitat Suitability Index (HSI). This index value is an indication of habitat quality (rated from 0.0 to 1.0 with 1.0 being ideal habitat) and is multiplied by the area of applicable habitat to obtain Habitat Units (HUs).

Changes in HUs will occur as a habitat matures naturally or is influenced by development. These changes influence the cumulative HUs derived over the period of analysis for the study area (50 years). Habitat Units are calculated for select target years and annualized over the period of analysis to derive the net Average Annual Habitat Units (AAHUs). Net AAHUs are used as the output measurement to compare the study alternatives.

The HEP procedures were used to evaluate the effects of the study alternatives on island and aquatic habitat quantity and quality. The Smallmouth Buffalo was used to assess backwater aquatic habitat; the Striped Bass was used to assess side channel aquatic habitat; and the Least Tern was used to assess island habitat. Each of these models is Regionally Approved for Use per EC 1105-2-412 and each model spreadsheet calculator is approved for regional use (Appendix G, *Habitat Evaluation & Quantification*). The multi-agency team completed an assessment of existing study area conditions, projected future conditions without the Project, and estimated expected impacts of study alternatives. A detailed description of the habitat analysis is provided in Appendix G, *Habitat Evaluation & Quantification.* Table

6-3 summarizes the habitat evaluation and provides the habitat output (Net AAHUs) that is compared to cost.

Table 6-3. Habitat Outputs (net average annualized habitat units rounded) for each considered alternative

Alt	Alternative Description	Islands Net AAHUs	Side Channel Net AAHUs	Backwater Net AAHUs	TOTAL Net AAHUs
		Least Tern	Striped Bass	Smallmouth Buffalo	
1	No Action (future without project)	0.00	0.00	0.00	0.00
2	Braided 200 ft Piasa Chute + Minimum Backwater Dredging + Island Diversity	55.3	302.2	9.0	366.5
3	Braided 200 ft Piasa Chute + Maximum Backwater Dredging + Island Diversity	62.7	302.2	11.4	376.3
4	Braided 200 Ft Piasa Chute+ Minimum Backwater Dredging + Notched Rock Structure + Island Diversity	55.3	365.4	9.5	430.1
5	Braided 200 ft Piasa Chute + Maximum Backwater Dredging + Notched Rock Structure + Island Diversity	62.7	355.6	11.9	430.2
6	Braided 300 ft Piasa Chute + Minimum Backwater Dredging + Island Diversity	61.3	346.6	9.4	417.4
7	Braided 300 ft Piasa Chute + Maximum Backwater Dredging + Island Diversity	68.7	337.2	11.9	417.8
8	Braided 300 ft Piasa Chute + Minimum Backwater Dredging + Notched Rock Structure + Island Diversity	61.3	376.5	9.8	447.6
9	Braided 300 ft Piasa Chute + Maximum Backwater Dredging + Notched Rock Structure + Island Diversity	68.7	366.4	12.3	447.4

6.2 Cost Estimates for Final Array of Alternatives

Table 6-4 shows an estimated cost of the final array of alternatives based on unit price estimates. Detailed breakdown of costs is outlined in Chapter 7, *Cost Estimates.* Cost estimates were prepared using October 2016 price levels. Annualized costs include construction costs, contingency costs, monitoring and adaptive management costs, and Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) costs. Project measures are on federally controlled waters; consequently, there are no lands and damages or relocation costs. The final array of alternatives cost estimates were based on unit price estimates annualized using the Fiscal Year 2017 discount rate of 2.875% and a 50-year period of analysis. The 50-year period of analysis was selected based on Corps Regulations (ER 1105-2-100, p. 2-11). The base year of 2025 was used and the period of analysis continued until 2075.

Table 6-4 Environmental Output and Costs of Each Alternative (Unit Price Estimates; October 2016 Price Level, 50-year period of analysis using 2.875 discount rate). Best buy plans highlighted in gray.

Alternative	Output (Net AAHU)	Construction Costs*	Annualized Construction Cost	Annualized OMRR&R Costs**	Annualized AM & Monitoring Costs**	Total Annualized Cost	Average Cost Per Output ($/AAHU)
1	0.00	$0	$0	$0	$0	$0	-
2	366.5	$22,130,000	$839,791	$5,850	$11,800	$857,641	$2,340
3	376.3	$24,500,000	$929,728	$5,850	$11,800	$947,578	$2,518
4	430.1	$23,750,000	$901,267	$5,850	$11,800	$919,117	$2,137
5	430.2	$26,250,000	$996,137	$5,850	$11,800	$1,013,987	$2,352
6	417.4	$27,130,000	$1,029,532	$5,850	$11,800	$1,047,381	$2,509
7	417.8	$29,630,000	$1,124,402	$5,850	$11,800	$1,142,252	$2,734
8	447.6	$28,880,000	$1,095,941	$5,850	$11,800	$1,113,791	$2,488
9	447.4	$31,250,000	$1.185.878	$5,850	$11,800	$1,203,728	$2,690

*includes 30% contingency, 15% E&D, and 10% S&A; based on unit price estimates
** include 30% contingency

6.2.1 Operation and Maintenance Considerations

Operation and maintenance considerations were developed for the final array of alternatives. For all alternatives the proposed measures have been designed to ensure low annual operation and maintenance requirements (Table 6-2); therefore, the estimated O&M costs among alternatives was the same. For analysis purposes, the costs presented for operation and maintenance used the 50-year period of analysis. Operation and maintenance may include performing site inspections and debris removal from rock structures each year. The estimated total annual operation and maintenance cost is $5,850 during the 50-year period of analysis (FY 17 discount rate of 2.875%). These quantities and costs may change during final design. A complete list of operation and maintenance needs will be provided in the OMRR&R Manual following construction completion.

Table 6-5. Estimated Annual Operation and Maintenance Costs (October 2016 Price Level)

O&M Item	Quantity	Unit	Unit Price ($)	Project First Cost ($)
Site Inspection	10	Hours	50	$500
Debris Removal	80	Hours	50	$4,000
			Subtotal	$4,500
			Contingencies (30%)	$1,350
			ANNUAL TOTAL O&M COST (FY 2017 discount rate of 2.875%)	**$5,850**

6.2.2 Repair, Rehabilitation, and Replacement Considerations

The IDNR is expected to operate and maintain the proposed project per the agreed terms in the Memorandum of Agreement (Appendix K, *draft* MOA [placeholder]), and should expect to incur costs associated with this responsibility outside of the 50-year period of analysis. Table 6-6 lists the major components and their associated frequencies of repair, rehabilitation, and replacement (RR&R). The District has constructed features of this nature within the Upper Mississippi River, and based on the performance of previous work as well as the hydraulic modeling results for this study (see Appendix C, *Hydraulics and Hydrology*), it was determined that the proposed project features would not require any repair, rehabilitation, or replacement during the 50-year period of analysis. These considerations were the same among the final array of alternatives. Potential RR&R items beyond the 50-year period of analysis does include replacement of rock (every 75 years), and excavation/island restoration (every 60 years). These items and costs will be included in the OMRR&R Manual.

Table 6-6. Repair, Rehabilitation, and Replacement Considerations

Component	Frequency
Repair, Rehabilitate, Replace Rock Structure	Every 75 years
Repair, Rehabilitate, Replace Backwater Area	Every 60 years
Repair, Rehabilitate, Replace Piasa Chute	Every 60 years
Repair, Rehabilitate, Replace Island Diversity Areas	Every 60 years

6.2.3 Adaptive Management and Monitoring Considerations

Costs for monitoring the final array of alternatives to determine the degree to which the alternative is meeting the success criteria and for informing potential adaptive management decisions are summarized in Table 6-4. Adaptive management and monitoring are projected to a maximum of 10 years. The estimated cost of the adaptive management and monitoring are included in the Total Project Cost Estimate[22]. Monitoring costs, regardless of alternative, include hydrographic surveys, mussel surveys, water quality (using UMRR-LTRM data), and fish monitoring and assessment (using UMRR-LTRM data) for 10 years post-construction. The estimated annualized adaptive management and monitoring cost is $12,000 during the 50-year period of analysis (FY 2018 discount interest rate of 2.75%). Further details are provided in Chapter 13, *Project Performance and Assessment Monitoring,* and in Appendix L, *Adaptive Management and Monitoring.*

[22] Per CECW-PB Memo dated 31 August 2009 Section 3.b of the Implementation Guidance for Section 2039 of WRDA 2007.

Table 6-7. Estimated Post-Construction Monitoring and Adaptive Management Costs ($, rounded) (October 2016 Price Level)

			Post-Construction Years										
Obj.	Work Category	Activity	1	2	3	4	5	6	7	8	9	10	SUBTOTAL
Piasa Chute	Monitoring, Analysis, & Reporting	Hydrographic /ADCP Survey/ISOPACH Analysis		20000					20000				40000
		UMRR LTRM Fisheries	X	X	X	X	X	X	X	X	X	X	0
		UMRR LTRM Water Quality	X	X	X	X	X	X	X	X	X	X	0
		Mussel Survey			40000					40000			80000
	AM Feature: Notch Rock Structure/Install Rock (if needed)					35000							35000
Piasa Island Backwater	Monitoring, Analysis, & Reporting	UMRR LTRM Fisheries	X	X	X	X	X	X	X	X	X	X	0
		UMRR LTRM Water Quality	X	X	X	X	X	X	X	X	X	X	0
		Gage Data Analysis	1000		1000		1000		1000		1000		5000
	AM Feature: Install rock/excavate backwater entrance (if needed)							70000					70000
Islands	Monitoring, Analysis, & Reporting	Public Aerial Imagery & Analysis	5000				5000					5000	15000
	AM Feature: Vegetation removal (if needed)				5000					5000			10000
Overall Project	Monitoring, Analysis, & Reporting	Site Inspections	2000			2000			2000		2000		8000
		Performance Evaluation Reporting					10000					10000	20000
												Subtotal	283,000
												Contingencies (30%)	85,000
												TOTAL	**$368,000**
												Annualized Monitoring and Adaptive Management Cost (FY 2017 2.875%; 50 year period of analysis)	**$12,000**

* The Project falls within a Corps UMRR-LTRM study reach; therefore no additional funds would be needed to collect data. Assessment of the data is included in the cost of preparing the Performance Evaluation Report

6.2.4 Cost Effectiveness and Incremental Cost Analysis

The CE/ICA analysis was performed on the 9 generated plans. The CE/ICA resulted in the identification of 5 cost effective alternatives, with three of them being "best buy plans" (including the No Action plan). See Appendix H, *CE/ICA* for more details. A cost-effective alternative is defined as one where no other alternative can achieve the same level of output (net AAHU) at a lower cost, or a greater level of output at the same or less cost. A sub-set of cost-effective alternatives are identified as "best buy plans". Best buy plans are cost-effective alternatives that provide the greatest increase in environmental output for the least increase in cost per environmental output. The final array of alternatives and result of the CE/ICA analysis is displayed in Table 6-2, above. Of the 9 alternatives evaluated, 5 plans were considered cost effective and 3 were considered best buys, including the No Action (Figure 6-1). The best buy plans are displayed in Figures 6-1, 6-2, and Table 6-8.

The best buy plans presented provide the information necessary to make well-informed decisions regarding desired project scale and measures. Progressing through the increasing levels of output (net AAHUs) for the best buy plans helps determine whether the increase in output is worth the additional cost. As long as decision makers consider a level of output to be worth the additional cost, subsequent levels of output are considered. When a level of output is determined to be not worth the additional cost, then subsequent levels of output will also likely be not worth the additional cost, and the final decision regarding desired project scale and measures for environmental restoration will be reached.

Typically in the evaluation of best buy plans, 'break points' are identified in either the last column or in the stair step progression from left to right in Figure 6-2. Break points are defined as significant increases or jumps in incremental cost per output, such that subsequent levels of output may not be considered worth the additional cost. Identification of such break points can be subjective. For Piasa and Eagle's Nest Islands study, break points were identified between each of the best buy plans.

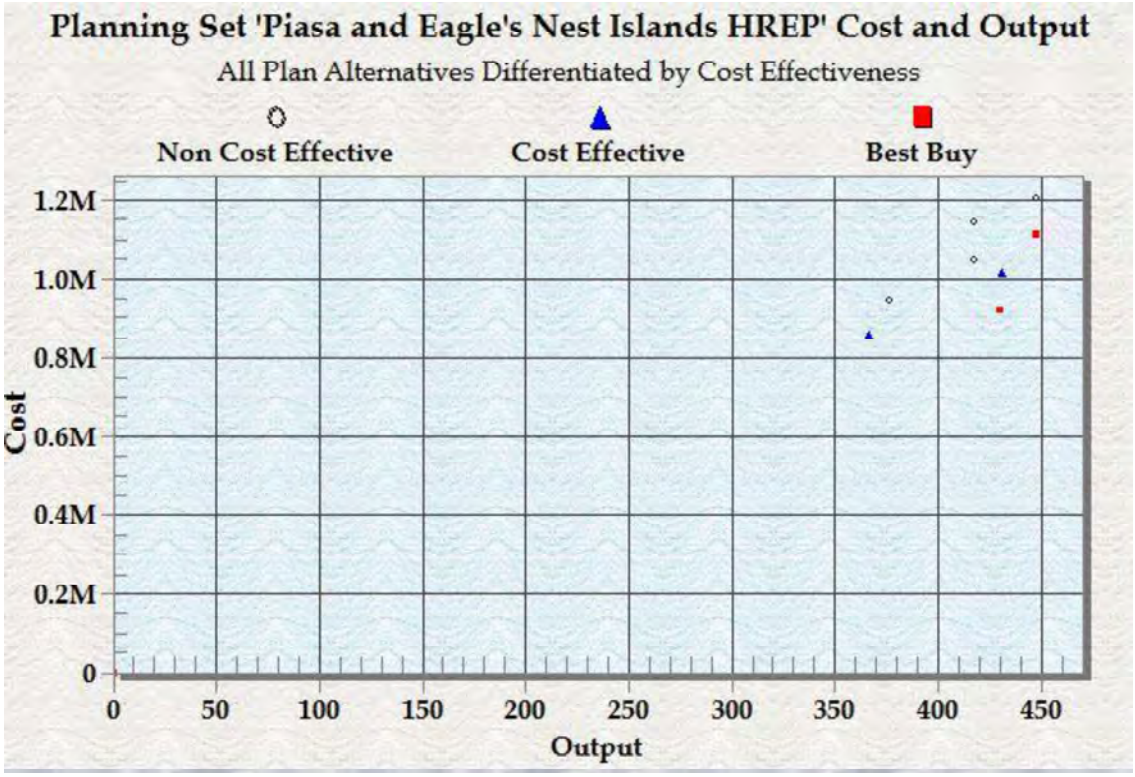


Figure 6-1. All Alternative Plans Differentiated by Cost Effectiveness.

