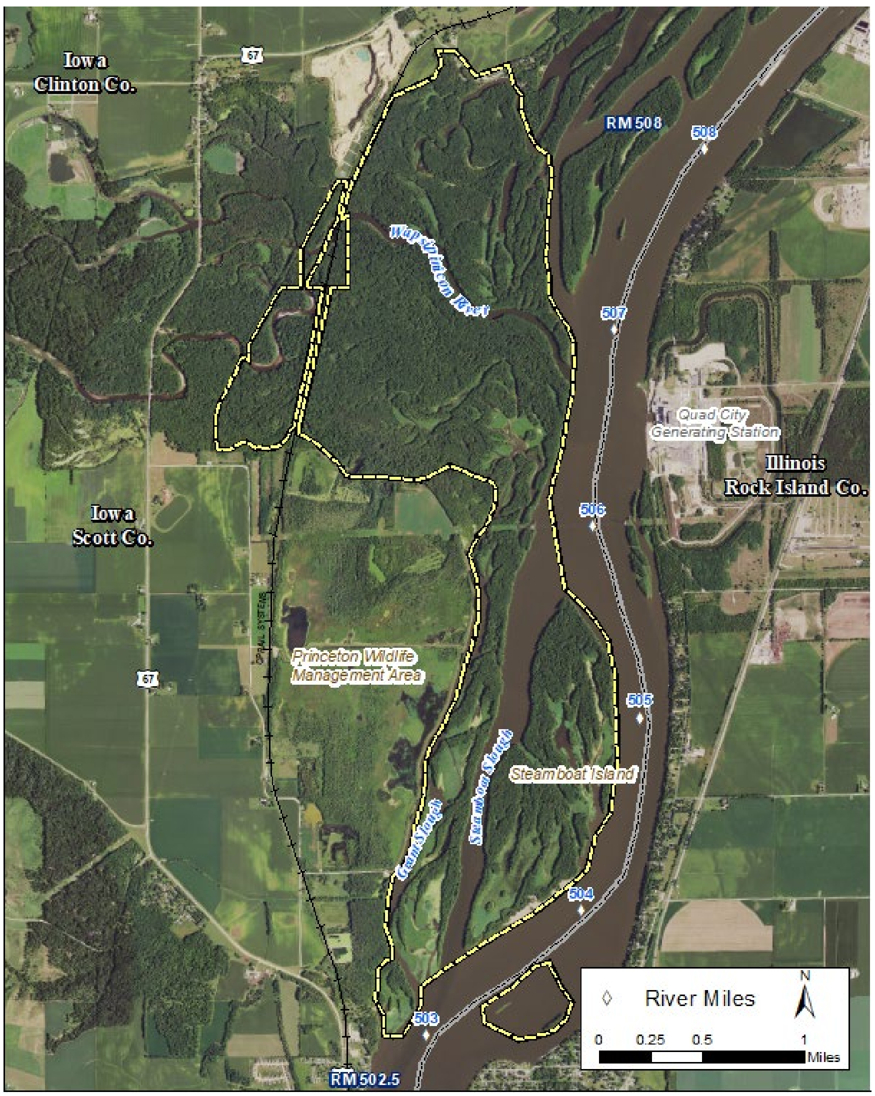
UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS



February 2021
Final Report

US Army Corps
of Engineers ®
Rock Island District

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EXECUTIVE SUMMARY

The *Steamboat Island Habitat Rehabilitation and Enhancement Project* (HREP) (Project) is located in Clinton & Scott Counties, Iowa, and Rock Island County, Illinois, in the middle section of Pool 14 of the Upper Mississippi River (UMR), between the town of Princeton, Iowa, river mile (RM) 502.5, and the Wapsipinicon River (RM 508.0). All Project lands are in Federal ownership and are managed by the U.S. Fish and Wildlife Service (USFWS) as part of the UMR National Wildlife and Fish Refuge (NWFR).

The Project area is comprised of approximately 2,620 acres of interconnected backwaters, secondary channels, wetlands, islands, floodplain habitat, and aquatic habitat. Though degraded, this important backwater area supports a diverse population of wildlife including waterfowl, migratory birds, fish, mussels, and mammals. Human activity within the UMR basin, floodplain, and channel has altered the hydrology, topography, and biotic communities present. Years of continual silt deposition has degraded aquatic and wetland habitats and, in some instances, converted them to low elevation terrestrial habitats characterized by reed canarygrass (*Phalaris arundinacea*) monocultures, a relatively low-quality habitat. Impoundment of the pool and permanently higher water elevations during the growing season have affected the health and diversity of floodplain habitat on islands and adjacent floodplain areas. Frequent inundation of floodplain forests are affecting forest composition and regeneration. All of these alterations have reduced the quality and diversity of aquatic and floodplain habitats and impaired ecosystem functions. Erosion and other stressors have reduced the acreage of Steamboat Island and other islands within Pool 14. While these stressors are likely to continue, as is the decline of the quality critical habitats, this Project provides an opportunity to restore the unique mosaic of habitats within the Project area and improve the quality, diversity, and sustainability of aquatic, wetland and floodplain habitats.

The goals of the Project are to maintain, enhance, and restore quality habitat for desirable native plant, animal, and fish species and maintain, enhance, restore, and emulate natural river processes, structures, and functions for a resilient and sustainable ecosystem. The objectives identified to meet these goals are to:

1. enhance and restore areal coverage and diversity of forest stands and habitat and increase diversity of bottomland hardwood forest, as measured in forested acres suitable to support hard mast species and structure, age, and species composition;

2. increase year-round aquatic habitat diversity, as measured by acres and limnophilic native fish use of overwintering habitat, as this habitat is the most limiting of seasonal habitats;

3. restore 50% of island acreage and topography lost since the 1950s and protect from erosion within the Project area, as measured by acres; and

4. protect existing backwater habitat from sediment deposition and enhance backwater and interior wetland areas, as measured by acres of backwater and survivability of scrub-shrub/pollinator habitat.

For planning purposes, the period of analysis was established as 50 years. Enhancement measures expected to achieve the Project goals and objectives include (see Figure ES-1):

- excavate channels and restore overwintering habitat in backwater areas;
- construct topographic diversity, to include forest, scrub/shrub, and pollinator habitat restoration and enhancement;
- implement Timber Stand Improvement techniques;
- restore and protect islands; and
- incorporate fish and mussel habitat, where appropriate.

Cost and habitat benefits were estimated for each measure. Habitat benefits were estimated using Habitat Evaluation Procedures. Cost Effectiveness & Incremental Cost Analyses were conducted to identify cost effective plans and reveal changes in cost for increasing levels of environmental outputs.

The Recommended Plan will restore backwater habitat on Steamboat Island proper and the Grant Slough complex by excavating backwater channels to a depth of 8 feet or more below flat pool to provide overwintering and year-round habitat for fish. Excavated material will be used to elevate portions of the Project area and enhance topographic diversity. The placement sites, located at existing sites of reed canarygrass monocultures, will be planted with native floodplain forest or scrub-shrub/pollinator habitat, providing significant environmental benefit. Other forest restoration actions will also occur, such as opening the forest canopy with TSI techniques to provide light to understory seedlings and saplings and interspersed tree plantings. A Grade Control Structure will be constructed at the northwest opening of the Cut-Through Channel on Steamboat Island proper to reduce the transfer of sediment and other materials into the southern portion of Steamboat Island, including Lower Lake. The northernmost end of Steamboat Island proper, which has been greatly eroded over time, will be restored and protected, as well as the northeast bank near Upper Lake. West Southeast Island, located southeast of Steamboat Island proper, which has also been greatly eroded over time, will be restored and protected. Where appropriate, fish and mussel habitat enhancement measures will be incorporated to bring further benefit to the species and communities that use the Project area. Implementation of the Recommended Plan will mimic pre-settlement conditions and restore the unique mosaic of habitats in the landscape and increase the quality and quantity of the bottomland hardwood forest, aquatic habitat, island acreage and topography, and backwater and interior wetland habitat, as well as provide important linkages between similar habitats in Pool 14. The Project outputs meet site management goals and objectives and support the overall goals and objectives of the UMRR Program and the UMR NWFR.

Section 906(e) of the 1986 Water Resources Development Act specifies that first-cost funding for enhancement measures located on lands managed as a national wildlife refuge will be 100% Federal. All Project measures will be located on federally-owned lands managed through a cooperative agreement with the USFWS; operation, maintenance, and repair of the lands will be the responsibility of the USFWS.

The Rock Island District's District Engineer has reviewed the Project outputs, a gain of 393.07 net Average Annual Habitat Units ($4,110 per Average Annual Habitat Unit), and determined that the implementation of the Recommended Plan is in the Federal interest. Therefore, the District Engineer recommends construction approval for the Steamboat Island HREP at an estimated construction expense of $26.4 million, including contingency and adaptive management measures. The total Estimated Cost, including planning, engineering and design, adaptive management measures, construction management, and contingency, is $33.6 million.

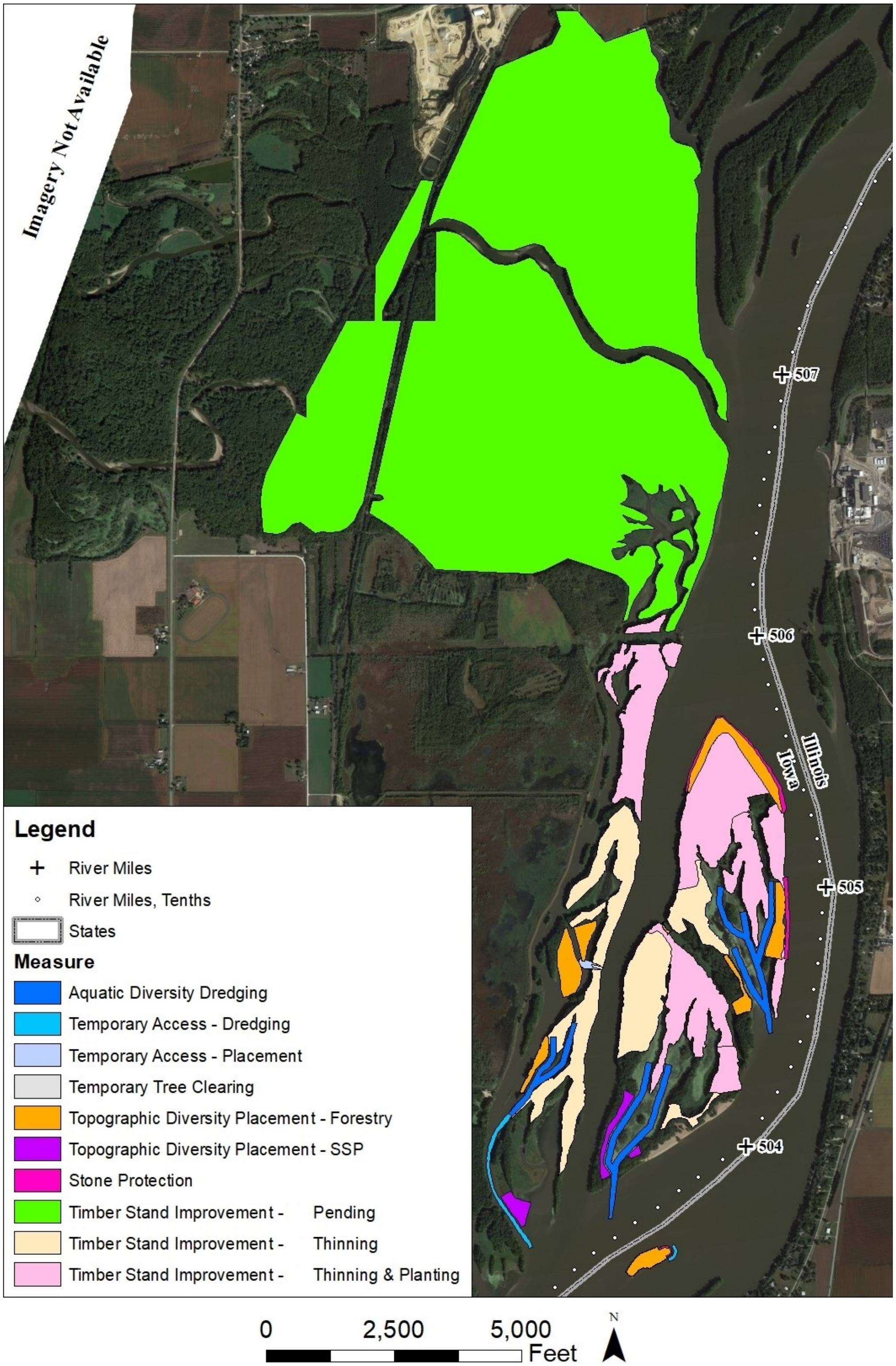

Figure ES-1. Project Measures

ACRONYMS

AAHU - Average Annual Habitat Unit

ADCP - Acoustic Doppler Current Profiler

AdH - Adaptive Hydraulics

APE - Area of Potential Effect

BIDEH - Biological Integrity, Diversity, and Environmental Health

CEDAS - Coastal Engineering Design and Analysis System

CEICA - Cost Effectiveness & Incremental Cost Analyses

CONUS - Continental United States

Corps - U.S. Army Corps of Engineers

CY – Cubic Yards

dbh - diameter at breast height

District - Rock Island District

DO - Dissolved Oxygen

DPR - Definite Project Report

EA - Environmental Assessment

EC - Engineering Circular

EHA - Essential Habitat Area

EPA – Environmental Protection Agency

ER - Engineer Regulation

ERDC -Engineering Research and Development

ESA - Environmental Site Assessment

ESA - Endangered Species Act

FEMA - Federal Emergency Management Agency

FWCA - Fish and Wildlife Coordination Act

FWIC - Fish and Wildlife Interagency Committee

GCS - Grade Control Structure

GIS - Geographic Information System

GCMs - Global Circulation Models

HEC-EFM - Hydrologic Engineering Center-Ecosystem Functions Model

HEP - Habitat Evaluation Procedures

HNA-II - Habitat Needs Assessment-II

HREP - Habitat Rehabilitation and Enhancement Project

HSI - Habitat Suitability Index

HTRW - Hazardous, Toxic, and Radioactive Waste

Iowa DNR - Iowa Department of Natural Resources

IDC – Interest During Construction

IL DNR - Illinois Department of Natural Resources

ISF - Iowa Site File

IWR - Institute for Water Resources

IWW - Illinois Waterway

L&D – Lock(s) and Dam

LiDAR – Light Detection and Ranging

LTRM - Long Term Resource Monitoring

MBTA - Migratory Bird Treaty Act

MSL - Mean Sea Level

MVD - USACE, Mississippi Valley Division

NAVD 88 - North American Vertical Datum of 1988

NGVD 29 - National Geodetic Vertical Datum

NEPA - National Environmental Policy Act

NRCS - Natural Resources Conservation Service

NRHP - National Register of Historic Places

NWFR -National Wildlife and Fish Refuge

NWRS – National Wildlife Refuge System

O&M - Operation and Maintenance

P&S – Plans & Specifications

PDT - Project Delivery Team

POR – Period of Record

QC - Quad Cities

REC - Recognized Environmental Condition

RM - River Mile

RRCT - River Resources Coordinating Team

SAV – Submersed Aquatic Vegetation

SHPO - State Historic Preservation Office

SMS - Surface Water Modeling System

SSP - Scrub-Shrub/Pollinator

TN – Ton

TPA – Trees Per Acre

TSI - Timber Stand Improvement

TSP - Tentatively Selected Plan

TSS – Total Suspended Solids

UMR - Upper Mississippi River

UMRR - Upper Mississippi River Restoration

UMRS - Upper Mississippi River System

UMRSFFS - Upper Mississippi River System Flow Frequency Study

URV - Unsubmerged Rigid Vegetation

USDA - United States Department of Agriculture

USFWS - U.S. Fish and Wildlife Service

USI - Upper Steamboat Island

WMA - Wildlife Management Area

WOWA - Weighted Order Weighted Average

WRDA - Water Resources Development Act

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PHOTOGRAPH

APPENDICES

SECTION I. INTRODUCTION

A. Location

The *Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP)* (Project) is located in Clinton and Scott Counties, Iowa, and Rock Island County, Illinois, in the middle section of Pool 14 of the Upper Mississippi River (UMR), between the town of Princeton, Iowa, river mile (RM) 502.5, and the Wapsipinicon River (RM 508.0) (Figure I-1). Areas considered as part of this Project and described as the Project area include Steamboat Island, Steamboat Slough, the adjacent secondary channel complex Grant Slough, smaller islands in the southeast portion of the Project area (West Southeast and East Southeast Islands), and the forested areas north and south of the Wapsipinicon River (Figure I-2). The Princeton State Wildlife Area (constructed as part of the Princeton Refuge HREP) is just west of the Project area. The Project area contains approximately 2,620 acres of interconnected backwaters, secondary channels, wetlands, islands, floodplain habitat, and aquatic habitat. Figures I-1 and I-2 and Plate 7 C-101 provide vicinity and specific location maps for the Project. All plates referenced in this document are included in Appendix P, *Plates.*

The Project lands, all of which are owned by the U.S. Army Corps of Engineers (Corps), Rock Island District (District), and the U.S. Fish and Wildlife Service (USFWS), are managed as a part of the UMR National Wildlife and Fish Refuge (NWFR) through a cooperative agreement between the USFWS and the Corps dated February 14, 1963, and an amended cooperative agreement dated July 31, 2001.

B. Purpose and Need

The District proposes to rehabilitate and enhance the Project area through construction of measures that will maintain, enhance, and restore quality habitat for native and desirable plant, animal, and fish species and maintain, enhance, restore, and emulate natural river processes, structures, and functions for a resilient and sustainable ecosystem. Though degraded, this important backwater area supports a diverse population of wildlife including waterfowl, migratory birds, fish, mussels, and mammals. Human activity within the UMR basin, floodplain, and channel has altered the hydrology, topography, and biotic communities present. Years of continual sediment deposition has degraded aquatic and wetland habitats and, in some instances, converted them to low elevation terrestrial habitats characterized by reed canarygrass monocultures, a relatively low-quality habitat. Impoundment of the pool and permanently higher water elevations during the growing season have affected the health of floodplain habitat on islands and adjacent floodplain areas. Frequent inundation of floodplain forests are affecting forest composition and regeneration. The largest concern is that without intervention, the Project area is likely to experience forest fragmentation and a continued influx of invasive species; essentially transitioning from forest to a reed canarygrass monoculture over time (Guyon et al., 2012). All of these alterations have reduced the quality and diversity of aquatic and floodplain habitats and impaired ecosystem functions. Erosion and other stressors have reduced the acreage of Steamboat Island and other islands within Pool 14. While these stressors are likely to continue, as is the decline of the quality critical habitats, this Project provides an opportunity to improve the quality, diversity, and sustainability of aquatic, wetland and floodplain habitats.

This Feasibility Report with Integrated Environmental Assessment (EA) presents a detailed account of the planning, engineering, construction details, and environmental considerations that resulted in the Recommended Plan.

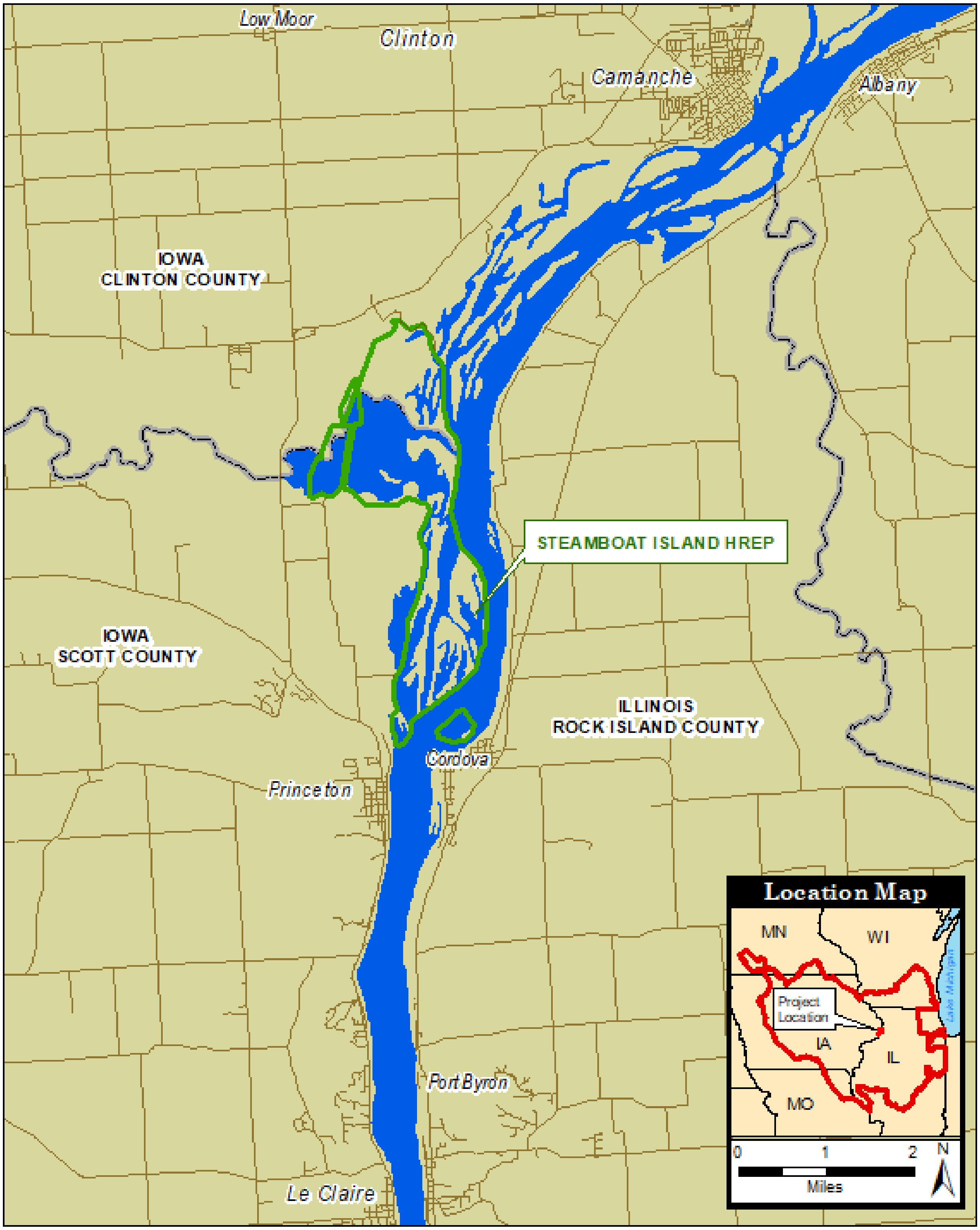


Figure I-1. Vicinity Map

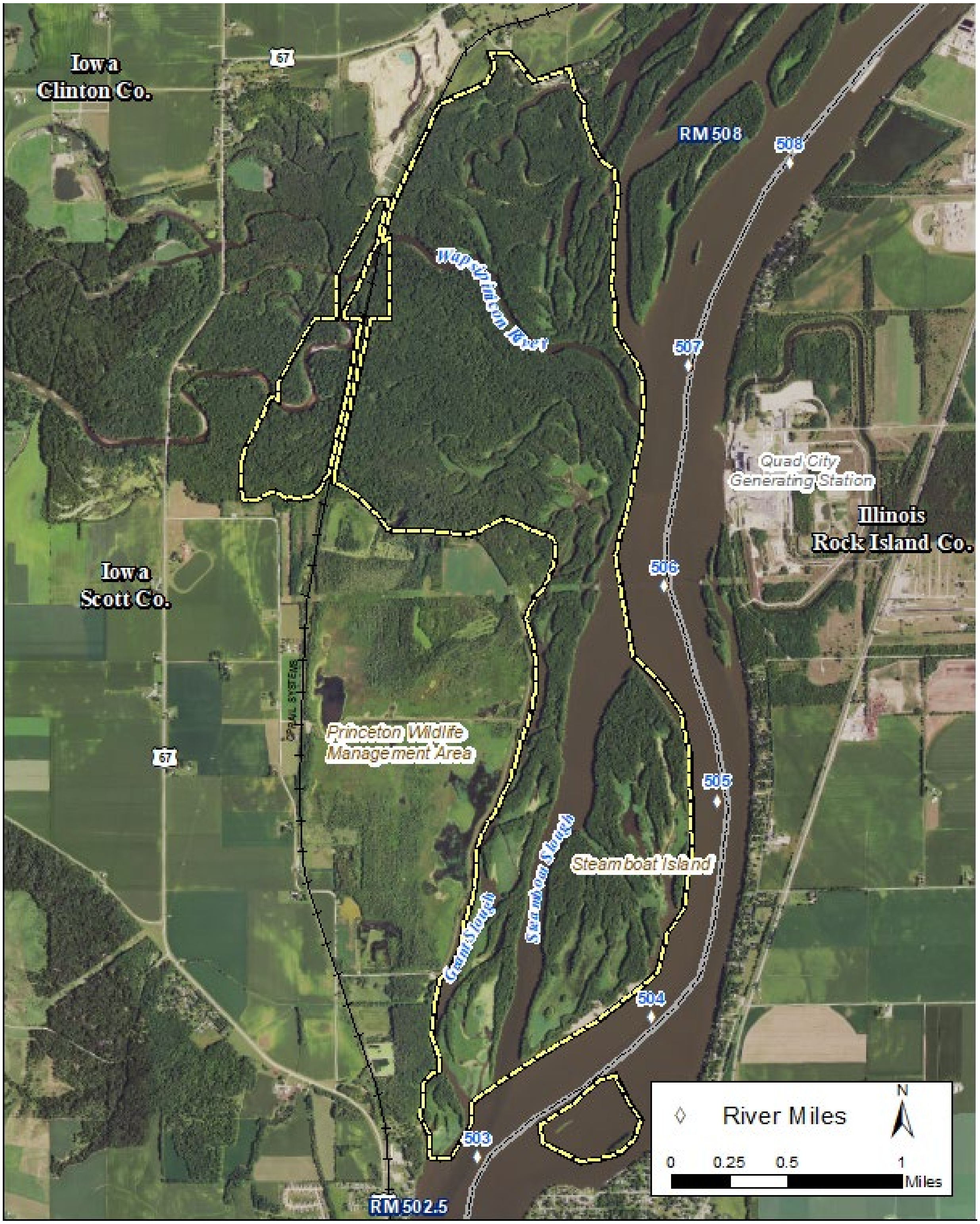


Figure I-2. Project Area Map

The need for rehabilitation and enhancement of the site is based on the following factors:

- Islands in the Project area have eroded and degraded over the course of time, as higher water levels, wind fetch, and erosion have caused loss in acreage and habitat quality.

- The existing topography has limited conditions suitable for forest and scrub-shrub/pollinator vegetation diversity and frequent inundation of the floodplain has affected natural regeneration. Consequently, quality floodplain forest and vegetation growth and survival are reduced. Without action, floodplain habitat will decrease in diversity through succession to silver maple, open canopy, and/or invasive species.

- The existing backwater aquatic habitat currently lacks adequate fish overwintering habitat conditions important for year-round habitat functioning. Without action, the available overwintering habitat will continue to decrease.

C. Project Selection

The Upper Mississippi River Restoration (UMRR) Program, authorized by the Water Resources Development Act (WRDA) of 1986 under Section 1103 and extended indefinitely by the WRDA of 1999, is a Federal-State partnership program for planning, construction and evaluation of fish and wildlife habitat rehabilitation projects and for monitoring the natural resources of the river system. It is a regional program that includes the Corps' St. Paul, Rock Island, and St. Louis Districts. Interagency groups in each of the Corps Districts, such as the Fish and Wildlife Interagency Committee (FWIC) and River Resources Coordinating Team (RRCT), identify, prioritize and select the rehabilitation projects. Field managers from the aforementioned interagency groups determine the areas that have degraded aquatic, wetland, and bottomland forest habitats and which UMRR-authorized objectives are priority for the area. The Federal Sponsor, the USFWS, with support from the non-Federal Project Partner, the Iowa Department of Natural Resources (Iowa DNR), nominated the Steamboat Island HREP for inclusion in the Corps' UMRR Program. The FWIC, a committee of state and Federal natural resource specialists working on Pools 11-22, then ranked the Project habitat benefits based on critical habitat needs along the UMR and the Illinois Waterway (IWW).

After considering resource needs and deficiencies pool by pool, the FWIC and the RRCT supported and recommended the Project as providing significant aquatic, wetland, and floodplain benefits with opportunities for habitat enhancement. The Mississippi Valley Division (MVD) approved the original Fact Sheet on September 20, 2010. A revised Fact Sheet, which included an expanded Project area (additional 2,100 acres) to allow for maximum rehabilitation and enhancement activities, was approved on May 22, 2018.

D. Implementation Responsibilities

Participants in the planning of the Steamboat Island HREP included the Corps, USFWS, Iowa DNR, and IL DNR (Table I-1). Under Federal regulations governing the implementation of NEPA, USFWS is a cooperating agency. Development of this Feasibility Report was actively coordinated with the participants during team meetings, phone conversations, and on-site visits to the Project area (Appendix A, *Correspondence*).

Table I-1. Participants in the Planning of the Steamboat Island HREP

U.S. ARMY CORPS OF ENGINEERS		
Marshall Plumley	Program Manager	Program Manager
Julie Millhollin	Project Manager	Project Manager
Rachel Perrine	Lead Planner	Study Manager, Plan Formulation
Davi Michl	Biologist	Environmental/HEP/Adaptive Mgmt
Lucie Sawyer	Hydraulic Engineer	Hydrology/Hydraulics
Anton Stork	Hydraulic Engineer	Hydrology/Hydraulics
Elizabeth Bruns	Hydraulic Engineer	Water Quality
Diane Karnish	Economist	Economics
Christine Nycz	Archaeologist	Cultural Resources
Felix Castro	Engineer	Geotechnical
John Lacina	Engineer	Costs & Specs
Kyle Nerad	Engineer, Technical Lead	Civil/Design
Stephen Gustafson	Environmental Protection Specialist	HTRW
Samuel Bailey	Real Estate	Real Estate
Kaileigh Thomas	Geographer	GIS
U.S. FISH AND WILDLIFE SERVICE		
Sharonne Baylor	Environmental Engineer	UMR NWFR
Ed Britton	Refuge Manager	UMR NWFR, Savanna District
Nate Williams	Deputy Refuge Manager	UMR NWFR, Savanna District
Sara Schmuecker	Fish and Wildlife Biologist	IL-IA Ecological Services Office
Tyler Porter	Fish and Wildlife Biologist	IL-IA Ecological Services Office
James Myster	RHPO/Archaeologist	Regional Office
DEPARTMENTS OF NATURAL RESOURCES		
Kirk Hansen	Mississippi River Habitat Coordinator	Iowa DNR
Scott Gritters	Fisheries Biologist	Iowa DNR
Matt O'Hara	Middle Mississippi River Biologist	IL DNR

U.S. Army Corps of Engineers, Rock Island District. The District is responsible for Project management and coordination with the Sponsor, Project partners, and other affected agencies. The District will submit the Feasibility Report; program funds; finalize Plans & Specifications (P&S); complete all NEPA requirements; advertise and award a construction contract; and perform construction contract supervision and administration. Section 906(e) of WRDA 1986 states that first cost funding for enhancement measures will be 100% Federal cost because the Project measures will be located on federally-owned land that is managed by the USFWS as a national wildlife refuge.

U.S. Fish and Wildlife Service. Because the project would be located on land managed by the UMR NWFR, the Regional Director of the USFWS, Region 3, will determine whether the project is compatible with Refuge goals and objectives and the Refuge Comprehensive Conservation Plan. The USFWS Regional Director will also determine if the USFWS approves the selected alternative for potential implementation and if the USFWS will assume operation and maintenance responsibilities. The Regional Director will also determine, based on the facts and recommendations contain herein, whether the final integrated Feasibility Report and EA meets the USFWS's obligation under NEPA, the Fish and Wildlife Coordination Act (FWCA) of 1965, the Endangered Species Act (ESA) of 1973, the Migratory Bird Treaty Act of 1918, and the Bald Eagle Protection Act of 1940. The USFWS has been a cooperating agency in the preparation of this EA and has been integral in the decision making process for the Feasibility Report.

The USFWS is the Federal Sponsor and has provided a Coordination Act Report. Operations and Maintenance, as described in Section VIII, *Cost Estimates*, Tables VIII-5 and VIII-6, is the responsibility of the USFWS in accordance with Section 107(b) of WRDA 1992, Public Law 102-580. The Corps will further specify these functions in the Project Operations and Maintenance (O&M) Manual, which will be provided after construction completion and prior to transferring the Project to the USFWS.

Upon completion of the construction as determined by the District Engineer, the USFWS shall accept the Project as part of the General Plans lands managed by the USFWS. The USFWS shall operate, maintain, and repair the Project as defined in this Report; 100 percent of all costs associated with the operation, maintenance, and repair of the Project will be borne by the USFWS.

Iowa Department of Natural Resources. The Iowa DNR, a non-Federal Project partner, has provided technical and other advisory assistance during all phases of the Project and will continue to provide assistance during implementation and monitoring.

Illinois Department of Natural Resources. The IL DNR, a non-Federal Project partner, has provided technical and other advisory assistance for measures in the Illinois portion of the Project area and will continue to provide assistance during implementation and monitoring.

E. Scope of Study

The scope of this study focuses on proposed Project measures that will increase the quality and quantity of the bottomland hardwood forest, aquatic habitat, island topography, and backwater and interior wetland habitats, provide important linkages between similar habitats in Pool 14, and enhance overall resource values. The Project is consistent with agency management goals and was planned for the benefit of resident and migratory birds, fish, and other wildlife. Field surveys and inventories, aerial photography, topographic surveys, Light Detection and Ranging (LiDAR) surveys, bathymetry surveys, wildlife and fisheries surveys, hydraulic modeling, soil borings, and habitat quantification procedures were completed to support the planning and assessment of proposed Project alternatives. Baseline water quality monitoring was performed to define present water quality conditions. A forest inventory was initiated in 2018 to evaluate the species composition and average age of the existing forest. These observations and surveys accomplished by the District, USFWS, and Iowa DNR, along with future studies and monitoring, will assist in evaluating Project performance.

F. Discussion of Prior Studies, Reports, and Existing Water Projects

The following summarizes prior studies, reports, and projects completed using UMRR authorities and which provided valuable information, experience, or guidance in the planning and/or design of the Project. Additional literature cited can be found in Appendix L and at the end of each Appendix.

Upper Mississippi River System-Environmental Management Program, Pool 14, Beaver Island HREP. This HREP is located in Clinton County, Iowa, upstream of the Steamboat Island Project at RMs 513.0 through 517.0. The Feasibility Report was completed in 2017 and construction began in 2019. This HREP was used to inform the Project during the planning phase in regards to resource data and feasibility-level design of restoration measures; it will continue to be used to inform the Project regarding the design of aquatic diversity elements and other lessons learned from construction and monitoring of that HREP.

Upper Mississippi River System-Environmental Management Program, Pool 14, Princeton Refuge HREP. This HREP is located in Scott County, Iowa, adjacent to the Steamboat Island HREP at RMs 504.0 through 506.4. The Definite Project Report (DPR) was completed in 1995 and construction was completed by 2002, with subsequent O&M manuals and inspection reports completed. As this HREP is immediately adjacent to the Project, it was used during the planning phase in regards to resource data and considered for incorporation of restoration efforts.

Upper Mississippi River Restoration-Environmental Management Program, Pool 18, Huron Island HREP. This HREP is located in Des Moines County, Iowa, downstream of the Steamboat Island Project at RMs 421.2 through 425.4. The DPR was completed in 2013 and is currently under construction. This HREP was used to inform the Project during the planning phase in regards to feasibility-level design of restoration measures and lessons learned from construction and monitoring, since it is currently under construction.

***Status and Trends of Selected Resources of the Upper Mississippi River System: A Report of the Long Term Resource Monitoring Program*.** U.S. Geological Survey (USGS), Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin. 2008. Monitoring data is summarized for 24 indicators of the ecological condition of the UMR System (UMRS) and Illinois River into one report, alongside historical observation and other scientific findings. This report provided recommendations for future environmental management of the UMRS and is used to support the development of HREP proposals, including Steamboat Island.

Upper Mississippi River Restoration Environmental Management Program Environmental Design Handbook. Corps, Rock Island District, Rock Island, IL, August 2006 and December 2012. These handbooks evaluate project measures and incorporate lessons learned throughout the life of the program, which was applied during the Project planning phase in regards to feasibility-level design of restoration measures.

Upper Mississippi River System Ecosystem Restoration Objectives, Corps, 2009. 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 used to support the development of HREP proposals, including Steamboat Island.

UMR National Wildlife and Fish Refuge Comprehensive Conservation Plan. USFWS, 2006. This plan guides the administration and management of the UMR NWFR and contains six goals and 41 associated objectives, as well as implementation strategies to achieve the objectives. As Steamboat Island is part of the UMR NWFR, the wildlife and habitat goals contained in the plan were considered during the planning phase in order to ensure synchronization between the Project and Refuge goals.

Upper Mississippi River National Wildlife and Fish Refuge Habitat Management Plan. USFWS, 2019. On file at Upper Mississippi River National Wildlife and Fish Refuge Headquarters Office, Winona, MN. 127 pp + Appendices A-F. This plan guides the habitat management of the UMR NWFR lands. As Steamboat Island is part of the UMR NWFR, the Priority Resources of Concern outlined in the plan were considered during the planning phase in order to ensure synchronization between the Project and Refuge management.

Bottomland hardwood forests along the Upper Mississippi River, 1997. Yin, Y., Nelson, J.C., & K.S. Lubinski. Natural Areas Journal: 17 (2). This report summarizes the historical condition of bottomland hardwoods in the UMRS and evaluates the challenges caused by a modified river environment to restoring diverse, productive, and naturally-regenerating bottomland hardwoods in the UMR. Information from this report was applied to the planning phase of the Project when considering forest measures, including timber stand improvement (TSI) and topographic diversity.

Habitat Needs Assessment-II, 2018. McCain, K.N.S., Schmuecker, S. and N.R. De Jager. This report combines data and surveys to evaluate how the existing conditions of the UMR compare to desired conditions identified by the UMRR partnership. The Habitat Needs Assessment-II (HNA-II) and the Indicators Report (referenced below) will be utilized to help inform habitat restoration activities into the future as the UMRR Program seeks to achieve the vision and goals of this multi-agency partnership. HNA-II was used during the planning phase of the Project to help determine goals and objectives, as well as desired future conditions.

Indicators of Ecosystem Structure and Function for the Upper Mississippi River System, 2018. De Jager, N.R., Rogala, J.T., Rohweder, J.J., Van Appledorn, M., Bouska, K.L., Houser, J.N., and J. Jankowski. U.S. Geological Survey Open-File Report 2018-1143. https://doi.org/10.3133/ofr20181143. This report documents the development of quantitative measures (indicators) of ecosystem structure and function for use in a Habitat Needs Assessment for the UMRS.

Developing a shared understanding of the Upper Mississippi River: the foundation of an ecological resilience assessment, 2018. Kristen Bouska, Jeffrey Houser, Nathan De Jager, Jon Hendrickson. Ecology and Society 23 (2):6. https://www.ecologyandsociety.org/vol23/iss2/art6/. This report articulates the temporal and spatial extent of the assessment of the UMRS, the relevant historical context, the valued services provided by the system, and the fundamental controlling variables that determine its structure and function. Along with HNA-II, this report was used during the planning phase of the Project to support goals and objectives.

G. Authority

The UMRR's original authorizing legislation was the 1986 WRDA, Section 1103 (33 U.S.C. 2201 et seq.; P.L. 99-662, 1986). The UMRR was originally comprised of five elements: HREPs, Long Term Resource Monitoring (LTRM), Recreation Projects, Economic Impacts of Recreation, and Navigation Monitoring. Currently, the UMRR is comprised of two elements: (1) plan, construct, and evaluate measures for fish and wildlife habitat improvement through HREPs, and (2) monitor the natural resources of the river system through the LTRM element. The other UMRR elements have either been successfully completed or are now carried out under other authorities.

The original authorizing legislation has been amended several times since its enactment. The 1990 WRDA, Section 405, extended the original UMRR authorization an additional five years to fiscal year 2002, which allowed for revitalization of the program. The 1992 WRDA, Section 107, amended the original authorization by allowing limited flexibility in how funds are allocated between the HREP program and the LTRM element. The 1992 WRDA also assigned sole responsibility for O&M of habitat projects to the agency that manages the lands on which the Project is located. The 1999

WRDA, Section 509, reauthorized UMRR as a continuing authority with reports to Congress every 6 years and changed the cost sharing percentage from 25% to 35%. 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.

SECTION II. AFFECTED ENVIRONMENT

A. Resource History of the Study Area

The Mississippi River, and what is presently Pool 14, has been very important to the social and economic development of the region. The earliest native cultures and explorers used the river for its ease of transportation and rich resources, which has continued into present time (USGS, 1998). Historical surveys indicate the area contained a mix of bottomland forests with a high proportion of oaks and other hard mast trees (Yin et al., 1997). River channels, seasonally flooded backwaters, floodplain lakes, and marshes were prevalent throughout the area (Theiling, 2010).

Channel manipulations to clear the channel and improve navigation on the UMR began around 1825. Measures to deepen the channel began in the 1880s. The completion of the lock and dam system, including Locks and Dam (L&D) 14 in 1939, changed the free-flowing river to a series of reservoirs and stabilized water levels and reduced lakes and marshes from the floodplain. These changes adversely affected the biological resources of the river and over time, the impacts of channel modification have contributed to a decrease in habitat structure, bottomland hardwood regeneration, and the amount of aquatic backwater habitat and isolated wetland habitat. This has led to a decrease in the habitat associated with each land cover type, as well as the fish and wildlife dependent on the habitat.

B. Description of Project Area and Current Management

All lands in the Project area are in Federal ownership and are managed by the USFWS as part of the UMR NWFR. Management of the Project was outgranted to the USFWS in 1963 (amended in 2001), but the Corps retained forestry management responsibility on Corps fee title lands. Mississippi River Project forestry management practices include timber harvest, thinning treatments, tree plantings, and follow-up vegetation control at tree planting areas. Typically, this is done on a small scale (2 to 20 acre treatment areas). The USFWS conducts no active habitat management on Steamboat Island and there are no water control structures or other infrastructure in place to maintain. There are no Closed Areas on Steamboat Island; it is open year-round to public access, including hunting. There are several public boat ramps providing access to the Project area located on both Iowa and Illinois shorelines, including the Cordova, IL, and Princeton, IA, boat ramps. Figure M-4 in Appendix M, *Engineering Design,* shows a map of all public access ramps in the Project area. There is a designated Slow No Wake Area within the backwaters of the Wapsipinicon Bottoms at RM 506.0 - 506.6. From March 16 through October 31, watercraft must travel at slow, no wake speeds, and no airboats or hovercraft are allowed.

The southeast shoreline of Steamboat Island, (a channel maintenance dredged material Historic Bankline Placement Site RM 503.5-504.1R, locally known as Princeton Beach) is a highly utilized public use area. Recreational boating, primitive camping, fishing, and other water- and recreation-related activities occur, especially on summer weekends when boats are typically crowded along the entire shoreline. The USFWS and the Iowa DNR conduct routine law enforcement patrols of this area but otherwise there are no other active management programs. Historic Bankline Placement Site RM 503.5-504.1R also receives periodic re-nourishment from the Steamboat Slough dredge cut, as part of the Long-Term Management Plan for dredged material in Pool 14 (USACE, 1999). Figure M-3 in Appendix M, *Engineering Design,* shows a map of historical dredge cuts and placement sites in the Project area. The Rock Creek Marina and Campground, managed by the Clinton County, Iowa, Conservation Board, is another high-use recreation area in the backwaters of the Wapsipinicon Bottoms. Rock Creek offers dock, boat, and cabin rentals and is the site of the Mississippi River Eco Tourism Center.

Directly across the river from the Wapsipinicon Bottoms is the Quad Cities (QC) Generating Station, a nuclear-fueled steam electric generating facility located on the Illinois shore near RM 506.5, just upstream of Cordova, Illinois. The station consists of two boiling water nuclear reactors that withdraw cooling water from the Mississippi River at a maximum rate of 2,253 cubic feet per second (cfs). Prior to beginning operation, the QC Generating Station developed the Long-term Fisheries Monitoring Program in 1971 to annually assess the impacts of its operations on fisheries in Pool 14. The QC Generating Station has varied its operations over the past decades from open-to closed-cycle modes, discharging cooling water to the river via a side-jet canal that completely encircles the Station and returns to the Mississippi River approximately one river mile upstream of the Project area (refer to Figure I-2). . The QC Generating Station is currently operating in open-cycle as a direct result of long-term fisheries monitoring to study potential impacts of operation in coordination with state and Federal agencies (Exelon Corp., 2019). The QC Generating Station is also home to the only privately-owned fish hatchery on the Mississippi River, having both raised and released millions of sport fish into the UMR, including many host fish species for freshwater mussels, which are abundantly located less than two river miles downstream of the discharge point. For further information regarding thriving mussel resources in the Project area, refer to Section II.D.3.

C. Floodplain Resources

Islands within the Project area have eroded over time, resulting in the loss of acreage and floodplain forest. Historical imagery of the area provides approximate changes in land mass, as shown in Figure II-1, but does not fully account for differences in river levels shown in the imagery.

The most quantifiable loss occurred after construction of L&D 14 at LeClaire, Iowa, as some portion of this loss may be contributed to inundation of the land instead of erosive loss. Comparing 1930s imagery (pre-lock and dam) to 2015 imagery, Steamboat Island proper lost 98.7 acres, the West Southeast (SE) Island lost 33.3 acres, and the East SE Island lost 9.8 acres. Comparing 1950s (post-lock and dam) imagery to 2015 imagery, Steamboat Island proper lost 19.2 acres, the West SE Island lost 1.5 acres, and the East SE Island lost 5.4 acres. All acreages are approximate.

As such, it can be estimated that approximately 80 acres of Steamboat Island proper were lost due to inundation and erosion in the first 20 years following construction of L&D 14. Additionally, approximately 20 acres have been lost since the 1950s, resulting in an average of 0.3 acre of loss per year over those 65 years. Since the start of this study in 2017, visual observations have confirmed active erosion at Steamboat Island proper and the Southeast Islands, including trees falling off banks into the river as a result of erosion and bank undercutting. Additional erosion of these islands was observed following near-record spring flooding in 2019, but these recent observations remain unmeasured at the time of this Report.

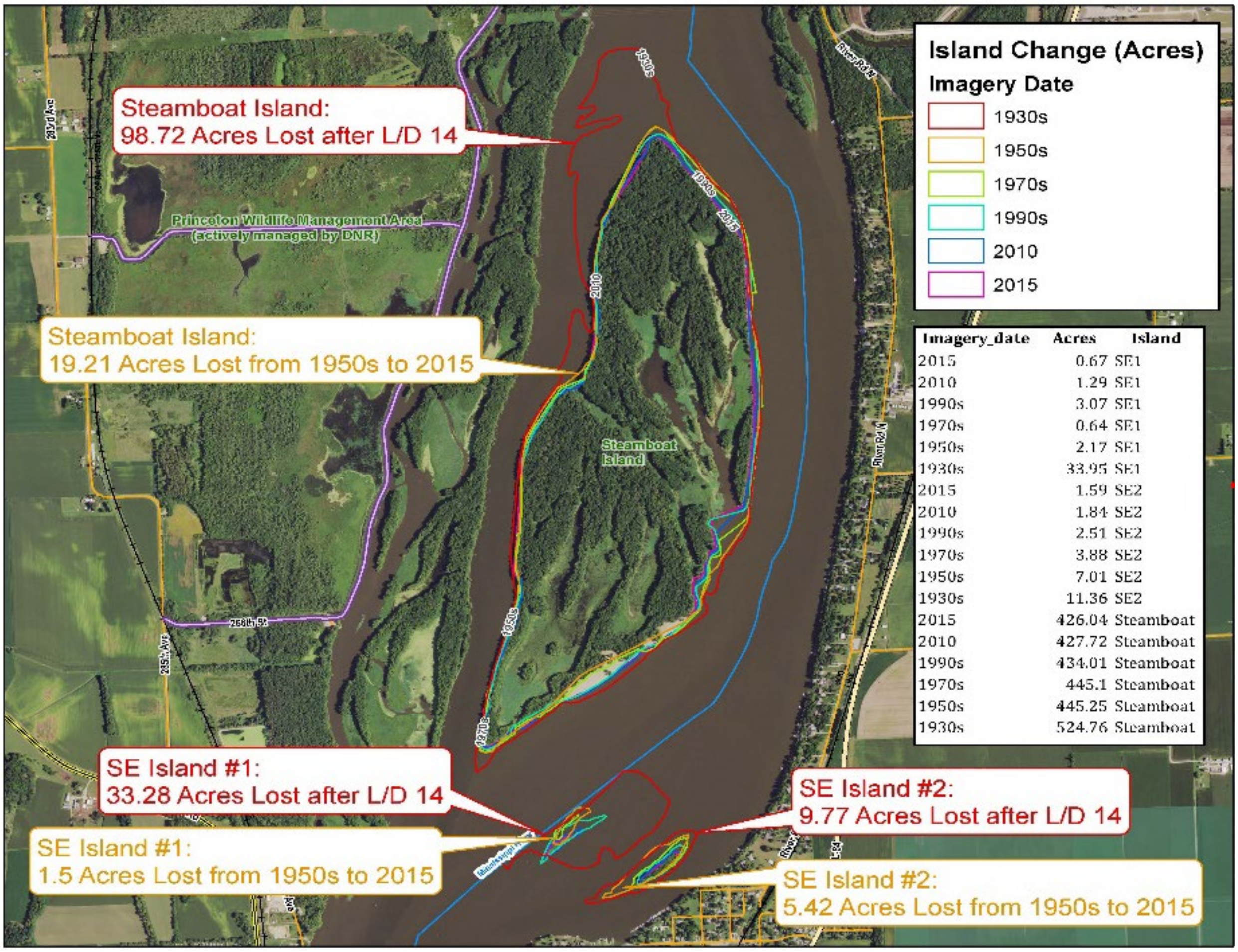


Figure II-1. Island Loss in the Project Area from 1930s to 2015

The Project area contains approximately 2,013 acres of floodplain habitat (Table II-1), defined as elevations above the aquatic threshold of the 70% exceedance duration profile corresponding with an elevation of 571.7 feet at river mile 504.5. 2010 LTRM land cover data (http://www.umesc.usgs.gov/data_library/land_cover_use) was utilized to calculate the floodplain forest habitat. The floodplain located within the Project area is comprised of 1,674 acres (83%) of floodplain forest habitat, 292 acres of emergent wetland (15%), and about 47 acres (2%) of predominantly scrub-shrub/pollinator habitat (of which 35 acres are reed canarygrass, a non-native invasive species). Scrub-shrub/pollinator habitat was identified as elevations above the 55-day inundation duration with 50% exceedance. Scrub-shrub/pollinator habitat may occupy a small percentage of floodplain but can also occur at upper elevations amongst other habitats. Sections II.C.1 and C.2 further describe the forest and wildlife communities and their habitats.

Table II-1. Steamboat Island Floodplain Habitat Distribution

Habitat Type	Acres	Percent	Criteria
Total Floodplain Area	2,013		
Emergent Wetland	292	15%	Area between aquatic and scrub-shrub/pollinator
Scrub-shrub/Pollinator	47	2%	Above 55-day inundation duration elevation exceeded ½ years (50% exceedance probability)
Floodplain Forest	1,674	83%	LTRM Land Cover data classified through aerial imagery and field observations

All elevations (Figure II-2) used in this report are expressed using the North American Vertical Datum of 1988 (NAVD88), unless otherwise stated. The conversion from NAVD88 to Mean Sea Level (MSL) 1912 at the Camanche, IA, river gage is (+0.77 feet) and (+0.73 feet) at L&D 14. See Appendix H, *Hydrology and Hydraulics*, for a complete table of datum conversions by river mile. Due to having a partial forest inventory identifying acreages of habitat types, assumptions regarding the flood tolerance for different habitat types within the Project area were made to estimate the existing habitat distribution.

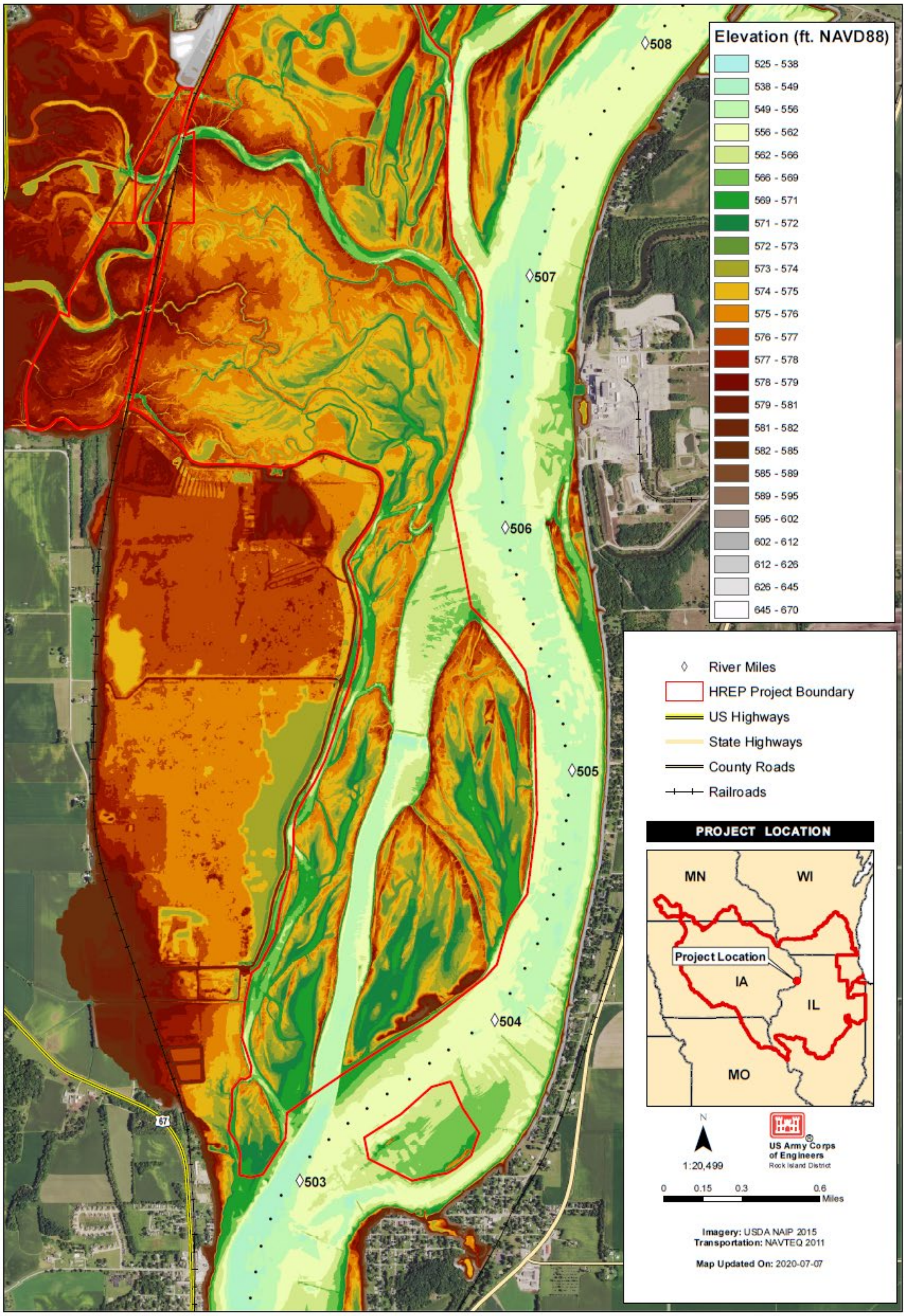


Figure II-2. Topographic and Bathymetric Elevation Map for Steamboat Island

1. Forest Diversity and Habitat. Large floodplain forests present in the Project area are important features of the landscape. As dynamic habitats exposed to frequent disturbances, they provide scarce resources for many groups of animals.

Since the completion of the UMR lock and dam system, water levels in Pool 14 are generally higher over the entire year, and periods of very low flow formerly common in the fall have been eliminated. Consequently, the majority of islands are located at or below elevations where increased flood duration and frequency exceeds thresholds for optimal survival, growth, and sustainability of a floodplain forest that includes hard mast trees (i.e., oaks and hickories) (De Jager et al., 2012; Guyon et al., 2012). Hard mast (acorns, hickories, etc) is an important food source for many species of floodplain wildlife.

Approximately 51% of the Project area is at an elevation (>574 feet) suitable to contain hard mast-producing trees. For more detailed information, see Appendix D, *Habitat Evaluation and Benefits Quantification*, and Appendix H, *Hydrology and Hydraulics*. Eighteen different species in the overstory were recorded during a 2018 forest inventory consisting primarily [10 or more average trees per acre (TPA)] of silver maple (*Acer saccharinum*), common hackberry (*Celtis occidentalis*), American elm (*Ulmus Americana*), green ash (*Fraxinus pennsylvanica*), eastern cottonwood (*Populus deltoids*), red mulberry (*Morus rubra*), black willow (*Salix nigra*) and pin oak (*Quercus palustris*) (Figure II-3). Silver maple was the most encountered tree species ranging from 35 to 171 average TPA. Areas with hard mast trees present were, on average, over 88 years old (range of 1874-1964) and were characterized by limited tree regeneration in the understory. This lack of production is directly related to increased water inundation and duration. Additional tree species found during this inventory can be found in Table II-2.

The existing stands of even-aged mature silver maple are a concern. Eventual mortality due to old age can be expected at nearly the same time for much of the forest, resulting in open canopies with limited understory tree seedlings and saplings available for regeneration. These conditions will likely facilitate the spread and dominance of non-desirable herbaceous vegetation, such as reed canarygrass, which prevents further recruitment of desirable tree species through direct competition with tree saplings. Examples of this can be found at numerous locations in the UMRS, where mortality of mature trees has been followed by invasion from reed canarygrass, further limiting recruitment of desirable trees. Refer to Section II.F., *Invasive Species,* for invasive terrestrial plants found during the 2018 forest inventory.

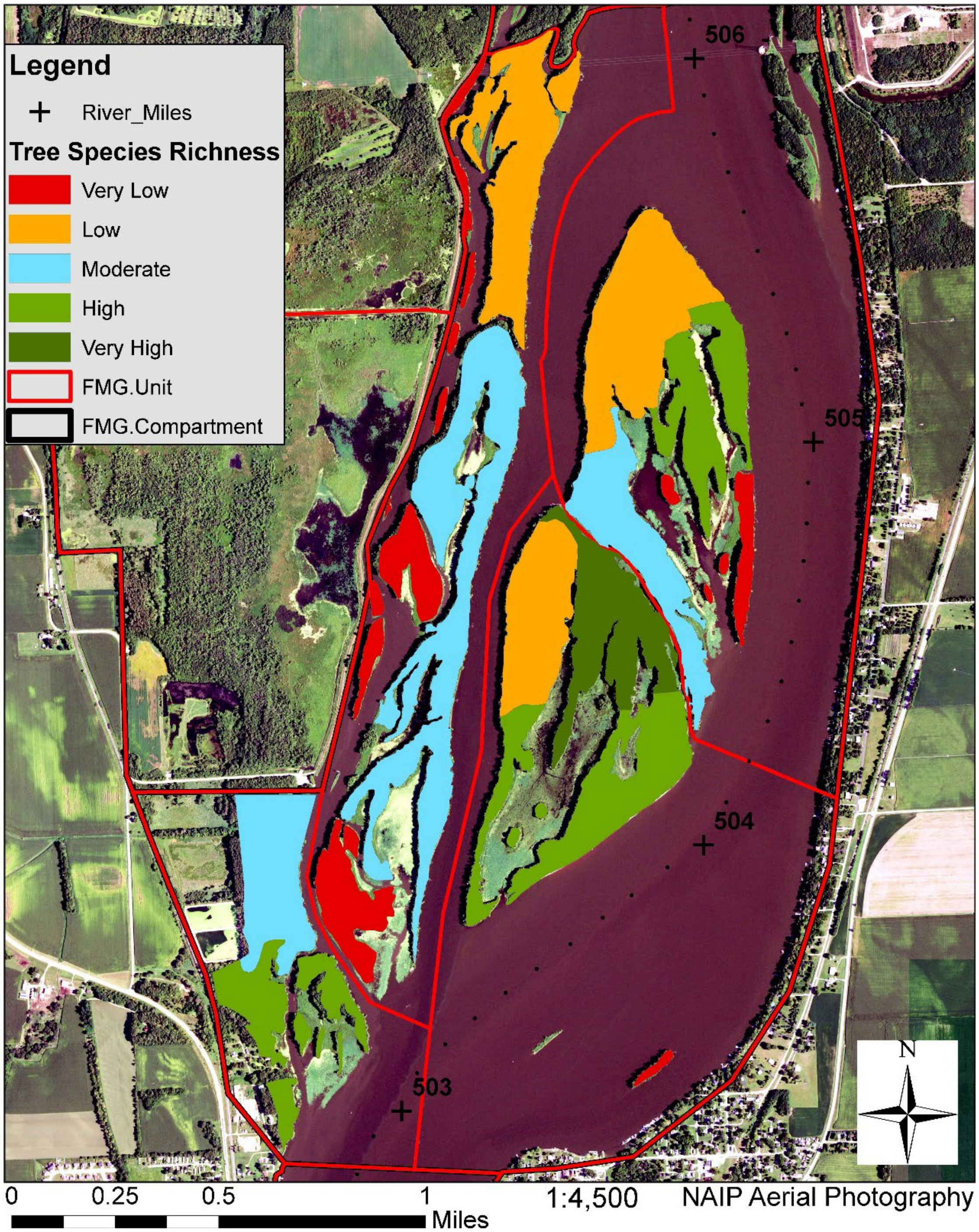


Figure II-3. Species Richness Results of the Steamboat Island Forest Inventory Conducted in 2018

Table II-2. Overstory and Understory Woody Tree and Shrub Species

Common Name	Scientific Name
Boxelder	*Acer negundo*
Silver Maple	*Acer saccharinum*
River Birch	*Betula nigra*
Bitternut Hickory	*Carya cordiformis*
Northern Pecan	*Carya illinoinensis*
Shellbark Hickory	*Carya laciniosa*
Northern Catalpa	*Catalpa speciosa*
Hackberry	*Celtis occidentalis*
Buttonbush	*Cephalanthus*
Eastern Redbud	*Cercis canadensis*
Silky Dogwood	*Cornus amomum*
Grey Dogwood	*Cornus racemosa*
Redosier Dogwood	*Cornus sericea*
Green Hawthorn	*Crataegus viridis*
Eastern Wahoo	*Euonymus atropurpureus*
Green Ash	*Fraxinus pennsylvanica*
Honey Locust	*Gleditsia triacanthos*
Kentucky Coffeetree	*Gymnocladus dioicus*
Black Walnut	*Juglans nigra*
White Mulberry	*Morus alba*
Red Mulberry	*Morus rubra*
American Sycamore	*Plantanus occidentalis*
Cottonwood	*Populus deltoides*
Swamp White Oak	*Quercus bicolor*
Bur Oak	*Quercus macrocarpa*
Pin Oak	*Quercus palustris*
Black Locust	*Robinia pseudoacacia*
Sandbar Willow	*Salix interior*
Black Willow	*Salix nigra*
American Elm	*Ulmus Americana*

2. Wetlands Diversity and Habitat. Wetlands provide habitat for an array of wildlife including breeding and migratory waterfowl and other waterbirds, breeding and migratory landbirds, herptiles (reptiles and amphibians), and semi-aquatic mammals. Through a desktop delineation, approximately 1,295 acres of wetlands at the Project area are frequently flooded and hydraulically connected to the Mississippi River. In general, floodplain wetlands for this Project were defined as areas lying between elevations 571.7–574.9 feet (Table II-1). Below elevation 571.7 is open water aquatic habitat, addressed in Section II.D., *Aquatic Resources*. The upper limit of wetland habitat was established as the 14-day inundation duration exceeded 50% of the time. Approximately 26% of the wetland habitat is classified as scrub-shrub/pollinator and emergent wetland habitat and 74% is considered to be bottomland hardwood forest. Emergent wetlands can be found in low-lying depressions sporadically located throughout the Project area. Inundation and increased water levels limits the establishment and function of emergent wetland habitat.

. **3. Bat Habitat.** Bats typically travel, forage, and roost within a variety of interconnected forested habitats, including riparian corridors, bottomlands, and uplands. Trees in excess of 3 inches dbh appear to provide suitable foraging and maternity roosting habitat (USFWS, 2019b). Exfoliating bark, cavities of dead and live trees, and snags (i.e., dead trees or dead portions of live trees) are important components of potentially suitable bat habitat. The Project area contains numerous large trees and snags, which potentially serve as roosting habitat, and open forest dominated by large trees adjacent to open water, which may provide foraging habitat for the federally-endangered Indiana bat (*Myotis sodalis*), federally-threatened northern long-eared bat (*Myotis septentrionalis*), and many other bat species. Refer to Section II.E for details on federally-listed species. A mist net survey conducted in the summer of 2015 for the Beaver Island HREP, which contains similar habitat, yielded 190 bats, representing seven species. No federally-threatened Indiana bats and 14 federally-threatened northern long-eared bats were captured at the site; however acoustic surveys indicated presence of both listed species in the Project area (USACE, 2017). The most common species captured were the little brown bat (*Myotis lucifugus)*, big brown bat (*Eptesicus fuscus)* and evening bat (*Nycticeius humeralis*). Due to Beaver Island HREP's proximity to Steamboat Island and similar habitat structure, these survey results provide a good indication of bat species diversity likely present in the Project area.

4. Pollinator Habitat. Pollinator species, such as bees, butterflies, other insects, and hummingbirds, are indicators of ecosystem health and provide benefits to habitat diversity. Pollinators play a crucial role in flowering plant reproduction and in the production of most fruits and vegetables. This group of species have the potential to provide higher quality crops and benefits to the agricultural community. Pollinators are currently in decline due to habitat loss and degradation and pesticide use. In the Midwest, the federally-listed endangered rusty patched bumble bee (*Bombus affinis)* and the candidate species monarch butterfly (*Danaus plexippus*) are two species that have garnered public and agency attention. Protection, restoration, and enhancement of flowering trees, shrubs, and forbs that produce pollen and nectar resources are vital to pollinator conservation. The Project area currently has limited wildflower production due to reed canarygrass domination. The areas that have the potential to establish flower producing shrubs and vegetation are overtaken by this invasive species.

5. Avian Community

a. Bald Eagle *(Haliaeetus leucocephalus)*. Bald eagles winter along the Mississippi River, including Pool 14, typically using large trees for roosting and building nests. Suitable perch trees where eagles can loaf and perch are numerous, including the forested areas of Steamboat Island. The bald eagle is a common inhabitant of the Project area during the breeding and non-breeding seasons. The bald eagle is protected under the Bald and Golden Eagle Protection Act of 1940. There is at least one known bald eagle nest within the Project area, which was last observed as active in 2017 (https://www.mvr.usace.army.mil/Missions/Recreation/Mississippi-River-Project/Education/Eagle-Watching/Eagle-Counts/).

b. Red-Shouldered Hawk (*Buteo lineatus*). Red-shouldered hawks generally require large tracts of forest with relatively high amount of canopy closure. Bottomland forests of the UMR are important breeding habitat for this species.

c. Heron Rookeries. Herons are wading birds that typically utilize the shorelines of aquatic areas, as well as emergent wetlands to forage for fish and other small prey. Great blue herons and great egrets usually breed in colonies in trees close to wetlands and other aquatic habitats. A colony, or rookery, can be as large as 500 nests. Heron rookeries in the UMR are vulnerable because the availability of suitable nesting habitat is declining. While the Project area contains suitable habitat for heron foraging, roosting, and nesting, there are no known heron rookeries in the Project area. The Beaver Island HREP, approximately 6 miles upstream from the Project area, also contains suitable habitat for heron foraging, roosting, and nesting.

d. Waterfowl. Waterfowl use wetlands to forage for a variety of wetland plants and invertebrate foods. The seasonal water conditions within the backwater lakes of the Project area are ideal for seed production by many wetland plants. Princeton Marsh Wildlife Management Area (WMA) is another HREP immediately adjacent to the Project area and continues to attract ducks and other waterfowl during fall and spring migrations, according to seasonal surveys conducted by the Iowa DNR in 2015.

e. Secretive Marsh Birds. Secretive marsh birds include sora, pied-billed grebe, American bittern, and king rail. Species in this group are typically considered to be high priority species within USFWS Region 3 and the Eastern Tallgrass Prairie and Prairie Hardwood Transition Bird Conservation Regions. Members of this group have habitat requirements that vary from dense stands of vegetation without open water to emergent wetlands that are in proximity to deeper submersed marshes, or wetlands that have a mix of both emergent and submersed vegetation.

f. Neotropical Migratory Birds. The Migratory Bird Treaty Act (MBTA) of 1918 regulates 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. As one of the four major migration flyways in North America, the Mississippi River Flyway offers ideal conditions for migratory birds and the UMR floodplain corridor is an important corridor for neotropical migratory birds that use forest habitat. Floodplain complexes and the habitat provided are highly important to migratory bird species, such as neotropical migrants. The diverse array of habitat types floodplain forests typically provide tend to support higher abundances of species and individuals. Knutson et al. (1998) found relative abundances of all birds and total numbers of neotropical migratory birds were almost twice as high in the UMR floodplain as in the adjacent uplands.

Healthy populations of floodplain forest wildlife, including migratory birds, require adequate habitat. Since impoundment, the forest community in the Project area has become less diverse and the dominance of silver maple and invasive reed canarygrass have increased. The changes in tree species composition, structure, and function have contributed to a reduction in diversity of habitat over time. These changes are likely to continue, and without intervention, Steamboat Island and the surrounding area will cease to provide migration, dispersal, breeding, nesting, and cover habitat for a wide range of migratory birds.

D. Aquatic Resources

The Project area contains approximately 614 acres of aquatic habitat. The site offers both lentic (i.e., a body of standing water; 127 acres) and lotic (i.e., actively moving water; 487 acres) aquatic habitat types. Although the site offers a diverse array of interconnected channels and backwaters, the habitat provided by these resources for aquatic organisms is limiting at times. The following sections describe the typical aquatic community composition and habitat that currently exist in the Project area.

1. Backwater Fishery Habitat. The Iowa DNR and the QC Generating Station have conducted fish sampling at several sites in the Project area and Pool 14 (Exelon Corp., 2019). Fish species sampled are similar to most other Mississippi River species. Many of the important recreational and commercial fish species (e.g., bluegill *Lepomis macrochirus*, largemouth bass *Micropterus salmoides*, black crappie *Pomoxis nigromaculatus)* are commonly found in the backwaters and Steamboat Slough during different times of the year. A 2017 Iowa DNR fall fish survey yielded 221 fish of 14 species, including 2 redfin pickerel (or grass pickerel, *Esox americanus*), a species listed as threatened in the state of Iowa.

In general, the backwater aquatic areas can be described as relatively shallow backwaters (Table II-3 and Figure II-4) that contain some aquatic vegetation. Large woody debris serves as important habitat. Substrates consist of various mixtures of silts, sands, and clays. Water quality is generally acceptable with intermittent high temperatures in the summer and occasional low dissolved oxygen (DO) levels in the winter (Appendix F, *Water Quality*).

Spawning habitat for centrarchid fish species does not appear to be limiting within the Project area. The apparent successful spawning is most likely due to the relatively stable high water during June and July (i.e., average water level change from June 10 to July 31 is a drop of 2.08 feet). These prolonged conditions provide the opportunity to utilize the floodplain to seek out low velocity (<3.0 cm/sec), warm water temperature (>18.0 °C), and stable substrates near structures (e.g., trees, scrub/shrub, miscellaneous vegetation) to successfully spawn.

Table II-3. Steamboat Island HREP Aquatic Habitat Depth Intervals, Acres per Depth Contour, Percent of Total, and Cumulative Percent

Depth Contour	Acres	Total	Cumulative
0 - 1'	140.0	22.8%	22.8%
1 - 2'	85.0	13.8%	36.7%
2 - 3'	53.6	8.7%	45.4%
3 - 4'	35.2	5.7%	51.1%
4 -5'	41.7	6.8%	57.9%
> 5'	258.5	42.1%	100.0%
Total Below Water Surface	613.9	100.0%	--

Reference Water Surface (70% annual duration, elevation 571.7 feet at RM 504.5)

Post-spawning rearing and foraging habitat for centrarchids in the summer and early fall typically consists of areas with adequate water quality (i.e., water temperatures 24-30°C, >8.0 mg/L DO, and abundant foraging opportunities for maximum growth). The average water temperature during the growing season (July–September) within the Project area is approximately 24.8°C. However, due to the shallow nature of the backwaters, midsummer water temperatures intermittently exceed 30.0°C, and DO concentrations dip below 5.0 mg/L. The main factors impacting water quality parameters in the Project's backwater areas are increased sediment deposition from agricultural runoff and more frequent flooding.

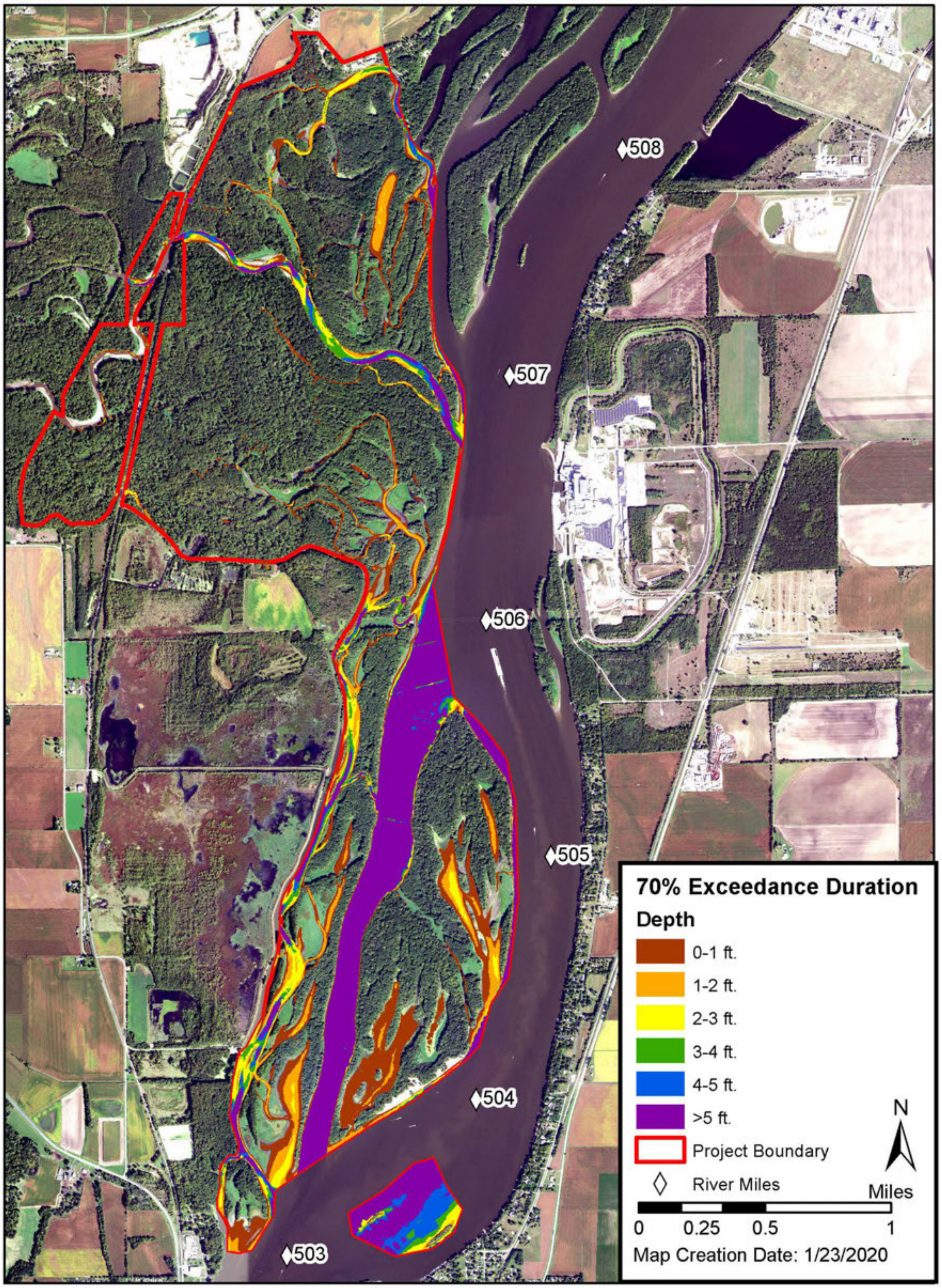


Figure II-4. Steamboat Island HREP – Aquatic Habitat Depth Intervals at 70% Exceedance Duration

Late fall and early winter, when the water temperatures begin to drop below 10.0°C, centrarchids will initiate movements from foraging areas to overwintering areas. Preferred habitat consists of deep water (>4 feet), low velocity (<1 cm/sec), high DO concentrations (> 5.0 mg/L), and warmer water temperatures (≥1.0°C). Ideally, this habitat is directly connected with the aforementioned fall foraging habitat and spawning habitat. The connection of these habitats reduces energy expenditure during times of low metabolic activity. This is especially important for young fish spawned the previous spring. Copeland and Noble (1994) noted yearling largemouth bass movements were limited through the first winter and the second growing season, indicating the need for connected spawning, overwintering, and fall foraging habitat in close proximity.

The existing backwaters in the Project area are limited with respect to high quality overwintering habitat (depth ≥ 4 feet in depth, average winter water velocity ≤ 1 cm/sec, DO concentrations ≥ 5 mg/L on average in winter, and temperatures ≥ 1.0°C in winter. Refer to Appendix D, *Habitat Evaluation and Benefits Quantification*. Of the available backwater habitat (127 acres), only about 0.14 acres are suitable depth for overwintering, which is located mainly in Upper Steamboat Lake (see Appendix D, *Habitat Evaluation and Benefits Quantification*). The physical characteristics of the backwaters are suboptimal for year-round habitat. Overwintering habitat is the most limited habitat type and should be restored to increase off-channel habitat (UMRCC Fisheries Plan, 2010).

2. **Riverine Fishery Habitat.** Riverine fishery habitat under consideration for this Project includes approximately 487 acres of Grant and Steamboat Sloughs and a portion of the Mississippi River main channel (main channel). Steamboat Slough has an average depth of 9 feet and flows, temperatures, and water quality measurements are similar to the main channel throughout the course of the year. Grant Slough is shallower than Steamboat Slough, but does provide a variety of aquatic habitats and supports fish and mussel species. Sedimentation and flow from the upstream Wapsipinicon River provide input to the sloughs. Steamboat Island and the land along Grant Slough provide side channel habitat suitable for freshwater mussel colonization. Without the existence of these areas, only main channel border habitat is available, which would likely have a negative impact on the riverine fish and mussel community currently inhabiting the sloughs.

3. **Mussel Habitat.** The USFWS's recovery plan for Higgins eye pearlymussel (USFWS, 2004) focuses on the recovery of the species within Essential Habitat Areas (EHA). In the recovery plan, the USFWS documented 10 EHAs and an additional 4 EHAs were documented in 2008. One EHA in Pool 14, the Cordova EHA, occurs across the main channel from Steamboat Island near Cordova, Illinois (RM 502.8 – 505.6). A portion of the Project area does intersect with the Cordova EHA boundary (an area of approximately 11 acres). The Cordova EHA was first surveyed in 2000, then in approximate increments of every four years with the latest survey occurring in 2018. Survey results indicate the Cordova EHA harbors a rich (over 23 species) and dense (average 10 live mussels/m^2) mussel community. The QC Generating Station has monitored mussels in Pool 14 since 2004 with the purpose of better understanding the local mussel conditions and identifying potential thermal impacts the nuclear plant may have on the mussel beds. The QC Generating Station applied for and received an adjusted thermal standard from state water quality standards in 2015 because of the data obtained during the fish and mussel monitoring programs. The facility also received an Incidental Take Permit (and approved Habitat Conservation Plan) for any potential impacts that could occur during the permit duration (J. Hass, pers. comm., 2019). The Station's fish hatchery has monitored, raised, and released many host fish species such as like bluegill, largemouth bass, sauger, walleye, and freshwater drum for freshwater mussels. The hatchery has also partnered with multiple government agencies for nearly a

decade to grow freshwater mussels on site using local mussel beds, for brood stock, including the federally-endangered Higgins eye pearlymussel.

Mussel surveys have been conducted in Pool 14 as early as 1987, and regularly since the USFWS's Draft Biological Opinion in 2000 (USFWS, 2004). These studies include surveys at Cordova EHA (last surveyed 2018), surveys conducted for the QC Generating Station (last surveyed in 2017), and an additional survey conducted by Iowa DNR in 2017. Each of the surveys provide insight into the potential mussel community within Steamboat Island (see Appendix A, *Correspondence,* for survey information).

An October 2018 mussel survey recovered 601 mussels (27 total species) at 7 different sample sites within the Project area. Grant Slough yielded the highest collection of around 315 live individuals of 17 species, including 3 individual yellow sandshell mussels (*Lampsilis teres)*, an Iowa state-endangered species. The East SE Island, located within the established Cordova EHA, included 161 live individuals of 16 species, including 6 individuals federally-endangered Higgins eye pearlymussel (*Lampsilis higginsii*) and 21 individuals Illinois state threatened species black sandshell *(Ligumia recta*). The most abundant mussel species (40.5% of the mussels collected) found were threeridge (*Amblema plicata*), plain pocketbook (*Lampsilis cardium*), and threehorn wartybak (*Obliquaria reflexa*), each species comprising 11% of the collected individuals (Appendix A, *Correspondence*). Refer to Section II.E for federally-listed species results.

4. Aquatic Vegetation. The UMRR-LTRM Land Cover/Land Use datasets document the coverage of submergent, emergent, and rooted floating aquatic vegetation within the Project area (Figure II-5). While coverage has varied over the years due to variability in the environmental conditions (e.g., backwaters filling in), submergent, emergent, and floating-leaved aquatic vegetation exists today in localized patches within the Project area (Johnson and Hagerty, 2008). Additionally, a few of the invasive aquatic plant species known to occur in Pool 14 are described in Section II.F.

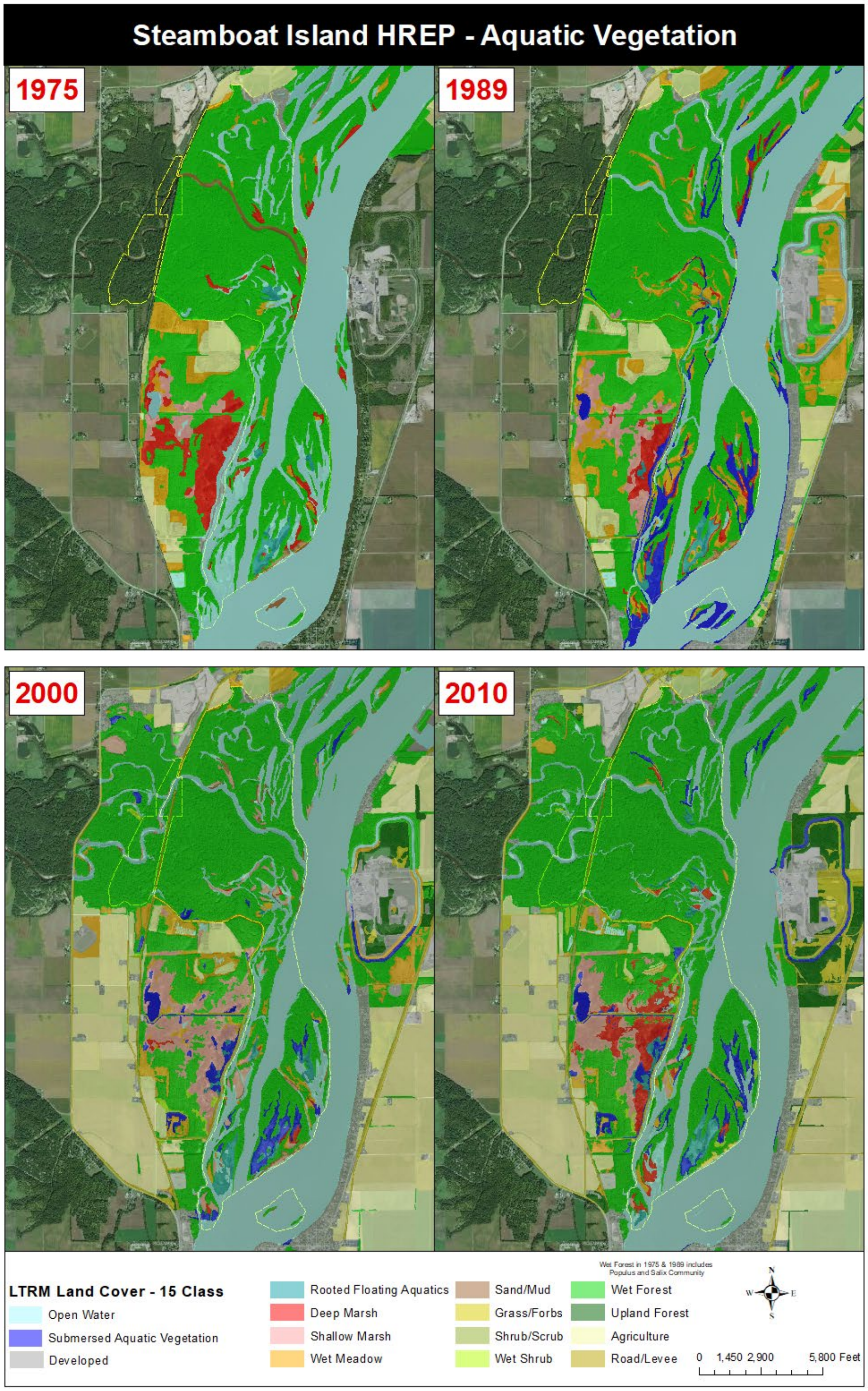


Figure II-5. Steamboat Island HREP – Aquatic Vegetation

E. Endangered and Threatened Species

The USFWS, through their Information for Planning and Consultation (IPaC) website, has identified the following as federally-endangered or threatened species with the potential to occur within Clinton and Scott Counties, IA and Rock Island, IL: Indiana bat, northern long-eared bat, eastern massasauga (*Sistrurus catenatus*), prairie bush clover (*Lespedeza leptostachya*), western prairie fringed orchid (*Platanthera praeclara*), eastern prairie fringed orchid (*Platanthera leucophaea*), Higgins eye pearlymussel, sheepnose mussel (*Plethobasus cyphyus*), spectaclecase mussel (*Cumberlandia monodonta*), and Iowa Pleistocene snail (*Discus macclintocki*).

1. Indiana Bat. The federally-endangered Indiana bat's range includes the eastern half of the United States, from Oklahoma, Iowa, and Wisconsin east to Vermont, and south to northwestern Florida. Indiana bats hibernate during the winter months in limestone caves and abandoned underground mines known as hibernacula. After hibernation, most females depart from the caves and abandoned underground mines during April, while males typically remain longer before migrating to summer habitats. Females migrate to summer habitats where they congregate to bear and raise young in what are known as maternity colonies. A habitat survey conducted by the Corps identified potentially suitable roosting trees throughout the Project area's forested areas that could also serve as primary or secondary maternity roosts (Appendix M, *Engineering Design*, Attachment F). Critical habitat has not been listed in Iowa. Due to the existing ideal habitat for bat use and identified species of Indiana bat from previous surveys conducted throughout Pool 14, presence is assumed within the Project area. Avoidance and minimization efforts in limiting tree clearing, including during the active season, have been implemented. Based on these efforts, additional surveys will not be required (see Appendix A, *Correspondence*).

2. Northern Long-Eared Bat. The northern long-eared bat is a federally-threatened bat and is found in the United States from Maine to North Carolina on the Atlantic Coast, westward to eastern Oklahoma and north through the Dakotas, even reaching into eastern Montana and Wyoming. They hibernate during the winter months in caves. After hibernation, they migrate to wooded areas to roost and forage during late spring and summer. During the summer, northern long-eared bats roost singly or in colonies under bark, in cavities or crevices of both live and dead trees. A habitat survey conducted by the Corps identified potentially suitable roosting trees throughout the Project area's forested areas that could also serve as secondary or primary maternity roosts (Appendix M, *Engineering Design*, Attachment F). Critical habitat has not been listed in Iowa. Due to the existing ideal habitat for bat use and identified species of northern long-eared bat from previous surveys conducted throughout Pool 14, presence is assumed within the Project area. Avoidance and minimization efforts in limiting tree clearing, including during the active season, have been implemented. Based on these efforts, additional surveys will not be required (Appendix A).

3. Eastern Massasauga. The eastern massasauga rattlesnake is a federally-threatened rattlesnake that is found in the United States from central New York to south-central Illinois and eastern Iowa. They live in wet areas including low areas along rivers and lakes and use adjacent uplands during part of the year. There was an identified presence adjacent to the Project area dated in 1999; however, a survey was not required based on the lack of suitable habitat within the Project area (Appendix A).

4. Prairie Bush Clover. The prairie bush clover is a federally-threatened prairie plant endemic to the tallgrass prairie region of the UMR Valley. Collection history and current distribution indicate the species is most abundant in an area that lies on drift of the Des Moines Lobe of the Wisconsin stage of glaciation, in northern Iowa and southern Minnesota. Habitat in this area typically consists of gentle, usually north-facing slopes, with fine silty loam, fine sandy loam or clay loam. The USFWS lists potential habitat statewide. However, the species has not previously been recorded in the area nor does the Steamboat Island floodplain offer suitable habitat for establishment or survival.

5. Eastern Prairie Fringed Orchid. The eastern prairie fringed orchid is a federally-threatened terrestrial orchid known to persist in 59 populations in 6 states. Most populations are in Wisconsin, Illinois, Michigan, and Ohio (USFWS, 1999). It occurs in a wide variety of habitats, from mesic prairie to wetlands such as sedge meadows, marsh edges, even bogs. It requires full sun for optimum growth and flowering and a grassy habitat with little or no woody encroachment.

The USFWS lists potential habitat statewide. However, the species has not previously been recorded in the Project area and the current state of invasive species domination limits the opportunity for establishment or survival.

6. Western Prairie Fringed Orchid. The western prairie fringed orchid is a federally-threatened terrestrial orchid known to occur at 175 sites in 8 ecoregions, including 41 counties across 6 states and one population in Manitoba (USFWS, 1996). Preferred habitat consists of unplowed, calcareous prairies and sedge meadows. Populations are mostly associated with poorly drained to moderately well drained, nearly level to gently sloping soils formed on loamy and clayey glacial till. Approximately 90% of known western prairie fringed orchids in the United States occurs in the Red River Valley of North Dakota and Minnesota.

According to the 1996 USFWS Recovery Plan, extant populations existed at 23 locations in 15 counties in Iowa, with Guthrie, Cherokee, and Mills counties containing the maximum number of documented flowering plants. The USFWS lists potential habitat statewide. However, the species has not previously been recorded in the Project area and the current state of invasive species domination limits the opportunity for establishment or survival.

7. Higgins Eye Pearlymussel. The Higgins eye pearlymussel is a federally-endangered freshwater mussel that has been found in parts of the UMR, Iowa River, St. Croix River, Wisconsin River, and Rock River. Higgins eye is characterized as a large river species and is usually found in areas with deep water and moderate currents. They typically inhabit areas with stable substrates varying from sand to boulders, but not firmly packed clay, flocculent silt, organic material, bedrock, concrete, or unstable sand.

Higgins eye pearlymussel has been found to occur within the Project area, including six individuals found during the 2018 survey at the small island in the southeast portion of the Project area immediately within the Cordova EHA.

8. Sheepnose Mussel. The sheepnose mussel is a federally-endangered freshwater mussel that has been found across the Midwest and Southeast. However, it has been eliminated from approximately two-thirds of the streams from which it was known historically; 25 streams are currently occupied compared to 76 in the past (USFWS, 2012). These mussels prefer larger rivers and streams with shallow areas that exhibit moderate to swift currents that flow over coarse sand and gravel. However, they have also been found in other substrates, such as mud, cobble and boulders, and in large rivers they may be found in deep runs.

According to the 2018 mussel survey, no individuals of sheepnose were collected. A past survey conducted in 2006 resulted in one live sheepnose identified outside of the Project area, indicating a low probability of presence within the Project area.

9. Spectaclecase Mussel. The spectaclecase mussel is a federally-endangered freshwater mussel that has been found in the Mississippi, Ohio, and Missouri River basins. Spectaclecase mussels are typically found in large rivers and in areas sheltered from the main force of current, such as under boulders or between interstitial spaces within a wingdam. It has been determined that this mussel species has declined significantly and is now known to be found in only 20 of 44 historical streams, representing a 55% decline (USFWS, 2014).

According to the most recent mussel survey (2018), no individuals of spectaclecase were collected nor preferred habitat encountered. Past surveys have not resulted with any spectaclecase records near the Project area, indicating a low probability of presence.

10. Iowa Pleistocene Snail. The endangered Iowa Pleistocene snail is found on north-facing slopes of the driftless area in Clayton, Clinton, Dubuque, Fayette, and Jackson Counties, Iowa. It occupies algific (cold producing) talus slopes at the outlet of underground ice caves along limestone bluffs within a narrow regime of soil moisture and temperature.

There is no critical habitat designated. The species has not previously been recorded in the area nor does the Project area offer suitable habitat for establishment or survival.

11. State Threatened or Endangered Species. In addition to federally-listed species, the Iowa DNR and IL DNR identified state-threatened or endangered species that have the potential to occur within Clinton and Scott Counties, Iowa, and Rock Island County, Illinois (Table II-4).

Table II-4. Clinton and Scott Counties, Iowa, and Rock Island County, Illinois, Threatened or Endangered Species

Common Name	Scientific Name	Class
Central Newt (T)	*Notophthalmus viridescens*	Amphibian
Four-toed Salamander (T)	*Hemidactylium scutatum*	Amphibian
Barn Owl (E)	*Tyto alba*	Bird
Cerulean Warbler (T)	*Dendroica cerulea*	Bird
Yellow-crowned Night Heron (E)	*Nyctanassa violacea*	Bird
Black-crowned Night Heron (E)	*Nycticorax nycticorax*	Bird
Yellow-headed Blackbird (E)	*Xanthocephalus xanthocephalus*	Bird
Grass Pickerel (T)	*Esox americanus*	Fish
Lake Sturgeon (E)	*Acipenser fulvescens*	Fish
Western Sand Darter (E)	*Ammocrypta clarum*	Fish
Longnose Sucker (T)	*Catostomus catostomus*	Fish
Crystal Darter (T)	*Crystallaria asprella*	Fish
Gravel Chub (T)	*Erimystax x-punctatus*	Fish
Banded Killifish (T)	*Fundulus diaphanus*	Fish
Pallid Shiner (E)	*Hybopsis amnis*	Fish
Running Pine (E)	*Lycopodium clavatum*	Fish
River Redhorse (T)	*Moxostoma carinatum*	Fish
Mudpuppy (T)	*Necturus maculosus*	Fish
Pugnose Shiner (E)	*Notropis anogenus*	Fish
American Eel (T)	*Anguilla rostrata*	Eel
Butterfly (T)	*Ellipsaria lineolata*	Freshwater Mussel
Spike (T)	*Elliptio dilatata*	Freshwater Mussel
Creeper (T)	*Strophitus undulatus*	Freshwater Mussel
Higgins Eye Pearlymussel (E)	*Lampsilis higginsii*	Freshwater Mussel
Pistolgrip (E)	*Tritogonia verrucosa*	Freshwater Mussel
Round Pigtoe (E)	*Pleurobema sintoxia*	Freshwater Mussel
Yellow Sandshell (E)	*Lampsilis teres*	Freshwater Mussel
Sheepnose (E)	*Plethobasus cyphyus*	Freshwater Mussel
Spectaclecase (E)	*Cumberlandia monodonta*	Freshwater Mussel
Purple Wartyback (T)	*Cyclonaias tuberculata*	Freshwater Mussel
Ebonyshell (E)	*Fusconaia ebena*	Freshwater Mussel
Black Sandshell (T)	*Ligumia recta*	Freshwater Mussel
Byssus Skipper (T)	*Problema byssus*	Insect
Indiana Bat (E)	*Myotis sodalis*	Mammal
Northern Long-eared Bat (T)	*Myotis septentrionalis*	Mammal
Southern Bog Lemming (T)	*Synaptomys copperi*	Mammal
Schreber's Aster (E)	*Aster schreberi*	Plant
Downy Yellow Painted Cup (E)	*Castilleja sessiliflora*	Plant
Sweet Indian Plantain (T)	*Cacalia suaveolens*	Plant
Spotted Coral-root Orchid (E)	*Corallorhiza maculata*	Plant
Mead's Milkweed (E)	*Asclepias meadii*	Plant
Waxleaf Meadowrue (E)	*Thalictrum revolutum*	Plant
Orange Grass St. John's Wart (E)	*Hypericum gentianoides*	Plant
Slender Dayflower (T)	*Commelina erecta*	Plant
Slender Ladies' tresses (T)	*Spiranthes lacera*	Plant
Pink Turtlehead (E-IL)	*Chelone obliqua*	Plant
Blanding's Turtle (E-IL,T-IA)	*Emydoidea blandingii*	Reptile
Eastern Massasauga Rattlesnake (E)	*Sistrurus catenatus*	Reptile
Ornate Box Turtle (T)	*Terrapene ornata*	Reptile

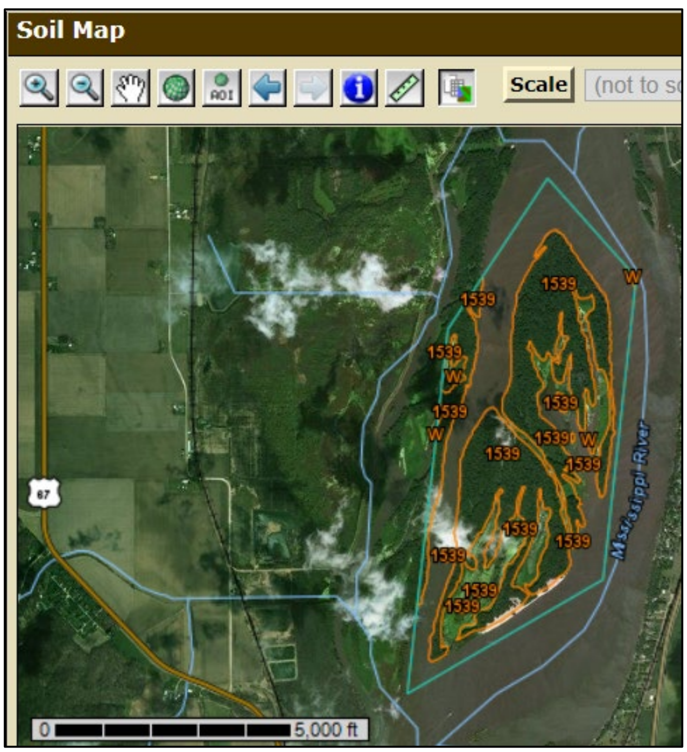
F. Invasive Species

Common invasive species known to be present in Pool 14 include purple loosestrife *(Lythrum salicaria);* curly-leaf pondweed (*Potamogeton crispus)*; Eurasian watermilfoil (*Myriophyllum spicatum)*; Asian clam *(Corbicula fluminea)*; zebra mussel *(Dreissena polymorpha)*; common carp *(Cyprinus carpio)*; reed canarygrass *(Phalaris arundinacea);* silver carp *(Hypophthalmichthys molitrix)*; Emerald Ash Borer *(Agrilus planipennis);* and bighead carp *(H. nobilis)*.

Invasive terrestrial plants found during the 2018 forest inventory include winter creeper (*Euonymus fortune*), Amur honeysuckle (*Lonicera maackii*), white mulberry (*Morus alba*), and reed canarygrass (*Phalaris arundinacea*). Non-native terrestrial plants found during the forest inventory include barnyardgrass (*Robinia pseudoacacia*).

G. Subsurface Soil Characterization

The Natural Resources Conservation Service (NRCS) publishes soil surveys for most counties in the United States. Information in a pre-published soil survey indicated that the dominant soil type present in the Project area is generally classified as Ambraw-Perks-Lawson complex, which is described as an alluvium product in the NRCS classification system. This series is described as frequently flooded, poorly drained soil with a water table that varies between ground surface and 1 foot deep (Figure II-6).



Scott County, Iowa (IA163)
Rock Island County, Illinois (IL161)

Rock Island County, Illinois (IL161)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
W	Water	0.7	0.1%
Subtotals for Soil Survey Area		**0.7**	**0.1%**

Scott County, Iowa (IA163)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1539	Ambraw-Perks-Lawson complex, frequently flooded, 0 to 2 percent slopes	343.4	45.5%
W	Water	410.0	54.4%
Subtotals for Soil Survey Area		**753.4**	**99.9%**
Totals for Area of Interest		**754.0**	**100.0%**

Figure II-6. Results of Project Area NRCS Web Soil Survey (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx)

Below ground surface materials, to depths ranging between 4.5 and 6.0 feet, are composed of lean and fat clays with varying silt and sand contents. The clays generally indicate a gradual change in stiffness with increased depth. Medium to fine sand lenses were found sporadically in most borings. Detailed subsurface soil characteristics can be found in Appendix G, *Geotechnical Considerations*.

H. Subsurface Explorations

District Geotechnical Branch personnel conducted subsurface exploration using a 4-inch diameter Iwan-style hand-auger on October 3, 2018 and a 2 ¾ -inch Outer Diameter vibrocore sampler on October 4, 2018 in order to characterize the composition and engineering properties of the soils present at Steamboat Island. Borings were taken at the locations shown in Appendix G, *Geotechnical Considerations*.

Borings SB-18-06, 07, 08, and 09 were taken within the Grant Slough Complex. Borings SB-18-01, 02, 03, 04, and 05 were taken within the downstream end of Steamboat Island. Borings SB-18-10, 11, 12, 13, 14, and 15 were taken within the upstream end of Steamboat Island. On each boring, samples were taken at sufficient intervals to classify all the strata encountered. Representative samples were taken for visual soil classification and moisture content from all recovered soils. Atterberg limit tests were performed on several of the clay samples gathered throughout the site to verify soil classifications and to characterize stratigraphy. Boring logs can be found in the Geotechnical Appendix (see Appendix G, *Geotechnical Considerations*).

The borings ranged up to approximately 12 feet deep from average water surface elevation (575.35 NAVD88). Below ground surface materials, to depths ranging between 4.5 and 7.0 feet, are composed of lean and fat clays generally showing a gradual change in stiffness with increased depth. Medium to fine sand lenses were found sporadically in most borings. Results for moisture contents ranged between 21 and 100, averaging 62, expressed as a percentage of the dry sample weight.

I. Water Quality

Baseline water quality monitoring was initiated at Steamboat Island by the District on December 19, 2014 at site W-M504.7S (Figure II-7; Plate 27, O-101; and Appendix F, *Water Quality*). Sites W-M504.9P, W-M505.7C, and W-M505.0B were added on June 6, 2017, and site W-M504.1E on December 8, 2017. Baseline monitoring continued through March 11, 2019, with eight samples collected during the summer months and two or three samples during the winter months each full year. For summaries of discrete grab samples, refer to Table F-1, Appendix F, *Water Quality*. In addition to grab samples, multi-parameter water quality monitoring instruments, or sondes, were used to collect more frequent data. Refer to Appendix F for more details.

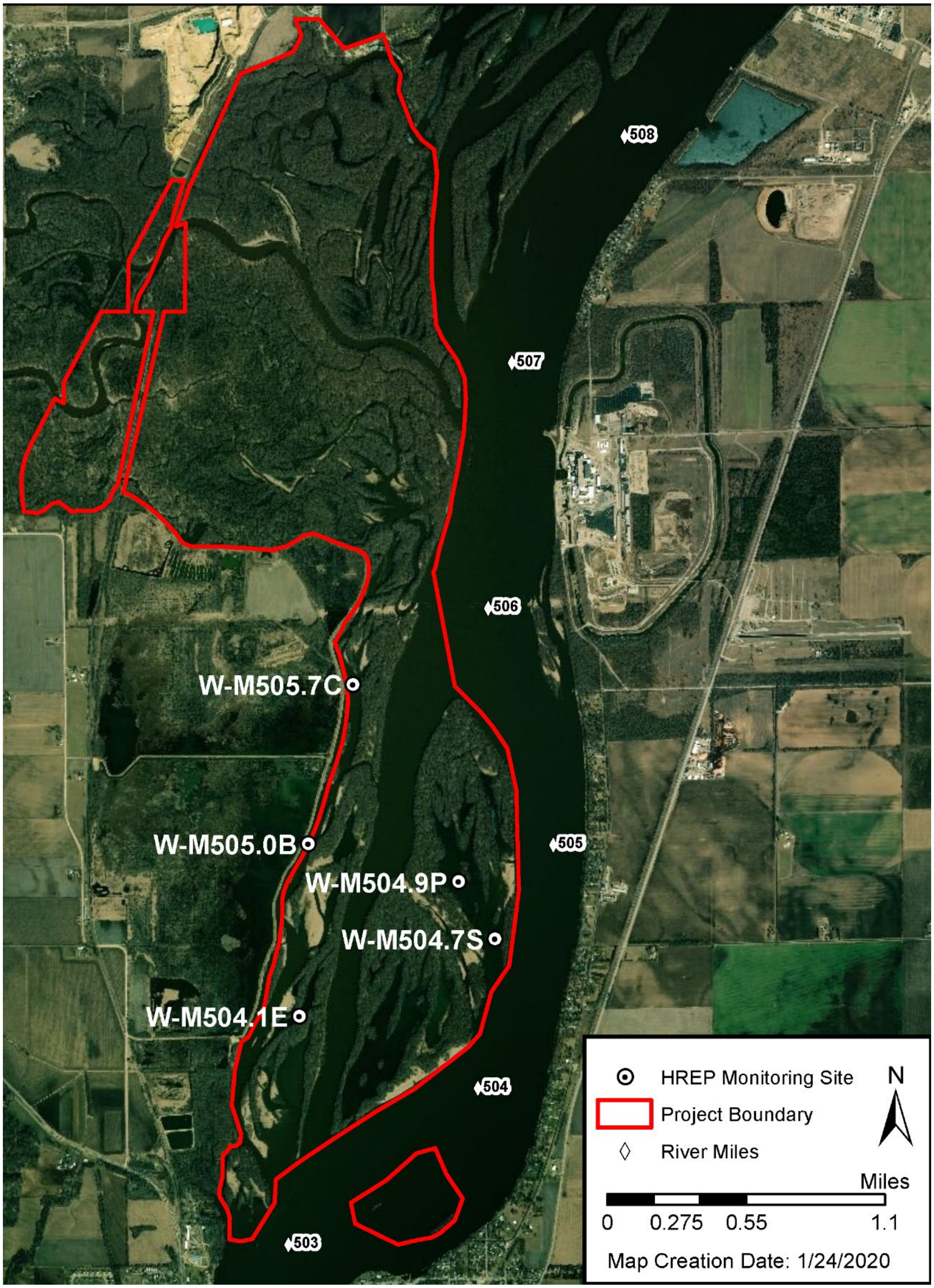


Figure II-7. Water Quality Monitoring Locations

Grab sample results readily indicate the lotic (river like) versus lentic (lake like) nature of the five monitoring sites (Figure II-8). Sites W-M505.0B and W-M505.7C exhibited lotic characteristics, while the remaining three sites were more lentic in nature. Preferred habitats for the backwater fishery have low velocities of < 3 cm/sec during summer spawning and < 1 cm/sec during the winter. The summer and winter median velocity values for the lotic sites (W-M505.0B and W-M505.7C) were ≥ 16 cm/sec; whereas, the highest median velocity at the remaining three sites (with lentic characteristics) was 3.93 cm/sec (summer at site W-M504.7S). Median summer velocities for the other two lentic sites (W-M504.9P and W-M504.1E) were below the 3 cm/sec threshold. At all sites, median summer velocity values were significantly greater than winter values. The maximum winter velocity recorded at any of the three lentic sites was 2.82 cm/sec at site W-M504.7S. This value was recorded on March 9, 2016, when the site was ice free and water levels had risen above winter lows. The median winter velocity for that site was 0.77 cm/sec, but there were several other occasions where the winter velocity exceeded 1 cm/sec at this site. The maximum recorded winter velocity at the other two lentic sites was below the 1 cm/sec threshold.

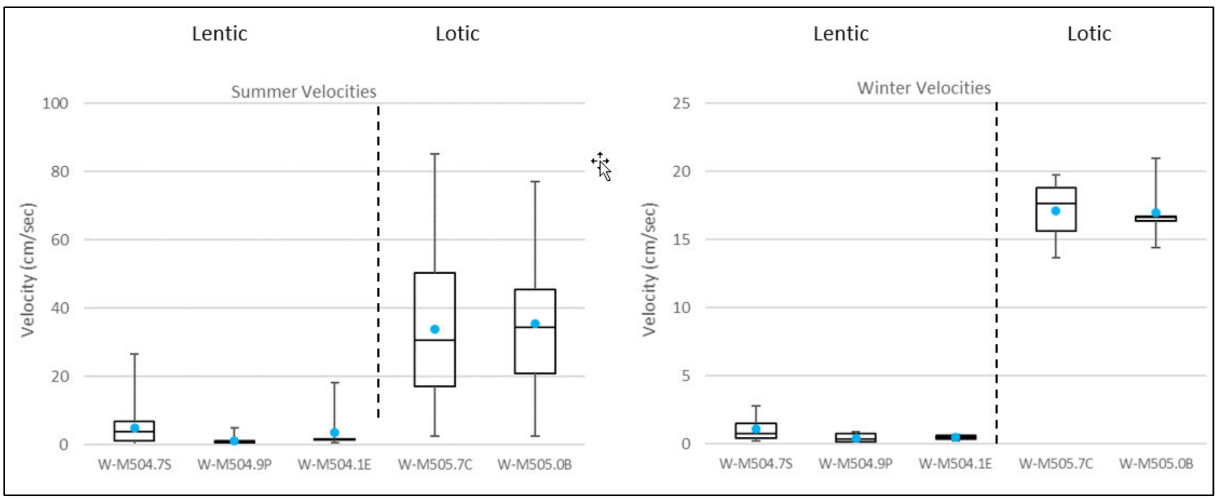


Figure II-8. Lentic vs Lotic Velocity Characteristics of Water Quality Sites

The lotic versus lentic nature of the five monitoring sites was also shown in grab sample measurements reflective of water clarity: Secchi disk depth, turbidity and total suspended solids (TSS). Light-related criteria necessary to support and sustain submersed aquatic vegetation (SAV) during the growing season in the UMR include a minimum Secchi disk depth of 50 cm, a maximum TSS concentration of 25 mg/L, and a maximum turbidity of 20 NTU, as described in UMRCC (2003). Summer median values of turbidity and total suspended solids at the lotic sites W-M505.0B and W-M505.7C exceeded values at the remaining three sites, while Secchi disk depth median values were less (Figure II-9). None of the readings at the lotic sites met the criteria necessary to support and sustain SAV during the growing season. Although the lentic sites generally exhibited better water clarity than the lotic sites, site W-M504.9P was the only site that consistently met all three SAV water clarity criteria, with sample measurements meeting target values on nearly all sampling occasions.

As shown in Figure II-9 and Figure II-10, DO grab sample concentrations ranged from 0.82 mg/L (summer at site W-M504.9P) to 23.22 mg/L (winter at site W-M504.9P). Of the five sites monitored, W-M504.9P visually contained the most aquatic vegetation (and also the lowest median velocity values), so it was not surprising to see both the minimum and maximum DO concentrations occur here. Median summer DO concentrations ranged from 5.31 mg/L at site W-M504.9P to 7.37 mg/L at site W-M505.0B, while median winter values were significantly higher, ranging from 11.75 mg/L at site W-M504.1E to 13.59 mg/L at site W-M504.7S. Twenty-two grab sample DO concentrations were less than the target level for backwater fishery habitat of 5 mg/L, with all but one occurring during the summer months (Appendix F). Most of the DO concentrations below the target level occurred at sites W-M504.7S (12) and W-M504.9P (7). The sole winter value below the target level was 4.98 mg/L at site W-M504.1E. Only one DO concentration was below the target level at the lotic sites W-M505.0B and W-M505.7C (4.95 mg/L on June 19, 2018, at site W-M505.7C).

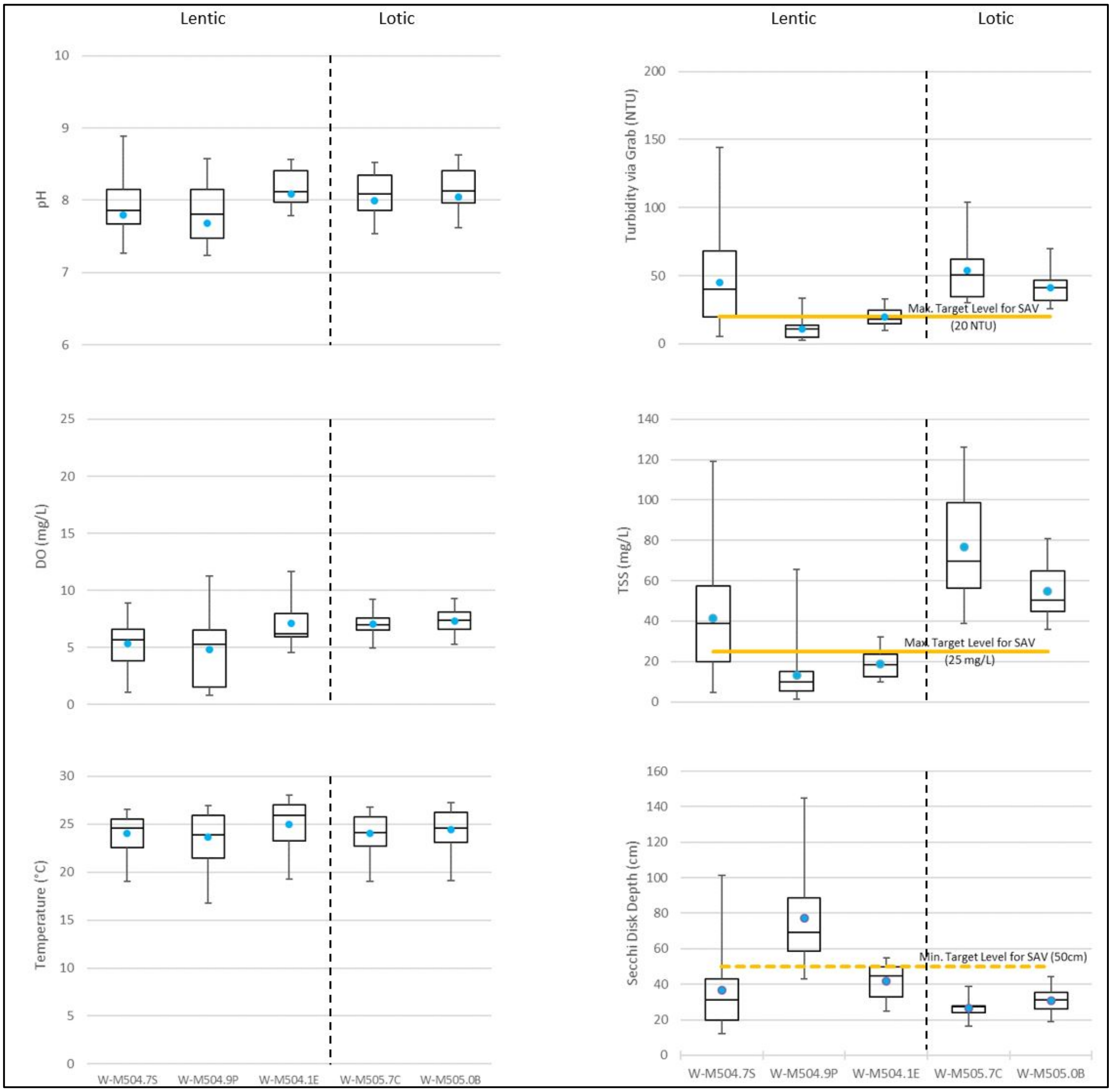


Figure II-9. Summer Grab Sample Data

Mean indicated by dot (●). pH mean calculated from mean [H+]. Summer target levels (▬) are from *UMRCC Proposed Light-Related Water Quality Criteria Necessary to Sustain Aquatic Vegetation in the Upper Mississippi River* (UMRCC, 2003).

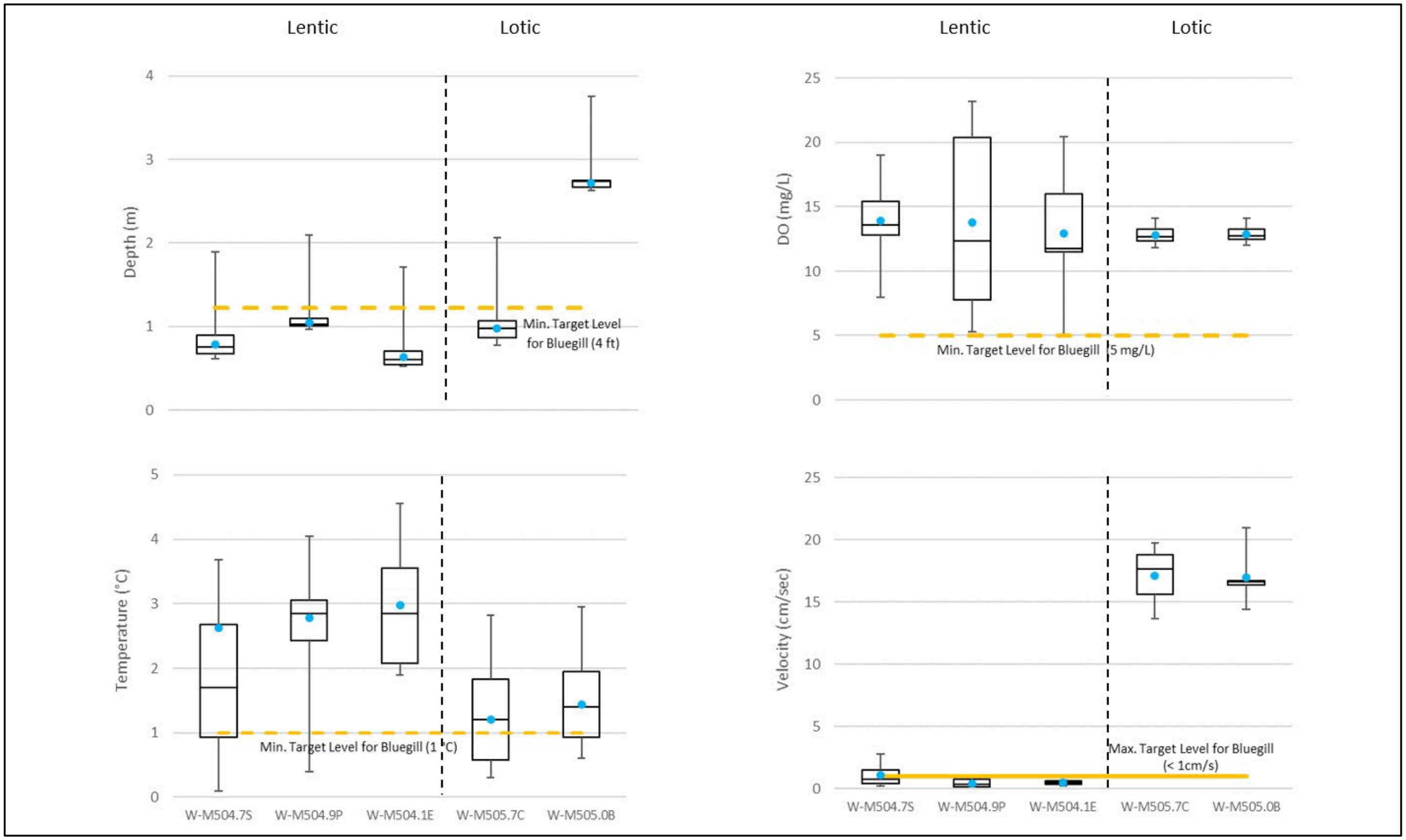


Figure II-10. Winter Grab Sample Data.

Mean indicated by dot (●). pH mean calculated from mean [H+]. Winter target levels (▬) are from *Bluegill Winter Habitat Suitability Index Model* (USACE, 1990) pH levels generally followed trends in DO, with higher pH measurements occurring during times of high DO concentrations. Grab sample median pH values during the summer ranged from 7.81 at site W-M504.9P to 8.13 at site W-M505.0B. The preferred pH range for backwater fishery habitat during the growing season is 6.5 to 8.5. All of the sites had at least one summer reading above 8.5, although most of these occasions were not significantly above the target range. The highest pH grab sample value recorded was 8.89 on August 11, 2015, at site W-M504.7S. The DO concentration on that date was 8.69 mg/L, which was the second highest summer grab sample reading recorded for that site.

Grab sample water temperatures ranged from a minimum of 0.1°C at site W-M504.7S to a maximum of 28.1°C at sites W-M504.7S and W-M504.9P. Preferred habitats for the backwater fishery have water temperatures of 24-30°C during the summer and ≥1.0°C during the winter. Summer median water temperatures ranged from 23.9°C at site W-M504.9P to 26.0°C at site W-M504.1E. Most of the readings below the preferred temperature range occurred either during the early or later portions of the summer monitoring season. These sites were usually visited early in the day before water temperatures had a chance to rebound from overnight low air temperatures, which has more of an effect on the early- and late-season values. Winter median water temperatures ranged from 1.2°C at site W-M505.7C to 2.9°C at sites W-M504.1E and W-M504.9P. Although median values were above the winter target of 1.0°C at all sites, colder temperatures were observed on several occasions at all sites except W-M504.1E. The lotic sites had colder median temperatures, which correlates with the higher velocities observed at these sites. Of the lentic sites, Site W-M504.7S saw more frequent occurrences below the 1.0°C threshold. Site W-M504.7S also had higher velocity readings than the other two lentic sites. These two parameters reflect this site's greater connectivity to the main channel.

Continuous water quality monitors were deployed at Steamboat Island sampling sites W-M504.7S and W-M504.9P during grab sample collection trips. They were typically positioned 1 to 2 feet above the river bottom and were programmed to collect data every 2 hours for a period of about 2 to 4 weeks during the summer and 6 to 14 weeks during the winter. Sondes were initially deployed at site W-M504.7S during the winter of 2014-2015 and at site W-M504.9P during the summer of 2017.

During the summer at site W-M504.7S, it was common to see nighttime DO concentrations fall below the target level of 5.0 mg/L (Appendix F). On occasion, continuous extended low DO concentrations were observed. There were no extended periods of low DO at this site during the summer of 2015; however, during the summer of 2016, most DO concentrations were below 5 mg/L, including a continuous period from July 22 to August 19. The summers of 2017 and 2018 were similar to 2015 in that it was common to see nighttime concentrations below 5 mg/L but there were no extended periods of continuous low DO. At site W-M504.9P, there were extended periods of low DO during both summers monitored (2017 and 2018). During 2017, the DO concentration was below 5 mg/L from July 2 to August 6 and again from August 14 to September 12, while in 2018, low DO concentrations extended from June 9 to June 20.

Winter DO concentrations at site W-M504.7S never fell below the target level during the five seasons monitored. The lowest DO concentration observed was 5.20 mg/L on December 12, 2018. Approximately half of the values were supersaturated. During both winters monitored at site W-M504.9P (2017-2018 and 2018-2019), DO concentrations less than 5 mg/L were measured. During the winter of 2017-2018, only a few instances were observed (minimum of 3.84 mg/L on February 15, 2018); whereas, during the next winter, three extended periods of low DO occurred: November 30 to December 16, 2018, February 1 to February 8, 2019, and February 14 to February 25, 2019.

Supersaturated DO concentrations also occurred during these two winters but were not as frequent relative to site W-M504.7S. Bacterial decomposition of organic matter, coupled with little oxygenated inflow likely contributed to the extended periods of low DO during the winter at site W-M504.9P, the more heavily vegetated of the two sites.

J. Hydrology and Hydraulics

Steamboat Island is located in the middle of Pool 14, approximately 9 miles upstream of Lock and Dam 14 and 16 miles downstream of Lock and Dam 13. Lock and Dam 14 is located near LeClaire, Iowa, and was placed into operation in June 1939 to provide navigable channel depths by maintaining a water surface elevation of 571.2 feet NAVD88 (flat pool) or higher. The annual river stage hydrograph is affected by river regulation such that low river stages are maintained higher by the dam during low discharge periods. Pool 14 is regulated using a dam control point, therefore the degree of influence of the impounding dam decreases as you move upstream of the dam where there is increasing fluctuation in river stage (Figure II-11).

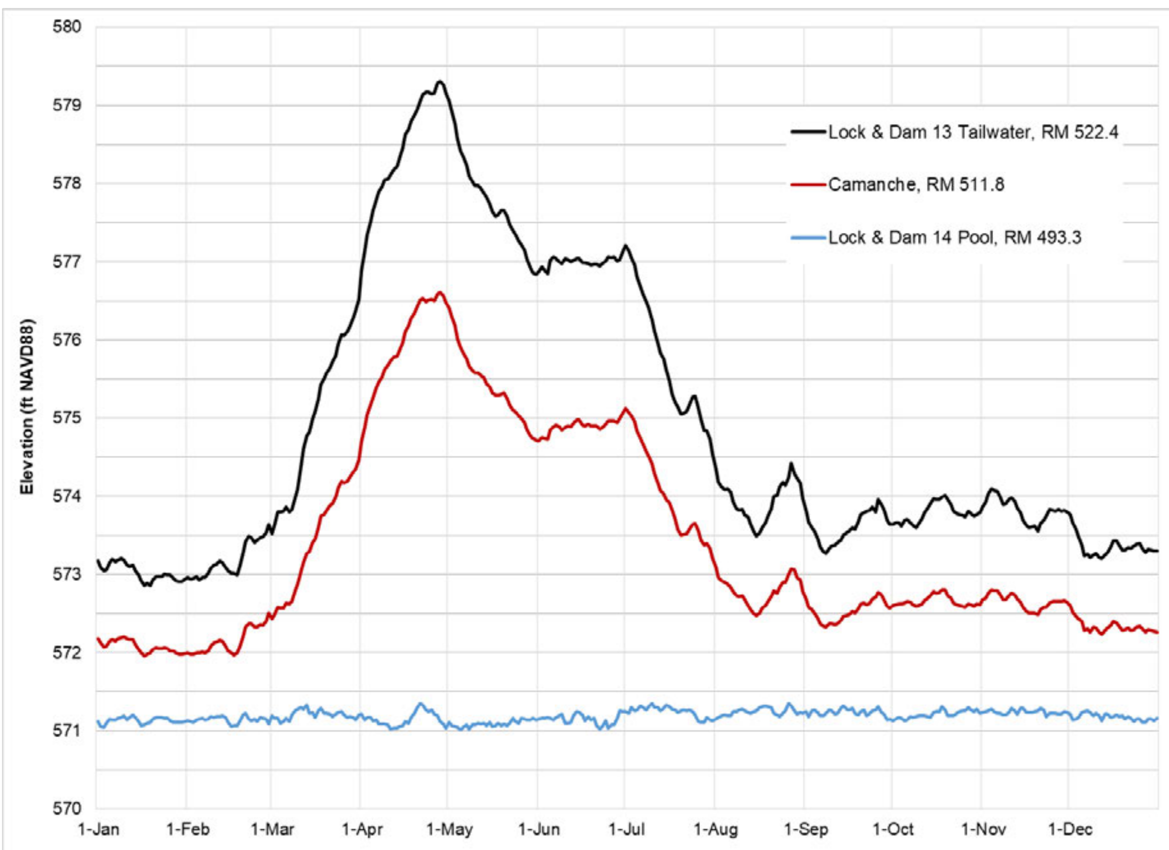


Figure II-11. Average Annual Stage Hydrographs – Upper, Middle, and Lower Portions of Pool 14 1987-2016

The USGS Clinton gage, co-located with the Corps' Camanche gage, is approximately 4 miles upstream of the Project area (RM 511.8) and drains an area of 85,600 square miles. Average annual discharge at Clinton/Camanche gage is 56,300 cfs (period of record 1987-2016). The long-term average annual elevation hydrograph (Figure II-12) illustrates a spring to early summer flood followed by mid to late summer low flows. There is generally a slight pulse through the fall followed by low and more stable flows through the winter.

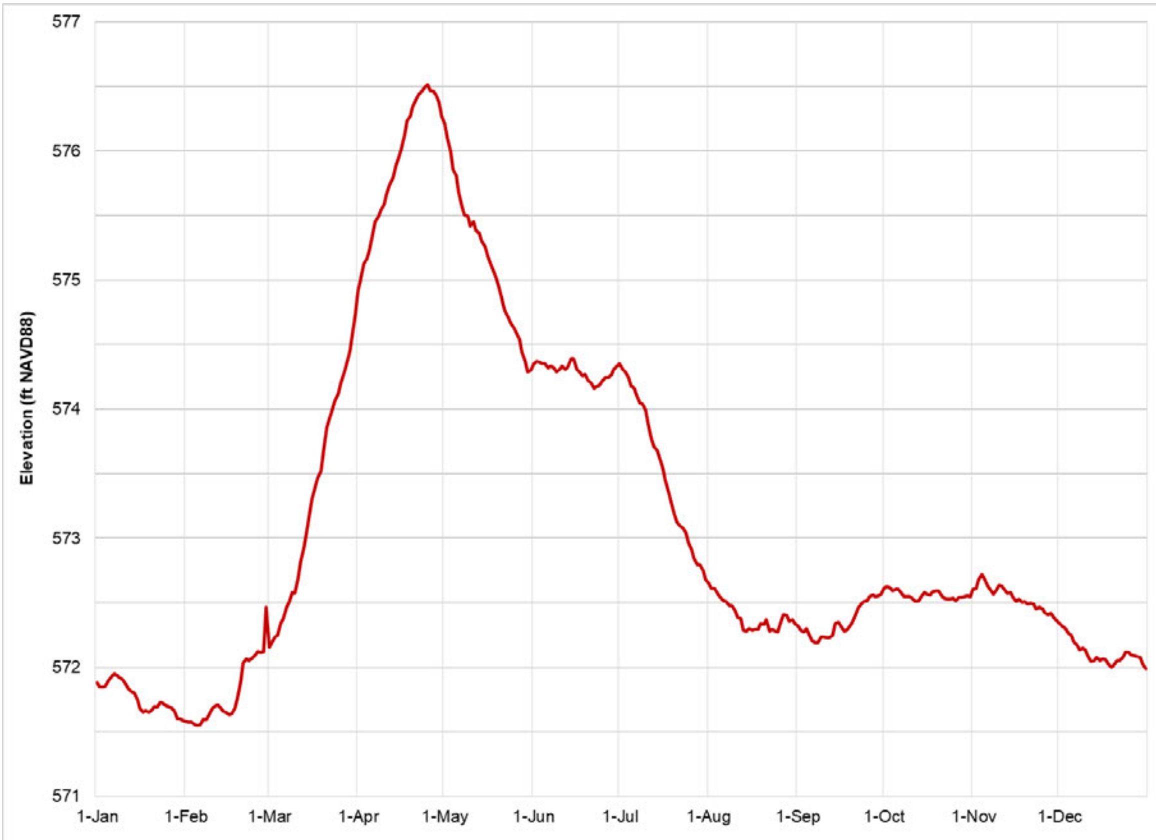


Figure II-12. Long-term Average Annual Elevation Hydrograph at the Camanche Gage – 1940-2016

Figure II-13 shows a comparison of annual elevation duration curves for the most recent 30-year period with the prior 30-year period for the Clinton/Camanche gage. The annual elevation duration curve for the current 30-year period (1987-2016) indicates a median river elevation of 572.6 feet and 572.3 feet for the prior 30-year period (1957-1986). This comparison indicates median river stage has increased since the last 30-year period. Appendix H, *Hydrology and Hydraulics*, includes additional hydrology and hydraulics information including a qualitative assessment of climate change impacts to hydrology at the Project. High water events at the Camanche gage have occurred in 1965, 2001, 1993, 2019 and 2011 (listed in order of decreasing magnitude). The highest flood on record occurred in April 1965 with a river elevation of 587.06 feet.

The Project area comprises side channels, secondary channels, smaller backwater channels, tributary channels, braided floodplain channels and island interior backwater lakes. Backwater areas include Upper Lake, Lower Lake, Northwest Grant Slough, and Southwest Grant Slough. Among the larger channels are the Wapsipinicon River tributary, main channel, Steamboat Slough side channel, and Grant Slough secondary channel. Some of the smaller interior channels convey water throughout the year and others are ephemeral. The East and West SE Islands are small islands located near the lower left-descending bank of Steamboat Island, south of Cordova, IL. During 50% chance exceedance flood conditions, approximately 75% of the Steamboat Island proper is inundated (Figure II-14).

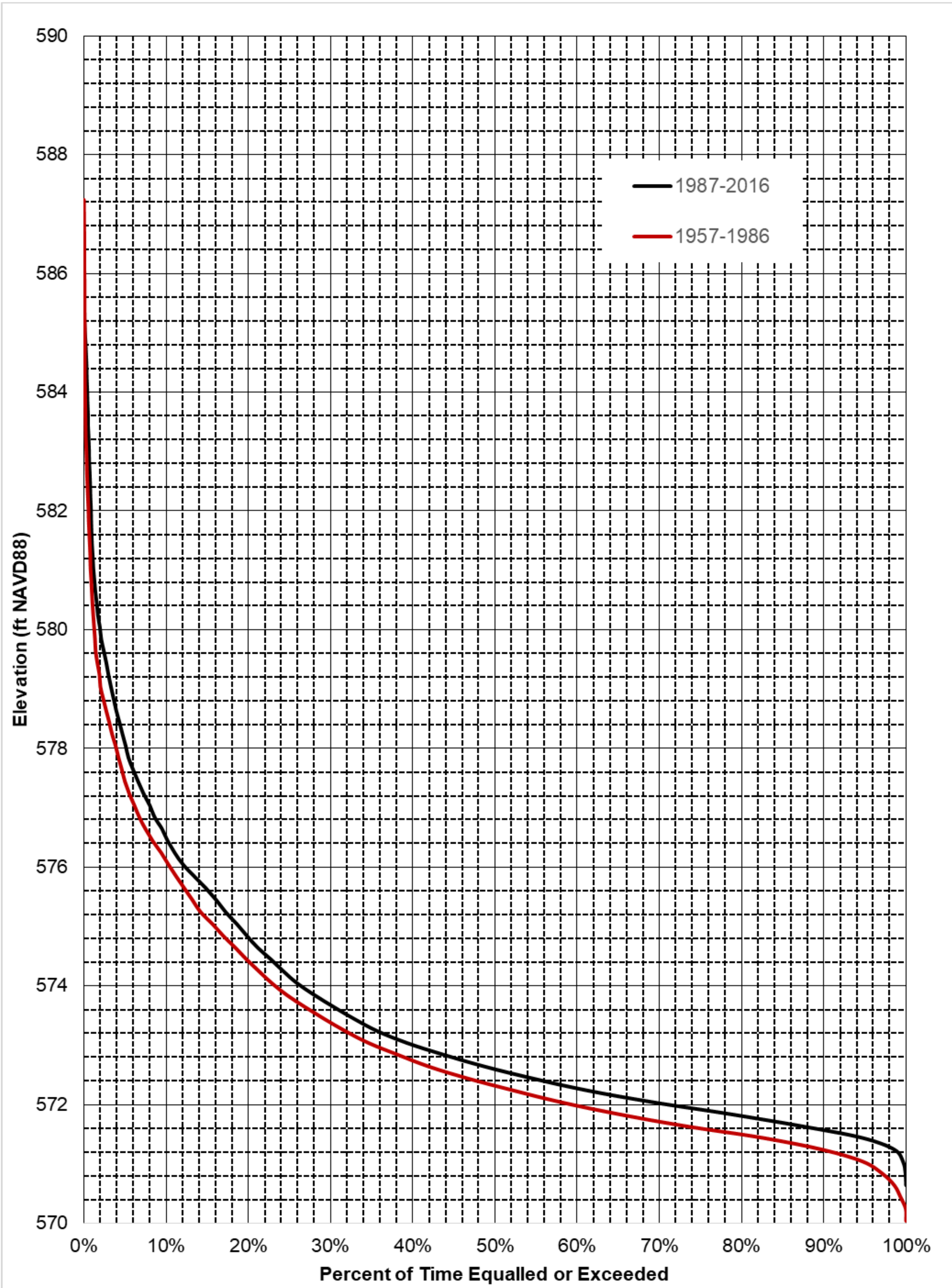


Figure II-13. Comparison of Annual Elevation-Duration Curves for Different Time Periods at the Camanche Gage

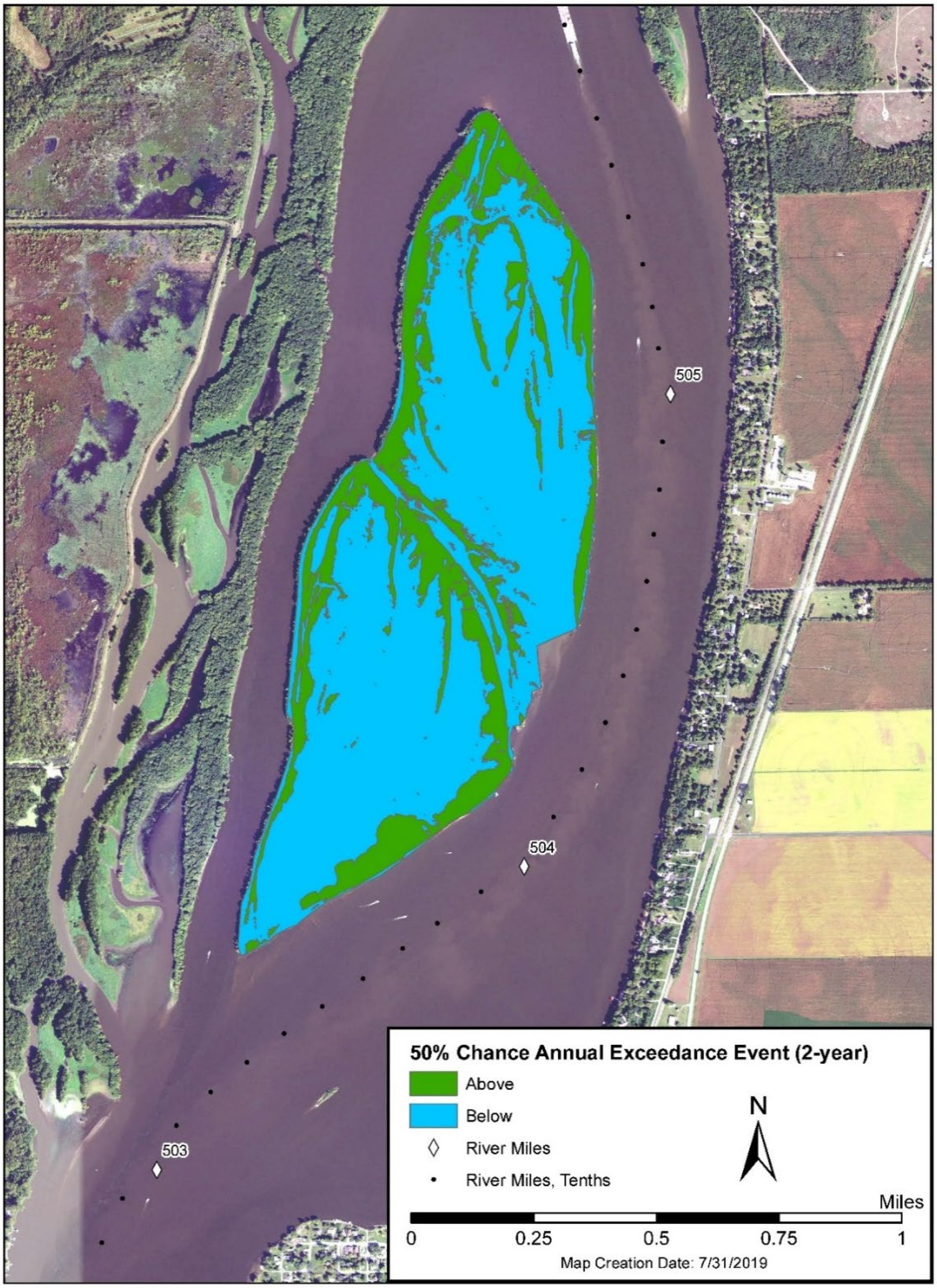


Figure II-14. Steamboat Island Inundation Under 50% Chance Exceedance Discharge

Several seasonal duration curves were computed based on the periods critical to habitat targeted for restoration for the Project. Low water conditions, which threaten DO concentrations and fish habitat, can occur during the winter (November through February) and summer (July through August) months. As shown in Figure II-15, the period between November and February represents the more critical conditions for fish. The reference water surface elevation used to distinguish floodplain (above water) from aquatic (below water) habitat was the 70% annual exceedance duration. The elevation at the Project site (approximately mid-Project, RM 504.5) that meets this criteria is 571.7 feet.

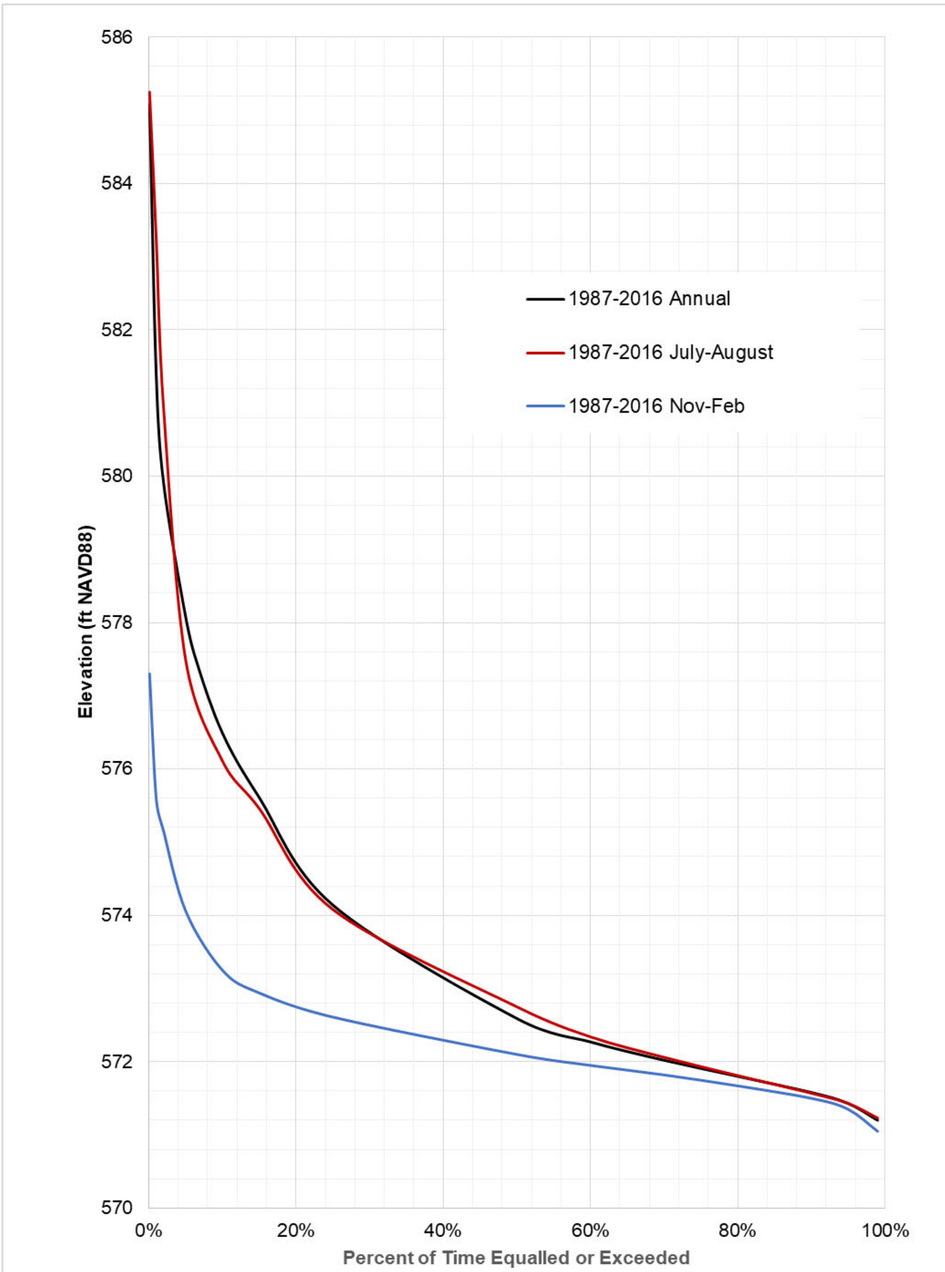


Figure II-15. Comparison of Seasonal and Annual Elevation Duration Curves at the Camanche Gage

Hard mast trees are most vulnerable to flood-induced mortality during the growing season, therefore, a growing season (April 15 to October 15) duration analysis was also completed. A comparison of the median growing season stage for the current 30-year period and the median growing season stage for the prior 30-year period indicates an increase in median stage of over 0.5 feet (Figure II-16). The stage record that shaped the existing conditions (Figure II-16) shows water levels have seen increased exceedance durations, which has contributed to the observed decline in species and age diversity among the floodplain forest community. See Appendix H, *Hydrology and Hydraulics*, for a qualitative assessment of climate change impacts to hydrology at the Project.

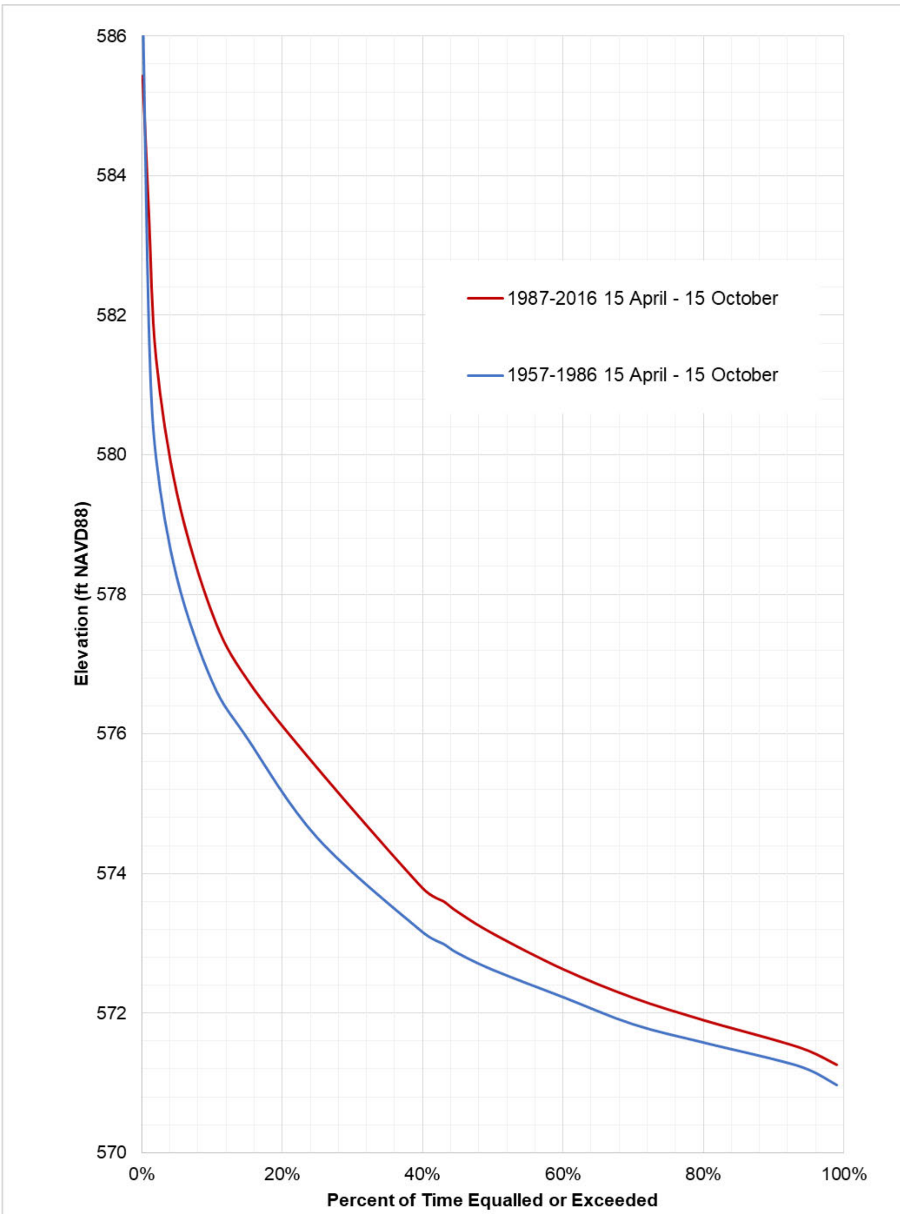


Figure II-16. Comparison of Growing Season Elevation-Duration Curves for Different Time Periods at the Camanche Gage

K. Sediment Deposition

The Wapsipinicon River is the largest tributary to Pool 14 and outlets on the Iowa side north of Steamboat Island. Maintenance dredging within Pool 14 occurs as needed to address shoaling issues impacting navigation. Table II-5 summarizes the historical dredging activity near the Project area and Figure II-17 illustrates the dredging locations. Additional dredging occurs within Pool 14 and placement may occur at Historic Bankline Placement Site RM 503.5-504.1R.

Table II-5. Historical Dredge Cuts near Steamboat Island HREP Project Area

Steamboat Island	Year	Cubic Yards	Dredging Events	Placement Site	Placement Type
Total Cubic Yards: 883,794	1961	72,766	503.3-503.7	503.5-503.8R	
Number of Events: 18	1968	150,731	503.4-504.0	503.6-503.8R, 503.8R, 503.9-504.1R, 503.6-504.1L	
	1972	119,999	503.3-503.9	503.3-503.6R, 503.6-504.0R	
	1973	72,506	503.5-504.0	503.3-503.4L, 503.5-503.7L	
	1985	26,666	503.6-503.9	503.7R, 503.8-504.0R	
	1986	34,222	503.6-504.0	503.5-503.7R	
	1988	23,400	503.6-503.9	503.5-503.9R	
	1990	56,495	503.7-504.0	502.9 (38,444; Thalweg); 503.5-503.7R (18,051)	Thalweg
	1991	48,729	503.4-504.0	502.7-503.1	Thalweg
	1995	29,193	503.2-503.8	2 events	Thalweg
Average per Event: 49,099	1995	13,738	503.2-503.8	2 events	Thalweg
	1999	24,352	503.3-503.8	503.7-504.0R (20,741; Bank), 503.0 (3,611; Thalweg)	Bank/Thalweg
	2002	24,148	503.3-503.8	503.7-504.0R (8,650; Bank); 503.0 (15,498; Thalweg)	Bank/Thalweg
	2006	35,143	503.3-503.7	502.7-503.1	Thalweg
	2009	21,308	503.3-503.8	503.7-503.9R (16,871 Bank); 502.9T (4,437; Thalweg)	Bank/Thalweg
	2011	37,507	503.3-503.9	503.7-503.8R (19,085; Bank); 502.8T (18,422; Thalweg)	Bank/Thalweg
	2014	23,411	503.5-503.9	502.9-503.2R	Thalweg
	2019	69,480	503.2-503.9	502.8	Thalwag

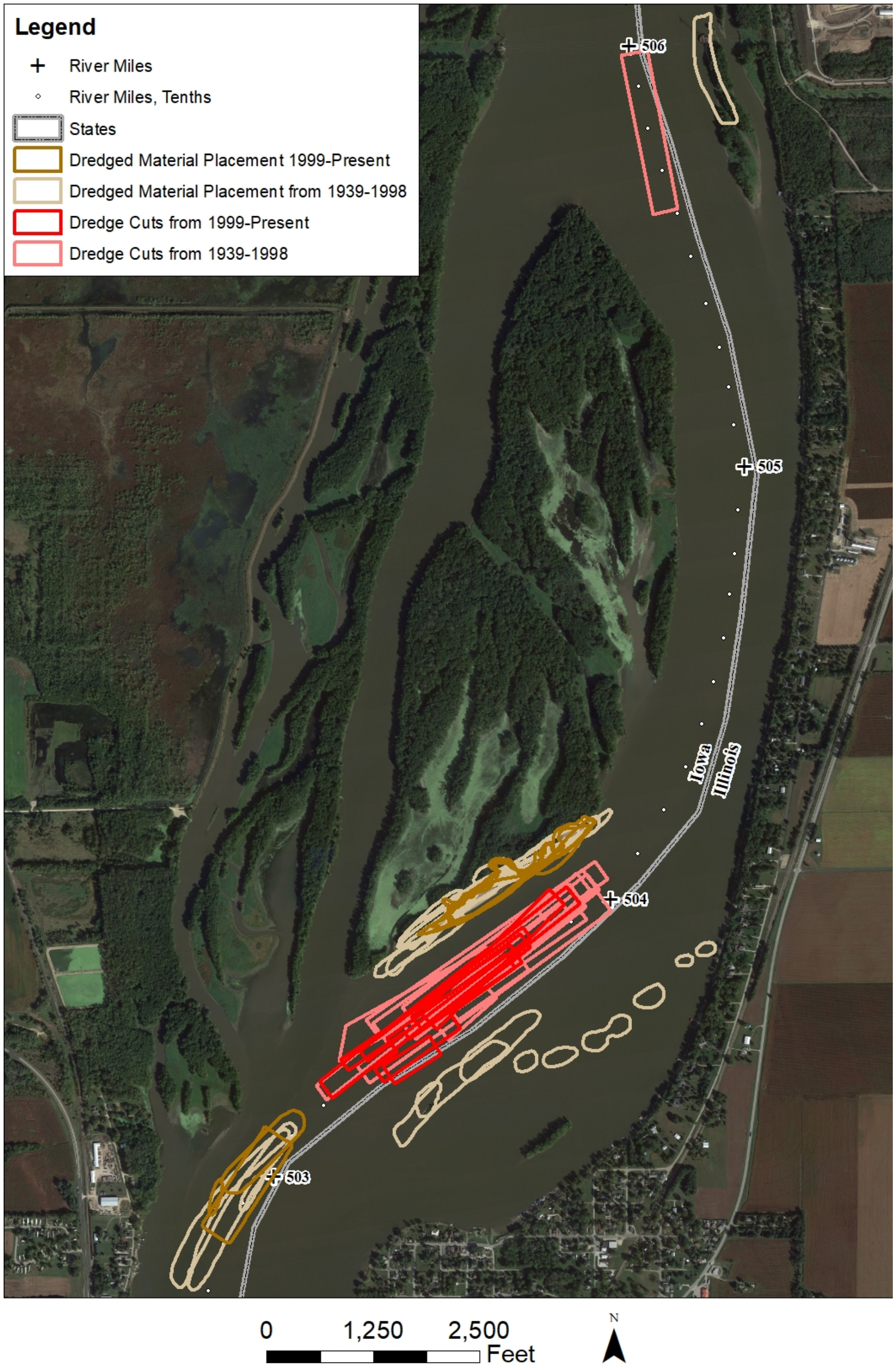


Figure II-17. Dredge Locations near Steamboat Island

Temporal and spatial variability are inherent in the numerous processes that drive sediment deposition, thereby sediment deposition rates are also dynamic. Some of the watershed features impacting backwater sediment deposition rates include geology and soils, land use, and other rainfall runoff characteristics of the contributing watershed, in addition to spatial and temporal variability of natural impoundments such as beaver dams.

To date, backwater sediment deposition studies within the UMR have focused on Pools 4-10 and Pool 13 (Aspelmeier, 1994; Eckblad et al., 1977; Korschgen et al., 1987; McHenry et al., 1984; Rogala & Boma, 1996; Rogala et al., 1997). Results from these studies vary from as much as 1.57 in/year (4.0 cm/year) (Pools 4-10) and as little as 0.08 in/year (0.2 cm/year) (Pool 7). A sediment deposition rate of 0.31 in/year (0.8 cm/year) was reported for Navigation Pool 13 (Rogala, et al., 1997). The Cumulative Effects Study indicates backwater sediment deposition rates derived from the sediment budget that vary from 0.2 in/year (0.5 cm/year) for Pools 12-19 to 0.12 in/year (0.31 cm/year) for Pools 20-26 (WEST Consultants, Inc., 2000). Seven backwater sites within Pool 14 were monitored for sediment deposition from 1984 through 2000 (Aspelmeier, 1994). Four of these sites were located in the Project area; one in Grant Slough near the Princeton Wildlife Management Area (Station 1), one in a backwater complex in Grant Slough (Station 2), one in the middle of Upper Lake (Station 3), and one in the middle of Lower Lake (Station 7). Annual measurements along a transect at Stations 1-3 were collected from 1984-1989. Stations 1 and 2 had repeated measurements in 1994. Measurements at the transect in Lower Lake (Station 7) were taken annually from 1987-1989 then in 2000 and most recently in 2017. During this observation period, flooding occurred in 1986, 1993, 1997, 2001, 2008, 2011, 2014, and 2019. Rates range from -0.8 in/year (erosion) to 2.2 in/year of deposition, however the overall trend is toward deposition. The average sediment deposition rate at Stations 1, 2, 3 and 7, based on the varying study periods, are 0.9 in/year (2.3 cm/year), -0.2 in/year (-0.5 cm/year), 0.6 in/year (1.5 cm/year) and 0.1 in/year (0.3 cm/year), respectively. As a result of the variability in reported values and the inherent variability in sediment deposition rates, an average annual sediment deposition rate of 0.4 in/year (1 cm/year) was assumed for the Project.

L. Historic and Cultural Resources

Pursuant to the National Historic Preservation Act (NHPA) of 1966, as amended, and its implementing regulations, 36 CFR Part 800, the Corps must consider potential effects of the undertaking on historic properties because the Project is located on Federal lands. The Corps must follow a suite of Federal and state laws pertaining to the protection of cultural resources. These laws and appropriate measures are referenced throughout Appendix O, *Programmatic Agreement for Cultural Resources*.

As evident through archeological remains, the Project area and its vicinity were previously inhabited by many known and unknown Native American groups throughout the past 10,000 years or more. The various Native American occupations are generally characterized by gradual and evolving settlement and land use strategies. The 1995 report entitled *The Historic Properties Management Plan for the Mississippi River, Pools 11 through 22, Rock Island District, Corps of Engineers* (Benn, et.al., 1995) and the 1989 report entitled *Archaeology, Geomorphology, and Historic Surveys in Pools 13 – 14, Upper Mississippi River* (Benn et.al., 1989) offer cultural history summaries relevant to the Project area.

Examining an area's mapped Landform Sediment Assemblages (LSA) assists in understanding prehistoric archeological potential, as documented in the report, *Landform Sediment Assemblage (LSA) Units in the Upper Mississippi River Valley, United States Army Corps of Engineers, Rock*

Island District (Bettis et.al., 1996). Mapped Project LSAs are Island, Early to Middle Holocene Channel Belt, and Tributary Fan. A large portion of the HREP is shown as underwater or seasonally inundated on 1930's plane table maps; those areas have no or extremely low potential to contain significant cultural resources.

Three prior archeological surveys overlap with small portions of the Project. The 1985 report entitled *Phase I Cultural Resources Survey: Archaeological and Geomorphic Reconnaissance at the Proposed Pipeline Crossing of the Northern Plains Natural Gas Company, Mississippi River Navigation Pool 14* (Anderson and Overstreet, 1985), documents survey of a pipeline proposed north of Steamboat Island proper. The limited excavations associated with the 1985 work do not conform to modern archeological fieldwork standards as provided in the Secretary of the Interior's *Standards and Guidelines for Identification and Evaluation* (48 FR 44720-23). The authors note that two cores excavated on the Tributary Fan west of the north tip of the island contained historic alluvium over 2.9-m thick.

The report *Archaeology, Geomorphology and Historic Surveys in Pools 13-14, Upper Mississippi River, Volume I: An Overview and Intensive Sample Survey of the Geomorphology and Cultural Resources of Mississippi River Pools 13 & 14* (Benn et al., 1989) primarily documented the area's geomorphology.

At the northwest corner of the Project, the report *Phase I Intensive Archaeological Survey and Geomorphological Investigation for Historic Properties, Rock Creek Marina and Campground, Clinton County Conservation Board, Clinton County, Iowa* (Stanley, 1996), assessed the possible impacts of marina and campground's improvements. The author found that prehistoric archeological potential is high within the upper 1.5 m of the Early to Middle Holocene soil column there.

The Corps reviewed the report, *An Investigation of Submerged Historic Properties in the Upper Mississippi River and Illinois Waterway* (American Resources Group, 1997), prepared by American Resources Group, Ltd. (Contract No. DACW25-93-D-0012, Delivery Order No. 37). No underwater historic properties are documented between RM 502 and 509.

A query of the Iowa Site File (ISF) Geographic Information System (GIS) archeological file database revealed three previously recorded terrestrial sites within the Steamboat Island HREP boundaries.

Archeologist Charles R. Keyes noted a possible historic Sauk or Meskwaki village at the mouth of the Wapsipinicon River. Designated site 13CN36, this village appears in the ISF GIS database as an upward-facing triangle, meaning both the site's location and boundaries are uncertain. Site 13CN59 is a historic Euro-American scatter recorded in the ISF GIS database as a downward-facing triangle, meaning the site's location is known, but its boundaries are uncertain. These two sites are discussed in the 1989 Benn et al. report; this report recommended site 13CN59 be preserved. The site 13CN36 recommendation called for subsurface testing to pinpoint the definite site location.

The final previously recorded site, isolated prehistoric find 13CN78, is documented in Stanley's 1996 report, where he mentions finding two pieces of flaking debris, one each found in the upper 10 cm of two shovel tests. Stanley recommended the site ineligible for National Register of Historic Places (NRHP) listing. The Iowa State Historic Preservation Office (SHPO) Database of Section 106 Review and Compliance Decisions for specific sites (accessible through the ISF GIS database) notes that, on 17 May 1996, the SHPO determined the site ineligible for NRHP listing.

Review of the 1930s Corps land acquisition/topographic maps reveals a variety of buildings and structures once stood within the Project area. These include fences, a log race related to timber harvests, a bridge, a pump, a small "stone dam," the side channel closing dam (labeled "stone retarding dam"), and several small buildings which likely functioned as hunting or fishing cabins.

Based on the nature of the Project, the Corps contracted Wapsi Valley Archaeology, Inc. of Anamosa, Iowa, to conduct an archaeological and geomorphological evaluation of the Project area. The work was completed during the summer 2020. The results are forthcoming and will be coordinated in accordance to the stipulations outlined in the Programmatic Agreement (Appendix O, *Programmatic Agreement for Cultural Resources*).

M. Socioeconomic Resources

The Project area is dominated by an undeveloped forested area and has little residential populations within the Project area. The Project is located in Pool 14 on the Mississippi River, which flows through Clinton and Scott Counties, Iowa, and Rock Island County, Illinois. Table II-6 shows cumulative acreage totals for Clinton, Scott, and Rock Island Counties classified by land and water resource descriptions. This information was retrieved from the 2018 USDA National Agricultural Statistics Service Cropland Data Layer. The land in these three counties is used primarily for agriculture, but there is also significant industrial development, especially adjacent to the Beaver Island HREP in the City of Clinton, Iowa, approximately 6 miles upstream of the Project area, as shown on Figure II-18 and Table II-7.

Table II-6: Land and Water Resource Acreages for Pool 14 Counties (USDA- National Agricultural Statistics Service)

Class Name	Acres
Corn	362,968
Soybeans	233,995
Grassland/Pasture	100,965
Deciduous Forest	96,294
Developed/Open Space	68,292
Developed/Low Intensity	46,326
Open Water	33,459
Woody Wetlands	39,863
Developed/Medium Intensity	23,295
Alfalfa	10,400
Developed/High Intensity	9,737
Herbaceous Wetlands	9,778

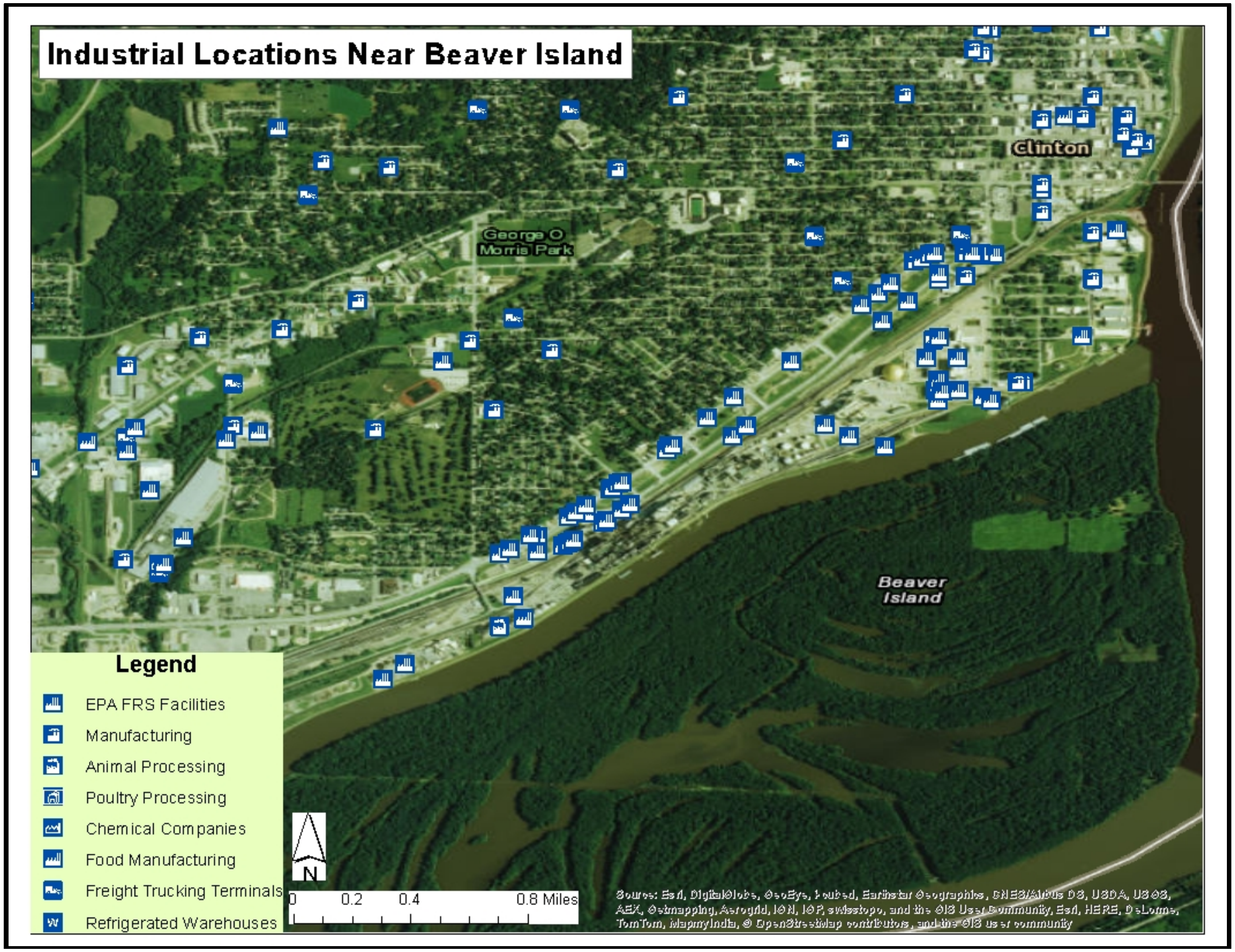


Figure II-18. Industrial Locations near Beaver Island HREP

Table II-7. Mississippi River Pool 14 Business and Industry Distribution by County

	Number of Establishments				
Major Industry	**Scott County, IA**	**Clinton County, IA**	**Rock Island County, IL**	**Total**	**% of Total**
Agriculture, forestry, fishing and hunting	4	8	2	14	0.2
Mining, quarrying, and oil and gas extraction	6	2	7	15	0.2
Utilities	11	4	9	24	0.3
Construction	448	114	235	797	9.2
Manufacturing	161	49	136	346	4.0
Wholesale trade	285	51	153	489	5.6
Retail trade	632	180	440	1252	14.4
Transportation and warehousing	129	62	108	299	3.4
Information	61	21	46	128	1.5
Finance and insurance	310	85	213	608	7.0
Real estate and rental and leasing	185	36	121	342	3.9
Professional, scientific, and technical services	397	59	279	735	8.5
Management of companies and enterprises	40	2	29	71	0.8
Administrative and support and waste management and remediation services	238	51	134	423	4.9
Educational services	50	6	38	94	1.1
Health care and social assistance	525	131	422	1078	12.4
Arts, entertainment, and recreation	73	22	53	148	1.7
Accommodation and food services	423	105	335	863	10.0
Other services (except public administration)	417	146	374	937	10.8
Industries not classified	7	1	1	9	0.1
Total	**4402**	**1135**	**3135**	**8672**	
% of Total	50.8	13.1	36.2		

Source: U.S. Census – 2016 County Business Patterns and 2016 North American Industry Classification System Codes

Socio-economic information from the U.S. Census, 2010, for Iowa and Illinois counties near the Project area is as follows:

Clinton, Iowa. With an average population density of 71 people per each of its 695 square miles (2010), Clinton County, Iowa, experienced a 5.5% decrease in total population from 49,116 to 46,429 people during the years 2010 to 2019 (2019 estimated). The median household income is estimated at $50,156, with 12.5% of persons living below the poverty level (2014-2018). Income per capita is $27,942 (2018). Of persons over 25 years of age, 91.1% have a high school education or higher and 19.1% have a Bachelor's degree or higher (2014-2018).

Scott County, Iowa. With an average population density of 361 people per each of its 459 square miles (2010), Scott County, Iowa, experienced an 4.7% increase in total population from 165,224 to 172,943 people during the years 2010 to 2019 (2019 estimated). The median household income is estimated at $58,803, with 12.4% of persons living below the poverty level (2014-2018). Income per capita is $31,873 (2018). Of persons over 25 years of age, 92.9% have a high school education or higher and 31.9% have a Bachelor's degree or higher (2014-2018).

Rock Island County, Illinois. With an average population density of 345 people per each of its 428 square miles (2010), Rock Island County experienced a 3.8% decrease in total population from 147,546 to 141,879 people during the years 2010 to 2019 (2019 estimated). The median household income is estimated at $52,630, with 14.2% of persons living below the poverty level (2014-2018).

Income per capita is $28,595 (2018). Of persons over 25 years of age, 88.9% have a high school education or higher and 23.2% have a Bachelor's degree or higher (2014-2018).

Along with non-monetary ecosystem restoration benefits that are measured in terms of increased habitat units per targeted species, potential economic benefits of habitat restoration also exist. These benefits can include an enhanced quality of life for humans, making it a more attractive location for business and new residential development. In addition, recreational activities tend to increase in relation to cleaner, more inhabitable water. Increased recreation then creates an economic multiplier, or ripple effect for tourism growth in affected areas. Affected areas of successful ecosystem restoration projects will almost certainly extend far beyond the boundaries of the Project area itself.

N. Hazardous, Toxic, and Radioactive Waste

A Phase I Hazardous, Toxic, and Radioactive Waste (HTRW) Environmental Site Assessment (ESA) for the Steamboat Island HREP was conducted. The Phase I ESA was completed in accordance with Engineering Regulation (ER) 1165-2-132, *HTRW Guidance for Civil Works Projects*; ER 405-1-12, *Real Estate Handbook*; ASTM Practice E 1527-13, and ASTM Practice E 1903-11.

The Phase I ESA revealed no evidence of a Recognized Environmental Condition (REC) that could potentially affect the Project area.

Based on the Phase 1 ESA, no further HTRW assessment is recommended. In addition, no restrictions are required on the proposed HREP measures (Appendix E, *Hazardous, Toxic, and Radioactive Waste*).

O. Future Without Project Conditions. Under the National Environmental Policy Act (NEPA) the No Action alternative is necessary to provide a reference point, enabling a comparison of environmental effects of the action alternatives. Due to either avoidance or no existing resources present, cultural, HTRW, socioeconomics, and man-made resources were all determined as not having foreseeable impacts both with and without the Project. The Project Delivery Team (PDT) determined hydrology and hydraulics, aquatic habitat, and floodplain habitat to be resources that would have significant impacts with the No Action alternative. In other words, without intervention, these resources will continue to degrade, emphasizing the importance of the Project. No other major restoration activities are anticipated to occur within or near the Project area at this time. The Corps will continue to operate and maintain the 9-foot Navigation Channel Project within Pool 14, Corps Foresters will continue to implement TSI measures at locations within the Project area, and the UMR NWFR staff will continue to manage refuge land.

1. Hydrology and Hydraulics. Flooding attributes such as duration, frequency, depth and timing have been identified throughout the literature as being the primary drivers of floodplain forest ecology. Elevations supportive of hard mast tree recruitment were characterized for this study based on growing season inundation duration and annual exceedance probability. As discussed in Section II.K, *Sediment Deposition*, stage durations have increased at the Camanche gage, thereby increasing the duration of island inundating flows in the Project area. Although the qualitative climate change assessment in Appendix H, *Hydrology and Hydraulics*, did not identify a statistically significant increasing trend in the 77-year inundation duration records, observed increases in stage duration support the need for a more resilient floodplain forest design through increased elevations in an uncertain future hydrologic regime. If stage durations continue to increase, inundation duration of forested areas will increase, resulting in associated tree mortality and greater loss of floodplain forest diversity and function, as well as the species that use floodplain forest habitat. Island acreage and function will also be lost, effecting aquatic habitat and function and the species that use these areas. It is assumed that increased flows and flooding, as well as the reduction of the islands southeast of Steamboat Island proper, will impact habitat suitability in the Cordova EHA, as shown in the HREP mussel model (see Appendix M, *Engineering Design,* Attachment C).

Without action, sediment deposition within the Project area backwater lakes is expected to continue. If sediment deposition rates as high as 0.4 in/year (1 cm/year), continue over the 50-year period of analysis, deposition of as much as 1.6 feet of sediment or greater may occur within the backwater areas, including overwintering habitat and wetlands.

2. **Aquatic Habitat.** Existing backwater habitat is very limited (less than 1 acre). Over time, this backwater area will be further reduced. If the Project area was subjected to an average sediment deposition rate of 0.4 in/year (1 cm/year) over the next 50 years (1.6 feet total), quality overwintering habitat would be reduced to near zero. It is unlikely the loss would be linear, as sediment deposition varies depending on water levels and flooding events.

It is anticipated that existing interior flowing channels will continue to exist, but may shift location. Remaining lentic habitat will consist of isolated interior shallow pools with fish access only during high water events. Rearing and foraging habitat currently provided by the interior backwaters will be substantially reduced as remaining pool habitat will have impaired water quality or restricted access during average flows. Consequently, summer habitat will either shift to another backwater complex or other flowing channels, if available, in Pool 14. Finally, overwintering habitat will continue to be of low quality within the interior backwaters of the Project.