Table 6-8. Cost effectiveness and Incremental Cost Analysis of best buy plans (Unit Price Estimates; October 2016 Price Level, 50-year period of analysis using 2.875 discount rate).

Alternative	Output (Net AAHU)	Total Annualized Cost	Incremental Output	Incremental Cost	Incremental Cost/Output ($/AAHU)
1 – No Action	0	0	0	0	0
4	430.1	$919,117	430.1	$919,117	$2,137
8	447.6	$1,113,791	17.5	$194,674	$11,124

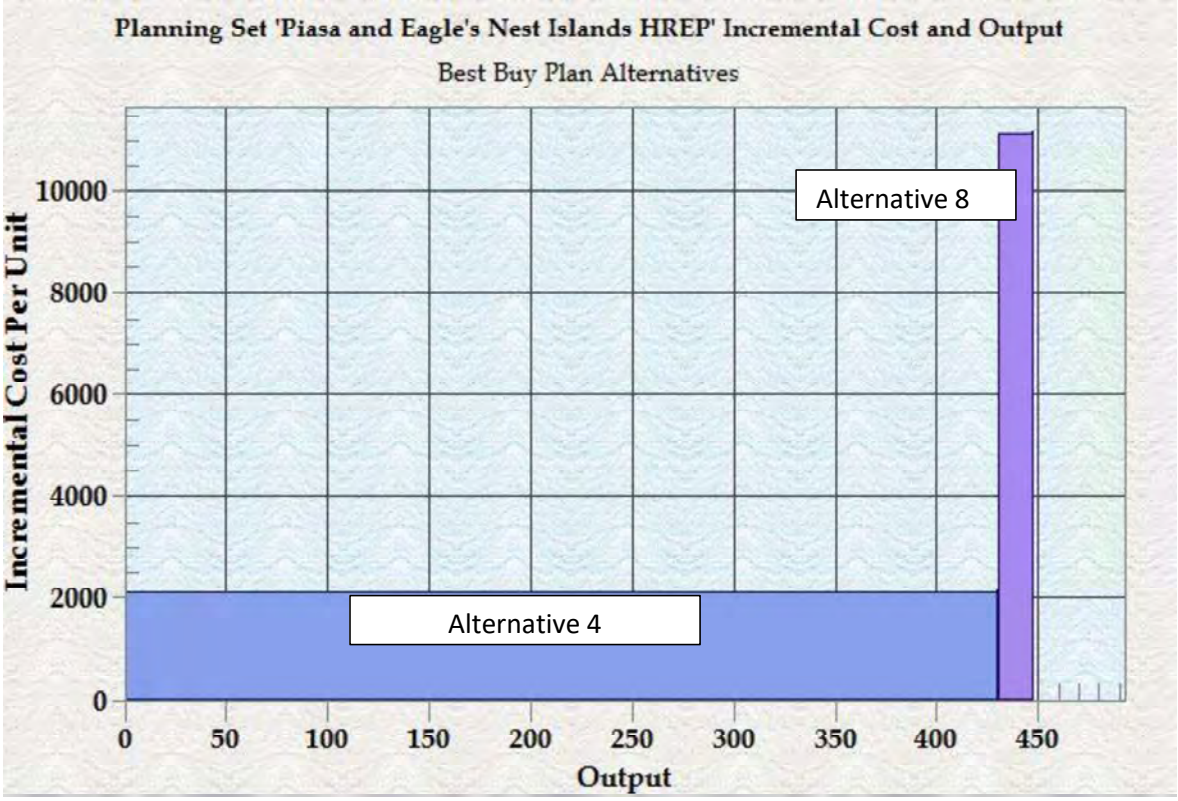


Figure 6-2. Incremental cost per output (net AAHUs) for the Piasa & Eagle's Nest Islands Best Buy Plans

7 Environmental Effects*

Chapter 2 identified the existing conditions of the resources at Piasa and Eagle's Nest Islands. Chapter 7 describes the environmental consequences of the proposed action alternatives and is organized by the same resource topics as described in Chapter 2. The depth of analysis of the alternatives corresponds to the scope and magnitude of the potential environmental impact. This chapter provides the scientific and analytic basis for the comparisons of the best buy alternatives (Alternative 1, 4, and 8) moved forward and describes the probable consequences (impacts, effects) of each alternative on the selected environmental resources. The purpose of characterizing the environmental consequences is to determine whether the resources, ecosystems, and human communities of concern are approaching conditions where additional stresses will have an important cumulative effect (CEQ, 1997).

The considered action alternatives (Alternative 4 or 8) would result in positive long-term benefits to island and aquatic habitats in and around Piasa and Eagle's Nest Islands (Table 7-1). The considered action alternatives would result in some conversion of cover types, but the resulting changes would provide habitat to a greater diversity of species. No federally protected species would be negatively affected. Due to construction, the considered action alternatives would result in short-term decreases in water quality, air quality, and aesthetics and disturb the area wildlife and public use. Long-term benefits to area habitats would far outweigh the short-term impacts. No negative social or economic impacts are anticipated. No impacts to historic and cultural resources are anticipated.

The chapter compares the effects of the following considered alternatives described in Chapter 6:

- Alternative 1: No Action
- Alternative 4: 200-foot braided dredge cut, notched rock structure, minimum backwater dredging, and island diversity
- Alternative 8: 300-foot braided dredge cut, notched rock structure, maximum backwater dredging, and island diversity

Besides the No Action Alternative and Alternative 4, the effects of Alternative 8 were also examined. This is because this alternative contains measures (i.e., 300-foot dredge cut and maximum backwater dredging) that are not present in Alternative 4 and is also considered a Best Buy Alternative. Unless otherwise stated, only these additional measures' potential effects are described and other effects are assumed to be the same as Alternative 4. All other alternatives will not be discussed explicitly because Alternative 4 or Alternative 8 contain all the measures that would be in these alternatives and the effects are captured in that discussion. When environmental effects of these alternatives are the same, they will be discussed collectively.

7.1 Hydrology & Hydraulics

Impacts of No Action Alternative: The study area would continue to be managed by Mel Price Locks and Dam Environmental Pool Management. During maximum drawdown, Piasa Chute and Piasa Island Backwater would have reduced depths providing limited aquatic habitat. The existing low flow and sediment transport within Piasa Chute would continue leading to reduced habitat quality within the side channel. Sedimentation would continue and fill in Piasa Island Backwater. The large depositional area would continue to propagate downstream and potentially fill in the side channel completely. Therefore, this alternative would have a negative effect on hydrology and hydraulics.

Impacts of Alternative 4: Positive impacts would result from Alternative 4 resulting from the dredge cut, notched rock structure, and island restoration. Locking in the depositional area with rock and enhancing it to restore an island would reduce the migration of that material downstream. The rock

placement on all the restored islands would improve the longevity of the islands and promote scour when overtopped which increases bathymetric diversity within the study area. The notched rock structure would not only promote increased flow into Piasa Chute but would also create deep scour holes with faster flows through the notches which is currently lacking in the study area. Alternative 4 would increase flow and shear within Piasa Chute which is related to improved sediment transport. Overall, Alternative 4 improves the flow and sediment transport which would have a positive effect on the aquatic habitat within the entire study area. Therefore, this alternative would have a positive effect on hydrology and hydraulics.

Impacts of Alternative 8: Similar impacts would be expected as discussed in Alternative 4; however, based on the hydraulic models, the 300 foot dredge cut had positive hydraulic results. There was slightly more hydraulic benefits (e.g., depth and flow) but minimal additional aquatic habitat improvements as compared to the 200 foot dredge cut. Therefore, this alternative would have a positive effect on hydrology and hydraulics.

Table 7-1. Summary of Environmental Effects of Considered Alternatives

Resource		No Action	Alternative 4	Alternative 8
Hydrology & Hydraulics		Negative	Positive	Positive
Aquatic Resources	Riverine Fisheries	Negative	Positive	Positive
	Backwater Fisheries	Negative	Positive	Positive
	Mussels	Negative	Positive	Positive
	Aquatic Vegetation	Negative	Positive	Positive
FP Habitat		Negative	Positive	Positive
Geology & Soils		No Effect	No Effect	No Effect
Wildlife & Migratory Birds		Negative	Positive	Positive
IL Resources of Concern		No Effect	No Effect	No Effect
Federally T&E Species		Negative	Positive	Positive
Invasive Species		No Effect	No Effect	No Effect
Water Quality		Negative	Positive	Positive
Air Quality		No Effect	No Effect	No Effect
GHG & Climate Change		No Effect	No Effect	No Effect
HTRW		No Effect	No Effect	No Effect
Historic & Cultural Resources		No Effect	No Effect	No Effect
Socioeconomics		No Effect	Positive	Positive
Aesthetics		No Effect	Positive	Positive
Noise Levels		No Effect	No Effect	No Effect
Environmental Justice		No Effect	No Effect	No Effect
(See following sections for explanation of positive, negative, no effect)				

7.2 Aquatic Resources

7.2.1 Riverine Fisheries

Impacts of No Action Alternative: The quality of aquatic habitat within Piasa Chute would continue to decline. River-borne sedimentation and lack of flow within the side channel would continue, further reducing the average depth and current velocities in the area, as well as the overall bathymetric diversity. Under the No Action Alternative, it is expected that the side channel would eventually provide limited habitat benefits for native fish species that are dependent on flowing water for all or part of their lives. As Piasa Chute degrades, it is likely the fish assemblage within the side channel would become dominated by generalist species, tolerant of poor water quality and limited habitat diversity, such as non-native carp. Therefore, this alternative would have a negative effect on riverine fisheries.

Impacts of Considered Action Alternatives: All considered action alternatives are expected to improve existing side channel habitat by restoring flow, bathymetric diversity (i.e., average depth), and sediment transport. In turn, the proposed actions are expected to increase the longevity of the side channel to persist into the future. All considered action alternatives would improve the habitat favorable for native fish species requiring flow for all or part of their lives. Through the habitat evaluation and quantification process, the Striped Bass HSI model generated 365.4 net AAHUs for Alternative 4, and 366.5 net AAHUs for Alternative 8 over the No Action Alternative. Therefore, the considered action alternatives would have a positive effect on riverine fisheries.

7.2.2 Backwater Fisheries

Impacts of No Action Alternative: The backwater fisheries located within the study area would likely continue their gradual decline. The backwater fisheries would continue to be poor due to loss of depth and lack of connectivity with the main channel. Deep, low flow, well oxygenated water is extremely important for overwintering fish habitat due to their reduced swimming capabilities. Piasa Island Backwater is expected to fill, have reduced dissolved oxygen levels, and become isolated, which would result in little habitat benefit to overwintering fishes. Without the project, the backwater fish habitat would continue to degrade and fish species diversity is expected to decline and become dominated by species tolerant of poor water quality conditions. Therefore, this alternative would have a negative effect on backwater fisheries

Impacts of Alternative 4: Alternative 4 includes dredging the entrance of the Piasa Island Backwater to improve depth and connectivity, which is expected to have a positive effect on this backwater habitat. The interior of Piasa Island would remain connected to the main channel year-round during normal river flows making it available to the fish community. The backwater would have deeper areas to improve its function as an overwintering habitat while still providing flooded emergent vegetation for cover and rearing. The additional water volume, improved habitat conditions, and increased connectivity during the summer months would also improve the area's nursery function as well. The fish assemblage within Piasa Island Backwater may experience a short-term negative effect during construction due to disturbance (e.g., noise and turbidity); however, in the long-term, the benefits of restoring connectivity and improving the backwater habitat far outweigh the potential short-term stress to the fish community. Through the habitat evaluation and quantification process (Smallmouth Buffalo HSI model), Alternative 4 generated 9.5 additional AAHUs over the No Action. Therefore, this alternative would have a positive effect on backwater fisheries.

Impacts of Alternative 8: This alternative is similar to Alternative 4 except it includes dredging the entire backwater, rather than just the entrance. This alternative would increase the total area of deep water overwintering habitat, but would also result in a reduction of flooded emergent vegetation, which provides cover and rearing habitat for numerous fish species. The negative effects of construction would persist longer than Alternative 4, but would cease after construction is completed. Sloughing of the dredge cut side slopes may lead to filling in of some of the deeper holes. Through the habitat evaluation and quantification process (Smallmouth Buffalo HSI model), Alternative 8 generated 12.3 additional AAHUs over the No Action. Therefore, this alternative would have a positive effect on backwater fisheries.

7.2.3 Mussels

Impacts of No Action Alternative: The two mussel beds located within the study area are dominated by a few common species with low recruitment. Without the project, the mussel resources are expected to

be similar to existing conditions which may lead to decline through time. Therefore, this alternative would have a negative effect on mussels.

Impacts of Considered Action Alternatives: All considered action alternatives took into account the location of the existing mussel beds and the potential effects changes in hydrology may have on the beds. Based on the hydraulic model outputs the flow over the known existing mussels would not change substantially over existing conditions. Mussel monitoring is a component of each considered alternative to detect changes to the beds as a result of implementation. This provides a valuable opportunity to learn more about how our project measures affect mussels. If changes to mussel resources occur that trigger an adaptive management feature, then modification to the notched rock structure may be implemented. Therefore, the considered action alternatives are anticipated to have a positive effect on mussels.