3. **Floodplain Habitat.** Influencing factors in the Project area have resulted in a lack of topographic diversity due to increased water levels. This has led to limited forest regeneration due to increased inundation height and duration. As such, the forest is dominated by over-mature even-aged silver maple stands, with limited regeneration, and decreasing numbers of hard mast-producing trees. Current topography shows a significant portion of the Project area is low in elevation and below the threshold for producing a sustainable hard mast-producing tree population. Without intervention, it is highly unlikely that the existing forest will regenerate in the next 50 years.

Based on the current age structure, it is anticipated that a large percentage of the current forest will experience mortality over the next 50 years. Without a new cohort of trees in the understory, canopy openings will likely be filled with non-desirable and invasive species. Essentially, the forest will slowly convert to a monoculture of reed canarygrass or other invasive species, which has far less habitat value to floodplain wildlife.

Achievement of a healthy age distribution and species diversity of floodplain trees increases the numbers of hard mast-producing trees and provides the conditions (i.e., increased elevation) to restore a sustainable diverse forest. This is important to neotropical migratory birds and other floodplain wildlife. A conversion of diverse forest to low quality reed canarygrass habitat or silver maple monoculture would alter the structure of the wildlife community. Although silver maple habitat provides high value for generalist bird species, the loss of forested areas is detrimental to migratory and specialist bird communities that require cottonwood, elm, and oak for migration and breeding. Consequently, neotropical and other migratory birds, bald eagles, hawks, herons, bats, and the other floodplain species that rely on the forest resources will be severely impacted.

Over time, non-forested floodplain habitat (wetlands, scrub-shrub habitat) will experience similar impacts, the loss of which will impact pollinator species, herons, waterfowl species, and secretive marsh birds.

Islands on the UMR, and within the Project area, have eroded over time from inundation, high water events, and changes in hydraulic forces. In the Project area specifically, it can be estimated that approximately 100 acres of Steamboat Island proper and over 40 acres of the Southeast Islands have been lost due to inundation and erosion. Active erosion is occurring in the Project area, including after the near-record Spring 2019 flood. The West SE Island is especially at risk of disappearing altogether if no action is taken to restore acreage and protect the island (Photograph II-1). It has been greatly reduced and has no method of protection against the flow of the main channel. The West SE Island is one of two islands that remain in the vicinity of the Cordova EHA and provide a buffer from the hydraulic forces of the main channel. The East SE Island and Cordova EHA both support federally-listed mussel species. Without action, the West SE Island will disappear, making the East SE Island and Cordova EHA more vulnerable and subject to adverse impacts.

Photograph II-1: West SE Island, September 2019

SECTION III. PROBLEMS AND OPPORTUNITIES

This section describes the development of Project objectives and constraints, including the identification of problems and opportunities (Section III.A), resource significance of the Project area (Section III.B), and goals and/or recommendations of overarching or related programs (Sections III.C-F), all of which are directly related to and support Project objectives (Section III.G).

A. Problems and Opportunities Identification

Historically, Steamboat Island contained a number of small backwater lakes, sloughs, cuts, and flowing side channels. Similar habitats were found in the Grant Slough complex and Wapsipinicon Bottoms as well. These habitats provided valuable overwintering, spawning, and feeding areas for a variety of fish, especially centrarchids. Migratory birds, including waterfowl, and wading birds, also used the area extensively.

Human activity within the UMR basin, floodplain, and channel has altered the hydrology, topography, and biotic communities present. Years of continual sediment deposition has degraded aquatic and wetland habitats and, in some instances, converted them to low elevation terrestrial habitats characterized by reed canarygrass monocultures, a relatively low-quality habitat. Impoundment of the pool and permanently higher water tables have affected the health of floodplain forest habitat on islands and adjacent floodplain areas. These higher water tables are affecting forest composition and regeneration. All of these alterations have reduced the quality and diversity of aquatic and floodplain habitats, impaired ecosystem functions, and reduced the acreage of Steamboat Island and other smaller islands in the area.

Problem. Loss of acreage, resiliency, structure and diversity of native floodplain forest and scrub-shrub habitats. The entire UMRS has undergone dramatic changes in the extent, composition, and structure of its floodplain forests over the last two centuries. The report *Ecological Status and Trends of the Upper Mississippi River System* (USGS, 1999)*,* found that what was once a diverse forest composed of mixed silver maple, willow, cottonwood, oak-hickory, and shrub communities is now nearly 80% mixed silver maple. Lack of tree regeneration, reduction of species diversity, and increased tree mortality can be directly attributed to the increase in flood frequency and duration over time and higher water tables. These losses in habitat value limit the present and future ability of the Project area to attract and sustain a diverse community of resident and migratory wildlife species.

Opportunity. There is an opportunity to restore and enhance the age, composition and structure of the current floodplain forest and scrub-shrub habitat in the Project area and to enhance the diversity of these habitats. Floodplain forests are essential life support systems to a tremendous array of wildlife species, including but not limited to bats, birds, herptiles, insects, and mammals. The variety of floodplain forest types and the associated plant and tree communities historically found on Steamboat Island provide necessary habitat for a large number of animal species. Improving the bottomland hardwood forest may increase recreational opportunities (mainly bird watching and other land-based activities) and socioeconomic conditions. Further use of the Project are would increase public awareness of the value of ecosystem restoration opportunities.

Problem. Loss of acreage of Steamboat Island and smaller islands in the Project area. Typically, the lower third of a pool represents the area where water levels were increased the most by the UMR lock and dam system, resulting in the inundation and eventual erosion of what were formerly islands and other terrestrial floodplain features. Islands serve many roles in the Mississippi River's ecosystem, including habitat and a source of food for various aquatic, wetland, and terrestrial species, and protection of aquatic vegetation by deflecting the current and breaking up waves as they roll across the large expanses of water immediately above the locks and dams. Erosion has reduced the number and acreage of islands in the lower sections of many Mississippi pools. When an island is lost, many of the aforementioned functions and benefits are also lost. Approximately 100 acres of Steamboat Island and 40 acres of the small islands near Cordova have been lost since the construction of L&D 14 (Section II, *Affected Environment*).

Opportunity. There is an opportunity to build islands and/or restore island acreage that has been lost in the Project area, in order to provide resilient and high quality habitat and ecosystem function to benefit an array of aquatic and wildlife species. There is also an opportunity to implement flow diversity structures, which would create diverse flows, and may also capture sediment, creating an island over time. Additional islands in the Project area and Pool 14 may increase recreational opportunities (mainly fishing and boating) and fishery output. Further use of the Project are would increase public awareness of the value of ecosystem restoration opportunities.

Problem. Loss of acreage, resiliency, structure and diversity of aquatic habitat. Backwater fish and mussel habitat is an important component of the Mississippi River ecosystem. This type of habitat has declined in most of the UMRS with the leveling effects of sediment deposition in off-channel areas. The regular occurrence of maintenance dredging in Pool 14 exemplifies the sediment deposition problem occurring in this reach. Benthic organisms, such as freshwater mussels, play a significant role in aquatic ecosystems. North America has the highest diversity of freshwater mussels in the world, with the highest mussel richness found in the Mississippi ecoregion. Currently more than half of the 78 known species are in some form of Federal or state listing.

Opportunity. There is an opportunity to restore backwater areas and improve habitat conditions for a large variety of backwater and channel fish species, including host species for a variety of freshwater mussels. There is an opportunity to increase overwintering habitat, improve spawning habitat, and increase nursery/rearing habitat to produce year round habitat within the Project area. There is also an opportunity to protect the integrity of high quality lentic habitats that currently exist in the interior of Steamboat Island and Grant Slough. The realization of these opportunities may also enhance local recreational opportunities (mainly fishing and boating), socioeconomic conditions, and fishery output. Further use of the Project are would increase public awareness of the value of ecosystem restoration opportunities.

B. Resource Significance

Due to the challenges associated with comparing non-monetized benefits, the concept of output significance plays an important role in ecosystem restoration evaluation. Along with information from cost effectiveness and incremental cost analyses, information on the significance of ecosystem outputs will help determine whether the proposed investment is worth its cost and whether a particular alternative should be recommended. Statements of significance provide qualitative information to help decision makers evaluate whether the value of the resources of any given restoration alternative are worth the costs incurred to produce them. ER 1105-2-100 define significance in terms of institutional, public, and technical recognition.

Institutional Recognition: Institutional recognition means that the importance of an environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies, tribes, or private groups. Sources of institutional recognition include public laws, s, rules and regulations, treaties, and other policy statements of the Federal Government; plans, laws, resolutions, and other policy statements of states with jurisdiction in the planning area; laws, plans, codes, ordinances, and other policy statements of regional and local public entities with jurisdiction in the planning area; and charters, bylaws, and other policy statements of private groups.

Public Recognition: Public recognition means that some segment of the general public recognizes the importance of an environmental resource, as evidenced by people engaged in activities that reflect an interest or concern for that particular resource. Such activities may involve membership in an organization, financial contributions to resource-related efforts, and providing volunteer labor and correspondence regarding the importance of the resource.

Technical Recognition: Technical recognition means that the resource qualifies as significant based on its "technical" merits, which are based on scientific knowledge or judgment of critical resource characteristics. Whether a resource is determined to be significant may of course vary based on differences across geographical areas and spatial scale. While technical significance of a resource may depend on whether a local, regional, or national perspective is undertaken, typically a watershed or larger (e.g., ecosystem, landscape, or ecoregion) context should be considered. Technical significance should be described in terms of one or more of the following criteria or concepts: scarcity, representativeness, status and trends, connectivity, limiting habitat, and biodiversity.

- *Scarcity* is a measure of a resource's relative abundance within a specified geographic range. Generally, scientists consider a habitat or ecosystem to be rare if it occupies a narrow geographic range (i.e., limited to a few locations) or occurs in small groupings. Unique resources, unlike any others found within a specified range, may also be considered significant, as well as resources that are threatened by interference from both human and natural causes.

- *Representativeness* is a measure of a resource's ability to exemplify the natural habitat or ecosystems within a specified range. The presence of a large number and percentage of native species, and the absence of exotic species, implies representation as does the presence of undisturbed habitat.

- *Status and Trend* measures the relationship between previous, current and future conditions.

- *Connectivity* is the measure of the potential for movement and dispersal of species throughout a given area or ecosystem. A resource's connection to other significant natural habitats.

- *Critical Habitat* is habitat that is essential for the conservation, survival, or recovery of one or more species.

- *Limiting Habitat* is the measure of resources present supporting significant species.

- *Biodiversity* is a measure of the variety of distinct species and the genetic variability within them.

The UMR and the Project area with its unique mosaic of habitats are a significant resource, as outlined in Table III-1.

Table III-1: Steamboat Island HREP Resource Significance

Resource	Institutional Recognition	Public Recognition	Technical Recognition
Aquatic Habitat (including backwater)	Fish and Wildlife Conservation Act of 1980 Clean Water Act UMR NWFR Comprehensive Conservation Plan (USFWS, 2006) UMR NWFR Habitat Management Plan (USFWS, 2019) National Wildlife Refuge System (NWRS) Biological Integrity, Diversity, and Environmental Health Policy UMR Wildlife and Fish Refuge Act of 1924 FWCA, as amended (16 U.S.C. § 661) NWRS Administrative Act of 1966 NWRS Improvement Act of 1997	In 1986, Congress designated the UMRS as both a nationally-significant ecosystem and a nationally-significant navigation system. The UMR Floodplain Wetlands are designated as a Ramsar Wetland of International Importance and Globally Important Bird Area. The National Research Council's Committee on Restoration of Aquatic Ecosystems has targeted the UMR and the Illinois River for restoration as 2 of only 3 large river-floodplain ecosystems so designated. The UMR Basin Association advocates for restoration of habitat on the UMR. The UMR Coordinating Committee (UMRCC), made up of UMR resource professionals, is also a strong advocate for habitat restoration on the river. The FWIC has identified backwater complexes in Pool 14 as priority areas in need of habitat restoration, which are priority areas for restoration as part of the UMR-IWW System Navigation Study (DeHaan et al. 2003). American Rivers, a non-governmental organization dedicated to protecting and restoring healthy, natural rivers, listed the Mississippi River in America's Top Ten Endangered Rivers for 2004. The River was a "special mention" on the 2011 list. The public recognizes the backwaters and side channels of Pool 14 as a locally and regionally important recreational fishery.	***Representativeness:*** Many of the important recreational and commercial fish species (e.g., bluegill, largemouth bass, black and white crappie, catfish, and buffalo species) are commonly found in the backwaters of the Project area and Pool 14 during different times of the year. ***Scarcity/Limiting Habitat*:** The Project area contains approximately 614 acres of aquatic habitat. The existing backwaters are limited with respect to high quality overwintering habitat (0.14 acres total), which experiences higher flows or low DO (<3 mg/L) in the winter. Over time, overwintering habitat in Pool 14 has been reduced, due to sediment deposition and geomorphic change, leading to eutrophication, and degraded aquatic habitat. Other efforts in Pool 14 have been accomplished to help restore limiting habitat.

Table III-1: Steamboat Island HREP Resource Significance

Resource	Institutional Recognition	Public Recognition	Technical Recognition
Aquatic Habitat (including backwater)		Fisheries biologists recognize the importance of off-channel deep water habitat to overwintering and year-round habitat to fish. Fisheries biologists have identified overwintering habitat as a limiting factor for centrarchid populations (Bodensteiner and Lewis, 1992 and 1994, Gent et al., 1995, Sheehan et al., 2000a and 2000b) and are continuing research on winter habitat selection of centrarchid fishes (Pitlo, 2003, Steuck, 2010).	
Threatened & Endangered Species	FWCA, as amended (16 U.S.C.§ 661) ESA of 1973, as amended UMR NWFR Comprehensive Conservation Plan (USFWS, 2006) UMR NWFR Habitat Management Plan (USFWS, 2019) NWRS Biological Integrity, Diversity, and Environmental Health Policy USFWS's recovery plan for Higgins eye (USFWS, 2004) NWRS Administrative Act of 1966 NWRS Improvement Act of 1997 UMR Wildlife and Fish Refuge Act of 1924	Congress has recognized the Nation's rich natural heritage is of "esthetic, ecological, educational, recreational, and scientific value to our Nation and its people."	***Representativeness:*** The USFWS has identified 10 federally-endangered or threatened species that have the potential to occur within Clinton and Scott Counties, Iowa, and Rock Island County, Illinois. Threatened and Endangered Species for the States of Illinois and Iowa are outlined in Table II-4 of this document. ***Scarcity/Limiting Habitat:*** There is 1 EHA listed in the Higgins eye recovery plan in Pool 14, with the next closest EHA located in Pool 16. The federally-endangered Higgins eye pearlymussel has been found in the Project area, with 6 found within the Cordova EHA during the 2018 survey. Even with the presence of the Cordova EHA and identified listed species, T&E species abundance and their habitat is still limited in the Project area and Pool 14.

Table III-1: Steamboat Island HREP Resource Significance

Resource	Institutional Recognition	Public Recognition	Technical Recognition
Migratory Birds	Migratory Bird Conservation Act of 1929, and associated treaties Migratory Bird Treaty Act of 1918 EO 13186 – Responsibilities of Federal Agencies to Protect Migratory Birds Bald and Golden Eagle Protection Act of 1940 FWCA, as amended (16 U.S.C.§ 661) NWRS Administrative Act of 1966 NWRS Improvement Act of 1997 UMR Wildlife and Fish Refuge Act of 1924 UMR NWFR Comprehensive Conservation Plan (USFWS, 2006)	Migratory birds provide the public with recreational opportunities, such as bird watching and hunting.	***Representativeness:*** Numerous migratory birds utilize Steamboat Island and the surrounding areas; the following as the most relevant in the area: Bald Eagle, Great Blue Heron, Waterfowl, and neotropical migratory birds. Knutson et al. (1998) found relative abundances of all birds and total numbers of neotropical migratory birds were almost twice as high in the UMR floodplain as in the adjacent uplands. ***Status and Trend:*** Changes in the Steamboat Island, Grant Slough, and Wapsipinicon River forest community have contributed to a reduction in diversity of habitat over time. These changes are likely to continue, and without intervention, the Project area will cease to provide migration, dispersal, breeding, nesting, and cover habitat for a wide range of migratory birds.
Floodplain Forests and Island Habitat	FWCA, as amended (16 U.S.C.§ 661) UMR NWFR Comprehensive Conservation Plan (USFWS, 2006). UMR NWFR Habitat Management Plan (USFWS, 2019) NWRS Biological Integrity, Diversity, and Environmental Health Policy NWRS Administrative Act of 1966 NWRS Improvement Act of 1997 UMR Wildlife and Fish Refuge Act of 1924	The UMR Floodplain Wetlands are designated as a Ramsar Wetland of International Importance and Globally Important Bird Area. The UMRCC recognized the importance of the floodplain forest to the fish and wildlife of the UMR in the report, *Upper Mississippi and Illinois River Floodplain Forests* (Urich et al., 2002). The report describes the habitat significance of the forest, describes changes in the floodplain forests, and recommends management actions to restore the species, age, and structural diversity of the forest. Knutson et al. (1996) described the importance of floodplain forest in the conservation and management of neotropical migratory birds.	***Representativeness/Status and Trend:*** The Project area contains approximately 2,013 acres of floodplain habitat, the majority of which does not experience optimal survival, growth, and sustainability of hard mast trees (i.e., nut producing trees) (De Jager et al., 2012; Guyon et al., 2012). The areas with hard mast trees present were on average over 88 years (ranged 1874 to 1964) old and contained little production in the understory. The largest concern is without intervention, the Project area is likely to experience forest fragmentation and an influx of invasive species, essentially transitioning from forest to grassland over time (Guyon et al., 2012). Consequently,

Table III-1: Steamboat Island HREP Resource Significance

Resource	Institutional Recognition	Public Recognition	Technical Recognition
		Regional groups recognize the importance of floodplain forests.	neotropical and other migratory birds, bats, and the other floodplain species that rely on the forest resources will be severely impacted. Islands serve a variety of functions and provide varying habitat to the fish, birds, and wildlife that use them. Since the 1930s (pre-impoundment) to 2019, approximately 140 acres of Steamboat Island proper and the West and East Southeast Islands have been lost due to erosion. The continued erosion and loss of the habitat and function will impact hydraulic relationships in the river, the habitat types islands provide, and the species that use them. The West and SE Islands currently support many fish and mussel species, including federally-listed species. ***Limiting Habitat:*** During a 2018 forest inventory, a total of 18 different species were recorded in the overstory, including Eastern redbud black walnut. Those species are not normally found in the floodplain in this region due to flood intolerance. The West and SE Islands are essential for conservation of federally- and state-listed mussel species, as they currently provide direct or indirect benefits to the federally-endangered Higgins eye pearlymussel, state-threatened black sandshell, and Cordova EHA.

Table III-1: Steamboat Island HREP Resource Significance

Resource	Institutional Recognition	Public Recognition	Technical Recognition
Mussels	FWCA, as amended (16 U.S.C.§ 661) ESA of 1973, as amended UMR NWFR Comprehensive Conservation Plan (USFWS, 2006) UMR NWFR Habitat Management Plan (USFWS, 2019) NWRS Biological Integrity, Diversity, and Environmental Health Policy NWRS Administrative Act of 1966 NWRS Improvement Act of 1997 UMR Wildlife and Fish Refuge Act of 1924	Freshwater mussels are of unique ecological value as natural biological filters, food for fish and wildlife, and indicators of good water quality. In the United States, some species are commercially harvested for their shells and pearls.	***Representativeness:*** 601 mussels (27 total species) were collected at seven different sample sites within the Project area during the October 2018 mussel survey. The most abundant mussel species (41% of the mussels collected) found were threeridge, plain pocketbook, and threehorn wartybak, each comprising 11% of the collected individuals. ***Scarcity:*** The Cordova EHA appears to harbor around 16 live unionid species, including the federally-endangered Higgins eye pearlymussel. ***Status and Trend:*** Without island restoration and protection, increased flows will likely have a negative impact on the diverse mussel community currently inhabiting the Cordova EHA.

C. Upper Mississippi River System Ecosystem Restoration Objectives

Formal planning for UMRS ecosystem management and restoration has been an ongoing process that was institutionalized in the 1970s with a Comprehensive Master Plan completed by the Upper Mississippi River Basin Commission in 1982. The Master Plan proposed an outline for the UMRR Environmental Management Program, which was authorized in WRDA 1986. The UMRR has been a National leader in ecosystem restoration planning and implementation for 30 years. UMRR partners have participated in several project planning cycles to develop regional ecosystem restoration needs and priorities. Their prior experience and strong interagency relationships provided the foundation to develop the ecosystem restoration component of the NESP which was authorized in WRDA 2007. Program partners understand the interrelated information needs of multiple navigation and ecosystem restoration programs, so Reach Planning was conducted to identify ecosystem objectives and subareas where they can be achieved in a program-neutral fashion. Reach Planning relied on participants from River Management Team workgroups including the Fish and Wildlife Work Group in the Upper Impounded Reach; the FWIC in the Lower Impounded Reach; the Illinois River Work Group in the Illinois River; and the River Resource Action Team in the Unimpounded Reach (also the Lower Impounded Reach and the Illinois River).

The *Upper Mississippi River System – Ecosystem Restoration Objectives 2009* 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 technical basis for investment decisions through 2013 and as a backdrop for the formulation of specific restoration projects and their adaptive management components.

The Reach Planning process led to the identification of high priority areas for restoration of natural river processes (as required by Section 8004 of WRDA 2007). The Reach Planning process also provided context for formulating project measures, defining performance measures, and designing monitoring plans. The Reach Planning framework emphasized system-wide environmental goals, implementation guidance to achieve objectives, considerations of scale and connectivity, and then identified a stepwise process for setting ecosystem restoration objectives that included: identifying unique characteristics, historic, existing, and future conditions, stressors, objectives, performance criteria, and indicators. Goals and objectives for the condition of the river ecosystem are central to river management and are linked to other elements of the framework.

1. **Over-Arching Ecosystem Goal:** *To conserve, restore, and maintain the ecological structure and function of the UMRS to achieve the vision*

2. **Ecosystem Goals:**

   - Manage for a more natural hydrologic regime
   - Manage for functions that shape diverse and dynamic channels and floodplain
   - Manage for natural materials transport and processing functions
   - 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

3. Lower Impounded Floodplain Reach Objectives. The Steamboat Island Project area is within the Lower Impounded Floodplain reach. Objectives for the reach include:

- A more natural stage hydrograph
- Naturalize the hydrologic regime of tributaries
- Increased water clarity
- Reduced nutrient loading from tributaries to rivers
- Reduced sediment loading and sediment resuspension in backwaters
- Increased storage and conveyance of flood water on the floodplain
- Restored backwater areas
- Restored bathymetric diversity, and flow variability in secondary channels, sand bars, shoals, and mudflats
- Restored habitat connectivity
- Restored riparian habitat
- Restored lower tributary valleys
- Restored floodplain topographic diversity
- Restored diversity and extent of native communities throughout their range in the UMRS
- Diverse and abundant native aquatic vegetation communities
- Reduced adverse effects of invasive species

D. Environmental Pool Plans

The FWIC created Pool Plans in September of 2002 that established common habitat goals and objectives for Pools 11-22 of the UMR. The following general resource problems for Pool 14 are taken directly from the draft report *Environmental Pool Plans, Corps of Engineers, Rock Island District, Mississippi River, Pools 11-22 (*USACE, *2004*), followed by specific proposed actions for the Project area.

1. Resource Problems

- Fine sediments are accumulating at accelerated rates within backwaters and other floodplain sites due to high suspended sediment concentrations and the reduced sediment transport capability of the navigation project.

- Habitats critical to migratory birds must be maintained, especially aquatic food resources and woodlands

- Coarse sediments, or bed load sediments, accumulate in side channels where they fill valuable habitats and restrict flows.

- An elevated water table favors moisture tolerant forest species and limits potential for species diversity.

- Watershed discharges into Pool 14 contribute to significant water quality and habitat problems, which impact natural resources. Issues include accelerated sediment deposition, and associated nutrient and contaminate delivery and urban and industrial discharges.

- L&D 13 and 14 restrain fish passage between pools.

- Information is needed to better assess and manage Pool 14 mussels, especially the Higgins eye pearlymussel population.

- The current pool water management regime, especially avoidance of seasonal low water, removes much potential for periodic regeneration of aquatic habitats.

2. Proposed Actions Specific to Steamboat Island HREP

- Increase island elevation with dredged material to introduce and sustain mixed bottomland tree and scrub-shrub species

- Restore and enhance wetland, floodplain, and bottomland forest habitat in order to support a diverse community of resident and migratory wildlife species and provide ecosystem function

- Restore and protect Steamboat Island and other smaller islands to provide resilient and high quality habitat and ecosystem function

- Construct a flow diversity structure to create diverse flows and provide unique aquatic habitat

- Restore fish overwintering areas and other aquatic habitats in the Project area

E. Upper Mississippi River National Wildlife and Fish Refuge Goals

Steamboat Island is part of the UMR NWFR. Broad goals and objectives are provided by legislation that guides management of the NWRS, including the NWRS Administration Act of 1966 and the NWRS Improvement Act of 1997 (16 U.S.C. 668dd to 668ee, Refuge Administration Act). These define the NWRS and authorizes the Secretary of the Interior to permit any use of refuge provided such use is compatible with the major purposes for which the refuge was established. The landmark Improvement Act, prepared the way for a renewed vision for the future of the NWRS whereby:

- wildlife comes first;

- refuges are cornerstones for biodiversity and ecosystem-level conservations;
- lands and waters of the System are biologically healthy; and
- refuge lands reflect nation and international leadership in habitat management and wildlife conservation.

Important provisions of this legislation and the subsequent policies to carry out its mandates include:

- The establishment of a Broad National Policy for the NWRS whereby each refuge shall be managed to fulfill the mission and its purposes.
- Directing the Secretary of the Interior to:
  - provide for the conservation of fish, wildlife, and plants within the System;
  - ensure biological integrity, diversity, and environmental health of the System for the benefit of present and future generations;
  - carry out the mission of the System and purposes of each refuge; if conflict exists between these, refuge purposes take priority;
  - ensure coordination with adjacent landowners and the states.
- Providing Compatibility of Uses Standards and Procedures whereby new or existing uses should not be permitted, renewed, or expanded unless compatible with the mission of the System or the purpose(s) of the refuge, and consistent with public safety.
- Planning, whereby each unit of the NWRS shall have a Comprehensive Conservation Plan completed by 2012.
- Compatibility Policy whereby no use for which the Service has authority may be allowed on a unit of NWRS unless it is determined to be compatible. A compatible use is a use that, in the sound professional judgment of the refuge manager, will not materially interfere with or detract from the fulfillment of the NWRS mission or the purposes of the national wildlife refuge. Managers must complete a written compatibility determination or each use, or collection of like uses, which is signed by the manager and the Regional Chief of Refuges in the respective Service region.
- Biological Integrity, Diversity, and Environmental Health (BIDEH) Policy whereby the Service is directed in the Refuge Improvement Act to "ensure that the biological integrity, diversity, and environmental health of the NWRS are maintained for the benefit of present and future generations of Americans…" The biological integrity policy helps define and clarify this directive by providing guidance on what conditions constitute BIDEH; guidelines for maintaining existing levels; guidelines for determining how and when it is appropriate to restore lost elements; and guidelines in dealing with external threats to BIDEH. The policy also provides guidance for the conservation and management of a broad spectrum of fish, wildlife, and habitat resources found on refuges and associated ecosystems.

The specific legislation establishing the UMR NWFR was the UMR Wild Life and Fish Refuge Act of 1924 and the stated purposes of the refuge in that legislation were:

- "…a refuge and breeding place for migratory birds included in the terms of the convention between the United States and the Great Britain for the protection of migratory birds, concluded August 16, 1916, and…

- …to such extent as the Secretary of Agriculture may be regulations prescribe, as a refuge and breeding place for other wild birds, game animals, fur-bearing animals, and for the conservation of wild flowers and aquatic plants, and…

- …to such extent as the Secretary of Commerce may by regulations prescribe as a refuge and breeding place for fish and other aquatic animal life."

The UMR NWFR Comprehensive Conservation Plan (USFWS, 2006) identified several relevant Goals and Objectives, including:

- **Environmental Health Goal:** We will strive to improve the environmental health of the Refuge by working with others.

- **Wildlife and Habitat Goal:** Our habitat management will support diverse and abundant native fish, wildlife, and plants.
  - Management practices will restore or mimic natural ecosystem processes or functions to promote a diversity of habitat and minimize operations and maintenance costs. Mimicking natural process in an altered environment often includes active management and/or structures such as drawdowns, moist soil management, prescribed fire, grazing, water control structures, dikes, etc.
  - Maintenance and operation costs of projects will be weighed carefully because annual budgets are not guaranteed.
  - Terrestrial habitat on constructed islands and other areas needs to best fit the natural processes occurring on the river, which in many cases will allow for natural succession to occur.
  - If project measures in Refuge Closed Areas serve to attract the public during the waterfowl season, spatial and temporal restrictions of uses may be required to reduce human disturbance of wildlife.
  - The aesthetics of projects in context of visual impacts to the landscape should be considered in project design.

Each refuge is required to complete a Habitat Management Plan that includes an identification of Resources of Concern associated with that refuge. Service policy (620 FW 1) defines Resources of Concern as: "All plant and/or animal species, species groups, or communities specifically identified in refuge purpose(s), System mission, or international, national, regional, state, or ecosystem conservation plans or acts. For example, waterfowl and shorebirds are a resource of concerns on a refuge whose purpose is to protect 'migrating waterfowl and shorebirds.' Federal or State threatened and endangered species on that same refuge are also a resource of concern under terms of the respective endangered species acts."

Furthermore, the comprehensive list of Resources of Concern associated with a refuge is refined to a subset known as Priority Resources of Concern. The Priority Resources of Concern have been identified by the UMR NWFR and they serve in part to represent refuge priorities when the refuge engages in the planning and execution of partnership activities such as UMRR HREPs (USFWS, 2019).

Priority Resources of Concern that are relevant to and could benefit from the Project include: Midwestern wooded swamps and floodplains, red-shouldered hawk, prothonotary warbler, cerulean warbler, transient neotropical migrant passerines, tree-roosting bats, and native invertebrate pollinators, dabbling ducks, secretive marsh birds, limnophilic native mussels and fish, fluvial-dependent native mussels, and fluvial-dependent migratory native fish.

F. Habitat Needs Assessment-II

The UMRR Program vision statement is for a healthier and more resilient UMR ecosystem that sustains the river's multiple uses. To address this vision, the UMRR Program developed a suite of 12 indicators that quantify aspects of ecosystem health and resilience (i.e., connectivity, redundancy and diversity, and controlling variables). These indicators reflect the ability of large floodplain river ecosystems to adapt and respond to disturbances and represent ecosystem-based management objectives developed for the UMRS (USACE, 2011). To identify habitat needs for the UMRS, the HNA-II effort used these indicators that quantify the basic structure and function of the river system developed in a previous report (De Jager et al., 2018). Habitat needs were defined by comparing individual indicators to the conditions desired by the management agencies of the UMRR Program. An assessment of current conditions using both quantitative data analysis and qualitative management perspectives was performed at two spatial scales: navigation pool and clusters of navigation pools that shared similar ecological attributes. The UMRR Program can use the information provided in the HNA-II to more effectively achieve the Program's goals.

Pool 14 is part of the Middle Impounded cluster, as identified by the River Teams, and has the following desired future conditions:

- Maintain and enhance aquatic vegetation diversity
- Restore floodplain topographic diversity and diversify inundation periods
- Restore function and diversity of aquatic habitat types by improving quality, depth and distribution of lotic and lentic habitats
- Restore, maintain and enhance floodplain vegetation diversity, including hard-mast (nut-producing) trees

G. Project Goals and Objectives

Based on the identified problems affecting the Project's natural resources and considering the management goals of the cooperating agencies, the Project goals are to maintain, enhance and restore quality habitat for native and desirable plant, animal, and fish species and maintain, enhance, restore and emulate natural river processes, structures and functions for a resilient and sustainable ecosystem. The objectives identified to meet these goals over the period of analysis are to:

- enhance and restore areal coverage and diversity of forest stands and habitat and increase diversity of bottomland hardwood forest, as measured in forested acres suitable to support hard-mast species and structure, age, and species composition;
- increase year-round aquatic habitat diversity, as measured by acres and limnophilic native fish use of overwintering habitat, as this habitat is the most limiting of seasonal habitats;
- restore 50% of island acreage and topography lost since the 1950s and protect from erosion within the Project area, as measured by acres; and
- protect existing backwater habitat from sediment deposition and enhance backwater and interior wetland areas, as measured by acres of backwater and survivability of scrub-shrub/pollinator habitat.

H. Planning Constraints and Considerations

The following constraints and considerations were included in plan formulation:

- **Navigation.** Ensure measures do not negatively impact the 9-foot navigation channel.
- **Environmental Laws and Regulations.** Construct measures consistent with Federal, state, and local laws. Compliance and coordination under NEPA emphasizes the importance of environmental impacts to be minimized and avoided, as much as possible. Therefore, the following constraints are considered when analyzing alternatives:
    - Minimize floodplain forest impacts
    - Minimize endangered species impacts
    - Minimize migratory bird impacts
    - Maintain hydraulic connectivity to allow for improved water quality for fish
    - Avoid cultural resources
- **Flood Heights.** Restoration measures should not increase flood heights or adversely affect private property or infrastructure.
- **Sponsor Considerations.** Where feasible, restoration measures should address refuge priorities and reduce O&M to address limits of refuge resources.

SECTION IV. POTENTIAL PROJECT MEASURES

This section discusses potential measures that will meet the goals and objectives outlined in Section III, *Problems and Opportunities*. For planning purposes, the period of analysis was established as 50 years. These potential measures were initially screened based on their contribution to the Project goals and objectives, engineering considerations, and local restrictions or constraints. Review of the four formulation criteria suggested by the U.S. Water Resources Council's Principles and Guidelines (P&G) (completeness, effectiveness, efficiency, and acceptability, defined in Section V.D) were used to aide in the screening of potential measures. Several measures were identified in the early planning stages; many of these were partially developed, then were determined not feasible and did not undergo further evaluation. Measures that were evaluated further are described in the following sections. Design criteria and typical photographs are provided in Appendix M, *Engineering Design*.

A. Aquatic Diversity, Topographic Diversity-Forestry, and Topographic Diversity-Scrub-Shrub/Pollinator Habitat

1. Aquatic Diversity Measures. Excavation has been proposed as a potential measure to provide suitable year-round aquatic diversity and habitat for fish, including critical overwintering habitat for centrarchid fish species. Excavation will also provide material needed to increase topographic diversity within the floodplain forest and to increase scrub-shrub and pollinator wetland habitats. Other fish habitat structures, such as stone or log structures, woody debris, or rock piles, may be incorporated into the design (refer to Section VI, *Recommended Plan: Description with Design, Construction, and Operation and Maintenance Considerations*). These measures may increase habitat diversity and provide additional fish habitat. Five locations were considered for aquatic diversity measures. Figure IV-1 shows the locations of these measures.

a. Steamboat Island Upper Lake Aquatic Diversity (Upper Lake). Upper Lake is located in the northern portion of Steamboat Island proper. This site was selected as a potential location to enhance suitable year-round aquatic diversity and habitat for fish, including the restoration of critical overwintering habitat for centrarchid fish species, as Upper Lake historically provided overwintering fish habitat. Upper Lake would be excavated to a depth of 8 feet below flat pool to an elevation of 563.2 feet, providing aquatic diversity through dredging and utilizing the dredged material for topographic diversity. The cut was aligned to follow naturally deeper areas and tie into the deeper water of the Mississippi River channel. Following naturally deeper areas minimizes dredging costs and may allow for increased lifespan of the cut. It is assumed that naturally deeper areas are maintaining depth through natural processes, and those natural processes may maintain the dredge cut in those locations as well. The cut is designed to a 60-foot bottom width with 3H:1V side slopes. At bottom depth, the cut encompasses 9.1 acres. The estimated quantity of dredging is 150,570 cubic yards (CY). Upper Lake would be constructed only in combination with addressing the breached natural berm referred to as the Northeast Bank (NE Bank). The NE Bank has eroded, allowing water from the Mississippi River channel to flow into Upper Lake and depositing sediment into the lake. Refer to Section IV.2 and Figure IV-2 for additional information on the NE Bank. It was assumed that material from Upper Lake would be placed at the NE Bank or Steamboat Island Upper Lake Placement 1. See Appendix M, *Engineering Design,* for further details.

This measure was retained for further evaluation.

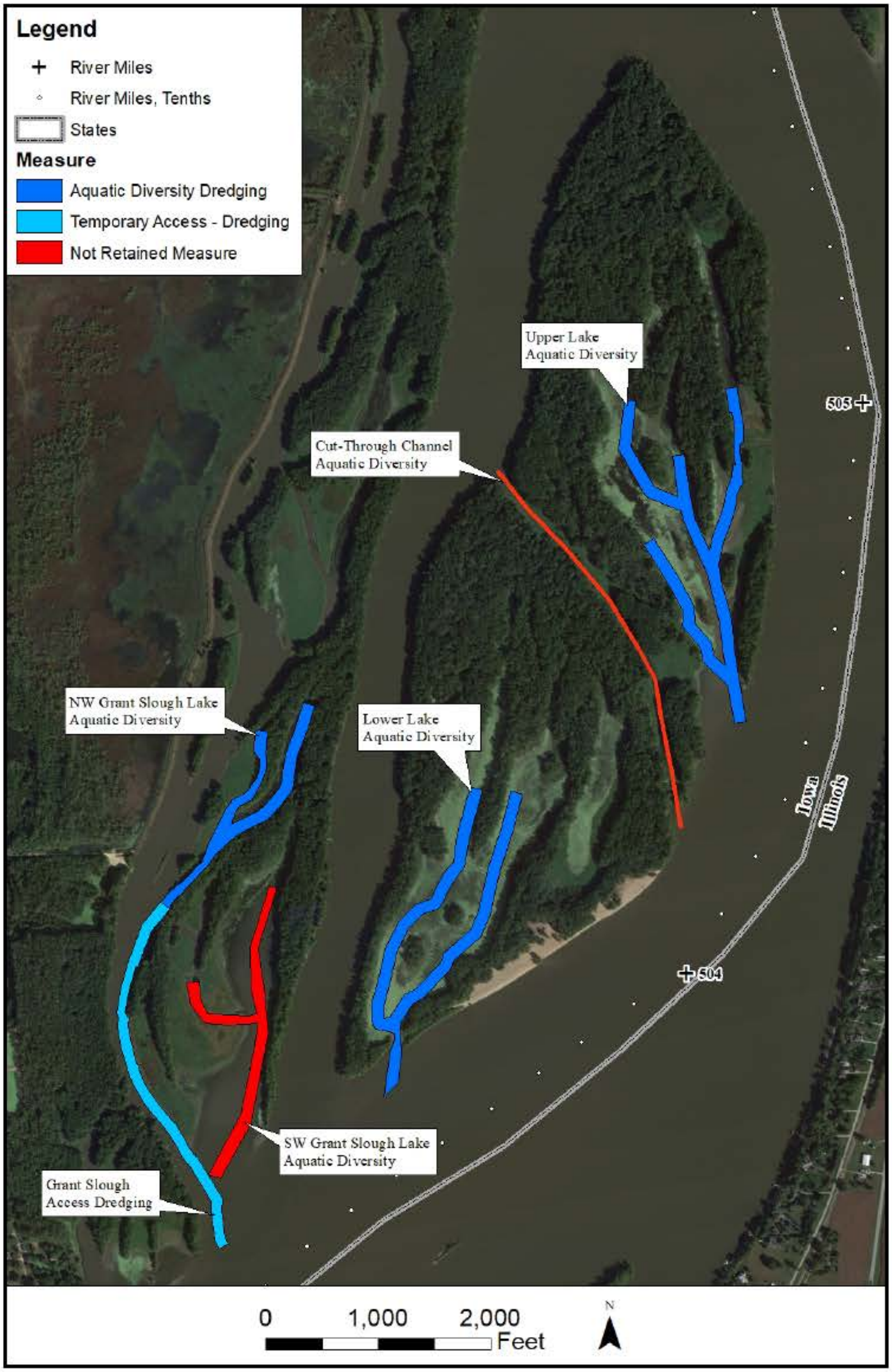


Figure IV-1: Aquatic Diversity Locations

b. Cut-Through Channel. The Cut-Through Channel bisects Steamboat Island proper into Upper and Lower Steamboat Island. This site was selected as a potential location to enhance suitable year-round aquatic diversity and habitat for fish, including critical overwintering habitat for centrarchid fish species, as the channel was historically deeper and provided aquatic diversity. Excavation in the Cut-Through Channel was considered to provide aquatic diversity for fish and/or mussel species and provide material for floodplain forest topographic diversity and scrub-shrub/pollinator habitat. During evaluation, it was determined that the Cut-Through Channel, which has been filling in over time due to sediment deposition, would likely continue to fill in if excavated. Additionally, the excavated Cut-Through Channel would have flows through it from Steamboat Slough to the main channel, which is not preferred habitat for overwintering fish species. Lastly, the PDT determined that allowing flows through the Cut-Through Channel would increase vulnerability for sediment-laden water to enter Lower Lake.

This measure was determined incomplete and ineffective and was not retained for further evaluation.

c. Steamboat Island Lower Lake Aquatic Diversity (Lower Lake). Lower Lake is located in the southern portion of Steamboat Island proper. This site was selected as a potential location to enhance suitable year-round aquatic diversity and habitat for fish, including the restoration of critical overwintering habitat for centrarchid fish species, as Lower Lake historically provided overwintering fish habitat. Lower Lake would be excavated to a depth of 8 feet below flat pool to an elevation of 563.2 feet, providing aquatic diversity through dredging and utilizing the dredged material for topographic diversity. Similarly to Upper Lake, the cut was aligned to follow naturally deeper areas and tie into the deeper water of the Mississippi River channel. The cut is designed to a 60-foot bottom width with 3H:1V side slopes. At bottom depth, the cut encompasses 7.5 acres. The estimated quantity of dredging is 126,302 CY. It was assumed that material from dredging Lower Lake would be placed at the scrub-shrub/pollinator placement sites in Lower Lake and the floodplain forest topographic diversity at the West SE Island. See Appendix M, *Engineering Design,* for further details.

This measure was retained for further evaluation.

d. Northwest Grant Slough Lake Aquatic Diversity (NW Grant Slough Lake). NW Grant Slough Lake is located in the southern portion of Grant Slough. This site was selected as a potential location to enhance suitable year-round aquatic diversity and habitat for fish, including the restoration of critical overwintering habitat for centrarchid fish species, as NW Grant Slough Lake historically provided overwintering fish habitat. NW Grant Slough Lake would be excavated to a depth of 8 feet below flat pool to an elevation of 563.2 feet, providing aquatic diversity through dredging and utilizing the dredged material for topographic diversity. The cut was aligned to follow naturally deeper areas and tie into Grant Slough. Grant Slough is generally deep enough to allow for fish passage from NW Grant Slough Lake, through Grant Slough, and into the Mississippi River. The cut is designed to a 60-foot bottom width with 3H:1V side slopes. At bottom depth, the cut encompasses 4.7 acres. The estimated quantity of dredging is 75,082 CY. It was assumed that material from dredging NW Grant Slough Lake would be placed at Grant Slough Placement 2 and the West SE Island. Access dredging will be required to access NW Grant Slough Lake. The access dredge cut would be excavated to a depth of 6 feet below flat pool to an elevation of 565.2 feet. This could provide aquatic diversity, but is not considered a measure when determining habitat benefits. The cut is designed to a 60-foot bottom width with 3H:1V side slopes. At bottom depth, the cut encompasses 4.6 acres. The estimated quantity of dredging is 13,556 CY. The material from access dredging into NW Grant Slough Lake will be used for topographic diversity measures. Likely locations for placement of the material include Grant Slough Placement Site 1 (IV.A.3.b) and the West Southeast Island (IV.B.1.b). See Appendix M, *Engineering Design,* for further details.

This measure was retained for further evaluation.

e. Southwest Grant Slough Lake Aquatic Diversity (SW Grant Slough Lake). SW Grant Slough Lake is located in the southern portion of Grant Slough. This site was selected as a potential location to enhance suitable year-round aquatic diversity and habitat for fish, including the restoration of critical overwintering habitat for centrarchid fish species, as NW Grant Slough Lake historically provided overwintering fish habitat. Excavation at SW Grant Slough Lake was considered in order to provide aquatic diversity through dredging and utilizing the dredged material for topographic diversity. A site visit revealed that the proposed SW Grant Slough Lake area is currently functioning well as a wetland complex and is an important resource in its current condition.

Due to the benefits it currently provides and potential environmental impacts that would occur if constructed, this measure was determined unacceptable and not retained for further evaluation.

2. Topographic Diversity Measures – Forestry Habitat. Planting native bottomland forest species on elevated placement areas associated with excavation for aquatic diversity has been proposed as a potential measure to diversify the forested areas in the Project area. Forest diversity sites were selected based on current vegetation quality and the proximity to potential dredge cut locations, as well as accessibility with construction equipment. Sites near aquatic diversity dredge cuts allow for side-cast placement and less handling of dredged material. Although many sites will allow for some side casting of material, material will still need to be spread out and graded at all sites. There are several locations within the Project area that are characterized by reed canarygrass monocultures. Placement at these sites requires no tree clearing or removal, however, 1.3 acres of tree clearing will be required for access to one site; converting these areas from invasive reed canarygrass to bottomland forest provides for a significant increase in habitat value. Isolated wetlands for herptile habitat will be created by constructing ridge and swale topography, or areas of slightly higher and slightly lower elevation, instead of a plateau of material. Figure IV-2 shows the locations of these measures.

Material excavated from the aquatic diversity dredge cuts will be placed to construct the topographic diversity sites to an optimum elevation for tree survival. Initial design elevations were determined based upon inundation duration tolerance criteria specific to the desired tree species and based upon input from the Project forester and hydraulic engineer. The upper limit of tree planting was identified as elevation 576.2 feet, which is based on the 25% exceedance probability for the minimally tolerant growing season inundation criteria (25-day inundation duration) and the lower limit of tree planting was identified as elevation 574.0 feet, based on the 25% exceedance probability for the moderately tolerant growing season inundation criteria (45-day inundation duration).

Once dredged material has dried sufficiently to work, the site will be graded. Final grade will include gradual and random ridge and swale topography, creating topographical diversity with elevation changes ranging from maximum elevation 576.2 feet to minimum elevation 574.7 feet. Ridges would not be uniform in width, length, or position across the placement area. Swales would vary in size and depth and, to allow for water retention, would not extend to either side of the placement area completely. The retention of water in these swales will allow for a slower rate of water migration through subsurface draining, which in turn aides in healthy root development. Refer to Appendix M, *Engineering Design*, for the topographic diversity forestry planting plan.

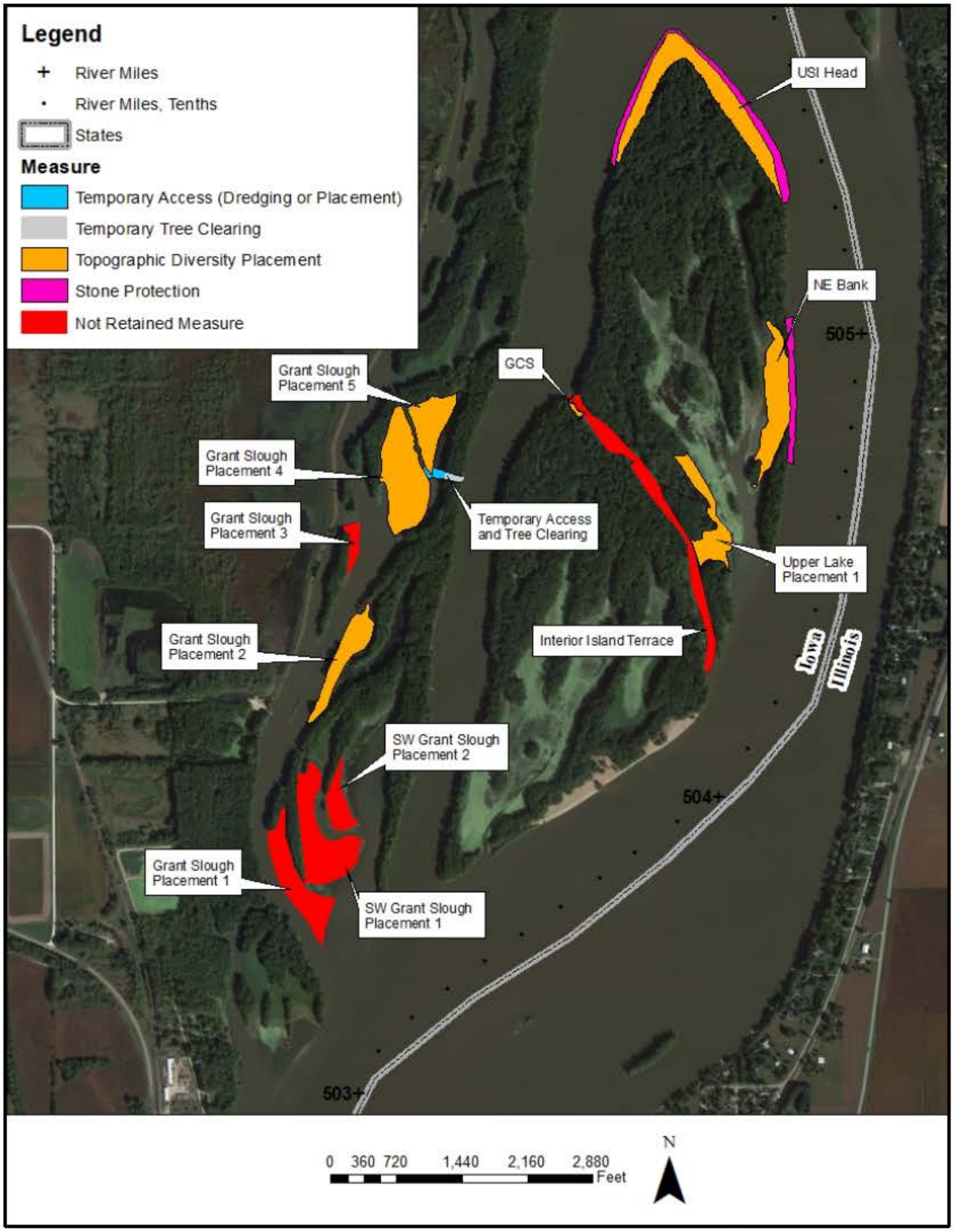


Figure IV-2: Topographic Diversity Locations – Forestry Habitat

a. Upper Steamboat Island Head (USI Head). Restoring the head of Steamboat Island as a topographic diversity site serves several purposes. It meets the objective of creating topographic diversity in an area that has lost forest habitat due to erosion, restores and protects island acreage, and protects Steamboat Island from further erosion. Island protection alone, using stone, was considered to be incomplete and ineffective, due to the lack of island restoration it would accomplish. This measure includes open water placement and 106,800 TN of stone protection to reduce the risk of erosion. Restoring this area to optimum tree survival elevations also provides an increased buffer to Upper Lake from this direction. The trees and other planted vegetation will reduce water velocities during high flows, allowing sediment to drop out before reaching Upper Lake. Due to this site's proximity and placement capacity, dredged material will need to be hauled in by barge from several locations, including Upper Lake Aquatic Diversity dredging, Lower Lake Aquatic Diversity dredging, NW Grant Slough Lake Aquatic Diversity dredging, Grant Slough access dredging, and potentially main channel dredging. This site has a dredged material capacity of 310,491 CY and is 14.2 acres in size. Building a chevron or bullnose dike structure to protect the island from erosive forces and allowing sediment to deposit over time, instead of placing material and protecting it, was considered. It was decided that placing stone protection followed by immediate placement of dredged material and planting with cover crops and then trees was preferred in order to establish floodplain forest species more quickly. Refer to Appendix M, *Engineering Design,* for more details.

This measure, with immediate placement of dredged material, was retained for further evaluation.

b. NE Bank. The NE Bank measure is located on the northeast bank of Steamboat Island proper, between Upper Lake and the main channel. Restoring the NE Bank as a topographic diversity site serves several purposes. It meets the objective of creating topographic diversity in an area that has lost forest habitat due to erosion and will help protect Upper Lake from sediment-laden flows from the main channel. Restoring this area to optimum tree survival elevations provides an increased buffer to Upper Lake from the main channel. The trees and other planted vegetation will reduce water velocities during high flows, allowing sediment to drop out before reaching Upper Lake. During lower flows, water from the main channel will no longer enter Upper Lake through the breached area. This site includes on-land placement in a reed canarygrass monoculture and open water placement. Material will be placed around the trees with care being taken not to damage the trees located in and around the placement site. This measure requires 8,853 TN of stone protection to keep the material from eroding. It was assumed that material for this site will come from the Upper Lake Aquatic Diversity dredging. Some material will be directly side cast into the placement site, while the remaining material will need to be hauled in, offloaded, and graded. This site has a dredged material capacity of 31,787 CY and is 8.3 acres in size. For this measure, the team also considered placing only stone protection to create a barrier between Upper Lake and the main channel. It was decided that placing dredged material in the breached area and the adjacent locations hosting low value vegetation, then planting with cover crops followed by trees, was preferred in order to restore floodplain forest species in this area. Refer to Appendix M, *Engineering Design,* for more details.

This measure, with dredged material placement, was retained for further evaluation.

c. Steamboat Island Upper Lake Placement 1 (Upper Lake Placement 1). Upper Lake Placement 1 is located in Upper Lake between the proposed Upper Lake Aquatic Diversity measure and the Cut-Through Channel. Upper Lake Placement 1 was chosen because it is a reed canarygrass monoculture within close proximity to the Upper Lake Aquatic Diversity measure. It meets the objective of creating topographic diversity and provides a large increase in habitat value, as it currently hosts low value vegetation dominated by reed canarygrass. Material will be placed around the trees with care being taken not to damage the trees in and around the placement site. The original design for this location had a smaller footprint and bridged the gap between Upper Lake and the Cut-

Through Channel. PDT discussions led to increasing the footprint of this placement site, extending it northwesterly along Upper Lake. This increased footprint provides for an increased buffer to Upper Lake during high water events when water flows through the Cut-Through Channel. The trees and other planted vegetation will reduce water velocities during high flows, allowing sediment to drop out before reaching Upper Lake. It was assumed that material for this site will come from the Upper Lake Aquatic Diversity dredging. Some material will be side cast into the placement site, while the remaining material will need to be hauled in, offloaded, and graded. This site has a dredged material capacity of 13,969 CY and is 5.3 acres in size. Refer to Appendix M, *Engineering Design,* for more details.

This measure was retained for further evaluation.

d. Interior Island Terrace. The Interior Island Terrace is located in the Cut-Through Channel. The design includes filling in the Cut-Through Channel with dredged material and planting floodplain forest species, creating a large tract of topographic diversity, as well as helping protect Lower Lake from sediment-laden water during high flows. Further evaluation of this measure determined the constructability of the measure would be difficult and costly due to the long, thin geometry of the site and increased material hauling and shaping costs. Additionally, the team felt that protecting Lower Lake could be done on a smaller scale by plugging the northwest and southeast ends of the Cut-Through Channel. Upon evaluation of this new measure, the team determined that the intent of the action should not be to block flow, but to help filter water and sediment using the vegetation planted at the topographic diversity site. These evaluations led to the Grade Control Structure (GCS) measure, described below in Section e, *Grade Control Structure*.

The Interior Island Terrace and northwest/southeast plug measures were determined to be incomplete and inefficient and were not retained for further evaluation.

e. Grade Control Structure. The GCS measure is located at the northwest end of the Cut-Through Channel at Steamboat Island proper. The GCS measure is a combination of open-water placement and placement on low-value vegetation and is designed to provide grade control for incoming flows and create topographic diversity. The primary role of the GCS is to filter water and sediment entering the Cut-Through Channel and provide protection to Lower Lake from sediment-laden water. The measure also creates forest habitat. Based on 2017 topobathymetric LiDAR imagery, the primary source of sediment-laden water flowing into Lower Lake is the northwest end of the Cut-Through Channel. Other locations where water or sediment may enter were noted, but this location looked to be the primary concern and an appropriate location for a measure. A site visit during high water supports this hypothesis. See Appendix M, *Engineering Design,* Attachment H, for more details. The measure would be constructed to an elevation of 574.0 feet, which is near the lower limit for moderately tolerant trees. During high flows, the vegetation will reduce water velocities, allowing sediment to drop out before reaching Lower Lake. The structure is designed with 59 TN of stone protection to combat erosive forces during high flows. Due to the measure's location, dredged material will need to be hauled in by barge from one of several locations including Upper Lake Aquatic Diversity dredging, Lower Lake Aquatic Diversity dredging, NW Grant Slough Lake Aquatic Diversity dredging, or Grant Slough access dredging. This site has a dredged material capacity of 610 CY and is 0.3 acres in size. Refer to Appendix M, *Engineering Design,* for more details.

This measure was retained for further evaluation.

f. Southwest Grant Slough Lake Placement 1 (SW Grant Slough Placement 1). SW Grant Slough Placement 1 is located adjacent to the proposed SW Grant Slough Lake Aquatic Diversity measure. This site was initially chosen because aerial imagery indicated the site was a reed canarygrass monoculture. A site visit revealed the proposed placement area is currently functioning well as a wetland complex with diverse wetland species and is an important resource in its current condition.

Due to the lack of degradation in this area, the benefits it currently provides, and potential environmental impacts that would occur if constructed, this measure was determined unacceptable and not retained for further evaluation.

g. Southwest Grant Slough Lake Placement 2 (SW Grant Slough Placement 2). SW Grant Slough Placement 2 is located adjacent to the proposed SW Grant Slough Lake Aquatic Diversity measure. This site was chosen because aerial imagery indicated the site was a reed canarygrass monoculture. A site visit revealed the proposed placement area is currently functioning well as a wetland complex with diverse wetland species and is an important resource in its current condition.

Due to the lack of degradation in this area, the benefits it currently provides and potential environmental impacts that would occur if constructed, this measure was determined unacceptable and not retained for further evaluation.

h. Grant Slough Placement 1. Grant Slough Placement 1 is located at the southern end of Grant Slough, near the outlet to Steamboat Slough. This site was chosen because it is a reed canarygrass monoculture within close proximity to the proposed aquatic diversity dredging in the SW Grant Slough Lake. Dredging in SW Grant Slough Lake was not retained for further evaluation, but the placement site was retained because it meets the objective of creating topographic diversity and provides a significant increase in habitat value. The site was considered for forestry or scrub-shrub/pollinator planting (see Section IV.A.3.b, *Grant Slough Placement 1*). As forestry habitat, the site has a dredged material capacity of 30,732 CY and 7.4 acres in size. As part of the Tentatively Selected Plan (TSP) refinement, it was ultimately decided that the preferred measure at this site was scrub-shrub/pollinator habitat, in order to expand the existing scrub-shrub habitat present near the potential measure and increase connectivity of a valuable habitat. It was assumed that material for this site will come from Grant Slough access dredging. Some material will be side cast into the placement site, while the remaining material will need to be hauled in, offloaded, and graded.

The forestry habitat measure was not retained for further evaluation. See additional information in Section IV.A.3.b for the scrub-shrub/pollinator planting habitat).

i. Grant Slough Placement 2. Grant Slough Placement 2 is located in Grant Slough between NW Grant Slough Lake and the Grant Slough channel. This site was chosen because it is a reed canarygrass monoculture within close proximity to the proposed aquatic diversity dredging in NW Grant Slough Lake. It would meet the objective of creating topographic diversity and provide a significant increase in habitat value, as it is currently low value vegetation dominated by reed canarygrass. Restoring this area to optimum tree survival elevations provides an increased buffer to NW Grant Slough Lake, which will reduce water velocities during high flows, allowing sediment to drop out before reaching NW Grant Slough Lake. It was assumed that material for this site will come from NW Grant Slough Lake Aquatic Diversity dredging. Some material will be side cast into the placement site, while the remaining material will need to be hauled in, offloaded, and graded. This

5.4-acre site has a dredged material capacity of 19,468 CY. Refer to Appendix M, *Engineering Design,* for more details.

This measure was retained for further evaluation.

j. Grant Slough Placement 3. Grant Slough Placement 3 is located in Grant Slough, northwest of Grant Slough Placement 2. This site was chosen because it is a reed canarygrass monoculture within close proximity to the proposed aquatic diversity dredging in NW Grant Slough Lake. When this site was considered, it was assumed access dredging would be required in Grant Slough to reach Grant Slough Placement Sites 4 and 5, and that Grant Slough Placement Site 3 would be a good topographic diversity location along this access dredging. When it was determined that accessing Grant Slough Placement Sites 4 and 5 from Steamboat Slough via minor tree clearing was more cost effective than access dredging into Grant Slough, Grant Slough Placement 3 was no longer a viable option for the low amount of topographic diversity obtained.

This measure was determined inefficient and not retained for further evaluation.

k. Grant Slough Placement 4 and 5. Grant Slough Placement 4 and 5 are located in the northern portion of Grant Slough. These sites, both currently reed canarygrass monocultures, are two physically different sites separated by a small channel, but are combined for discussion as it is assumed that they would be constructed together. The placement sites meet the objective of creating topographic diversity and provide a large increase in habitat value, as they are currently low value vegetation dominated by reed canarygrass. Restoring these areas to optimum tree survival elevations provides a large tract of topographic diversity. Due to this measure's proximity and placement capacity, dredged material will need to be hauled in by barge from several locations, including Lower Lake and NW Grant Slough Lake Aquatic Diversity dredging, and Grant Slough access dredging. This site has a dredged material capacity of 60,358 CY and is 16.8 acres in size. Approximately 1.3 acres of tree clearing between the placement sites and Steamboat Slough will be required for access. Access dredging into the sites from Grant Slough was initially evaluated, but assumed to be more costly than 1.3 acres of tree clearing, so it was eliminated from further analysis or quantity calculations. Approximately 4,036 CY of material will need to be placed to build up the access location after tree clearing. Once Grant Slough Placement 4 and 5 are built, the material for the access route will be excavated and likely placed at USI Head. The 1.3 acres of temporary tree clearing will be restored to pre-Project conditions. Refer to Appendix M, *Engineering Design,* for more details.

This measure was retained for further evaluation.

l. Mix Organics with Dredged Material. This method would create suitable material for vegetation planting at the topographic diversity sites. Dredged material that is dominantly sand does not provide sufficient support for vegetation. Mixing the dredged material with organics such as fines, wood chips, and other organics can result in a suitable soil.

This method was further evaluated for topographic diversity, but later eliminated after determining that other more cost-effective methods could be used to obtain similar results. Refer to Section VI, *Recommended Plan: Description with Design, Construction, and Operation and Maintenance Considerations*, for more information.

3. Topographic Diversity Measures - Scrub-Shrub/Pollinator Habitat. Planting native scrub-shrub/pollinator species (SSP) on elevated placement areas associated with aquatic diversity dredging has been proposed as a potential measure to increase scrub-shrub wetlands and pollinator habitat areas in the Project area. SSP sites were determined based on presence of low value vegetation dominated by reed canarygrass and suitability to support SSP, as well as accessibility for construction equipment. Sites near aquatic diversity dredge cuts allow for side cast placement and less handling of dredged material. Although many sites will allow for some side casting of material, material will still need spread out and graded at all sites. There are several locations in the Project area that are mainly reed canarygrass monocultures. Placement at these sites requires no tree clearing. Converting these areas from a monoculture of reed canarygrass to scrub-shrub/pollinator habitat provides a significant increase in habitat value. SSP sites near existing scrub-shrub/pollinator habitats will help protect the existing habitat, while increasing and enhancing the habitat in that area. Figure IV-3 shows the locations of these measures.

Material excavated from the aquatic diversity dredge cuts will be placed to construct the scrub-shrub/pollinator sites to an optimum elevation for scrub-shrub/pollinator survival. Initial design elevations were determined based upon inundation duration tolerance criteria specific to the desired species and input from the Project forester and hydraulic engineer. The upper planting limit for scrub-shrub/pollinator habitat was identified as elevation 573.1 feet; this elevation is based on the 50% exceedance probability for maximum tolerant growing season inundation criteria (55-day inundation duration). Field observations by the Project forester support that existing scrub-shrub/pollinator species are thriving at higher elevations than the calculated upper limit, so these plantings may be incorporated at higher elevations.

Once dredged material has dried sufficiently to work, the site will be graded. Final grade will include gradual and random ridge and swale topography, creating topographical diversity with elevation changes ranging from 573.1 feet to minus 1.5 foot. Ridges would not be uniform in width, length, or position across the placement area. Swales would vary in size and depth and would not completely extend to either side of the placement area to allow for water retention. The retention of water in these swales will allow for a slower rate of water migration through subsurface draining, which in turn aids in healthy root development. Refer to Appendix M, *Engineering Design,* for the scrub-shrub/pollinator planting plan.

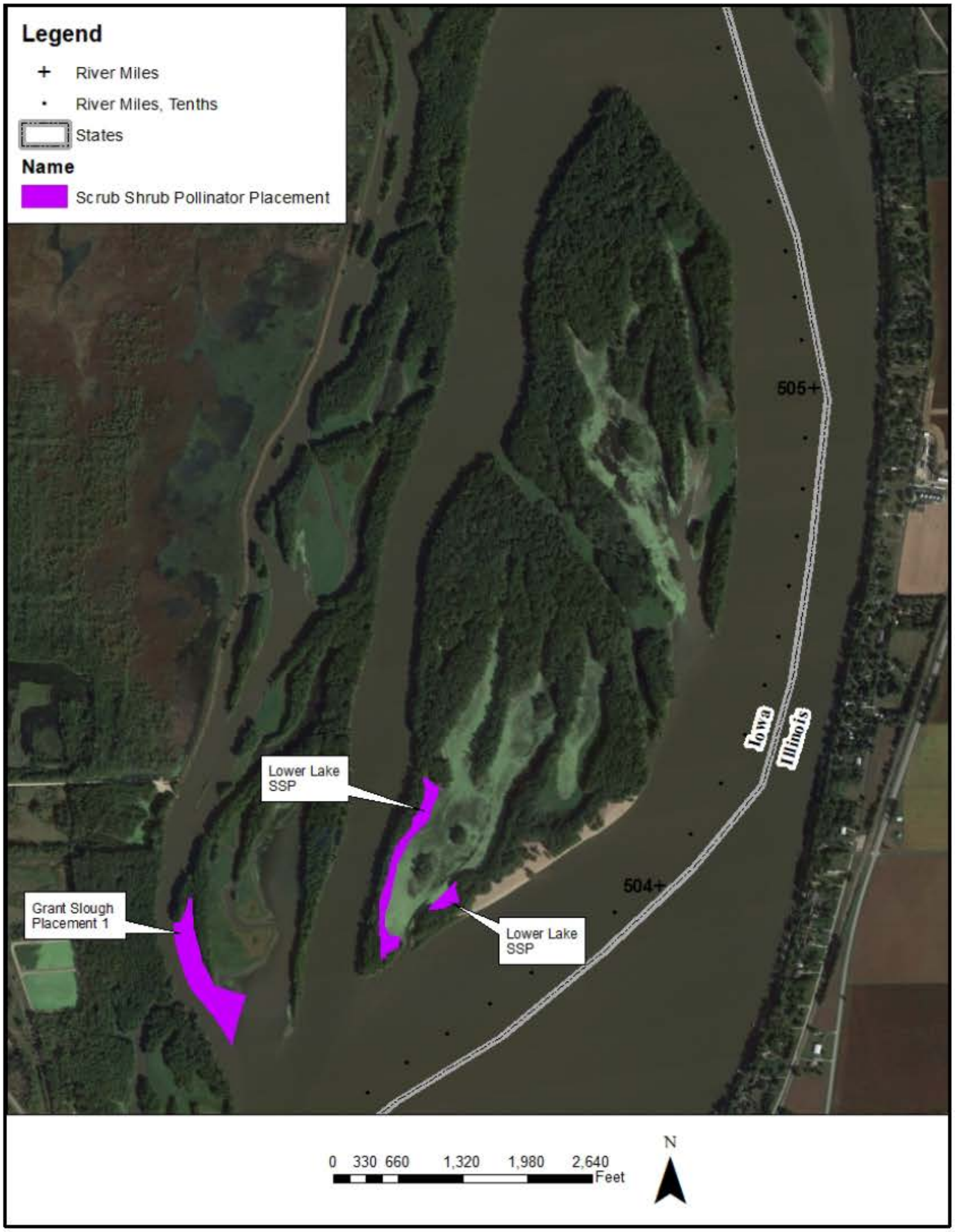


Figure IV-3: Topographic Diversity Locations – Scrub-Shrub/Pollinator Habitat

a. Lower Lake Scrub-Shrub/Pollinator Habitat (Lower Lake SSP). Two sites were identified in Lower Lake for scrub-shrub/pollinator habitat, but are considered one location for evaluation and discussion. Both sites are currently open water. The east site is adjacent to existing stands of button bush and other wetland species. The west site is adjacent to bottomland forest, but will create a transition zone between aquatic and bottomland forest habitats. These sites would be constructed to suitable scrub-shrub/pollinator survival elevations and planted with scrub-shrub/pollinator species. Scrub-shrub/pollinator species can exist over a range of elevations, but elevation 573.1 feet was selected based on the Corps-certified (per EC 1105-2-412) Hydrologic Engineering Center-Ecosystem Functions Model (HEC-EFM) 50% exceedance probability for maximum tolerant growing season inundation criteria (55-day inundation duration). It was assumed that material for this site would come from Lower Lake Aquatic Diversity dredging. Some material will be side cast to the placement site. The rest of the material would need hauled in, offloaded, and graded. This site has a dredged material capacity of 3,352 CY and is 5.3 acres in size. Adjacent areas with existing scrub-shrub/pollinator species will be enhanced with TSI methods such as coppicing of button bush. Refer to Appendix M, *Engineering Design,* for more details.

This measure was retained for further evaluation.

b. Grant Slough Placement 1. This site is located at the southern end of Grant Slough near the outlet to Steamboat Slough. This site was chosen because it is a reed canarygrass monoculture within close proximity to the proposed aquatic diversity dredging in SW Grant Slough Lake. Dredging in SW Grant Slough Lake was not retained for further evaluation, but the placement site was retained because it meets the objective of creating topographic diversity and provides a large increase in habitat value, as it is currently low-value vegetation dominated by reed canarygrass. The site was considered for forestry or scrub-shrub/pollinator planting (see Section IV.A.2.h, *Grant Slough Placement 1*). It was decided that the preferred measure at this site was scrub-shrub/pollinator habitat, in order to expand existing similar habitat near the site and increase connectivity of a valuable habitat. It was assumed that material for this measure will come from access dredging into Grant Slough. Some material will be side cast to the placement site. The rest of the material would need hauled in, offloaded, and graded. As a scrub-shrub/pollinator site, this site has a dredged material capacity of 983 CY and is 7.4 acres in size. Refer to Appendix M, *Engineering Design,* for more details.

This measure was retained for further evaluation.

B. Small Island Restoration and Protection, Small Island Creation, and Flow Diversity

1. Small Island Restoration and Protection Measures. Small islands still exist in the Project area, but have eroded significantly since construction of the locks and dams and associated inundation. Comparison of aerial imagery taken at similar river elevations estimates that islands have been eroding at a rate of 0.05 acres/year to 0.13 acres/year (see Appendix M, *Engineering Design,* for more details on erosion rates). Islands create a variety of habitats including bottomland and/or floodplain forest and scrub-shrub habitat, aquatic zones, and transitional zones. Aquatic zones can include subsurface structure for fish, mussels, and other aquatic species. Transitional zones bridge the gap between these habitats. Islands alter hydraulic connectivity, create flow diversity, and lower wind fetch. Islands may be restored through material placement to desired elevations and footprints. Depending on river velocities, erosion protection may be required. Island protection alone, using stone, was considered as an option. The stone protection would just protect the existing island footprint and not expand or restore the island footprint. This was considered incomplete and ineffective, due to the lack of island restoration it would accomplish. Figure IV-4 shows the locations of these measures.

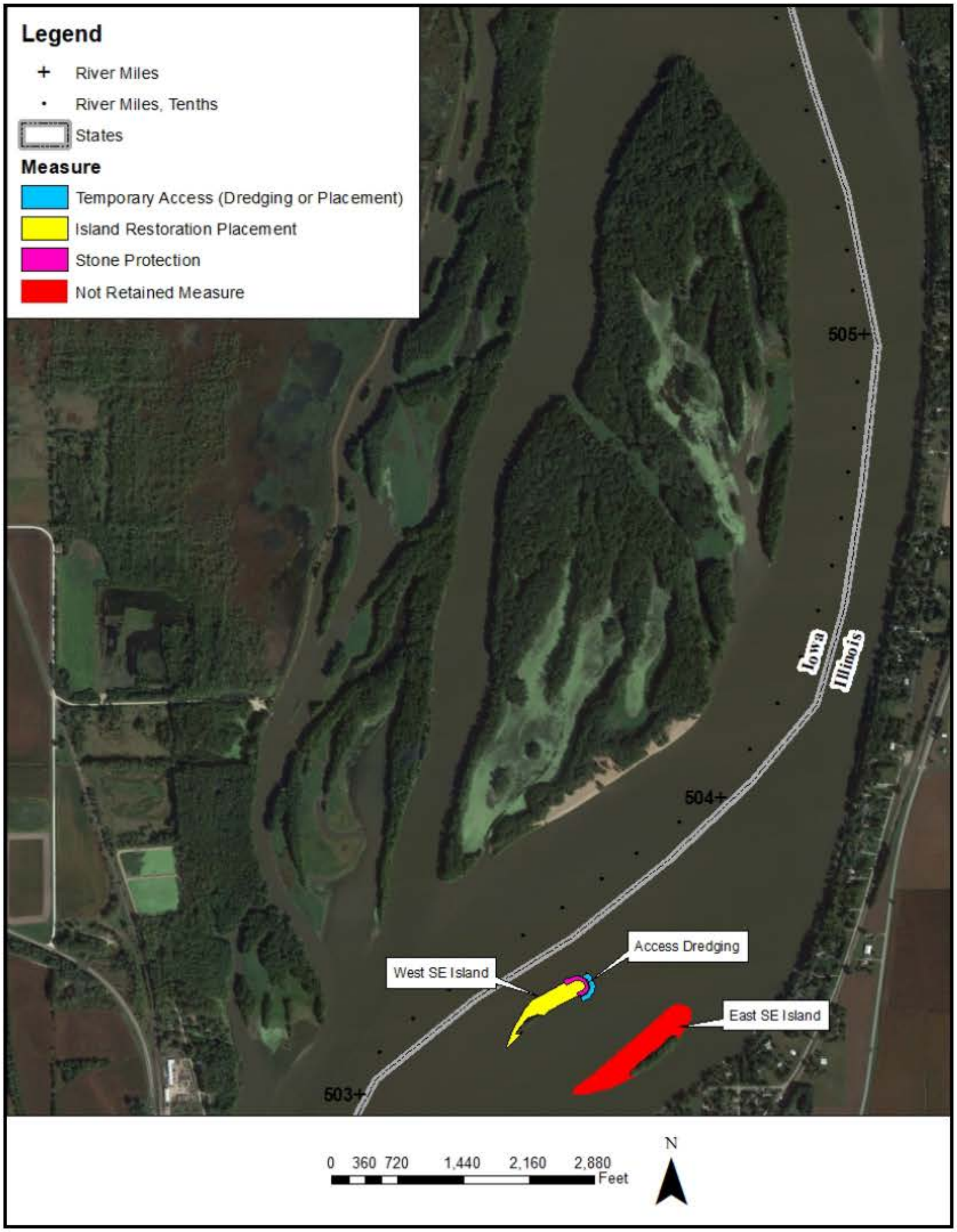


Figure IV-4: Small Island Restoration and Protection Locations

a. East Southeast Island (East SE Island). The East SE Island is a naturally occurring island, but has eroded significantly due to inundation. On average, it has been eroding at a rate of 0.5 acres/year (see Appendix M, *Engineering Design,* Attachment I). The footprint for restoring the East

SE Island was based on aerial imagery from 1927 and 1938, which show fairly consistent island geometry, though exact river elevations could not be determined for that imagery as no specific date was provided. Restoring the island to optimum tree survival elevations would allow the island to be planted with trees and other vegetation, reducing the risk of erosion and creating a topographically diverse site. The existing island would not be modified as part of the measure, but the footprint would be expanded to the historic geometry. Stone protection would also be required at the upstream end of the island to combat erosive forces of the main channel. Due to the presence of the Cordova EHA and federally-listed Higgins eye pearlymussel recorded during a 2018 survey, the PDT eliminated the measure in order to avoid take of a listed species, maintain consistency with the UMRR Program goals, and stay consistent with the UMR NWFR priorities and past projects. Should the listing status and/or conditions change, a measure at this location could be considered for a future HREP.

This measure was determined to be unacceptable and was not retained for further evaluation.

b. West Southeast Island (West SE Island). The West SE Island is a naturally occurring island and has also been used as a dredged material placement site, but has undergone significant erosion. On average, is has been eroding at a rate of 0.13 acres/year (see Appendix M, *Engineering Design,* Attachment I). The footprint for restoring the West SE Island is based on aerial imagery from the 1990s, which show fairly consistent island geometry, though exact river elevations could not be determined for that imagery as no specific date was provided. Restoring the island to optimum tree survival elevations allows for the island to be planted with trees and other vegetation, reducing the risk of erosion and creating a topographically diverse site. The existing island would not be modified as part of the measure, but the footprint would be expanded to the historic geometry. Stone protection will also be required at the upstream end of the island to combat erosive forces of the main channel. Refer to Appendix M, *Engineering Design,* for more details.

This measure was retained for further evaluation.

2. Small Island Creation Measures. Small islands used to exist in the Project area, but have eroded significantly and are no longer visible at flat pool conditions. The proposed islands would be created through dredged material placement to desired elevations and footprints. Depending on river velocities, erosion protection may be required. Figure IV-5 shows the locations of these measures.

a. Upstream Steamboat Slough. During the early planning phase, island creation at the upstream end of Steamboat Slough was discussed based on anecdotal information that a small island used to exist. However, no historic information, such as size and location, could be found for this island. Additionally, bathymetry did not show evidence of a recently eroded island and depths are fairly deep in this portion of Steamboat Slough. The depth would make it very costly to build an island to an appropriate elevation at this location and benefits would be minimal.

This measure was determined to be inefficient and was not retained for further evaluation.

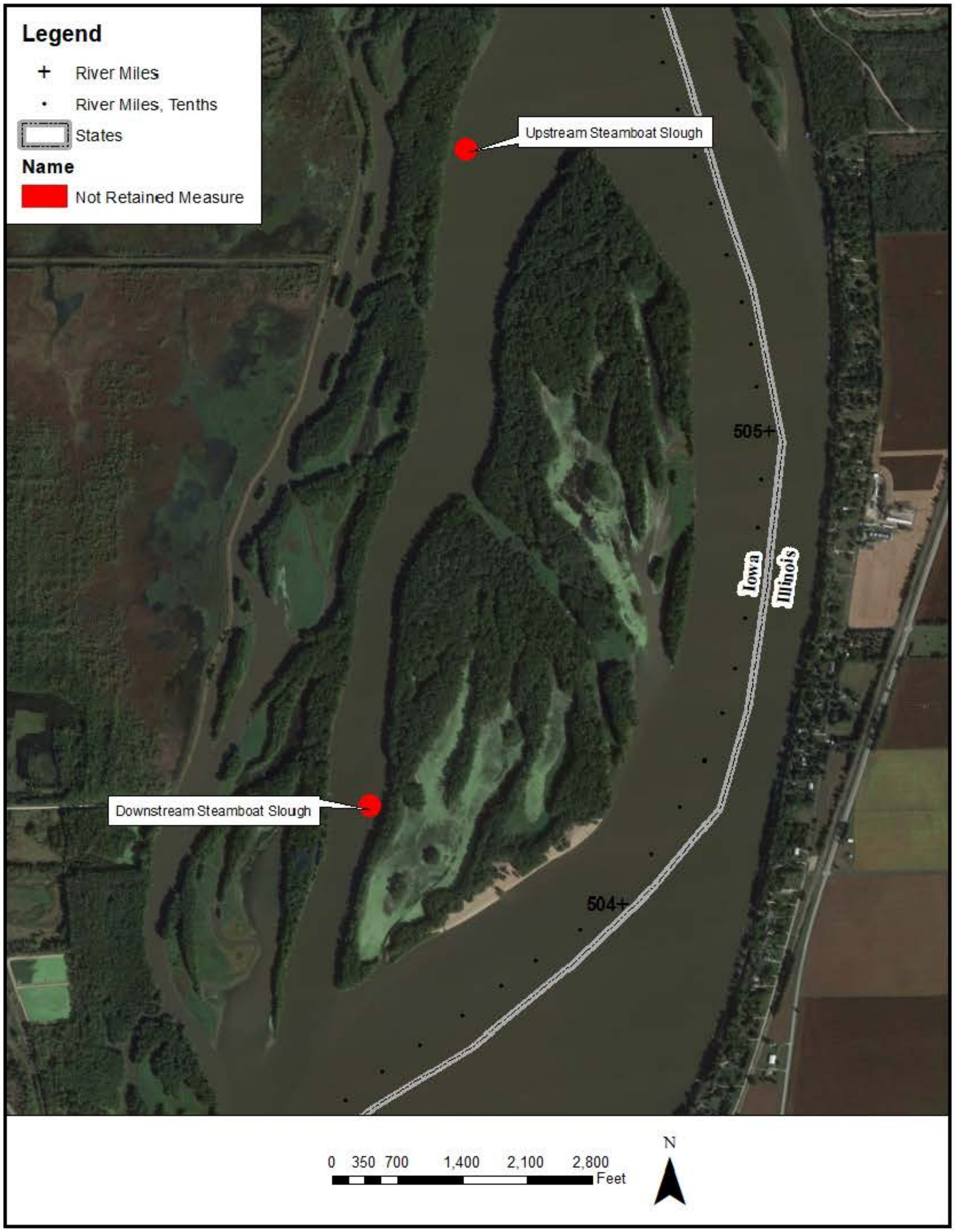


Figure IV-5: Small Island Creation Locations

a. Upstream Steamboat Slough. During the early planning phase, island creation at the upstream end of Steamboat Slough was discussed based on anecdotal information that a small island used to exist. However, no historic information, such as size and location, could be found for this island. Additionally, bathymetry did not show evidence of a recently eroded island and depths are fairly deep in this portion of Steamboat Slough. The depth would make it very costly to build an island to an appropriate elevation at this location and benefits would be minimal.

This measure was determined to be inefficient and was not retained for further evaluation.

b. Downstream Steamboat Slough. Aerial imagery shows a historic island up until 2012 in the downstream portion of Steamboat Slough. Bathymetry supports that there was an island in this location that has recently eroded away, as depths are shallow (2 feet below flat pool). The measure was preliminarily designed to include dredged material placement and stone protection to a historic footprint. Based on preliminary estimates, it was determined that this measure would not be cost effective for the minimal benefit it would provide. Following this, a flow diversity structure, outlined in Section B.3.b, *Flow Diversity Structure*, was formulated for this location.

This measure was determined to be inefficient and was not retained for further evaluation.

3. Flow Diversity. Flow diversity alters the flow in an area and, depending on other conditions, has the added benefit of providing aquatic habitat. An increase in flow by constructing flow diversity structures or installing a pump station may help with sedimentation issues and create more suitable habitat for species that require clearer water. Decreases in flow may allow for slack areas that fish use for overwintering habitat or to ambush prey caught in adjacent turbulent flows. Flow diversity measures may result in creating deep scour holes utilized by some species, as well as create depositional areas and even small islands used by other species. Flow diversity can be created in a variety of ways, such as placing material and structures in the flow path or altering existing structures in the flow path. These may increase or decrease flows, depending on the intent of the measure. Four different measures were considered for flow diversity (locations shown in Figure IV-6).

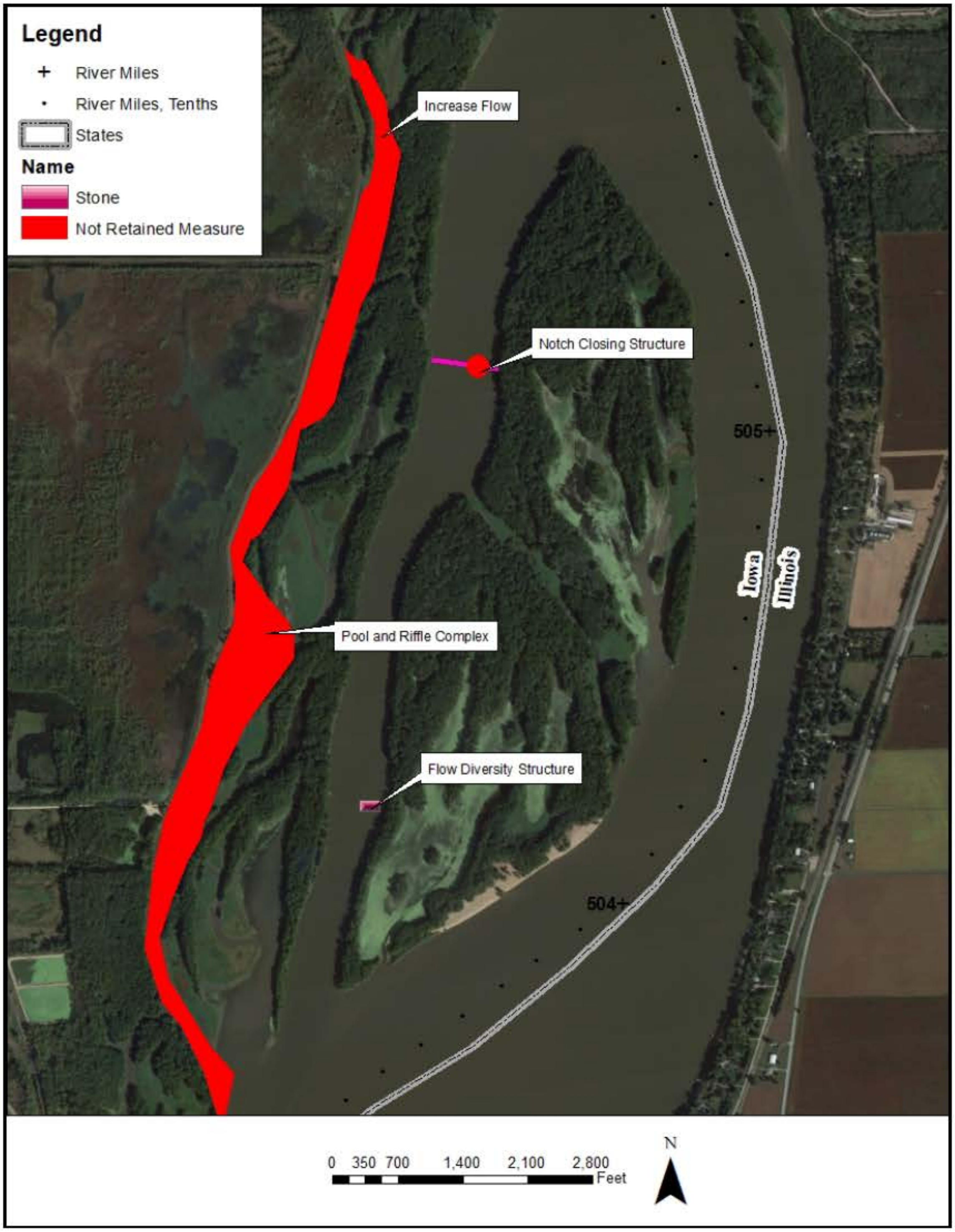


Figure IV-6: Flow Diversity Locations

a. Notch Closing Structure. An existing closing dam located in Steamboat Slough was proposed to be notched to ensure that flow could continue into the backwater habitat and provide flow diversity in Steamboat Slough. Acoustic Doppler Current Profiler measurements showed that there is currently flow diversity within Steamboat Slough and sufficient flows over the closing dam.

This measure was determined to be incomplete and was not retained for further evaluation.

b. Flow Diversity Structure. This measure is located where an island used to exist in Steamboat Slough (see Section B.2.b, *Downstream Steamboat Slough*.). A stone structure was designed for this measure, based on structures used by St. Paul District for seed islands. It is anticipated that the stone structure would create diverse flows in the area, and may also capture sediments, creating an island over time. The flows around stone structures and created islands are diverse because they offer turbid flows around edges, as well as areas of slack water. This further diversifies flow and aquatic habitats, depending on the water level and flow conditions. Refer to Appendix M, *Engineering Design,* for more details.

This measure was retained for further evaluation.

c. Increase Flow. A pump station to increase the flow in Grant Slough and achieve fish habitat was originally proposed as a Project measure. However, it was determined that Grant Slough has sufficient flow for fish habitat. Additionally, a pump station requires continuous operation and maintenance costs, which was not preferred by the Sponsor.

This measure was determined to be incomplete and was not retained for further evaluation.

d. Pool and Riffle Complexes. Pool and riffle structures increase bathymetric diversity, which allow for an increase in aquatic habitat diversity. Pool and riffle structures were proposed in Grant Slough. Grant Slough has sufficient flow for fish habitat, but there is not a sufficient amount of flow to ensure a successful pool and riffle system.

This measure was determined to be incomplete and was not retained for further evaluation.

C. Forest Habitat Measures. Several forest habitat measures were formulated for a broad portion of the Project area. TSI includes a variety of measures that improve forest habitat health, diversity, and resilience for multiple areas, based on current environmental and forest conditions. Traditional methods include tree thinning, girdling, and tree planting. Traditional TSI is included over much of the existing forested areas in the Project boundary (Figure IV-7). Restoring floodplain forest along the southeast shoreline of Steamboat Island proper, Historic Bankline Placement Site RM 503.5-504.1R (locally known as Princeton Beach), and evaluation of sediment around trees were also considered for forest habitat measures and are less typical methods. Refer to Figure IV-8 for these locations.

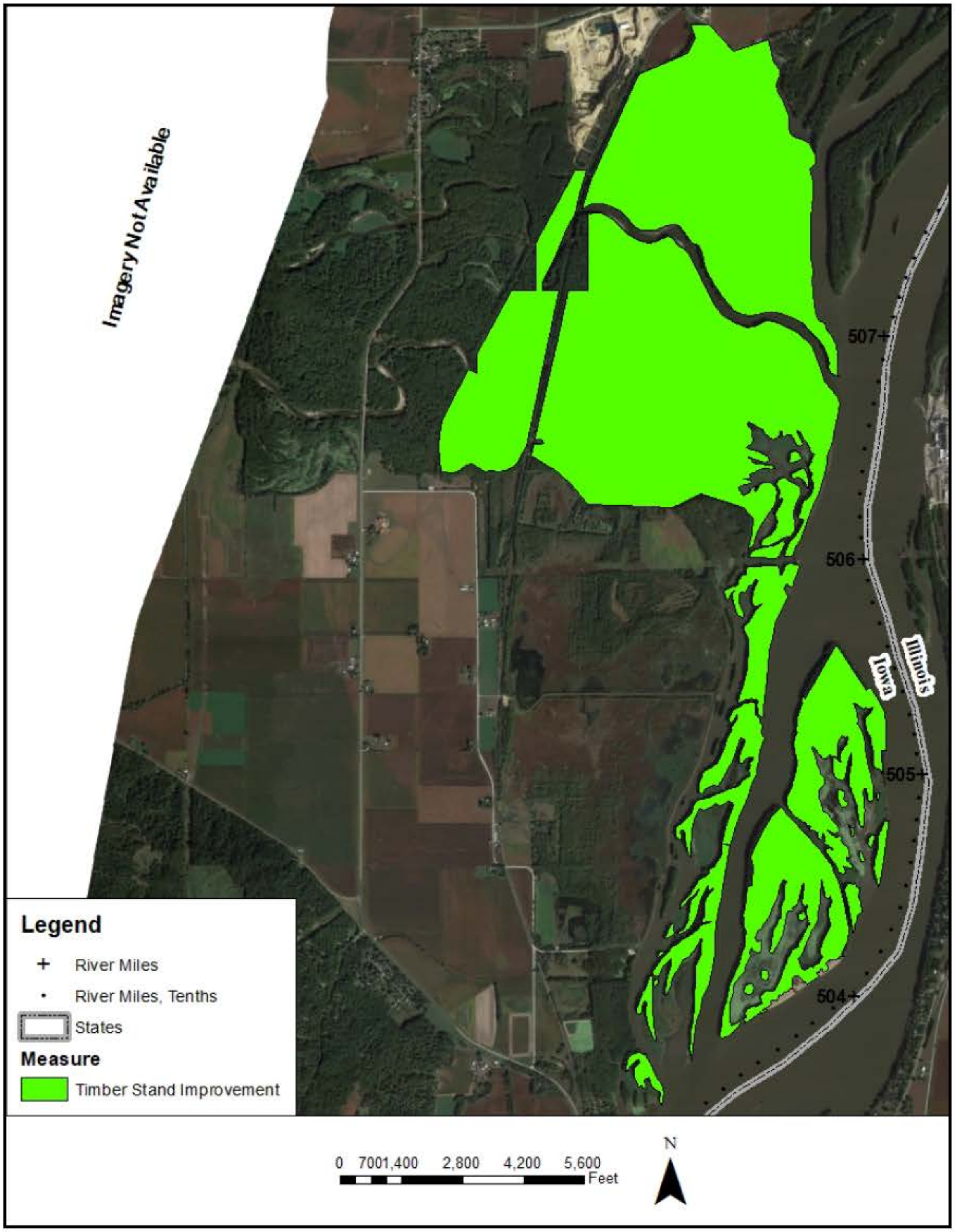


Figure IV-7: Forest Habitat Measures - Timber Stand Improvement Locations

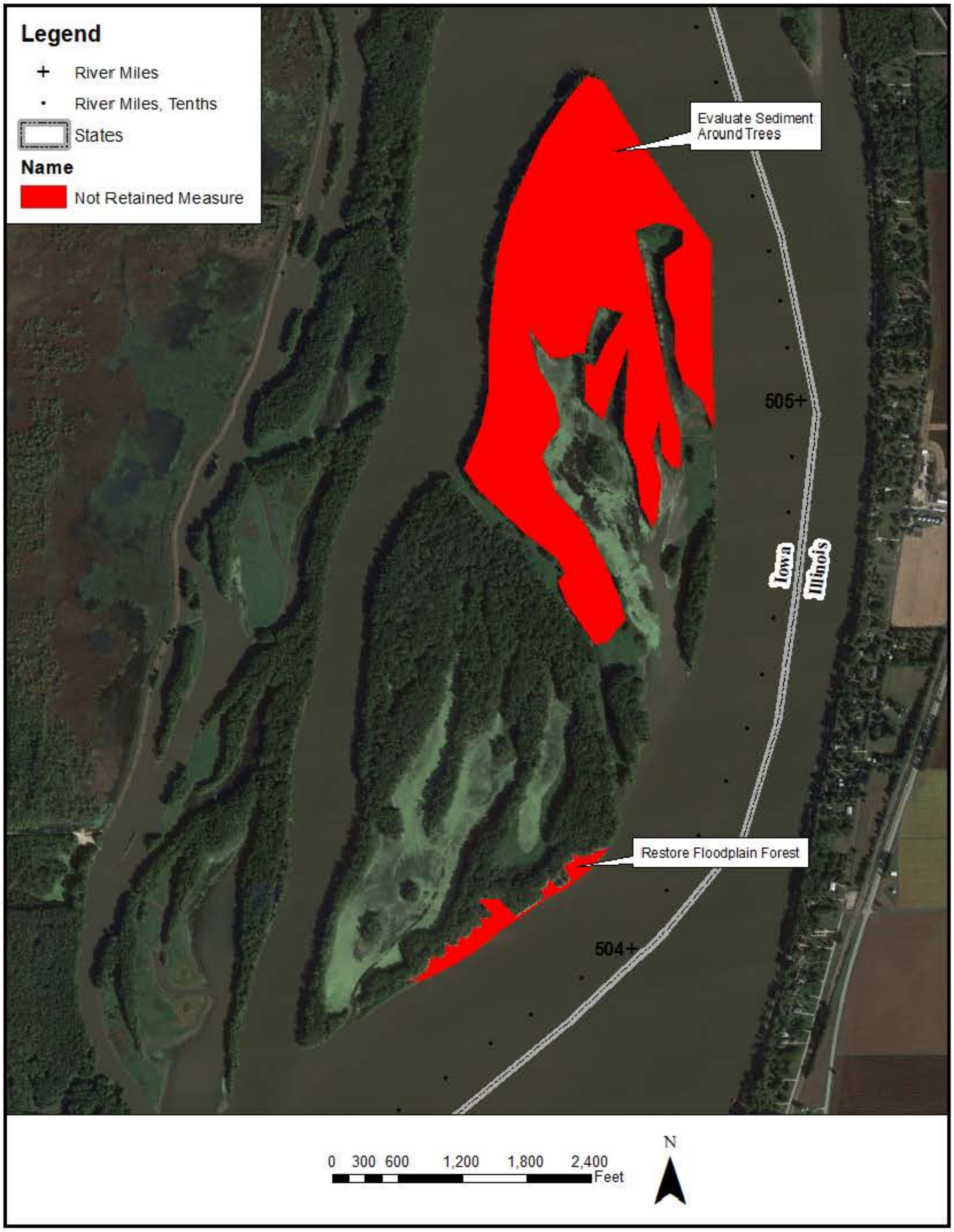


Figure IV-8: Forest Habitat Measures – Sediment Around Trees and Restore Floodplain Forest Locations

1. Timber Stand Improvement. TSI includes a combination of tree thinning treatments, tree planting, and invasive species management over the entire Project area. Tree thinning would open the canopy and benefit desirable understory tree seedlings and saplings by increasing the amount of light available to them. Planting trees increases diversity and improves recruitment of various tree ages**.** Invasive species management would reduce undesirable vegetation and competition for native species. A timber inventory was conducted during the 2018 growing season. TSI historically has resulted in significant benefits for minimal cost.

This measure was retained for the TSP.

2. Restore Floodplain Forest. The dredged material placement site along the southeast shoreline of Steamboat Island proper, Historic Bankline Placement Site RM 503.5-504.1R, consists of dredged sand. This measure would cover the sand with soil to an elevation suitable for vegetation and tree survival, and then planted with various forested wetland trees, understory species, forested wetland shrubs, and buffer species. Implementation of this measure would cause impacts on navigation, due to the loss of a placement site, and public use, due to the loss of a recreation area.

This measure was determined to be unacceptable and was not retained for further evaluation.

3. Evaluate Sediment Around Trees. This measure includes placing dredged material in and around mature trees to various elevations. The intent was to study how different thicknesses of dredged material placed around trees could impact survivorship. That information could be used for future projects. Previous studies have been done by different HREP planning teams and the results were not conclusive. While dead trees may be good bat habitat, it was decided that this measure may cause more adverse impacts than benefits by killing trees and/or allowing invasive species to establish.

This measure was determined to be unacceptable and was not retained for further evaluation.

D. Mussel Habitat Incorporation. This measure includes placing mussel substrate, such as river stone, when constructing other measures, such as stone protection or dredged material placement sites. This would enhance and maintain existing mussel habitat in the area, where analysis shows conditions are favorable. Most healthy beds in large rivers contain a variety of tribes, species, and age classes (Dunn et al, 2016) and are constrained to stable areas of the riverbed, which have physical boundaries generally defined by changes in a combination of substrate, depth, and/or current velocity. The formation of these beds seems to be a function of biotic and abiotic variables. Strayer (2008) proposed the following list of functional characteristics of mussel habitat:

- allows juveniles to settle (shears are not excessive during juvenile settlement)
- provides support (soft enough for burrowing, firm enough for support)
- is stable (stays in place during floods, no sudden scour or fill)
- delivers food (sediment organic matter for juveniles, current provides suspended food to adults
- delivers essential materials (oxygen, calcium, etc.)
- provides favorable temperatures for growth and reproduction
- provides protection from predators (interstitial juveniles)
- contains no toxic materials

These conditions were used as screening criteria to identify potential locations where mussel substrate could be incorporated with other measures. Figure IV-9 shows the locations of these measures.

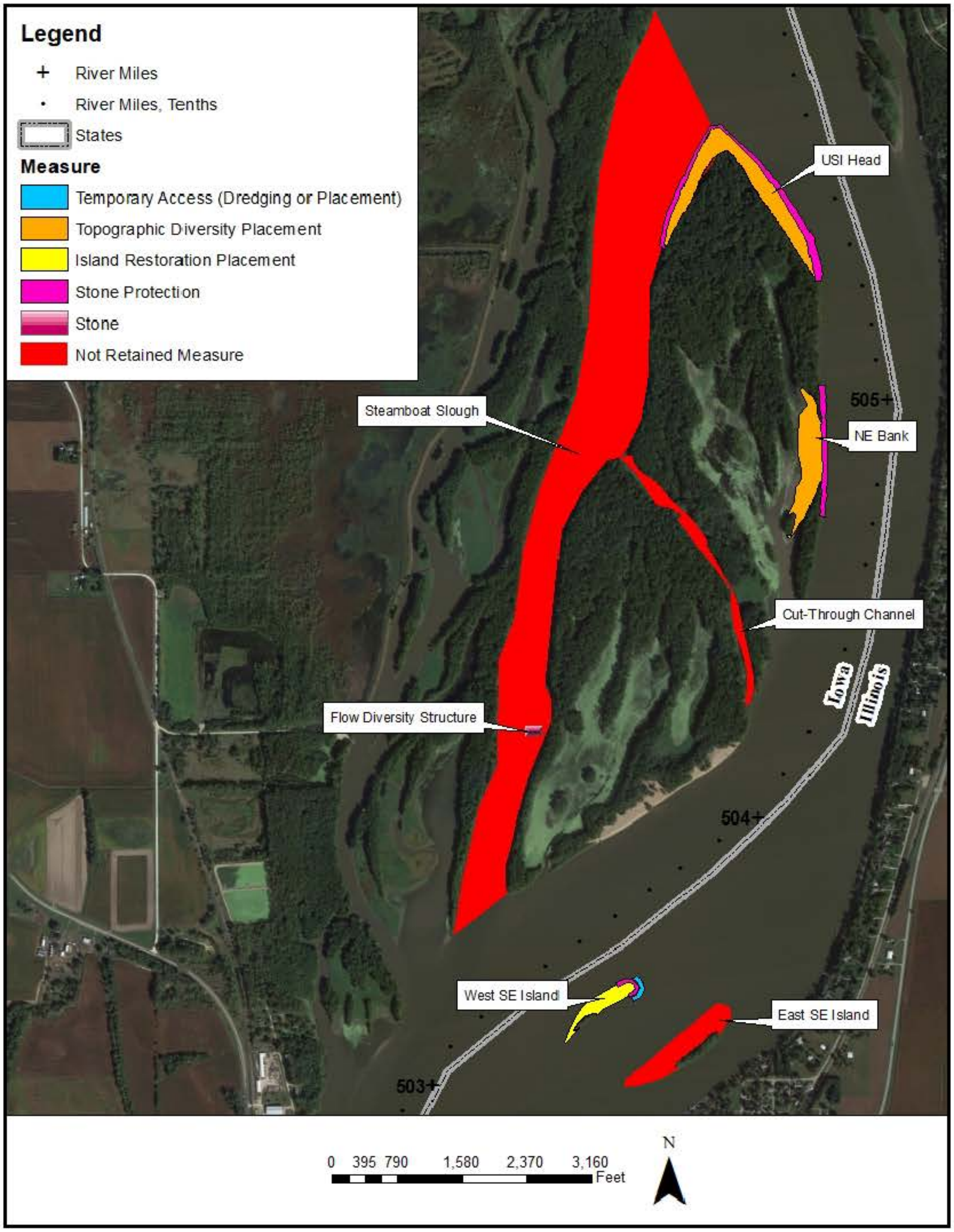


Figure IV-9: Mussel Habitat Incorporation Locations

1. USI Head. Restoring the Head of Steamboat Island was proposed as a topographic diversity measure. This restoration will require stone protection due to high velocities from the main channel. If functional conditions are present, mussel habitat can be incorporated into the stone protection.

This measure was retained for further evaluation.

2. NE Bank. The NE Bank was proposed as a topographic diversity measure. This restoration will require stone protection due to high velocities from the main channel. If functional conditions are present, mussel habitat can be incorporated into the stone protection.

This measure was retained for further evaluation.

3. West SE Island. The East and West SE Islands were proposed as island restoration and topographic diversity measures, however the East SE Island was not retained for further evaluation, so mussel substrate will not be incorporated at this location. The restoration of the West SE Island will require stone protection due to high velocities from the main channel. If functional conditions are present, mussel habitat can be incorporated into the stone protection.

This measure was retained for further evaluation.

4. Cut-Through Channel. An aquatic diversity measure was originally proposed for the Cut-Through Channel, which would have included mussel habitat and could have incorporated mussel substrate. As the Cut-Through Aquatic Diversity measure was eliminated, it was no longer possible to include mussel habitat.

This measure was determined incomplete and ineffective and was not retained for further evaluation.

5. Steamboat Slough. Steamboat Slough was considered for mussel habitat along the bank of Steamboat Island near the Cut-Through Channel and throughout Steamboat Slough. When discussing the Interior Island Terrace measure, it was assumed that stone protection would be required along the west bank of Steamboat Island, south of the Cut-Through Channel. If functional conditions were present, mussel habitat could be incorporated into the stone protection. However, since the Interior Island Terrace was not retained for further evaluation, neither was the mussel substrate incorporation.

Mussel habitat enhancement and creation was proposed for Steamboat Slough, to enhance existing habitat and mussel populations. Depths are fairly deep in Steamboat Slough and it was decided that it would be very costly to construct new mussel habitat measures or enhance existing habitat.

This measure was determined incomplete and inefficient and was not retained for further evaluation.

6. Flow Diversity Structure. The proposed Flow Diversity Structure would be constructed of riprap. If functional conditions are present, mussel habitat could be incorporated into the riprap.

This measure was retained for further evaluation.

E. Marine Traffic Management through Enforcement and Mooring Cell Creation

1. Enforcement. Stricter enforcement of marine traffic laws and regulations was proposed as a potential non-structural measure to help preserve Steamboat Island. Prop-wash from commercial and recreational boat traffic is a contributor to erosion of Steamboat Island. Likewise, commercial vessels pushing up against the island for fleeting also contribute to erosion of Steamboat Island. Creating no wake zones, no fleeting zones, and enforcement of those laws could cut down on erosion. Figure IV-10 shows the locations of these measures.

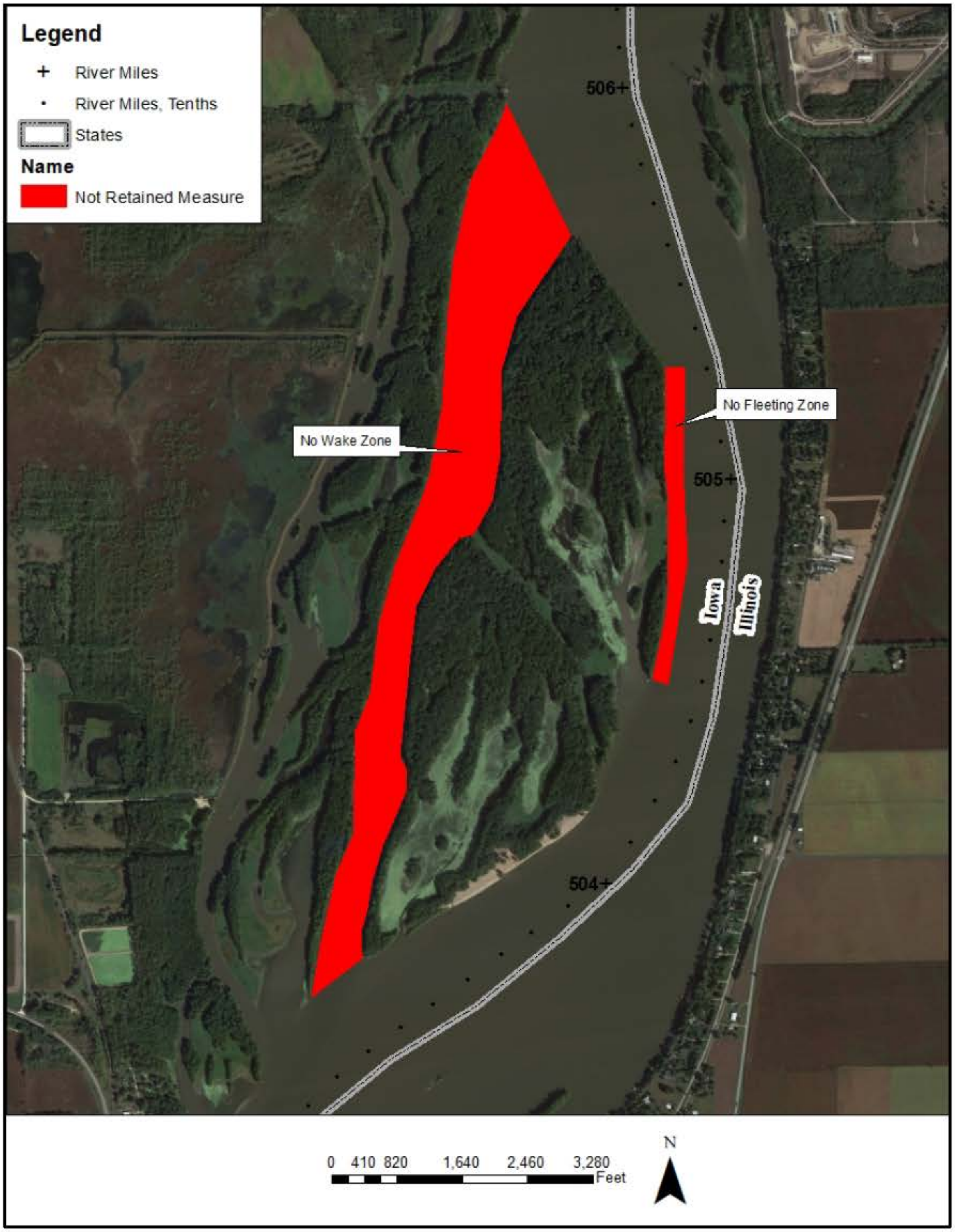


Figure IV-10: Enforcement Locations

a. NE Bank. The NE Bank was proposed as a key location for creating and enforcing a no fleeting zone. Commercial traffic fleeting occurs in this area, and the NE Bank has recently breached, allowing sediment laden water into Upper Lake. It was determined that the fleeting issue could not be corrected under the UMRR Program but other agencies could choose to pursue enforcement through their own programs.

This measure was determined to be incomplete and was not retained for further evaluation.

b. Steamboat Slough. Steamboat Slough was proposed as a key location for creating and enforcing a no wake zone. Recreational boaters cruise at wake-causing speeds in Steamboat Slough, creating prop-wash against Steamboat Island. It was determined that the wake issue could not be corrected under the UMRR Program but other agencies could choose to pursue enforcement through their own programs.

This measure was determined to be incomplete and was not retained for further evaluation.

2. Mooring Cells. Construction of mooring cells for barges to use for fleeting was proposed as a potential measure to help preserve Steamboat Island. Commercial vessels currently push up against Steamboat Island for fleeting. Constructing mooring cells would encourage commercial traffic to fleet against them versus against Steamboat Island. The navigation channel side of Steamboat Island was proposed as a key location for constructing mooring cells (Figure IV-11). It was determined that constructing mooring cells is outside the scope of the UMRR Program.

This measure was determined to be incomplete and was not retained for further evaluation.

F. Sediment Load Management. Sediment load management was proposed for the Project, including the establishment of buffer strips and construction of sediment basins. Figure IV-12 shows the locations of these measures.

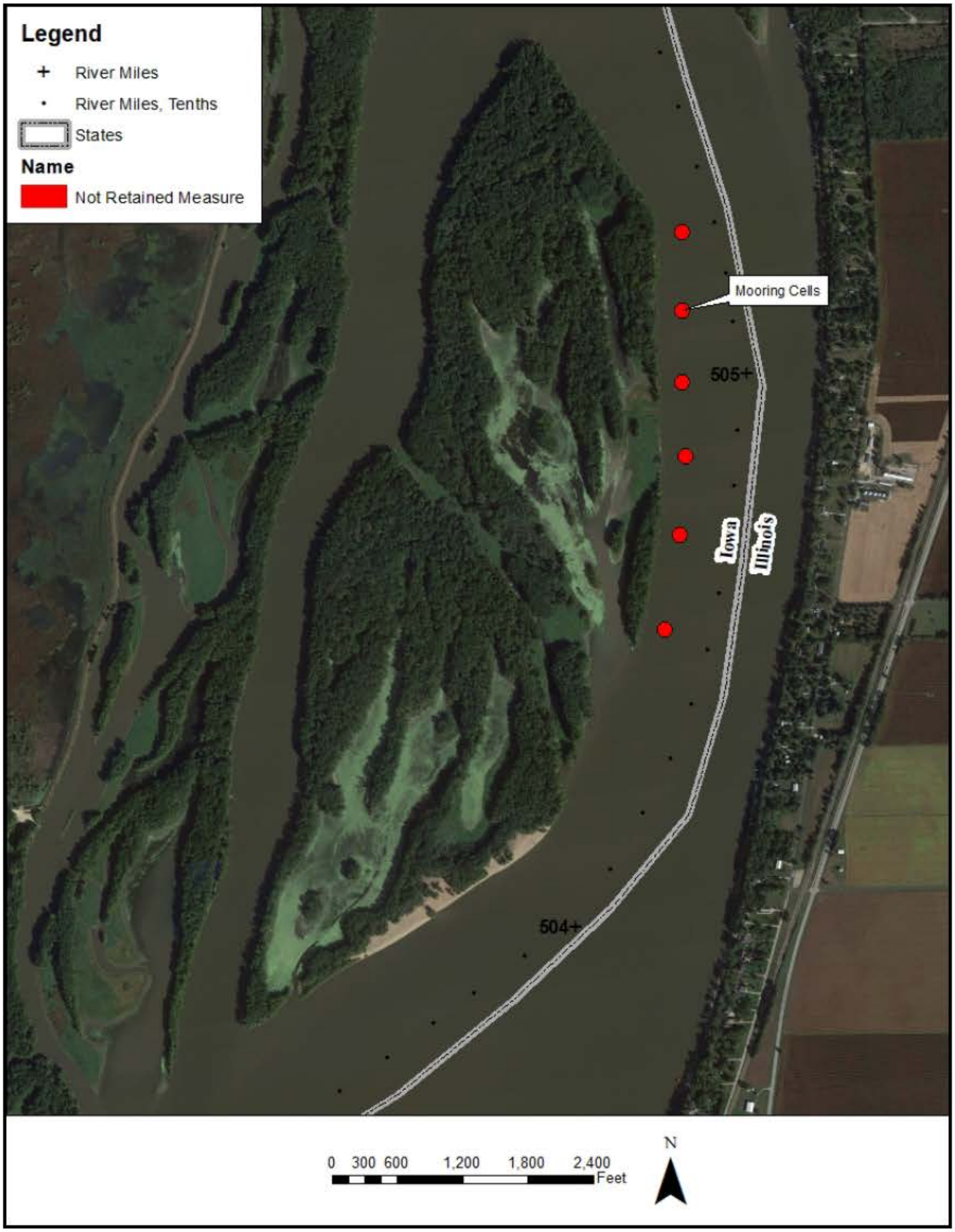


Figure IV-11: Mooring Cells Locations

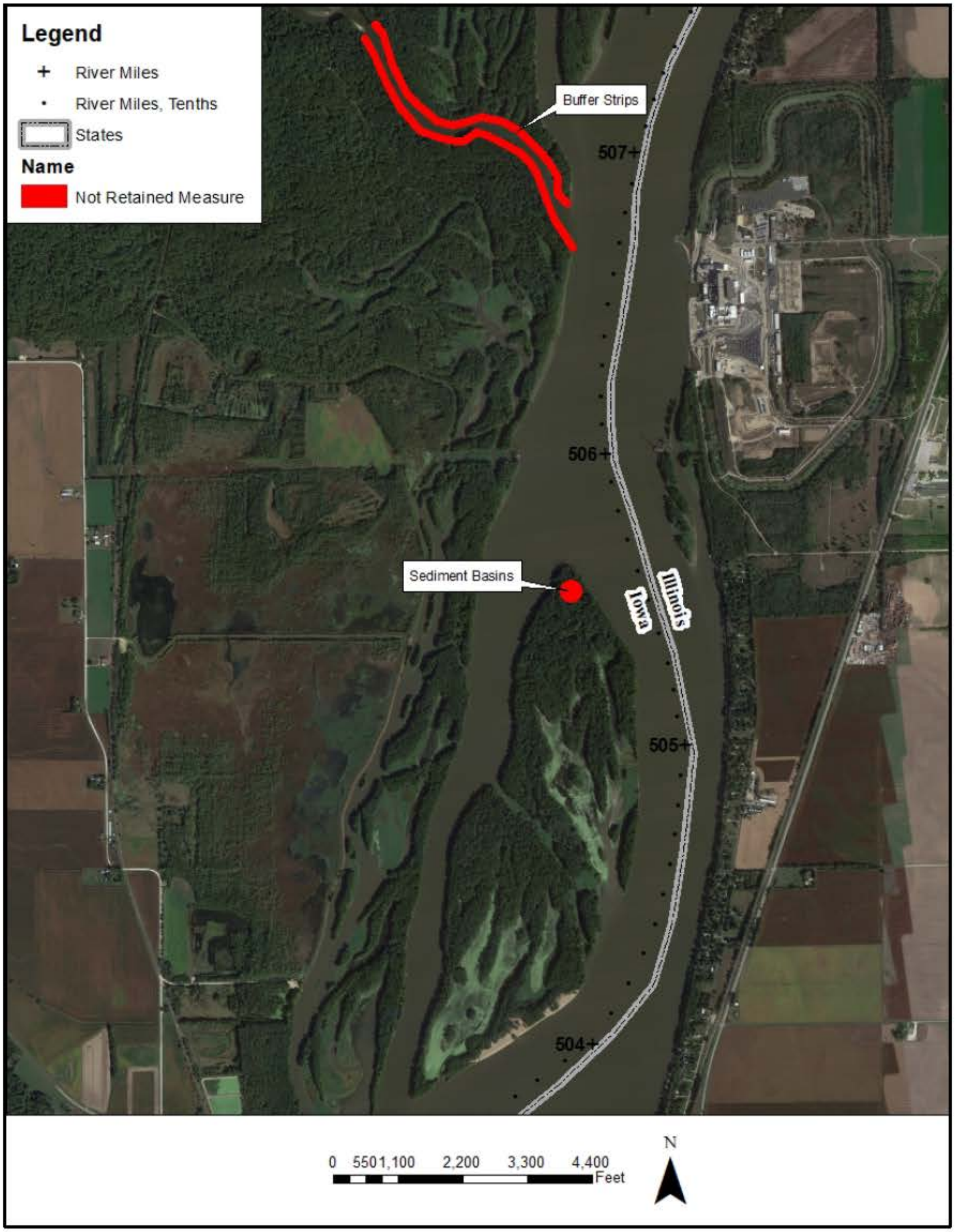


Figure IV-12: Sediment Management Locations

1. Buffer Strips. It is assumed that the Wapsipinicon River produces a higher sediment load during high water events. Planting buffer strips along the Wapsipinicon River may help filter out sediment before the water reaches the Mississippi River at the upstream end of the Project area. Due to the authorized boundary of UMRR and Project scope, the amount of sediment that buffer strips within the Project area would filter out would be minimal compared to the amount of sediment contained in the Wapsipinicon River. Buffer strips along the Wapsipinicon River may be implemented by other programs or landowners in the Project vicinity, but are not a part of this Project.

This measure was determined to be incomplete and was not retained for further evaluation.

2. Sediment Basins. A sediment basin consists of an earthen embankment or a ridge and channel combination, constructed across the slope and watercourse to form a sediment trap and water detention basin. Sediment basins upstream of dredge cuts were proposed to capture sediment before entering the Upper and Lower Lakes. However, the amount of sediment that a sediment basin would filter out would be very minimal compared to the amount of sediment coming into Steamboat Island proper.

This measure was determined to be ineffective and was not retained for further evaluation.

G. Complex Connectivity. Modifying the connectivity within the complex was proposed. Some portions of the Project area could benefit from increased connectivity, while other areas could benefit from decreased connectivity. Altering connectivity can provide many benefits, such as changed flow and velocity, as a result of the changed sediment load. Figure IV-13 shows the locations of these measures.

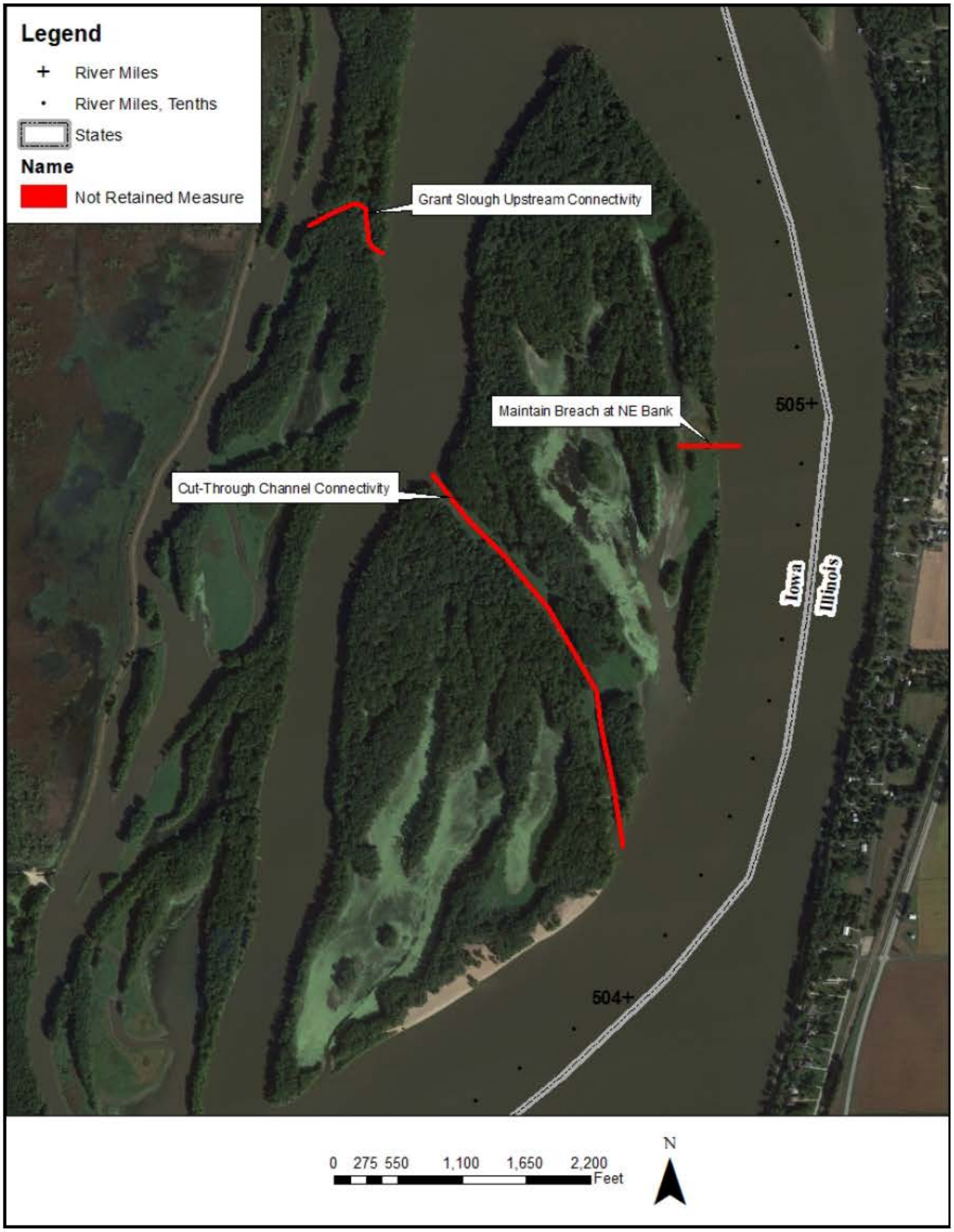


Figure IV-13: Complex Connectivity Locations

1. **Maintain Breach at NE Bank.** The NE Bank was breached between 2010 and 2011 and, since that time, Upper Lake has been directly connected to the main channel. During initial team meetings, maintaining the flow through the NE Bank was suggested as a potential non-structural measure, but as potential measures were developed and discussed, sustaining connectivity was eliminated, as restoring and protecting the NE Bank, in conjunction with creating aquatic diversity in Upper Lake, would be of greater benefit to the Project area in regards to aquatic habitat and topographic diversity.

This measure was determined to be ineffective and incomplete and was not retained for further evaluation.

2. **Cut-Through Channel Connectivity.** Excavation of the Cut-Through Channel was considered to provide connectivity between Steamboat Slough and the main channel. Historically, the watercourse was a flow-through channel, but has been silting in over time. As potential measures were developed and discussed, it was determined the Cut-Through Channel would likely continue to fill in even if excavated and may increase vulnerability for sediment laden water to enter Lower Lake.

This measure was determined to be ineffective and incomplete and was not retained for further evaluation.

3. **Grant Slough Upstream Connectivity.** Modifying the connectivity between Grant Slough and Steamboat Slough was considered during early planning meetings. The amount and source of sediment entering Grant Slough may come from Steamboat Slough, the Wapsipinicon River, or the main channel. The District has limited water quality data in this area. The PDT decided there wasn't enough information to make informed decisions about the measure, as a Project measure or Adaptive Management measure.

This measure was determined to be incomplete and was not retained for further evaluation.

H. Miscellaneous. Two other proposed Project measures are pool-wide drawdown and acquiring real estate west of Princeton Marsh. Figure IV-14 shows the locations of these measures.

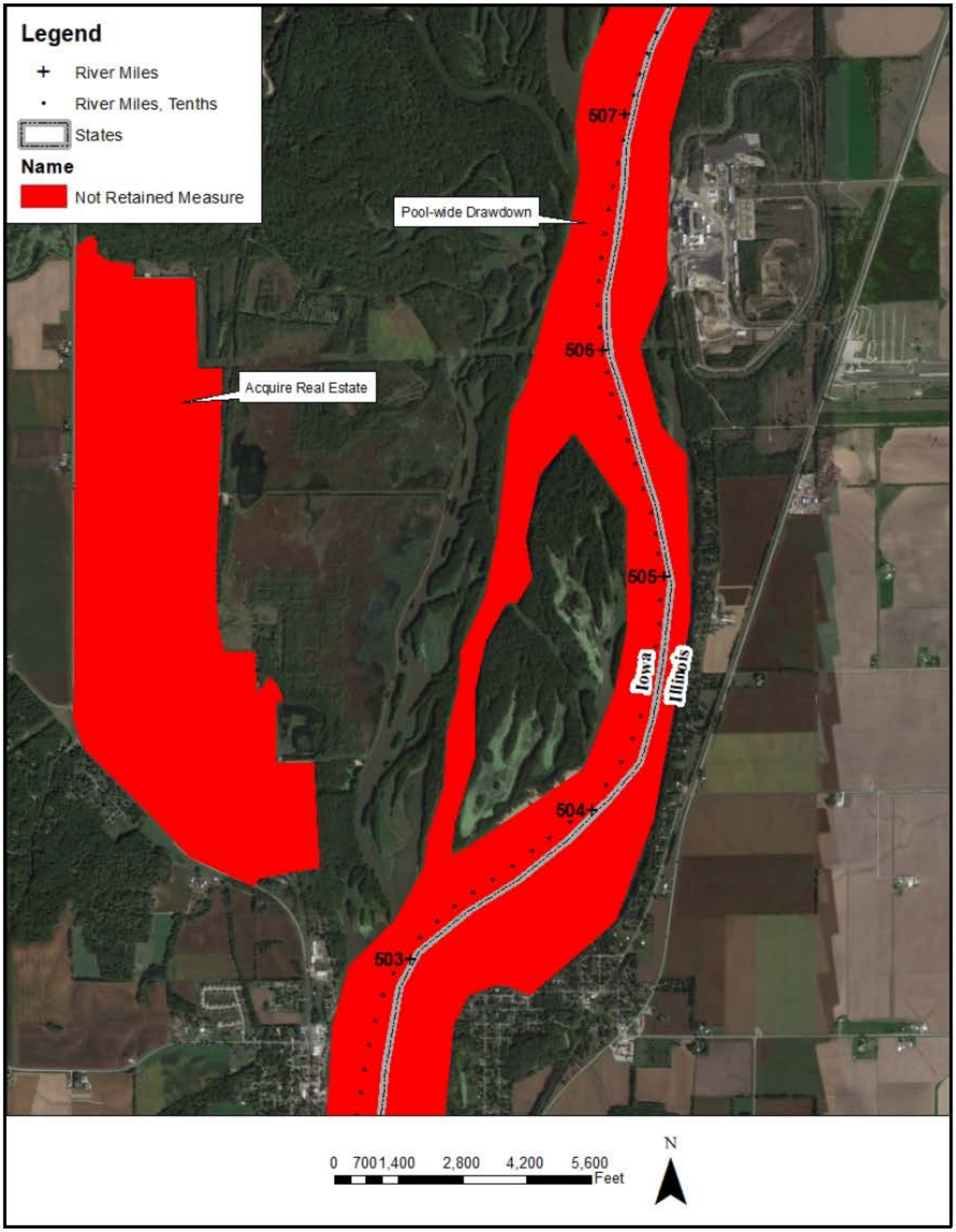


Figure IV-14: Miscellaneous Measure Locations

1. **Pool-wide Drawdown.** Pool-wide drawdowns have been shown to help restore diversity and abundance of native aquatic vegetation communities through the restoration of a more natural seasonal hydrograph. Water level management is a broad topic that includes maintaining water levels in the channel to support commercial navigation, modifications of the dam operating procedures for environmental benefits, or managing water levels in isolated management areas on the floodplain. Water level management in the main channel is the typical operating procedure that creates and maintains the existing array of habitats. The greatest interest of current stakeholders is to expose sediment to establish emergent perennial and annual wetland plants in shallow aquatic areas. Pool-scale drawdowns can be accomplished while maintaining navigation and are considered non-structural. A pool drawdown is a larger scale measure than what this Project scope entails.

This measure was determined to be incomplete and was not retained for further evaluation.

2. **Acquire Real Estate West of Princeton Marsh.** Acquisition of agricultural land west of Princeton Marsh, a non-structural measure, could provide benefits to sediment loading, nutrient loading, habitat creation, and more. Land taken out of agriculture production can be converted to buffer strips, timber stands, wetlands, and other habitats. These habitats would provide another buffer to the river system to prevent sediment and nutrients from entering the system. USFWS, Iowa DNR, and the Corps determined they were not able to acquire this property under the UMRR Program. Real estate acquisition for the purposes of restoration and enhancement may be implemented by other programs or landowners in the Project vicinity, but are not a part of this Project.

This measure was determined to be incomplete and was not retained for further evaluation.

I. Summary of Retained Measures

Figure IV-15 shows all retained measures. Figure IV-16 focuses on the measures near Steamboat Island proper, but omits TSI for clarity.

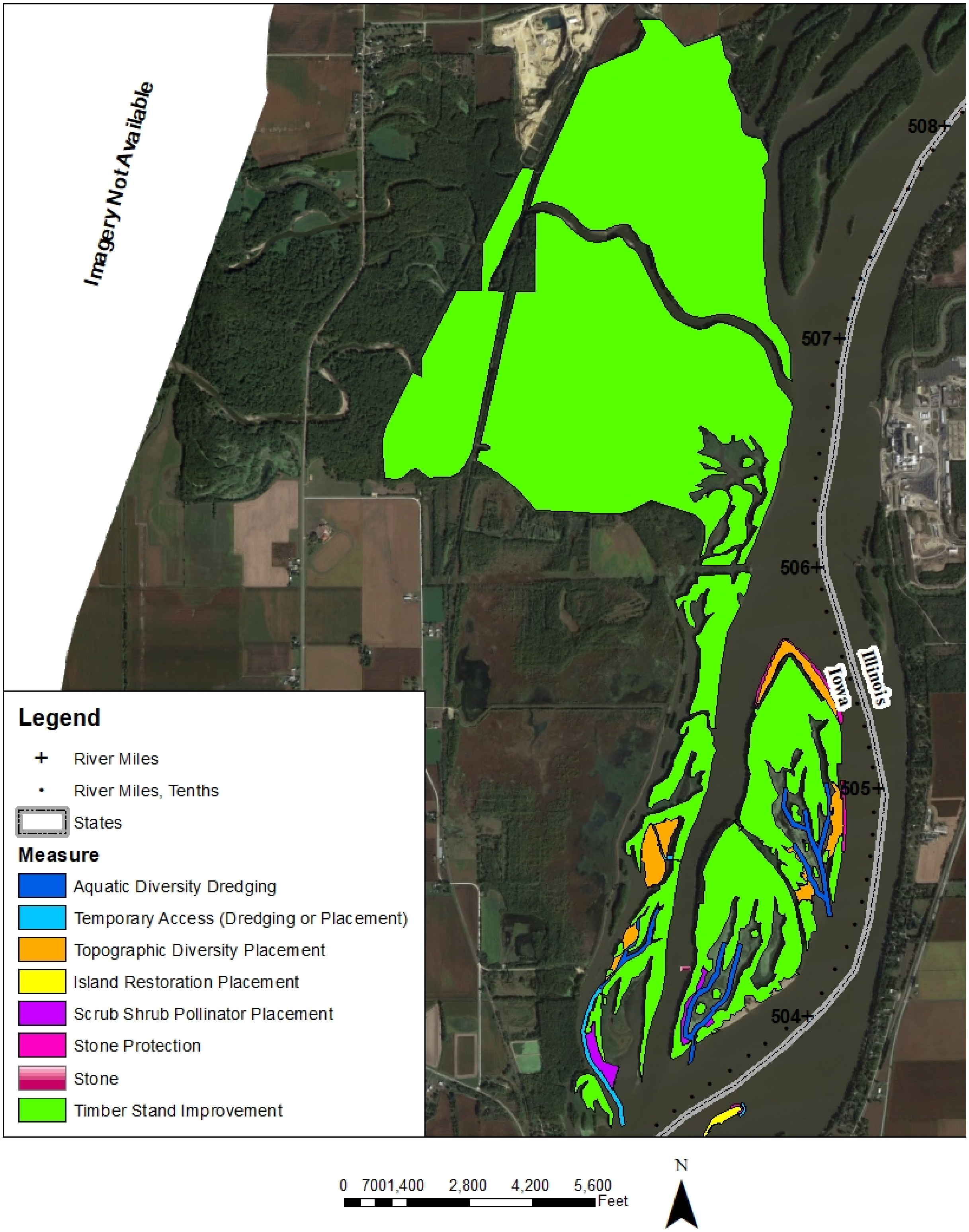


Figure IV-15: All Retained Measures Locations

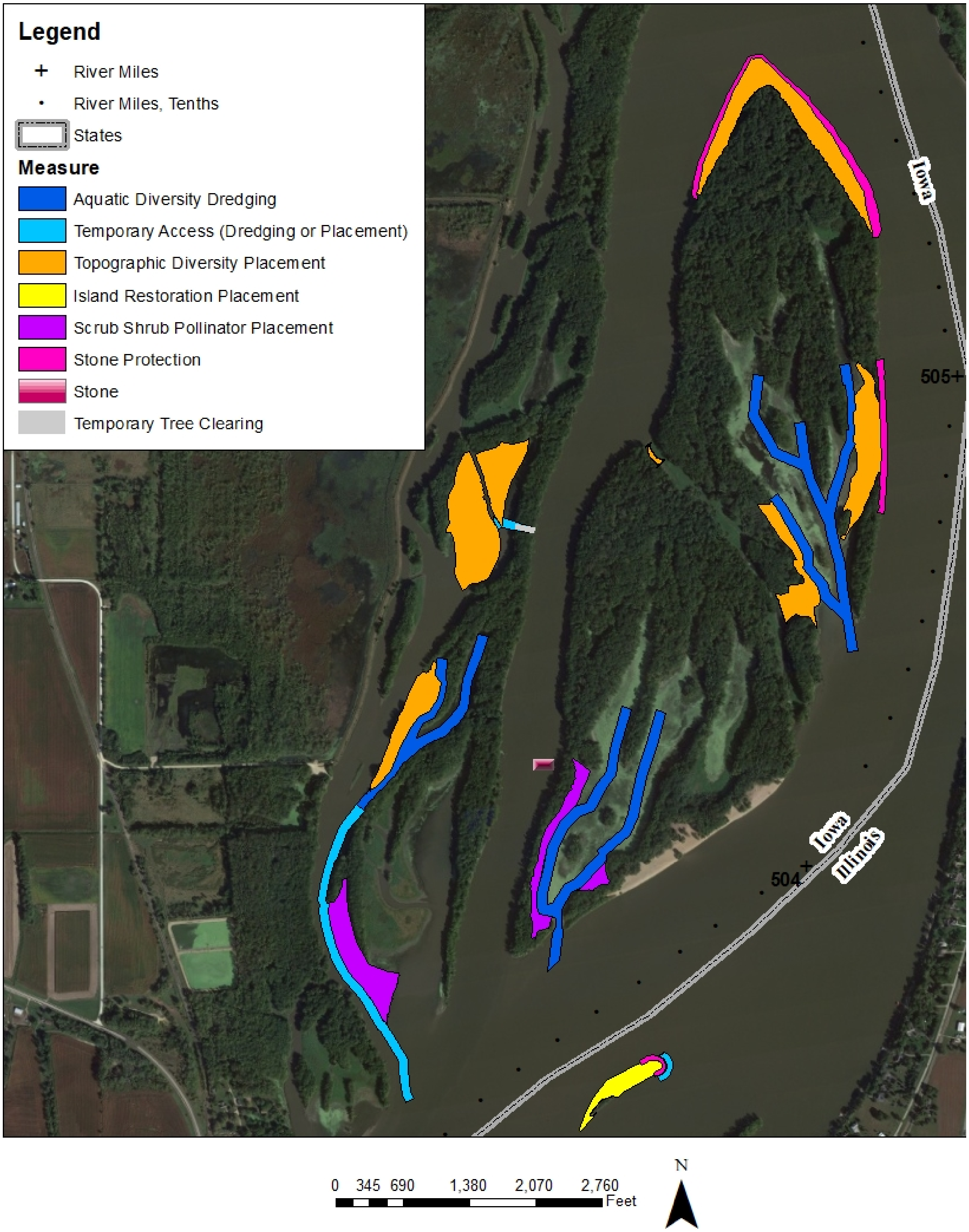


Figure IV-16: Retained Measures Locations, Omitting TSI

J. Quantity Calculations & Measure Layout

Areas, distances, and other measurements for the potential measures were measured using ArcMap. Depths and elevations were obtained from the topobathymetric LiDAR flown over the Steamboat Island Project area December 13, 2017. A TIFF surface was created with the topobathymetric LiDAR elevation information. Measures were laid out in ArcMap and assigned elevations. The Raster Surface Cut/Fill tool in ArcMap was used to calculate quantities of cut (dredging/excavation) and fill (placement sites) by comparing the designs of these potential measures to the TIFF surface (Table IV-1).

The potential measures balance shows 564,490 CY needed for placement and only 366,189 CY of dredging. Additional dredging would be required to construct measures as designed. In analyzing potential measures, it was assumed that additional dredging will come from the main channel, adjacent to measure locations. Updated quantities for the Recommended Plan are located in Table VI-1 in Section VI, *Recommended Plan: Description with Design, Construction, and Operation and Maintenance Considerations*.

Table IV-1: Summary of the Quantities for the Retained Potential Measures

Aquatic Diversity				
Location/Measure	**Acres**	**Dredging (CY)**	**Placement (CY)**	**Stone Protection (TN)**
Upper Lake	9.1	150,570		
Lower Lake	7.5	126,302		
NW Grant Slough Lake	4.7	75,082		
Access to Grant Slough	4.6	13,556		
Access to West SE Island	0.5	679		
Flow Diversity Structure	0.2			2,484
Total	**26.6**	**366,189**		2,484

Topographic Diversity & Scrub-Shrub/Pollinator Habitat				
Location/Measure	**Acres**	**Dredging (CY)**	**Placement (CY)**	**Stone Protection (TN)**
USI Head	14.2		310,491	106,800
NE Bank	8.3		31,787	8,853
West SE Island	3.5		59,079	6,014
Upper Lake Placement 1	5.3		13,969	
Grant Slough Placement 2	5.4		19,468	
Grant Slough Placement 4 & 5	16.8		124,752	
GCS	0.3		610	59
Grant Slough Placement 1 (SSP)	7.4		983	
Lower Lake SSP Placement	5.3		3,352	
Total	**66.5**		**564,491**	**121,726**

SECTION V. DEVELOPMENT AND EVALUATION OF ALTERNATIVES

Retained measures and their dependencies described in Section IV, *Potential Project Measures,* were carried forward for development of alternatives. The PDT, including the Sponsor and Project partners, further evaluated the retained measures to determine necessary refinement, additional dependencies, and ecologically relevant combinations for moving forward with alternative development.

Upper Lake: This measure includes the Upper Lake Aquatic Diversity measure; this measure was determined to be dependent on the restoration and protection of the NE Bank, in order to protect the Aquatic Diversity and dredge cut from sediment-laden water of the main channel. This measure may also incorporate fish and mussel habitat.

Lower Lake: This measure includes the Lower Lake Aquatic Diversity measure. This measure may also incorporate fish habitat.

NW Grant Slough Lake: This measure includes the NW Grant Slough Lake Aquatic Diversity measure. This measure may also incorporate fish habitat.

Topographic Diversity – Forestry Habitat: This measure includes the placement of material and plantings at seven locations over the Project area. Most topographic diversity sites will be located at locations that are currently monocultures of reed canarygrass.

Timber Stand Improvement: This measure includes a combination of tree thinning treatments, tree planting efforts, and invasive species management over portions of the Project area.

Topographic Diversity - Scrub-Shrub/Pollinator Habitat: This measure includes the placement of material and scrub-shrub/pollinator plantings at two locations in the Project area.

Island Restoration and Protection: This measure includes the restoration and protection of USI and the West SE Island, which will also incorporate forestry habitat. This measure may incorporate mussel habitat.

Flow Diversity: This measure includes the construction of a flow diversity stone structure in Steamboat Slough.

As the team progressed toward a final array of alternatives for evaluation, the PDT identified the following additional considerations and rules for combining measures:

- Upper Lake Aquatic Diversity and Lower Lake Aquatic Diversity were combined for purposes of alternative formulation to meet constructability & material balance. They will together increase overwintering habitat that is currently limiting on Steamboat Island proper. TSI will be included in all alternatives.
- Topographic diversity (forestry and scrub-shrub/pollinator habitats) is included in all alternatives.

A. Formulation of Project Alternatives

After all potential measures and their dependencies were identified, the Institute for Water Resources (IWR) Planning Suite software (IWR Planning) was used to facilitate development of alternative combinations of the measures. Input into the software included potential measures only, since the measures (including dependencies) could be implemented independently. This resulted in 64 possible alternatives, which were further reduced through an iterative process based on completeness and effectiveness. The full plan formulation process is shown in Figure V-1.

Of the 64 possible alternatives, combinations that were single measures were eliminated from further consideration, as they were ineffective and would not provide a complete ecosystem restoration project. Combinations that lacked an aquatic diversity measure were eliminated from further consideration, as the PDT determined that restoring a limiting habitat was necessary for a complete project and important to the Project area. Measures that were determined to be dependent on other measures were eliminated as stand-alone alternatives and integrated as such. Specifically, the PDT determined that the GCS was necessary with the proposed excavation in the Lower Lake Aquatic Diversity measure to aid in the reduction of sediment transfer into that backwater system. This resulted in an initial array of 32 possible alternatives.

Further comparison and analysis of the initial array determined that, in order for the Project area to remain a significant resource for the UMR and contribute to the unique mosaic of habitats, alternatives would need to include aquatic diversity and protection thereof, as well as island restoration and protection to mimic historic conditions and support the dynamic system. Furthermore, the restoration and protection of USI Head and all aquatic diversity measures on Steamboat Island proper were determined to be essential to the restoration of the Project area and highest priority for the Sponsor and Project partners; retaining these measures for all alternatives would meet Project objectives and result in a complete and effective Project. Restoration and protection of USI Head would protect the measures and investment on Steamboat Island proper and prevent sediment transport to other significant habitats downstream, including the Cordova EHA. Over time, continued degradation of USI Head could lead to unplanned changes in the thalweg of the main channel. For all these reasons, all alternatives that did not include USI Head restoration and protection, Upper Lake Aquatic Diversity (and associated NE Bank measure), and Lower Lake Aquatic Diversity were eliminated from further comparison, which resulted in a final array of nine alternatives.

Of the remaining eight action alternatives, a base plan was identified as a stand-alone project with the combination of measures needed to achieve a minimum level of restoration (Table V-1), to include the restoration and protection of the USI Head and aquatic diversity measures on Steamboat Island proper. The PDT then identified the maximum restoration plan that contained the maximum amount of habitat restoration and produced the maximum restoration output (Table V-1). The remaining with-Project alternatives included combinations of Grant Slough Complex, the West SE Island, and Flow Diversity added onto the base plan. This approach resulted in the final array of nine alternatives, including the No Action Alternative (Tables V-2 and V-3).

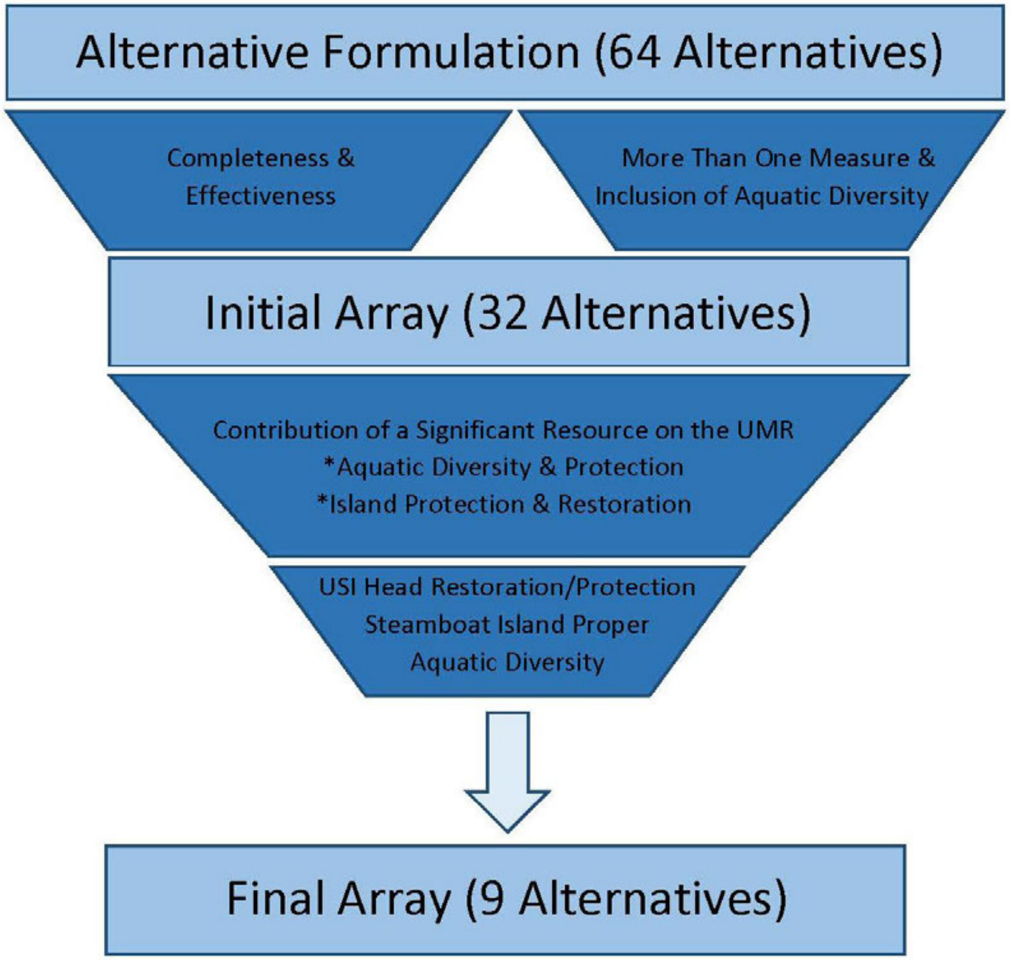


Figure V-1: Alternative Formulation

B. Evaluation of Final Array of Project Alternatives

1. Habitat Benefits. The initial habitat benefit evaluation was further refined and additional detail applied to the final array of alternatives to finalize the environmental benefits. This assessment includes a summary of the existing biological conditions used in the evaluation, as well as a forecast for future conditions under the No Action Alternative and each potential Project measure. The evaluation was conducted by a multi-agency team that included representatives from the USFWS, Project partners, and the Corps. Aquatic and floodplain benefits were quantified through the use of the Habitat Evaluation Procedures (HEP; USFWS 1980a).

a. 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 wildlife species. The HEP are based on the assumption that habitat for selected wildlife species can be described by a Habitat Suitability Index (HSI). This index value (from 0.0 to 1.0) 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 (50 years). Habitat Units are calculated for select target years and annualized using the IWR Planning Suite II tool annualizer over the period of analysis to derive a net Average Annual Habitat Unit (AAHU) quantity. By using target years, AAHUs were annualized using a linear interpolation approach, essentially drawing a straight line between target years and then calculating the area under the curve for the resulting planning horizon benefit curve. Resulting net AAHUs are used as the output measurement to compare alternatives for the proposed Project.

Threshold elevations to model aquatic, SSP, and forestry acres for the Project were developed based on growing season inundation duration and exceedance probability criteria determined by the PDT's best professional judgment. Time series analyses to identify the appropriate elevation threshold for each habitat type was performed using HEC-EFM. Acreages for each habitat type were then calculated based on existing conditions and with-Project terrains and elevation thresholds.

The HEP procedures were used to evaluate the effects of the proposed Project measures on aquatic and floodplain habitat quantity and quality. The PDT used four Corps-approved [per EC 1105-2-412] habitat evaluation methodologies in their analyses:

- The Bluegill HSI model (Stuber et al., 1982; Palesh and Anderson, 1990) was used to assess backwater aquatic habitat because bluegills require backwater habitat for all or most of their life cycle and are often limited in the availability of high quality overwintering habitat.

- The Walleye HSI model (McMahon et al., 1984) was used to assess the riverine components because it is rheophilic or oriented to flow, and captures the benefits from an increase in forage, water clarity, and spawning habitat afforded by the measures. Additionally, walleye is a popular host fish species for numerous freshwater mussels that inhabit the Project area.

- The Yellow Warbler HSI Model (Schroeder, 1982) was used to assess pioneer floodplain forest habitat because yellow warblers prefer hydrophytic scrub-shrub habitat for foraging and nesting and are often limited in the availability of quality wet scrub-shrub habitat.

- The Grey Squirrel HSI Model (Allen, 1987) was used to assess mast tree habitat because grey squirrels require diverse mast-producing tree habitat for forage, cover, and reproduction, and are often limited in the availability of mast-producing trees in the floodplain.

A summary of the habitat analysis is provided in Table V-1. Assessment of existing Project area conditions, projected future conditions without the Project, and expected impacts of proposed Project description of the habitat analysis are provided in Appendix D, *Habitat Evaluation and Benefits Quantification*.

Table V-1: Habitat Types and Areas Evaluated for This Assessment

Habitat Type	Evaluation Area	Area (acres)	Habitat Suitability Index Model
Aquatic	Steamboat Island (Upper and Lower Lakes) – Aquatic Diversity	23	Bluegill
	NW Grant Slough – Aquatic Diversity	6	Bluegill
	Steamboat Slough – Flow Diversity	0.4	Walleye
	West SE Island – Mussel Habitat	1	Walleye
Floodplain[1]	Steamboat Island – Forest Topographic Diversity (3 sites)	14	Yellow Warbler/Gray squirrel
	Steamboat Island – SSP Topographic Diversity (Lower Lake)	5	Yellow Warbler
	USI Head – Forest Topographic Diversity	14	Yellow Warbler/Gray squirrel
	Grant Slough Complex – Forest Topographic Diversity (4 sites)	30	Yellow Warbler/Gray squirrel
	West SE Island – Forest Topographic Diversity	4	Yellow Warbler/Gray squirrel
	TOTAL	**97.4**	

[1]TSI measures were not included in the initial habitat analysis, but were anticipated to help restore the process and function of ~900 acres of floodplain forest in the Project Area.

2. Cost Estimate for Measures. Table V-2 shows the estimated cost of Project alternatives as of completion of the habitat analysis and for use in the comparison of alternatives, prior to selection, refinement, and developing a full cost estimate of a TSP. Cost estimates for alternative comparison were prepared using January 2019 price levels; annualized costs include construction costs, contingency costs, adaptive management costs and Operation and Maintenance, Repair, Replacement and Rehabilitation costs. Project measures are on Federal lands; consequently, there are no lands and damages or relocation costs. Total Project costs were annualized based on the Fiscal Year 2019 discount rate of 2.875% and a 50-year period of analysis. Interest During Construction (IDC) was calculated using end of year compounding based on a six-year period of construction, using the Fiscal Year 2019 discount rate of 2.875%. A more detailed breakdown of costs based on further design refinement for the Recommended Plan is outlined in Section VIII, *Cost Estimates.*

C. Comparison of Final Array of Project Alternatives

IWR Planning was used to complete a Cost Effective and Incremental Cost Analysis (CEICA) for the nine alternatives (including the No Action Alternative), using the AAHUs and annualized costs included in Table V-2 and described in this section. The CEICA is used when project benefits are not measured in dollars and is used to ensure the least cost alternative is identified for each possible level of environmental output, and the maximum level of output is identified for any level of investment. Cost Effectiveness evaluation is used to identify the least costly solution to achieve a range of Project benefits; the Incremental Cost Analysis identifies the subset of cost-effective plans that are superior financial investments, called "Best Buys," through analysis of the preliminary incremental costs. Best Buys are the plans that are the most efficient at producing the output variable or provide the greatest increase in AAHUs for the least increase in preliminary cost. The first Best Buy is the most efficient plan, producing output at the lowest incremental cost per unit. If a higher level of output is desired than that provided by the first Best Buy, the second Best Buy is the most efficient plan for producing additional output, and so on.

Table V-3 and Figure V-2 show the resulting alternatives differentiated by cost effectiveness. From this list of nine alternatives, four Best Buy Plans were identified (Table V-4 and Figure V-3).

Table V-2: Environmental Output and Costs of Final Array of Alternatives
January 2019 Price Level – 50-year period of analysis using 2.875% discount rate

Alt. Number	Measures	Over-wintering (Net AAHUs)	Floodplain Forest (Net AAHUs)	Island Prot./Mussel Substrate (Net AAHUs)	Flow Diversity (Net AAHUs)	Net AAHUs	Construction Costs w/ Contingency ($)	Annualized Costs ($)	Annualized Operation Costs ($)	Annualized Maintenance Costs ($)	Annualized Adaptive Mgmt Costs ($)	IDC ($)	Total Annualized Costs ($)
0	No Action Plan	0	0	0	0	0	0	0	0	0	0	0	0
18	USI Head, Steamboat Island aquatic diversity	19.09	24.50	0	0	43.59	21,443,000	848,303	0	56,506	905	911,306	907,143
19	USI Head, Steamboat Island aquatic diversity, Grant Slough Complex	25.03	46.50	0	0	71.53	28,170,000	1,114,429	0	56,506	905	1,197,197	1,174,112
22	USI Head, Steamboat Island aquatic diversity, Flow Diversity	19.09	24.50	0	0.10	43.69	21,665,000	861,927	0	58,009	905	1,048,328	922,270
23	USI Head, Steamboat Island aquatic diversity, Grant Slough Complex, Flow Diversity	25.03	46.50	0	0.10	71.63	28,412,000	1,130,352	0	58,009	905	1,374,802	1,191,538
26	USI Head, Steamboat Island aquatic diversity, West SE Island	19.09	27.40	0.64	0	47.13	25,546,000	1,010,621	0	61,554	5,516	1,085,680	1,086,210
27	USI Head, Steamboat Island aquatic diversity, SE Island, Grant Slough Complex	25.03	49.40	0.64	0	75.07	32,656,000	1,278,853	0	61,554	5,516	1,044,057	1,355,285
30	USI Head, Steamboat Island aquatic diversity, West SE Island, Flow Diversity	19.09	27.40	0.64	0.10	47.23	25,768,000	1,046,974	0	63,057	5,516	1,821,636	1,124,066
31	USI Head, Steamboat Island aquatic diversity, West SE Island, Grant Slough Complex, Flow Diversity	25.03	49.40	0.64	0.10	75.17	33,259,000	1,325,221	0	63,057	5,516	1,662,941	1,403,156

Table V-3: Final Array of Alternatives Differentiated by Cost Effectiveness

Alt. Number	Alternative	Annualized Cost ($)	Output (AAHU)	Average Cost ($)	Cost Effective
0	No Action Plan	0	0	0	Best Buy
18	USI Head, Steamboat Island aquatic diversity	907,143	43.59	20,811	Yes
19	USI Head, Steamboat Island aquatic diversity, Grant Slough Complex	1,174,112	71.53	16,414	Best Buy
22	USI Head, Steamboat Island aquatic diversity, Flow Diversity	922,270	43.69	21,109	Yes
23	USI Head, Steamboat Island aquatic diversity, Grant Slough Complex, Flow Diversity	1,191,538	71.63	16,635	Yes
26	USI Head, Steamboat Island aquatic diversity, West SE Island	1,086,210	47.13	23,047	Yes
27	USI Head, Steamboat Island aquatic diversity, West SE Island, Grant Slough Complex	1,355,285	75.07	18,054	Best Buy
30	USI Head, Steamboat Island aquatic diversity, West SE Island, Flow Diversity	1,124,066	47.23	23,800	Yes
31	USI Head, Steamboat Island aquatic diversity, West SE Island, Grant Slough Complex, Flow Diversity	1,403,156	75.17	18,666	Best Buy

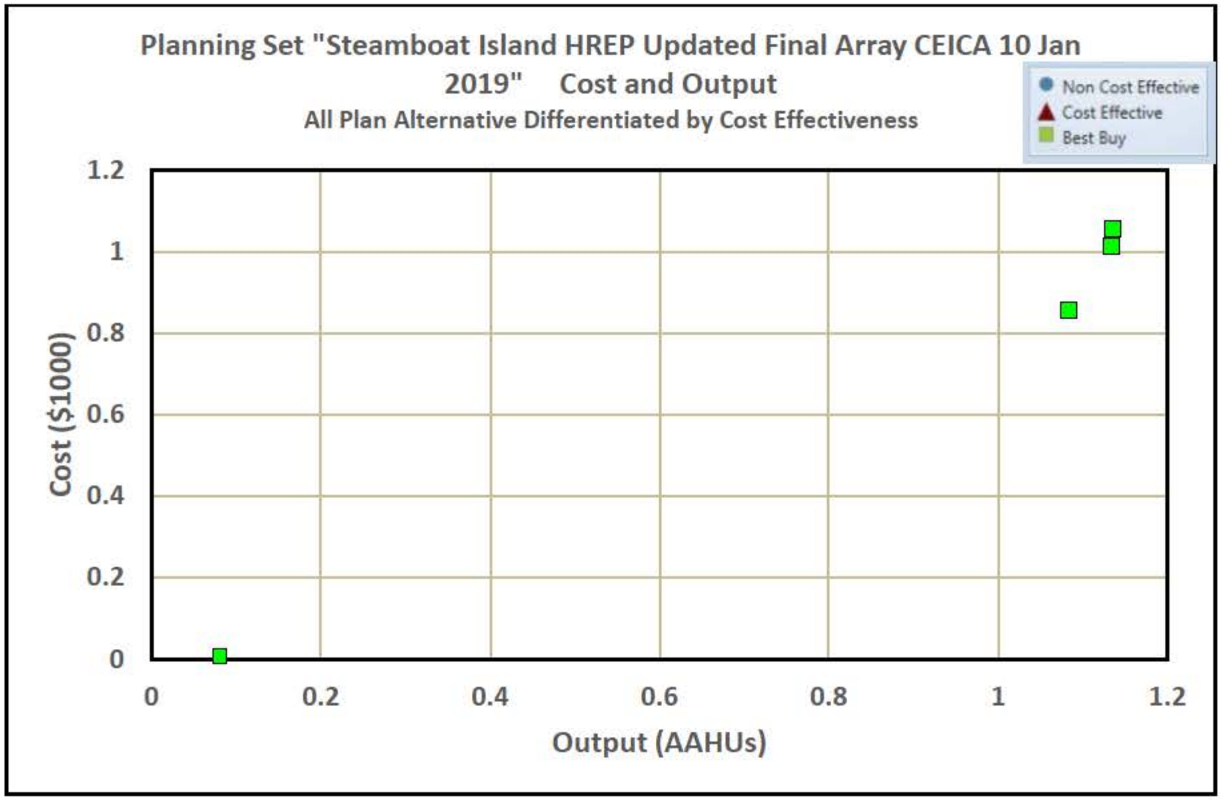


Figure V-2: Final Array of Alternatives Differentiated by Cost Effectiveness

Table V-4: "Best Buy" Combinations

Alt. Number	Alternative	Outputs (HU)	Annualized Cost ($)	Average Cost ($)	Incremental Cost ($)	Incremental Output (HU)	Incremental Cost/Output ($/HU)
0	No Action Plan	0	0	0	0	0	0
19	USI Head, Steamboat Island aquatic diversity, Grant Slough Complex	71.53	1,174,112	16,414	1,174,112	71.53	16,414
27	USI Head, Steamboat Island aquatic diversity, West SE Island, Grant Slough Complex	75.07	1,355,285	18,054	181,173	3.54	51,179
31	USI Head, Steamboat Island aquatic diversity, West SE Island, Grant Slough Complex, Flow Diversity	75.17	1,403,156	18,666	47,871	0.10	478,710

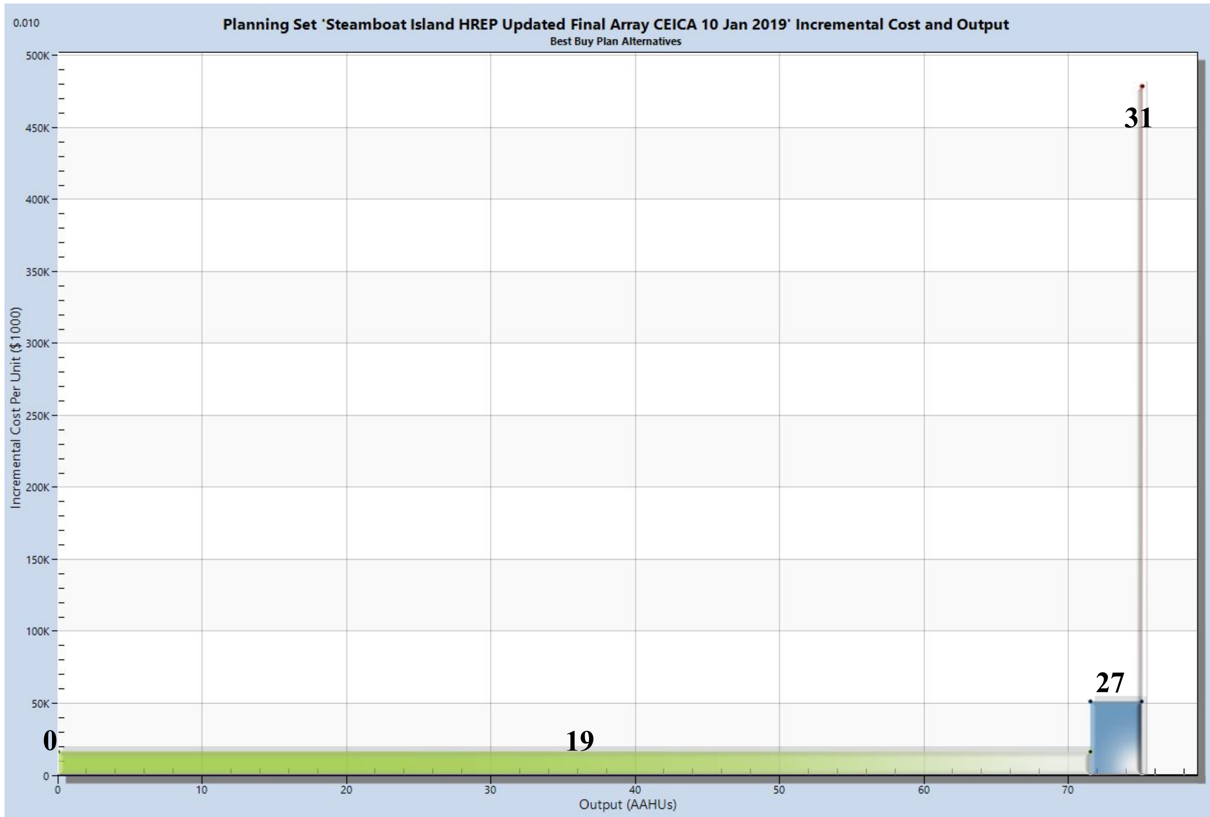


Figure V-3: Steamboat Island "Best Buy" Plans

D. Selection of the Recommended Plan

Federal planning for water resources development was conducted in accordance with the U.S. Water Resources Council's P&G.

> *"For ecosystem restoration projects, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, shall be selected. The selected plan must be shown to be cost effective and justified to achieve the desired level of output. This plan shall be identified as the National Ecosystem Restoration (NER) Plan."*

Review of the four formulation criteria suggested by the P&G (completeness, effectiveness, efficiency, and acceptability, defined below) and resource significance (institutional, public, and technical) were used to aide in the selection of the TSP.

- ***Completeness.*** Completeness is the extent to which an alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. That could require relating the plan to other types of public or private plans if the other plans are crucial to achieving the contributions to the objective. Completeness varies in the plans, depending on the measure that are incorporated.
- ***Effectiveness***. All the plans in the final array provide some contribution to the Project objectives. Effectiveness is defined as a measure of the extent to which a plan achieves its objectives.
- ***Efficiency.*** All the plans in the final array provide net benefits. Efficiency is a measure of the plan's cost-effectiveness expressed in net benefits.
- ***Acceptability.*** All the plans in the final array must be in accordance with Federal law and policy. Acceptability is the extent to which the alternative plans are acceptable in terms of applicable laws, regulations, and public policies. All the plans in the final array provide some level of acceptability for the Sponsor and Project partners.
- ***Institutional Recognition.*** The importance of an environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies, tribes, or private groups.
- ***Public Recognition.*** Some segment of the general public recognizes the importance of an environmental resource, as evidenced by people engaged in activities that reflect an interest or concern for that particular resource.
- ***Technical Recognition.*** The resource qualifies as significant based on its "technical" merits, which are based on scientific knowledge or judgment of critical resource characteristics. Technical significance should be described in terms of one or more of the following criteria or concepts: scarcity, representativeness, status and trends, connectivity, limiting habitat, and biodiversity.

The PDT reviewed the Best Buy Plans (Table V-4 and Figure V-3) and determined that the cost to implement the first iteration of Best Buy Plans above the No Action Plan, Alternative 19, was worth the incremental investment above the No Action Plan because it provides an acceptable level of restoration for an acceptable cost. Alternative 19 includes the Grant Slough Complex, in addition to the Steamboat Island proper measures. It provides 71.53 habitat units over the No Action Plan at an incremental cost per unit of output ($/HU) of $16,414. This alternative is efficient, effective, complete, and acceptable. Alternative 19 would provide restoration over a majority of the Project area.

The next Best Buy Plan, Alternative 27 (75.07 AAHUs; $51,179 $/HU), differs from Alternative 19 by adding restoration and protection of the West SE Island and an additional 3.54 AAHUs. The PDT determined that this alternative is also efficient, effective, complete, and acceptable, and would be considered further, as it provides additional benefits and contributes to the restoration and protection of the unique and diverse mosaic of habitats within the Project area. However, Alternative 27 would further support a complete and effective Project, without adding adverse impacts. The additional 3.54 AAHUs of the TSP, as compared to Alternative 19, contribute to many aspects of resource significance and provide additional ecosystem output. The additional forest habitat and island acreage of the West SE Island will be used as a refuge, feeding, and breeding ground for migratory birds, fish, and other wildlife. It will support transitional zone habitat at the edge of the island and aquatic diversity just outside of its land mass. The restoration and protection of the West SE Island will provide direct and indirect benefits to the mussel community and their host species. 3.54 AHHUs, while seemingly small, will do a great deal for the institutional and technical importance of the Project area and Pool 14. The West SE Island measure contributes to overall connectivity by supporting the Cordova EHA and providing fish and mussel habitat in the side channel, providing limiting habitat that is essential for the conservation of the Higgins eye pearlymussel, and contributes to the unique mosaic of habitats that are desired for the Project area.

The last Best Buy Plan, Alternative 31 (75.17 AAHUs; $478,710 $/HU), differs from Alternative 27 by adding the construction of the Flow Diversity measure within Steamboat Slough. The PDT determined that although there would be minimal additional benefits, Alternative 31 would not be considered further because the incremental cost was not worth the small amount of benefit the alternative would provide. The additional 0.1 AAHU would provide some aquatic diversity but not contribute to the institutional or technical significance in the Project area or Pool 14.

The other cost-effective alternatives between Best Buy Alternatives 19 and 27 would not fully realize the Project objectives and the Sponsors' needs because the Grant Slough complex is not included in Alternatives 22 and 26 and/or the West SE Island is not included in Alternatives 22 and 23. The Grant Slough complex currently has existing, but low quality, overwintering habitat and is important because its proximity to the main channel would maintain a hydraulic connection, providing adequate DO levels to overwintering fish during severe winters or other low DO events. The restoration and protection of the West SE Island would result in a higher amount of diverse forest habitat, as described previously, and indirectly benefit an existing EHA by providing additional aquatic habitat diversity and act as a buffer from the flow of the main channel. The inclusion of these measures into the TSP provide benefit and habitat to the Project area and Pool 14, where these habitat needs have been diminishing over time and will continue to do so if no action is taken.

As a result of this discussion and review of the formulation criteria, the PDT concluded that Alternative 27 is the Recommended Plan and the NER Plan since it reasonably maximizes ecosystem restoration benefits at an acceptable incremental cost. Table V-5 shows how the Recommended Plan compares to other plans based on the P&G criteria and Resource Significance of the Outputs.

Table V-5: Recommended Plan Justification as Compared With Other Alternatives

Alternative	Efficiency (CEICA)	Acceptability /Sponsor Priority	Completeness	Robustness and Connectivity (# Lakes Excavated)	Limiting Habitat (acres)	Island Restoration/Protection (acres)	Topographic Diversity (acres)	Aquatic Diversity (acres)
No Action	BB	1	0	0	0.0	0	0	0
18	CE	1	1	2	42.0	14	19	23.0
19	BB	3	3	3	78.0	14	49	29.0
22	CE	1	1	2	42.4	14	19	23.4
23	CE	3	3	3	78.4	14	49	29.4
26	CE	3	3	2	47.0	18	23	24.0
27 (TSP)	BB	5	5	3	83.0	18	53	30.0
30	CE	3	3	2	47.4	18	23	24.4
31	BB	5	5	3	83.4	18	53	30.4

Assumptions:
All acres come from HEP
Acceptability: 1 - Low Priority, 3 - Medium Priority, 5 - High Priority
Completeness: 0 - Incomplete, 1 - Minimally Complete, 3 - Moderately Complete, 5 - Maximally Complete
Robustness and Connectivity, measured by the number of lakes excavated (overwintering habitat): More than 2 considered ideal
Limiting Habitat, combined acres overwintering habitat, forestry and SSP habitat: More than 75 acres considered ideal
Topographic and aquatic diversity will not require clearing or placing on existing diverse areas; all topographic diversity will be located in existing reed canary grass fields
Topographic diversity, combined acres forestry and SSP habitat: More than 25 acres considered ideal
Aquatic diversity, combined acres overwintering habitat: Maximization of benefits considered ideal

The Recommended Plan is important to the Project area and offers a unique opportunity to restore the unique mosaic of habitats in the landscape, mimic pre-settlement conditions, increase the quality and quantity of bottomland hardwood forest, aquatic habitat, island acreage and topography, backwater and interior wetland habitat, and provide important linkages between similar habitats in Pool 14. The enhancement of Steamboat Island and the whole Project area offered by the Recommended Plan is preferred among the other plans, specifically because of the improvements to the recognized significant resources (institutional, public, and technical) and the quality and quantity of island restoration and protection. The Recommended Plan meets Project objectives, realizes natural resource, recreational, and socioeconomic opportunities, and allows for consideration of constraints.

The institutional importance of the Steamboat Island HREP and the Recommended Plan is primarily demonstrated as it meets the goals and objectives of the UMR NWFR, to provide a refuge and breeding ground for migratory birds, fish, other wildlife, and plants. The incorporation of mussel habitat into Project measures and the enhancement of bat habitat by TSI actions provide benefits to species protected under the ESA of 1973, as amended. Additional habitat gains will result for floodplain forest quality through increasing hardwood forest stand species diversity, age, and structure. This will also provide long-term benefits to resident migratory bird and other species relying on hard mast trees as a source of food and shelter, implementing the goals and objects set forth in the MBTA; EO 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds;* the Bald and Golden Eagle Protection Act of 1940; and the FWCA, as amended (16 U.S.C. § 661). The restoration and protection of island acreage and habitat will also contribute to these institutional values.

The public importance of the Steamboat Island HREP and the Recommended Plan is primarily demonstrated by the multi-agency coordination effort in maintaining a high quality UMR ecosystem while avoiding adverse impacts. Steamboat Island represents one of the largest habitat restoration projects in Pool 14 to restore degraded environmental conditions within the backwater and floodplain forest habitats that will also benefit migratory birds, fish, other wildlife, and plants. This Project addresses the public's and natural resource specialists' needs and preferences in local habitat restoration and recreation.

The technical importance of the Steamboat Island HREP and the Recommended Plan is primarily demonstrated by improving habitat for a variety of species, thus increasing the representativeness, connectivity, and limiting habitat of the area. Expansion of the aquatic limiting habitat by excavation in Upper Lake, Lower Lake, and NW Grant Slough Lake will increase backwater depths with the resulting improvement in water quality, aquatic diversity, and fish habitat. This should promote and improve seasonal refugia with resulting benefits to the warm-water fisheries communities. Restoration and protection of the NE Bank will protect the overwintering area in Upper Lake, as well as provide an increase in floodplain forest. The GCS will reduce sediment transfer and deposition into overwintering areas, thereby protecting the resulting biodiversity and habitat restoration. Expansion of the forested and SSP limiting habitat will increase island acreage and the topographic diversity in the Project area; the biodiversity of the floodplain forest and SSP species will be increased through plantings, which is important for Pool 14 connectivity and the species which use these habitats. The enhancement of the floodplain forest by these and other TSI actions will improve the scarcity of habitat available for migratory bird and listed bat species in the area by providing foraging, roosting, and breeding areas. In addition, the restoration and protection of USI and the West SE Island will restore many acres of island habitat within Pool 14 that have been lost, which serves important functions for the ecosystem. Incorporation of fish and mussel habitat into Project measures will directly benefit the Project area and enhance the value of the adjacent Cordova EHA. The West SE Island restoration and protection is vital because the adjacent side channel lies within the Cordova EHA established for the recovery of the endangered Higgins eye pearlymussel. If the West SE Island eroded away, the freshwater mussel community inhabiting the EHA may be negatively impacted, including federally-listed mussels, through direct connection of the adjacent side channel with the main channel. All of these improvements would extend beyond each individual measure and are expected to benefit the entire fish and wildlife communities within adjacent areas, therefore improving connectivity and representativeness.