7.2.4 Aquatic Vegetation

Impacts of No Action Alternative: Without the project, abundance of submersed aquatic vegetation would continue to be low within the study area due to high turbidity, and lacking the water levels required to support submersed aquatic vegetation. Therefore, this alternative would have a negative effect on submersed aquatic vegetation.

Impacts of Considered Action Alternatives: Alternative 4 may provide additional opportunities for emergent vegetation within Piasa Island Backwater, whereas Alternative 8 would most likely eliminate opportunities for emergent vegetation due to dredging of the entire backwater. The measure of island restoration included in all considered action alternatives may also provide opportunities for emergent vegetation to develop. Therefore, the considered action alternatives may have a positive effect on submersed aquatic vegetation.

7.3 Floodplain Habitat

Impacts of No Action Alternative: Without the project, open water would likely be the dominant land cover classification. The forested islands of Piasa and Eagle's Nest would continue to be distinctive features within the floodplain landscape. The forested islands, which fall within lower land surface elevations, would continue to support flood tolerant tree species. Nut-producing trees would continue to be a minor component of the overall forest inventory of these islands. Piasa Island Backwater is likely to convert from aquatic habitat to land through time, which may provide additional wetland habitat but at a trade-off of losing valuable backwater habitat within Pool 26. Therefore, this alternative would have a negative effect on floodplain habitat.

Impacts of Considered Action Alternatives. The forested islands of Piasa and Eagle's Nest would continue to be distinctive features within the floodplain landscape, and the newly restored islands would add additional complexity and diversity within the study area. Piasa Island Backwater is expected to be maintained as aquatic habitat rather than convert to terrestrial habitat. Alternative 4 would allow for floodplain habitat diversity on Piasa Island with forest, emergent wetland and aquatic habitats while Alternative 8 would have less opportunity for emergent wetlands due to the larger area of the dredge cut. Therefore, the considered action alternatives would have a positive effect on floodplain habitat.

7.4 Geology & Soils

Impacts of No Action Alternative: No major impacts to geology or soils would be expected. Sediment loads from the Mississippi River may be deposited within the study area during flooding. Therefore, this alternative would have no effect on geology and soils.

Impacts of Considered Action Alternatives: Temporary, minor impacts to geology and soils would be expected due to construction activities. The dredge cut would impact existing bathymetry and flow. Improved flow and sediment transport are expected to reduce sedimentation within Piasa Chute. Sediment loads from the Mississippi River may still be deposited within the study area during flooding, but project measures are designed to improve flow and sediment transport; therefore, it is expected that impacts from sedimentation would be reduced. The island restoration sites may promote soil development over time if the islands become vegetated, capture organic matter, and build soils, but overall the considered action alternatives would have no effect on geology and soils.

No soils in the study area are designated as prime farmland; therefore, no considered action alternatives would impact prime farmland.

7.5 Wildlife & Migratory Birds

7.5.1 Bald Eagle

On August 9, 2007, the bald eagle was removed from the federal list of threatened and endangered species. It remains protected under the MBTA as well as Bald and Golden Eagle Protection Act of 1940. The Bald and Golden Eagle Protection Act prohibits unregulated take of bald eagles. The USFWS recently finalized a rule defining "take" that includes "disturb". Based on this rule, the USFWS developed the National Bald Eagle Management Guidelines[23]. These guidelines indicate that in undisturbed areas no construction activities should occur within 660 feet of a visible eagle's nest and 330 feet of a non-visible nest during breeding season.

Impacts of No Action Alternative: Bald eagles are expected to continue to inhabit the study area during the winter months. Therefore, this alternative would have no effect on the bald eagle.

Impacts of Considered Action Alternatives: To date, there are no known active nests within the study area, but eagles frequently utilize the study area. Because new nests may be built, consultation with the USFWS will continue throughout the design and construction phase to ensure no eagles are impacted and a pre-construction survey would be completed.

During each design phase, the project sponsor will be consulted and, if necessary, site visits conducted to determine location of all nests and determine if they are active as defined in the USFWS guidelines. The plans and specs would delineate the 660 foot buffer area and include timelines (December-August) to avoid all active nests and minimize effects to this species during the breeding season. In the long-term the proposed action alternatives would improve the habitat and ecosystem resources which are expected to result in positive effects to this species.

7.5.2 Great Blue Heron

Impacts of No Action Alternative: Great Blue Heron are expected to continue to inhabit the study area. As the study area habitat declines, the existing rookery may be abandoned. Therefore, this alternative may have a negative effect on the species.

Impacts of Considered Action Alternatives: All considered action alternatives seek to improve aquatic and island habitat within the study area. The rookery on Eagle's Nest would not be directly affected by any constructed measure; however, during construction short-term, minor disturbance (e.g., noise) may occur. The long-term the improvements to the habitat by the proposed project would continue to

[23] Available at https://www.fws.gov/northeast/ecologicalservices/eaglenationalguide.html Accessed on 16 Nov 2016.

support the habitat needed for heron foraging, roosting, and nesting. Therefore, the considered action alternatives would have a positive effect on the species.

7.5.3 Neotropical Migratory Birds

Impacts of No Action Alternative: Without the project, the forested islands of Piasa and Eagle's Nest would continue to support some use of migratory birds, such as neotropical migrants. However, over time as the habitat complexity decreases due to loss of side channel, backwater, and island habitats, use of the study area may decline into the future. Therefore, this alternative may have a negative effect on neotropical migrants.

Impacts of Considered Action Alternatives: Migratory birds favor floodplain complexes with high habitat diversity. The proposed alternatives all increase habitat diversity and complexity within the study area by restoring islands and enhancing aquatic habitats. These improvements to habitat are expected to have a positive effect on neotropical migratory birds.

7.6 Illinois Resources of Concern

Impacts of No Action and Considered Action Alternatives: The five protected resources in the vicinity of the study area include (1) Principia Hill Prairies East Illinois Natural Areas Inventory Site, (2) Principia Hill Prairies – East Natural Heritage Landmark, (3) Gray Bat (*Myotis grisescens*), (4) the Indiana bat (*Myotis sodalis*), and (5) the timber rattlesnake (*Crotalus horridus*). The first two resources are the hill prairies and are outside the study area in the uplands and would not be affected by any considered alternative. The Gray Bat and Indiana Bat are discussed in Section 7.7. The Timber Rattlesnake is found most commonly in mature deciduous forest in rugged, hilly, rocky terrain along rock bluffs. This habitat type is not found within the study area. Timber Rattlesnake are not expected to be affected by any considered alternative. Therefore, the no action and all considered action alternatives would have no effect on Principia Hill Prairies sites or the timber rattlesnake (effects determination for the gray bat and Indiana bat are discussed in Section 7.7).

7.7 Federally Listed Threatened & Endangered Species

In accordance with the Endangered Species Act, a list of federally threatened and endangered animals and plants was obtained from the USFWS. This satisfies the "request for species list requirements" for ESA Section 7 Consultation. The least tern, northern long-eared bat, Indiana bat, decurrent false aster, eastern prairie fringed orchid, spectaclecase, pallid sturgeon and eastern massasauga are listed as federally threatened or endangered within Jersey and Madison Counties, Illinois. The Corps prepared a Biological Assessment (Appendix D) and submitted it to the USFWS on 15 December 2016. Based on the information provided, the Corps determined the proposed project *May Affect*, *Not Likely to Adversely Affect* for the least tern, northern long-eared bat, and Indiana bat. The proposed project will have *No Effect* on the decurrent false aster, eastern prairie fringed orchid, spectaclecase, pallid sturgeon, or eastern massasauga. The USFWS replied to the Biological Assessment through informal consultation with a concurrence letter dated 30 January 2017 (Appendix D, *Biological Assessment*).

7.8 Invasive Species

Reed canary grass and Japanese hops are present on Piasa and Eagle's Nest Islands. With or without the project these plants are expected to continue to be prevalent on the islands. Therefore, the no action and considered action alternatives would have no effect on reed canary grass and Japanese hops compared to existing conditions.

Juvenile and adult Asian carps are known to use the study area. With or without the project, Asian carps are expected to continue to use the study area. With the considered action alternatives, improving side channel and backwater habitats needed by native species should assist the native fishes in competing with Asian carps for shared resources; however, the considered action alternatives would have no effect on invasive fish species in terms of reducing or increasing their presence.

7.9 Water Quality

Impacts of No Action Alternative: Piasa Island Backwater would likely become disconnected from the main channel for longer periods of time, or become disconnected completely and loose depth over time. This would likely result in decreased dissolved oxygen, increased temperature, and degraded water quality. Without the project, the water quality within Piasa Chute is expected to degrade as the chute loses depth and flow. Therefore, this alternative would have a negative effect on water quality.

Impacts of Considered Action Alternatives: Long-term water quality improvements are expected to occur as a result of the proposed project measures of dredging in Piasa Chute and Piasa Island Backwater. The improved velocities within Piasa Chute would improve sediment transport reducing sedimentation in the side channel. Improved connectivity with the Mississippi River and Piasa Island Backwater would improve the water quality of the backwater through expected improvement in dissolved oxygen.

Short-term minor increases in turbidity are expected to occur due to construction activities. These effects would be less than significant. All required water quality permits will be followed to minimize water quality impacts during construction and implementation of avoidance, minimization, and best management practices would be used. Therefore, the considered action alternatives would have a positive effect on water quality (See Appendix I, *Clean Water Act 404(b)1)*.

7.10 Air Quality

Impacts of No Action Alternative: Air quality within the study area would likely remain similar to current conditions, with Madison County air quality being influenced by the St. Louis metro area. Therefore, this alternative would have no effect on air quality.

Impacts of Considered Action Alternatives: Minor, temporary increases in airborne particulates are expected to occur as a result of mobilization and use of diesel construction equipment. These increases would be less than significant. No long-term air quality standard violations are anticipated for any considered alternative. None of the considered action alternatives are expected to have any long-term adverse effects on the air quality of Jersey and Madison counties, Illinois. Any required air quality restrictions would be followed and implemented. Therefore, the considered action alternatives would have no effect on air quality.

7.11 Greenhouse Gas & Climate Change

Impacts of No Action Alternative: With the No Action Alternative, greenhouse gas emissions for the study area are expected to be similar to current conditions. With the No Action Alternative, climate change could potentially impact the study area through increased frequency of high water events related to expected increased precipitation coupled with more extreme droughts. However, there is no consensus on the forecasted changes to climate for this region. Therefore, this alternative would have no effect on greenhouse gas and not contribute to climate change.

Impacts of Considered Action Alternatives: With any of the considered action alternatives, minor greenhouse gas emissions due to equipment used for construction activities and transporting of

material are expected. The project was designed to account for extremes of the potential forecasted climate change scenarios discussed in the literature, but it was determined climate change would not be a significant factor in regards to project performance. Therefore, the considered action alternatives would have no effect on greenhouse gas and not contribute to climate change.

7.12 HTRW

Impacts of No Action Alternative: No HTRW would be expected. If any HTRW matter is encountered during construction of this project, the USACE will be contacted to coordinate the handling and disposal of the material. However, no project features are located near any known HTRW concerns. Therefore, this alternative would have no effect on HTRW.

Impacts of Considered Action Alternatives: A short-term risk of fuel spill during construction activities would exist. The contractor would be required to have a spill clean-up plan and utilize best management practices during construction. If during construction, any HTRW material would be encountered during dredging, the Corps should be contacted to coordinate the handling and disposal of the material. Therefore, this alternative would have no effect on HTRW.

7.13 Historic and Cultural Resources

Impacts of No Action Alternative: No impacts to cultural or historical resources are anticipated. Therefore, this alternative would have no effect on historic and cultural resources.

Impacts of Considered Action Alternatives:

No known documented historic or modern shipwrecks are located within the study area. There is no known prehistoric occupation of the study area lands. No impacts to cultural or historical resources are anticipated with any of the considered action alternatives.

On 17 October 2016, a letter was sent to the Illinois State Historic Preservation Officer (SHPO), initiating consultation under Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA). The letter report outlined the proposed alternative and indicated that the Illinois Inventory of Archaeological Sites, an internal USACE shipwreck database, and a USACE reported ship-loss database, had been consulted and no known historic properties would be adversely affected.

The District received a letter from the IL SHPO on 2 November 2016 with no objection to the proposed project. A copy of the correspondence is included in Appendix B, *Coordination.* If, however, cultural resources were to be encountered during construction, all work would stop in the affected area and further consultation would take place as per 36 CFR 800-13. Moreover, should the project alternatives change from those discussed during initial consultation, or are not implemented within two years of 2 November 2016, consultations will be reinitiated.

Dated 2 December 2014, a tribal consultation letter outlining the project was sent to the 28 federally recognized tribes affiliated with the St. Louis District. Two tribes responded with no objections being raised (Appendix B, *Coordination*). Should the alternatives change from those discussed during initial consultation, follow-up letters will be sent.

Therefore, the considered action alternatives would have no effect on historic and cultural resources.

7.14 Socioeconomics

Impacts of No Action Alternative: No impacts to socioeconomics would be expected. Human use of the area would likely decline as the side channel becomes too shallow for recreational uses and public access. Therefore, this alternative would have no effect on socioeconomics.

Impacts of Considered Action Alternatives: The considered alternatives have no measureable impacts on community cohesion; property values; industrial growth; life, health and safety; or privately owned farms. The increase in recreational use and positive impacts to the Piasa Harbor Marina with these alternatives would likely increase community, regional, and business growth; and tax revenues.

No public opposition has been expressed, nor is any expected. In the long-term, habitat improvement would increase wildlife and fish populations and diversity. This would in turn increase outdoor recreational opportunities including bird watching, hunting, fishing, and boating. In the short-term, construction activities would likely disturb recreational activities within the study area, but could also create short-term employment opportunities.

Employment opportunities are evaluated using the Corps Institute for Water Resources and the Louis Berger Group regional economic impact modeling tool called RECONS (Regional ECONomic System). This modeling tool automates calculations and generates estimates of jobs and other economic features such as income and sales associated with the Corps' annual Civil Works program spending.

The analysis evaluated economic impacts at three levels of geography: region, state, and nation. The unit price estimate for Alternative 4 is $23,750,000 (unit price estimates; October 2016 price levels). Of this total project expenditure, $11,832,940 would be captured within the regional impact area. The rest is expected to benefit the state or the nation. The expenditures made by the Corps for various services and products are expected to generate additional economic activity that can be measured in jobs, income, sales and gross regional products summarized in Table 7-2, and includes impacts to the region, the State impact area, and the Nation.

Therefore, the considered action alternatives would have a positive effect on socioeconomics.

Table 7-2. Overall Summary Economic Impacts of Alternative 4 using unit price estimates (October 2016 price levels)

Impacts	Impact Areas	Regional	State	National
Total Spending		$23,750,000	$23,750,000	$23,750,000
Direct Impact	Output	$11,832,940	$22,543,811	$23,774,192
	Job	148.04	284.08	300.20
	Labor Income	$4,657,312	$9,820,856	$10,424,845
	GRP	$5,366,261	$11,184,175	$11,860,591
Total Impact	Output	$15,761,623	$47,163,860	$68,572,833
	Job	183.11	445.68	559.84
	Labor Income	$5,814,603	$18,591,134	$24,853,645
	GRP	$7,602,904	$25,872,685	$36,418,958

7.15 Aesthetics

Impacts of No Action Alternative: A decline in aesthetics may occur due to degrading habitat and loss of side channel depth leading to declining fish and wildlife populations using the area. Therefore, this alternative would have no effect on aesthetic resources.

Impacts of Considered Action Alternatives: Short-term impacts would occur with construction equipment. In the long-term aesthetic resources would improve as a result of improved water depths, increased island habitat, and overall increased wetland wildlife use and fisheries use of the study area.

The improvements would make the study area more aesthetically pleasing to many visitors. Therefore, the considered action alternatives would have a positive effect on aesthetic resources.

7.16 Noise Levels

Impacts of No Action Alternative: No change in noise levels would be expected. Therefore, this alternative would have no effect on noise levels.

Impacts of Considered Action Alternatives: The construction of the considered action alternatives would generate a temporary increase in noise levels. These noise levels would be less than significant and would be minimal compared to existing noise levels from barge traffic adjacent to the study area as well as the offloading of coal from barges to the power plant across the channel on the Missouri bank, or the road traffic along the National Scenic Byway of the Great River Road which parallels the study area. Noise from construction activities may lead to temporary displacement of some fish and wildlife species. No long-term impacts would be expected. Therefore, the considered action alternatives would have no effect on noise levels.

7.17 Environmental Justice

Executive Order 12898 requires the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations and policies. Fair treatment means that no group of people, including a racial, ethnic, or a socioeconomic group should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of Federal, state, local, and tribal programs and policies. Meaningful involvement means that:

- Potentially affected community residents have an appropriate opportunity to participate in decision making about a proposed activity that could affect their environment and/or health;
- The public's contribution can influence the regulatory agency's decision;
- The concerns of all participants will be considered in the decision making process; and
- The decision makers seek out and facilitate the involvement of those potentially affected.

The District will comply with the provisions of the EO through coordination and the NEPA review process. No concerns regarding this EO are expected.

Impacts of No Action Alternative: No change in environmental justice would be expected. Therefore, this alternative would have no effect on environmental justice.

Impacts of Considered Action Alternatives: No differential impacts to minority or low income populations are expected with any of the action alternatives. Short-term increases in employment could be realized during construction. Therefore, the considered action alternatives would have no effect on environmental justice.

7.18 Man-Made Resources

The proposed project should not impact levees in Illinois or Missouri. The study area would not result in any significant change in floodplain storage. Navigation training structures will not be impacted by any considered action alternatives. Impacts to the navigation channel will not occur as a result of any considered action alternatives.

7.19 Probable Unavoidable Adverse Impacts (on all resources)

Temporary, unavoidable adverse impacts including increased turbidity and noise would result from construction activities. Turbidity and noise levels would return to normal when construction is completed. All seasonal construction restrictions recommended by USFWS and IDNR will be adhered to for protection of threatened and endangered species.

The loss of some benthic organisms currently inhabiting the footprint areas for the proposed islands, notched rock structure, and dredging is a likely effect of all considered action alternatives. Following construction, benthic organisms should rapidly recolonize the excavated areas, especially the added habitat diversity created with stone placement and increased water depths. Dredge placement areas would be naturally re-vegetated after construction with native vegetation.

Probable and unavoidable adverse impacts could occur relating to any of the preceding discussed resources. These impacts would be minimized by implementation of avoidance, minimization, and use of best management practices during construction.

7.20 Relationship of Short-Term Uses and Long-Term Productivity

Construction activities would temporarily disrupt fish, wildlife, and human recreational use in the immediate vicinity of the study area. Long-term productivity of natural resource management would benefit considerably by the construction of the considered action alternatives. Long-term productivity would be improved through increased reliability of a mosaic of habitat diversity including islands, side channel, and connected backwater habitats. These habitats provide more dependable reproduction, foraging, and resting areas for migratory and resident wildlife and aquatic species. With the increased habitat diversity, both game and nongame species would benefit. In turn, both consumptive and non-consumptive users would realize heightened opportunities for recreational use. Negative long-term impacts are expected to be minimal.

7.21 Irreversible and Irretrievable Commitment of Resources

Irreversible commitments are those that cannot be reversed, except perhaps in the extreme long run (The Shipley Group, 2010). Simply stated, once the resource is removed it can never be replaced. For the action alternatives considered, there are no irreversible commitments of natural resources. This study is in the planning stage. Money has been expended to complete this planning document and pre-project monitoring. No construction dollars, which are considered irreversible, have been expended for the study.

Irretrievable commitments are those that are lost for a period of time (The Shipley Group, 2010). Construction activities of any of the considered action alternatives will temporarily disrupt natural resource productivity. The purchase of materials and the commitment of man-hours, fuel, and machinery to perform the study signal an irretrievable loss in exchange for the benefits of the habitat improvements.

7.22 Compliance with Environmental Statutes

All considered action alternatives were subject to compliance review with all applicable environmental regulations and guidelines. Table 7-3 provides a list of environmental protection statutes and other environmental requirements which were considered during the development of this report. The table reports the applicability or compliance of the considered action alternatives as it relates to each statute and requirement for the current stage of planning.

Table 7-3. Federal Policy Compliance Status

Federal Laws[1]	Compliance Status
Abandoned Shipwreck Act of 1987, as amended, 43 USC § 2101, et seq.	Full
American Indian Religious Freedom Act, as amended, 42 USC § 1996	Full
Archaeological and Historic Preservation Act, as amended, 54 USC § 312501, et seq.	Full
Bald and Golden Eagle Protection Act, as amended, 16 USC § 668, et seq.	Full
Clean Air Act, as amended, 42 USC § 7401, et seq.	Full
Clean Water Act, as amended, 33 USC § 1251, et seq.	Pending[2]
Comprehensive Environmental Response, Compensation, and Liability Act, as amended, 42 USC § 9601, et seq.	Full
Endangered Species Act, as amended, 16 USC § 1531, et seq.	Full
Farmland Protection Policy Act, as amended, 7 USC § 4201, et seq.	Full
Federal Water Project Recreation Act, as amended, 16 USC §460l-12, et seq. and 16 USC § 662	Full
Fish and Wildlife Coordination Act, as amended, 16 USC § 661, et seq.	Pending[2]
Flood Control Act of 1944, as amended, 16 USC § 460d, et seq. and 33 USC § 701, et seq.	Full
Food Security Act of 1985, as amended, 16 USC § 3801, et seq.	Full
Land and Water Conservation Fund Act of 1965, as amended, 16 USC § 460l-4, et seq.	Full
Migratory Bird Treaty Act of 1918, as amended, 16 USC § 703, et seq.	Full
National Environmental Policy Act, as amended, 42 USC § 4321, et seq.	Pending[3]
National Historic Preservation Act, as amended, 54 USC § 300101, et seq.	Full
National Trails System Act, as amended, 16 USC § 1241, et seq.	Full
Noise Control Act of 1972, as amended, 42 USC § 4901, et seq.	Full
Resource Conservation and Recovery Act, as amended, 42 USC § 6901, et seq.	Full
Rivers and Harbors Appropriation Act of 1899, as amended, 33 USC § 401, et seq.	Pending[2]
Wilderness Act, as amended, 16 USC § 1131, et seq.	Full
Executive Orders[4]	
Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, EO 12898, February 11, 1994, as amended	Full
Floodplain Management, EO 11988, May 24, 1977, as amended	Full
Invasive Species, EO 13112, February 3, 1999, as amended	Full
Protection and Enhancement of Environmental Quality, EO 11991, May 24, 1977	Full
Protection and Enhancement of the Cultural Environment, EO 11593, May 13, 1971	Full
Protection of Wetlands, EO 11990, May 24, 1977, as amended	Full
Recreational Fisheries, EO 12962, June 7, 1995, as amended	Full
Responsibilities of Federal Agencies to Protect Migratory Birds, EO 13186, January 10, 2001	Full
Trails for America in the 21st Century, EO 13195, January 18, 2001	Full

[1] Also included for compliance are all regulations associated with the referenced laws. All guidance associated with the referenced laws were considered. Further, all applicable Corps of Engineers laws, regulations, policies, and guidance have been complied with but not listed fully here.

[2] Required permits, coordination would be sought during document review.

[3] Full compliance after submission for public comment and signing of FONSI.

[4] This list of Executive Orders is not exhaustive and other Executive Orders not listed may be applicable.

8 Cumulative Effects *

This chapter identifies possible cumulative effects of the considered alternatives when combined with past trends and other ongoing or expected future plans and projects.

8.1 Cumulative Effects Overview

Cumulative effects result from the proposed action when added to other past, present, and reasonably foreseeable projects or actions. Cumulative effects are not caused by a single project, but include the effects of a particular project in conjunction with other projects (past, present, and future) on the particular resource. Cumulative effects are studied to enable the public, decision-makers, and project proponents to consider the "big picture" effects of a given project on the community and the environment. In a broad sense, all impacts on affected resources are probably cumulative; however, the role of the analyst is to narrow the focus of the cumulative effects analysis to important issues of national, regional, and local significance (CEQ, 1997).

The Council on Environmental Quality (CEQ) issued a manual entitled *Considering Cumulative Effects Under the National Environmental Policy Act* (1997). This manual presents an 11-step procedure for addressing cumulative impact analysis. The cumulative effects analysis for the Piasa and Eagle's Nest Islands HREP followed these 11 steps, shown in Table 8-1.

Table 8-1. 11-Step Approach for Assessing Cumulative Effects

Component	Steps
SCOPING	1. Identify Resources
	2. Define the study area for each resource
	3. Define time frame for analysis
	4. Identify other actions affecting the resources
DESCRIBING THE AFFECTED ENVIRONMENT	5. Characterize resources in terms of their response to change and capacity to withstand stress
	6. Characterize stresses in relation to thresholds
	7. Define baseline conditions
DETERMINING THE ENVIRONMENTAL CONSEQUENCES	8. Identify cause-and-effect relationships
	9. Determine magnitude and significance of cumulative effects
	10. Assess the need for mitigation of significant cumulative effects
	11. Monitor and adapt management accordingly

8.2 Scoping for Cumulative Effects

8.2.1 Bounding Cumulative Effects Analysis

Cumulative effects analysis requires expanding the geographic boundaries and extending the time frame to encompass additional effects on the resources, ecosystems, and human communities of concern.

8.2.1.1 Identifying Geographic Boundaries

The geographic boundaries for each resource were determined by the distribution of the resource itself, and the area within that distribution where the resource could be affected by considered action alternatives in combination with other past, present, and reasonably foreseeable actions. The primary area considered in the cumulative effects analysis is limited to Pool 26.

8.2.1.2 Identifying Timeframe

The timeframe for the cumulative effects analysis for each considered resource begins when past actions began to change the status of the resource from its original condition, setting the long-term trend currently evident and likely to continue into the reasonably foreseeable future. The timeframe for this analysis began in the early 19th century when the region began to be altered by non-indigenous settlers, and ends in 2075 (end of 50-year period of analysis for the study).

8.2.2 Identifying Past, Present, and Reasonably Foreseeable Future Actions

Chapter 2 discussed the condition of each resource by describing the present condition and providing historical context (i.e., the past condition) for how the resource got to its current state. The Project Delivery Team used information from field surveys, discussions with project sponsor, scoping comments, and literature searches to assess the past and existing conditions of the resource and to identify present and reasonably foreseeable future actions.