E. Evaluation of Additional Floodplain Benefits Quantified by the Hydrogeomorphic Approach

TSI measures were not included in the initial habitat analysis, but were anticipated to help restore the process and function of ~900 acres of floodplain forest in the Project area. Since TSI prescriptions were anticipated to be the same for all Final Array Project alternatives, the Hydrogeomorphic (HGM) Approach was later applied to support the Recommended Plan and demonstrate the additional benefits provided by TSI actions relative to the cost of the Project. Single use approval of the HGM Approach to assess the ecological functions of forested wetlands in the Project area was provided in May 2020 (see Appendix A, *Correspondence*). The results of this analysis determined an additional 318 net AAHUs are gained by TSI implementation, resulting in a total of 393.07 AAHUs. See Appendix D, *Habitat Evaluation and Benefits Quantification,* for further information on the methods and results. For a detailed breakdown of costs by measure (including TSI prescriptions), see Appendix I, *Cost Estimate*. Total annual cost per AAHU is described in Section VIII, *Cost Estimates*, Table VIII-7.

F. Risk and Uncertainty

Areas of risk and uncertainty have been analyzed and were defined so that decisions could be made regarding the reliability of estimated benefits and the costs of alternative plans. Risk is defined as the probability or likelihood for an outcome. Uncertainty refers to the likelihood that an outcome results from a lack of knowledge about critical elements or processes that then contributes to risk or natural variability in the same elements or processes.

The PDT worked to manage risk in developing measures by expanding on and referencing successful similar work completed by previous HREPs and the Design Handbook. The PDT used that experience and information to identify possible risks and decrease uncertainty in plan formulation. No measures in the Recommended Plan are believed to be burdened by significant risk or uncertainty regarding the eventual success of the proposed measures. Significant risk would be avoided by proper design, appropriate selection, and correct seasonal timing of applications.

The dynamic and complex nature of riverine environmental processes is a principal source of uncertainty. This source of uncertainty effects the USI and West SE Island restoration and protection measures the most, as erosion will continue to occur during Project planning and design, and high or low water during construction may affect construction. Construction risks, including the uncertainty of future high water events, are quantified in Appendix I-B, *Project Cost and Schedule Risk Analysis Report.* Post-construction evaluation, including performance monitoring and long-term performance reporting, and adaptive management measures would be used to address uncertain outcomes in all Recommended Plan components.

Success of floodplain forest plantings was identified as having a low level of risk (medium likelihood, low consequence). Risk to floodplain forest features with topographic diversity due to increased inundation duration was mitigated during design by increasing topographic diversity elevations to account for changing hydrology. Furthermore, risks to floodplain forest plantings due to dredge material, herbivory and predation were reduced using a phased planting and monitoring schedule. The reasoning and probability of mortality and poor establishment is commonly associated with multiple drivers, rather than simply one direct cause. Incorporating a phased planting effort to directly counter the primary drivers that have caused high probability of mortality in the past helps to further buy down risk by building up the organic material in the dredge material (cover crops), planting early successional tree species one growing season prior to late successional tree species (diversity), and increasing resilience by planting trees in higher densities.

Further detail on phased planting and monitoring schedules can be found in Appendix M, *Engineering Design*. This knowledge of relevant forest ecosystem structure and function is a result of UMRR Forestry Monitoring efforts, having produced monitoring data to understand relationships among project management actions and corresponding outcomes.

It is expected that overwintering and summer habitat in the dredged backwater will not be limited by dissolved oxygen or flow. Furthermore, the Beaver Island HREP is currently in construction and has an adaptive management and monitoring design for aquatic diversity and backwater fish habitat, which can inform the design process for this Project. However, sediment transport and deposition may occur in the aquatic diversity sites, depending on river conditions and function of Project measures. This expectation remains uncertain and the risk is low (medium likelihood, low consequence). If monitoring demonstrates a need for reduced sediment transport, an adaptive management measure to modify the NE Bank and/or GCS will be implemented.

It is expected that implementation of the GCS and NE Bank restoration will not significantly alter hydraulic forces within Steamboat Island and will bring benefit to the Project by reducing the transfer and deposition of sediment into the overwintering areas. Adaptive management measures have been formulated to address the low risk (low likelihood, low consequence) and uncertainty associated with these structures. For further information, see Appendix K, *Monitoring and Adaptive Management Plan*. Hydraulic modeling of the Recommended Plan demonstrated that impacts to flood profiles met the “no-rise” requirements as interpreted by the States of Iowa and Illinois.

Sea level rise is not expected to impact the Recommended Plan since the Project is located several hundred feet above mean sea level. However, uncertainty in future hydrology and the associated sediment transport regime introduces risks to Project performance, such as successful floodplain forest restoration and dredge cut longevity. As shown in Figure II-9 and II-12, stage duration has increased over the last sixty years. Consideration of risk due to future hydrology informed the design of the floodplain forest with topographic diversity measures. A description of how observed changes in growing season inundation duration were applied to topographic diversity design and a qualitative assessment of climate change impacts is documented in Appendix H, *Hydrology and Hydraulics*, Table H-21, *Climate Risk Summary*, which shows climate risks for each Project measure.

SECTION VI. RECOMMENDED PLAN: DESCRIPTION WITH DESIGN, CONSTRUCTION, AND OPERATION AND MAINTENANCE CONSIDERATIONS

The Recommended Plan was developed following the CEICA and was refined with more design details. All measures described below passed the CEICA. The Recommended Plan is shown on Figure VI-1 and Plate 8, C-102, and described as follows:

- Restoring topographic diversity in portions of the Project area by increasing existing elevations and planting trees, shrubs, understory plants, and buffer species, as well as implementing TSI measures, to address the Project objective of enhancing and restoring areal coverage and diversity of forest stands and habitat and increase diversity of bottomland hardwood forest.

- Increasing aquatic diversity in the Project area backwaters, specifically in Steamboat Island Upper Lake, Steamboat Island Lower Lake, and NW Grant Slough Lake, by excavation, which will address the Project objective of increasing year-round aquatic habitat. Where appropriate, additional fish and mussel habitat may be incorporated to bring further benefit to the species that use the Project area. Due to the low cost and risk of these structures, further design will occur in coordination with the Sponsor and resource agencies during the P&S stage. Incorporating these structures is an additional benefit from the proposed stone protection and not specifically tied to project objectives (Section III.G, *Complex Connectivity*) requiring monitoring for success (Section X, *Project Performance Monitoring*) or adaptive management (Appendix K, *Monitoring and Adaptive Management Plan*). However, similar structures have been implemented at other HREPs (e.g., Beaver Island; Huron Island) and monitoring of these sites will better inform the Project's design of these structures. Preliminary design information for the fish and mussel habitat can be found in Appendix M, *Engineering Design*.

- Restoring and protecting island acreage on portions of Steamboat Island proper and the whole West SE Island by placing stone protection and dredged material, then planting with trees, to address the Project objective of restoring island acreage and protecting from erosion within the Project area.

- Placing protection measures at the NE Bank and the northwest end of the Cut-Through Channel of Steamboat Island and restoring SSP habitat in the Project area, to address the Project objective of protecting existing backwater habitat from sediment deposition and enhancing backwater and interior wetland areas.

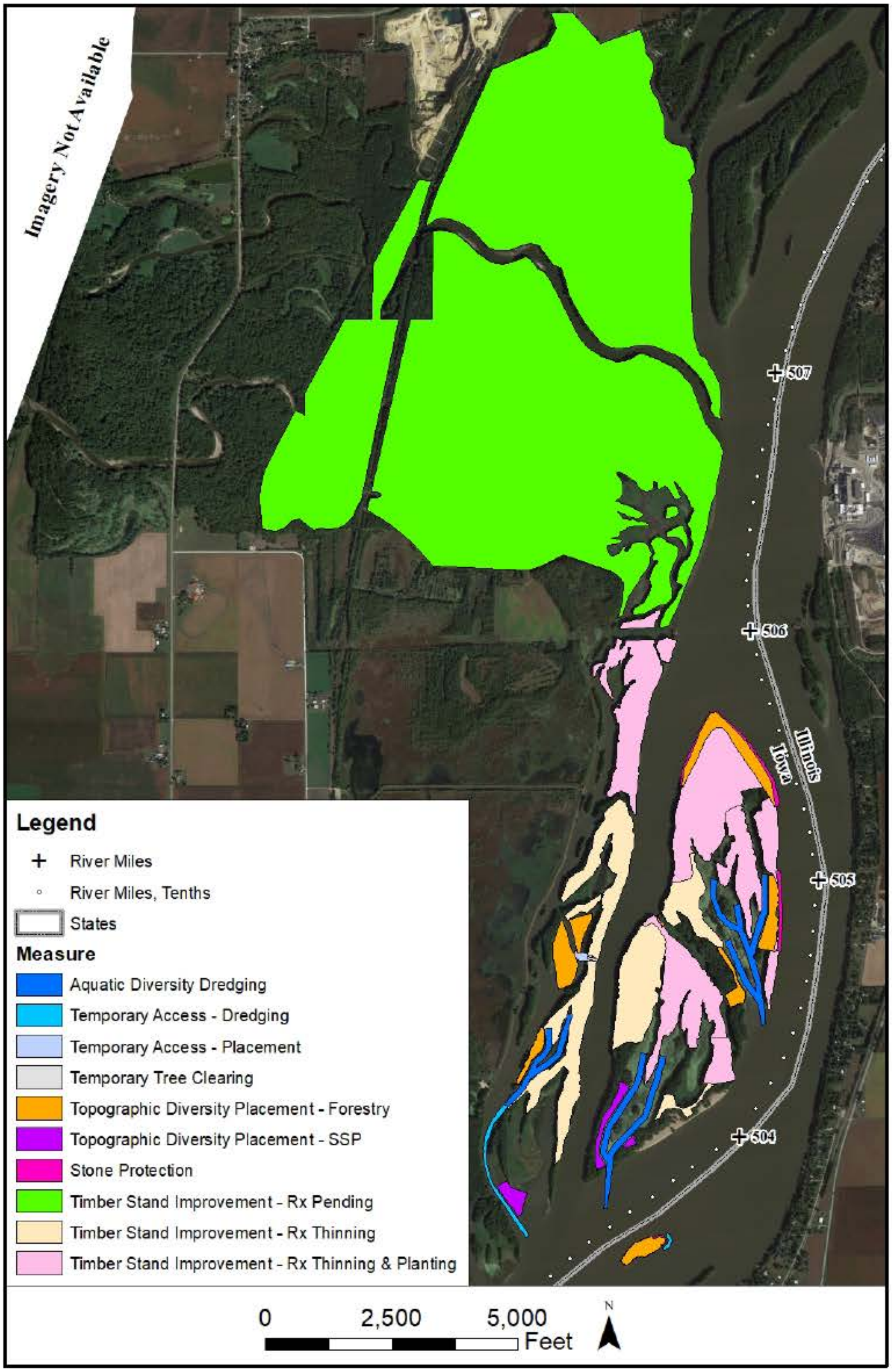


Figure VI-1: Recommended Plan

A. Aquatic Diversity, Topographic Diversity – Forestry, and Topographic Diversity – Scrub-Shrub/Pollinator Habitat

The aquatic diversity, topographic diversity-forestry, and topographic diversity-SSP measures are listed as separate measures because they are distinct habitat types. However, these measures are intertwined, as material used from excavation of the aquatic diversity areas will be used for topographic diversity measures.

1. Aquatic Diversity Measures. Excavation has been proposed as a potential measure to provide suitable year-round habitat for fish, including critical overwintering habitat for centrarchid fish species. Excavation will also provide material to increase topographic diversity within the Project area. Mechanical excavation or dredging would be required for these aquatic diversity sites (Plate 24, C-301). Appendix M, *Engineering Design*, lists design constraints or considerations.

Aquatic diversity was considered using a mechanical dredge. Mechanical dredging necessitates adjacent placement or handling excavated material multiple times, but it does not require a large settling basin as would be required for a hydraulic dredging placement site or cause an increase in effluent for water quality as is a risk of hydraulic dredging. The material would be immediately available for use at a topographic diversity site. A floating excavator, barge mounted crane, or barge mounted excavator could be used. For excavation areas with a larger bottom width or a further reach for placement of dredged material, a barge mounted crane with a bucket of sufficient size would likely dredged material. Other dredged material will need to be hauled by barge to nearby placement sites. Refer to Appendix M, *Engineering Design*, for photographs of various dredges which may be used.

a. Steamboat Island Upper Lake Aquatic Diversity. Steamboat Island Upper Lake is in the northern portion of Steamboat Island proper. The dredge cut would be excavated to provide aquatic diversity through dredging, utilizing the dredged material for topographic diversity. The cut was situated to ensure it will tie into deeper water in the main channel, and placed in deeper water locations. Fishery structures such as woody debris or rock piles may be added to this area to provide a more diverse habitat. Material excavated from this site will be transported to topographic diversity sites near the cut (Steamboat Island Upper Lake Placement Site 1 or the NE Bank) and other sites as required. This measure was revised after formulation. Refer to Appendix M, *Engineering Design,* for quantities and design details and for revisions to the measure.

b. Steamboat Island Lower Lake Aquatic Diversity. Steamboat Island Lower Lake is in the southern portion of Steamboat Island proper. The dredge cut would be excavated to provide aquatic diversity through dredging, utilizing the dredged material for topographic diversity. The cut was situated to ensure it will tie into deeper water in the main channel, and placed in deeper water locations. Fishery structures such as woody debris or rock piles may be added to this area to provide additional diverse habitat. Material excavated from this site will be transported to SSP sites near the cut (Lower Lake SSP measure) and other topographic diversity sites. This measure was minimally revised after formulation. Refer to Appendix M, *Engineering Design,* for quantities and design details.

c. NW Grant Slough Lake Aquatic Diversity. NW Grant Slough Lake is located in southern Grant Slough. The dredge cut would be excavated to provide aquatic diversity through dredging, utilizing the dredged material for topographic diversity. The cut was situated to ensure it will tie into deeper water in Grant Slough and placed in deeper water locations. However, access dredging will likely be required to access the lake. Fishery structures such as woody debris or rock piles may be added to this area to provide a more diverse habitat. Material excavated from this site will be used for topographic diversity sites near the cut (Grant Slough Placement Site 1 and 2) and other topographic diversity sites as required. This measure was minimally revised after formulation. Refer to Appendix M, *Engineering Design,* for quantities and design details.

2. Topographic Diversity Measure - Forestry. Topographic diversity sites were determined based on proximity to proposed aquatic diversity dredge cuts, presence of low-value vegetation dominated by reed canarygrass, and absence of high-value vegetation, including native trees, shrubs and non-woody plants. Preference was given to sites adjacent to the aquatic diversity sites, which allows for side-cast placement and less handling of dredged material. Appendix M, *Engineering Design*, outlines detailed design considerations.

Due to existing conditions of the proposed topographic diversity sites, tree clearing will not be required before placing material to the optimum elevation for tree survival at the topographic diversity sites (refer to Plate 24, C-301 for typical placement method). The exception to this is 1.3 acres of tree clearing required to access Grant Slough Placement Sites 4 and 5. No tree clearing will be conducted during the federally endangered Indiana bat and northern long-eared bat maternity season of April 1 to September 30. Cleared trees shall be removed from the site or utilized as habitat structures on site. Material will come from excavated channels within the Project area. The sites will either be sloped to drain, or will have +0' to -1.5' elevation changes to create swales across the wider sites. Once placed material is shaped, temporary seeding will be employed prior to permanent seeding and tree planting.

Tree species to be planted are included in Appendix M, *Engineering Design*. Tree wraps or other measures to prevent herbivory will be provided. Forested wetland shrubs will be interplanted with the forested wetland trees. Herbaceous planting efforts will be conducted prior to shrub and tree plantings.

Topographic diversity sites are shown on Plate 8, C-102, *IC*. Each site is further detailed in this section. TSI activities will be implemented on approximately 900 acres of the Project and would incorporate thinning treatments, tree planting, and invasive species management that will promote healthy forest growth. TSI activities will result in positive long-term benefits to federally-listed bat species by providing additional habitat and/or potential roost trees, providing foraging habitat, and increasing solar exposure to occupied roost trees adjacent to clearing areas. TSI activities would provide the following functions:

- reduced density to provide adequate growing space and sunlight;
- increased natural regeneration of native tree species;
- snag creation for the benefit of wildlife use and habitat;
- tree planting to increase tree species diversity and age assemblage;
- increased complexity of forest structure for the benefit of avian species; and
- reduced invasive species dispersal

a. Upper Steamboat Island Head. The USI Head measure will restore and protect island habitat, bringing the footprint back to what is recorded in the 1931 Brown's Map, and provide forest habitat for the Project area. The area has been eroded and is currently open water. Dredged material would be placed and the site constructed to optimum tree survival elevations. The footprint of this site will allow for variations in plantings, and minor variations in elevation height (+/- 1 foot) to provide small swales on top of the placement sites. This area would be planted with various forested wetland trees, understory species, forested wetland shrubs, and buffer species. Stone protection will be required at the upstream most end of placement. This measure was minimally revised after formulation. Refer to Appendix M, *Engineering Design*, for quantities and design details.

b. NE Bank. The NE Bank topographic diversity site, located adjacent to Steamboat Island Upper Lake, will restore the natural barrier between Upper Lake and the Mississippi River, limiting flow and sediment from entering the lake. The site currently consists of a reed canarygrass monoculture and open water, but is adjacent to higher diversity areas. Most of the material at this location will come from the Steamboat Island Upper Lake aquatic diversity cut. After dredged material is placed, the site will be planted with various forested wetland trees, understory species, forested wetland shrubs, and buffer species. The site will require stone protection on the east bank adjacent to the main channel.

This measure was later revised in the Recommended Plan to address stone protection quantities and the slope of dredged material placement. Refer to Appendix M, *Engineering Design*, for quantities and design details.

c. Steamboat Island Upper Lake Placement Site 1. Upper Lake Placement Site 1, currently dominated by reed canarygrass, was originally formulated to be a small area between Steamboat Island Upper Lake and the Cut-Through Channel. It was later expanded to include a narrow strip to the northwest to provide a larger buffer between Steamboat Island Upper Lake and the Cut-Through Channel. The northeast portion of the placement site is adjacent to Steamboat Island Upper Lake and will allow for side-cast placement; the remainder of the site will have dredged material transported and placed. The site will be built to optimum elevations for tree survival and planted with various forested wetland trees, understory species, forested wetland shrubs, and buffer species. This measure was minimally revised after formulation. Refer to Appendix M, *Engineering Design,* for quantities and design details.

d. Grade Control Structure. The GCS, located at the northwest end of the Cut-Through Channel, is a combination of open water placement and placement on low-value vegetation and is designed to provide grade control for incoming flows and create topographic diversity. The site will provide protection to Lower Lake and adjacent interior wetlands by reducing water velocities and capturing sediment that enters from Steamboat Slough. The material for placement will most likely come from aquatic diversity dredging in Grant Slough. The measure incorporates stone to protect the site from further erosion. The site would be constructed to optimum tree survival elevations and planted with various forested wetland trees, forested wetland shrubs, and non-woody wetland plants. This measure was minimally revised after formulation. Refer to Appendix M, *Engineering Design,* for quantities and design details.

e. Grant Slough Placement Site 2. Grant Slough Placement Site 2 is located adjacent to NW Grant Slough Lake and is currently a reed canarygrass monoculture. The site would be built to optimum elevations for tree survival, using side-cast material from dredging the NW Grant Slough

Lake aquatic diversity cut, then planted with various forested wetland trees, understory species, forested wetland shrubs, and buffer species.

This measure was later revised in the Recommended Plan to address the slope of dredged material placement, which decreased placement capacity. Refer to Appendix M, *Engineering Design*, for quantities and design details.

f. Grant Slough Placement Sites 4 and 5. Grant Slough Placement Sites 4 and 5, located north of NW Grant Slough Lake between Grant Slough and Steamboat Slough, are currently comprised of low-value vegetation. The measure is designed to create topographic diversity and forest habitat in an area that has lost forest habitat over the years due to high water events, erosion, and competition from invasive species. Site access will be from Steamboat Slough and result in 1.3 acres of tree clearing. The site would be built to optimum elevations for tree survival and then planted with various forested wetland trees, understory species, forested wetland shrubs, and buffer species. The 1.3 acres of temporary impact would be restored using the same species. This measure was minimally revised after formulation, including an initial quantity error correction. The error correction was a Scrivener's error of a quantity to be reported that, once caught, was changed. Changing the quantity did not affect the outcome of the plan formulation or Recommended Plan as, while incorrect numbers were used, they were consistently compared for ranking alternatives against one another. Refer to Appendix M, *Engineering Design,* for quantities and design details.

3. Topographic Diversity Measures - SSP Habitat. The Project area, and portion of Pool 14 in which the Project is located, has very limited SSP habitat. SSP sites were determined based on presence of low value vegetation dominated by reed canarygrass and absence of high-value vegetation, as well as suitability of that site to support SSP vegetation. The SSP sites are expected to be protected from degradation, due to their location within the Project area. Appendix M, *Engineering Design*, outlines detailed design considerations.

Material will come from excavated channels within the Project area. The sites will either be sloped to drain, or will have +0' to -1.5' elevation changes to create swales across the wider sites. Once placed material is shaped, temporary seeding will be employed prior to permanent seeding and SSP habitat planting.

a. Lower Lake SPP. The Lower Lake SSP sites, located in Lower Lake, are open water placement on low value vegetation and designed to create SSP habitat in an area that has lost forest and SSP habitat over the years due to high water events, erosion, and competition from invasive species. The material for placement will most likely come from Lower Lake aquatic diversity dredging. The site currently has no SSP habitat, but is adjacent to higher diversity areas. This site would be constructed to optimum SSP survival elevations and planted with various forested wetland shrubs, non-woody wetland plants, and scrub-shrub/pollinator species. This measure was minimally revised after formulation. Refer to Appendix M, *Engineering Design,* for quantities and design details.

b. Grant Slough Placement Site 1 SSP. Grant Slough Placement Site 1 SSP is located at the downstream-most end of Grant Slough and is currently a reed canarygrass monoculture. The site would be built to optimum elevations for SSP survival, using side-cast material from Grant Slough access dredging, then planted with various forested wetland shrubs, non-woody wetland plants, and scrub-shrub/pollinator species. During formulation, this site was considered for either forestry or SSP plantings. Based on existing site conditions, the team decided to pursue the SSP measure. This measure was minimally revised after formulation. Refer to Appendix M, *Engineering Design,* for quantities and design details.

B. Island Restoration and Protection. Small island restoration sites were selected to expand existing islands and restore lost island footprint. Stone was incorporated to protect the restored island from erosion. Appendix M, *Engineering Design*, outlines detailed design considerations.

1. West SE Island. This island will be restored and protected through a combination of open water placement and bankline placement. It is designed to restore the island footprint and create topographic diversity and forest habitat in an area that has lost forest habitat over the years due to high water events, erosion, and competition from invasive species. The material for placement will most likely come from access dredging for stone placement, dredging in Grant Slough (access or aquatic diversity), or aquatic diversity dredging in Lower Lake. By protecting this restored island with stone, the island will be protected from further erosion. This site would be constructed to optimum tree survival elevations, then planted with various forested wetland trees, forested wetland shrubs, and non-woody wetland plants. This measure was minimally revised after formulation. Refer to Appendix M, *Engineering Design,* for quantities and design details.

Details of quantities and design for the Recommended Plan can be found in Appendix M, *Engineering Design*. A summary of quantities is located in Table VI-1.

Table VI-1: Summary of the Quantities for the Recommended Plan Measures

Aquatic Diversity				
Location/Measure	**Acres**	**Dredging (CY)**	**Placement (CY)**	**Stone Protection (TN)**
Upper Lake	12.7	194,828		
Lower Lake	11.4	170,158		
NW Grant Slough Lake	5.9	87,704		
Access to Grant Slough	5.0	10,721		
Access to West SE Island	0.6	855		
Total	**35.6**	**464,266**		

Topographic Diversity & Scrub-Shrub/Pollinator Habitat				
Location/Measure	**Acres**	**Dredging (CY)**	**Placement (CY)**	**Stone Protection (TN)**
USI Head	14.4		274,530	102,941
NE Bank	7.6		30,990	22,403
West SE Island	5.4		76,020	6,115
Upper Lake Placement 1	4.1		10,972	
Grant Slough Placement 2	3.6		11,886	
Grant Slough Placement 4 & 5	13.8		47,503	
GCS	0.2		561	162
Grant Slough Placement 1 (SSP)	4.3		3,077	
Lower Lake SSP Placement	5.6		2,988	
Total	**59.0**		**458,527**	**131,621**

C. Forest Habitat (Timber Stand Improvement). TSI includes a variety of measures that improve forest habitat health, diversity, and resilience for tracts of timber. Prescriptions are based on current environmental and forest conditions and focused on areas at higher risk of forest decline. Eleven sites, contained within three units, will be improved through silvicultural prescriptions. Proposed methods include tree thinning treatments, tree planting, and invasive species management. A map of the sites as well as detailed design considerations and design details are outlined in Appendix M, *Engineering Design*.

D. Design Considerations

1. Location. See Section I, *Introduction*.

2. Survey Data. The project vertical datum is NAVD88 (converted from MSL1912, which is what the river gages report). The project horizontal datum is IL West State Plane NAD 83, US Survey Feet. Survey data has come from Corps hydrosurvey (several events), UMRR LiDAR, and Corps ground survey (Plate 3, V-101). Flat pool at the Project location (RM 504.5) is 571.2 NAVD88. At RM 504.5, to convert elevations in MSL1912 to NAVD88, 0.85 feet must be subtracted.

3. Access. The Project is located on and near an island in the Mississippi River, so all access will be by water. Seven boat ramps, located nearby the Project, are public boat ramps available for use by the contractor (see Appendix M*, Engineering Design*). Some ramps may have limits in terms of size and weight of equipment that may be launched. The Contractor will need to abide by local boat ramp usage regulations.

4. Excavated Material. Excavated material will be required to construct the topographic diversity sites. Geotechnical borings are provided in Appendix P, *Plates*.

5. Historic Properties. Historic properties are addressed in Sections II.L and IX.G of this report. The layout and design of measures will be conducted to avoid impacts to historic properties. Contract specifications will include requirements to the contractor for what to do in case historic properties are encountered during construction.

6. Hazardous, Toxic, and Radioactive Waste. As required for all earth working projects in the District, it is recommended that the Environmental Protection specification section include requirements for HTRW testing of any material to be brought onto the site or removed from the site to ensure the material is not contaminated. If contaminated material is identified, the Corps would stop work and follow the steps outlined in ER 1165-2-132, *Hazardous, Toxic, and Radioactive Waste Guidance for Civil Works Projects*. A Phase I HTRW ESA was conducted and revealed no evidence of a REC that could potentially affect the Project area (see Section II.N. of the Main Report). If any evidence of a REC is discovered during construction activities, operations will cease until an assessment is performed, at which time the Phase I ESA will be revisited. All construction equipment should be cleaned and free of soil residues, plants, pests, noxious weeds and seeds.

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

E. Construction Considerations

1. Permits. Laws of the United States and the States of Iowa and Illinois have assigned the Corps, Iowa DNR, IL DNR, and the Illinois Environmental Protection Agency (IL EPA) with specific and different regulatory roles designed to protect the waters within and on the State boundaries. Protecting Iowa and 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, administered by the Iowa DNR and the IL EPA, should not be confused with the Corps' 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 to regulate the nonpoint source discharges of dredged or fill material into waters of the United States.

The Iowa DNR is the State agency created by consolidating all previous duties of the Iowa DNR of Water, Air, and Waste Management; the Conservation Commission; the Energy Policy Council; and the Iowa Geological Survey. The Iowa DNR administers permit programs for conserving and protecting Iowa's water, recreational and environmental resources, and for the prevention of damage resulting from unwise floodplain development. The Iowa DNR also has jurisdiction over sovereign lands and waters and certain fee title lands of the State (Iowa Code, Chapters 106 and 111). On meandered streams and lakes, sovereign State property is that land below the ordinary high water mark.

The Iowa DNR has authority to regulate construction on all floodplains and floodways in the State. The Iowa DNR's administrative rules explain when a permit must be obtained for various types of floodway/floodplain-development. Examples are channel straightening, levee construction, excavation and stockpiling of overburden and rock materials, building construction, dams, stream crossings, and bank protection work. Anyone planning to perform or allow such floodplain construction must contact the Iowa DNR to determine if a floodplain construction permit is needed.

Section 10/404 Permit. The Project will need to show compliance with Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. The District anticipates obtaining Nationwide Permit (NWP) #27 (Aquatic Ecosystem Restoration) in order to be compliant with Section 404 of the CWA. Section 401 Water Quality Certification conditions have already been coordinated and documented as a part of the NWP. This Project will abide by all conditions of the NWP and Water Quality Certification permits. This permit will be coordinated using the Joint Application Form.

Sovereign Lands and Floodplain Permits. These permits, issued by the Iowa DNR and IL DNR, were applied for during feasibility report development using the Joint Application Form.

National Pollutant Discharge Elimination System (NPDES). The Contractor is responsible for obtaining the NPDES Storm Water Permit prior to initiating construction. A storm water discharge or NPDES permit for construction activities will 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 Project will trigger the need for the contractor to apply for this permit. With or without the permit, the Corps requires an environmental protection plan that addresses contaminants as well as erosion control measures. Working near a river requires extra care and erosion control measures. Contract requirements should require the use of an erosion control mat or fence to control erosion and sediment deposition of soil prior to establishing vegetative cover. The contractor would be required to prepare an erosion control plan to ensure that unprotected soil is not allowed to leave the Project site work limits. The contractor would be required to comply with all local codes and permit requirements.

Refuge Special Use Permit. During Plans & Specifications, the District will apply for this permit, issued by the USFWS Refuge Manager.

No other construction requirements are known at this time; however, the PDT will coordinate with the Sponsor and appropriate regulatory agencies during design and construction to ensure requirements are met.

2. Construction Materials. Only common construction materials are required and can likely be obtained from local sources. Materials used for topographic diversity construction include dredged material. Refer to Appendix P, *Plates*, Plate 4 (B-101, *Boring Plan*) and Plates 5 and 6 (B-601 and B-602, *Boring Logs*) for more information. Stone will be used for the NE Bank restoration and protection, GCS measure, and island restoration and protection measures. Refer to Appendix G, *Geotechnical Considerations*, for information on gradation sizes. Plants and trees to be planted will be obtained through approved nurseries using native sources.

3. Construction Schedule Constraints. Scheduling of construction contracts would depend on availability of funds, and based on expected funding, it is likely that the Project would be awarded in at least two construction contracts (plantings will likely be a separate contract).

- No clearing of trees shall be allowed between April 1 and September 30 to avoid impacts to bat roosting trees and maternity colonies.

- Construction staging and access points to Project measures will be defined during Plans & Specifications to avoid and minimize potential impacts to aquatic resources and freshwater mussel resources.

- Coordination with USFWS 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. The NWFR is actively used during the hunting season.

- 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. There is an active bald eagle nest within the Project area. Construction activities and other sources of disturbance should be avoided within a 660-foot buffer area from the nest, when active.

- In accordance with Executive Order 13186, *Responsibilities of Federal Agencies To Protect Migratory Birds*, take of migratory birds protected under the MBTA should be avoided or minimized, to the extent practicable, to avoid adverse impact on migratory bird resources.

- Placement of dredged materials and final preparation of the topographic diversity sites shall be completed before seeding and planting of vegetation will be allowed.

- Trees and shrubs shall be planted during optimum times for each species. Final planting dates will be coordinated during the P&S phase.

4. Construction Sequence. The probable construction sequence is summarized in Table VI-2; however, no sequence will be required contractually.

F. Operational Considerations

Operation and maintenance of UMRR HREPs is similar to that undertaken by the partner agencies in day-to-day management of parks, boat ramps, wildlife management areas, and other public use areas. The purpose of assigning O&M costs to the Project Sponsor is to ensure commitment and accountability. HREPs are designed and constructed to operate for 50 years with proper maintenance. This Project was designed to reduce overall operation costs. In general, operation is limited to routine inspections to ensure that the measures are performing as designed. Total estimates of annual operation costs are shown in Section VIII, *Cost Estimates*. A complete list of operation needs would be provided in an O&M manual following construction completion and preparation of as-built drawings, and prior to transferring the project to the USFWS.

Table VI-2: Steamboat Island HREP Probable Construction Sequence

Sequence	Construction	Instructions	Purpose
1	TSI (Year 1) and Temporary Access Grant Slough 4 & 5 (tree cutting and clearing)	Tree clearing can occur only between Oct 1 & Mar 31.	Clearing areas in preparation for new seed and/or plantings.
2	GCS, NE Bank, and West SE Island bankline protection	Riprap likely to be handled multiple times.	Constructing this in an earlier construction stage would ensure that USI Head, GCS, NE Bank, and West SE Island
3	Excavate Dredge Cuts for Upper Lake Aquatic Diversity	Two flat barges moving between floating plant and placement sites.	Provide aquatic diversity.
4	Transport Material to various Topographic Diversity Placement Sites	Material likely to be handled multiple times.	Elevate areas for better tree survival.
5	Shape Topographic Diversity Placement Sites	Sufficient drying time of 9 months between placement and shaping will be required.	Match elevations defined by inundation criteria.
6	TSI cutting and clearing (Year 2) and TSI tree and shrub planting (Year 1)	Tree clearing can occur only between Oct 1 & Mar 31.	Clearing areas in preparation for new seed and/or plantings. Plantings improve forest diversity.
7	TSI cutting and clearing (Year 3), TSI tree and shrub planting (Year 2, and Cover Crop seeding.	Tree clearing can occur only between Oct 1 & Mar 31. Plantings between Oct 15 & Dec 5. Cover Crop seeding Apr 1 to May 20 & Aug 20 to Sep 20.	Clearing areas in preparation for new seed and/or plantings. Plantings and seeding improve forest diversity.
8	Lower Lake Aquatic Diversity Dredging, Grant Slough Access Dredging, West SE Island Construction, NW Grant Slough Lake Aquatic Diversity Dredging, Grant Slough Sites 4 and 5 Temporary Access (placement).	Two flat barges moving between floating plant and placement sites.	Provide aquatic diversity.
9	Transport Material to various Topographic Diversity Placement Sites	Material likely to be handled multiple times.	Elevate areas for better tree survival.
10	Shape Topographic Diversity Placement Sites	Sufficient drying time of 9 months between placement and shaping will be required.	Match elevations defined by inundation criteria.
11	TSI tree and shrub planting (Year 3) and Cover Crop seeding.	Containerized tree and shrub plantings between Oct 15 & Dec 5. Cover Crop seeding Apr 1 to May 20 & Aug 20 to Sep 20.	Plantings and seeding improve forest diversity.
12	Additional Cover Crop Seeding, Native Species Planting, Bare Root Seedling Planting, and Planting	Cover Crop seeding Apr 1 to May 20 & Aug 20 to Sep 20. Native Species Planting, Bare Root Seedling Planting, and	Plantings and seeding improve forest diversity.
13	Containerized tree and shrub planting begins.	Fast-growing containerized tree and shrub plantings between Oct 15 & Dec 5.	Plantings improve forest diversity.
14	Additional Cover Crop seeding, Additional Native Species Planting, Bare Root Seedling Planting, and Planting Forbes/Grasses.	Cover Crop seeding Apr 1 to May 20 and Aug 20 to Sep 20. Native Species Planting, Bare Root Seedling Planting, and Plant Forbes/Grasses plantings between Apr 1 & May 20.	Plantings and seeding improve forest diversity.
15	Containerized tree and shrub planting ends.	Slow and fast-growing containerized tree and shrub plantings between Oct 15 & Dec 5.	Plantings improve forest diversity.

G. Maintenance Considerations

The proposed measures have been designed to ensure low annual maintenance requirements. Maintenance will include replacing rock and removing vegetation and debris from the NE Bank restoration and protection, GCS measure, and island restoration and protection measures. The estimated annual maintenance costs are presented in Section VIII, *Cost Estimates*. Maintenance requirements would be further detailed in the Project's O&M manual published after construction completion and preparation of as-built drawings, and prior to transferring the project to the USFWS.

H. Repair, Rehabilitation and Replacement Considerations

Repair, rehabilitation and replacement considerations may extend outside of the typical 50-year period of analysis, as the USFWS is expected to maintain the HREP as outlined in the Memorandum of Agreement (MOA). Rehabilitation cannot be accurately measured during P&S or construction phases. Rehabilitation is the reconstructive work that significantly exceeds the annual O&M requirements and is needed as a result of major storms or flood events.

I. Value Engineering

A Value Management Plan will be completed during the P&S phase. Numerous Value Engineering (VE) studies have been conducted on previous UMRR HREPs with similar measures (topographic diversity, bathymetric diversity, and overwintering habitat) within the past several years.

SECTION VII. PROJECT IMPLEMENTATION SCHEDULE

Table VII-1 presents the Project Implementation Schedule.

Table VII-1: Project Implementation Schedule

Event	Scheduled Date
District Quality Control Review – Feasibility	January 2020
Major Subordinate Command Decision Milestone Meeting	April 2020
Agency Technical Review	May 2020
Public Review of Draft Report	May 2020
Submit Final Feasibility Report to MVD	September 2020
Approved Final Feasibility Report from MVD	December 2020
Execute the Memorandum of Agreement with the USFWS	March 2021
Initiate Design	September 2020
Complete Design	September 2026
Complete All Construction Stages	2028

SECTION VIII. COST ESTIMATES

Table VIII-1 compares costs for the fully funded estimate (FFE) and the current working estimate (CWE) (Appendix I, *Cost Estimate*). The FFE was calculated based on the proposed construction schedule, expected escalation costs, and a contingency factor, and represents the money expected to be spent at the end of construction. The detailed CWE of Project design and construction costs is presented in Table VIII-2. Quantities and costs may vary during final design.

Table VIII-1. Project Design and Construction Cost Estimates (February 2020 Price Level)

Account	Measure	FFE[1]	CWE
01	Lands and Damages	$0	$0
06	Fish and Wildlife Facilities	$19,635,213	$17,418,440
16	Bank Stabilization	$9,793,459	$8,974,619
30	Planning, Engineering and Design	$6,468,571	$4,518,000
31	Construction Management	$3,097,849	$2,698,800
	Project Cost Estimates	**$38,995,092**	**$33,609,859**

[1] Fully funded estimate is marked up to midpoint of construction for each construction stage

A. Performance Monitoring and Adaptive Management. Costs for performance monitoring to determine the degree which the Project is meeting the success criteria and for informing potential adaptive management decisions are summarized in Table VIII-3. See Section X, *Project Performance Monitoring*, and Appendix K, *Monitoring and Adaptive Management Plan*, for a full description of post-construction evaluation, including performance monitoring and long-term performance reporting, and adaptive management activities. Performance monitoring and adaptive management are projected to approximately 10 years.

Table VIII-2. Detailed Cost Estimate of Current Working Estimate with Contingency

Account Code	Item	Quantity	Unit	Amount	Contingency (%)	Escalation	Total Cost with Contingency CWE
CONSTRUCTION COSTS							
06	Adaptive Management	1	LS	$212,236	20.0	0	$254,684
32	Mobilization and Demobilization	1	LS	$1,137,923	20.0	0	$1,365,507
06	Dredging, Placement, and Shaping	1	LS	$9,358,381	20.0	0	$11,230,057
06	Topographic Diversity (Forestry Planting)	1	LS	$514,639	20.0	0	$617,567
06	Topographic Diversity (SSP Planting)	1	LS	$123,841	20.0	0	$148,609
06	Island Restoration & Protection (SE) Island)	1	LS	$1,303,498	20.0	0	$1,564,197
06	Timber Stand Improvement (TSI)	1	LS	$1,749,303	20.0	0	$2,099,164
16	Bank Stabilization (Stone Protection)	1	LS	$6,979,345	20.0	0	$8,375,215
	Survey and Quality Control	1	LS	$615,049	20.0	0	$738,059
TOTAL CONSTRUCTION COSTS				**$21,994,215**			**$26,393,059**
PLANNING, ENGINEERING, & DESIGN (PED) COSTS							
30	P&S, EDC	1	LS	$3,765,000	20.0	0	$4,518,000
						TOTAL PED COSTS	**$4,518,000**
CONSTRUCTION MANAGEMENT COSTS							
31	Construction Management	1	LS	$2,249,000	20.0	0	$2,698,800
				TOTAL CONSTRUCTION MANAGEMENT COSTS			**$2,698,800**

TOTAL PROJECT COSTS $33,609,859

Table VIII-3: Estimated Performance Monitoring and Adaptive Management Costs ($) (February 2020 Price Level)

				Post-Construction Years									
Objective	**Work Category**	**Activity**	**PED**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**Total**
Floodplain Forest Diversity	Monitoring, Analysis, Reporting	Forest Plot Survey Monitoring [2]	-	$6,000	$6,000	$8,000	$8,000	$12,000	-	$12,000	$12,000		$64,000
												Floodplain Forest Diversity Subtotal:	***$64,000***
Aquatic Diversity	Monitoring, Analysis, Reporting	Backwater Bathymetry[1]	-	-	-	-	-	$30,000	-	-	-	$30,000	$60,000
		Water Quality/ Data Analysis	-	$4,000	$4,000	$4,000	$4,000	$6,500	-	-	-	-	$22,500
	AM: NE Bank/GCS modification								$255,000				$255,000
												Aquatic Diversity Subtotal:	***$337,500***
Island Restoration/Protection	Monitoring, Analysis, Reporting	Topographic, LiDAR, or Remote Sensing surveys [2]	-	-	-	$30,000	-	$30,000	-	-	-	$60,000	$120,000
												Island Restoration and Restoration Subtotal:	***$120,000***
Backwater/ Interior Wetlands Protection	Monitoring, Analysis, Reporting	Topographic or LiDAR surveys [2]	-	-	-	$30,000	-	$30,000	-	$60,000	-	-	$120,000
		Backwater Bathymetry	-	-	-	-	-	$30,000	-	-	-	$30,000	$60,000
		Water Quality/Data Analysis	-	$4,000	$4,000	$4,000	$4,000	$6,500	-	-	-	-	$22,500
		Scrub-Shrub/Pollinator Habitat Monitoring [3]	-	-	-	-	-	-	-	-	-	-	(footnote 3)
	AM: NE Bank modification								$191,000				(footnote 4)
												Backwater/Interior Wetlands Protection Subtotal:	***$202,500***
												TOTAL	***$724,000***

[1] Fish surveys completed by the Iowa DNR will aid in determining success of the aquatic habitat component.

[2] Topographic, LiDAR, or Remote Sensing surveys will be conducted for the whole Project concurrently, the cost of which is $60,000. This survey will assess Island Protection/Restoration and Backwater/Interior Wetlands Protection objectives; distribution of costs between objectives is reflected in the Table.

[3] Forestry monitoring cost estimates include SSP monitoring costs, as surveys are conducted concurrently.

[4] Backwater/Interior Wetlands Protection Adaptive Management (NE Bank Modification) costs are accounted for in Aquatic Diversity Adaptive Management

B. Long-Term Performance Reporting. Costs for collection of basic site-inspection data to report long-term Project performance are summarized in Table VIII-4. These costs include preparation of Performance Evaluation Reports that summarizes the Project's long-term ability to meet Project success criteria, inform O&M adjustments, and provide basic data for planning purposes. This monitoring starts following completion of performance monitoring and adaptive management (approximately 10 years), if implemented, with the exception of water quality monitoring. Long-term performance reporting is a UMRR Program cost and not included in the Steamboat Island HREP cost estimate.

Table VIII-4. Estimated Long-Term Annual Monitoring Costs ($)

Site Inspections	Unit Cost	Frequency	Year Start	Quantity	Total Cost
Water Quality	$11,000	Every Year	6	20	$220,000
Bathymetric Survey	$60,000	Every 5 Years	11	8	$480,000
Forestry Survey	$20,000	Every 10 Years	15	4	$80,000
Reporting	$15,000	Every 5 Years	11	8	$120,000
				Subtotal	**$900,000**
				Contingencies (20%)	**$180,000**
				TOTAL	***$1,080,000***

C. Operation and Maintenance Considerations. The proposed Project measures have been designed to ensure low annual O&M requirements (Table VIII-5). O&M may include performing inspections and debris removal from rock structures. The estimated total annual O&M cost is $7,200. These quantities and costs may change during final design. Significant changes in O&M will be coordinated with the Sponsor. A complete list of O&M needs will be provided in an O&M manual following construction completion and preparation of as-built drawings, and prior to transferring the project to the USFWS.

Table VIII-5. Estimated Annual Operation and Maintenance Costs (February 2020 Price Level)

	Quantity	Unit	Unit Price ($)	Total Cost ($)
Operation				0
Maintenance				
Site Inspections (all measures)	40	Hours	50	2,000
Debris Removal (rock structures)	80	Hours	50	4,000
			Subtotal	**$6,000**
			Contingencies (20%)	**$1,200**
			TOTAL	***$7,200***

D. Repair, Rehabilitation, and Replacement Considerations. For analysis purposes, the costs presented for O&M used the 50-year period of analysis. The USFWS is expected to operate and maintain the Project per the agreed-to terms in the Memorandum of Agreement (Appendix C) and should expect to incur costs associated with this responsibility outside of the 50-year period of analysis. Table VIII-6 lists the major Project components and their associated frequencies of repair, rehabilitation, and replacement. Estimates of these costs will be included in the O&M manual.

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

Component	Frequency
Replace Rock Structures	Every 75 Years
Rehab Aquatic Diversity Areas	Every 60 Years

E. Annual Habitat Unit Cost. The costs used for analysis purposes include total Project costs, IDC, and annualized O&M, adaptive management, and monitoring costs. The annualized costs and AAHUs were used to calculate a total annual cost per annual habitat unit (Table VIII-7). The total cost per habitat unit is $4,110.

Table VIII-7. Total Annual Cost per Annual Habitat Unit ($000)

Construction Cost	IDC	Total Project Costs	Annual Construction Cost	Annual O&M	Annual Adaptive Management	Annual Monitoring Costs	Total Annual Costs	AAHUs	Total Annual Cost/AAHU
$36,264	$6,561	$42,825	$1,586	$7.2	$8	$14.8	$1,616	393.07	$4.11

SECTION IX. ENVIRONMENTAL EFFECTS OF THE RECOMMENDED PLAN

The following sections describe the potential environmental effects (both adverse and beneficial) the Recommended Plan may have on the resources addressed in Section II*, Affected Environment*. The discussion is organized by potential direct, indirect, and cumulative effects on the identified resources. The No Action, or Future Without Project (FWOP) Alternative describes a scenario without intervention, where observed increases in river stage duration will continue to degrade both aquatic and floodplain habitat. Limited backwater habitat will likely disappear as sediment deposition increases and floodplain forest regeneration will be further be impaired as tree mortality increases and reed canarygrass invades resulting canopy gaps. The FWOP Alternative is further discussed in Section II.O.

The effects described in the following sections may be temporary or long-term in duration. Minor effects are typically considered negligible, while moderate adverse effects may be either avoided or counteracted by other actions that further enhance or benefit the resource. According to NEPA guidance, the meaning of significant effects varies with the context (where the action occurs) and intensity (how much damage or improvement the action causes). Non-significant effects means there is no substantial change to the resource, while significant effects may be beneficial or adverse. The effects of the Recommended Plan may furthermore occur immediately as a result of the action (direct), occur later in time or removed in distance in response to the action (indirect), or may be reasonably expected to occur, given similar restoration actions within the UMRR Program (cumulative).

A. Short-Term Construction Effects

The proposed Project construction would take place within Steamboat Island proper, Grant Slough, and the West SE Island. No measurable change in floodplain storage would occur as a result of the Project, and the Project would not directly induce additional development within the floodplain. More detailed information is available in Section IX.B., *Floodplain Resources*, and Appendix H, *Hydrology and Hydraulics.*

There are several publicly-owned and managed options for staging and access within the Project area and Pool 14. All public access locations are currently developed and would not result in environmental impacts or impacts to recreation. Minor short-term impacts in the form of dust, noise, and temporary disruption of traffic may result, at times, from increased travel to the staging and construction area.

Construction of the Project measures would require approximately 1.3 acres (currently identified) for tree clearing and access to enable topographic diversity site construction. Temporary disruptions to wildlife are likely to occur. This includes Indiana and northern long-eared bats, which likely use a part of the area for feeding and roosting. The area designated for clearing is not anticipated to negatively affect primary roost trees, primary feeding corridors, and areas of high bat activity. No clearing of trees shall be allowed between April 1 and September 30 to avoid the bat maternity roosting season. There is an active bald eagle nest located at the northern end of Steamboat Island. Any tree thinning would be minimal near this area to avoid disturbance. Seasonal limitations will be in compliance with USFWS regulations and adhere to buffer restrictions (660 feet) during periods when the nest is active. The Corps, in consultation with the USFWS (see Appendix A, *Correspondence*), anticipates no long-term adverse effects to wildlife, Indiana bats, northern long-eared bats, or bald eagles as a result of this Project.

Disruption of the habitat during tree planting would be minimal. Post-planting and periodic operation and maintenance procedures, such as undesirable vegetation control through hand pulling or herbicide treatments, would have little impacts on the environment. Any required herbicide treatments would be applied by a licensed applicator using state and Federal standards, thus minimizing potential localized impacts.

Construction activity would temporarily increase turbidity immediately downstream of the proposed dredge cuts and in-water construction. Material will be mechanically excavated and placed in the floodplain. Although macroinvertebrate density and diversity is relatively low, temporary disruption and minor loss is expected to occur through dredging and rock placement. A 2019 mussel survey was conducted in Grant Slough and the West SE Island. The West SE Island area revealed very few live mussels, most of which were common, tolerant species (refer to Section II.D.3 for previous mussel survey results in the Project area). There were no federally-listed endangered species encountered during this survey and only one Illinois-state listed species (black sandshell) that occurred was well outside the design footprint of the West SE Island. Project survey efforts identified a species-rich assemblage of mussels within Grant Slough, with pockets of higher density areas. The surveys will be used to inform the alignment of the access channel dredging within Grant Slough to avoid and minimize impacts to areas of higher mussel densities. These areas should be recolonized shortly following construction.

B. Floodplain Resources

The measures of the proposed plan will improve the ecological structure and function for approximately 950 acres of bottomland forested wetland habitat through an increase in floodplain elevation, hard mast tree plantings, and implementation of TSI strategies. This is highly important as floodplains are important elements of regional landscapes, controlling ecosystem processes (e.g., sediment deposition, nutrient cycling, and community succession), ecosystem properties (e.g., soil texture, fertility, and plant species composition,), and ecosystem services (e.g., denitrification and biodiversity), making them biodiversity hotspots in the landscape. Of these floodplain characteristics, the proposed plan would directly or indirectly benefit all of them.

Section II, *Affected Environment,* explained roughly 51% of the island is at an elevation (>574 feet) assumed suitable for hard mast-producing trees. The areas with hard mast trees present were, on average, over 88 years-old (ranges 1874 to 1964) and contained little production in the understory. This lack of production is directly related to increased water inundation and duration. Current topography shows a significant portion of the Project area is low in elevation and below the threshold for producing a sustainable nut producing tree population. It is highly unlikely hard mast-producing trees will regenerate without intervention in the next 50 years. The proposed plan effectively works to stop and reverse this trend, which should increase habitat availability and quality for migratory birds (i.e., neotropical, waterfowl, bald eagle, heron), endangered species (i.e., Indiana bat, northern long-eared bats), general wildlife, reptiles and amphibians, etc.

The following structural and functional elements contribute to the overall habitat value and benefits of the Project.

1. **Increase Topographic Diversity**. A critical element to floodplain forest diversity is water inundation duration. Lower elevations flood more often and for longer periods of time than higher elevations, which influences nutrient cycling, germination, and growth of native tree species (De Jager

et al., 2012). Benefits from the proposed measures result from the increased elevation of the Project in relation to the pre-dam reference condition. The increased elevation promotes tree survival, establishment, production, and sustainability, and an increase in habitat complexity and diversity. Although at a small scale, nutrient uptake and cycling at the Project site could reduce nutrient delivery downstream.

2. **Increase Hard Mast Tree Species**. Currently 18 species of native trees are present. In addition to increases in elevation and habitat quality, benefits are accrued from an increase in tree species (Appendix M, *Engineering Design*, Attachment F). An increase in hard mast species provides habitat diversity, which increases cover, food, and reproduction habitat for a wide variety of floodplain species. This is especially important for the federally-endangered Indiana bat and northern long-eared bat, and numerous species covered under the MBTA (e.g., foraging and reproductive habitat for diving and dabbling duck, herons, shorebirds, bald eagles, etc.) that will benefit from increased foraging and roosting opportunities.

3. **Increase Mast Tree Sustainability.** Over 3,000 containerized trees from 7 hard mast-tree species will be planted above the 2-year flood elevation, which has been shown to be the critical threshold for hard mast tree survival (De Jager et al., 2012). An increase in survival increases seed production and dispersal. As such, regeneration and recruitment opportunities will increase, which creates additional reproduction, foraging, and cover habitat for all floodplain species, including the local avian community.

4. **Increase Pollinator Habitat**. Protection and establishment of wild flowers and prairie grasses that produce attractants are vital to pollinator conservation. The Project area has limited wildflower production due to reed canarygrass domination; areas that have the potential to establish flower producing shrubs/vegetation are overtaken by this invasive species. Over ten acres of SSP habitat will be restored to provide benefits to essential pollinators in the surrounding area.

5. **Reduction in Forest Fragmentation**. Well-connected floodplain forest communities are critical for wildlife dispersion, migration, survival, habitat quality, and a buffer against undesirable species. Without intervention, the area would convert to a mix of silver maple forest, moist soil species, and reed canarygrass, which has less habitat value than a diverse floodplain. This conversion would also impact migratory birds and listed bat species that rely on well-connected diverse forest habitat for migration, nesting, and foraging purposes. The strategic locations of the constructed placement sites and associated planting of desirable species would buffer against fragmentation and provide a mosaic of interconnected habitat throughout the Project.

6. **Limit Invasive Species Distribution.** Over time, the over-mature silver maple stand will experience significant mortality. As a result, canopy openings could increase reed canarygrass establishment. This has already been documented within the UMRS and is expected to continue. An increase in elevation increases hard mast tree production, and the operation and maintenance of the Project will limit opportunities for invasive species establishment.

7. **Backwater Habitat Protection.** Topographic diversity sites, the NE Bank, and the GCS will serve as protection for the excavated backwater lakes during high water events. The sites would function as flow breaks, resulting in reduced sediment deposition within the backwaters, decreased turbidity, increased water clarity, and decreased flow.

C. Aquatic Resources

Additional discussion of aquatic and water quality impacts is contained in Appendix B, *Clean Water Act, Section 404(b)(1) Assessment: NWP 27 Justification.* The proposed plan would benefit 614 acres of aquatic habitat, both directly and indirectly, through an increase in backwater and riverine habitat structure and function. Specifically, backwater habitat is improved through increased depths and improved water quality for aquatic organisms. Riverine habitat geomorphic processes are improved through a reduction of island erosion and restoration of side channel structure and function. This not only improves habitat for all types of riverine fish species, but it also prevents degradation of an existing freshwater mussel community containing at least one federally-listed species, the Higgins eye pearlymussel.

Of the available backwater habitat in the Project area, only about 0.14 acres are suitable depth for overwintering, mainly located in Upper Steamboat Lake (see Section II, *Affected Environment*). Overwintering habitat is a limiting habitat type due to the shallow nature of the backwater, ice cover, and flows into the Project. The following structural and functional elements contribute to the overall habitat value and benefits.

1. **Increased Backwater Depths.** Nearly 614 acres of aquatic habitat will be improved as a result of this Project. Of the 127 acres classified as lentic habitat, approximately 29 acres (with depths > 4 feet) will be immediately improved for the purposes of overwintering fish habitat, with the remainder contributing significantly to the year-round habitat required by fish in the UMRS. This represents an increase from 0.11% to nearly 22% in overwintering habitat. Currently, overwintering habitat is limited in Pool 14 and is mainly attributed to reduced depths in backwaters, which will be addressed by this Project. Increased depths provide areas where higher water temperatures and DO can persist in the winter. Year-round habitat is improved by increasing lateral and longitudinal connectivity for overwintering, spawning, and rearing habitat connectivity, and access to movement corridors.

2. **Reduced Island Erosion and Restoration of Side Channel Function**. Island habitat in the UMRS is highly valuable for habitat diversity, and has been steadily declining in Pool 14. Installation of rock protection at the restored USI Head will reduce erosive forces, restore valuable off-channel fish habitat, and facilitate the restoration of geomorphic processes and habitat function. Implementation of rock protection at the restored West SE Island would facilitate sediment deposition at the tail-end of the island, resulting in an increase in island acreage, wildlife habitat diversity, and potential tree production. The tail-end of the island will also serve as shallow, low flow sandbar habitat desired by shorebirds, turtles, and riverine species (e.g., shovelnose sturgeon, catfish, and walleye). The flow refuge afforded by the island will be critical low-flow foraging and nursery habitat for both backwater and riverine fish species. Finally, the rock protection is critical to limit the continued deterioration of the West SE Island because without the island, the side channel ceases to exist, converting this area to main channel habitat. This particular side channel lies within the Cordova EHA established for the recovery of the endangered Higgins eye pearlymussel. Without this side channel under FWOP conditions, the freshwater mussel community, including federally-listed mussels, inhabiting the EHA and adjacent side channel may be negatively impacted.

3. **Fish and Mussel Substrate Improvements**. As part of the Project, fish habitat (e.g., rock substrate, large woody debris) and mussel habitat (e.g., mixture of various sizes of river rock suitable as substrate for multiple mussel species) may be installed at the island protection sites and within

aquatic diversity sites. This has immediate direct benefits to the fish and mussels that inhabit the area in the form of increased habitat structure and function.

D. Invasive Species

The effect of the Project on invasive species distribution and abundance were considered throughout the planning process. State and Federal natural resources agencies have weighed the benefits that this Project will have on invasive species, as well as to the native communities that it is intended to help sustain, and fully support this Project.

The proposed plan would buffer against reed canary grass population growth by managing canopy openings and promoting tree growth which would shade this invasive grass species. The increased elevation and diversity of planted scrub-shrub species and tree species should work to out-complete reed canary grass growth.

Invasive aquatic plants such as Eurasian watermilfoil may colonize the bathymetric diversity components of this Project as sedimentation reduces depths of dredged areas to the point where light can penetrate to the bottom and rooted aquatic plants can become established. This successional process occurs in most backwaters within the UMR as they fill with sediment over time and is unavoidable.

The proposed Project includes measures that will increase off-channel habitat, which may potentially be used by juvenile and adult Asian carp in future years, as they have currently migrated as north as Pool 16 (Kolar et al., 2005). However, if these species do migrate into the Project area, this additional habitat is unlikely to have a major effect on the abundance of these species because it comprises only a small component of the overall habitat available in Pool 14. The Recommended Plan is consistent with Strategy 3.2.3 identified in the Asian Carp Working Group's *Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States* (Conover et al., 2007), which recommends that natural resources managers minimize the potential range expansion of Asian carp in conjunction with actions that enhance the aquatic environment to sustain native biological communities. The PDT recognizes the risk of this Project being used by Asian carp due to the dynamic nature of dispersal and inter-specific competition, however, the known positive benefits of these rehabilitated habitats for native species are well known. Healthy native fish populations and their habitats is one of the major priorities of management agencies for slowing the spread of non-native organisms.

Natural resources managers recognize that there will always be some degree of risk that a project will unintentionally enhance the spread of invasive species because of the dynamic nature of dispersal and inter-specific competition that cannot be fully understood until after a nuisance species becomes prolific.

E. Endangered and Threatened Species

The Higgins eye pearlymussel, sheepnose mussel, spectaclecase mussel, Indiana bat, and Iowa Pleistocene snail are federally-endangered species listed in the Project area, while the prairie bush clover, Western and Eastern prairie fringed orchid, Eastern massasauga, and northern long-eared bat are listed as federally-threatened species. The Recommended Plan was revised to avoid and minimize impacts to federally-listed mussel species and a follow-up survey in 2019 yielded no federally-listed mussel species within the Recommended Plan footprint. In coordination with the USFWS, the 2019 survey results precluded the need for a Biological Assessment and the District determined the proposed Project *May Affect,* but is *Not Likely to Adversely Affect* the Higgins eye pearlymussel, due to the potential impacts from in-water rock and dredged material placement, as well as necessary access dredging (approximately 5.6 acres). The determination for listed bats included the seasonal limitations on tree clearing and conservation measures that will be in place to avoid important maternity colonies during construction. The USFWS replied to the District's informal consultation letter, which included determination of effects for all federally-listed species (Table IX-1), with a concurrence letter dated February 21, 2020 (Appendix A, *Correspondence*).

Table IX-1: Determination of Effects from Proposed Modifications for Federally-listed Species

Species	Scientific Name	Status	Determination of Impacts
Indiana Bat	*Myotis sodalis*	Endangered	Not Likely to Adversely Affect
Northern Long-Eared Bat	*Myotis septentrionalis*	Threatened	Not Likely to Adversely Affect
Higgins Eye Pearlymussel	*Lampsilis higginsii*	Endangered	Not Likely to Adversely Affect
Sheepnose Mussel	*Plethobasus cyphyus*	Endangered	No Effect
Spectaclecase Mussel	*Cumberlandia monodonta*	Endangered	No Effect
Eastern Massasauga	*Sistrurus catenatus*	Threatened	No Effect
Prairie Bush Clover	*Lespedeza leptostachya*	Threatened	No Effect
Western Prairie Fringed Orchid	*Platanthera praeclara*	Threatened	No Effect
Eastern Prairie Fringed Orchid	*Platanthera leucophaea*	Threatened	No Effect
Iowa Pleistocene Snail	*Discus macclintocki*	Endangered	No Effect

1. Direct Effects

a. Indiana Bat and Northern Long-Eared Bat. The Project includes approximately 1.3 acres of tree clearing for access to topographic diversity sites. The overall forested habitat that exists on Steamboat Island proper is approximately 1,674 acres. When compared to the number of acres potentially affected by the Project, the District determined it to be about 0.07% of the total. This limited amount of tree removal will not result in fragmentation of bat roosting or foraging habitat and cleared areas will be replanted following the completion of construction. Further, tree clearing will be completed outside of the bat active period; therefore, removal of unidentified maternity roost trees is unlikely to result in the incidental take of Indiana or northern long-eared bats.

b. Higgins Eye Pearlymussel. The proposed excavation, including access dredging, of the backwaters in the Project area should have no direct impacts to the Higgins eye pearlymussel because the backwaters do not appear to contain suitable habitat.

As part of the restoration of the head of Steamboat Island and the West SE Island, the Project proposes to install bank stabilization to reduce island erosion. The construction of the bank stabilization would potentially affect approximately 4,130 linear feet of substrate through rock placement at the head of Steamboat Island and 380 linear feet of substrate at the West SE Island. Shifting sand and/or flocculent silt conditions within this footprint are generally not considered to be ideal for Higgins eye. Furthermore, they were not collected within this immediate area during extensive mussel surveys. Collectively, there is a low likelihood of presence.

Higgins eye pearlymussel has been found to occur within the Project area with six individuals found during a 2018 survey at the East SE Island. As a result, the East SE Island was removed from further consideration. The West SE Island was retained and the District conducted an effects analysis to determine the extent to which placement of rock would influence the hydraulics of the channel, thus potentially impacting the structure and function of the existing mussel bed. This approach inductively derives a spatially explicit model of mussel habitat suitability directly from study area data (i.e., mussel occurrences, site-scale modeled hydraulic conditions).

Building upon a previous CART model developed by Zigler et al. (2008), machine-learning models (Phillips et al., 2006;), mussel community health metrics (Dunn et al., 2016), and best professional judgment (Kelner, pers comm., April, 2019), the District used a two-dimensional hydraulic model to assess the degree to which the presence or absence of mussels might be impacted by the Project measures. Refer to Appendix M, *Engineering Design*, Attachment C, for more detailed information on the HREP Mussel Model. When comparing existing conditions to future with-project conditions at the West SE Island, the District found changes in velocity, shear stress, substrate composition, and channel slope may increase habitat suitability for mussels in this area. Furthermore, Figure IX-1 demonstrates how the derived mussel habitat suitability model estimated a higher probability of suitable mussel habitat (red indicates areas of higher mussel habitat suitability) in the with-Project condition, suggesting conditions are not likely to change significantly and may improve with-Project implementation (Figure IX-1).

2. Indirect Effects. The Recommended Plan for the Steamboat Island HREP includes planting over 4,000 containerized trees from 15 species, 7 of which are native hard mast tree species. In addition, approximately 10 acres of a mix of several species of forested wetland shrub/scrub plants will be planted. Long-term, these plantings should provide the bat community with habitat complexity and diversity through increased forage opportunities and potential roost tree production. TSI throughout the island increases the habitat quality and value to all species, including the Indiana bat and northern long-eared bat.

Mussel habitat improvements, particularly near the southeast islands, provide increased opportunities for mussel colonization, growth, and reproduction in a pool that contains a designated EHA.

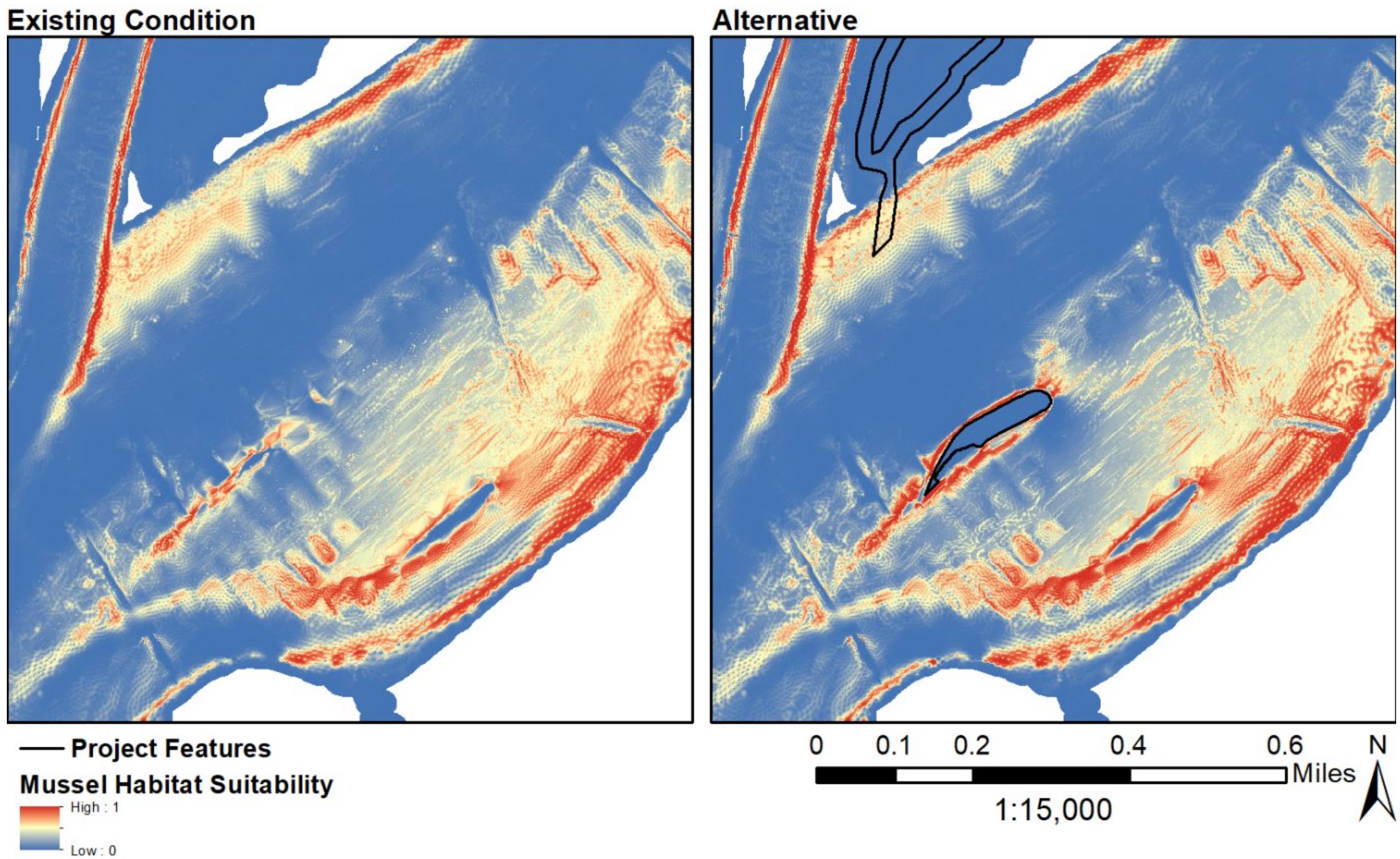


Figure IX-1: Spatially-explicit HREP Mussel Model of Existing and Future With-Project Implementation of the West SE Island

3. Long-Term Effects. Corps Foresters will continue to implement forest management measures after construction of this Project. Measures such as large-scale clearing of non-desirable trees, large scale tree plantings, and continued implementation of TSI strategies will contribute to the overall health and continued success of the forest community in the Project area. Although this Project will avoid the clearing of identified primary roost trees and directly facilitate the creation of future tree snags, long-term tree clearing activities potentially impacts the structure and function of the island habitat for feeding, resting, and reproduction activities.

F. Hazardous, Toxic, and Radioactive Waste

A Phase I ESA for the Steamboat Island HREP was conducted. The Phase I ESA revealed no evidence of a REC that could potentially affect the Project area. Based on the Phase I ESA, no further HTRW assessment is recommended. No HTRW impacts to the Project area or surrounding environment are anticipated (see Appendix E, *HTRW Documentation Report*).

G. Historic and Cultural Resources

The geomorphological and cultural evaluation of the Area of Potential Effect (APE) were delayed for over two years due to excessive and prolonged high water and flooding of the Project area. Field investigations were completed in August 2020, the results are currently pending. A full assessment of effects to cultural resources for the Project activities cannot be determined at this time. Initial project coordination letters were sent to consulting parties on December 20, 2019 (Appendix A, *Correspondence*). A Programmatic Agreement (PA) detailing cultural work to be conducted and coordinated with appropriate parties was drafted (Appendix O, *Programmatic Agreement for Cultural Resources*). The draft PA was subsequently disseminated for review and comment on January 31, 2020. Comments were received from consulting parties and a second draft of the PA was sent out for review and comment on May 6, 2020. To date, the Corps has received no objections to the Project. The Illinois State Historic Preservation Office (SHPO) made the determination of no historic properties affected for the portion of the Project under their jurisdiction (Appendix A, *Correspondence*). The Illinois SHPO, having completed consultation in accordance with procedures outlined in NHPA (36 CFR 800) for the portion of the Project that falls within Illinois' jurisdiction, and the Advisory Council on Historic Preservation have chosen not to participate in the PA. The PA was executed on September 30, 2020. Additional determinations of effect will be made and coordinated in accordance with the executed PA.

While the Corps is assured that no historic properties would be affected by the Recommended Plan, if any undocumented cultural resources are identified or encountered during the undertaking, the Corps will discontinue Project activities and resume coordination with the consulting parties to identify the significance of the historic property and determine any potential effects.

H. Hydrology and Hydraulics

1. Discharge and Velocity. Velocities throughout the Steamboat Island proper will be reduced by the NE Bank and GCS, thereby providing conditions suitable for overwintering. The NE Bank will reduce the velocities in Upper Lake, and the GCS will reduce velocities in Lower Lake. The mussel habitat suitability model (Appendix M, *Engineering Design,* Attachment C*)* indicated minimal changes to the existing suitable mussel habitat distribution within the Project area and therefore no negative impacts to the existing mussel bed are expected as a result of the measures.

2. Inundation Duration. The topographic diversity enhancement measures will afford greater survivability to hard mast trees by increasing the elevation in order to reduce the frequency of long duration root inundation which results in mortality.

3. Sediment Deposition. The NE Bank and GCS are intended to help reduce sediment deposition throughout Upper Lake and Lower Lake by reducing input from a primary sediment source.

4. Flood Risk. The Project demonstrates compliance with the Federal Emergency Management Agency's (FEMA) "no-rise" to the 1% annual exceedance probability water surface profile. Compliance with Illinois and Iowa floodplain requirements has been demonstrated and required floodplain permits will be obtained during plans and specifications. Detailed discussion of floodplain assessment is included in Appendix H, *Hydrology and Hydraulics*.

I. Socioeconomic Resources

1. Community and Regional Growth. No short-term or long-term impacts to the growth of the neighboring community or region are anticipated as a result of the Project. Recreational opportunities will be improved in the Project area, increasing the attractiveness of the area for wildlife observation, waterfowl hunting, sport fishing, boating, photography, and commercial fishing.

2. Community Cohesion. The proposed habitat restoration Project has positive impacts on community cohesion by attracting visitors and recreationists from other communities. Overall, the Project would have no adverse impacts to the quality of the human environment.

3. Displacement of People. There are no residential properties that would be displaced.

4. Property Values and Tax Revenues. The Project area is federally-owned land managed by the USFWS. No change in property values or tax revenues would occur.

5. Public Facilities and Services. Temporary use of the local public boat ramps during construction will potentially limit availability for boat ramp usage. However, the proposed Project would positively impact public facilities and services by increasing habitat diversity, resulting in additional opportunities for recreational use of the area following construction.

6. Life, Health, and Safety. The Project poses no threats to the life, health, or safety of recreationists in the area.

7. Business and Industrial Activity. No substantial changes in business and industrial activities will occur during construction. Long-term beneficial impacts to business and industrial development would be related to tourism and recreational activities.

8. Employment and Labor Force. Short-term employment opportunities in the area may increase slightly during construction. The Project would not directly affect employment of the labor force in nearby Illinois and Iowa counties.

9. Farm Displacement. No farms or farmsteads would be displaced as a result of the proposed Project. No prime and unique farmland would be impacted.

10. Aesthetic Values. Clearing of some woody vegetation would occur because of construction activities. Following construction, the area would be reseeded and planted with hard mast trees. No permanent adverse impacts to area aesthetics are anticipated. The enhancement of habitat areas would make the wildlife area more aesthetically pleasing to visitors.

11. Noise Levels. Heavy machinery will generate temporary noise during construction, disturbing wildlife and recreationists in the area. The Project area is rural with no significant, long-term impacts.

12. Air Quality. Minor, temporary increases to air quality due to construction activity may occur as a result of construction and transportation of materials. In 2002, EPA classified diesel emissions as a likely human carcinogen, and in 2012 the International Agency for Research on Cancer concluded that diesel exhaust is carcinogenic to humans. Diesel exhaust can also lead to other serious health conditions and can worsen heart and lung disease, especially in vulnerable populations, such as children and elderly people. A Construction Emission Control Checklist provided by the EPA will be utilized in developing diesel emissions specifications during the P&S phase of the Project.

J. Man-Made Resources

This section describes the potential effects of the Recommended Plan on the man-made resources the Project area that were built to support commercial navigation and reduce flood risk. The proposed Project will not impact the performance of flood reduction levees in Iowa or Illinois or result in any significant change in floodplain storage. Impacts to navigation training structures and the 9-foot navigation channel will not occur as a result of Project implementation.

K. Probable Adverse Impacts Which Cannot Be Avoided

An unavoidable adverse impact would be the clearing of vegetation for construction. In an effort to minimize tree clearing, the placement sites dominated by reed canarygrass were selected. The only area that will need to be cleared is located near Grant Slough to reduce the need for extensive access dredging for topographic diversity measures. This will require approximately 1.3 acres of clearing to accommodate the measures footprints, grading and shaping, and access. Clearing of existing vegetation, particularly over-mature silver maple stands, would be kept to the minimum required for construction activities and post-construction maintenance, and will adhere to seasonal restrictions recommended by the USFWS for protection of threatened and endangered species.

The loss of some benthic organisms currently inhabiting the footprint areas for bank stabilization and dredging is a likely effect of the proposed action. Following construction, benthic organisms should rapidly recolonize the excavated areas, especially due to the added habitat diversity created with stone placement and increased backwater depth.

L. Short-Term Versus Long-Term Productivity

Construction activities would temporarily disrupt wildlife and human use of the Project area. Long-term productivity for natural resource management would benefit considerably by the construction of this Project. Long-term productivity would be enhanced through increased reliability of hard mast-producing tree production, enhancement of existing submerged, emergent and wetland vegetation, and providing more dependable reproduction, foraging, and resting areas for migratory birds, resident wildlife, and aquatic species. Overall habitat diversity would increase, and both game and nongame wildlife species would benefit from the proposed Project. In turn, both consumptive and non-consumptive users would realize heightened opportunities for recreational use. Negative long-term impacts are expected to be minimal on all ecosystems associated with the Project.

M. Irreversible or Irretrievable Resource Commitments

The purchase of materials and the commitment of man-hours, fuel, and machinery to perform construction are irretrievable. Other than the aforementioned, none of the proposed actions are considered irreversible.

N. Relationship of the Proposed Project to Land-Use Plans

The proposed Project would not change the use of any floodplain or aquatic resources. If implemented, the Corps does not expect the proposed action to alter or conflict with other authorized Corps projects.

O. Cumulative Impacts

Cumulative effects occur when a relationship exists between a proposed action and other actions which have occurred, are occurring, or are expected to occur in a similar location. The primary area considered in the cumulative effects analysis is limited to Pool 14.

1. Past Actions. The most significant navigation action in Pool 14 was the authorization, construction, and operation and maintenance of the 9-foot Navigation Channel Project. Construction of L&D 14 raised water levels by as much as 7 feet. Floodplains are now inundated more often and for longer durations. Temporarily inundated wetlands were converted to permanently inundated lakes and sloughs. Several fluvial processes were disrupted, which includes sediment transport and hydrologic fluctuations. The effects from the construction can still be seen today with decreased topographic diversity, floodplain vegetation diversity, lack of regeneration, and shallow backwaters.

Portions of Pool 14 are periodically excavated to maintain the navigation channel by the District. As a result, several wingdams and closure structures have been constructed in the pool. While these areas provide some level of habitat for aquatic species, they also work to direct flows to the main channel and reduce flows in the secondary and tertiary channels. While construction of wingdams is not very likely in the near future, dredging and O&M of existing structures will continue.

Construction of the Princeton Refuge HREP (RM 504.0–506.4) was completed in 1998. The HREP was developed to reduce forest fragmentation, increase bottomland hardwood diversity, and enhance migratory waterfowl habitat.

2. Present and Foreseeable Actions. The Corps will continue to operate and maintain the 9-foot Navigation Channel Project. This includes continuation of dredging, placement of material, and construction, operation, and maintenance of river regulating structures (i.e., chevrons, closing structures, and wingdams).

Corps Foresters will continue to implement TSI measures at locations within the Project area. These measures include tree thinning, hard mast tree plantings, and non-desirable vegetation maintenance.

These efforts will continue in the future on the island.

Cumulative impacts of the proposed action are not expected to be significant. The proposed Project should have positive long-term benefits to the fish, wildlife, and other natural resources inhabiting the area. This Project, in concert with Princeton Refuge HREP, Beaver Island HREP, and ongoing forestry management strategies, should counter some of the past, current, and foreseeable actions described earlier. In total, 56 HREPs have been completed, benefiting nearly 106,000 acres on the UMRS. Twenty-two projects are in various stages of planning, engineering, or design, which will benefit another 65,000 acres of habitat when implemented.

3. **Compliance with Environmental Statutes.** See Table IX-2.

Table IX-2: Relationship of Plans to Environmental Protection Statutes and Other Environmental Requirements

Federal Environmental Protection Statutes and Requirements	Applicability/ Compliance[1]
Analysis of Impacts on Prime and Unique Farmland (CEQ Memorandum, 11 Aug 80)	Not Applicable
Archaeological and Historic Preservation Act, 16 U.S.C. 469, et seq.	Full Compliance
Clean Air Act, as amended, 42 U.S.C. 1857h-7, et seq.	Full Compliance
Clean Water Act, Sections 404 and 401	Full Compliance
Corps of Engineers Planning Guidance Handbook (ER 1105-2-100)	Full Compliance
Endangered Species Act of 1973, as amended, 16 S.C. 1531, et seq.	Full Compliance
Executive Order 11988 – Floodplain Management	Full Compliance
Executive Order 11990 - Protection of Wetlands	Full Compliance
Executive Order 12898 – Environmental Justice	Full Compliance
Executive Order 13112 - Invasive Species	Full Compliance
Farmland Protection Policy Act. 7 U.S.C. 4201, et seq.	Not Applicable
Federal Water Protection Recreation Act, 16 U.S.C. 460-(12), et seq.	Full Compliance
Fish and Wildlife Coordination Act, 16 U.S.C. 601, et seq.	Full Compliance
Green House Gases, CEQ Memorandum 18, Feb 2010	Full Compliance
Land and Water Conservation Fund Act, 16 U.S.C. 460/-460/-11, et seq.	Not applicable
National Environmental Policy Act, 42 U.S.C. 321, et seq.	Pending[2]
National Historic Preservation Act, 16 U.S.C. 470a, et seq.	Full Compliance
Rivers and Harbors Act, 33 U.S.C. 403, et seq.	Full Compliance
Watershed Protection and Flood Prevention Act, 16 U.S.C. 1001, et seq.	Not Applicable
Wild and Scenic Rivers Act, 16 U.S.C. 1271, et seq.	Not Applicable

[1] Full Compliance = having met all requirements of the statute for the current stage of planning; Not Applicable = no requirements for the statute or Project does not contain resources applicable to the law.

[2] The Project will be in full compliance with NEPA once the Finding of No Significant Impacts is signed.

The Environmental Operating Principles (EOPs) outline the Corps' role and responsibility to sustainably use and restore our natural resources in a world that is complex and changing. The Recommended Plan meets the intent of the EOPs. The PDT proactively considered the environmental consequences of the proposed Project, as well as the benefits of the Recommended Plan. The Project would be constructed in compliance with all applicable environmental laws and regulations. In accordance with the EOPs, the Corps has proposed a Project that supports economic and environmentally sustainable solutions.

SECTION X. PROJECT PERFORMANCE MONITORING

Per Section 2039 of WRDA 2007, monitoring for ecosystem restoration studies will be conducted to determine Project success. "Monitoring includes 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." This section summarizes the resource monitoring, data collection, and post-construction evaluation plan. Table X-1 describes the activities involved in post-construction evaluation. Performance monitoring will occur for 10 years post construction and be used to determine the degree to which the Project is meeting the success criteria and for informing potential adaptive management decisions. Long-term performance reporting will commence following the 10-year performance monitoring and adaptive management stage. Long-term performance reporting demonstrates the ability to meet Project success criteria through the period of analysis, inform O&M adjustments, and provide basic data for planning purposes. Further details on performance monitoring and adaptive management are provided in Appendix K, *Monitoring and Adaptive Management Plan*.

Table X-1: Post Construction Monitoring Description

	Monitoring Stage	Length of Time	Description	Funding Source
Post-Construction Evaluation	Performance Monitoring	10 years	For entire Project, determine the degree to which the Project is meeting the success criteria and for informing potential adaptive management decisions	Project Cost
	Adaptive Management	10 years	Provides a process for making decisions in the face of uncertainty and learning from outcomes of management actions; may improve the performance of a designed construction measure that is not meeting performance criteria	Project Cost
	Long-Term Performance Reporting	50 years	For entire Project, demonstrates the ability to meet Project success criteria through the period of analysis, inform O&M, and provide basic data for planning and UMRR Program purposes	UMRR Program Cost

Table X-2 presents overall types, purposes, and responsibilities for monitoring and data collection. Table X-3 presents actual monitoring and data parameters grouped by Project phase, as well as data collection intervals. Table X-4 presents the post-construction evaluation plan, which displays several specific parameters and the levels of enhancement that the Project hopes to achieve. Other factors may be considered to evaluate Project performance.

The PDT relied on several assumptions to determine enhancement measures and develop target thresholds as outlined in Table X-3. The following explanation should assist managers in evaluating performance for the extended life of the Project.

Table X-2: Overall Types, Purposes, and Responsibilities of Monitoring and Data Collection

Project Phase	Type of Activity	Purpose	Responsible Agency	Implementing Agency	Funding Source
Pre-Project	Pre-Project Monitoring	Identify and define problems at HREP. Establish need of proposed Project measures.	Project Partners	Project Partners	Project Partners
	Baseline Monitoring	Establish baselines for performance evaluation.	Corps	Corps	HREP
Design	Data Collection for Design	Include quantification of Project objectives, design of Project, and development of Performance Evaluation Reports.	Corps	Corps	HREP
Construction	Construction Monitoring	Assess construction impacts; assure permit conditions are met.	Corps	Corps	HREP
Post-Construction	Performance Evaluation Monitoring	Determine success of Project as related to objectives and success criteria.	Corps (quantitative) Iowa DNR (field observations)	Project Partners through Cooperative Agreement, USFWS thru O&M, or Corps	HREP/ Iowa DNR

Table X-3: Resource Monitoring and Data Collection Summary [1]

	WATER QUALITY DATA						ENGINEERING DATA			NATURAL RESOURCE DATA					
	Pre-Project Phase		P&S		Post-Const. Phase [3]		Pre-Project Phase	P&S	Post-Const. Phase	Pre-Project Phase	P&S	Const. Phase	Post-Const. Phase		
Type Measurement	**Jun-Sep**	**Dec-Mar**	**Jun-Sep**	**Dec-Mar**	**Jun-Sep**	**Dec-Mar**								**Agency**	**Remarks**
Point Measurements															
Water Quality Stations [2]														Corps	
Air Temperature	2W	6W	2W	6W	2W	6W									
Wind Direction	2W	6W	2W	6W	2W	6W									
Wind Velocity	2W	6W	2W	6W	2W	6W									
Percent Cloud Cover	2W	6W	2W	6W	2W	6W									
Wave Height	2W	6W	2W	6W	2W	6W									
Water Depth	2W	6W	2W	6W	2W	6W									
Velocity	2W	6W	2W	6W	2W	6W									
DO	2W	6W	2W	6W	2W	6W									
Water Temperature	2W	6W	2W	6W	2W	6W									
pH	2W	6W	2W	6W	2W	6W									
Specific Conductance	2W	6W	2W	6W	2W	6W									
Total Alkalinity	2W	6W	2W	6W	2W	6W									
Secchi Disk Depth	2W	6W	2W	6W	2W	6W									
Turbidity	2W	6W	2W	6W	2W	6W									
Suspended Solids	2W		2W		2W										
Chlorophyll	2W		2W		2W										
Ice Thickness		6W		6W		6W									
Snow Depth		6W		6W		6W									
Mussel Survey [8]										2				Corps	Jun 2018; Jun 2019
Boring Stations [4]															
Geotechnical Borings							1	1						Corps	
Fish Stations															
Electrofishing [5]										Q			Q	Iowa DNR	Jun-Dec
Vegetation Surveys															
Hard Mast Tree Survey [6]													10Y	Corps	
Forest Transects												Y (4)	7		
Scrub-Shrub Survey												Y (2)	7	Corps	
Sediment (Bathymetry)									5Y					Corps	
Mapping [7]							1		3					Corps	

Legend

W = Weekly	nW = Every “n” weeks
M = Monthly	nY = Every “n” years
Y = Yearly	1,2,3 = Number of times data is collected within designated Project phase
Q = Quarterly	Y(n) = Annually for “n” Years

[1] See Plate 28, O-102 for post construction phase monitoring. Note that the information presented in this table includes data obtained to develop the Project (Pre-Project Phase), during Project design, and Post-Construction phase. Post-construction work refers to monitoring and data collection used in the Performance Evaluation Reports

[2] Pre-Project water quality stations are shown on Plate 27, O-101: W-M505.7C, W-M505.0B, W-M 504.9P, W-M504.7S, and W-M504.1E. Post-Construction water quality stations are shown on Plate 28, O-102: W-M 504.9P, W-M504.7S, W-M503.6L, and W-M504.1E.

[3] Water quality data will be collected during approximately 50% of the long-term monitoring period.

[4] See Plate 4, B-101 for geotechnical boring locations and Plates 5 and 6, B-601 and B-602 for boring logs and dates.

[5] Fish sampling by the Iowa DNR will occur annually during 4 events from summer through late fall; once in each of the three LTRM periods, then once in late fall (overwintering), or until ice cover occurs. The Iowa DNR’s sampling data will be used to evaluate Project effectiveness.

[6] Hard mast tree (forestry) surveys will be conducted twice as best determined by Corps foresters approximately 10 years apart following completion of Performance Monitoring activities to determine tree planting effectiveness.

[7] Depending on river conditions and Program budget, the following methods could be utilized: topographical survey, LiDAR survey, and remote sensing or aerial imagery comparison.

[8] There will be no post-construction monitoring mussel surveys. Performance monitoring is tied to objectives (Section III) and there is no formal mussel habitat objective requiring monitoring to determine success. The annual interagency Cordova Mussel Blitz has been identified as an opportunity to leverage mussel resource data in the Project area.

Table X-4: Post-Construction Evaluation Plan

Enhancement Measures	Measurement	Location	Year 0 w/o Alt	Year 1 w/ Alt	Year 10 w/ Alt	Year 25 w/ Alt	Year 50 w/ Alt	Method	Field Observations by Sponsor
Aquatic Diversity/ Overwintering Habitat (Lower Lake, Upper Lake, NW Grant Slough)	Acres of Aquatic Habitat (deep water ≥4 ft, low velocity ≤1 cm/sec, high dissolved oxygen concentrations ≥5.0 mg/L, increased water temperature ≥1.0°C)	Lower Lake	0 acres	10.4 acres	10.2 acres	9.8 acres	9.2 acres	Water Quality Stations (depth, velocity, dissolved oxygen, temperature), and Bathymetry	Presence of fish during overwintering season
		Upper Lake	0.14 acres	12.5 acres	12.2 acres	11.8 acres	11.2 acres		
		NW Grant Slough	0 acres	6.0 acres	5.9 acres	5.8 acres	5.5 acres		
		All locations (constructed dredge cuts)	0.14 acres	29 acres	28 acres	27 acres	26 acres		
Topographic Diversity Sites - Forestry	Percent survivability; trees/acre	All topographic diversity sites	0%	≥90% survival (of planted species); >800 trees/acre after planting	≥60% survival; 800 trees/acre	≥60% survival; 350-500 trees/acre	≥40% survival; 150-250 trees/acre	Tree Survey	Visual Observations
Topographic Diversity Sites – SSP (Lower Lake, Grant Slough Site 1)	Percent survivability of SSP species	All SSP sites	0%	≥80% survival	≥60% survival	≥45% survival	≥30% survival	Shrub Survey	Visual Observations
TSI	Forest Metrics – timber inventory stand summary	All TSI Areas	0%	>90% Silvicultural Treatment Target Threshold	>90% Silvicultural Treatment Target Threshold	>60% Silvicultural Treatment Target Threshold	>40% Silvicultural Treatment Target Threshold	Standard Timber Inventory Protocol	Visual Observations
Island Restoration and Protection	Acres of island (constructed)	USI Head	0	14.2 acres	14.2 acres	14.2 acres	14.2 acres	Topographic Survey and Aerial Imagery	Visual Observations
		NE Bank	0	8.3 acres	8.3 acres	8.3 acres	8.3 acres		
		West SE Island	0	3.5 acres	3.5 acres	3.5 acres	3.5 acres		
		All locations (constructed islands)	0	26	26	26	26		

Aquatic Diversity/Overwintering Habitat. The water quality and depth metrics for overwintering habitat in Table X-3 were revised based on a proposed update to the Bluegill Overwintering HSI Model, which occurred during a 2019 UMRR partnership workshop. Performance evaluations of Aquatic Diversity/Overwintering Habitat will compare pre-project overwintering acres that meet all of the water quality and depth metrics with targets at Years 1, 10, 25, and 50. Target acreages were calculated by measuring the areas of designed dredge cuts with depth greater than or equal to 4 feet below flat pool, which corresponds to a bottom elevation of 567.2 feet. The reduction in target acreages over time reflects the uniform 1 cm/year sediment deposition rate referenced in Section II of this report. Refer to Appendix K, *Monitoring and Adaptive Management Plan* for further details regarding locations and monitoring methodology.

Topographic Diversity Sites – Forestry. Performance of this enhancement measure will be documented by percent survivability of planted tree species and density (TPA), as there are currently no trees occupying the proposed topographic diversity sites. Trees planted will be the baseline for monitoring performance into the future. Performance evaluations of these targets will be conducted by Corps' foresters to assess topographic diversity sites at Years 1, 10, 25, and 50. Performance targets are based on lessons learned from other HREPs with tree plantings on placement sites. Refer to Appendix K, *Monitoring and Adaptive Management Plan*, for further details regarding planting locations and monitoring methodology and Appendix M, *Engineering Design*, for forestry data, planting plans, and prescriptions.

Topographic Diversity Sites – Scrub-Shrub/Pollinator Habitat. Performance of this enhancement measure will be documented by percent survivability of planted SSP species, as there are currently no SSP species occupying the proposed topographic diversity sites. SSP species planted will be the baseline for monitoring performance into the future. Performance evaluations of these targets will be conducted by Corps' foresters to assess topographic diversity sites at Years 1, 10, 25, and 50. Performance targets are based on lessons learned from other HREPs with scrub-shrub plantings on placement sites. Refer to Appendix K, *Monitoring and Adaptive Management Plan*, for further details regarding locations and monitoring methodology and Appendix M, *Engineering Design*, for forestry data, planting plans, and prescriptions.

Timber Stand Improvement. TSI includes thinning treatments, tree planting, and invasive species management to meet desirable forest health, diversity, and resilience based on current environmental and forest conditions. Silvicultural treatment prescriptions were devised based on the 2018 forest inventory and a forest stand reconnaissance conducted in 2019, which provides a baseline for monitoring performance into the future. Additionally, forest age, structure, and function will be assessed during forest surveys scheduled in Table X-2 and compared to the 2018 baseline survey. Performance evaluations of these targets will be conducted by Corps' foresters to assess TSI sites at Years 1, 10, 25, and 50. Refer to Appendix M, *Engineering Design*, for forestry data, planting plans, and prescriptions.

Island Restoration and Protection. Performance of this enhancement measure is based on as-built acreage of islands following construction to have a baseline for monitoring performance into the future. It is assumed that implementation of the island protection measures will not significantly alter hydraulic forces within the Project area, will continue to provide stabilization, and may even help islands accrete over time. Refer to Appendix K, *Monitoring and Adaptive Management Plan,* for further details regarding locations and monitoring methodology and Appendix M, *Engineering Design*.

SECTION XI. REAL ESTATE REQUIREMENTS

The Steamboat Island HREP is a part of the UMRR Program authorized by Section 1103 of the WRDA of 1986, Public Law 99-662, as amended. Project location and description can be found in Sections I and II of this Report.

All lands necessary for the Project are owned by the United States. The acquisition of Project lands was administered by the Corps and the USFWS, Savanna District, as part of the UMR NWFR.

For this Project, the USFWS is acting as the Federal Sponsor. The Project would be 100% Federal cost. A map showing the Project area is included on Plate 7, (C-101, *Site Plan*) in Appendix P, *Plates.*

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

All placement materials would be excavated from within navigational servitude and Project waters and from existing top soil within the Project area.

All access to the Project will be by water. Boat ramps in the Project vicinity are public boat ramps, which the contractor may use. The Contractor will need to abide by local boat ramp usage regulations. See Appendix M, *Engineering Design*, for additional details.

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

A Memorandum of Agreement between the USFWS and the Corps is included as Appendix C and a Real Estate Plan is included as Appendix J. Estimated O&M costs can be found in Section VIII, *Cost Estimates¸* Table VIII-5.

SECTION XII. COORDINATION, PUBLIC VIEWS, AND COMMENTS

Coordination has been made throughout the planning process with the following State and Federal agencies and local entities:

U.S. Fish and Wildlife Service

Iowa Department of Natural Resources

Illinois Department of Natural Resources

Illinois State Historic Preservation Office

Iowa State Historic Preservation Office

Exelon Power Plant, Cordova, Illinois

The USFWS, Iowa DNR, and IL DNR have been cooperating agencies in the preparation of this EA and have been integral in the decision making process for the Feasibility Report, including informal reviews of the Report throughout its development. Review comments included need for clarification in roles and responsibilities, TSP design, and potential environmental impacts. Letters of support provided by the Project Sponsor and partners are provided in Appendix A, *Correspondence*.

A. Coordination Meetings

Numerous coordination meetings were held with Project Sponsor and partners to discuss the Project. The following meetings demonstrate ongoing coordination:

- April 26-27, 2017. Kick-off meeting, including a site visit and planning charette, to consult and collaborate on the initial study scope.
- May 24, 2017, and June 14, 2017. General scoping meetings to discuss study scope and general Project elements.
- July 6, 2017. Conceptual model workshop to develop a conceptual model for the Project.
- July 20, 2017, and August 31, 2017. PDT meetings to discuss an expanded Project scope and define Project problems, opportunities, goals, and objectives.
- October 18, 2017, and November 28, 2017-May 18, 2018. Measures workshop and subsequent PDT meetings to consult and collaborate on potential Project measures, in relation to the Project goals & objectives, conceptual ecological model, constraints & considerations, and known existing conditions.
- June 5, 2018 to September 6, 2018. PDT Meetings and Alternative Workshop to consult and collaborate on Project alternatives, comprised of potential Project measures.
- December 17, 2018 to January 17, 2019: CEICA Workshop and subsequent PDT meeting to decide on a TSP.
- February 7, 2019 to September 16, 2019: PDT meetings to refine the TSP and associated measures, as well as performance monitoring and adaptive management of the TSP.

B. Coordination by Correspondence

Refer to Appendix A, *Correspondence*, for specific coordination efforts to date.

C. Public Views and Comments

An open house was held on March 26, 2014, in Clinton, Iowa, to discuss the initiation of the Feasibility Study and proposed Project with interested members of the public and to gather public input (Appendix N, *Distribution List*). Representatives from the Corps, USFWS, and Iowa DNR were present to talk one-on-one with attendees. Information packets and "Subject Matter Expert" tables included information about the UMRR program, preliminary Project elements, potential Project measures, bathymetric data, general design information, current imagery of Steamboat Island, and information about the Iowa DNR and the UMR NWFR. Seventy five members of the public attended the evening session and another 19 people watched the live feed streamed by the District's Corporate Communications Office. Three comment sheets were returned. Respondents indicated they used the area for recreation, fishing, boating, and water sports. Generally, the most common concern from the open house was the lack of deep water, overwintering habitat and fishing/boating opportunities due to the backwater channels and sloughs being significantly silted in. Respondents indicated that they would like to see dredging and channel restoration occur in the Project area, for both fisheries and recreation benefits.

Public Review of the Draft Feasibility Report and TSP took place May-June 2020. The Project website included the Draft Feasibility Report with Integrated EA, a Project summary, a virtual presentation, and comment submission form. The virtual presentation included an overview of the Project, basic information on the TSP, and information on how to provide input. During public review, 29 comments were received from the public (13 supportive comments, 6 recreation-focused comments, 8 project questions/comments, and 2 unrelated comments), 3 agencies provided comments (USFWS, Iowa DNR, US EPA Region 7), one radio interview and one television interview were conducted, and many news articles were released. The virtual presentation had 381 views and was the 2nd highest video on the YouTube channel in 90 days. Non-agency comments received during public review resulted in coordination with the respondent in order to provide clarification on UMRR authority and Project intentions; no non-agency public comment resulted in the modification of the TSP or revision of the Report. USFWS comments and responses included concurrence with previously established procedures and documents, as well as a request to ensure clear implementation of TSI. Additional details for implementation of TSI will be described during P&S. Iowa DNR had no concerns with the Draft Report or TSP. US EPA comments and responses included clarification of post-construction monitoring as related to aquatic diversity and the inclusion of diesel emissions specifications for the Project.

SECTION XIII. CONCLUSIONS

Full realization of the potential habitat value in the Steamboat Island HREP area has been hindered by increased water levels, sedimentation, and erosive forces from the implementation of the UMRS 9-Foot Navigation Channel Project, which has led to lack of floodplain connectivity, habitat fragmentation, loss of floodplain topographic diversity and aquatic habitat, altered water regime, and loss of native wetland habitats. Establishing off-channel areas containing reliable aquatic/SSP habitat and establishing floodplain areas that would support survival and regeneration of hard mast-producing trees would allow the Project area to realize the highest benefit to desirable plant, animal, and fish, species.

The restoration measures of the Recommended Plan (backwater dredging and aquatic diversity, topographic diversity, island restoration and protection, grade control) are designed to meet the Project's objectives (see Section III, *Problems and Opportunities*).

Assessment of the future with-Project scenario shows definite increases in total habitat units over the 50-year period of analysis, benefitting target species and a majority of other aquatic and bottomland hardwood forest dwelling species. These increases represent quantification of the projected outputs: improved habitat quality and increased preferred habitat quantity.

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

RECOMMENDATIONS

I have weighed the outputs to be obtained from the full implementation of the Steamboat Island 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 expenditure of Federal funds. I recommend that the Division Engineer approve the proposed Project to include excavating backwaters, constructing topographic and aquatic diversity, restoring and protecting islands, and implementing grade control measures.

The total Federal estimated Project cost, including general design and construction management, is approximately $33,610,000.

At this time, I further recommend that funds in the amount of $1,229,000 be allocated for the Project's Planning, Engineering, and Design.

16 February 2021

Date

Digitally signed by SATTINGER.STEVEN.MICHAEL.1164506939
Date: 2021.02.16 11:55:36 -06'00'

Steven M. Sattinger, P.E.
Colonel, US Army
Commander & District Engineer

FINDING OF NO SIGNIFICANT IMPACT

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA, AND ROCK ISLAND COUNTY, ILLINOIS

The U.S. Army Corps of Engineers, Rock Island District (Corps) has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. This IFR/EA dated 31 January 2020, for the Steamboat Island Habitat Rehabilitation and Enhancement Project addresses ecosystem restoration opportunities and feasibility in the Pool 14, Upper Mississippi River (UMR) river miles (RM) 502.5-508.0. The final recommendation is dated 31 January 2020.

The Final IFR/EA, incorporated herein by reference, evaluated various alternatives that would 1) maintain, enhance, and restore quality habitat for desirable native plant, animal, and fish species and 2) maintain, enhance, restore, and emulate natural river processes, structures, and functions for a resilient and sustainable ecosystem in the study area. The Recommended Plan is the National Ecosystem Restoration (NER) Plan and includes:

- backwater dredging and aquatic diversity (30 acres of overwintering habitat)
- grade control structure (1 structure)
- island restoration/protection (26 acres)
- topographic diversity – forest or scrub-shrub/pollinator habitat (66 acres)
- timber stand improvement (900 acres)
- mussel and fish habitat incorporation (to be determined in plans & specifications)

In addition to a "No Action" plan, eight alternatives were evaluated. The alternatives included distinct combinations of backwater dredging/aquatic diversity, island restoration and protection, topographic diversity, timber stand improvement, grade control structure, and flow diversity. Non-structural measures were considered but not selected for alternative formulation because they were found to be incomplete, ineffective, or not within the scope of the authorized project.

SUMMARY OF POTENTIAL EFFECTS

For all alternatives, the potential effects were evaluated, as appropriate. Table 1 is a summary assessment of the potential effects of the Recommended Plan:

Table 1: Summary of Potential Effects of the Recommended Plan

	Insignificant Effects	Insignificant Effects as a Result of Mitigation	Resource Unaffected By Action
Aesthetics	☐	☐	☒
Air Quality	☐	☐	☒
Aquatic Resources/Wetlands	☒	☐	☐
Invasive Species	☒	☐	☐
Fish and Wildlife Habitat	☐	☐	☒
Threatened/Endangered Species/Critical Habitat	☒	☐	☐
Historic Properties	☐	☐	☒
Other Cultural Resources	☐	☐	☒
Floodplains	☒	☐	☐
Hazardous, Toxic & Radioactive Waste	☐	☐	☒
Hydrology	☒	☐	☐
Land Use	☐	☐	☒
Navigation	☐	☐	☒
Noise Levels	☐	☐	☒
Public Infrastructure	☐	☐	☒
Socio-Economics	☐	☐	☒
Environmental Justice	☐	☐	☒
Soils	☐	☐	☒
Tribal Trust Resources	☐	☐	☒
Water Quality	☐	☐	☒
Climate Change	☐	☐	☒

All practicable and appropriate means to avoid or minimize adverse environmental effects were analyzed and incorporated into the Recommended Plan. Best Management Practices as detailed in the IFR/EA will be implemented, if appropriate, to minimize impacts.

No compensatory mitigation is required as part of the Recommended Plan.

Public review of the draft IFR/EA and FONSI will be completed in June 2020.

ENDANGERED SPECIES ACT:

Pursuant to the Endangered Species Act of 1973, as amended, Section 7 consultation requirements have been met for the Recommended Plan. Informal consultation was concluded with a USFWS concurrence letter, dated 21 February 2020.

NATIONAL HISTORIC PRESERVATION ACT: Coordination for the Project is ongoing in accordance with the Cultural Programmatic Agreement executed on September 30, 2020.

CLEAN WATER ACT SECTION 404(B)(1) COMPLIANCE:

Pursuant to the Clean Water Act of 1972, as amended, the discharge of dredged or fill material associated with the Recommended Plan has been found to be compliant with section 404(b)(1) Guidelines (40 CFR 230). The Clean Water Act Section 404(b)(1) Guidelines evaluation is found in Appendix B, *Clean Water Act Section 404(b)(1) Assessment* of the IFR/EA.

401 WQC: Water quality certification pursuant to section 401 of the Clean Water Act is included with the issuance of Nationwide Permit NO. 27.

OTHER SIGNIFICANT ENVIRONMENTAL COMPLIANCE

All applicable environmental laws have been considered and coordination with appropriate agencies and officials has been completed.

FINDING

Technical, environmental, and cost effectiveness criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies.* All applicable laws, executive orders, regulations, and local government plans were considered in evaluation of alternatives. Based on this report, the reviews by other Federal, State and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that the Recommended Plan would not cause significant adverse effects on the quality of the human environment; therefore, preparation of an Environmental Impact Statement is not required.

Digitally signed by SATTINGER.STEVEN.MICHAEL.1164506939
Date: 2021.02.16 11:56:15 -06'00'

16 February 2021
Date

Steven M. Sattinger, P.E.
Colonel, US Army
Commander & District Engineer

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX A

CORRESPONDENCE

Appendix A
Correspondence

1. Letter dated June 26, 2017, from the District to resource agencies and initiating NEPA coordination and requesting information from consulting parties

2. Letter dated July 21, 2017, from the USFWS in response to the District's letter dated June 26, 2017, providing information regarding environmental resources in the Project area, including federally-protected species

3. Report from Scott Gritters, Fisheries Biologist, IADNR, and Dan Kelner, USACE, providing mussel data gathered during the August 2, 2017, shoreline survey of Steamboat Slough

4. Memorandum dated August 31, 2017, from the MVD Director of Programs to the Rock Island District Commander approving the Review Plan for the Steamboat Island HREP

5. Public Review After Action Report documenting the open house held March 26, 2018, and the comments received from the public

6. Email dated May 18, 2018, from Seth Moore, Environmental Specialist, IADNR, to the Rock Island District providing information regarding environmental resources in the Project area, including Federal and state-protected species

7. Memorandum dated May 22, 2018, from the MVD Director of Programs to the Rock Island District Commander approving the revised Steamboat Island HREP fact sheets and enclosures

8. Final Report dated November 9, 2018, from Ecological Solutions and Innovations, Inc., providing results of mussel survey conducted in the Project area to aid in refining Project measures

9. Conference call dated November 15, 2018, with the USACE, the USFWS, IADNR, and ILDNR, recounting discussion of the November 9, 2018, mussel survey results, working through each Project measure to determine potential impacts, and identifying areas requiring further survey

10. Email dated December 4, 2018, from the USFWS and IL DNR providing Steamboat Island HREP mussel considerations for Federal and state-listed endangered and threatened species

11. Final Report dated January 24, 2019, from Ecological Solutions and Innovations, Inc., providing results of mussel survey conducted in the Cordova EHA used to assess habitat suitability in the HREP Mussel Model

12. Email dated April 9, 2019, from Sara Schmuecker, USFWS, regarding an April 4, 2019, meeting with the Corps, USFWS, and IADNR to discuss the scope of the 2019 mussel survey and concurrence that no bat or eastern massasauga rattlesnake surveys are required

13. Memorandum for Record dated June 6, 2019, recounting the In-Progress Review meeting with MVD on April 11, 2019

14. Survey report of mussel data gathered during the 2016 surveys of the Steamboat Slough and the Cordova mussel beds provided by email from Jeremiah Hass, Fisheries Biologist, QC Generating Station.

15. Memorandum for Record dated September 13, 2019, recounting discussions with the IADNR on September 12, 2019, to provide guidance and a path forward regarding floodplain permitting for the Project

16. Memorandum for Record dated October 3, 2019, from Rachel Perrine, USACE, documenting the floodplain permitting coordination with IADNR and determination that the Project does not require a floodplain permit from the State of Iowa

17. Meeting Read Ahead package for PDT meeting on November 7, 2019, describing the results of the mussel survey conducted in August 2019 to the PDT for discussion

18. Email from Davi Michl, USACE, recounting phone conversation with the USFWS on December 19, 2019, documenting the USFWS determination that a Biological Assessment is not warranted based on the 2019 mussel survey results and informal consultation can be concluded by letter with effects determination

19. Letter dated December 20, 2019, from the Rock Island District to Illinois and Iowa SHPOs and cultural groups describing the proposed Project, historical properties in the Project area, and the need for a Programmatic Agreement to ensure Section 106 compliance

20. Letter dated January 8, 2020, from the Illinois SHPO providing evidence of Section 106 compliance and no objection to the Project

21. Letter dated January 22, 2020, from the Rock Island District to the USFWS requesting concurrence with determinations made by the District regarding federally-endangered or threatened species listed under the Endangered Species Act and requesting concurrence to conclude informal consultation

22. Letter dated February 21, 2020, from the USFWS to the Rock Island District providing concurrence with determinations made by the District regarding federally-endangered or threatened species listed under the Endangered Species Act and concluding informal consultation

23. Letter of Support dated April 8, 2020 from Sabrina Chandler, Refuge Manager, Upper Mississippi River National Wildlife and Fish Refuge, regarding the Steamboat Island HREP and value of the Project

24. Letter of Support dated April 9, 2020, from Kayla Lyon, Director, Iowa DNR, regarding the Steamboat Island HREP and value of the Project

25. Letter dated May 6, 2020, from the Rock Island District to Iowa SHPO requesting the review and written comments or concurrent on the Project

26. Memorandum for Commander, Rock Island District, dated May 20, 2020, from National Ecosystem Restoration Planning Center of Expertise (ECO-PCX) documenting single use approval of applying the Arkansas Delta Hydrogeomorphic Approach to demonstrate TSI benefits for the Project

27. Letter dated June 22, 2020, providing the Final Fish and Wildlife Coordination Act Report from Kraig McPeek, U.S. Fish and Wildlife Service

28. Letter dated September 30, 2020, from the Rock Island District to the Advisory Council on Historic Preservation providing the fully executed cultural Programmatic Agreement

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS - ROCK ISLAND DISTRICT
CLOCK TOWER BUILDING - PO BOX 2004
ROCK ISLAND ILLINOIS 61204-2004

REPLY TO
ATTENTION OF

June 26, 2017

Regional Planning and Environmental
Division North (RPEDN)

SEE DISTRIBUTION LIST

The U.S. Army Corps of Engineers, Rock Island District (District), is currently planning an Upper Mississippi River Restoration Program (UMRR), Habitat Rehabilitation and Enhancement Project (HREP) for Steamboat Island, Mississippi River. The proposed Project is located in Pool 14 between the Wapsipinicon River (River Mile 506.5) and the town of Princeton (RM 502.5) in Scott County, Iowa (Encl. 1). Authority for this Project was provided in the Water Resources Development Act of 1986, Section 1103. The Project sponsor is the U.S. Fish and Wildlife Service.

Habitat quality on Steamboat Island and an adjacent secondary channel complex is degraded by channel and backwater sedimentation, water level fluctuations, forest and wetland degradation, and invasive species encroachment. Habitat degradation results in reduced habitat quality for forest, wetland, backwater, and riverine species. The objective of the Project will be to preserve and restore natural habitat diversity using measures such as: increasing backwater depth, maintaining aquatic connectivity, protecting wetlands, conducting timber stand improvement, increasing topographic diversity, and forest plantings.

The District proposes to study various restoration alternatives and their efficiency in meeting the Project's objectives. Restoration measures may include various backwater dredging techniques (e.g., hydraulic, mechanical); hardwood timber stand improvement (e.g., berm, planting, selective thinning); hydrological connection (e.g., water control structures, dredged channels, rock structures, etc.); or any combination thereof. Dredging will increase bathymetric and topographic diversity as backwaters are deepened and terrestrial areas are raised with dredged material. Maintaining and improving hydraulic connectivity helps manage side channel, backwater, and wetland habitat to provide fish access to spawning, feeding, and overwintering habitats.

The District plans to prepare National Environmental Policy Act (NEPA) documentation for this Project. At that time, we will identify any existing significant resources or other environmental concerns associated with the proposed Project such as wetlands; state- or federally-listed threatened/endangered species; prime and unique farmlands; land use plans; or floodplain/floodway issues. Additionally, as part of the NEPA alternative analysis, the District will evaluate the Project's habitat benefits. We will be forming a Habitat Evaluation Procedures (HEP) team to determine the habitat benefits associated with various alternatives. Stakeholder input and participation on this team is welcomed and strongly encouraged.

The District requests your comments on this Project with respect to concerns for or anticipated effects on any resources within your agency's jurisdictional oversight. Any reports, studies, or other research concerning environmental resources in the Project vicinity are also valuable. Please provide your comments within 30 days of the date of this letter.

If you have any questions or would like to participate during the HEP analysis, please contact Dr. Charles Theiling of our Environmental Planning Branch, [redacted] email: charles.h.theiling@usace.army.mil, or by writing to our address, ATTN Regional Planning and Environmental Division North (Chuck Theiling).

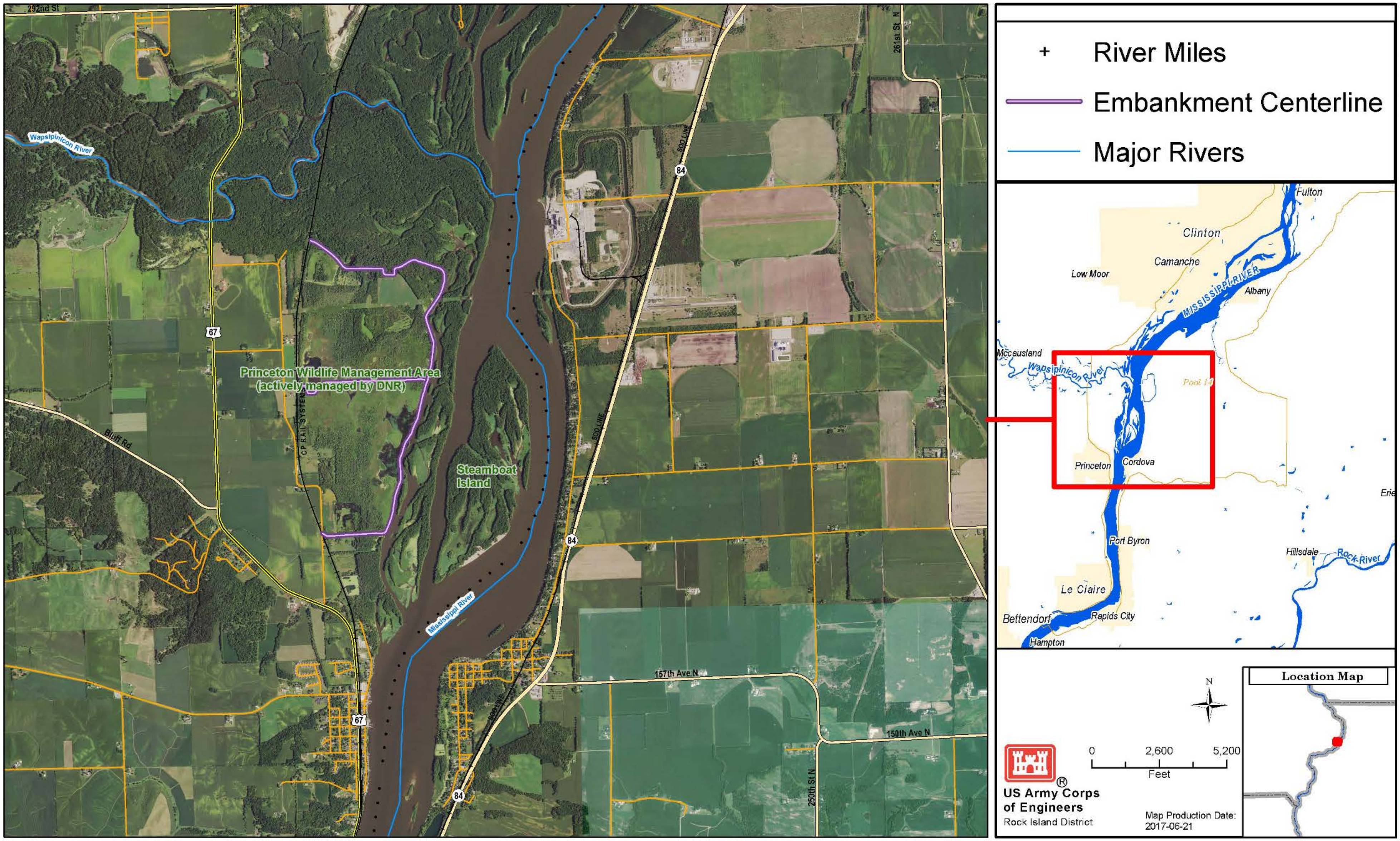
Sincerely,

Jodi K Creswell

Jodi K. Creswell
Chief, Environmental Planning Branch (RPEDN)

Encl
(as)

Enclosure 1: Steamboat Island HREP Site Map



DISTRIBUTION LIST

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Illinois & Iowa Field Office
1511 47th Avenue
Moline, Illinois 61265
Phone: (309) 757-5800 Fax: (309) 757-5807

IN REPLY REFER TO:
FWS/IIFO

July 21, 2017

Jodi Creswell
Chief, Environmental Planning Branch
Attn: Charles Theiling
U.S. Army Corps of Engineers
Rock Island District
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61201-2004

Dear Ms. Creswell:

Thank you for the opportunity to review the proposed Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP). The Steamboat Island HREP is located in Pool 14 of the Mississippi River, between the town of Princeton (River Mile 502.5) and the Wapsipinicon River (River Mile 506.5), in Scott County, Iowa. Per your letter of June 26, 2017, the Corps proposes to study the following habitat restoration alternatives for potential implementation at the Steamboat HREP site: backwater dredging, hardwood timber stand improvement (e.g. berm, planting, selective thinning), and hydrological connection (e.g., water control structures, dredged channels, rock structures, etc.). We have reviewed your letter and have the following comments.
Section 7 of the Endangered Species Act of 1973 requires that actions authorized, funded, or carried out by Federal agencies not jeopardize federally threatened or endangered species or adversely modify designated critical habitat. To fulfill this mandate, Federal agencies (or their designated non-federal representative) must consult with the Service if they determine their project "may affect" listed species or critical habitat.

In order for you to evaluate the potential effects of your project on federally listed species, you can download a list of species listed for Scott County from the Service's Region 3 Technical Assistance website at http://www.fws.gov/midwest/endangered/section7/sppranges/index.html. Habitat descriptions for these species can also be found on our website. You may use these descriptions to help you determine if there is suitable habitat within the project area. If no suitable habitat exists within the project area or its area of impact, and no species or critical habitat is present, it is appropriate to determine the project will have "no effect" on listed species. If you determine the action will have "no effect" on listed species or critical habitat, concurrence with that determination from the Service is not required. Concurrence for "no effect" determinations will not be provided by the Illinois-Iowa Ecological Services Field "Office for projects in Illinois or Iowa due to reductions in staff. We recommend you maintain a written record of why a "no effect" finding is warranted and include it in your administrative record. An example of a "no effect" memo can be found on our website at http://www.fws.gov/midwest/endangered/section7/s7process/letters.html.

If suitable habitat is found in the area of your project, the appropriate determination is that the project "may affect" listed species. In some instances surveys may be recommended to help make this determination. Additional information on how to make accurate effect determinations and how to document your determination can be found on our website at http://www.fws.gov/midwest/endangered/section7/s7process/step1.html.

Additionally, the Service removed bald eagles (*Haliaeetus leucocephalus*) from protection under the ESA on August 8, 2007. However, they remain protected today under the MBTA and the Eagle Act. The Eagle Act prohibits take which is defined as, "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, or disturb" (50 CFR 22.3). Disturb is defined in regulations as, "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior."

In particular, the proposed project actions, as described in your letter of June 26, 2017, have the potential to impact federally protected migratory tree bat, migratory bird, eagle, and freshwater mussel resources.

Migratory Tree Bats

Summer habitat for the federally endangered Indiana bat (*Myotis sodalis*) and northern long-eared bat (*Myotis septentrionalis*) includes roosts under loose tree bark on dead or dying trees and foraging within or along the edges of forested areas. The proposed project includes the removal and/or alteration of forested habitat that has the potential to provide summer roosting and foraging habitat for these bat species. Should impacts to forested areas be planned, we recommend a survey be conducted to identify Indiana and northern long-eared bat roost trees. Identified roost trees should not be felled, tree clearing should not result in habitat fragmentation, and we recommend all tree clearing be conducted outside of the maternity season of April 1 through September 30. Please note, certain incidental take resulting from tree removal is identified in the final 4(d) Rule for the northern long-eared bat (50 CFR 17) as exempted from prohibition under the Endangered Species Act.

Migratory Birds and Eagles

The forested habitat on Steamboat Island has the potential to provided nesting habitat to several species of migratory birds. We recommend that any proposed removal and/or alteration of forested habitat be conducted prior to spring nesting to reduce potential impacts during the nesting season.

Bald eagles winter along the Mississippi River, including Pool 14. Suitable perch trees where eagles can loaf and perch are numerous, including the forested areas of Steamboat Island. One bald eagle nest site is known to occur on the head of Steamboat Island. This nest was observed to be active in 2017. All construction activities should be restricted within 660 feet of any identified active eagle nest to outside the nesting season.

Freshwater Mussels

A significant mussel resource has historically been documented throughout Pool 14, particularly within the vicinity of Steamboat Island. Mussel surveys along the right and left descending banklines of Steamboat Island have identified upwards of 21 freshwater mussel species, as recently as 2012, including the federally endangered Higgin's eye pearlymussel *(Lampsilis higginsii)* and several State of Iowa listed species. Additionally, the project is within range of the federally endangered sheepnose mussel (*Plethobasus cyphyus*) and the spectaclecase mussel (*Cumberlandia monodonta*). Proposed project construction activities including installation of water control structures, dredging, and placement of rock structures have the potential to disrupt or alter freshwater mussel habitat. Should impacts to potentially suitable mussel habitat be identified, we recommend a freshwater mussel survey be conducted.

These comments provide technical assistance only and do not constitute the report of the Secretary of the Interior on the project within the meaning of Section 2(b) of the Fish and Wildlife Coordination Act, do not fulfill the requirements under Section 7 of the Endangered Species Act, nor do they represent the review comments of the U.S. Department of the Interior on any forthcoming environmental statement.

Thank you for the coordination of this project and for the opportunity to provide comments. If you have any questions regarding these comments, please contact [redacted] of my staff at [redacted] or [redacted].gov.

Sincerely,

Heidi Woeber

for Kraig McPeek
Field Office Supervisor

S:\Office Users\Sara\UMRR Program\HREPs\Steamboat\2017 07-19 Steamboat Island HREP TE Letter

Shoreline mussel survey of Pool 14, Steamboat Slough side channel, at River Mile 505 Conducted by Scott Gritters- Iowa Department of Natural Resources and Dan Kelner U.S. Army Corps of Engineers.

Methods

Trained malacologists from the Corps of Engineers, US Fish and Wildlife Service and Iowa DNR conducted five timed freshwater mussels' searches (pollywogging) of Steamboat Slough on August 2nd, 2017 (Figure 1). The survey teams searched shallow shoreline areas on both the right and left descending bank. Five qualitative searches totaling 440 minutes of search time were recorded. Sampling locations are shown in Figure 1.

On August 2nd, the Pool 14 surface elevation recorded at the USGS gauge 05420500 in the Mississippi River at Clinton, IA was 11.2 feet and the flow was 51,600 cubic feet per second. Water temperature was 27.2 degrees Celsius. Substrate of all five sites surveyed was predominately mud with some sand and some evidence of zebra mussel shells. The high mud content may be due to the recent flooding of the Wapsipinicon River which is just upstream of the survey site. In most areas nearly a foot of "new" sediment covered most of the river bottom. Survey depth to allow shoreline searching (non-divers) was generally less than one meter and was a limited habitat as most of the slough depth is over one meter. This survey represents most of the shallow near shore habitat that exists in Steamboat Slough. If additional mussel surveys are warranted they will need to be conducted by dive teams in the deeper water.

Findings

The 440 minutes of timed searches yielded 11 mussel species. By this richness metric the Iowa DNR would classify this site as fair to poor compared to other Mississippi River mussel beds. The mean catch rate which could be calculated combined for sites two and five and was 0.16 mussels per minute or 8 mussels per hour. This catch rate would be considered poor compared to other Mississippi River mussel beds. Catch rate of mussels seemed to decrease northward in the slough. The upper most sampling site (Site 5) was nearly devoid of mussels but appeared to have similar habitat to the other sites surveyed. Most of the mussel species surveyed are considered "tolerant" species, and able to survive in poorer habitat reaches of the Mississippi River.

The collection of 21 Yellow Sandshells (*Lampsilis teres)* was a significant finding in this survey. The Yellow Sandshell is considered an Iowa state endangered species but apparently has made a recent comeback in this reach of Mississippi River. Yellow sandshell have been found in recent surveys of Pool 14 and neighboring Pools. All Yellow Sandshell specimens found in this survey were found at the lower three sites (Sites 1-3).

Conclusion

Limited habitat exists for shoreline searches in Steamboat Slough and much of the habitat available was sampled during this effort. Shoreline habitat in Steamboat Slough generally consisted of mud and sand. The mussels that exist along the shorelines of Steamboat Slough are generally common tolerant species and density and richness appears to be somewhat low. If additional surveys of the Slough are warranted they will need to be conducted by diving teams in deeper water.

Figure 1. Locations of timed mussel searches in Steamboat Slough on August 2nd, 2017.

Table 1. Mussel species found in Pool 14, Steamboat Slough wadding Survey on August 2nd, 2017

Scientific name	Common Name	Site 1	Site 2	Site 3	Site 4	Site 5	Totals
Amblema plicata	three ridge	X	23	X	X		**X**
Fusconaia flava	wabash pigtoe	X		X	X		**X**
Lampsilis cardium	plain pocketbook	X		X	X		**X**
Lampsilis teres	yellow sandshell	3	5	13			**21**
Leptodea fragilis	fragil papershell			X	X		**X**
Obliquaria reflexa	three horn wartyback	X	5	X	X	1	**X**
Potamilus alatus	pink heelsplitter			X			**X**
Potamilus ohiensis	pink papershell		2				**2**
Pyganodon grandis	giant floater		2	X	X		**X**
Quadrula pustulosa	pimpleback		1		X		**X**
Toxolasma parvus	liliput	X		X			**X**
Total			38			1	
Number of Species		6	6	9	7	1	**11**
Time Searched (min)		60	180	70	70	60	**440**
UTM Easting		722152	722194	722330	722586	722749	
UTM Northing		4618998	4619250	4619599	4620295	4621104	
X= species found live							

DEPARTMENT OF THE ARMY
MISSISSIPPI VALLEY DIVISION, CORPS OF ENGINEERS
P.O. BOX 80
VICKSBURG, MISSISSIPPI 39181-0080

REPLY TO
ATTENTION OF:

CEMVD-DE

31 AUG 17

MEMORANDUM FOR Commander, Rock Island District

SUBJECT: Review Plan Approval for the Upper Mississippi River Restoration (UMRR) Habitat Rehabilitation Enhancement Project, Steamboat Island

1. References:

a. Memorandum, CEMVR-PD-F, 6 July 2017, subject: Upper Mississippi River Restoration (UMRR) Habitat Rehabilitation Enhancement Project, Steamboat Island Review Plan (RP) (encl 1).

b. Memorandum, CEMVD-RB-T, 21 August 2017, subject as above (encl 2).

c. Memorandum, CECW-MVD, 16 May 2012, subject: Request for Approval of a Model Peer Review Plan for the Upper Mississippi River System Environmental Management Program (encl 3).

d. EC 1165-2-214, 15 December 2012, subject: Civil Works Review Policy.

2. The enclosed Review Plan (RP) (encl 4) is a combined decision document and implementation document review plan. It includes the MVD EMP checklist and has been prepared in accordance with EC 1165-2-214. The RP has been coordinated between the Business Technical Division and the Upper District Support Team.

3. I hereby approve this RP, which is subject to change as circumstances require, consistent with study development under the Project Management Business Process. Subsequent revisions to this RP or its execution will require new written approval from this office. Non-substantive changes to this RP do not require further approval. The district should post the approved RP to its website.

4. The MVD point of contact is Mr. Gabe Harris, CEMVD-PDM, [redacted]

4 Encls

MICHAEL C. WEHR
Major General, USA
Commanding

STEAMBOAT ISLAND
Upper Mississippi River Restoration (UMRR)
Habitat Rehabilitation and Enhancement Project (HREP)
AFTER ACTION REPORT

1. Introduction. This document serves as the after-action report for the Steamboat Island HREP (Project) Public Open House held on March 26, 2018. At the public meeting US Army Corps of Engineers (USACE), US Fish and Wildlife Service (USFWS), and Iowa Department of Natural Resource (IADNR) representatives were available to discuss the existing and historic conditions at Steamboat Island and surrounding area, the preliminary problems, goals, and objectives developed by the team, and potential Project features brainstormed by the team, as well as gather comments and other pertinent feedback from the public. A short formal presentation was held at the beginning of the Open House.

2. Open House Objective. The objective of the Open House was to give a short presentation addressing the initiation of the HREP Feasibility Study and answer questions and listen to comments from the public.

3. Open House Location. The Open House was held at the Mississippi River Eco-Tourism Center in Rock Creek Park, 3942 291st Street, Camanche, IA.

4. Medium. A post card announcement was mailed to 330 addressees including congressional interests, federal, state and local governmental agencies; businesses, environmental organizations, media and the general public inviting them to attend an open house. The Corporate Communications Office also sent a news release to area television and radio stations and newspapers. Three radio and newspaper interviews were conducted prior to the Open House. USFWS Upper Mississippi River National Wildlife and Fish Refuge (UMR NWFR) also posted the Project and Open House information on their website.

5. Open House Format.

a. Date/Time: The open house was held on March 26, 2018 from 4:00 pm – 6:00 pm.

b. Staff: The Steamboat Island UMRR/HREP is a joint effort with the following agencies: USACE-Rock Island and St. Paul Districts, the USFWS, and the IADNR. The Corps/agency technical experts were present to talk one-to-one with the attendees during the Open House and to answer any questions. The representatives were:

Rachel Perrine – USACE-St. Paul District
Julie Millhollin – USACE-Rock Island District
Marshall Plumley – USACE-Rock Island District
Kathryn Herzog – USACE- St. Paul District
Cynthia Peterson – USACE- St. Paul District
Kyle Nerad – USACE-Rock Island District
Steve Gustafson – USACE-Rock Island District

Jessica Steslow – USACE-Rock Island District
Kara Mitvalsky – USACE-Rock Island District
Lucie Sawyer – USACE-Rock Island District
Sam Heilig – USACE-Rock Island District
Ben Vandermyde – USACE-Rock Island District
Mike Griffin – IADNR
Kirk Hansen – IADNR
Scott Gritters – IADNR
Sara Schmuecker – USFWS, Illinois-Iowa Field Office
Tyler Porter – USFWS, Illinois-Iowa Field Office
Sharonne Baylor – USFWS, UMR NWFR
Ed Britton – USFWS, UMR NWFR-Savanna District
Russ Engelke – USFWS, UMR NWFR-Savanna District

c. Information and Displays. Each guest received a folder that contained UMRR information, the Open House Comment Card, a 2-page Project summary, and a copy of the Project's "Considerations and Constraints" map. A synchronized presentation was developed for the short formal presentation, which was well received by the audience. Three Subject Matter Expert (SME) stations were set up in the room: Engineering, Environmental, and Programs/Planning. Each SME had "Project Overview" and "Potential Project Features" (poster-size) maps. A presentation showing examples of potential Project features was developed and displayed after the formal presentation on the main screen and at the Engineering SME station. The Engineering SME also displayed a large map showing the bathymetric LiDAR data collected in 2018 and had copies (CD and hard copy) of the UMRR Design Handbook available. The Environmental SME also had a poster-size map of the Project's "Considerations and Constraints" on display. The Programs/Planning SME had copies of the Feasibility Report schedule, 6-step planning process, and copies of the 2016 Report to Congress. USFWS provided information about the UMR NWFR and Federally-listed species profiles. There was an area near the SME stations that had large Project overview maps that the public could mark on and indicate areas of interest or feature ideas.

d. Social Media: The Corporate Communications Office streamed the Open House live on Facebook. At one time during the meeting, 19 people were watching the live feed. During the meeting there were 7 comments from the public and the team fielded 3 questions from the online comments. During and after the event, the Facebook live video was shared 14 times, reached 2,815 people and was viewed 1,167 times. Prior to the Open House, an event was created on Facebook by the Corporate Communications office and was shared to partnering agencies. This event reached more than 18,000 people in 12 days and garnered 113 responses from Facebook users. An article about the Open House published by a local newspaper was also shared by the Corporate Communications office on Facebook and it was shared 9 times and reached an additional 2,484 people.

6. Attendance. There were approximately 75 people in attendance. The attendees were asked to complete a comment sheet. Results of the returned comments are shown in paragraph 7 below.

7. Public Comments. Attendees were asked to fill out a comment sheet. A total of 3 sheets were submitted.

a. All surveyed participants ‘completely agreed’ that the Open House gave them an opportunity to better understand the Project and provided an opportunity to offer comments and feedback to the Project team.

b. Participants also appreciated the opportunity to talk with technical experts during the Open House.

c. Comment Card statements:
   - Improve Beaver Island back to fisheries and hunting and areas around the Island.
   - Keep public appraised of the project.
   - A significant resource at the Project area is the opportunity for the public to get closer to a natural setting while remaining close to home.
   - If you expand the beach area for boaters first, this will generate a very favorable public opinion. Boaters spend money and this helps the local economy.
   - Shallow water at the beach is preferred by today’s boaters and a larger shallow beach area is needed to accommodate the volume of boaters.
   - Steamboat Slough should be opened back up to make it a good “off channel” water sports area.
   - More recreational usage at “Princeton Beach” will increase the conflict between barge traffic and recreational and water sports boaters. As part of this project, steps need to be taken to reduce this danger.
   - Barges loaded with toxic chemicals tie up for days on the north end of Steamboat Island across the river from Hugunins light at 504.6L. In line with the ECO theme of this project this practice should be prohibited.

d. Questions/Features ideas from guests (discussions between public and technical experts):
   - Can we dredge and do aquatic diversity in the forested area south of the Wapsipinicon River?
   - Can we incorporate a better connection between the Project and Princeton WMA (pumping, etc)?
   - How often will we dredge to address future sedimentation?
   - Can we deal with the sand that comes off “Princeton Beach” and silts in downstream?
   - How will the team prioritize dredging areas?

e. Additional comments (discussions between public and technical experts):
   - There was a lot of positive feedback about the Open House and Project. The guests expressed satisfaction in the UMRR Program and that we are pursuing restoration efforts at Steamboat Island and surrounding area.
   - The Engineering SME received positive feedback about the new technology being used to collect LiDAR data.
   - Ben, Project Forester, received positive feedback about the process and potential ideas for forestry improvement – many were excited about hickory plantings.
   - Many guests have maps/photos to share and are interested in volunteer efforts during Project construction/planting. We will have to look into how to use volunteers for construction and implementation.
   - A guest reported that a Professor Danforth used to take a houseboat to the Project area and do bug/bird/etc counts. We may be able to find and use that information.
   - A guest reported that there are sites within the Project area that contain purple turtlehead flowers.
   - A guest was concerned that the wing dam would be left out of the project. The wing dam had a large opening (150 feet) and it was about 10 feet deep, but now you can't get through with a canoe. The wing dam is in the "cut off" area. He would like the wing dam fixed and noted that he used to run his houseboat over it.

8. **Team Comments.** Members of the USFWS, IADNR, and USACE-Rock Island District also provided feedback on the event.

   a. Set up of the room (presentation area with sitting in center and SME stations around the back wall of the room) provided a good layout for people to ask questions to the right project team member.

   b. The facility was great and provided adequate room for public participation.

   c. Facebook Live worked well and provided a forum for commenting for the people who were unable to attend.

   d. The team discussed having one map for public mark-up vs. a map at each SME station. There are pros and cons to each way.

8. Summary. The Open House was successfully executed and provided the public with a good forum to provide comments for the Project and initiation of the Feasibility Study. The discussion between the study team personal and the public was informative. Attendees generally support the open house format and the Project.

Rachel Perrine, CEMVP-RPEDN-PD-F, 26 April 2018

From: Moore, Seth
To: [redacted]
Subject: [Non-DoD Source] Re: Steamboat HREP
Date: Fr day, May 18, 2018 10:07:56 AM

Kathryn,

Here are some comments from staff about the HREP.

Staff Botanist/Ecologist John Pearson

The only Iowa location of state-Endangered Black-footed Quillwort (Isoetes melanopoda) was last reported in wetland habitat at the mouth of the Wapsipinicon River. A survey for this rare aquatic plant species would be very useful for its conservation.

Another state-listed species in the project area, Pink Turtlehead (Chelone obliqua) Special Concern was recently discovery in vicinity of Shaff Lake and the Mississippi River Ecotourism Center. I recommend survey for these two species in suitable habitat throughout the project area.

Staff Endangered Species Coordinator, Kelly Poole

Indiana Bat and Northern Long Eared Bat guidelines would apply if tree removal occurs. In addition tree removal could impact the state-Endangered red-shoulder hawk (Buteo lineatus) which is known to nest in upper 1/3 of the project area but has potential in suitable habitat through out.

If you have questions concerning these comments, please let me know.

Thank you,

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Seth Moore | Environmental Specialist

Iowa Department of Natural Resources

[redacted]

Blockedwww.iowadnr.gov <Blockedhttp //www.iowadnr.gov/>

On Mon, May 14, 2018 at 7 12 AM, Herzog, Kathryn M [redacted] > wrote

Good morning Seth,

In response to your email to Julie concerning Steamboat HREP, we are working closely with Kirk Hansen of IA DNR (cc'd). If you want to send me any specific information, please feel free to do so. We are working on existing conditions and any information you want to provide could be incorporated. An informal email will work.

Thanks,
Kat Herzog

[redacted]
United States Army Corps of Engineers
Environmental Planning Section
St. Paul District at Rock Island
Clock Tower Building
P.O. Box 2004
Rock Island, IL 61204-2004

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, MISSISSIPPI VALLEY DIVISION
P.O. BOX 80
VICKSBURG, MISSISSIPPI 39181-0080

CEMVD-PDM

MEMORANDUM FOR Commander, Rock Island District

SUBJECT: Revised Factsheet Approval - Upper Mississippi River Restoration Program, Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP), Scott County, Iowa

1. References:

a. Memorandum, CEMVR-PM-M, 2 March 2018, subject: Upper Mississippi River Restoration Program, Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP), Scott County, Iowa, Revised Fact Sheet (encl 1).

b. Memorandum, CEMVD-PD-SP, 29 September 2010, subject: Upper Mississippi River Restoration – Environmental Management Program (UMRR-EMP), Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP), Scott County, Iowa, Fact Sheet (encl 2).

2. Subject Fact Sheet is approved for continued HREP planning (encl 3).

3. The MVD point of contact for this action is Mr. Gabe Harris, CEMVD-PDM, ([redacted]

3 Encls

GARY L. YOUNG
Chief, Planning Division

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, ROCK ISLAND DISTRICT
PO BOX 2004 CLOCK TOWER BUILDING
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO
ATTENTION OF

MAR 02 2018

CEMVR-PM-M

MEMORANDUM FOR Commander, US Army Corps of Engineers, Mississippi Valley Division (CEMVD-PD-SP/Harris), PO Box 80, 1400 Walnut Street, Vicksburg, Mississippi 39181-0080

SUBJECT: Upper Mississippi River Restoration Program, Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP), Scott County, Iowa, Revised Fact Sheet

1. The subject Fact Sheet (Encl 1) is submitted for your review and approval. An electronic copy has been sent to Mr. William Harris, CEMVD-PD-SP.

2. The original Steamboat Island HREP Fact Sheet was approved on 29 September 2010 (Encl 2).

3. The project area has expanded from 500 acres to about 2,600 acres. The area in the revised Fact sheet includes Steamboat Island, Steamboat Slough, and adjacent secondary channel complex (Grant Slough), smaller island southeast of Steamboat Island and the forested areas south and north of the Wapsipinicon River. The additional project area will protect, enhance, and restore aerial coverage and diversity of floodplain forest habitat and increase hard mast-producing trees.

4. Questions concerning this document should be addressed to Ms. Julie Millhollin, Project Manager, [redacted] or e-mail: [redacted].

Encls
as

CRAIG S. BAUMGARTNER
COL, EN
Commanding

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT (HREP)
SCOTT COUNTY, IOWA,
UPPER MISSISSIPPI RIVER RESTORATION-ENVIRONMENTAL MANAGEMENT PROGRAM
ROCK ISLAND DISTRICT

FACT SHEET
Revised

I. LOCATION

The Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP) is located in Scott County, Iowa, in the middle of Pool 14 along the right descending bank of the Upper Mississippi River (UMR). Steamboat Island HREP lies between the town of Princeton (UMR River Mile 502.5) and the Wapsipinicon River (UMR RM 506.5), within the UMR National Wildlife and Fish Refuge. Areas considered as part of this Project and described as the Project area include Steamboat Island, Steamboat Slough, an adjacent secondary channel complex (Grant Slough), smaller islands southeast of Steamboat Island, and the forested areas south and north of the Wapsipinicon River (Figure 1). The Princeton State Wildlife Area is just west of the island.

II. EXISTING RESOURCES

The Project area includes interconnected backwaters, wetlands, islands, floodplain habitat, backwater lakes, sloughs, and flowing channels. Though degraded, this important backwater area supports a diverse population of wildlife including ducks, geese, swans, pelicans, eagles, and muskrats. Figure 2 shows 2000 and 2010 land cover data for the Project area.

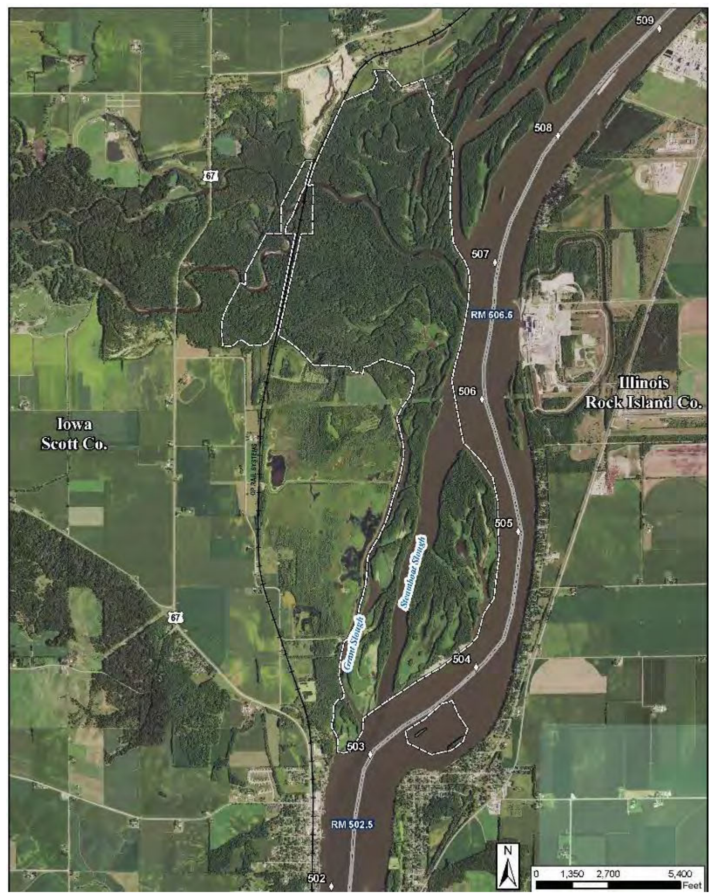

Figure 1. General Project Location

III. PROBLEM IDENTIFICATION

Historically, Steamboat Island contained a number of small backwater lakes, sloughs, cuts, and flowing side channels. Similar habitats were found in the Grant Slough complex as well. These habitats provided valuable overwintering, spawning, and feeding areas for a variety of fish, especially centrarchids. Migratory birds, including waterfowl, shorebirds, and wading birds also used the area extensively.

Years of silt deposition has allowed willows and silver maples to colonize the once-aquatic portions of the Project area, resulting in a degraded aquatic and wetland complexes. In addition, impoundment of the pool and permanently higher water tables have affected the health of floodplain habitat on islands and adjacent floodplain areas. These higher water tables are affecting forest composition and regeneration.

IV. PROJECT GOALS AND OBJECTIVES

Project goals are derived from the Environmental Pool Plans, Pools 11 through 22; the Habitat Needs Assessment; and Reach Planning efforts. These project goals are consistent with the systemic goals adopted by the Environmental Management Program, now referred to as the Upper Mississippi River Restoration Coordinating Committee and the Navigation Environmental Coordination Committee in January of 2008.

Maintain, Enhance and Restore Quality Habitat for all Native and Desirable Plant, Animal and Fish Species

- protect, enhance, and restore aquatic habitat for viable populations of fish, invertebrates, aquatic and semi-aquatic mammals, reptiles, amphibians, waterfowl, shorebirds, etc.
- protect, enhance, and restore floodplain habitat for viable populations of the variety of mammals, birds, reptiles, amphibians, etc.
- protect, enhance, and restore aerial coverage and diversity of floodplain forest habitat and increase hard mast-producing trees

Maintain, Enhance, Restore, and Emulate Natural River Processes, Structures and Functions for a Sustainable Ecosystem

- stabilize flows throughout the complex
- restore sediment transport and deposition throughout the complex to a more "natural" condition
- minimize adverse effects of elevated water table on soil moisture conditions

V. PROPOSED PROJECT FEATURES

The proposed project includes backwater dredging to provide critical overwintering habitat for fish such as bass, crappie, yellow perch, and bluegill. The increase in wetland diversity would restore feeding habitat for resident and migratory birds. Dredged material could be used to create topographic diversity on the islands, to provide sediment control, or to maintain, create, or enhance nearby islands. Forest diversity could be accomplished by elevating islands, planting hardwoods, and forest management (Figure 3).

The above-proposed features will protect, enhance, and restore quality wetland habitat for all native and desirable plant, wildlife, and fish species. Targeted animals include eagles, mussels, fish, turtles, migrating waterfowl, mammals, and waterbirds. Targeted plants include emergent vegetation such as arrowhead, burreed, and bulrush; submersed vegetation such as wild celery and sago pondweed; and floodplain vegetation such as swamp white oak, and button bush.

VI. IMPLEMENTATION CONSIDERATIONS

Backwater and channel maintenance dredging material could be used for topography enhancements; to provide sediment control; or to maintain, create, or enhance nearby islands.

VII. FINANCIAL DATA

All project lands are federally-owned and are managed by the U.S. Fish and Wildlife Service (USFWS) as part of the UMR National Wildlife and Fish Refuge. The estimated cost for the general planning, design, and construction of the actions noted in Section V is $13 million.

Since this project is located on a National Wildlife Refuge, it is 100 percent federally funded. The USFWS is the project sponsor and is responsible for operation and maintenance costs.

VIII. STATUS

The project was submitted to the Fish and Wildlife Interagency Committee on January 12, 2006 and accepted by the River Resources Coordinating Team on January 24, 2006 and reaffirmed in May 2010.

IX. POINTS OF CONTACT

Marshall Plumley, Program Manager, U.S. Army Corps of Engineers, Rock Island District, [redacted]
Ed Britton, USFWS, Savanna District Manager, [redacted]
Kirk Hansen, Mississippi River Wildlife Biologist, Iowa Department of Natural Resources, [redacted]

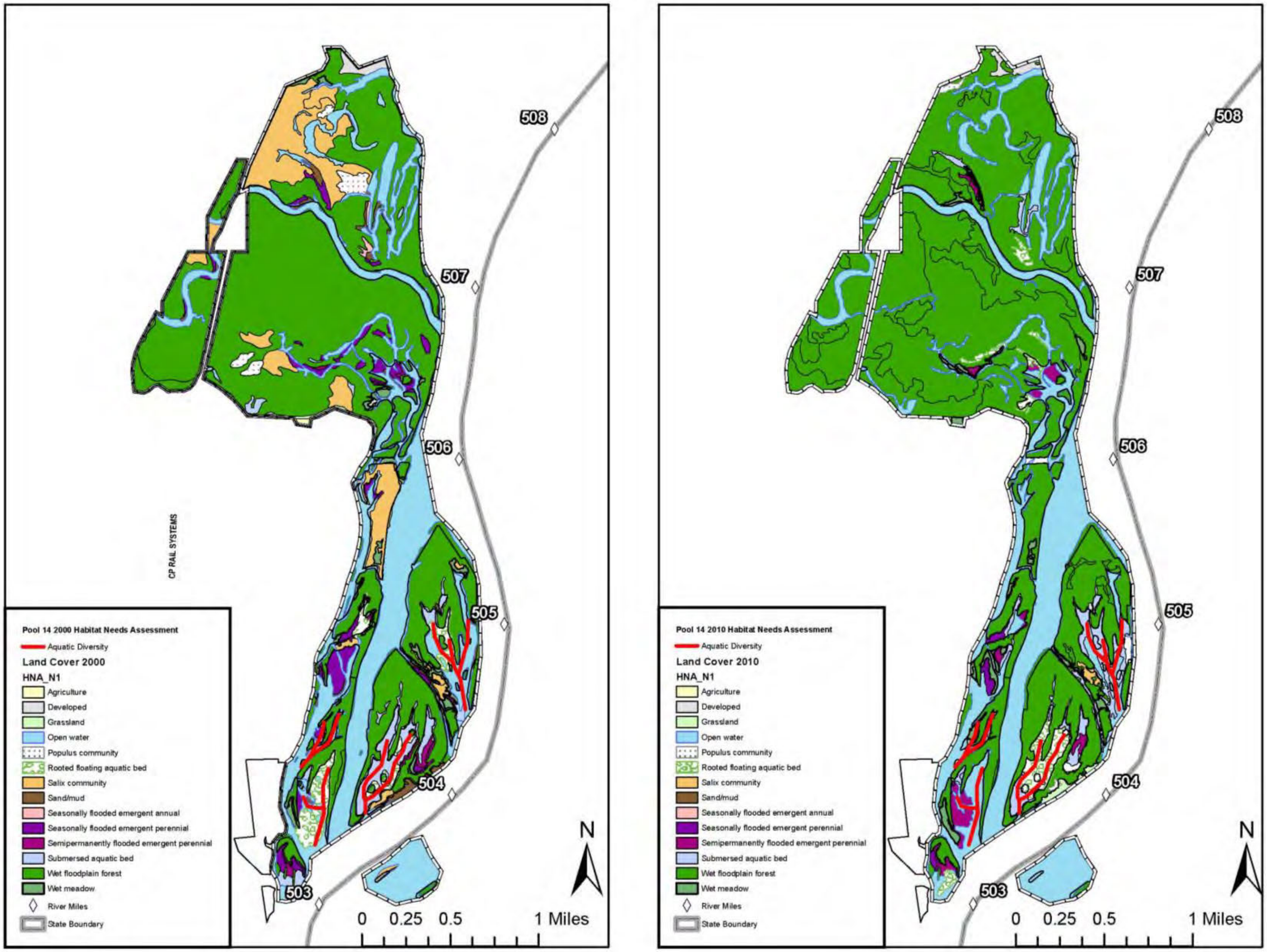

Figure 2. 2000 and 2010 Land Cover Data

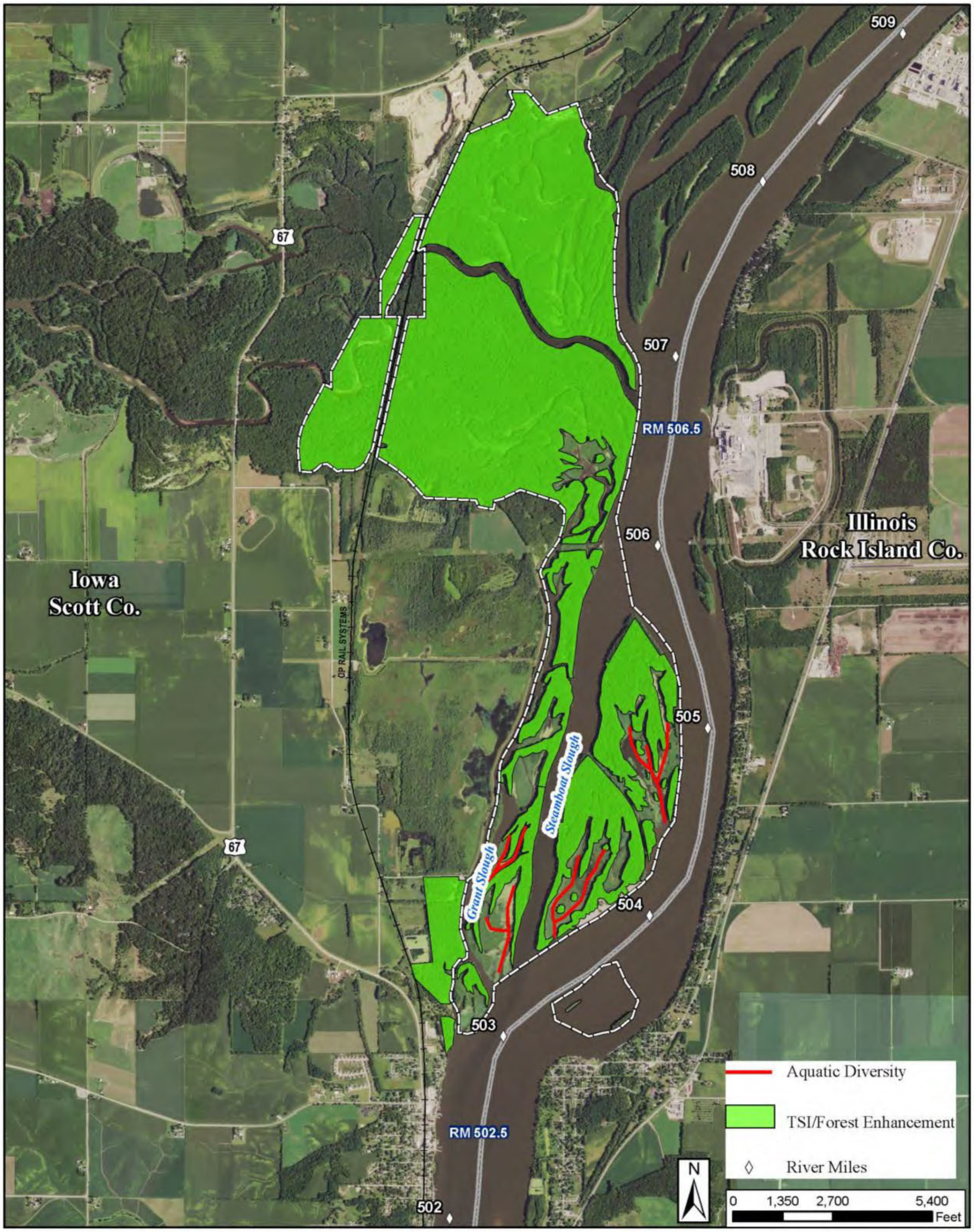

Figure 3. Proposed Project Features

DEPARTMENT OF THE ARMY
MISSISSIPPI VALLEY DIVISION, CORPS OF ENGINEERS
P.O. BOX 80
VICKSBURG, MISSISSIPPI 39181-0080

REPLY TO
ATTENTION OF:

CEMVD-PD-SP 29 September 2010

MEMORANDUM FOR Commander, Rock Island District, ATTN: CEMVR-PM-M

SUBJECT: Upper Mississippi River Restoration - Environmental Management Program (UMRR-EMP), Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP), Scott County, Iowa, Fact Sheet

1. Reference memorandum, CEMVR-PM-M, 08 July 2010, subject as above.

2. Subject fact sheet is approved for continued HREP planning (encl 1).

3. The MVD point of contact is Elizabeth Ivy, CEMVD-PD-SP, [redacted]

Encl

Charles B. Barton
CHARLES B. BARTON
Chief, District Support Team for
St. Louis, Rock Island, and
St. Paul

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT (HREP)
SCOTT COUNTY, IOWA,
UPPER MISSISSIPPI RIVER RESTORATION-ENVIRONMENTAL MANAGEMENT PROGRAM
ROCK ISLAND DISTRICT

FACT SHEET

I. LOCATION

The Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP) is located on the right descending bank of the Mississippi River in Pool 14 of the Upper Mississippi River (UMR) within the UMR National Wildlife and Fish Refuge, between RM 503.5 to 505.5, approximately 1 mile above Princeton, Iowa. It is bound by the main channel on the north, east, and south and by Steamboat Slough on the west (figure 1). The Princeton State Wildlife Area is just west of the island.

II. EXISTING RESOURCES

This area includes backwater lakes, sloughs, flowing channels, and remnant islands. Though degraded, this important backwater area supports a diverse population of wildlife including ducks, geese, swans, pelicans, eagles, and muskrats. Figure 2 shows 1989 and 2000 land cover data for the project area.

III. PROBLEM IDENTIFICATION

Historically, Steamboat Island contained a number of small backwater lakes, sloughs, cuts, and flowing side channels. These habitats provided valuable overwintering, spawning, and feeding areas for a variety of fish, especially centrarchids. Migratory birds, including waterfowl, shorebirds, and wading birds also used the area extensively.

Years of silt deposition has allowed willows and silver maples to colonize the once-aquatic portions of the island, resulting in a degraded wetland complex. In addition, impoundment of the pool and permanently higher water tables have affected the health of floodplain habitat on islands and adjacent floodplain areas. These higher water tables are affecting forest composition and regeneration.

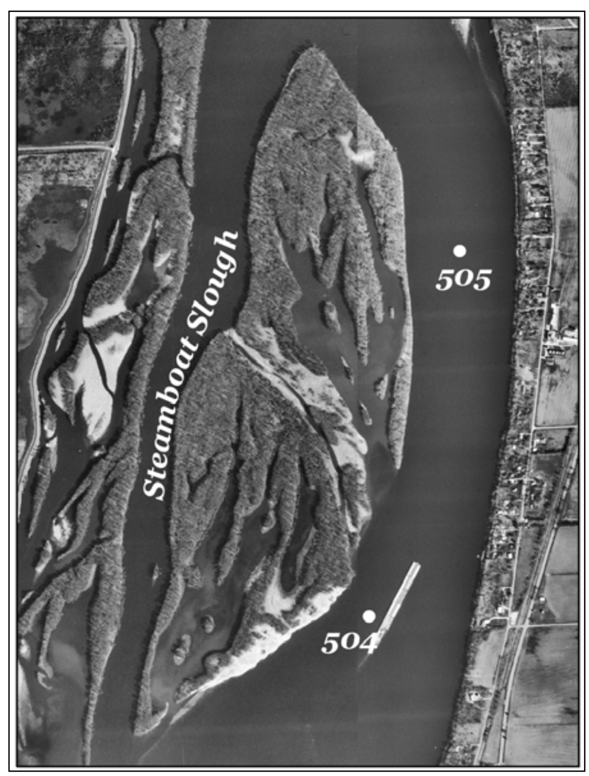

Figure 1. General Project Location

IV. PROJECT GOALS AND OBJECTIVES

Project goals are derived from the Environmental Pool Plans, Pools 11 through 22; the Habitat Needs Assessment; and Reach Planning efforts. These project goals are consistent with the systemic goals adopted by the Environmental Management Program Coordinating Committee and the Navigation Environmental Coordination Committee in January of 2008.

Maintain, Enhance and Create Quality Habitat for all Native and Desirable Plant, Animal and Fish Species

- protect, enhance, and restore aquatic habitat for viable populations of fish, invertebrates, aquatic and semi-aquatic mammals, reptiles, amphibians, waterfowl, shorebirds, etc.
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Maintain, Enhance, Restore, and Emulate Natural River Processes, Structures and Functions for a Sustainable Ecosystem

- stabilize flows throughout the complex
- restore sediment transport and deposition throughout the complex to a more "natural" condition
- manage pool water elevations to emulate more natural seasonal water elevations
- minimize adverse effects of elevated water table on soil moisture conditions

V. PROPOSED PROJECT FEATURES

The proposed project includes backwater dredging to provide critical overwintering habitat for fish such as bass, crappie, yellow perch, and bluegill. The increase in wetland diversity would restore feeding habitat for resident and migratory birds. Dredged material could be used to create topographic diversity on the islands, to provide sediment control, or to maintain, create, or enhance nearby islands. Forest diversity could be accomplished by elevating islands, planting hardwoods, and forest management (figure 3).

The above-proposed features will protect, enhance, and restore quality wetland habitat for all native and desirable plant, wildlife, and fish species. Targeted animals include eagles, mussels, fish, turtles, migrating waterfowl, mammals, and waterbirds. Targeted plants include emergent vegetation such as arrowhead, burreed, and bulrush; submersed vegetation such as wild celery and sago pondweed; and floodplain vegetation such as swamp white oak, and button bush.

VI. IMPLEMENTATION CONSIDERATIONS

Backwater and channel maintenance dredging material could be used for topography enhancements; to provide sediment control; or to maintain, create, or enhance nearby islands.

VII. FINANCIAL DATA

All project lands are federally-owned by the Corps of Engineers and are managed by the U.S. Fish and Wildlife Service (USFWS) as part of the UMR National Wildlife and Fish Refuge. The estimated cost for the general planning, design, and construction of the actions noted in Section V is $6 million. Since this project is located on a National Wildlife Refuge, it is 100 percent federally funded. The USFWS is the project sponsor and is responsible for operation and maintenance costs.

VIII. STATUS

The project was submitted to the Fish and Wildlife Interagency Committee on January 12, 2006 and accepted by the River Resources Coordinating Team on January 24, 2006 and reaffirmed in May 2010.

IX. POINTS OF CONTACT

Marvin Hubbell, Program Manager, U.S. Army Corps of Engineers, Rock Island District, [redacted]
Ed Britton, USFWS, Savanna District Manager, [redacted]
Mike Griffin, Mississippi River Wildlife Biologist, Iowa Department of Natural Resources, [redacted]

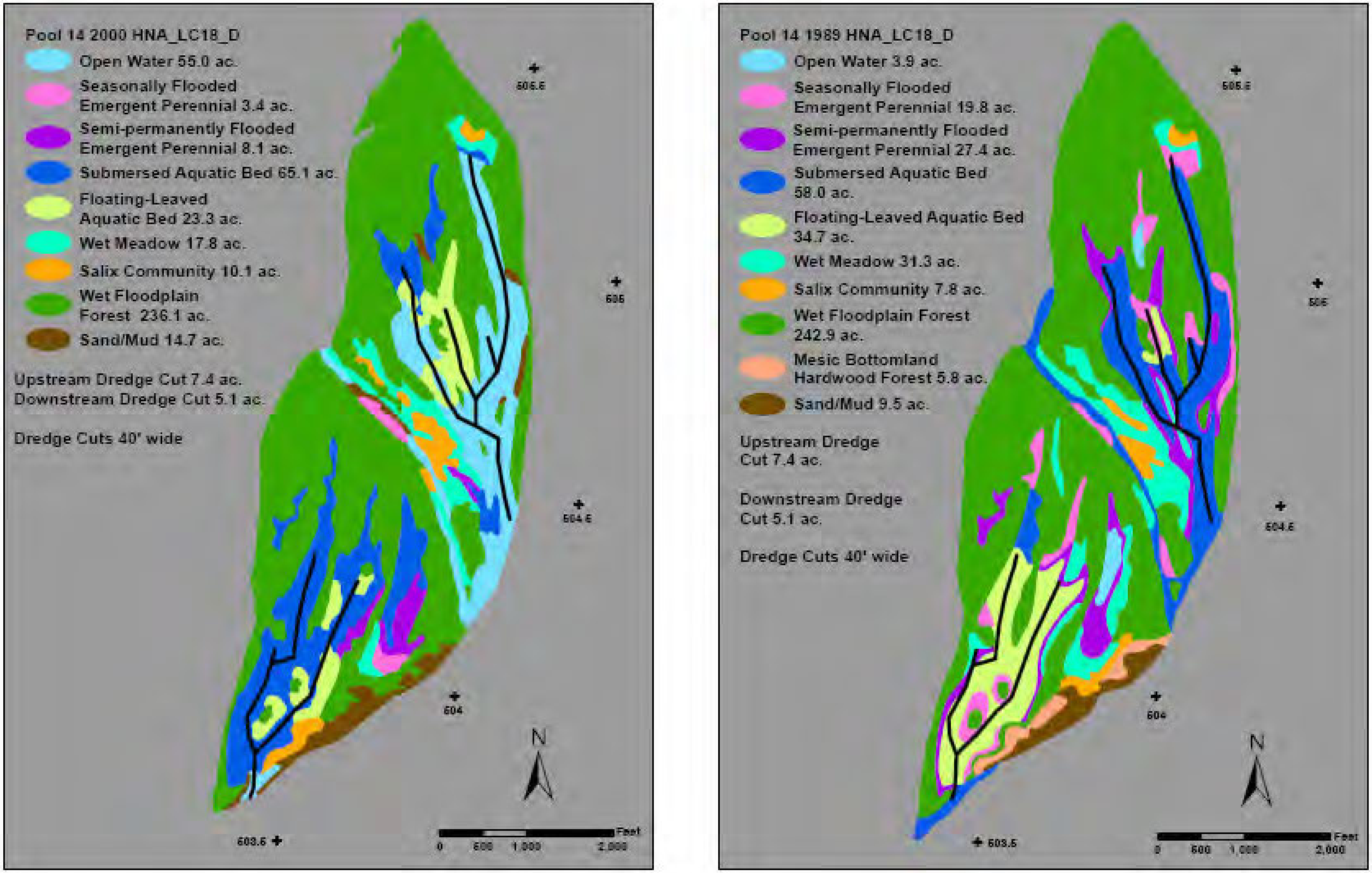


Figure 2. 1989 and 2000 Land Cover Data

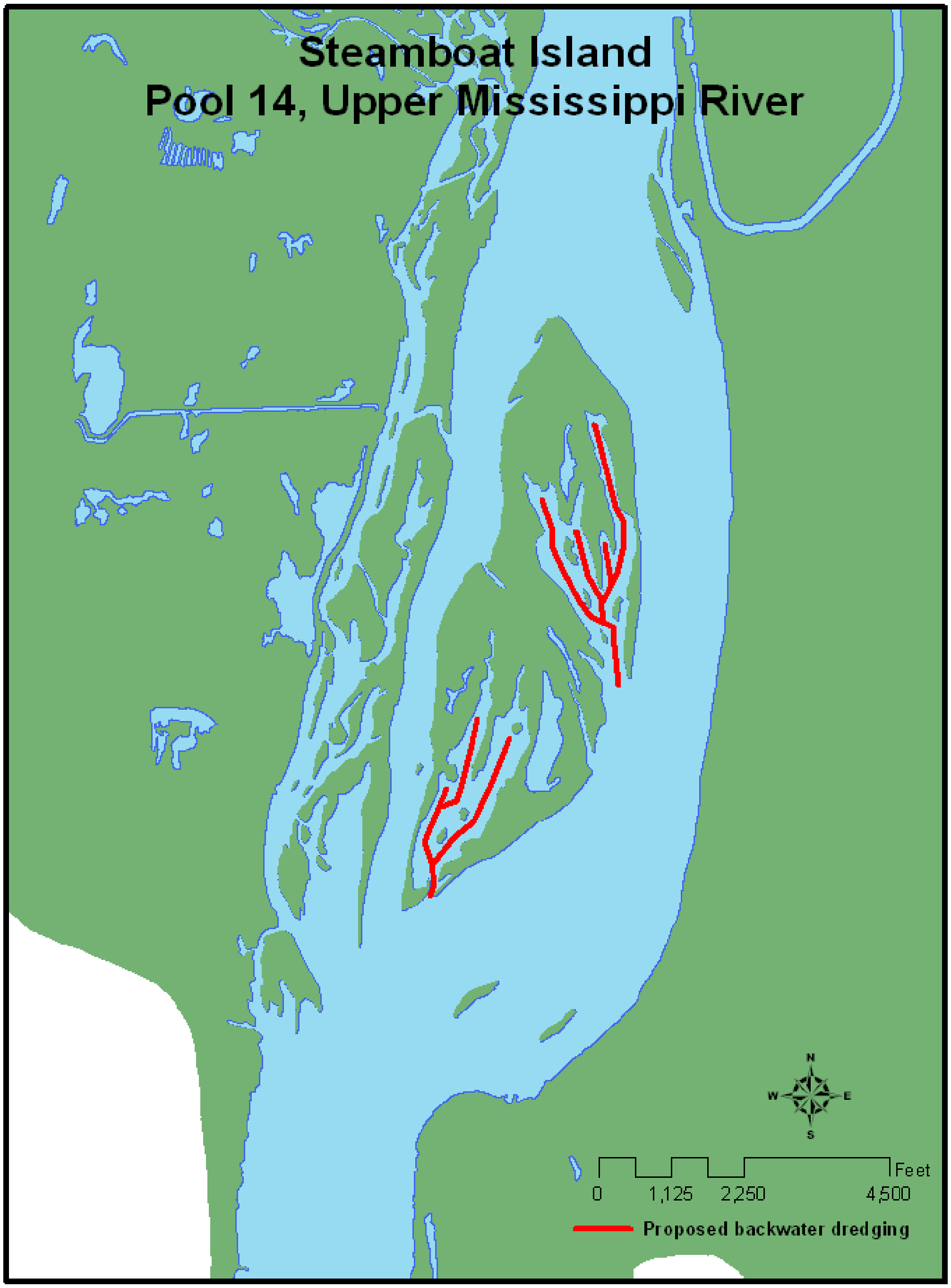


Figure 3. Proposed Project Features

Pesi 1027.06

FINAL REPORT
ASSESSMENT OF NATIVE AND NON-INDIGENOUS MUSSEL SPECIES FOR THE STEAMBOAT ISLAND HREP AT POOL 14 OF THE UPPER MISSISSIPPI RIVER IN SCOTT COUNTY, IOWA.

09 November 2018

Prepared for:

U.S. Army Corps of Engineers – Rock Island District
1500 Rock Island Drive
Rock Island, Illinois 61201

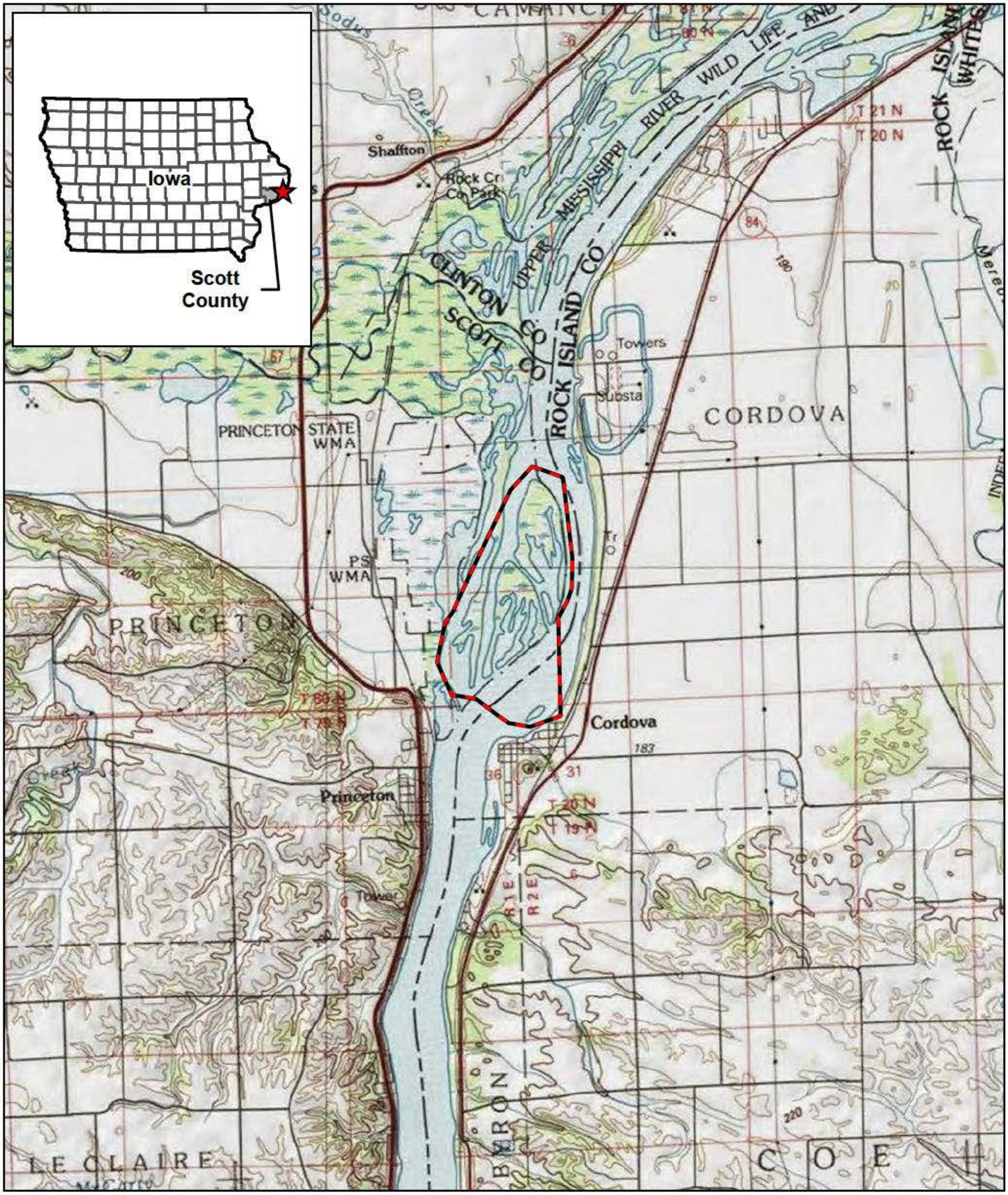
Contract No. W912EK-16-D-0010

Prepared by:

Environmental Solutions & Innovations, Inc.