"Reasonably foreseeable actions" were defined as actions or projects with a reasonable expectation of actually happening, as opposed to potential developments expected only on the basis of speculation. Accordingly, the Project Delivery Team applied the following criteria when determining reasonably foreseeable actions:

- Actions on an agency's list of proposed actions
- Actions where scoping has started
- Actions already permitted
- Actions where budgets have been requested

Based on these criteria, the following projects were identified as being reasonably foreseeable and were included in this cumulative effects analysis:

- The Corps will continue the operation and maintenance of the 9-foot navigation channel project. This includes continuation of dredging, placement of material, and construction and maintenance of river training structures for navigation purposes. The Corps Master Plan for the Mississippi River (RM 300-0) identifies all known plans for new channel improvement structures and revetments or modifications to existing structures and revetments within the St. Louis District Corps through the year 2017. A minor maintenance dredging area is located upstream at RM 212.5 and downstream at RM 204. There are no proposed construction projects within 5 miles upstream of Piasa and Eagle's Nest Islands; however, some structure modifications are proposed downstream at RM 204.
- Foresters and Biologists with the Corps will continue to implement vegetation and wildlife management and monitoring on General Plan Lands in Pool 26. This includes but is not limited to timber stand improvements, forestry inventory, tree plantings, and bat monitoring.
- The Corps will continue to implement Environmental Pool Management within Pool 26.
- From 2000-2014, the Corps Regulatory Program issued 176 permits which impacted aquatic resources within Pool 26. Of these, 82% fell under a nationwide permit, 6% were regional general permits, and 6% were standard permits, while 6% were in other activities. The most common nationwide permit issued was for bank stabilization (NWP 13). Forecasting future permit activities is not well developed; therefore, it is assumed that future permit activities within Pool 26 watershed would be similar to the period from 2000-2014.
- <u>Ecosystem Restoration Projects in the vicinity of Pool 26:</u>
    - UMRR Dresser Island HREP (operation by Missouri Department of Conservation (MDC))
    - UMRR Pools 25 & 26 Islands (operation by MDC)

- UMRR West Alton HREP (approved Fact Sheet)
- UMRR Calhoun Point HREP (operation by IDNR)
- UMRR Cuivre Island HREP (operation by MDC)
- UMRR Swan Lake HREP (operation by USFWS; Illinois River)
- UMRR Stump Lake HREP (operation by USFWS; Illinois River)
- Cora Island (operated by USFWS; Missouri River)
- Columbia Bottom (operated by MDC; Missouri River)

The Piasa and Eagle's Nest Islands HREP complements these present and future actions. Even though some permitted activities allow for impacts to wetlands, others allow for wetland and stream restoration activities which complement the efforts to improve habitat within Pool 26 of the Mississippi River.

8.3 Cumulative Effects by Resource

The remainder of this chapter describes the results of the cumulative effects analysis for each resource considered from Chapters 2 and 7. Table 8-2 is a checklist identifying potential incremental cumulative effects on the resources affected by the Piasa and Eagle's Nest Islands HREP. Table 8-3 summarizes the past, present, and reasonably foreseeable actions that might impact each resource category identified to have an incremental cumulative effect. If a resource was not identified to have a cumulative effect then this resource was not discussed in detail within the chapter. The cumulative effects analysis discusses future conditions as follows:

- Without the Project: No Corps Action
- With the Project: All considered action alternatives (Alternatives 4 and 8) are discussed as a whole unless otherwise noted

8.3.1 Hydrology & Hydraulics

Past actions have altered the hydrology of the Mississippi River through lock and dam construction. Many cumulative effects are discussed in the Navigation Study by WEST (2000) and will not be repeated here. In summary, the assessment acknowledged the tremendous changes brought about by the construction of the 9-foot Channel Project in conjunction with other impacts occurring throughout the watershed resulting in declines of backwaters and side channel habitats.

Without Project: Piasa Chute would continue to degrade due to loss of flow and depth and minimal sediment transport. Piasa Island Backwater would continue to degrade due to lack of connectivity with the main channel of the Mississippi River. The large depositional area upstream of the study area would continue to propagate downstream and potentially fill in the side channel completely. This deterioration would have a negative impact on the management of the study area and its ability to provide important backwater and side channel habitat within Pool 26.

Considered Action Alternatives: No negative cumulative impacts would be expected from any of the considered action alternatives, combined with other present actions by others, and reasonably foreseeable future actions. The considered action alternatives would improve depth, flow, bathymetric diversity, and connectivity of backwater and side channel habitat in Pool 26. See Plates 60-63 for changes in shear stress and velocities.

Table 8-2. Checklist for identifying potential cumulative effects

Resource	Without Project	With Project		Past Actions	Other Present Actions	Other Future Actions	Piasa & Eagle's Nest's Incremental Cumulative Impact
		Construction	Operation				
Hydrology & Hydraulics	M	S[1]	+	H	X	X	+
Aquatic Resources	M	S[1]	+	H	X	X	+
Floodplain Habitat	S	S[1]	+	H	X	X	+
Geology & Soils	X	S[1]	X	X	X	X	X
Wildlife & Migratory Birds	S	S[1]	+	M	X	X	+
IL Resources of Concern and T&E Species	S	S[1]	+	H	X	X	+
Invasive Species	+	X	S	+	+	X	X
Water Quality	M	S[1]	+	M	X	X	+
Air Quality	X	X	X	X	X	X	X
Greenhouse Gas	X	S[1]	X	X	X	X	X
HTRW	X	X	X	X	X	X	X
Historic & Cultural Resources	X	X	X	X	X	X	X
Socioeconomics	X	X	X	X	X	X	X
Aesthetics	X	X	X	X	X	X	X
Noise Levels	X	X	X	X	X	X	X
Environmental Justice	X	X	X	X	X	X	X
KEY X = no change; S = slight adverse effect; S[1] = temporary, slight adverse effect; M = moderate adverse effect; H = high adverse effect; + = beneficial effect							

8.3.2 Aquatic Resources

The past actions within the Mississippi River basin, which includes Pool 26, have adversely impacted the aquatic resources, including fisheries and mussels, by disconnecting the river from its floodplain, altering hydrology, and sedimentation. These actions have led to loss of access to spawning and rearing habitat for fish and degraded aquatic habitat. Given that mussels use fish as their hosts to spread glochidia (larva), they have also been impacted by loss of spawning and rearing fish habitat, as well as changes in flow and sediment which affect mussel bed development. Present and future actions, including the considered action alternatives, seek to offset these past negative actions to fisheries and mussel resources.

Without Project: The fisheries and mussel resources throughout the study area would likely continue their gradual decline due to poor aquatic habitat.

Considered Action Alternatives: No negative cumulative impacts would be expected. The considered action alternatives should have long-term benefits to the fisheries resources and in turn mussels within the study area and in Pool 26.

	Present Actions	Future Actions	No Action Alternative	Conside
of river system from natural oled lock and dam system; loss habitat; loss of side channel ng impacts; navigation impacts; deral, state, and private habitat land mgmt programs	Continued impacts due to land use changes in watershed, lock & dam operation, climate change; continued operation of Environmental Pool Management	Continued impacts due to land use changes in watershed, lock & dam operation, climate change; continued operation of Environmental Pool Management	Loss of flow and minimal sediment transport within Piasa Chute; Piasa Backwater disconnected	No nega improve connect increase navigati
nstruction; altered hydrology &	Continued maintenance and operation of aquatic resources by state and federal agencies; continued impacts due to lock & dam operation; degrading habitat for fish and mussel resources would continue	Continued maintenance and operation of aquatic resources by state and federal agencies; continued impacts due to lock & dam operation; degrading habitat for fish and mussel resources would continue	Continued decline of aquatic resources	Localize aquatic sedimen construc cumulat
nstruction; inundation of islands; foot Channel Project; Land use t fragmentation and conversion	Continued operation of 9-Foot Channel Project and Environmental Pool Management	Continued operation of 9-Foot Channel Project and Environmental Pool Management	Continued decline of island habitat	Increase improve Tempora due to o activities
es; loss of both aquatic and Corps, other federal, state, and restoration and land mgmt se habitat loss	Maintenance of current habitat conditions due to maintenance of lock and dam system; habitat restoration and land mgmt through USACE, other federal, state, and private programs; maintenance of current floodplain habitat conditions due to continued land use/ urbanization; dredging impacts; navigation impacts; native species continue to be impacted by exotic species	Continued maintenance of current habitat conditions due to maintenance of lock and dam system; habitat restoration and land mgmt through USACE, other federal, state, and private programs; maintenance of current floodplain habitat conditions due to continued land use/ urbanization; dredging impacts; navigation impacts; native species continue to be impacted by exotic species	Continued decline of physical habitat (both aquatic and island); decline in wildlife use	Improve and islar wildlife a
es; habitat fragmentation and s of aquatic, island, and tat; Corps, other federal, state, bitat restoration and land mgmt se habitat loss; recognition of rough Endangered Species Act multiple T&E species	Maintenance of current habitat conditions due to maintenance of lock and dam system and existing dikes/revetment; floating barge habitat project for Least Tern; ESA	Continued maintenance of current habitat conditions due to maintenance of lock and dam system and existing dikes/revetment; floating barge habitat project for Least Tern; ESA	Potential decline in quality and quantity of ecosystem resources; continued loss of important habitat needed by T&E Species	Tempora due to o construc expecte likely to species
an populations and result in increased water ns. Establishment of Clean Water PA, state environmental ssociated regulations greatly ions.	Continued population growth and development result in increased potential for water quality impacts. Continued regulation enforcement and societal recognition prevent water quality degradation	Continued regulation enforcement and societal recognition. Continued population growth and development result in increased potential for water quality impacts	Increased sedimentation; increased turbidity; decreased dissolved oxygen concentrations	Localize suspend concent activities improve dissolve

8.3.3 Floodplain Habitat

Islands are distinctive features within the floodplain landscape. Past actions have degraded islands within Pool 26 through direct inundation from lock and dam construction. Limited opportunities for new island formation to occur naturally is unlikely due to the Corps Operation and Maintenance of the 9-foot Channel Project.

Without Project: The quality of island habitat within the study area would likely continue to decline which would lead to reduction in quality island habitat within Pool 26. The gradual deterioration would have a negative impact on the management of the study area and its contribution of island habitat within the Pool 26.

Considered Action Alternatives: No negative cumulative impacts would be expected from any of the considered action alternatives, combined with other present actions by others, and reasonably foreseeable future actions. The considered action alternatives should have positive long-term benefits to the floodplain and island habitat within the study area and will contribute to improving habitat within Pool 26.

8.3.4 Wildlife & Migratory Birds

Piasa and Eagle's Nest Islands and other floodplain conservation areas provide mid-migration habitat for the Mississippi Flyway, one of the major migratory bird flight corridors in North America. The Mississippi River and floodplain are the center of this flyway. This mid-migration habitat is recognized in the North American Waterfowl Management Plan as a habitat of major concern. Past actions within the watershed have deteriorated the physical habitat (both aquatic and island) which in turn negatively affects the resident and migratory wildlife using that habitat. Present and future actions, including the considered action alternatives, seek to offset these past negative actions to resident and migratory wildlife caused by habitat loss, fragmentation, and degradation.

Without Project: The gradual deterioration of the physical habitat (both aquatic and island) within the Project would have negative impacts on management and its contribution to wildlife resources within the Pool 26 watershed. With no improvements to ecosystem function and structure, wildlife and migratory birds use of the study area is expected to decline. It is also expected that with the declines in wildlife use, the public use of the study area would decline.

Considered Action Alternatives: No negative cumulative impacts would be expected from any of the considered action alternatives, combined with other present actions by others, and reasonably foreseeable future actions. The considered action alternatives should have positive long-term benefits to wildlife and migratory birds using the study area and will contribute to improving wildlife resources within Pool 26.

8.3.5 Threatened & Endangered Species

Chapter 2 and Chapter 7 identified the federally listed threatened and endangered species as well as the Illinois Resources of Concern. These resources have been adversely impacted by habitat loss, fragmentation, degradation, and conversion throughout the range of each (*i.e.,* least tern, northern long-eared bat, and Indiana bat, decurrent false aster, eastern prairie fringed orchid, spectaclecase, pallid sturgeon, or eastern massasauga). Present and future actions, including the considered action alternatives, seek to offset these past negative actions to these species.

Without Project: The quality and quantity of ecosystem resources would continue to decline within the study area and surrounding areas. This would result in continued loss of important habitat required by the federally listed threatened and endangered species and Illinois Resources of Concern.

Considered Action Alternatives: With the project, no negative cumulative impacts would be expected to occur for the threatened and endangered species or for the Illinois Resources of Concern. With the considered action alternatives, wetland habitat, side channel habitat, and island habitat required by some or all of these species are expected to improve. The considered action alternatives, along with other present and foreseeable future restoration projects may affect, but not likely to adversely affect these species long-term.

8.3.6 Water Quality

Past actions have degraded water quality within the Upper Mississippi River, including Pool 26. In general, past and present laws and regulations have led to improved water quality; however, site-specific problems will likely persist into the future. Based on the UMRR-LTRM water quality data and analysis Pool 26 is a highly productive river reach (Soeken-Gittinger & Chick, 2013). This trend is likely to continue in the future.

Without Project: Pool 26 water quality would likely remain similar to the current trends. Piasa Island Backwater would likely continue to lose depth, have increased turbidity, and low dissolved oxygen due to becoming more and more disconnected from the main channel of the Mississippi River. Piasa Chute would likely continue to lose depth and flow and become disconnected from the main channel leading to the loss of important side channel habitat.

Considered Action Alternatives: No negative cumulative impacts to water quality should be expected long-term. The considered action alternatives seek to improve depth and flow of the side channel, and improve connectivity of the backwater to the main channel. This should improve dissolved oxygen levels throughout the year.

9 Plan Selection

In chapters 7 and 8, the no action and considered action alternatives (i.e., the best buys, Alternatives 4 and 8) were compared based on their anticipated environmental effects. Along with that information, the Project Delivery Team and IDNR evaluated the best buy alternatives in their ability to meet the study objectives and achieve the four Principles and Guidelines evaluation criteria identified in ER 1105-2-100. This alternative comparison and evaluation led to identification of a Tentatively Selected Plan (TSP).

9.1 Alternative Evaluation Criteria

9.1.1 Principles and Guidelines (P&G) Criteria

The four evaluation criteria are acceptability, completeness, effectiveness, and efficiency. The descriptions of each are below.

Completeness is the extent to which an alternative provides and accounts for all necessary investments or other actions that ensure the realization of the planning objectives (P&G Section VI.1.6.2(c)(1).

Effectiveness is the extent an alternative alleviates the specified problems and achieves the specified objectives (P&G Section VI.6.2.(c)(2))

Efficiency is the extent to which an alternative is the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the nation's environment (P&G Section VI.1.6.2(c) (3)).