4525 Este Avenue
Cincinnati, Ohio 45232
Phone: (513) 451-1777
Fax: (513) 451-3321
Stow, OH • Indianapolis, IN • Orlando, FL • Springfield, MO • Pittsburgh, PA • Teays Valley, WV

FIGURES



Area of Investigation (AOI)

N
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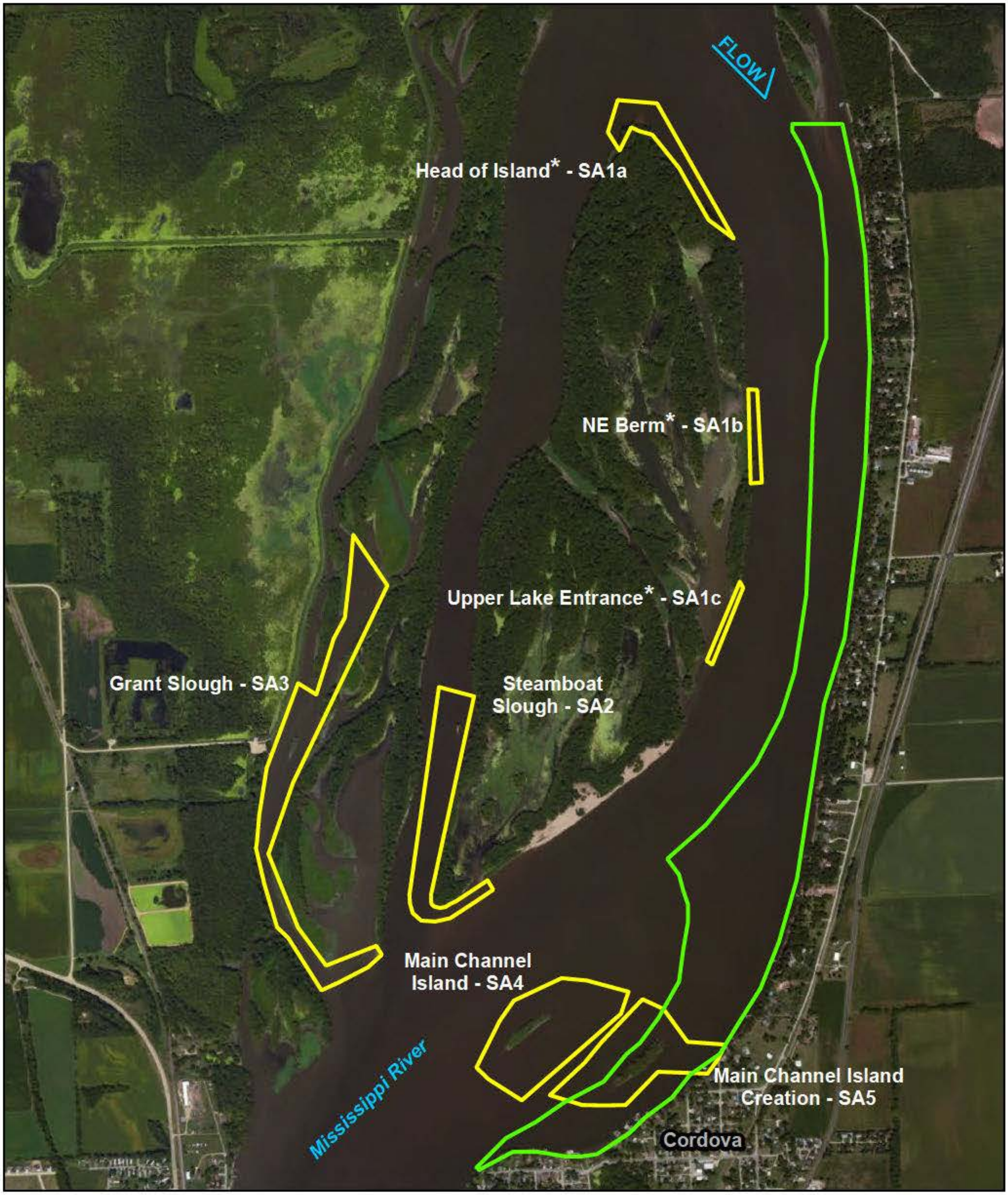
Figure 1. Location of freshwater mussel surveys in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

Project No. 1027.06	1,000 0 1,000 2,000 Meters Base Map: ESRI "USGS Topographic Map"	ESI	ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.



Cordova Essential Habitat Area (EHA) Study Area (SA) *Steamboat Island Complex - SA1

Figure 2. Freshwater mussel survey extent in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) Area in the Upper Mississippi River in Scott County, Iowa.

N W E S

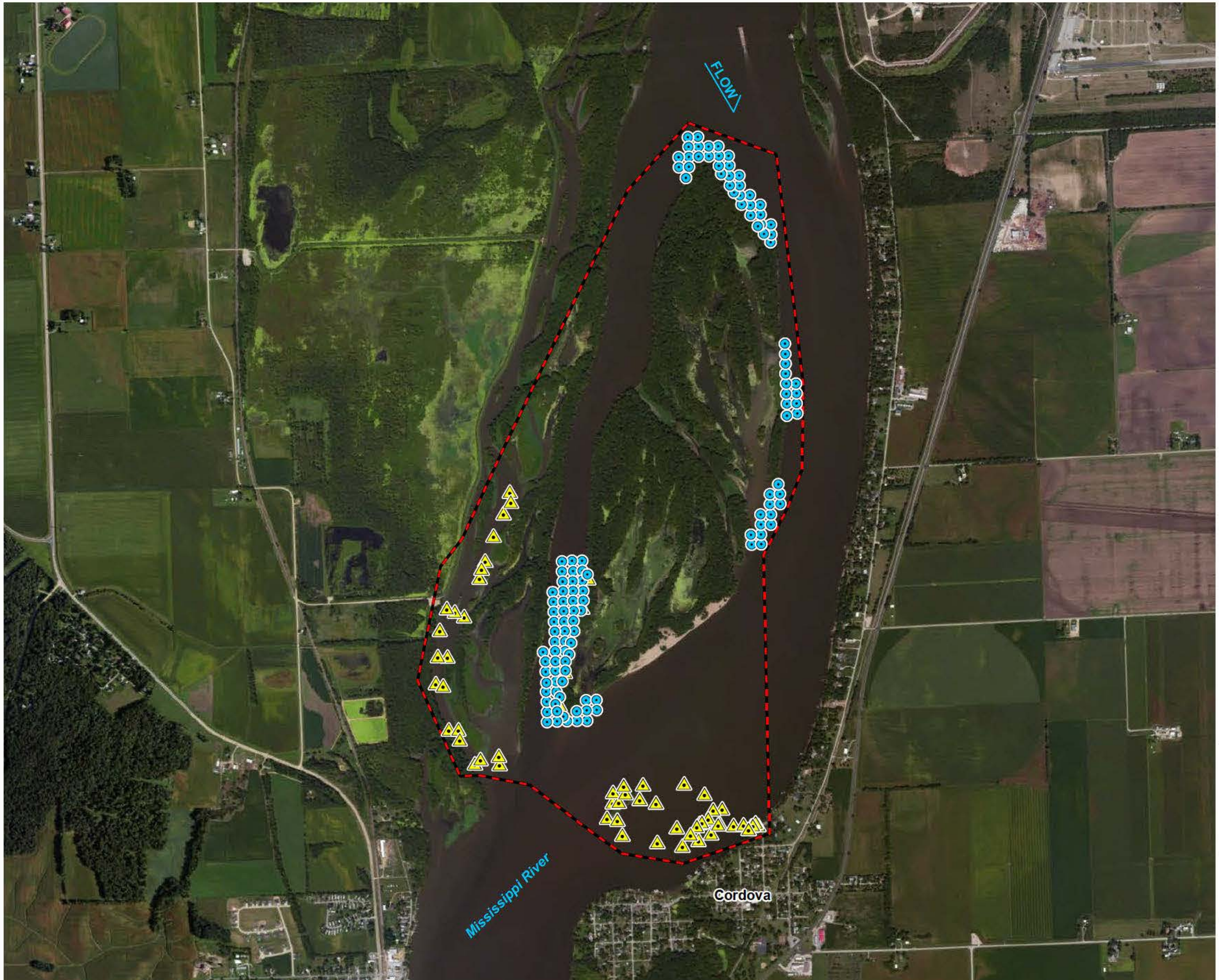
Project No. 1027.06

250 0 250 500 Meters

Base Map: ESRI "World_Imagery (Clarity)"

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

Figure 3. Quantitative and qualitative sample locations in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River in Scott County, Iowa.



Quantitative Sampling Location (123)

Qualitative Sampling Location (60)

Area of Investigation (AOI)

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Meters

250 0 250 500

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 10/11/2018

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC

1027.06

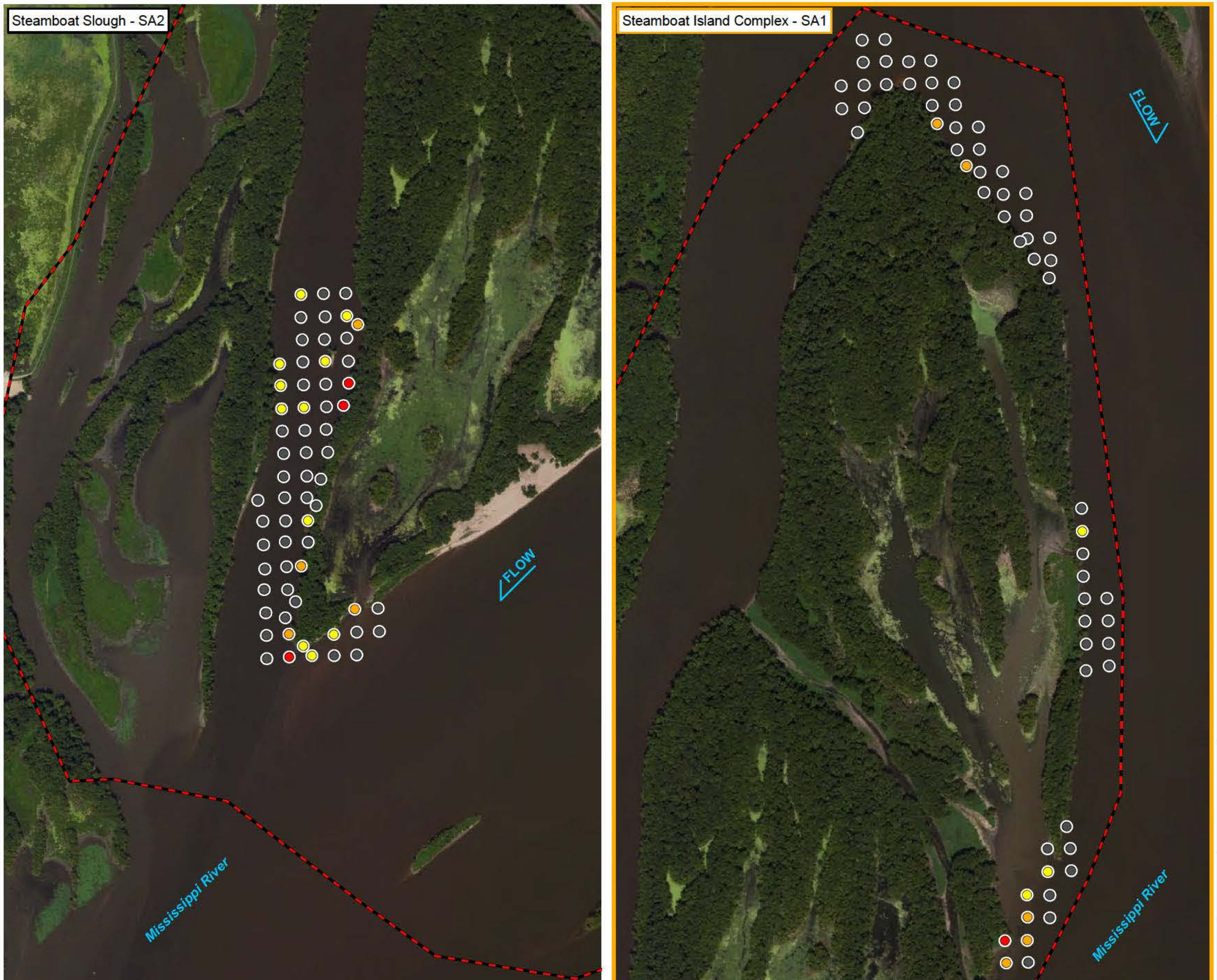
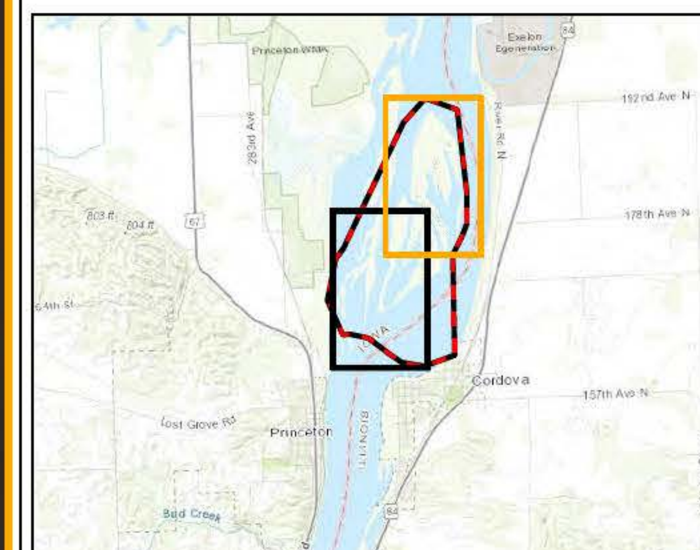


Figure 4. Quantitative mussel abundance for freshwater mussel surveys at Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

Mussel Abundance (no./0.25m²)

- 0 (96)
- 1 (14)
- 2 - 4 (9)
- 5 - 6 (4)
- Area of Investigation (AOI)



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W E
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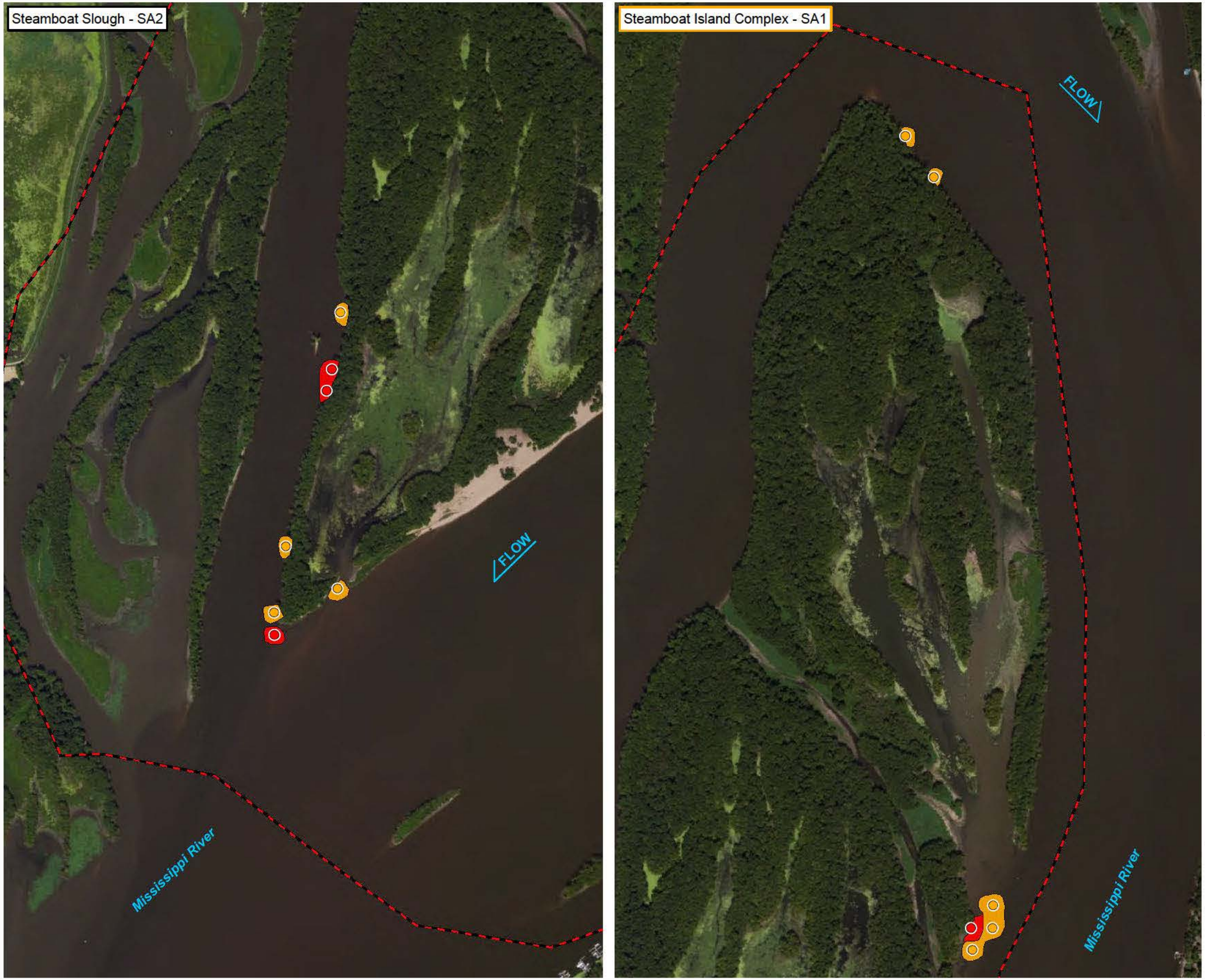
Meters
110 0 110 220

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 10/12/2018

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC
1027.06

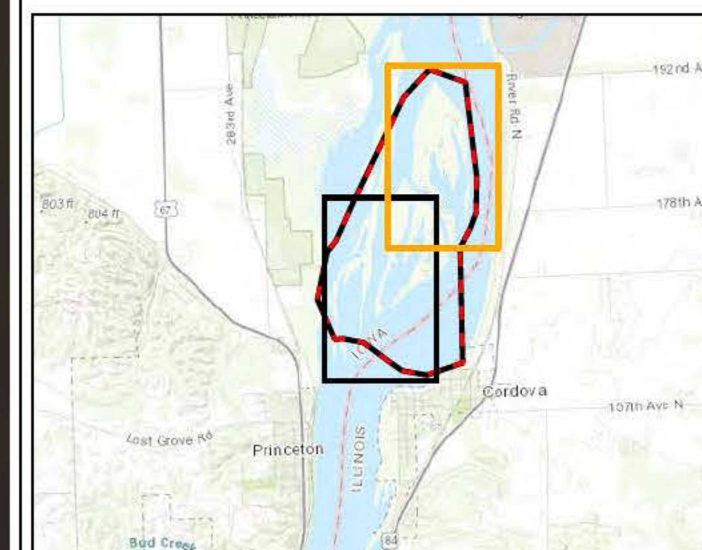
Figure 5. Extrapolated mussel densities in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River in Scott County, Iowa.



Mussel Abundance (no./0.25m²)

Abundance

- 2 - 4 (9)
- 5 - 6 (4)
- Area of Investigation (AOI)



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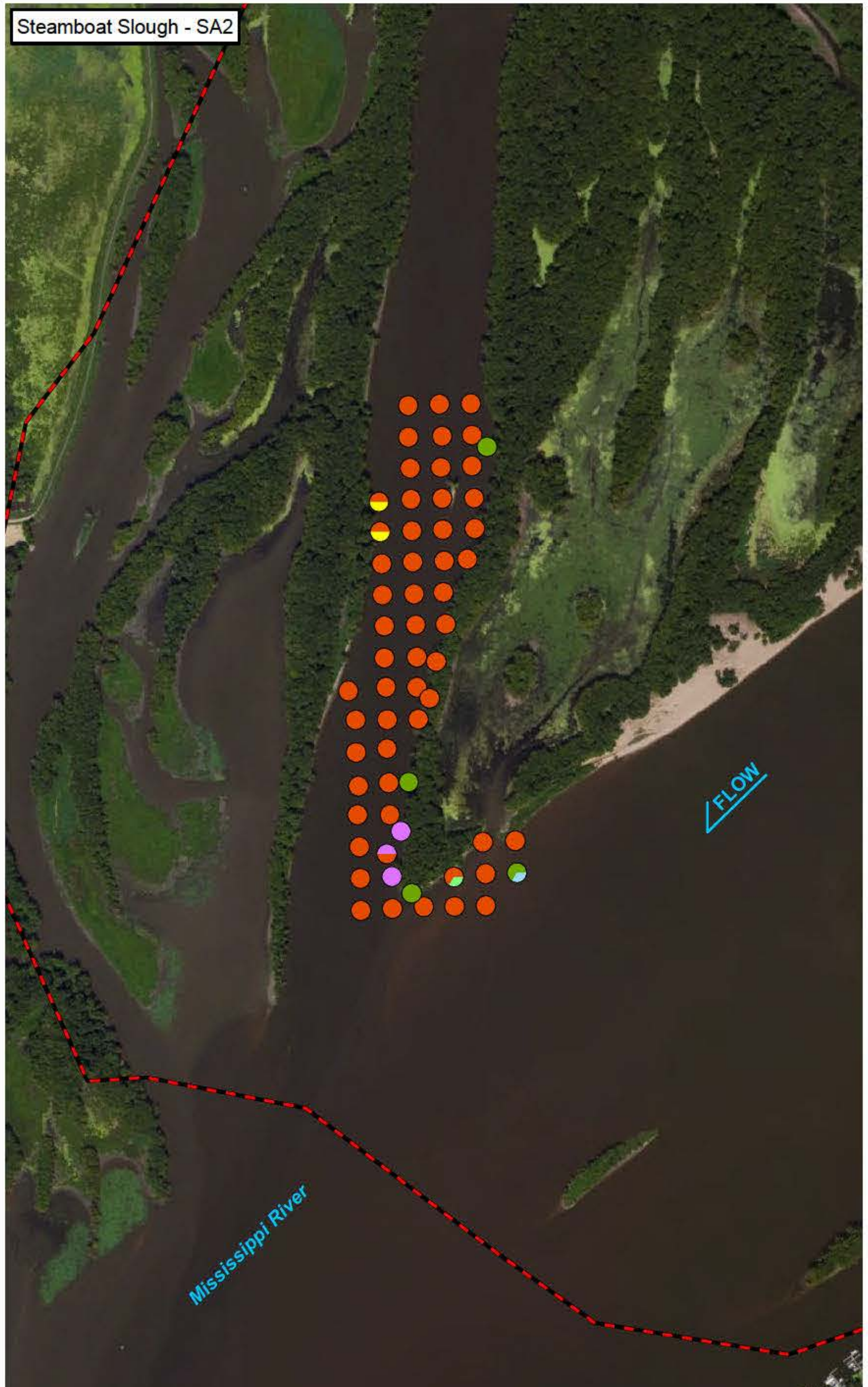
Meters

110 0 110 220

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 10/12/2018

ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC

1027.06



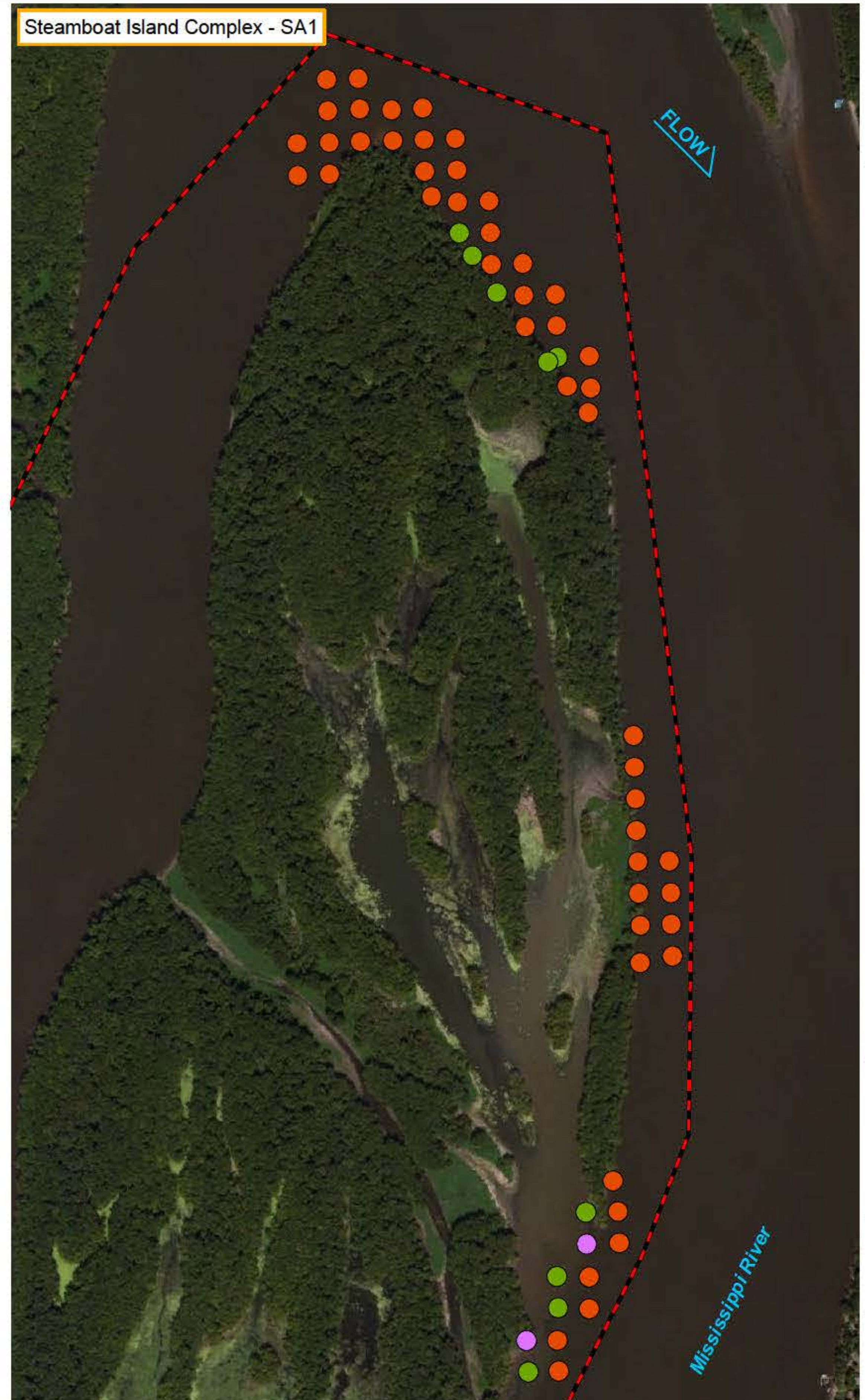
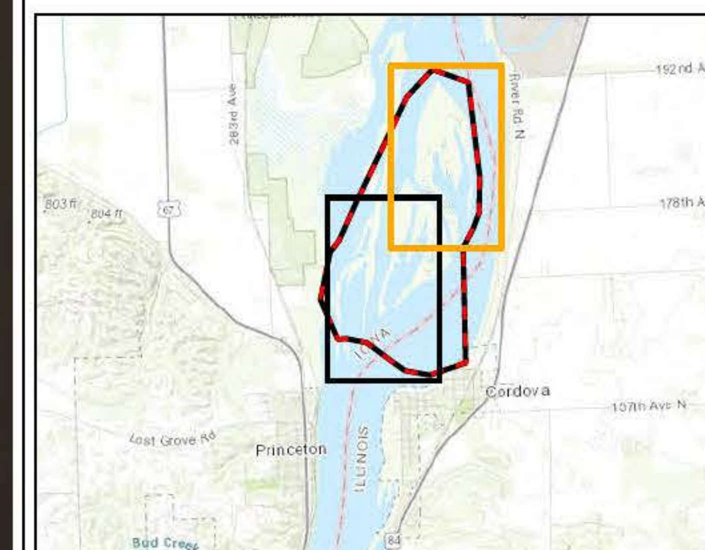


Figure 6. Quantitative sample substrate composition during freshwater mussel surveys in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

Quantitative Sampling Location

- clay
- fines
- sand
- gravel
- cobble
- boulder
- bedrock_hardpan
- other
- Area of Investigation (AOI)



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Meters
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Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 10/12/2018

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC
1027.06

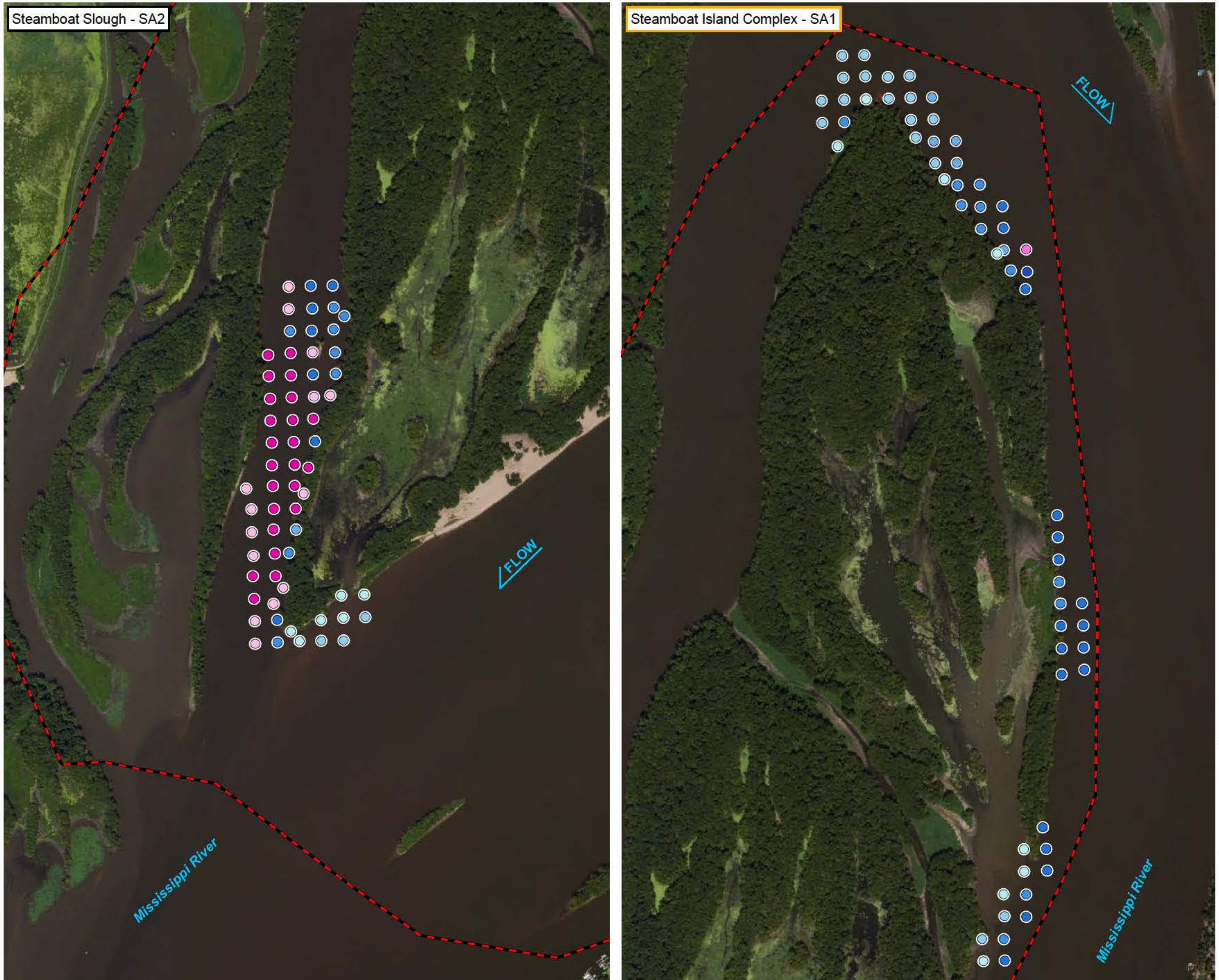
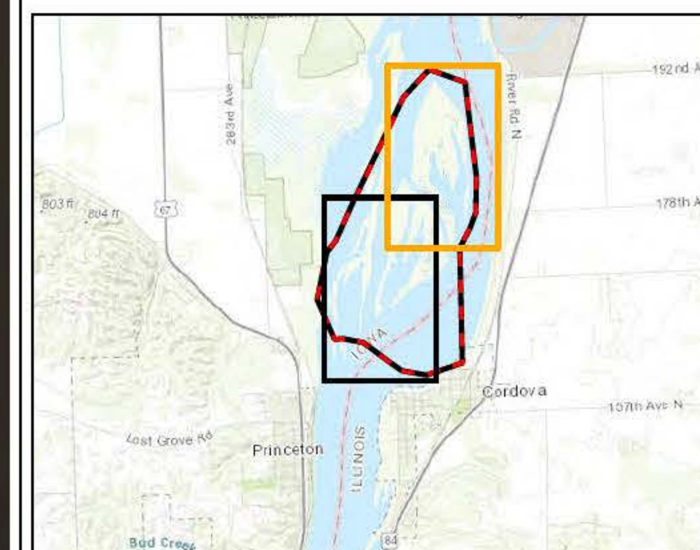


Figure 7. Sample depth of quantitative freshwater mussel surveys in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River in Scott County, Iowa.

Depth (meter)

- 0.5 - 1.0
- 1.1 - 2.0
- 2.1 - 3.0
- 3.1 - 4.0
- 4.1 - 5.0
- 5.1 - 6.0
- 6.1 - 7.3
- Area of Investigation (AOI)



N
W E
S

Meters
110 0 110 220

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 10/12/2018

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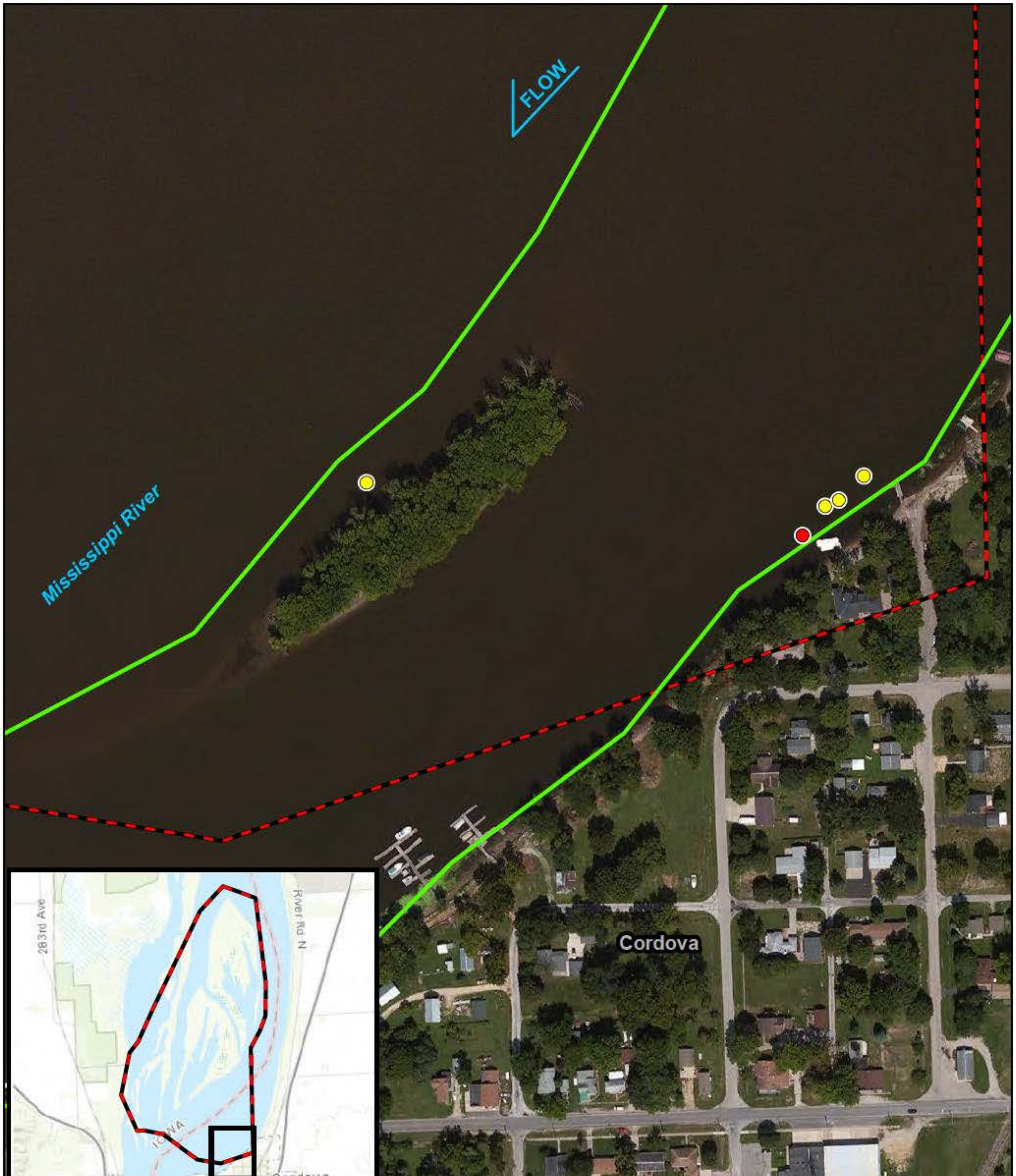

Higgins eye pearlymussel abundance
1
2
Cordova Essential Habitat Area (EHA)
Area of Investigation (AOI)

N
W
E
S

Figure 8. Occurrence and abundance of Higgins eye pearlymussel (*Lampsilis higginsii*) in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River in Scott County, Iowa.

Project No. 1027.06

40 0 40 80 Meters

Base Map: ESRI "World_Imagery (Clarity)"

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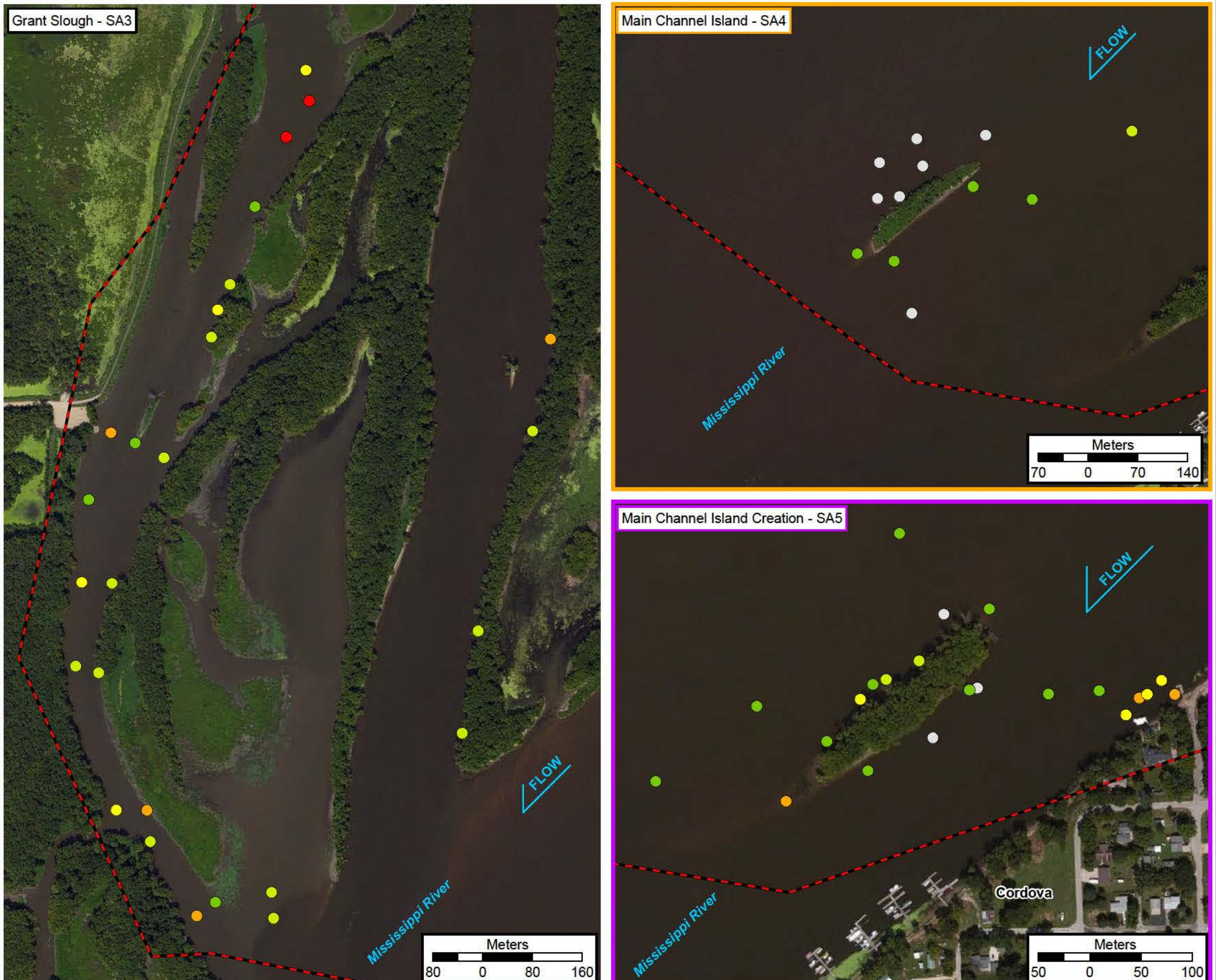
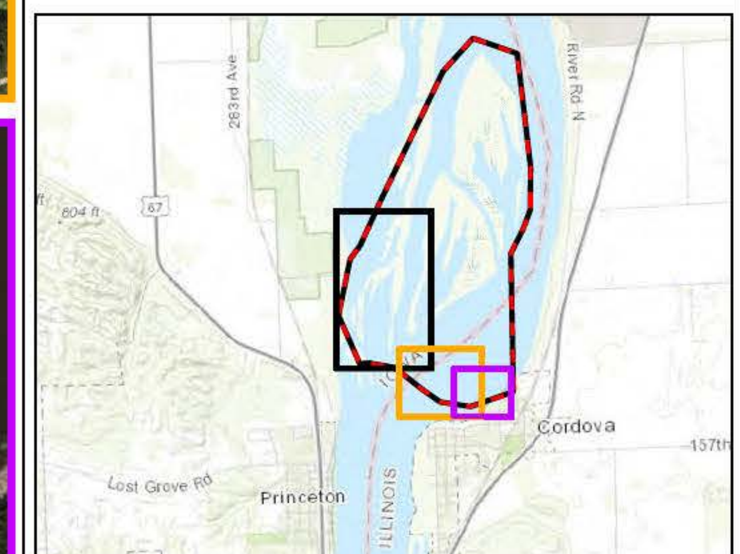
Figure 9. Qualitative mussel abundance for freshwater mussel surveys in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River in Scott County, Iowa.



Catch per unit effort (CPUE) (live mussels per hour)

- 0
- 1 - 50
- 51 - 150
- 151 - 250
- 251 - 350
- 351 - 516
- Area of Investigation (AOI)



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Scale as Shown

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 10/12/2018

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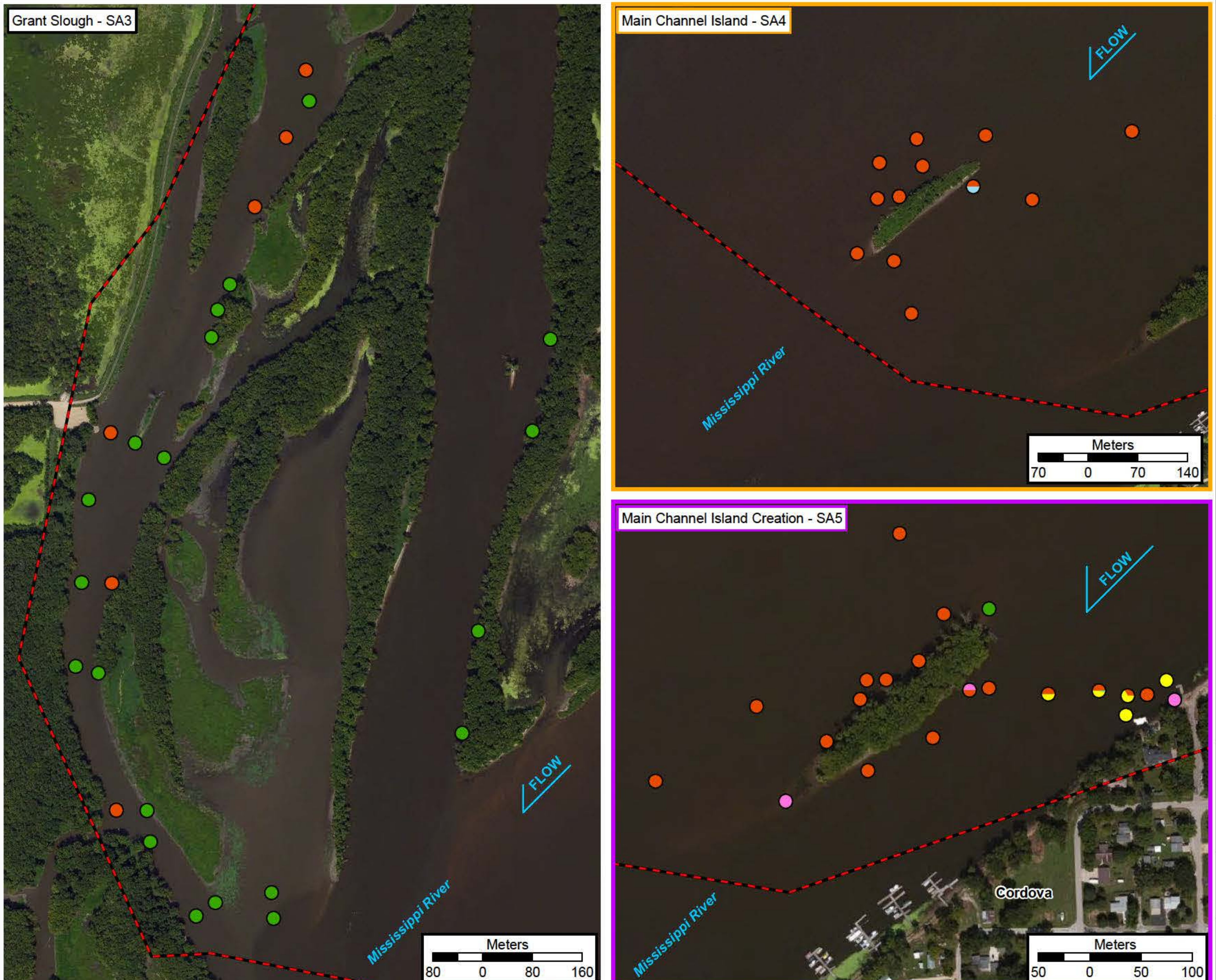
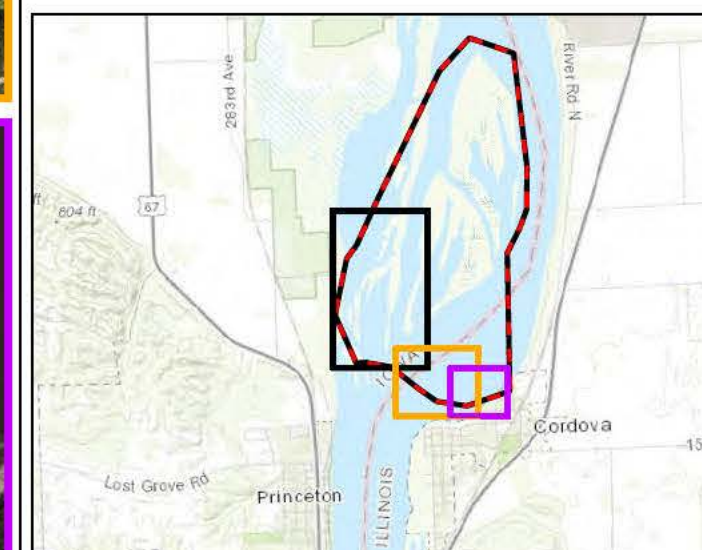


Figure 10. Substrate composition during qualitative freshwater mussel surveys in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River in Scott County, Iowa.

Qualitative Sampling Location

- clay
- fines
- sand
- gravel
- cobble
- boulder
- bedrock_hardpan
- other
- Area of Investigation (AOI)



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Scale as Shown

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 10/12/2018

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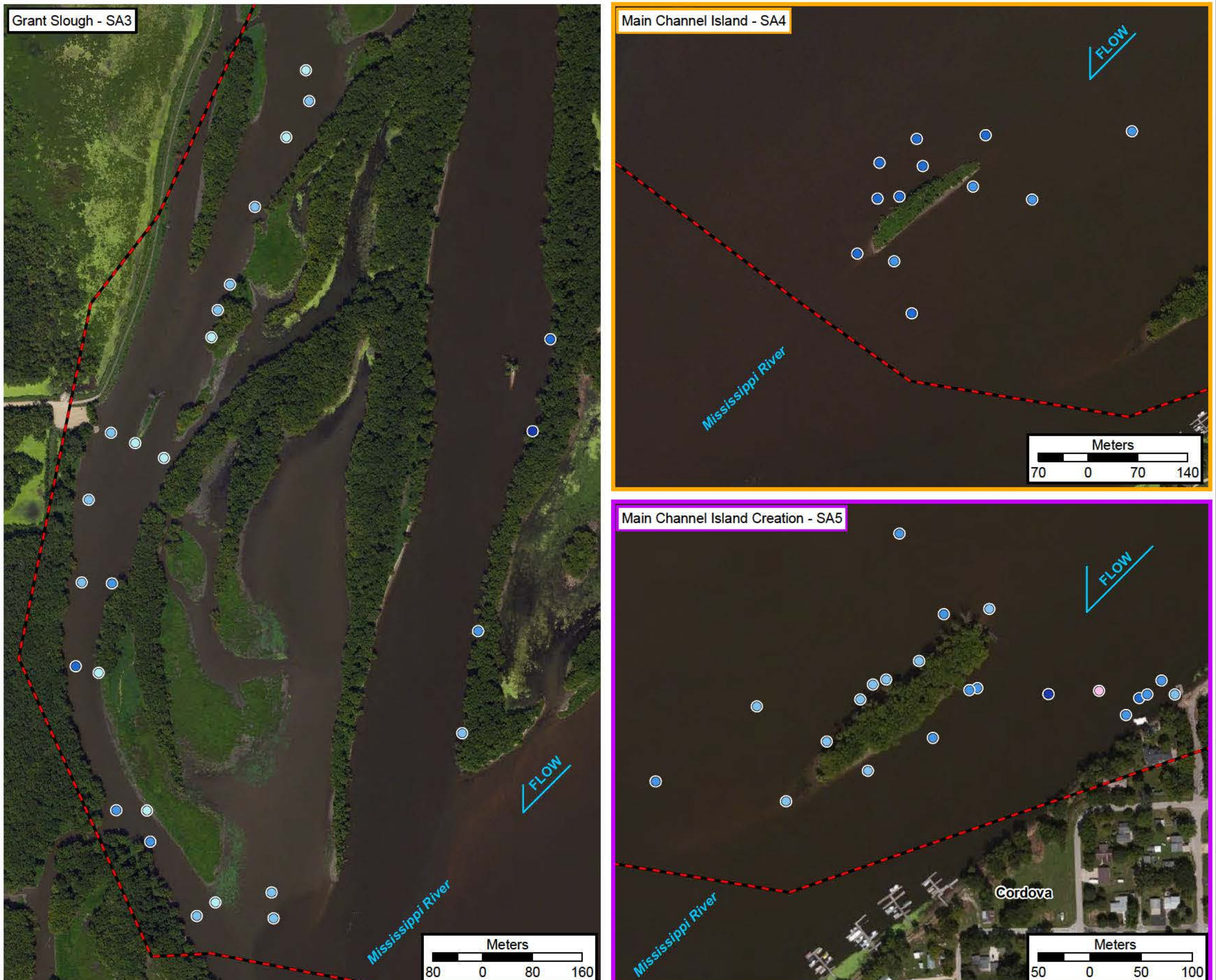
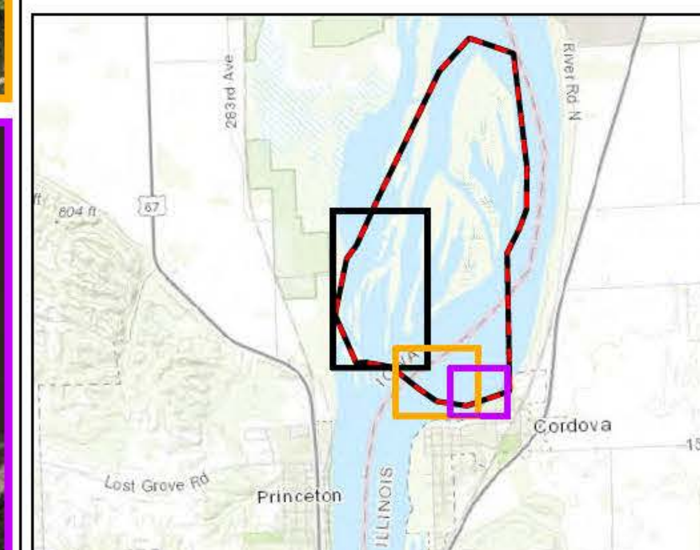
Figure 11. Sample depth of qualitative freshwater mussel surveys in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River in Scott County, Iowa.



Depth

- 0.6 - 1.0
- 1.1 - 2.0
- 2.1 - 3.0
- 3.1 - 4.0
- 4.1 - 5.0
- 5.1 - 5.2
- Area of Investigation (AOI)



N
W E
S

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 10/12/2018

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1027.06

TABLES

Table 1. Historical unionid species list for Pool 14 in the Upper Mississippi River near Scott County, Iowa.

Mussel Species		
Scientific Name[1]	Common Name	Status[2]
Amblemini		
Amblema plicata	threeridge	
Anodontini		
Anodonta suborbiculata	flat floater	
Arcidens confragosus	rock pocketbook	
Lasmigona complanata	white heelsplitter	
Lasmigona compressa	creek heelsplitter	
Lasmigona costata	fluted shell	
Pyganodon grandis	giant floater	
Strophitus undulatus	creeper	IA_T
Utterbackia imbecillis	paper pondshell	
Lampsilini		
Actinonaias ligamentina	mucket	
Ellipsaria lineolata	butterfly	IL_T, IA_T
Epioblasma triquetra	snuffbox	FE, IL_E
Lampsilis cardium	plain pocketbook	
Lampsilis higginsii	Higgins eye pearlymussel	FE, IA_E, IL_E
Lamsilis siliquoidea	fatmucket	
Lampsilis teres	yellow sandshell	IA_E
Leptodea fragilis	fragile papershell	
Ligumia recta	black sandshell	IL_T
Obliquaria reflexa	threehorn wartyback	
Obovaria olivaria	hickorynut	
Potamilus alatus	pink heelsplitter	
Potamilus capax	fat pocketbook	FE, IL_E
Potamilus ohiensis	pink papershell	
Toxolasma parvum	liliput	
Truncilla donaciformes	fawnsfoot	
Truncilla truncata	deertoe	
Margaritiferidae		
Cumberlandia monodonta	spectaclecase	FE, IA_E, IL_E
Pleurobemini		
Cyclonaias nodulata	wartyback	
Cyclonaias pustulosa	pimpleback	
Cyclonaias tuberculata	purple wartyback	IL_T, IA_T
Elliptio crassidens	elephant ear	IL_E
Eurynia dilatata	spike	IL_T
Fusconaia ebena	ebonyshell	IL_E
Fusconaia flava	Wabash pigtoe	
Plethobasus cyphyus	sheepnose	FE, IA_E, IL_E
Pleurobema sintoxia	round pigtoe	IA_E
Quadrulini		
Megalonaias nervosa	washboard	
Theliderma metanevra	monkeyface	
Quadrula quadrula	mapleleaf	
Tritogonia verrucosa	pistolgrip	IA_E

[1]Scientific nomenclature derived from Williams et al. 2017

[2]FE = federally endangered, IA_E = Iowa endangered, IA_T = Iowa threatened, IL_E = Illinois endangered, IL_T = Illinois threatened

Table 2. Summary of quantitative and qualitative samples collected in Pool 14 at the Steamboat Island Habitat Restoration and Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

				Quantitative Efforts			Qualitative Efforts		
Location		Study Area	Survey Area (m^2)	Sample Area (m^2)	No. Samples	Total Area Sampled (m^2)	No. Samples	Sample Duration (min)	Total Time (min)
Pool 14	1	Steamboat Island Complex	60,581	0.25	61	15.25	0	0	0
	2	Steamboat Slough	91,418	0.25	62	15.5	4	5	20
	3	Grants Slough	151,798	0	0	0	22	5	110
	4	Main Channel Island	126,302	0	0	0	12	5	60
	5	Main Channel Island Creation	108,537	0	0	0	22	5	110
		Total	538,636		123	30.75	60		300

Table 3. Unionid species collected during 2018 quantitative and qualitative mussel surveys in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

Mussel Species		Quantitative				Qualitative					
Scientific Name	Common Name	No. live	Rel. Abund. (%)	No. FD[1]	No. ≤5y	No. live	Rel. Abund. (%)	No. FD[1]	No. ≤5y	Total	%
Amblemini											
Amblema plicata	threeridge	12	21.4	1	10	231	42.5	5	84	243	40.5
	Subtotal	12	21.4	1	10	231	42.5	5	84	243	40.5
Anodontini											
Arcidens confragosus	rock pocketbook	-	-	-	-	2	0.4	1	0	2	0.3
Lasmigona complanata	white heelsplitter	-	-	-	-	6	1.1	(WD)	0	6	1.0
Pyganodon grandis	giant floater	1	1.8	(WD)	0	14	2.6	1	0	15	2.5
Utterbackia imbecillis	paper pondshell	3	5.4	1	3	1	0.2	1	1	4	0.7
	Subtotal	4	7.2	1	3	23	4.2	3	1	27	4.5
Lampsilini											
Actinonaias ligamentina	mucket	0	0.0	(SF)	0	0	0.0	(SF)	0	0	0
Ellipsaria lineolata	butterfly	-	-	-	-	1	0.2	(WD)	0	1	0.2
Lampsilis cardium	plain pocketbook	1	1.8	(SF)	0	67	12.3	2	9	68	11.3
Lampsilis higginsii	Higgins eye pearlymussel	-	-	-	-	6	1.1	(WD)	1	6	1
Lampsilis teres	yellow sandshell	1	1.8	(SF)	1	3	0.6	(WD)	2	4	0.7
Leptodea fragilis	fragile papershell	3	5.4	(WD)	3	16	2.9	(WD)	16	19	3.2
Ligumia recta	black sandshell	0	0.0	(WD)	0	21	3.9	1	1	21	3.5
Obliquaria reflexa	threehorn wartyback	15	26.8	(WD)	15	53	9.7	1	52	68	11.3
Obovaria olivaria	hickorynut	-	-	-	-	0	0.0	1	0	0	0
Potamilus alatus	pink heelsplitter	-	-	-	-	14	2.6	1	4	14	2.3
Potamilus ohiensis	pink papershell	-	-	-	-	4	0.7	1	4	4	0.7
Toxolasma parvum	liliput	6	10.7	(WD)	6	3	0.6	(WD)	3	9	1.5
Truncilla donaciformis	fawnsfoot	3	5.4	3	3	8	1.5	(WD)	8	11	1.8
Truncilla truncata	deertoe	0	0.0	(WD)	0	0	0.0	1	0	0	0.0
	Subtotal	29	51.9	3	28	196	35.7	8	100	225	37.5
Pleurobemini											
Cyclonaias nodulata	wartyback	3	5.4	(WD)	3	3	0.6	(WD)	3	6	1
Cyclonaias pustulosa	pimpleback	1	1.8	(WD)	1	26	4.8	4	8	27	4.5
Fusconaia flava	Wabash pigtoe	0	0.0	(SF)	0	10	1.8	(WD)	5	10	1.7
Pleurobema sintoxia	round pigtoe	-	-	-	-	0	0.0	(SF)	0	0	0
Reginaia ebena	ebonyshell	-	-	-	-	0	0.0	(WD)	0	0	0
	Subtotal	4	7.2	0	4	39	7.0	4	16	43	7.2
Quadrulini											
Megalonaias nervosa	washboard	-	-	-	-	4	0.7	(WD)	0	4	0.7
Quadrula quadrula	mapleleaf	7	12.5	(WD)	5	52	9.6	1	30	59	9.8
Theliderma metanevra	monkeyface	-	-	-	-	0	0.0	(WD)	0	0	0
	Subtotal	7	12.5	0	5	56	10.3	1	30	63	10.5
Total		56	100	5	50	545	100	21	231	601	100
Total Species		16				27				27	
Species Richness (Live)		12				21				21	
Effort (min)						300					
Avg. CPUE (no./hour)						109.0					
Density ± 95% CI		1.82 ± 0.80									
Population Estimate		155,477 - 398,149									

[1] FD = fresh deadshell - numbers represent the summation of fresh deadshell, WD = weathered deadshell, SF = subfossil shell

Table 4. Mussel assemblage attributes in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

Data Analysis/ Attributes		Quantitative	Qualitative	Total
Evenness (slope)		-0.261	-0.224	-
Diversity (1-D)		0.8578	0.7812	-
Rarefaction ES_x (95%CI)				
	x=10 individuals	6 (3-8)	6 (2-7)	-
	x=50 individuals	12 (10-14)	12 (7-15)	-
	x=100 individuals	14	15 (10-18)	-
	x=200 individuals	16	18 (14-20)	-
	x=300 individuals	18	19 (17-22)	-
No. Species				
	Amblemini	1	1	1
	Anodontini	2	4	4
	Lampsilini	6	10	10
	Pleurobema	2	3	3
	Quadrulini	1	2	2
	Total	12	20	20
Abundance[1]				
	Amblemini	12 (20.4)	231 (42.5)	243 (40.8)
	Anodontini	4 (7.2)	23 (4.2)	27 (4.5)
	Lampsilini	29 (51.9)	196 (35.9)	224 (37.3)
	Pleurobema	4 (7.2)	39 (7.0)	43 (7.2)
	Quadrulini	7 (12.5)	56 (10.3)	63 (10.5)
	Total	56	545	601
Fresh deadshell mortality (%)		5 (8.9)	21 (3.8)	26 (4.3)
No. unionids ≤ 5 years old		50	232	282
Recruitment (% ≤ 5 years old)		89.3	42.5	46.8
No. ≤ 30mm (%)		21 (37.5)	113 (20.8)	149 (24.8)
Zebra Mussel Infestation				
No. Zebra Mussel / unionid[1]				
	0	0	500 (91.7)	556 (92.5)
	1 - 10	0	45 (8.3)	45 (7.5)
	11 - 50	0	0 (0)	0 (0)
	> 50	0	0 (0)	0 (0)
% Zebra Mussel Coverage[1]				
	0	0	500 (91.7)	556 (92.5)
	1 - 10	0	34 (6.2)	34 (5.7)
	11 - 50	0	11 (2.0)	11 (1.8)
	51 - 100	0	0	-

[1]Relative abundance provided in parentheses (%)

Table 5. Quantitative mussel density and population estimates at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in Pool 14 of the Upper Mississippi River, Scott County, Iowa.

Species	No. live	Relative Abundance (%)	Density (no./m^2)	95% CI[1]	Population Estimate	95% CI[1]
Amblemini						
Amblema plicata	12	21.4	0.39	0.10 - 0.67	59,317	16,682 - 10,1952
Anodontini						
Pyganodon grandis	1	1.8	0.03	0 - 0.09	4,943	0 - 14,728
Utterbackia imbecillis	3	5.4	0.10	0 - 0.20	14,829	0 - 31,638
Lampsilini						
Lampsilis cardium	1	1.8	0.03	-0.0 - 0.09	4,943	0 - 14,728
Lampsilis teres	1	1.8	0.03	-0.0 - 0.09	4,943	0 - 14,728
Leptodea fragilis	3	5.4	0.10	-0.0 - 0.20	14,829	0 - 31,638
Obliquaria reflexa	15	26.8	0.49	0.17 - 0.79	74,146	26,851 - 121,442
Toxolasma parvum	6	10.7	0.20	0.01 - 0.37	29,659	2,381 - 56,936
Truncilla donaciformis	3	5.4	0.10	0 - 0.20	14,829	0 - 31,638
Pleurobemini						
Cyclonaias nodulata	3	5.4	0.10	-0.0 - 0.20	14,829	0 - 31,638
Cyclonaias pustulosa	1	1.8	0.03	-0.0 - 0.09	4,943	0 - 14,728
Quadrulini						
Quadrula quadrula	7	12.5	0.23	0.03 - 0.41	34,602	5,785 - 63,418
Total	**56**		**1.82**	**1.02 - 2.61**	**276,813**	**155,477 - 398,149**

[1]CI = Confidence Interval; Negative CI truncated to 0

Table 6. Age frequency distribution of live mussels collected during quantitative survey efforts at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in Pool 14 of the Upper Mississippi River, Scott County, Iowa.

	Age (external annuli estimation)																				
Species	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	18	19	≥20	Total
Amblemini																					
Amblema plicata		2	1	2	5			1	1												12
Anodontini																					
Pyganodon grandis										1											1
Utterbackia imbecillis	1	2																			3
Lampsilini																					
Lampsilis cardium								1													1
Lampsilis teres	1																				**1**
Leptodea fragilis		2	1																		**3**
Obliquaria reflexa	1	1	2	8	3																**15**
Toxolasma parvum		1	1	2	1	1															6
Truncilla donaciformis				3																	3
Pleurobemini																					
Cyclonaias nodulata			1	2																	3
Cyclonaias pustulosa					1																1
Quadrulini																					
Quadrula quadrula				1	2	2	2														7
Grand Total	3	8	6	18	12	3	2	2	1	1	0	0	0	0	0	0	0	0	0	0	56
Total %	5.4	14.3	10.7	32.1	21.4	5.4	3.6	3.6	1.8	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

Table 7. Length frequency distribution of live mussels collected during quantitative survey efforts at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in Pool 14 of the Upper Mississippi River, Scott County, Iowa.

	length (mm, anterior to posterior)																												
Species	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100	100-105	105-110	110-115	115-120	120-125	125-130	130-135	135-140	Total
Amblemini																													
Amblema plicata				2	1			2	3	1		1			1	1													12
Anodontini																													
Pyganodon grandis								0																		1			1
Utterbackia imbecillis				1				2																					3
Lampsilini																													
Lampsilis cardium																								1					1
Lampsilis teres			1																										1
Leptodea fragilis					2	1																							3
Obliquaria reflexa			1		1	1	3	6		2	1																		15
Toxolasma parvum		1	2	1	1	1																							6
Truncilla donaciformis				1	2																								3
Pleurobemini																													
Cyclonaias nodulata					1		1	1																					3
Cyclonaias pustulosa								1																					1
Quadrulini																													
Quadrula quadrula									1	2		1	2	1															7
Grand Total	0	1	4	5	8	3	4	12	4	5	1	2	2	1	1	1	0	0	0	0	0	0	0	1	0	1	0	0	56
Total %	0.0	1.8	7.1	8.9	14.3	5.4	7.1	21.4	7.1	8.9	1.8	3.6	3.6	1.8	1.8	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	1.8	0.0	0.0	100.0

Table 8. Unionid species collected in Steamboat Island Complex (SA1) and Steamboat Slough (SA2) during 2018 quantitative mussel survey efforts in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

Species	Steamboat Island Complex[1]		Steamboat Slough		TOTAL	
	No. live	Rel. Abund. (%)	No. live	Rel. Abund. (%)	No. live	Rel. Abund. (%)
Amblemini						
Amblema plicata	6	30.0	6	16.7	12	21.4
Subtotal	6	30.0	6	16.7	12	21.4
Anodontini				0.0		
Pyganodon grandis	1	5.0	0	0.0	1	1.8
Utterbackia imbecillis	1	5.0	2	5.6	3	5.4
Subtotal	2	10.0	2	5.6	4	7.1
Lampsilini		0.0		0.0		
Lampsilis cardium	0	0.0	1	2.8	1	1.8
Lampsilis teres	0	0.0	1	2.8	1	1.8
Leptodea fragilis	2	10.0	1	2.8	3	5.4
Obliquaria reflexa	4	20.0	11	30.6	15	26.8
Toxolasma parvum	4	20.0	2	5.6	6	10.7
Truncilla donaciformis	1	5.0	2	5.6	3	5.4
Subtotal	11	55.0	18	50.0	29	51.8
Pleurobemini		0.0		0.0		
Cyclonaias nodulata	0	0.0	3	8.3	3	5.4
Cyclonaias pustulosa	0	0.0	1	2.8	1	1.8
Subtotal	0	0.0	4	11.1	4	7.1
Quadrulini		0.0		0.0		
Quadrula quadrula	1	5.0	6	16.7	7	12.5
Subtotal	1	5.0	6	16.7	7	12.5
Total	20	100	36	100	56	100.0
Species Richness (Live)	8		11		12	
Density ± 95% CI	1.31 ±1.00		2.32 ±1.25		1.82 ±0.80	
Population Estimate	18,725 - 140,176		97,604 - 327,048		155,477 - 398,149	

[1]Steamboat Island Complex composed of 3 study areas: Head of Island, NE Berm, and Upper Lake Entrance

Table 9. Habitat attributes during mussel survey efforts in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

Study Area	Effort Type	No. Samples	Depth (m) Ave.	Depth (m) Min.	Depth (m) Max.	Average % Substrate Composition: Bedrock	Boulder	Cobble	Gravel	Sand	Silt	Clay
1 Steamboat Island Complex	Quantitative	61	2.9	0.6	6.1	0.0	0.0	0.0	0.0	76.2	2.4	21.3
2 Steamboat Slough	Quantitative	62	4.7	0.5	7.3	0.8	0.0	0.3	1.2	77.3	4.0	16.3
Total		123	3.8	0.5	7.3	0.4	0.0	0.2	0.6	76.8	3.3	18.8
2 Steamboat Slough	Qualitative	4	3	1.5	4.3	0.0	0.0	0.0	0.0	0.0	0.0	100.0
3 Grant Slough	Qualitative	22	1.4	0.6	3	0.0	0.0	0.0	0.0	21.8	0.0	78.2
4 [1]MCI	Qualitative	12	3	2.1	4	4.2	0.0	0.0	0.0	75.0	0.0	20.8
5 [1]MCI Creation	Qualitative	22	2.3	1.2	5.2	0.0	0.0	0.2	11.1	57.0	10.5	21.6
Total		60	2.2	0.6	5.2	0.8	0.0	0.1	4.1	43.8	3.8	47.4

[1]MCI = Main Channel Island

Table 10. Power analysis of live mussels collected during quantitative survey efforts in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

		Pool 14 at Steamboat HREP
Sample Size (# quadrats)		123
Mean Mussel Density (individuals / m^2)		1.82
95% Confidence Interval		0.80
Standard Deviation		4.47
Precision[1]		43.8%
		No. of Samples
Precision Level[1]		
	15%	1,072
	20%	603
	25%	386

[1]Precision level = 95% CI of mean

Table 11. Unionid species collected during 2018 qualitative mussel surveys in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

Mussel Species	Qualitative									
	Steamboat Slough		Grant Slough		MCI		MCI Creation		TOTAL	
Scientific Name	No. live	Rel. Abund. (%)	No. live	Rel. Abund. (%)	No. live	Rel. Abund. (%)	No. live	Rel. Abund. (%)	No. live	Abund. (%)
Amblemini										
Amblema plicata	20	41.7	174	55.2	5	25.0	32	19.8	231	42.4
Subtotal	20	41.7	174	55.2	5	25.0	32	19.8	231	42.4
Anodontini										
Arcidens confragosus	0	0.0	2	0.6	0	0.0	0	0.0	2	0.4
Lasmigona complanata	0	0.0	2	0.6	0	0.0	4	2.5	6	1.1
Pyganodon grandis	2	4.2	11	3.5	0	0.0	1	0.6	14	2.6
Utterbackia imbecillis	0	0.0	1	0.3	0	0.0	0	0.0	1	0.2
Subtotal	2	4.2	16	5.1	0	0.0	5	3.1	23	4.2
Lampsilini										
Ellipsaria lineolata	0	0.0	0	0.0	0	0.0	1	0.6	1	0.2
Lampsilis cardium	6	12.5	6	1.9	4	20.0	51	31.5	67	12.3
Lampsilis higginsii	0	0.0	0	0.0	0	0.0	6	3.7	6	1.1
Lampsilis teres	0	0.0	3	1.0	0	0.0	0	0.0	3	0.6
Leptodea fragilis	0	0.0	11	3.5	0	0.0	5	3.1	16	2.9
Ligumia recta	0	0.0	0	0.0	2	10.0	19	11.7	21	3.9
Obliquaria reflexa	9	18.8	26	8.3	5	25.0	13	8.0	53	9.7
Potamilus alatus	2	4.2	5	1.6	0	0.0	7	4.3	14	2.6
Potamilus ohiensis	0	0.0	3	1.0	0	0.0	1	0.6	4	0.7
Toxolasma parvum	0	0.0	2	0.6	0	0.0	1	0.6	3	0.6
Truncilla donaciformis	0	0.0	8	2.5	0	0.0	0	0.0	8	1.5
Subtotal	17	35.4	64	20.3	11	55.0	104	64.2	196	2.8
Pleurobemini										
Cyclonaias nodulata	1	2.1	1	0.3	0	0.0	1	0.6	3	0.6
Cyclonaias pustulosa	0	0.0	15	4.8	4	20.0	7	4.3	26	4.8
Fusconaia flava	0	0.0	6	1.9	0	0.0	4	2.5	10	1.8
Subtotal	1	2.1	22	7.0	4	20.0	12	7.4	39	7.2
Quadrulini										
Megalonaias nervosa	0	0.0	0	0.0	0	0.0	4	2.5	4	0.7
Quadrula quadrula	8	16.7	39	12.4	0	0.0	5	3.1	52	9.5
Subtotal	8	16.7	39	12.4	0	0.0	9	5.6	56	10.3
Total	48	100	315	100	20	100	162	100	545	100
Species Richness (live)	21		21		21		21		21	
Qualitative Effort (min)	20		110		60		110		300	
Avg. CPUE (no./hour)	144.0		171.8		20.0		88.4		109.0	
Min. CPUE (no./hour)	60.0		24.0		0.0		0.0		0.0	
Max. CPUE (no./hour)	348.0		516.0		120.0		300.0		516.0	

[1] MCI = Main Channel Island

Table 12. Length frequency distribution of live mussels collected during qualitative survey efforts at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in Pool 14 of the Upper Mississippi River, Scott County, Iowa.

	length (mm, anterior to posterior)																																
Species	*0-5*	*5-10*	*10-15*	*15-20*	*20-25*	*25-30*	*30-35*	*35-40*	*40-45*	*45-50*	*50-55*	*55-60*	*60-65*	*65-70*	*70-75*	*75-80*	*80-85*	*85-90*	*90-95*	*95-100*	*100-105*	*105-110*	*110-115*	*115-120*	*120-125*	*125-130*	*130-135*	*135-140*	*140-145*	*145-150*	*150-155*	*155-160*	*Total*
Amblemini																																	
Amblema plicata						4	7	7	7	5	8	10	12	12	20	21	25	20	34	15	10	5	4	3	1			1					231
Anodontini																																	
Arcidens confragosus																				1		1											2
Lasmigona complanata																										2		2			1	1	6
Pyganodon grandis													1												2	3	1	2		1	3	1	14
Utterbackia imbecillis												1																					1
Lampsilini																																	
Ellipsaria lineolata													1																				1
Lampsilis cardium										1				2			1	1	3	3	3	10	20	18	2	1	2						67
Lampsilis higginsii															2		1		3														6
Lampsilis teres					1															1			1										3
Leptodea fragilis			1									2	1	2		2				1	2	2	3										16
Ligumia recta																1						1	4	2	2	2	5	2	2				21
Obliquaria reflexa				1	1	3	16	13	10	6	3																						53
Potamilus alatus										1					3		1			2	1			1		1	1	3					14
Potamilus ohiensis											1				1						1	1											4
Toxolasma parvum				1	1	1																											3
Truncilla donaciformis		1	2	1	3	1																											8
Pleurobemini																																	
Cyclonaias nodulata						1			1	1																							3
Cyclonaias pustulosa					1		1	1	1	6	9	3	2	1		1																	26
Fusconaia flava						1	1	1	1		1	4	1																				10
Quadrulini																																	
Megalonaias nervosa																										2	1	1					4
Quadrula quadrula							2	2	2	6	7	3	3	8	7	4	3	4		1													52
Grand Total	0	1	3	3	7	11	27	24	22	26	29	23	21	25	33	29	31	25	40	24	17	20	32	24	7	11	10	11	2	1	4	2	545
Total %	0.0	0.2	0.6	0.6	1.3	2.0	5.0	4.4	4.0	4.8	5.3	4.2	3.9	4.6	6.1	5.3	5.7	4.6	7.3	4.4	3.1	3.7	5.9	4.4	1.3	2.0	1.8	2.0	0.4	0.2	0.7	0.4	100.0

Table 13. Age frequency distribution of live mussels collected during qualitative survey efforts in Pool 14 at the Steamboat Island Habitat and Restoration Enhancement Project (HREP) in the Upper Mississippi River, Scott County, Iowa.

	Age (external annuli estimation)																					
Species	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	>20	Total
Amblemini																						
Amblema plicata			9	19	26	30	29	32	36	26	14	5	3	2								231
Anodontini																						
Arcidens confragosus								2														2
Lasmigona complanata							1	1	1	1	1	1										6
Pyganodon grandis			1				1	1	3	3	2	2	1									14
Utterbackia imbecillis			1																			1
Lampsilini																						
Ellipsaria lineolata							1															1
Lampsilis cardium				2	1	6	7	6	9	14	6	10	4		2							67
Lampsilis higginsii						1		1		1	1	1	1									6
Lampsilis teres	1				1		1															3
Leptodea fragilis	1		3	8	3	1																16
Ligumia recta						1		6	3	3	2	2	1	1	1	1						21
Obliquaria reflexa		1	14	21	14	2					1											53
Potamilus alatus				3	1		1	1	5	2			1									14
Potamilus ohiensis			1		1	2																4
Toxolasma parvum	1	1	2	3	1																	8
Truncilla donaciformis				2		1																3
Pleurobemini																						
Cyclonaias nodulata				2		1																3
Cyclonaias pustulosa				3	3	2	6		5	3	2	2										26
Fusconaia flava			2	2	1		2	2	1													10
Quadrulini																						
Megalonaias nervosa													1	1	1	1						4
Quadrula quadrula			3	7	11	9	12	4	2	2	2											52
Grand Total	3	2	36	72	63	56	61	56	65	55	31	23	12	4	4	2	0	0	0	0	0	545
Total %	0.6	0.4	6.6	13.2	11.6	10.3	11.2	10.3	11.9	10.1	5.7	4.2	2.2	0.7	0.7	0.4	0.0	0.0	0.0	0.0	0.0	100.0

Study Area[1]		Sample ID	Species	New Tag(s)[2]	Sex	Age (years)	Length (mm)	Substrate Composition	Depth (m)	No. Zebra Mussels
5	MCI Creation	20180927153010	*Lampsilis higginsii*	0500-0501	F	7	73.6	50% clay 50% gravel	2.7	0
5	MCI Creation	20180927153010	*Lampsilis higginsii*	0502-0503	M	11	90.4	50% clay 50% gravel	2.7	0
5	MCI Creation	20180927153011	*Lampsilis higginsii*	0504-0505	F	9	84.5	50% clay 50% sand	2.4	0
5	MCI Creation	20180927153018	*Lampsilis higginsii*	0506-0507	F	12	92.0	30% clay 10% fines 60% sand	2.1	0
5	MCI Creation	20180924152030	*Lampsilis higginsii*	A18	M	10	93.5	25% clay 25% sand 50% gravel	3.0	0
5	MCI Creation	20180924152024	*Lampsilis higginsii*	B18	M	5	73.4	100% sand	1.5	0

[1]MCI = Main Channel Island

[2]Orange tags

Steamboat Island HREP
Mussel Survey Results Discussion
Conference Call
November 15, 2018

Attendees: Sharonne Baylor (USFWS), Ed Britton (USFWS), Nate Williams (USFWS), Sara Schmuecker (USFWS), Tyler Porter (USFWS), Vanessa Armentrout (USFWS) and Scott Gritters (IA DNR)
*Jenny Skufka (IL DNR) provided input prior to call.

The team worked through the proposed Project features, one by one, to assess potential freshwater mussel resources that may be impacted as identified by the 2018 mussel survey, avoidance and minimization measures, alternatives, and conservation measures. As detailed in the notes below, the team emphasizes the need to work through all potential avoidance and minimization measures to reduce potential mussel resource impacts related to Project feature footprints, access routes, etc. prior to addressing permitting and take. Based on the 2018 mussel survey results, the team recommends all proposed Project features continue to be carried forward for consideration.

<u>SE Islands</u>

- 2018 Mussel Survey Results
    - Island closest to main channel: Mussel resources surrounding this island were found to be sparse along the main channel border (NW side), with freshwater mussel densities increasing to 1-50 mussels/hour CPUE along the east side of the island, bordering the Cordova EHA.
    - Cordova EHA Island: Mussel densities were found to be fairly consistent on all sides of the island, varying from 0 to 350 mussels/hour CPUE. Although this island is located inside of the EHA mussel bed and construction may result in initial mussel impacts, the team feels that the long-term benefits of increased flow diversity, increased potential mussel habitat, and increased fish habitat/attraction, particularly smallmouth bass (Higgin's-eye host), outweigh removing the feature from Project consideration.
- Avoidance and Minimization Measures
    - This mussel survey was originally designed with only spot surveys surrounding the SE islands to determine whether or not a mussel resource is present, with the intent of completing additional quadrat survey work should these features remain in consideration for the Project.
        - Illinois DNR:
            - If work is planned in areas where Illinois DNR listed species are present, an incidental take permit will be needed.
            - IL DNR is currently working to revise their mussel survey requirements. Jenny will provide additional information, when available.
        - USFWS:
            - Additional survey work may be necessary in areas on the east side of the island closest to the main channel, within the Cordova EHA, or access dredging areas that were not previously surveyed if they are

carried forward as part of the Project design. However, based on the long-term EHA survey data and information from the 2018 mussel survey, we may be able to calculate a take estimate that could be used to develop the BA and BO (assuming TE presence) without additional survey work needed.

    - A BA/BO will be necessary for any work conducted within the Cordova EHA.

  - Consider concentrating the Cordova mussel cleaning around the SE islands next summer (2019) to better delineate locations of mussel resources and identify potential project footprint and access locations where impacts to mussel resources may be avoided/reduced.
  - Reduce the use of the Cordova boat ramp for Project construction when outside of a high water event. Limit use to small crafts. Other large boats and barges should launch/stage from another site.
- Alternatives Considered
  - Consider phasing construction, with this portion of the Project completed last to allow for any additional survey, permitting, or other necessary measures. Process-wise would this be feasible?
- Conservation Measures
  - Relocate mussels from areas of potential impact prior to construction of the SE islands, particularly the Cordova EHA Island.
  - Consider integrating the benched mussel habitat substrate design (like Beaver Island HREP) into the rock armoring design to provide additional mussel and fish benefits.

<u>Grant Slough</u>

- 2018 Mussel Survey Results
  - Mussel resources throughout the length of Grant Slough were documented to be fairly consistent on both sides of the slough with around 51 – 350 mussels/hour CPUE in the majority of the survey areas. The upstream-most survey sites within Grant Slough were documented to have a CPUE of 351-516 mussels/hour, near the GS #4 and 5 dredged material placement areas.
- Avoidance and Minimization Measures
  - Additional mussel surveys may facilitate design of the access dredging route through Grant Slough to minimize and avoid impacts to mussel resources within the slough. Deconstruct the actions in Grant Slough once they are near-final and plan accordingly for mussel avoidance and minimization.
- Alternatives Considered
  - Consider accessing placement areas GS #4 and 5 from Steamboat Slough. *Reference Scott's timed search surveys for mussel resources on the Steamboat Slough side of GS #4 and 5. USFWS and IADNR are in agreement with tree clearing to access the placement sites if done between October 1 and March 31.
- Conservation Measures
  - Consider relocation of mussels from proposed dredge cut footprints.

Lower Steamboat Slough

- 2018 Mussel Survey Results
  - Overall, there appears to be a fairly low mussel abundance within lower Steamboat Slough with a CPUE of 51-150 mussel/hour. Of the 62 quads that were completed, 44 were identified to have no mussels, 11 quads had 1 mussel per $0.25m^2$, 4 quads had 2-4 mussel per $0.25m^2$, and 3 quads had 5-6 mussel per $0.25m^2$.
- Avoidance and Minimization Measures
  - None discussed
- Alternatives Considered
  - None discussed
- Conservation Measures
  - Consider relocating mussels from feature footprint.

Head of Island

- 2018 Mussel Survey Results
  - Overall, there appears to be a fairly low mussel abundance at the head of Steamboat Island with a CPUE of 2-4 mussels/hour. Of the 36 quadrats, 34 had 0 mussels and 2 had 2-4 mussel per $0.25m^2$.
- Avoidance and Minimization Measures
  - None discussed
- Alternatives Considered
  - None discussed
- Conservation Measures
  - Consider integrating the benched mussel habitat substrate design (like Beaver Island HREP) into the rock armoring design.
  - Consider relocating mussels from feature footprint.

NE Berm and Upper Lake Entrance

- 2018 Mussel Survey Results
  - NE Berm: Only one mussel was identified from the 12 quadrats collected from the NE Berm location.
  - Upper Lake Entrance: 13 quadrats were collected, ranging from 0 to 6 mussel per $0.25m^2$. Mussel densities appear to increase as you move downstream. CPUE ranged from 2-6 mussels/hour.
- Avoidance and Minimization Measures
  - None discussed
- Alternatives Considered
  - None discussed
- Conservation Measures
  - Consider relocating mussels from areas of potential impact.

From:	Schmuecker, Sara
To:	Herzog, Kathryn M [redacted]
Cc:	Skufca, Jenny
Subject:	[Non-DoD Source] Steamboat Island Mussel Considerations
Date:	Tuesday, December 4, 2018 1:31:10 PM

Hi Kat -

Below are the combined FWS and IL DNR requirements for take permits associated with the SE islands features with respect to the presence of Higgins eye, black sandshell, and the Cordova EHA. Please Note: This is a collective list with not all of these items being required by both Agencies. We tried to encompass all potential island feature designs in the below conservation measures; however, various actions and impacts that may be identified as the project features are further refined may require additional assessment.

Channel Island = the SE island closest to the channel.

EHA Island = the SE island located within the Cordova EHA.

- **Work-zone Restrictions:** Restrict work to the minimum necessary area. Identify Authorized Work Areas for project contractors to prevent construction activities from occurring in identified Environmentally Sensitive Areas.

- **Surveys:** Current surveys are sufficient to prepare a FWS BA/BO and IL DNR ITP. No additional survey is needed. However, we are currently assuming the presence of Higgins eye at the Channel Island due to its proximity to the Cordova EHA and low resolution of survey completed. If the EHA Island is removed from the project, additional survey work at the Channel Island may negate the need for BA/BO preparation, pending results. As previously discussed by the PDT, the Cordova mussel cleaning effort may be able to meet additional survey requirements, provided the draft Upper Mississippi River Mussel Survey Guidance is followed, which would require divers in water depths that are not possible to pollywog and an appropriate level of survey effort.

- **Relocation:** With the purpose of this project being habitat restoration, we would like to see mussels relocated from all areas where mussel resources were identified during the survey effort as a minimization measure. However, at a minimum, mussels should be relocated from all areas of high density (10 mussels or greater) as identified during the 2018 mussel survey and presented on the Steamboat Island HREP - Constraints map.

- **Post-Construction Monitoring:** Post-construction monitoring would be required to test the assumptions of affects analyses used to determine take estimates. The scale and duration of the monitoring will depend on the final feature design, associated impacts, and whether one or both islands are carried forward in project planning. Monitoring of the EHA Island may include monitoring around the project footprint to assess EHA habitat impacts. Survival monitoring of relocated mussels may be incorporated into ongoing monitoring associated with the Cordova EHA (every 4-years).

- **Zebra Mussels:** Barges and watercraft used for construction activities should be inspected for the presence of zebra mussels prior to launching to reduce potential infestation impacts to the EHA.

- **Cordova boat ramp:** Use of the Cordova boat ramp should be limited to small watercraft. No barges or other equipment requiring dredging or sediment disturbance within the Cordova EHA should launch from or utilize the ramp.

As always, please feel free to reach out with any questions.

Sara Schmuecker
U.S. Fish and Wildlife Service
Illinois - Iowa Field Office
[redacted]

Pesi 1027.05

FINAL REPORT
MONITORING OF
NATIVE AND NON-INDIGENOUS MUSSEL SPECIES
IN THE UPPER MISSISSIPPI RIVER AT
TWO HIGGINS EYE PEARLYMUSSEL (*LAMPSILIS HIGGINSII*)
ESSENTIAL HABITAT AREAS,
CORDOVA, ILLINOIS (POOL 14) AND BUFFALO, IOWA (POOL 16)

24 January 2019

Prepared for:

U.S. Army Corps of Engineers – Rock Island District
1500 Rock Island Drive
Rock Island, Illinois 61201

Contract No. W912EK-16-D-0010

Prepared by:

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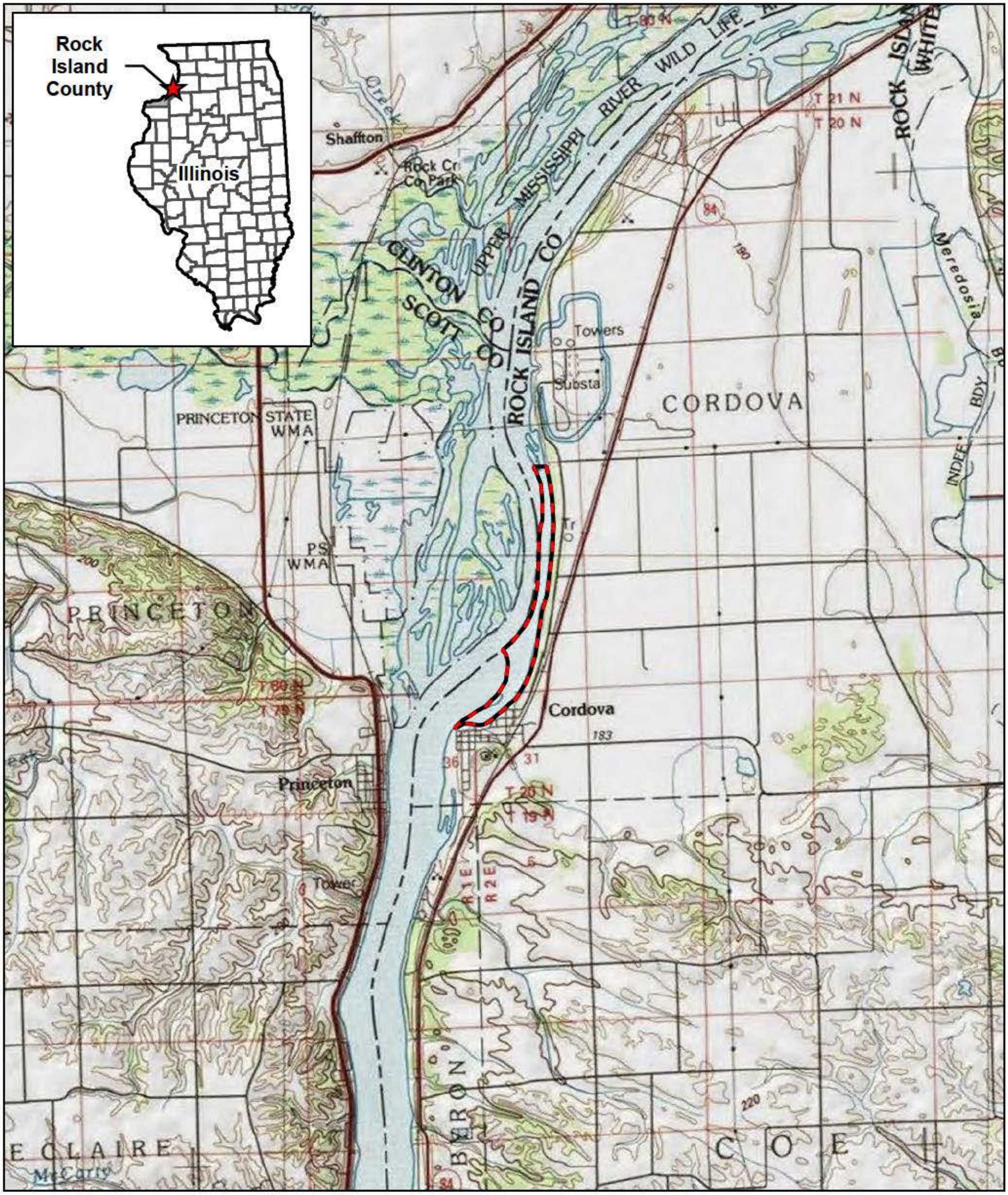
FIGURES



Essential Habitat Area (EHA)

Figure 1. Location of freshwater mussel surveys in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River, Rock Island County, Illinois.

N
W E
S

Project No. 1027.05

990 0 990 1,980 Meters

Base Map: ESRI "USGS Topographic Map"

ESI ENVIRONMENTAL SOLUTIONS & INNOVATIONS, INC.

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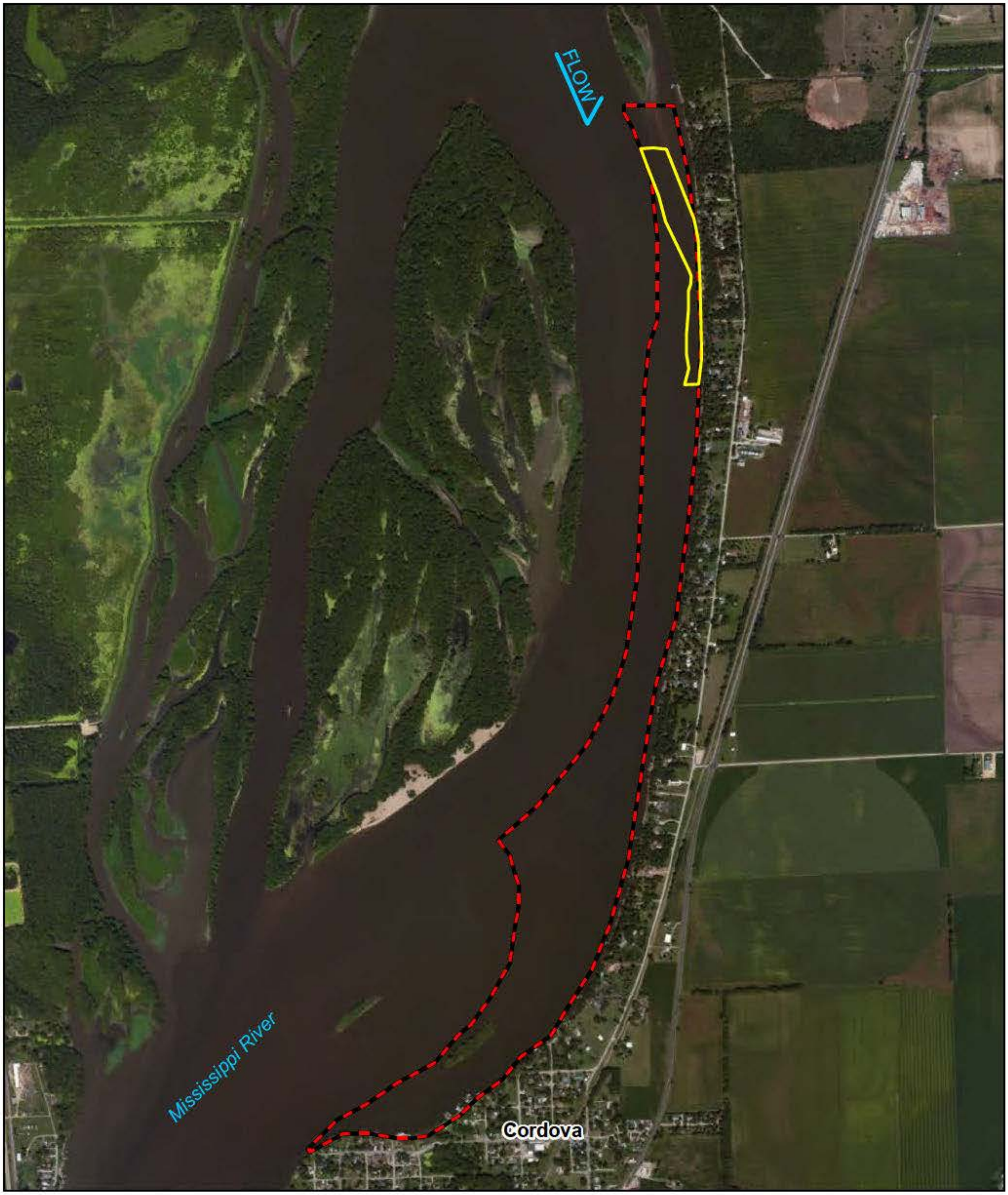

Long Term Monitoring Site (LTMS) Essential Habitat Area (EHA)

N
W E
S

Figure 3. Freshwater mussel survey extent in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Rock Island County, Illinois.

Project No. 1027.05

250 0 250 500 Meters

Base Map: ESRI "World_Imagery (Clarity)"

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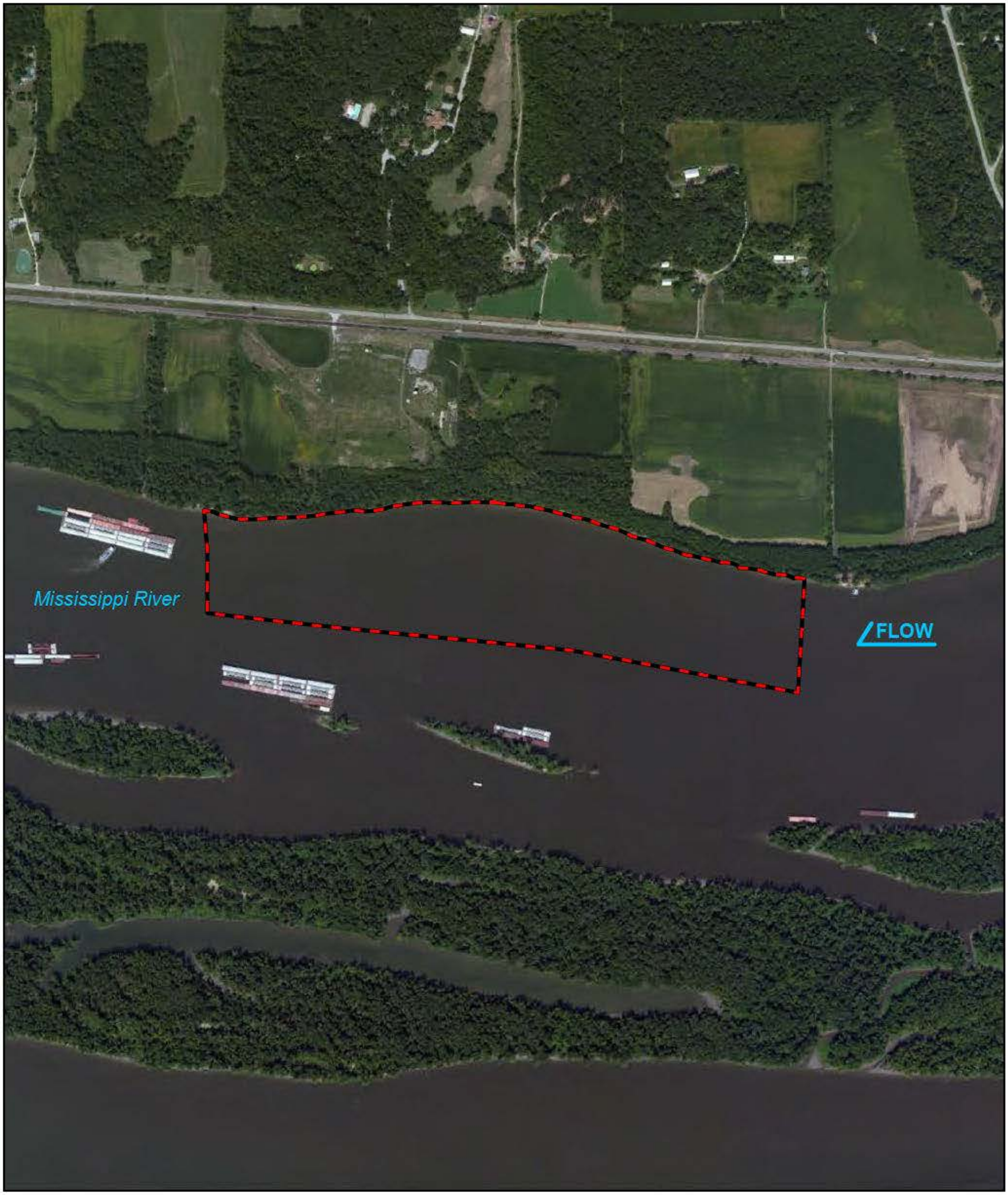

Essential Habitat Area (EHA)

N
W E
S

Figure 4. Freshwater mussel survey extent in Pool 16 at the Buffalo Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Scott County, Iowa.

Project No. 1027.05

150 0 150 300 Meters

Base Map: ESRI "World_Imagery (Clarity)"

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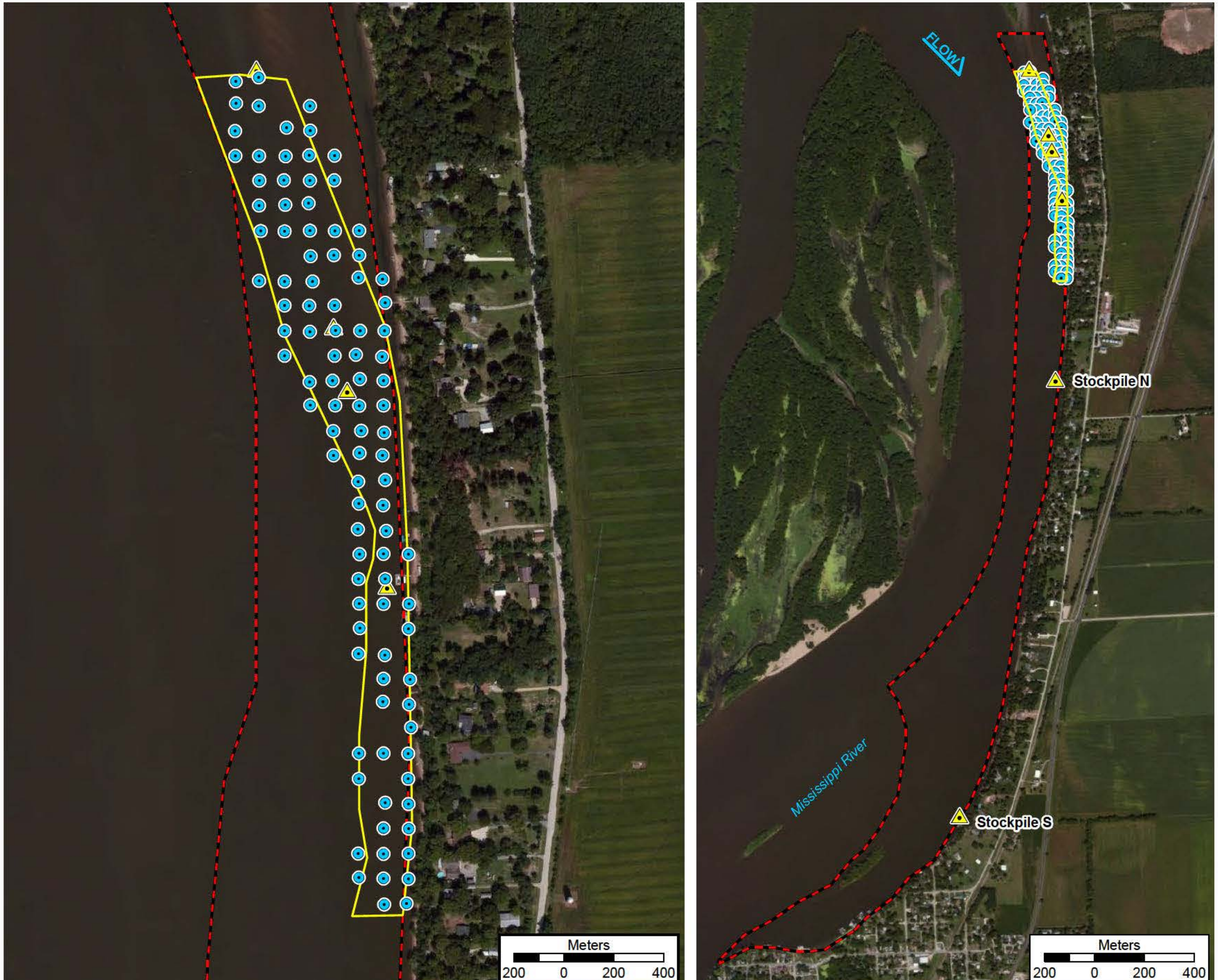
Figure 5. Quantitative and qualitative sample locations in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Rock Island County, Illinois.



Qualitative Sampling Location (6)

Quantitative Sampling Location (100)

Long Term Monitoring Site (LTMS)

Essential Habitat Area (EHA)

N

W E

S

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 1/18/2019

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1027.05

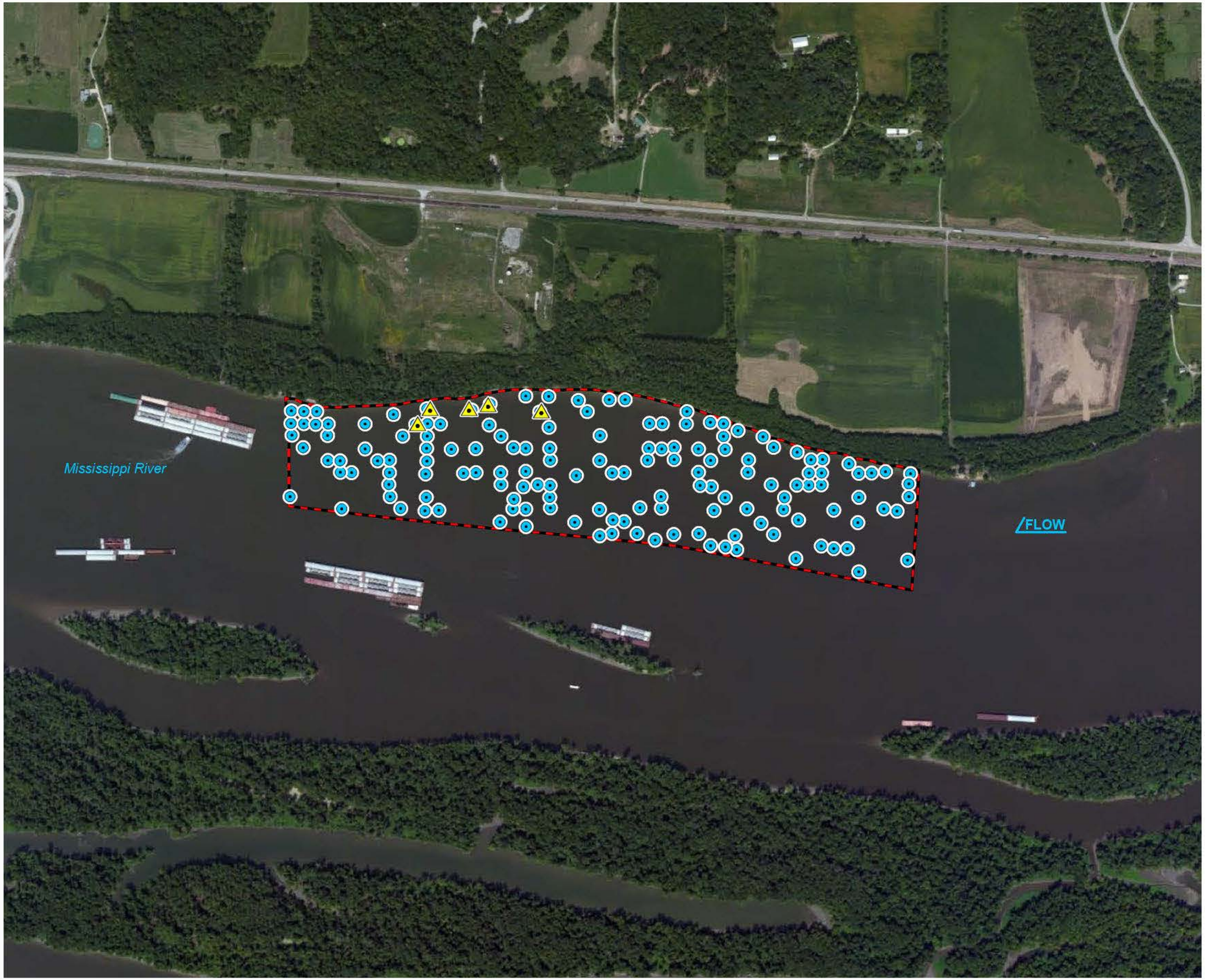

Figure 6. Quantitative and qualitative sample locations in Pool 16 at the Buffalo Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Scott County, Iowa.

Quantitative Sampling Location (150)
Qualitative Sampling Location (5)
Essential Habitat Area (EHA)

N
W
E
S

Meters
100 0 100 200

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 11/28/2018

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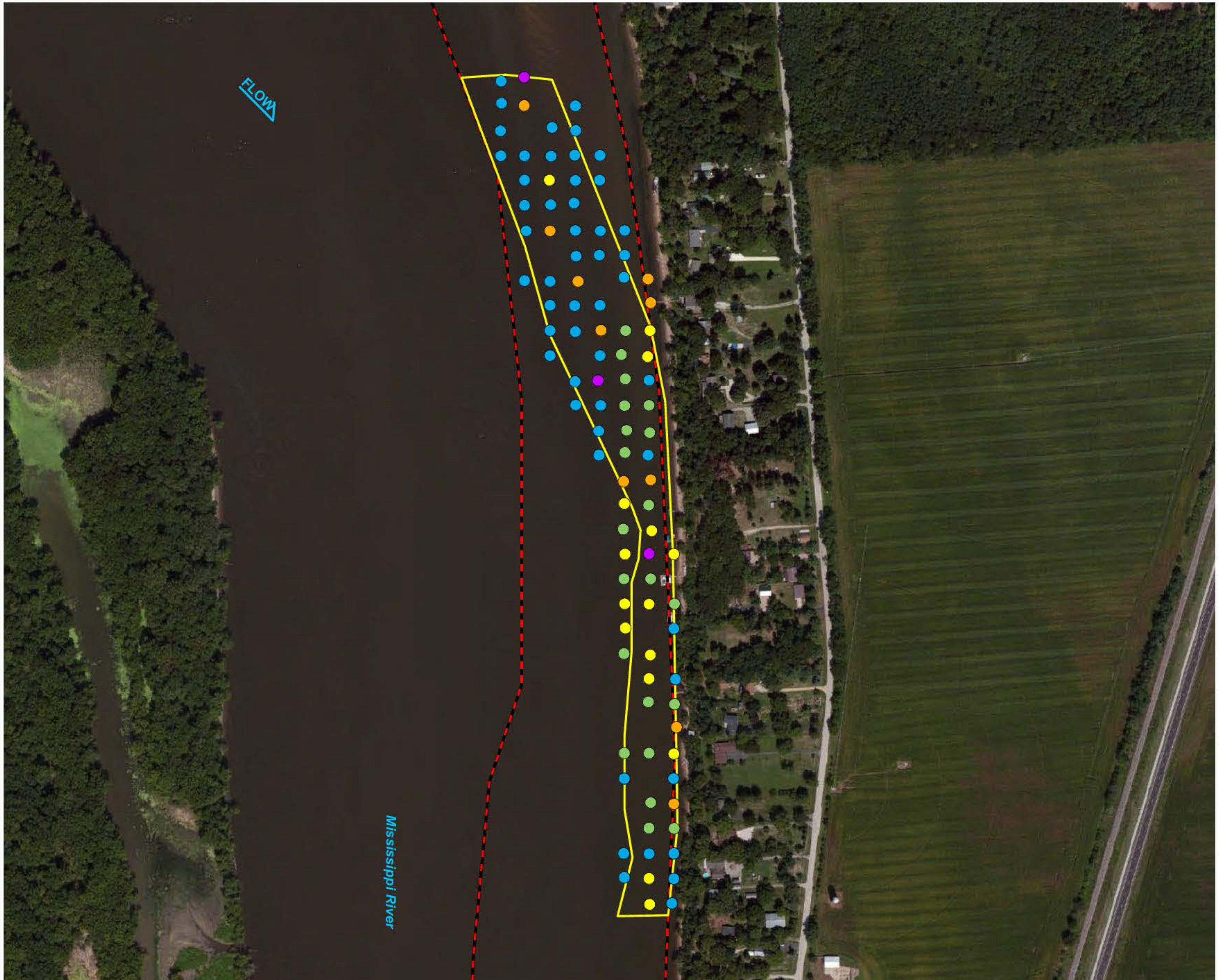
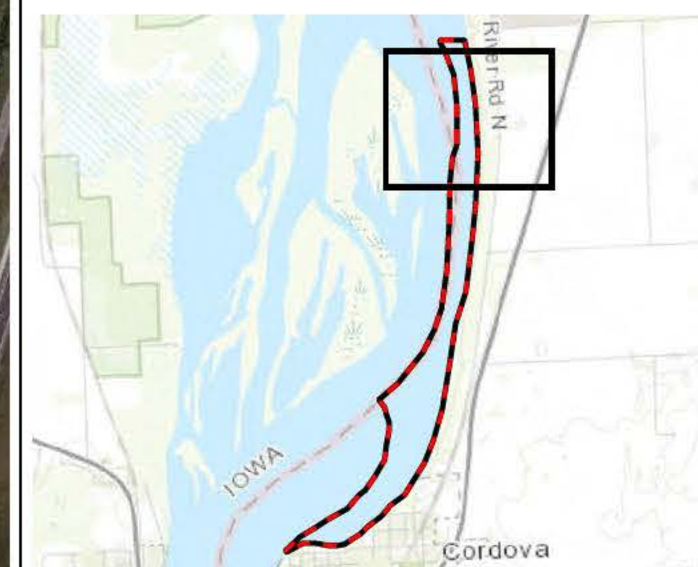
1027.05

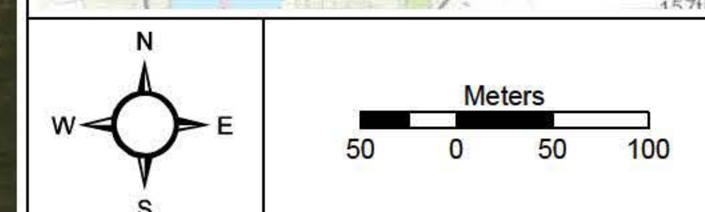
Figure 7. Quantitative mussel abundance for freshwater mussel surveys at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Rock Island County, Illinois.



Mussel Abundance (no./0.25m²)

- 0 - 1 (51)
- 2 - 3 (21)
- 4 - 5 (15)
- 6 - 9 (10)
- 10 - 12 (3)
- Long Term Monitoring Site (LTMS)
- Essential Habitat Area (EHA)





Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 1/23/2019

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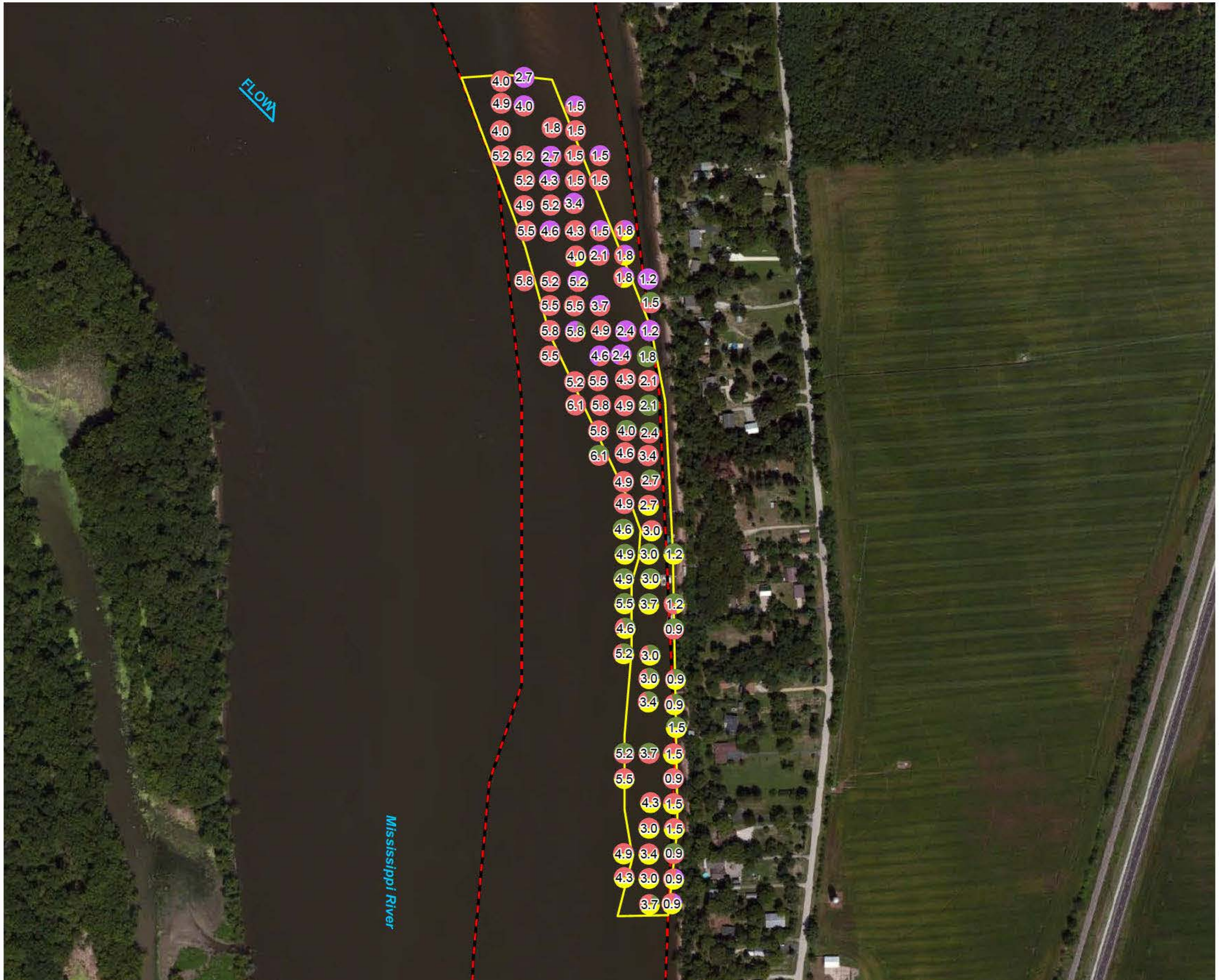
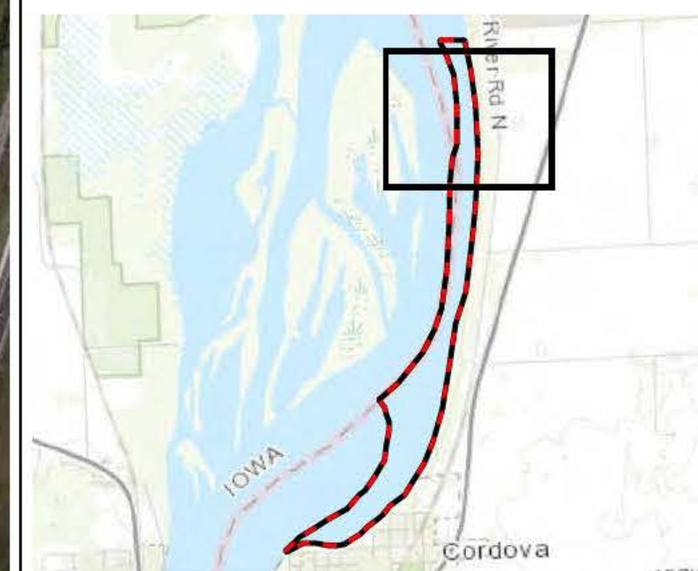
Figure 8. Quantitative sample depth and substrate composition for freshwater mussel surveys in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Rock Island County, Illinois.



Quantitative Sampling Location

- Clay
- Fines
- Sand
- Gravel
- Long Term Monitoring Site (LTMS)
- Essential Habitat Area (EHA)



N
W E
S

Meters
50 0 50 100

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 1/18/2019

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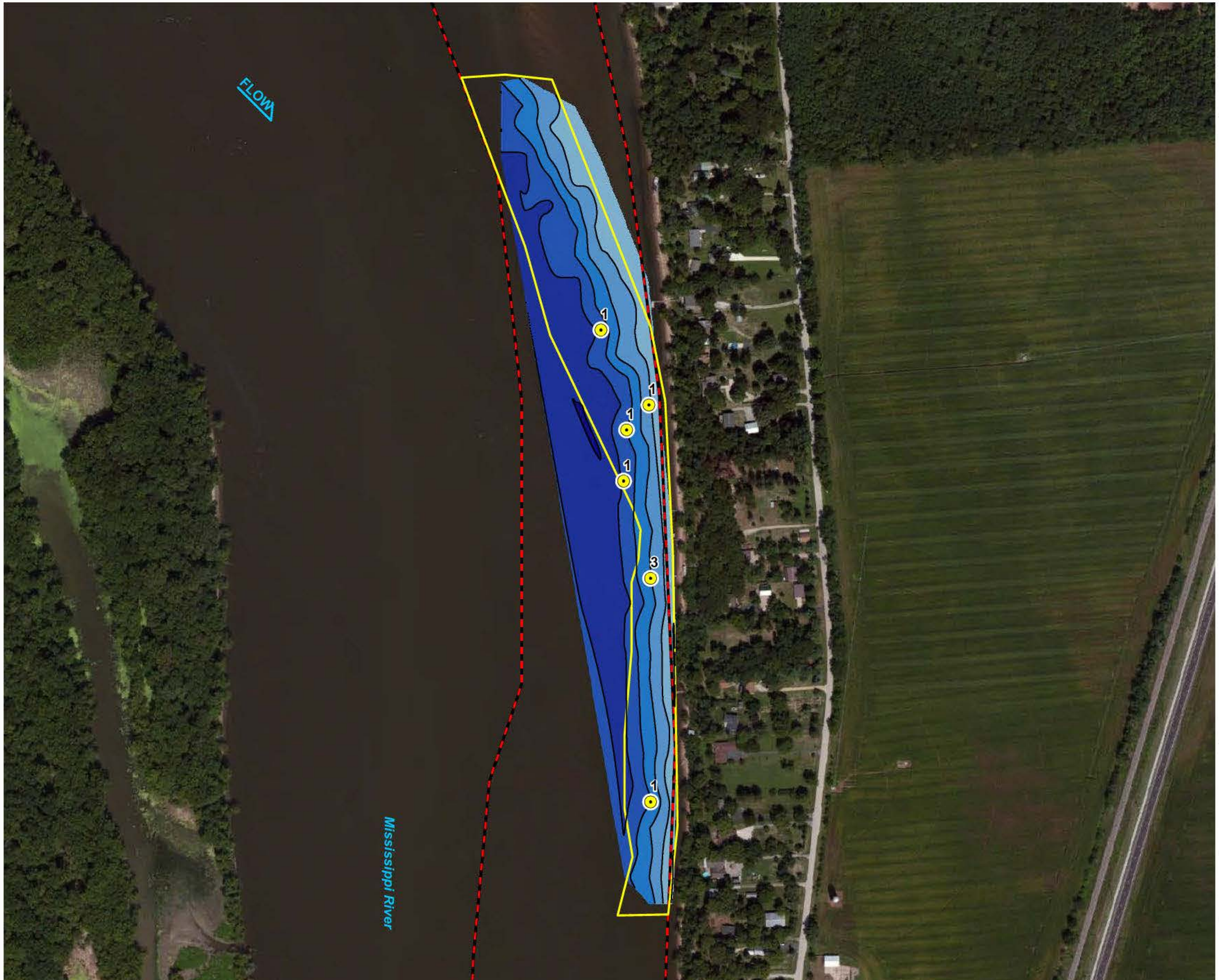
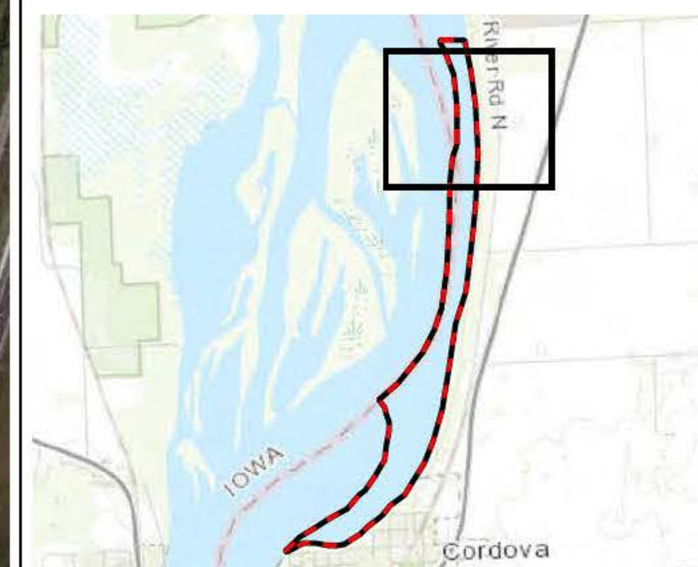
Figure 9. Bathymetric profile and occurrence of federally endangered mussels in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Rock Island County, Illinois.



- Higgins' eye pearly mussel location (6)
- Long Term Monitoring Site (LTMS)
- Essential Habitat Area (EHA)

Bathymetry data (depth in meters)

- 0.92 - 1.0
- 1.1 - 2.0
- 2.1 - 3.0
- 3.1 - 4.0
- 4.1 - 5.0
- 5.1 - 6.0
- 6.1 - 6.1



N
W E
S

Meters
50 0 50 100

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 1/18/2019

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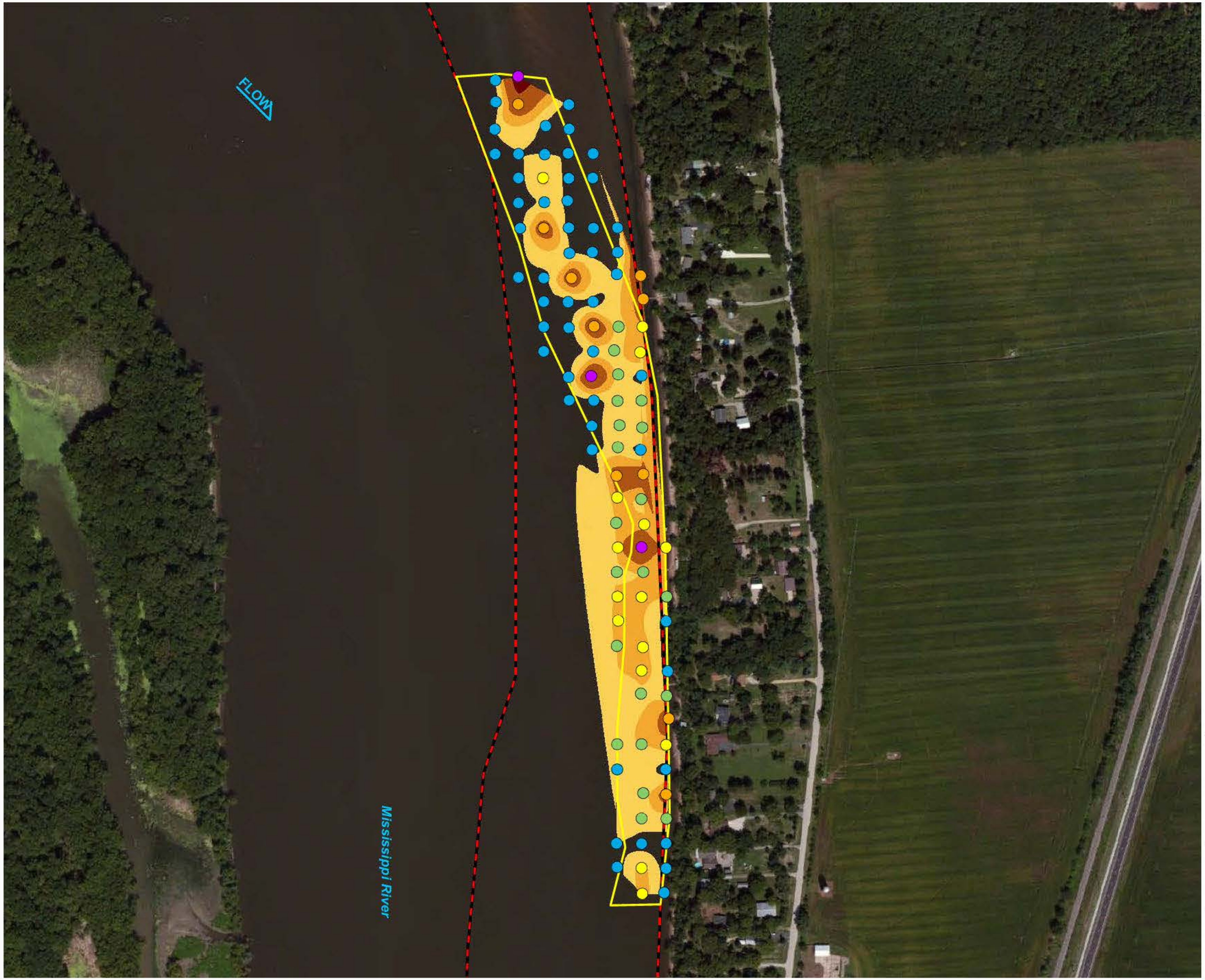
Figure 10. Extrapolated mussel densities in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Rock Island County, Illinois.



Quantitative Sampling Location

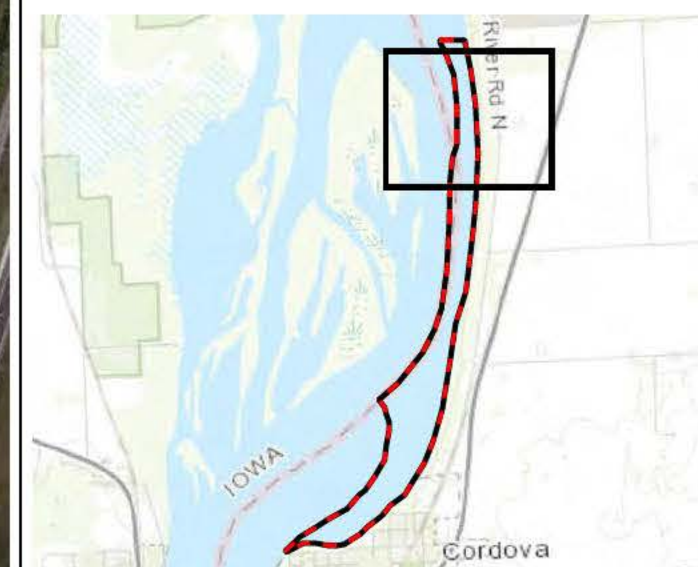
- 0 - 1 (51)
- 2 - 3 (21)
- 4 - 5 (15)
- 6 - 9 (10)
- 10 - 12 (3)

Extrapolated Mussel Density (no./0.25m²)

- 0 - 1
- 2 - 3
- 4 - 5
- 6 - 9
- 10 - 12

Long Term Monitoring Site (LTMS)

Essential Habitat Area (EHA)



N
W E
S

Meters

50 0 50 100

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 11/28/2018

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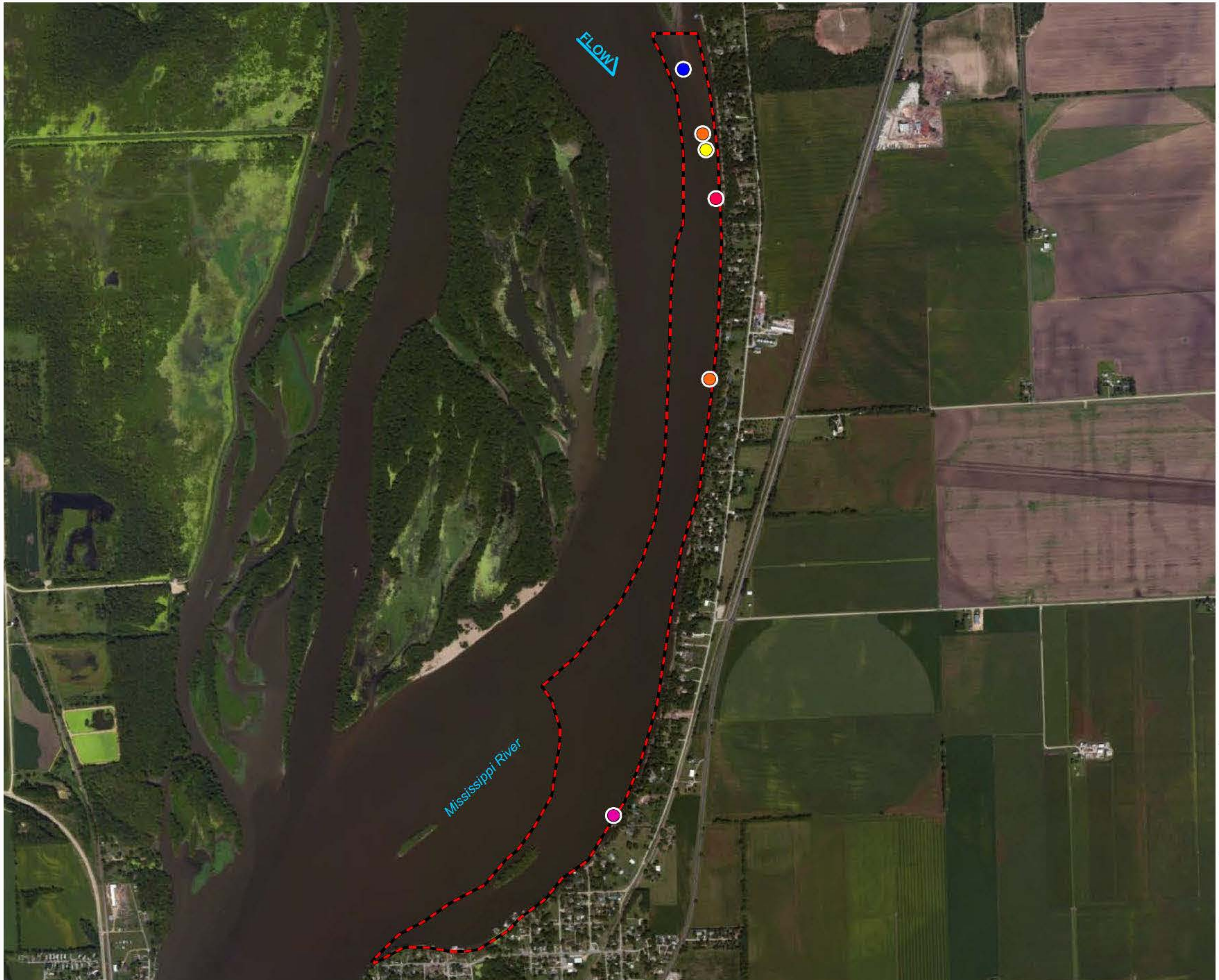
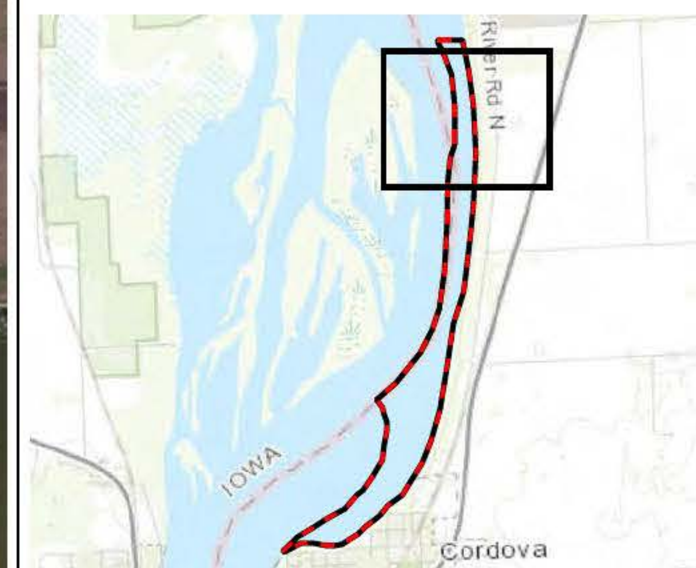
Figure 11. Qualitative mussel abundance for freshwater mussel surveys in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Rock Island County, Illinois.



Catch per unit effort (CPUE) (live mussels per hour)

- 30 (1)
- 31 - 34 (2)
- 35 - 50 (1)
- 51 - 103 (1)
- 104 - 170 (1)
- Essential Habitat Area (EHA)



N
W E
S

Meters
200 0 200 400

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 11/28/2018

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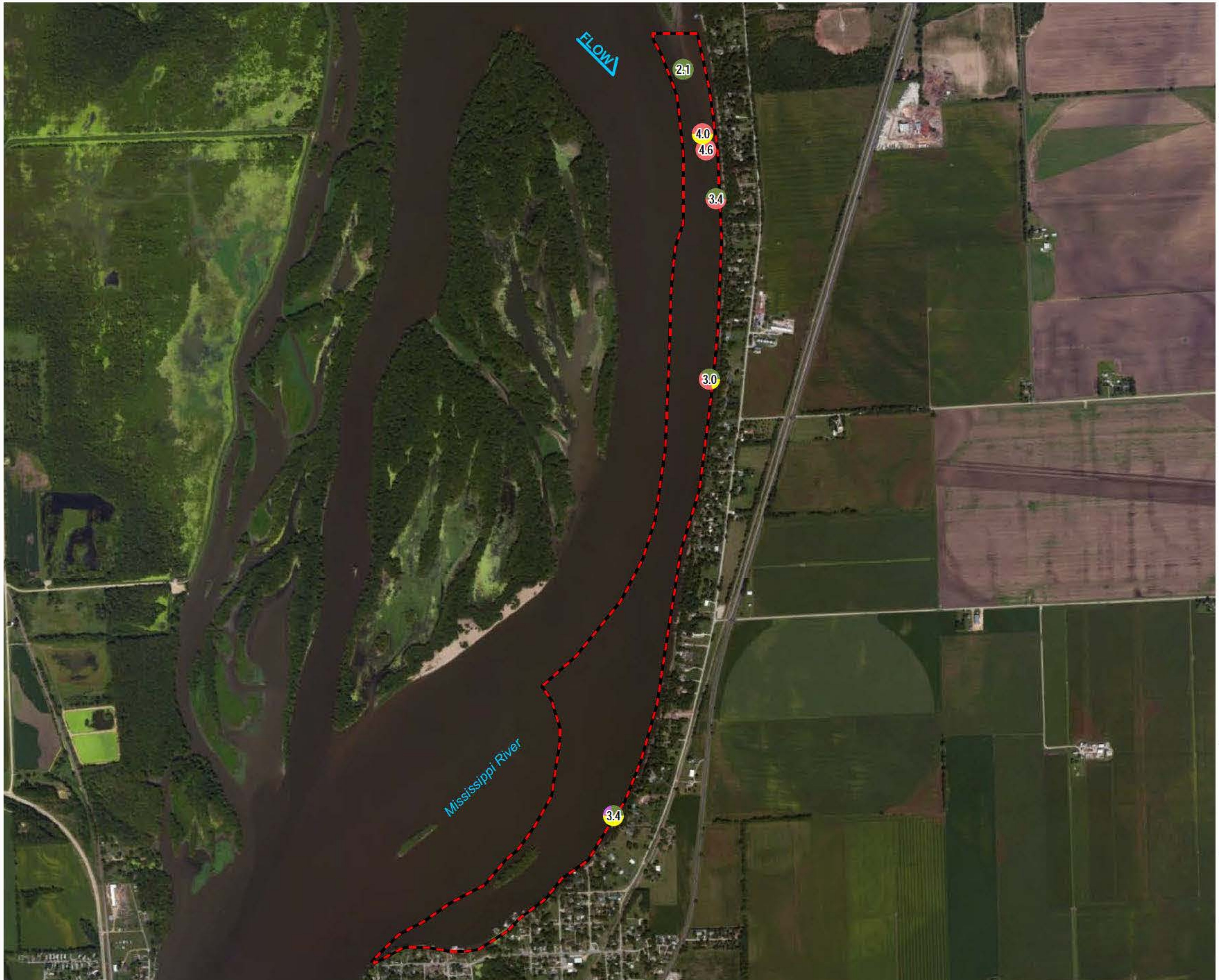
Figure 12. Qualitative sample depth and substrate composition for qualitative freshwater mussel surveys in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River in Rock Island County, Illinois.



Quantitative Sampling Location

- Clay
- Fines
- Sand
- Gravel
- Essential Habitat Area (EHA)

N S W E

Meters

200 0 200 400

Base Map: ESRI ArcGIS Web service - "World_Imagery (Clarity)" accessed - 11/28/2018

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TABLES

Table 1. Summary of quantitative and qualitative samples collected in Pools 14 and 16 at the Cordova and Buffalo Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Areas in the Upper Mississippi River, Rock Island County, Illinois and Scott County, Iowa.

			Quantitative Efforts			Qualitative Efforts		
UMRS Pool	Site	Survey Area (m^2)	Sample Area (m^2)	No. Samples	Total Area Sampled (m^2)	No. Samples	Sample Duration (min)	Total Time (min)
Pool 14	Cordova	45,000	0.25	100	25	6	30	180
Pool 16	Buffalo	85,300	0.25	150	37.5	5	30	150

Table 2. Historical unionid species list for Pool 14 in the Upper Mississippi River.

Mussel Species		
Scientific Name[1]	Common Name	Status[2]
Amblemini		
Amblema plicata	threeridge	
Anodontini		
Arcidens confragosus	rock pocketbook	
Lasmigona complanata	white heelsplitter	
Lasmigona compressa	creek heelsplitter	
Lasmigona costata	fluted shell	
Pyganodon grandis	giant floater	
Strophitus undulatus	creeper	IA_T
Utterbackia imbecillis	paper pondshell	
Utterbackiana suborbiculata	flat floater	
Lampsilini		
Actinonaias ligamentina	mucket	
Ellipsaria lineolata	butterfly	IL_T, IA_T
Epioblasma triquetra	snuffbox	FE, IL_E
Lampsilis cardium	plain pocketbook	
Lampsilis higginsii	Higgins eye pearlymussel	FE, IA_E, IL_E
Lamsilis siliquoidea	fatmucket	
Lampsilis teres	yellow sandshell	IA_E
Leptodea fragilis	fragile papershell	
Ligumia recta	black sandshell	IL_T
Obliquaria reflexa	threehorn wartyback	
Obovaria olivaria	hickorynut	
Potamilus alatus	pink heelsplitter	
Potamilus capax	fat pocketbook	FE, IL_E
Potamilus ohiensis	pink papershell	
Toxolasma parvum	liliput	
Truncilla donaciformes	fawnsfoot	
Truncilla truncata	deertoe	
Margaritiferidae		
Margaritifera monodonta	spectaclecase	FE, IA_E, IL_E
Pleurobemini		
Cyclonaias nodulata	wartyback	
Cyclonaias pustulosa	pimpleback	
Cyclonaias tuberculata	purple wartyback	IL_T, IA_T
Elliptio crassidens	elephant ear	IL_E
Eurynia dilatata	spike	IL_T
Fusconaia ebena	ebonyshell	IL_E
Fusconaia flava	Wabash pigtoe	
Plethobasus cyphyus	sheepnose	FE, IA_E, IL_E
Pleurobema sintoxia	round pigtoe	IA_E
Quadrulini		
Megalonaias nervosa	washboard	
Theliderma metanevra	monkeyface	
Quadrula quadrula	mapleleaf	
Tritogonia verrucosa	pistolgrip	IA_E

[1]Scientific nomenclature derived from Williams et al. 2017

[2]FE = federally endangered, IA_E = Iowa endangered, IA_T = Iowa threatened, IL_E = Illinois endangered, IL_T = Illinois threatened

Table 3. Historical unionid species list for Pool 16 in the Upper Mississippi River.

Mussel Species		
Scientific Name[1]	Common Name	Status[2]
Amblemini		
Amblema plicata	threeridge	
Anodontini		
Arcidens confragosus	rock pocketbook	
Lasmigona complanata	white heelsplitter	
Lasmigona costata	fluted shell	
Pyganodon grandis	giant floater	
Strophitus undulatus	creeper	IA_T
Utterbackia imbecillis	paper pondshell	
Utterbackiana suborbiculata	flat floater	
Lampsilini		
Actinonaias ligamentina	mucket	
Ellipsaria lineolata	butterfly	IL_T, IA_T
Epioblasma triquetra	snuffbox	FE, IL_E
Lampsilis cardium	plain pocketbook	
Lampsilis higginsii	Higgins eye pearlymussel	FE, IA_E, IL_E
Lampsilis teres	yellow sandshell	IA_E
Leptodea fragilis	fragile papershell	
Ligumia recta	black sandshell	IL_T
Ligumia subrostrata	pondmussel	
Obliquaria reflexa	threehorn wartyback	
Obovaria olivaria	hickorynut	
Potamilus alatus	pink heelsplitter	
Potamilus capax	fat pocketbook	FE, IL_E
Potamilus ohiensis	pink papershell	
Toxolasma parvum	liliput	
Truncilla donaciformes	fawnsfoot	
Truncilla truncata	deertoe	
Margaritiferidae		
Margaritifera monodonta	spectaclecase	FE, IA_E, IL_E
Pleurobemini		
Cyclonaias nodulata	wartyback	
Cyclonaias pustulosa	pimpleback	
Cyclonaias tuberculata	purple wartyback	IL_T, IA_T
Elliptio crassidens	elephant ear	IL_E
Eurynia dilatata	spike	IL_T
Fusconaia ebena	ebonyshell	IL_E
Fusconaia flava	Wabash pigtoe	
Plethobasus cyphyus	sheepnose	FE, IA_E, IL_E
Pleurobema sintoxia	round pigtoe	IA_E
Quadrulini		
Megalonaias nervosa	washboard	
Theliderma metanevra	monkeyface	
Quadrula quadrula	mapleleaf	
Tritogonia verrucosa	pistolgrip	IA_E

[1]Scientific nomenclature derived from Williams et al. 2017

[2]FE = federally endangered, IA_E = Iowa endangered, IA_T = Iowa threatened, IL_E = Illinois endangered, IL_T = Illinois threatened

Table 4. Unionid species collected during 2018 quantitative and qualitative mussel surveys in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River, Rock Island County, Illinois.

Mussel Species		Quantitative				Qualitative					
Scientific Name	Common Name	No. live	Rel. Abund. (%)	No. FD[1]	No. ≤5y	No. live	Rel. Abund. (%)	No. FD[1]	No. ≤5y	Total	%
Amblemini											
Amblema plicata	threeridge	49	20.4	5	14	124	29.6	-	35	173	26.3
	Subtotal	49	20.4	5	14	124	29.6	0	35	173	26.3
Anodontini											
Arcidens confragosus	rock pocketbook	0	-	(WD)	-	1	0.2	(WD)	0	1	0.2
Lasmigona complanata	white heelsplitter	1	0.4	(WD)	0	11	2.6	-	1	12	1.8
Pyganodon grandis	giant floater	0	-	(WD)	-	3	0.7	-	1	3	0.5
Utterbackia imbecillis	paper pondshell	1	0.4	(WD)	1	2	0.5	1	2	3	0.5
	Subtotal	2	0.8	0	1	17	4.1	1	4	19	2.9
Lampsilini											
Actinonaias ligamentina	mucket	0	-	(SF)	-	0	-	-	-	0	0.0
Ellipsaria lineolata	butterfly	3	1.3	(WD)	3	2	0.5	(WD)	0	5	0.8
Lampsilis cardium	plain pocketbook	21	8.8	(WD)	6	44	10.5	-	8	65	9.9
Lampsilis higginsii	Higgins eye pearlymussel	8	3.3	(WD)	2	11	2.6	-	0	19	2.9
Lampsilis teres	yellow sandshell	1	0.4	(WD)	1	1	0.2	(WD)	0	2	0.3
Leptodea fragilis	fragile papershell	33	13.8	5	33	10	2.4	-	10	43	6.5
Ligumia recta	black sandshell	11	4.6	(WD)	1	53	12.6	-	2	64	9.7
Obliquaria reflexa	threehorn wartyback	19	7.9	2	15	48	11.5	-	38	67	10.2
Obovaria olivaria	hickorynut	1	0.4	(WD)	0	2	0.5	-	0	3	0.5
Potamilus alatus	pink heelsplitter	8	3.3	(WD)	6	13	3.1	-	5	21	3.2
Potamilus ohiensis	pink papershell	3	1.3	(WD)	3	1	0.2	-	1	4	0.6
Toxolasma parvum	liliput	11	4.6	1	11	1	0.2	(WD)	1	12	1.8
Truncilla donaciformis	fawnsfoot	28	11.7	2	28	2	0.5	(WD)	2	30	4.6
Truncilla truncata	deertoe	0	-	(WD)	-	0	-	-	0	0	0.0
	Subtotal	147	61.3	10	109	188	44.9	0	67	335	50.8
Pleurobemini											
Cyclonaias nodulata	wartyback	1	0.4	1	1	4	1.0	(WD)	4	5	0.8
Cyclonaias pustulosa	pimpleback	22	9.2	6	11	34	8.1	(WD)	3	56	8.5
Cyclonaias tuberculata	purple wartyback	0	-	(SF)	-	0	-	-	-	0	0.0
Fusconaia flava	Wabash pigtoe	9	3.8	(WD)	3	25	6.0	(WD)	6	34	5.2
Pleurobema sintoxia	round pigtoe	0	-	(WD)	-	0	-	(SF)	-	0	0.0
Plethobasus cyphyus	sheepnose	0	-	(SF)	-	0	-	-	-	0	0.0
	Subtotal	32	13.3	7	15	63	15.0	0	13	95	14.4
Quadrulini											
Megalonaias nervosa	washboard	0	-	(WD)	-	4	1.0	(WD)	0	4	0.6
Quadrula quadrula	mapleleaf	9	3.8	2	3	23	5.5		10	32	4.9
Theliderma metanevra	monkeyface	1	0.4	(WD)	0	0	-	-	-	1	0.2
Tritigonia verrucosa	pistolgrip	0	-	(WD)	-	0	-	-	-	0	0.0
	Subtotal	10	4.2	2	3	27	6.4	0	10	37	5.6
Total		240	100	24	142	419	100	1	129	659	100
Total Species		29				23				29	
Species Richness (Live)		20				22				23	
Effort (min)						180					
Avg. CPUE (no./hour)						139.7					
Density (no./m²) ± 95% CI		9.6 ± 2.30									
Population Estimate		328,585 - 535,415									

[1] FD = fresh deadshell - numbers represent the summation of fresh deadshell, WD = weathered deadshell, SF = subfossil shell

Table 5. Mussel assemblage attributes at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River, Rock Island County, Illinois.

Data Analysis/ Attributes	Quantitative	Qualitative	Total
Evenness (slope)	-0.214	-0.202	-
Diversity (1-D)	0.8992	0.8654	-
Rarefaction ES_x (95%CI)			
x=10 individuals	7 (4-8.5)	NA[1]	-
x=50 individuals	14 (10.5-16)	NA[1]	-
x=100 individuals	17 (13.5-19)	NA[1]	-
x=200 individuals	20 (18-22)	NA[1]	-
x=300 individuals	NA	NA[1]	-
No. Species			
Amblemini	1	1	1
Anodontini	2	4	4
Lampsilini	12	12	12
Pleurobema	3	3	3
Quadrulini	2	2	3
Total	20	22	23
Abundance[2]			
Amblemini	49 (22.1)	124 (29.6)	173 (26.3)
Anodontini	2 (0.9)	17 (4.1)	19 (2.9)
Lampsilini	147 (63.6)	188 (44.9)	335 (50.8)
Pleurobema	32 (13.9)	63 (15)	95 (14.4)
Quadrulini	10 (4.3)	27 (6.4)	37 (5.6)
Total	240	419	659
Fresh deadshell mortality (%)	24 (9.1)	1 (0.2)[3]	27 (4.1)
No. unionids ≤ 5 years old	142	129	265
Recruitment (% ≤ 5 years old)	59.2	30.8	40.2
No. ≤ 30mm (%)	103 (42.9)	25 (6.0)	106 (16.1)
Zebra Mussel Infestation			
Zebra Mussel Density (no./m²)	0.6	-	-
No. Zebra Mussel / unionid[2]			
0	225 (93.75)	409 (97.6)	634 (96.1)
1 - 5	15 (6.25)	10 (2.4)	25 (6.0)
6-10	0 (0.0)	0 (0)	0 (0)
> 10	0 (0.0)	0 (0)	0 (0)
% Zebra Mussel Coverage[2]			
0	225 (93.75)	409 (97.6)	634 (96.1)
1 - 10	11 (4.6)	4 (0.95)	15 (2.3)
11 - 50	4 (1.7)	6 (1.4)	10 (1.5)
51 - 100	0 (0.0)	0 (0.0)	0 (0.0)

[1]Accurate confidence intervals could not be established due to a lack of sampling units

[2]Relative abundance provided in parentheses (%)

Table 6. Quantitative mussel density and population estimates at Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in Pool 14 of the Upper Mississippi River, Rock Island County, Illinois.

Species	No. live	Relative Abundance (%)	Density (no./m^2)	95% CI[1]	Population Estimate	95% CI[1]
Amblemini						
Amblema plicata	49	20.4	1.96	1.05 - 2.87	88,200	47,462-128,968
Anodontini						
Lasmigona complanata	1	0.4	0.04	0-0.12	1,800	0-5,372
Utterbackia imbecillis	1	0.4	0.04	0-0.12	1,800	0-5,372
Lampsilini						
Ellipsaria lineolata	3	1.3	0.12	0-0.26	5,400	0-11,523
Lampsilis cardium	21	8.8	0.84	0.46-1.22	37,800	20,739-54861
Lampsilis higginsii	8	3.3	0.32	0.03-0.61	14,400	12,80-27,520
Lampsilis teres	1	0.4	0.04	0-0.12	1,800	0-5,372
Leptodea fragilis	33	13.8	1.32	0.78-1.86	59,400	35,025-83,775
Ligumia recta	11	4.6	0.44	0.19-0.69	19,800	8,569-31,031
Obliquaria reflexa	19	7.9	0.76	0.37-1.15	34,200	16,840-51,560
Obovaria olivaria	1	0.4	0.04	0-0.12	1,800	0-5,372
Potamilus alatus	8	3.3	0.32	0.10-0.54	14,400	4,662-24,138
Potamilus ohiensis	3	1.3	0.12	0-0.30	5,400	0-13,354
Toxolasma parvum	11	4.6	0.44	0.00-0.88	19,800	208-39,392
Truncilla donaciformis	28	11.7	1.12	0.67-1.57	50,400	30,044-70,756
Pleurobemini						
Cyclonaias nodulata	1	0.4	0.04	0-0.12	1,800	0-5,372
Cyclonaias pustulosa	22	9.2	0.88	0.45-1.31	39,600	20,216-58,984
Fusconaia flava	9	3.8	0.36	0.11-0.61	16,200	4,741-27,659
Quadrulini						
Quadrula quadrula	9	3.8	0.36	0.11-0.61	16,200	4,741-27,659
Theliderma metanevra	1	0.4	0.04	0-0.13	1,800	0-5,372
Total	**240**		**9.60**	**7.30 - 11.90**	**432,000**	**328,585-535,415**

[1]CI = Confidence Interval; Negative CI truncated to 0

Table 7. Age frequency distribution of live mussels collected during quantitative survey efforts at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in Pool 14 of the Upper Mississippi River, Rock Island County, Illinois.

	Age (external annuli estimation)																				
Species	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	18	19	≥20	Total
Amblemini																					
Amblema plicata		3	3	3	4	1	7	10	8	9	1										49
Anodontini																					
Lasmigona complanata																	1				1
Utterbackia imbecillis		1																			1
Lampsilini																					
Ellipsaria lineolata		1	1	1																	3
Lampsilis cardium	2		1	2	1			1	3	1	2	1	3	2	1		1				21
Lampsilis higginsii				2					1	1	1		2	1							8
Lampsilis teres					1																1
Leptodea fragilis	7	15	5	5	1																33
Ligumia recta					1				1	3	2	1	1	1	1						11
Obliquaria reflexa		4	1	5	2	3	2	2													19
Obovaria olivaria							1														1
Potamilus alatus		4	1		1			1	1												8
Potamilus ohiensis		1		1	1																3
Toxolasma parvum			5	5	1																11
Truncilla donaciformis		1	13	11	3																28
Pleurobemini																					
Cyclonaias nodulata		1																			1
Cyclonaias pustulosa	1	5	1		3	1	1	4	1	1	3					1					22
Fusconaia flava			2	1			1		3	2											9
Quadrulini																					
Quadrula quadrula		1				2		2	2	1	1										9
Theliderma metanevra															1						1
Grand Total	10	37	33	36	19	7	12	20	20	18	10	2	6	4	3	1	2	0	0	0	240
Total %	4.2	15.4	13.8	15.0	7.9	2.9	5.0	8.3	8.3	7.5	4.2	0.8	2.5	1.7	1.3	0.4	0.8	0.0	0.0	0.0	100.0

Table 8. Length frequency distribution of live mussels collected during quantitative survey efforts at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in Pool 14 of the Upper Mississippi River, Rock Island County, Illinois.

	length (mm, anterior to posterior)																														
Species	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100	100-105	105-110	110-115	115-120	120-125	125-130	130-135	135-140	140-145	145-150	Abundance
Amblemini																															
Amblema plicata		1	4	2	1	4	2		1	1		4	7	6	8	4	2			2											49
Anodontini																															
Lasmigona complanata																														1	1
Utterbackia imbecillis					1																										1
Lampsilini																															
Ellipsaria lineolata				1	2																										3
Lampsilis cardium		1					1		1	1	1	1							2	3	5	3	1		1						21
Lampsilis higginsii					2										1	1			1	3											8
Lampsilis teres																	1														1
Leptodea fragilis		2	1	6	1	5	3		3	3		5	1	1			1		1												33
Ligumia recta													1									1	3		2		2	2			11
Obliquaria reflexa		3	1	1		6	1	1	5	1																					19
Obovaria olivaria										1																					1
Potamilus alatus				2	1	1		1												1	1	1									8
Potamilus ohiensis					1				1							1															3
Toxolasma parvum		2	9																												11
Truncilla donaciformis		7	17	4																											28
Pleurobemini																															
Cyclonaias nodulata		1																													1
Cyclonaias pustulosa		4	3			3	1	1	3	2		4			1																22
Fusconaia flava			2				1		1	2			2	1																	9
Quadrulini																															
Quadrula quadrula		1						1	1			2	3	1																	9
Theliderma metanevra																									1						1
Grand Total	0	22	37	16	9	19	9	4	16	11	1	16	14	9	10	6	4	0	4	9	6	5	4	0	4	0	2	2	0	1	240
Total %	0.0	9.2	15.4	6.7	3.8	7.9	3.8	1.7	6.7	4.6	0.4	6.7	5.8	3.8	4.2	2.5	1.7	0.0	1.7	3.8	2.5	2.1	1.7	0.0	1.7	0.0	0.8	0.8	0.0	0.4	100.0

Table 9. Habitat attributes during mussel survey efforts in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River, Rock Island County, Illinois.

		Depth (m)			Average % Substrate Composition						
Effort Type	No. Samples	Ave.	Min.	Max.	Bedrock	Boulder	Cobble	Gravel	Sand	Silt	Clay
Quantitative	100	3.5	0.9	6.1	0.0	0.0	0.0	16.1	57.3	12.8	13.9
Qualitative	6	3.4	2.1	4.6	0.0	0.0	0.0	20.0	40.0	3.3	36.7

Table 10. Power analysis of live mussels collected during quantitative survey efforts in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River, Rock Island County, Illinois.

		Pool 14 at Cordova
Sample Size (# quadrats)		100
Mean Mussel Density (individuals / m^2)		9.60
95% Confidence Interval		2.30
Standard Deviation		11.58
Precision[1]		24.0%
		No. of Samples
Precision Level[1]		
	15%	259
	20%	146
	25%	93

[1]Precision level = 95% CI of mean

Table 11. Federally endangered mussels collected in Pool 14 at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in the Upper Mississippi River, Rock Island County, Illinois.

Sample ID	Species	New Tag(s)[1]	Sex	Age (years)	Length (mm)	Substrate Composition	Depth (m)	No. Zebra Mussels	FORMER Sample ID
Stockpile_S	*Lampsilis higginsii*	C246	F	8	85.4	50% gravel 30% clay 20% fines	3.4	0	Qual_06
Stockpile_S	*Lampsilis higginsii*	C265	F	9	90.7	50% gravel 30% clay 20% fines	3.4	0	Qual_06
Stockpile_S	*Lampsilis higginsii*	C511	F	7	93.2	50% gravel 30% clay 20% fines	3.4	0	Qual_06
Stockpile_S	*Lampsilis higginsii*	C483	M	10	96.8	50% gravel 30% clay 20% fines	3.4	0	Qual_06
Stockpile_S	*Lampsilis higginsii*	C402	M	10	97.0	50% gravel 30% clay 20% fines	3.4	0	Qual_06
Stockpile_S	*Lampsilis higginsii*	C341	M	11	104.1	50% gravel 30% clay 20% fines	3.4	0	Qual_06
201809281539	*Lampsilis higginsii*	0528-0529	M	12	91.9	40% clay 40% sand 20% gravel	3.0	0	Qual_04
201809281539	*Lampsilis higginsii*	0526-0527	F	8	69.1	100% clay	2.1	0	Qual_04
201809281538	*Lampsilis higginsii*	0524-0525	F	7	72.5	50% gravel 50% sand	4.0	0	Qual_03
201809281538	*Lampsilis higginsii*	0522-0523	M	8	90.8	50% gravel 50% sand	4.0	0	Qual_03
201809281536	*Lampsilis higginsii*	0520-0521	F	9	70.9	50% clay 50% sand	3.4	0	Qual_01
201809281524	*Lampsilis higginsii*	no tag	J	3	28.2	50% gravel 50% sand	4.3	0	89
201809281506	*Lampsilis higginsii*	0514-0515	M	8	71.8	50% clay 50% gravel	3.0	0	71
201809281506	*Lampsilis higginsii*	0516-0517	F	10	75.1	50% clay 50% gravel	3.0	0	71
201809281506	*Lampsilis higginsii*	0518-0519	M	13	100.0	50% clay 50% gravel	3.0	0	71
201809271561	*Lampsilis higginsii*	0512-0513	M	9	91.9	50% clay 50% sand	4.9	0	61
201809271556	*Lampsilis higginsii*	0510-0511	M	12	99.0	50% clay 50% sand	4.0	0	56
201809271554	*Lampsilis higginsii*	no tag	J	3	29.4	100% clay	2.1	0	54
201809271540	*Lampsilis higginsii*	0508-0509	M	12	99.1	100% sand	4.9	0	40

[1]Orange tags

Table 12. Length frequency distribution of live mussels collected during qualitative survey efforts at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in Pool 14 of the Upper Mississippi River, Rock Island County, Illinois.

	length (mm, anterior to posterior)																															
Species	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100	100-105	105-110	110-115	115-120	120-125	125-130	130-135	135-140	140-145	145-150	150-155	
Amblemini																																
Amblema plicata				3	2	5	7	3	5	5	5	10	8	14	16	16	11	9	5													124
Anodontini																																
Arcidens confragosus																			1													1
Lasmigona complanata																			1				1		1	1	3	2	1	1		11
Pyganodon grandis								1											1										1			3
Utterbackia imbecillis									2																							2
Lampsilini																																
Ellipsaria lineolata											1				1																	2
Lampsilis cardium										1	1			1	1	2	1	1	4	8	3	8	7	5	1							44
Lampsilis higginsii														1	2			1	4	2	1											11
Lampsilis teres																	1															1
Leptodea fragilis										1	4	3						2														10
Ligumia recta																		1		1		3		10	11	8	10	6	1	1	1	53
Obliquaria reflexa				1	2	1	10	8	12	13	1																					48
Obovaria olivaria											2																					2
Potamilus alatus									1				2	1		2	1			1	3					1		1				13
Potamilus ohiensis									1																							1
Toxolasma parvum				1																												1
Truncilla donaciformis			1	1																												2
Pleurobemini																																
Cyclonaias nodulata						1	1	1	1																							4
Cyclonaias pustulosa						2	2	3	5	3	8	7	4																			34
Fusconaia flava					3	2	1	2	5	1	3	6	2																			25
Quadrulini																																
Megalonaias nervosa																			1						1				2			4
Quadrula quadrula							3	2	5	2		3	2	4		1	1															23
Grand Total	0	0	1	6	7	11	24	20	37	26	25	29	18	21	20	21	15	14	17	12	7	11	8	15	14	10	13	9	5	2	1	419
Total %	0	0	0.2	1.4	1.7	2.6	5.7	4.8	8.8	6.2	6	6.9	4.3	5	4.8	5	3.6	3.3	4.1	2.9	1.7	2.6	1.9	3.6	3.3	2.4	3.1	2.1	1.2	0.5	0.2	100

Table 13. Age frequency distribution of live mussels collected during qualitative survey efforts at the Cordova Higgins eye pearlymussel (*Lampsilis higginsii*) Essential Habitat Area in Pool 14 of the Upper Mississippi River, Rock Island County, Illinois.

	Age (external annuli estimation)																					
Species	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	≥20	Total
Amblemini																						
Amblema plicata			4	10	7	14	12	27	18	19	5	4	3	1								124
Anodontini																						
Arcidens confragosus										1												1
Lasmigona complanata						1		1	1	2	3		2	1								11
Pyganodon grandis			1				1				1											3
Utterbackia imbecillis			1	1																		2
Lampsilini																						
Ellipsaria lineolata							1	1														2
Lampsilis cardium				5	2	1	3	7	13	5	5	1	1	1								44
Lampsilis higginsii								2	3	2	2	1	1									11
Lampsilis teres							1															1
Leptodea fragilis		1	7		2																	10
Ligumia recta						2		1	1	5	4	14	11	10	1	3	1					53
Obliquaria reflexa			3	6	12	17	6	3				1										48
Obovaria olivaria							1		1													2
Potamilus alatus			2	1	1	1	3	2	1	1		1										13
Potamilus ohiensis				1																		1
Toxolasma parvum			1																			1
Truncilla truncata			1	1																		2
Pleurobemini																						
Cyclonaias nodulata				1	2	1																4
Cyclonaias pustulosa					3		8	5	4	5	5	4										34
Fusconaia flava				5		1	5	1	3	5	1	4										25
Quadrulini																						
Megalonaias nervosa							1								1	1					1	4
Quadrula quadrula				1	8	1	2	2	5	2		2										23
Grand Total	0	1	20	32	37	39	44	52	50	47	26	32	18	13	2	4	1	0	0	0	1	419
Total %	0.0	0.2	4.8	7.6	8.8	9.3	10.5	12.4	11.9	11.2	6.2	7.6	4.3	3.1	0.5	1.0	0.2	0.0	0.0	0.0	0.2	100.0

From:	Schmuecker, Sara
To:	Michl, Davi E CIV [redacted]
Cc:	Gritters, Scott; Perrine, Rachel E [redacted] Stephens, Erica L [redacted] Nerad, Kyle R [redacted]
Subject:	[Non-DoD Source] Re: [EXTERNAL] Steamboat 2019 Mussel Survey - Bathymetry Maps + Meeting Notes (UNCLASSIFIED)
Date:	Tuesday, April 9, 2019 11:05:09 AM

Looks good! I provided just a couple quick comments, below.

Thanks,

Sara

Sara Schmuecker
U.S. Fish and Wildlife Service
Illinois - Iowa Field Office
1511 47th Avenue, Moline, IL 61265
[redacted]

On Tue, Apr 9, 2019 at 8:29 AM Michl, Davi E CIV USARMY CEMVP (US) [redacted] wrote:

> CLASSIFICATION: UNCLASSIFIED
>
> *html
>
> Sara/Scotty,
>
> Per our 2 APR 2019 meeting, I have attached bathymetry maps of Grant Slough and the West SE Island to help make a determination of where you would like to see additional spot dives/quadrats for the upcoming 2019 Mussel Survey and whether the FWS Dive Team will be able to survey based on depths.
>
> Kyle, Scotty wondered what the width of the access dredge cut in Grant Slough would be -- do you have this info? Also, will there be some sort of access channel for the West SE Island beyond the horseshoe at the head of the island?
>
> General meeting minutes (feel free to revise, as needed):

- Grant Slough

  o FWS/DNR would like to see additional survey points (quads? Spot dives?) in between the 2018 survey points to fill in the gaps cover our bases for ~~the BA~~ Section 7 consultation. Survey points would be focused towards the downstream end of Grant Slough where access dredging is planned.

- West SE Island

  o Need to define area of impact, including any access dredging that will occur here (Kyle?)

  o 8' limit to FWS diving

  o FWS/DNR would like to see a mixture of quadrats/spot dives in high mussel density areas here After the impact area and access channel (if needed) have been defined, we'd like to fill in any spatial gaps to certify the whole area of impact has been surveyed due to its proximity to the Cordova EHA.

- Other notes

  o At this time, a bat survey is not required, but we may adjust as we approach design phase Correct. Early in the planning process we discussed that there would be no clear cutting and any limited/select cutting would be conducted outside of the Indiana bat maternity season.

  o No Eastern massasauga rattlesnake survey are required

Please let me know if I captured our discussion accurately—thanks!

V/R,

Davi Michl

Regional Planning and Environment Division North

U.S. Army Corps of Engineers

[redacted]

[redacted]

CEMVR-PM-M 06 JUN 2019

MEMORANDUM FOR RECORD CEMVD-PDM [Mary (LeeAnn) Riggs]

SUBJECT: In-Progress Review (IPR) Teleconference for the Upper Mississippi River Restoration (UMRR) Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP)

1. References:

   a. EC 1165-2-217 Civil Works Review Policy, 20 February 2018

   b. ER 1105-2-100 Planning Guidance Notebook, 22 April 2000

   c. EP 1105-2-58 Continuing Authorities Program, 01 March 2019

   d. "*Steamboat Island HREP IPR April 2019 MFR Attachments.pdf*", UMRR Steamboat Island HREP IPR slide deck, 11 April 2019

2. April 11, 2019 IPR Attendees:

MVD:
Kendall Smith
Daniel (Brian) Chewning
Gary Young
Matthew Mallard
Mary (LeeAnn) Riggs
Jennifer Ryan
Brynn Morgan
Randel Holder
George (Thatch) Shepard
James Briggs
Gregory Miller

RPEDN (MVP):
Karla Sparks, MVR Plan Formulation Chief
Rachel Perrine, Lead Planner
Jodi Creswell, RPEDN Environmental Planning Branch Chief
Camie Knollenberg, RPEDN Plan Formulation Chief
Terry Birkenstock, Acting Chief, RPEDN

MVR:
Erica Stephens, Project Manager
Kyle Nerad, Civil Engineer/Design Lead

3. Agenda:

   a. Study Overview

   b. Steamboat Island HREP Overview

   c. Alternative Development/Evaluation

   d. Tentatively Selected Plan (TSP)

   e. Risk-Informed Decision Making

   f. Schedule

   g. IPR Comments/Concurrence

4. Purpose: To discuss the TSP for the Steamboat Island UMRR HREP (Project) and confirm MVD support for the path forward.

5. Discussion: *See reference d. "Steamboat Island HREP IPR April 2019 MFR Attachments.pdf" for IPR slides deck (information added to original slide deck in blue italics).*

Slide 4: The original approved Fact Sheet included Steamboat Island proper only, but the Revised Fact Sheet includes Grant Slough, the Wapsipinicon bottoms, and islands located southeast of Steamboat Island proper. MVD approved the Revised Fact Sheet on May 22, 2018. This expansion will allow the Project to restore, enhance, and increase additional bottomland forest, floodplain habitat, and aquatic habitats.

Slide 5: Human activity, years of silt deposition, and high water elevation through impoundment of the Upper Mississippi River (UMR) have altered the hydrology (i.e. increased water inundation and duration), topography (i.e. decreased area for less tolerant tree species), and biotic communities in the Project area. Sedimentation and altered hydrology have reduced areas of deep water overwintering habitat and acreage of island habitat. The structure of the floodplain forest, overall health, and sustainability (i.e. reproduction and recruitment) have been significantly affected through an increase in the amount of water and length of time water is present on areas that have historically contained flood-intolerant wetland tree species. As a result, flood-tolerant tree species (i.e. willows and silver maples) have colonized much of the Project area. The combination of stressors continue to degrade and decrease aquatic and wetland structure and function in the complex. While these factors will remain across the planning horizon, the Project provides a unique opportunity to increase quality, diversity, and sustainability of bottomland forest, floodplain, island, and aquatic habitats.

Slide 6: A unique feature for this Project is the pollinator habitat. Pollinator species, such as bees, butterflies, and hummingbirds, are indicators of ecosystem health and provide benefits to habitat diversity. Pollinators are currently in decline due to habitat loss and intensive farming practices; however, the UMR brings benefit to the pollinators, such as being used as a migration path for monarch butterflies. In the Midwest, the federally-listed endangered rusty-patched bumblebee and the candidate species monarch butterfly are two species that have acquired attention. The Project has the opportunity to incorporate pollinator species habitat that produce attractants vital to pollinator conservation. This would affect composition of seed mixes, but not add significant additional cost.

Slide 10: The data used for the CEICA analysis implies a high level of confidence, but there is a specific reason behind the numbers that were used for cost and output. Instead of rounding the costs and habitat units, the PDT wanted to keep the specifics to see how the Flow Diversity, Grant Slough complex, and SE Island features would fare in cost effectiveness and benefits. The CEICA showed us that the small amount of benefit that the Flow Diversity feature brought to its alternatives was cost effective but NOT a Best Buy. The alternatives that contained the SE Island feature were Best Buys, but only if Grant Slough were included. Depending on if and how we had rounded all the numbers, the differences between the alternatives relative to cost and benefit would not have been evident and alternatives would have been screened in a less calculated manner.

6. Questions During IPR:

a. MVD: Since higher water elevations are listed as a problem, shouldn’t a pool drawdown be considered as a feature?

MVR: A pool drawdown was on the initial measures list, but was screened from further consideration. The lock and dam system has increased water levels in the pools, which impacts floodplain forest growth and recruitment (i.e., drowning non-tolerant wetland trees) and replacing over time to more tolerant willows and maples. In addition, sedimentation in the backwaters has increased as a result in increased water inundation. A measure such as water level management isn’t effective or efficient for this Project due to the limited applicability of the feature measure and will not address the problems present within Steamboat Island. Topographic diversity (placing dredged material to raise elevation and planting trees on the raised area) gets the trees to a higher elevation, reducing the impact of increased water elevation. Screening of a water level management measure will be clearly described in the Report.

b. MVD: Is the Sponsor willing to fund operation and maintenance of the stone at the head of Steamboat Island?