Acceptability is the workability and viability of the alternative with respect to acceptance by federal and non-federal entities and the public and compatibility with existing laws, regulations, and public policies (P&G Section VI.6.2(c)(4)).

A matrix (Table 9-1) was prepared to rank each best buy alternative according to how well the alternative met the evaluation criteria while considering the study objectives. The following is a discussion of the factors considered when ranking the alternatives. The PDT reviewed the best buy alternatives and determined that the cost to implement the first iteration of best buy alternatives (Alternative 4) above the No Action Alternative was worth the incremental investment above the No Action Alternative (Alternative 1) since it provides an acceptable level of restoration for an acceptable cost. Alternative 4 provides 430.1 AAHUs over the No Action Alternative at an incremental cost per AAHU of $2,137 using unit price estimates.

The next best buy alternative, Alternative 8, differs from Alternative 4 by having a 300 foot dredge cut in Piasa Chute versus the 200 foot dredge cut. The PDT determined that the minimal additional benefits were not worth the incremental investment. Alternative 8 would not be considered further since it is similar to Alternative 4 but only provides an additional 17.5 AAHUs over Alternative 4 at an incremental cost per AAHU of $11,124 using unit price estimates. The PDT and IDNR deemed this alternative not worth the additional cost.

9.1.2 Four P&G Accounts

9.1.2.1 National Ecosystem Restoration (NER) Plan

Engineering Regulation 1105-2-100 directs that Corps of Engineers ecosystem restoration projects should contribute to national ecosystem restoration. The NER Plan reasonably maximizes ecosystem restoration benefits compared to costs. In addition to considering the system benefits and costs, it also considers information that cannot be quantified such as environmental significance and scarcity,

socioeconomic impacts, and historic properties information. While there were other best buy alternatives that met or partially met the objectives, Alternative 4 reasonably maximizes ecosystem restoration benefits compared to costs (ER 1105-2-100 p. 2-7). Alternative 4 (430.1 net AAHUs) is identified as the NER Plan.

9.1.2.2 Regional Economic Development (RED)

All action alternatives would have a positive impact on the regional economy. ReCONS model was run and while the amount of regional benefits varied, the percentage of Federal expenditure total regional benefits (100%) were equivalent and not useful as a screening criterion for comparison.

9.1.2.3 Environmental Quality (EQ)

It is anticipated that all alternatives would have a positive effect on ecological resources. No known cultural sites have been identified, and aesthetics are expected to be enhanced by all alternatives since they improve habitat. Potential temporary adverse effects could result from construction activities (e.g., dredging, emissions), but construction BMPs will be strictly adhered to, such that any and all adverse effects are temporary and minimal. Consequently, alternatives were ranked on AAHU output: alternatives that had benefits higher than 425 AAHUs scored high, alternatives with net benefits from 376-424 AAHUs scored medium, and all other alternatives ranked low.

9.1.2.4 Other Social Effects (OSE)

All alternatives assume positive social impacts through improved depth and connectivity of aquatic habitats for recreation and aesthetics. Alternatives scored the same as for effectiveness.

Table 9-1. Best Buy Plans Evaluation

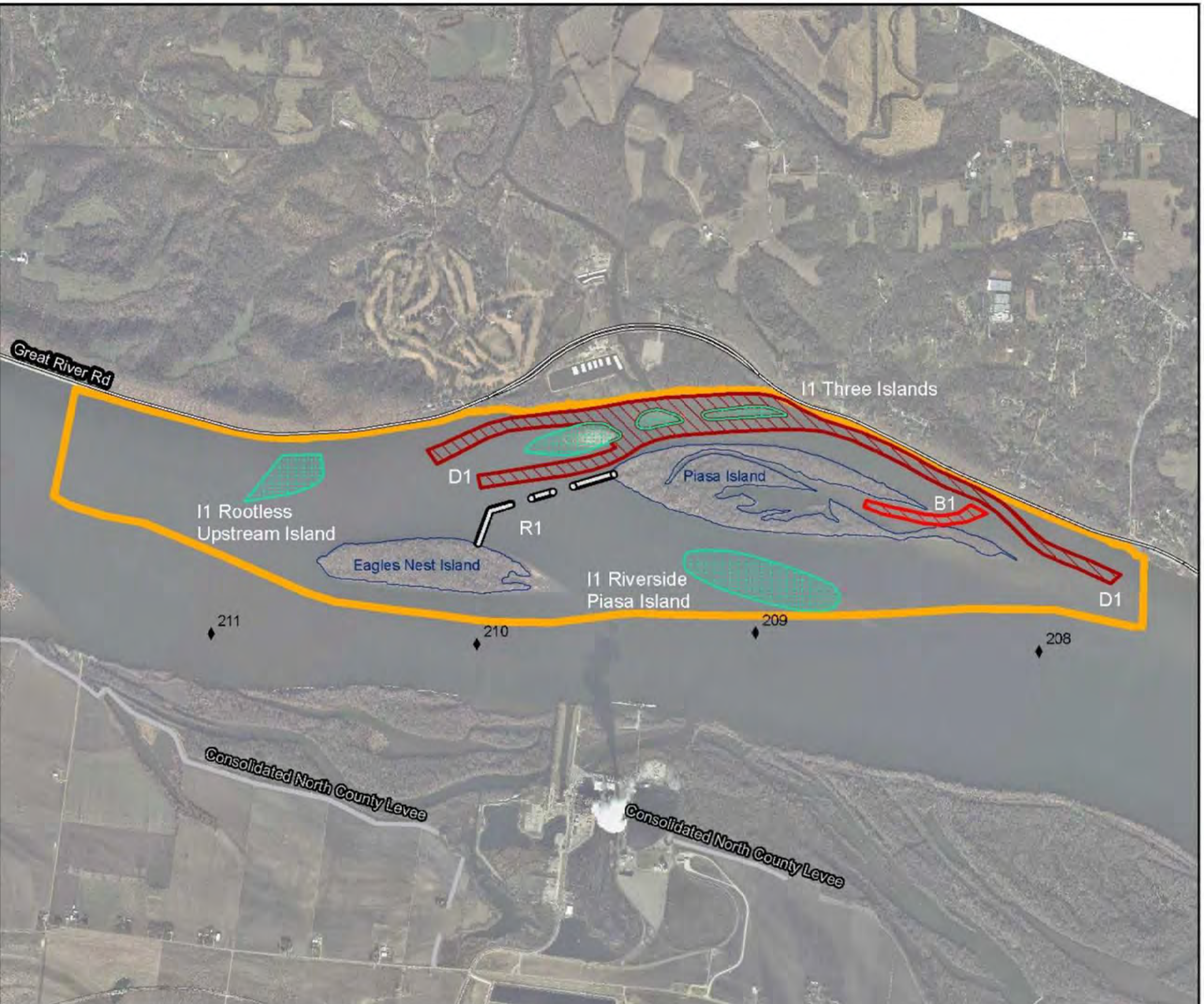
Best Buy Alt.	P&G Evaluation Criteria				P&G Accounts		
	Acceptability	Completeness	Effectiveness	Efficiency	NER	EQ	OSE
1	Low	Low	Low	Low	No	No	No
4	High	High	High	High	Yes	Yes	Yes
8	High	High	High	Medium	Yes	Yes	Yes

9.2 Tentatively Selected Plan

As a result of the discussions above and review of the evaluation criteria (Tables 7-1, 8-3, and 9-1), the PDT and sponsor recommend that Alternative 4 be the TSP. This alternative best meets the study goal and objectives, is cost effective and justified as a best buy alternative. Alternative 4 is the NER plan and yields an overall output of 430.1 net AAHUs. The preliminary estimated total first costs of the study was updated after Alternative 4 was identified as the Tentatively Selected Plan. The updated detailed project first cost of the TSP is $26,746,000 and is anticipated to yield 430.1 net AAHUs. Using the Fiscal Year 2018 Federal discount rate of 2.75%, this results in an average annual cost of $2,345 per AAHU.

Alternative 4 restores approximately 76 acres of island habitat, restores approximately 49 acres of backwater by increasing connectivity and depth, and improves depth and flow for approximately 485 acres of side channel habitat within the study area. Alternative 4 includes excavating Piasa Chute with a 200 foot braided dredge cut 10 feet below minimum pool, excavating Piasa Island Backwater to 10 feet below minimum pool to improve entrance conditions to restore connectivity and fisheries habitat, construction of a notched rock structure to improve flow and bathymetric diversity (Plates 60-63) within the study area, and constructing islands with the dredge material with stone protection to restore the historic island mosaic that once existed (Figure 9-1).

Piasa and Eagle's Nest Island HREP
Tentatively Selected Plan



Piasa and Eagle's Nest Island Habitat Rehabilitation & Enhancement Project

- UMR Miles
- Levee
- Highways
- Rock Structure R1
- Restore Islands
- 200ft Dredged Channel D1
- Backwater Dredging B1
- UMR Islands
- Boundary

Location Map

0.25 0.125 0 0.25 Miles

9.2.1 Consistency with Corps Campaign Plan

The Corps has developed a Campaign Plan[24]. This study is consistent with the Corps Campaign Plan by producing lasting benefits for the nation, by optimizing agency coordination, and by using innovative solutions in pursuit of a sustainable, environmentally beneficial, and cost-effective ecosystem restoration design.

9.2.2 Consistency with Corps Environmental Operating Principles

The Corps has reaffirmed its commitment to the environment by formalizing a set of "Environmental Operating Principles" (EOP)[25] applicable to all decision-making and programs. The EOPs were considered during plan formulation and the proposed plan is consistent with the EOPs. The TSP promotes sustainability and economically sound measures by incorporating the most natural and least cost methods for restoring side channel, island, and backwater habitats for fish and wildlife species. Alternative formulation involved collaborative interactions with multiple agencies and stakeholders, and the general public.

9.2.3 Risk and Uncertainty

Areas of risk and uncertainty have been analyzed and were defined so that decisions could be made with some knowledge of the degree of reliability of the estimated benefits and costs of alternative plans. Risk is a measure of the probability and consequence of uncertain future events. The team worked to manage risk in developing measures. It developed measures by expanding on and referencing successful similar work completed by other UMRR HREPs, the *UMRR Design Handbook* (USACE, 2012), and applied lessons learned from Corps programs and activities as related to using river training structures for maintaining the 9-foot navigation channel. The team used that experience from previous projects to identify possible risks and decrease uncertainty in plan formulation. No measures in the TSP are believe to be burdened by significant risk or uncertainty regarding the eventual success of the proposed habitats. Significant risk would be avoided by proper design, appropriate selection, and correct seasonal timing or applications. The dynamic and complex nature of riverine environmental processes is a principal source of uncertainty. Post-construction monitoring and adaptive management plans would be used to address unplanned outcomes in all proposed measures.

Based on modeling results, it is expected that the proposed measures would increase velocities and flow conditions within the side channel complex resulting in a reduced rate of deposition within Piasa Chute. However, there is high uncertainty on the timing, frequency, and overall impacts of specific hydrologic events (large floods, for example) that could alter the expected performance of these measures. If monitoring demonstrates a need to address unexpectedly high rates of sediment deposition within Piasa Chute, adaptive management measures including the modification of proposed rock structures or the installation of additional rock structure(s) could be implemented.

During feasibility, project features were only moved forward if the structures were located outside the existing mussel bed limits. The existing identified beds are dominated by thicker shelled species tolerant of fluctuating water levels and siltation (Ecological Specialist Inc, 2014). Based on modeling results, the flow over the existing mussel beds showed minimal change. However, there is some uncertainty on how flow will change after implementation of the proposed project. If monitoring shows a reduction of the quality of the bed, based on malacologist expertise, then adaptive management measures would be implemented.

[24] Available online at: http://www.usace.army.mil/About/Campaign-Plan/; accessed 20 January 2017
[25] Available online at: http://www.usace.army.mil/Missions/Environmental/Environmental-Operating-Principles/; accessed 20 January 2017

Sea level rise is not expected to impact the Tentatively Selected Plan since the study area is located several hundred feet above mean sea level. However, a potential risk and uncertainty associated with sea level on the UMRS includes a potential for increased sedimentation related to aggradation and flooding.

10 Tentatively Selected Plan: Description with Design, Construction, Operations, Maintenance, Repair, Rehabilitation, and Replacement Considerations

This chapter provides further information on the Tentatively Selected Plan. The measures of the Tentatively Selected Plan are designed to address study objectives (Table 10-1). The Tentatively Selected Plan for ecosystem restoration at Piasa and Eagle's Nest Islands includes:

- Increasing aquatic diversity in Piasa Chute, by constructing a braided dredge cut.
- Enhancing aquatic diversity in Piasa Island Backwater by dredging the entrance and reconnecting the backwater to the Mississippi River.
- Constructing a notched rock structure between Piasa and Eagle's Nest Islands to improve flow and sediment transport through Piasa Chute without negatively impacting overall flow within the entire study area.
- Restoring islands by beneficially re-using the dredged material and placing stone protection to maintain the islands and promote scour when islands are overtopped.

Table 10-1. Study goal and objectives as related to Tentatively Selected Plan measures

Restoration Measure	Goal: Restore and improve the quality and diversity of aquatic and island ecosystem resources within the study area		
	Obj 1: Restore depth and increase flow within Piasa Chute	Obj 2: Increase depth and connectivity of Piasa Island Backwater	Obj 3: Increase the spatial coverage of islands
Piasa Chute Aquatic Diversity	X		
Piasa Island Backwater Restoration		X	
Placement of New Notched Rock structure	X		
Island Restoration	X	X	X

The Tentatively Select Plan is illustrated in Figure 9-1, above. A detailed description of the project measures included in the Tentatively Selected Plan is provided in Chapter 4, and summarized in Table 10-2. The remainder of this chapter discusses the design, construction, and operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) considerations for the TSP.

10.1 Design Considerations

The study has been developed to a feasibility level of design. Design details are included in the technical appendices and plates. As with all feasibility level studies, these details will be refined in the Plans and Specifications (P&S) Stage.