MVR: USFWS is supportive of the feature and we are working through cost concerns with them.

c. MVD: What is the cost per habitat unit (and is cost typically $2-3K/unit)? With the high cost of the Project, the benefits seem low.

MVR: The $2-3K reference has historically referred to cost per acre and is a general frame of reference based on historic estimates. The estimated Project first cost (~$41,232,000) cannot be compared to the estimated Average Annual Habitat Units (~75), as those two items are not measured the same. Project first cost is not annualized and the net gain of 75 AAHUs is annualized. We do not have final cost per habitat unit or cost per acre right now, as we are finalizing the TSP and adjusting costs and benefits as we increase the level of detail on the TSP. We are confident in the final ranking of alternatives and selection of the TSP is justified. We understand the need to fully capture the ecological benefits of the Project and will investigate quantification of benefits to the fullest extent. In addition, some ecological significant aspects of the Project (e.g., biodiversity, contribution to limiting habitat, ecological connectivity, Essential Habitat Area quality, and restoration of island/wetland mosaic complex reflective of historic areas) are difficult to quantify through traditional methods. The significance of the outputs from the Project will be qualitatively described in detail to tell the whole story of the Project and how it contributes to ecological structure and function in Pool 14 and the broader UMRS. We recognize MVD's concern with the cost. The Project may result in a larger area than most HREPs, is worth the added investment and has support from the UMRR Regional Program Manager (Marshall Plumley), Partner (Iowa DNR), and Sponsor (USFWS) for the TSP. Previous HREP monitoring has showed that O&M cost for rock structures is low, as long as the rock is appropriately sized and located.

7. Action Item
   a. MVR will provide MFR of IPR meeting for review by April 18, 2019.

8. The MVR point of contact is Ms. Erica Stephens, [redacted], or email: [redacted]

Dennis W. Hamilton

Dennis W. Hamilton, P.E., P.M.P.
Chief, Programs and Project
Management Division

Enclosure:
Steamboat Island HREP IPR April 2019 MFR Attachments.pdf",
UMRR Steamboat Island HREP IPR slide deck, 11 April 2019

2016 Results of Unionid Mussel Monitoring near Quad Cities Nuclear Station, Mississippi River Miles 495 to 515

Prepared for:

Exelon Generation Company
Warrenville, IL

Prepared by:

Ecological Specialists, Inc.
O'Fallon, Missouri
an EcoAnalysts company

May 2017

(ESI Project #16-013)

1.0 Introduction

Exelon Generation (Exelon) requested alternate thermal standards pursuant to Section 316(a) of the Clean Water Act from the Illinois Pollution Control Board for its Quad Cities Nuclear Station (QCNS), which they received in July 2015 along with renewal of their National Pollutant Discharge Elimination System (NPDES) permit. Freshwater unionid mussel (unionid) beds harboring federal, Iowa, and/or Illinois threatened and endangered (T&E) species *Lampsilis higginsii*, *Plethobasus cyphyus*, *Ellipsaria lineolata*, *Ligumia recta*, *Pleurobema sintoxia*, *Lampsilis teres*, and *Strophitus undulatus* occur upstream and downstream of the QCNS. Additionally, the Cordova Essential Habitat Area (EHA) for *Lampsilis higginsii* occurs downstream and the Hansons Slough EHA occurs upstream of the QCNS plant (USFWS, 2008). In 2004, Exelon established a monitoring program for freshwater unionids near the QCNS thermal discharge diffuser. The purpose of the monitoring program was to provide data and information regarding the unionid community, to evaluate the effects QCNS discharge has had on the community, and to compare community characteristics observed following the approval of alternate thermal standards to the baseline unionid community characteristics.

Three unionid beds occur within 3500 m (approximately 2 river miles) of the QCNS thermal diffuser: the Steamboat Slough (SS) Bed, located approximately 675 to 1125 meters (m) downstream of the QCNS mixing zone; the Upstream (UP) Bed, located approximately 730 to 1130 m upstream of the QCNS diffuser; and the Cordova Bed, located about 3300 to 3700 m downstream of QCNS (Figure 1-1). Ecological Specialists, Inc. (ESI) monitored each of these unionid beds in 2004, 2005, 2006, 2007, 2008, and 2012. In 2007, the monitoring program added 400 m sections of 3 additional beds to further evaluate unionid community characteristics among and within unionid beds. The 3 additions were: the Albany Bed, located approximately 14,000 to 14,400 m upstream of the diffuser; the Hansons Slough (HS) Bed, located approximately 5000 to 5400 m upstream of the diffuser; and the Woodwards Grove (WG) Bed, located approximately 10,500 to 10,900 m downstream of the diffuser (Figure 1-1). All 6 beds were sampled in 2007, 2008, and 2012.

QCNS currently operates under NPDES permit conditions that allow 219 (2.5%) exclusion hours per year, during which the plant may cause river temperatures to exceed maximum temperature standards by up to 3° F, except during July, August, and September, the temperature standards may be exceeded by up to 5° F for no more than 131.4 hours of the annual 219-hour allotment. Prior to July 2015, QCNS operated under NPDES permit conditions that allowed 87.6 (1%) excursion hours per year, during which the plant may cause rivet temperatures to exceed maximum temperature standards by up to 3° F. QCNS operated within these permit conditions between 2000 and 2016, except for 2006 and 2012. Less than the allotted 87.6 excursion hours were used in 2001 (57.35 hours), 2005 (42.50 hours), 2007 (74.00 hours), 2009 (5.00 hours), 2010 (36.00 hours), and 2011 (33.00 hours; Table 1-1). No excursion hours were used between 2013 and 2016. In 2006 and 2012, QCNS was granted provisional variances from these permit conditions that allowed additional excursion hours at temperatures up to 5° F. The provisional variances were granted to address periods of low Mississippi River flows and high ambient river temperatures experienced in the summer of 2006 and in the spring and summer of 2012. QCNS used 222.75 (2.5%) excursion hours in 2006, and water temperature during excursion hour events exceeded maximum temperature standards by up to 5°F**.** Similar conditions (low river flows and/or high river temperatures) occurred in the spring and summer of 2012. QCNS used 442.50 (5.1%) excursion hours in 2012.

The Exelon mussel bed monitoring program specifies that monitoring will be conducted in years when excursion hours exceed the allotted 87.6 excursion hours or if monitoring has not occurred for 4 years. 2016 met the latter condition since excursion hours were not exceeded from 2013 – 2016. Monitoring was conducted at all 6 mussel beds near QCNS in 2016. This report presents the results of the 2016 monitoring activities and compares results with previous years.

2.0 Sampling and Analytical Methods

The Albany, Hansons Slough, Upstream, Steamboat Slough, Cordova, and Woodwards Grove beds (Table 2-1) were sampled between October 25 and November 3, 2016, using the same methods ESI used in 2007, 2008, and 2012 (ESI, 2013). Density, age distribution, and observed mortality were estimated using quantitative sampling methods. Species richness was estimated from qualitative samples. The extent of infestation by zebra mussels (*Dreissena polymorpha*) in the beds was also observed and recorded during monitoring events.

At each of the 6 sites, 90 0.25m^2 quantitative quadrat samples were collected. Sampling locations in each bed were randomly selected using GIS, and points were plotted on a Trimble Juno GPS. Samples were obtained from each location by a diver who excavated all substrate material from the quadrat to a depth of 15 cm into a 6-mm mesh bag. A surface crew retrieved the bag and rinsed material through 12 mm and 6 mm sieves. Substrate and debris were searched and unionids removed. All live unionids were identified to species, measured (length in millimeters [mm]), aged (external annuli count), and returned to the river. Freshly dead shells (FD; dead within the past year, nacre shiny, hinge flexible, valves attached, with or without tissue) were identified, counted, and classified as young unionids (Ambleminae ≤5 years old; Lampsilinae and Anodontinae ≤3 years old) or adults. Weathered shells (WD; dead many months to years, nacre chalky, hinge brittle, valves typically separated, periostracum intact) and subfossil shells (SF; dead many years to decades, periostracum eroded, valves separate, very chalky) were noted as present. Water depths (pneumometer) were recorded for each sample location. Substrate composition was estimated using a modified pebble count (Wolman, 1954). The substrate particle category (Wentworth scale) was recorded for each corner and the center of each quadrat (90 x 5 = 450 substrate observations per site). The percentage of each substrate category was calculated for each site.

The qualitative sampling approach was designed to collect as many individuals as possible, thereby increasing the probability of finding rare species (Kovalak et al., 1986). For each qualitative sample, a diver searched for and collected unionids for 5-minute intervals at 25 locations spread throughout each bed. All live and fresh shells of unionids were identified, designated as adults or young unionids, and counted. Live unionids were returned to the river. The position of each qualitative sample was recorded with a Trimble Juno GPS. Bottom water temperature, dissolved oxygen (DO) levels, and current velocity (meters/second) were recorded at each location.

Data regarding the mussel bed community characteristics were analyzed using Analysis of Variance methodology (ANOVA). The following parameters were analyzed: differences in total, young and adult density; differences in Ambleminae and Lampsilinae density; and differences in density of freshly dead shells based on sampling dates and bed location. The data were log (x+1) transformed for ANOVAs and significance level was $p<0.05$ for all tests. Bonferroni post-hoc tests were used to detect differences among dates within each site. Regression analysis was used to determine the slope (rate of increase) of species with respect to cumulative individuals, using the equation: cumulative species = slope * log (cumulative individuals). The intercept constant was set to zero, as no species are present if no individuals are collected. Rarefaction species richness (number of species based on an equal number of individuals) was calculated to compare species richness among years. EstimateS v9.1.0 (Colwell, 2013) was used to calculate rarefaction richness.

3.0 Results and Discussion

3.1 River Flow Rates and Water Temperatures

River flow was relatively high in 2016. Average monthly flow in August and September 2016 was higher than all previous monitoring years and October was higher than all but 2010 (Figure 3-1). Ambient river temperatures were relatively normal in 2016 and no excursion hours were used.

3.2 Upstream Beds

3.2.1 Albany Bed

Albany Bed was the upstream-most bed sampled. The bed extends upstream from Albany, IL (near RM 513) to Cattail Slough (near RM 516). Although very long, the bed is narrow, extending an average of only about 40 m from the bank into the river. The widest portion of the bed (about 70 m wide) was within the town of Albany, IL, near RM 513 and was selected for sampling (Figure 1-1). Land use along the riverbank is residential, and the bank is lined with rip-rap.

The Albany Bed was most similar to the Cordova Bed in habitat characteristics. Substrate was primarily zebra mussel shells mixed with gravel and sand (Table 3-1). Zebra shell increased while cobble and sand decreased in 2016, but this may be due to sample location rather than habitat change, as the values seem to be within the range of previous years (Table 3-2). As in previous years, zebra mussel shells were still a significant substrate component, particularly near the riverward edge of the bed. Depth within the bed ranged from 1.5 to 6.1 m, and DO (8.5 to 8.9 mg/L) was consistent with other sites at the time of sampling (Table 3-1). Similar to 2012, water temperature was relatively low (range 52.9 to 53.5°F), as sampling was conducted in late October. Water temperature in the Albany Bed was generally consistent with other sites. Current velocity (0 to 0.7 m/sec) was higher than previous years due to high water conditions in 2016. No zebra mussel infestation was observed in 2016, which was a decline from 2008 to 2012 (11.2 and 3.8 zebra mussels/unionid in 2008 and 2012, respectively), but was similar to 2007 (0.1 zebra mussels/unionid), and was comparable to the low infestation rates observed in 2016 at other sites (Tables 3-1 and 3-2).

Since habitat was similar between the Albany and Cordova beds, the unionids communities should be similar unless other factors were affecting community characteristics. The Albany Bed unionid community was most like the Cordova Bed community. *Amblema p. plicata* was the dominant species in both beds, Lampsilinae and Ambleminae were similar in abundance, and relative abundance of most species was similar (Table 3-3). However, *Quadrula p. pustulosa* (10.0%) and *Truncilla donaciformis* (11.3%) appeared more abundant in the Albany Bed (5.6% and 3.0%, respectively, Cordova Bed), and *Leptodea fragilis* (15.4%) was more abundant in the Cordova Bed than in the Albany Bed ((4.9%); Table 3-3). Both beds contained the live threatened or endangered species (T&E species) *L. recta*, *L. higginsii*, *E. lineolata*, and *S. undulatus* (Table 3-3). *Ligumia recta* were more abundant in the Albany and Cordova beds than in the other beds in this monitoring study. *Lampsilis teres* (found in the Albany bed in 2012) was collected live in the Cordova bed in 2016.

Density did not differ significantly between Cordova and Albany beds for live unionids, adults, young, Ambleminae, Lampsilinae, or freshly dead unionids (Table 3-4). Species richness regression slopes were 8.17 and 7.58, respectively, 3.3 Downstream Beds

3.3.1 Steamboat Slough Bed

The SS Bed is located approximately 750 m downstream of the QCNS mixing zone (Figure 1-1). Substrate in the SS Bed consisted of sand and silt, with some clay also present in 2016. While silt typically comprised 25-50% of the substrate in previous years, it was not a significant component of the substrate in 2016. Water depth ranged from 0.9 to 4.3 m and averaged 2.3 m (Table 3-18). Current velocity has varied from 0 (August 2006) to 0.6 m/sec (July 2004) and in 2016 ranged from 0.2 to 0.5 m/sec. Dissolved oxygen ranged from a low of 5.1 mg/L in August 2006 to a high of 12.8 mg/L in July 2005. In 2016, DO averaged 8.3 mg/L and was similar to DO in other unionid beds downstream of the QCNS facility (Table 3-1). Very few zebra mussels were found in the SS Bed in previous monitoring events. However, zebra mussel infestation was higher in 2016 than in previous years, and was the highest of all beds sampled in 2016. Water temperature ranged from 53.1 to 53.6°F and was consistent with declining water temperatures throughout the 2016 study period.

The SS Bed continues to support a less dense and less species rich unionid community than the UP Bed, although dominant species were similar between the 2 beds. *Obliquaria reflexa* (25.0%) was the most frequently encountered species in 2016, followed by *Quadrula quadrula* (20.5%), a species which has increased in abundance in the past 2 monitoring events. *Amblema plicata* and *Quadrula p. pustulosa* (18.2% each) were also commonly encountered (Table 3-19). One new species, *Quadrula metanevra,* was collected in 2016.

Density in the SS Bed has been relatively consistent in prior years. Density in 2016 (2.0 unionids/m^2) was lower than in all previous monitoring events, but was not significantly different from density in July 2004 or August 2008 (Table 3-20). Ambleminae continue to comprise a higher percent of the community than Lampsilinae (63.4% vs. 34.6%), and overall, Ambleminae density (1.3/m^2) was significantly greater than Lampsilinae (0.6/m^2) density. Ambleminae density was significantly higher than Lampsilinae density in 2008, 2012, and 2016, but did not differ from Lampsilinae density in previous years (Table 3-20). Density of total live adults, total live young, live Ambleminae, Ambleminae adults and young, live Lampsilinae, and Lampsilinae adults and young have all fluctuated over time (significantly higher or lower in some monitoring events), but no increasing or decreasing trends were apparent. No significant differences were detected in density of fresh dead unionids (total, Lampsilinae, or Ambleminae) in the SS Bed among monitoring years. Mortality was ≤10% overall as well as for both Amblemines and Lampsilines, and was consistent with mortality in previous years. Overall recruitment has fluctuated over the years, but was relatively low (20.8%) in 2016. On average, though, the SS Bed tends to have lower recruitment than most other beds in the study. Ambleminae recruitment (21.2%) was similar to previous years, but Lampsilinae recruitment was notably lower (7.1%) than in previous years. Similar declines in Lampsilinae recruitment were observed in several other beds in 2016.

Age of unionids collected in quantitative samples ranged from 2 to 24 years old (Table 3-21). Four of the 6 Ambleminae species were represented by young individuals. Although no Ambleminae juveniles ≤3 years old were collected in quantitative samples in 2012, several individuals in this age class were present in 2016. Only 2 of the 5 Lampsilinae species were represented by young individuals, and only 1 individual ≤3 years old was collected.

T&E species occurred at a very low frequency in the SS Bed, with only a few individuals collected in any year and/or only sporadically collected (Table 3-19). *Ligumia recta* have been consistently collected in the last 7 monitoring events. *Pleurobema sintoxia* was collected in August 2006 and October 2007. *Ellipsaria lineolata* were found in July 2004 and 2005, but have not been collected since. *Lampsilis teres* was only found alive in 2007 and 2012, and all individuals collected in 2012 were 0-1 years old. Two individuals of *Lampsilis higginsii*, previously thought to not occur in the SS Bed, were found in the SS Bed in 2008; however, no *L. higginsii* have been collected since.

3.3.2 Cordova Bed

The Cordova Bed is one of the Essential Habitat Areas designated in the *L. higginsii* recovery plan (USFWS, 2004). This bed has historically harbored a dense and diverse unionid community. However, density within this bed has declined in recent years primarily due to heavy zebra mussel infestation. The portion of the Cordova Bed sampled in this study is approximately 3300 m downstream of QCNS mixing zone, on the Illinois bank of the river (Figure 1-1).

Zebra mussels were more abundant in the Cordova Bed than other beds during most past monitoring events. In 1994, zebra mussel density in the Cordova bed was <10/m^2 (Miller and Payne, 1995). In 1999, most unionids in the Cordova Bed had <50 zebra mussels attached. By 2000, zebra mussels encrusted all unionids and covered the substrate in most of the Cordova Bed. In 2001, few zebra mussels were found within 20 m of the bank, but density further from the bank averaged 3000 to 4000/m^2. However, in 2002, zebra mussels declined appreciably and only one-third of the unionids had a few zebra mussels attached. Zebra mussel density in 2003 had declined to <1000/m^2. Zebra mussel density increased in the Cordova Bed in 2004; however, density declined in 2005 and remained low in 2006 and 2007 (Table 3-22). Infestation was very high in 2008 and then declined appreciably in later sampling years; no unionids were infested with zebra mussels in 2016 (Table 3-22). Zebra mussel infestation in the Cordova Bed was comparable to the Albany and Hansons Slough Beds in 2016.

Zebra mussel infestation has resulted in high unionid mortality and reduced density within the Cordova Bed. Before heavy zebra mussel infestation (1994), density in the Cordova Bed ranged from 51 to 83 unionids/m^2 and recruitment (measured as percentage of unionids ≤30 mm) ranged from 10 to 49% (Miller and Payne, 1996). In 1999, zebra mussel density was extremely high, unionid mortality was near 50%, and recruitment was near zero at RM 504.3 (ESI, 1999). Between 2001 and 2003, zebra mussel density declined, unionid density and recruitment increased, and mortality declined. Density in 2002 and 2003 ranged from 3.6 to 8.1 unionids/m^2 and, in 2003, recruitment was near 44% (Farr et al., 2002; ERDC, 2003 preliminary data). Unionid density and recruitment have remained stable since 2004, with density averaging 4.7 unionids/m^2 and percentage young unionids averaging 31.8% (Table 3-23). Strayer and Malcolm (2007) also noted a dramatic decline in unionid density in the Hudson River following zebra mussel infestation, followed by a lower density unionid community coexisting with zebra mussels for several years until other invasive species affected unionid abundance (blue crabs that were feeding on zebra mussels, shifted to juvenile unionids when zebra mussels declined; Strayer, personal communication, 2017).

The Cordova Bed differs from the UP and SS beds in that it occurs along a slight outside bend in the river, and its substrate has been coarser (higher percentages of gravel, cobble, shell; Table 3-1). Substrate in 2016 was similar to previous years, and still contained a relatively high percentage of zebra mussel shells. Depth ranged from 0.1 to 7.3 m over all monitoring events, and averaged 3.1 m in 2016. Dissolved oxygen in the Cordova Bed was similar to previous years, averaging 8.3 mg/L (range, 8.2 to 8.6 mg/L; Table 3-22). Current velocity (average, 0.5 m/sec) was higher than in previous years, perhaps due to high discharge during sampling. Water temperature in 2016 was consistent with declining water temperatures throughout the study period, and ranged from 55.0 to 55.8°F.

Species composition and relative abundance in the Cordova Bed were similar to the Albany Bed, and similar trends in unionid community characteristics were observed at both sites. Average relative abundance of Ambleminae (46.3%) and Lampsilinae (48.5%) in this bed was fairly equal (Table 3-24). As in all prior monitoring events, *A. plicata* (33.7%) dominated the community in 2016. *Quadrula p. pustulosa* appeared to be declining somewhat in this bed, but relative abundance of this species was higher in 2016 (12.2%) than in all previous years. Recruitment was markedly lower (11.2%) in 2016 than in all previous monitoring events. Species richness was similar to previous years (20 species collected in 2016), and the slope of the species richness curve remained consistent. Total density and density of adults and juveniles all fluctuated throughout monitoring events, with no apparent increasing or decreasing trends, though juvenile density was significantly lower in 2016 than in 2012. Density of fresh dead shells and overall mortality were lower than in previous monitoring events, as no mortality was observed in 2016 (Table 3-23).

Characteristics specific to Ambleminae and Lampsilinae were similar between the Cordova Bed and the Albany Bed in 2012. Density of total Ambleminae, total Lampsilinae, Ambleminae adults and juveniles, and Lampsilinae adults and juveniles fluctuated throughout monitoring events, with no apparent increasing or decreasing trends, as did density of fresh dead shells and overall mortality. No mortality was observed in either subfamily. Recruitment of both Ambleminae (7.7%) and Lampsilinae (2.4%) was the lowest recorded in all monitoring events thus far; however, recruitment was relatively low in several other beds as well. Density of Ambleminae and Lampsilinae did not differ in 2016 (Table 3-23).

Age of unionids collected in quantitative samples from the Cordova Bed ranged from 1 to 28 years old (Table 3-25). Only 2 of the 5 Ambleminae species and 3 of the 10 Lampsilinae species in this bed were represented by young individuals. The majority of juveniles collected were *Quadrula p. pustulosa*, a species previously thought to be declining somewhat in this bed.

Threatened and endangered species, including *E. lineolata, L. recta,* and *L. higginsii,* continue to be collected regularly from the Cordova Bed. All 3 of these species were present in 2016. *Ligumia recta* and *L. higginsii* have been collected in all monitoring events, while *E. lineolata* has only been collected since 2005. *Lampsilis teres*, not previously collected

4.0 Conclusions

Community characteristics within unionid mussel beds upstream and downstream of the QCNS diffuser discharge have fluctuated over time, but these beds continue to support low to moderate density, species rich unionid communities. The monitoring program focused on unionid beds with similar habitat characteristics upstream and downstream of the diffuser; Cordova (downstream) was most similar to Albany (Upstream), Steamboat Slough (downstream) had similar characteristics to both UP and Hanson Slough beds (upstream). Characteristics of all of these communities varied slightly from previous monitoring events, and some significant differences among years were observed. However, no consistent increasing or decreasing trends were apparent when all monitoring years were considered. Rather, characteristics observed in 2016 were similar to previous monitoring events and likely reflect natural fluctuations. Recruitment appeared to be lower in some of the beds than in previous years, but this may be due to higher water levels in the last few years, as recruitment of many species seems to be lower during high water years.

Results of this study also show that community characteristics within the beds sampled in this study do not seem to be significantly affected by the QCNS thermal effluent. Unionid beds downstream of the QCNS exhibited similarities and differences in habitat and unionid community characteristics with unionid beds upstream of the QCNS, and no significant trends were observed that distinguished the downstream beds from the upstream beds.

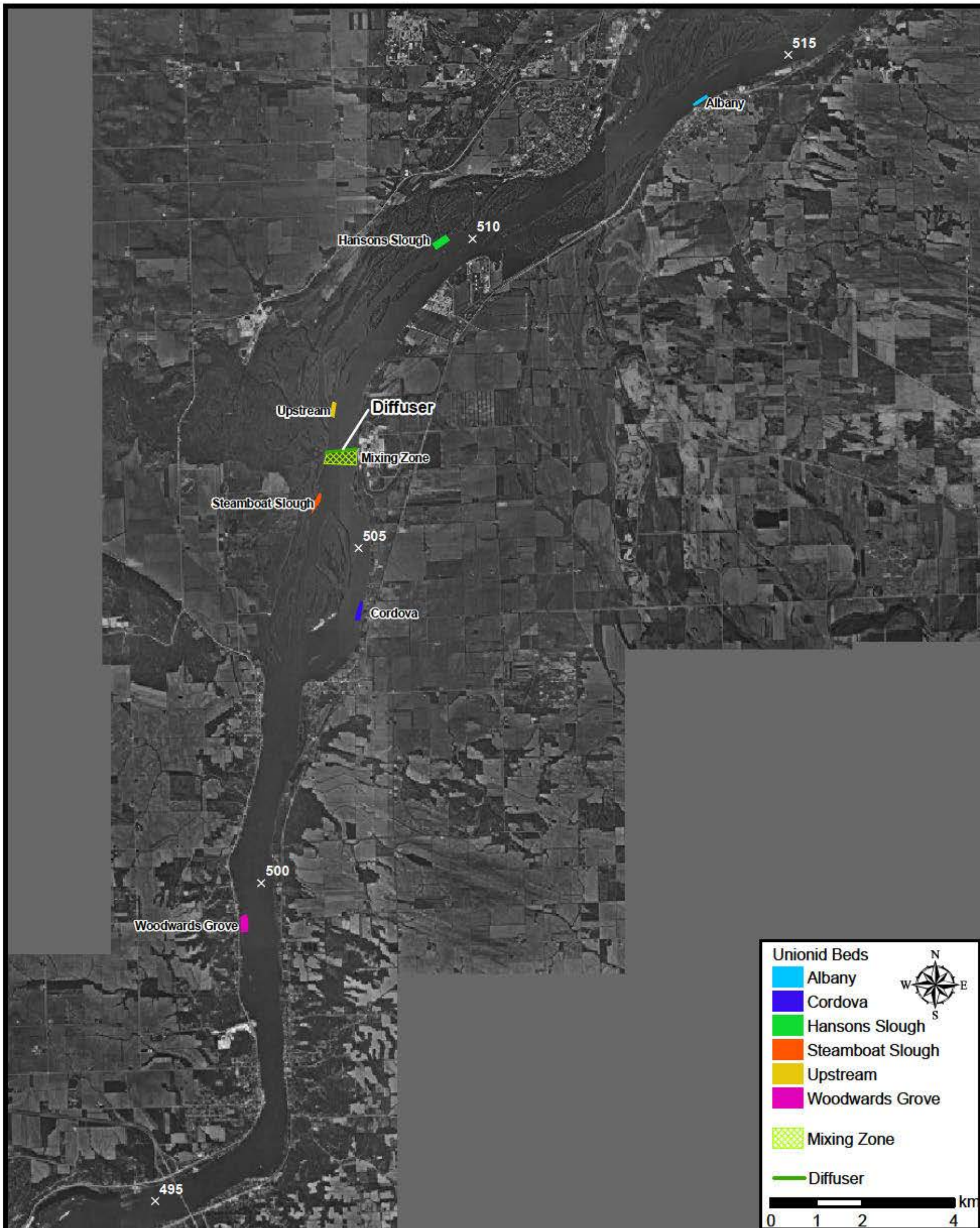

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Figure 1-1. Unionid bed monitoring areas near QCNS, 2004 through 2016.

Table 2-1. Unionid sample sites within the QCNS study area, 2004 to 2016.

Site	MRM	Sample area (m)	Distance from diffuser (km)	Sample dates								
				Jul-04	Jul-05	Oct-05	Aug-06	Sep-06	Oct-07	Aug-08	Oct-12	Oct-16
Albany Bed	513.5	400 x 70	14.0 -14.8						x	x	x	x
Hansons Slough (HS)	509.5	400 x 150	5.0 - 5.4						x	x	x	x
Upstream Bed (UP)	507.0	400 x 80	0.7 - 1.1	x	x	x	x	x	x	x	x	x
Steamboat Slough Bed (SS)	505.6	400 x 50	0.9 - 1.3	x	x	x	x	x	x	x	x	x
Cordova Bed	504.0	400 x 100	3.3 - 3.7	x	x	x	x	x	x	x	x	x
Woodwards Grove Bed (WG)	499.5	400 x 150	10.5 - 10.9						x	x	x	x

MRM= Mississippi River Mile

Table 3-1. Comparison of habitat conditions among unionid beds sampled in October 2016.

	Upstream Beds			Downstream Beds		
	Albany	HS	UP	SS	Cordova	WG
Sample date	Oct 27, 28, 31	Oct 25, 31	Oct 25, 27, 28, Nov 3	Oct 28, Nov 2	Oct 29, Nov 1	Oct 30, Nov 1
Discharge (cfs)[1]	93,807 to 98,771	87,775 to 98,771	87,775 to 97,592	96,878 to 97,327	97,592 to 98,231	98,231 to 98,963
Dist from bank (m)	10 to 70	10 to 150	45 to 115	35 to 115	10 to 90	10 to 150
Dist from mix zone (m)	14,000 to 14,400	5,000 to 5,400	730 to 1,130	675 to 1,125	3,030 to 3,365	10,500 to 10,900
Substrate						
% Bedrock	8	0	0	0	0	0
% Boulder	3	0	0	0	6	0
% Cobble	9	0	0	1	3	1
% Gravel	11	0	0	0	24	0
% Sand	14	70	60	87	14	58
% Silt	5	20	1	0	11	7
% Clay	5	8	32	12	6	15
% Detritus	0	0	0	0	0	0
% Shell	45	1	5	0	37	18
% Vegetation	0	0	0	0	0	0
Depth (m)						
Ave.	3.6	2.2	4.8	3.2	3.1	4.3
Range	(1.5 to 6.1)	(0.6 to 3.7)	(2.1 to 7.6)	(1.8 to 3.9)	(1.2 to 7.3)	(1.5 to 7.6)
CV[2]	33.0	29.0	28.0	15.0	34.0	26.0
Bottom temp (°F)						
Ave.	53.2	53.7	54.8	53.4	55.5	55.6
Range	(52.9 to 53.5)	(53.6 to 53.8)	(54.4 to 54.9)	(53.1 to 53.6)	(55.0 to 55.8)	(55.2 to 55.8)
CV[2]	0.8	0.3	0.5	0.6	0.7	0.5
Bottom DO (mg/L)						
% saturation	83.1	87.5	83.9	78.6	80.7	80.7
Ave.	8.8	9.2	8.7	8.3	8.3	8.3
Range	(8.5 to 8.9)	(8.9 to 9.6)	(7.7 to 8.9)	(8.2 to 8.4)	(8.2 to 8.6)	(7.9 to 8.4)
CV[2]	1.2	2.4	2.4	0.6	1.0	1.4
Bottom current velocity (m/sec)						
Ave.	0.5	0.4	0.5	0.4	0.5	0.4
Range	(>0 to 0.7)	(0.2 to 0.5)	(0.4 to 0.5)	(0.2 to 0.5)	(0.3 to 0.7)	(0.1 to 0.5)
CV[2]	26.0	19.0	7.0	24.0	23.0	23.0
Rel. zebra mussel inf.[3]	0.0	0.0	0.4 (0 - 10)	6.8 (0 - 10)	0.0	0.6 (0 - 10)

[1]Lock and Dam 14 (LeClaire, IA; MRM 493.3)

[2]CV = coefficient of variation (Standard deviation*100/mean)

[3]Average and range of zebra mussels per unionid

Table 3-3. Comparison of average species relative abundance (%)[1] among unionid beds upstream and downstream of QCNS.

	Upstream beds			Downstream beds		
	Albany[2]	HS[2]	UP[3]	SS[3]	Cordova[3]	WG[2]
Margaritiferidae						
Cumberlandia monodonta	**SF**	**-**	**-**	**-**	**-**	**-**
Ambleminae						
Amblema plicata	21.4	18.9	22.2	27.7	34.2	15.2
Cyclonaias tuberculata	**WD**	**-**	**SF**	**-**	**SF**	**SF**
Elliptio crassidens	**SF**	**-**	**-**	**-**	**-**	**-**
Elliptio dilatata	**SF**	**-**	**-**	**-**	**SF**	**WD**
Fusconaia ebena	WD	-	WD	WD	WD	WD
Fusconaia flava	3.6	5.1	5.2	2.8	2.1	0.4
Megalonaias nervosa	1.7	0.1	0.4	X	2.4	3.8
Plethobasus cyphyus	**SF**	**-**	**-**	**-**	**P**	**SF**
Pleurobema sintoxia	**SF**	**0.2**	**WD**	**X**	**WD**	**X**
Quadrula metanevra	X	X	0.1	X	WD	SF
Quadrula nodulata	0.5	3.8	1.2	11.3	0.3	6.1
Quadrula p. pustulosa	10.0	35.1	8.2	7.7	5.6	2.8
Quadrula quadrula	4.3	5.7	6.8	13.8	1.7	25.6
Tritogonia verrucosa	**SF**	**-**	**WD**	**WD**	**WD**	**WD**
Total Ambleminae	41.4	68.8	44.1	63.4	46.3	53.8
Anodontinae						
Anodonta suborbiculata	-	-	-	-	-	X
Arcidens confragosus	0.5	X	0.4	0.5	0.5	1.4
Lasmigona c. complanata	1.4	0.2	1.6	0.8	0.6	1.2
Lasmigona costata	-	-	-	-	-	SF
Pyganodon grandis	1.2	0.2	0.2	3.8	1.5	1.2
Strophitus undulatus	**0.2**	**WD**	**WD**	**-**	**0.1**	**-**
Utterbackia imbecillis	2.6	WD	0.5	FD	2.5	7.7
Total Anodontinae	5.9	0.4	2.7	2.0	5.1	11.6
Lampsilinae						
Actinonaias ligamentina	WD	0.1	X	X	0.3	SF
Ellipsaria lineolata	**0.5**	**1.7**	**0.5**	**0.3**	**0.4**	**0.4**
Lampsilis cardium	8.2	7.8	7.2	2.9	8.2	1.5
Lampsilis higginsii	**1.3**	**0.3**	**0.1**	**X**	**2.0**	**0.2**
Lampsilis ovata	-	-	X	-	-	-
Lampsilis siliquoidea	SF	-	-	-	0.1	-
Lampsilis teres	**0.3**	**X**	**0.5**	**0.5**	**WD**	**0.3**
Leptodea fragilis	4.9	0.8	5.8	1.7	15.4	8.9
Ligumia recta	**7.5**	**0.9**	**0.9**	**0.2**	**4.3**	**0.4**
Obliquaria reflexa	12.7	14.5	29.4	21.9	7.5	12.7
Obovaria olivaria	1.8	1.6	2.7	0.6	0.3	0.2
Potamilus alatus	1.1	0.2	0.4	0.5	1.7	2.1
Potamilus capax	**-**	**-**	**WD**	**-**	**-**	**-**
Potamilus ohiensis	0.2	1.0	1.1	3.5	0.6	2.9
Toxolasma parvus	2.6	0.2	0.3	0.1	2.6	0.3
Truncilla donaciformis	11.3	1.4	3.8	2.2	3.0	6.4
Truncilla truncata	0.3	0.3	0.5	0.1	0.5	0.2
Total Lampsilinae	52.7	30.8	53.1	34.6	48.5	36.6
No. species live/FD	25	25	26	26	26	25
Total species	35	27	32	28	33	33
No. live/FD T&E species	5	5	4	5	5	5
Total no. T&E species	11	6	9	6	10	9

[1]Numbers represent % that species represents in quantitative samples X=not collected in quantitative samples, but found in qualitative samples

[2]Average of October 2007, August 2008, and October 2012

[3]Average of all monitoring events 2004 to 2016

FD = freshly dead shell, WD = weathered shell, SF = subfossil shell, P=collected in a recent study by ILDNR (D Sallee, pers com)

Bold indicates Illinois, Iowa and Federally threatened and endangered species

Table 3-4. Comparison of average community characteristics among unionid beds upstream and downstream of QCNS.

	Upstream beds			Downstream beds		
	Albany[4]	HS[4]	UP[5]	SS[5]	Cordova[5]	WG[4]
Total no.[1]	404	1082	735	557	436	905
Ave. no./m[2,2]	5.3 ± 0.8A	8.3 ± 1.3B	9.9 ± 1.1B	4.1 ± 0.4A	4.7 ± 0.5A	8.8 ± 1.2B
Ave. CPUE [3]	10.0	32.2	25.5	21.8	15.2	24.8
Ave. no. species/qual sample[3]	5.1	7.1	6 9	6.2	5.9	7.0
Total no. live/FD species[1]	20.5	20.3	21.6	16.2	20.3	22.3
Cumulative live/FD species	25	25	26	26	25	25
Rarefaction species richness[3]						
100	17	11	13	10	15	14
250	20	15	17	14	19	18
500	21	18	20	16	20	20
750	-	20	22	16	-	22
Regression slope	8.17	6.30	7 32	5.64	7.58	7.49
Ave. no. young/m[2,2]	2.0 ± 0.4AC	2.1 ± 0.4AC	2.6 ± 0.4CD	0.9 ± 0.2B	1.6 ± 0.3A	3.6 ± 0.8D
Ave. no. adults/m[2,2]	3.1 ± 0.5A	6.1 ± 1.1B	7.0 ± 0.9B	3.1 ± 0.4A	3.1 ± 0.3A	4.8 ± 0.7B
% young[2]	40.6	22.4	29.4	22.1	31.8	41.6
% of species w/ ≤5 yrs[2]	64.0	66.8	69.1	58.6	60.5	66.6
Ave. no. FD/m[2,2]	0.5 ± 0.2A	0.4 ± 0.2AB	0.6 ± 0.1A	0.2 ± 0.1B	0.5 ± 0.2A	0.3 ± 0.1AB
%Mortality[2]	8.8	5.1	4 9	3.6	12.1	2.8
% adult mortality[2]	10.7	6.6	6 1	4.4	11.8	6.0
% juvenile mortality[2]	6.6	1.0	7 5	2.8	12.6	0.9
Ambleminae						
Total no. [2]	50.0	127.8	84.6	48.1	39.2	95.8
Total no. [1]	152.8	597.5	259.0	334.1	205.4	436.0
Ave. no./m[2,2]	2.2 ± 0.4A*	5.7 ± 0.9BC*	4.6 ± 0.6C*	2.6 ± 0.3A*	2.1 ± 0.3A*	4.3 ± 0.6BC*
Ave. no.≤5yrs/m[2,2]	0.7 ± 0.2A	1.5 ± 0.3B	1.3 ± 0.2B	0.6 ± 0.1A	0.5 ± 0.1A	1.3 ± 0.3B
Ave. no.>5yrs/m[2,2]	1.6 ± 0.4A	4.2 ± 0.8B	3.2 ± 0.5CD	2.0 ± 0.3AC	1.6 ± 0.2A	3.0 ± 0.5BD
% young[2]	29.7	22.9	28.6	23.2	26.0	30.3
Total no. species[1]	5.8	6.8	5 9	5.4	5.4	6.3
Total no. species w/young[1]	4.3	5.0	5 1	4.4	4.1	5.5
Total no. adult species[1]	5.8	6.3	5.7	5.4	5.2	6.3
Ave. no. FD/m[2,2]	0.2 ± 0.1AB	0.3 ± 0.1B	0.1 ± 0.1AB	0.1 ± 0.0A	0.2 ± 0.1AB	0.0 ± 0.1A
%Mortality[2]	9.2	4.9	2.4	2.2	8.8	1.1
% adult mortality[2]	6.5	5.4	2 9	1.9	5.9	1.7
% juvenile mortality[2]	8.2	0.0	3.6	1.4	17.9	0.0
Lampsilinae						
Total no. [2]	63.5	56.5	94.0	26.4	43.3	73.3
Total no. [1]	124.5	265.3	294 3	159.4	125.9	161.8
Ave. no./m[2,2]	2.8 ± 0.5A#	2.5 ± 0.5A#	5.1 ± 0.6C#	1.4 ± 0.2B#	2.3 ± 0.3A*	3.3 ± 0.6A#
Ave. no.≤3yrs/m[2,2]	1.3 ± 0.3AD	0.6 ± 0.2BC	1.4 ± 0.2D	0.3 ± 0.1C	0.9 ± 0.2AB	1.8 ± 0 5D
Ave. no.>3yrs/m[2,2]	1.6 ± 0.3AB	1 9 ± 0.4A	3.6 ± 0.5C	1.1 ± 0.2B	1.4 ± 0.2AB	1.4 ± 0.3AB
% young[2]	39.3	19.4	29.4	20.3	33.5	48.5
Total no. species[1]	10.0	10.5	11.6	8.2	10.9	11.8
Total no. species w/young[1]	7.3	6.0	8.6	4.7	6.1	7.5
Total no. adult species[1]	8.8	9.0	10.0	7.3	10.0	10.5
Ave. no. FD/m[2,2]	0.3 ± 0.1AB	0.2 ± 0.1AB	0.4 ± 0.1B	0.1 ± 0.0A	0.3 ± 0.1AB	0.1 ± 0.1AB
%Mortality[2]	7.6	5.2	6.0	5.4	13.1	4.3
% adult mortality[2]	15.4	8.3	7.4	8.2	13.4	12.8
% juvenile mortality[2]	5.0	6.7	11.5	2.4	8.6	0.0

[1]Quantitative and Qualitative combined; [2]Quantitative data only; [3]Qualitative data only
[4]Average of October 2007, August 2008, October 2012, and October 2016
[5]Average of all monitoring events 2004 to 2016
Different letters within a row indicates a significant difference (ANOVA, p<0 05)
Different symbols within a column indicate a significant difference (t-test, p≤0 05)

Table 3-13. Comparison of community characteristics among unionid beds upstream and downstream of QCNS, 2016.

	Upstream beds			Downstream beds		
	Albany	HS	UP	SS	Cordova	WG
Total no.[1]	208	457	673	313	342	445
Ave. no./m^{2,2}	3.5 ± 1.0A	3.4 ± 1 2A	11 2 ± 3.4B	2.0 ± 0.7A	4.4 ± 1.2AC	7.6 ± 2.1BC
Ave. CPUE [3]	5.2	15.2	16.8	10.7	9.8	11.0
Ave. no. species/qual sample[3]	3.1	4.8	4.5	4.3	5.0	4.8
Total no. live/FD species[1]	18	15	20	14	20	21
Cumulative live/FD species	25	25	26	26	25	25
Rarefaction species richness[3]						
100	16	10	13	9	15	14
250	-	13	17	13	19	18
500	-	-	19	-	-	-
750	-	-	-	-	-	-
Regression slope	7.76	5.37	7.10	5.08	7.72	7.61
Regression slope - 95% CI	7.11 - 8.41	3.60 - 7.13	5.98 - 8.21	3.39 - 6.76	6.42 - 9.03	6.26 - 8.96
Ave. no. young/m^{2,2}	1.0 ± 0.5A	0.2 ± 0 2A	2.2 ± 1.0A	0.4 ± 0.3A	0.5 ± 0.3A	1.7 ± 0.6A
Ave. no. adults/m^{2,2}	2.4 ± 0.8AB	3.2 ± 1.2ABC	9.1 ± 3.1C	1.6 ± 0.6AC	3.9 ± 1.0ABC	5.9 ± 1.8C
% young[2]	29.1	5.2	19.4	20.8	11 2	22.8
% of species w/ ≤5 yrs[2]	50.0	26.7	60.0	42.9	31.6	52.4
Ave. no. FD/m^{2,2}	0.3 ± 0.2A	0.2 ± 0.2AB	0.0 ± 0.1AB	0.0 ± 0.1AB	0.0 ± 0.0B	0.0 ± 0.1AB
%Mortality[2]	8.2	4.9	0.4	2.2	0.0	0.6
% adult mortality[2]	-	-	-	-	-	-
% juvenile mortality[2]	-	-	-	-	-	-
Ambleminae						
Total no. [2]	29	51	142	30	52	112
Total no. [1]	67	228	211	221	126	188
Ave. no./m^{2,2}	1.3 ± 0.5A*	2.3 ± 0.8A*	6.3 ± 2.3B*	1.3 ± 0.6A*	2.3 ± 0.7A*	5.0 ± 1.4B*
Ave. no.≤5yrs/m^{2,2}	0.3 ± 0 2AB	0.1 ± 0.1B	0.6 ± 0.4AB	0.3 ± 0.3B	0.2 ± 0.2B	0.8 ± 0.4A
Ave. no.>5yrs/m^{2,2}	1.0 ± 0.4AB	2.2 ± 0.8B	5.7 ± 2.2AB	1.1 ± 0.5B	2.1 ± 0.7B	4 2 ± 1.3A
% young[2]	24.1	3.9	9.2	21.2	7.7	16.1
Total no. species[1]	6	7	6	6	5	6
Total no. species w/young[1]	3	1	4	4	2	4
Total no. adult species[1]	6	7	6	6	5	6
Ave. no. FD/m^{2,2}	0.3 ± 0.2A	0.2 ± 0.2AB	0.0 ± 0.1AB	0.0 ± 0.1AB	0.0 ± 0.0B	0.0 ± 0.1AB
%Mortality[2]	17.1	7.3	0.7	3.2	0.0	0.9
% adult mortality[2]	-	-	-	-	-	-
% juvenile mortality[2]	-	-	-	-	-	-
Lampsilinae						
Total no. [2]	41	26	104	13	41	47
Total no. [1]	44	151	196	90	102	73
Ave. no./m^{2,2}	1.8 ± 0.7AB#	1.2 ± 0.6AB#	4.6 ± 1.4C#	0.6 ± 0 3B#	1.9 ± 0.6A*	2.1 ± 0.8AB#
Ave. no.≤3yrs/m^{2,2}	0.5 ± 0.3A	0.1 ± 0 1A	1.6 ± 0.7B	0.1 ± 0.2A	0.2 ± 0.2A	0.6 ± 0.3A
Ave. no.>3yrs/m^{2,2}	1.3 ± 0.5ABC	1.1 ± 0.6AC	3.0 ± 1.2B	0.4 ± 0.3C	1.6 ± 0.6AB	1 5 ± 0.7ABC
% young[2]	4.8	3.8	24.0	7.1	2.4	12.8
Total no. species[1]	8	7	11	6	10	11
Total no. species w/young[1]	5	3	8	2	3	6
Total no. adult species[1]	7	6	10	5	10	11
Ave. no. FD/m^{2,2}	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
%Mortality[2]	0.0	0.0	0.0	0.0	0.0	0.0
% adult mortality[2]	-	-	-	-	-	-
% juvenile mortality[2]	-	-	-	-	-	-

[1]Quantitative and Qualitative combined; [2]Quantitative data only; [3]Qualitative data only
Different letters within a row indicates a significant difference (ANOVA, p<0 05)
Different symbols within a column indicate a significant difference (t-test, p≤0 05)

Table 3-18. Comparison of SS Bed habitat conditions between July 2004, July and October 2005, August and September 2006, October 2007, August 2008, October 2012, and October 2016.

	Jul-04	Jul-05	Oct-05	Aug-06	Sep-06	Oct-07	Aug-08	Oct-12	Oct-16	Ave.
Sample date	July 16, 2004	July 26-28, 2005	Oct 5-6, 2005	Aug 4-5, 2006	Sept 20-24, 2006	Oct 5-13, 2007	Aug 20-23, 2008	Oct 31-Nov 1, 2012	Oct 28, Nov 2	
Discharge (cfs)[1]	65,969	39,203 to 41,262	54,383 to 52,887	27,695 to 35,189	21,257 to 30,178	56,600 to 77,700	27,594 to 33,497	26,878 to 26,994	96,878 to 97,327	
Substrate temp N end	-	-	-	88 0 to 87 4	-	62 0 to 70 1	80 0 to 82 0	-	-	
Substrate temp S end	-	-	-	88 0 to 87 1	-	61 4 to 70 1	80 2 to 83 5	-	-	
Dist from bank (m)	35 to 115	35 to 115	35 to 115	35 to 115	35 to 115	35 to 115	35 to 115	35 to 115	35 to 115	
Dist from mix zone (m)	675 to 1125	675 to 1125	675 to 1125	675 to 1125	675 to 1125	675 to 1125	675 to 1125	675 to 1125	675 to 1125	
<u>Substrate</u>										
% Boulder	0	0	2	0	0	0	1	0	0	<1
% Cobble	<1	0	0	0	0	0	2	0	0	<1
% Gravel	<1	0	0	0	0	0	1	0	1	<1
% Sand	90	91	95	69	71	49	55	49	87	73
% Silt	6	9	3	23	26	49	39	51	0	23
% Clay	3	<1	0	6	2	1	1	0	12	3
% Detritus	<1	1	0	2	1	1	1	0	0	<1
% Shell	0	0	<1	0	0	0	0	0	0	<1
<u>Depth (m)</u>										
Ave	2 4	1 8	2 7	2 0	2 1	1 9	2 5	2 2	3 2	2 3
Range	(1 7 to 3 7)	(0 9 to 2 7)	(0 9 to 4 3)	(1 2 to 3 4)	(1 2 to 3 3)	(0 9 to 3 4)	(1 5 to 3 0)	(1 5 to 3 0)	(1 8 to 3 9)	
CV[2]	24	20	74	32	18	25	15	15	15	
<u>Bottom temp (°F)</u>										
Ave	79 7	85 1	71 1	88 0	66 4	60 8	80 3	52 0	53 4	70 7
Range	(77 0 to 80 6)	(81 5 to 86 0)	(69 4 to 73 2)	(87 4 to 88 7)	(64 6 to 67 1)	60 8	(78 8 to 80 6)	(51 1 to 53 2)	(53 1 to 53 6)	
CV[2]	1 2	3 0	4 4	0 6	1 3	0 0	0 8	1 2	0 6	
<u>Bottom DO (mg/L)</u>										
% saturation	83 3	119 3	92 2	146 5	91 8	84 1	100 0	112 6	78 6	
Ave	6 7	9 1	8 1	10 9	8 5	8 3	8 0	12 1	8 3	8 9
Range	(6 4 to 7 4)	(7 5 to 12 8)	(7 8 to 8 9)	(5 1 to 12 0)	(7 9 to 9 5)	(7 6 to 9 0)	(7 8 to 8 2)	(11 8 to 12 5)	(8 2 to 8 4)	
CV[2]	10 9	20 7	3 1	14 0	4 0	5 3	1 4	1 2	0 6	
<u>Bottom current velocity (m/sec)</u>										
Ave	0 4	0 2	0 3	<0 1	0 1	0 2	0 1	0 1	0 4	0 2
Range	(0 2 to 0 6)	(0 1 to 0 3)	(0 1 to 0 5)	(0 to 0 2)	(0 1 to 0 2)	(0 1 to 0 4)	(>0 to 0 2)	(>0 to 0 2)	(0 2 to 0 5)	
CV[2]	16	21	31	185	23	226	37	48	24 0	
Rel zebra mussel inf[3]	Minor	0 1 (0 to 1)	0 1 (0 to 10)	0 0	0 02 (0 to 1)	0 01 (0 to 1)	0 1 (0 to 2)	0 7 (0 to 12)	6 8 (0 to 10)	1 0

[1]Lock and Dam 14 (LeClaire, IA; MRM 493 3)

[2]CV = coefficient of variation (Standard deviation*100/mean)

[3]Minor = a few zebra mussels attached to a few unionids; 2005, 2006, 2007, 2008, 2012 average and range of zebra mussels per unionid

Table 3-19. Comparison of SS Bed unionid relative abundance (%) between July 2004, July and October 2005, August and September 2006, October 2007, August 2008, October 2012, and October 2016[1].

	Jul-04	Jul-05	Oct-05	Aug-06	Sep-06	Oct-07	Aug-08	Oct-12	Oct-16	Ave.
Ambleminae										
Amblema plicata	41.5	26.8	30.9	32.2	22.3	22.6	26.8	28.2	18.2	27.7
Fusconaia ebena	-	-	-	-	-	-	SF	WD	-	WD
Fusconaia flava	X	9.8	2.1	1.1	3.2	2.2	4.9	X	2.3	2.8
Megalonaias nervosa	-	-	-	-	-	X	-	-	-	X
Pleurobema sintoxia	**-**	**-**	**-**	**X**	**-**	**X**	**-**	**-**	**-**	**X**
Quadrula metanevra	-	-	-	-	-	-	-	-	X	X
Quadrula nodulata	9.8	2.4	6.4	11.1	13.8	16.1	17.1	15.5	9.1	11.3
Quadrula p. pustulosa	4.9	7.3	5.3	4.4	3.2	10.8	4.9	10.7	18.2	7.7
Quadrula quadrula	4.9	14.6	17.0	12.2	11.7	9.7	13.4	20.4	20.5	13.8
Tritogonia verrucosa	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**WD**	-	**WD**
Total Ambleminae	61.1	61.0	61.7	61.1	54.3	61.3	67.1	74.8	68.3	63.4
Anodontinae										
Arcidens confragosus	X	2.4	X	-	-	-	-	X	2.3	0.5
Lasmigona c. complanata	2.4	X	X	X	1.1	1.1	2.4	X	X	0.8
Pyganodon grandis	X	2.4	X	1.1	FD	X	2.4	WD	-	3.8
Utterbackia imbecillis	-	X	X		FD	-	-	-	-	FD
Total Anodontinae	2.4	4.9	0.0	1.1	1.1	1.1	4.9	0.0	2.3	2.0
Lampsilinae										
Actinonaias ligamentina	-	-	-	-	X	-	-	-	-	X
Ellipsaria lineolata	**2.4**	**X**	**-**	**-**	**-**	**-**	**WD**	**-**	**-**	**0.3**
Lampsilis cardium	4.9	X	5.3	4.4	7.4	2.2	X	1.9	X	2.9
Lampsilis higginsii	**-**	**-**	**-**	**-**	**-**	**-**	**X**	**-**	**-**	**X**
Lampsilis teres	**-**	**-**	**X**	**-**	**-**	**X**	**WD**	**4.9**	**-**	**0.5**
Leptodea fragilis	X	2.4	4.3	2.2	3.2	-	1.2	1.9	X	1.7
Ligumia recta	**-**	**-**	**1.1**	**X**	**1.1**	**X**	**X**	**X**	**X**	**0.2**
Obliquaria reflexa	26.8	22.0	22.3	23.3	19.1	28.0	18.3	12.6	25.0	21.9
Obovaria olivaria	2.4	-	X	X	2.1	X	X	1.0	-	0.6
Potamilus alatus	-	-	X	1.1	-	1.1	-	X	2.3	0.5
Potamilus ohiensis	X	7.3	3.2	4.4	7.4	3.2	3.7	-	2.3	3.5
Toxolasma parvus	-	-	WD	-	-	-	-	1.0	-	0.1
Truncilla donaciformis	-	2.4	2.1	2.2	4.3	2.2	4.9	1.9	-	2.2
Truncilla truncata	-	X	X	-	-	1.1	WD	-	-	0.1
Total Lampsilinae	36.5	34.1	38.3	37.8	44.7	37.6	28.0	25.2	29.6	34.6

[1]Numbers represent % that species represents in quantitative samples. X=not collected in quantitative samples, but found in qualitative samples
FD = freshly dead shell, WD = weathered shell, SF = subfossil shell
Bold indicates Illinois, Iowa and Federally threatened and endangered species

Table 3-20. Comparison of SS bed unionid community characteristics between July 2004, July and October 2005, August and September 2006, October 2007, August 2008, October 2012, and October 2016.

	Jul-04	Jul-05	Oct-05	Aug-06	Sep-06	Oct-07	Aug-08	Oct-12	Oct-16	Ave
Total no [1]	547	426	657	398	537	546	712	875	313	557
Ave no /m^{2,2}	3 4±2 0AC	4 1±1 2AB	4 2±0 9A	9 0±2 6B	4 2±1 0A	4 1±1 0A	3 6±1 0AC	4 6±1 3A	2 0±0 7C	4 1 ± 0 4
Ave CPUE [3]	36 1	19 3	22 5	15 4	17 7	18 1	25 2	30 9	10 7	21 8
Ave no species/qual sample[3]	7 7	5 6	7 2	6 0	6 3	6 8	6 2	6 1	4 3	6 2
Total no live/FD species[1]	15	16	19	16	16	18	15	17	14	16 2
Cumulative live/FD species	15	18	20	21	22	23	24	25	26	26
Rarefaction species richness[3]										
100	10	10	12	11	11	12	10	9	9	10
250	14	14	16	15	13	15	13	13	13	14
500	15	-	18	-	14	18	14	15	-	16
750	-	-	-	-	-	-	-	16	-	16
Regression slope	5 48	5 56	6 55	5 97	5 32	6 24	5 22	5 35	5 08	5 64
Regression slope - 95% CI	4 79 - 6 16	4 09 - 7 02	5 37 - 7 73	3 76 - 8 19	4 92 - 5 71	4 23 - 8 26	4 15 - 6 29	4 52 - 6 18	3 39 - 6 76	
Ave no young/m^{2,2}	0 2 ±0 2A	0 4±0 4AC	0 4 ±0 2A	1 8±0 8B	1 5±0 5BC	1 3±0 5BC	1 8±0 6B	0 8±0 4ABC	0 4±0 3A	0 9 ± 0 2
Ave no adults/m^{2,2}	3 3 ±1 9AC	3 7±1 2AB	3 8 ±0 9B	7 2±2 3B	2 7±0 8A	2 8±0 8AC	1 9±0 7AC	3 7±1 2AB	1 6±0 6C	3 1 ± 0 4
% young[2]	4 9	9 8	8 5	20 0	35 1	32 3	48 8	18 4	20 8	22 1
% of species w/ ≤5 yrs[2]	33 3	41 7	63 6	66 7	84 6	55 6	66 7	72 7	42 9	58 6
Ave no FD/m^{2,2}	0 2 ±0 2A	0 1 ±0 2A	0 1 ±0 2A	0 1±0 2A	0 5±0 3A	0 1±0 1A	0 1±0 2A	0 2±0 2A	0 0±0 1A	0 2 ± 0 1
%Mortality[2]	4 7	2 4	3 1	1 1	8 7	2 1	3 5	4 6	2 2	3 6
% adult mortality[2]	-	-	-	1 4	9 0	1 6	4 5	5 6	-	4 4
% young mortality[2]	-	-	-	0 0	8 3	3 2	2 4	0 0	-	2 8
Ambleminae										
Total no [2]	25	25	58	55	51	57	55	77	30	48 1
Total no [1]	335	259	347	207	275	287	541	565	221	337 4
Ave no /m^{2,2}	2 1±1 4AC*	2 5±1 0ABC*	2 6±0 7ABC*	5 5±2 2B*	2 3±0 7AC*	2 5±0 7ABC*	2 4±0 8ABC*	3 4±1 0AB*	1 3±0 6C*	2 6 ± 0 3*
Ave no ≤5yrs/m^{2,2}	0 2±0 2AB	0 2±0 3AB	0 2±0 2A	1 2±0 7BC	0 8±0 4ABC	1 1±0 5BC	1 3±0 5C	0 4±0 3AB	0 3±0 3AB	0 6 ± 0 1
Ave no >5yrs/m^{2,2}	1 9±1 3AB	2 3±1 0AB	2 4±0 7AB	4 3±1 9B	1 5±0 6A	1 4±0 5A	1 2±0 6A	3 0±1 0AB	1 1±0 5A	2 0 ± 0 3
% young[2]	8 0	8 0	6 9	21 8	33 3	43 9	52 7	13 0	21 2	23 2
Total no species[1]	5	5	5	6	5	7	5	5	6	5 4
Total no species w/young[1]	5	4	4	4	5	5	5	4	4	4 4
Total no adult species[1]	5	5	5	6	5	7	5	5	6	5 4
Ave no FD/m^{2,2}	0 1±0 2A	0 0±0 0A	0 0±0 1A	0 1±0 2A	0 0±0 1A	0 0±0 1A	0 0±0 1A	0 1±0 2A	0 0±0 1A	0 1 ± 0 0
%Mortality[2]	3 8	0 0	1 7	1 8	1 9	1 7	1 8	3 8	3 2	2 2
% adult mortality[2]	-	-	-	2 3	2 9	0 0	0 0	4 3	-	1 9
% young mortality[2]	-	-	-	0 0	0 0	3 8	3 3	0 0	-	1 4
Lampsilinae										
Total no [2]	15	14	36	34	42	35	23	26	13	26 4
Total no [1]	163	123	197	99	265	152	161	198	90	160 9
Ave no /m^{2,2}	1 3±0 9BC*	1 4±0 8ABC*	1 6±0 6ABC*	3 4±1 3A*	1 9±0 7AB*	1 6±0 6BC*	1 0±0 5BC#	1 2±0 5BC#	0 6±0 3C#	1 4 ± 0 2#
Ave no ≤3yrs/m^{2,2}	0 0±0 0A	0 2±0 3A	0 2±0 2A	0 6±0 5A	0 7±0 4A	0 2±0 2A	0 5±0 3A	0 4±0 3A	0 1±0 2A	0 3 ± 0 1
Ave no >3yrs/m^{2,2}	1 3±0 9AB	1 2±0 7AB	1 4±0 6AB	2 8±1 3A	1 2±0 5AB	1 3±0 5AB	0 5±0 3B	0 8±0 4AB	0 4±0 3AB	1 1 ± 0 2
% young[2]	0 0	14 3	11 1	17 6	35 7	14 3	47 8	34 6	7 1	20 3
Total no species[1]	9	7	10	8	8	9	8	9	6	8 2
Total no species w/young[1]	7	3	5	6	6	4	4	5	2	4 7
Total no adult species[1]	7	7	10	6	8	8	8	7	5	7 3
Ave no FD/m^{2,2}	0 1±0 2A	0 1±0 2A	0 1±0 1A	0 0±0 0A	0 3±0 2A	0 0±0 1A	0 1±0 1A	0 1±0 1A	0 0±0 1A	0 1 ± 0 0
%Mortality[2]	6 3	6 7	5 3	0 0	12 5	2 8	8 0	7 1	0 0	5 4
% adult mortality[2]	-	-	-	0 0	12 9	3 2	14 3	10 5	-	8 2
% young mortality[2]	-	-	-	0 0	11 8	0 0	0 0	0 0	-	2 4

[1]Quantitative and Qualitative combined; [2]Quantitative data only; [3]Qualitative data only; Species richness includes preliminary samples in 2004
Different letters within a row indicates a significant difference (ANOVA, p<0 05)
Different symbols within a column indicates a significant difference (t-test; p<0 10)

Table 3-21. Age (external annuli count) frequency of unionid species collected in the SS Bed, October 2016.

			Age (external annuli count)[1]																			
Subfamily	Species	Young[2]	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	24	Total
Ambleminae	*Amblema plicata*	Y	-	-	-	-	-	-	-	-	-	-	-	3	-	-	1	2	1	-	1	8
	Fusconaia flava	N	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
	Quadrula metanevra	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	Quadrula nodulata	Y	1	1	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	4
	Quadrula p. pustulosa	Y	-	1	-	-	1	1	1	-	-	-	-	1	-	1	2	-	-	-	-	8
	Quadrula quadrula	Y	1	1	-	1	1	-	-	-	-	-	1	2	-	-	1	-	-	1	-	9
Ambleminae Total			2	3	0	1	2	2	1	0	0	0	2	7	0	1	4	2	1	1	1	30
Anodontinae	*Arcidens confragosus*	N	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
	Lasmigona c. complanata	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Anodontinae Total			0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Lampsilinae	*Lampsilis cardium*	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	Leptodea fragilis	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	Ligumia recta	**N**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	Obliquaria reflexa	Y	-	-	1	1	-	1	1	-	-	-	3	2	-	1	-	1	-	-	-	11
	Potamilus alatus	N	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	Potamilus ohiensis	Y	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Lampsilinae Total			1	0	1	1	0	2	1	0	0	0	3	2	0	1	0	1	0	0	0	13
Total			3	3	1	2	2	4	2	0	0	0	5	9	0	3	4	3	1	1	1	44

Bold indicates Illinois, Iowa, and Federally threatened and endangered species

[1]Quantitative samples only

[2]All sample methods

Table 3-22. Comparison of Cordova Bed habitat conditions between July 2004, July and October 2005, August and September 2006, October 2007, August 2008, October 2012, and October 2016.

	Jul-04	Jul-05	Oct-05	Aug-06	Sep-06	Oct-07	Aug-08	Oct-12	Oct-16	Ave.
Sample date	Jul 13-14, 2004	July 27, 2006	Oct 3-4, 2005	Aug 3-4, 2006	Sept 20-24, 2006	Oct 6-12, 2007	Aug 19-25, 2008	Oct 28-29, 2012	Oct 29, Nov 1	
Discharge (cfs)[1]	72,916 to 69,220	38,153	47,125 to 52,245	18,544 to 27,695	21,257 to 30,178	67,300 to 77,700	27,439 to 33,497	26,697 to 26,704	97,592 to 98,231	
Substrate temp N end	-	-	-	-	-	60 8 to 69 3	76 6 to 80 4	-	-	
Substrate temp S end	-	-	-	-	-	61 0 to 69 0	77 1 to 81 0	-	-	
Dist from bank (m)	10 to 90	10 to 90	10 to 90	10 to 90	10 to 90	10 to 90	10 to 90	10 to 90	10 to 90	
Dist from mix zone (m)	3030 to 3365	3030 to 3365	3030 to 3365	3030 to 3365	3030 to 3365	3030 to 3365	3030 to 3365	3030 to 3365	3030 to 3365	
Substrate										
% Boulder	<1	3	2	0	0	3	2	3	6	2
% Cobble	2	0	1	<1	<1	<1	3	4	3	2
% Gravel	13	6	10	13	8	15	29	28	24	16
% Sand	33	77	66	40	43	17	23	23	14	37
% Silt	27	6	9	9	21	19	19	24	11	16
% Clay	13	0	0	19	7	1	5	0	6	6
% Detritus	<1	0	<1	0	<1	<1	2	0	0	<1
% Shell	12	8	13	18	18	44	13	16	37	20
% Vegetation	0	0	0	<1	1	1	4	0	0	1
Depth (m)										
Ave	2 0	2 1	3 0	1 7	2 2	1 6	2 5	2 5	3 1	2 3
Range	(0 6 to 3 4)	(1 2 to 3 7)	(0 6 to 6 7)	(0 6 to 3 0)	(0 1 to 6 4)	(0 9 to 2 7)	(0 6 to 4 6)	(0 6 to 6 1)	(1 2 to 7 3)	
CV[2]	28	86	147	45	57	32	44	56	34	
Bottom temp (°F)										
Ave	77 5	77 5	65 5	87 3	64 2	60 9	78 3	51 2	55 5	68 7
Range	(73 4 to 79 3)	(73 4 to 80 2)	(54 0 to 67 1)	(85 6 to 89 1)	(63 9 to 65 3)	(60 9 to 61 7)	(77 0 to 79 9)	(50 5 to 53 1)	(55 0 to 55 8)	
CV[2]	0 6	5 9	5 3	2 8	1 0	0 9	0 8	1 3	0 7	
Bottom DO (mg/L)										
% saturation	73 1	-	88 2	87 5	82 4	85 1	114 8	108 8	80 7	
Ave	6 0	-	8 3	8 5	7 8	8 4	9 3	12 1	8 3	8 6
Range	(5 7 to 6 6)	-	(7 2 to 14 0)	(7 7 to 9 6)	(4 3 to 18 1)	(8 0 to 8 6)	(8 4 to 13 9)	(11 5 to 12 7)	(8 2 to 8 6)	
CV[2]	12 6	-	3 7	7 3	55 6	1 7	16 6	3 2	1 0	
Bottom current velocity (m/sec)										
Ave	0 2	0 2	0 2	<0 1	0 1	0 2	<0 1	<0 1	0 5	4 0
Range	(0 1 to 0 4)	(0 1 to 0 3)	(0 1 to 0 5)	(0 0 to 0 2)	(>0 0 to 0 1)	(0 0 to 0 4)	(0 0 to 0 1)	(0 0 to 0 1)	(0 3 to 0 7)	
CV[2]	48	42	54	127	52	71	79	87	23	
Rel zebra mussel inf[3]	Very heavy	0 3 (0 to 5)	1 3 (0 to 50)	0 1 (0 to 20)	0 3 (0 to 12)	0 01 (0 to 1)	16 4 (0 to 100+)	3 1 (0 to 25)	0 0	2 7

[1]Lock and Dam 14 (LeClaire, IA; MRM 493 3)

[2]CV=coefficient of variation (Standard deviation*100/mean)

[3]Very heavy=most unionids coated or encased with zebra mussels; 2005, 2006, 2007, 2008, 2012 average and range of zebra mussels per unionid

Table 3-23 Comparison of Cordova Bed unionid community characteristics between July 2004, July and October 2005, August and September 2006, October 2007, August 2008, October 2012, and October 2016

	Jul-04	Jul-05	Oct-05	Aug-06	Sep-06	Oct-07	Aug-08	Oct-12	Oct-16	Ave
Total no [1]	320	164	375	430	745	651	455	438	342	436
Ave no /$m^{2,2}$	5 7±1 9ABC	3 0±1 3AC	5 8±1 5AB	3 7±1 4ABC	3 0±1 1C	4 7±1 2ABC	4 6±1 0ABC	6 8±1 4B	4 4±1 2ABC	4 7 ± 0 5
Ave CPUE [3]	15 8	6 7	10 2	19 7	27 1	21 8	14 1	11 4	9 8	15 2
Ave no species/qual sample[3]	6 6	3 3	5 1	7 4	7 5	7 6	5 8	5 2	5 0	5 9
Total no live/FD species[1]	20	18	21	19	20	23	22	20	20	20 3
Cumulative live/FD species	20	20	22	23	24	25	25	25	25	25
Rarefaction species richness[3]										
100	15	15	16	15	13	15	15	16	15	15
250	19	-	19	18	16	19	19	19	19	19
500	-	-	-	-	18	22	-	-	-	20
750	-	-	-	-	-	-	-	-	-	-
Regression slope	7 76	7 20	7 89	7 36	6 58	7 91	7 96	7 82	7 72	7 58
Regression slope - 95% CI	5 96 - 9 56	6 18 - 8 22	5 66 - 10 13	5 33 - 9 39	5 13 - 8 03	6 21 - 9 61	6 19 - 9 73	7 45 - 8 19	6 42 - 9 03	
Ave no young/$m^{2,2}$	2 2±1 0AC	0 6 ±0 5AB	2 1 ±0 9A	1 1±0 6AB	0 8±0 4AB	1 6±0 7A	2 0±0 6AC	3 5±1 0C	0 5±0 3B	1 6 ± 0 3
Ave no adults/$m^{2,2}$	3 5 ±1 4A	2 4±1 2A	3 7 ±0 9A	2 6±1 3A	2 2±0 9A	3 0±0 9A	2 6±0 7A	3 3±0 9A	3 9±1 0A	3 1 ± 0 3
% young[2]	33 8	20 0	36 2	29 7	25 4	35 2	43 7	51 0	11 2	31 8
% of species w/ ≤5 yrs[2]	53 8	55 6	61 1	62 5	71 4	69 6	63 6	75 0	31 6	60 5
Ave no FD/$m^{2,2}$	1 8 ±1 6AB	0 8 ±0 9AB	0 2±0 2B	0 6±0 5AB	1 4±0 6A	0 2±0 2B	0 2±0 2B	0 4±0 6B	0 0±0 0B	0 5 ± 0 2
%Mortality[2]	24 4	21 1	3 0	14 0	31 6	3 7	4 6	6 1	0 0	12 1
% adult mortality[2]	-	-	-	13 3	31 5	2 9	4 9	6 3	-	11 8
% juvenile mortality[2]	-	-	-	15 4	32 0	5 1	4 3	6 0	-	12 6
Ambleminae										
Total no [2]	27	18	51	15	33	48	57	52	52	39 2
Total no [1]	120	79	151	221	497	304	211	140	126	205 4
Ave no /$m^{2,2}$	2 3±1 1A*	1 8±1 1A*	2 3±0 8A*	1 5±0 8A*	1 5±0 7A*	2 1±0 8A*	2 5±0 7A*	2 3±0 7A*	2 3±0 7A*	2 1 ± 0 3*
Ave no ≤5yrs/$m^{2,2}$	0 8±0 6A	0 5±0 4A	0 5±0 4A	0 5±0 4A	0 4±0 3A	0 5±0 3A	1 0±0 5A	0 4±0 3A	0 2±0 2A	0 5 ± 0 1
Ave no >5yrs/$m^{2,2}$	1 5±0 8A	1 3±1 0A	1 8±0 7A	1 0±0 6A	1 1±0 6A	1 6±0 7A	1 5±0 6A	1 9±0 7A	2 1±0 7A	1 6 ± 0 2
% young[2]	33 3	27 8	21 6	33 3	27 3	25 0	40 4	17 3	7 7	26 0
Total no species[1]	6	5	5	6	5	6	6	5	5	5 4
Total no species w/young[1]	4	2	4	6	5	6	4	4	2	4 1
Total no adult species[1]	6	5	5	5	5	5	6	5	5	5 2
Ave no FD/$m^{2,2}$	0 3±0 3A	0 3±0 5A	0 2±0 2A	0 2±0 3A	0 3±0 3A	0 1±0 2A	0 1±0 1A	0 2±0 4A	0 0±0 0A	0 2 ± 0 1
%Mortality[2]	10 0	14 3	7 3	11 8	17 5	5 9	3 4	8 8	0 0	8 8
% adult mortality[2]	-	-	-	9 1	7 7	5 3	2 9	4 4	-	5 9
% juvenile mortality[2]	-	-	-	16 7	35 7	7 7	4 2	25 0	-	17 9
Lampsilinae										
Total no [2]	40	11	74	18	33	55	44	74	41	43 3
Total no [1]	116	50	72	147	147	164	221	114	102	125 9
Ave no /$m^{2,2}$	3 3±1 2AB*	1 1±0 6A*	3 3±1 0AB*	1 8±0 9AB*	1 5±0 6A*	2 4±0 8AB*	2 0±0 6AB*	3 3±0 7B#	1 9±0 6AB*	2 3 ± 0 3*
Ave no ≤3yrs/$m^{2,2}$	1 4±0 7AB	0 1±0 2B	1 6±0 7A	0 5±0 4B	0 4±0 2B	1 1±0 5AB	0 9±0 4AB	2 0±0 6A	0 2±0 2B	0 9 ± 0 2
Ave no >3yrs/$m^{2,2}$	1 9±0 8A	1 0±0 6A	1 7±0 6A	1 3±0 8A	1 1±0 5A	1 4±0 5A	1 1 ±0 4A	1 3±0 5A	1 6±0 6A	1 4 ± 0 2
% young[2]	42 5	9 1	47 3	27 8	24 2	43 6	45 5	59 5	2 4	33 5
Total no species[1]	11	9	12	10	10	13	12	11	10	10 9
Total no species w/young[1]	8	4	4	7	6	7	8	8	3	6 1
Total no adult species[1]	9	9	12	10	9	12	11	8	10	10 0
Ave no FD/$m^{2,2}$	1 5±1 2A	0 4±0 5AB	0 0±0 0B	0 2±0 3AB	0 9±0 5A	0 0±0 1B	0 1±0 1B	0 2±0 3B	0 0±0 0B	0 3 ± 0 1
%Mortality[2]	31 0	26 7	0 0	10 0	38 9	1 8	4 3	5 1	0 0	13 1
% adult mortality[2]	-	-	-	7 1	43 2	0 0	7 7	9 1	-	13 4
% juvenile mortality[2]	-	-	-	16 7	20 0	4 0	0 0	2 2	-	8 6

[1]Quantitative and Qualitative combined; [2]Quantitative data only; [3]Qualitative data only
Different letters within a row indicates a significant difference (ANOVA, p<0 05)
Different symbols within a column indicate a significant difference (t-test, p≤0 05)

Table 3-24. Comparison of Cordova Bed unionid relative abundance (%) between July 2004, July and October 2005, August and September 2006, October 2007, August 2008, October 2012, and October 2016[1].

	Jul-04	Jul-05	Oct-05	Aug-06	Sep-06	Oct-07	Aug-08	Oct-12	Oct-16	Ave.
Ambleminae										
Amblema plicata	27.9	50.0	24.6	27.0	35.8	33.3	46.6	28.8	33.7	34.2
Cyclonaias tuberculata	**-**	**-**	**-**	**-**	**-**	**-**	**SF**	**SF**	**-**	**SF**
Elliptio dilatata	**-**	**-**	**-**	**-**	**-**	**-**	**SF**	**-**	**-**	**SF**
Fusconaia ebena	WD	-	-	-	-	-	SF	SF	-	WD
Fusconaia flava	X	3.3	3.1	2.7	4.5	1.0	1.0	1.3	2.0	2.1
Megalonaias nervosa	2.9	X	4.6	2.7	4.5	1.9	1.0	2.0	2.0	2.4
Pleurobema sintoxia	**-**	**-**	**-**	**-**	**-**	**-**	**WD**	**SF**	**-**	**WD**
Quadrula metanevra	X	-	-	WD	-	-	SF	SF	-	SF
Quadrula nodulata	-	-	-	2.7	FD	X	X	WD	-	0.3
Quadrula p. pustulosa	5.9	6.7	4.6	2.7	4.5	7.6	4.9	1.3	12.2	5.6
Quadrula quadrula	2.9	X	2.3	2.7	X	1.9	1.9	0.7	3.1	1.7
Tritogonia verrucosa	**WD**	**-**	**WD**	**-**	**-**	**-**	**SF**	**-**	**-**	**WD**
Total Ambleminae	39.6	60.0	39.2	40.5	49.3	45.7	55.3	34.0	53.0	46.3
Anodontinae										
Arcidens confragosus	X	3.3	X	X	X	X	X	X	1.0	0.5
Lasmigona c. complanata	1.5	X	1.5	WD	1.5	X	X	X	1.0	0.6
Pyganodon grandis	X	X	0.8	8.1	X	X	1.0	3.3	X	1.5
Strophitus undulatus	**-**	**-**	**-**	**-**	**-**	**1.0**	**-**	**SF**	**-**	**0.1**
Utterbackia imbecillis	X	FD	1.5	2.7	FD	1.0	1.0	14.4	2.0	2.5
Total Anodontinae	1.5	3.3	3.8	10.8	1.5	1.9	1.9	17.6	4.0	5.1
Lampsilinae										
Actinonaias ligamentina	X	-	-	-	1.5	1.0	-	SF	X	0.3
Ellipsaria lineolata	**WD**	**-**	**X**	**2.7**	**FD**	**X**	**X**	**1.3**	**X**	**0.4**
Lampsilis cardium	7.4	6.7	5.4	16.2	6.0	7.6	7.8	5.2	11.2	8.2
Lampsilis higginsii	**1.5**	**X**	**0.8**	**2.7**	**4.5**	**1.9**	**4.9**	**X**	**2.0**	**2.0**
Lampsilis siliquoidea	-	-	-	-	X	-	-	-	1.0	0.1
Lampsilis teres	**-**	**-**	**-**	**WD**	**-**	**-**	**WD**	**-**	**-**	**WD**
Leptodea fragilis	33.8	16.7	29.2	8.1	10.4	12.4	6.8	17.7	3.1	15.4
Ligumia recta	**1.5**	**X**	**6.2**	**5.4**	**7.5**	**2.9**	**2.9**	**3.9**	**8.2**	**4.3**
Obliquaria reflexa	8.8	3.3	6.9	5.4	-	8.6	8.7	11.1	14.3	7.5
Obovaria olivaria	X	X	0.8	X	-	X	1.9	X	X	0.3
Potamilus alatus	X	X	0.8	5.4	1.5	3.8	1.9	1.3	1.0	1.7
Potamilus ohiensis	1.5	3.3	X	-	-	X	X	0.7	-	0.6
Toxolasma parvus	1.5	6.7	3.8	FD	1.5	5.7	2.9	1.3	-	2.6
Truncilla donaciformis	2.9	-	2.3	X	1.5	8.6	3.9	5.9	2.0	3.0
Truncilla truncata	WD	-	0.8	2.7	WD	-	1.0	-	-	0.5
Total Lampsilinae	58.9	36.7	56.9	48.6	49.3	52.4	42.7	48.4	42.8	48.5

[1]Numbers represent % that species represents in quantitative samples. X=not collected in quantitative samples, but found in qualitative samples
FD = freshly dead shell, WD = weathered shell, SF = subfossil shell
Bold indicates Illinois, Iowa and Federally threatened and endangered species

Table 3-25. Age (external annuli count) frequency of unionid species collected in the Cordova Bed, October 2016.

Subfamily	Species	Young[2]	Age (external annuli count)[1] 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	28	Total
Ambleminae	*Amblema plicata*	Y	-	-	-	-	-	-	1	-	-	1	-	3	5	7	9	3	-	-	-	2	-	2	-	33
	Fusconaia flava	N	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	2
	Megalonaias nervosa	N	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2
	Quadrula p. pustulosa	Y	-	-	1	2	1	-	1	1	-	-	2	1	1	-	1	1	-	-	-	-	-	-	-	12
	Quadrula quadrula	N	-	-	-	-	-	1	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	3
Ambleminae Total			0	0	1	2	1	1	3	2	0	1	3	4	7	8	10	4	0	0	0	2	0	2	1	52
Anodontinae	*Arcidens confragosus*	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
	Lasmigona c. complanata	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
	Pyganodon grandis	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	Utterbackia imbecillis	Y	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Anodontinae Total			1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	4
Lampsilinae	***Ellipsaria lineolata***	**N**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	0
	Lampsilis cardium	N	-	-	-	-	-	-	1	2	1	-	-	2	2	-	1	1	1	-	-	-	-	-	-	11
	Lampsilis higginsii	**N**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	2
	Lampsilis siliquoidea	N	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
	Leptodea fragilis	Y	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
	Ligumia recta	**Y**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**1**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	7
	Obliquaria reflexa	Y	-	-	-	-	2	4	3	1	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	14
	Obovaria olivaria	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	Potamilus alatus	N	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
	Truncilla donaciformis	N	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Lampsilinae Total			0	1	0	1	2	7	5	4	3	0	3	3	3	0	4	2	1	0	0	0	1	1	0	41
Total			1	1	2	3	3	8	8	6	3	1	6	7	10	8	15	6	1	0	0	2	2	3	1	97

Bold indicates Illinois, Iowa, and Federally threatened and endangered species

[1]Quantitative samples only

[2]All sample methods

Memorandum for Record

Subject: Steamboat Island HREP Floodplain Modeling Discussion held on 12 September 2019

Present:
IADNR: Kelly Stone
USACE: Lucie Sawyer, Anton Stork, Shirley Johnson, Julie Millhollin, Rachel Perrine, Kyle Nerad

See "Steamboat Island HREP_IADNR_Floodplain_Call.pdf" slides and discussion below

Lucie introduced the Steamboat Island HREP (Project), Project Delivery Team (PDT), Project problems/objectives, and Tentatively Selected Plan (TSP).

Lucie explained the floodplain modeling accomplished so far and acknowledged the effective (2014) Flood Insurance Study (FIS) and (2011) Flood Insurance Rate Map (FIRM). Elevations from a "refined existing terrain" which utilized green LiDAR (Steamboat Island, Steamboat Slough), echo boat data (Grant Slough), and updated hydrosurvey in the main navigation channel were used to update the Effective Model (2004 Floodway Model) cross-section geometry. The With-Project geometry elevations were based off of a with-project terrain. Lucie showed the floodplain impacts due to the TSP Upper Steamboat Island (USI) restoration/protection measure. The Sponsor (USFWS) has been concerned about how we will ever be able to restore islands that have eroded and degraded in the Upper Mississippi River (UMR) with the given flood constraints. The Sponsor suggested we coordinate with MVP, who had gone through similar situations, and MVP suggested restoring the island to a footprint shown in a past FIS and FIRM.

Our proposal to use the 1993 FIRM footprint (as defined by the 1953 USGS 7.5 Min Quad Maps) for the USI restoration & protection design footprint was presented to Kelly. Elevations would be based on the 1991 7.5 Min Quad Map, as the 1953 map did not contain contours. The use of these maps further shows that the island did, historically, have a larger footprint than what is existing. The current (2011) FIRM and the historic (1993) FIRM show the same footprint for USI, which is much broader than what exists and is also broader than the USI as shown in the 2004 Effective Model. The 2004 Effective Model shows the USI to be broader than what currently exists but not as broad as the FIRM. This discussion illustrated the discrepancy between the way features are shown in the Effective FIRM Mapping and the Effective Modeling, which Kelly mentioned is often the case. He clarified that ultimately the Effective Model is considered the reference for comparison, not the FIRM.

Kelly inquired about other developments or manmade structures that would impact floodplain impacts in the Project area, as the 2004 Effective Model may not include structures or developments that communities may have constructed. The combination of degradation/erosion at the upstream end of Steamboat Island and further development in the watershed would impact floodplain modeling.

Kelly supports using Effective Model elevations prior to recent erosion occurring. Kelly recommends modeling the 2004 Effective Model (NOT with refined terrain) and with-Project in a 4-step series to see difference in each step (Effective, Corrected Effective, with Project, etc). Kelly, Shirley, and Lucie discussed how to use the 2004 Effective Model in the pool that has very inconsistent aggradation rates. Kelly recommended identifying where there has been deposition and choosing cross-section elevation sources that represent the deposited condition to include in the corrected effective (to avoid attributing depositional WSEL impacts to the With-Project). The modeling should be able to get back to no impact by filling back in where island has eroded. The 1993 FIRM footprint is not consistent enough to use; Kelly recommends relying more on the cross sections of the 2004 Effective Model (but not necessarily the 2004 footprint) to demonstrate no impacts due to island restoration.

Path Forward:

- Lucie model the Base Condition utilizing 2004 Effective Model cross-sections to show larger USI footprint and where appropriate use refined existing condition terrain and compare to TSP (With-Project).
- Tell the story of what happened and show how the data supports that story.

- If necessary, find other excavation that would increase flow conveyance to offset floodplain impacts (including channel maintenance activities in Project vicinity).
- Continue coordination and contact Kelly if more questions arise; request Kelly to review to Floodplain Permit in Joint Permit Application package.

CEMVP-PD-F 3 October 2019

Memorandum for Record

Subject: Steamboat Island HREP Floodplain Modeling Update & Iowa DNR Coordination

After incorporating the recommendations from Kelly Stone, Lucie was able to model the original TSP design of the USI restoration/protection measure and show “no rise”. Lucie sent information to Kelly with her methodology and results, including the “no rise” table, and requested confirmation that she was on the right path. During a phone call on 24 September, Kelly Stone recommended, based on the minimal review he was able to do, that we should move forward with the modeled results. He also informed Lucie that we will not need a floodplain permit issued from the State of Iowa, as the Project area contains 100% Federal land. We still need to show “no rise” and acquire a floodplain permit from the State of Illinois (“no rise” has already been demonstrated for Illinois standards).

Written by Rachel Perrine, CEMVP-RPEDN-PD-F, 3 October 2019

STEAMBOAT ISLAND HREP

PDT MEETING ATTACHMENTS

07 Nov 2019

US Army Corps of Engineers

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2019 DRAFT MUSSEL SURVEY RESULTS

Davi Michl, PD-P

07 Nov 2019

CAVEAT: ALL INFORMATION CONTAINED IN THIS PACKAGE IS BASED OFF RAW DATA ONLY – CONTRACTOR REPORT IS NOT YET AVAILABLE

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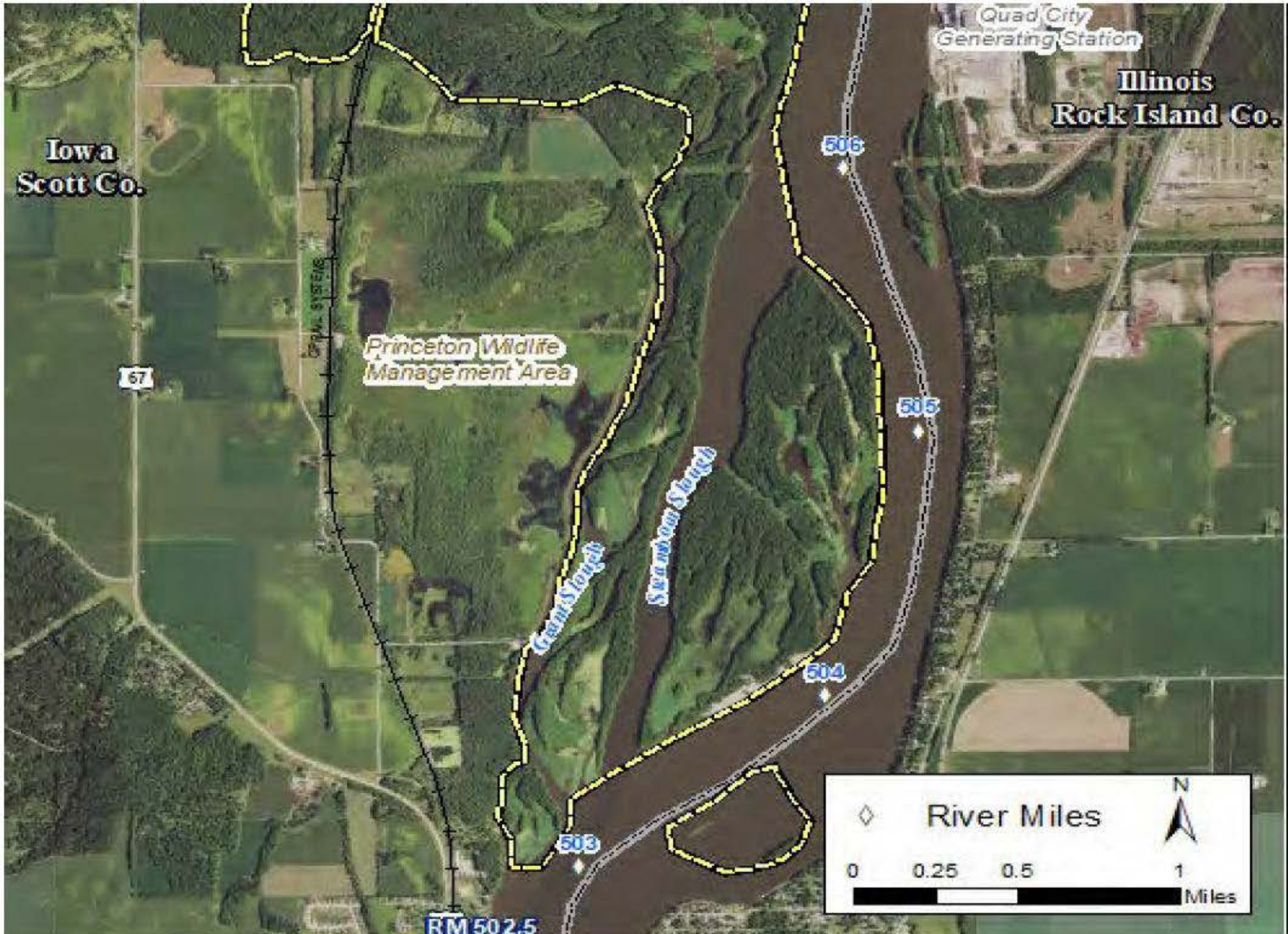
PROJECT LOCATION



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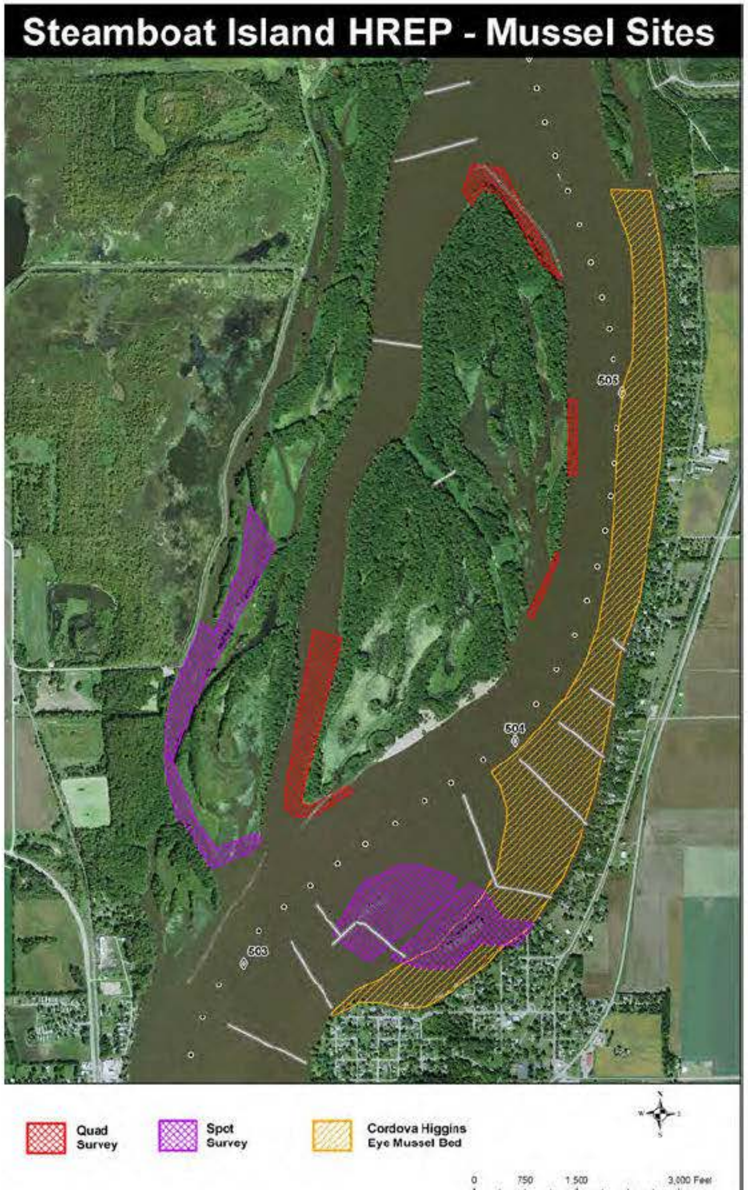
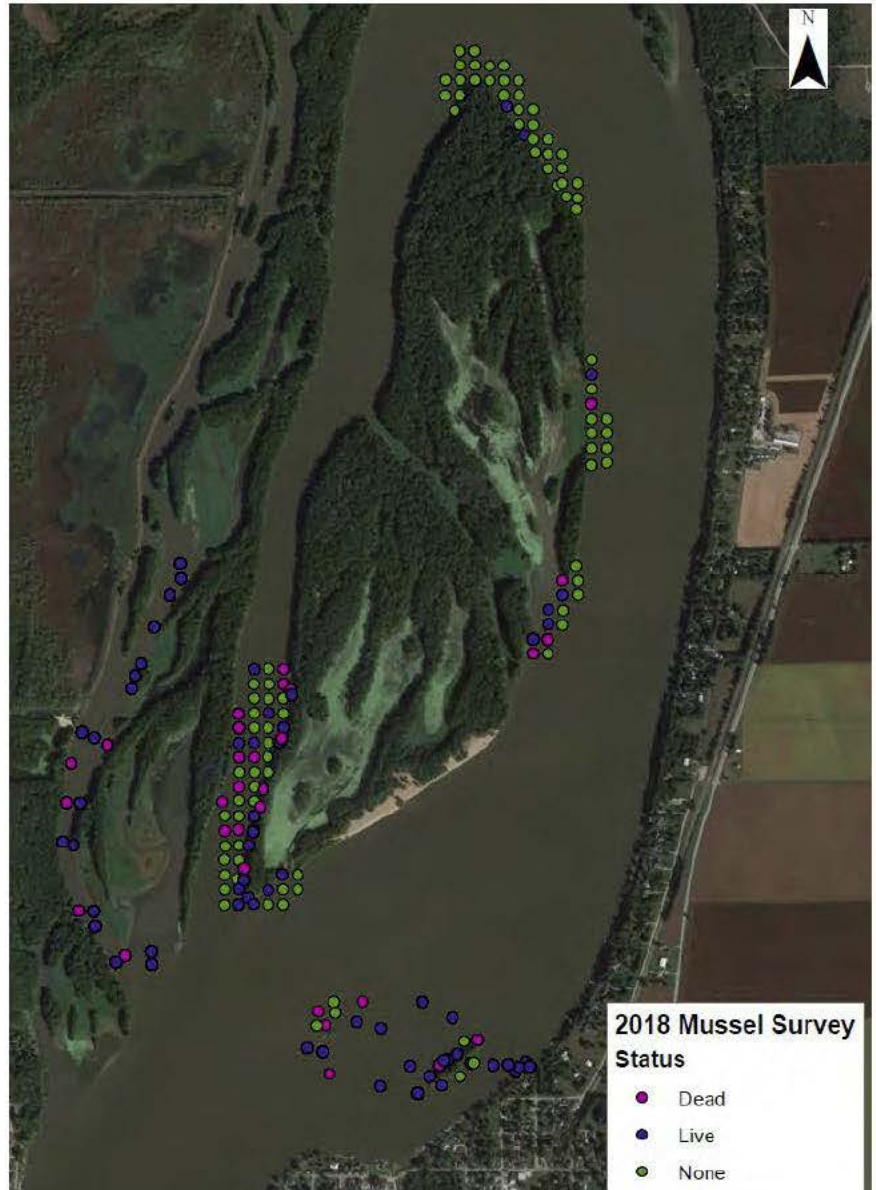
2018 MUSSEL SURVEY





SAMPLE LOCATIONS & METHOD

- 18-19 Aug. 2019
- Total 50 sampling locations
  - 25 Quadrats
  - 25 Timed Searches
- Grant Slough
  - Goal: Survey Proposed Dredging Areas for Presence/Absence
    - 10 Quads
    - 10 **5-min** Timed

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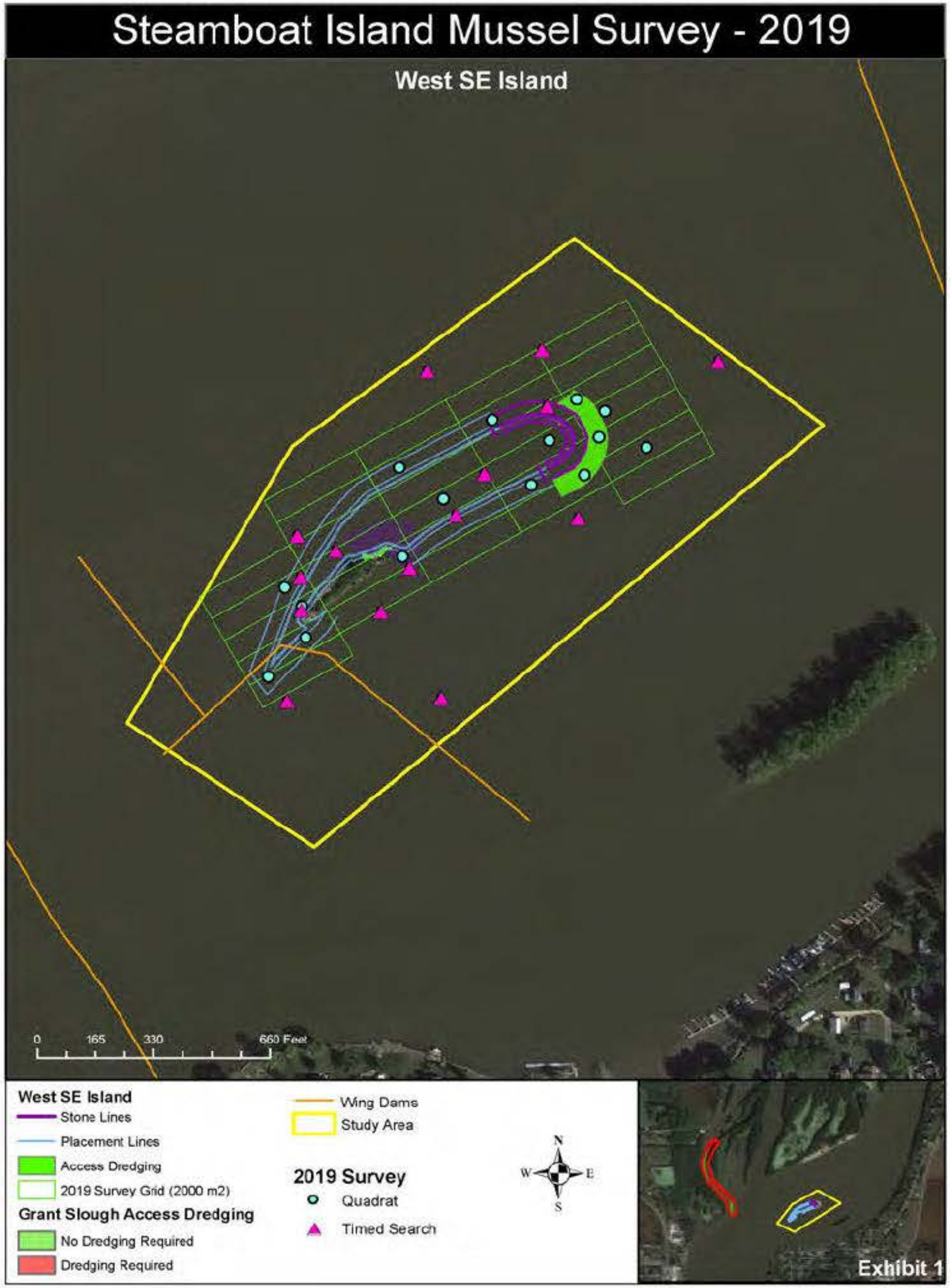

SAMPLE LOCATIONS & METHOD

- West SE Island
  - 15 Quads
  - 15 **10-min** Timed
    - Consistent with 2013 survey guidelines (2,000 m^2 grid with random start)
- Goals:
  - Increase coverage & fill in spatial gaps
  - Verify consistent substrate conditions

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DESCRIPTIVE STATS

- Total 270 live mussels, 20 species
- Quadrats
  - 52 live mussels, 10 species
    - 0 live mussels @ 100 % West SE Island sites
    - Live mussels @ 80% Grant Slough sites (max 18)
  - Mussels concentrated @ upstream edge
- Timed Searches
  - 218 live mussels, 19 species
    - Live mussels @ 53% West SE Island timed intervals (max 3)
    - Live mussels @ 100% Grant Slough timed intervals (max 32)
- Age structure (mean = 19 yrs; min=1/max=55))
  - ≤ 5 yrs = 5.2% (14/270)
  - ≥ 15 yrs = 71.9% (194/270)

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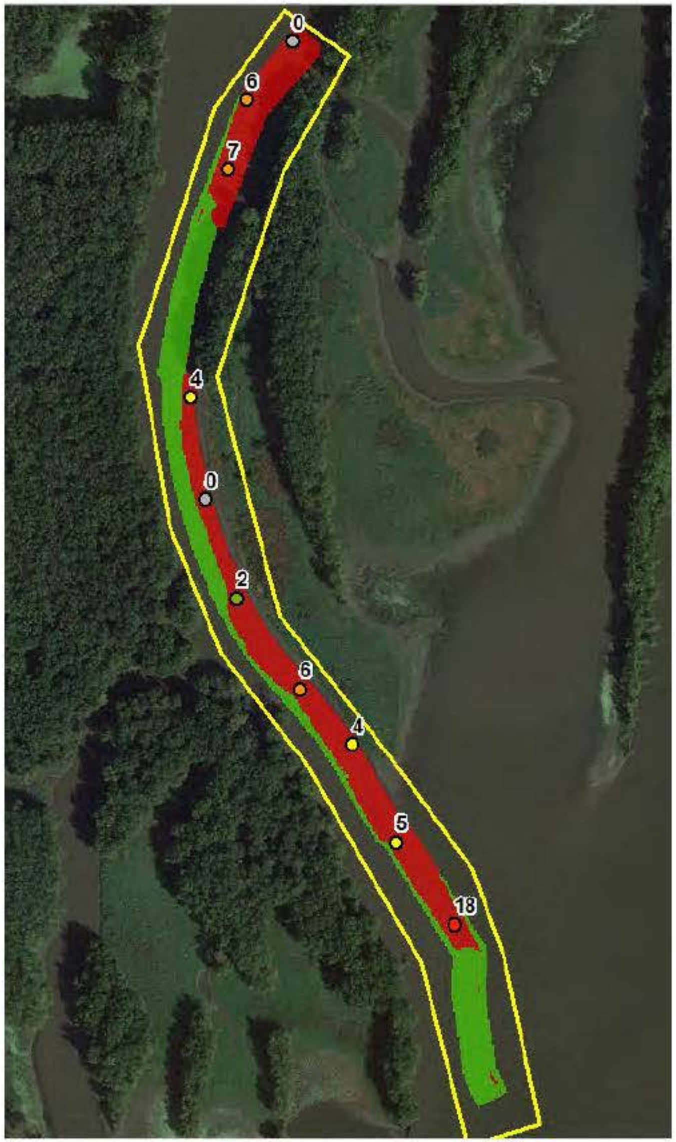
QUADRAT ABUNDANCE (NO/0.25 M^2)



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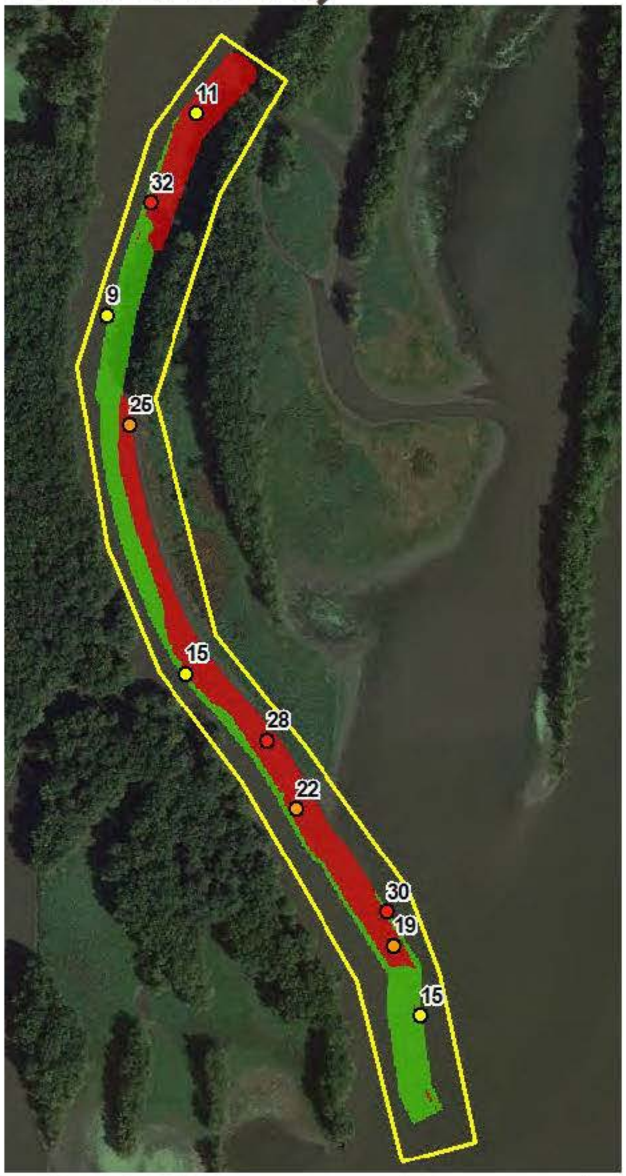
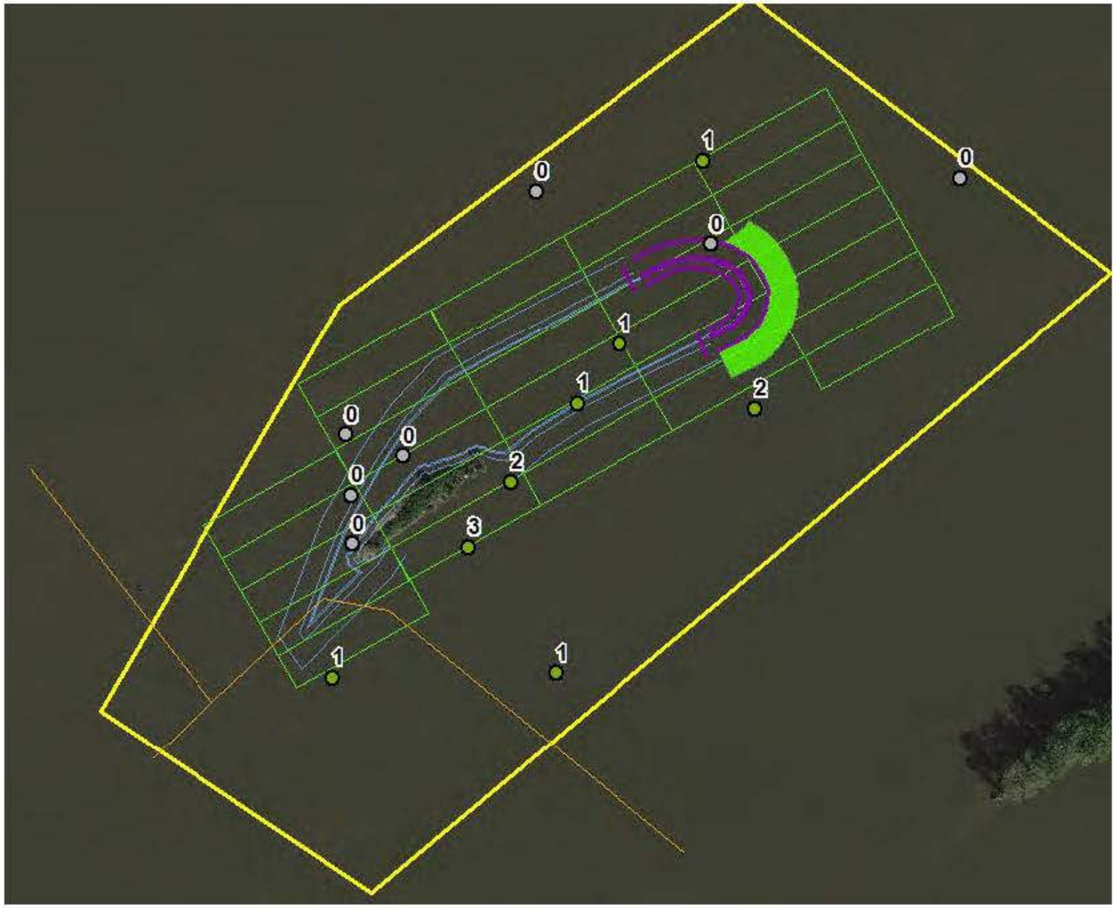
QUALITATIVE ABUNDANCE (NO./TIMED SEARCH)





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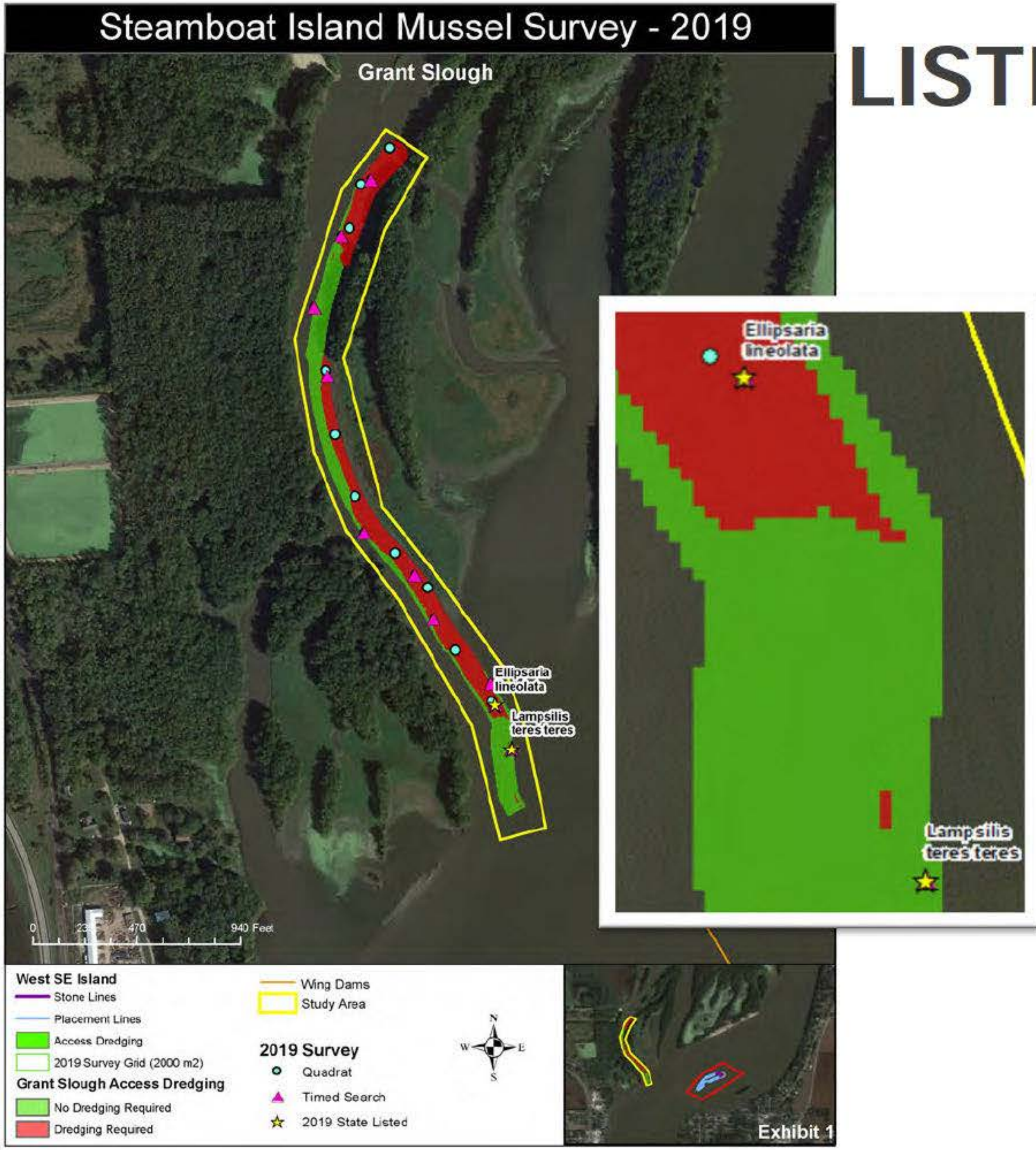

LISTED SPECIES

- NO Federally-listed
- Grant Slough
- State-listed
  - IA-E
    - *Lampsilis teres* (yellow sandshell, 1)
  - IL-T/IA-T
    - *Ellipsaria lineolata* (butterfly, 1)

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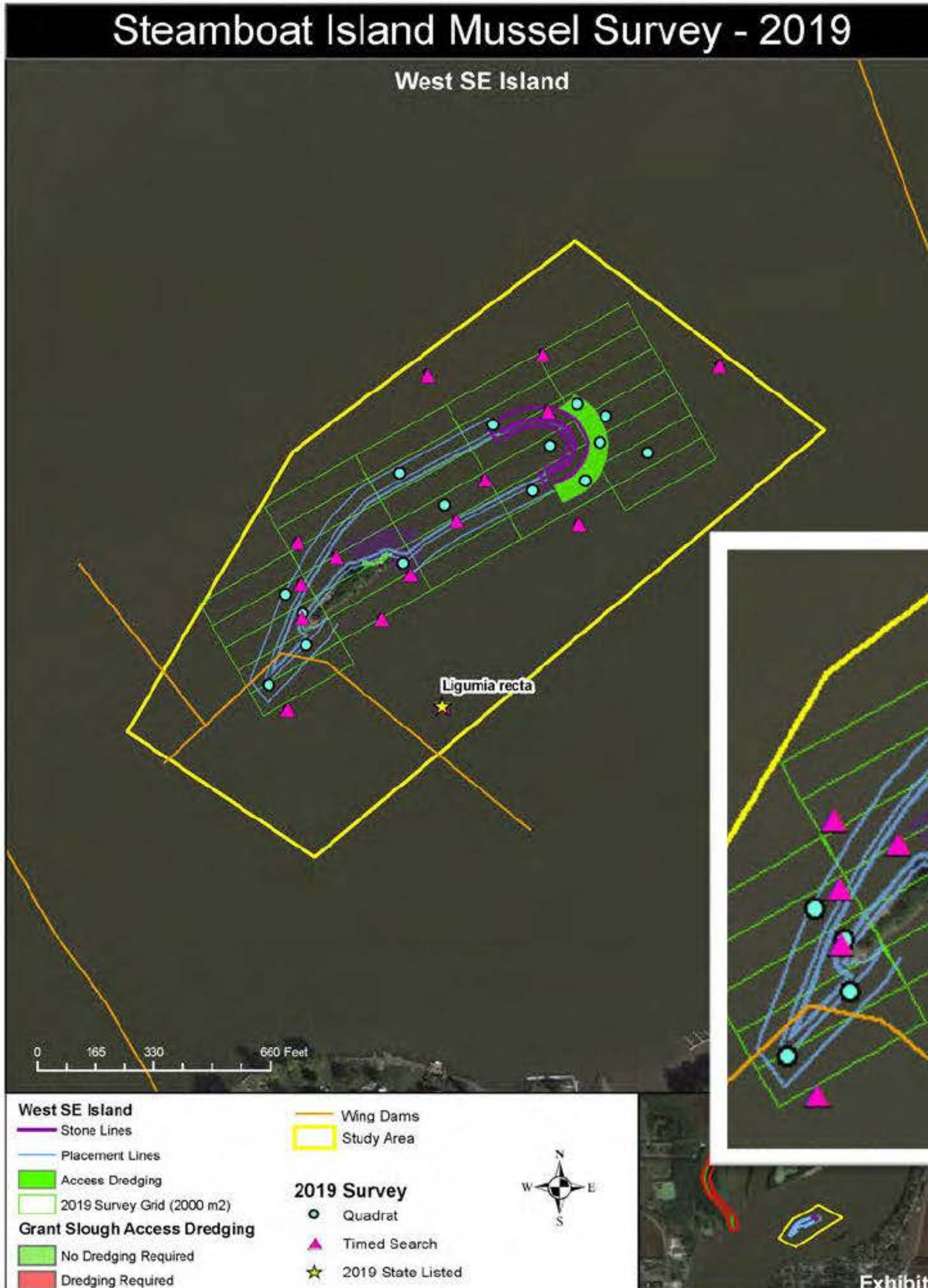
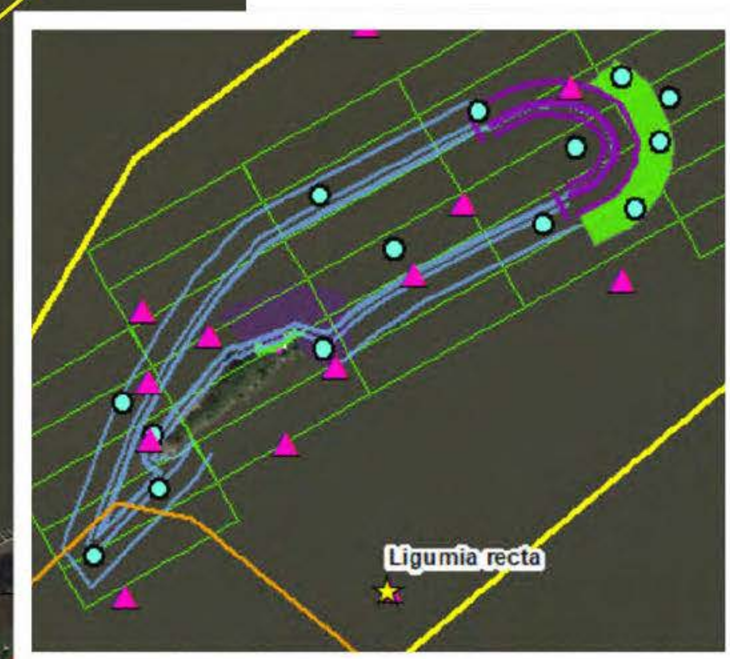
LISTED SPECIES



- NO Federally-listed
- West SE Island
- State-listed
  - IL-T
    - Ligumia recta (black sandshell,1)



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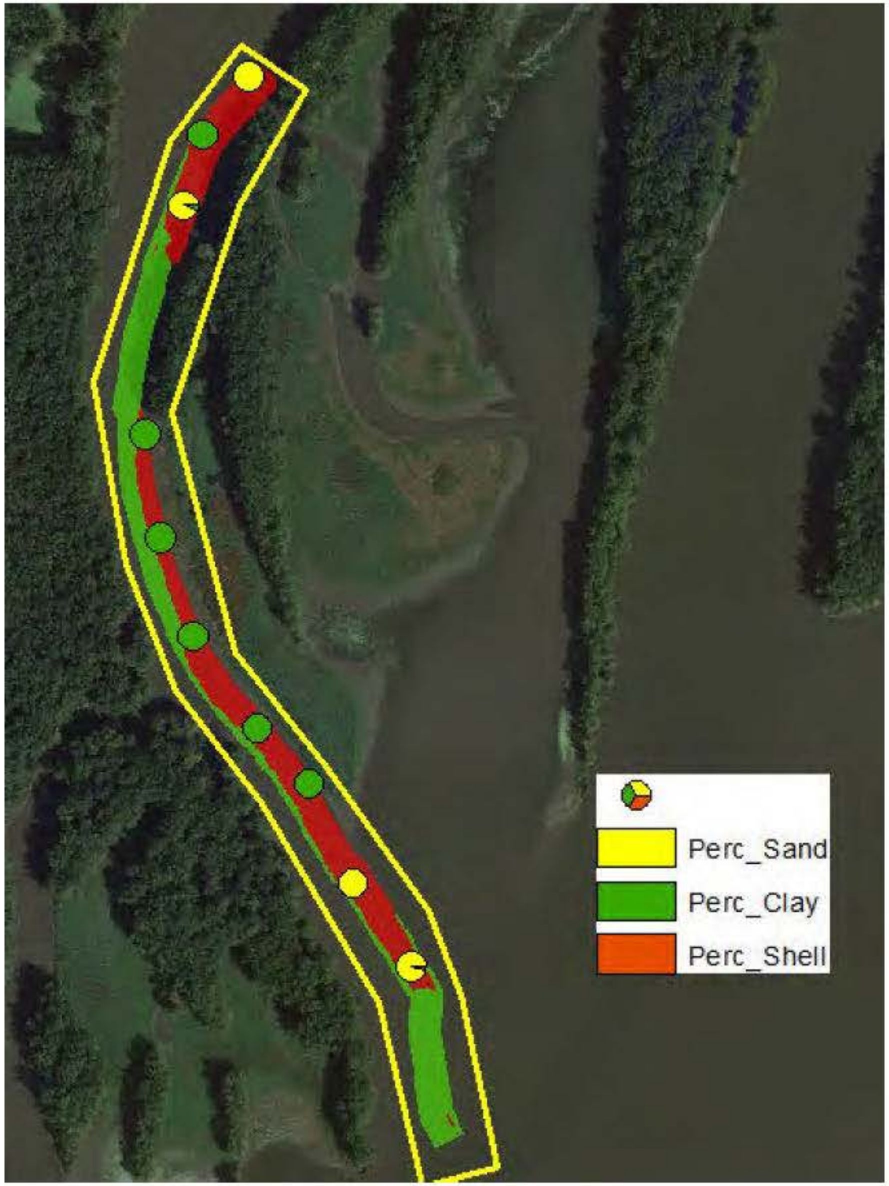
SPECIES COUNTS

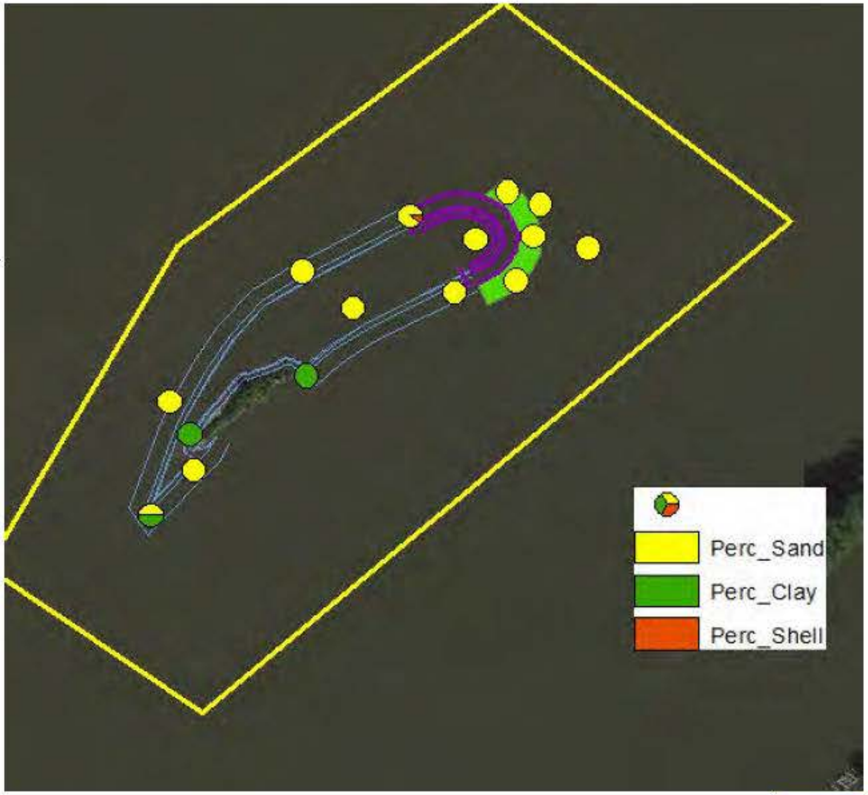
- *Amblema plicata* (threeridge) – 35.6% (n = 96)
- *Quadrula quadrula* (mapleleaf) – 15.2% (n = 41)
- *Obliquaria reflexa* (threehorn wartyback) – 12.6% (n = 34)
- *Quadrula pustulosa pustulosa* (pimpleback) – 10% (n = 27)
- *Truncilla donaciformis* (fawnsfoot) – 6.7% (n = 18)
- *Potamilus alatus* (pink heelsplitter) – 6.7% (n = 18)

- ≤ 7 individuals/14 remaining species

QUADRAT SUBSTRATE

- Grant Slough
  - 100% clay @ 60% sites
- West SE Island
  - 100% sand @ 73.3% sites; confirmed conditions from 2018





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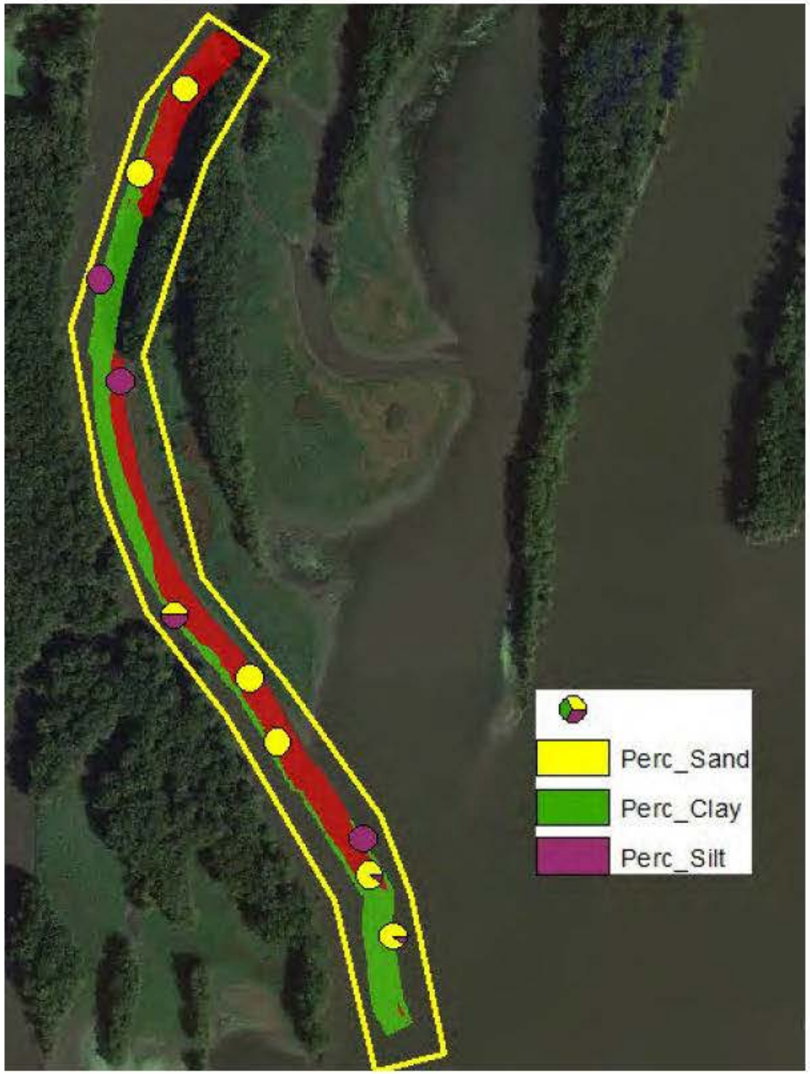
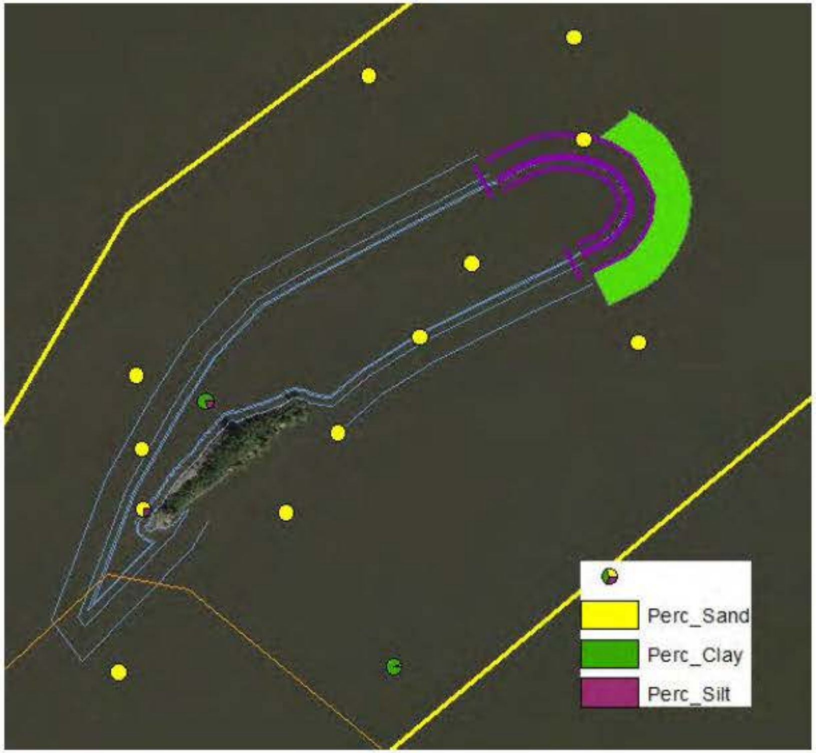
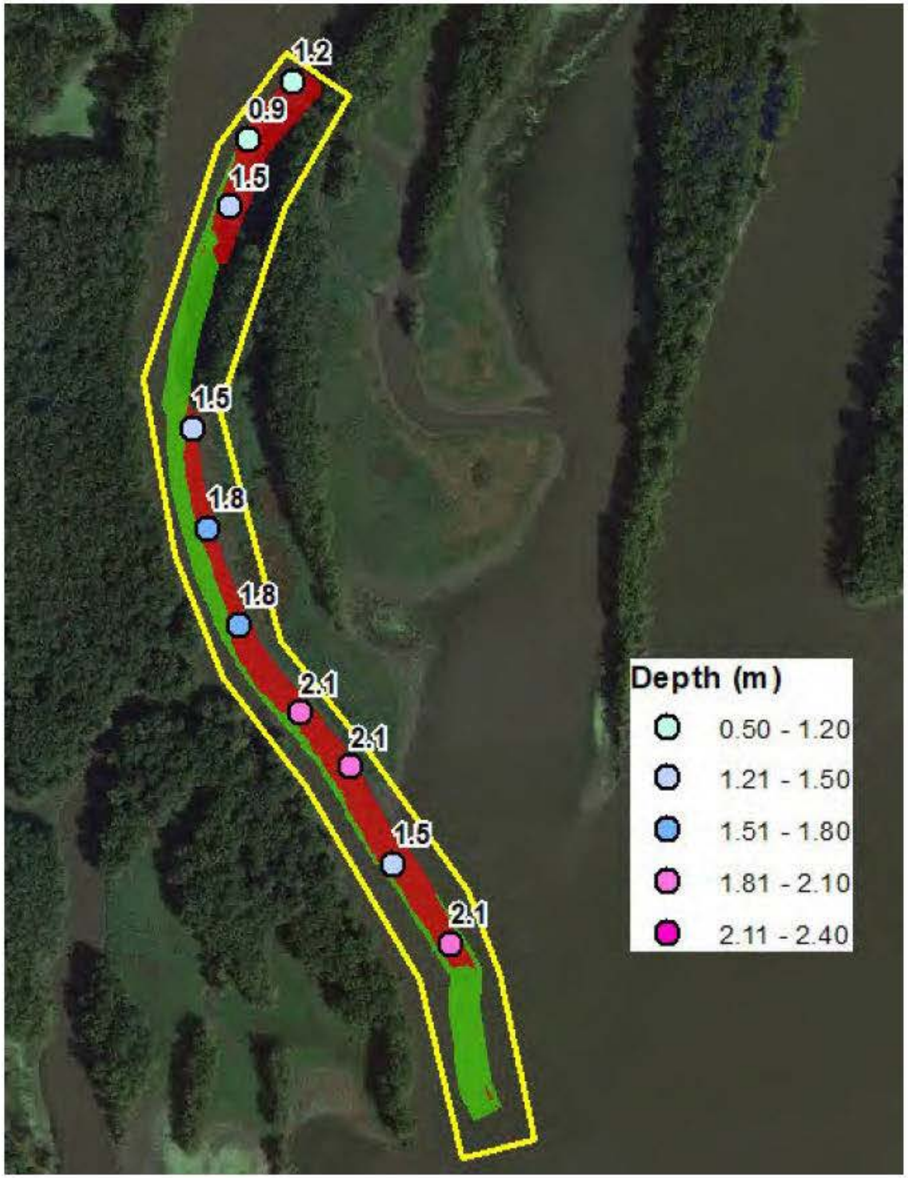
TIMED SEARCH SUBSTRATE

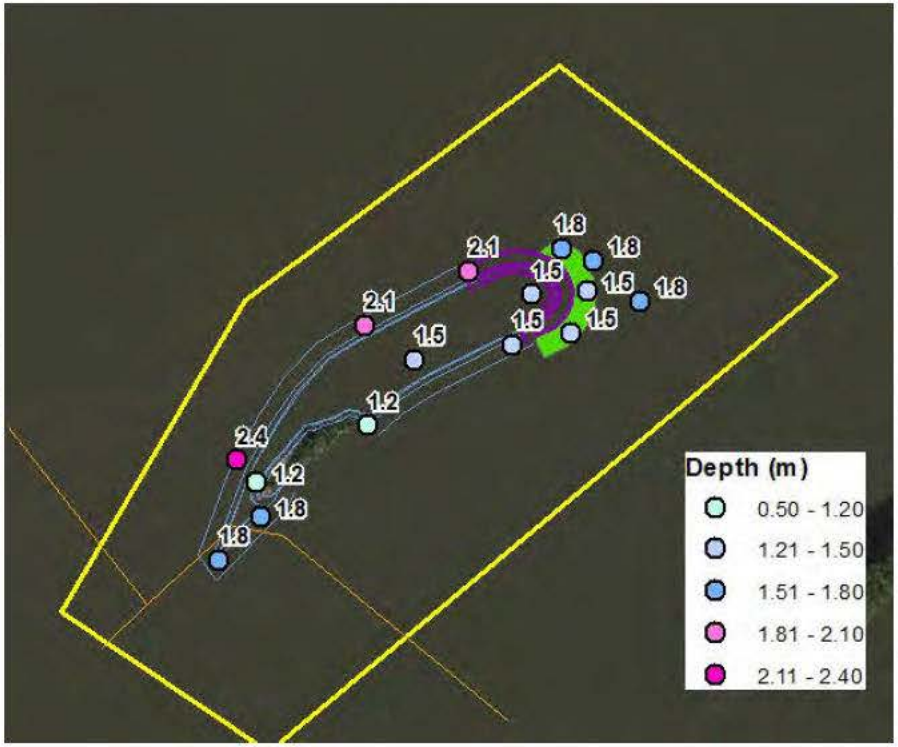
- Grant Slough
  - 100% sand @ 40% sites
- West SE Island
  - 100% sand @ 73.3% sites





QUADRAT DEPTHS (M)





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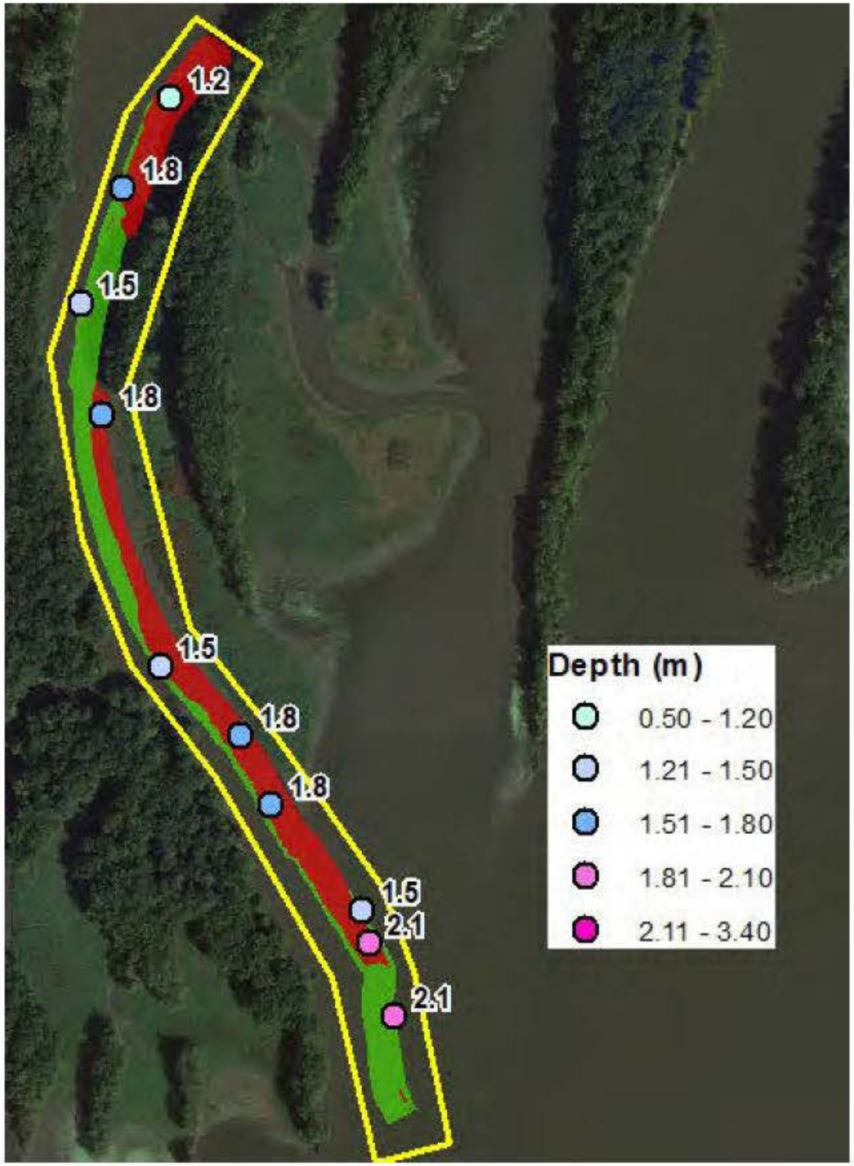
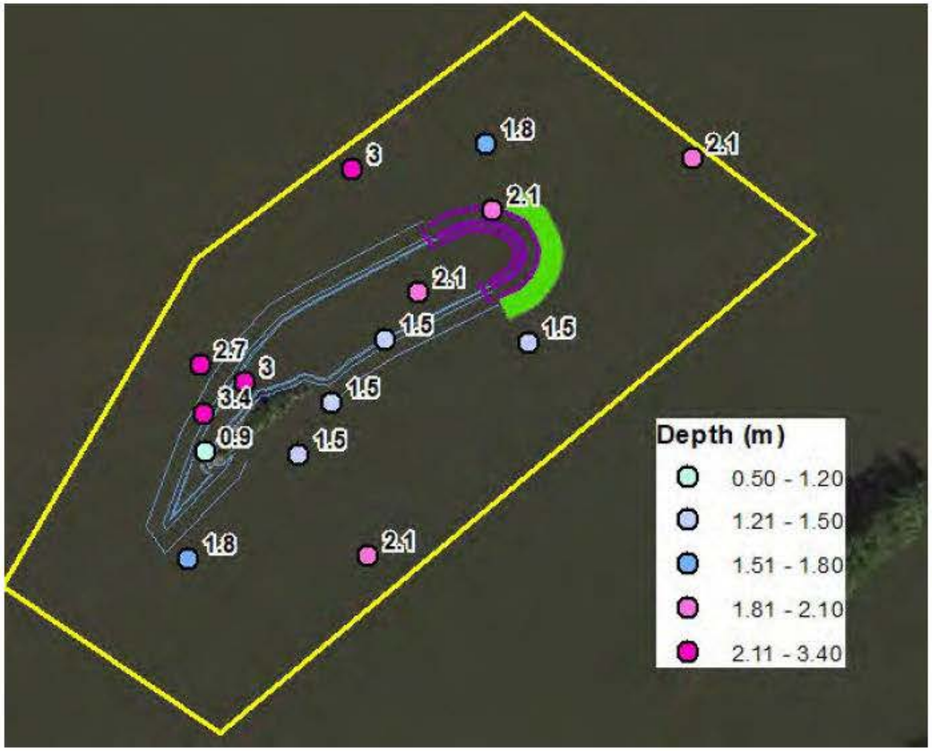
TIMED SEARCH DEPTHS (M)





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U.S. ARMY

From: MICHL, DAVI E [redacted]
To: MICHL, DAVI E [redacted]
Cc: Perrine, Rachel E [redacted]
Subject: Steamboat - 19 Dec 2019 call FWS (UNCLASSIFIED)
Date: Thursday, December 19, 2019 7:55:00 AM

CLASSIFICATION: UNCLASSIFIED

FYI

Telephone call 19 Dec 2019 with Sara Schmuecker, per District Responses to FWS FS Review:

NLAA or No Effect determination =no BA no BO; informal consultation concluded by letter

MR, p. II-15: avoidance during active season = bat surveys not required
    3 in 5 inch foraging habitat for bats Indiana vs NLEB (not 15 inches)

Sara added some clarifying language to the document - Environmental concurs

V/R,

Davi Michl
Regional Planning and Environment Division North
U.S. Army Corps of Engineers
[redacted]

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, ROCK ISLAND DISTRICT
PO BOX 2004 CLOCK TOWER BUILDING
ROCK ISLAND, ILLINOIS 61204-2004

December 20, 2019

Regional Planning and Environmental
Division North (RPEDN)

SUBJECT: Steamboat Island Habitat Rehabilitation and Enhancement Project, Clinton and Scott Counties, Iowa, and Rock Island County, Illinois

Review and Compliance Coordinator
State Historic Preservation Office
600 East Locust
Des Moines, Iowa 50319-0290

This letter is to inform you of an upcoming U.S. Army Corps of Engineers, Rock Island District (District) habitat rehabilitation and enhancement project (Project) on Steamboat Island in Rock Island County, Illinois, and Clinton and Scott Counties, Iowa. Steamboat Island is located between river miles 502.5 and 508.0 on the Mississippi River (Enclosure 1). The Project details are briefly outlined below. The identification and evaluation of historic properties and determinations of effect will not be completed prior to the completion of the environmental assessment needed for compliance with the National Environmental Policy Act (NEPA), making the execution of a Programmatic Agreement (PA) for this Project an appropriate course of action, pursuant to 36 CFR 800.14(b)(1)(ii). The District greatly values your participation and input, inviting your agency to participate as a consulting party and signatory in a forthcoming PA as per 36 CFR 800.14(b)(1)(ii).

Historic Properties

Portions of the Project area have been subjected to cultural survey and have resulted in the documentation of three archeological sites (Enclosure 2). Archeologist Charles R. Keyes noted a possible historic Sauk or Meskwaki village at the mouth of the Wapsipinicon River. Designated site 13CN36, this village appears in the ISF GIS database as an upward-facing triangle, meaning both the site's location and boundaries are uncertain. Site 13CN59 is a historic Euro-American scatter recorded in the Iowa Site File GIS database as a downward-facing triangle, meaning the site's location is known, but its boundaries are uncertain. These two sites are discussed in a 1989 Benn et al. report; this report recommended site 13CN59 be preserved. The site 13CN36 recommendation called for subsurface testing to pinpoint the definite site location.

The final previously recorded site, isolated prehistoric find 13CN78, is documented in Stanley's 1996 report, where he mentions finding two pieces of flaking debris, one each found in the upper 10 cm of two shovel tests. Stanley recommended the site ineligible for National Register of Historic Places (NRHP) listing. The Iowa State Historic Preservation Office (SHPO) Database of Section 106 Review and Compliance Decisions for specific sites (accessible through the ISF GIS database) notes that, on 17 May 1996, the SHPO determined the site ineligible for NRHP listing.

Additionally, a review of the 1930s Corps land acquisition/topographic maps reveals a variety of buildings and structures once stood within the Project area. These include fences, a log race related to timber harvests, a bridge, a pump, a small "stone dam," the side channel closing dam (labeled "stone retarding dam"), and several small buildings which likely functioned as hunting or fishing cabins. These structures are currently unevaluated.

Federal Undertaking

Pursuant to the National Historic Preservation Act (NHPA) of 1966, as amended, and its implementing regulations, 36 CFR Part 800, the District has determined that work at Steamboat Island has potential to cause effects to a historic property [36 CFR 800.3(a)(1)] and as a consequence will require a determination of effect within the Area of Potential Effect (APE).

Area of Potential Effect

The Project is located in T80N, R5E, Sections 11, 12, 13, 14, in Clinton County, Iowa, T80N, R5E, Sections 23, 24, 25, 35, 36, in Scott County, Iowa, T79N, R5E, Sections 1 and 2, Scott County, Iowa, and in T20N, R1E, Sections 25, 30, 36 in Rock Island County, Illinois. All Project lands are in Federal ownership by the District and the U.S. Fish and Wildlife Service (USFWS), and are managed via cooperative agreement between both parties as part of the Upper Mississippi River National Wildlife and Fish Refuge (NWFR). The Project and area of potential effect (APE) encompasses 2,627 acres of interconnected backwaters, secondary channels, wetlands, and islands. Approximately 1,820 acres of the Project area is terrestrial, with the remaining acreage permanently or seasonally inundated. The APE boundaries may be refined as the project progresses. The majority of the APE resides in Iowa, including Steamboat Island and land immediately adjacent to the west of the slough. The Illinois APE includes only a small island to the southeast of Steamboat Island.

Present and Proposed Courses of Action

The Project goals are to maintain, enhance, and restore quality habitat for desirable native plant, animal, and fish species and maintain, enhance, restore, and emulate natural river processes, structures, and functions for a resilient and sustainable ecosystem. This will be accomplished through a variety of actions including (Enclosure 3):

- excavate channels and restore overwintering habitat in backwater areas
- construct topographic diversity, to include forest, scrub/shrub, and pollinator habitat restoration and enhancement
- implement Timber Stand Improvement (TSI) techniques
- restore and protect islands
- construct bank protection and incorporate mussel substrate, where appropriate

Specific project features, including design and execution of the timber stand improvements, are not currently known. However, the types of actions to be performed and their potential impacts will be included in the PA.

Although contractors have been secured to perform the necessary work, the geomorphological and cultural evaluations of the Area of Potential Effect (APE) have been delayed due to excessive and prolonged high water and flooding of the project area. In order to effectively evaluate the APE for cultural resources, the pool level needs to at or below 10.1 feet. For the past five years, the majority of the work areas have been inundated (Enclosure 4). Therefore, a full assessment of effects to cultural resources for the project activities cannot be determined at this time. It is due to this constant inundation that the cultural and geomorphological surveys have been delayed. Once the pool level reaches the necessary level, work described in the stipulations of the forthcoming PA will be completed and cultural and geomorphological assessments will be conducted. Determinations of effect will then be made. The geomorphological assessments of the entire APE will aid in directing cultural work.

This PA will be included in an appendix of the final National Environmental Policy Act (NEPA) document, the Environmental Assessment (EA) as per 36 CFR 800.8. The draft EA will be available for public review. Evidence of this PA will be included in the draft EA. The PA is necessary as the District needs to complete the NEPA process, but cultural work has not been completed due to lack of access.

The District would like all future courses of action, including development of the PA, to involve the Iowa SHPO and other consulting party's input, thus ensuring that future decisions regarding the site are in line with consulting party wishes.

Consulting Parties Invitation

The Corps identified you as a consulting party for this undertaking (36 CFR 800.2) and invites your participation in the Section 106 process. Ultimately, the goal of the consultation is to identify any concerns and reach mutually agreeable decisions while taking into account the interests of Tribal, state and Federal governments and other consulting parties. The Distribution List (Enclosure 5) reflects the parties that received this mailing. The District invites you to identify any other consulting parties and provide input on issues relating to this undertaking.

The District hopes your agency will agree to participate as a consulting party and choose to participate as a signatory of the PA. If you wish to participate, please provide the District with a letter, email, or phone call to that effect within 30 days of receipt of this letter. Please also provide the District with a point of contact for future consultation on the Project.

The District's point of contact for this action is Ms. Christine Nycz of our Environmental Compliance Branch at ([redacted] by e-mail: [redacted] or in writing to our address, ATTN: Environmental Compliance Branch (Christine Nycz).

Sincerely,

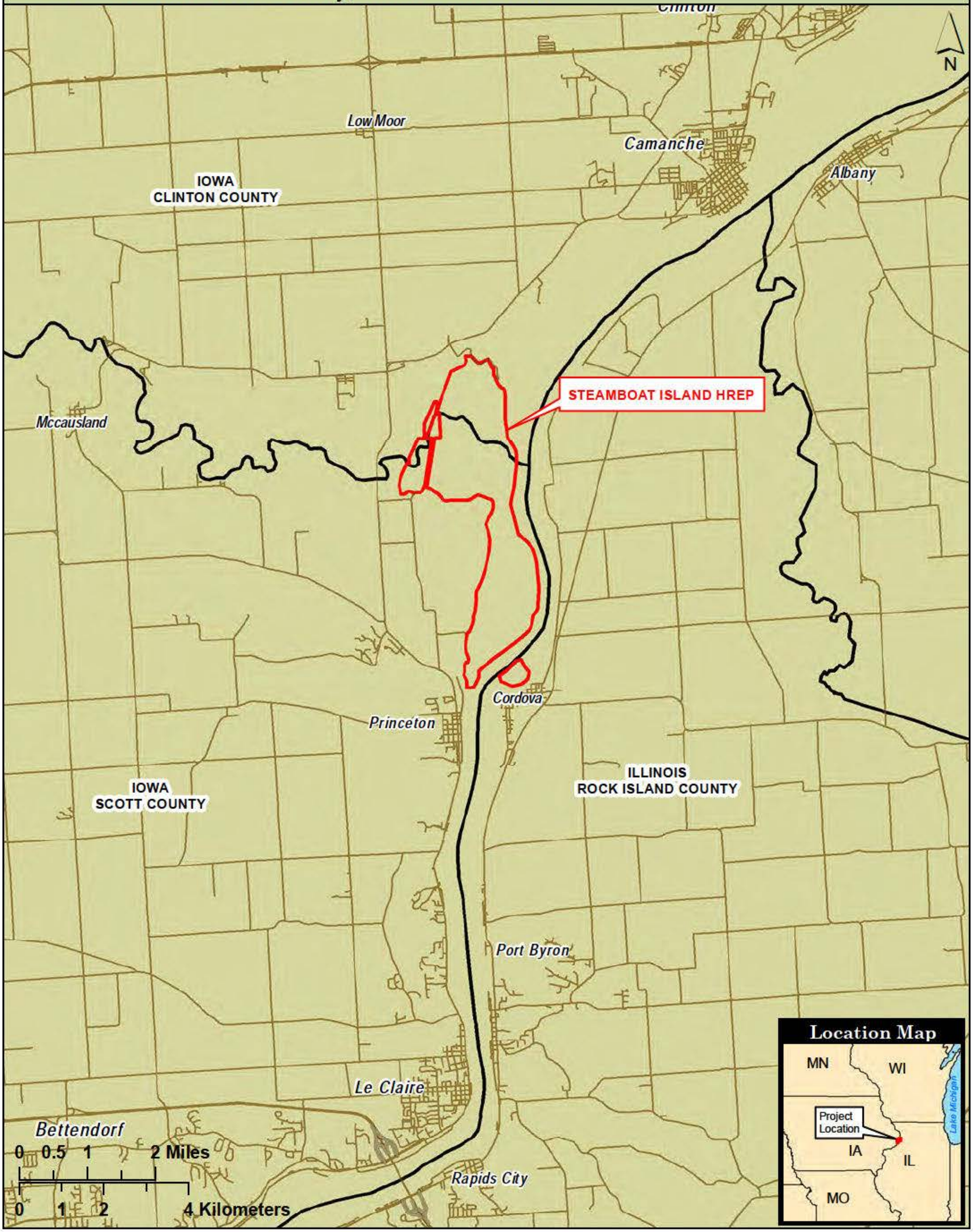
Jodi K Creswell

Jodi Creswell
Chief, Environmental Planning
Branch (RPEDN)

Enclosures (5)

US Army Corps of Engineers® Rock Island

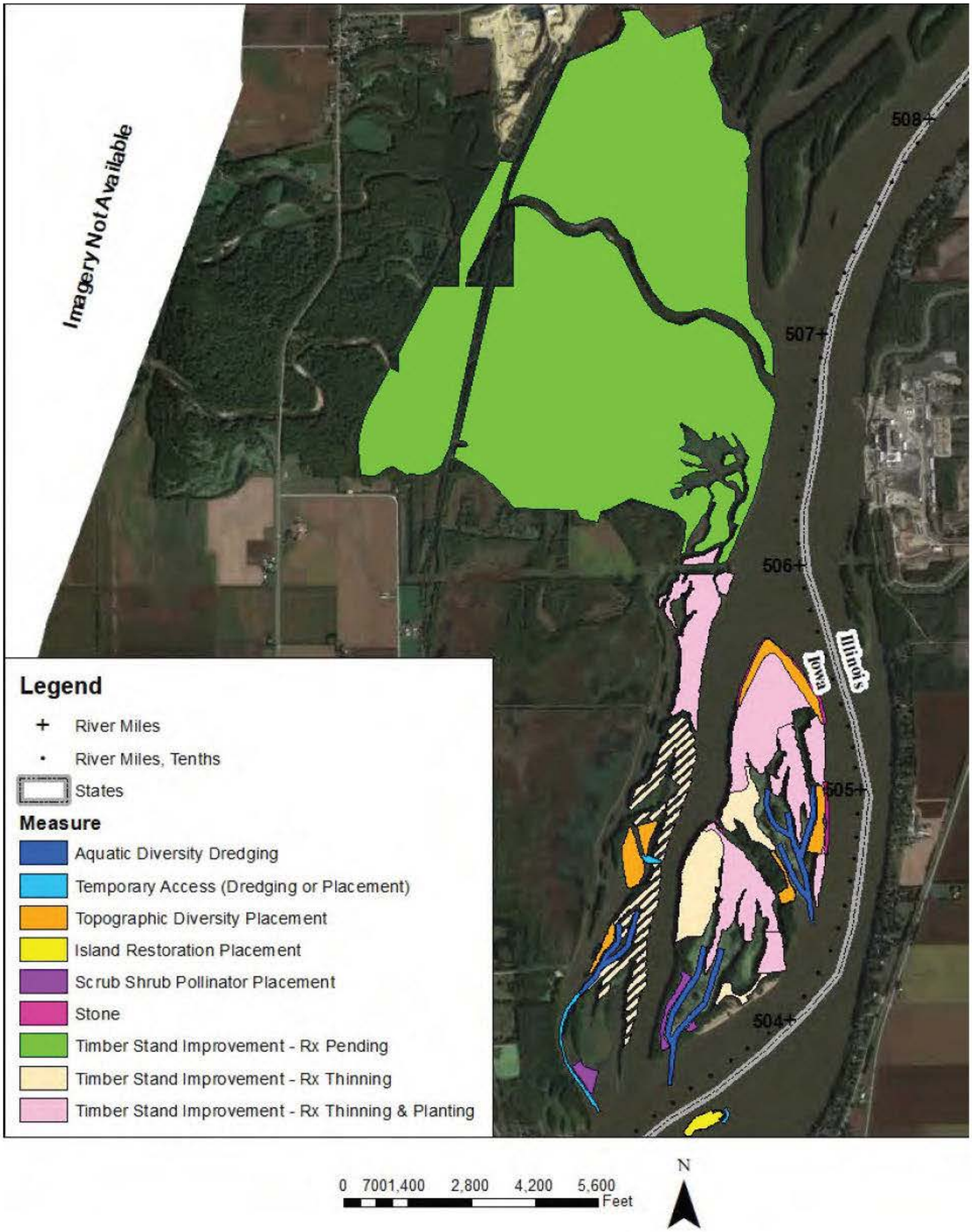
Steamboat Island HREP Project Location Map, Clinton & Scott Counties, Iowa, and Rock Island County, Illinois: Enclosure 1



ENCLOSURE 2

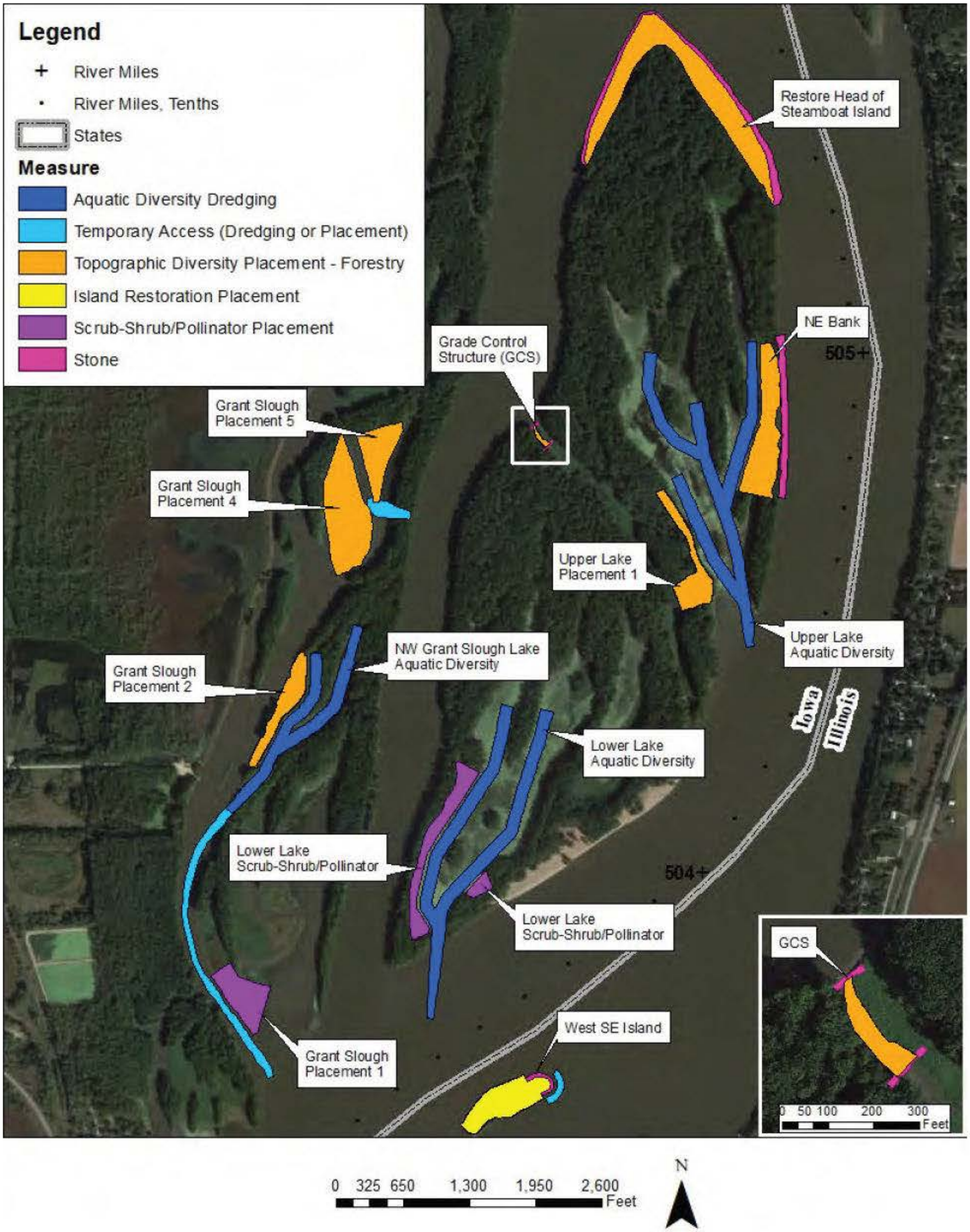
This enclosure has been removed. The Archaeological Resources Protection Act of 1979 prohibits the distribution of site location information to the public.

Steamboat Island HREP Project Details Map, Clinton & Scott Counties, Iowa, and Rock Island County, Illinois: Enclosure 3

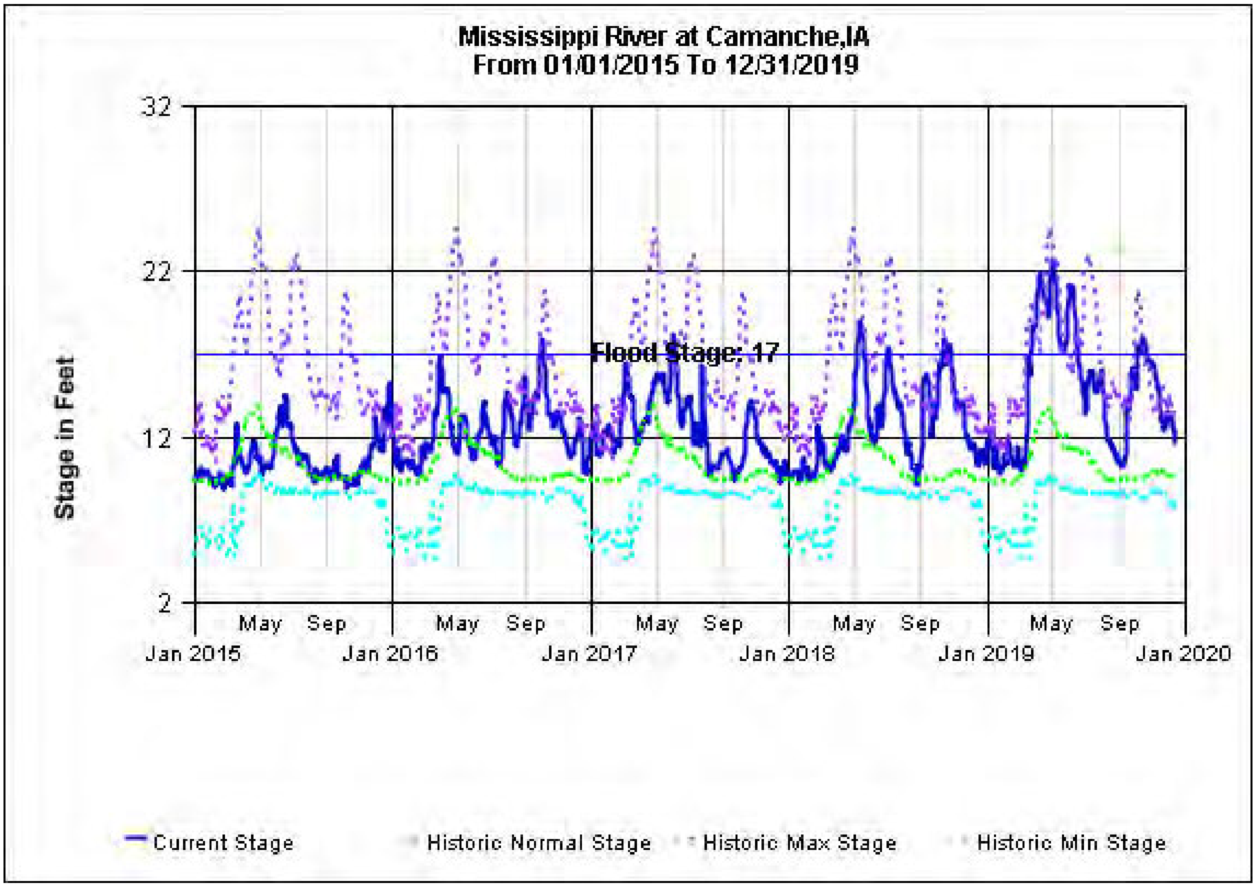


US Army Corps of Engineers Rock Island

Steamboat Island HREP Project Details Map, Clinton & Scott Counties, Iowa, and Rock Island County, Illinois: Enclosure 3b



Enclosure 4: Flood Stage Graph



Graph showing five year water levels at the Camanche, IA river gage, located five miles north of the Wapsipinicon River confluence with the Mississippi River (near the north end of the Steamboat Island HREP project area).

Enclosure 5: Distribution List

MR. STEVE VANCE, THPO
CHEYENNE RIVER SIOUX TRIBE
PO BOX 590
EAGLE BUTTE , SD 57625

DR. KELLI MOSTELLER, THPO
CITIZEN POTAWATOMI NATION
1601 S GORDON COOPER DR
SHAWNEE, OK 74801

MERLE MARKS, THPO
CROW CREEK SIOUX TRIBE OF THE CROW CREEK RESERVATION, SD
PO BOX 50
FT. THOMPSON, SD 57339

MR. GARRIE KILLSAHUNDRED, THPO
FLANDREAU SANTEE SIOUX TRIBE
22964 483RD AVE.
FLANDREAU, SD 57028

MR. MICHAEL LARONGE, THPO
FOREST COUNTY POTAWATOMI COMMUNITY
PO BOX 340
CRANDON, WI 54520

MR. DYAN YOUPEE, THPO
FORT PECK ASSINIBOINE & SIOUX TRIBES
P.O. BOX 1027
POPLAR, MT 59255

JAN HANSEN CITY OF CLINTON
HISTORIC PRESERVATION COMMISSION
611 S. 3RD ST. PO BOX 2958
CLINTON, IA 52732

MR. BILL QUACKENBUSH, THPO
HO-CHUNK NATION
PO BOX 667
BLACK RIVER FALLS, WI 54615

MR. JEFF KRUCHTEN, SHPO
ILLINOIS STATE HISTORIC PRESERVATION OFFICE
1 OLD STATE CAPITOL PLAZA
SPRINGFIELD, IL 62701

MS. HEATHER GIBB, R&C COORDINATOR
IOWA STATE HISTORIC PRESERVATION OFFICE
600 EAST LOCUST
DES MOINES, IA 50319

COMPLIANCE AND REVIEW
IOWA STATE HISTORIC PRESERVATION OFFICE
600 EAST LOCUST
DES MOINES, IA 50319-0290

MR. LANCE FOSTER, THPO
IOWA TRIBE OF KANSAS & NEBRASKA
3345 B THRASHER RD
WHITE CLOUD, KS 66097

MR. EAGLE MCCLELLAN, CULTURAL PRESERVATION DIRECTOR
IOWA TRIBE OF OKLAHOMA
335588 E 750 RD
PERKINS, OK 74059

MS. CRYSTAL DOUGLAS, THPO
KAW NATION
DRAWER 50
KAW CITY, OK 74641

Enclosure 5: Distribution List

MR. CURTIS SIMON, NAGPRA REPRESENTATIVE
KICKAPOO TRIBE IN KANSAS
1107 GOLDFIND RD
HORTON, KS 66439

MR. KENT COLLIER, NAGPRA REPRESENTATIVE
KICKAPOO TRIBE IN OKLAHOMA
PO BOX 70
MCLOUD, OK 74851

MS. CHEYANNE ST. JOHN, THPO
LOWER SIOUX INDIAN COMMUNITY
PO BOX 308
MORTON, MN 56270

MR. DAVID GRIGNON, THPO
MENOMINEE INDIAN TRIBE OF WISCONSIN
PO BOX 910
KESHENA, WI 54135-0910

MS. DIANE HUNTER, THPO
MIAMI TRIBE OF OKLAHOMA
PO BOX 1326
MIAMI, OK 74355

MR. THOMAS BRINGS, THPO
OGLALA SIOUX TRIBE
PO BOX 320
PINE RIDGE, SD 57770

MR. THOMAS PARKER, THPO
OMAHA TRIBE OF NEBRASKA
PO BOX 368
MACY, NE 68039

MR. JESS HENDRIX, ARCHEOLOGIST
OSAGE NATION
627 GRANDVIEW AVE
PAWHUSKA, OK 74056

MS. ELSIE WHITEHORN, THPO
OTOE-MISSIOURIA TRIBE
8151 HWY 177
RED ROCK, OK 74651

MR. LOGAN PAPPENFORT, NAGPRA REPRESENTATIVE
PEORIA TRIBE OF INDIANS OF OKLAHOMA
PO BOX 1527
MIAMI, OK 74355

MR. NICHOLAS MAURO, THPO
PONCA TRIBE OF NEBRASKA
PO BOX 288
NIOBRARA, NE 68760

MS. HALONA CABE, THPO
PONCA TRIBE OF OKLAHOMA
20 WHITE EAGLE DR
PONCA CITY, OK 74601

MS. HATTIE MITCHELL, NAGPRA REPRESENTATIVE
PRAIRIE BAND POTAWATOMI
16281 Q ROAD
MAYETTA, KS 66509

MR. NOAH WHITEHORN, THPO
PRAIRIE ISLAND INDIAN COMMUNITY
5636 STURGEON LAKE RD
WELCH, MN 55089

Enclosure 5: Distribution List

MR. BEN RHODD, THPO
ROSEBUD SIOUX TRIBE
PO BOX 809
ROSEBUD, SD 57570

CHAIRPERSON TIAUNA CARNES
SAC & FOX NATION OF MISSOURI IN KANSAS & NEBRASKA
305 N MAIN
RESERVE, KS 66434-9723

MS. SANDRA MASSEY, NAGPRA REPRESENTATIVE
SAC & FOX NATION OF OKLAHOMA
920883 SOUTH HWY 99
STROUD, OK 74079

MR. JOHNATHAN BUFFALO, DIRECTOR HISTORIC PRESERVATION DEPT.
SAC & FOX TRIBE OF THE MISSISSIPPI IN IOWA
303 MESKWAKI RD
TAMA, IA 52339-9629

MR. DUANE WHIPPLE, THPO
SANTEE SIOUX TRIBE OF NEBRASKA
108 SPIRIT LAKE AVE W
NIOBRARA, NE 68760

MS. DIANNE DESROSIERS, THPO
SISSETON-WAHPETON OYATE
PO BOX 907
SISSETON, SD 57262

DR. ERICH LONGIE, THPO
SPIRIT LAKE NATION
PO BOX 359
FORT TOTTEN, ND 58335

MR. JON EAGLE, THPO
STANDING ROCK SIOUX TRIBE
PO BOX D
FT. YATES, ND 58538

MS. SAMANTHA ODEGARD, THPO
UPPER SIOUX COMMUNITY, MINNESOTA
PO BOX 147
GRANITE FALLS, MN 56241

MR. JAMES MYSTER, REGIONAL ARCHAEOLOGIST/RHPO
US FISH AND WILDLIFE SERVICE
5600 AMERICAN BLVD W STE 1049
BLOOMINGTON, MN 55437

MR. EBEN CRAWFORD, NAGPRA ASST.
WINNEBAGO TRIBE OF NEBRASKA
PO BOX 687
WINNEBAGO, NE 68071

MR. KIP SPOTTED EAGLE, THPO
YANKTON SIOUX TRIBE
PO BOX 1153
WAGNER, SD 57380

Rock Island County PLEASE REFER TO: SHPO LOG #006122319
Cordova
Between Mississippi River miles 502.5 & 508
Section:25-Township:20N-Range:1E, Section:30-Township:20N-Range:1E, Section:36-Township:20N-Range:1E
COERI
Rehabilitation & enhancement project - Steamboat Island Habitat

January 8, 2020

Jodi Creswell
Department of the Army
Corps of Engineers, Rock Island District
Clock Tower Building, P.O. Box 2004
Rock Island, IL 61204-2004

Dear Ms. Creswell:

We have reviewed the documentation submitted for the referenced project(s) in accordance with 36 CFR Part 800.4. Based upon the information provided, no historic properties are affected. We, therefore, have no objection to the undertaking proceeding as planned.

Please retain this letter in your files as evidence of compliance with section 106 of the National Historic Preservation Act of 1966, as amended. This clearance remains in effect for two (2) years from date of issuance. It does not pertain to any discovery during construction, nor is it a clearance for purposes of the Illinois Human Skeletal Remains Protection Act (20 ILCS 3440).

If you are an applicant, please submit a copy of this letter to the state or federal agency from which you obtain any permit, license, grant, or other assistance. If further assistance is needed contact Jeff Kruchten, Chief Archaeologist at [redacted] or [redacted]

Sincerely,

Robert F. Appleman
Deputy State Historic
Preservation Officer

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, ROCK ISLAND DISTRICT
CLOCK TOWER BUILDING - PO BOX 2004
ROCK ISLAND, ILLINOIS 61204-2004

REPLY TO
ATTENTION OF

January 22, 2020

Regional Planning and Environmental
Division North (RPEDN)

Illinois – Iowa Services Field Office
U.S. Fish and Wildlife Service
1511 47th Avenue
Moline, IL 61265

ATTN: Kraig McPeek and Sara Schmuecker

Dear Kraig and Sara:

The U.S. Army Corps of Engineer (Corps), Rock Island District (District), is preparing to implement a habitat rehabilitation and enhancement project (Project), part of the Upper Mississippi River Restoration (UMRR) Program at Steamboat Island (Project) in Pool 14 of the Upper Mississippi River (UMR). The Project area extends along the UMR, on both sides of the navigation channel between river miles (RM) 502.5 and 508.0, Clinton and Scott Counties, IA, and Rock Island County, IL. The District obtained a list of federally endangered and threatened species with preferred habitat types for the Project area using the U.S. Fish and Wildlife Service (USFWS) Information for Planning and Conservation (IPaC) website and USFWS species fact sheets (Table 1).

A Tentatively Selected Plan (TSP) was identified and refined to avoid impacts to listed species, while also meeting the Project's goals and objectives by 1) restoring topographic diversity, including timber stand improvement (TSI) measures, to increase diversity of bottomland hardwood forest and scrub-shrub/pollinator (SSP) habitat; 2) restoring aquatic diversity in backwaters to provide year-round habitat for fish; 3) restoring and protecting island acreage from erosion, and 4) placing bankline stone protection measures to protect existing backwater habitat from sedimentation and enhance backwater interior wetlands (Enclosure 1).

With the receipt of this letter, the District is requesting concurrence with our determinations made through informal Section 7 consultation between the Corps and the USFWS on this Project. The District determined the Project is not likely to adversely affect any listed species.