10.1.1 Location

The study area is in Pool 26 between RM 207.5 and 211.5 in Jersey and Madison counties, Illinois.

Table 10-2. Piasa and Eagle's Nest Islands HREP Measure Summary of the Tentatively Selected Plan

Item	Quantity	Unit of Measure
Piasa Chute Braided Dredge Cut:		
Quantity Excavated	885,000	Cubic Yards
Average Bottom Width	200	Feet
Average Bottom Elevation	405.3	NAVD 88
Piasa Island Backwater Dredging:		
Quantity Excavated	156,000	Cubic Yards
Average Bottom Width	200	Feet
Average Bottom Elevation	405.3	NAVD 88
Rock Structure with two 400-foot wide notches		
Total Length (Island to Island)	3,100	Feet
Upstream Slope	2	H:1V
Downstream Slope	2	H:1V
Average Top Elevation	420.57	NAVD 88
Graded Stone A	42,400	Ton
Island Restoration		
Three Islands		
Quantity Capacity	177,000	Cubic Yards
Island Diversity	26	Acres
Stone Protection	60,700	Ton
Average Top Elevation	420.57	NAVD 88
Riverside Piasa Island		
Quantity Capacity	631,000	Cubic Yards
Island Diversity	43	Acres
Stone Protection	29,900	Ton
Average Top Elevation	422.57	NAVD 88
Upstream Rootless Island		
Quantity Capacity	233,000	Cubic Yards
Island Diversity	8	Acres
Stone Protection	56,000	Ton
Average Top Elevation	420.57	NAVD 88

10.1.2 Survey Data

The study area is in NAVD 88, IL West State Plane NAD 83, US Survey Feet. The elevation data used to create the AdH computational mesh was compiled using several datasets that covered both above and

below the waterline. The sources include a combination of Light Detection and Ranging surveys (LiDAR) and hydrographic surveys, which consisted of single beam surveys, multi-beam surveys, and Acoustic Doppler Current Profile surveys. LiDAR data are collected above the water surface while hydrographic or bathymetric surveys are used to collect elevation data below the water surface. Acoustic Doppler Current Profile surveys collected speed and distance data of the current within the Mississippi River in the study area. The surveys were merged together to create a single elevation dataset representing all areas above and below the waterline within the numerical model mesh domain (See Appendix C, *Hydrology and Hydraulics*). Minimum Pool at the study area is 415.12 NAVD 88 (RM 209).

It is recommended that the following data surveys and analyses be performed during Plans and Specifications prior to construction in order to obtain more accurate quantities:

- Channel Stability Analysis for Piasa Chute dredge cut
- Hydrographic surveys

10.1.3 Access

The study area is located within the Mississippi River, so all access will be by water. In order to access the excavation sites with traditional construction equipment, an access channel 30 feet wide and to a depth of 411.57 feet NAVD 88 (4 feet below minimum pool) would need to be constructed. All other work should have sufficient water depths for conventional construction equipment. River access can be obtained from the Piasa Harbor boat ramp near RM 210 on the Illinois bank. It is assumed that heavy material such as riprap or bedding stones would be transported by river from boat ramps closer to the quarries.

10.1.4 Excavated Material

Excavated material would be required to construct the island diversity measures. Prior to construction, sampling of the proposed excavations would be performed and evaluated for 401 Clean Water Act compliance per the Inland Testing Manual (ITM). During construction, if contaminated material is identified, the Corps would stop work and follow the steps outlined in ER 1165-2-132.

10.1.5 Public Access and Security

Safety and security are important parameters which would be detailed during the Plans and Specifications Phase. Of specific concern will be the coordination of regional hunting seasons with the construction season.

10.2 Construction Considerations

10.2.1 Protected Species

10.2.1.1 Bald Eagles

Consideration (in coordination with the USFWS) will be given during P&S preparation sequencing construction activities in a manner that minimizes impacts.

10.2.1.2 Indiana bat and Northern long-eared bat

Tree clearing is not anticipated at this time; however, if during P&S tree clearing is needed then additional consultation with USFWS would be required. Construction work would require tree clearing activities be scheduled outside April 1 to September 30 when the bats are known to inhabit summer habitat. If tree clearing activities must occur during this period, coordination with USFWS will occur. At a minimum, a site visit by a team of biologists will be required to determine if any roost trees are among

those trees proposed for removal. If removal of a roost tree is proposed, then the District must enter into Section 7 consultation with the USFWS. The consultation will determine if the proposed action is likely to jeopardize the continued existence of the Indiana bat or Northern long-eared bat.

10.2.1.3 Migratory Wildlife

The development of P&S will attempt to minimize disruption of migratory wildlife during fall and early winter.

10.2.2 Permits

Laws of the United States and the State of Illinois have assigned the Corps, Illinois EPA, and Illinois DNR with specific and different regulatory roles designed to protect the waters within and on the State's boundaries. Protecting Illinois' waters is a cooperative effort between the applicant and regulatory agencies.

The basis for the Corps' regulatory functions over public waterways was formed in 1899 when Congress passed the Rivers and Harbors Act of 1899. Until 1968, the Rivers and Harbors Act of 1899 was administered to protect only navigation and the navigable capacity of this Nation's waters. In 1968, in response to a growing national concern for environmental values, the policy for review of permit applications with respect to Sections 9 and 10 of the Rivers and Harbors Act was revised to include additional concerns (fish and wildlife, conservation, pollution, aesthetics, ecology, and general welfare) besides navigation. This new type of review was identified as a "public interest review."

The Corps' regulatory function was expanded when Congress passed the Federal Water Pollution Control Act Amendments of 1972. The purpose of the Federal Water Pollution Control Act was to restore and maintain the chemical, physical, and biological integrity of this Nation's waters. Section 402 of the Act established the National Pollutant Discharge Elimination System (NPDES) to regulate industrial and municipal source discharges of pollutants into the Nation's waters. The NPDES permit program is administered by the Illinois EPA (ILEPA) and should not be confused with the Corps of Engineer's Section 404 permit program. Section 404 of the Federal Water Pollution Control Act (now called the Clean Water Act due to amendments in 1977) established a permit program to be administered by the Corps of Engineers to regulate nonpoint source discharges of dredged or fill material into waters of the United States.

The IDNR is the state agency that administers permit programs for conserving and protecting Illinois' water, recreational and environmental resources, and for the prevention of damage resulting from unwise floodplain development under Illinois state law. All proposed restoration measures have been designed to be in voluntary compliance with the policies behind Illinois state law.

Under Illinois state law, IDNR-Office of Water Resources (IDNR-OWR) has authority to regulate construction on all floodplains and floodways in the state, per the Rivers, Lakes, and Streams Act of Illinois. The IDNR-OWR administrative rules explain when a permit must be obtained for various types of floodway/floodplain development. Any person who plans to perform or allow such floodplain construction has a duty to contact the IDNR to determine if a floodplain construction permit is required under Illinois law. The District will coordinate with IDNR as required by all laws applicable to the study area.

10.2.2.1 Section 404 /401 Compliance

The District is compliant with Section 404 of the Clean Water Act based upon the 404(b)(1) evaluation (Appendix I, *Clean Water Act*). ILEPA Section 401 water quality certification is mandatory for all projects

requiring a Federal Section 404 permit. Section 401 water quality certification is the ILEPA's concurrence that a project is consistent with the state's water quality standards. Short- and long-term impacts to water quality and water-related uses are evaluated in the Section 401 certification review. A Section 401 water quality certification would be obtained as part of the 404(b)(1) process.

10.2.2.2 National Pollutant Discharge Elimination System (NPDES)

A storm water discharge or NPDES permit for construction activities may be required. Effective March 10, 2003, the NPDES storm water discharge permit is required when a construction activity disturbs more than one acre. The construction contract for the study area may trigger the need for the contractor to apply for this permit. With or without the permit, the Corps requires an environmental plan that addresses contaminants as well as erosion control measures. The contractor would be required to prepare an erosion control plan to ensure that unprotected soil is not allowed to leave the study area work limits. The contractor would be required to comply with all local codes and permit requirements.

10.2.3 Construction Material

Only common construction materials are required for this project and can likely be obtained from local sources. Materials used for placement sites and pad construction include excavated material. Quarry-grade riprap and/or stone will be used for the river training structures and stone protection measures.

10.2.4 Construction Schedule Constraints

Scheduling of construction contracts would depend on availability of funds, and based on expected funding, it is likely that the contract would be awarded in at least two construction contracts.

The following information indicates various scheduling constraints and must be confirmed and evaluated during P&S:

- At this time, tree clearing is not anticipated but if determined it is required during P&S, then additional consultation with the USFWS would be required. If tree clearing is needed then no clearing of trees greater than 3 inches in diameter with loose peeling bark shall be allowed between April 1 and September 30 (during Indiana Bat and Northern-Long-Eared bat breeding and rearing season).
- Coordination with IDNR personnel is required prior to working during the seasonal waterfowl and deer hunting seasons. During peak hunting weekends or dates, all construction activities may be required to cease for a short period of time.
- At this time, tree clearing is not anticipated but if determined it is required during P&S, then additional consultation with the USFWS would be required. If tree clearing is needed then no clearing of trees where roosting or occupied nests exist shall be allowed when bald eagles or red-shouldered hawks are present in the area. Although there are known nest sites, currently, none are known to exist within 660 feet of the selected measures. If any nesting activity is observed, no construction activities within 660 feet of the nest shall be allowed.
- In accordance with Executive Order 13186, take of migratory birds protected under the Migratory Bird Treaty Act should be avoided or minimized, to the extent practicable, to avoid adverse impacts on migratory bird resources.

10.2.5 Construction Sequence

The probable construction sequence is summarized in Table 10-3; however, no sequence will be required contractually.

Table 10-3. Proposed Construction Sequence

Sequence	Construction	Duration	Start	Finish
Phase 1	Dredging & Island Building	360 days	12/1/2019	7/3/2020
Phase 2	Dredging & Island Building	240 days	2/1/2020	1/8/2021
Phase 3	Notched Rock Structure	210 days	2/1/2021	11/30/2021

10.3 Operational Considerations

Operation and maintenance of UMRR habitat projects is similar to that undertaken by the partner agencies in day-to-day management of parks, boat ramps, wildlife management areas and other such public use areas. Habitat projects are designed and constructed to operate for 50 years with proper maintenance.

The Study was designed to reduce overall operation costs. In general, operation is limited to routine inspections to ensure that the measures are performing as designed. Annual operations costs are shown in Chapter 12, *Cost Estimates.* A complete list of operation needs will be provided in the Study's OMRR&R Manual after construction completion.

10.4 Maintenance Considerations

The proposed measures have been designed to ensure low annual maintenance requirements. Maintenance will include removing vegetation and debris from the notched rock structure and the stone protection on the restored island. The estimated annual maintenance costs are presented in Chapter 12, *Cost Estimates.* Maintenance requirements will be further detailed in the Study's OMRR&R Manual after construction.

10.5 Repair, Rehabilitation, and Replacement Considerations

Repair, rehabilitation, and replacement considerations may extend outside the typical 50-year period of analysis, as the Project sponsor is expected to maintain the HREP until it is no longer authorized and should expect to incur costs associated with the responsibility outside of the 50-year period of analysis. Rehabilitation cannot be accurately measured during the design or construction phase. Rehabilitation is reconstructive work that significantly exceeds the annual operation and maintenance requirements and is needed as a result of major storm or flood events. Repair, Rehabilitation, and Replacement considerations are presented in Chapter 12, *Cost Estimates.*

10.6 Value Engineering

A Value Engineering Study is anticipated during the Plans & Specifications development phase of the Study in accordance with ER 11-1-321. However, per implementation guidance Section 1004 of the Water Resources Reform and Development Act (WRRDA) of 2014, Removal of Duplicative Analysis (2017) conducting a Value Engineering Study for water resources planning (feasibility) studies was rescinded; therefore, a Value Engineering Study was not conducted during the feasibility study.

11 Schedule for Design & Construction

Table 11-1 presents the schedule for the completion of the feasibility study. The proposed construction schedule is shown in Table 11-2.

Table 11-1. Tentative Feasibility Study Schedule

Event	Scheduled Date
District Quality Control #1 – Feasibility	December 2014
HSR Model Completion	October 2015
District Quality Control #2 – Feasibility	February 2017
Agency Technical Review of Draft Report #1	February 2018
MSC Decision Milestone	April 2018
Public and Agency Review of Draft Report	May 2018
Submit Final Feasibility Report to Mississippi Valley Division (MVD)	July 2018
Approval of Final Feasibility Report from MVD	Sept 2018
Execute the Memorandum of Agreement with Sponsor	Feb 2019
Initiate Design	October 2019
Complete Construction	September 2025
Complete OMRR&R Manual	December 2025

Table 11-2. Tentative Project Design and Construction Schedule

Task	START DATE	END DATE
Phase I		
Plans & Specs	Oct 2019	May 2021
Acquisition	June 2021	Sept 2021
Construction	Oct 2021	Sept 2022
Phase II		
Plans & Specs	Oct 2021	May 2022
Acquisition	June 2022	Sept 2023
Construction	Oct 2023	Sept 2024
Phase III		
Plans & Specs	Oct 2023	May 2024
Acquisition	June 2024	Sept 2024
Construction	Oct 2024	Sept 2025

12 Cost Estimates

The preliminary estimated total first cost of the study was updated after Alternative 4 was identified as the Tentatively Selected Plan. The updated estimated total first cost of the TSP is $26,746,000 and is anticipated to yield 430.1 net AAHUs. Using the Fiscal Year 2018 Federal discount rate of 2.75%, this results in an average annual cost of $2,345 per AAHU. Table 12-1 shows the estimated Project First Cost. The detailed estimate of the project design and construction costs are provided in Appendix J, *Cost Estimate;* however, due to the sensitivity of providing this detailed cost information which could bias construction contract bidding, this material will be omitted prior to public review. Quantities and costs may vary during final design. All cost estimates are calculated using the FY2017 fiscal year pricing. Annualization used the FY 2018 discount rate of 2.75%.

Table 12-1. Project First Cost Estimates. (October 2017 Price Level – 50 year period of analysis using a 2.75% discount rate for FY2018)

Account Code		Project Cost
01	Lands and Damages	$0[1]
06	Fish & Wildlife Facilities	$20,541
30	Planning, Engineering, & Design	$3,927,000
31	Construction Management	$2,167,000
	TOTAL PROJECT FIRST COSTS	**$26,746,000**
	Annualized Construction Cost	$990,696
	Interest During Construction	$0[2]
	Annualized OMRR&R	$5,850
	Annualized Monitoring & AM	$12,000
	Total Annualized Cost	$1,008,546

[1] Restoration measures are on federally controlled waters; consequently, there are no lands and damages or relocation costs

[2]Project could be completed in 1 year or less without funding constraints; however, due to normal limits for this program it was anticipated to take 3 years to construct. Current cost numbers do not include IDC which is in alignment with planning directives regarding evaluating projects based on an engineeringly constructible schedule in absence of funding constraints.

13 Project Performance Evaluation & Adaptive Management

This chapter summarizes the project performance evaluation and adaptive management needed to assess the habitat changes resulting from the implementation of the Piasa and Eagle's Nest Islands study. The project performance evaluation is designed to gauge progress toward meeting the project objectives.

Per Section 2039 of WRDA 2007, monitoring for ecosystem restoration studies will be conducted to determine project success, and is defined as:

> *The systematic collection and analysis of data that provides information useful for assessment of Project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed to attain Project benefits.*

The implementation guidance for Section 2039, in the form of a CECW-PB Memo dated 31 August 2009, also requires that an adaptive management plan be developed for all ecosystem restoration projects. At the programmatic level for UMRR, knowledge gained from monitoring one project can be applied to other projects. Opportunities for this type of adaptive management are common within the UMRR.

The primary incentive for implementing an adaptive management plan is to increase the likelihood of achieving desired project outcomes given the identified uncertainties, which may include incomplete description and understanding of relevant ecosystem structure and function; imprecise relationships among project management actions and corresponding outcomes; engineering challenges in implementing project alternatives; and ambiguous management and decision-making processes.

The restoration measures in the considered alternatives have been operating successfully for over 30 years at several locations within the UMRS. The *UMRR HREP Design Handbook* (2012) documents lessons learned and success stories from other HREPs throughout the UMRS that have implemented dredging, river training structures, and island building. Using an adaptive management approach during planning and design of the Piasa and Eagle's Nest Islands HREP will ensure that the considered alternatives represent the most effective design and operation to achieve project goal and objectives. As with other HREPs implemented through UMRR, a monitoring and performance evaluation plan has been developed, and the results of the plan will be used to measure success of the project and determine whether adjustments in operation may be made to promote its success.

The monitoring and adaptive management plan was developed with input from state and Federal resource agencies and is detailed in Appendix L, *Monitoring and Adaptive Management*. Performance indicators were developed to measure the success of project objectives. The indicators were developed to be specific, measurable, attainable, realistic, and timely. The project objectives, performance indicators, monitoring target, time of effect, frequency of monitoring, adaptive management triggers, and responsibilities of monitoring and data collection are summarized in Table 13-1. Per Section 2039 guidance, monitoring costs (not to exceed 10 years after project construction) were considered as part of project costs.

The monitoring information will be compiled, reviewed, and summarized in a Performance Evaluation Report that will be written 5 years after data collection has started. This report will evaluate the performance of the constructed measures in meeting the objectives of the Piasa and Eagle's Nest Islands HREP.

Table 13-1. Summarized performance evaluation plan

Obj	Measure	Performance Indicator	Monitoring Target (Desired Outcome)	Years 1-5	Year 25	Year 50	Measurement	Responsible Party
Restore depth and increase flow within Piasa Chute	Piasa Chute Aquatic Diversity (D1) Notched Rock Structure (R1)	Bathymetric diversity	% of side channel ≥ 8 feet deep	>75%	>65%	>50%	Hydrographic survey	Corps
		Average current velocity	>2.0 ft/sec	>2.0	>2.0	>2.0	ADCP survey	Corps
		Minimum dissolved oxygen (mg/L)	> 5.0 mg/L	>5.0	>5.0	>5.0	Seasonal WQ	UMRR-LTRM
		Native fish assemblage	Increase in abundance (CPUE) over existing conditions of fish species preferring flowing habitat (i.e., fluvial specialists and dependents)	Increase	Increase	Increase	Seasonal Electrofishing	UMRR-LTRM
		Mussels	Mussel density (individuals per m^2) of Piasa Head Bed and Piasa Toe Bed maintained/ improved	>1.5/m^2 (Piasa Head) >5.5/m^2 (Piasa Toe)	>1.5/m^2 (Piasa Head) >5.5/m^2 (Piasa Toe)	>1.5/m^2 (Piasa Head) >5.5/m^2 (Piasa Toe)	Mussel dive survey	Corps
Increased depth and connectivity of Piasa Island Backwater	Piasa Island Backwater (B1)	Bathymetric Diversity	% of backwater ≥ 5 feet deep	≥ 15%	>12%	>10%	Hydrographic survey	Corps
		Minimum dissolved oxygen (mg/L)	> 5.0 mg/L	>5.0	>5.0	>5.0	Seasonal WQ	UMRR-LTRM
		Native fish assemblage	Increase in abundance (CPUE) over existing conditions of fish species preferring slackwater habitat	Increase	Increase	Increase	Seasonal Electrofishing	UMRR-LTRM
		Connectivity	% of year Piasa Island Backwater is connected to main channel	>90%	>80>	>70%	Visual observations; Gage readings	Sponsor/ Corps
Increase aerial coverage of islands	Restored Islands (I1)	Acres of island	Acres of restored islands > 420.57 ft NAVD 88	>75 acres	> 65 acres	>60 acres	Hydrographic surveys and aerial photos	Corps
		Vegetative Cover	% cover of woody vegetation taller than 5 feet	<15%	<25%	<50%	Visual observations	Corps

14 Real Estate Requirements

The Piasa and Eagle's Nest Islands HREP is part the UMRR Program authorized by Section 1103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended. The study area is located within the Mississippi River in Pool 26 between RM 207.5 and 211.5.

All restoration measures and activities are located on federally managed lands and waters and as such, the project first cost will be 100% federal. Currently USACE and USFWS are in the process of adding the study area to the General Plan Lands Agreement between the USACE and the USFWS, subsequently to the Cooperative Agreement For Management of USACE General Plan Lands between the USFWS and IDNR (Appendix A, Authorization and Agreements). Per these agreements the Illinois Department of Natural Resources (IDNR) will manage the lands and waters as a national wildlife refuge to enhance fish and wildlife. Responsibility for the operation, maintenance, rehabilitation, replacement, and repair would be the responsibility of IDNR.

There are no proposed Public Law 91-646 relocations as there are no acquisitions required.

All placement materials would be excavated from within study area waters and the ordinary high water mark.

Access to the study area would be by water (Mississippi River) from a public boat ramp located adjacent to the study area near Piasa Harbor.

There are no known hazardous, toxic, or radioactive sites within the study area.

Additional real estate requirements are provided in Appendix M*, Real Estate Plan*.

15 Implementation Responsibilities and View

15.1 U.S Army Corps of Engineers

The Corps is responsible for study management and coordination with the IDNR and other affected agencies. The Corps will submit the feasibility report; program funds; finalize plans and specifications; complete all NEPA requirements; advertise and award a construction contract; and perform construction contract supervision and administration. Construction of the HREP using the power of navigational servitude is appropriate due to ancillary benefits to navigation. The Corps has agreed to support this HREP's monitoring and data collection needs as outlined earlier in this report.

15.2 U.S. Fish and Wildlife Service

The USFWS is the Federal project sponsor and is responsible for providing comments for this study pursuant to the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and the Endangered Species Act of 1973, as amended (See Appendix B, Coordination). The draft Fish and Wildlife Coordination Act Report was received 26 May 2017 (See Appendix B, Coordination). The project will be constructed at 100 percent Federal cost; therefore a formal Project Cooperation Agreement is not required. Currently USACE and USFWS are in the process of adding the study area to the General Plan Lands Agreement between the USACE and the USFWS, subsequently to the Cooperative Agreement For Management of USACE General Plan Lands between the USFWS and IDNR (Appendix A, Authorization and Agreements). Per these agreements the Illinois Department of Natural Resources (IDNR) will manage the lands and waters as a national wildlife refuge to enhance fish and wildlife.

15.3 Illinois Department of Natural Resources

The IDNR is the project sponsor and has provided technical and other advisory assistance during all phases of the project and will continue to provide assistance during project implementation. The Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R) of the project is the responsibility of the IDNR in accordance with Section 107(b) of WRDA 1992, Public Law 102-580. The annualized OMRR&R costs are estimated at $5,850. These functions will be further specified in the project OMRR&R Manual to be provided by the Corps prior to final acceptance of the HREP by the sponsor. The IDNR has agreed to support this HREP's monitoring and data collection needs as outlined earlier in this report.

16 Conclusions*

Full realization of the potential habitat value in Piasa and Eagle's Nest Islands has been hindered by loss of depth and flow into Piasa Chute, loss of connectivity between the Piasa Island Backwater and the main channel of the Mississippi River, loss of islands due to inundation caused by impoundment, and the subsequent degradation of aquatic resources. Establishing connectivity between the backwater and main channel would contribute to overwintering fish habitat as well as feeding areas for migratory wildlife; providing bathymetric diversity and flow within Piasa Chute would provide important side channel habitat within Pool 26; and restoring historic islands would allow the study area to realize the highest benefit to fish and wildlife.

The Tentatively Selected Plan restoration measures for Piasa and Eagle's Nest Islands (dredging, notched rock structure, and islands) are designed to meet the study's objectives of restoring and protecting side channel, backwater, and island habitats.

Assessment of the future-with-project scenario shows definite increases in total habitat units over the 50-year period of analysis for the evaluated species. These increases represent quantification of the projected outputs: improved habitat quality and increased preferred habitat quantity.

Furthermore, Piasa and Eagle's Nest Islands HREP is consistent with and fully supports the overall goals and objectives of the Upper Mississippi River Restoration Program.

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Certification of Legal Review

The Piasa and Eagle's Nest Islands Habitat Rehabilitation and Enhancement Project Draft Feasibility Report, including all associated documents required by law and regulation, has been fully reviewed by the Office of Counsel, St. Louis District and is approved as legally sufficient.

2/12/18
Date

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William P. Levins, District Counsel

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Keli N. Robertson, Asst. District Counsel

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UPPER MISSISSIPPI RIVER RESTORATION PROGRAM
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

PIASA & EAGLE'S NEST ISLANDS
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

Recommendations

I have weighed the outputs to be obtained from the full implementation of the Piasa and Eagle's Nest Islands HREP against its estimated cost and have considered the various alternatives proposed, impacts identified, and overall scope. In my judgment, this Project, as proposed, justifies the expenditures of Federal funds. I recommend that the Division Engineer approve the proposed project to include:

- Excavation of Piasa Chute
- Excavation of Piasa Island Backwater
- Notched rock structure between Piasa and Eagle's Nest Islands
- Construction of islands

The estimated Project First Cost, including general design and construction management, is $26,746,000.

_____ _____

Date

BRYAN K. SIZEMORE
COL, EN
Commanding

UPPER MISSISSIPPI RIVER RESTORATION PROGRAM
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

PIASA & EAGLE'S NEST ISLANDS
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

Finding of No Significant Impact

I have reviewed the information provided within this Feasibility Report with Integrated Environmental Assessment, along with data obtained from Federal and State agencies having jurisdiction by law or special expertise, and from the interested public. I find that the proposed ecosystem restoration project in Pool 26, Madison and Jersey Counties, Illinois, would not significantly affect the quality of the human environment. Therefore, it is my determination that an Environmental Impact Statement is not required. This determination may be re-evaluated if warranted by further developments.

The "No Federal Action" alternative was evaluated and is unacceptable to recommend as it does not meet the study goal and objectives. An array of restoration measures was considered from which action alternatives were derived. The measures include:

- Excavation of Piasa Chute
- Excavation of Piasa Island Backwater
- Notched rock structure between Piasa and Eagle's Nest Islands
- Construction of islands

Factors considered in making a determination that an Environmental Impact Statement was not required are as follows:

1. The Project is anticipated to improve the habitat value of Piasa and Eagle's Nest Islands for fish.
2. Aside from temporary disturbance, no long-term adverse impacts to natural or cultural resources are anticipated. No Federally-protected species would be adversely affected by the proposed action.
3. The Project complies with Sections 401 and 404 of the Clean Water Act.
4. The Project complies with Section 106 of the National Historic Preservation Act.
5. No significant social or economic impacts to the study area are expected.
6. No hazardous or toxic waste issues are expected.
7. No adverse significant cumulative impacts are anticipated.

_____ _____

Date

BRYAN K. SIZEMORE
COL, EN
Commanding

Appendices

Appendix A - Authorization & Agreements

Appendix B – Coordination

Appendix C - Hydrology & Hydraulics

Appendix D - Biological Assessment

Appendix E - Hazardous, Toxic, & Radioactive Waste

Appendix F - Historical & Cultural Resources

Appendix G - Habitat Evaluation & Quantification

Appendix H - Cost Effectiveness & Incremental Cost Analysis

Appendix I - Clean Water Act - 404(b)1 Evaluation

Appendix J - Cost Estimate Summary

Appendix K - DRAFT MEMORANDUM OF AGREEMENT

Appendix L - MONITORING AND ADAPTIVE MANAGEMENT

APPENDIX M - REAL ESTATE PLAN

Appendix N - Distribution List