Table 1. List of Federally-endangered and threatened Species with Preferred Habitat Types Which Have the Potential to Occur Within Clinton and Scott Counties, IA and Rock Island County, IL

Species	Scientific Name	Status	Habitat Types
Indiana bat	*Myotis sodalis*	Endangered	During the winter, caves and mines and during the summer, underneath peeling bark of dead or dying trees
Northern long-eared bat	*Myotis septentrionalis*	Threatened	During the winter, caves and mines and during the summer, underneath flaky bark, in cavities or in crevices of both live trees and snags (dead trees).
Higgins eye pearlymussel	*Lampsilis higginsii*	Endangered	Large rivers with deep water and moderate currents.
Sheepnose mussel	*Plethobasus cyphyus*	Endangered	Large rivers and streams where it is usually found in shallow areas with moderate to swift currents flowing over coarse sand and gravel.
Spectaclecase mussel	*Cumberlandia monodonta*	Endangered	Large rivers where they live in areas sheltered from the main force of the river current, such as beneath rock slabs, between boulders and even under tree roots.
Eastern massasauga rattlesnake	*Sistrurus catenatus*	Threatened	Wet areas including low areas along rivers and lakes, moving to adjacent uplands during the summer
Prairie bush clover	*Lespedeza leptostachya*	Threatened	Found only in the tallgrass prairie region
Western prairie fringed orchid	*Platanthera praeclara*	Threatened	Occur most often in mesic to wet unplowed tallgrass prairies and meadows but have been found in old fields and roadside ditches.
Eastern prairie fringed orchid	*Platanthera leucophaea*	Threatened	Mesic to wet prairies and meadows, marsh edges, or even bogs; requires grassy habitat with little to no woody encroachment
Iowa Pleistocene snail	*Discus macclintocki*	Endangered	Leaf litter of special cool and moist hillsides or algific talus slopes.

DESCRIPTION OF THE PROPOSED ACTIONS

The District is preparing a Feasibility Report with Integrated Environmental Assessment (EA) for implementation of the Project. The report will describe the existing conditions, future without Project conditions, alternative evaluation, and effects of the TSP. The following sections from the draft Report provide information regarding the potential effects of restoration activities planned within Steamboat Island proper, Grant Slough, and the West SE Island. The aquatic diversity, forest diversity, and SSP measures are listed as separate measures because they are distinct habitat types. However, these measures are intertwined as material used from mechanical excavation of the aquatic diversity areas will be used for topographic diversity and SSP sites. Table 2 provides a summary of all excavation and placement quantities for the TSP.

Dredge cuts for aquatic diversity sites and access channels were designed to a 60-ft bottom width where practicable. In some locations, the bottom width is narrowed down to 30 ft to avoid excavating land above the water surface. Side slopes of the dredge cut were designed at 4H:1V. Excavation would be to 8ft below flat pool, or elevation 563.2ft NAVD88.

Forest diversity sites were selected based on current vegetation quality and the proximity to potential dredge cut locations, as well as accessibility with construction equipment. Sites will be raised to an elevation of 576.2ft NAVD88 and planted with tree species. SSP sites were determined based on presence of low value vegetation dominated by reed canary grass and suitability of that site to support SSP vegetation, as well as accessibility with construction equipment. Sites will be raised to an elevation of 573.1ft NAVD88 and planted with SSP species.

Island restoration and protection sites were selected to build off existing islands and restore island footprint that has been lost from erosion and inundation. These measures include a combination of open water and bankline placement of dredged material and stone protection.

Timber stand improvement (TSI) measures include tree plantings, thinning treatments, and non-desirable vegetation maintenance. It is estimated approximately 900 acres of active TSI strategies will be implemented in the next 10 years within the Project area.

Table 2: Excavation and Fill Data Summary

Dredge Cuts & Placement Sites	Dredging: Length (linear ft)	Dredging: Dredging Quantity (cy)	Placement: Stone Length	Placement: Capacity (cy)	Placement: Stone (TN)
Steamboat Island (SI) Upper Lake	6,902	194,828	–	–	–
SI Lower Lake	5,758	170,158	–	–	–
Grant Slough Lake	3,377	87,704	–	–	–
Access to Grant Slough	3,017	10,721	–	–	–
Access to SE Island	372	855	–	–	–
Restore Upper SI (USI) Head	–	–	3,863	274,530	102,941
Northeast (NE) Bank	–	–	1,589	30,990	22,403
West Southeast (SE) Island	–	–	418	76,020	6,115
SI Upper Lake Placement Site	–	–		10,972	–
Grant Slough Placement 2	–	–		11,886	–
Grant Slough Placement 4 & 5	–	–		47,503	–
Grade Control Structure (GCS)	–	–	264	561	162
Grant Slough Placement 1 (SSP)	–	–	–	3,077	–
Lower Lake SSP	–	–	–	2,988	–
Totals in Draft TSP	19,426	464,266	6,134	458,527	131,622
Totals in Draft TSP (accounts for shrinking/bulking)	**19,426**	**510,692**	**6,134**	**504,380**	**131,622**

SPECIES STATUS IN THE ACTION AREA

The Higgins eye pearlymussel, sheepnose mussel, spectaclecase mussel, Indiana bat, and Iowa Pleistocene snail are federally-endangered species listed in the Project area, while the prairie bush clover, Western and Eastern prairie fringed orchids, Eastern massasauga, and northern long-eared bat are listed as federally-threatened species.

1. Higgins eye pearlymussel. Due to the presence of 6 live Higgins eye mussels recovered during a 2018 mussel survey, the TSP was revised to avoid and minimize impacts to federally-listed mussel species by removing the East SE Island from the Project footprint (Enclosure 2, SA5). A follow-up survey of the West SE Island and Grant Slough in 2019 yielded no federally-listed mussel species and revealed substrates high in shifting sand and/or flocculent silt, generally considered to be unsuitable habitat (Enclosure 3). Collectively, there is a low likelihood of Higgins' eye presence within the Project's revised footprint.

2. Sheepnose mussel. According to the most recent mussel survey (2019), no individuals of sheepnose were collected (Enclosure 3). Similarly, no sheepnose individuals were recovered during a 2018 survey of the wider Project area (Enclosure 2). A past survey conducted in 2006 resulted in one live sheepnose identified outside of the Project area, indicating a low probability of presence

3. Spectaclecase mussel. According to the most recent mussel survey (2019), no individuals of spectaclecase were collected nor preferred habitat encountered (Enclosure 3). Similarly, no spectaclecase individuals were recovered during a 2018 survey of the wider Project area (Enclosure 2). Past surveys have not resulted with any spectaclecase records near the Project area, indicating a low probability of presence.

4. Indiana and Northern long eared bats. Due to the existing ideal habitat for bat use and identified species of Indiana and Northern long eared bats from previous surveys conducted throughout Pool 14, presence is assumed within the Project area. Avoidance and minimization efforts in limiting tree clearing, including during the active season, will be implemented. Based on these efforts, the USFWS determined additional surveys will not be required at this time.

5. Eastern massasauga rattlesnake. The last identified presence of Eastern massasauga was reported adjacent to the Project area in 1999; however, the USFWS determined a survey was not required based on the lack of suitable habitat within the Project area.

6. Iowa Pleistocene snail. The species has not previously been recorded in the area nor does the Project area offer suitable habitat for establishment or survival.

7. Listed plant species. While potential habitat exists statewide in Iowa for the prairie bush clover, eastern prairie fringed orchid, and western prairie fringed orchid, none have previously been recorded in the Project area and the current state of invasive species domination limits the opportunity for establishment or survival.

EFFECTS OF THE PROPOSED ACTIONS

Construction activity would temporarily increase turbidity immediately downstream of the proposed dredge cuts and in-water construction. Utilizing mechanical dredging to build up topographic diversity sites and existing islands reduces impacts to the local water column and its associated aquatic communities. Although macroinvertebrate density and diversity is relatively low, temporary disruption and minor loss is expected to occur through dredging and rock placement. These areas should be recolonized shortly following construction. The PDT decided to use 2019 survey results to inform access dredging design and further avoid and minimize mussel impacts in the more densely inhabited areas of Grant Slough. Additionally, fish habitat (e.g., rock substrate, large woody debris) and mussel habitat (e.g., mixture of various sizes of river rock suitable as substrate for multiple mussel species) will be installed at the island protection sites and within aquatic diversity sites, providing immediate direct benefits to fish and mussels that inhabit the area in the form of increased habitat structure and function.

Recommendations for these measures were provided by the USFWS and IADNR and incorporated to the design.

The Project includes approximately 1.3 acres of tree clearing to access to topographic diversity sites in Grant Slough. Due to these activities, temporary disruptions to Indiana and Northern long eared bats may occur; however, the area designated for clearing is not anticipated to negatively affect primary roost trees, feeding corridors, and areas of high bat activity. The overall forested habitat which exists on Steamboat Island proper is approximately 1,674 acres. When compared to the number of acres potentially affected by the Project, the District determined it to be about 0.07% of the total. Any tree removal will be conducted October 1 – March 31 to avoid the bat maternity roosting season and all areas will be re-planted upon construction completion.

Corps' foresters will continue to implement TSI measures at various locations within the Project area to increase tree health, structural diversity and forest resilience (Enclosure 4). These measures include tree plantings, thinning treatments, and non-desirable vegetation maintenance. Disruption of the habitat during tree planting would be minimal. Post-planting and periodic operation and maintenance procedures, such as undesirable vegetation control through hand pulling or herbicide treatments, would have little impacts on the environment. Any required herbicide treatments would be applied by a licensed applicator using state and Federal standards, thus minimizing potential localized impacts. Estimated tree thinning prescriptions in the Project area are variable between management units and are described in further detail in the Report. All tree thinning efforts will be conducted October 1 – March 31 to avoid the bat maternity roosting season and trees marked to be cut or saved will be coordinated with the PDT prior to construction.

EFFECTS DETERMINATION AND CONSERVATION MEASURES

The TSP was revised to avoid and minimize impacts to federally-listed mussel species. The results from two survey events did not identify the three federally-endangered mussel species within the revised TSP footprint. In coordination with the USFWS, the 2019 survey results precluded the need for a Biological Assessment and the District determined the proposed Project *May Affect,* but is *Not Likely to Adversely Affect* the Higgins eye pearlymussel, due to the potential impacts from in-water rock and dredged material placement, as well as necessary access dredging (approximately 5.6 acres).

~~Tree clearing is minimal for the Project area and will be replanted following construction.~~ Any tree removal will adhere to seasonal limitations to avoid the bat maternity roosting season. Corps' Foresters will continue to implement forest management measures (including TSI strategies) following construction of this Project, providing the bat community with habitat complexity and diversity through increased forage opportunities and potential roost tree production. In coordination with the USFWS, the District determined the proposed project

May Affect, but is *Not Likely to Adversely Affect* Indiana and Northern long eared bats by temporarily reducing the amount of potential roosting and foraging habitat and create short-term fragmented woodlands within the action area (approximately 1.3 acres).

In planning and coordination efforts, the District has taken the aforementioned conservation measures to minimize and avoid impacts to listed species for the Project. It is determined the proposed Project is not likely to adversely affect any threatened or endangered species or their critical habitat (Table 3). Therefore, the District is requesting conclusion of informal consultation, in compliance with the legal requirements set forth under Section 7 of the Endangered Species Act (15 U.S.C. 1536 (c)) and applicable guidance documents.

Table 3. Determination of Impacts from Proposed Modifications to Federally-endangered and -threatened Species

Species	Scientific Name	Status	Determination of Impacts
Indiana Bat	*Myotis sodalis*	Endangered	Not Likely to Adversely Affect
Northern Long-Eared Bat	*Myotis septentrionalis*	Threatened	Not Likely to Adversely Affect
Higgins Eye Pearlymussel	*Lampsilis higginsii*	Endangered	Not Likely to Adversely Affect
Sheepnose mussel	*Plethobasus cyphyus*	Endangered	No Effect
Spectaclecase mussel	*Cumberlandia monodonta*	Endangered	No Effect
Eastern massasauga	*Sistrurus catenatus*	Threatened	No Effect
Prairie Bush Clover	*Lespedeza leptostachya*	Threatened	No Effect
Western Prairie Fringed Orchid	*Platanthera praeclara*	Threatened	No Effect
Eastern Prairie Fringed Orchid	*Platanthera leucophaea*	Threatened	No Effect
Iowa Pleistocene snail	*Discus macclintocki*	Endangered	No Effect

Please provide any other comments, concerns, or questions you may have regarding this Project within 30 days of receipt of this letter. Address your responses to Ms. Davi Michl of our Environmental Planning Branch by telephone [redacted] in writing to our address above, ATTN: Environmental Planning Branch (Michl), or email: [redacted]

Sincerely,

Jodi Creswell

Jodi Creswell
Chief, Environmental Planning Branch

(RPEDN)
Enclosures (4)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Illinois & Iowa ES Field Office
1511 47th Avenue
Moline, Illinois 61265
Phone: (309) 757-5800 Fax: (309) 757-5807

IN REPLY REFER
TO:
FWS/ILIAFO
TAILS #03E18000-2020-I-0836

February 21, 2020

Jodi Creswell
Chief, Environmental Planning Branch
U.S. Army Corps of Engineers
Rock Island District
Attn: Davi Michl
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61201-2004

Dear Ms. Creswell:

This responds to your letter requesting concurrence from the Fish and Wildlife Service (Service) for the Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP), dated January 22, 2020. The Steamboat Island HREP is part of the Upper Mississippi River Restoration (UMRR) Program and is located within Pool 14 of the Upper Mississippi River, extending along both sides of the navigation channel between river miles 502.5 and 508.0, Clinton and Scott Counties, Iowa, and Rock Island County, Illinois. As part of the project, the U.S. Army Corps of Engineers, Rock Island District (District) has identified a tentatively selected plan (TSP) that incorporates refinements and conservation measures to minimize and avoid impacts to federally listed species, as your letter describes. You determined that the project may affect but is not likely to adversely affect (NLAA) the federally endangered Indiana bat (*Myotis sodalis*) and Higgins eye pearlymussel (*Lampsilis higginsii*), and the federally threatened northern long-eared bat (*Myotis septentrionalis*). This informal consultation addresses potential effects to the species in accordance with section 7 of the Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 *et seq.*) and 50 CFR § 402 of our interagency regulations governing section 7 of the Act.

Multiple bat surveys have been conducted throughout the floodplain forests of Pool 14 in recent years. Specifically, a bat survey was completed in 2015 at the Beaver Island HREP, located approximately eight river miles upstream from the project area. The Beaver Island HREP survey identified both northern long-eared bats (acoustics and mist-netting) and Indiana bats (acoustics only). Additionally, a season-long acoustic survey conducted at the adjacent Princeton Wildlife Management Area identified use by both Indiana bats and northern long-eared bats in 2018; however, neither species was collected through mist-netting efforts. Due to the known presence of both the Indiana and northern long-eared bats within the project vicinity and the identification of potentially suitable habitat throughout the project area, we assume presence of these species throughout the project.

Project activities resulting in potential disturbance to Indiana and northern long-eared bat habitat include tree clearing to allow equipment access to the topographic diversity sites within the Grant Slough area and active timber stand improvement (TSI) practices. The TSP identifies approximately 1.3 acres of tree removal, which is roughly 0.07 percent of the total forested habitat available within the Steamboat Island complex. The tree removal, as proposed, will not result in fragmentation of bat roosting or foraging habitat and cleared areas will be replanted following the completion of construction. Recent tree inventories have identified potential roosting habitat throughout the remaining forested sections of the Steamboat Island complex, including trees that likely serve as primary or secondary roosts. Because the District proposes to complete this limited amount of tree clearing between October 1 and March 31, which is outside the bat active period, removal of unidentified maternity roost trees is unlikely to result in the incidental take of Indiana or northern long-eared bats. Further, the Service has identified certain incidental take of the northern long-eared bat resulting from tree removal as exempted from prohibition under the final 4(d) Rule of the Act (50 CFR 17).

TSI practices to be implemented across approximately 900 acres on Steamboat Island over the next ten years include thinning treatments, removal of non-desirable vegetation, and tree plantings. We anticipate thinning treatments, such as girdling, to benefit tree-roosting bats through the creation of increased snag habitat, canopy openings, and solar exposure. We further expect the removal of non-desirable vegetation within the understory to open up flight and foraging corridors to facilitate bat movement throughout the complex. The proposed tree plantings will consist of mast trees, including species which produce exfoliating bark, providing additional bat habitat as the trees mature. Additionally, proposed topographic diversity features include raising the ground elevation in areas currently dominated by low quality vegetation, such as the invasive reeds canary grass. Desirable tree species will be planted in these elevated areas, expanding upon existing forest habitat and increasing the quality, health, and resilience of the stand. Collectively, we expect these activities to result in positive, long-term benefits for potential roost tree production, foraging habitat, and habitat diversity. All tree thinning efforts will be completed outside of the bat maternity season, between October 1 and March 31, and any required herbicide treatments will be applied by a licensed applicator using state and federal standards, thus minimizing potential localized impacts.

For the reasons stated above, **we concur with your determination that the project may affect but is not likely to adversely affect** Indiana bats and northern long-eared bats.

Project features and activities resulting in disturbance to aquatic habitats include the mechanical dredging of dredge cuts for increased aquatic diversity sites and access channels. The TSP identifies approximately 510,692 cubic yards of proposed dredging. Additionally, the TSP proposes to restore acreage within the historic footprints at the head of Steamboat Island and the west southeast island that has been lost through erosion and inundation. Island footprint restoration and will include a combination of open water and bankline placement of dredged material and installation of approximately 504,380 cubic yards of stone protection to stabilize these sites and other areas of bankline erosion throughout the project area.

Freshwater mussel surveys were completed within the project area in 2018 and 2019. A combination of quantitative and qualitative sampling was conducted within most proposed project feature areas during the 2018 survey, with survey work confined to qualitative "spot" sampling within Grant Slough and the southeast islands. This effort identified six live Higgins eye pearlymussels between the Illinois bankline and the east southeast island. The east southeast island is located within the Cordova Higgins eye essential habitat area (EHA), spanning the Illinois bankline between approximate river miles 503-505.5. The District subsequently altered the project area boundaries to omit the east southeast island and areas within the EHA to minimize and avoid impacts to the Higgins eye pearlymussel.

A follow-up mussel survey was completed in 2019, to further assess the mussel resources within Grant Slough and surrounding the west southeast island. There were no federally listed mussel species identified as part of this effort. However, both survey efforts identified a species-rich assemblage of mussels within Grant Slough, with pockets of higher density areas. Together, these surveys will be used to inform the alignment of the access channel dredging within Grant Slough to avoid and minimize impacts to areas of higher mussel densities.

Further, the integration of rip rap, large woody debris, and a mixture of various sizes of river rock will provide suitable substrate and habitat features for freshwater mussel resources and their respective host fish. Collectively, we expect these features to increase the aquatic habitat structure and function within the project area.

For the reasons stated above, **we concur with your determination that the project may affect but is not likely to adversely affect** Higgins eye pearlymussels.

Two additional federally endangered mussel species are known to have ranges overlapping the project area, the sheepnose mussel (*Plethobasus cyphyus*) and the spectaclecase mussel (*Cumberlandia monodonta*). Historic surveys have found sheepnose within the Cordova EHA; however this species has not been identified in survey efforts since one fresh dead and one live individual were found in 2005 and 2006, respectively. Surveyors employed spectaclecase-specific survey methods where potentially suitable habitat was encountered during the 2018 and 2019 survey efforts within the project area; however, efforts resulted in the collection of no live specimens or shells.

The District made no effect determinations for the sheepnose mussel, spectaclecase mussel, eastern massasauga (*Sistrurus catenatus*), prairie bush clover (*Lespedeza leptostachya*), western prairie fringed orchid (*Platanthera praeclara*), eastern prairie fringed orchid (*Platanthera leucophaea*), and the Iowa Pleistocene snail (*Discus macclintocki*). The Illinois-Iowa Ecological Services Field Office has no regulatory or statutory authority for concurring with "no effect" determinations. However, we recommend you maintain a written record of your "no effect" determination and include it in your decision record. An example "no effect" memo can be found on our website at http://www.fws.gov/midwest/endangered/section7/s7process/letters.html.

Finally, the Service removed bald eagles from protection under the Act on August 8, 2007. However, they remain protected today under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act (Eagle Act). The Eagle Act prohibits take which is defined as, "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, or disturb" (50 CFR 22.3). We define disturb in regulations as, "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." An eagle nest has been known to exist within the project boundaries, at the head of Steamboat Island; however, it is suspected that the nest may have fallen as a result of flood impacts in 2019. The status of this nest should be confirmed prior to the onset of construction activities. Should potential disturbance to eagles or eagle nests be identified, consultation should be initiated.

This letter provides comments under the authority of and in accordance with provisions of 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. Should you modify the project or if new information indicates endangered species may be affected, consultation should be initiated. Thank you for the opportunity to provide comments. If you have any additional questions or concerns, please contact please contact Sara Schmuecker of my staff at [redacted]

Sincerely,

Kraig McPeek
Field Supervisor

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Upper Mississippi River National Wildlife and Fish Refuge
102 Walnut Street, Suite 204
Winona, Minnesota 55987

April 8, 2020

Julie Millhollin
Project Manager
U.S. Army Corps of Engineers
Rock Island District
Clock Tower Building, PO Box 2004
Rock Island, IL 61204-2004

Julie

Dear Ms. Millhollin:

The Upper Mississippi River National Wildlife and Fish Refuge (Refuge) has reviewed the draft Feasibility Report and Tentatively Selected Plan for the Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP) and provides the following statements in support of the project.

This project meets the goals and objectives of the Refuge. The Refuge was established by Congress in 1924 to provide a refuge and breeding ground for migratory birds, fish, other wildlife, and plants. There have been many changes in environmental conditions on the Upper Mississippi River since the Refuge was established that have resulted in substantial ecosystem degradation. Steamboat Island represents a key location found in Pool 14 to restore degraded environmental conditions within the backwater and floodplain forest habitats that will benefit migratory birds, fish, other wildlife, and plants.

The Steamboat Island HREP will benefit a large area of Pool 14. This is especially important because Pool 14 begins the transition of the Upper Mississippi River ecosystem, and Steamboat Island is a key element of environmental integrity before the transition. As you proceed downriver from Steamboat Island, the river abruptly changes to a narrow channel with relatively fast flowing current. Downriver shoreline areas are in private and commercial ownership with high demand for residential, industrial and community development.

The existence of numerous backwater lakes and extensive flowing side channels within and around Steamboat Island provides an excellent opportunity to restore favorable habitats for fish and wildlife within this forested floodplain ecosystem. Steamboat Island, Grant Slough and the adjacent Wapsipinicon River bottoms make up a large footprint on the Upper Mississippi River, and its extensive acreage of both land and water provides a unique opportunity to restore a relatively large ecosystem in a section of river that is greatly degraded.

The project will increase aquatic diversity and provide important environmental benefits for many species of fish and wildlife. The deepening of backwater lakes will improve water quality, increase oxygen content, and provide optimum habitat for a variety of aquatic species. It will also provide year-round fish habitat, but more importantly will restore overwintering habitat that is currently nearly non-existent within the Steamboat Island complex and adjacent project areas in Pool 14. The dredged material from the aquatic areas will be used beneficially to increase island elevations.

Increasing island elevations will complement the areas of existing floodplain forest, while minimizing impacts to threatened, endangered, and protected species. Currently, most of the amphibians and reptiles that inhabit Steamboat Island are flooded out during annually re-occurring high water events. High water events that cover the island are occurring more often and for longer periods, often extending throughout the summer. The proposed elevated island areas will provide a land sanctuary and allow for the seasonal survival of many species of reptiles and amphibians.

Improving forest diversity and quality is an important part of this HREP project. Throughout the project footprint a mixture of forest quality can be found, with higher elevations having a greater species diversity and overall forest health. However, lower elevations suffer in both diversity and health and have been subject to longer inundation periods over the last decade. Raising the elevation by a few feet will allow the planting of floodplain tolerant hardwood trees and provide additional forest habitat acres. In addition, wetland shrubs are to be inter-planted within the trees. Timber stand improvement to include selective tree harvest, crop tree release and girdling will occur in other low diversity forest areas where excavated material will not be placed. The increased tree diversity will provide additional long-term benefits to migratory birds and federally-listed bat species, furthering the mission of the USFWS.

The placement of a grade control structure within the Steamboat Island's cut-through channel, in an effort to deflect sediment and reduce silt laden flows from entering the lower lakes of Steamboat Island, will provide optimum protection for the longevity of the Steamboat Island HREP project. Water flows entering the lower lakes are the primary source of sedimentation from the nearby confluence of the Wapsipinicon River. A river training structure to eliminate this primary source of silt is a critical component of the project. Additional protection along the NE bank line will also ensure that existing and restored habitat throughout the upper lakes will be self-sustaining.

The project includes bank line protection for the island head and the NE bank of Steamboat Island. It also includes the restoration of a small island adjacent to the main island. The small SE island has been subject to extensive erosion and has lost the majority of its historical footprint. Restoration of the island will provide flow diversity within the area and has the potential to support habitat for the Federally Endangered Higgins eye pearly mussel. Restoration of the island head and NE bank line provide an essential barrier that will protect Steamboat Island from wind and wave action, especially from passing towboats and recreational boaters. Erosion at the head of Steamboat Island and along its east shoreline is substantial. Stabilization of the island will prevent future shoreline erosion and will provide long term protection to Steamboat Island and its interior habitat.

In summary, the Refuge supports the Steamboat Island HREP project and considers it to be another important habitat restoration and enhancement project that can be completed in Pool 14. The island's large size, extensive forestry component, numerous backwater lakes, and flowing side channels make it a vital HREP project.

We appreciate our continued partnership with the Corps and state agencies on the Steamboat Island project and the Upper Mississippi River Restoration program. Should you have questions regarding this letter, please contact Mr. Ed Britton, Savanna District Manager, at [redacted] or Ms. Sharonne Baylor, Environmental Engineer, at [redacted]

Sincerely,

Sabrina Chandler

Sabrina Chandler
Refuge Manager

cc: Ed Britton, Upper Mississippi River NW&FR
Nate Williams, Upper Mississippi River NW&FR
Kraig McPeek, Illinois-Iowa Field Office
Sara Schmuecker, Illinois-Iowa Field Office
Stephen Winter, Upper Mississippi River NW&FR
Sharonne Baylor, Upper Mississippi River NW&FR
Kirk Hansen, Iowa Department of Natural Resources

Julie Millhollin
Project Manager
U. S. Army Corps of Engineers
Rock Island District
Clock Tower BLDG. PO Box 2004
Rock Island IL 61204-2004

April 9, 2020

Dear Mrs. Millhollin:

This will serve as the letter of support from the Iowa Department of Natural Resources (DNR) for the Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP) under the Upper Mississippi River Restoration (UMRR) program. The Iowa DNR fully concurs with the draft feasibility report and the Tentatively Selected Plan (TSP). My staff has been intricately involved with the planning of this critical HREP. The TSP is expensive but provides the critical habitat needed to accomplish the goals of the project. The Steamboat Island Project includes measures to improve bottomland hardwood forest coverage and diversity, increase acreage of backwater overwintering habitat, restore lost island acreage and protect them from future erosion, reduce sedimentation in off-channel backwaters and wetlands, and restore scrub-shrub/pollinator habitat within Steamboat Island, Grant Slough, and the Wapsipinicon River Delta in Pool 14.

The forest community of the Upper Mississippi River (UMR) changed considerably following water level increases caused by impoundment of the river for the 9-foot navigation project in the 1930's. Currently, the islands of the UMR are dominated by Silver Maple and Cottonwood. These soft mast trees are important to the islands of the Mississippi because they provide nesting sites for many species of birds, including bald eagles, colony nesting birds, cavity nesting birds and migratory neo-tropical passerines. These soft mast trees have colonized many of the islands on the Mississippi River, but are not long lived. Most stands are relatively even aged and near the end of their life span, and there has been little regeneration on these low areas on the River. This HREP will provide large areas for a diversity of bottomland hardwood forest and scrub-shrub/pollinator species, which directly benefit migratory and resident wildlife species. Providing higher areas to enhance forest diversity, along with proposed Timber Stand Improvement prescriptions, will encourage and promote a sustainable, healthy and resilient forest for many years to come.

Off-channel, overwintering habitat is critical to maintaining the health and resiliency of the fisheries community of the UMR. Over time, the quantity and quality of this habitat has declined due to sedimentation and island dissection. This HREP will restore this critically important habitat within Steamboat Island where it has been all but lost. Additionally, protection of the NE bank of Steamboat Island and the grade control structure in the cut-through channel are critical for reducing sediment delivery and ensuring project longevity.

Islands are critical for maintaining the mosaic of diverse habitats within the UMR. Steamboat Island and the SE Islands near Cordova have lost over 150 acres to erosion since construction of Lock and Dam 14. Erosion and dissection of islands cause degradation of interior wetlands and backwaters by accelerating sedimentation and increasing velocities. This HREP will restore island acreage to preserve and enhance the structure and function of Steamboat and the West Southeast Island.

The Iowa DNR is very supportive and proud to be a non-federal partner of the Steamboat Island HREP. We look forward to the timely completion of this environmental restoration project. We are fully committed to the partnership developed under UMRR and pledge to help with project execution and evaluation. Fish and wildlife along the Mississippi River will benefit immensely from this project.

Sincerely,

Kayla Lyon

Kayla Lyon
Director, Iowa Department of Natural Resources

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, ROCK ISLAND DISTRICT
PO BOX 2004 CLOCK TOWER BUILDING
ROCK ISLAND, ILLINOIS 61204-2004

May 6, 2020

Regional Planning and Environmental
Division North (RPEDN)

SUBJECT: Steamboat Island Habitat Rehabilitation and Enhancement Project, Clinton and Scott Counties, Iowa

Review and Compliance Coordinator
State Historic Preservation Office
600 East Locust
Des Moines, Iowa 50319-0290

The U.S. Army Corps of Engineers, Rock Island District (District), proposes the Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP) (Project) including U.S. Fish and Wildlife Service and District fee title lands in Clinton and Scott Counties, Iowa, and in Rock Island County, Illinois (SHPO R&C #180382050). The Project is partially located within the Upper Mississippi River National Wildlife and Fish Refuge (NWFR), in Pool 14, between river miles 502.5 and 508.0 (see Figure O-A-1 within Enclosure 1).

The Project details are briefly outlined below. The identification and evaluation of historic properties and determinations of effect will not be completed prior to the completion of the environmental assessment needed for compliance with the National Environmental Policy Act (NEPA), making the execution of a Programmatic Agreement (PA) for this Project an appropriate course of action, pursuant to 36 CFR 800.14(b)(1)(ii). The District greatly values your participation and input, inviting your agency to review and comment on the second draft of the PA as per 36 CFR 800.14(b)(1)(ii) (Enclosure 1).

The Project goals are to maintain, enhance, and restore quality habitat for desirable native plant, animal, and fish species and maintain, enhance, restore, and emulate natural river processes, structures, and functions for a resilient and sustainable ecosystem. These goals will be accomplished through a variety of actions including (see Figures O-A-2 and O-A-3 within Enclosure 1):

- Restoring <u>topographic diversity</u> in portions of the Project area by increasing existing elevations and planting trees, shrubs, understory plants, and buffer species, as well as implementing <u>timber stand improvement</u> (TSI) measures, to address the Project objective of enhancing and restoring areal coverage and diversity of forest stands and habitat and increase diversity of bottomland hardwood forest. Where possible, topographic diversity features were developed adjacent to dredging locales to allow for side cast of materials directly onto the placement site.

- Increasing aquatic diversity in the Project area backwaters, specifically in Steamboat Island Upper Lake, Steamboat Island Lower Lake, and NW Grant Slough Lake, by excavation, which will address the Project objective of increasing year-round aquatic habitat. Where appropriate, additional fish and mussel habitat may be incorporated to bring further benefit to the species that use the Project area.

- Restoring and protecting island acreage on portions of Steamboat Island proper and the whole West SE Island by placing stone protection and dredged material, then planting with trees, to address the Project objective of restoring island acreage and protecting from erosion within the Project area.

- Placing protection measures at the NE Bank and the northwest end of the Cut-Through Channel of Steamboat Island and restoring shrub-scrub pollinator habitat in the Project area, to address the Project objective of protecting existing backwater.

Project access will be by water via public access boat ramps. One land-based access area is proposed for access to two topographic diversity locations within Grant Slough (see Figure O-A-3 within Enclosure 1). If additional land-based staging or access locations are needed, additional coordination will be carried out separately, as per the PA. Timber stand improvement activities include tree cutting (cut and left in place), tree planting (excavation up to 18 inches in depth), and limited tree removal (including root removal with ground disturbance up to 3 ft in depth). Timber stand improvement plans have not yet been finalized and therefore, those determinations of effect will be coordinated separately as well, under the stipulations of the PA.

Federal Undertaking

Pursuant to the National Historic Preservation Act (NHPA) of 1966, as amended, and its implementing regulations, 36 CFR Part 800, the District has determined that work at Steamboat Island has potential to cause effects to a historic property [36 CFR 800.3(a)(1)] and as a consequence will require a determination of effect within the Area of Potential Effect (APE).

Area of Potential Effect

The Project is located in T80N, R5E, Sections 11, 12, 13, 14, in Clinton County, Iowa, T80N, R5E, Sections 23, 24, 25, 35, 36, in Scott County, Iowa, T79N, R5E, Sections 1 and 2, Scott County, Iowa, and in T20N, R1E, Sections 25, 30, 36 in Rock Island County, Illinois. All Project lands are in Federal ownership by the District and the U.S. Fish and Wildlife Service (USFWS), and are managed via cooperative agreement between both parties as part of the Upper Mississippi River National Wildlife and Fish Refuge (NWFR). The Project and area of potential effect (APE) encompasses 2,627 acres of interconnected backwaters, secondary channels, wetlands, and islands (see Figure O-A-2 within Enclosure 1). Approximately 1,820 acres of the Project area is terrestrial, with the remaining acreage permanently or seasonally inundated. The APE boundaries may be refined as the project progresses. The majority of the APE resides in Iowa, including Steamboat Island and land immediately adjacent to the west of the slough. The Illinois APE includes only a small island to the southeast of Steamboat Island.

The vertical APE (ground surface and below) varies depending on Project measure. Table 1 lists Project measures, associated actions and potential impacts, and identifies the maximum depth of the APE in those locations. The slough west of Steamboat Island and backwater channels within the island have been identified on historic maps dating to the 1930s. Mechanical dredging within the backwater channel and slough locations are removing only recent sediment accumulation within these existing natural backwater and slough areas. Maximum dredging depth below flat water pool level will be 10 feet (3 m), with an average depth of 6 to 8 feet (1.8 to 2.4 m). Tree removal activities hold the deepest land-based impacts with an APE extending 3 feet (0.9 m) below surface. These impacts are limited to the 1.3 acre Temporary Tree Clearing area proposed for access to topographic diversity placement locations (see Figure O-A-3 in Enclosure 1). The remaining Project measure impacts are no greater than 1 to 2 feet (0.3 to 0.6 m) below surface (Table 1).

Consulting Parties

The District finds the organizations identified on the Distribution List are entitled to be consulting parties, as set out in 36 CFR 800.2, and invites them by copy of this letter to participate in the Section 106 process. The District invites the consulting parties to:

- identify any other consulting parties as per 36 CFR 800.3(f);
- comment as per 36 CFR 800.2(d)(3) on the District' plan to involve the public by utilizing the District' normal procedures for public involvement under the National Environmental Policy Act (NEPA); and,
- comment on or contribute to identification efforts including definition of the APE, all as per 36 CFR 800.4(a-b).

Previous Investigations and Historic Properties Identification

Examining an area's mapped Landform Sediment Assemblages (LSA) assists in understanding prehistoric archeological potential, as documented in the 1996 report entitled, *Landform Sediment Assemblage (LSA) Units in the Upper Mississippi River Valley, United States Army Corps of Engineers, Rock Island District*, by E. Arthur Bettis III, Jeffrey D. Anderson, and James S. Oliver of Cresco, Iowa's, Bear Creek Archaeology (BCA), Inc. Mapped Project LSAs are Island, Early to Middle Holocene Channel Belt, and Tributary Fan (Enclosure 2). A large portion of the HREP is shown as underwater or seasonally inundated on 1930s plane table (USACE acquisition) maps; those areas have no or extremely low potential to contain significant near-surface cultural resources.

Three prior archeological surveys overlap with small portions of the Project (Enclosure 3). The 1985 report entitled *Phase I Cultural Resources Survey: Archaeological and Geomorphic Reconnaissance at the Proposed Pipeline Crossing of the Northern Plains Natural Gas Company, Mississippi River Navigation Pool 14*, by Jeffrey D. Anderson and David F. Overstreet of Brice, Petrides, Donahue, documents survey of a pipeline proposed north of Steamboat Island proper. The limited excavations associated with the 1985 work do not conform to modern archeological fieldwork standards as provided in the Secretary of the Interior's Standards and Guidelines for Identification and Evaluation (48 FR 44720-23). The authors note that two cores excavated on the Tributary Fan west of the north tip of the island contained historic alluvium over 2.9-m thick.

The 1989 report entitled *Archaeology, Geomorphology and Historic Surveys in Pools 13-14, Upper Mississippi River, Volume I: An Overview and Intensive Sample Survey of the Geomorphology and Cultural Resources of Mississippi River Pools 13 & 14*, by David W. Benn, Jeffrey D. Anderson, Robert C. Vogel, and Lawrence Conrad primarily documented the area's geomorphology.

At the northwest corner of the Project, the 1996 report entitled *Phase I Intensive Archaeological Survey and Geomorphological Investigation for Historic Properties, Rock Creek Marina and Campground, Clinton County Conservation Board, Clinton County, Iowa*, by BCA's David G. Stanley assessed the possible impacts of marina and campground's improvements. The author found that prehistoric archeological potential is high within the upper 1.5 m of the Early to Middle Holocene soil column there.

The District reviewed the report, *An Investigation of Submerged Historic Properties in the Upper Mississippi River and Illinois Waterway* (October 1997), prepared by American Resources Group, Ltd. (Contract No. DACW25-93-D-0012, Delivery Order No. 37). No underwater historic properties are documented between RM 502 and 509.

A query of the Iowa Site File (ISF) Geographic Information System (GIS) archeological file database revealed three previously recorded terrestrial sites within the Steamboat Island HREP boundaries (Enclosure 3). Archeologist Charles R. Keyes noted a possible historic Sauk or Meskwaki village at the mouth of the Wapsipinicon River. Designated site 13CN36, this village appears in the ISF GIS database as an upward-facing triangle, meaning both the site's location and boundaries are uncertain. Site 13CN59 is a historic Euro-American scatter recorded in the Iowa Site File GIS database as a downward-facing triangle, meaning the site's location is known, but its boundaries are uncertain. These two sites are discussed in a 1989 Benn et al. report; this report recommended site 13CN59 be preserved. The site 13CN36 recommendation called for subsurface testing to pinpoint the definite site location.

The final previously recorded site, isolated prehistoric find 13CN78, is documented in Stanley's 1996 report, where he mentions finding two pieces of flaking debris, one each found in the upper 10 cm of two shovel tests. Stanley recommended the site ineligible for National Register of Historic Places (NRHP) listing. The Iowa State Historic Preservation Office (SHPO) Database of Section 106 Review and Compliance Decisions for specific sites (accessible through the ISF GIS database) notes that, on 17 May 1996, the SHPO determined the site ineligible for NRHP listing.

Additionally, a review of the 1930s Corps land acquisition/topographic maps reveals a variety of buildings and structures once stood within the Project area. These include fences, a log race related to timber harvests, a bridge, a pump, a small "stone dam," the side channel closing dam (labeled "stone retarding dam"), and several small buildings which likely functioned as hunting or fishing cabins. These structures are currently unevaluated.

Present and Proposed Courses of Action

Geomorphological and cultural evaluations of the Area of Potential Effect (APE) have been delayed due to excessive and prolonged high water and flooding of the project area. Since 2017, the majority of the APE has been inundated. Once the pool level allows access, work described in the stipulations of the PA will be completed and cultural and geomorphological assessments will be conducted. The geomorphological assessments of the APE will aid in directing cultural work. Areas with potential for cultural resource deposits within the APE, as determined by the geomorphological assessment, will be subject to further cultural investigation. Cultural resources identified within the APE will be assessed for integrity and significance in accordance with the PA. Avoidance measures will be implemented where possible.

This PA will be included as *Appendix O* of the final District authored National Environmental Policy Act (NEPA) document entitled *Upper Mississippi River Restoration Feasibility Report with Integrated Environmental Assessment* as per 36 CFR 800.8. The draft EA will be available for public review. Evidence of this PA will be included in the draft EA. The PA is necessary as the District needs to complete the NEPA process, but cultural work has not been completed due to lack of access.

Determination of Effect

HREP standards are to avoid historic properties within the APE when possible. If historic properties cannot be avoided and will be impacted by Project actions, additional coordination will be conducted in accordance with the PA. As dredging will take place to remove recent sediment within long-standing backwater channels and slough areas, work performed in these locations will have ***no effect on historic properties***. Tree cutting activities involve no ground disturbance and therefore have ***no potential to effect historic properties***.

Pending results of geomorphological investigation, is it expected that topographic diversity (material placement, shaping, and subsequent planting), island restoration and protection (material placement), and stone placement activities have low potential to impact near-surface historic properties.

Request for Comment from Consulting Parties

The Corps identified you as a consulting party for this undertaking (36 CFR 800.2) and invites your participation in the Section 106 process. The District is seeking information from all consulting parties regarding their concerns with issues relating to the potential effects of this undertaking on historic properties. The Distribution List (Enclosure 4) reflects the parties that received this mailing.

The District requests your written comments or concurrence on this project within 30 days, pursuant to 36 CFR 800.3(c)(4). Please provide the District with a letter and/or email with comments within 30 days of receipt of this letter.

The District's point of contact for this action is Ms. Christine Nycz of our Environmental Compliance Branch at [redacted], by e-mail: [redacted], or in writing to our address, ATTN: Environmental Compliance Branch (Christine Nycz).

Sincerely,

Jodi Creswell

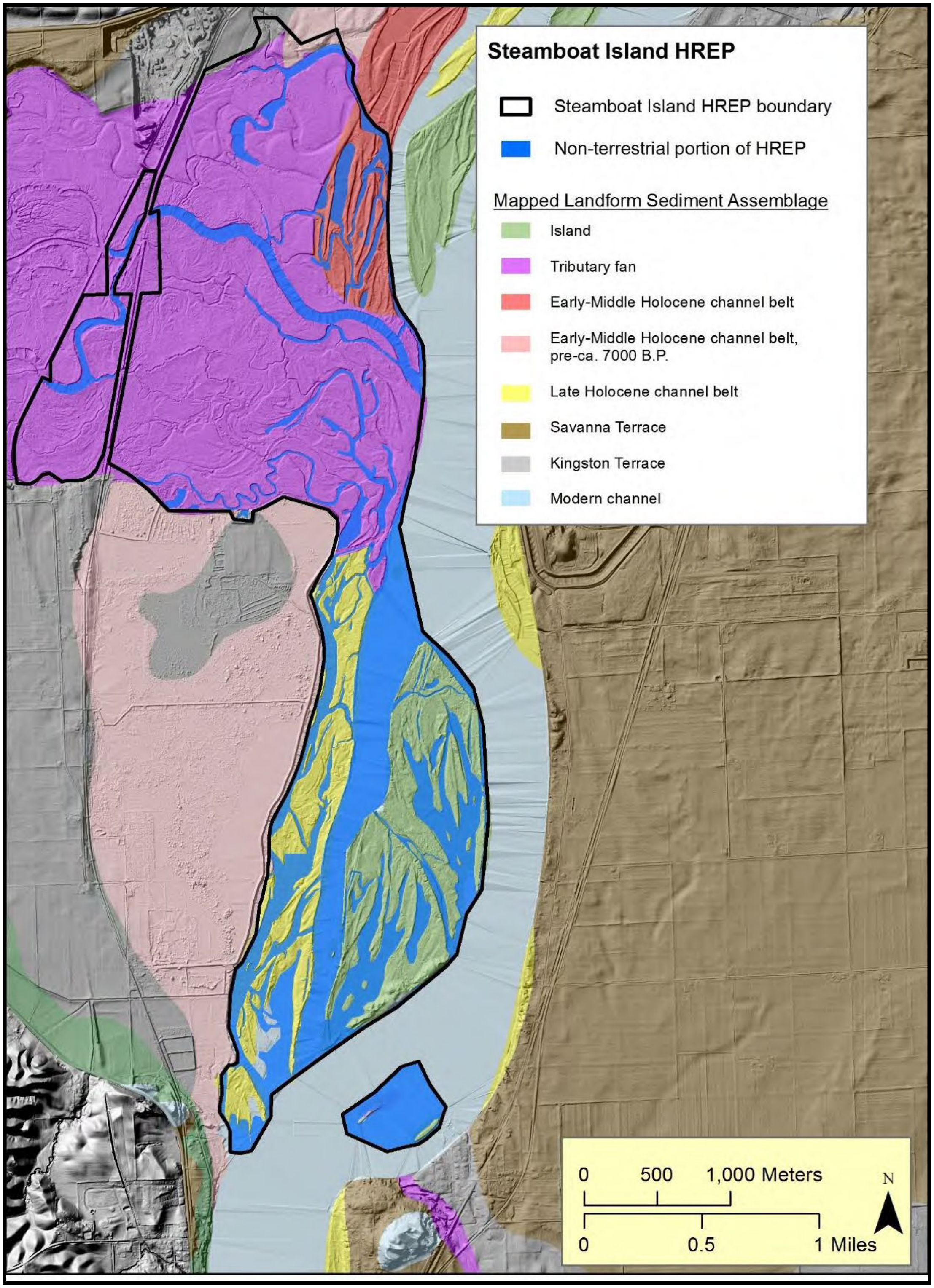
Digitally signed by CRESWELL.JODI.K.[redacted]
Date: 2020.05.06 13:19:37 -05'00'

Jodi Creswell
Chief, Environmental Planning
Branch (RPEDN)

Enclosures (4)

Table 1. Outline of Project Measures Having the Potential to Impact Cultural Resources and Associated APE

Project Measure	Action	Potential Impact	Vertical APE	Impact Level
Aquatic Diversity Dredging	Mechanical dredging	Dredging of materials within natural backwater area, maximum 10 feet below flat pool elevation	Recent sediment, maximum 10 ft (3 m); average 6-8 ft (1.8-2.4 m) below flat pool elevation	Low
Temporary Access in Grant Slough	Tree clearing 1.3 acres; heavy machinery	Maximum depth of disturbance is 3 feet	3 ft (0.9 m) below surface	Moderate-to-High
Topographic Diversity Measures – Forest Habitat	Placing dredge material	Grading top 1-2 inches prior to dredge material placement; seeding/planting	1 ft (0.3 m) below surface	Low
Timber Stand Improvement	Tree thinning and planting (specific acreages and locations for this action are yet to be determined)	Most holes for planting will be 18 inches in depth, with maximum depth of disturbance is 3 feet due to root growth; tree cutting will leave fallen tree in place, use of skid steer to remove trees on east side of Steamboat Island only	3 ft (0.9 m) below surface	Moderate-to-High
Island Restoration and Protection	Dredge material and stone placement on submerged island to restore historic footprint; tree planting	Material placement and tree planting	1-2 ft (0.3-0.6 m) below surface	Low
Topographic Diversity Measures - Scrub-Shrub/Pollinator	Dredge material placement, planting	Grading top 1-2 inches prior to dredge material placement; seeding/planting	1 ft (0.3 m) below surface	Low
Stone Placement	Stone placement	Placement of stone on dredge material	1 ft (0.3 m) below surface	Low



Enclosure 2. Project Area with overlapping LiDAR imagery and mapped Landform Sediment Assemblages.

Enclosure 4: Distribution List

Ms. Dyan Youpee, THPO
Fort Peck Assiniboine and Sioux Tribes
P.O. Box 1027
Poplar, MT 59255

Mr. Lance Foster, THPO
Iowa Tribe of Kansas and Nebraska
3345 B. Thrasher Rd.
White Cloud, KS 66097

Ms. Diane Hunter, THPO
Miami Tribe of Oklahoma
P.O. Box 1326
Miami, OK 74355

Mr. Nicholas Mauro, THPO
Ponca Tribe of Nebraska
P.O. Box 288
Niobrara, NE 68760

Mr. Ben Rhodd, THPO
Rosebud Sioux Tribe
P.O. Box 809
Rosebud, SD 57570

Mr. Johnathan Buffalo, Director Historic Preservation
Sac and Fox Tribe of the Mississippi in Iowa
303 Meskwaki Rd.
Tama, IA 52339-9629

Ms. Kelly Schott, Environmental Branch Coordinator
Sac and Fox Tribe of the Mississippi in Iowa
303 Meskwaki Rd.
Tama, IA 52339-9629

Mr. Dan Higginbottom, Archaeologist
Compliance and Review
Iowa State Historic Preservation Office
600 East Locust
Des Moines, IA 50319-0290

Mr. James Myster, Regional Archaeologist/RHPO
U.S. Fish and Wildlife Service
5600 American Blvd. W Ste. 1049
Bloomington, MN 55437

Mr. Ed Britton, Wildlife Refuge Manager
U.S. Fish and Wildlife Service
Savanna District Upper Mississippi River National Wildlife and Fish Refuge
7071 Riverview Rd.
Thomson, IL 61285

Enclosure 4: Distribution List

Dr. John Doershuk, Archaeologist
Office of the State Archaeologist
700 South Clinton St.
The University of Iowa
Iowa City, IA 52242

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, MISSISSIPPI VALLEY DIVISION
P.O. BOX 80
VICKSBURG, MISSISSIPPI 39181-0080

CEMVD-PDP 20 May 2020

MEMORANDUM FOR Commander, Rock Island District, U.S. Army Corps of Engineers (Attn: Ms. Camie Knollenberg, CEMVP-PD-F)

SUBJECT: Approval for Single Use – Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Functions of Forested Wetlands in the Delta Region of Arkansas, Version 2.0 (AR Delta HGM) for the Upper Mississippi River Restoration Program (UMRR Program) Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP)

1. References:
   a. Engineer Circular 1105-2-412: Assuring Quality of Planning Models, 31 Mar 2011.

   b. US Army Corps of Engineers. Assuring Quality of Planning Models – Model Certification/Approval Process: Standard Operating Procedures. Feb 2012.

   c. Memorandum to Directors of National Planning Centers of Expertise – SUBJECT: Modification of the Model Certification Process and Delegation of Model Approval for Use, 04 Dec 2017.

   d. Memorandum from the Director of Civil Works to MSC Commanders – SUBJECT: Delegation of Model Certification, 11 May 2018.

   e. Memorandum to Director of the National Ecosystem Restoration Planning Center of Expertise - SUBJECT: Recommend Single Use Approval of the Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Functions of Forested Wetlands in the Delta Region of Arkansas, Version 2.0 (AR Delta HGM) for the Upper Mississippi River Restoration Program (UMRR Program) Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP), 15 May 2020.

2. An independent review conducted by the National Ecosystem Restoration Planning Center of Expertise evaluated the subject model for use in the Steamboat Island HREP. The model and application thereof was found to be technically sound, computationally correct, and usable for Civil Works planning, and policy compliant using appropriate functional assessment procedures.

3. The AR Delta HGM is approved for single use for application in the study. The model meets the criteria in References 1.a. and 1.b. There are no unresolved issues.

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Gary L. Young
Chief, MVD Planning and Policy and Director,
National Ecosystem Restoration Planning
Center of Expertise

SUBJECT: Approval for Single Use – Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Functions of Forested Wetlands in the Delta Region of Arkansas, Version 2.0 (AR Delta HGM) for the Upper Mississippi River Restoration Program (UMRR Program) Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP)

CF
CEMVD-PDP (Lawton, Mallard, Miller, Mickal)
CEMVP-PD-C (Johnson)
CEMVP-PD-F (Knollenberg, Perrine, Richards, Sparks)
CEMVP-PD-P (Cornish, Creswell, McCain, Michl, Runyon)
CEMVR-PM (Millholin, Plumley)

United States Department of the Interior

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IN REPLY REFER TO:
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June 22, 2020

Colonel Steven M. Sattinger
District Engineer
U.S. Army Corps of Engineers
Rock Island District
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Sattinger:

This letter constitutes our final Fish and Wildlife Coordination Act Report (FWCAR) for the Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP) and is intended to provide compliance with Subsection 2(b) of the Fish and Wildlife Coordination Act, (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.); Section 7 of the Endangered Species Act of 1973, as amended; the National Environmental Policy Act; and the Migratory Bird Treaty Act (40 Stat, 755, as amended; 16 U.S.C. 703 et seq. The Steamboat Island HREP is a component of the Upper Mississippi River Restoration (UMRR) Program authorized by Section 1103 of the Water Resources Development Act (WRDA) of 1986. The interagency planning team designed the Steamboat Island HREP to further the mission of the UMRR Program: “To work within a partnership among federal and state agencies and other organizations; to construct high-performing habitat restoration, rehabilitation projects; to produce state-of-the-art knowledge through monitoring, research, and assessment; and to engage other organizations to accomplish the UMRR Program’s vision.”

The Steamboat Island HREP is located in Pool 14 of the Upper Mississippi River (UMR), river miles (RM) 502.5 through 508.0, Clinton and Scott Counties, Iowa, and Rock Island County, Illinois. The U.S. Fish and Wildlife Service (USFWS) is the Sponsor for the Steamboat Island HREP. All project lands are owned by the USFWS and the U.S. Army Corps of Engineers, Rock Island District (District), and are managed as part of the USFWS’ UMR National Wildlife and Fish Refuge (NWFR) through a cooperative agreement between the USFWS and the District.

STATE AGENCY COORDINATION

The USFWS prepared this letter in cooperation with the Iowa Department of Natural Resources (IADNR) and the Illinois Department of Natural Resources (ILDNR), with coordinated comments and recommendations presented regarding the construction of the Steamboat Island HREP. Significant coordination between the USFWS, IADNR, ILDNR, and District resulted in a thoroughly reviewed and critiqued project with design providing optimum benefits to fish and wildlife resources, while protecting and enhancing unique and diverse resources within the project boundaries. The significant interagency coordination throughout the planning process demonstrates the ecological value of this project towards maintaining and restoring habitat quality, diversity, and resilience within the Steamboat Island complex and the larger UMR system.

PREVIOUS REPORTS AND STUDIES

Refer to Section I(F) of the UMRR draft Feasibility Report with Integrated Environmental Assessment for the Steamboat Island HREP (draft Feasibility Report hereafter), dated April 2020, for a full discussion of prior studies, reports, and existing water projects applicable to the Steamboat Island HREP.

DESCRIPTION OF THE PROJECT AREA

Pool 14 is the 29.2-mile segment of the UMR extending upstream from Lock and Dam 14 (RM 493.3) at Pleasant Valley, Iowa, to Lock and Dam 13 (RM 522.5) at Fulton, Illinois. Numerous islands and backwater complexes are scattered throughout the upper portion of the pool. Beginning immediately downstream of the Steamboat Island HREP, the river becomes constricted and lacks off-channel habitats as it enters an area formerly (pre-navigation) characterized by the Rock Island rapids within the Fulton-Rock Island gorge (IADNR 2020). The Pool 14 floodplain is natural, without levees, with the exception of the northern one-third of the Pool. Sections of levees extend downstream of Lock and Dam 13 from approximate RM 510.0 to 522.5, bordering Fulton, Illinois, and Clinton, Iowa, in addition to a small approximately two mile-long segment bordering Albany, Illinois (USACE and FEMA 2020). The majority of the riparian environment within Pool 14 consists of agricultural, residential, urban, and industrial development with interspersed undeveloped areas. The largest tributary to the Pool is the Wapsipinicon River (Iowa), which enters the Pool immediately upstream of Steamboat Island, within the project area at approximate RM 506.8. Additional smaller tributary streams enter the Pool from both Iowa and Illinois.

The USFWS owns the majority of public lands within the Pool 14 floodplain and manages these areas as part of the UMR NWFR, Savanna District. Additional lands are held by the District under the Nine-Foot Navigation Project and the State of Iowa. The Princeton Refuge HREP is located within the State of Iowa’s Princeton Wildlife Management Area, downstream from the Wapsipinicon River confluence and adjacent to the Steamboat Island HREP (RM 504.0R through 506.5R). The Princeton Refuge HREP was completed in 1995 under the UMRR Program and continues to be managed by the IADNR. The Beaver Island HREP, managed by the UMR NWFR, Savanna District, is located approximately eight river miles upstream of the

Steamboat Island HREP, and is currently under construction.

A distinguishing feature of Pool 14 is the presence of the Exelon Generation Co. nuclear plant (Exelon) located in Cordova, Illinois, directly across the channel from the Wapsipinicon River confluence (RM 506.5). Exelon operates under a Section 10(a)(1)(B) incidental take permit for the federally endangered Higgins eye pearlymussel (*Lamsilis higginsii*) and sheepnose mussel (*Plethobasus cyphyus*), due to the generation of a thermal plume discharge into the UMR at RM 506.4. Increased thermal conditions have been documented to impact the reproduction, feeding, growth, and burrowing behavior of freshwater mussels; therefore, as part of the Habitat Conservation Plan and incidental take permit, freshwater mussel monitoring has been conducted throughout the pool over multiple years (Exelon Generation 2009). One of the monitoring sites is located at the upper end of Steamboat Slough (RM 505.5), within the Project area. This monitoring site is the closest downstream site to the warm water effluent mixing zone. The dominate species within this bed are within the Ambleminae subfamily, a group of mussels known to have a somewhat higher thermal tolerance comparatively; however, individuals of Higgins eye pearlymussel have been found within the lower portion of the bed on occasion (Exelon Generation 2009). Monitoring of the Steamboat Slough bed did not begin until several years following the onset of thermal discharge; however, the bed has maintained species richness and densities throughout the long-term monitoring period, indicating the effects of the Exelon warm water discharge are unlikely to significantly influence the project area (Exelon Generation 2009).

Human activity over the past two centuries within the UMR and its floodplain, including the construction of the lock and dam system, has contributed to the alteration of the hydrology and topography historically present (USACE 2012). Such conditions have adversely impacted the biological resources of the river through reduction of habitat diversity, structure, and resilience. Specific to the Steamboat Island area, the construction of Lock and Dam 13 and Lock and Dam 14 in 1939, and other anthropogenic influences have resulted in altered flood regimes, including higher flood pulses and the reduction of historically common low flow periods. Furthermore, navigation infrastructure and floodplain development have collectively resulted in increased water levels, flow, sedimentation, and erosion leading to reduced diversity, quality, and acreage of aquatic habitat, native floodplain forest, and ephemeral wetlands through succession.

The altered channel and flow velocities have led to the erosion and loss of islands throughout Pool 14. Since the construction of Lock and Dams 13 and 14, Steamboat Island proper has been reduced by more than 80 acres, with an average of 0.3 acres of loss per year over the past 65 years (USACE 2020). Similar conditions have been experienced at other islands throughout the Pool. “Since the start of this study in 2017, visual observations have confirmed active erosion at Steamboat Island proper and the Southeast Islands, including trees falling off banks into the river as a result of erosion and bank undercutting” (USACE 2020). The continued loss of island acreage results in increased open water and wind fetch conditions. Wind fetch-generated wave action further erodes away banklines, exposing and deteriorating habitats such as interior wetlands and backwater overwintering areas. Further, island erosion results in loss of aquatic habitat structure and flow diversity important for mussel resources.

As banklines erode, islands become dissected, allowing flow and sediment to enter the previously protected interior backwater and wetland habitats, reducing the quantity and quality of these limited habitat types and the biota that depend on them. Sedimentation has prevented access to and connectivity between many backwater areas, further reducing their functionality. These types of backwater areas provide habitat for multiple life-stages of various fish species, but are particularly ideal over-wintering habitat for certain fishes, including centrarchid species. Interior wetlands are an important habitat for a wide variety of wildlife, including birds, waterfowl, pollinators, amphibians, and reptiles. As sediment and flows enter wetlands, desirable scrub-shrub and pollinator vegetation is often replaced by less desirable herbaceous plant species, such as reed canary grass (*Phalaris arundinacea*).

Further, the altered flood pulse has resulted in year-round flooding of floodplain forests adjacent to the navigation channel, supporting the proliferation of flood-tolerant tree species, such as silver maple (*Acer saccharinum*), and invasive herbaceous plants, such as reed canary grass. Such conditions result in a loss of flood intolerant hardwood mast tree species diversity and recruitment, with a migration towards a monotypic forest. Consequently, a loss of nut producing hardwood trees has been observed, which are a critical food source for many species of floodplain wildlife. As degradation of the quality and quantity of aquatic and floodplain habitats within the project area and UMR system continues, the Steamboat Island HREP offers an opportunity to preserve, restore, and protect the diverse habitats present within the Steamboat Island complex and to provide long-term benefits to the biota dependent on them.

As provided in Section I(A) of the draft Feasibility Report, areas included within the Steamboat Island HREP include, Steamboat Island, Steamboat Slough, the adjacent secondary channel Grant Slough complex, a small island in the southeast portion of the project area (West Southeast Island), and the forested areas north and south of the Wapsipinicon River confluence. The Steamboat Island complex contains approximately 2,013 acres of floodplain habitat, with this acreage including approximately 1,674 acres of floodplain forest habitat, 292 acres of emergent wetland habitat, and 47 acres of predominantly scrub-shrub/pollinator habitat (USACE 2020). Additionally, the project area includes approximately 614 acres of lotic and lentic aquatic habitat (USACE 2020). The USFWS does not conduct active habitat management within the Project area; however, the District has retained forestry management responsibility on fee title lands and continues to conduct small-scale forestry management actions (USACE 2020).

The areas of quality habitat persisting throughout the Steamboat Island and Grant Slough complex area support a diverse assemblage of fish and wildlife resources, including UMR NWFR identified Priority Resources of Concern (USFWS 2019), state and federally listed threatened and endangered species, migratory birds, and other protected species. Additional information on resources and recent surveys can be found in Section II of the draft Feasibility Report.

PROJECT OBJECTIVES

The goals of the Steamboat Island HREP, as provided in the draft Feasibility Report, are to "maintain, enhance, and restore quality habitat for desirable native plant, animal, and fish species and maintain, enhance, restore, and emulate natural river processes, structures, and functions for a resilient and sustainable ecosystem." These goals were developed in accordance with the

UMR NWFR management plan, with input provided by state and federal biologists. Objectives, as presented in Section III(G) of the draft Feasibility Report to meet these goals include:

1. "enhance and restore areal coverage and diversity of forest stands and habitat and increase diversity of bottomland hardwood forest, as measured in forested acres suitable to support hard-mast species and structure, age, and species composition;
2. increase year-round aquatic habitat diversity, as measured by acres and limnophilic native fish use of overwintering habitat, as this habitat is the most limiting of seasonal habitats;
3. restore 50% of island acreage and topography lost since the 1950s and protect from erosion within the project area, as measured by acres; and
4. protect existing backwater habitat from sediment deposition and enhance backwater and interior wetland areas, as measured by acres of backwater and survivability of scrub-shrub/pollinator habitat."

Although the Steamboat Island HREP is a component of the UMRR Program, the project also supports several additional efforts identifying ecosystem restoration needs and priorities across systemic, regional and local scales. Of particular note, the Steamboat Island HREP supports resource management goals and objectives identified by the UMR NWFR through their Habitat Management Plan (HMP) (USFWS 2019). As stated in Section III(E) of the draft Feasibility Report, the priority resources of concern identified within the HMP "that are relevant and could benefit from the project include: Midwestern wooded swamps and floodplains, red-shouldered hawk, prothonotary warbler, cerulean warbler, transient neotropical migrant passerines, tree-roosting bats, native invertebrate pollinators, dabbling ducks, secretive marsh birds, limnophilic native mussels and fish, fluvial-dependent native mussels, and fluvial-dependent migratory native fish." A full summary of relevant resource management plans is provided in Section III(C) of the draft Feasibility Report.

DISCUSSION OF SELECTED PROJECT FEATURES

The interagency planning team identified and considered more than 40 potential project features to support the objectives identified for the Steamboat Island HREP. Project features considered were categorized under the following measures: aquatic habitat diversity, topographic diversity for floodplain forest habitat, topographic diversity for scrub-shrub/pollinator habitat, island restoration and protection, small island creation, flow diversity, forest habitat measures, incorporation of mussel habitat substrate, marine traffic management through enforcement and mooring cell creation, sediment load management, complex connectivity, pool-wide drawdown, and real estate acquisition. Refer to Section IV of the draft Feasibility Report for a full list of the identified project measures and descriptions. Measures were further assessed by the planning team with eight measures and their dependencies being retained for further evaluation. As discussed in Section V of the draft Feasibility Report, the planning team identified the following guidelines to inform combinations of the measures into alternatives, in accordance with project goals and objectives: (1) the Upper Lake Aquatic Diversity measure was determined to be dependent on the restoration and protection of the NE bank to protect the dredge cut from sedimentation; (2) the Lower Lake Aquatic Diversity measure was determined to be dependent on the Grade Control Structure (GCS) to prevent the dredge cut from sedimentation; (3) the Upper Lake Aquatic Diversity and Lower Lake Aquatic Diversity measures were combined to balance constructability and material needs; (4) Upper Lake Aquatic Diversity, Lower Lake Aquatic Diversity, NW Grant Slough Lake Aquatic Diversity, and Island Restoration and Protection measures may incorporate fish and/or mussel habitat features; (5) alternatives comprised of single measures and those that lacked aquatic diversity measures were determined to be ineffective in meeting the project goals and objectives and were eliminated from further consideration; (6) Timber Stand Improvement (TSI) and Topographic Diversity measures were included in all alternatives; and (7) Aquatic Diversity and restoration/protection of the Upper Steamboat Island (USI) head were determined to be necessary to meet project goals and objectives; therefore, only alternatives that included both of these measures were carried forward. These considerations and additional evaluation by the planning team resulted in a final array of nine alternatives, including the No Federal Action alternative (or future without project), being carried forward. Refer to Section V of the draft Feasibility Report for further discussion.

As described in Section V(B)(1)(a) of the draft Feasibility Report, a habitat benefit evaluation was conducted "to evaluate the effects of the proposed project measures on aquatic and floodplain habitat quantity and quality." The assessment was conducted by an interagency team that included representatives from the USFWS, IADNR, ILDNR, and the District. Habitat Evaluation Procedures (HEP) and Hydraulic Engineering Center Ecosystem Functions Model (HEC-EFM) were utilized to quantify aquatic and floodplain benefits. As Section V(B) describes, "the HEP are based on the assumption that habitat for selected wildlife species can be described by a Habitat Suitability Index (HSI). This index value (from 0.0 to 1.0) 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." Average annual habitat units (AAHUs) for each species are typically calculated to reflect expected habitat conditions over a 50-year project life. To assess habitat quality and quantity changes throughout the life of the project, target years where identified at intervals where noticeable habitat changes may be expected. HEC-EFM further informed the evaluation by identifying the appropriate elevation threshold for each habitat type, allowing respective acreages to be calculated and compared between existing, future without project, and future with project conditions.

Aquatic habitat benefits were quantified through application of the Bluegill (Stuber et al. 1982, Palesh and Anderson 1990, USFWS 1980) and Walleye (McMahon et al. 1984, USFWS 1980) Habitat Suitability Index (HSI) Models. Floodplain habitat benefits were quantified through use of the Gray Squirrel (Allen 1987, USFWS 1980) and Yellow Warbler (Schroeder 1982, USFWS 1980) HSI Models. Additional discussion of these evaluation procedures is provided in Section V(B) and Appendix D of the draft Feasibility Report. Four of the nine alternatives were identified as "best buy" options and were further assessed by the planning team. Of these, Alternative #27 was determined to best meet the defined project objectives, the Sponsor's objectives, and other agency identified goals. Alternative #27 was ultimately recommended by the planning team as the preferred alternative and carried forward as the TSP (Table 1).

Table 1: Tentatively Selected Plan (TSP)

Project Feature/Location	Description	Objective(s)
Steamboat Island Upper Lake Steamboat Island Lower Lake NW Grant Slough Lake	Aquatic Diversity: Increase aquatic diversity in the project area backwaters by excavation. Where appropriate, additional fish and mussel habitat may be incorporated to bring further benefit to the species that occupy the project area.	Increase year-round aquatic habitat
Upper Steamboat Island Head NE Bank Steamboat Island Upper Lake Placement Site 1 Grade Control Structure (GCS) Grant Slough Placement Site 2 Grant Slough Placement Sites 4 and 5	Topographic Diversity (Forestry): Restore topographic diversity throughout portions of the project area by increasing existing elevations and planting hard mast tree species	Enhance and restore areal coverage and diversity of forest stands and habitat and increase diversity of bottomland hardwood forest.
Lower Lake Grant Slough Placement Site 1	Topographic Diversity (SSP): Restore topographic diversity throughout portions of the project area by increasing existing elevations and planting shrubs, understory plants, and buffer species.	Enhance and restore areal coverage and diversity of scrub-shrub/pollinator (SSP) habitat.
West Southeast Island Steamboat Island proper	Island Restoration and Protection: Restore and protect island acreage on portions of Steamboat Island proper and the whole West Southeast Island by placing stone protection and dredged material, then planting with trees.	Restore island acreage and protect from erosion, protect existing backwater habitat from sediment deposition, and enhance backwater and interior wetland areas.
Forest Habitat (TSI) at 11 sites, contained within three units within the Project boundaries (approx.. 900 acres)	Timber Stand Improvement (TSI): Conduct tree thinning, planting, and invasive species management treatments to increase floodplain forest age, structure, and species diversity.	Enhancing and restore diversity of forest stands and habitat and increase diversity of bottomland hardwood forest.

DISCUSSION OF FUTURE WITHOUT AND WITH PROJECT

To better compare and evaluate project features, the planning team used professional judgement and experience to apply a number of general and site-specific assumptions. These assumptions allow the team to extrapolate site conditions 50 years into the future within the project area and vicinity and compare the future with and without project conditions. These assumptions are presented in Appendix C of this report. The primary factors identified to affect future conditions of the project area include sedimentation, backwater lake water quality, flood inundation and duration, and island erosion.

Overwintering Fish Habitat
The aquatic habitat within the project area is comprised of main channel border, interconnected side-channels, and backwater areas. Collectively, these areas comprise approximately 127 acres of lentic and 487 acres of lotic aquatic habitat (USACE 2020). Continued bankline erosion and island dissection within the project area have allowed flow to enter isolated backwater habitats, increasing connectivity and carrying sediment into the backwater lakes, reducing their depth and quality. Sedimentation rates within the Steamboat Island HREP boundaries were monitored at four locations between 1984 and 2000 by the IADNR (USACE 2020). As provided in Section II(K) of the draft Feasibility Report, sedimentation rates were observed to be dynamic, ranging from -0.8 inches per year (erosion) to 2.2 inches per year (deposition). Overall, sedimentation trended towards deposition, with an estimated rate of 0.4 inches per year (USACE 2020). These changes are anticipated to result in the continued degradation of off-channel lacustrine fisheries habitat and succession of aquatic areas to flood tolerant herbaceous species, such as reed canary grass.

Changes in water quality and temperature would occur with additional sedimentation. Key factors influencing overwintering habitat and water quality conditions include dissolved oxygen, temperature, and water velocities. Baseline water quality monitoring of one site within the Steamboat Island complex interior was initiated in 2014. Two additional lentic habitat monitoring sites were added in 2017. These recent surveys have identified backwater areas within the project to experience intermittent high temperatures in the summer and occasional low dissolved oxygen (DO) levels in the winter, with existing suitable overwintering habitat limited to approximately 0.14 acres (USACE 2020). Overall, the existing aquatic habitat lacks adequate overwintering conditions (i.e., depth and flows) important for year-round habitat functioning.

The Bluegill Habitat Suitability Index (HSI) model (Stuber et al. 1982, Palesh and Anderson 1990) was selected to assess the existing, future without project, and future with project backwater aquatic habitat conditions on the overwintering centrarchid community. Without action, the current sedimentation rates indicate the overwintering fish habitat within the Steamboat Island proper complex will likely be reduced from the existing 0.14 acres to zero acres within 10 years from the present (USACE 2020). Dredging of the Steamboat Island and Grant Slough complex backwater lakes and access channels is expected to benefit local fish communities by providing access to backwater overwintering habitats with depths conducive to supporting ideal dissolved oxygen and temperature profiles.

Additionally, installation of the GCS within the Steamboat Island cut-through channel and elevation and protection of the NE Bank will aid in the reduction of sediment transfer throughout the Steamboat Island complex interior and into the backwater lakes and wetlands system and further restore ecosystem function. Although slowed rates of sedimentation will likely persist, adequate depths and acreage are expected to be maintained, with these features continuing to provide long term benefits to backwater and overwintering fish communities throughout the 50-year life of the project. Further, the potential integration of large woody debris may provide additional suitable substrate and habitat features for backwater fish.

Mussel Habitat

Islands within the Steamboat Island HREP boundary have experienced significant erosion, resulting in degraded structure and function. Of particular importance are the Southeast Islands which border an Essential Habitat Area (EHA) for the Higgins eye pearlymussel, spanning the Cordova, Illinois bankline between RM 503-505.5. These islands have been eroding at a rate of approximately 0.14 acres per year, exposing the Cordova EHA mussel bed to main channel flows (USACE 2020). As discussed in Section II(D) of the draft Feasibility Report, the Cordova EHA mussel bed is known to harbor more than 23 freshwater mussel species with an average density of 10 live mussels per square meter. This unique mussel resource was identified to extend into the Steamboat Island HREP, with more than 27 species of mussels found during a 2018, survey of the project area (ESI 2018). The Southeast Islands and Steamboat Island banklines provide for flow and structure diversity, resulting in habitat benefits for both the local mussel resources and their respective host fish species. At the current rate of erosion, the West Southeast Island is expected to completely disappear within the next few years, further reducing aquatic habitat structure diversity within the project area and potentially exposing and negatively impacting the surrounding mussel community.

The Walleye HSI model (McMahon et al. 1984) was selected by the interagency planning team to assess the existing, future without project, and future with project aquatic habitat conditions of riverine components. This model was selected in the absence of an approved mussel model to predict the Steamboat Island HREP effects on the potential occupation of the riverine project features by the federally endangered Higgin's-eye pearlymussel and common generalist mussel species through occupation by walleye host individuals. Installation of bankline stabilization features and mussel substrate into areas currently experiencing high erosion, as modeled for the West Southeast Island, is expected to result in an initial decrease in habitat quality as the substrate is established. Installation of mussel habitat substrate in conjunction with bankline stabilization features will provide approximately one acre of aquatic habitat benefits at the West Southeast Island, including reduction of wind fetch and erosion effects, long-term availability of stable substrates for the mussel community to occupy, and increased habitat structure and cover for host fish and other riverine fish species. Further, protection of the island may result in continued island growth through accretion, further extending benefits for the mussel and fish community.

Floodplain Forest and Scrub-Shrub/Pollinator (SSP) Habitat

River flood stages, and the resulting inundation of floodplain forest areas lacking topographic diversity, have increased since installation of the UMR lock and dam system, and have continued to increase since as a result of changing hydraulic conditions. Specifically, average flood stage elevations have increased approximately 0.3 feet between the 30-year monitoring periods of 1957-1986 and 1987-2016, within the vicinity of the Steamboat Island HREP (USACE 2020). Increased flood height, frequency, and duration have resulted in the displacement of tree stands of diverse species and age towards even-aged stands of flood tolerant tree species and invasive herbaceous plants. The Steamboat Island complex contains approximately 2,013 acres of floodplain habitat. This acreage includes approximately 1,674 acres of floodplain forest habitat, 292 acres of emergent wetland habitat, and 47 acres of predominantly scrub-shrub/pollinator habitat (USACE 2020). Roughly half of the Steamboat Island HREP is at an elevation suitable for hard-mast tree growth. A 2018 survey of the project forests identified eighteen tree species in the overstory, dominated by flood-tolerant silver maples (*Acer saccharinum*) (USACE 2020). Overall, desirable hard-mast tree stands were documented to be old, exceeding 80 years of age, with limited regeneration in the understory. As these even-aged stands continue to age and reach mortality, the resulting canopy openings and lack of tree regeneration facilitate the colonization of non-desirable herbaceous vegetation, such as reed canary grass (*Phalaris arundinacea*). Conversion of habitat from floodplain forests to non-desirable herbaceous vegetation has recently been observed within the Steamboat Island HREP boundaries, with 35 acres of the existing scrub-shrub/pollinator (SSP) habitat being dominated by reed canary grass (USACE 2020). A key component of the Steamboat Island HREP includes preserving areas of unique and diverse patches of forest while restoring the surrounding areas of non-desirable vegetation. As provided in Section VI of the draft Feasibility Report, restoration of topographic diversity throughout the project includes "increasing existing elevations and planting trees, shrubs, understory plants, and buffer species, as well as implementing TSI measures." The planning team targeted areas of undesirable vegetation (reed canary grass) to convert to higher elevation areas capable of supporting hard-mast trees and SSP vegetation while avoiding impacts to floodplain forest resources

The Yellow Warbler HSI model (Schroeder 1982) was used to assess pioneer/early successional floodplain forest habitat, while the Grey Squirrel HSI model (Allen 1987) was used to assess mast tree habitat. Due to the topographic diversity features specifically targeting existing reed canary grass monoculture areas with low habitat value, the existing and future without conditions provide no habitat benefits. Following implementation of topographic diversity features and plantings of diverse species of hard mast trees and SSP vegetation, benefits are projected to remain low initially, as the vegetation becomes established, followed by an increase until full benefits are realized. Changes in floodplain forest species and age structure composition under future with-project conditions are projected to improve as existing diverse patches of hardwood mast tree species are allowed to regenerate in response to the raised elevation of surrounding areas above that of frequent and prolonged inundation. Proposed conservation measures, as identified in the draft Feasibility Report, include TSI activities for over 900 acres within the Steamboat Island HREP boundaries. TSI will include continued tree thinning treatments, plantings, and invasive species management resulting in maintained high habitat quality throughout the life of the project. Collectively, these activities are expected to result in positive long-term benefits for birds, bats, pollinators and other wildlife species, including increased foraging habitat, production of potential roost tree habitat, and increased overall habitat diversity. Further, the positioning of Pool 14 within the Mississippi River Flyway, one of the four major migratory flyways in North America, will result in improvements made to Steamboat Island HREP's floodplain habitats having the potential to benefit a significant number of migratory bird species.

THREATENED AND ENDANGERED SPECIES

To facilitate compliance with Section 7 of the Endangered Species Act of 1973, as amended, Federal agencies are required to obtain information concerning any species, listed or proposed to be listed, which may be present in the area of a proposed action through the USFWS' Information for Planning and Consultation (IPaC) website. The following is a list of federally listed species with ranges within Clinton and Scott Counties, Iowa, and Rock Island County, Illinois (Table 2). Ideal habitat descriptions for these species are provided in Section II(E) of the draft Feasibility Report.

Table 2. List of Federal Threatened and Endangered Species for Clinton and Scott Counties, Iowa, and Rock Island, Illinois.

Common Name	Scientific Name	Listing Status	Classification
Higgins eye pearlymussel	*Lampsilis higginsii*	Endangered	Freshwater Mussel
Sheepnose mussel	*Plethobasus cyphyus*	Endangered	
Spectaclecase mussel	*Cumberlandia monodonta*	Endangered	
Indiana bat	*Myotis sodalis*	Endangered	Bat
Northern long-eared bat	*Myotis septentrionalis*	Threatened	
Prairie bush clover	*Lespedeza leptostachya*	Threatened	Plant
Western prairie fringed orchid	*Platanthera praeclara*	Threatened	
Eastern prairie fringed orchid	*Platanthera leucophaea*	Threatened	
Iowa Pleistocene snail	*Discus macclintocki*	Endangered	Snail
Eastern Massasauga	*Sistrurus catenatus*	Threatened	Reptile

The USFWS concurred that implementation of the project and conservation measures as presented in the draft Feasibility Report and the Corps' request for concurrence dated February 21, 2020, is "not likely to adversely affect" any known federally listed threatened or endangered species. Please refer to the USFWS' concurrence letter dated February 21, 2020, for further discussion (Appendix A). A summary of specific species concerns and conservation measures agreed upon through the planning process and ESA Section 7 informal consultation, as presented in our concurrence letter, follows.

Higgin's-eye pearlymussel, Sheepnose and Spectaclecase Mussels
Project features and activities resulting in disturbance to aquatic habitats include the mechanical dredging of dredge cuts for increased aquatic diversity sites and access channels. The TSP identifies approximately 510,692 cubic yards of proposed dredging. Additionally, the TSP proposes to restore acreage within the historic footprints at the head of Steamboat Island and the West Southeast Island that has been lost through erosion and inundation. Island footprint restoration and will include a combination of open water and bankline placement of dredged material and installation of approximately 504,380 cubic yards of stone protection to stabilize these sites and other areas of bankline erosion throughout the project area.

Freshwater mussel surveys were completed within the project area in 2018 and 2019. A combination of quantitative and qualitative sampling was conducted within most proposed project feature areas during the 2018 survey, with survey work confined to qualitative "spot" sampling within Grant Slough and the Southeast Islands. This effort identified six live Higgins eye pearlymussels between the Illinois bankline and the East Southeast Island. The East Southeast Island is located within the Cordova EHA. The project area boundaries were subsequently altered to omit the East Southeast Island and areas within the EHA to minimize and avoid impacts to the Higgins eye pearlymussel.

A follow-up mussel survey was completed in 2019, to further assess the mussel resources within Grant Slough and surrounding the West Southeast Island. There were no federally listed mussel species identified as part of this effort. However, both survey efforts identified a species-rich assemblage of mussels within Grant Slough, with pockets of higher density areas. Together, these surveys will be used to inform the alignment of the access channel dredging within Grant Slough to avoid and minimize impacts to areas of higher mussel densities.

Further, the integration of rip rap, large woody debris, and a mixture of various sizes of river rock will provide suitable substrate and habitat features for freshwater mussel resources and their respective host fish. Collectively, we expect these features to increase the aquatic habitat structure and function within the project area.

Two additional federally endangered mussel species are known to have ranges overlapping the project area, the sheepnose mussel and the spectaclecase mussel. Historic surveys have found sheepnose within the Cordova EHA mussel bed; however, this species has not been identified in survey efforts since one fresh dead and one live individual were found in 2005 and 2006, respectively. Surveyors employed spectaclecase-specific survey methods where potentially suitable habitat was encountered during the 2018 and 2019 survey efforts within the project area; there were no live specimens or shells found.

Indiana bat and northern long-eared bat

Survey efforts have identified the federally endangered Indiana bat and the threatened northern long-eared bat within the floodplain forests of Pool 14 in recent years. Specifically, a bat survey was completed in 2015, at the Beaver Island HREP, located approximately eight river miles upstream from the project area (Kiser et al. 2015). The Beaver Island HREP survey identified both northern long-eared bats (acoustics and mist-netting) and Indiana bats (acoustics only). Additionally, a season-long acoustic survey conducted at the adjacent Princeton Wildlife Management Area identified use by both Indiana bats and northern long-eared bats in 2018; however, neither species was collected through mist-netting efforts. Due to the known presence of both the Indiana and northern long-eared bats within the project vicinity and the identification of potentially suitable habitat throughout the project area, we assume presence of these species throughout the project.

Project activities resulting in potential disturbance to Indiana and northern long-eared bat habitat include tree clearing to allow equipment access to the topographic diversity sites within the Grant Slough area and active TSI practices. The TSP identifies approximately 1.3 acres of tree removal, which is roughly 0.07 percent of the total forested habitat available within the Steamboat Island complex. The tree removal, as proposed, will not result in fragmentation of bat roosting or foraging habitat and cleared areas will be replanted following the completion of construction. Recent tree inventories have identified potential roosting habitat throughout the remaining forested sections of the Steamboat Island and Grant Slough complex, including trees that likely serve as primary or secondary roosts. Because the District proposes to complete this limited amount of tree clearing between October 1 and March 31, which is outside the bat active period, removal of unidentified maternity roost trees is unlikely to result in the incidental take of Indiana or northern long-eared bats. Further, the Service has identified certain incidental take of the northern long-eared bat resulting from tree removal as exempted from prohibition under the final 4(d) Rule of the Act (50 CFR 17).

TSI practices to be implemented across approximately 900 acres on Steamboat Island over the next ten years include thinning treatments, removal of non-desirable vegetation, and tree plantings. We anticipate thinning treatments, such as girdling, to benefit tree-roosting bats through the creation of increased snag habitat, canopy openings, and solar exposure. We further expect the removal of non-desirable vegetation within the understory to open up flight and foraging corridors to facilitate bat movement throughout the complex. The proposed tree plantings will consist of mast trees, including species which produce exfoliating bark, providing additional bat habitat as the trees mature. Additionally, proposed topographic diversity features include raising the ground elevation in areas currently dominated by low quality vegetation, such as the invasive reed canarygrass. Desirable tree species will be planted in these elevated areas, expanding upon existing forest habitat and increasing the quality, health, and resilience of the stand. Collectively, we expect these activities to result in positive, long-term benefits for potential roost tree production, foraging habitat, and habitat diversity. All tree thinning efforts will be completed outside of the bat maternity season, between October 1 and March 31, and any required herbicide treatments will be applied by a licensed applicator using state and federal standards, thus minimizing potential localized impacts.

Additional Species

Five additional federally listed species, the eastern massasauga, prairie bush clover, western prairie fringed orchid, eastern prairie fringed orchid, and the Iowa Pleistocene snail, are known to occur in counties throughout Iowa and Illinois bordering Pool 14; however, suitable habitat for these species is not found within the project area. Although Eastern massasauga has historically been known to occur within the adjacent Princeton Wildlife Management Area, a live specimen has not been collected from this area since 1999. Further, the previously-occupied area is separated from potentially suitable habitat within the project area by habitat barriers; therefore, potential adverse impacts to the species as a result of the project are not anticipated.

Although no longer a listed species, bald eagles (*Haliaeetus leucocephalus)* continue to be protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Bald eagles winter along the Mississippi River, including Pool 14. Suitable perch trees where eagles can loaf and perch are numerous. An eagle nest has been known to exist within the project boundaries, at the head of Steamboat Island; however, it is suspected that the nest may have fallen as a result of flood impacts in 2019. The status of this nest and the potential presence of new nests should be confirmed prior to the onset of construction activities.

State of Iowa and Illinois threatened and endangered species that may occur within Scott and Clinton Counties, Iowa, and Rock Island, Illinois include the following (Table 3).

Table 3. State of Iowa and Illinois Threatened and Endangered Species Occurring in Scott and Clinton Counties, Iowa, and Rock Island County, Illinois (Table II-4, draft Feasibility Report).

Common Name	Scientific Name	Listing Status	Classification
Butterfly	*Ellipsaria lineolata*	Threatened	Freshwater Mussel
Spike	*Elliptio dilatata*	Threatened	
Creeper	*Strophitus undulatus*	Threatened	
Higgins Eye Pearlymussel	*Lampsilis higginsii*	Endangered	
Pistolgrip	*Tritogonia verrucosa*	Endangered	
Round Pigtoe	*Pleurobema sintoxia*	Endangered	
Yellow Sandshell	*Lampsilis teres*	Endangered	
Sheepnose	*Plethobasus cyphyus*	Endangered	
Spectaclecase	*Cumberlandia monodonta*	Endangered	
Purple Wartyback	*Cyclonaias tuberculata*	Threatened	
Ebonyshell	*Fusconaia ebena*	Endangered	
Black Sandshell	*Ligumia recta*	Threatened	
Grass Pickerel	*Esox americanus*	Threatened	Fish
Lake Sturgeon	*Acipenser fulvescens*	Endangered	
Western Sand Darter	*Ammocrypta clarum*	Endangered	
Longnose Sucker	*Catostomus catostomus*	Threatened	
Crystal Darter	*Crystallaria asprella*	Threatened	
Gravel Chub	*Erimystax x-punctatus*	Threatened	
Banded Killifish	*Fundulus diaphanus*	Threatened	
Pallid Shiner	*Hybopsis amnis*	Endangered	
Running Pine	*Lycopodium clavatum*	Endangered	
River Redhorse	*Moxostoma carinatum*	Threatened	
Pugnose Shiner	*Notropis anogenus*	Endangered	
American Eel	*Anguilla rostrata*	Threatened	
Indiana Bat	*Myotis sodalis*	Endangered	Mammal
Northern Long-eared Bat	*Myotis septentrionalis*	Threatened	
Southern Bog Lemming	*Synaptomys copperi*	Threatened	
Central Newt	*Notophthalmus viridescens*	Threatened	Amphibian
Four-toed Salamander	*Hemidactylium scutatum*	Threatened	
Blanding's Turtle	*Emydoidea blandingii*	Endangered (IL)/ Threatened (IA)	Reptile
Eastern Massasauga Rattlesnake	*Sistrurus catenatus*	Endangered	
Ornate Box Turtle	*Terrapene ornata*	Threatened	
Barn Owl	*Tyto alba*	Endangered	Bird
Cerulean Warbler	*Dendroica cerulea*	Threatened	
Yellow-crowned Night Heron	*Nyctanassa violacea*	Endangered	
Black-crowned Night Heron	*Nycticorax nycticorax*	Endangered	
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	Endangered	
Byssus Skipper	*Problema byssus*	Threatened	Insect
Schreber's Aster	*Aster schreberi*	Endangered	Plant
Downy Yellow Painted Cup	*Castilleja sessiliflora*	Endangered	
Sweet Indian Plantain	*Cacalia suaveolens*	Threatened	
Spotted Coral-root Orchid	*Corallorhiza maculata*	Endangered	

Common Name	Scientific Name	Listing Status	Classification
Mead's Milkweed	*Asclepias meadii*	Endangered	Plant
Waxleaf Meadowrue	*Thalictrum revolutum*	Endangered	
Orange Grass St. John's Wart	*Hypericum gentianoides*	Endangered	
Slender Dayflower	*Commelina erecta*	Threatened	
Slender Ladies' tresses	*Spiranthes lacera*	Threatened	
Pink Turtlehead	*Chelone obliqua*	Endangered (IL)	

CONCLUSIONS AND RECOMMENDATIONS

The Steamboat Island HREP represents a unique opportunity to provide needed habitat restoration within lower Pool 14 of the UMR, through restoration and enhancement of degrading floodplain and aquatic habitats that will benefit migratory birds, fish, and other wildlife and plant resources dependent on these habitats. Additionally, the Steamboat Island HREP provides and maintains important linkages between similar habitats and refugia for migratory birds, fish, and wildlife species throughout Pool 14, including the Princeton Refuge HREP and Beaver Island HREP. The project measures were designed to support the goals and objectives of the UMR NWFR, which "…was established by an Act of Congress on June 7, 1924, as a refuge and breeding place for migratory birds, fish, and other wildlife, and plants" (USFWS 2019). Further, the significant interagency coordination throughout the planning process demonstrates the ecological value of this project towards maintaining and restoring habitat quality, diversity, and resilience within the Steamboat Island complex and the larger UMR system. Finally, the post-construction performance monitoring and adaptive management framework, outlined in Appendix K of the draft Feasibility Report, will allow the project features to be evaluated and modified, as necessary, to further support the intended ecological goals and benefits of the project.

Therefore we recommend the preferred alternative as stated in Section VI of the draft Feasibility Report which includes:

- "Restoring topographic diversity in portions of the Project area by increasing existing elevations and planting trees, shrubs, understory plants, and buffer species, as well as implementing TSI measures, to address the Project objective of enhancing and restoring areal coverage and diversity of forest stands and habitat and increase diversity of bottomland hardwood forest.
- Increasing aquatic diversity in the Project area backwaters, specifically in Steamboat Island Upper Lake, Steamboat Island Lower Lake, and NW Grant Slough Lake, by excavation, which will address the Project objective of increasing year-round aquatic habitat. Where appropriate, additional fish and mussel habitat may be incorporated to bring further benefit to the species that use the Project area.
- Restoring and protecting island acreage on portions of Steamboat Island proper and the whole West SE Island by placing stone protection and dredged material, then planting with trees, to address the Project objective of restoring island acreage and protecting from erosion within the Project area.

- Placing protection measures at the NE Bank and the northwest end of the Cut-Through Channel of Steamboat Island and restoring SSP habitat in the Project area, to address the Project objective of protecting existing backwater habitat from sediment deposition and enhancing backwater and interior wetland areas."

Thank you for the opportunity to provide this Fish and Wildlife Coordination Act Report. If you have any questions, please contact Sara Schmuecker of my staff at (309) 757-5800, ext. 203.

Sincerely,

KRAIG MCPEEK

Digitally signed by KRAIG MCPEEK
Date: 2020.06.29 14:26:52 -05'00'

Kraig McPeek
Field Supervisor

Cc:

USFWS	Ed Britton, Nate Williams, Sharonne Baylor, Susan Cooper
IA DNR	Kirk Hansen
IL DNR	Rebekah Anderson, Matt O'Hara

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Appendix A

Endangered Species Act Section 7
Informal Consultation

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Illinois & Iowa ES Field Office
1511 47th Avenue
Moline, Illinois 61265
Phone: (309) 757-5800 Fax: (309) 757-5807

IN REPLY REFER
TO FWS/ILIAFO
TAILS #03E18000-2020-I-0836

February 21, 2020

Jodi Creswell
Chief, Environmental Planning Branch
U.S. Army Corps of Engineers
Rock Island District
Attn: Davi Michl
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61201-2004

Dear Ms. Creswell:

This responds to your letter requesting concurrence from the Fish and Wildlife Service (Service) for the Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP), dated January 22, 2020. The Steamboat Island HREP is part of the Upper Mississippi River Restoration (UMRR) Program and is located within Pool 14 of the Upper Mississippi River, extending along both sides of the navigation channel between river miles 502.5 and 508.0, Clinton and Scott Counties, Iowa, and Rock Island County, Illinois. As part of the project, the U.S. Army Corps of Engineers, Rock Island District (District) has identified a tentatively selected plan (TSP) that incorporates refinements and conservation measures to minimize and avoid impacts to federally listed species, as your letter describes. You determined that the project may affect but is not likely to adversely affect (NLAA) the federally endangered Indiana bat (*Myotis sodalis*) and Higgins eye pearlymussel (*Lampsilis higginsii*), and the federally threatened northern long-eared bat (*Myotis septentrionalis*). This informal consultation addresses potential effects to the species in accordance with section 7 of the Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 *et seq.*) and 50 CFR § 402 of our interagency regulations governing section 7 of the Act.

Multiple bat surveys have been conducted throughout the floodplain forests of Pool 14 in recent years. Specifically, a bat survey was completed in 2015 at the Beaver Island HREP, located approximately eight river miles upstream from the project area. The Beaver Island HREP survey identified both northern long-eared bats (acoustics and mist-netting) and Indiana bats (acoustics only). Additionally, a season-long acoustic survey conducted at the adjacent Princeton Wildlife Management Area identified use by both Indiana bats and northern long-eared bats in 2018; however, neither species was collected through mist-netting efforts. Due to the known presence of both the Indiana and northern long-eared bats within the project vicinity and the identification of potentially suitable habitat throughout the project area, we assume presence of these species throughout the project.

Project activities resulting in potential disturbance to Indiana and northern long-eared bat habitat include tree clearing to allow equipment access to the topographic diversity sites within the Grant Slough area and active timber stand improvement (TSI) practices. The TSP identifies approximately 1.3 acres of tree removal, which is roughly 0.07 percent of the total forested habitat available within the Steamboat Island complex. The tree removal, as proposed, will not result in fragmentation of bat roosting or foraging habitat and cleared areas will be replanted following the completion of construction. Recent tree inventories have identified potential roosting habitat throughout the remaining forested sections of the Steamboat Island complex, including trees that likely serve as primary or secondary roosts. Because the District proposes to complete this limited amount of tree clearing between October 1 and March 31, which is outside the bat active period, removal of unidentified maternity roost trees is unlikely to result in the incidental take of Indiana or northern long-eared bats. Further, the Service has identified certain incidental take of the northern long-eared bat resulting from tree removal as exempted from prohibition under the final 4(d) Rule of the Act (50 CFR 17).

TSI practices to be implemented across approximately 900 acres on Steamboat Island over the next ten years include thinning treatments, removal of non-desirable vegetation, and tree plantings. We anticipate thinning treatments, such as girdling, to benefit tree-roosting bats through the creation of increased snag habitat, canopy openings, and solar exposure. We further expect the removal of non-desirable vegetation within the understory to open up flight and foraging corridors to facilitate bat movement throughout the complex. The proposed tree plantings will consist of mast trees, including species which produce exfoliating bark, providing additional bat habitat as the trees mature. Additionally, proposed topographic diversity features include raising the ground elevation in areas currently dominated by low quality vegetation, such as the invasive reeds canary grass. Desirable tree species will be planted in these elevated areas, expanding upon existing forest habitat and increasing the quality, health, and resilience of the stand. Collectively, we expect these activities to result in positive, long-term benefits for potential roost tree production, foraging habitat, and habitat diversity. All tree thinning efforts will be completed outside of the bat maternity season, between October 1 and March 31, and any required herbicide treatments will be applied by a licensed applicator using state and federal standards, thus minimizing potential localized impacts.

For the reasons stated above, **we concur with your determination that the project may affect but is not likely to adversely affect** Indiana bats and northern long-eared bats.

Project features and activities resulting in disturbance to aquatic habitats include the mechanical dredging of dredge cuts for increased aquatic diversity sites and access channels. The TSP identifies approximately 510,692 cubic yards of proposed dredging. Additionally, the TSP proposes to restore acreage within the historic footprints at the head of Steamboat Island and the west southeast island that has been lost through erosion and inundation. Island footprint restoration and will include a combination of open water and bankline placement of dredged material and installation of approximately 504,380 cubic yards of stone protection to stabilize these sites and other areas of bankline erosion throughout the project area.

Freshwater mussel surveys were completed within the project area in 2018 and 2019. A combination of quantitative and qualitative sampling was conducted within most proposed project feature areas during the 2018 survey, with survey work confined to qualitative "spot" sampling within Grant Slough and the southeast islands. This effort identified six live Higgins eye pearlymussels between the Illinois bankline and the east southeast island. The east southeast island is located within the Cordova Higgins eye essential habitat area (EHA), spanning the Illinois bankline between approximate river miles 503-505.5. The District subsequently altered the project area boundaries to omit the east southeast island and areas within the EHA to minimize and avoid impacts to the Higgins eye pearlymussel.

A follow-up mussel survey was completed in 2019, to further assess the mussel resources within Grant Slough and surrounding the west southeast island. There were no federally listed mussel species identified as part of this effort. However, both survey efforts identified a species-rich assemblage of mussels within Grant Slough, with pockets of higher density areas. Together, these surveys will be used to inform the alignment of the access channel dredging within Grant Slough to avoid and minimize impacts to areas of higher mussel densities.

Further, the integration of rip rap, large woody debris, and a mixture of various sizes of river rock will provide suitable substrate and habitat features for freshwater mussel resources and their respective host fish. Collectively, we expect these features to increase the aquatic habitat structure and function within the project area.

For the reasons stated above, **we concur with your determination that the project may affect but is not likely to adversely affect** Higgins eye pearlymussels.

Two additional federally endangered mussel species are known to have ranges overlapping the project area, the sheepnose mussel (*Plethobasus cyphyus*) and the spectaclecase mussel (*Cumberlandia monodonta*). Historic surveys have found sheepnose within the Cordova EHA; however this species has not been identified in survey efforts since one fresh dead and one live individual were found in 2005 and 2006, respectively. Surveyors employed spectaclecase-specific survey methods where potentially suitable habitat was encountered during the 2018 and 2019 survey efforts within the project area; however, efforts resulted in the collection of no live specimens or shells.

The District made no effect determinations for the sheepnose mussel, spectaclecase mussel, eastern massasauga (*Sistrurus catenatus*), prairie bush clover (*Lespedeza leptostachya*), western prairie fringed orchid (*Platanthera praeclara*), eastern prairie fringed orchid (*Platanthera leucophaea*), and the Iowa Pleistocene snail (*Discus macclintocki*). The Illinois-Iowa Ecological Services Field Office has no regulatory or statutory authority for concurring with "no effect" determinations. However, we recommend you maintain a written record of your "no effect" determination and include it in your decision record. An example "no effect" memo can be found on our website at http://www.fws.gov/midwest/endangered/section7/s7process/letters.html.

Finally, the Service removed bald eagles from protection under the Act on August 8, 2007. However, they remain protected today under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act (Eagle Act). The Eagle Act prohibits take which is defined as, "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, or disturb" (50 CFR 22.3). We define disturb in regulations as, "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." An eagle nest has been known to exist within the project boundaries, at the head of Steamboat Island; however, it is suspected that the nest may have fallen as a result of flood impacts in 2019. The status of this nest should be confirmed prior to the onset of construction activities. Should potential disturbance to eagles or eagle nests be identified, consultation should be initiated.

This letter provides comments under the authority of and in accordance with provisions of 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. Should you modify the project or if new information indicates endangered species may be affected, consultation should be initiated. Thank you for the opportunity to provide comments. If you have any additional questions or concerns, please contact please contact Sara Schmuecker of my staff at 309-757-5800 x 203.

Sincerely,

Kraig McPeek
Field Supervisor

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APPENDIX B

Habitat Evaluation and Benefits Quantification Results

Tables extracted from Appendix D of the ***draft*** Upper Mississippi River Restoration Feasibility Report with Integrated Environmental Assessment, Steamboat Island HREP (USACE 2020)

Table D-3: Aquatic Benefit Evaluation Results for Backwater Excavation Measures

Measure	Measure Name	Condition	Target Year	Bluegill SI	SI Final	Acres	HUs	AAHUs	Net AAHUs
				OUTPUT					
Overwinter Fish Habitat	No Action-Steamboat Island Proper Complex	Existing	0	0.52	0.52	0.14	1.0	0.10	**0.0**
		FWOP	10	0.52	0.52	0	0.0		
			25	0.52	0.52	0	0.0		
			50	0.52	0.52	0	0.0		
	Steamboat Island Proper Complex	With Project	1	0.94	0.94	23	22.0	19.19	**19.1**
			10	0.87	0.87	23	21.0		
			20	0.87	0.87	23	21.0		
			30	0.87	0.87	21	19.0		
			50	0.77	0.77	19	15.0		
	No Action- Grant Slough Complex	Existing	0	0.52	0.52	0	0.0	0.00	**0.0**
		FWOP	10	0.52	0.52	0	0.0		
			25	0.52	0.52	0	0.0		
			50	0.52	0.52	0	0.0		
	Grant Slough Complex	With Project	1	0.94	0.94	6	6.0	5.94	**5.9**
			10	0.87	0.87	6	6.0		
			20	0.87	0.87	6	6.0		
			30	0.87	0.87	6	6.0		
			50	0.77	0.77	6	5.0		

Table D-4: Mussel Habitat Benefit Evaluation Results for Flow Diversity/Island Restoration Measures

Measure	Measure Name	Condition	Target Year	Walleye SI	SI Final	Acres	HUs	AAHUs	Net AAHUs
				OUTPUT					
Mussel Habitat	No Action	Existing	0	0.30	0.30	0.4	0.1	0.10	**0.0**
		FWOP	10	0.25	0.25	0.4	0.1		
			25	0.20	0.20	0.4	0.1		
			50	0.15	0.15	0.4	0.1		
	Steamboat Slough Flow Diversity	With Project	1	0.72	0.72	0.4	0.3	0.20	**0.1**
			10	0.74	0.74	0.4	0.3		
			25	0.75	0.75	0.4	0.3		
			50	0.74	0.74	0.4	0.3		
	No Action	Existing	0	0.74	0.74	0	0.0	0.00	**0.0**
		FWOP	10	0.72	0.72	0	0.0		
			25	0.70	0.70	0	0.0		
			50	0.65	0.65	0	0.0		
	West SE Island	With Project	1	0.31	0.31	1	0.3	0.64	**0.6**
			10	0.71	0.71	1	0.7		
			25	0.70	0.70	1	0.7		
			50	0.74	0.74	1	0.7		

Table D-5: Floodplain Benefit Evaluation Results for Topographic Diversity Measures

Measure	Measure Name	Condition	Target Year	Gray Squirrel SI	Yellow Warbler SI	SI Final	Acres	HUs	AAHUs	Net AAHUs
				OUTPUT						
Floodplain Forest/ Scrub-Shrub Wetlands	No Action-USI Head	Existing	0	0.00	0.00	0.00	14	0.0	0.00	**0.00**
		FWOP	20	0.00	0.00	0.00	14	0.0		
			30	0.00	0.00	0.00	14	0.0		
			50	0.00	0.00	0.00	14	0.0		
	USI Head	With Project	1	0.00	0.00	0.00	14	0.0	10.30	**10.30**
			20	0.00	1.00	1.00	14	14.0		
			30	0.91	0.00	0.91	14	12.7		
			50	0.91	0.00	0.91	14	12.7		
	No Action-Steamboat Island Proper Complex	Existing	0	0.00	0.00	0.00	14	0.0	0.00	**0.00**
		FWOP	20	0.00	0.00	0.00	14	0.0		
			30	0.00	0.00	0.00	14	0.0		
			50	0.00	0.00	0.00	14	0.0		
	Steamboat Island Proper Complex	With Project	1	0.00	0.00	0.00	14	0.0	10.30	**10.30**
			20	0.00	1.00	1.00	14	14.0		
			30	0.91	0.00	0.91	14	12.7		
			50	0.91	0.00	0.91	14	12.7		
	No Action-Grant Slough Complex	Existing	0	0.00	0.00	0.00	30	0.0	0.00	**0.00**
		FWOP	20	0.00	0.00	0.00	30	0.0		
			30	0.00	0.00	0.00	30	0.0		
			50	0.00	0.00	0.00	30	0.0		
	Grant Slough Complex	With Project	1	0.00	0.00	0.00	30	0.0	22.00	**22.00**
			20	0.00	1.00	1.00	30	30.0		
			30	0.91	0.00	0.91	30	27.2		
			50	0.91	0.00	0.91	30	27.2		
	No Action-West SE Island	Existing	0	0.00	0.00	0.00	4	0.0	0.00	**0.00**
		FWOP	20	0.00	0.00	0.00	4	0.0		
			30	0.00	0.00	0.00	4	0.0		
			50	0.00	0.00	0.00	4	0.0		

Table D-5: Floodplain Benefit Evaluation Results for Topographic Diversity Measures (continued)

				OUTPUT						
Measure	**Measure Name**	**Condition**	**Target Year**	**Gray Squirrel SI**	**Yellow Warbler SI**	**SI Final**	**Acres**	**HUs**	**AAHUs**	**Net AAHUs**
Floodplain Forest/ Scrub-Shrub Wetlands	West SE Island	With Project	1	0.00	0.00	0.00	4	0.0	2.90	**2.90**
			20	0.00	1.00	1.00	4	4.0		
			30	0.91	0.00	0.91	4	3.6		
			50	0.91	0.00	0.91	4	3.6		
	No Action-Steamboat Island Proper Complex Scrub-Shrub	Existing	0	[redacted]	0.00	0.00	5	0.0	0.00	**0.00**
		FWOP	20	[redacted]	0.00	0.00	5	0.0		
			30	[redacted]	0.00	0.00	5	0.0		
			50	[redacted]	0.00	0.00	5	0.0		
	Steamboat Island Proper Complex Scrub-Shrub	With Project	1	[redacted]	0.00	0.00	5	0.0	3.90	**3.90**
			20	[redacted]	1.00	1.00	5	5.0		
			30	[redacted]	1.00	1.00	5	5.0		
			50	[redacted]	1.00	1.00	5	5.0		

Table D-6: Floodplain Benefit Evaluation Results for Timber Stand Improvement Measures

Measure	Measure Name	Condition	Target Year	HGM FCI	FCI Final	Acres	HUs	AAHUs	Net AAHUs
Timber Stand Improvement	No Action-TSI	Existing	0	0.64	0.64	900	576.0	461.00	**0.00**
		FWOP	50	0.51	0.51	900	459.0		
	TSI Prescriptions	With Project	1	0.64	0.64	900	576.0	779.00	**318.0**
			50	0.87	0.87	900	783.0		

APPENDIX C

Assumptions

Text extracted from Appendix D of the ***draft*** Upper Mississippi River Restoration Feasibility Report with Integrated Environmental Assessment, Steamboat Island HREP (USACE 2020)

A. Quantity Component. Traditionally, the Corps has used the quantity and quality of habitat jointly, in the form of habitat units (HUs), to measure benefits provided by ecosystem restoration projects. The quantity portion is often measured as area (acres of habitat, landform, etc.) or number of species; in some systems, it is measured as length (miles of stream bank). The evaluation conducted for the Project uses acres, delineated by polygons, to represent the quantity. The area associated with each management measure must have a clear definition for use as guidance in estimating the area component of the ecosystem output model, and must be applied consistently to all actions evaluated. From the qualitative and quantitative determinations, the standard unit of measure, HU, is calculated using the formula (HSI x Acres = HUs) for all selected HSI models.

With or without a project, habitat conditions change over time; therefore, the overall value of a proposed project depends upon the comparison of expected with-project benefits to expected without-project benefits. Annualized HUs are referred to as average annual habitat units (AAHUs). To assess the change over the period of analysis, the PDT identified target years (TYs) where a change in the habitat variables may be noticed. Noticeable changes are characterized by a change in habitat benefit output. Model TYs by species:

- Bluegill TY: 0, 1, 10, 20, 30, 50
- Walleye TY: 0, 1, 10, 25, 50
- Yellow warbler TY: 0, 1, 20, 30, 50
- Gray squirrel TY: 0, 1, 20, 30, 50

For this Project, the area of the action footprint (physical footprint of management measures) was selected to measure and compare the habitat benefits of each alternative (Table D-1). When multiple management measures are included in an action, the footprint equals the total of the management-measure footprints with no double counting of overlapping areas addressed by two or more management measures. Acreage differs for Future With and Without Project due to the trade-off between unlimiting habitat (ex: wetland) for limiting habitat (ex: aquatic).

There are trade-offs associated with restricting the evaluation of benefits to the action footprint. On the one hand, benefits can be accurately quantified with a high degree of certainty and allow for the development of specific and measurable criteria to be used in monitoring Project performance; however, the action footprint also tends to grossly underestimate the areal extent of ecological benefits because the area of restored biotic/abiotic processes usually covers a much broader scale.

Although the habitat evaluation of the Project was limited to the action footprint, it should be recognized that benefits of various measures likely extend beyond this immediate footprint as biotic and abiotic processes are restored. However, estimating habitat benefits at higher scales (e.g., area of restored process, area of potential influence) was considered too uncertain or speculative to accurately assess.

Table D-1: Habitat Types and Areas Evaluated for this Assessment

Habitat Type	Evaluation Area	Area (acres)	HSI Model
Aquatic	Steamboat Island (Upper and Lower Lakes) – Aquatic Diversity	23	Bluegill
	NW Grant Slough – Aquatic Diversity	6	Bluegill
	Steamboat Slough – Flow Diversity	0.4	Walleye
	West SE Island – Mussel Habitat	1	Walleye
Floodplain[1]	Steamboat Island – Forest Topographic Diversity	14	Yellow Warbler/Gray squirrel
	Steamboat Island – Scrub-Shrub/Pollinator Topographic Diversity (Lower Lake)	5	Yellow Warbler
	USI Head – Forest Topographic Diversity	14	Yellow Warbler/Gray
	Grant Slough Complex – Forest Topographic Diversity (4 sites)	30	Yellow Warbler/Gray squirrel
	West SE Island – Forest Topographic	4	Yellow Warbler/Gray
TOTAL		97.4	

[1] TSI measures were not included in the initial habitat analysis, but they were anticipated to help restore the process and function of ~900 acres of floodplain forest in the Project Area. See Sections III.C.3 and IV for methods and results of the Hydrogeomorphic (HGM) Approach that was later applied to support the TSP.

B. Quality of Aquatic Benefits. The methodology utilized for evaluating benefits to aquatic habitat incorporates the HEP format, which was developed by the USFWS. 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. HEP is based on the assumption that habitat for selected fish and wildlife species can be described by a HSI. This index value (on a scale from 0.0 to 1.0) is multiplied by the area of applicable habitat to obtain HUs, which are used in comparisons of the relative value of fish and wildlife habitat at points in time.

Changes in HUs will occur as a habitat matures naturally or is influenced by development. These changes influence the cumulative HUs derived over the life of the Project (50 years). HUs are calculated for select target years and annualized (using IWR Planning Suite NER Annualizer) over the life of the Project to derive AAHUs. AAHUs are used as the output measurement to compare the measures and alternatives for the proposed Project.

1. Backwater Habitat. The Corps-approved (per EC 1105-2-412) Bluegill HSI model (Stuber et al. 1982a; Palesh and Anderson 1990) was used to assess the backwater habitat benefits resulting from the aquatic diversity measures at Upper Lake, Lower Lake, and NW Grant Slough. These species were selected because they require backwater habitat for all or most of their life cycle and are often limited in the availability of high quality overwintering habitat. The following assumptions in applying the Bluegill HSI model were made:

Baseline Condition. Detailed water quality data was collected from 2014 to present at monitoring stations in the backwater area. Due to the length of the data collection and location, it was assumed the data collected at each station was representative of the entire backwater. For the purposes of model input, the spawning season was May to June, growing season June to September, and overwintering December to February. It was assumed the water quality entering Steamboat Island interior was similar to Steamboat Slough and the main channel.

Future Without Project Conditions. Future conditions of all backwater lakes were based on an average sediment deposition rate of 1 cm/year over the next 50 years. This rate was determined based on information obtained from IADNR sedimentation studies (Aspelmeier, 1994). It is not likely that aquatic habitat loss would be linear, as most sedimentation occurs during flooding events. Nonetheless, over time aquatic habitat will be reduced significantly. Remaining lentic habitat will consist of isolated interior shallow pools with fish access only during high water events or small (< 0.14 acre) limited overwintering areas. It is probable that the Project area will continue to provide spawning habitat based on future floodplain conditions. Rearing and foraging habitat currently provided by the interior backwaters will be substantially reduced as remaining pool habitat will have impaired water quality or restricted access during average flows. Consequently, summer habitat will shift to another backwater complex or to other flowing channels, if available, in Pool 14. Finally, overwintering habitat will continue to be limited to near zero within the interior backwaters of the Project.

Future With Project Conditions. The proposed final depth of each backwater lake is 8 feet. With approximately 1.6 feet of sediment accumulating over 50 years, adequate depths would still be present for overwintering habitat. Therefore, it was assumed percent backwater greater than 4 feet in depth would increase to near 80% with a slight decrease over time due to sediment deposition on the slopes of the excavation site.

2. Riverine Habitat. The Corps-approved (per EC 1105-2-412) Walleye HSI model (McMahon et al. 1984) was used to assess the riverine habitat benefits resulting from West SE Island protection via riprap bank stabilization. Walleye was selected primarily because it is a popular host fish species for numerous freshwater mussels that inhabit the Project area. Walleye is rheophilic (or oriented to flow) and captures the benefits from an increase in forage, water clarity, and spawning habitat afforded by the restoration measures; therefore, the increasing of suitable fish hosts was assumed to have potential benefits to the freshwater mussel community. The following assumptions in applying the Walleye HSI models were made:
Baseline Condition. Water quality and hydraulic data from the main channel was assumed to be similar to the West SE Island. For the purposes of model input, the spawning season for walleye was March to May and growing season June to October. The 2019 mussel survey confirmed the absence of ideal mussel habitat as substrates were dominated by shifting sand and no mussels were recovered during the quantitative portion of the survey.

Future Without Project Conditions. It was assumed West SE Island would continue to experience erosion at a rate of 0.14 acres per year (see Appendix M, *Engineering Design* for more details on erosion rates). At its current estimated size of 0.36 acres, the island will have completely eroded within the span of a few years. Consequently, available habitat structure and cover, food production, and potential spawning habitat for walleye and mussels would be reduced.

Future With Project Conditions. Restoration and protection of the island would reduce erosion and potentially initiate island growth through reduced year-round velocities and aggradation of sediments. Rock would increase habitat structure for fish cover and because preferred mussel habitat is currently absent, no mussel impacts were assessed for the model. Due to the increase in habitat availability and complexity, cover and forage fish abundance is expected to increase. The stone protection area around the island was multiplied by a factor of 2 to create a "shadow effect" of preferred mussel habitat, amounting to approximately 1 acre. A very important element is the continued structure and function of the island and its potential indirect benefit as a buffer to the Cordova EHA. This continues to provide the functional attributes necessary for the freshwater mussel community to continue to exist, reproduce, and recruit to the population.

C. Quality of Floodplain Benefits. HEC-EFM was used to derive preliminary acreages for floodplain forest and scrub-shrub/pollinator benefits (Section V, *Development and Evaluation of Alternatives*). Threshold elevations to model aquatic, scrub-shrub, and forestry acres for the Project area were developed based on growing season inundation duration and exceedance probability determined by the PDT's best professional judgment (see Appendix M, *Engineering Design*). Time series analyses to identify the appropriate elevation threshold for each habitat type was performed using HEC-EFM. Acreages for each habitat type were then calculated based on existing conditions and with-Project terrains and elevation thresholds. Then, both the Corps-approved (per EC 1105-2-412) Yellow Warbler (Schroeder, 1982) and the Gray Squirrel (Allen, 1987) HSI models were employed to quantify the habitat benefits associated with increases in topographic diversity and bottomland forest restoration during both initial succession and forest maturation.

1. Forestry Habitat. Alternative restoration states include the area and height of topographic diversity. Topographic diversity is important because different plant communities occur within specific flood zones, and lack of physical diversity can lead to low plant community diversity, which has been seen in large rivers nation-wide. The upper limit of tree planting was identified as 576.2 feet NAVD88, which is based on the 25-percent exceedance probability for the minimally tolerant growing season inundation criteria (25-day inundation duration) and the lower limit of tree planting was identified based on the 25-percent exceedance probability for the moderately tolerant growing season inundation criteria (45-day inundation duration).

The Yellow Warbler HSI Model was used to assess pioneer floodplain forest habitat because yellow warblers prefer hydrophytic scrub-shrub habitat for foraging and nesting and are often limited in the availability of quality wet scrub-shrub habitat. For measures that only involve the planting of forestry habitat, the Yellow Warbler model was only modeled at TY 20 to represent the benefits accrued during initial succession of the floodplain forest. The following assumptions in applying the Yellow Warbler HSI model were made:

Baseline Condition. There is currently very few hard mast tree species available in the Project area. Areas that have the required elevation to support this habitat are either dominated by reed canary grass monocultures or have been eroded by increasing flood frequency and duration and higher water tables. A lack of tree regeneration, species diversity, and increased mortality characterizes the floodplain forest in the Project area.

Future Without Project Conditions. It is assumed that tree mortality and tree recruitment will continue at a rate similar to the last 30 years. Open canopy areas will continue to be degraded and likely result in reed canary grass monoculture development, especially in areas already dominated by this invasive species. For areas that currently have existing forestry habitat, it was assumed that increasing water inundation and duration and island erosion will result in a continued loss of topographic diversity.

Future With Project Conditions. Placement at these sites requires very little tree clearing (1.3 acres) and results in a significant increase in habitat benefits as areas currently dominated by reed canary grass monocultures are converted floodplain forest habitat with inclusion of hard mast tree species. Restoring island areas to optimum tree survival elevations also provides an increased buffer to backwater lakes, helping to slow down water during high flows and allow sediment to drop out prior to reaching potential overwintering habitat. TSI efforts (tree thinning treatments, tree planting, and invasive species management) would continue for the life of the Project (50 years) to further improve habitat health, diversity, and resilience of forestry sites.

The Gray Squirrel HSI Model was used to assess hard mast tree habitat because grey squirrels require diverse mast producing tree habitat for forage, cover, and reproduction, and are often limited in the availability of mast producing trees in the floodplain. The Gray Squirrel HSI was only modeled at TYs 30 and 50 to represent the amount of time it would take for tree plantings to mature and begin accruing habitat benefits. In applying the Gray Squirrel HSI model, the same assumptions were made as the Yellow Warbler HSI Model.

2. Scrub-Shrub/Pollinator Habitat. The Yellow Warbler HSI Model was used to assess pioneer floodplain forest habitat because yellow warblers prefer hydrophytic scrub-shrub habitat for foraging and nesting and are often limited in the availability of quality wet scrub-shrub habitat. For measures that only involve the planting of scrub-shrub/pollinator habitat, the yellow warbler model was used for all TYs to evaluate habitat benefits.

The upper limit for scrub-shrub/pollinator planting was identified as 573.1 feet NAVD88; this elevation is based on the 50-percent exceedance probability for maximum tolerant growing season inundation duration (55-day inundation duration). However, field observations by the Project forester support that scrub-shrub/pollinator species can thrive at higher elevations than the upper limit, so these plantings may be incorporated at higher elevations. The following assumptions in applying the Yellow Warbler HSI model were made:

Baseline Condition. There is currently very little scrub-shrub/pollinator habitat available in the Project area. Areas that have the required elevation to support this habitat are either dominated by reed canary grass monocultures or open water areas adjacent to existing scrub-shrub/pollinator habitat.

Future Without Project Conditions. Open canopy areas will continue to be degraded and likely result in reed canary grass monoculture development, especially in areas already dominated by this invasive species. For areas adjacent to existing shrub-shrub/pollinator habitat, it was assumed that sediment deposition and increasing water inundation and duration will result in a continued loss of topographic diversity.

Future With Project Conditions. Placement at these sites requires no tree clearing and removal and provides significant habitat benefits as reed canary monocultures are converted to scrub-shrub/pollinator habitat. Planting at sites near existing scrub-shrub/pollinator habitat will help to protect the existing habitat, while increasing and enhancing the habitat in that area. TSI efforts (buttonbush coppicing) would continue for the life of the Project (50 years) to further enhance the topographic diversity of scrub-shrub/pollinator habitat sites.

3. TSI Benefits Using HGM Approach. TSI measures were not included in the initial habitat analysis, but were anticipated to help restore the process and function of ~900 acres of floodplain forest in the Project area. Since TSI prescriptions were anticipated to be the same for all Final Array Project alternatives, the Hydrogeomorphic (HGM) Approach was later applied to support the TSP and demonstrate the additional benefits provided by TSI actions relative to the cost of the Project. The HGM Approach is a collection of concepts and methods for developing functional indices and using them to assess the capacity of a wetland to perform functions relative to similar wetlands in a region. This approach to functional assessment estimates the change in functioning induced by alteration of a wetland, either positive or negative. Though initially designed to be used in the context of the Clean Water Act Section 404 permit reviews, the HGM Approach can also be used to determine the amount of positive effects (i.e., increases in sustainable levels of functioning) normally through restoration of previously altered wetlands of the same type. For this assessment, the PDT used the Corps-certified HGM Approach for Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley (Klimas et al., 2004), a regional guidebook which provides the models and reference data used to assess the functional capacity of the floodplain forest to:

- Detain floodwater,
- Detain precipitation,
- Cycle nutrients,
- Export organic carbon,
- Maintain plant communities, and
- Provide habitat for fish and wildlife.

Similar to the HEP format, the PDT used the HGM approach and assessment models to evaluate habitat benefits resulting from TSI implementation, which are described as Functional Capacity Index (FCI) values (on a scale from 0.0 – 1.0). The FCI values for all functions were averaged and multiplied by area to derive net benefits (AAHUs) between the Future Without and Future With Project conditions at TY 50. The following assumptions in applying the Delta Region HGM guidebook to the Project area were made:

Baseline Condition. A lack of tree regeneration, species diversity, and increased mortality characterizes the floodplain forest in the Project area. The forest is currently dominated by over-mature even-aged silver maple stands, with limited regeneration and decreasing numbers of hard mast-producing trees. TSI prescriptions were derived from current environmental and forest conditions and focused on areas at higher risk of forest decline (approximately 900 acres).

Future Without Project Conditions. It is assumed that tree mortality and tree recruitment will continue at a rate similar to the last 30 years. Future average flood frequency and duration were also assumed to remain constant over the Project life (50 years). Without TSI implementation and successive tree recruitment, open canopy areas will continue to be degraded and likely result in reed canarygrass monoculture development. This slow progression over several decades will further increase the probability of conversion from closed-canopy forest communities to expansive acres of non-native herbaceous species. Thus, as mortality of even-aged silver maple stands increases, tree basal area (BA) and density are assumed to decrease by half from the baseline condition. These forecasted conditions for the FWOP were based on Corps' forester best professional judgment, reflecting reference stand conditions of the UMR that can reasonably be expected to occur without implementation of TSI in the Project area.

Future With Project Conditions. It is assumed that implementation of TSI will alter the long-term impacts of an overstocked forest, improving forest habitat health, diversity, and resilience in the Project area. TSI actions (tree thinning treatments, tree planting, and invasive species management) will continue for the life of the Project (50 years), gradually opening the forest canopy, providing light to understory seedlings and saplings and interspersed tree plantings, enabling recruitment of various tree ages, and reducing undesirable vegetation and competition for native species. In the short term, these alterations will help uniformly distribute needed growing space and sunlight throughout TSI areas during a single treatment window of just under 2 years, thereby reducing the risk of forest conversion to non-native species by creating favorable conditions to young tree establishment. After 50 years, the amount of growing space (BA) will increase from the baseline condition, while tree density will even out over the Project life. These forecasted conditions for the FWP were based on Corps' forester best professional judgment, reflecting reference stand conditions of the UMR that can reasonably be expected to occur following implementation of TSI in the Project area.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, ROCK ISLAND DISTRICT
PO BOX 2004 CLOCK TOWER BUILDING
ROCK ISLAND, ILLINOIS 61204-2004

September 30, 2020

Regional Planning and Environmental
Division North (RPEDN)

Mr. Reid Nelson, Director
Office of Federal Agency Programs
Advisory Council on Historic Preservation
401 F Street NW, Suite 308
Washington, DC 20001-2637

Dear Mr. Nelson:

The U.S. Army Corps of Engineers, Rock Island District is considering the Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP), Clinton and Scott Counties, Iowa, and Rock Island County, Illinois.

We are providing a fully executed original Programmatic Agreement (PA) (Enclosure 1). In addition, please find correspondence and other documentation setting out the history of this project (Enclosure 2). This PA addresses potential adverse effects to historic properties and is provided for filing with your office, as per 36 CFR 800. The Distribution List receiving this coordination is listed in Enclosure 3.

If you have questions regarding this matter, please contact Ms. Christine Nycz of our Environmental Compliance Branch, [redacted] or in writing to our address, ATTN: Planning, Programs, and Project Management Division (Christine Nycz).

Sincerely,

CRESWELL.JODI.K[redacted]
Digitally signed by CRESWELL.JODI.K[redacted]
Date: 2020.09.29 15:12:31 -05'00'

Jodi Creswell
Chief, Environmental Planning Branch RPEDN

Enclosures (2)

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX B

CLEAN WATER ACT SECTION 404(b)(1) ASSESSMENT:
NATIONWIDE PERMIT 27 JUSTIFICATION

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
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APPENDIX B

CLEAN WATER ACT SECTION 404(b)(1) ASSESSMENT: NATIONWIDE PERMIT 27 JUSTIFICATION

TABLES

FIGURE

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
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APPENDIX B

CLEAN WATER ACT SECTION 404(b)(1) ASSESSMENT:
NATIONWIDE PERMIT 27 JUSTIFICATION

I. CLEAN WATER ACT COMPLIANCE INTRODUCTION

The District and the USFWS are required to comply with Clean Water Act (CWA) Sections 401 and 404 for the *Steamboat Island Habitat Rehabilitation and Enhancement Project* (Project). This appendix details the District and USFWS justifications why this Project meets the conditions and requirements of CWA Nationwide Permit (NWP) 27 – Aquatic Habitat Restoration, Establishment, and Enhancement Activities.

Within its current regulatory program, the Corps has authority over work on structures in navigable waterways under Section 10 of the Rivers and Harbors Act of 1899 and over the discharge of dredged or fill material under Section 404 of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500). This latter requirement applies to wetlands and other valuable aquatic areas throughout the United States.

This assessment, in conjunction with the Environmental Assessment, will assist in analysis of the alternatives for this Project, resulting in the Recommended Plan. Furthermore, this evaluation will provide information and data to the States of Iowa and Illinois water quality certifying agencies demonstrating compliance with State water quality standards, informing the decision making process concerning State 401 water quality certification.

II. THE PERMITTING PROCESS

The Corps requires permits for building or developing in, on, or over wetlands and waters of the United States. The Corps regulatory program permit evaluation process results in permit decisions balancing the need for proposed development with protection of the nation's aquatic environment. The level of the Corps evaluation is commensurate with the level of the environmental impacts and the aquatic functions and values involved in the particular area being impacted. Authorization can range from programmatic permits to Individual Permit review. Impacts to higher ecological value areas would be subject to a much more detailed evaluation and a strong focus on avoidance and minimization of impacts to the aquatic environment. In the case of this Project, the planning team's CWA compliance procedures include:

- consulting with the local Corps regulatory office, which is located at the District headquarters office in Rock Island, Illinois. This consultation determined that the Project preliminarily complies with NWP 27 and would not require an Individual 404 Permit.

- demonstrating why NWP 27 would be the appropriate level of compliance. This appendix outlines the information the District's regulatory office reviewed to make their final concurrence/non- concurrence determination.

- having the District's Regulatory Branch provide a written statement of concurrence/non-concurrence, the information herein satisfies the use of NWP 27 (see Appendix A, *Correspondence).*

III. PROJECT DESCRIPTION

A. Location. The Project is located in the middle section of Pool 14 of the Upper Mississippi River in Clinton and Scott Counties, Iowa, and Rock Island County, Illinois. The Project area is between river miles (RM) 502.5 and 508.0, adjacent to the Cities of Princeton, Iowa, and Cordova, Illinois.

B. General Description. The District proposes to rehabilitate and enhance the Project through construction of measures that will increase the quality of year-round habitat for the fish community, increase floodplain forest vegetation diversity, and improve the overall structure and function of the Project. The purpose of this feasibility report is to present a detailed account of the planning, engineering, and construction details of the Recommended Plan to allow final design and construction to proceed subsequent to approval of this document.

C. Project Measures. The District performed a thorough plan formulation process to identify potential management measures and restoration actions addressing the Project objectives. Many alternatives, which are a combination of one or more measures, were considered, evaluated, and screened in producing a final array of alternatives. The District subsequently identified a Recommended Plan (Figure B-1). Sections IV, V, and VI of the Main Report details the plan formulation process, each measure of the Recommended Plan, as well as those measures the District also considered. The Recommended Plan includes: restoration of aquatic and topographic diversity, including forestry and SSP habitat, island restoration and protection, and timber stand improvement of bottomland hardwood forest. Refer to Appendix M, *Engineering Design,* for quantities and design details.

1. Aquatic Diversity Measures. Dredge cuts were designed to 60-feet bottom width where practicable. In some locations, the bottom width is narrowed down to 30 feet to avoid excavating land above the water surface. Side slopes of the dredge cut were designed at 4H:1V. Excavation would be to 8 feet below Flat pool, or elevation 563.2 feet NAVD88.

2. Topographic Diversity Measures. Topographic diversity sites were selected based on current vegetation quality and the proximity to potential dredge cut locations, as well as accessibility with construction equipment. Sites will be raised to an elevation of 576.2 feet NAVD88 and planted with tree species. A phased planting approach will be used to increase the probability of plant survivability and overall site success. Approximately 1.3 acres of tree clearing will be required to allow access to Grant Slough Placement sites 4 and 5, though the area will be re-planted when construction is complete.

3. Scrub-shrub/Pollinator (SSP) Habitat Measures. SSP sites were determined based on presence of low value vegetation dominated by reed canary grass and suitability of that site to support SSP vegetation, as well as accessibility with construction equipment. Sites will be raised to an elevation of 573.1 feet NAVD88 and planted with SSP species. A phased planting approach will be used to increase the probability of plant survivability and overall site success.

4. Island Protection and Restoration Measures. Island restoration sites were selected to build off existing islands and restore island footprint that has been lost from erosion. These measures include a combination of open water and bankline placement of dredged material and stone protection.

5. Timber Stand Improvement (TSI) Measures. Corps' foresters will continue to implement TSI measures at various locations within the Project area. These measures include tree plantings, thinning treatments, and non-desirable vegetation maintenance. It is estimated approximately 900 acres of active TSI strategies will be implemented in the next 10 years within the Project area.

6. General Description of Dredged and Fill Material. An estimated total of 510,692 cubic yards (cy) of material will be mechanically excavated within the Project area. Geotechnical soil borings from the pools indicate the material is soft lean clays and fat clays with an underlying layer of medium to fine sand. Elutriate testing or sieve analyses are not required (under Section 401 of the Clean Water Act) for this Project because material is unlikely to be a carrier of contaminants based on the HTRW Phase 1 assessment [40 CFR230.60 (b)]. In addition, the discharge and extraction sites are adjacent to one another and thus subject to the same source of contaminants [40 CFR230.60 (c)].

An estimated total of 131,622 tons (TN) of clean riprap will be used to restore and protect the head of Upper Steamboat Island (USI Head) (102,941 TN), the Northeast Bank (NE Bank) (22,403 TN), the West SE Island (6,115 TN), and to construct the Grade Control Structure (GCS) (162 TN) (Appendix P, *Plates*, Plate 8, C-102). During the pre-construction engineering and design (PED) phase of the Project, river stone will likely be incorporated on the slopes and toes of stone protection placement in the water to further enhance preferred mussel habitat. Only 1.3 acres of tree removal will be required for dredged material placement site access. To allow for any excess dredging that may occur, the dredged material will be placed within the topographic diversity sites that have a total capacity for 504,380 cy of material. Refer to Table B-1 for further details on the quantities for dredge cuts and placement.

Table B-1: Excavation and Fill Data Summary

	Dredging		Placement		
Dredge Cuts & Placement Sites	**Length (linear ft)**	**Dredging Quantity (cy)**	**Stone Length**	**Capacity (cy)**	**Stone (TN)**
SI Upper Lake	6,902	194,828	–	–	–
SI Lower Lake	5,758	170,158	–	–	–
Grant Slough Lake	3,377	87,704	–	–	–
Access to Grant Slough	3,017	10,721	–	–	–
Access to SE Island	372	855	–	–	–
Restore USI Head	–	–	3,863	274,530	102,941
NE Bank	–	–	1,589	30,990	22,403
West SE Island	–	–	418	76,020	6,115
SI Upper Lake Placement Site	–	–		10,972	–
Grant Slough Placement 2	–	–		11,886	–
Grant Slough Placement 4 & 5	–	–		47,503	–
GCS	–	–	264	561	162
Grant Slough Placement 1 (SSP)	–	–	–	3,077	–
Lower Lake SSP	–	–	–	2,988	–
Totals in Recommended Plan	19,426	464,266	6,134	458,527	131,622
Totals in Recommended Plan (accounts for shrinking/bulking)	**19,426**	**510,692**	**6,134**	**504,380**	**131,622**

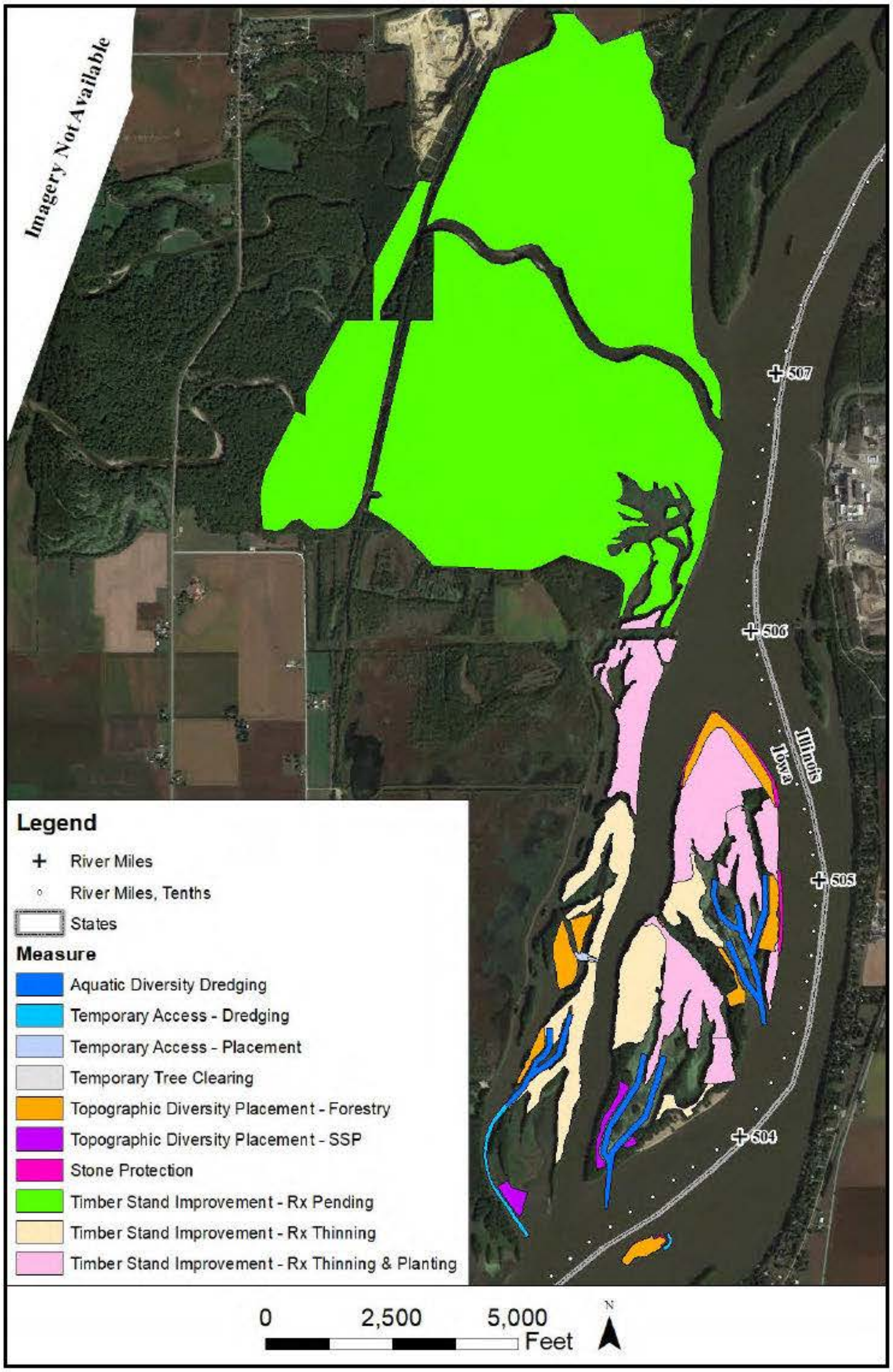

Figure B-1: Recommended Plan

IV. FACTUAL DETERMINATIONS

A. Physical Substrate Determinations

1. Substrate Elevation and Slope. Flat pool in the Project area is approximately elevation 571.2 (Lock and Dam 14, Le Claire, Iowa). The proposed Project measures intend to increase the floodplain elevation to increase topographic diversity. The maximum elevation of the dredged material placement sites is at elevation 576.2' NAVD88 for floodplain forest sites and 573.1' NAVD88 for SSP sites. Stone protection top elevation will be 574.0' NAVD88 at the West SE Island, 574.7' NAVD88 at the Head of Steamboat Island and 575.25' NAVD88 at the NE Bank. All stone will have slopes of 3H:1V river side and 1.5H:1V land side where applicable. Mussel substrate may be incorporated to stone protection on the slopes and toe of stone placement in the water.

2. Sediment Type. Surficial soils within the placement sites are generally fluvaquent soils, which is described as an alluvium product in the NRCS classification system. This series is described as frequently flooded and water table is said to vary between ground surface and 1 foot deep. Subsurface borings indicate the Project area generally consists of lean, medium, and fat clays gradually changing into stiff clay with increasing depth. This clay layer was underlain sporadically with medium to fine sand lenses.

3. Excavated/Fill Material Movement. Excavated material placement sites are in areas located above flat pool or low flow conditions, which indicates minimal movement of materials. Placement areas will be heavily planted with native hard mast and other floodplain trees, scrub-shrub species, and native grass species, which will help to ensure stability. Flat slopes have been designed to reduce any loss of slope or height that may occur as a result of settling or erosion during high flow events (2-year flood). Rock placement should experience minimal material movement. Adequate rock size is proposed to reduce settling and material movement during high flow events.

4. Physical Effects on Benthos. Any immobile benthos present at the placement site would be buried as a result of construction activities. With the increase in aquatic vegetation, woody debris, and rock, benthic organisms should recolonize quickly.

5. Actions Taken to Minimize Impacts. The construction footprint was kept as small as possible to minimize impacts to the benthic community. Construction materials to be used are physically stable and clean, reducing the chances for impacting the river. Mechanical excavation prevents excess water runoff back into the river and reduces instability by keeping the material consolidated. Tree plantings, ground cover, and erosion control materials will be installed following berm shaping.

B. Water Circulation, Fluctuation, and Salinity Determinations

1. Water. No significant differences in water chemistry are expected following Project construction, and no violations of applicable state water standards are anticipated. The rock materials are inert material that would have little effect on water chemistry. Water clarity, odor, taste, pH, temperature, and dissolved gas levels would not change. The nature of all fill materials would not cause any significant changes in nutrient levels. The construction should not impair the aquatic ecosystem's capability to sustain life, or reduce the suitability of the Mississippi River for aquatic organisms, human consumption, recreation, or aesthetics.

2. Current Patterns and Circulation. Shallow water placements could have a minor effect on flow patterns in the immediate vicinity of the structures. However, no measurable reductions of inflow to backwater areas are anticipated. No significant effects to existing current patterns or water circulation are expected to result from this action.

3. Normal Water Level Fluctuation. No changes in normal water level fluctuations are anticipated to result from the proposed Project.

4. Salinity Gradient. This consideration is not applicable in the location of the proposed Project.

5. Actions Taken to Minimize Impacts. The construction footprint was kept as small as possible and measures were designed and aligned to minimize any potential for adverse effects to water circulation and fluctuation.

C. Suspended Particulate/Turbidity Determinations

1. Expected Changes in Suspended Particles and Turbidity Levels in Vicinity of Placement Site. Suspended solids and turbidity values would be expected to temporarily increase during excavation and placement. A return to ambient conditions should occur shortly after completion of construction. No long-term impacts to suspended solids and turbidity levels are anticipated.

2. Effects on Physical and Chemical Properties of the Water Column

- **Light Penetration.** The Project would have short-term adverse impacts during construction due to turbidity plumes. Following construction, turbidity and associated light penetration would be expected to return to pre-construction levels.

- **Dissolved Oxygen (DO).** Placement of excavated material should have no short- or long-term adverse impacts on DO levels. Aquatic diversity measures should help to maintain DO in the Project area at levels (5 mg/l minimum) suitable for year-round fish habitat.

- **Toxic Metals and Organics.** No increase in contaminants in the aquatic environment would result from the placement of fill material. Excavating and placement of fine material is not expected to have toxic effects on fish, wildlife, or other aquatic organisms.

- **Aesthetics.** Temporary increases in suspended sediments would have a minor short-term impact on aesthetics in the Project area. No long-term negative effects on aesthetics are anticipated to result from the Project.

3. Effects on Biota. Minor disturbances to organisms present in the construction zone could occur as a result of fill activity and excavating. These disturbances are short-term and are offset by the overall lift to the local natural resources.

D. Contaminant Determinations. No contaminants that would exceed State standards have been identified in substrates to be excavated. Possible introduction by equipment or construction-related contaminants would be controlled by adherence to runoff monitoring plans during construction activity. No toxic materials would be introduced to the area as a result of construction activities. Rock riprap would be clean, uncontaminated stone from an approved source.

E. Aquatic Ecosystem and Organism Determinations

1. Effects on Plankton. Only short-term and minimal effects are anticipated to occur as a result of excavating and fill activity. No significant impacts to plankton are expected.

2. Effects on Benthos. No significant impacts to benthos at the placement site or at the location of mechanical excavating are anticipated. For the most part, aquatic substrates would be affected incidentally to adjacent construction activities. Aquatic substrates would be directly affected by mechanical excavating. These substrates would eventually be covered with material of similar character. Recolonization of benthic organisms should occur quickly.

3. Effects on Nekton. The restoration of backwaters would substantially improve the quality of fish habitat in this area. The primary factor that is limited at present and at risk in the future is overwintering habitat, due to limited deep off-channel aquatic areas protected from high current velocities. Channel excavation in the aforementioned backwater lakes would ensure areas of suitable depth, flow, dissolved oxygen, and temperature would be available during severe winter conditions in the future.

4. Effects on Aquatic Food Web. The loss of the benthic organisms within the footprint of the riprap bank protection should not cause any significant impact to any level/segment of the aquatic food web, or disrupt the flow of energy between trophic levels. This small benthic loss should not result in the reduction or potential elimination of food chain organism populations and should not cause any decrease in the overall productivity and nutrient export capability of the ecosystem.

Improvements in backwater and riverine habitat through aquatic vegetation establishment, spawning and overwintering habitat protection, and increased depth should increase primary and secondary production in the Project area. This increase in production should lead to an increased forage base for fish and wildlife.

5. Effects on Special Aquatic Sites

- **Sanctuaries and Refuges.** The Project area is located within the UMR NWFR. There are many designated "closed areas" found in the Refuge, but none of these occur within or will be impacted by the Project area.

- **Wetlands, Mud Flats and Vegetated Shallows.** The Project area contains 2,013 acres of interconnected backwaters, secondary channels, wetlands, and floodplain habitat. The Project involves excavating material from Upper and Lower Steamboat Island Lakes and NW Grant Slough Lake to restore approximately 42 acres of backwater overwintering habitat. In order to be considered a wetland under the 1987 Corps of Engineers Wetland Delineation Manual, three criteria are required: *hydric soils, hydrophilic vegetation, and* *hydrology*. The following describes how the proposed sites will stay within this criteria after placement of material to provide topographic diversity:

- ***Hydric Soils.*** Section IV.A above outlines the types of soils that are present in and around the Project area, which are generally classified as Ambraw-Perks-Lawson complex, which is described as an alluvium product in the NRCS classification system. Borings were taken approximately 12 feet deep from the top of water elevation (575.35 NAVD88). Below ground surface materials depths ranged between 4.5 and 7.0 feet and are composed of lean, medium, and fat clays. Atterberg limit tests were performed on several of the clay samples gathered throughout the site. Results for liquid limits ranged between 45 and 83, and plastic limits between 20 and 32 (for more detail, see Appendix G, *Geotechnical Considerations*).

- ***Vegetation.*** The dominant wetland type that currently exist in the Project area is considered freshwater forested. Following placement of the excavated material, 67 acres of reed canary grass monocultures will be converted to higher quality bottomland hardwoods. Roughly 51% of the island is at an elevation (> 574 feet) suitable to contain hard mast producing trees; however, there are very few areas currently supporting hard mast trees and those that are present are on average over 88 years (ranged 1874 to 1964) old and contain little production in the understory. This lack of production is directly related to increased water inundation and duration. Current topography shows a significant portion of the Project is low in elevation and below the threshold for producing a sustainable hard mast producing tree population and it is highly unlikely present trees will regenerate without intervention in the next 50 years. The proposed plan effectively works to stop and reverse this trend; thus, increasing habitat availability and quality for migratory birds (i.e., neotropical, waterfowl, bald eagle, heron rookeries), endangered species (i.e., Indiana bat, northern long-eared bats), general wildlife, reptiles and amphibians, etc.

  The placement sites will either be sloped to drain, or will have +0’ to -1.5’ elevation changes to create swales across the wider sites. Once shaping is complete, temporary seeding may be employed if permanent seeding cannot occur immediately. This area would be planted with various forested wetland trees, understory species, forested wetland shrubs, and be surrounded by buffer species as listed in Appendix M, *Engineering Design*.

  According to the Corps’ National Wetland Plant List and Indicator Rating Definitions, obligate indicator status is defined as occurring at a 99% rating under natural conditions in wetlands. Currently, the obligate species *Cephalanthus occidentalis* (buttonbush) is present above elevations of 573.1 in the Project area. Therefore, it is assumed that the wetland vegetation planted at/or above 573.1 feet will be successful for the life of the Project.

- ***Hydrology.*** Corps Regulatory defines wetland hydrology (1987 Corps of Engineers Wetlands Delineation Manual) as inundation or saturation to the surface continuously for at least 5% of the growing season in most years (50% probability of recurrence). Utilizing further guidance in this manual, the growing season for Clinton

County was established using the NOAA Regional Climate Center AgACIS output for the days above 28 degrees F with a 50% chance of the growing season occurring therein, and the 1987-2016 period of temperature record. The resulting growing season was April 12 to October 20. Five percent of the growing season (191 days) is equivalent to 9.55 days which is rounded to 10. The USACE Regulatory team member provided that a 14-day analysis is preferred over 5% of the growing season (10-day). River stages at the Camanche gage (RM 511.8) for the 20-year period 1997-2016 were used in HEC-EFM to determine the maximum of the 14-day minimum elevations (during the growing season) that has a 50% probability of occurring. The resulting elevation was interpolated upstream to the Project location (RM 504.5) and converted to the NAVD88 datum arriving at elevation 574.9 feet. The upper limit for the tree planting elevation was based upon the 25 percent exceedance probability for the minimally tolerant growing season inundation criteria (25-day inundation duration), which is 575.2 feet at RM 504.5. In compliance with ECB 2014-10, consideration of climate change and future hydrologic conditions during the 50-year period of analysis was given with the appropriate floodplain forest design elevation selected at a maximum of 576.2 feet. While the maximum wetland elevation in this area was lower than the maximum elevation selected by the PDT for the proposed Project, the 1987 Corps Regulatory Manual does not include consideration of climate change and future hydrology.

6. Threatened and Endangered Species. No bat surveys have been conducted for the Project. Only 1.3 acres of tree clearing will be required for access to topographic diversity sites, which will be conducted outside the maternity roost season. Two summer mussel surveys resulted in the identification of low to moderate quality mussel habitat and no federally-listed species were recovered in the proposed design footprint. The overall forested habitat which exists in the Project area is approximately 1,674 acres. When compared to the number of acres potentially affected by the Project, the District determined tree clearing to be about 0.07 percent of the total.

The proposed excavating of the backwaters in the Project area should have no direct impacts to the Higgins eye pearly mussel since the backwaters do not appear to contain suitable habitat. It is estimated approximately 900 acres of active TSI strategies will be implemented in the future in the Project area.

Correspondence from the USFWS indicates no impacts are anticipated to threatened or endangered species or their habitats, provided construction activities are scheduled and monitored to avoid direct impacts, conservation measures are implemented, and conditions do not change significantly (Appendix A, *Correspondence*).

7. Other Wildlife. Wildlife species that utilize forested and non-forested wetland habitats should benefit in the long term from the proposed action.

F. Proposed Placement Site Determinations

1. Mixing Zone Determinations. Discussions pertaining to turbidity and suspended particulates are summarized in Section II. I. Contaminants were discussed previously in Section II, N.

2. A small amount of fine-grained material could migrate from the placement sites and become diluted with adjacent side channel and main channel border flow. Fine-grained material used for construction of the topographic diversity feature would result in temporary localized increases in suspended material. The use of mechanical excavating should help to minimize these effects.

3. Determination of Compliance with Applicable Water Quality Standards. Due to the nature of this Project and the proposed aquatic habitat improvement, it will be covered under Nationwide Permit 27, which includes Section 401 Water Quality Certification for the States of Illinois and Iowa, under Section 404 of the Clean Water Act.

4. Potential Effects on Human-Use Characteristics. Implementation of the proposed Project will have no significant adverse effects on municipal or private water supplies; recreational or commercial fisheries; water-related recreation or aesthetics; parks; national monuments; or other similar preserves.

5. Determination of Cumulative Effects on the Aquatic Ecosystem. The District continues the operation and maintenance of the 9-foot Navigation Channel Project. This includes continuation of excavating and placement of sediment and dike construction (i.e., chevrons, closing structures, and wing dams).

Corps' foresters will continue to implement TSI measures at locations within the Project area. These measures include tree plantings, thinning treatments, and non-desirable vegetation maintenance. These efforts will continue in the future on the island. It is estimated approximately 900 acres of active TSI strategies will be implemented for the duration of the Project.

It is anticipated within the next 10 years, the Steamboat HREP and other HREP Projects will commence planning efforts for implementation. These would be similar to Steamboat Island with objectives for increased backwater depth, topographic diversity, floodplain vegetation diversity, and restored aquatic processes.

Cumulative impacts of the proposed action are not expected to be significant. The Project offers a unique opportunity to restore and enhance fish and wildlife resources in this section of Pool 14. The multi-agency coordination effort has demonstrated the value of this Project towards maintaining a high quality UMR ecosystem while avoiding adverse impacts. Steamboat Island HREP, Beaver Island HREP, and Princeton Refuge HREPs represent a cumulative synergy of habitat restoration in Pool 14 to restore degraded environmental conditions within the backwater and floodplain forest habitats that will benefit migratory birds, fish, other wildlife, and plants.

5. Determination of Secondary Effects on the Aquatic Ecosystem. No significant secondary effects should result from construction of the proposed Project.

V. NATIONWIDE PERMIT (NWP) COMPLIANCE DOCUMENTATION

In order to use a NWP, the Project must comply with four sets of conditions:

- General NWP conditions
- NWP 27 special conditions

- IL-EPA 401 Water Quality Certification conditions
- Iowa 401 Water Quality Certification conditions

For the full language of NWP permit conditions and NWP 27 special conditions, refer to the District's Regulatory Branch website for *Nationwide Permits – Illinois* and *Nationwide Permits – Iowa* links.

Table B-2 shows the 32 general NWP conditions and the District's compliance responses.[1] Table B-3 shows the eight NWP 27 special conditions and the District's compliance responses[1]. There are nine Illinois Regional Conditions for NWP use. Table B-4 documents the District's response to each Condition.

The Illinois Environmental Protection Agency (IEPA) has conditioned Section 401 water quality certification applicable to NWP 27. Department of the Army authorization pursuant to Section 404 of the CWA (33U.S.C.1344) under NWP 27 would be subject to the IEPA conditions. All activities conducted under NWP 27 shall be in accordance with the provisions of 35 Il. Adm. Code 405.108.

Table B-5 shows the IEPA Section 401 Water Quality Certification conditions for NWP 27 and the District's compliance responses[1].

Iowa has conditioned Section 401 water quality certification applicable to NWP 27. Department of the Army authorization pursuant to Section 404 of the CWA (33U.S.C.1344) under NWP 27 will be subject to the Iowa conditions. Table B-6 shows the Iowa Regional Conditions Section 401 Water Quality Certification conditions for NWP 27 and the District's compliance responses.

VI. CONCLUSION

The planning team concludes this Project meets the conditions of CWA, Section 404 by an existing Department of Army NWP for aquatic habitat restoration, establishment and enhancement activities, as described in the January 6, 2017, Federal Register, Reissuance of Nationwide Permits; Notice (82 FR 1860).

The District and USFWS realize NWP 27 may be modified, reissued, or revoked prior to construction or on March 19, 2022. The planning team would remain informed of changes to the NWPs. If construction activities are not completed prior to 12 months from the date of the modifications or revocation of the NWP, the team would reevaluate the Project's 404(b)(1) compliance status and would coordinate the Project with the District's Regulatory Branch. The Project would be in full compliance with the current CWA regulations prior to any construction and activities.

[1] The Main Report contains detailed discussions on most of these topics. If the Main Report does not address the condition, a detailed response is presented in these tables.

Table B-2: General NWP Conditions and Compliance Responses

#	General NWP Condition	Compliance Response
1	Navigation	No navigation impacts expected. Project measures would not impact the 9-foot navigation channel in the UMRS. The Project would not impact barge operation, safety, or tow handling. The Project would not impact recreation boating.
2	Aquatic Life Movements	Positive impacts expected with Project objective of creating year-round fish habitat.
3	Spawning Areas	Project measures anticipated to improve quality spawning habitats over the life of the Project for fish and wildlife. This quality would last over the life of the Project.
4	Migratory Bird Breeding Areas	Project measures would not negatively impact emergent wetland habitat for bird nesting habitat (see Appendix D).
5	Shellfish Beds	No shellfish beds present in the Project area
6	Suitable Material	Only local material (sand and clay) would be used for topographic diversity placement sites. Planted trees would be from local seed sources and flood tolerant.
7	Water Supply Intakes	No public water supply intakes present in the Project area.
8	Adverse Effects From Impoundments	No anticipated impoundments as part of the Project.
9	Management of Water Flows	Project measures would handle fluctuating water levels including fluctuating river levels.
10	Fills Within 100-Year Floodplains	This Project would comply with applicable FEMA approved floodplain management requirements.
11	Equipment	Use of heavy equipment would be done in dry conditions and would not impact the water column clarity or water quality standards. If construction would take place in wet conditions, turbidity would be short term and no material would be allowed to migrate off site.
12	Soil Erosion and Sediment Controls	The Project would require standard construction guidelines to avoid erosion and sediment re-suspension.
13	Removal of Temporary Fills	Temporary coffer dams would be removed and their locations would be restored to preconstruction conditions.
14	Proper Maintenance	The USFWS would maintain Project measures over the 50-year Project life.
15	Single and Complete Project	The Project would be a single project.
16	Wild and Scenic Rivers	Not Applicable
17	Tribal Rights	Not Applicable

Table B-2: General NWP Conditions and Compliance Responses

#	General NWP Condition	Compliance Response
18	Endangered Species	Full Compliance. See Main Report Section IX.E.
19	Migratory Birds and Bald and Golden Eagles	An eagle nest at the USI head was last observed as active in 2017. Any tree thinning would be minimal near this area to avoid disturbance. Seasonal limitations will be in compliance with USFWS regulations.
20	Historic Properties	Pending; anticipate Full Compliance. See Main Report Section IX.G.
21	Discovery of Previously Unknown Remains and Artifacts	The District Engineer would be notified immediately and coordination initiated, if previously unknown remains and artifacts are discovered.
22	Designated Critical Resource Waters	This Project is not located in or contains any Designated Critical Resource Waters
23	Mitigation	This Project would not require wetland mitigation.
24	Safety of Impounded Structures	Not Applicable.
25	Water Quality	This Project would comply with the Illinois & Iowa water quality standards (See Tables B-4, B-5 and B-6.)
26	Coastal Zone Management	Not Applicable
27	Regional and Case-By-Case Conditions	Not Applicable
28	Use of Multiple Nationwide Permits	The Project PDT requests only NWP 27.
29	Transfer of NWP Verifications	The PDT anticipates USFWS management of the Project site for the 50-year Project life.
30	Compliance Certification	The USFWS would submit the compliance certification upon receipt of the NWP.
31	Activities Affecting Structures or Works Built by the United States	This Project does not require Section 408 permission.
32	Pre-Construction Notification	Full compliance expected.

Table B-3: Nationwide Permit 27 Conditions and Compliance Responses

#	NWP 27 Condition	Compliance Response
1	Project Intent. Does it meet the intent of aquatic habitat restoration, establishment, and enhancement activities?	This Project's goals and objectives (Main Report Section III, G.) meet the intent of aquatic habitat restoration, establishment, and enhancement.
2	Tidal Areas	This Project does not include any tidal areas
3	Net increase in aquatic resource function and services.	Project measures would provide quality aquatic resources/habitats over the life of the Project for fish and wildlife. Without Project, bottomland floodplain and aquatic habitat would decline from extended inundation periods and sedimentation of backwaters. See Appendix D, which demonstrates a net increase in habitat value.
4	Project features meet the NWP intent	Project measures include backwater dredging to restore aquatic diversity, dredge placement to enhance topographic diversity of bottomland forest and SSP habitat, and island restoration and protection.
5	Alteration of a stream or natural wetlands is prohibited	The proposed Project would not alter any stream or areal quantity of wetland habitats.
6	Reversion	Not applicable
7	Reporting	Full compliance expected.
8	Notifications	Full compliance expected.

Table B-4: Illinois Regional Conditions and Compliance Responses

#	Illinois Regional Condition	Compliance Response
1	Stormwater management facilities shall not be located within a stream,	The Project is not a stormwater project.
2	For newly constructed channels through areas that are unvegetated, native grass filter strips, or a riparian buffer with native trees or shrubs, a minimum of 25 feet wide from the top of bank must be planted along both sides of the new channel. A survival rate of 80% of desirable native species with aerial coverage of at least 50% shall be achieved within 3 years of establishment of the buffer strip.	Aquatic diversity sites were aligned with deepest parts of existing backwater areas to minimize dredging and design with nature. Channels are offset of 30 feet from topographic diversity sites, which will be planted with floodplain forest or SSP species and are designed to heights for plant survivability. A phased planting approach and adaptive management strategy will be employed to ensure plant survival.
3	Side slopes of a newly constructed channel will be no steeper than 2:1 and planted to permanent, perennial, native vegetation if not armored.	The proposed channels would have side slopes greater than 2H:1V. Since they are underwater, the slopes would quickly revegetate.
4	For a single-family residence authorized under Nationwide Permit No. 29, the permanent loss of waters of the United States (including jurisdictional wetlands) must not exceed 1/4 acre.	Not applicable.
5	For NWP 46, the discharge of dredged or fill material into ditches and canals that would sever the jurisdiction of an upstream water of the United States from a downstream water of the United States is not allowed.	Not applicable.
6	For NWP 52, no project will be authorized within Lake Michigan. An individual permit will be required.	Not applicable.
7	Any bank stabilization activity involving a method that protrudes from the bank contours, such as jetties, stream barbs, and/or weirs, will require a pre-construction notification in accordance with General Condition 32.	No bank stabilization would involve a method that protrudes from the existing bank contours.
8	Mitigation shall be constructed prior to, or concurrent with, the discharge of dredged or fill material into waters of the United States unless an alternate timeline is specifically approved in the authorization.	No mitigation is proposed for this ecosystem restoration and enhancement project.
9	Operation of heavy equipment within the stream channel should be avoided. If in-stream work is unavoidable, it shall be performed in such a manner as to minimize the duration of the disturbance, turbidity increases, substrate disturbance, bank disturbance, and disturbance to riparian vegetation. This condition does not further restrict otherwise authorized drainage ditch maintenance activities.	All heavy equipment operation would use BMPs to reduce turbidity and substrate and vegetation disturbances.

Table B-5: IEPA Section 401 Water Quality Certification for NWP 27 Conditions

#	IEPA Section 401 Water Quality Certification for NWP 27	Compliance Response
1	All activities conducted under NWP 27 shall be in accordance with the provisions of 35 Ill. Adm. Code 405.108. Work in reclaimed surface coal mine areas are required to obtain prior authorization from the Illinois EPA for any activities that result in the use of acid-producing mine refuse.	Not applicable. No acid-producing mine refuse would be used in this Project
2	The applicant shall not cause:	
	a. violation of applicable provisions of the IEPA; **b.** water pollution defined and prohibited by the IEPA; **c.** violation of applicable water quality standards of the Illinois Pollution Control Board, Title 35, Subtitle C: *Water Pollution Rules and Regulation*; **d.** interference with water use practices near public recreation areas or water supply intakes.	Full compliance expected. A public boat launch is within the Project area; access to the area would be limited during construction.
3	All areas affected by construction shall be mulched and seeded as soon after construction as possible. The applicant shall undertake necessary measures and procedures to reduce erosion during construction. Interim measures to prevent erosion during construction shall be taken and may include the installation of sedimentation basins and temporary mulching. All construction within the waterway shall be conducted during zero or low flow conditions. The applicant shall be responsible for obtaining an NPDES Storm Water Permit prior to initiating construction if the construction activity associated with the project will result in the disturbance of 1 or more acres, total land area. An NPDES Storm Water Permit may be obtained by submitting a properly completed Notice of Intent form by certified mail to the Agency's Division of Water Pollution Control, Permit Section.	Full compliance expected. Contractor would acquire NPDES permits, if required. Contractor would use erosion reduction BMPs.

Table B-6: Iowa Regional Conditions and Section 401 Water Quality Certification for NWP 27 Conditions

#	Iowa Section 401 Water Quality Certification for NWP 27	Compliance Response
1	Side slopes of newly constructed channel will be no steeper than 2:1 and planted to permanent, perennial, native vegetation if not armored.	The proposed channels would have side slopes greater than 2H:1V. Since they are underwater, the slopes would quickly revegetate.
2	Nationwide permits with mitigation may require recording of the nationwide permit and pertinent drawings with the Registrar of Deeds or other appropriate official charged with the responsibility for maintaining records of title to, or interest in, real property and require the permittee to provide proof of that recording to the Corps.	The Project does not require mitigation.
3	Mitigation shall be scheduled prior to, or concurrent with, the discharge of dredged or fill material into waters of the United States, unless an alternate timeline is specifically approved in the authorization.	Not applicable.
4	For newly constructed channels through areas that are unvegetated, native grass filter strips, or a riparian buffer with native trees or shrubs a minimum of 35 feet wide from the top of the bank must be planted along both sides of the new channel. A survival rate of 80 percent of native species shall be achieved within 3 years of establishment of the buffer strip.	Aquatic diversity sites were aligned with deepest parts of existing backwater areas to minimize dredging and design with nature. Channels are offset of 30 feet from topographic diversity sites, which will be planted with floodplain forest or SSP species and are designed to heights for plant survivability. A phased planting approach and adaptive management strategy will be employed to ensure plant survival.
5	For single-family residences authorized under nationwide permit 29, the permanent loss of waters of the United States,(including jurisdictional wetlands, must not exceed ¼ acre.	Not applicable.
6	For nationwide permit 46, the discharge of dredged or fill material into ditches that would sever the jurisdiction of an upstream water of the United States from a downstream water of the United States is not allowed.	Not applicable.
7	For projects that impact an Outstanding National Resource Water, Outstanding Iowa Water, fens, bogs, seeps, or sedge meadows, a Pre-Construction Notice in accordance with General Condition No. 32 and an Individual Section 401 Water Quality Certification will be required.	Mississippi River is a Special Waters of Concern and Project will be coordinated for comments.

Table B-6: Iowa Regional Conditions and Section 401 Water Quality Certification for NWP 27 Conditions

#	Iowa Section 401 Water Quality Certification for NWP 27	Compliance Response
8	For nationwide permits when the Corps District Engineer has issued a waiver to allow the permittee to exceed the limits of the nationwide permit, an individual Section 401 Water Quality Certification will be required.	Not applicable.
9	Operation of heavy equipment within the stream channel should be avoided. If in-stream work is unavoidable, it shall be performed in such a manner as to minimize the duration of the disturbance, turbidity increases, substrate disturbance, bank	Heavy equipment will be used and operated within the stream channel. However, it shall be performed in such a manner as to minimize the duration of the disturbance, turbidity
10	Any bank stabilization activity involving a method that protrudes from the bank contours, such as jetties, stream barbs, and/or weirs, will require a pre-construction notification in accordance with General Condition 32.	No bank stabilization would involve a method that protrudes from the existing bank contours.
11	Beyond what is described in General Condition #6, suitable fill material shall consist of clean materials, free from debris, trash, and other deleterious materials. If broken concrete is used as riprap, all reinforcing rods must be cut flush with the surface of the concrete, and individuals pieces of concrete shall be appropriately graded and not exceed 3 feet in any dimension. Asphalt, car bodies, and broken concrete containing asphalt, and liquid concrete are specifically excluded.	Only local material (sand and clay) would be used for topographic diversity placement sites. Planted trees would be from local seed sources and flood tolerant.
12	No non-native, invasive or other plant species included on the Corps "Excluded Plant List" shall be planted for re-vegetation or stabilization purposes. To prevent the spread of non-native and/or invasive plant species, the permittee shall ensure that equipment to be utilized in Water of the United States is cleaned before arriving on site. Wash water shall not be discharged into any wetland, waterway,	Only native vegetation will be planted as part of the Project. Many of the topographic diversity sites to be planted occur on sites currently occupied by reed canary grass monocultures.

UPPER MISSISSIPPI RIVER RESTORATION
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POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX B

CLEAN WATER ACT SECTION 404(b)(1) EVALUATION

FINDINGS OF COMPLIANCE OR NONCOMPLIANCE WITH CWA AND NWP 27

1. Alternatives considered for the proposed action are as follows:

Alternative A: No Federal Action

Alternative B: Recommended Plan. This includes dredging deep water habitat, placement and shaping of dredged material for the purposes of restoring a diverse forest community, and providing stone protection at various locations in the Project area to reduce island erosion, provide bank stabilization, and improve mussel substrate.

2. No significant impacts to federally-endangered species will result from this Project. The U.S. Fish and Wildlife Service, Ecological Services Office, Moline, Illinois, supports this determination.

3. The proposed Project meets the conditions of Section 404 of the CWA by an existing Department of the Army NWP for aquatic habitat restoration, establishment and enhancement activities as described in the January 6, 2017, Federal Register, Reissuance of Nationwide Permits, Notice (82 FR 1860).

Digitally signed by SATTINGER.STEVEN.MICHAEL.1164506939
Date: 2021.02.16 11:57:22 -06'00'

16 February 2021

(Date)

Steven M. Sattinger, P.E.
Colonel, US Army
Commander & District Engineer

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX C

MEMORANDUM OF AGREEMENT

MEMORANDUM OF AGREEMENT
BETWEEN
THE DEPARTMENT OF THE ARMY

AND

THE UNITED STATES FISH AND WILDLIFE SERVICE

FOR

HABITAT REHABILITATION AND ENHANCEMENT
OF THE
UPPER MISSISSIPPI RIVER SYSTEM
AT STEAMBOAT ISLAND, MISSISSIPPI RIVER POOL 14,
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

I. PURPOSE

The purpose of this Memorandum of Agreement (MOA) is to establish the relationships, arrangements, and general procedures under which the U.S. Fish and Wildlife Service (USFWS) and the Department of the Army (DA) will operate in constructing, operating, maintaining, repairing, and rehabilitating the *Steamboat Island, Clinton & Scott Counties, Iowa, and Rock Island County, Illinois, Habitat Rehabilitation and Enhancement Project* (Project), a separable element of the Upper Mississippi River Restoration.

II. BACKGROUND

A. The Project lands of the *Steamboat Island, Clinton & Scott Counties, Iowa and Rock Island County, Illinois, Habitat Rehabilitation and Enhancement Project* are owned in fee by the United States of America and managed under the provisions of a cooperative agreement between the DA and the USFWS, dated February 14, 1963, and an amended cooperative agreement dated July 31, 2001.

B. Section 1103 of the Water Resources Development Act (WRDA) of 1986, Public Law 99-662, authorizes construction of measures for the purpose of enhancing fish and wildlife resources in the Upper Mississippi River System. Under conditions of Section 906(e) of the WRDA of 1986, Public Law 99-662, 100 percent of the construction costs of those fish and wildlife features for the Project are the responsibility of the DA. Pursuant to Section 107 (b) of the WRDA of 1992, Public Law 102-580, 100 percent of the costs of operation and maintenance for the Project are the responsibility of the USFWS.

III. GENERAL SCOPE

The Project to be accomplished pursuant to this MOA shall consist of the following:

- Enhancing and restoring areal coverage and diversity of forest stands and habitat and increasing diversity of bottomland hardwood forest in select areas by:
  - increasing existing elevations and planting trees, shrubs, understory plants, and buffer species;
  - performing Timber Stand Improvement (TSI) measures such as tree thinning treatments, tree planting, and invasive species management;

- Increasing year-round aquatic habitat diversity in the Steamboat Island proper backwater in Upper Lake and Lower Lake, as well as Northwest Grant Slough Lake in the Grant Slough complex through excavation and additions of fisheries structure;

- Restoring and protecting acreage and topography of islands within the Project area by placing and protecting dredged material to extend existing island footprints; and

- Protecting existing backwater habitat from sediment deposition and enhancing backwater and interior wetland areas by the construction of a grade control structure at the northwest end of the Cut-Through Channel and establishment of scrub-shrub/pollinator habitat.

IV. RESPONSIBILITIES

A. The Department of the Army Responsibilities

1. Construction. Construction of the Project consists of excavating channels to provide overwintering habitat in backwater areas, constructing topographic diversity sites, to include forest, scrub/shrub, and pollinator habitat restoration and enhancement, implementing TSI techniques, restoring and protecting islands, constructing a grade control structure, and incorporating fish and mussel habitat, where appropriate.

2. Major Rehabilitation. The Federal share of any mutually agreed upon rehabilitation of the Project that exceeds the annual operation and maintenance requirements identified in the Feasibility Report with Integrated Environmental Assessment and that is needed as a result of specific storm or flood events.

3. Construction Management. Subject to and using funds appropriated by the Congress of the United States, and in accordance with Section 906(e) of the WRDA of 1986, Public Law 99-662, the DA will construct the Steamboat Island Habitat Rehabilitation and Enhancement Project as described in the *Upper Mississippi River Restoration, Feasibility Report with Integrated Environmental Assessment, Steamboat Island Habitat Rehabilitation and Enhancement Project*, dated February 2021, applying those procedures usually followed or applied in Federal projects, pursuant to Federal laws, regulations, and policies. The USFWS will be afforded the opportunity to review and comment on all modifications and change orders prior to the issuance to the contractor of a Notice to Proceed. If the DA encounters potential delays related to construction of the Project, the DA will promptly notify the USFWS of such delays.

4. Maintenance of Records. The DA will keep books, records, documents, and other evidence pertaining to costs and expenses incurred in connection with construction of the Project to the extent and in such detail as will properly reflect total costs. The DA shall maintain such books, records, documents, and other evidence for a minimum of 3 years after completion of construction of the Project and resolution of all relevant claims arising therefrom, and shall make available at its offices, at reasonable times, such books, records, documents, and other evidence for inspection and audit by authorized representatives of the USFWS.

B. USFWS Responsibilities

Upon completion of construction as determined by the District Engineer, Rock Island, the USFWS shall accept the Project as part of the General Plans lands managed by the USFWS. The USFWS shall operate, maintain, and repair the Project as defined in the *Upper Mississippi River Restoration, Feasibility Report with Integrated Environmental Assessment, Steamboat Island Habitat*

Rehabilitation and Enhancement Project dated February 2021. In accordance with Section 107(b) of the WRDA of 1992, Public Law 102-580, 100 percent of all costs associated with the operation, maintenance, and repair of the Project will be borne by the USFWS. The DA will develop an Operation and Maintenance Manual for the Project to be provided to USFWS at Project completion and transfer.

V. MODIFICATION AND TERMINATION

This MOA may be modified or terminated at any time by mutual agreement of the parties. Any such modification or termination must be in writing. Unless otherwise modified or terminated, this MOA shall remain in effect for a period of 50 years after initiation of construction of the Project.

VI. REPRESENTATIVES

The following individuals or their designated representatives shall have authority to act under this MOA for their respective parties:

The U.S. Fish and Wildlife Service:	Deputy Regional Director, Great Lakes Region U.S. Fish and Wildlife Service 5600 American Boulevard West, Suite 990 Bloomington, Minnesota 55437-1458
The Department of the Army:	District Engineer U.S. Army Engineer District, Rock Island Clock Tower Building P. O. Box 2004 Rock Island, Illinois 61204-2004

VII. EFFECTIVE DATE

This Steamboat Island Habitat Rehabilitation and Enhancement Project MOA shall become effective when signed by the appropriate representatives of both parties.

THE DEPARTMENT OF THE ARMY

Digitally signed by SATTINGER.STEVEN.MICHAEL.1164506939
Date: 2021.03.17 08:15:59 -05'00'

Steven M. Sattinger, P.E
Colonel, US Army
Commander & District Engineer

Date ________________________

U.S. FISH AND WILDLIFE SERVICE

CHARLES TRAXLER

Digitally signed by CHARLES TRAXLER
Date: 2021.03.12 10:02:41 -06'00'

Charles Traxler
Acting Regional Director, Great Lakes Region
U.S. Fish and Wildlife Service

Date ___________________________

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
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APPENDIX D

HABITAT EVALUATION AND BENEFITS QUANTIFICATION

UPPER MISSISSIPPI RIVER RESTORATION
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APPENDIX D

HABITAT EVALUATION AND BENEFITS QUANTIFICATION

TABLES

UPPER MISSISSIPPI RIVER RESTORATION
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POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
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APPENDIX D

HABITAT EVALUATION AND BENEFITS QUANTIFICATION

I. INTRODUCTION

This appendix presents the *Steamboat Island Habitat Restoration and Enhancement Project* (Project) habitat analysis and benefit quantification that informed the CEICA used by the PDT to evaluate all possible Project alternatives and ultimately select the TSP. This assessment includes a summary of the existing biological conditions used in the evaluation, as well as a forecast for future conditions under the No Action Alternative and each potential Project measure. The evaluation was conducted by a multi-agency team of biologists from the USFWS, the IA DNR, the IL DNR, and the District.

These planning procedures are based upon the planning framework established in, *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* [P&G (U.S. Water Resources Council, 1983)]. For District environmental planning, where traditional benefit-cost analysis is not possible because costs and benefits are expressed in different units, cost effectiveness and incremental cost analyses offer plan evaluation approaches consistent with the Corps' P&G Program paradigm. This paradigm provides a rational and deliberate approach to solving problems and making decisions, which requires information about future environmental conditions with, and without, the implementations of each alternative plan under consideration. The data, assumptions, and processes used to support these environmental forecasts are outlined below.

II. EXISTING AND FUTURE WITHOUT PROJECT BIOLOGICAL CONDITIONS

A. Aquatic Habitat. Existing water quality data was collected by the District (2014-present); land cover data was obtained through a 2017 topobathymetric LiDAR survey; substrate information was gathered from geotechnical borings and mussel survey data; and velocities were generated from H&H modeling and field collections. Future With and Without Project data was estimated using best professional judgment of the PDT and H&H modeling, when applicable. Inherent in best professional judgment are the underlying assumptions, which are described in Sections III.B and III. C of this Appendix. Section II of the Main Report, *Affected Environment,* includes a description of how these parameters influence fish life history and habitat quality.

B. Floodplain Habitat. Historic floodplain data was obtained through pre-dam topography maps; existing floodplain habitat was derived from a 2018 forest survey and 2017 topobathymetric LiDAR survey data; GIS analyses; H&H modeling; and consensus of the resource managers. Following construction of L&D 14, the physical conditions of the Project area were altered significantly. Since the 1930s, over 140 acres of Steamboat Island and the southeast islands have been lost due to inundation and erosion in succeeding years, which significantly altered the hydrology and forest conditions of the Project area. Where once a diverse forest community, including several hard-mast species, was prominent on the island, now only an even-aged mature silver maple and other flood-tolerant species inhabit the area. Forest stands are mature, even-aged, and experiencing a high rate of mortality without recruitment. Consequently, percent open canopy is increasing, with reed canary grass beginning to dominate those areas.

III. HABITAT BENEFIT EVALUATION METHODS

The purpose of the habitat benefit evaluation is to evaluate and quantify, to the extent possible, environmental benefits of alternative plans for aquatic and floodplain habitat improvements. Aquatic benefits were quantified through the use of Engineering Circular 1105-2-412, *Assuring Quality of Planning Models* and the Upper Mississippi River System Overwintering Bluegill and Walleye Habitat Suitability Index (HSI) Models (HEP; USFWS 1980). Floodplain benefits were quantified through the use of the Gray Squirrel and Yellow Warbler HSI Models (HEP; USFWS 1980).

A. Quantity Component. Traditionally, the Corps has used the quantity and quality of habitat jointly, in the form of habitat units (HUs), to measure benefits provided by ecosystem restoration projects. The quantity portion is often measured as area (acres of habitat, landform, etc.) or number of species; in some systems, it is measured as length (miles of stream bank). The evaluation conducted for the Project uses acres, delineated by polygons, to represent the quantity. The area associated with each management measure must have a clear definition for use as guidance in estimating the area component of the ecosystem output model, and must be applied consistently to all actions evaluated. From the qualitative and quantitative determinations, the standard unit of measure, HU, is calculated using the formula (HSI x Acres = HUs) for all selected HSI models.

With or without a project, habitat conditions change over time; therefore, the overall value of a proposed project depends upon the comparison of expected with-project benefits to expected without-project benefits. Annualized HUs are referred to as average annual habitat units (AAHUs). To assess the change over the period of analysis, the PDT identified target years (TYs) where a change in the habitat variables may be noticed. Noticeable changes are characterized by a change in habitat benefit output. Model TYs by species:

- Bluegill TY: 0, 1, 10, 20, 30, 50
- Walleye TY: 0, 1, 10, 25, 50
- Yellow warbler TY: 0, 1, 20, 30, 50
- Gray squirrel TY: 0, 1, 20, 30, 50

For this Project, the area of the action footprint (physical footprint of management measures) was selected to measure and compare the habitat benefits of each alternative (Table D-1). When multiple management measures are included in an action, the footprint equals the total of the management-measure footprints with no double counting of overlapping areas addressed by two or more management measures. Acreage differs for Future With and Without Project due to the trade-off between unlimiting habitat (ex: wetland) for limiting habitat (ex: aquatic).

There are trade-offs associated with restricting the evaluation of benefits to the action footprint. On the one hand, benefits can be accurately quantified with a high degree of certainty and allow for the development of specific and measurable criteria to be used in monitoring Project performance; however, the action footprint also tends to grossly underestimate the areal extent of ecological benefits because the area of restored biotic/abiotic processes usually covers a much broader scale.

Although the habitat evaluation of the Project was limited to the action footprint, it should be recognized that benefits of various measures likely extend beyond this immediate footprint as biotic and abiotic processes are restored. However, estimating habitat benefits at higher scales (e.g., area of restored process, area of potential influence) was considered too uncertain or speculative to accurately assess.

Table D-1: Habitat Types and Areas Evaluated for this Assessment

Habitat Type	Evaluation Area	Area (acres)	HSI Model
Aquatic	Steamboat Island (Upper and Lower Lakes) – Aquatic Diversity	23	Bluegill
	NW Grant Slough – Aquatic Diversity	6	Bluegill
	Steamboat Slough – Flow Diversity	0.4	Walleye
	West SE Island – Mussel Habitat	1	Walleye
Floodplain[1]	Steamboat Island – Forest Topographic Diversity (3 sites)	14	Yellow Warbler/Gray squirrel
	Steamboat Island – Scrub-Shrub/Pollinator Topographic Diversity (Lower Lake)	5	Yellow Warbler
	USI Head – Forest Topographic Diversity	14	Yellow Warbler/Gray squirrel
	Grant Slough Complex – Forest Topographic Diversity (4 sites)	30	Yellow Warbler/Gray squirrel
	West SE Island – Forest Topographic Diversity	4	Yellow Warbler/Gray squirrel
	TOTAL	**97.4**	

[1] TSI measures were not included in the initial habitat analysis, but they were anticipated to help restore the process and function of ~900 acres of floodplain forest in the Project Area. See Sections III.C.3 and IV for methods and results of the Hydrogeomorphic (HGM) Approach that was later applied to support the TSP.

B. Quality of Aquatic Benefits. The methodology utilized for evaluating benefits to aquatic habitat incorporates the HEP format, which was developed by the USFWS. 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. HEP is based on the assumption that habitat for selected fish and wildlife species can be described by a HSI. This index value (on a scale from 0.0 to 1.0) is multiplied by the area of applicable habitat to obtain HUs, which are used in comparisons of the relative value of fish and wildlife habitat at points in time.

Changes in HUs will occur as a habitat matures naturally or is influenced by development. These changes influence the cumulative HUs derived over the life of the Project (50 years). HUs are calculated for select target years and annualized (using IWR Planning Suite NER Annualizer) over the life of the Project to derive AAHUs. AAHUs are used as the output measurement to compare the measures and alternatives for the proposed Project.

1. Backwater Habitat. The Corps-approved (per EC 1105-2-412) Bluegill HSI model (Stuber et al. 1982a; Palesh and Anderson 1990) was used to assess the backwater habitat benefits resulting from the aquatic diversity measures at Upper Lake, Lower Lake, and NW Grant Slough. These species were selected because they require backwater habitat for all or most of their life cycle and are often limited in the availability of high quality overwintering habitat. The following assumptions in applying the Bluegill HSI model were made:

Baseline Condition. Detailed water quality data was collected from 2014 to present at monitoring stations in the backwater area. Due to the length of the data collection and location, it was assumed the data collected at each station was representative of the entire backwater. For the purposes of model input, the spawning season was May to June, growing season June to September, and overwintering December to February. It was assumed the water quality entering Steamboat Island interior was similar to Steamboat Slough and the main channel.

Future Without Project Conditions. Future conditions of all backwater lakes were based on an average sediment deposition rate of 1 cm/year over the next 50 years. This rate was determined based on information obtained from IADNR sedimentation studies (Aspelmeier, 1994). It is not likely that aquatic habitat loss would be linear, as most sedimentation occurs during flooding events. Nonetheless, over time aquatic habitat will be reduced significantly. Remaining lentic habitat will consist of isolated interior shallow pools with fish access only during high water events or small (< 0.14 acre) limited overwintering areas. It is probable that the Project area will continue to provide spawning habitat based on future floodplain conditions. Rearing and foraging habitat currently provided by the interior backwaters will be substantially reduced as remaining pool habitat will have impaired water quality or restricted access during average flows. Consequently, summer habitat will shift to another backwater complex or to other flowing channels, if available, in Pool 14. Finally, overwintering habitat will continue to be limited to near zero within the interior backwaters of the Project.

Future With Project Conditions. The proposed final depth of each backwater lake is 8 feet. With approximately 1.6 feet of sediment accumulating over 50 years, adequate depths would still be present for overwintering habitat. Therefore, it was assumed percent backwater greater than 4 feet in depth would increase to near 80% with a slight decrease over time due to sediment deposition on the slopes of the excavation site.

2. Riverine Habitat. The Corps-approved (per EC 1105-2-412) Walleye HSI model (McMahon et al. 1984) was used to assess the riverine habitat benefits resulting from West SE Island protection via riprap bank stabilization. Walleye was selected primarily because it is a popular host fish species for numerous freshwater mussels that inhabit the Project area. Walleye is rheophilic (or oriented to flow) and captures the benefits from an increase in forage, water clarity, and spawning habitat afforded by the restoration measures; therefore, the increasing of suitable fish hosts was assumed to have potential benefits to the freshwater mussel community. The following assumptions in applying the Walleye HSI models were made:

Baseline Condition. Water quality and hydraulic data from the main channel was assumed to be similar to the West SE Island. For the purposes of model input, the spawning season for walleye was March to May and growing season June to October. The 2019 mussel survey confirmed the absence of ideal mussel habitat as substrates were dominated by shifting sand and no mussels were recovered during the quantitative portion of the survey.

Future Without Project Conditions. It was assumed West SE Island would continue to experience erosion at a rate of 0.14 acres per year (see Appendix M, *Engineering Design* for more details on erosion rates). At its current estimated size of 0.36 acres, the island will have completely eroded within the span of a few years. Consequently, available habitat structure and cover, food production, and potential spawning habitat for walleye and mussels would be reduced.

Future With Project Conditions. Restoration and protection of the island would reduce erosion and potentially initiate island growth through reduced year-round velocities and aggradation of sediments. Rock would increase habitat structure for fish cover and because preferred mussel habitat is currently absent, no mussel impacts were assessed for the model. Due to the increase in habitat availability and complexity, cover and forage fish abundance is expected to increase. The stone protection area around the island was multiplied by a factor of 2 to create a "shadow effect" of preferred mussel habitat, amounting to approximately 1 acre. A very important element is the continued structure and function of the island and its potential indirect benefit as a buffer to the Cordova EHA. This continues to provide the functional attributes necessary for the freshwater mussel community to continue to exist, reproduce, and recruit to the population.

C. Quality of Floodplain Benefits. HEC-EFM was used to derive preliminary acreages for floodplain forest and scrub-shrub/pollinator benefits (Section V, *Development and Evaluation of Alternatives*). Threshold elevations to model aquatic, scrub-shrub, and forestry acres for the Project area were developed based on growing season inundation duration and exceedance probability determined by the PDT's best professional judgment (see Appendix M, *Engineering Design*). Time series analyses to identify the appropriate elevation threshold for each habitat type was performed using HEC-EFM. Acreages for each habitat type were then calculated based on existing conditions and with-Project terrains and elevation thresholds. Then, both the Corps-approved (per EC 1105-2-412) Yellow Warbler (Schroeder, 1982) and the Gray Squirrel (Allen, 1987) HSI models were employed to quantify the habitat benefits associated with increases in topographic diversity and bottomland forest restoration during both initial succession and forest maturation.

1. Forestry Habitat. Alternative restoration states include the area and height of topographic diversity. Topographic diversity is important because different plant communities occur within specific flood zones, and lack of physical diversity can lead to low plant community diversity, which has been seen in large rivers nation-wide. The upper limit of tree planting was identified as 576.2 feet NAVD88, which is based on the 25-percent exceedance probability for the minimally tolerant growing season inundation criteria (25-day inundation duration) and the lower limit of tree planting was identified based on the 25-percent exceedance probability for the moderately tolerant growing season inundation criteria (45-day inundation duration).
The Yellow Warbler HSI Model was used to assess pioneer floodplain forest habitat because yellow warblers prefer hydrophytic scrub-shrub habitat for foraging and nesting and are often limited in the availability of quality wet scrub-shrub habitat. For measures that only involve the planting of forestry

habitat, the Yellow Warbler model was only modeled at TY 20 to represent the benefits accrued during initial succession of the floodplain forest. The following assumptions in applying the Yellow Warbler HSI model were made:

Baseline Condition. There is currently very few hard mast tree species available in the Project area. Areas that have the required elevation to support this habitat are either dominated by reed canary grass monocultures or have been eroded by increasing flood frequency and duration and higher water tables. A lack of tree regeneration, species diversity, and increased mortality characterizes the floodplain forest in the Project area.

Future Without Project Conditions. It is assumed that tree mortality and tree recruitment will continue at a rate similar to the last 30 years. Open canopy areas will continue to be degraded and likely result in reed canary grass monoculture development, especially in areas already dominated by this invasive species. For areas that currently have existing forestry habitat, it was assumed that increasing water inundation and duration and island erosion will result in a continued loss of topographic diversity.

Future With Project Conditions. Placement at these sites requires very little tree clearing (1.3 acres) and results in a significant increase in habitat benefits as areas currently dominated by reed canary grass monocultures are converted floodplain forest habitat with inclusion of hard mast tree species. Restoring island areas to optimum tree survival elevations also provides an increased buffer to backwater lakes, helping to slow down water during high flows and allow sediment to drop out prior to reaching potential overwintering habitat. TSI efforts (tree thinning treatments, tree planting, and invasive species management) would continue for the life of the Project (50 years) to further improve habitat health, diversity, and resilience of forestry sites.

The Gray Squirrel HSI Model was used to assess hard mast tree habitat because grey squirrels require diverse mast producing tree habitat for forage, cover, and reproduction, and are often limited in the availability of mast producing trees in the floodplain. The Gray Squirrel HSI was only modeled at TYs 30 and 50 to represent the amount of time it would take for tree plantings to mature and begin accruing habitat benefits. In applying the Gray Squirrel HSI model, the same assumptions were made as the Yellow Warbler HSI Model.

2. Scrub-Shrub/Pollinator Habitat. The Yellow Warbler HSI Model was used to assess pioneer floodplain forest habitat because yellow warblers prefer hydrophytic scrub-shrub habitat for foraging and nesting and are often limited in the availability of quality wet scrub-shrub habitat. For measures that only involve the planting of scrub-shrub/pollinator habitat, the yellow warbler model was used for all TYs to evaluate habitat benefits.

The upper limit for scrub-shrub/pollinator planting was identified as 573.1 feet NAVD88; this elevation is based on the 50-percent exceedance probability for maximum tolerant growing season inundation duration (55-day inundation duration). However, field observations by the Project forester support that scrub-shrub/pollinator species can thrive at higher elevations than the upper limit, so these plantings may be incorporated at higher elevations. The following assumptions in applying the Yellow Warbler HSI model were made:

Baseline Condition. There is currently very little scrub-shrub/pollinator habitat available in the Project area. Areas that have the required elevation to support this habitat are either dominated by reed canary grass monocultures or open water areas adjacent to existing scrub-shrub/pollinator habitat.

Future Without Project Conditions. Open canopy areas will continue to be degraded and likely result in reed canary grass monoculture development, especially in areas already dominated by this invasive species. For areas adjacent to existing shrub-shrub/pollinator habitat, it was assumed that sediment deposition and increasing water inundation and duration will result in a continued loss of topographic diversity.

Future With Project Conditions. Placement at these sites requires no tree clearing and removal and provides significant habitat benefits as reed canary monocultures are converted to scrub-shrub/pollinator habitat. Planting at sites near existing scrub-shrub/pollinator habitat will help to protect the existing habitat, while increasing and enhancing the habitat in that area. TSI efforts (buttonbush coppicing) would continue for the life of the Project (50 years) to further enhance the topographic diversity of scrub-shrub/pollinator habitat sites.

3. TSI Benefits Using HGM Approach. TSI measures were not included in the initial habitat analysis, but were anticipated to help restore the process and function of ~900 acres of floodplain forest in the Project area. Since TSI prescriptions were anticipated to be the same for all Final Array Project alternatives, the Hydrogeomorphic (HGM) Approach was later applied to support the TSP and demonstrate the additional benefits provided by TSI actions relative to the cost of the Project. The HGM Approach is a collection of concepts and methods for developing functional indices and using them to assess the capacity of a wetland to perform functions relative to similar wetlands in a region. This approach to functional assessment estimates the change in functioning induced by alteration of a wetland, either positive or negative. Though initially designed to be used in the context of the Clean Water Act Section 404 permit reviews, the HGM Approach can also be used to determine the amount of positive effects (i.e., increases in sustainable levels of functioning) normally through restoration of previously altered wetlands of the same type. For this assessment, the PDT used the Corps-certified HGM Approach for Forested Wetlands in the Delta Region of Arkansas, Lower Mississippi River Alluvial Valley (Klimas et al., 2004), a regional guidebook which provides the models and reference data used to assess the functional capacity of the floodplain forest to:

- Detain floodwater,
- Detain precipitation,
- Cycle nutrients,
- Export organic carbon,
- Maintain plant communities, and
- Provide habitat for fish and wildlife.

Similar to the HEP format, the PDT used the HGM approach and assessment models to evaluate habitat benefits resulting from TSI implementation, which are described as Functional Capacity Index (FCI) values (on a scale from 0.0 – 1.0). The FCI values for all functions were averaged and multiplied by area to derive net benefits (AAHUs) between the Future Without and Future With Project conditions at TY 50. The following assumptions in applying the Delta Region HGM guidebook to the Project area were made:

Baseline Condition. A lack of tree regeneration, species diversity, and increased mortality characterizes the floodplain forest in the Project area. The forest is currently dominated by over-mature even-aged silver maple stands, with limited regeneration and decreasing numbers of hard mast-producing trees. TSI prescriptions were derived from current environmental and forest conditions and focused on areas at higher risk of forest decline (approximately 900 acres).

Future Without Project Conditions. It is assumed that tree mortality and tree recruitment will continue at a rate similar to the last 30 years. Future average flood frequency and duration were also assumed to remain constant over the Project life (50 years). Without TSI implementation and successive tree recruitment, open canopy areas will continue to be degraded and likely result in reed canarygrass monoculture development. This slow progression over several decades will further increase the probability of conversion from closed-canopy forest communities to expansive acres of non-native herbaceous species. Thus, as mortality of even-aged silver maple stands increases, tree basal area (BA) and density are assumed to decrease by half from the baseline condition. These forecasted conditions for the FWOP were based on Corps' forester best professional judgment, reflecting reference stand conditions of the UMR that can reasonably be expected to occur without implementation of TSI in the Project area.

Future With Project Conditions. It is assumed that implementation of TSI will alter the long-term impacts of an overstocked forest, improving forest habitat health, diversity, and resilience in the Project area. TSI actions (tree thinning treatments, tree planting, and invasive species management) will continue for the life of the Project (50 years), gradually opening the forest canopy, providing light to understory seedlings and saplings and interspersed tree plantings, enabling recruitment of various tree ages, and reducing undesirable vegetation and competition for native species. In the short term, these alterations will help uniformly distribute needed growing space and sunlight throughout TSI areas during a single treatment window of just under 2 years, thereby reducing the risk of forest conversion to non-native species by creating favorable conditions to young tree establishment. After 50 years, the amount of growing space (BA) will increase from the baseline condition, while tree density will even out over the Project life. These forecasted conditions for the FWP were based on Corps' forester best professional judgment, reflecting reference stand conditions of the UMR that can reasonably be expected to occur following implementation of TSI in the Project area.

IV. HABITAT EVALUATION RESULTS

Section IV of the Main Report, *Potential Project Measures*, describes each potential Project measure in detail. After a lengthy process involving preliminary analysis, identification of compatibility, dependencies, and input from our resource agencies, the Project planning team identified a list of measures to be formulated into alternatives before this habitat quantification exercise (Table D-2). Table s D-3, D-4, and D-5 provide summaries of the results of the habitat benefit evaluation.

Table D-2: Combined Aquatic and Topographic Diversity Measures

Alt. 18	USI Head, Steamboat Island aquatic diversity
Alt. 19	USI Head, Steamboat Island aquatic diversity, Grant Slough Complex
Alt. 22	USI Head, Steamboat Island aquatic diversity, Flow Diversity
Alt. 23	USI Head, Steamboat Island aquatic diversity, Grant Slough Complex, Flow Diversity
Alt. 26	USI Head, Steamboat Island aquatic diversity, West SE Island
Alt. 27	USI Head, Steamboat Island aquatic diversity, SE Island, Grant Slough Complex
Alt. 30	USI Head, Steamboat Island aquatic diversity, West SE Island, Flow Diversity
Alt. 31	USI Head, Steamboat Island aquatic diversity, West SE Island, Grant Slough Complex, Flow Diversity

A. Aquatic Benefits. Tables D-3 and D-4 provide the final Suitability Index (SI), acres for each alternative, habitat units, gross AAHUs, and net AAHUs (lift) for each TY under consideration.

B. Floodplain Benefits. Tables D-5 and D-6 provide the final SI (or FCI), acres for each alternative, habitat units, gross AAHUs, and net AAHUs (lift) for each TY under consideration.

Table D-3: Aquatic Benefit Evaluation Results for Backwater Excavation Measures

Measure	Measure Name	Condition	Target Year	OUTPUT Bluegill SI	SI Final	Acres	HUs	AAHUs	Net AAHUs
Overwinter Fish Habitat	No Action-Steamboat Island Proper Complex	Existing	0	0.52	0.52	0.14	1.0	0.10	**0.0**
		FWOP	10	0.52	0.52	0	0.0		
			25	0.52	0.52	0	0.0		
			50	0.52	0.52	0	0.0		
	Steamboat Island Proper Complex	With Project	1	0.94	0.94	23	22.0	19.19	**19.1**
			10	0.87	0.87	23	21.0		
			20	0.87	0.87	23	21.0		
			30	0.87	0.87	21	19.0		
			50	0.77	0.77	19	15.0		
	No Action-Grant Slough Complex	Existing	0	0.52	0.52	0	0.0	0.00	**0.0**
		FWOP	10	0.52	0.52	0	0.0		
			25	0.52	0.52	0	0.0		
			50	0.52	0.52	0	0.0		
	Grant Slough Complex	With Project	1	0.94	0.94	6	6.0	5.94	**5.9**
			10	0.87	0.87	6	6.0		
			20	0.87	0.87	6	6.0		
			30	0.87	0.87	6	6.0		
			50	0.77	0.77	6	5.0		

Table D-4: Mussel Habitat Benefit Evaluation Results for Flow Diversity/Island Restoration Measures

Measure	Measure Name	Condition	Target Year	OUTPUT Walleye SI	SI Final	Acres	HUs	AAHUs	Net AAHUs
Mussel Habitat	No Action	Existing	0	0.30	0.30	0.4	0.1	0.10	0.0
		FWOP	10	0.25	0.25	0.4	0.1		
			25	0.20	0.20	0.4	0.1		
			50	0.15	0.15	0.4	0.1		
	Steamboat Slough Flow Diversity	With Project	1	0.72	0.72	0.4	0.3	0.20	0.1
			10	0.74	0.74	0.4	0.3		
			25	0.75	0.75	0.4	0.3		
			50	0.74	0.74	0.4	0.3		
	No Action	Existing	0	0.74	0.74	0	0.0	0.00	0.0
		FWOP	10	0.72	0.72	0	0.0		
			25	0.70	0.70	0	0.0		
			50	0.65	0.65	0	0.0		
	West SE Island	With Project	1	0.31	0.31	1	0.3	0.64	0.6
			10	0.71	0.71	1	0.7		
			25	0.70	0.70	1	0.7		
			50	0.74	0.74	1	0.7		

Table D-5: Floodplain Benefit Evaluation Results for Topographic Diversity Measures

				OUTPUT						
Measure	**Measure Name**	**Condition**	**Target Year**	**Gray Squirrel SI**	**Yellow Warbler SI**	**SI Final**	**Acres**	**HUs**	**AAHUs**	**Net AAHUs**
Floodplain Forest/ Scrub-Shrub Wetlands	No Action-USI Head	Existing	0	0.00	0.00	0.00	14	0.0	0.00	**0.00**
		FWOP	20	0.00	0.00	0.00	14	0.0		
			30	0.00	0.00	0.00	14	0.0		
			50	0.00	0.00	0.00	14	0.0		
	USI Head	With Project	1	0.00	0.00	0.00	14	0.0	10.30	**10.30**
			20	0.00	1.00	1.00	14	14.0		
			30	0.91	0.00	0.91	14	12.7		
			50	0.91	0.00	0.91	14	12.7		
	No Action-Steamboat Island Proper Complex	Existing	0	0.00	0.00	0.00	14	0.0	0.00	**0.00**
		FWOP	20	0.00	0.00	0.00	14	0.0		
			30	0.00	0.00	0.00	14	0.0		
			50	0.00	0.00	0.00	14	0.0		
	Steamboat Island Proper Complex	With Project	1	0.00	0.00	0.00	14	0.0	10.30	**10.30**
			20	0.00	1.00	1.00	14	14.0		
			30	0.91	0.00	0.91	14	12.7		
			50	0.91	0.00	0.91	14	12.7		
	No Action-Grant Slough Complex	Existing	0	0.00	0.00	0.00	30	0.0	0.00	**0.00**
		FWOP	20	0.00	0.00	0.00	30	0.0		
			30	0.00	0.00	0.00	30	0.0		
			50	0.00	0.00	0.00	30	0.0		
	Grant Slough Complex	With Project	1	0.00	0.00	0.00	30	0.0	22.00	**22.00**
			20	0.00	1.00	1.00	30	30.0		
			30	0.91	0.00	0.91	30	27.2		
			50	0.91	0.00	0.91	30	27.2		
	No Action-West SE Island	Existing	0	0.00	0.00	0.00	4	0.0	0.00	**0.00**
		FWOP	20	0.00	0.00	0.00	4	0.0		
			30	0.00	0.00	0.00	4	0.0		
			50	0.00	0.00	0.00	4	0.0		

Table D-5: Floodplain Benefit Evaluation Results for Topographic Diversity Measures (continued)

Floodplain Forest/ Scrub-Shrub Wetlands	West SE Island	With Project	1	0.00	0.00	0.00	4	0.0	2.90	**2.90**
			20	0.00	1.00	1.00	4	4.0		
			30	0.91	0.00	0.91	4	3.6		
			50	0.91	0.00	0.91	4	3.6		
	No Action-Steamboat Island Proper Complex Scrub-Shrub	Existing	0	0.00	0.00	0.00	5	0.0	0.00	**0.00**
		FWOP	20	0.00	0.00	0.00	5	0.0		
			30	0.00	0.00	0.00	5	0.0		
			50	0.00	0.00	0.00	5	0.0		
	Steamboat Island Proper Complex Scrub-Shrub	With Project	1	0.00	0.00	0.00	5	0.0	3.90	**3.90**
			20	0.00	1.00	1.00	5	5.0		
			30	0.00	1.00	1.00	5	5.0		
			50	0.00	1.00	1.00	5	5.0		

Table D-6: Floodplain Benefit Evaluation Results for Timber Stand Improvement Measures

Measure	**Measure Name**	**Condition**	**Target Year**	**HGM FCI**	**FCI Final**	**Acres**	**HUs**	**AAHUs**	**Net AAHUs**
Timber Stand Improvement	No Action-TSI	Existing	0	0.64	0.64	900	576.0	461.00	**0.00**
		FWOP	50	0.51	0.51	900	459.0		
	TSI Prescriptions	With Project	1	0.64	0.64	900	576.0	779.00	**318.0**
			50	0.87	0.87	900	783.0		

V. COST EFFECTIVENESS/INCREMENTAL COST ANALYSES AND TENTATIVELY SELECTED PLAN DISCUSSION

The results of the habitat analysis support the premise that the functions and values of the Project can be restored by implementing one of the described cost effective alternatives or best buy plans (see Section V, *Development and Evaluation of Alternatives,* for a review of CEICA and TSP selection process). The HEP analysis indicates substantial improvements in both aquatic and floodplain habitats of the Project. Overwintering habitat would be significantly improved through excavation and island protection, which greatly enhances habitat diversity through habitat complexity, protection, and growth. Floodplain habitat can certainly be improved through topographic diversity, which creates the opportunity for hardwood species to survive and grow. This in turn provides a significant improvement in food, cover, breeding, and overwintering habitat for nearly every species of wildlife residing in and/or migrating to the floodplain. Due to the acreage of the Project floodplain, it is difficult for a single Project to re-create conditions which were present prior to the 9-foot navigation channel implementation. However, the Recommended Plan would make great strides in restoring the structure and function those conditions provided.

VI. LITERATURE CITED

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HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE DOCUMENTATION REPORT

I. GENERAL

A. Authority. The Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP; Project) is an ecosystem restoration project being developed through the Upper Mississippi River Restoration (UMRR) Program. The UMRR Program, authorized by the Water Resources Development Act (WRDA) of 1986 under Section 1103 and extended indefinitely by the WRDA of 1999, is a Federal/State partnership program for planning, construction and evaluation of fish and wildlife habitat rehabilitation projects and for monitoring the natural resources of the river system. It is a regional program that includes the U. S. Army Corps of Engineers' (Corps) St. Paul, Rock Island, and St. Louis Districts. The purpose of the HREPs is to preserve and restore habitat on the Mississippi and Illinois floodplain river systems.

B. Guidance and Policy. The Corps' Engineering Regulation (ER) 1105-2-100, *Planning Guidance Notebook,* provides guidance for the conduct of Civil Works Planning. The policies and authorities outlined in ER 1165-2-132, *Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects*, and ER 405-1-12, *Real Estate Handbook*, were developed to facilitate the early identification and appropriate consideration of HTRW issues in all of the various phases of a water resources study or project. Division Regulation 1165-2-132 provides divisional guidance for HTRW assessment for Civil Works projects. American Society for Testing and Materials (ASTM) Standards E1527-13 and E1528-06 provide a comprehensive guide for conducting Phase I Environmental Site Assessments (ESA). ASTM Standard E1903-97(2002) provides guidance for Phase II ESAs. These references provide information on what considerations are to be factored into project planning and implementation. The Corps' policy is to avoid construction of civil works projects when HTRW is located within project boundaries or may affect or be affected by such projects.

II. INTRODUCTION

A. Purpose and Scope. The specific purpose of an HTRW Documentation Report is to adequately document an appropriate inquiry into HTRW activities on potential project lands. The scope of this report documents the HTRW investigation for the Steamboat Island HREP Feasibility Study.

This HTRW inquiry is required in order to minimize and prevent Federal liability under the Comprehensive Environmental Response, Compensation and Liability Act and to reduce any threats to Project workers and avoid costly delays associated with environmental abatement activities.

A Phase I ESA for the Feasibility Study area was conducted by personnel from the USACE Rock Island District (District) Environmental Engineering Section (CEMVR-EC-DN). Copies of the Phase I ESA are available from CEMVR-EC-DN.

B. Limiting Conditions and Methodologies Used. The techniques used to assess HTRW contamination within and adjacent to the Project area consisted of review of historical documents, Federal and state environmental databases, aerial photographs, topographic maps, and conducting interviews and site visits. The scope of inquiry was limited to investigating onsite HTRW potential within the Project boundaries as well as offsite HTRW potential within a reasonable distance (according to ASTM standards) from the Project.

III. STUDY AREA

A. Description. The Study Area is comprised of U. S. Government-owned tracts on Steamboat Island, area along the eastern border of Princeton Refuge, two small unnamed islands southeast of Steamboat Island proper, and forested floodplain to the north and south of the mouth of the Wapsipinicon River. A portion of the northern border is delineated by 291st St., Camanche, IA, and Wendling Quarries. The Study Area covers approximately 2,620 acres consisting of woodlands, meadows, wetlands, shorelines, and open water. It is situated approximately between Mississippi River Miles 503 and 507. The entirety of the main island lies within Pool 14. The USFWS maintains Steamboat Island proper in the Study Area.

To the west of the Study Area is the Princeton Refuge, which is managed by the Iowa DNR. To the east are the navigation channel of the Mississippi River, private rural residences on the Illinois shoreline, and row crop agricultural areas. To the north is forested floodplain associated with the mouth of the Wapsipinicon River. Steamboat Island proper is surrounded by the Mississippi River, creating shorelines along the boundaries.

The Study Area is located within portions of three counties. Township 80 North, Range 5 East, Sections 11, 12, 13 and 14 in Clinton County, Iowa; Township 80 North, Range 5 East, Sections 13, 14, 23, 24, 25, 35 and 36 in Scott County, Iowa; and Township 20 North, Range 6 East, Sections 30, 31 and 36 in Rock Island County, Illinois.

Appendix E-A includes an aerial photo of the Study Area.

B. Physical Setting. The USGS topographical map from 2017 was used for records review. Surface elevation for the Study Area ranges from approximately 560 feet to 580 feet above mean sea level (NAVD 1988). The Study Area is comprised of islands formed in the Mississippi River as well as floodplain forests associated with the mouth of the Wapsipinicon River.

Surficial geology consists of Deforest Formation, Quaternary System silty clay loam and clay loams associated with the modern channel of the Wapsipinicon and Mississippi River valleys. Bedrock geology consists of Silurian Age, Hopkinton and Blanding Formation dolomites. According to the USDA NRCS Web Soil Survey, soils surrounding the Study Area consist of loamy fluvaquents with 0 to 2 percent slopes, frequently flooded.

IV. ENVIRONMENTAL SITE ASSESSMENT

A Phase I ESA was completed in the spring of 2018 for the Study Area and adjacent area. The Phase I ESA documented the Study Area history, reviewed state and Federal environmental databases, and identified potential Recognized Environmental Conditions (RECs).

A. Historical Use Information. The Study Area has been a forested island and floodplain complex since at least the 1890s. This determination is based on plat maps from the 1890s, aerial photos taken throughout the 20th Century (1930s, 1950s-2000), and into the 21st Century (2000s, 2013-2015), as well as interviews. The U.S. Government purchased the properties of the Study Area in 1940 in support of the 9-foot Navigation Channel Project on the adjacent Mississippi River. The USFWS manages the Study Area lands. The District places dredge materials from the navigation channel on the southeastern portion of the Steamboat Island bankline and also leases a cottage site in Tract 1als 8, near the center of Steamboat Island. This area is a popular destination for recreational boaters.

One potential REC, the QC Generating Station, located east of the Study Area, was observed in the aerial photographs (Appendix E-B).

No Sanborn Fire Insurance Maps were found for the Study Area or immediate surrounding properties.

B. Site Reconnaissance. Site visits were conducted by Steve Gustafson (CEMVR-EC-DN) on April 26, 2017, August 29, 2017, and December 3, 2017. A reconnaissance was performed with visual inspection of surrounding properties. The following observations were made:

- No indications of spills or staining were observed on the natural or manmade surfaces.
- No indications of hazardous materials storage areas.
- No indications of refuse or illegal dumping

C. Findings. The Phase I ESA identified one potential REC in or near the Study Area:

- QC Generating Station was identified within a 1-mile radius. The QC Generating Station is considered a small quantity generator of hazardous waste and a permitted discharger of wastewater (chlorine, elevated temperature water, zinc, boron, total suspended solids, oil and grease).

V. CONCLUSIONS

There are no Controlled RECs or Historic RECs present in the Study Area. The potential REC of the QC Generating Station is considered de minimus. Further research into NPDES discharge data associated with the facility did not indicate any HTRW concerns, and the only potential impact from the facility is considered thermal, which is not an HTRW concern. The substances permitted for discharge are not of the magnitude to warrant HTRW concerns on the proposed Project areas. Therefore, there are no RECs associated with the Study Area.

VI. RECOMMENDATIONS

No further HTRW assessment is recommended.

VII. LIMITATIONS

No ESA can wholly eliminate uncertainty regarding the existence for recognized environmental conditions concerning a property. This assessment is intended to reduce, but not eliminate, uncertainty regarding the existence of recognized environmental conditions in connection with a property with reasonable limits of time and cost. If any previously unaddressed recognized environmental condition should arise, this HTRW Documentation Report will be revisited. Title searches and research into environmental liens were not conducted for this report, but will be required prior to construction phase of the preferred alternative.

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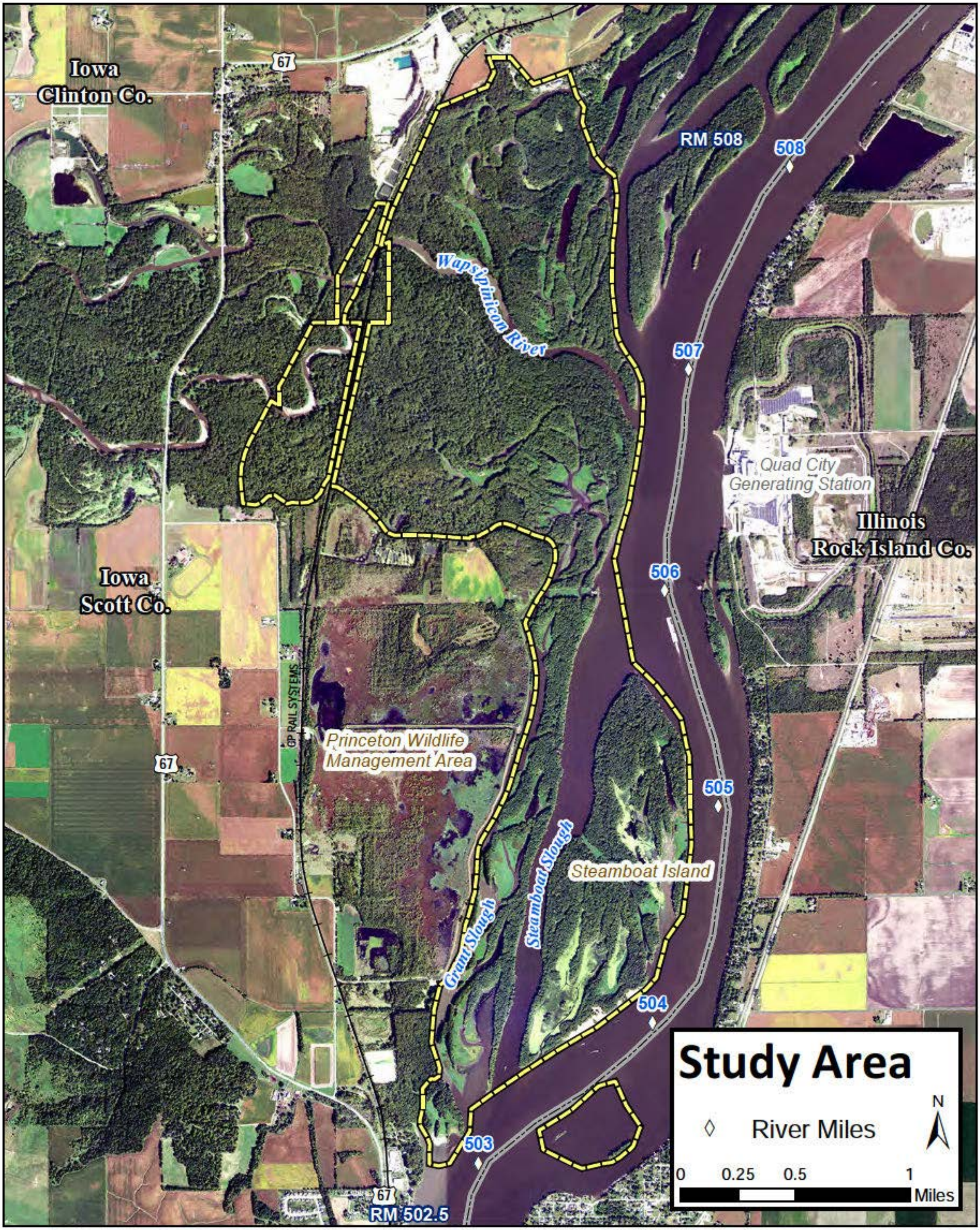
APPENDIX E-A

STUDY AREA


Iowa
Clinton Co.
67
RM 508
508
Wapsipinicon River
507
Quad City
Generating Station
Illinois
Rock Island Co.
506
Iowa
Scott Co.
GP RAIL SYSTEMS
Princeton Wildlife
Management Area
67
505
Steamboat Slough
Steamboat Island
Grant Slough
504
503
67
RM 502.5
Study Area
River Miles
N
0
0.25
0.5
1
Miles

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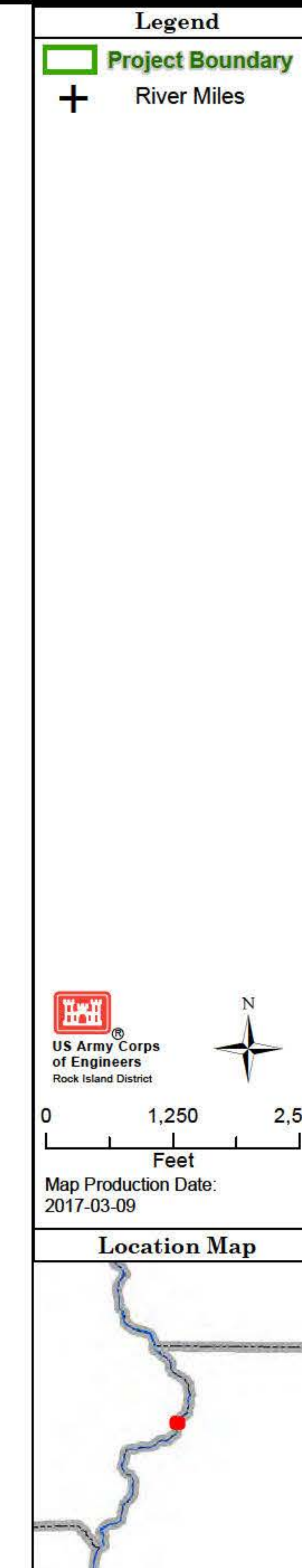
APPENDIX E-B

HISTORICAL AERIAL PHOTOGRAPHS

Steamboat HREP- Aerial 2015

Steamboat HREP- NAIP Aerial 2010

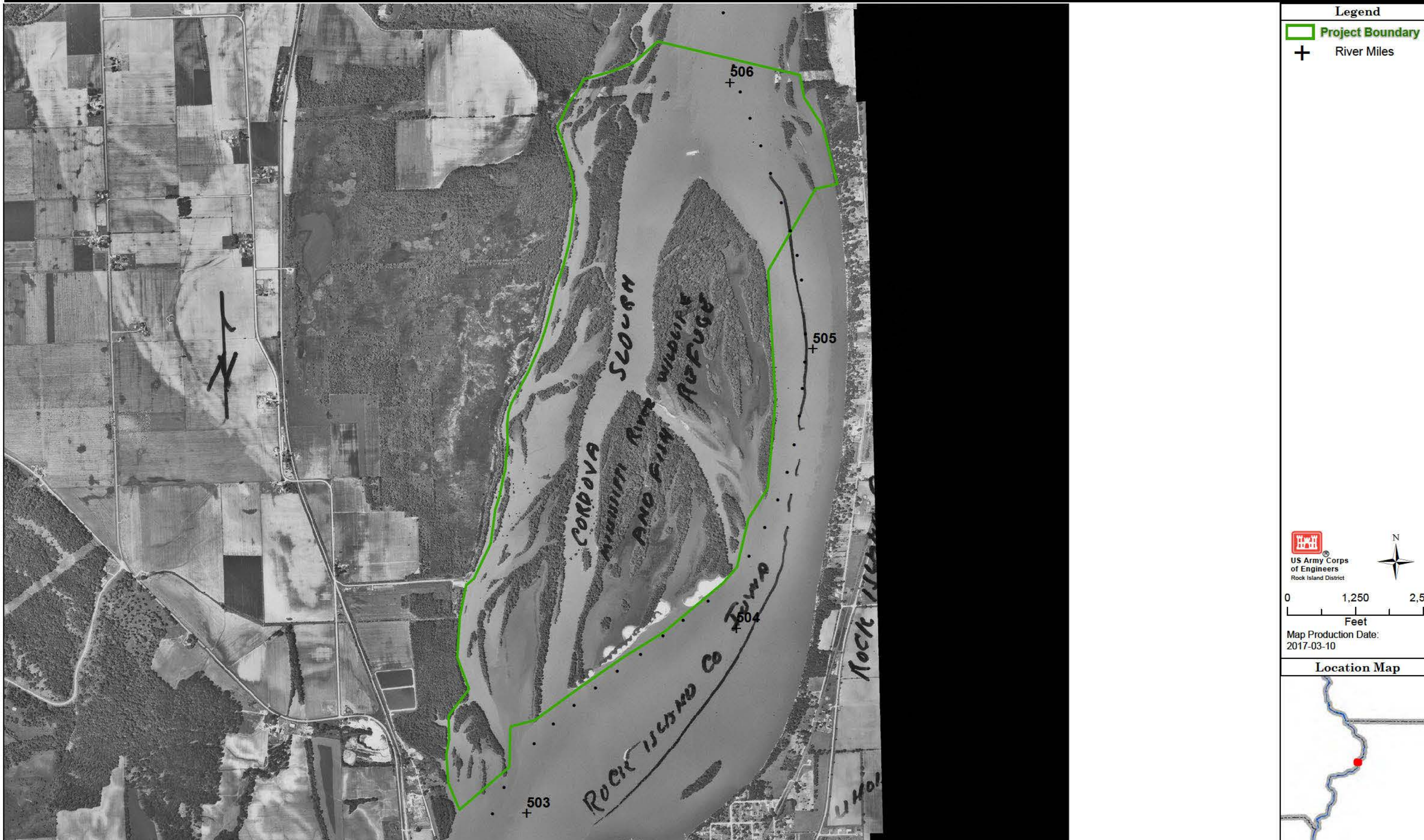
Steamboat HREP- Aerial 2005 Scott County



Steamboat HREP- Aerial 1990s

Steamboat HREP- Aerial 1980s CIR

Steamboat HREP- Aerial 1970s



Steamboat HREP- Aerial 1960s

Legend

Project Boundary

River Miles

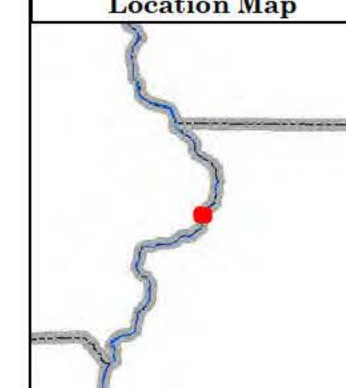
US Army Corps of Engineers
Rock Island District

N

0 1,250 2,500
Feet

Map Production Date:
2017-03-10

Location Map



Steamboat HREP- Aerial 1950s

Steamboat HREP- Aerial 1930s

Steamboat HREP- Aerial 1927 Mississippi River

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WATER QUALITY

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WATER QUALITY

TABLES

FIGURES

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APPENDIX F

WATER QUALITY

I. PURPOSE

The purpose of this appendix is to evaluate the results from water quality monitoring performed by Rock Island District (District) personnel at potential environmental enhancement sites located within the *Steamboat Island Habitat Rehabilitation and Enhancement Project* (Project). Water quality monitoring was performed with the primary objective of defining pre-Project baseline water quality conditions.

II. INTRODUCTION

Baseline water quality monitoring was initiated in order to determine pre-Project conditions and assist with selecting and locating measures and/or alternatives for habitat rehabilitation and enhancement. This monitoring also supports future evaluation of the Project related to the goal of restoring and protecting off-channel aquatic and wetland habitat. Of particular importance is an increase in aquatic habitat diversity and providing the water quality characteristics critical for overwintering fish. The District initiated baseline water quality monitoring at the Project on December 19, 2014, at site W-M504.7S (Figure F-1).

Sites W-M504.9P, W-M505.7C, and W-M505.0B were added on June 6, 2017, and site W-M504.1E on December 8, 2017. Baseline monitoring continued through March 11, 2019, with eight samples collected during the summer months and two or three samples during the winter months each full year. Site W-M504.7S was initially chosen as a representative pre-Project monitoring location because the Project fact sheet identified the Upper and Lower Lakes of Steamboat Island as likely areas to restore overwintering habitat. A site in Lower Lake (W-M503.6L) was identified but not sampled due to inadequate water depth. During the feasibility phase, site W-M504.9P was added to observe the differences between an isolated portion of the upper interior lake and the area affected by inflow from the main channel via the breached northeast bank of Steamboat Island. Aquatic vegetation has been observed near both sites, with coontail being the dominant species at site W-M504.7S and lotus at site W-M504.9P, the more heavily vegetated of the two sites. NW Grant Slough Lake was also a proposed overwintering habitat location (site W-M504.1E). This site was identified during the feasibility phase and lotus and coontail have been identified there.

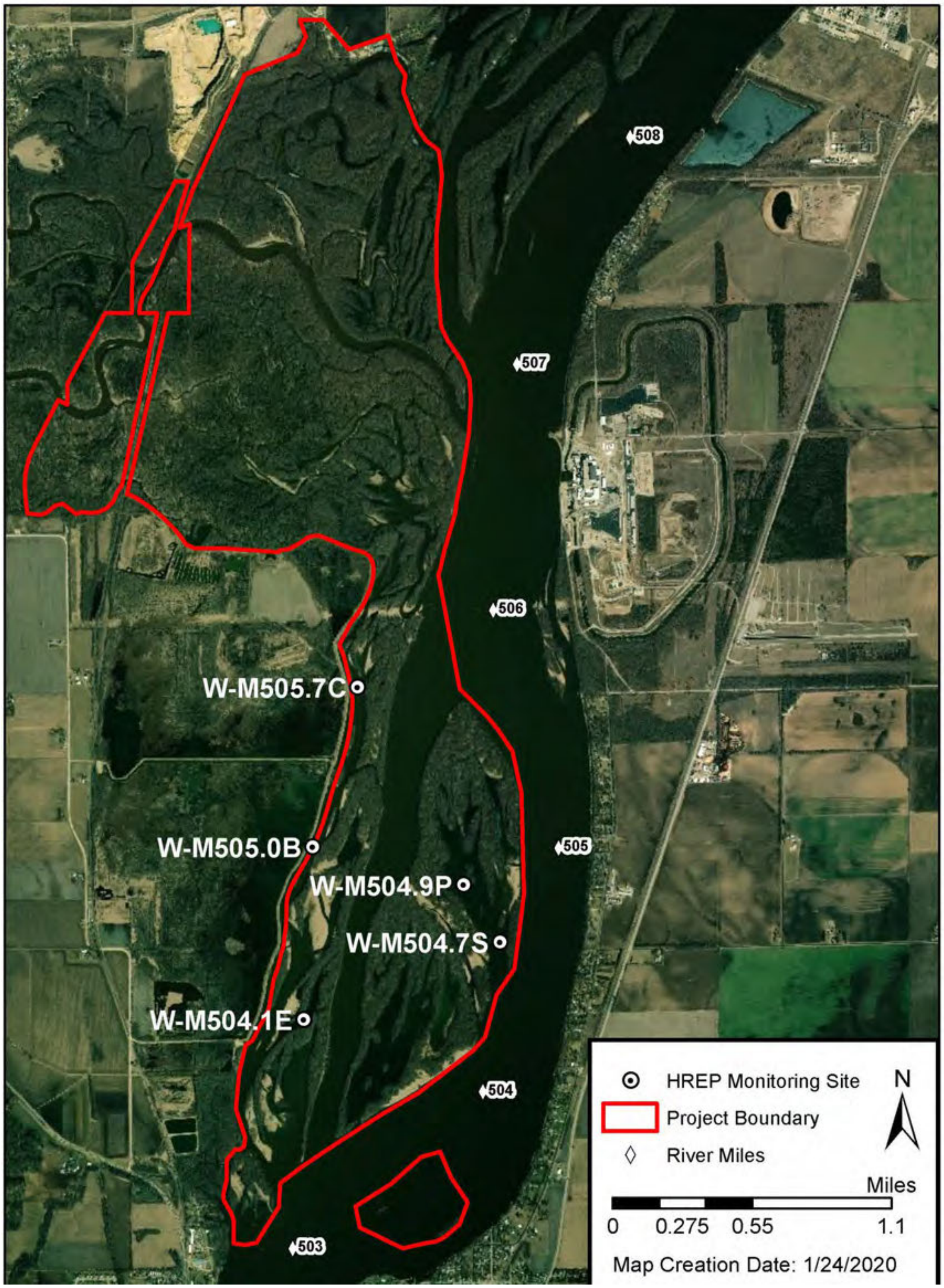


Figure F-1: Project Water Quality Monitoring Locations

Sites W-M505.7C and W-M505.0B are located in Grant Slough, above and below, respectively, a cut-through channel that flows from Steamboat Slough into Grant Slough. The purpose of these sites was to observe differences in water quality in Grant Slough caused by flow coming in from a bisecting channel and to provide information related to the potential placement of a sediment closure structure within the Project to reduce sediment input. These two sites are deeper, have greater water velocities, and little aquatic vegetation relative to the other three sampling sites.

III. METHODS

Baseline water quality monitoring was accomplished through a combination of collecting grab (discrete) water samples and deploying continuous monitors (sondes). Eight grab samples were collected during the summer months, and two or three grab samples were collected during the winter months at each site, each year. In general, sampling date, time, water depth, water transparency via Secchi disk depth, water velocity, wave height, air temperature, percent cloud cover, wind speed and direction, pH, water temperature, DO, and specific conductance were recorded in the field. During the summer months, a water sample was collected just below the surface at each sampling site. The sample was placed on ice and shipped to ARDL, Inc., Mt. Vernon, Illinois for total suspended solids (TSS) and chlorophyll analyses. Water grab samples were collected for turbidity as measured in Nephelometric Turbidity Units (NTU)[1] and alkalinity analyses, which were performed in-house. Sample collection/preservation and field/laboratory analytical procedures were performed according to USEPA approved methods. In addition to the manually collected data, YSI 6600 or EXO2 multi-parameter water quality sondes were deployed on numerous occasions. Typically, the sondes were suspended 1 to 2 feet from the river bottom and were programmed to record the following data every 2 hours: DO, pH, water temperature, depth, specific conductance, and turbidity as measured in Formazin Nephelometric Units (FNU)[1] (primarily since 2016). The 2-hour frequency gives sufficient resolution to the data and conserves sonde battery life and recorder storage space. Summer deployments typically lasted 2 to 4 weeks, while in the winter the sondes were deployed for approximately 6 to 14 weeks.

IV. RESULTS AND DISCUSSION

In general, sites W-M504.7S, W-M504.9P and W-M504.1E exhibit more lake-like (lentic) characteristics than the more riverine (lotic) sites W-M505.0B and W-M505.7C. The lentic sites typically exhibit lower water velocities, and have better water clarity as reflected in measurements of Secchi disk depth, turbidity and total suspended solids. These differences, along with others, are described below in detail for each of the five Project water quality monitoring sites. Minimum, maximum, average and median statistics for several parameters at each site are displayed for the summer and winter seasons in Table F-1.

A. Site W-M504.7S. Table F-2 shows the results from surface grab sample monitoring at site W-M504.7S. This site had the longest period of record, covering five winter and four summer sampling seasons. DO concentrations below the target level of 5 mg/L were observed during

[1] Due to differences in sensor type, sonde turbidity readings are reported in FNU and turbidity grab samples analyzed with a turbidimeter are reported in NTU. For the purposes of this evaluation, it was assumed that 1FNU = 1 NTU.

each summer season, with at least half of the readings during the summers of 2017 and 2018 falling below the target level.

Winter grab sample DO concentrations at site W-M504.7S never fell below the target level during the five seasons monitored. The lowest DO concentration observed was 7.94 mg/L on February 3, 2015. Approximately half of the values were supersaturated. The median water temperature was 1.7°C and the lowest value was 0.1°C. Velocities ranged from 0.24 cm/sec to 2.82 cm/sec with a median of 0.77 cm/sec.

A sonde was deployed at site W-M504.7S on every sampling trip. Figure F-2 shows results from the 2015 summer season. Figure 2 also shows grab samples collected with handheld instruments to validate sonde readings. DO and temperature were measured at the depth of the sonde, but due to the limitations of the field pH meter used, pH was only measured at the surface. It was common to see DO concentrations fall below the target level concentration of 5 mg/L during the night, but they always recovered the following day. DO concentrations regularly reached supersaturated levels during daytime hours. The diurnal DO concentration swing was typically 5-6 mg/L, but at times exceeded 10 mg/L. The summers of 2017 and 2018 were similar to 2015 in that it was common to see nighttime concentrations below 5 mg/L but there were no extended periods of continuous low DO. This was not true, however, during the summer of 2016, when most DO concentrations were below 5 mg/L, including a continuous period from July 22 to August 19 (Figure F-3). Water clarity and chlorophyll values during this period suggest a lack of photosynthetic activity was the likely cause for the low DO concentrations. The low concentrations were confirmed by handheld meter readings at the depth of the sonde of 2.16 mg/L on August 2, 2016 and 0.84 mg/L on August 16, 2016. Surface grab sample DO concentrations were also below 5 mg/L on these dates; thus, indicating low DO throughout the water column.

DO concentrations measured by sonde during the winter at site W-M504.7S also never fell below the target level during the five monitoring seasons. The lowest DO concentration observed was 5.20 mg/L on December 12, 2018 (Figure F-4). This figure is reflective of the remaining four winter seasons monitored in that no DO concentrations were below 5 mg/L and approximately half of the values were supersaturated. The average sonde-measured water temperatures for the five winter seasons were (beginning with the 2014-2015 season): 1.42, 3.46, 1.72, 2.09 and 2.11°C, respectively.

B. Site W-M504.9P. Site W-M504.9P was monitored for two winter and two summer seasons. Table 3 shows the results from grab sample monitoring at site W-M504.9P. This site is the most isolated from the effects of the main channel and is the most heavily vegetated site (primarily lotus). This likely contributed to the minimum (0.82 mg/L on July 18, 2017) and maximum (23.22 mg/L on January 31, 2018) DO concentrations of all sites occurring here. Seven DO concentrations at this site were below 5 mg/L, all occurring during the summer months. Six consecutive grab sample DO concentrations collected from July 5, 2017, through September 12, 2017, were below 5 mg/L. The isolated nature of this site was also shown in measurements reflective of water clarity—Secchi disk depth, turbidity and total suspended solids. The summer median value for Secchi disk depth (69.3 cm) was the highest of all five sites, while turbidity (11.0 NTU) and total suspended solids (9.7 mg/L) median values were the lowest. The maximum Secchi disk depth here was an exceptional 145.0 cm, which was equal to the water depth, on July 5, 2017.

The lowest winter grab sample DO concentration was 5.27 mg/L on November 30, 2018. Median velocities here were the lowest of the five sites at 0.38 cm/sec, while the maximum winter velocity here was 0.90 cm/sec. The median winter water temperature here was the warmest of the sites (tied with site W-M504.1E) at 2.9°C.

Sondes were deployed at Site W-M504.9P during the summers of 2017 and 2018. The low grab sample DO concentrations measured for an extended period during the summer of 2017 were mirrored by the sonde monitoring results as shown in Figure F-5. Except for a few readings, DO concentrations were below 5 mg/L from June 28, 2017, through September 12, 2017. During the summer of 2018, DO concentrations were considerably higher at this site (Figure F-6). Lower water velocities (less mixing), water temperatures (lower rates of photosynthesis) and chlorophyll a concentrations (fewer photosynthetic organisms) likely all contributed to the extended low DO concentrations observed during the summer of 2017. Another factor to consider at site W-M 504.9P is the predominance of lotus here. Although water clarity at this site was relatively good (median Secchi disk depth value of 65.0 cm versus 34.0 cm at site W-M504.7S), shading caused by the large areal coverage of floating lotus leaves inhibited algal photosynthesis. Of note during the summer of 2018 was the shifting of the sonde from its initially deployed position to a location approximately 200 meters downstream (where it was found floating on the surface on September 27, 2018). The sonde was apparently removed from its weight and snag line by someone and left to drift. A sudden change in depth measured by the sonde on August 19, 2018, suggests this is likely when the sonde was disturbed.

Sondes were deployed during the winters of 2017-2018 and 2018-2019 at site W-M504.9P, with results shown in Figures F-7 and F-8, respectively. DO concentrations were supersaturated approximately half the time during the winter of 2017-2018 and significantly less during the winter of 2018-2019. DO concentrations below 5 mg/L occurred only during parts of two brief periods over the winter of 2017-2018 (January 10-11, 2018 and February 14-16, 2018); whereas, low DO concentrations occurred during three extended periods over the winter of 2018-2019 (November 30-December 16, 2018; January 29-February 8, 2019; and February 14-25, 2019). Lower median water velocities during the winter of 2018-2019 (0.26 cm/sec vs. 0.66 cm/sec in winter of 2017-2018) may have contributed to the differences in DO concentrations between the two monitoring periods. Average winter sonde-measured water temperatures were 3.74°C in 2017-2018 and 3.56°C in 2018-2019, which were warmer than those at site W-M504.7S (2.09 and 2.11°C, respectively). Readings below 3°C were 14.9% in 2017-2018 and 37.0% in 2018-2019.

C. Site W-M504.1E. The last site to exhibit lentic characteristics is W-M504.1E. This site had the shortest monitoring period, commencing on December 28, 2017. Table F-4 displays the results from grab sample monitoring which occurred here. This site is located off Grant Slough and visual observations suggest it is intermediate in the amount of aquatic vegetation relative to sites W-M504.7S and W-M504.9P. Two grab sample DO concentrations measured here were below the target level concentration: 4.58 mg/L on August 14, 2018 and 4.98 mg/L on November 30, 2018. For the two winter seasons that were monitored here, median water velocity was 0.51 cm/sec and median water temperature 2.9°C. In general, this site was intermediate in water quality characteristics when compared to sites W-M504.7S and W-M504.9P. Sondes were not deployed at this site.

D. Sites W-M505.7C and W-M505.0B. The last two sampling locations exhibited lotic characteristics and are discussed together due to data similarities. The sites are located in Grant Slough, at points approximately equidistant up- and downstream from a bisecting channel that flows from Steamboat Slough into Grant Slough. These sites were monitored primarily to provide information related to the potential placement of a sediment closure structure within the Project to reduce sediment input. Both sites have the same period of record, commencing on June 6, 2017, and extending for two summer and two winter monitoring seasons. Grab sample results for the two sites are shown in Tables F-5 and F-6. Only one DO concentration at the two sites was below 5 mg/L: 4.95 mg/L on June 19, 2018 at site W-M505.7C. On the same sampling day, the DO concentration at site W-M505.0B was slightly higher, at 5.30 mg/L. Median water velocities at the two sites were relatively high at 19.36 and 23.39 cm/sec, respectively. Median winter water temperatures (1.2 and 1.4°C, respectively) were somewhat lower than the three lentic sites (1.7, 2.9 and 2.9°C); while median summer chlorophyll a concentrations (57.3 and 55.6 mg/m^3, respectively) were considerably higher (14.0, 26.0 and 18.3 mg/m^3).

Parameters reflective of water clarity also confirmed the lotic nature of these two sites. Median summer turbidity (41.0 and 44.9 NTU, respectively) and total suspended solids (50.2 and 69.8 mg/L, respectively) were higher than the three lentic sites (18.1, 40.4 and 11.0 NTU; and 18.4, 40.4 and 9.7 mg/L), while Secchi disk depth values were lower (31.0 and 27.5, respectively, versus 44.8, 31.3 and 69.3 cm). Additional discussion of water clarity related parameters is found below in Section E. Sondes were not deployed at sites W-M505.7C and W-M505.0B.

E. Light-Related Criteria Necessary to Support Submersed Aquatic Vegetation. Light-related criteria necessary to support and sustain submersed aquatic vegetation (SAV) during the growing season in the UMR include a Secchi disk depth of 50 cm, a TSS concentration of 25 mg/L, and a turbidity of 20 NTU, as described in UMRCC (2003). Figures F-9, F-10, and F-11 are box plots of the Secchi disk depths, TSS concentrations, and turbidity measurements for all five sites during the summer months compared to the UMRCC criteria. The percentage of water clarity measurements during the 2015-2018 growing seasons at site W-M504.7S that met the criteria were as follows: Secchi disk depth (21.9%), TSS (37.5%) and turbidity (25%). Site W-M504.9P was sampled during the growing seasons of 2017 and 2018. This site is more isolated from the effects of the main channel and it was reflected in the water clarity results which showed higher percentages of readings meeting the criteria: Secchi disk depth (81.3%), TSS (100%) and turbidity (93.8%). Site W-M504.1E showed intermediate results compared to the preceding two sites. As expected, the two lotic sites, W-M505.7C and W-M505.0B, had the most diminished water clarity. Results at these two sites were identical in that none of the Secchi disk depth, TSS or turbidity grab sample results met the criteria necessary to support and sustain SAV during the growing season. In addition to grab samples, Figure F-11 also included sonde-measured results for sites W-M504.7S and W-M504.9P. These results indicate the sondes were more effective at capturing high turbidity events; whereas, with grab samples only, these events would have been missed. The maximum sonde-measured turbidity values at sites W-M504.7S and W-M504.9P were 1682.95 and 349.31 FNU, respectively, while the maximum grab sample values were only 144 and 33.5 NTU.

V. CONCLUSION

Pre-Project baseline water quality monitoring was initiated at five Project sites: W-M504.7S (December 19, 2014), three sites on June 6, 2017 (W-M504.9P, W-M505.7C and W-M505.0B) and W-M504.1E (December 8, 2017). Monitoring continued at all sites through March 11, 2019. Monitoring was accomplished through the collection of discrete grab samples, as well as by utilization of continuous monitors (at sites W-M504.7S and W-M504.9P only).

Sites W-M504.7S, W-M504.9P and W-M504.1E exhibited lentic water quality characteristics, while sites W-M505.0B and W-M505.7C exhibited lotic characteristics. The lentic sites typically had lower water velocities, and better water clarity as reflected in measurements of Secchi disk depth, turbidity and total suspended solids. A grab sample DO concentration below the target level of 5 mg/L occurred only once at the lotic sites, while at the lentic sites, numerous low concentrations were measured, nearly all during the summer sampling season.

Sonde-measured DO concentrations at sites W-M504.7S and W-M504.9P varied by year and season. It was rare to see a winter DO concentration below 5 mg/L at either site (in fact, supersaturated values were common), except for W-M504.9P during the winter of 2018-2019, when there were three extended periods of continuous low DO. This was attributed to the lower water velocities experienced during this winter season. Increasing water depth via dredging would help alleviate the low DO concentrations here by providing a larger volume of DO in the water column prior to ice-over. Introduction of flow would also help but at the expense of increasing the sediment load and velocities. Sonde-measured winter water temperatures were generally above 3°C at site W-M504.9P, but not so at site W-M504.7S. Dredging would create deep-water habitat that would likely stratify and have water temperatures close to 4°C near the bottom.

While it was common for sonde-measured summer nighttime DO concentrations to fall below 5 mg/L at the two sites and recover the following day, there were also extended periods of low DO, lasting nearly all of the summer season at site W-M504.7S during 2016 and site W-M504.9P during 2017. Lower chlorophyll a values during these periods suggest a lack of photosynthetic activity, among other factors, contributed to the low DO concentrations. Supersaturated DO values were also common during the summer and were often accompanied by wide diurnal swings in concentration. Introduction of flow to these two sites during the growing season could help increase DO concentrations but, again, would also introduce sediment and decrease water clarity.

Only site W-M504.9P currently exhibits the light-related characteristics conducive to SAV growth. With dredging, the lentic sites W-M504.7S and W-M504.1E would likely show improvements in light related water quality characteristics. Further isolation of site W-M504.7S from main channel flows by restoring the bank line upstream of the site would also likely improve light related water quality characteristics in that part of the backwater.

The Recommended Plan includes aquatic diversity dredging for Steamboat Island's Lower Lake in the vicinity of site W-M503.6L. Although representative monitoring could not be performed at this site because it was too shallow, Google Earth images over time indicate this site contains more aquatic vegetation than the sites that were monitored. The increased vegetation here would result in a high oxygen demand when plants senesce and bacterial decomposition occurs. This, coupled with the shallow water depth, could potentially result in extended periods of low DO at this site during the winter months; thus, making it a prime candidate for aquatic diversity enhancement via dredging.

VI. REFERENCE

Upper Mississippi River Conservation Committee (UMRCC). (2003). *Proposed Light-Related Water Quality Criteria Necessary to Sustain Submersed Aquatic Vegetation in the Upper Mississippi River*.

Table F-1: Seasonal Summary Statistics for Five Monitoring Sites

Site	Water Depth (m)	Velocity (cm/sec)	Water Temp. (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Secchi Disk Depth (cm) [1]	Turbidity (NTU)	Total Suspended Solids (mg/L) [2]	Chlorophyll a (mg/m3)[3]
W-M504.1E Summer									
Min.	0.560	0.49	19.3	4.58	7.79	25.0	9.8	9.8	12.4
Max.	1.810	18.21	28.0	11.64	8.56	55.0	33.1	32.0	80.5
Avg.	0.993	3.44	25.0	7.14	-	41.8	19.8	18.8	30.8
Median	0.948	1.47	26.0	6.23	8.12	44.8	18.1	18.4	18.3
W-M504.1E Winter									
Min.	0.520	0.22	1.9	4.98	7.37	-	7.6	-	-
Max.	0.785	0.71	4.7	20.46	8.12	-	195.0	-	-
Avg.	0.633	0.49	3.0	12.96	-	-	44.7	-	-
Median	0.610	0.51	2.9	11.75	7.86	-	13.3	-	-
W-M504.7S Summer									
Min.	0.630	0.01	19.0	1.09	7.27	12.0	5.3	4.7	<1.0
Max.	2.020	26.52	28.1	8.91	8.89	>101.5	144.0	119.0	66.0
Avg.	1.135	4.97	24.1	5.34	-	36.7	45.6	41.5	16.5
Median	1.085	3.93	24.6	5.69	7.86	31.3	40.4	40.4	12.8
W-M504.7S Winter									
Min.	0.620	0.24	0.1	7.94	7.12	-	4.2	-	-
Max.	1.040	2.82	11.3	19.03	8.72	-	53.4	-	-
Avg.	0.786	1.09	2.6	13.94	-	-	18.4	-	-
Median	0.760	0.77	1.7	13.59	7.95	-	13.0	-	-
W-M504.9P Summer									
Min.	0.960	0.02	16.8	0.82	7.24	43.0	2.4	2.6	4.9
Max.	2.325	4.80	28.1	11.26	8.58	>145	33.5	19.0	148
Avg.	1.439	0.99	23.7	4.85	-	77.3	11.0	9.4	33.9
Median	1.420	0.64	23.9	5.31	7.81	69.3	11.0	9.7	26.0
W-M504.9P Winter									
Min.	0.970	0.13	0.4	5.27	7.30	-	5.1	-	-
Max.	1.165	0.90	5.2	23.22	8.39	-	17.4	-	-
Avg.	1.051	0.46	2.8	13.76	-	-	11.9	-	-
Median	1.028	0.38	2.9	12.37	8.08	-	12.6	-	-

[1] Winter Secchi disk depth measurements are collected only when there is no ice cover. Due to limited data points, summary statistics are not provided for the winter season; however, all collected Secchi disk depth measurements are

[2] Total suspended solids and chlorophyll samples are not collected during the winter months.

Table F-1: Seasonal Summary Statistics for Five Monitoring Sites

Site	Water Depth (m)	Velocity (cm/sec)	Water Temp. (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Secchi Disk Depth (cm) [1]	Turbidity (NTU)	Total Suspended Solids (mg/L) [2]	Chlorophyll a (mg/m3)[3]
W-M505.0B Summer									
Min.	2.480	2.57	19.1	5.30	7.62	19.1	25.8	36.0	4.7
Max.	4.090	77.00	27.7	9.30	8.63	44.5	69.7	81.0	210
Avg.	3.058	35.40	24.4	7.33	-	30.6	41.4	55.0	65.3
Median	2.975	34.35	24.6	7.37	8.13	31.0	41.0	50.2	55.6
W-M505.0B Winter									
Min.	2.630	14.44	0.6	12.00	7.57	-	9.3	-	-
Max.	2.810	20.99	2.3	14.12	8.32	-	159	-	-
Avg.	2.720	16.96	1.4	12.90	-	-	42.5	-	-
Median	2.738	16.65	1.4	12.72	7.80	-	20.3	-	-
W-M505.7C Summer									
Min.	0.820	2.56	19.0	4.95	7.54	16.5	30.1	39.0	4.8
Max.	3.230	85.20	27.7	9.23	8.52	39.0	104	126	215
Avg.	1.445	33.83	24.0	7.07	-	26.8	53.6	76.8	68.7
Median	1.330	30.66	24.2	7.00	8.09	27.5	50.4	69.8	57.3
W-M505.7C Winter									
Min.	0.780	13.65	0.3	11.80	7.55	-	8.9	-	-
Max.	1.215	19.72	2.1	14.09	8.34	-	174.0	-	-
Avg.	0.979	17.13	1.2	12.84	-	-	45.4	-	-
Median	0.975	17.65	1.2	12.69	7.85	-	19.1	-	-

[1] Winter Secchi disk depth measurements are collected only when there is no ice cover. Due to limited data points, summary statistics are not provided for the winter season; however, all collected Secchi disk depth measurements are

[2] Total suspended solids and chlorophyll samples are not collected during the winter months.

Table F-2: Water Quality Monitoring Results from Samples Collected at Site W-M504.7S

Date	Water Depth (m)	Velocity (cm/sec)	Water Temp (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Secchi Disk Depth (cm)	Turbidity (NTU)	Total Suspended Solids (mg/L)	Chlorophyll a (mg/m^3)	Chlorophyll b (mg/m^3)	Chlorophyll c (mg/m^3)	Pheophytin a (mg/m^3)
12/19/2014	0.930	0.90	1.8	15.58	8.39	-	18.3	-	-	-	-	-
2/3/2015	0.710	0.46	0.5	7.94	7.72	-	11.4	-	-	-	-	-
3/10/2015	0.690	0.36	1.0	19.03	8.40	-	53.4	-	-	-	-	-
6/2/2015	1.300	2.17	20.3	6.13	7.67	39.5	21.2	27.5	1.2	<1.0	9.7	<1.0
6/16/2015	1.750	-	23.0	5.71	7.54	19.5	68.9	112	<1.0	<1.0	3 1	<1.0
6/30/2015	1.090	-	22.7	5.45	7.68	28	33.6	34	<1.0	2.3	3 3	<2.0
7/14/2015	0.960	-	25.7	7.31	8.30	37	12.6	13.8	1.7	3.5	2 9	<1.0
7/28/2015	0.850	-	26.7	3.92	7.94	50	20.2	14.8	<1.0	1.8	3 2	<1.0
8/11/2015	0.845	-	24.7	8.69	8.89	36	25.2	22.1	10.1	18.6	10.7	<1.0
8/25/2015	0.830	-	21.0	7.95	8.53	38	31.7	35.2	5.6	10.7	8.4	<1.0
9/9/2015	0.770	7.02	24.5	5.67	8.37	66	12.3	14.3	3.6	6.1	6 2	<1.0
1/8/2016	0.800	-	2.8	13.04	7.12	-	5.29	-	-	-	-	-
3/9/2016	1.000	2.82	11.3	15.62	8.72	34.0	23.2	-	-	-	-	-
6/7/2016	1.090	1.97	21.5	2.96	7.86	18.0	67.6	56	22.4	1.6	2 3	12.7
6/21/2016	1.250	3.94	25.3	3.49	7.64	24.4	56.1	41	11.7	1.9	3 1	8.5
7/6/2016	1.085	0.95	25.0	5.39	7.77	39.5	22.4	20	13.7	<1.0	<1.0	4.3
7/19/2016	0.875	1.73	25.7	1.09	7.40	>87.5	5.41	5.8	8.4	<1.0	<1.0	2.6
8/2/2016	1.415	6.43	25.7	3.43	7.41	73.0	11.9	8 3	5.9	<1.0	<1.0	1.5
8/16/2016	1.015	0.44	24.5	1.12	7.27	>101.5	5.32	4.7	10.9	<1.0	<1.0	<1.0
8/30/2016	1.820	8.64	23.7	5.46	7.61	23.0	46.1	36.5	7.7	<1.0	<1.0	3.8
9/13/2016	1.500	2.78	21.9	5.81	7.84	43.0	24.9	15	7.3	<1.0	<1.0	2
12/21/2016	0.760	0.42	0.5	14.53	8.07	-	4.15	-	-	-	-	-
1/30/2017	1.040	2.58	0.1	12.78	7.83	-	8.78	-	-	-	-	-
2/22/2017	0.945	0.75	7.2	14.82	8.25	>94.5	8.67	-	-	-	-	-
6/6/2017	1.850	11.84	22.0	8.91	8.17	38.0	35.9	50	52.4	2	5 9	15
6/20/2017	1.320	6.76	25.1	6.73	8.05	30.5	49.5	47.6	25.5	<1.0	1.4	11.4
7/5/2017	1.170	4.00	25.0	6.63	7.99	21.0	58.1	55.5	23.7	<1	1.6	8.4
7/18/2017	0.920	0.01	24.3	4.18	7.80	19.0	79.9	65.6	13.9	<1	1.7	8.4
8/1/2017	1.085	1.01	24.8	5.91	7.77	23.5	52.9	46.8	23.7	<1.0	1.6	4
8/15/2017	0.730	5.87	23.3	4.12	8.09	16.5	77.9	65.6	66	<1.00	6.7	8
8/29/2017	0.790	0.87	20.1	3.22	7.61	18.0	74.3	65.5	15.5	<1.0	<1.0	5.4
9/12/2017	0.705	0.51	19.0	3.65	7.79	16.0	83.3	65.3	18	2.7	3.8	<1.0
12/8/2017	0.620	1.53	3.1	18.21	8.56	-	14.6	-	-	-	-	-
1/31/2018	0.630	0.77	1.5	14.13	7.91	-	20.2	-	-	-	-	-
3/8/2018	0.665	0.72	0.9	12.87	7.98	55.0	15.3	-	-	-	-	-
6/5/2018	0.940	3.92	23.3	6.99	8.38	32.0	44.8	47.5	37.4	<1.00	1 3	15.9
6/19/2018	1.130	5.31	27.6	6.22	8.12	29.0	54.5	49.5	36.3	3	<1.0	7.2
7/5/2018	2.020	26.52	28.1	6.24	-	43.5	18.3	21.8	14.1	<1.00	<1.00	5.6

7/17/2018	1.440	11.62	27.8	6.49	8.49	53.0	16.5	19.5	11.8	<1.00	<1.00	3.1
7/31/2018	1.025	4.83	25.5	8.59	8.41	62.0	18.8	20.8	25.6	<1.00	<1.00	2.6
8/14/2018	0.630	0.80	26.4	2.07	7.73	20.0	80.3	61.5	25	2.8	<1.00	11.4
8/28/2018	0.690	1.37	25.2	4.73	7.95	12.0	144	119	21.3	<1.00	<1.00	95.4
9/24/2018	1.420	7.86	20.4	6.58	7.88	17.0	89.9	67.5	4.6	<1.0	<1.0	<1.0
11/30/2018	0.800	1.58	2.3	12.09	7.73	-	10.7	-	-	-	-	-
2/14/2019	0.660	0.24	1.6	11.71	7.42	-	9.89	-	-	-	-	-
3/11/2019	0.760	1.08	2.2	12.83	7.79	-	53.2	-	-	-	-	-
MIN.	**0.620**	**0.01**	**0.1**	**1.09**	**7.12**	**12.0**	**4.15**	**4.7**	**<1.0**	**<0.1**	**<1.0**	**<1.0**
MAX.	**2.020**	**26.52**	**28.1**	**19.03**	**8.89**	**101 5**	**144.0**	**119.0**	**66.0**	**18.6**	**10.7**	**95.4**
AVG.	**1.029**	**3.68**	**17.5**	**7.96**	**-**	**38.8**	**37.0**	**41.6**	**16.5**	**2.1**	**2.6**	**7.6**
MEDIAN	**0.943**	**1.73**	**22.9**	**6.54**	**7.88**	**34.0**	**24.1**	**38.8**	**12.8**	**<0.1**	**1 5**	**3.5**

Table F-3: Water Quality Monitoring Results from Samples Collected at Site W-M504.9P

Date	Water Depth (m)	Velocity (cm/sec)	Water Temp (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Secchi Disk Depth (cm)	Turbidity (NTU)	Total Suspended Solids (mg/L)	Chlorophyll a (mg/m³)	Chlorophyll b (mg/m³)	Chlorophyll c (mg/m³)	Pheophytin a (mg/m³)
6/6/2017	2.090	1.17	20.9	6.36	7.81	65.0	12.6	10.3	27.1	<1	2.4	10.4
6/20/2017	1.570	0.28	24.7	5.26	7.90	69.0	12.5	11.5	24.8	<1.0	<1.0	7.2
7/5/2017	1.450	0.29	23.9	3.89	7.55	>145.0	2.4	<2.9	13.5	<1	<1	1.2
7/18/2017	1.260	0.02	23.8	0.82	7.47	115.0	4.88	4.4	4.9	<1	1.7	<1.0
8/1/2017	1.460	0.71	23.9	1.23	7.24	126.0	4.77	4.0	27.2	<1	1.8	3.6
8/15/2017	1.070	0.32	21.6	1.61	7.49	88.0	4.01	4.79	25.4	2.6	<1.00	2.6
8/29/2017	1.110	0.31	19.5	1.04	7.40	75.0	2.46	2.6	6.6	<1.0	<1.0	1.8
9/12/2017	1.080	0.57	16.8	1.25	7.46	91.0	6.7	5.6	19.7	<1.0	<1.0	3.7
12/8/2017	1.000	0.84	2.9	11.56	8.04	-	16.1	-	-	-	-	-
1/31/2018	0.970	0.25	5.2	23.22	8.39	-	7.93	-	-	-	-	-
3/8/2018	1.025	0.90	2.8	13.18	8.11	55.0	17.4	-	-	-	-	-
6/5/2018	1.270	1.53	23.3	8.33	8.19	51.0	15.5	19.0	88.5	12.3	2.2	27.9
6/19/2018	1.450	0.47	28.0	11.26	8.58	43.0	14.9	18.8	148	19.5	7.2	16.6
7/5/2018	2.325	4.80	28.1	5.58	-	77.0	9.4	9.6	13.7	<1.00	<1.00	2.5
7/17/2018	1.765	1.07	26.7	6.35	8.25	62.5	13	9.71	26.5	<1.00	<1.00	8.3
7/31/2018	1.390	1.05	24.1	7.59	8.11	69.5	9.35	7.6	28.5	<1.00	<1.00	6
8/14/2018	0.960	0.32	27.5	4.61	7.91	49.5	17.6	15.6	36.9	<1.00	<1.00	5.1
8/28/2018	1.010	0.73	25.7	7.07	8.31	61.0	13.2	10.5	44.8	<1.00	<1.00	8.7
9/24/2018	1.770	2.25	20.3	5.36	7.77	49.0	33.5	15.0	6.9	<1.0	<1.0	2.2
11/30/2018	1.165	0.13	3.1	5.27	7.34	-	5.1	-	-	-	-	-
2/14/2019	1.030	0.15	2.3	6.51	7.30	-	9.4	-	-	-	-	-
3/11/2019	1.115	0.51	0.4	22.81	8.32	-	15.7	-	-	-	-	-
MIN.	**0.960**	**0.02**	**0.4**	**0.82**	**7.24**	**19.0**	**2.40**	**2.6**	**4.9**	**<1**	**<1.0**	**<1.0**
MAX.	**2.325**	**4.80**	**28.1**	**23.22**	**8.58**	**>145.0**	**79.9**	**65.6**	**148.0**	**19.5**	**7.2**	**27.9**
AVG.	**1.333**	**0.85**	**18.0**	**7.28**	**-**	**70.3**	**14.70**	**13.2**	**33.9**	**3.0**	**1.2**	**6.8**
MEDIAN	**1.213**	**0.54**	**22.5**	**5.97**	**7.90**	**65.0**	**12.55**	**10.0**	**26.0**	**<1.0**	**<1.0**	**4.4**

Table F-4: Water Quality Monitoring Results from Samples Collected at Site W-M504.1E

Date	Water Depth (m)	Velocity (cm/sec)	Water Temp (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Secchi Disk Depth (cm)	Turbidity (NTU)	Total Suspended Solids (mg/L)	Chlorophyll a (mg/m^3)	Chlorophyll b (mg/m^3)	Chlorophyll c (mg/m^3)	Pheophytin a (mg/m^3)
12/8/2017	0.520	0.57	3.1	11.40	7.98	-	9.46	-	-	-	-	-
1/31/2018	0.540	0.71	3.7	20.46	8.12	-	29.7	-	-	-	-	-
3/8/2018	0.575	0.64	1.9	11.81	7.89	>57.5	16.8	-	-	-	-	-
6/5/2018	0.770	1.51	22.6	9.44	8.37	52.5	15.0	13.0	49.3	5.3	1.6	9.8
6/19/2018	0.980	1.36	27.9	11.64	8.44	44.5	16.6	19.0	80.5	6.9	4.1	18
7/5/2018	1.810	18.21	28.0	5.41	-	49.0	19.6	32.0	16.4	<1.00	<1.00	5.1
7/17/2018	1.060	1.79	26.7	6.31	8.56	45.0	27.8	24.0	20.2	1.3	<1.00	5.1
7/31/2018	0.915	1.43	23.5	7.51	8.09	55.0	9.76	9.75	14.4	<1.00	<1.00	4.5
8/14/2018	0.560	1.77	26.1	4.58	7.85	29.0	13.4	11.0	12.4	<1.00	<1.00	2.9
8/28/2018	0.590	0.49	25.8	6.12	8.12	34.0	23.5	23.6	40.2	5.1	<1.00	7.1
9/24/2018	1.260	0.98	19.3	6.14	7.79	25.0	33.1	17.8	13.0	<1.0	<1.0	2.0
11/30/2018	0.785	0.45	4.7	4.98	7.37	-	7.6	-	-	-	-	-
2/14/2019	0.645	0.22	2.6	11.68	7.41	-	9.85	-	-	-	-	-
3/11/20119	0.730	0.32	1.9	17.44	7.82	-	195.0	-	-	-	-	-
MIN.	**0.520**	**0.22**	**1.9**	**4.58**	**7.37**	**25.0**	**7.60**	**9.8**	**12.4**	**<1.0**	**<1.0**	**2.0**
MAX.	**1.810**	**18.21**	**28.0**	**20.46**	**8.56**	**>57.5**	**195.0**	**32.0**	**80.5**	**6.9**	**4.1**	**18.0**
AVG.	**0.839**	**2.18**	**15.6**	**9.64**	**-**	**43.5**	**30.51**	**18.8**	**30.8**	**2.6**	**1.1**	**6.8**
MEDIAN	**0.750**	**0.85**	**21.0**	**8.48**	**7.98**	**45.0**	**16.70**	**18.4**	**18.3**	**0.9**	**<1.0**	**5.1**

Table F-5: Water Quality Monitoring Results from Samples Collected at Site W-M505.7C

Date	Water Depth (m)	Velocity (cm/sec)	Water Temp (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Secchi Disk Depth (cm)	Turbidity (NTU)	Total Suspended Solids (mg/L)	Chlorophyll a (mg/m^3)	Chlorophyll b (mg/m^3)	Chlorophyll c (mg/m^3)	Pheophytin a (mg/m^3)
6/6/2017	3.230	85.20	22.5	9.23	8.09	28.0	41.7	54	215	<1	21.9	44.2
6/20/2017	1.645	33.64	23.8	6.55	7.87	16.5	104	126	30.1	<1.0	1.9	13
7/5/2017	1.270	35.15	24.4	6.96	7.84	20.0	78.2	108	12.9	<1	<1	1.6
7/18/2017	1.100	2.56	25.4	7.34	8.15	21.0	66.8	96.5	93.6	3.6	5.4	23.6
8/1/2017	1.390	53.05	22.8	6.41	7.54	28.0	4.77	125	16.4	<1.0	<1.0	5.1
8/15/2017	1.010	12.81	23.4	8.41	8.52	39.0	31.8	50	124	5.9	10.9	17.2
8/29/2017	0.980	18.95	21.6	6.91	8.06	28.0	45.8	66	84.7	2	6.2	10.1
9/12/2017	0.820	4.85	20.3	7.56	8.17	28.0	34.9	68.4	98	2.3	8.2	13.9
12/8/2017	0.780	13.65	2 1	14.09	8.34	64.0	14.2	-	-	-	-	-
1/31/2018	0.840	18.26	0.8	12.89	7.86	50.0	23.2	-	-	-	-	-
3/8/2018	0.950	15.14	1.6	12.48	7.84	30.0	37.3	-	-	-	-	-
6/5/2018	1.190	26.06	23.9	7.69	8.34	25.5	56.8	105	56.8	2.1	2.2	12
6/19/2018	1.420	37.75	26.2	4.95	7.64	25.0	44	57.2	8.4	<1.0	<1.0	3.6
7/5/2018	2.240	68.06	27.7	5.93	-	36.0	30.1	41.1	20.8	<1.00	<1.00	2.1
7/17/2018	1.800	49.38	26.8	6.18	8.47	19.0	82.4	89.6	31.2	<1.00	<1.00	10.3
7/31/2018	1.390	27.68	25.1	7.95	8.4	32.0	34.3	60.4	133	8	7.5	23.7
8/14/2018	0.920	14.76	25.8	6.98	8.07	27.0	58.7	71.3	57.7	1.3	3.7	7.5
8/28/2018	0.880	17.66	25.8	7.01	8.36	27.0	60.5	71.2	111	2.1	9.4	15.4
9/24/2018	1.840	53.75	19.0	7.02	7.82	28.0	32.9	39.0	4.8	<1.0	<1.0	1.0
11/30/2018	1.215	19.00	1 9	13.43	8.03	95.0	8.89	-	-	-	-	-
2/14/2019	1.000	19.72	0 3	12.35	7.56	-	14.9	-	-	-	-	-
3/11/2019	1.090	17.03	0 5	11.8	7.55	12.0	174	-	-	-	-	-
MIN.	**0.780**	**2.56**	**0 3**	**4.95**	**7.54**	**12.0**	**4.77**	**39.0**	**4 8**	**<1.0**	**<1.0**	**1.0**
MAX.	**3.230**	**85.20**	**27.7**	**14.09**	**8.52**	**95.0**	**174.0**	**126.0**	**215.0**	**8.0**	**21.9**	**44.2**
AVG.	**1.318**	**29.28**	**17.8**	**8.64**	**-**	**32.3**	**49.1**	**76.8**	**68.7**	**2.0**	**5.0**	**12.8**
MEDIAN	**1.145**	**19.36**	**23.1**	**7.45**	**8.06**	**28.0**	**39.5**	**69.8**	**57.3**	**0.9**	**3.0**	**11.2**

Table F-6: Water Quality Monitoring Results from Samples Collected at Site W-M505.0B

Date	Water Depth (m)	Velocity (cm/sec)	Water Temp (°C)	Dissolved Oxygen (mg/L)	pH (SU)	Secchi Disk Depth (cm)	Turbidity (NTU)	Total Suspended Solids (mg/L)	Chlorophyll a (mg/m^3)	Chlorophyll b (mg/m^3)	Chlorophyll c (mg/m^3)	Pheophytin a (mg/m^3)
6/6/2017	3.830	68.71	22.3	9.3	8 11	28.0	40.1	61.6	210	<1	20.8	68.5
6/20/2017	3.310	38.30	24.4	6.7	7 98	20.0	69.7	79.6	30.1	<1	1.9	13
7/5/2017	2.990	44.53	24.8	7.24	7 94	21.0	52.4	64.0	14.3	<1	<1	4.4
7/18/2017	2.860	2.57	25.9	7.49	8 13	28.0	59.2	81.0	108	1.6	8.7	26.8
8/1/2017	3.120	36.02	23.4	6.7	7.62	39.5	32.7	52.4	16.9	<1.0	<1.0	3.2
8/15/2017	2.770	14.65	23.8	8.94	8.63	44.5	25.8	36.0	132	5.9	12.2	15.2
8/29/2017	2.780	25.38	21.9	7.15	8	38.0	34.3	47.7	84	2.5	7.5	11
9/12/2017	2.700	19.66	20.6	8.07	8.3	35.0	41.8	44.8	83	1.4	6.9	8.3
12/8/2017	2.740	16.74	2.3	14.12	8 32	61.0	12.5	-	-	-	-	-
1/31/2018	2.650	14.44	1.0	12.88	7.82	50.0	25.3	-	-	-	-	-
3/8/2018	2.755	16.64	1.8	12.56	7.77	37.0	33.6	-	-	-	-	-
6/5/2018	2.870	32.67	24.3	7.8	8 38	33.0	45.1	70.5	52.8	1.5	2.2	11.2
6/19/2018	3.060	41.57	26.7	5.3	7.67	29.0	29.8	40.9	10	<1.0	<1.0	3.1
7/5/2018	4.090	77.00	27.7	5.83	-	34.0	26.7	48.3	21.6	<1.00	<1.00	1.9
7/17/2018	3.305	54.44	27.1	6.29	8 52	23.0	57.3	66.8	22.9	1.1	<1.00	7.2
7/31/2018	2.960	26.90	25.5	8.27	8.44	37.0	25.8	44.8	106	6.7	5.2	18.6
8/14/2018	2.570	21.40	27.1	8.29	8 33	33.0	34.4	41.2	58.3	1	3.6	<1.00
8/28/2018	2.480	14.34	26.1	7.72	8.46	27.0	43.4	50.4	90.7	<1.00	6.4	7.8
9/24/2018	3.230	48.31	19.1	6.14	7.83	19.1	43.7	50.0	4.7	<1.0	<1.0	<1.0
11/30/2018	2.810	20.99	2.0	13.35	7 97	81.0	9.27	-	-	-	-	-
2/14/2019	2.630	16.32	0.6	12.48	7 58	-	15.3	-	-	-	-	-
3/11/2019	2.735	16.65	0.9	12	7 57	12.0	159	-	-	-	-	-
MIN.	**2.480**	**2.57**	**0.6**	**5.30**	**7 57**	**12.0**	**9.27**	**36.0**	**4.7**	**<1.0**	**<1.0**	**<1.0**
MAX.	**4.090**	**77.00**	**27.7**	**14.12**	**8.63**	**81.0**	**159.0**	**81.0**	**210.0**	**6.7**	**20.8**	**68.5**
AVG.	**2.966**	**30.37**	**18.2**	**8.85**	**-**	**34.8**	**41.7**	**55.0**	**65.3**	**1.6**	**4.9**	**12.6**
MEDIAN	**2.835**	**23.39**	**23.6**	**7.94**	**8.00**	**33.0**	**34.4**	**50.2**	**55.6**	**0.8**	**2.9**	**8.1**

FIGURE F-2. PRE-PROJECT DISSOLVED OXYGEN, pH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M504.7S DURING SUMMER 2015

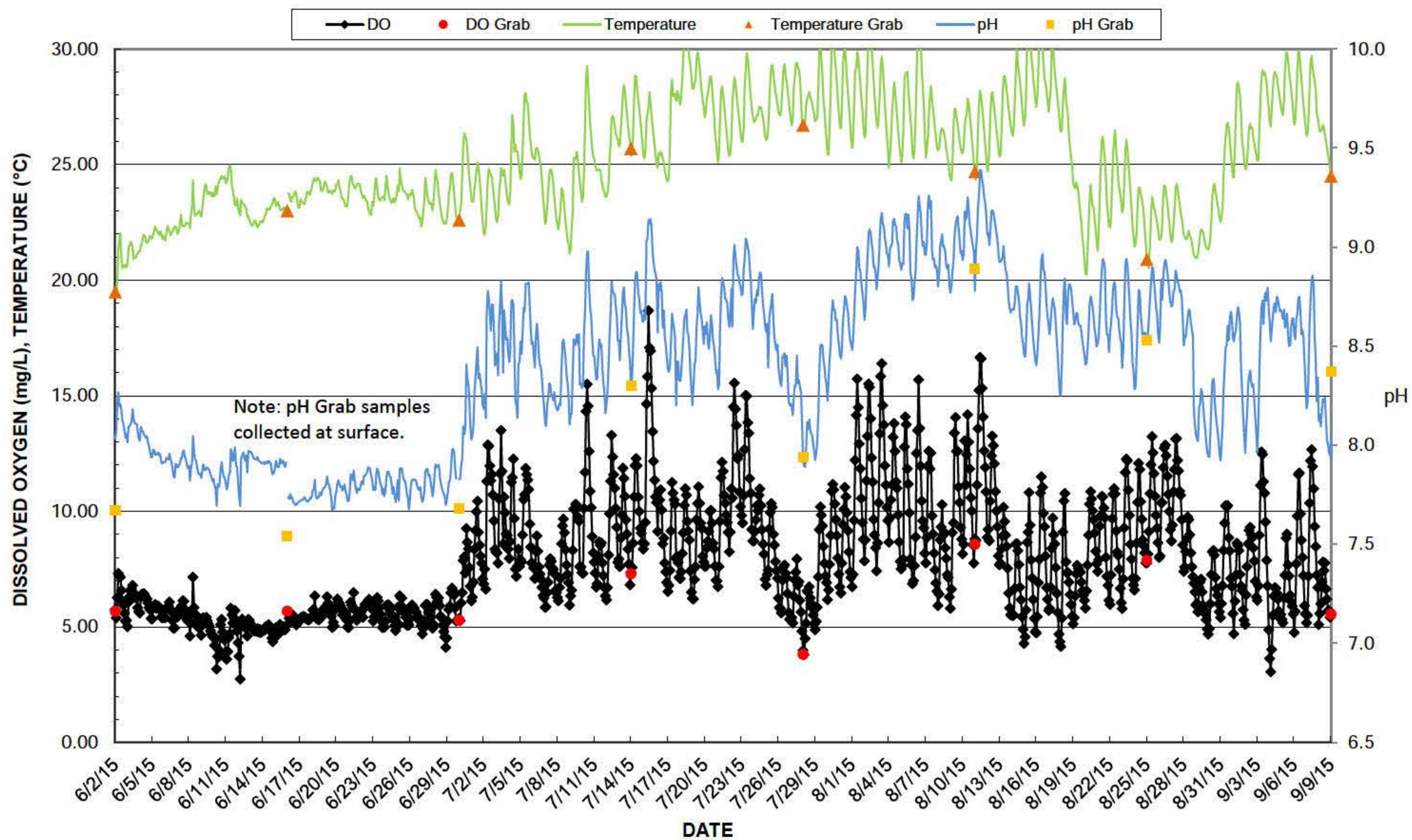


FIGURE F-3. PRE-PROJECT DISSOLVED OXYGEN, pH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M504.7S DURING SUMMER 2016

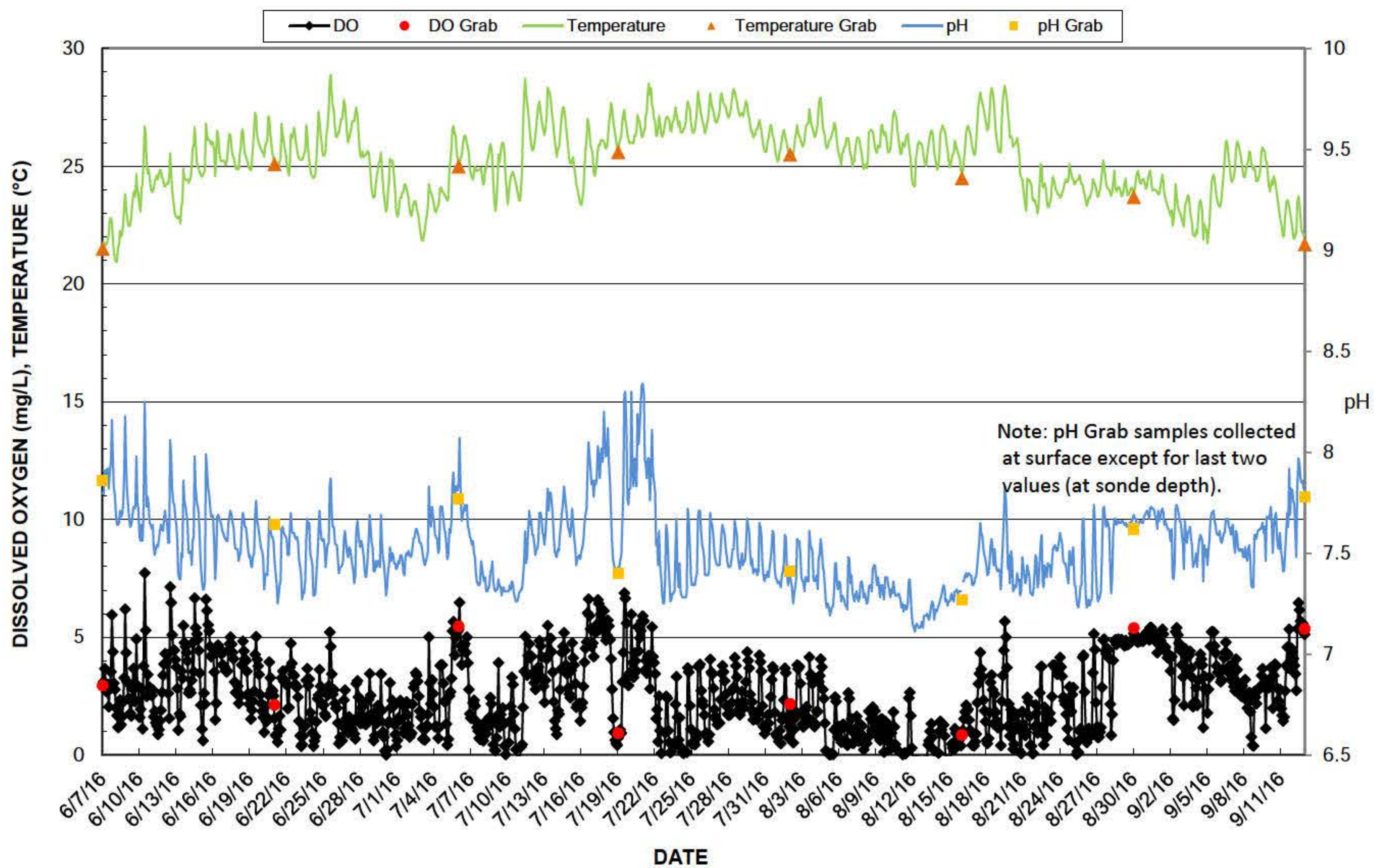


FIGURE F-4. PRE-PROJECT DISSOLVED OXYGEN, pH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M504.7S DURING WINTER 2018-2019

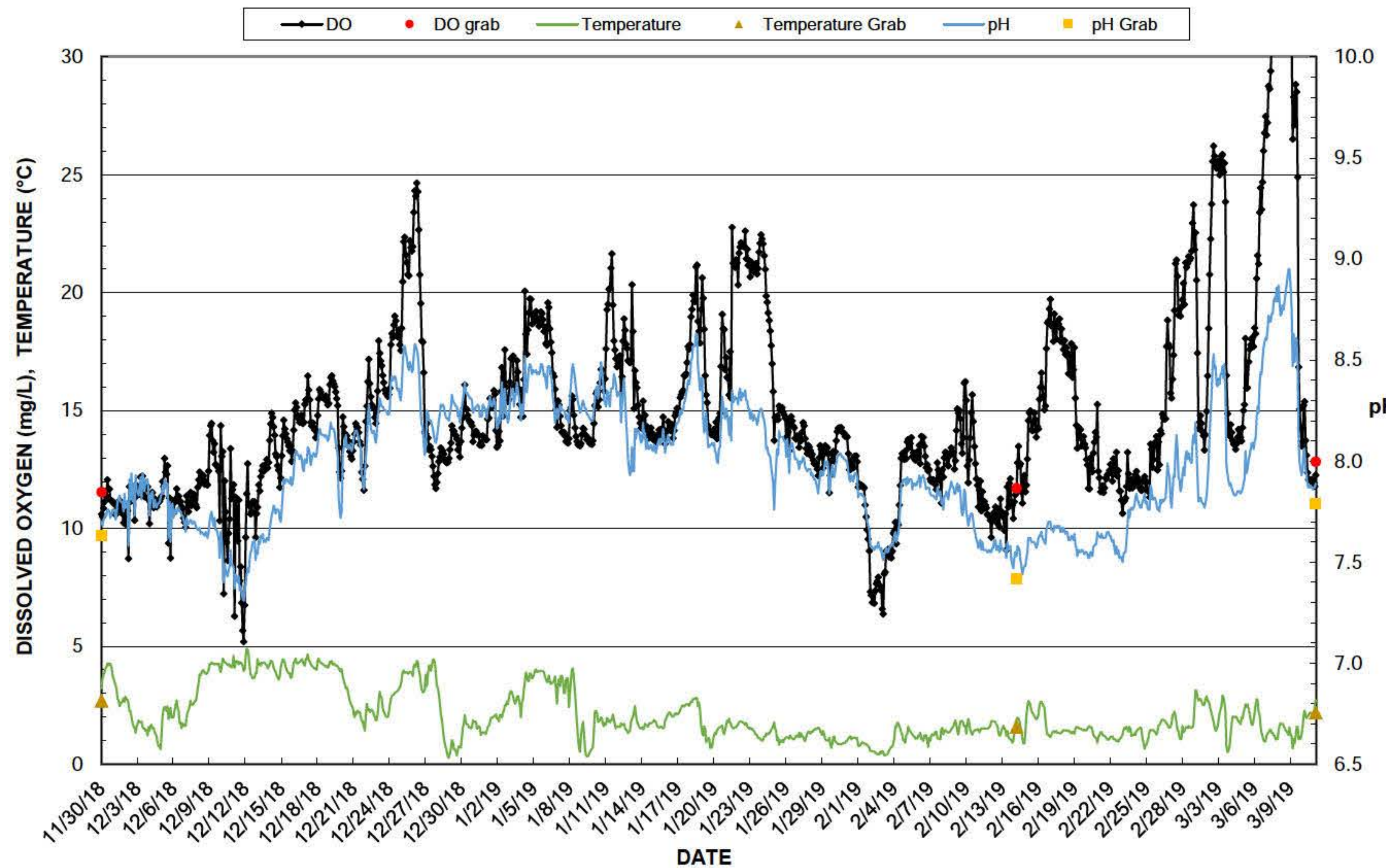


FIGURE F-5. PRE-PROJECT DISSOLVED OXYGEN, pH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M504.9P DURING SUMMER 2017

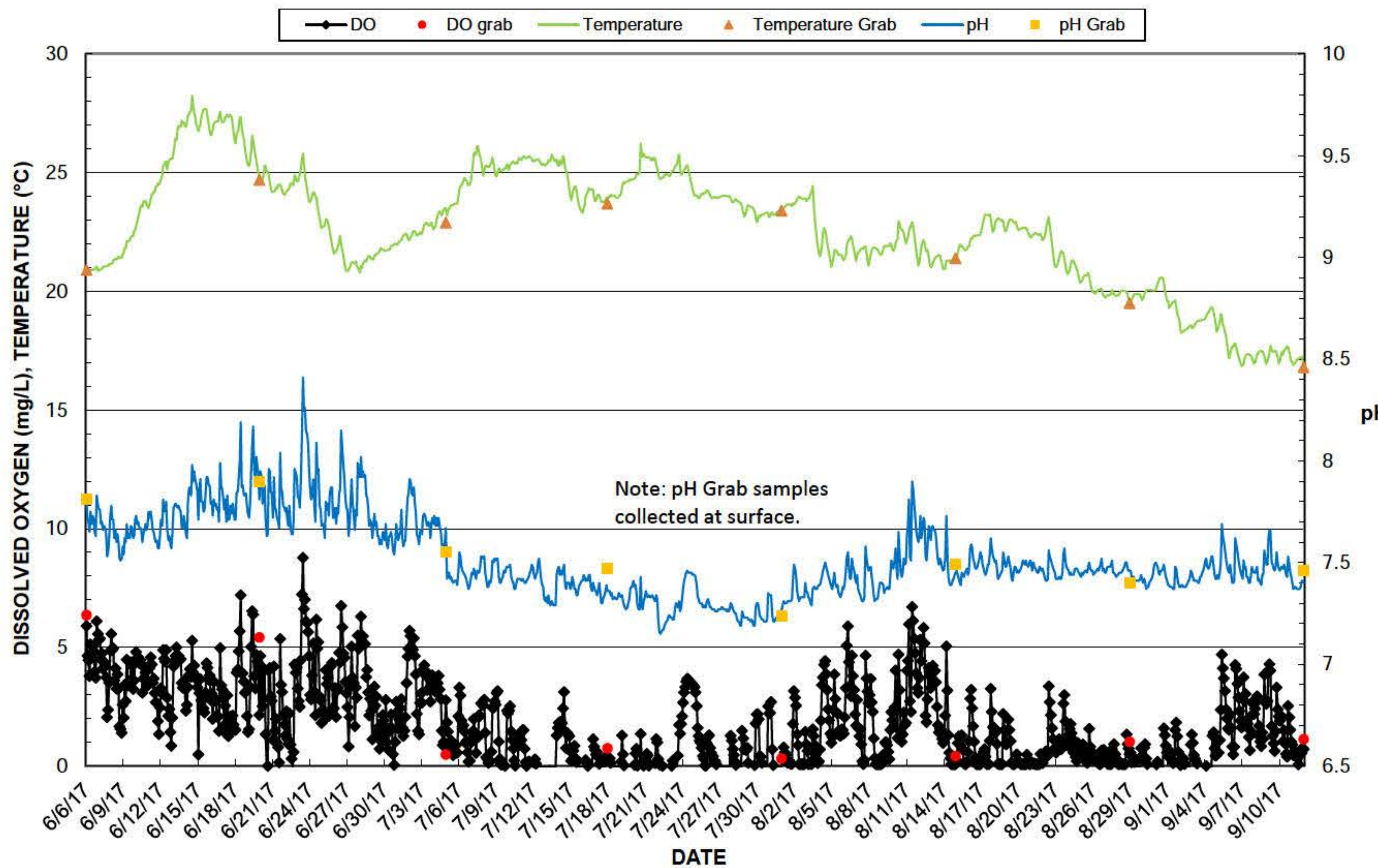


FIGURE F-6. PRE-PROJECT DISSOLVED OXYGEN, pH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M504.9P DURING SUMMER 2018

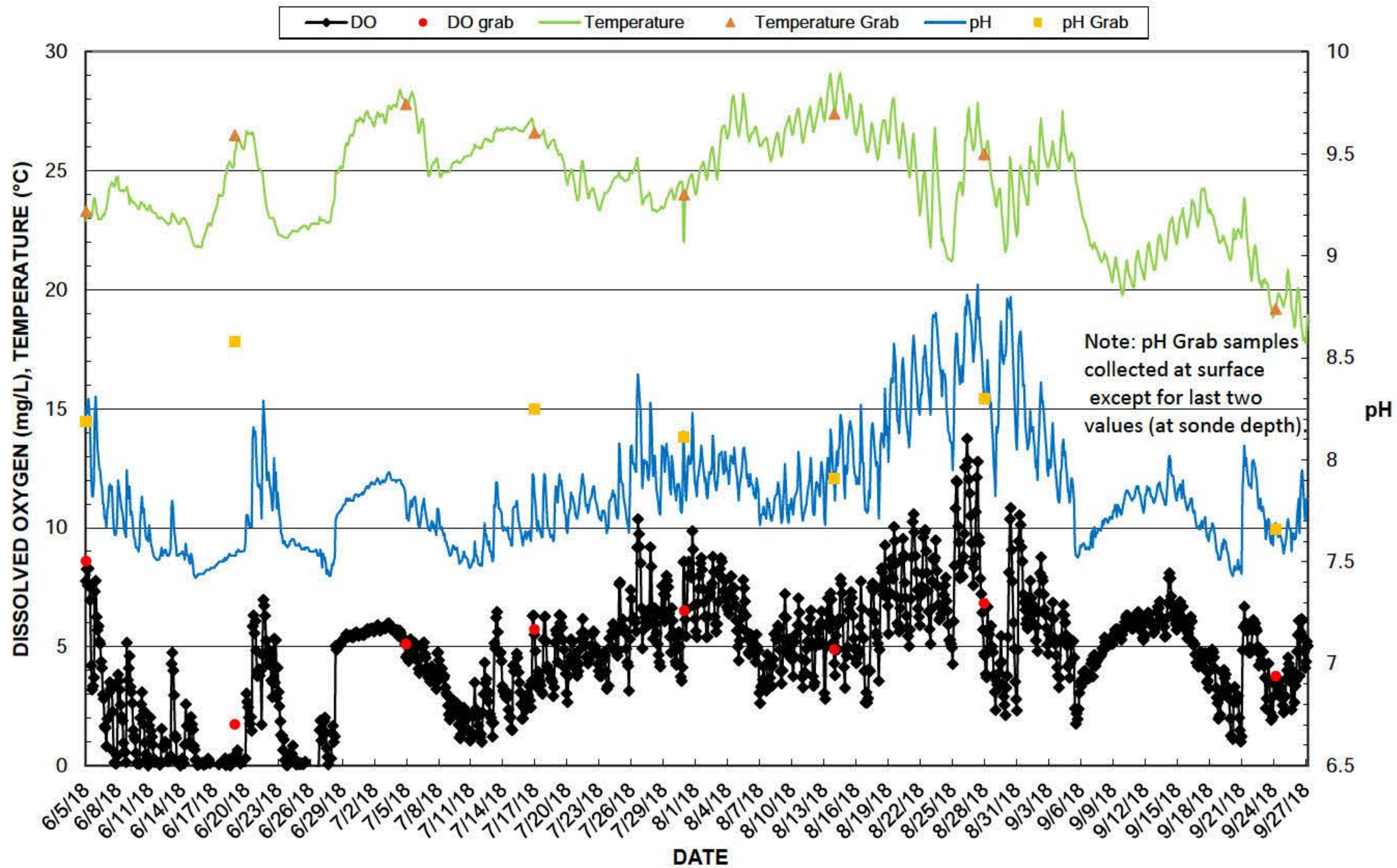


FIGURE F-7. PRE-PROJECT DISSOLVED OXYGEN, pH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M504.9P DURING WINTER 2017-2018

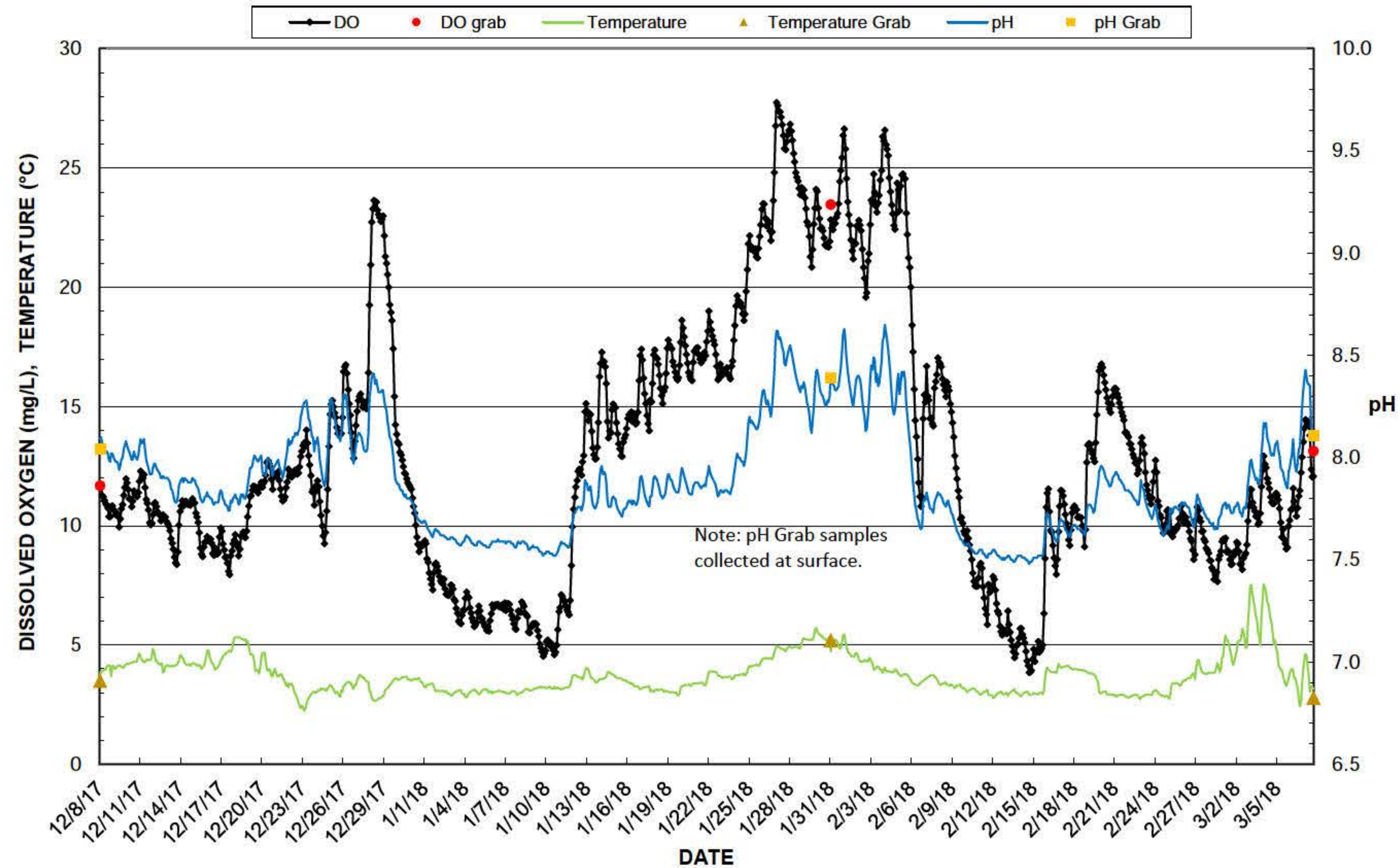
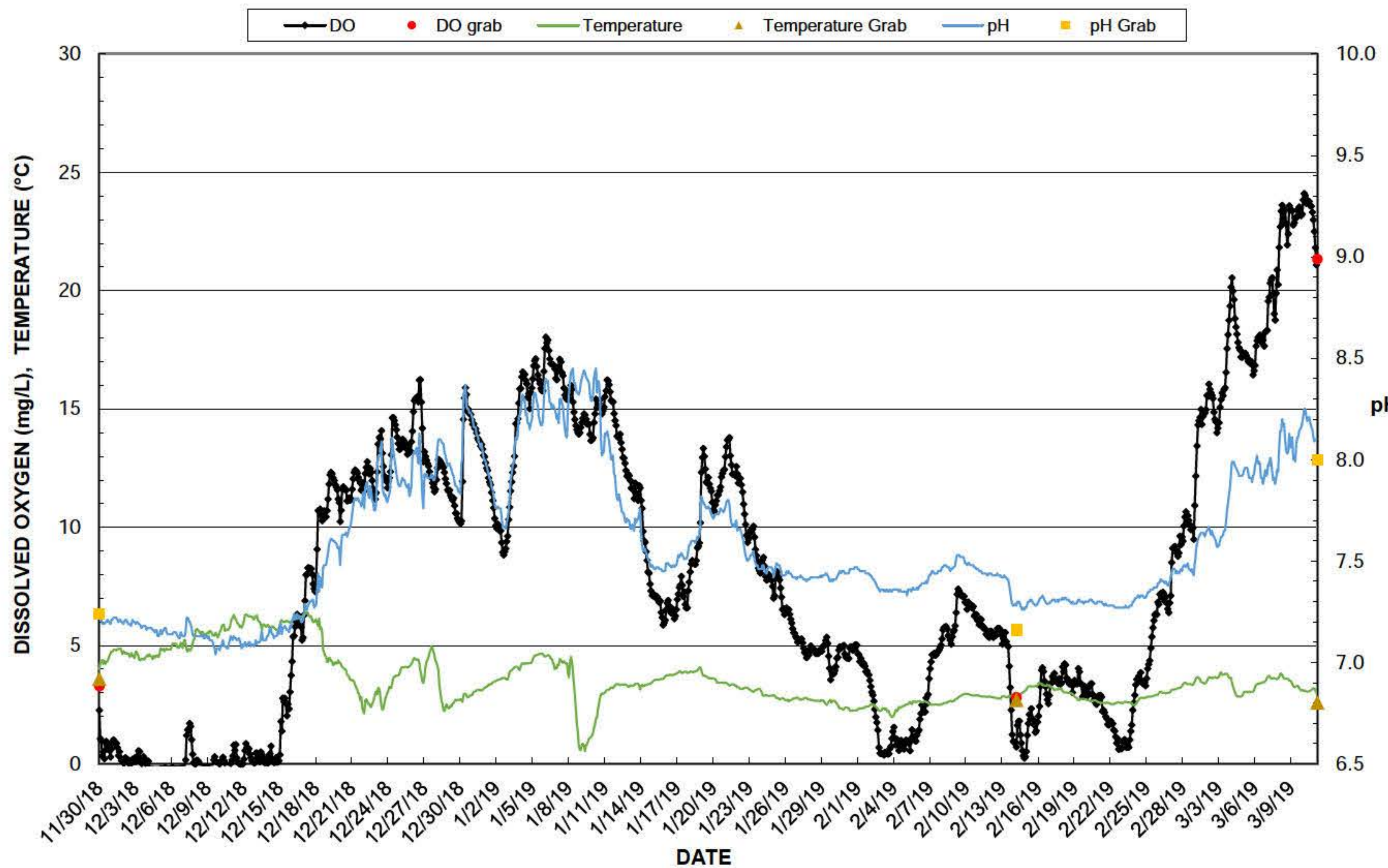


FIGURE F-8. PRE-PROJECT DISSOLVED OXYGEN, pH, AND TEMPERATURE VALUES COLLECTED WITH A CONTINUOUS MONITOR AT SITE W-M504.9P DURING WINTER 2018-2019



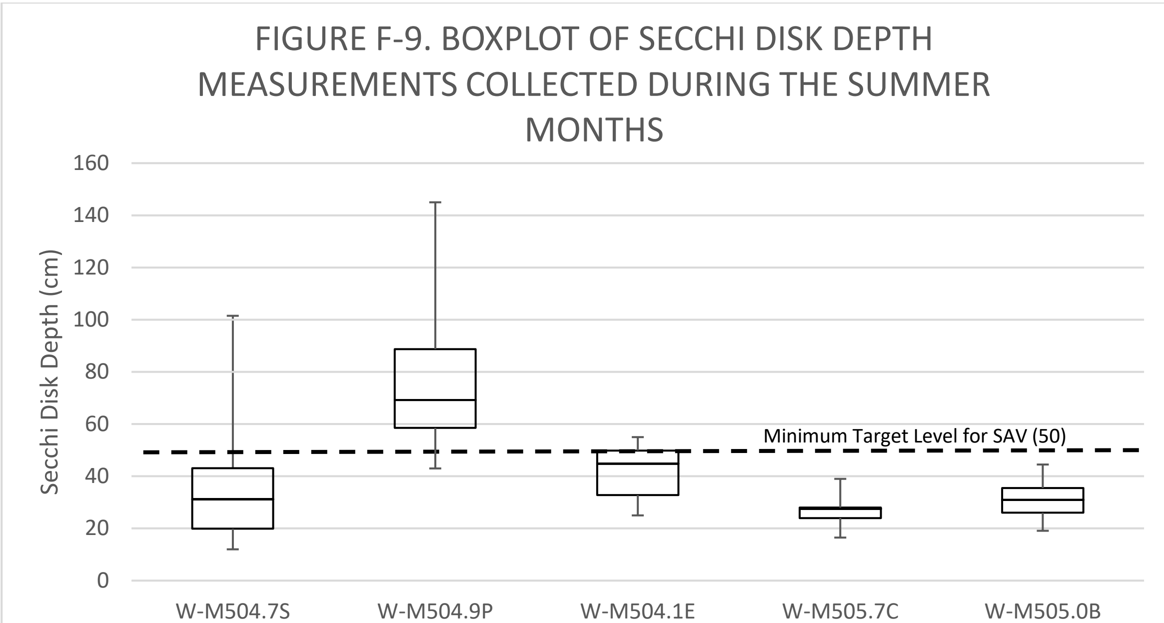


FIGURE F-9. BOXPLOT OF SECCHI DISK DEPTH MEASUREMENTS COLLECTED DURING THE SUMMER MONTHS
Secchi Disk Depth (cm)
160
140
120
100
80
60
40
20
0
Minimum Target Level for SAV (50)
W-M504.7S
W-M504.9P
W-M504.1E
W-M505.7C
W-M505.0B

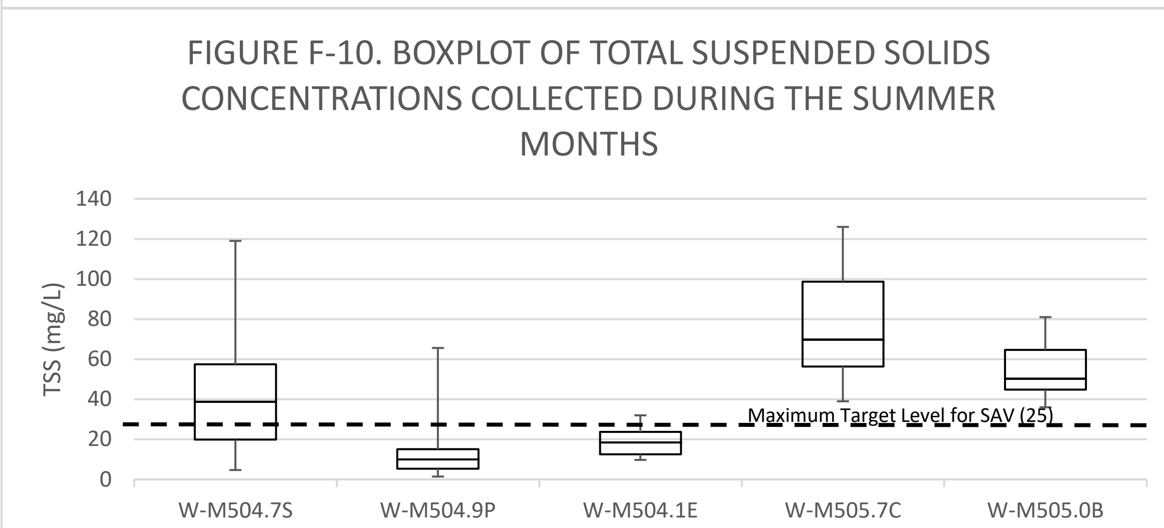


FIGURE F-10. BOXPLOT OF TOTAL SUSPENDED SOLIDS CONCENTRATIONS COLLECTED DURING THE SUMMER MONTHS
TSS (mg/L)
140
120
100
80
60
40
20
0
Maximum Target Level for SAV (25)
W-M504.7S
W-M504.9P
W-M504.1E
W-M505.7C
W-M505.0B

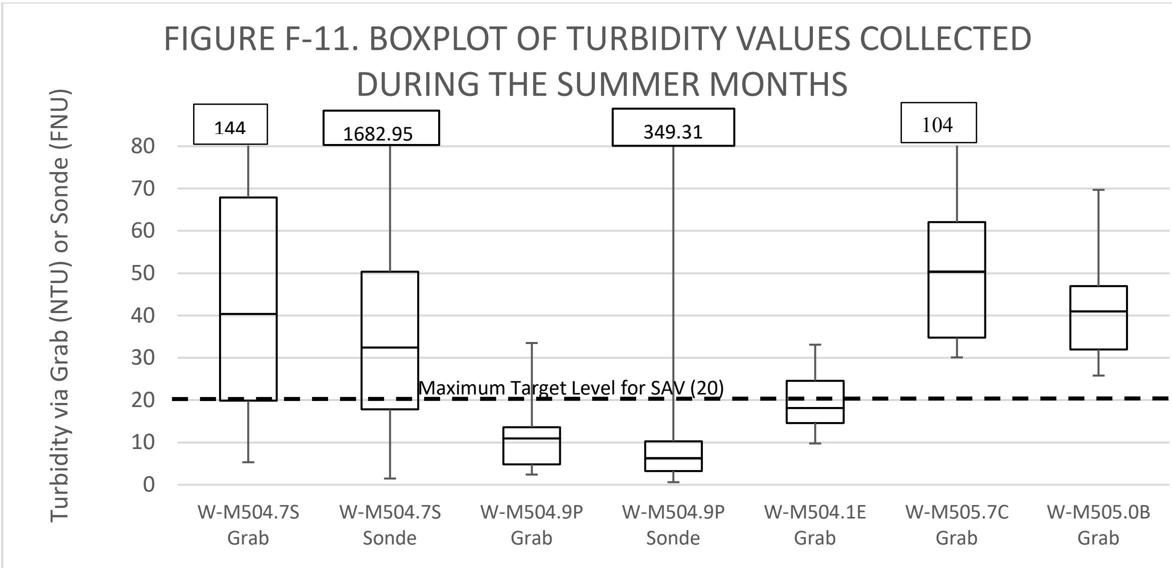


FIGURE F-11. BOXPLOT OF TURBIDITY VALUES COLLECTED DURING THE SUMMER MONTHS
Turbidity via Grab (NTU) or Sonde (FNU)
144
1682.95
349.31
104
Maximum Target Level for SAV (20)
80
70
60
50
40
30
20
10
0
W-M504.7S Grab
W-M504.7S Sonde
W-M504.9P Grab
W-M504.9P Sonde
W-M504.1E Grab
W-M505.7C Grab
W-M505.0B Grab

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX G

GEOTECHNICAL CONSIDERATIONS

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
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APPENDIX G

GEOTECHNICAL CONSIDERATIONS

FIGURES

APPENDICES

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX G

GEOTECHNICAL CONSIDERATIONS

I. PURPOSE AND SCOPE

This appendix presents the general geology and specific geotechnical analyses relevant to the Steamboat Island HREP (Project) (Anderson, 1983; Prior, 1976). The Rock Island District (District) Engineering and Construction Division's Geotechnical Branch obtained representative soil borings, performed laboratory analysis and interpretation, and provided sufficient geotechnical analyses and recommendations to support the alternatives. Final exploration, subsurface characterization, and geotechnical design will be performed during the engineering and design phase. Figure G-1 shows the Recommended Plan, as described in Section VI, *Recommended Plan: Description with Design, Construction, and Operation and Maintenance Considerations,* of the Main Report.

II. PHYSIOGRAPHY

The Project area is situated within the Dissected Till Plains Section of the Central Lowlands Province of the Interior Plains. The Project area has little topographic relief and consists of shallow backwaters, bottomland, and islands that are subject to permanent high water tables and annual flooding.

III. GEOLOGY

The Project lies entirely within the Mississippi River floodplain, which consists of alluvial soils at and near the surface and glacial deposits at depths. The surface stratum is usually clay, varying in thickness from about 3 to 20 feet. This is underlain by a sand and gravel stratum, which extends to an intermittent glacial till clay at a depth of 40 to 80 feet or to bedrock at a depth of 120 to 160 feet.

IV. SURFICIAL SOILS

The USDA NRCS publishes soil surveys for most counties in the United States (NRCS, Web Soil Survey). Information contained in these reports pertains to soil within 5 feet of the surface. These soils are mapped by soil series. A soil series is a group of soils having almost identical profiles. All soils of a particular series have horizons that are similar in compositions, thickness, and arrangement.

Information contained in the NRCS Web Soil Survey indicated that the dominant soil type present in and around the Project area is generally classify as Ambraw-Perks-Lawson complex, which is described as an alluvium product in the NRCS classification system. This series is described as frequently flooded, poorly drained soil with a water table that varies between ground surface and 1 foot deep. See Figure G-2 for the results of the Project area NRCS Web Soil Survey.

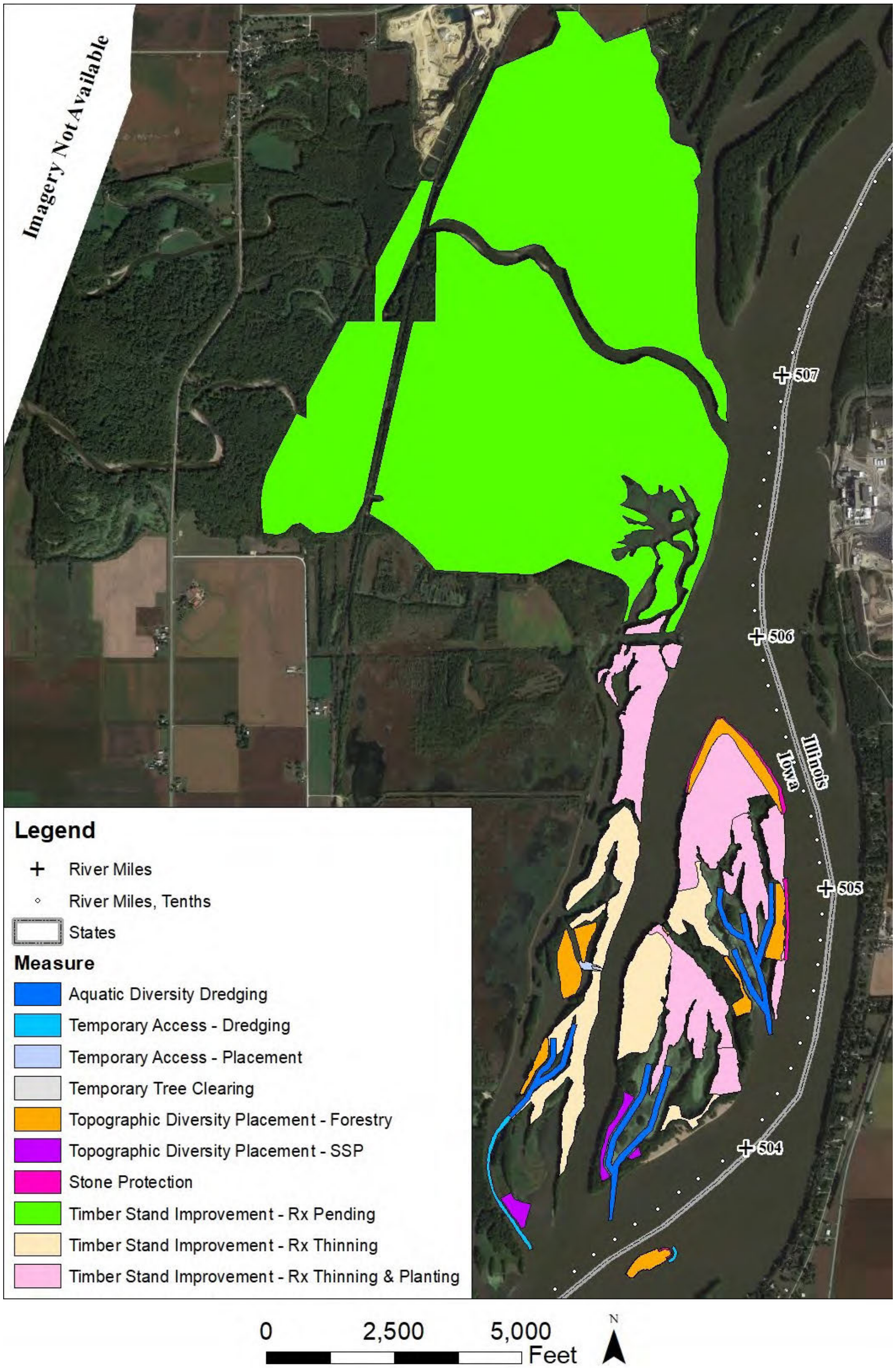
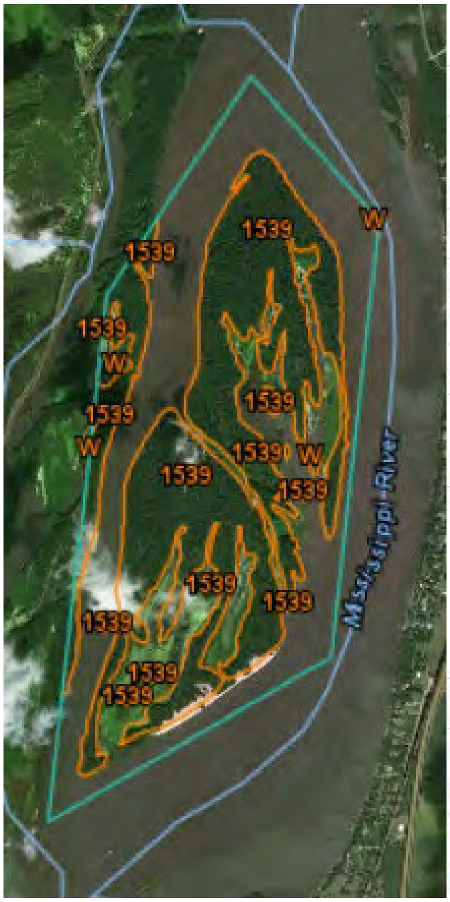


Figure G-1: Recommended Plan



Scott County, Iowa (IA163)
Rock Island County, Illinois (IL161)

Rock Island County, Illinois (IL161)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
W	Water	0.7	0.1%
Subtotals for Soil Survey Area		**0.7**	**0.1%**

Scott County, Iowa (IA163)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1539	Ambraw-Perks-Lawson complex, frequently flooded, 0 to 2 percent slopes	343.4	45.5%
W	Water	410.0	54.4%
Subtotals for Soil Survey Area		**753.4**	**99.9%**
Totals for Area of Interest		**754.0**	**100.0%**

Figure G-2: Results of Project Area NRCS Web Soil Survey (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx)

V. SUBSURFACE EXPLORATION

District Geotechnical Branch personnel conducted subsurface exploration using a 4-inch diameter Iwan-style hand-auger on October 3, 2018, and a 2 ¾ -inch OD vibrocore sampler on October 4, 2018, in order to characterize the composition and engineering properties of the soils present at the Project site. Borings were taken at the locations shown on Sheet B-101 (Attachment 1).

Borings SB-18-06, 07, 08, and 09 were taken within the Grant Slough Complex. Borings SB-18-01, 02, 03, 04, and 05 were taken within the downstream end of Steamboat Island. Borings SB-18-10, 11, 12, 13, 14, and 15 were taken within the upstream end of Steamboat Island. Samples were taken at sufficient intervals to classify all the strata encountered at each boring location. Representative samples were taken for visual soil classification and moisture content from all recovered soils. Atterberg limit tests were performed on several of the clay samples gathered throughout the site to verify soil classifications and to characterize stratigraphy. Boring logs can be found on Sheets B-601 and B-602 (Attachment 1).

VI. LABORATORY TESTING

All fine-grained samples were analyzed for water content. Results for moisture contents ranged from 21 to 100, averaging 62, expressed as a percentage of the dry sample weight.

Atterberg limit tests were performed on several of the clay samples gathered throughout the site in order to confirm visual classifications. Results for liquid limits ranged between 45 and 83, and plastic limits between 20 and 32.

VII. STRATIGRAPHY

The borings ranged up to approximately 12 feet below average water surface elevation during the 2-day period that the borings were completed (575.35 NAVD88). Below ground surface materials depths ranged between 4.5 and 7.0 feet and are composed of lean, medium, and fat clays. Various types of granular materials were encountered beneath the clays in most borings. Medium to fine sand lenses were found sporadically in most borings.

VIII. SITE CHARACTERIZATION

In order to prepare the appropriate geotechnical analyses for design of the selected Project measures, it was necessary to characterize the Project according to typical clay and sand foundation depths and strengths, typical embankment heights and strengths, and water depths. All boring logs and river bottom transects were analyzed in detail.

The top of sand foundation will be taken as elevation 565.0. Sand foundation strength will be taken as 28 degrees angle of internal friction. The top of clay foundation at dredged material placement sites will be taken as elevation 573.0. Foundation clay unconsolidated-undrained (end-of-construction) shear strengths were obtained by the District's moisture content correlation (Figure G-3). Clay foundation strength will be taken as either 300 psf cohesion unconsolidated-undrained strength or an assumed drained strength of ϕ = 19 degrees angle of internal friction in accordance with the plasticity correlations contained in Duncan et. al, 1989.

Although the Recommended Plan design includes placement of dredged material to create topographic diversity up to elevation 576.2, the top of topographic diversity (embankment) is assumed to be elevation 580.0 here to account for future design variation.

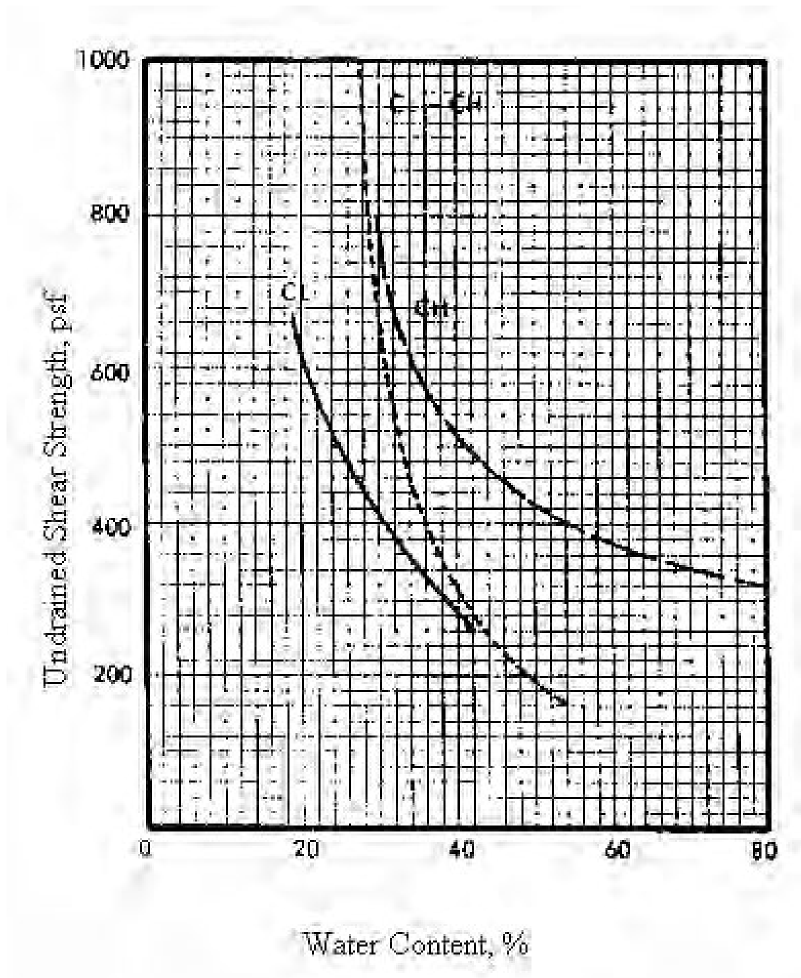


Figure G-3: MVR Unconsolidated-Undrained Shear Strengths

Uncompacted earth embankment strengths were difficult to estimate due to the nature of the proposed placement method. As described below, the embankments will most likely be placed by the clamshell dredging method, with part occurring under water. Double-handling of material may also be required. Critical shear strengths could vary between remolded and unconsolidated-undrained. The unconsolidated-undrained foundation shear strengths described above are considered pertinent to the uncompacted earth embankment strengths since the foundation soils would be used in the embankment construction. Remolded shear strengths for uncompacted earth embankment design were also considered, since the soil would be at least partially disturbed and remolded by the mechanical dredging operations. The uncompacted earth embankment strength will be taken as 200 psf cohesion due to the remolded strength reduction. Rock (riprap for grade control structure and bank protection) shear strength parameters will be taken as c=0 and ϕ=45 degrees.

IX. DREDGING DESIGN

Project measures include mechanical dredge cuts in order to provide both excavation for aquatic diversity and borrow material for uncompacted earth embankment construction.

The preferred dredging technique for clay is mechanical. Review of the boring logs indicates that the in-place uncompacted embankment borrow material is soft to firm clay. A mechanical dredging method is required to minimize disturbance of the borrow soils so that maximum possible soil strength is realized during and after uncompacted embankment construction. Three-cubic-yard minimum-capacity clamshell bucket and excavators have been successfully utilized at similar projects. A large-capacity clamshell bucket that is specifically designed for removal of any firmer in situ clays may be necessary. The bottom 15% (approximate) of the total depth of dredge cut will occur in the underlying sand foundation.

Uncompacted earth embankments will be constructed using mostly (approximately 85%) mechanically-dredged fine sediments. It must be stressed that embankment construction by clamshell dredging of fine sediments is not ideal. Soil strength estimation is difficult, especially when placement is made under water, because compaction of cohesive soils cannot occur. The contractor will not be allowed to ‘throw’ the material from the clamshell, but must ‘place’ the clamshell on the placement area ground surface and then release the material in order to obtain maximum strength from the in situ borrow material.

X. STABILITY

The foundation and embankment engineering properties were characterized previously in this appendix. The bottom of the dredge cut was taken as elevation 563.0. An idealized dredge cut section was developed to determine stability as shown in Figure G-4.

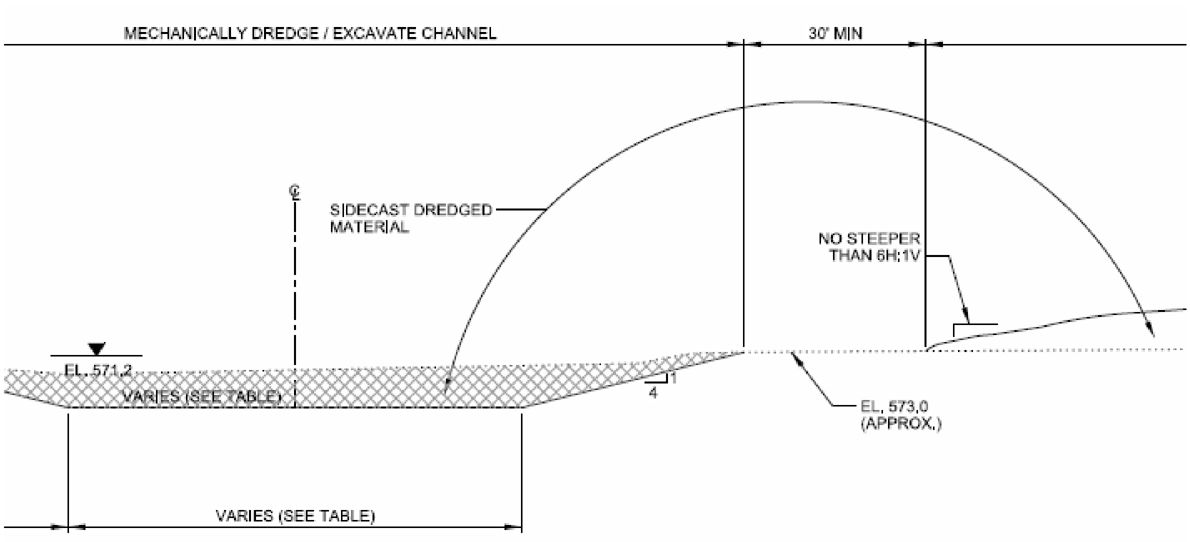


Figure G-4: Typical Section, Dredge Cut and Placement Area

The foundation and embankment engineering properties were characterized previously in this appendix. The bottom of the dredge cut was taken as elevation 563.0. An idealized dredge cut section was developed to determine stability as shown in Figure G-4.

Both drained and undrained clay foundation strength parameters were modeled with GeoStudio slope stability package (GeoStudio 2016). As described in EM 1110-2-1902 (USACE, 1970), the dredge cut will not be subjected to pool fluctuation, seepage, or earthquake forces. The in situ strength of dredge cut area soil prior to unloading was considered most critical due to the apparent strength gain from negative soil pore water pressures upon unloading. The program was run in the search mode, and numerous other surfaces were modeled, as shown in Attachment 2. The stability analyses of the dredge cut slope revealed that the drained condition was found to be the most critical and resulted in a factor of safety against sliding for the 4H:1V cut slopes of 1.28, as shown in Figure G-5.

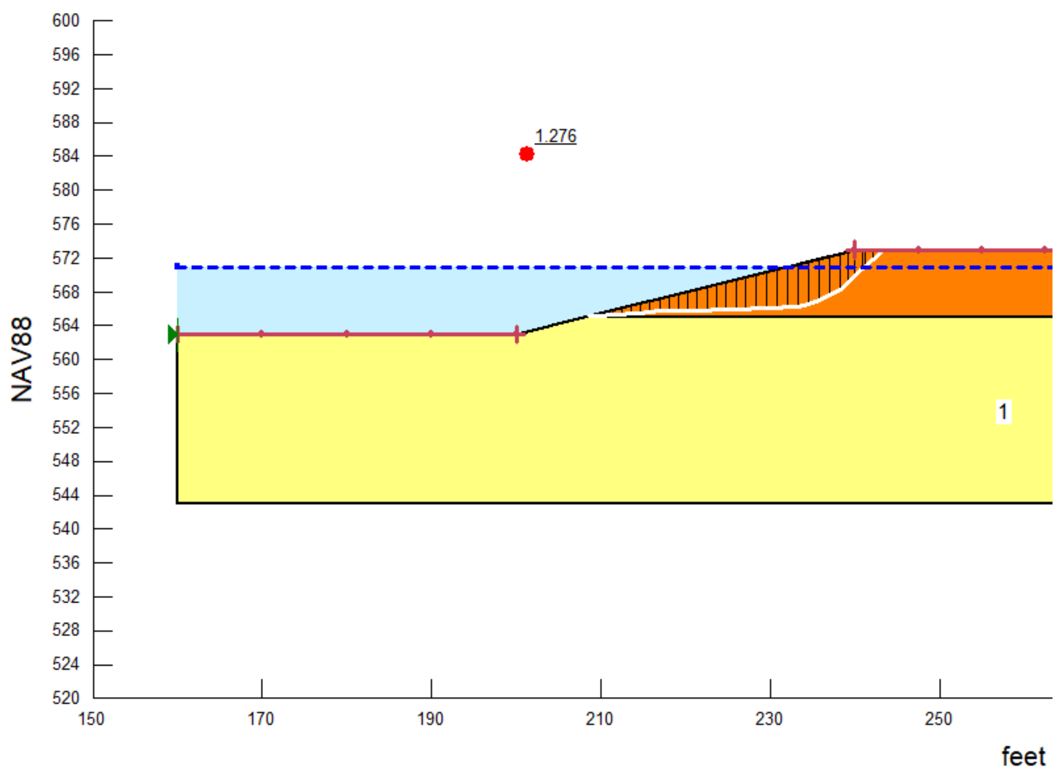


Figure G-5: Critical Slip Surface

It is recommended that the cut slopes be placed no closer than 30 feet from the toe of the uncompacted embankment and other dredged material placement areas in order to avoid influence on both the uncompacted earth embankment and the dredge cut stabilities. Contracting a mechanical dredge large enough to reach the entire placement area from the excavated channels may prove problematic. In this case, a minimum clearance distance of 20 feet can be allowed, as long as localized embankment and dredge cut slope failures are acceptable. Instantaneous isolated embankment and shallow foundation failures can be expected due to the unpredictable nature of the borrow material and placement method.

Fine embankment and foundation soils will gain strength and greater stability with time as the cohesive soils are allowed to consolidate and drain. Double handling of dredged material or two or more dredge cuts may also be necessary. Considerations regarding the material handling have been incorporated in the probable construction sequence, provided in the Main Report. The contract duration is assumed to account for material handling issues, embankment material drying, consolidation, and strength gain issues that will dictate when all excavation can be completed. Similar projects have been completed successfully within a three-year contract duration and/or separate stages for channel excavation and shaping.

XI. SETTLEMENT AND SHRINKAGE

Settlement calculations are not considered relevant to this Project due to the following: 1) relatively thin top clay layer with minimal settlement, 2) unpredictable desiccation, drying, and consolidation shrinkage of the uncompacted embankment, and 3) significant time lapse (at least two years) for the majority of the foundation settlement and uncompacted embankment desiccation and drying to occur prior to 'final shaping' of the embankment. Based upon similar projects, the shrinkage of the uncompacted embankment due to drying, desiccation, and consolidation is estimated at 15%. Additional surveys will be completed following the majority of settlement and shrinkage and shortly before commencement of any final shaping and planting work.

XII. EROSION PROTECTION

Erosion protection stone is proposed for the bank protection for the Upper Steamboat Island (USI) Head restoration and protection, the West SE Island restoration and protection, the NE Bank restoration and protection, and the Grade Control Structure (GCS). Hydraulic analysis and design (Appendix H, *Hydrology and Hydraulics*) was done to select a minimum rock gradation/thickness and slope that will resist both river current and wave attack for these features. The following selected rock protection exceeded the minimum recommendation based upon ice flow durability considerations.

USI Head - Iowa Class B Revetment, or equivalent
- Nominal top size of 650 pounds
- At least 20% of the stones are to weigh more than 500 pounds
- At least 50% of the stones are to weigh more than 275 pounds
- At least 90% of the stones are to weigh more than 25 pounds

West SE Island - Iowa Class B Revetment, or equivalent
- Nominal top size of 650 pounds
- At least 20% of the stones are to weigh more than 500 pounds
- At least 50% of the stones are to weigh more than 275 pounds
- At least 90% of the stones are to weigh more than 25 pounds

NE Bank - Iowa Class C Revetment, or equivalent
- Nominal top size of 450 pounds
- At least 50% of the stones weighing more than 275 pounds
- At least 90% of the stones weighing more than 75 pounds

GCS - Iowa Class E Revetment, or equivalent
Nominal top size of 250 pounds
At least 50% of the stones are to weigh more than 90 pounds
At least 90% of the stones are to weigh more than 5 pounds

The recommended minimum thickness of the USI Head and West SE Island bank erosion protection is three feet, and placed on a slope no steeper than 1.5H:1V. The recommended minimum thickness of the NE Bank erosion protection is 2 feet. The GCS slopes will be no steeper than 1.5H:1V. Stability and settlement considerations are minimal for these measures, since near-surface sand comprises their foundations.

The recommended rock erosion protection is available locally.

XIII. RECOMMENDATIONS

- **Uncompacted Earth Embankments**
    - Provide slopes no steeper than 6H:1V.
    - Place the embankment material carefully. A minimum mechanical dredge bucket capacity of 3.0 cubic feet is recommended to minimize borrow material disturbance and to maximize uncompacted embankment strength.
    - Place uncompacted earth embankments no closer than 30 feet from dredge cuts.
    - Allow minimum 2-year contract duration to allow for adequate drying, desiccation, and consolidation prior to final shaping and planting stage.

- **Dredge Cuts**
    - Dredge the cut slopes no steeper than 4H:1V.
    - Place the dredge cut slopes no closer than 30 feet from uncompacted embankment toes.

- **Rock**
    - Provide slopes no steeper than 1.5H:1V.
    - Use Iowa Class B Revetment for the USI Head and West SE Island measures, Iowa Class C Revetment for the NE Bank measure, and Iowa Class E Revetment for the GCS.

XIV. REFERENCES

Anderson, Wayne (1983), Geology of Iowa, The Iowa State University Press, Ames, IA.

Duncan, J.M., Horz, R.C., and Yang, T. L. (1989), Shear Strength Correlations for Geotechnical Engineering, Department of Civil Engineering, Virginia Polytechnic University, Blacksburg, VA.

GeoStudio 2016, version 8.16.3.14580 Copyright © 1991-2017 GEO-SLOPE International Ltd, Calgary, Alberta, Canada.

Prior, Jean (1976), A Regional Guide to Iowa Landforms, Iowa Geological Survey, Iowa City, IA.

USACE (1970), Engineer Manual 1110-2-1902: *Stability of Earth and Rockfill Dams*, U.S. Army Corps of Engineers, Washington, DC.

Web Soil Survey, (http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm) (Last Modified: 04/09/2019) Natural Resources Conservation Service, U.S. Department of Agriculture, Washington, DC.

Attachment 1

Boring Locations and Logs

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A1 BORING LOCATIONS

SCALE : 1"=1000'-0"

0 1000' 2000'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY:		DATE:
DWN BY:	CKD BY:	SOLICITATION NO.:
SUBMITTED BY:		CONTRACT NO.:
PLOT SCALE: AS SHOWN	PLOT DATE:	PROJECT CODE: B5MRSI1801
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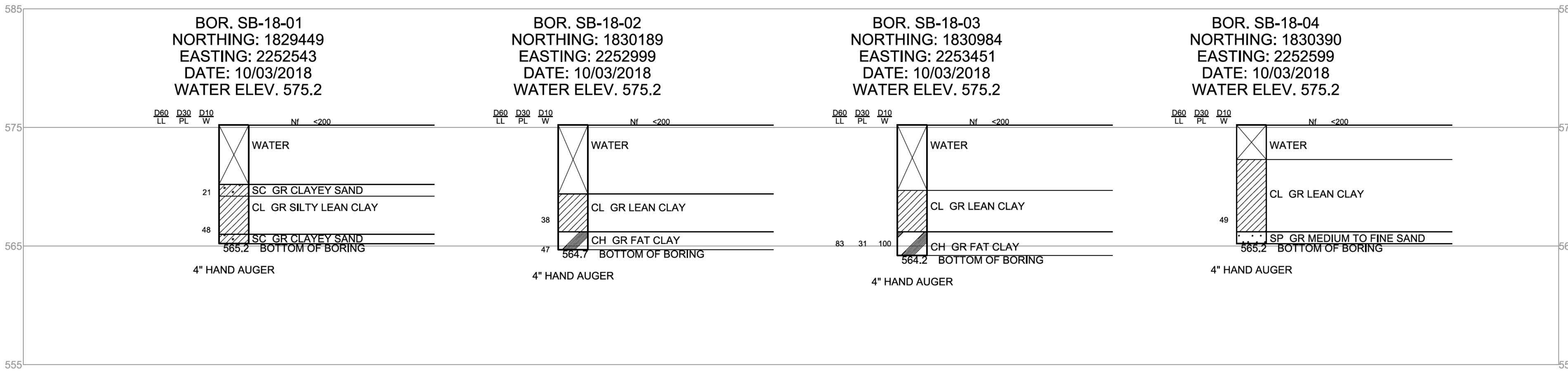
MISSISSIPPI RIVER
RIVER MILES 502.5 - 506.5
SCOTT COUNTY, IA
STEAMBOAT ISLAND HREP
FEASIBILITY REPORT
PLAN
BORING LOCATIONS

Sheet ID
B-101

REVIEW



ELEVATIONS IN FEET 1988 NAVD

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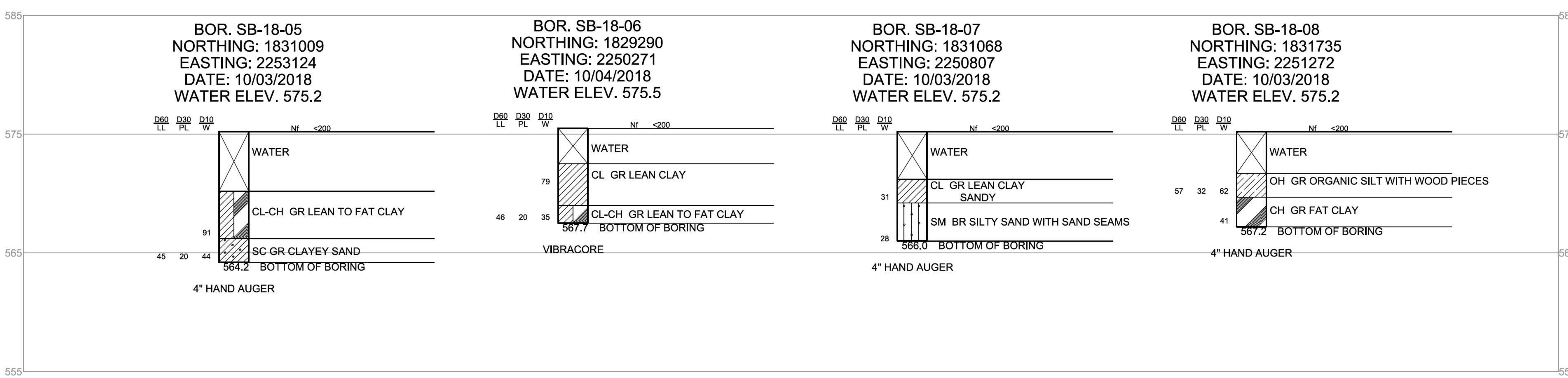

A1 BORING LOGS

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US Army Corps of Engineers

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD | DATE: | SOLICITATION NO.: | CONTRACT NO.: | PROJECT CODE: B5MRSI1801

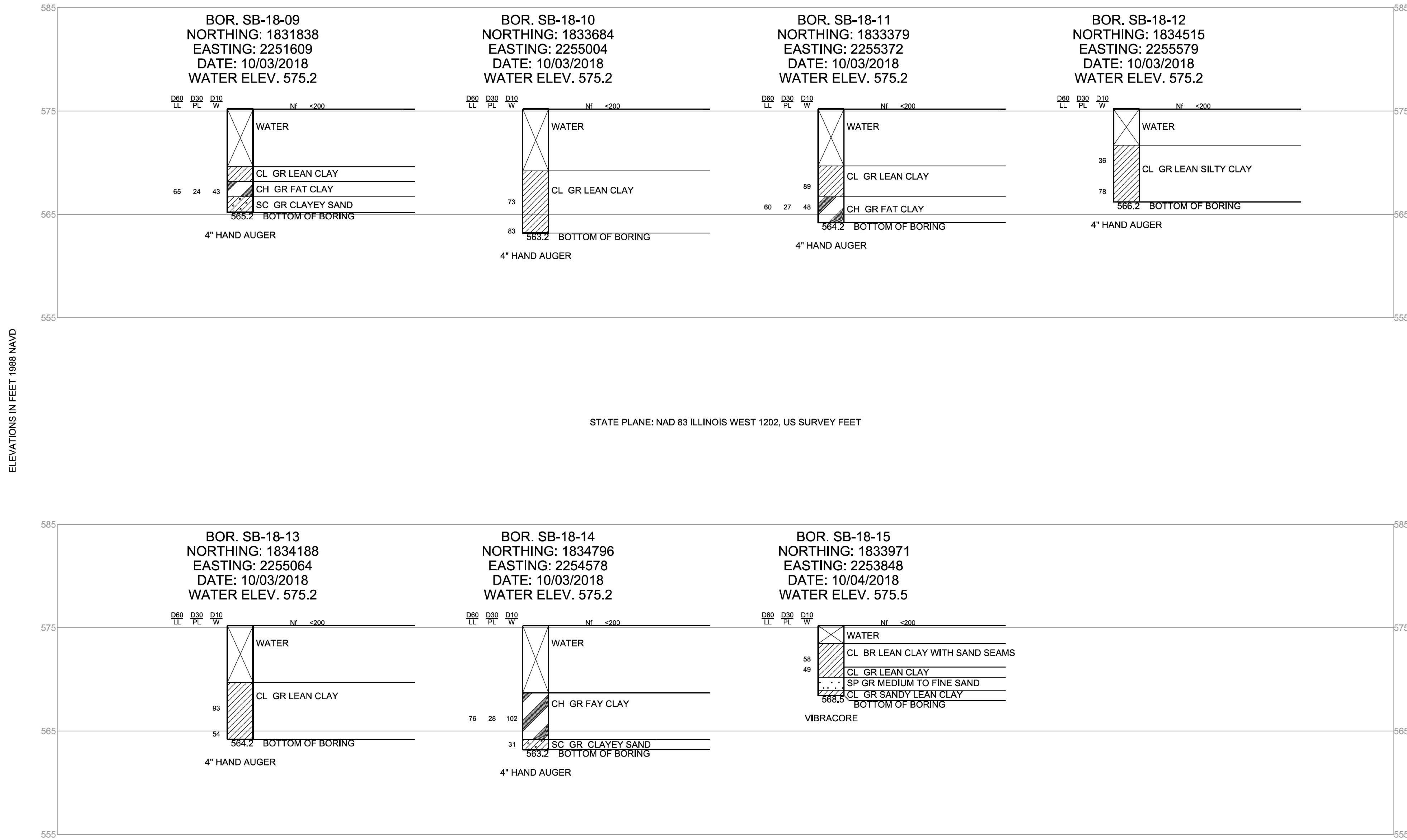
DWN BY: E. JOHNSON | CKD BY: | SUBMITTED BY:

PLOT SCALE: AS SHOWN | PLOT DATE: | SIZE: ANSI D | FILE NAME: B5MRSI1801

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO. IA - ROCK ISLAND CO. IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT
DIAGRAM
BORING LOGS

Sheet ID
B-601

REVIEW



A1 **BORING LOGS**

SCALE : 1"=5'-0"

0 5' 10'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: | DATE:
DWN BY: | CKD BY: | SOLICITATION NO.:
SUBMITTED BY: | CONTRACT NO.:
PLOT SCALE: AS SHOWN | PLOT DATE: | PROJECT CODE: B5MRSI1801
SIZE: ANSI D | FILE NAME: B5MRSI1801_B-602xxx.dgn

MISSISSIPPI RIVER
RIVER MILES 502.5 - 506.5
SCOTT COUNTY, IA
STEAMBOAT ISLAND HREP
FEASIBILITY REPORT
DIAGRAM
BORING LOGS

Sheet ID
B-602

REVIEW

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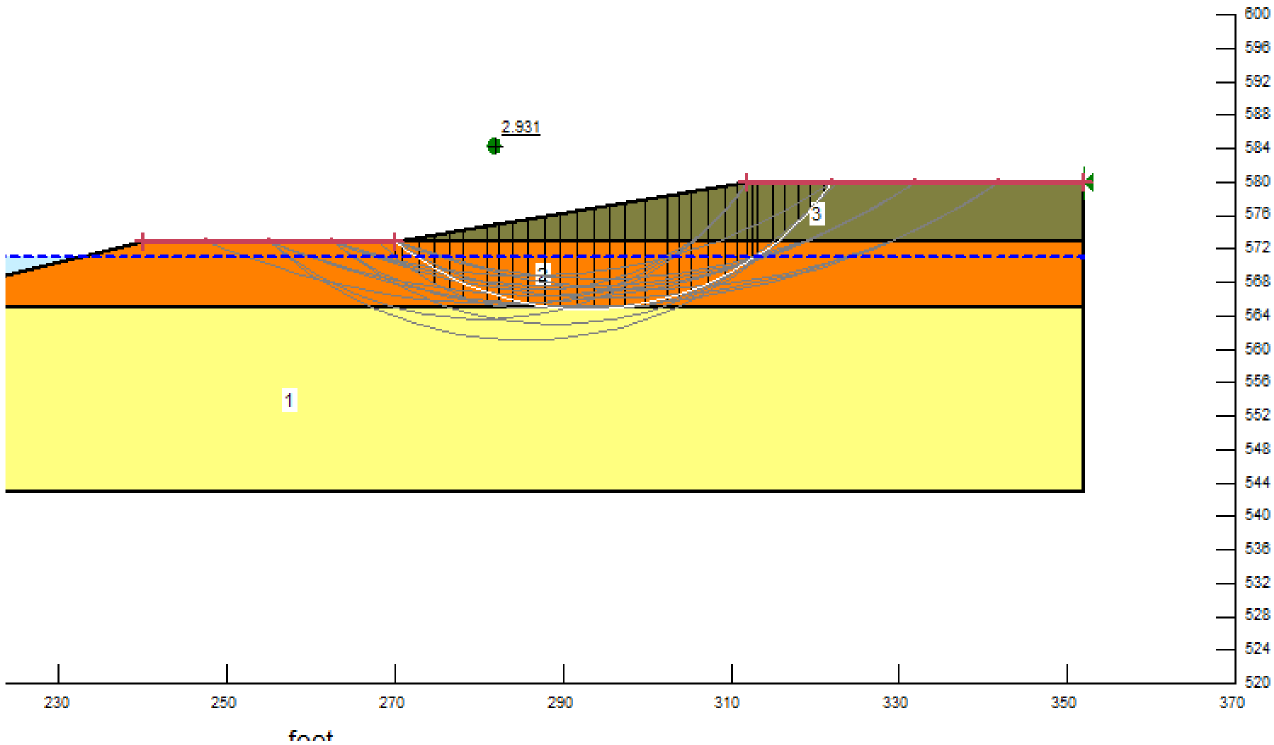
Attachment 2

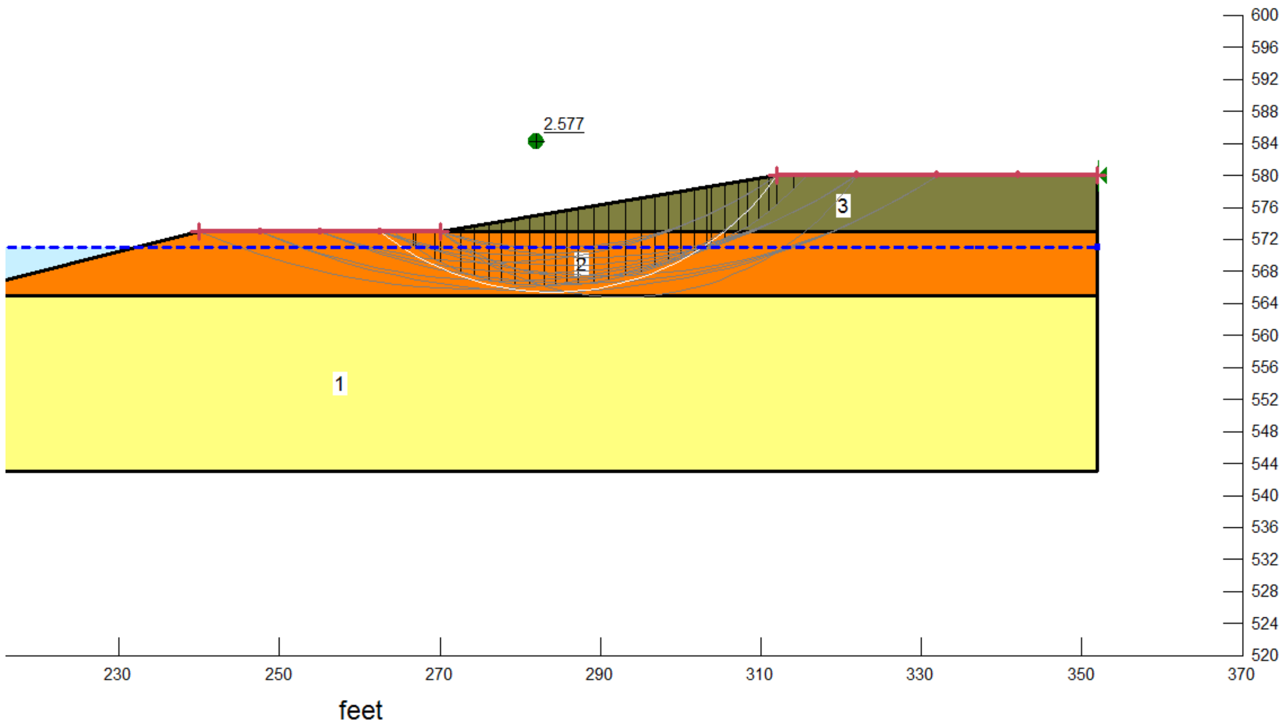
Stability Analyses

LEGEND

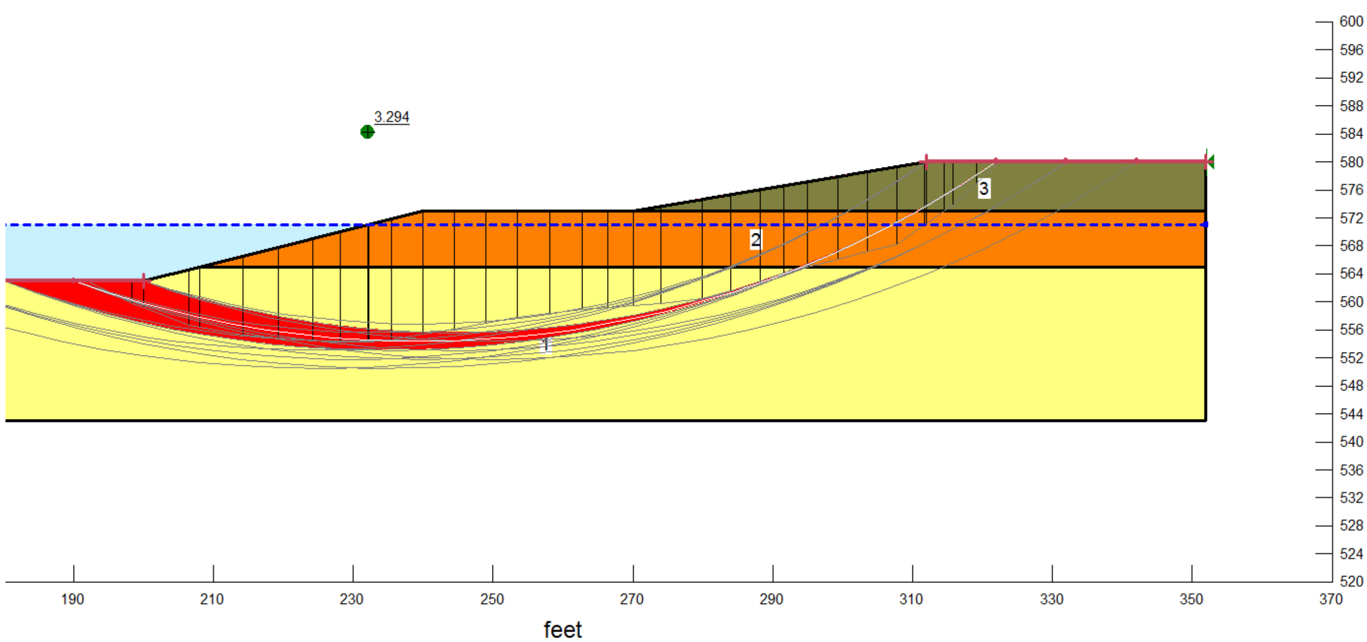
Material 1	Sand
Material 2	Foundation
Material 3	Embankment



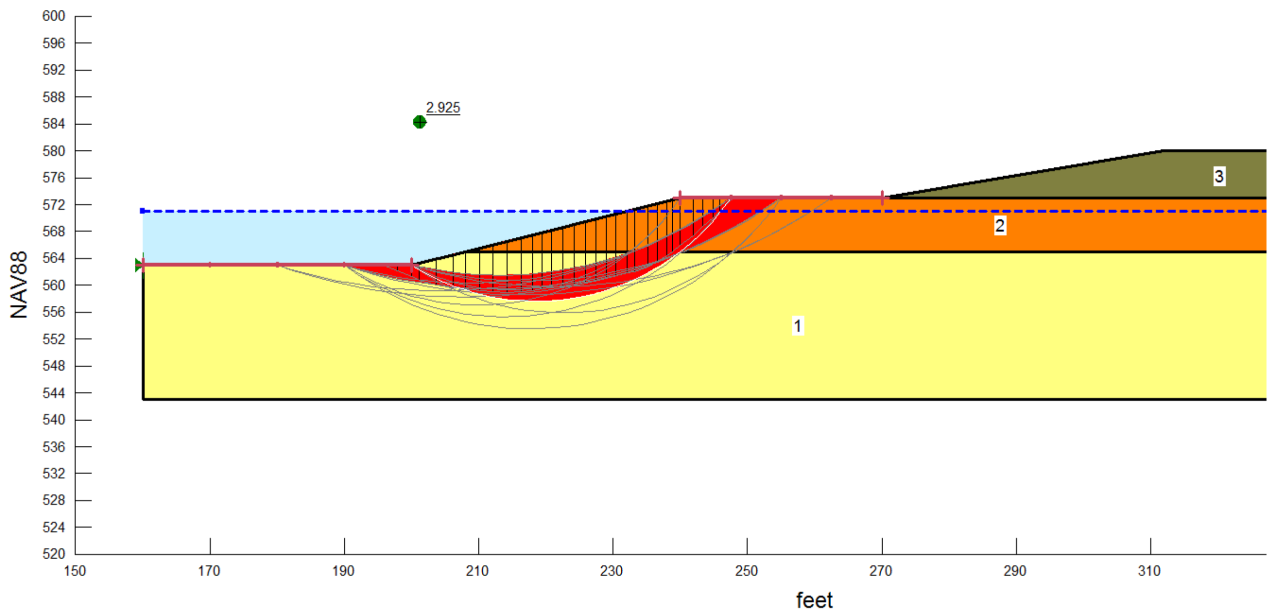
Embankment c=200 psf   Foundation c= 300 psf



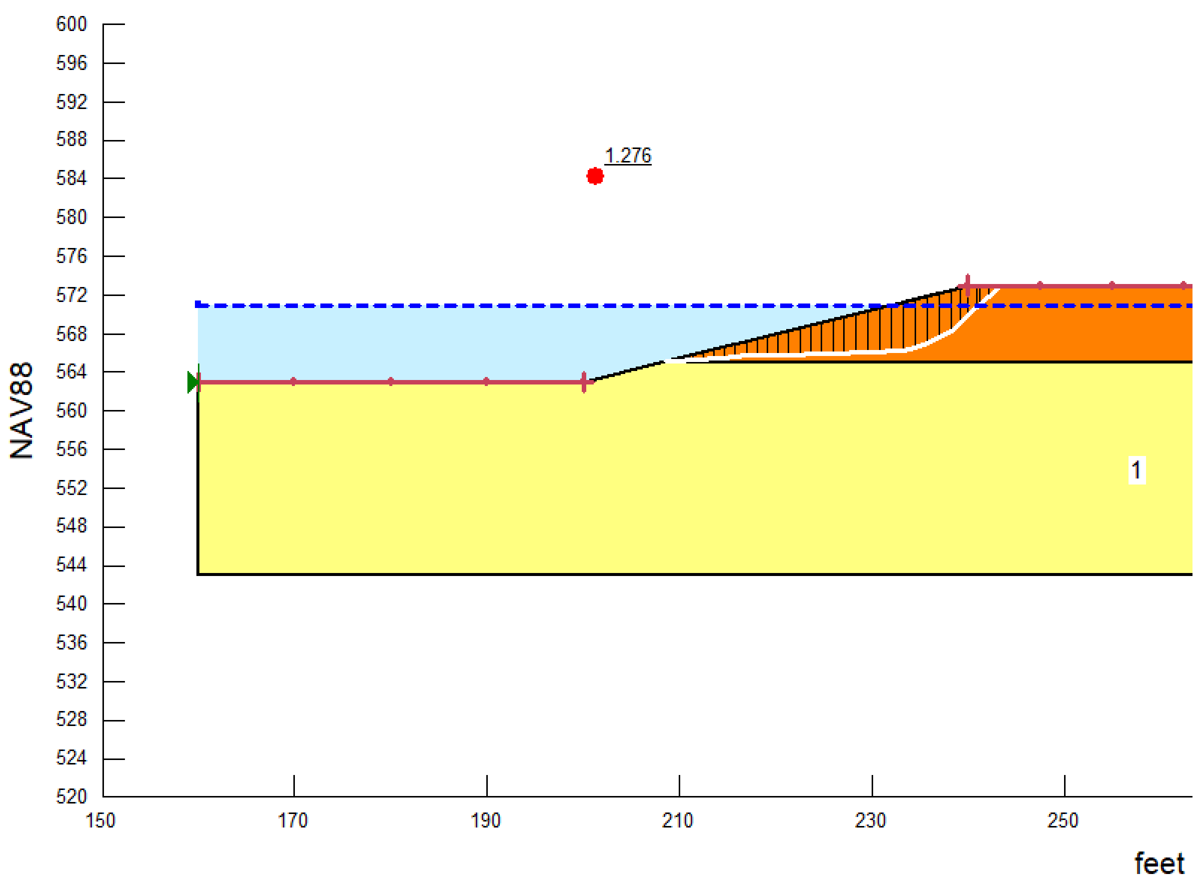
Embankment c=200 psf   Foundation ϕ= 19 degrees



Embankment c=200 psf   Foundation ϕ= 19 degrees



Embankment c=200 psf   Foundation c= 300 psf



Embankment c=200 psf   Foundation ϕ= 19 degrees

Slope Stability

File Information

File Version: 8.16
Title: Steamboat Island
Created By: Kinney, Randall S MVR
Last Edited By: Kinney, Randall S CIV USARMY CEMVR (US)
Revision Number: 29
Date: 6/13/2019
Time: 9:35:50 AM
Tool Version: 8.16.3.14580
File Name: Steamboat Island.gsz
Directory: P:\SLOPE STABILITY\GEO-SLOPE (from C drive Mar 29 2013)\GeoStudio2007\
Last Solved Date: 6/13/2019
Last Solved Time: 9:36:03 AM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Slope Stability

Kind: SLOPE/W
Method: Spencer
Settings
- PWP Conditions Source: Piezometric Line
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No

Slip Surface Option: Entry and Exit
Critical slip surfaces saved: 1
Resisting Side Maximum Convex Angle: 1 °
Driving Side Maximum Convex Angle: 5 °
Optimize Critical Slip Surface Location: Yes
Critical Slip Surface Optimizations
Maximum Iterations: 2,000
Convergence Tolerance: 1e-007
Starting Points: 8
Ending Points: 16
Complete Passes per Insertion: 1
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.01
Minimum Slip Surface Depth: 3 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Sand

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Foundation

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 19 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Embankment

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion': 200 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (160, 563) ft
Left-Zone Right Coordinate: (200, 563) ft
Left-Zone Increment: 4
Right Projection: Range
Right-Zone Left Coordinate: (240, 573) ft
Right-Zone Right Coordinate: (270, 573) ft
Right-Zone Increment: 4
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (160, 563) ft
Right Coordinate: (352, 580) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	160	571
Coordinate 2	352	571

Points

	X (ft)	Y (ft)
Point 1	160	563
Point 2	200	563
Point 3	208	565

Point 4	240	573
Point 5	270	573
Point 6	312	580
Point 7	352	580
Point 8	352	573
Point 9	352	565
Point 10	160	543
Point 11	352	543

Regions

	Material	Points	Area (ft²)
Region 1	Sand	10,11,9,3,2,1	4,136
Region 2	Foundation	3,4,5,8,9	1,024
Region 3	Embankment	5,6,7,8	427

Current Slip Surface

Slip Surface: 126
F of S: 1.276
Volume: 96.585757 ft³
Weight: 11,590.291 lbs
Resisting Moment: 711,625.2 lbs-ft
Activating Moment: 556,135.66 lbs-ft
Resisting Force: 2,040.1136 lbs
Activating Force: 1,602.5615 lbs
F of S Rank (Analysis): 1 of 126 slip surfaces
F of S Rank (Query): 1 of 126 slip surfaces
Exit: (208.65695, 565.16424) ft
Entry: (243.42115, 573) ft
Radius: 15.568852 ft
Center: (167.69369, 896.93473) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	209.22991	565.19104	362.47883	369.10151	2.2803715	0
Slice 2	210.56681	565.24064	359.38438	382.30094	7.8908044	0
Slice 3	211.88751	565.3092	355.10604	392.44568	12.857069	0
Slice 4	213.00101	565.40075	349.39295	397.25915	16.481655	0
Slice 5	214.11451	565.49231	343.67986	402.07263	20.106242	0
Slice 6	215.228	565.58387	337.96676	406.88609	23.730829	0
Slice 7	216.3415	565.67542	332.25367	411.69956	27.355415	0
Slice 8	217.45998	565.73633	328.45283	421.58502	32.067983	0
Slice 9	218.58345	565.7666	326.56426	434.02665	37.002268	0
Slice 10	219.70692	565.79686	324.67569	446.46829	41.936554	0
Slice 11	220.83039	565.82713	322.78712	458.90992	46.87084	0
Slice 12	221.95386	565.8574	320.89855	471.35156	51.805125	0
Slice 13	223.07733	565.88766	319.00998	483.79319	56.739411	0
Slice 14	224.2008	565.91793	317.12141	496.23483	61.673696	0
Slice 15	225.32427	565.94819	315.23284	508.67647	66.607982	0
Slice 16	226.44774	565.97846	313.34427	521.1181	71.542267	0
Slice 17	227.63329	566.02205	310.6243	531.74464	76.137838	0
Slice 18	228.88092	566.07896	307.07295	542.70195	81.133571	0
Slice 19	230.12855	566.13587	303.52159	553.65925	86.129304	0
Slice 20	231.37618	566.19278	299.97023	564.61655	91.125037	0
Slice 21	232.65534	566.25114	296.32914	585.94938	99.724246	0
Slice 22	233.92607	566.44988	283.92749	581.69143	102.52835	0
Slice 23	235.15685	566.78758	262.85501	576.8834	108.12865	0
Slice 24	236.37673	567.28171	232.02114	533.59004	103.8385	0
Slice 25	237.58571	567.93228	191.42588	491.94455	103.47688	0
Slice 26	238.64265	568.66063	145.97665	415.1288	92.676517	0
Slice 27	239.54755	569.46677	95.673447	349.28475	87.325375	0

Slice 28	240.44372	570.26513	45.855818	273.35021	78.332599	0
Slice 29	241.07537	570.83021	10.594896	211.31224	69.112524	0
Slice 30	241.71088	571.40435	-25.231596	153.86704	52.980672	0
Slice 31	242.60603	572.21306	-75.694788	75.884251	26.129043	0
Slice 32	243.23738	572.80871	-112.86319	17.911045	6.1672675	0

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX H

HYDROLOGY AND HYDRAULICS

UPPER MISSISSIPPI RIVER RESTORATION
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WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
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APPENDIX H

HYDROLOGY AND HYDRAULICS

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
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STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508
CLINTON & SCOTT COUNTIES, IOWA, AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX H

HYDROLOGY AND HYDRAULICS

I. INTRODUCTION AND LOCATION

The *Steamboat Island Habitat Rehabilitation and Enhancement Project* (Project) is located between RM 502.5 and 508 within Pool 14 of the UMR, near the communities of Princeton, Iowa, and Cordova, Illinois (Figure H-1). Steamboat Island proper is situated on the Iowa (western) side of the Mississippi River, along the inside of a large bend in the river. Steamboat Slough, a side channel, flows along the right-descending bank (RDB) of Steamboat Island and the Mississippi River flows along the left-descending bank (LDB). The mouth of the Wapsipinicon River enters the Mississippi River immediately upstream of Steamboat Island. A secondary channel on the Iowa side of the island, called Grant Slough, originates in the Wapsipinicon floodplain and flows parallel to Steamboat Slough. The East and West Southeast Islands are two small islands located near the lower LDB of Steamboat Island, south of Cordova, Illinois.

The Project area is in the middle of Pool 14, approximately 9 miles upstream of Locks and Dam (L&D) 14 and 16 miles downstream of L&D 13. L&D 14 is located near LeClaire, Iowa, and was placed into operation in June 1939. L&D 13, located in Fulton, Illinois, was placed into operation in May 1939. Pool 14 extends from RM 493.3 to RM 522.4 and includes portions of Clinton and Scott Counties in Iowa, and Rock Island and Whiteside Counties in Illinois. The Wapsipinicon River is the largest tributary to Pool 14. All elevations used in this appendix are expressed using the NAVD 88 unless otherwise stated. A single Project-wide conversion of +0.85’ from NAVD 88 to MSL 1912 was recommended by the District Survey Branch (EC-TS). For the purposes of converting water surface elevations across the Project’s hydraulic analysis reach, a linear interpolation between the recommended conversions at L&D 14 (+0.73 ft) (RM 493.3) and Camanche, IA (+0.77 ft) (RM 511.8) was used (Table H-1). Elevation conversions from North American Vertical Datum of 1988 (NAVD 88) to National Geodetic Vertical Datum (NGVD 29) are also provided (Table H-2).

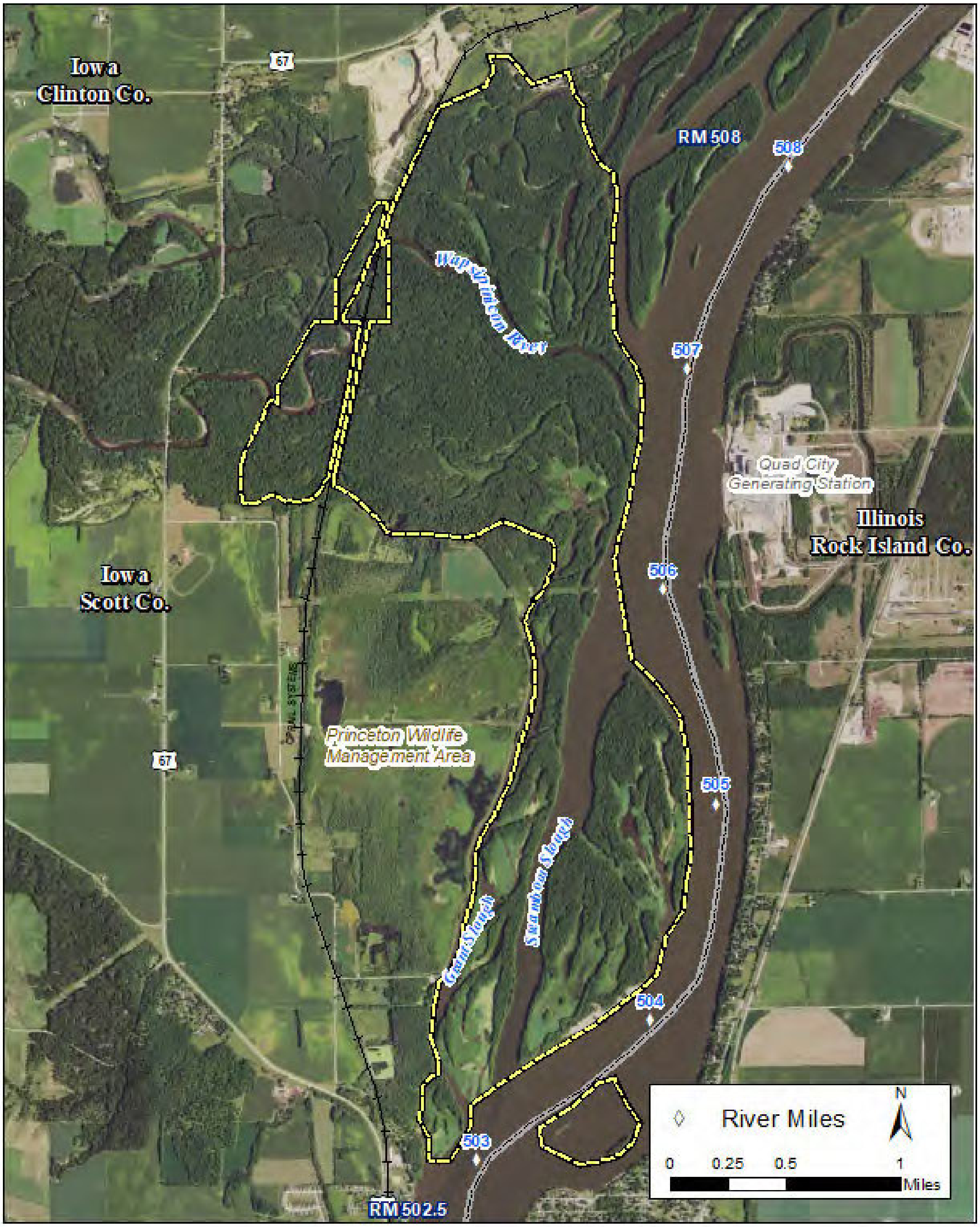

Figure H-1: Project Area Map

Table H-1: Elevation Conversion from NAVD 88 to MSL 1912 in Feet

River Mile	NAVD 88 to MSL 1912 Conversion (ft)
511.8	+0.77
511.6	+0.77
511	+0.77
510.1	+0.77
509.3	+0.76
509	+0.76
508.6	+0.76
507.9	+0.76
507.4	+0.76
506.9	+0.76
506	+0.76
505.5	+0.76
505	+0.76
504.5	+0.75
504	+0.75
503.3	+0.75
503.1	+0.75
502.9	+0.75
502.5	+0.75
502	+0.75

River Mile	NAVD 88 to MSL 1912 Conversion (ft)
501.74	+0.75
501.5	+0.75
501	+0.75
500.5	+0.75
500	+0.74
499.5	+0.74
499	+0.74
498.5	+0.74
498	+0.74
497.1	+0.74
496.8	+0.74
496.5	+0.74
496	+0.74
495.3	+0.73
495	+0.73
494.6	+0.73
494	+0.73
493.4	+0.73
493.3	+0.73

Table H-2: Elevation Conversion from NAVD 88 to NGVD 1929 in Feet

River Mile	NAVD 88 to NGVD 1929 Conversion (ft)
511.8	+0.24
511.6	+0.24
511	+0.24
510.1	+0.24
509.3	+0.24
509	+0.24
508.6	+0.24
507.9	+0.24
507.4	+0.23
506.9	+0.23
506	+0.23
505.5	+0.23
505	+0.23
504.5	+0.23
504	+0.23
503.3	+0.23
503.1	+0.23
502.9	+0.23
502.5	+0.23
502	+0.23

River Mile	NAVD 88 to NGVD 1929 Conversion (ft)
501.74	+0.23
501.5	+0.23
501	+0.23
500.5	+0.23
500	+0.22
499.5	+0.22
499	+0.22
498.5	+0.22
498	+0.22
497.1	+0.22
496.8	+0.22
496.5	+0.22
496	+0.22
495.3	+0.22
495	+0.22
494.6	+0.22
494	+0.22
493.4	+0.21
493.3	+0.21

Table H-3 provides the datum conversion from MSL1912 to NAVD 88 for elevations of Project measures and other locations in the Project area such as the Camanche and L&D 14 gage. Also included are the elevations at the Camanche gage that approximately correspond to when the water surface profile exceeds the elevations of Project measures. The elevations are rounded to the nearest tenth, and the conversions used in the table are described in the paragraph above. The 50%, 20% and 10% annual chance exceedance water surface profiles from the 2004 Upper Mississippi River System Flow Frequency Study (2004 UMRSFFS) are also shown in Table H-3.

Table H-3: Elevation Conversion from NAVD 88 to NGVD 1929 in Feet

River Mile	Measure/Landmark	Elevation of Measure (MSL1912/NAVD 88)	Corresponding Elevation at Camanche Gage (MSL1912/NAVD 88)	50% ACE (MSL1912/NAVD 88)	20% ACE (MSL1912/NAVD 88)	10% ACE (MSL1912/NAVD 88)
511.8	Camanche Gage (Gage Zero)	(563.21/562.44)	NA	(578.8/578.0)	(581.3/580.5)	(583.2/582.4)
	Flood Stage (17 ft)	(580.21/579.44)	NA	(578.8/578.0)	(581.3/580.5)	(583.2/582.4)
505.6	Upper Steamboat Island Head	(577.1/576.2)	(579.6/578.8)	(576.5/575.7)	(578.3/577.5)	(580.2/579.4)
504.9	NE Bank	(577.1/576.2)	(580.3/579.5)	(576.2/575.4)	(577.8/577.0)	(579.8/579.0)
504.7	Grade Control Structure	(574.9/574.0)	(576.6/575.9)	(576.1/575.4)	(577.7/577.0)	(579.7/579.0)
504.7	Grant Slough Placement 5	(577.1/576.2)	(580.4/579.6)	(576.1/575.4)	(577.7/577.0)	(579.7/579.0)
504.6	Grant Slough Placement 4	(577.1/576.2)	(580.5/579.7)	(576/575.3)	(577.6/576.9)	(579.6/578.9)
504.5	Upper Lake Aquatic Diversity	(564.1/563.2)	NA	(576/575.3)	(577.6/576.9)	(579.6/578.9)
504.5	Upper Lake Placement 1	(577.1/576.2)	(580.5/579.8)	(576/575.3)	(577.6/576.9)	(579.6/578.9)
504.1	Grant Slough Placement 2	(577.1/576.2)	(580.8/580.1)	(575.8/575.1)	(577.4/576.7)	(579.4/578.7)
504.1	NW Grant Slough Lake Aquatic Diversity	(564.1/563.2)	NA	(575.8/575.1)	(577.4/576.7)	(579.4/578.7)
503.7	Lower Lake SSP	(574.0/573.1)	(575.6/574.9)	(575.5/574.8)	(577.3/576.6)	(579.3/578.6)
503.6	Lower Lake Aquatic Diversity	(564.1/563.2)	NA	(575.5/574.8)	(577.0/576.3)	(579.0/578.3)
503.5	West SE Island	(577.1/576.2)	(581.5/580.7)	(575.4/574.7)	(576.9/576.2)	(578.9/578.2)
503.2	Grant Slough Placement 1	(574.0/573.1)	(575.9/575.1)	(575.3/574.6)	(576.7/576.0)	(578.7/578.0)
493.3	L&D 14 Gage (Gage Zero)	(577.08/556.35)	NA	(572/571.3)	(572.0/571.3)	(572.2/571.5)
	Flat Pool (14.90 ft)	(571.98/571.25)	NA	(572/571.3)	(572.0/571.3)	(572.2/571.5)

II. CLIMATE

Monthly climate data for the Clinton #1 U.S. Cooperative Network Station (gage #131635) is summarized in Tables H-4 and H-5. The data for precipitation, snowfall and temperature below is from the most recent 30-year period, 1987-2016.

Table H-4: Average and Extremes of Monthly Precipitation and Snowfall (COOP gage #131635)

	Precipitation					Snow		
	Average	Maximum		Minimum		Average	Maximum	
Month	(in)	(in)	Year	(in)	Year	(in)	(in)	Year
Jan	1.44	2.84	1999	0.53	2016	9.1	20.3	1995
Feb	1.53	3.33	2001	0.17	1987	7.7	27.0	2008
Mar	2.26	5.27	1991	0.58	2014	3.3	13.3	1999
Apr	3.17	7.55	2013	0.75	2005	0.5	5.9	1997
May	3.92	12.35	1996	0.74	1992	0.0	0.0	
Jun	4.84	14.63	1990	0.89	1988	0.0	0.0	
Jul	3.65	8.75	1992	0.15	1991	0.0	0.0	
Aug	4.71	13.78	1987	1.10	2013	0.0	0.0	
Sep	3.03	6.35	1992	0.61	2009	0.0	0.0	
Oct	2.32	5.82	1998	0.29	2005	0.1	2.5	1997
Nov	2.20	6.74	2015	0.26	2007	1.6	10.3	1997
Dec	1.95	4.71	2015	0.48	1995	9.1	25.6	2000
Annual	**34.99**					**31.39**		

Fluctuation of temperatures in east-central Iowa can be extreme, evidenced by a minimum monthly temperature of -29° F in February and a maximum monthly temperature of 103° F in July. Precipitation is moderate with an average annual value of 34.99 inches. The average annual snowfall is 31.39 in.

Table H-5: Average and Extremes of Monthly Temperature (COOP gage #131635)

Month	Average (°F)	Maximum (°F)	Minimum (°F)
Jan	22.63	67	-27
Feb	26.35	70	-29
Mar	39.21	83	-15
Apr	51.63	90	16
May	62.46	94	24
Jun	71.40	100	39
Jul	74.80	103	49
Aug	72.87	101	45
Sep	65.29	98	29
Oct	53.10	91	15
Nov	40.18	79	2
Dec	27.09	70	-22
Annual	**50.69**		

III. TOPOGRAPHY

The Project area is comprised of side channels, secondary channels, smaller backwater channels, tributary channels, braided floodplain channels and island interior backwater lakes. Backwater areas include Upper Lake, Lower Lake, Northwest Grant Slough, and Southwest Grant Slough. Among the larger channels are the Wapsipinicon River tributary, Mississippi River main channel, Steamboat Slough side channel and Grant Slough secondary channel. Some of the smaller backwater channels convey water throughout the year and others are ephemeral. Steamboat Island proper is split in two by a bisecting channel that provides ephemeral connectivity between the Mississippi River and Steamboat Slough.

On December 3, 2017, topobathymetric Light Detection and Ranging (LiDAR) data was collected for the Project area. Traditional near-infrared LiDAR was fully integrated with green wavelength return (bathymetric) LiDAR to collect elevation data below the water surface. Depth penetration below the water surface is approximately 1.5x Secchi depth. Field measurements of secchi depth were collected at about 15 locations at the time the LiDAR was flown to assess underwater extent of the data collection. The measured secchi depths were between 60 and 80 centimeters throughout the Project area. The average water surface elevation at L&D 14 was 572.0 feet MSL 1912 (flat pool) (RM 493.3) and 573.7 feet MSL 1912 at the Camanche gage (43% annual exceedance duration) (RM 511.8) on the flight date. The District Survey Section (EC-TS) collected conventional survey data in various locations where there were gaps in the bathylidar data collection.

Steamboat Island proper is approximately 430 acres. The highest elevations occur along the perimeter of the island where natural ridge features form and on the southeast end of the lower island where Historic Bankline Placement Site RM 503.5-504.1R is located (Figure H-2). During 50% annual exceedance probability flood conditions, approximately 75% of the Steamboat Island proper is inundated (Figure H-3).

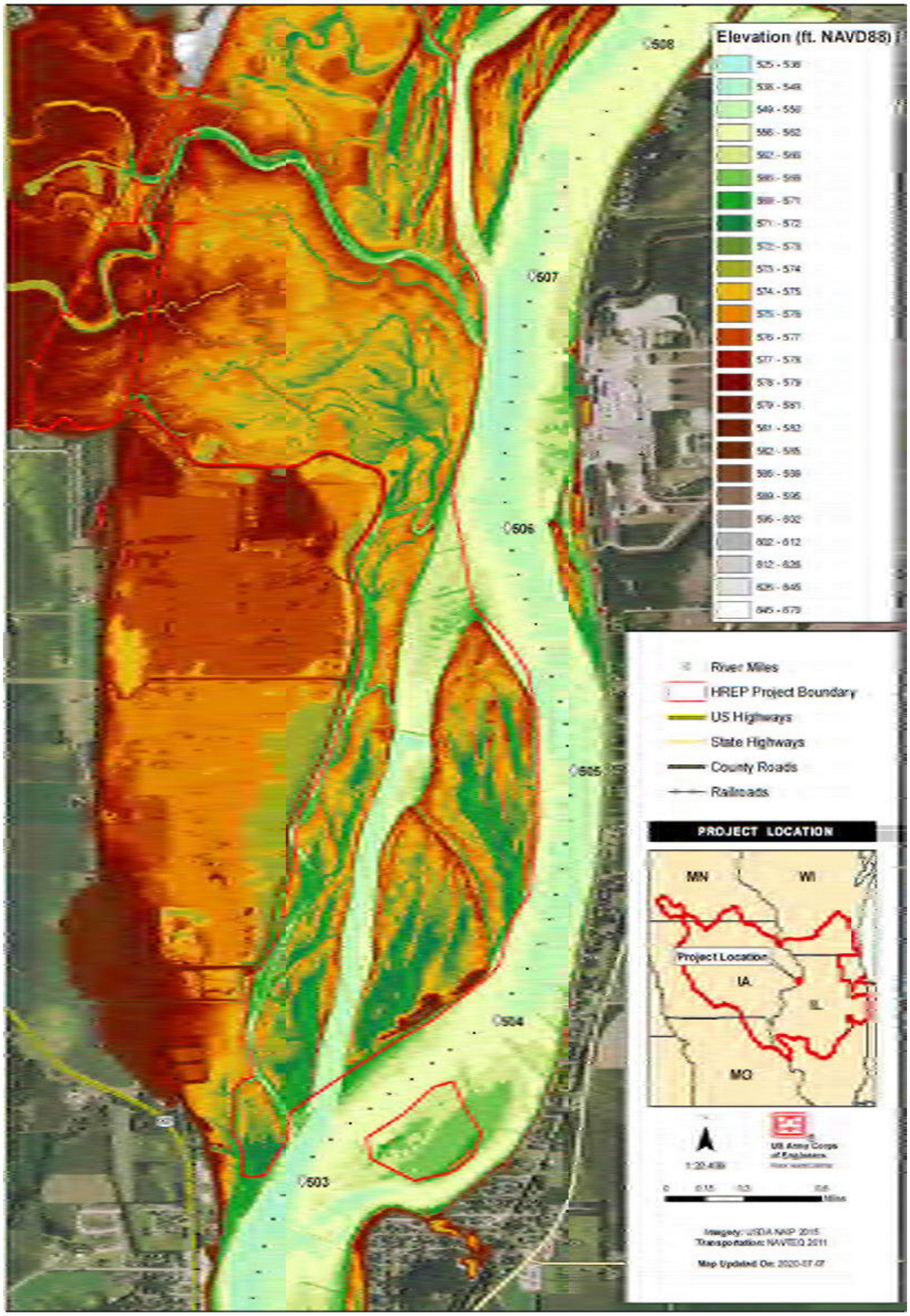

Figure H-2: Topographic and Bathymetric Elevation Map

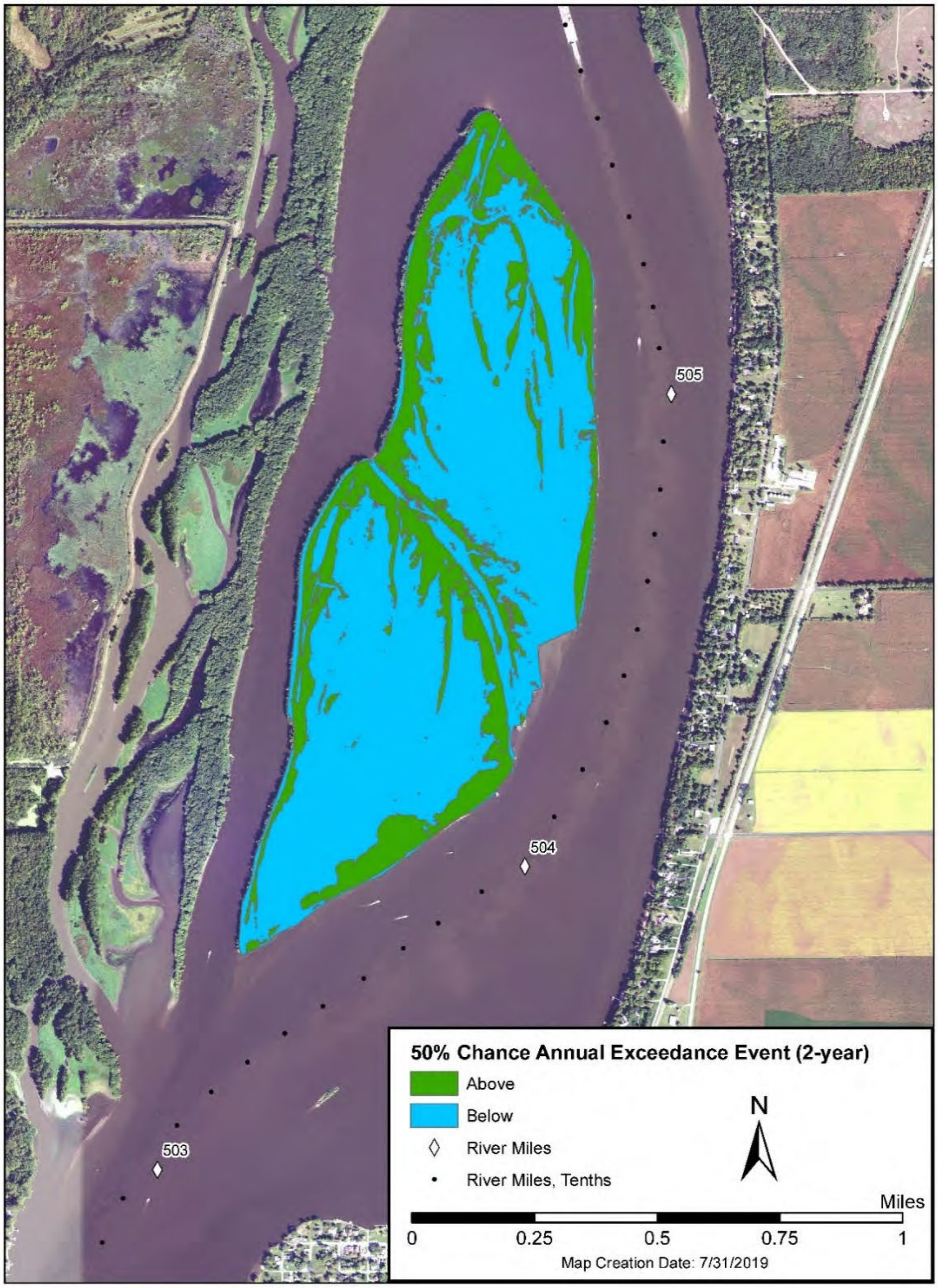

Figure H-3: Steamboat Island Inundation Under 50% Annual Exceedance Probability Discharge

IV. BATHYMETRY

Data supporting an existing pool-wide bathymetric surface for Pool 14 was reviewed to assess the age and coverage of available bathymetric data to identify and prioritize areas where updated survey was needed to support hydrodynamic modeling for the Project. Bathymetric LiDAR collected in December 2017, as described in Section III, provided extensive and detailed coverage of most all of the backwater areas in the study area as well as many of the areas within the Grant Slough Complex. Additional bathymetric survey collection of the main channel across from and upstream of Steamboat Island proper using single beam cross-sections collected by the District's Operations Division's (OD-T) hydrosurvey vessel, 'Coot' (Figure H-4). The existing closing structure on Steamboat Slough was densely surveyed using both OD-T single beam hydrosurvey and multi beam bathymetric survey using the District's remotely-operated echo boat (Figure H-5). The echo boat was also used to collect bathymetry in Grant Slough and Steamboat Slough. As stated in Section III, MVR Survey Section (EC-TS) collected conventional survey data in various locations where there were gaps in the bathymetric LiDAR collection. For the areas outside the immediate Project boundary, the OD-T Pool 14 surface provided the most recently collected bathymetric data and the most complete coverage to support development of an elevation model extending the full reach of the hydrodynamic model (RM 493.3 to RM 511.3). These topographic and bathymetric data sources were merged to create a 5-foot resolution gridded elevation model for the Project area and the hydrodynamic model mesh (Figure H-2).

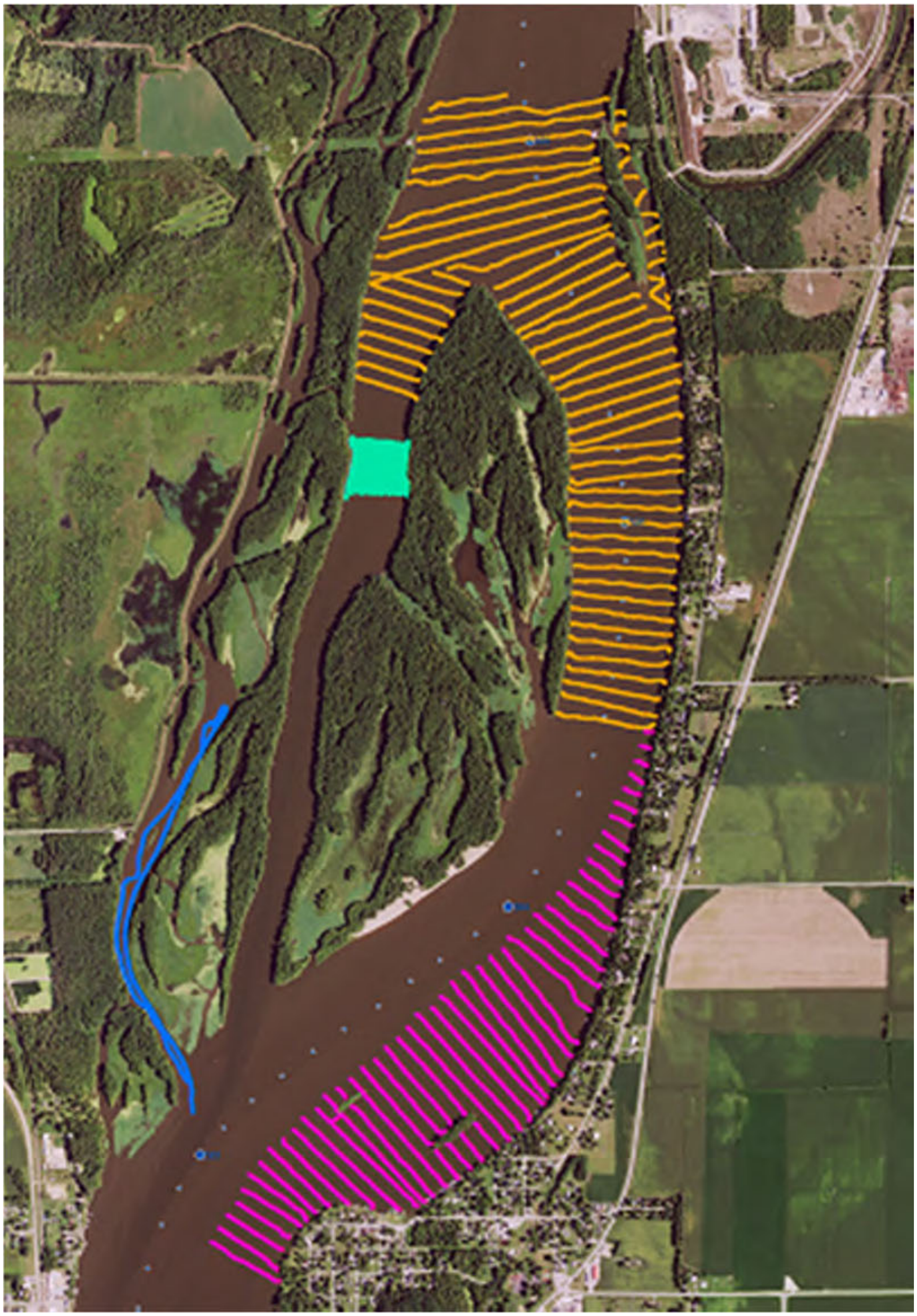

Figure H-4: 2018 Single Beam Hydrosurvey Collection Extent

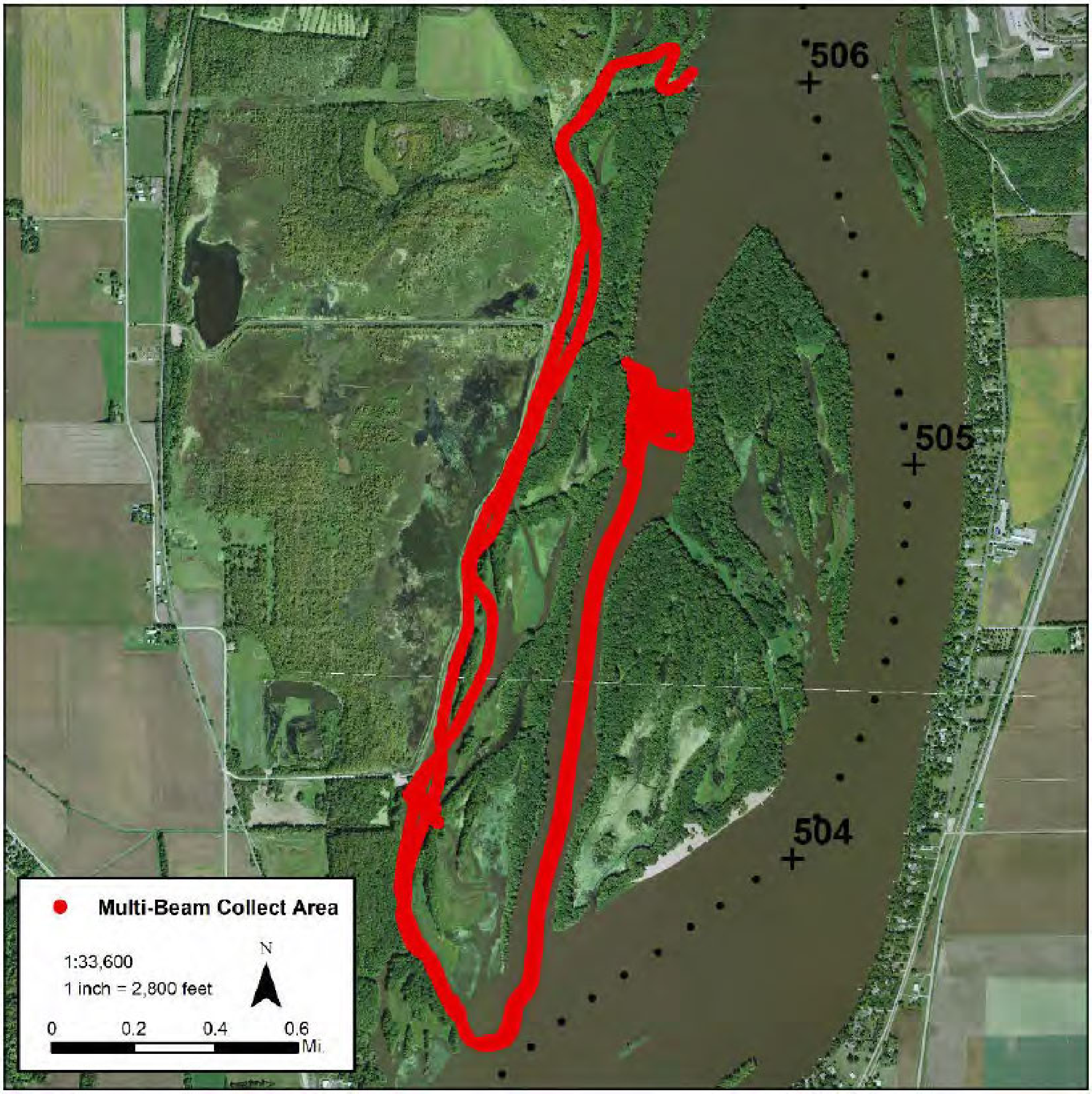

Figure H-5: 2018 Echo Boat Multi Beam Hydrosurvey Collection Extent

V. HYDROLOGY AND HYDRAULICS OVERVIEW

A. Historic and Current Mississippi River Hydrology. The District records continuous stages at L&D 14 and at L&D 13. The USGS and the District make joint use of the stream gage at Camanche, Iowa (USGS gage 05420500, Mississippi River at Clinton, Iowa), providing continuous measurements of both stage and discharge. Table H-6 shows a summary of the nearby gages and their characteristics. The Clinton/Camanche gage (RM 511.8) with a drainage area of 85,600 square miles, is closest to the Project and provides the longest period of record (POR). The USGS maintains discharge records for a

POR beginning in 1873 to present for the Clinton/Camanche gage, whereas the District maintains stage records for a period from 1939 (following construction of the locks and dams) to present. The District has maintained records of discharge at the lock and dam gages since 1986.

Table H-6: Summary of Available Stream Gages

Gage Name	River Mile	Drainage Area (sq. miles)	Gage Zero Elevation (ft MSL 1912)	Gage Zero Elevation (ft NAVD 88)	Period of Record	Flat Pool/Tail (ft MSL 1912) (ft NAVD 88)
Mississippi River at L&D 13, Fulton, IL (Tailwater)	522.4	85,500	568.70	567.71	1939-present	572.00 571.01
Mississippi River at Camanche, IA (USGS gage 05420500 Mississippi River at Clinton, IA)	511.8	85,600	563.21 (562.68 [1])	562.44 (562.41)	1939-present (1873-present)	n/a
Mississippi River at L&D 14, LeClaire, IA (Pool)	493.3	88,400	557.08	556.35	1939-present	571.98 571.25

[1] References NGVD 1929 Vertical Datum

L&D 14 provides navigable channel depths by maintaining a minimum water surface elevation of 571.24 feet (flat pool). Pool 14 is regulated using a dam control point. The annual hydrograph is impacted by the dam, whereby low river stages are made higher during low discharge periods, ultimately resulting in less river stage fluctuation. However, as you move further upstream in the pool, the effects of the dam are diminished and greater fluctuation in river stage occurs as illustrated in Figure H-6. As shown in this figure, the Clinton/Camanche gage, located approximately 4 miles upstream of the Project area (RM 511.8), in the upper portion of the pool, experiences significant fluctuation. Average annual discharge at Clinton/Camanche gage is 56,300 cfs (POR 1987-2016).

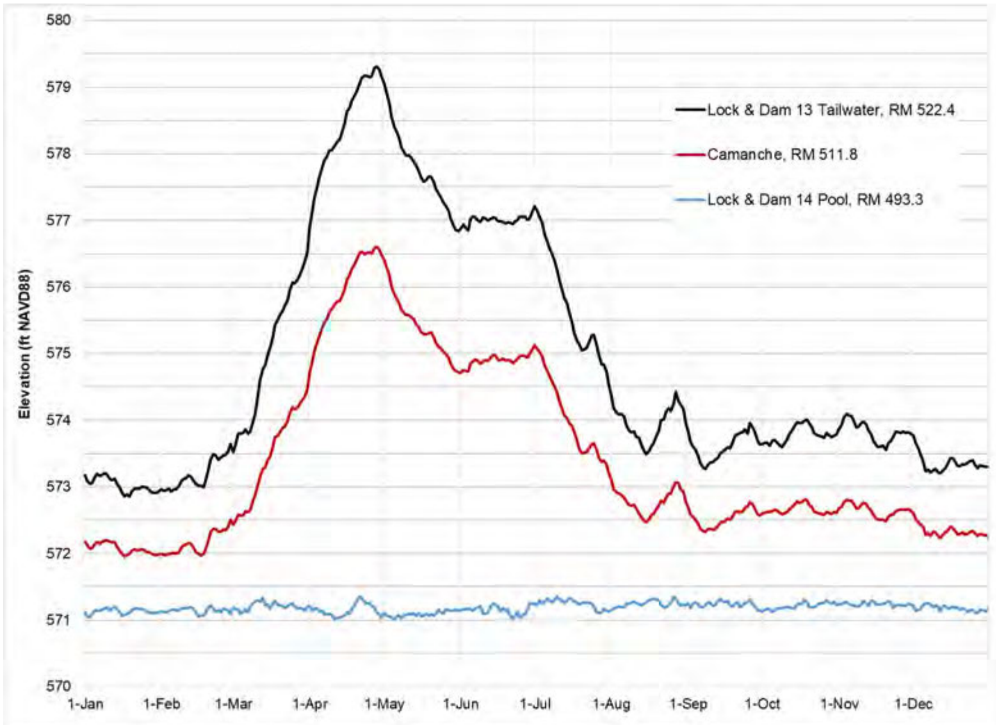

Figure H-6: Average Annual Elevation Hydrographs for the Upper, Middle, and Lower Portions of Pool 14 (1987-2016)

B. Flood Conditions. The 2004 UMRSFFS includes several cross sections through the Project area (USACE, 2004). Table H-7 shows results from the 2004 UMRSFFS that pertain to the Project area and the Camanche gage (RM 511.8); however, the elevations are in MSL 1912. The 50% annual exceedance probability discharge at RM 505 is 134,000 cfs, with a resulting water surface elevation of 575.44 feet NAVD 88 (576.2 feet MSL 1912).

Table H-8 lists the 14 highest water events at the Camanche gage; the highest flood on record occurred in late April 1965 and resulted in a water surface elevation of 587.06 feet (24.65 feet of stage). It is worth noting that three of the top five flood events have occurred within the most recent 20 years.

Table H-7: 2004 Upper Mississippi River System Flow Frequency Study (Elevations in MSL 1912)

	Exceedance Probability															
River	0.5		0.2		0.1		0.04		0.02		0.01		0.005		0.002	
Mile	feet	cfs	feet	cfs	feet	cfs	feet	cfs	feet	cfs	feet	cfs	feet	cfs	feet	cfs
491.3	565.8	134,000	567.6	178,000	569.1	206,000	571.0	241,000	572.8	265,000	574.4	289,000	575.7	313,000	577.1	344,000
492	566.1	134,000	568.0	178,000	569.4	206,000	571.3	241,000	573.1	265,000	574.7	289,000	576.0	313,000	577.4	344,000
492.5	566.3	134,000	568.2	178,000	569.7	206,000	571.6	241,000	573.3	265,000	574.9	289,000	576.2	313,000	577.7	344,000
493	566.5	134,000	568.4	178,000	569.9	206,000	571.8	241,000	573.6	265,000	575.2	289,000	576.5	313,000	578.0	344,000
493.2	566.6	134,000	568.5	178,000	569.9	206,000	571.8	241,000	573.6	265,000	575.2	289,000	576.5	313,000	578.0	344,000
493.4	572.0	134,000	572.0	178,000	572.2	206,000	574.1	241,000	576.1	265,000	577.8	289,000	579.2	313,000	581.0	344,000
494	572.2	134,000	572.2	178,000	572.7	206,000	574.7	241,000	576.5	265,000	578.2	289,000	579.6	313,000	581.3	344,000
494.6	572.3	134,000	572.4	178,000	573.1	206,000	575.1	240,000	576.9	265,000	578.5	289,000	579.9	313,000	581.6	344,000
495	572.4	134,000	572.5	178,000	573.4	206,000	575.4	240,000	577.2	265,000	578.8	289,000	580.1	313,000	581.8	344,000
495.3	572.6	134,000	572.7	178,000	573.8	206,000	575.8	240,000	577.6	265,000	579.1	289,000	580.5	313,000	582.1	344,000
496	572.9	134,000	573.0	178,000	574.4	206,000	576.4	240,000	578.1	265,000	579.6	289,000	581.0	313,000	582.6	344,000
496.5	573.2	134,000	573.4	178,000	575.1	206,000	577.1	240,000	578.7	265,000	580.2	289,000	581.5	313,000	583.1	344,000
496.8	573.4	134,000	573.7	178,000	575.4	206,000	577.5	240,000	579.0	265,000	580.5	289,000	581.8	313,000	583.3	344,000
497.1	573.5	134,000	573.9	178,000	575.7	206,000	577.8	240,000	579.3	265,000	580.8	289,000	582.1	313,000	583.6	344,000
498	573.7	134,000	574.3	178,000	576.1	206,000	578.2	240,000	579.8	265,000	581.3	289,000	582.6	313,000	584.1	344,000
498.5	573.8	134,000	574.5	178,000	576.4	206,000	578.5	240,000	580.1	265,000	581.6	289,000	582.9	313,000	584.4	344,000
499	574.0	134,000	574.7	178,000	576.6	206,000	578.7	240,000	580.3	265,000	581.8	289,000	583.1	313,000	584.7	344,000
499.5	574.2	134,000	575.0	178,000	576.9	206,000	579.1	240,000	580.6	265,000	582.1	289,000	583.4	313,000	585.0	344,000
500	574.3	134,000	575.2	178,000	577.2	206,000	579.3	240,000	580.9	265,000	582.3	289,000	583.7	313,000	585.2	344,000
500.5	574.4	134,000	575.4	178,000	577.4	206,000	579.5	240,000	581.1	265,000	582.5	289,000	583.9	313,000	585.4	344,000
501	574.5	134,000	575.6	178,000	577.6	206,000	579.7	240,000	581.3	265,000	582.7	289,000	584.0	313,000	585.6	344,000
501.5	574.6	134,000	575.8	178,000	577.8	206,000	579.9	240,000	581.5	265,000	582.9	289,000	584.3	313,000	585.8	344,000
501.74	574.7	134,000	575.9	178,000	577.9	206,000	580.0	240,000	581.6	265,000	583.1	289,000	584.4	313,000	585.9	344,000
502	574.8	134,000	576.0	178,000	578.0	206,000	580.2	240,000	581.7	265,000	583.2	289,000	584.5	313,000	586.1	344,000
502.5	575.0	134,000	576.3	178,000	578.3	206,000	580.4	240,000	582.0	265,000	583.5	289,000	584.8	313,000	586.4	344,000
502.9	575.1	134,000	576.4	178,000	578.4	206,000	580.6	240,000	582.2	265,000	583.7	289,000	585.0	313,000	586.6	344,000
503.1	575.2	134,000	576.6	178,000	578.6	206,000	580.8	240,000	582.3	265,000	583.8	289,000	585.1	313,000	586.7	344,000
503.3	575.3	134,000	576.8	178,000	578.8	206,000	581.0	240,000	582.5	265,000	584.0	289,000	585.3	313,000	586.8	344,000
504	575.8	134,000	577.3	178,000	579.3	206,000	581.3	240,000	582.8	265,000	584.2	289,000	585.5	313,000	587.1	344,000
505	576.2	134,000	577.8	178,000	579.8	206,000	581.8	240,000	583.3	265,000	584.6	289,000	585.9	313,000	587.4	344,000
505.5	576.5	134,000	578.2	178,000	580.1	206,000	582.1	240,000	583.6	265,000	584.9	289,000	586.2	313,000	587.7	344,000
506	576.7	134,000	578.5	178,000	580.4	206,000	582.4	240,000	583.8	265,000	585.2	289,000	586.4	313,000	587.8	344,000
506.9	576.9	134,000	578.8	178,000	580.7	206,000	582.7	240,000	584.1	265,000	585.6	289,000	586.8	313,000	588.1	344,000
507.4	577.2	131,000	579.2	174,000	581.1	202,000	583.1	235,000	584.7	260,000	586.1	283,000	587.3	307,000	588.6	337,000
507.9	577.4	131,000	579.5	174,000	581.4	202,000	583.4	235,000	585.0	260,000	586.4	283,000	587.6	307,000	588.9	337,000
508.6	577.7	131,000	579.8	174,000	581.7	202,000	583.7	235,000	585.3	260,000	586.7	283,000	587.9	307,000	589.2	337,000
509	577.8	131,000	580.0	174,000	581.9	202,000	583.9	235,000	585.5	260,000	586.9	283,000	588.1	307,000	589.3	337,000
509.3	578.0	131,000	580.2	174,000	582.1	202,000	584.1	235,000	585.7	260,000	587.1	283,000	588.3	307,000	589.5	337,000

Table H-7 (cont'd): 2004 Upper Mississippi River System Flow Frequency Study (Elevations in MSL 1912)

	Exceedance Probability															
River	**0.5**		**0.2**		**0.1**		**0.04**		**0.02**		**0.01**		**0.005**		**0.002**	
Mile	**feet**	**cfs**	**feet**	**cfs**	**feet**	**cfs**	**feet**	**cfs**	**feet**	**cfs**	**feet**	**cfs**	**feet**	**cfs**	**feet**	**cfs**
510.1	578.3	131,000	580.6	174,000	582.5	202,000	584.5	235,000	586.1	260,000	587.5	283,000	588.6	306,000	589.8	337,000
511	578.5	131,000	580.9	174,000	582.8	202,000	584.8	235,000	586.4	259,000	587.8	283,000	588.9	306,000	590.1	337,000
511.6	578.7	131,000	581.1	174,000	583.1	202,000	585.1	235,000	586.6	259,000	588.0	283,000	589.1	306,000	590.3	337,000
512	578.9	131,000	581.4	174,000	583.3	202,000	585.4	235,000	586.9	259,000	588.3	283,000	589.4	306,000	590.6	337,000
512.7	579.1	131,000	581.6	174,000	583.6	202,000	585.6	235,000	587.2	259,000	588.6	283,000	589.7	306,000	590.9	337,000
513	579.2	131,000	581.8	174,000	583.8	202,000	585.9	235,000	587.4	259,000	588.9	283,000	590.0	306,000	591.2	337,000
514	579.5	131,000	582.2	174,000	584.1	202,000	586.3	235,000	587.8	259,000	589.3	283,000	590.4	306,000	591.5	337,000
514.4	579.7	131,000	582.4	174,000	584.3	202,000	586.5	235,000	588.0	259,000	589.5	283,000	590.6	306,000	591.7	337,000
515	579.9	131,000	582.6	174,000	584.6	202,000	586.7	235,000	588.3	259,000	589.8	283,000	590.9	306,000	592.0	337,000
515.5	580.1	131,000	582.9	174,000	584.9	202,000	587.0	235,000	588.6	259,000	590.0	283,000	591.1	306,000	592.3	337,000
516	580.4	131,000	583.1	174,000	585.1	202,000	587.2	235,000	588.8	259,000	590.2	283,000	591.3	306,000	592.5	337,000
516.6	580.5	131,000	583.3	174,000	585.3	202,000	587.4	235,000	589.0	259,000	590.4	283,000	591.5	306,000	592.7	337,000
517	580.6	131,000	583.4	174,000	585.4	202,000	587.6	235,000	589.1	259,000	590.6	283,000	591.7	306,000	592.8	337,000
517.7	580.8	131,000	583.6	174,000	585.6	202,000	587.8	235,000	589.4	259,000	590.8	283,000	591.9	306,000	593.0	337,000
517.95	580.8	131,000	583.6	174,000	585.6	202,000	587.9	235,000	589.5	259,000	590.9	283,000	592.0	306,000	593.2	337,000
518	580.9	131,000	583.7	174,000	585.7	202,000	587.9	235,000	589.5	259,000	590.9	283,000	592.0	306,000	593.1	337,000
518.05	580.8	131,000	583.7	174,000	585.7	202,000	587.9	235,000	589.5	259,000	591.0	283,000	592.1	306,000	593.2	337,000
518.1	580.9	131,000	583.7	174,000	585.8	202,000	588.0	235,000	589.6	259,000	591.0	283,000	592.1	306,000	593.2	337,000
518.15	581.0	131,000	583.8	174,000	585.9	202,000	588.1	235,000	589.7	259,000	591.2	283,000	592.3	306,000	593.4	337,000
518.4	581.1	131,000	584.0	174,000	586.0	202,000	588.3	235,000	589.9	259,000	591.4	283,000	592.5	306,000	593.6	337,000
519.1	581.3	131,000	584.2	174,000	586.3	202,000	588.6	235,000	590.2	259,000	591.7	283,000	592.8	306,000	593.9	337,000
519.6	581.4	131,000	584.3	174,000	586.4	202,000	588.7	235,000	590.4	259,000	591.9	283,000	593.0	306,000	594.1	337,000
519.75	581.4	131,000	584.4	174,000	586.5	202,000	588.8	235,000	590.4	259,000	591.9	283,000	593.0	306,000	594.2	337,000
519.9	581.5	131,000	584.4	174,000	586.5	202,000	588.8	235,000	590.5	259,000	592.0	283,000	593.1	306,000	594.2	337,000
519.95	581.5	131,000	584.5	174,000	586.6	202,000	588.9	235,000	590.6	259,000	592.1	283,000	593.2	306,000	594.3	337,000
520	581.6	131,000	584.5	174,000	586.6	202,000	589.0	235,000	590.6	259,000	592.2	283,000	593.3	306,000	594.4	337,000
520.4	581.7	131,000	584.7	174,000	586.8	202,000	589.2	235,000	590.8	259,000	592.4	283,000	593.5	306,000	594.7	337,000
520.6	581.8	131,000	584.8	174,000	586.9	202,000	589.3	235,000	591.0	259,000	592.6	283,000	593.7	306,000	594.9	337,000
521	581.9	131,000	585.0	174,000	587.1	202,000	589.5	235,000	591.2	259,000	592.8	283,000	593.9	306,000	595.1	337,000
521.2	581.9	131,000	585.0	174,000	587.2	202,000	589.6	235,000	591.3	259,000	592.9	283,000	594.0	306,000	595.2	337,000
521.7	582.0	131,000	585.1	174,000	587.3	202,000	589.8	235,000	591.5	259,000	593.1	283,000	594.3	306,000	595.5	337,000
522.2	582.1	131,000	585.2	174,000	587.4	202,000	589.9	235,000	591.6	259,000	593.2	283,000	594.4	306,000	595.6	337,000
522.3	582.1	131,000	585.3	174,000	587.5	202,000	589.9	235,000	591.7	259,000	593.3	283,000	594.5	306,000	595.7	337,000
522.4	582.1	131,000	585.3	174,000	587.5	202,000	590.0	235,000	591.7	259,000	593.3	283,000	594.5	306,000	595.7	337,000
522.5	582.2	131,000	585.3	174,000	587.5	202,000	590.0	235,000	591.7	259,000	593.3	283,000	594.5	306,000	595.8	337,000
522.6	583.0	131,000	585.7	174,000	587.9	202,000	590.4	235,000	592.1	259,000	593.7	283,000	594.9	306,000	596.2	337,000
522.7	583.1	131,000	585.9	174,000	588.0	201,000	590.5	235,000	592.2	259,000	593.8	283,000	595.0	306,000	596.2	337,000
522.8	583.1	131,000	585.9	174,000	588.1	201,000	590.5	235,000	592.2	259,000	593.8	283,000	595.0	306,000	596.2	337,000

Table H-8: Record High Stages at Camanche Gage for the 1940-2019 Period of Record

Stage	Elevation (ft NAVD 88)	Date
20.64	583.05	10/07/1986
20.65	583.06	03/25/1973
20.78	583.19	05/07/1975
20.92	583.33	07/03/2014
21.00	583.41	04/26/1951
21.16	583.57	06/15/2008
21.24	583.65	04/27/1952
21.52	583.93	04/26/1969
21.58	583.99	04/19/1997
21.93	584.34	04/21/2011
22.77	585.18	05/01/2019
22.98	585.39	07/08/1993
23.62	586.03	04/24/2001
24.65	587.06	04/28/1965

C. Stage Hydrographs and Elevation Duration. The Camanche gage long-term average annual elevation hydrograph (Figure H-7) illustrates a spring to early summer flood followed by mid to late summer low flows. There is generally a slight pulse through the fall followed by low and more stable flows through the winter.

Figure H-8 shows a comparison of annual-elevation duration curves for the most recent 30-year period with the prior 30-year period for the Camanche gage. The annual elevation-duration curve for the current 30-year period (1987-2016) indicates a median river elevation of 572.6 feet and 572.3 feet for the prior 30-year period (1957-1986). This comparison indicates median river stage has increased over the last 30 years.

The period from 1987-2016 was selected to characterize existing conditions and as the basis for design. This most recent 30-year period was selected because it is considered short enough to represent a stationary dataset (i.e. statistical properties of the data are not changing over time) and long enough to provide a large enough sample size to adequately represent the population. Seasonal duration curves were computed based on periods critical to habitat targeted for restoration in the Project area. Low water conditions, which threaten DO concentrations and fish habitat, occur during the winter (November through February) and summer (July through August) months. As shown in Figure H-9, the overwintering period between November and February represents the more critical conditions for fish. The reference water surface elevation used to distinguish floodplain (above water) from aquatic (below water) habitat was the 70% annual exceedance duration (Figure H-9). The elevation at the Project site (approximately mid-Project, RM 504.5) that meets this criteria is 571.7 feet.

Figure H-7: Long-Term Average Annual Elevation Hydrograph at the Camanche Gage (1940-2016)

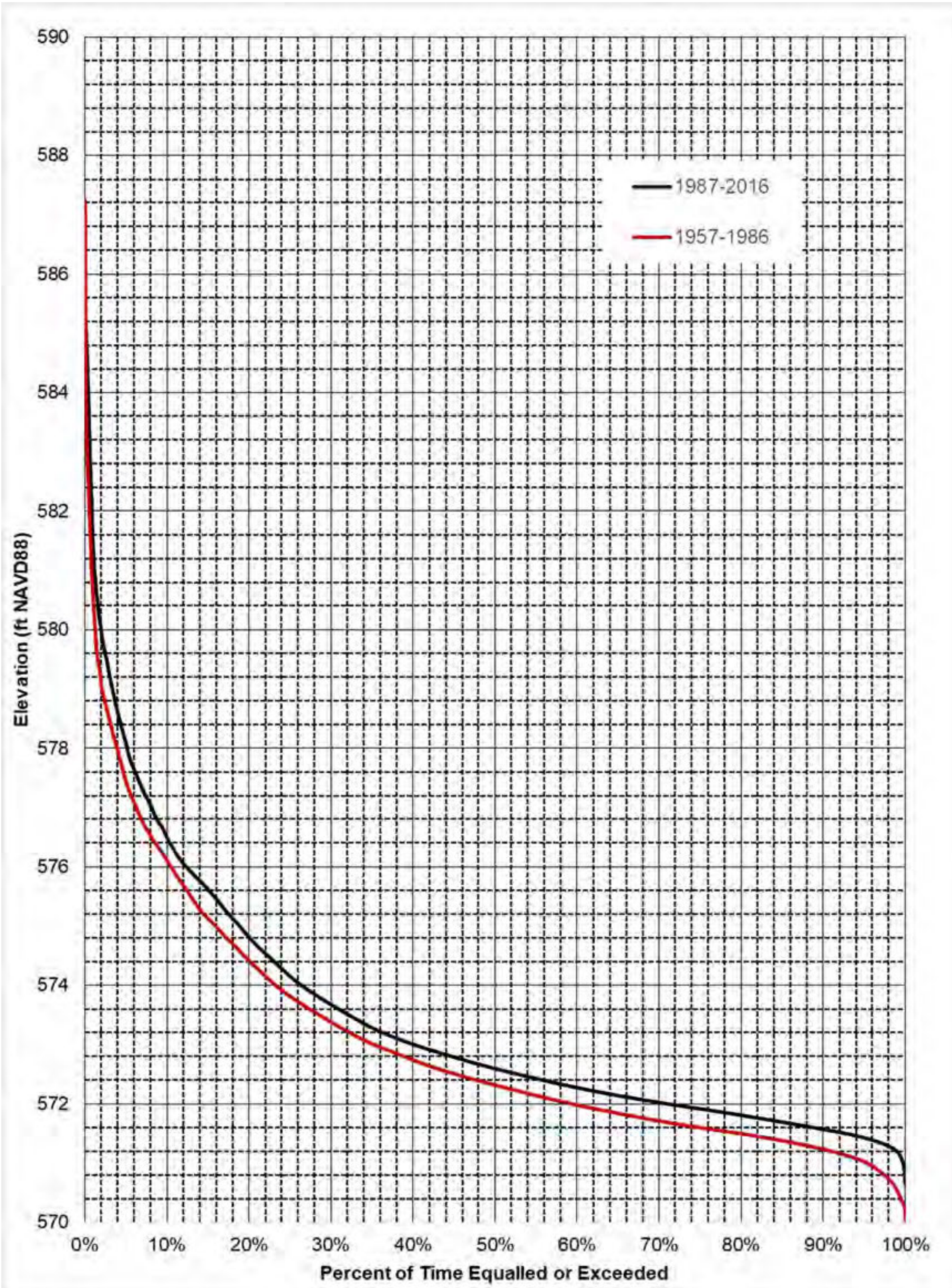

Figure H-8: Comparison of Annual Elevation-Duration Curves for Different Time Periods at the Camanche Gage

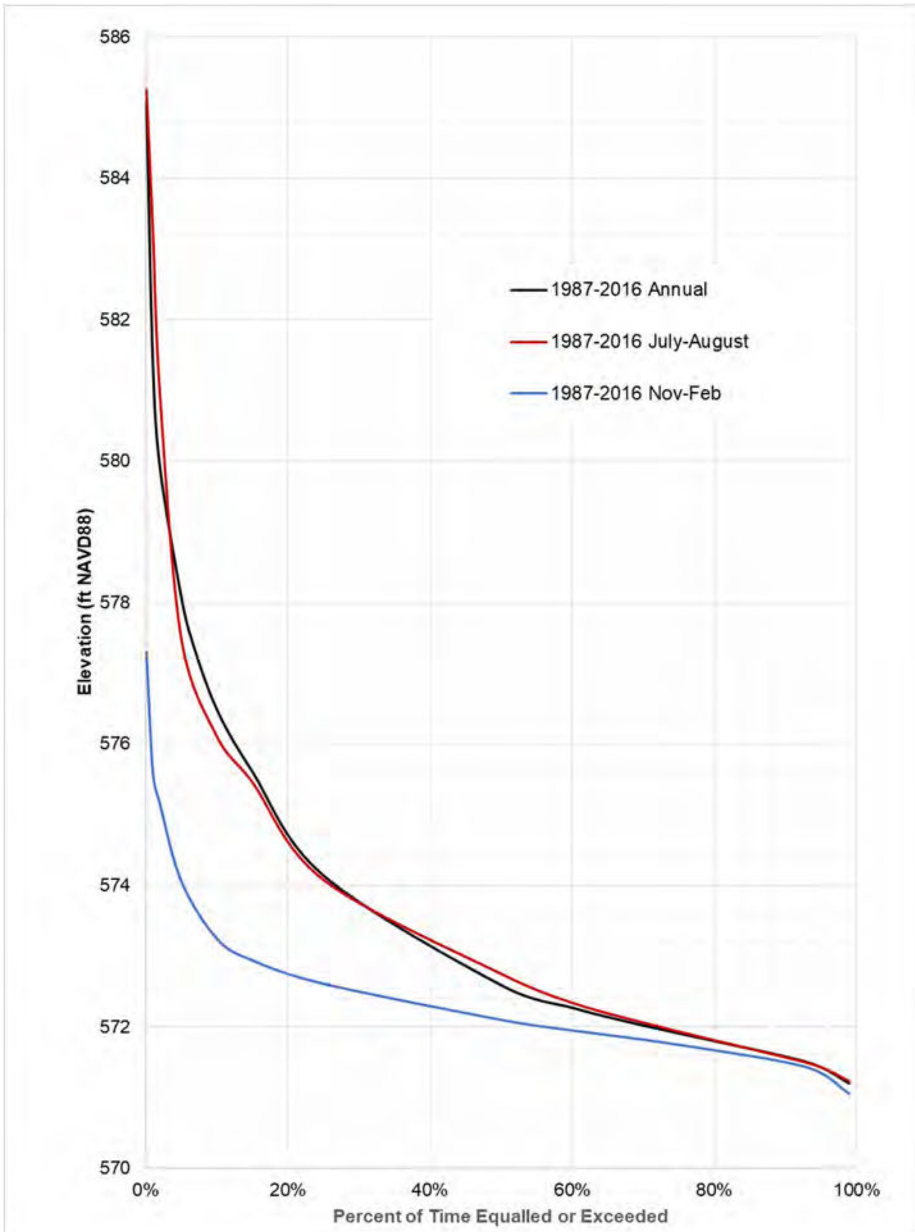

Figure H-9: Comparison of Seasonal and Annual Elevation-Duration Curves at the Camanche Gage

Hard mast trees are most vulnerable to flood-induced mortality during the growing season, therefore a growing season (April 15 – October 15) duration analysis was also completed (Figure H-10). A comparison of the median growing season stage for the current 30-year period and the median growing season stage for the prior 30-year period indicates an increase of over 0.5 feet (Figure H-10). The stage record that has shaped our existing conditions shows water levels have seen increased exceedance durations, contributing to the observed decline in species and age diversity among the floodplain forest community.

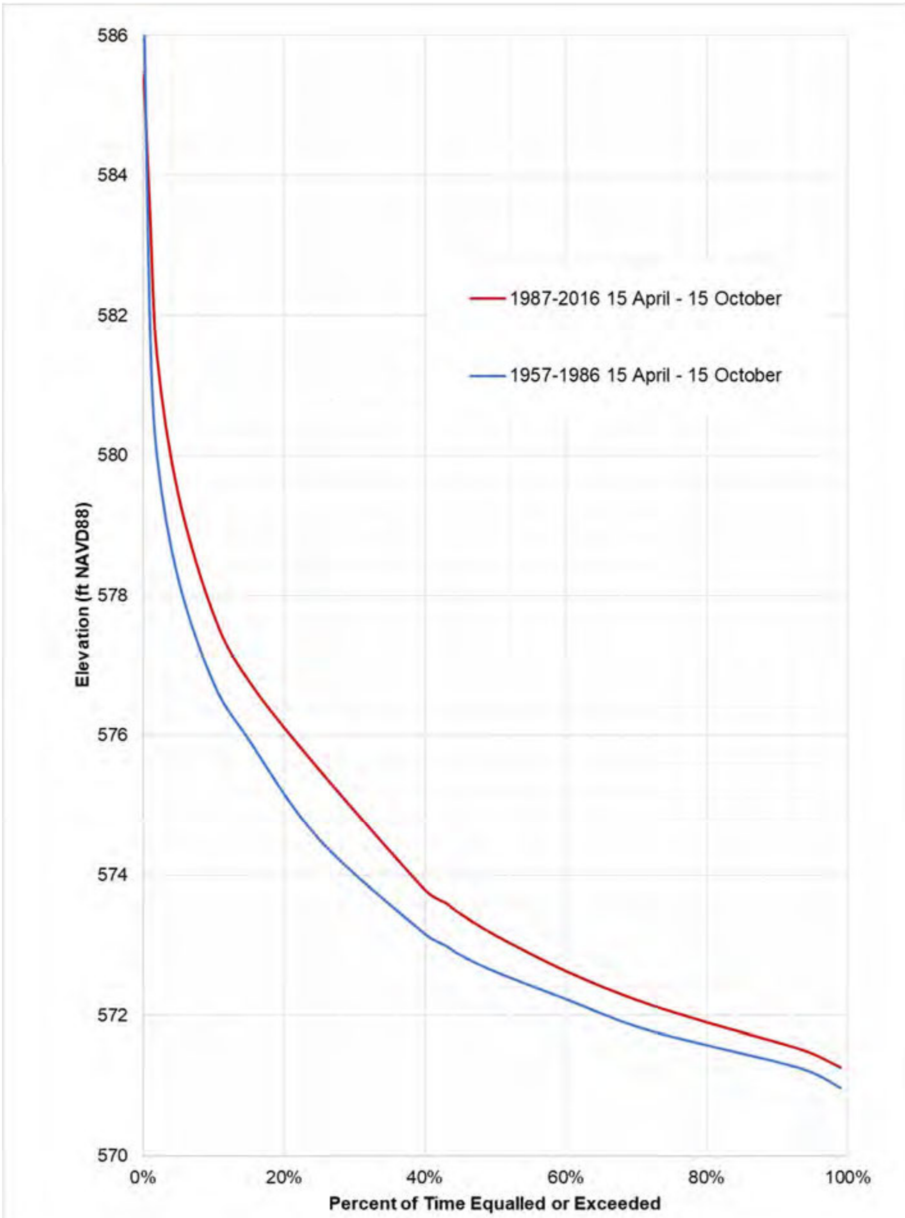

Figure H-10: Comparison of Growing Season Elevation-Duration Curves for Different Time Periods at the Camanche Gage

VI. SEDIMENT DEPOSITION

The Wapsipinicon River is the largest tributary to Pool 14 and outlets on the Iowa side in the northern portion of the Project area. Maintenance dredging within Pool 14 occurs as needed to address shoaling issues impacting navigation. Figure H-11 illustrates nearby dredging locations.

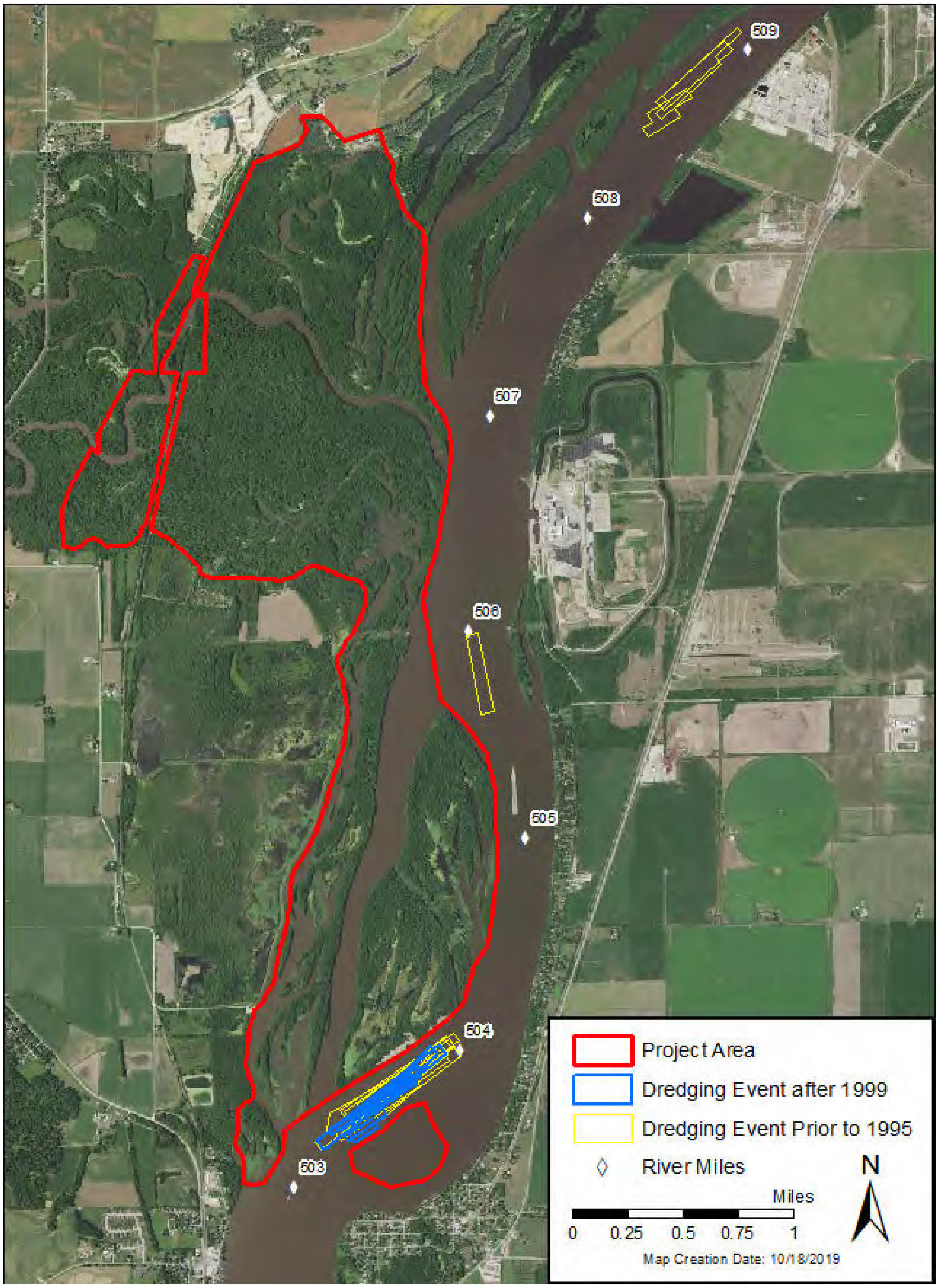

Figure H-11: Dredge Locations near Steamboat Island

Temporal and spatial variability are inherent in the numerous processes that drive sediment deposition, thereby sediment deposition rates are also dynamic. Some of the watershed features impacting backwater sediment deposition rates include geology and soils, land use, and other rainfall runoff characteristics of the contributing watershed, in addition to spatial and temporal variability of natural impoundments such as beaver dams. To date, backwater sediment deposition studies within the UMR have focused on Pools 4-10 and Pool 13 (Aspelmeier, 1994; Eckblad et al., 1977; Korschgen et al., 1987; McHenry et al., 1984; Rogala & Boma, 1996; Rogala et al., 1997). Results from these studies vary from as much as 1.57 in/year (4.0 cm/year) (Pools 4-10) and as little as 0.08 in/year (0.2 cm/year) (Pool 7). Rogala et al. (2003) reported an average backwater sediment deposition rate of 0.19 in/year (0.47 cm/year) for Pool 13. The Cumulative Effects Study indicates backwater sedimentation deposition rates derived from the sediment budget that vary from 0.2 in/year (0.5 cm/year) for Pools 12-19 to 0.12 in/year (0.31 cm/year) for Pools 20-26 (USACE, 2000).

Seven backwater sites within Pool 14 were monitored for sediment deposition from 1984 through 2000 by former IA DNR biologist, Bill Aspelmeir (1994, Appendix M, *Engineering Design*, Attachment E). Four of these sites were located in the Project area; one in Grant Slough near the Princeton WMA (Station 1), one in a backwater complex in Grant Slough (Station 2), one in the middle of Upper Lake (Station 3), and one in the middle of Lower Lake (Station 7) (see Appendix M Attachment E for map). Annual measurements along a transect at Stations 1-3 were collected from 1984-1989. Stations 1 and 2 had repeated measurements in 1994. Measurements at the transect in Lower Lake (Station 7) were taken annually from 1987-1989 then in 2000 and most recently in 2017. During this observation period, flooding occurred in 1986, 1993, 1997, 2001, 2008, 2011, 2014, and 2019. Rates range from -0.8 in/year (erosion) to 2.2 in/year of deposition, however the overall trend is toward deposition. The average sediment deposition rate at Stations 1, 2, 3 and 7, based on the varying study periods, are 0.9 in/year (2.3 cm/year), -0.2 in/year (-0.5 cm/year), 0.6 in/year (1.5 cm/year) and 0.1 in/year (0.3 cm/year), respectively (Table H-9). As a result of the variability in reported values and the inherent variability in sediment deposition rates, an average annual sediment deposition rate of 0.4 in/year (1 cm/year) was assumed for the Project.

Table H-9: Summary of Aspelmeir Sediment Deposition Rates within the Project Area

Station and Description	Long Term Average in/yr (cm/yr)	Period
Station 1, Grant Slough next to Princeton WMA	0.9 (2.3)	1984-1994
Station 2, Backwater Complex in Grant Slough	-0.2 (-0.5)	1984-1994
Station 3, Upper Lake	0.6 (1.5)	1984-1989
Station 7, Lower Lake	0.1 (0.3)	1987-2017

VII. HYDRAULIC MODELING DEVELOPMENT

A. Mesh Development. In 2018, a two dimensional (2-D) mesh for the Steamboat Island Project area was constructed for use with the hydraulic model Adaptive Hydraulics (AdH) in anticipation of the upcoming Project (USACE, 2015). The AdH model was created to assist in the design and evaluate the impact of the Project measures. The upstream boundary of the model is RM 511.3 near Camanche, IA, and the downstream boundary of the model is RM 493.3 at L&D 14. Due to the connectivity between the Wapsipinicon River and Grant Slough, the Wapsipinicon River was included in the modeled area. The model extends just west of Highway 67 on the Wapsipinicon River. The extents of the model on the Mississippi River were chosen because of the proximity to the Camanche and L&D 14 gages. The extents of the mesh fully include the 100-year discharge extents.

A 2-D steady-state hydrodynamic model was chosen in order to capture all the flow leaving the main channel relevant to the Project. For example, flow down Grant Slough and Steamboat Slough, as well as flow through Steamboat Island proper were all considered relevant based on the Project measures identified for feasibility evaluation. Modeling these components is most effectively done using a 2-D model. The hydrodynamic code AdH solves the 2-D vertically averaged form of the Navier-Stokes equation.

The approach to developing the AdH mesh was to first digitize the mesh nodes and breaklines using the Surface Water Modeling System (SMS) based upon aerial imagery and elevation data described in Section IV of this appendix. The elevation data available in the Project area was very detailed and allowed for a refined model mesh (Figure H-12). Arcs were used to create resolution for influential features where supporting bathymetric data exists, further reducing node spacing in specific areas. The density of the mesh varied throughout the model. Within the navigation channel mesh node density was much less than around river training structures and backwater areas. Representing the small streams located in the side channels and backwater areas resulted in a very dense mesh network. The size of the AdH model required simulations to take place using the Engineering Research and Development Center (ERDC) Lab's High Performance Computing resources for efficient simulation times. Shapefiles of Project measures were provided in order to incorporate into the AdH model during the mesh generation. Mesh bathymetry was based on the 5-foot gridded elevation model, and a point file was created to represent each of the grid cells was used to extract elevations for the AdH mesh nodes.

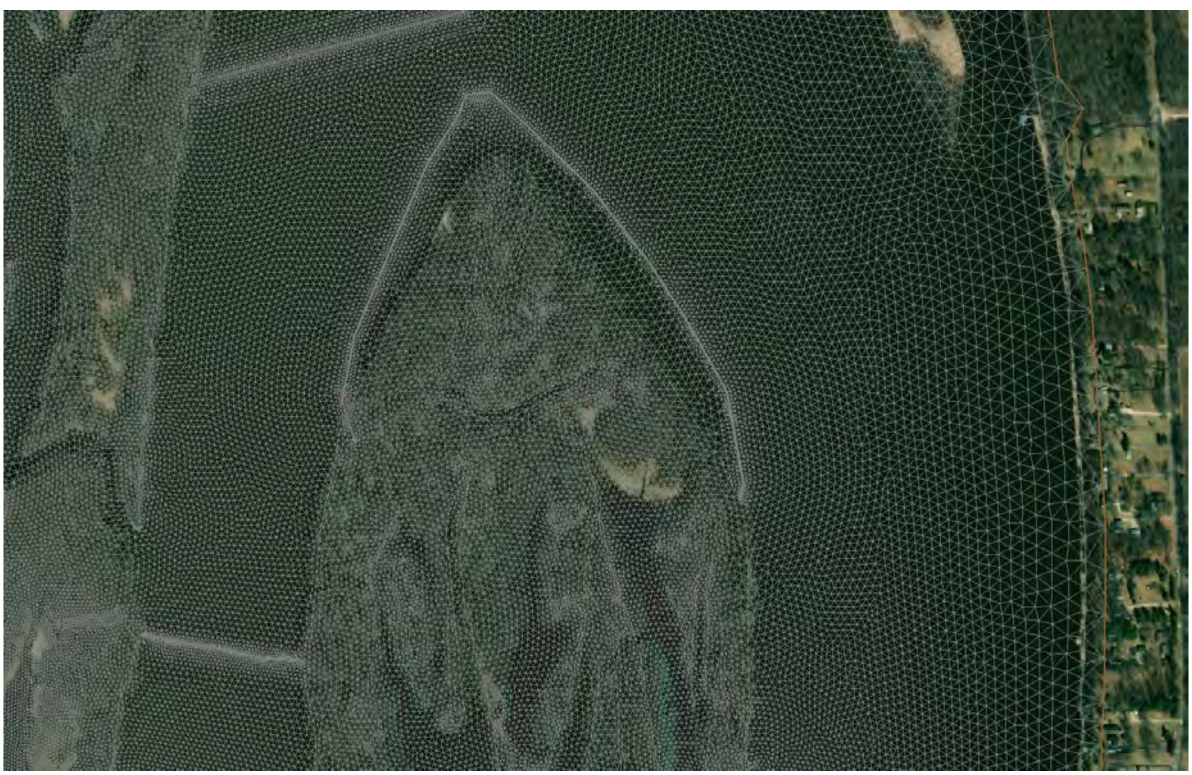

Figure H-12: AdH Model Mesh Depicting the Head of Steamboat Island

B. Model Calibration. Acoustic Doppler Current Profiler (ADCP) measurements in Pool 14 were collected under two different discharges. Discharge conditions were targeted based on conditions predictive of mussel presence. On July 26, 2017 the 600 KHz ADCP unit was deployed to collect discharge measurements within the model reach under conditions of ~133K cfs. On September 25 and 26, 2017, the 1200 KHz ADCP unit was deployed to collect discharge measurements under conditions of ~45,400 cfs. Calibration of the model utilized ADCP measurements from both events and the parameters of calibration were discharge, velocity, water surface slope.

To calibrate the 2D AdH model to the observed ADCP data in the Project area, the corresponding gage discharges and elevations were found to be used as boundary conditions. The two ADCP collections taken on July 26, 2017, and September 25 and 26, 2017, correspond to the Q5 (5% exceedance duration) and Q50 (50% exceedance duration) discharge levels at L&D 14, respectively. The Q5 event also approximately corresponds to the 50% chance exceedance event (2-year). Figures H-13 and H-14 show the location of the ADCP transects for the July 2017 and September 2017 collections, respectively.

For the July 26, 2017, ADCP collection, the discharge value initially used as the upstream boundary condition in the steady state hydraulic model was the average flow at the Camanche gage on the Mississippi River during the time of the collection (approx. 1300 to 1530) at 114,000 cfs. The boundary condition for the Wapsipinicon River was an inflow of 5,590 cfs, which was taken from the daily data at the DeWitt, IA, gage (USGS 05422000). The elevation of Pool 14 was used as the downstream boundary condition, and the daily value for July 26, 2017, was 570.7 feet. During the calibration process, the upstream boundary condition on the Mississippi River was changed to the observed L&D 13 discharge of 129,000 cfs. The observed discharge at the Camanche gage produced lower discharges in the model simulations than the ADCP data. After further analysis, L&D 13 appeared to be more representative of the flow at the upstream end of the model and the Camanche gage might not be accounting for the side channel on the Illinois side.

From the other ADCP collection taken September 2017, most of the transects were taken on the 25^{th} and only a few collected on the 26^{th}. The upstream Mississippi River boundary condition of the model was 45,273 cfs based on the ADCP transects of Arc 17 and 19. Since observed measurements were taken at the upstream boundary, those values were used over the L&D 13 discharge. The observed ADCP measurements were closer to the flow at L&D 13 than at Camanche. The discharge at the DeWitt, IA, gage was 510 cfs on the 25^{th} and was used as the boundary condition for the Wapsipinicon River. The elevation of Pool 14 of 571.34 feet was used as the downstream boundary condition.

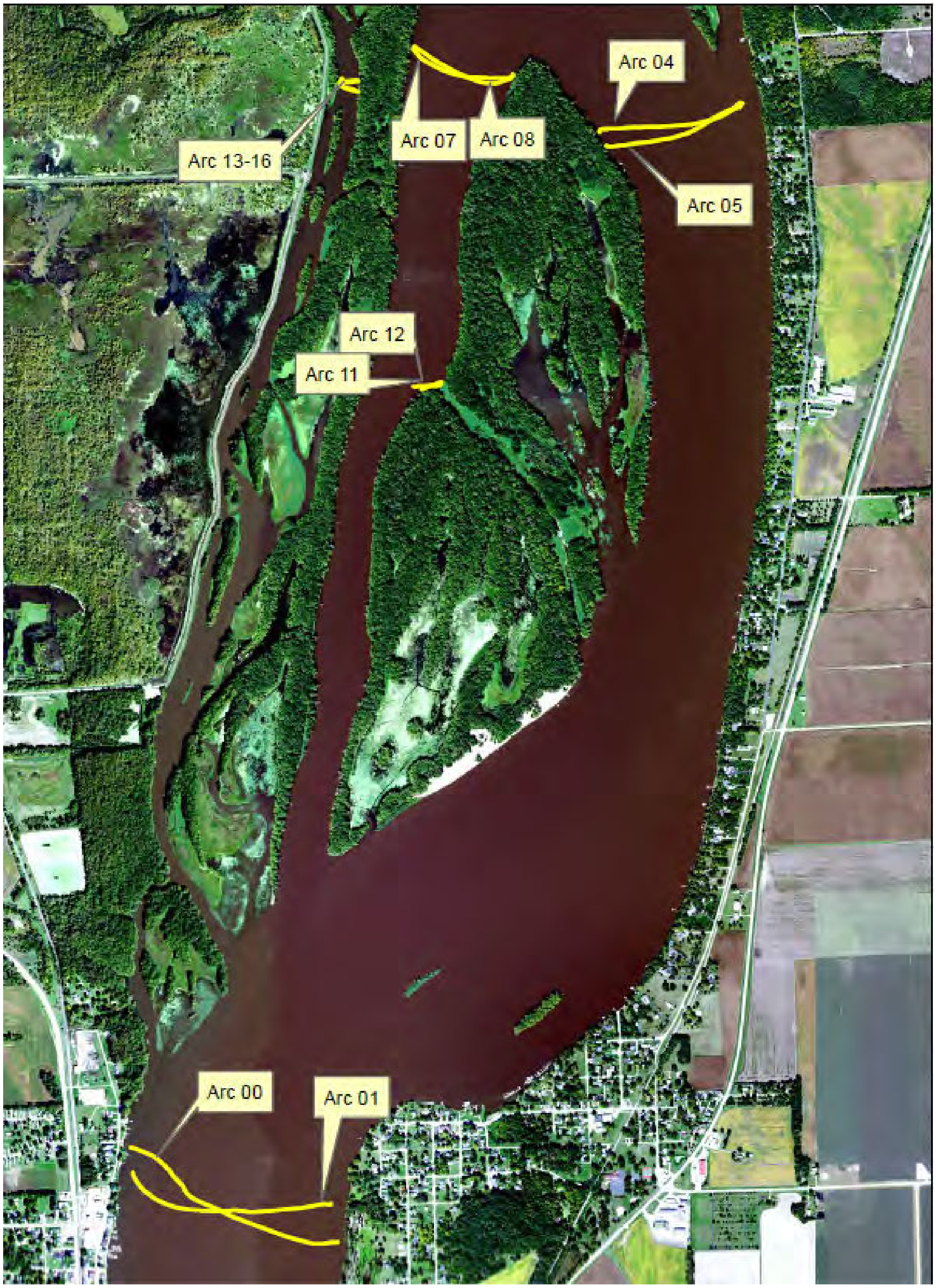

Figure H-13: July 2017 ADCP Transects at Steamboat Island

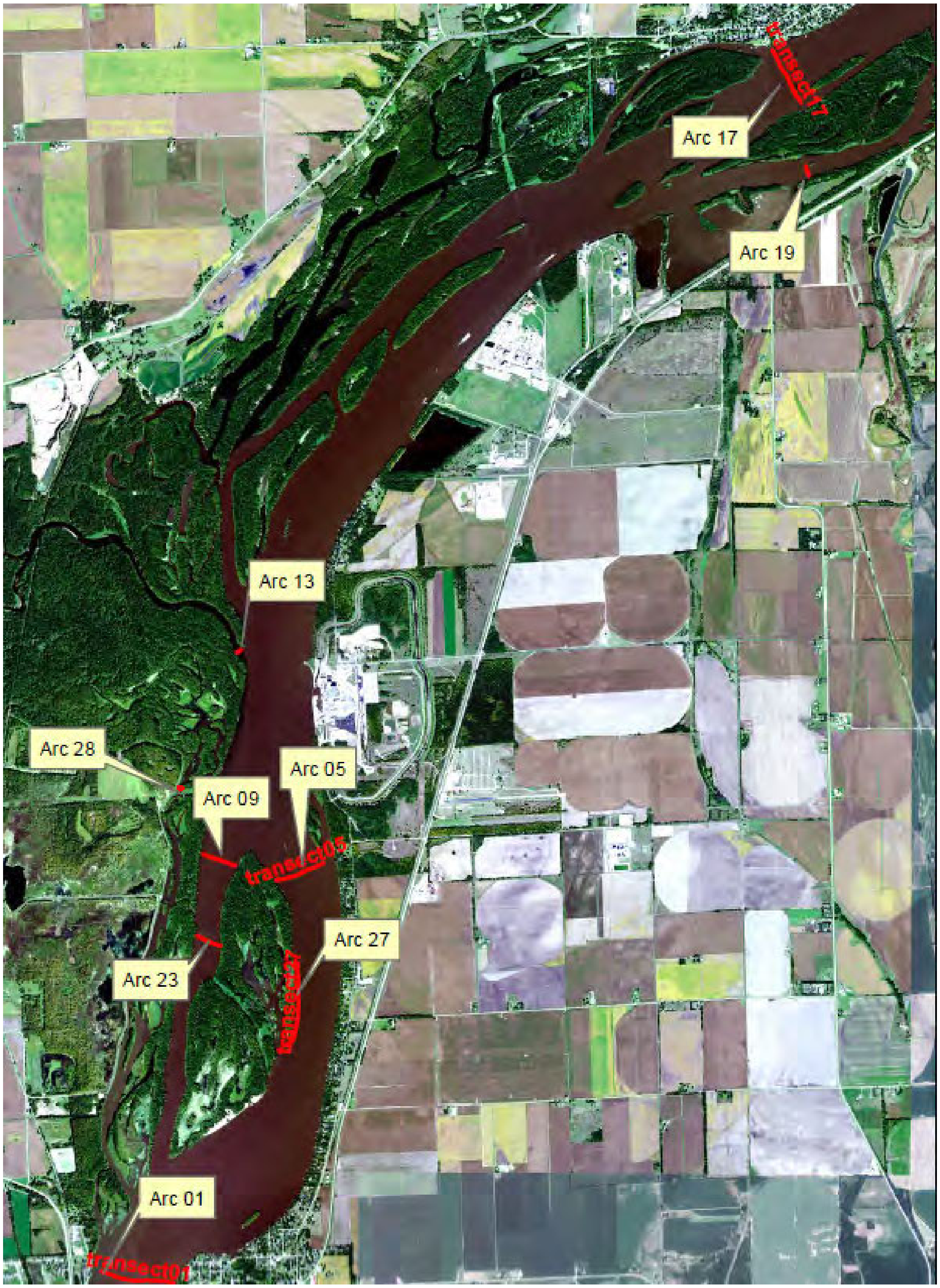

Figure H-14: September 2017 ADCP Transects at Steamboat Island

New material types were defined where a change in frictional parameters was anticipated based on channel morphology, bed material, or vegetation density and type. Individual material types were defined for the main channel, tributaries, interior channels, overbank areas, rock structures and forested areas. Material types were first assigned based on elevation to capture the deepest parts of the main channel as well as differences between land and water. The material types were then refined through aerial imagery and other resources such as the locations of rock structures (Figure H-15). Manning's roughness was the primary method used to represent frictional losses throughout the model domain. However, flow over the islands is largely impacted by the forest and understory vegetation, and roughness on the island could be better represented using the unsubmerged rigid vegetation (URV) card. Unlike Manning's roughness, the computation used the URV card account for an increase in roughness associated with a rising water depth due to the presence of vegetation. The URV card parameters include bed roughness height (understory height), average stem diameter, and average stem density. Recommendations for the URV card values were provided by the PDT forester based on typical forested area conditions. Table H-10 shows the final parameters.

Table H-10: Final Manning's Roughness Values

			Unsubmerged Rigid Vegetation Parameters		
Material Type Map ID	**Material Type**	**Final Manning's n Value (Calibration Range)**	**Bed Roughness Height (ft)**	**Average Stem Diameter (ft)**	**Average Stem Density (stems/ft2)**
2	Main Channel- Deepest Part	0.023 (0.021-0.023)	N/A	N/A	N/A
3	Main Channel and Slough	0.027 (0.023-0.027)	N/A	N/A	N/A
1	Tributary	0.029	N/A	N/A	N/A
4	Interior Channel/Backwater	0.27 (0.025-0.029)	N/A	N/A	N/A
5	Floodplain - Open Field	0.035 (0.035-0.05)	N/A	N/A	N/A
7	Rock Structure	0.06	N/A	N/A	N/A
6	Island/Forested Area	N/A (0.038-0.05)	5	1.1	0.003

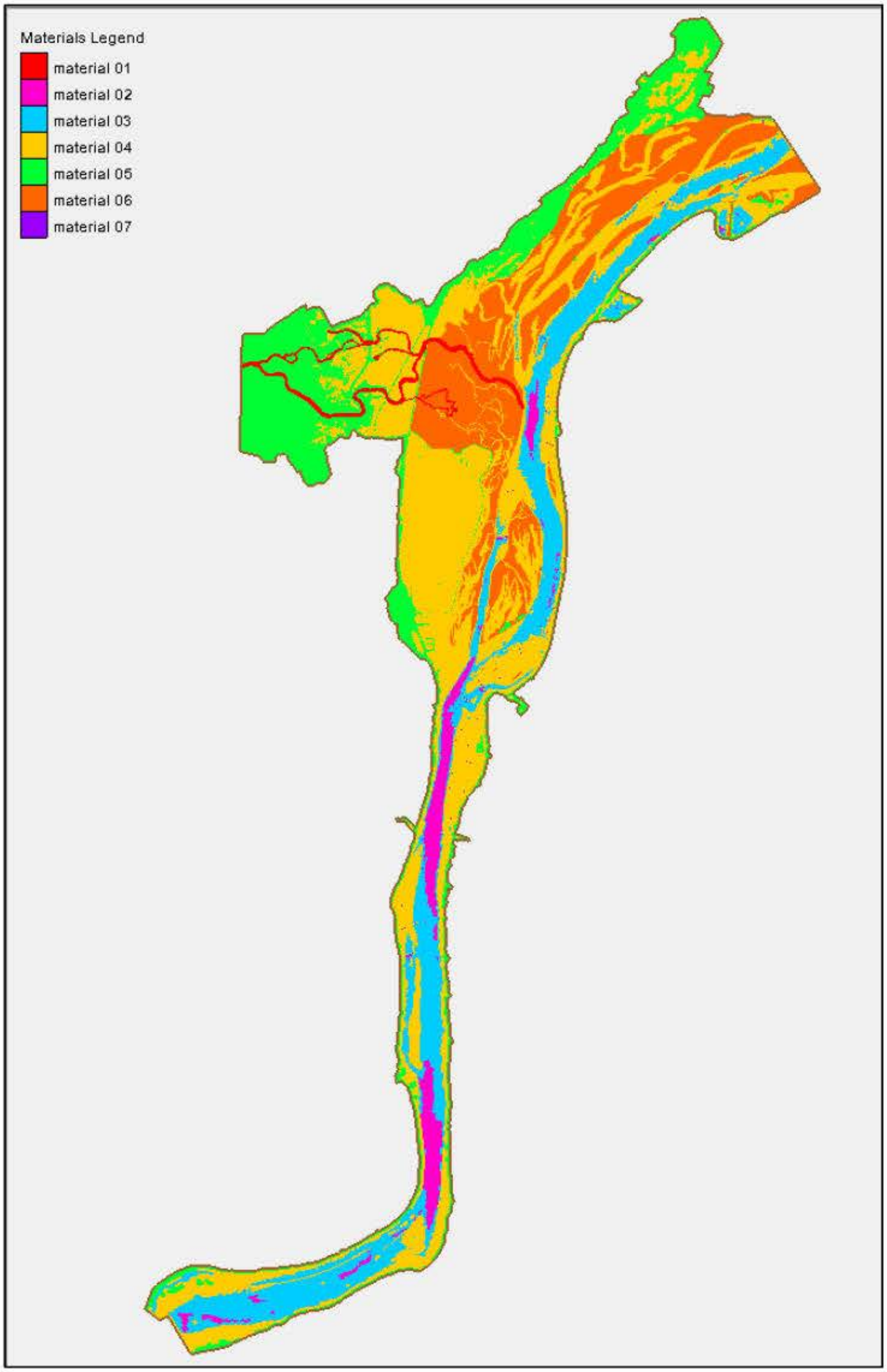

Figure H-15: AdH Material Type Map

The final boundary conditions used in the AdH model are displayed in Table H-11.

Table H-11: Boundary Conditions for Steamboat Island AdH model

Location	July 2017 Calibration (Q5)	September 2017 Calibration (Q50)
Mississippi River- Upstream	129,000 cfs	45,273
Wapsipinicon River- Upstream	5,590 cfs	510
Mississippi River- Downstream	570.7 NAVD 88	571.34 NAVD 88

Calibration of the AdH model began with comparing the computed discharges to the observed ADCP discharges collected in July and September 2017. Table H-12 compares the observed ADCP discharge at the different transects to the computed AdH discharges for the Q5 flows. Then a velocity comparison between the observed and computed was done. Figures H-16 through H-27 display the results of that comparison for the final calibration run. Figure H-28 shows the final calibrated velocity results for the existing conditions under a Q5 discharge. Velocity values are shown between 2 and 6 ft/s.

Table H-12: Summary of Q5 July 2017 ADCP (133k cfs) Observed vs. Computed Discharge

Transect	Description	Observed Discharge (cfs)	Computed Discharge (cfs)	% Error
Arc 16	US Grant Slough	4,422	2,667	40%
Arc 15	US Grant Slough	4,272	2,831	34%
Arc 14	US Grant Slough	5,569	2,602	53%
Arc 13	US Grant Slough	3,469	1,944	44%
Arc 12	Steamboat Island Cut Through Inlet	4,791	1,889	61%
Arc 11	Steamboat Island Cut Through Inlet	7,519	5,539	26%
Arc 08	US Steamboat Slough	35,690	32,628	9%
Arc 07	US Steamboat Slough	34,763	32,540	6%
Arc 05	Main Channel RM 505.4	92,589	95,176	3%
Arc 04	Main Channel RM 505.4	93,294	93,561	0%
Arc 01	Main Channel RM 502.6	131,541	132,425	1%
Arc 00	Main Channel RM 502.6	134,490	134,100	0%

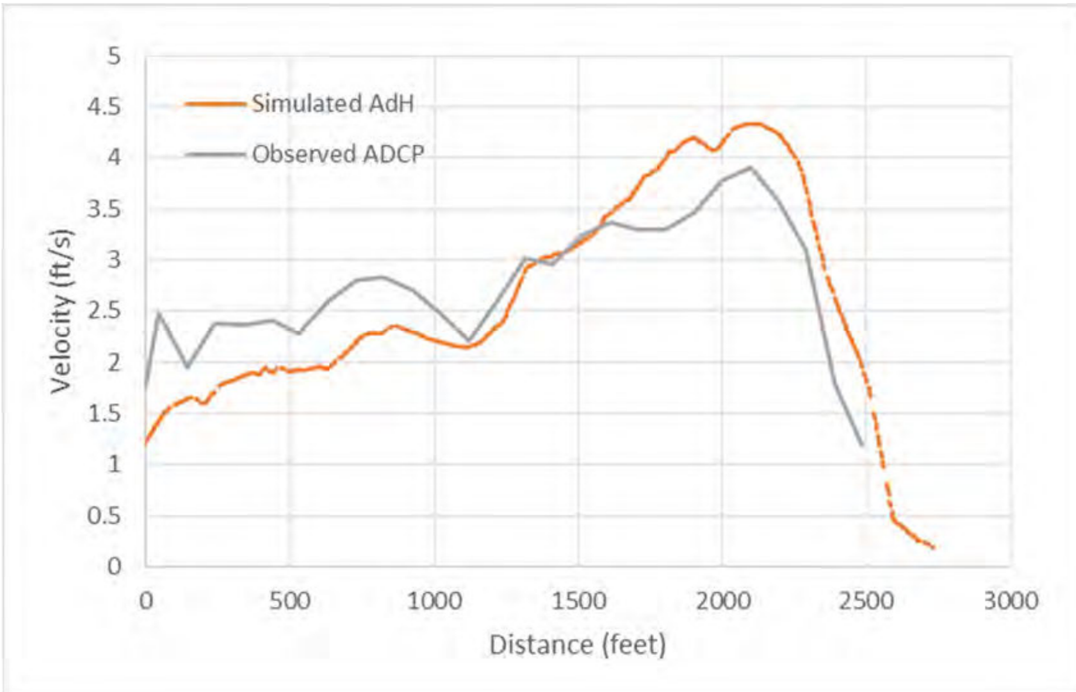

Figure H-16: Steamboat Island Model Simulated vs. Observed Velocities at Arc 00 Under Q5 Discharge

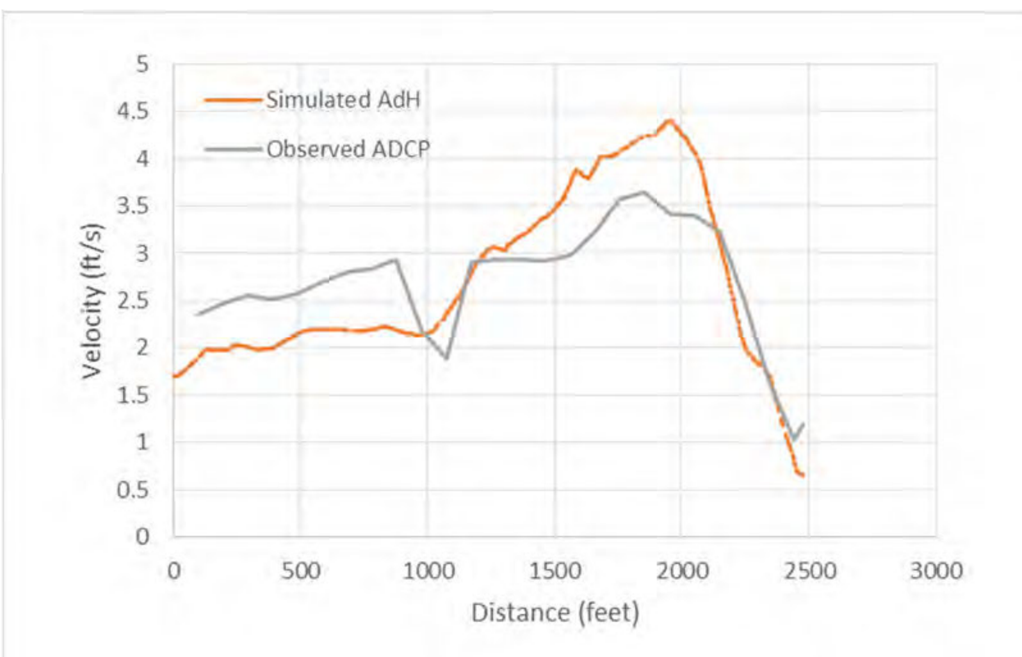

Figure H-17: Steamboat Island Model Simulated vs. Observed Velocities at Arc 01 Under Q5 Discharge

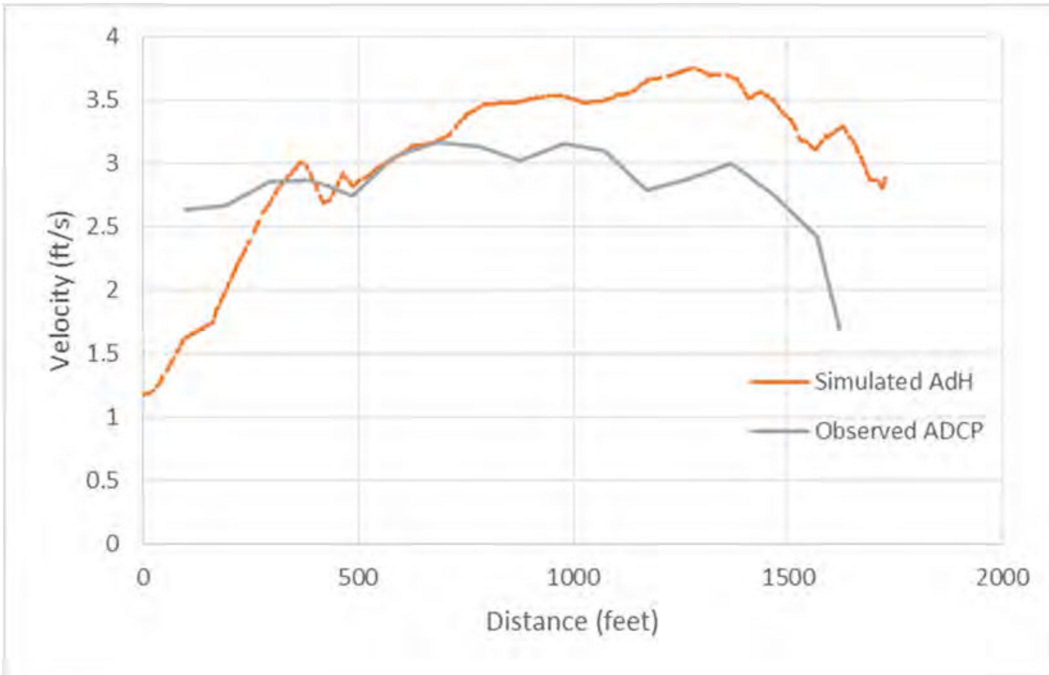

Figure H-18: Steamboat Island Model Simulated vs. Observed Velocities at Arc 04 Under Q5 Discharge

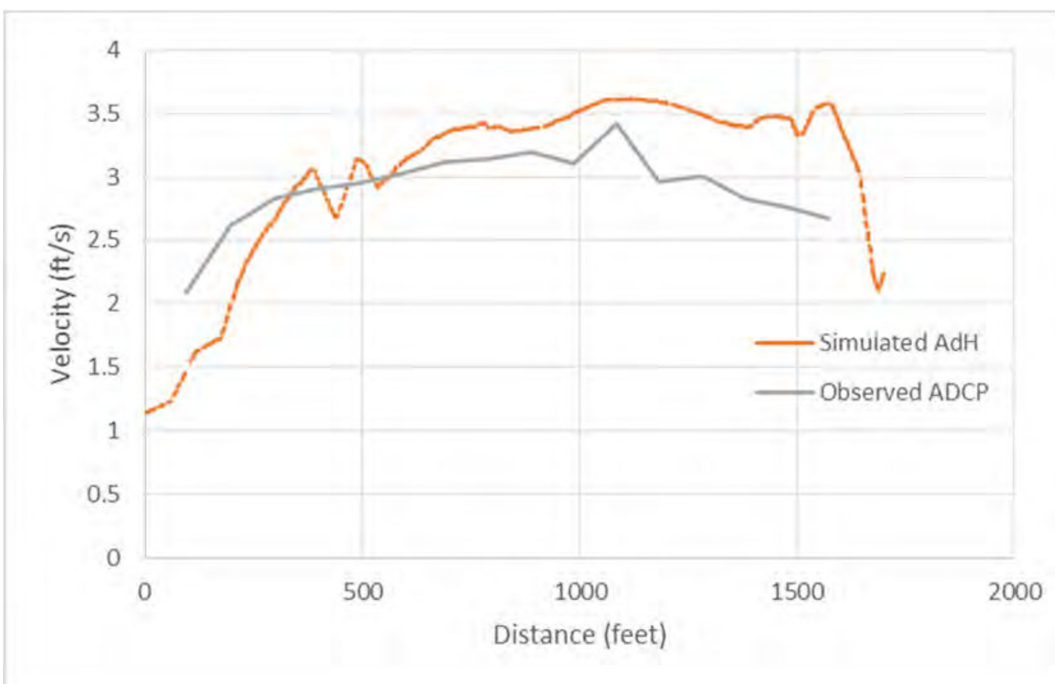

Figure H-19: Steamboat Island Model Simulated vs. Observed Velocities at Arc 05 Under Q5 Discharge

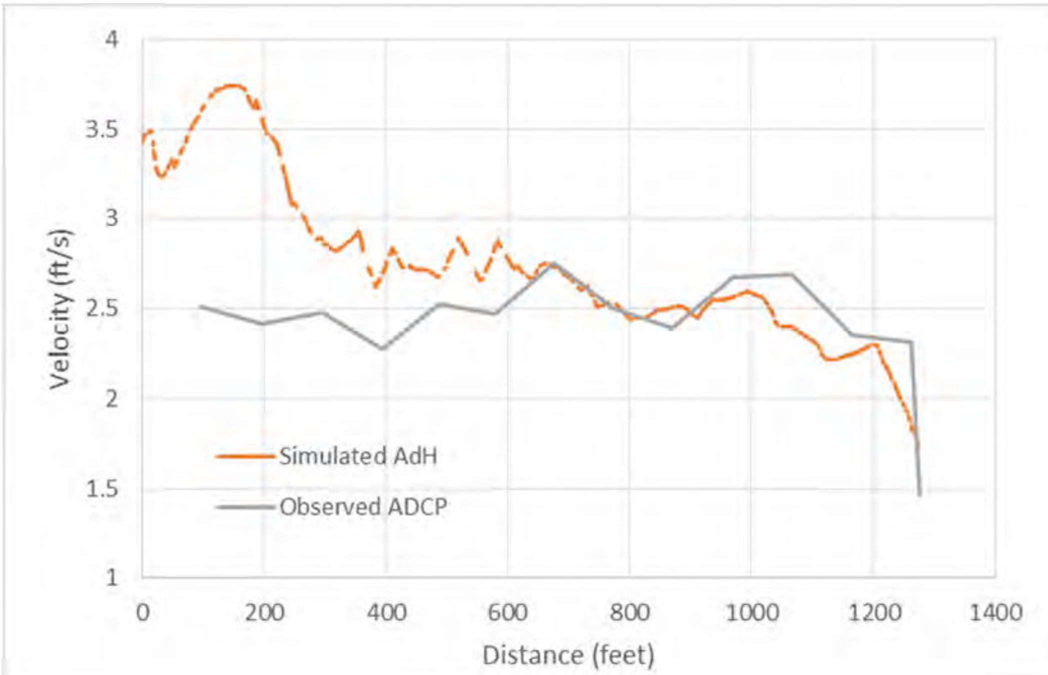

Figure H-20: Steamboat Island Model Simulated vs. Observed Velocities at Arc 07 Under Q5 Discharge

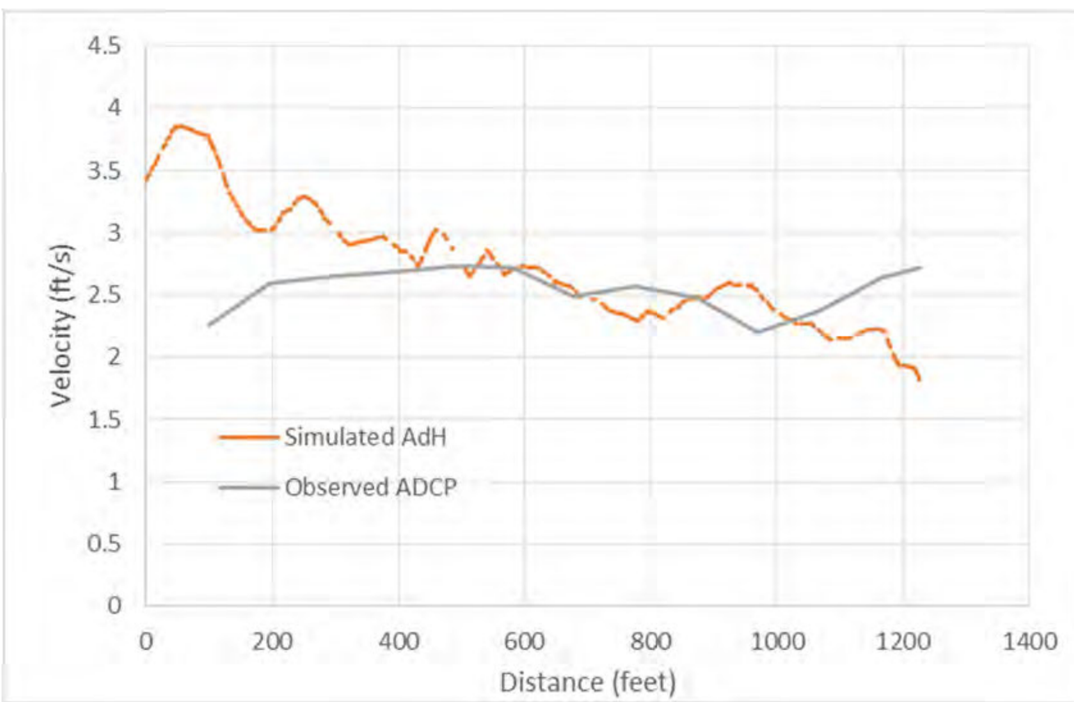

Figure H-21: Steamboat Island Model Simulated vs. Observed Velocities at Arc 08 Under Q5 Discharge

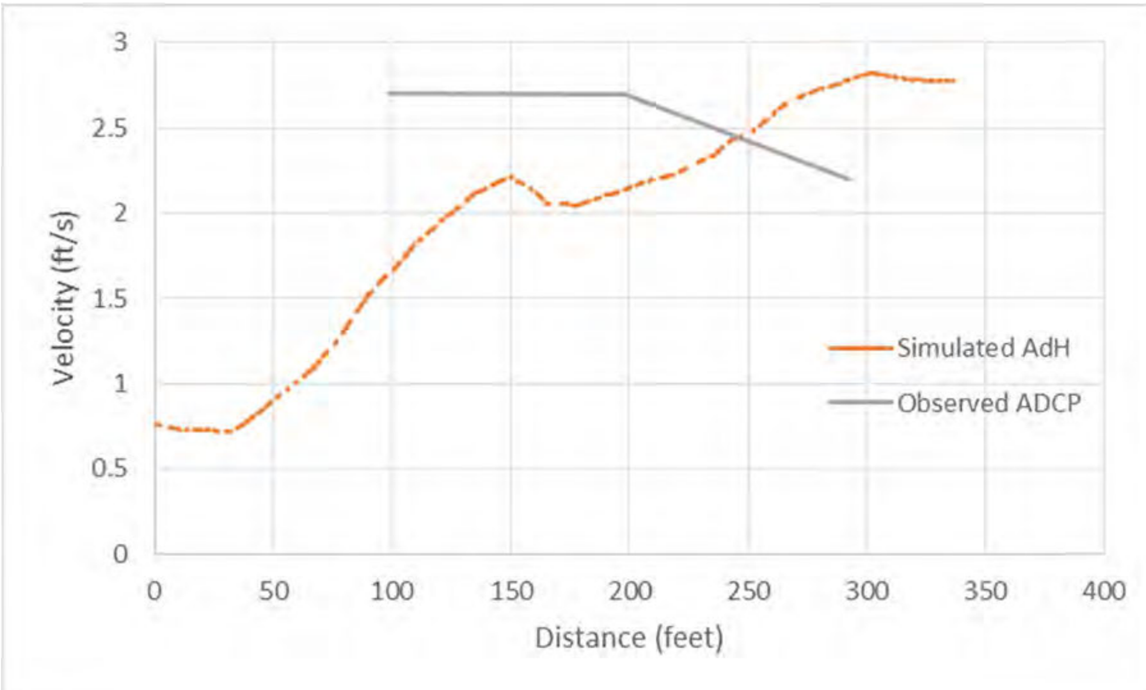

Figure H-22: Steamboat Island Model Simulated vs. Observed Velocities at Arc 11 Under Q5 Discharge

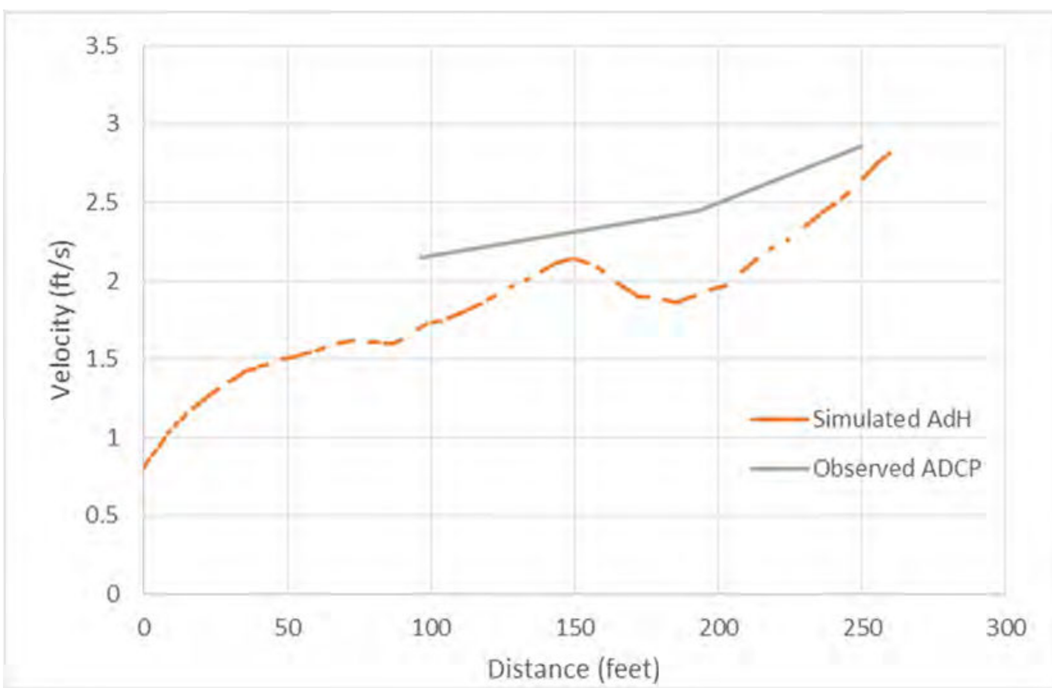

Figure H-23: Steamboat Island Model Simulated vs. Observed Velocities at Arc 12 Under Q5 Discharge

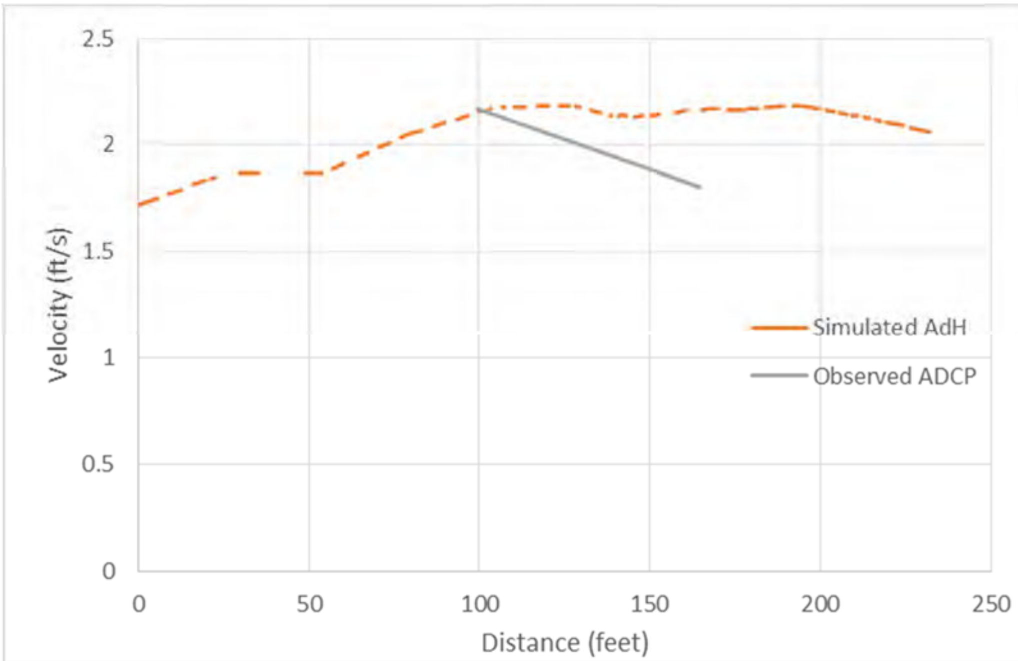

Figure H-24: Steamboat Island Model Simulated vs. Observed Velocities at Arc 13 Under Q5 Discharge

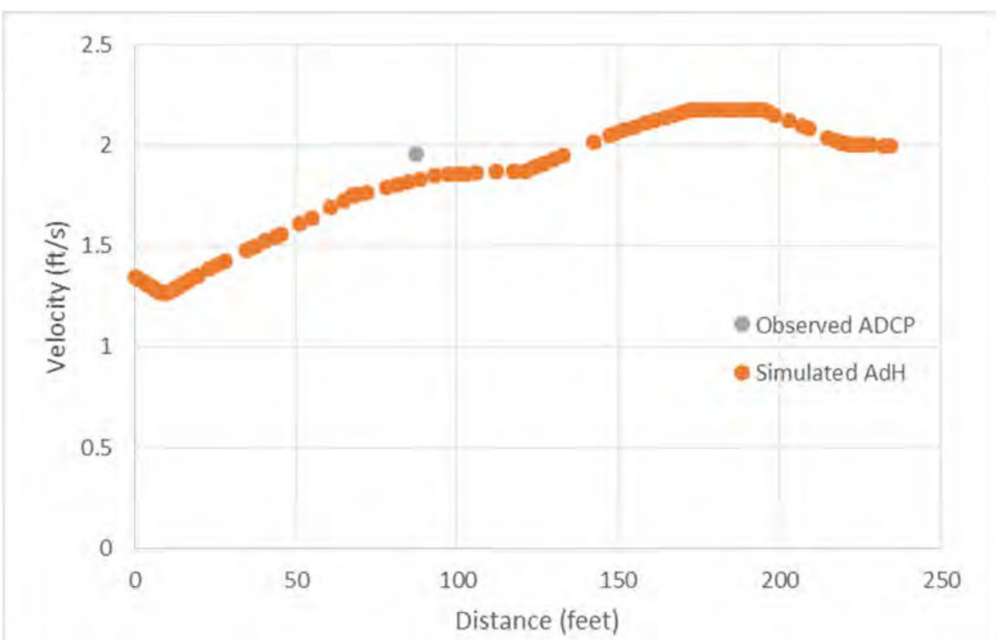

Figure H-25: Steamboat Island Model Simulated vs. Observed Velocities at Arc 14 Under Q5 Discharge

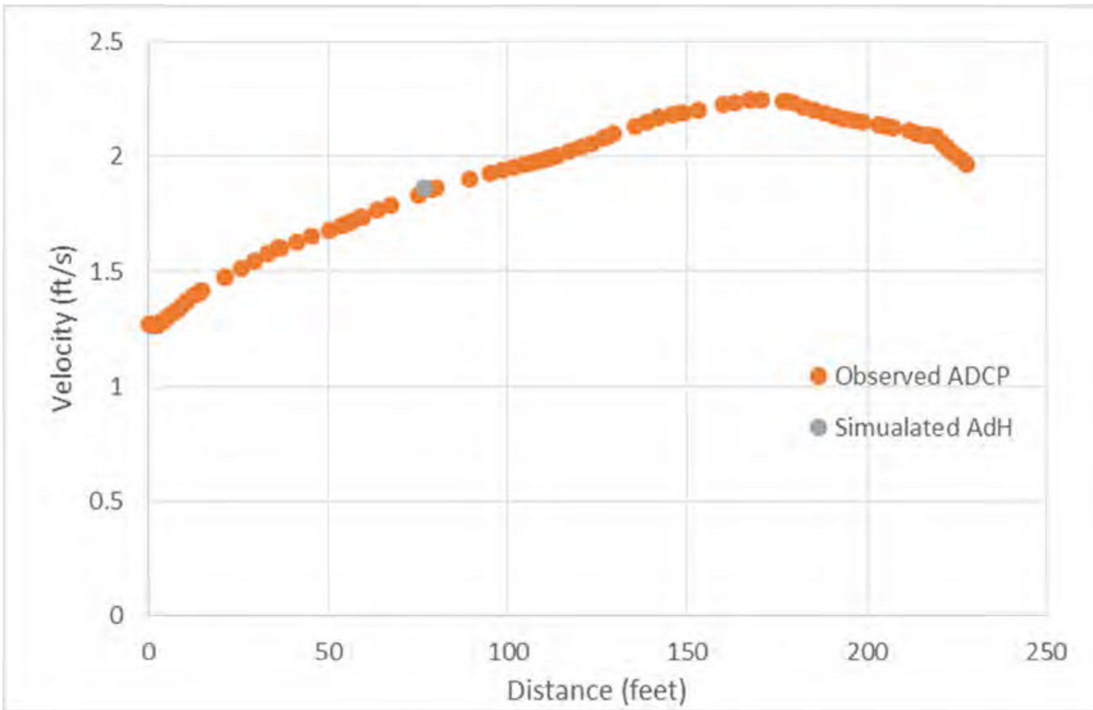

Figure H-26: Steamboat Island Model Simulated vs. Observed Velocities at Arc 15 Under Q5 Discharge

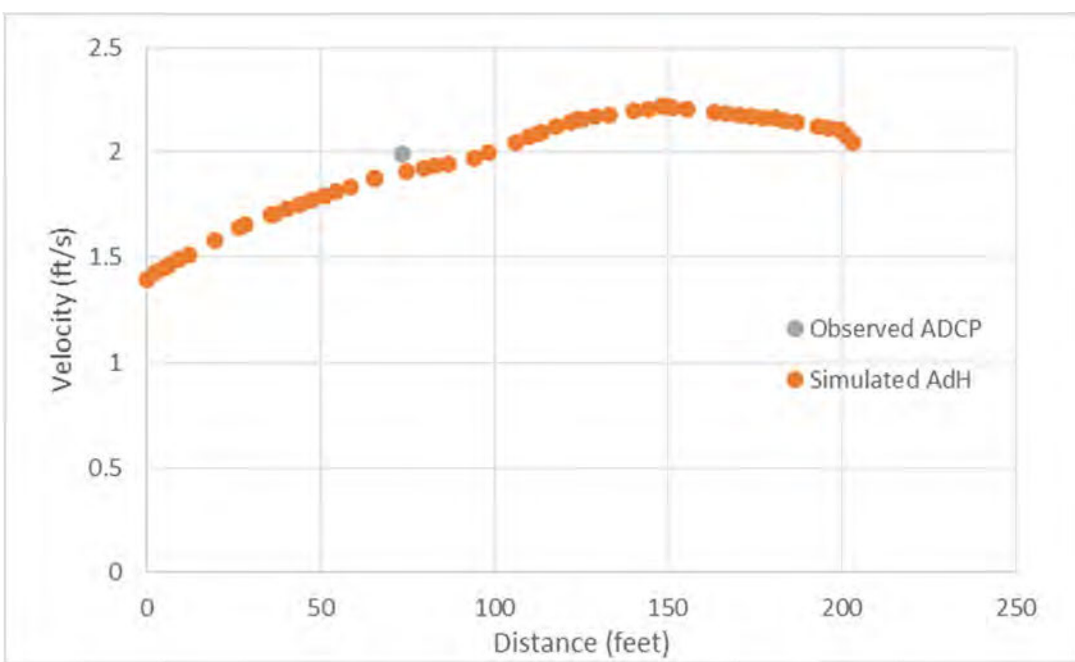

Figure H-27: Steamboat Island Model Simulated vs. Observed Velocities at Arc 16 Under Q5 Discharge

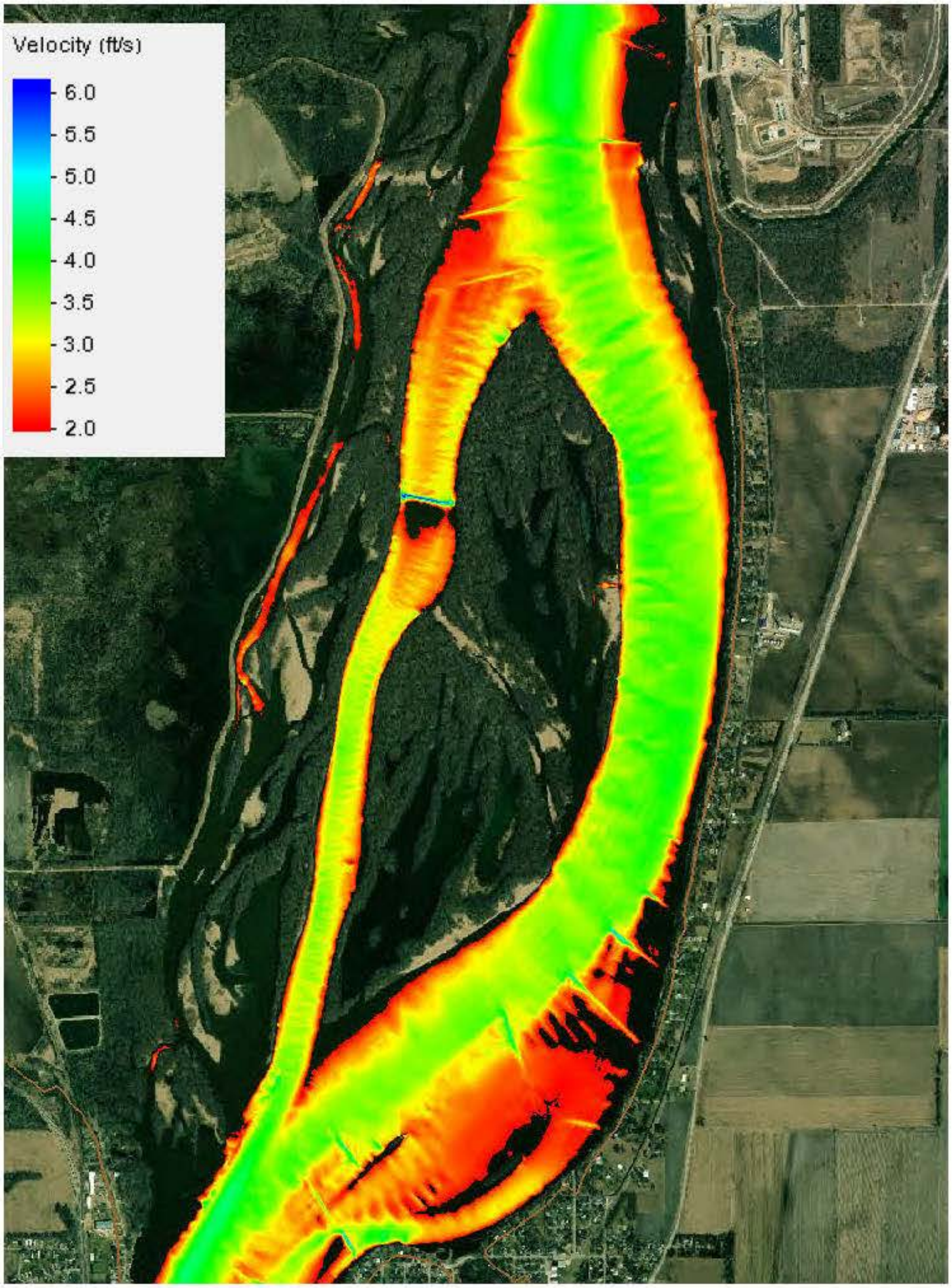

Figure H-28: Existing Condition Velocity Results for Q5 Discharge

Table H-13 compares the observed ADCP discharge at the different transects to the computed AdH discharges for the Q50 flows. Then a comparison between the observed and computed velocities at the transects was done. Figures H-29 through H-35 display the results of that comparison for the final calibration run.

Table H-13: Summary of Q50, September 2017 ADCP (45k cfs) Observed vs. Computed Discharge

Transect	Description	Observed Discharge (cfs)	Computed Discharge (cfs)	% Error
Arc 28	US Grant Slough	199	268	35%
Arc 27	No ADCP Data	NA	275	NA
Arc 23	Steamboat Slough	9,381	9,187	2%
Arc 19	Side Channel RM 511.2	3,015	2,105	30%
Arc 17	Outside Model Extents	42,258	-	NA
Arc 13	Wapsipinicon River Outlet	639	382	40%
Arc 09	US Steamboat Slough	9,527	9,805	3%
Arc 05	Main Channel RM 505.4	35,839	33,890	5%
Arc 01	Main Channel RM 502.7	45,398	45,329	0%

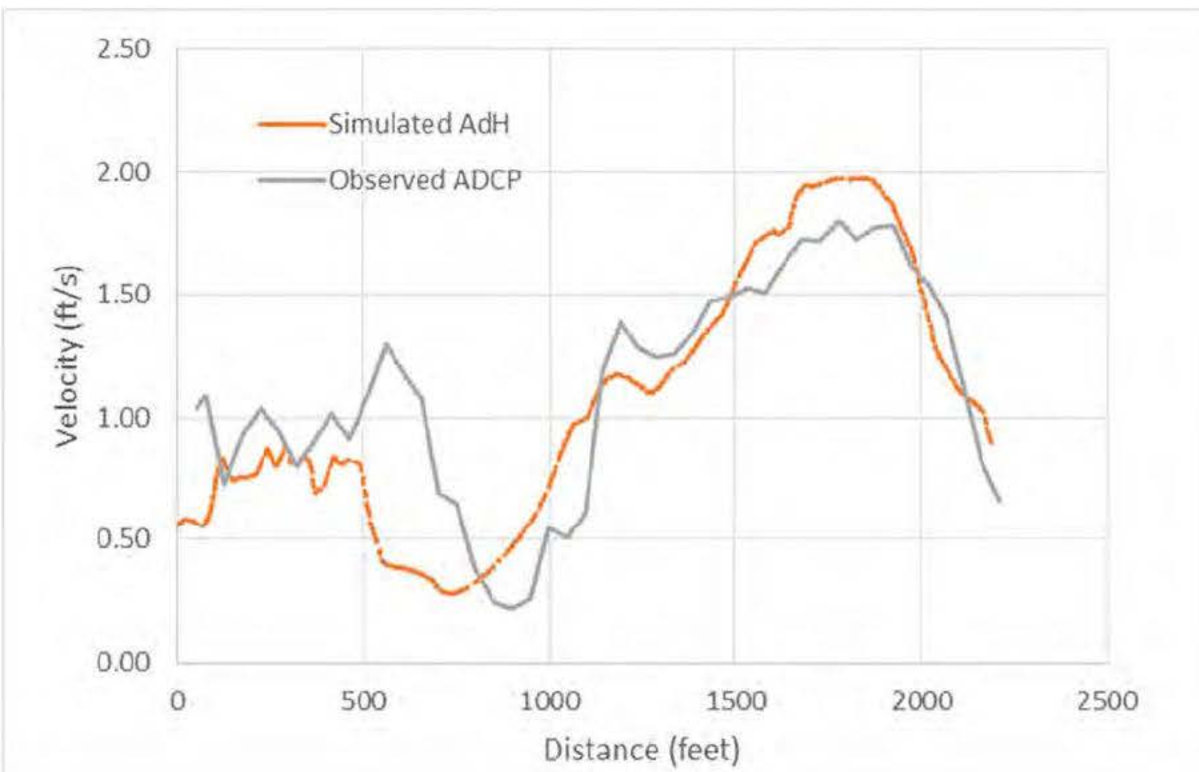

Figure H-29: Steamboat Island Model Simulated vs. Observed Velocities at Arc 01 Under Q50 Discharge

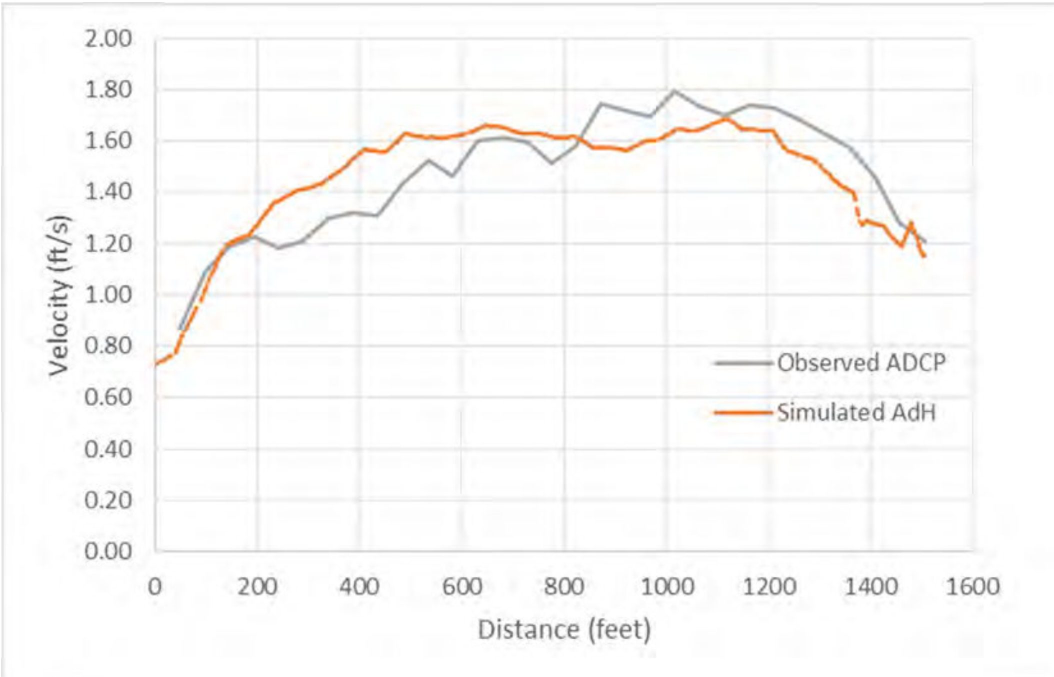

Figure H-30: Steamboat Island Model Simulated vs. Observed Velocities at Arc 05 Under Q50 Discharge

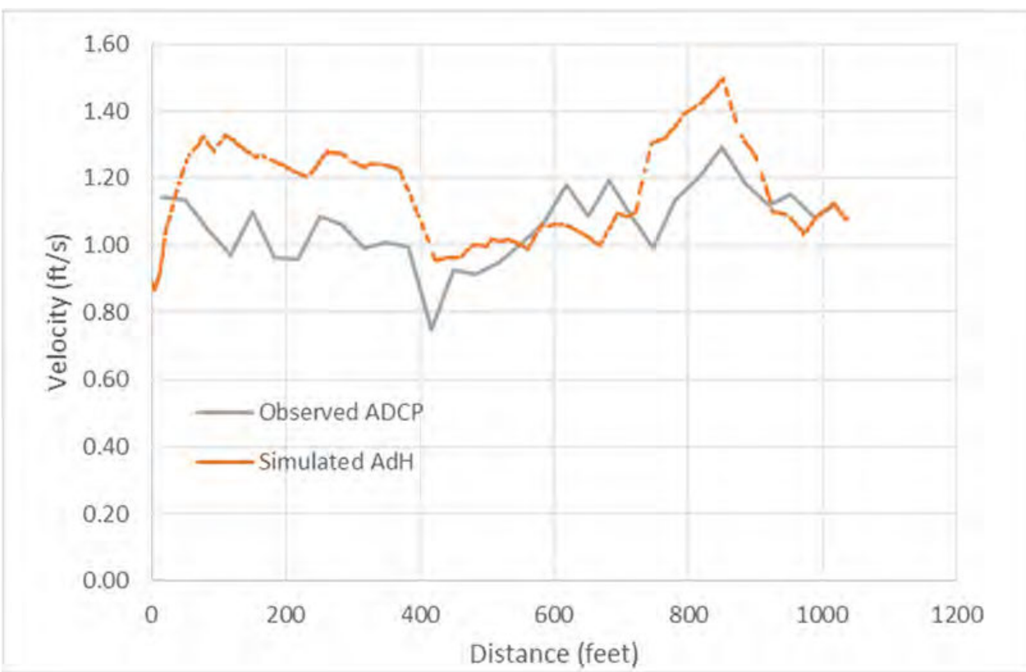

Figure H-31: Steamboat Island Model Simulated vs. Observed Velocities at Arc 09 Under Q50 Discharge

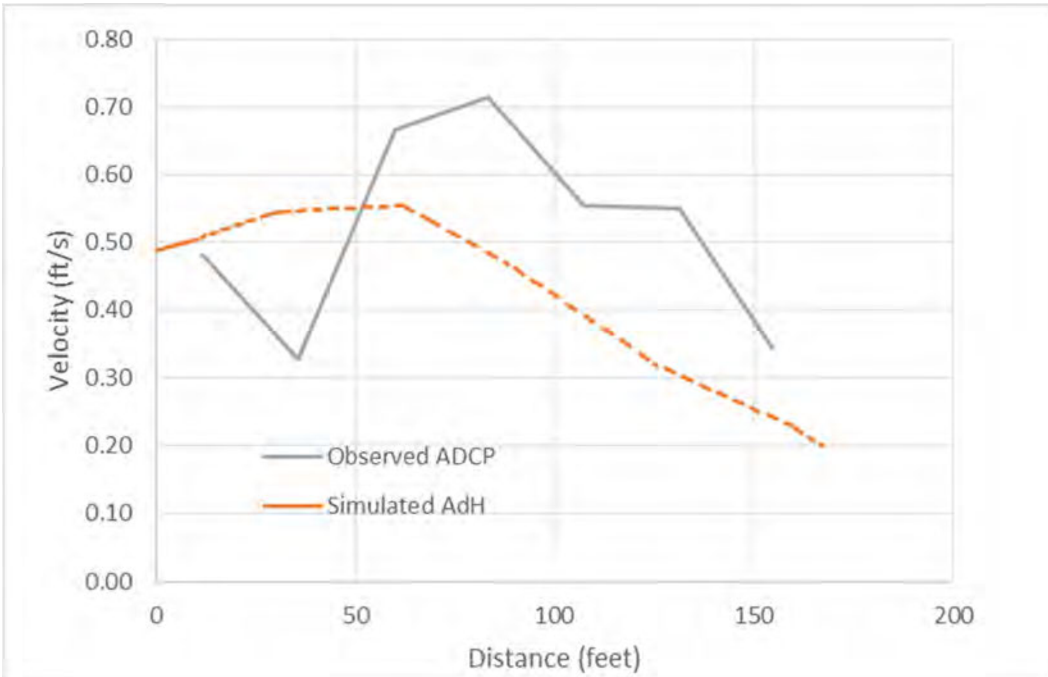

Figure H-32: Steamboat Island Model Simulated vs. Observed Velocities at Arc 13 Under Q50 Discharge

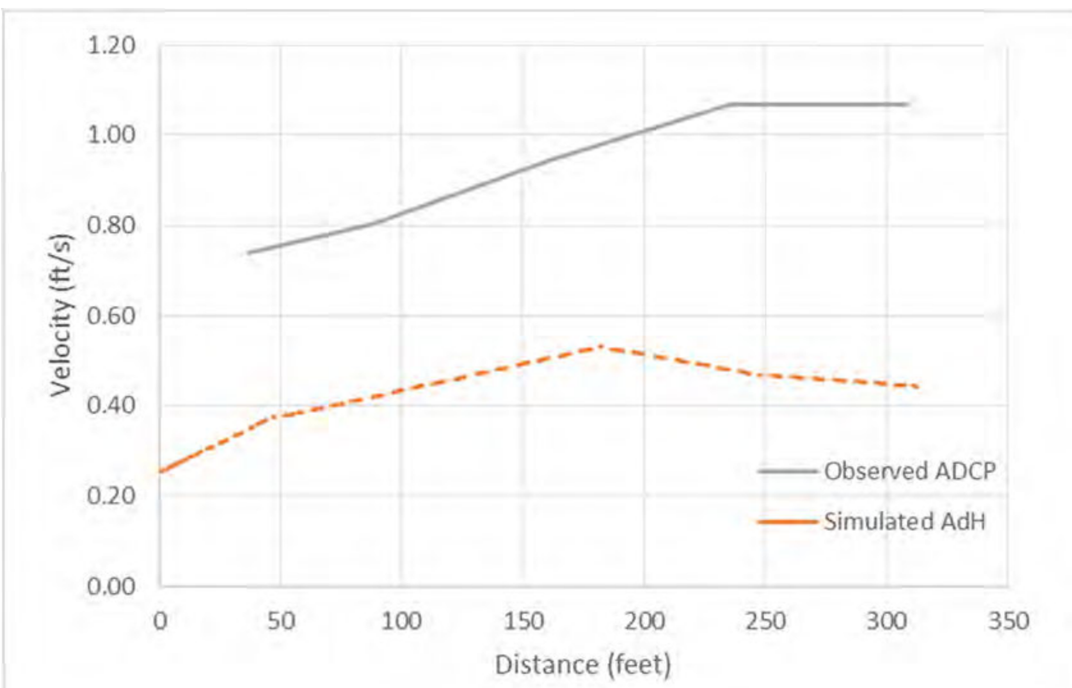

Figure H-33: Steamboat Island Model Simulated vs. Observed Velocities at Arc 19 Under Q50 Discharge

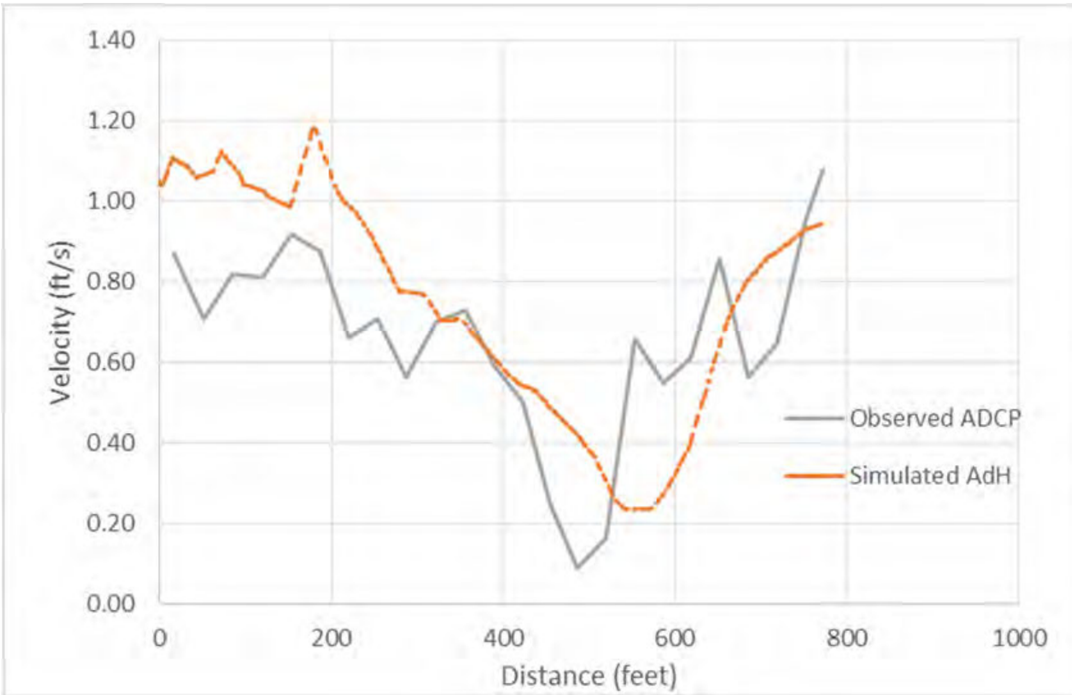

Figure H-34: Steamboat Island Model Simulated vs. Observed Velocities at Arc 23 Under Q50 Discharge

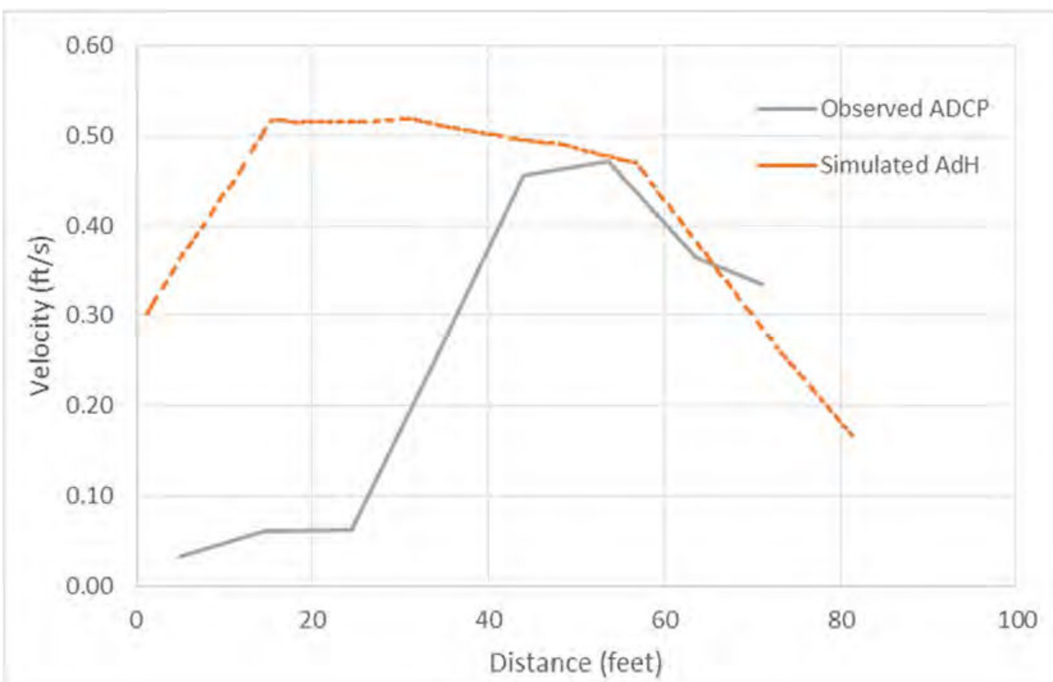

Figure H-35: Steamboat Island Model Simulated vs. Observed Velocities at Arc 28 Under Q50 Discharge

Figure H-36 shows the final calibrated velocity results for the existing conditions under a Q50 discharge. Velocity values are shown between 1 and 4 ft/s.

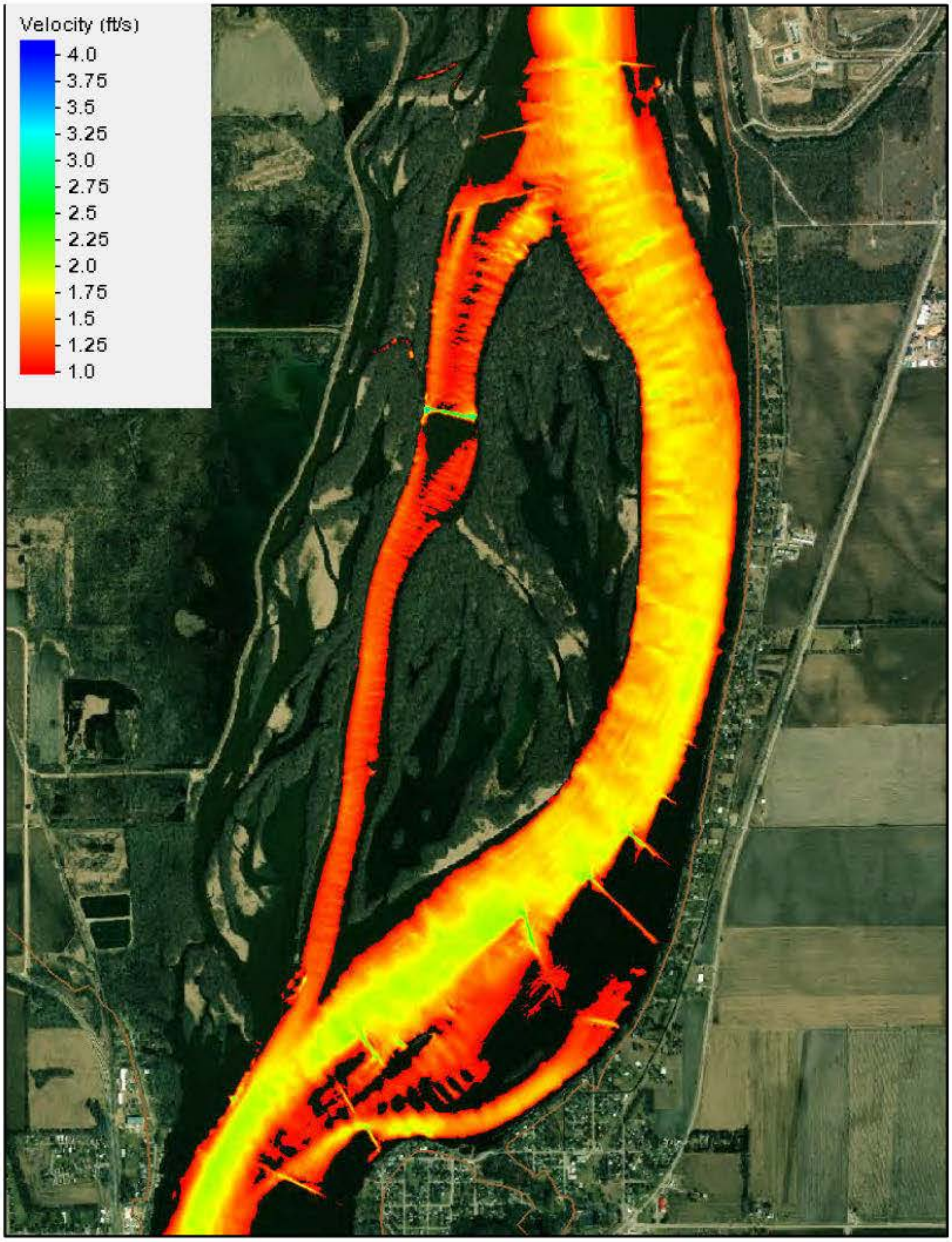

Figure H-36: Existing Condition Velocity Results for Q50 Discharge

A comparison of observed vs. simulated fall between the Camanche gage (RM 511.8) and L&D 14 (RM 493.3) was also completed in the calibration process. The downstream model boundary extends to RM 493.3 near L&D 14. The upstream model boundary only extends to RM 511.3, so in order to estimate a "simulated" water surface elevation the slope computed between RM 493.3 and the upstream model boundary was linearly extrapolated upstream to RM 511.8 (Camanche). The observed fall record was comprised of water surface elevations under the modeled discharge for the most recent 30-year POR. Values from December through February were removed in order to ensure ice-impacted stages were not included. Figure H-37 shows the results of this comparison.

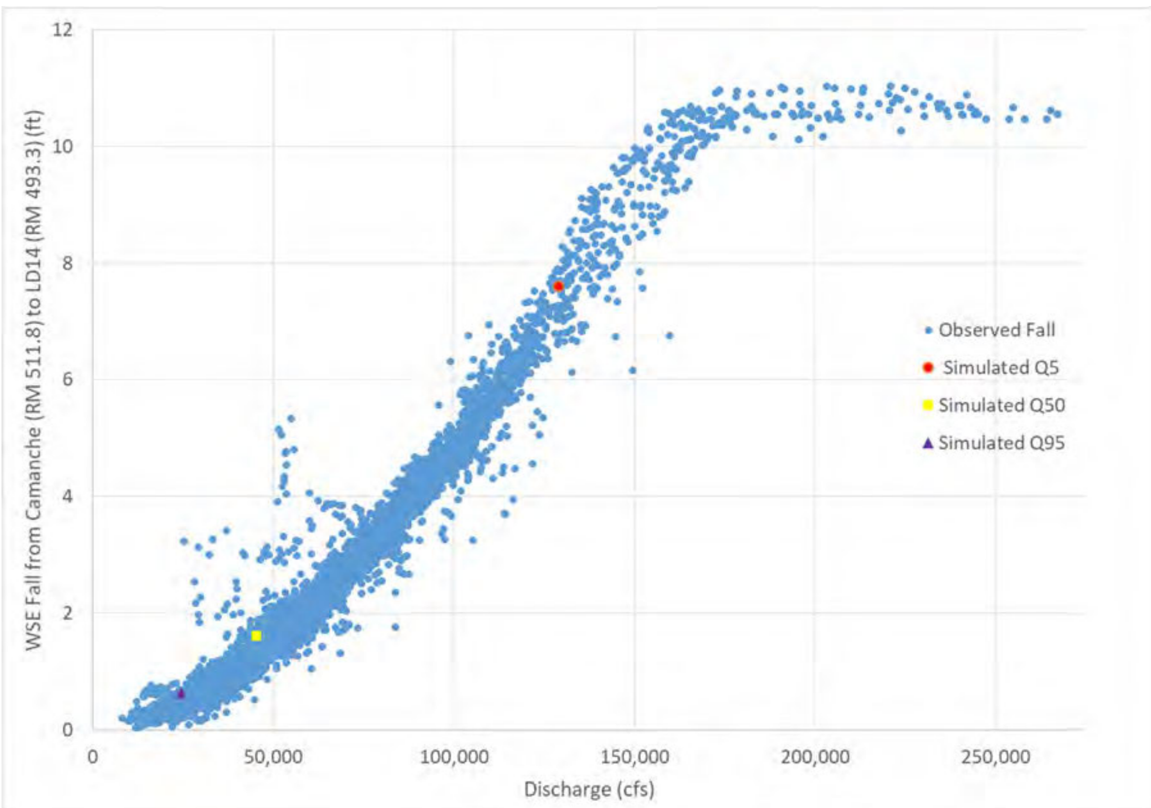

Figure H-37: Steamboat Island Model Simulated vs. Observed Fall from Camanche, Iowa to L&D 14

The 50% annual chance exceedance event (2-year) from the UMRSFFS water surface profile was compared with the Q5 event simulated by AdH within the river reach from RM 511.8 to RM 493.3 (Figure H-38). The UMRFFS flow at RM 511.6 was 131,000 cfs whereas the discharge at the upstream boundary condition of the AdH model was 129,000 cfs. The UMRFFS elevation at RM 493.4 near L&D 14 was 571.3 feet and the AdH boundary condition used was 570.7 feet based on observed conditions.

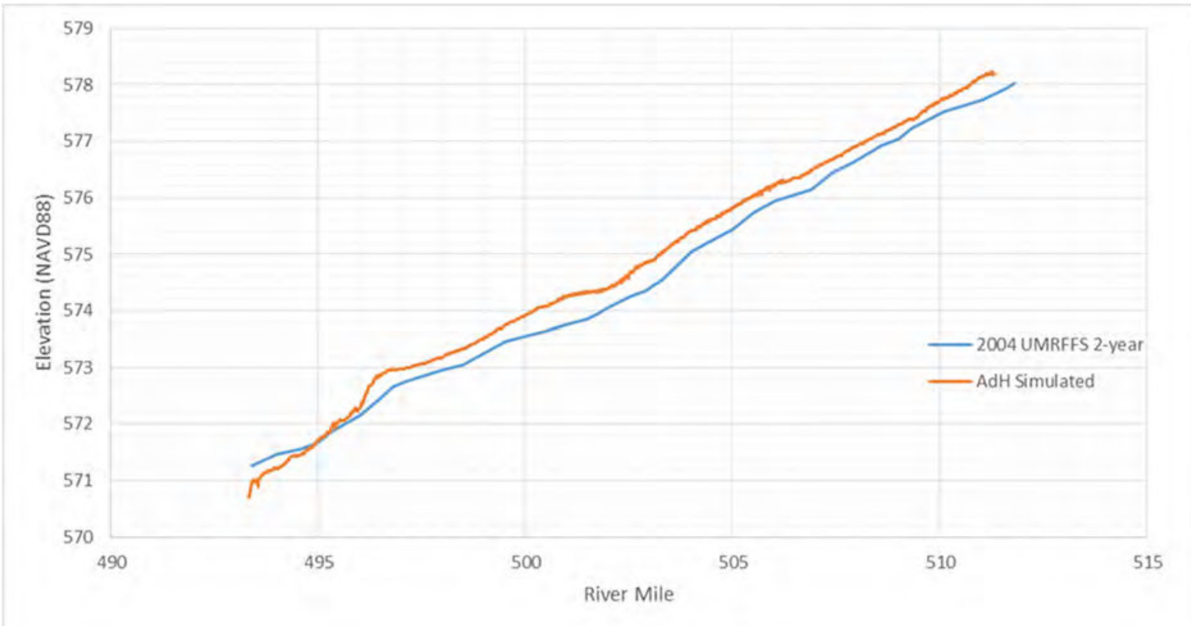

Figure H-38: Comparison of Water Surface Profiles Between AdH and UMRFFS

Calibration efforts in backwater areas presented challenges. Accurately simulating flow through Grant Slough was more difficult than capturing flow splits around Steamboat Island proper. Refining the mesh near the Wapsipinicon River and altering the Wapsipinicon River inflow were attempts to improve the calibration of the flows down Grant Slough. Computed discharges are very sensitive to geometry and because most of the backwater channels are relatively narrow, geometry errors are generally more significant due to the physical limitations of the data collection instruments. A larger difference between observed and simulated flows in Grant Slough and other small tributaries may be attributed to bathymetry data, model geometry or inaccuracy in ADCP collection in shallow areas. Most of the Project measures are located near the main channel and Steamboat Slough and the decision was made that the value added to the Project measure analyses by improving the model calibration does not warrant the required resources and time. Again, a comparative analysis will sufficiently identify the presence/absence of shear stress and water surface slope impacts. The AdH model extents are shown in Figure H-39.

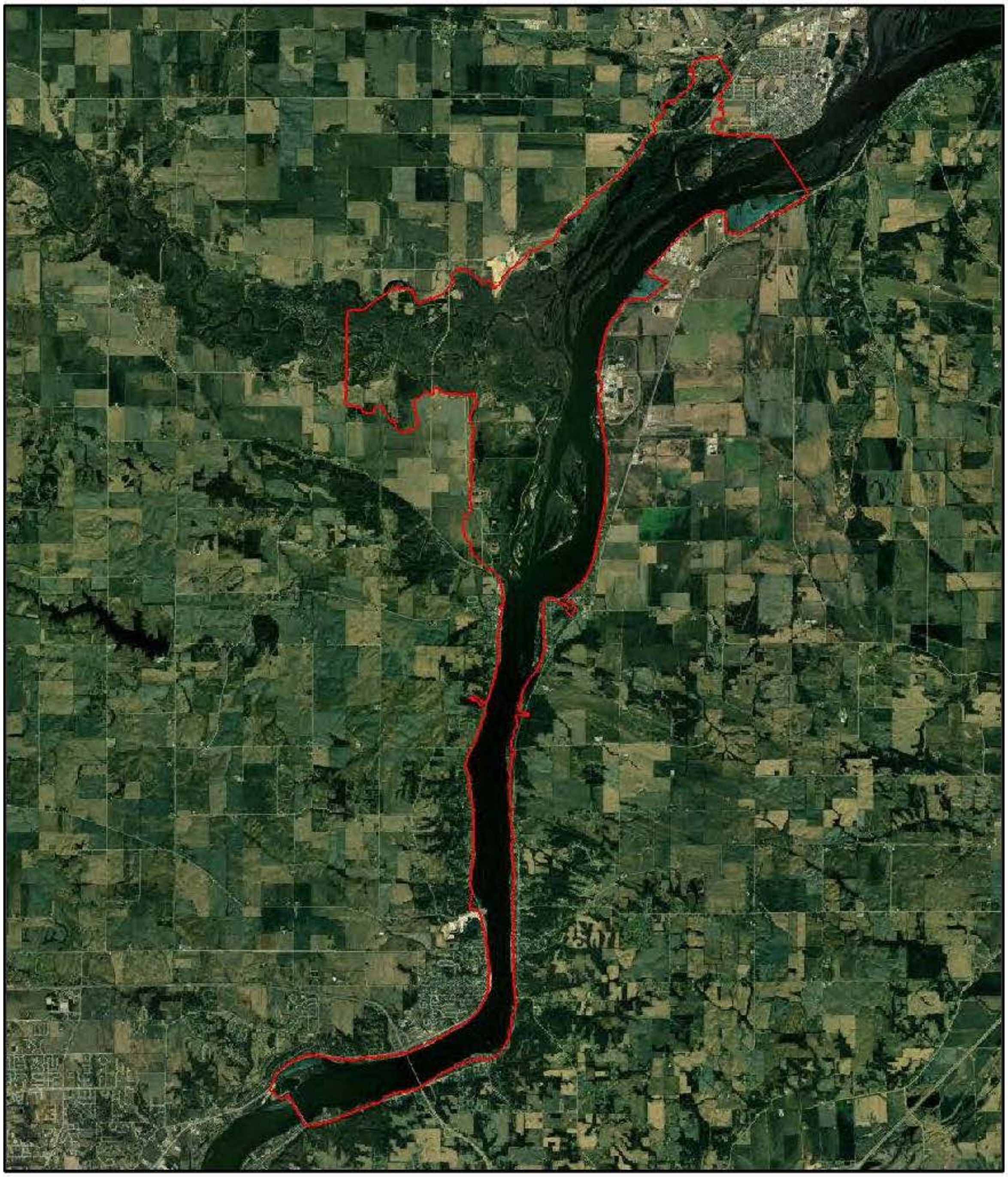

Figure H-39: Extent of the Steamboat Island AdH Model Mesh

VIII. PROJECT MEASURES EVALUATED

A. Aquatic Diversity Measures (Upper Lake, Lower Lake, NW Grant Slough Lake). Suitable habitat for fish will be incorporated into the Project through Aquatic Diversity measures that consist of excavation and dredging. The Aquatic Diversity measures are Upper Lake Aquatic Diversity, Lower Lake Aquatic Diversity, and NW Grant Slough Lake Aquatic Diversity. The average depth of the dredge cuts will be eight feet below flat pool with side slopes of 4H: 1V. Dredging depths were designed to accommodate the anticipated deposition rate discussed in Section VI: Sediment Deposition of 0.4 in/year (1 cm/year), or 1.6 feet of sediment over the 50 year design life. Rounded to 2 feet, this allowance for sedimentation was added to the target habitat depths to obtain the following design depths.

- Overwintering depth of 6 feet plus 2 additional feet for sediment deposition, 8 feet total below flat pool
- Connection depth of 4 feet plus 2 additional feet for sediment deposition, 6 feet total below flat pool
- Deep hole depth 8 feet plus 2 additional feet for sediment deposition, 10 feet total below flat pool

Additional design details of the Aquatic Diversity measures can be found in Appendix M, *Engineering Design.*

B. Topographic Diversity Measures. Floodplain forest diversity is dependent on river conditions during the growing season. Design analysis for floodplain forest measures as part of recent HREPs (Huron Island and Beaver Island) has focused on consecutive days of inundation duration during the growing season. Inundation duration thresholds for three different flood tolerance groups have been identified based on best professional judgment provided by PDT foresters and are summarized in Table H-14.

Table H-14: Consecutive Inundation Duration Tolerance Used for Floodplain Forest Design Criteria

Consecutive Inundation Duration Growing Season Tolerance (Days)	Tree Species
Minimal (25-35)	Green Hawthorne, Basswood, Dogwood, Elderberry, Persimmon, Kentucky Coffeetree, Honey Locust, Black Walnut[1], Shellbark Hickory[1]
Moderate (35-45)	Bur Oak, Northern Pecan, Pin Oak, Swamp White Oak, River Birch, Hackberry, American Elm and Green Ash
Maximum (45-55)	Buttonbush, Black Willow, Sand-bar Willow, Eastern Cottonwood, Silver Maple

[1] Black walnut and Shellbark Hickory are the least tolerant.

A lack of floodplain forest diversity (in species and age) is attributed to more frequent sustained high water levels that inhibit forest succession and result in mortality, among other stressors. Increasing elevations for tree plantings reduces inundation duration, increasing likelihood for forest succession and survival. Hydrologic Engineering Center-Ecosystem Function Model (HEC-EFM, USACE, 2013) was used to analyze the most recent 30-year stage record at the Camanche Gage (RM 511.8), to establish an upper limit and lower limit for tree planting, based on inundation duration tolerances of specific tree-species (Table H-14). Growing season (March 10 – November 5) stage values for the 1987-2016 period were analyzed to determine the annual maximum elevation that meets the specified consecutive inundation duration criteria, resulting in a single elevation value for each year in the analysis period. For example, the moderately tolerant species can withstand 35-45 consecutive days of inundation. For a given year EFM uses a moving 35-day window to identify each 35-day minimum values in a given year, for every year included in the period of record. Finally, an exceedance probability is specified, for example 50%, and EFM ranks each of the annual maximum values from the previous step and returns the value that has a 50% exceedance probability. The PDT forester indicated that if inundation duration exceeds the design threshold once every 4 years for minimally and moderately tolerant species and once every 2 years for maximum tolerant species, this would not result in increased mortality. Therefore, the 25% exceedance probability elevation is selected for minimally and moderately tolerant species, and the 50% exceedance probability elevation is selected for maximum tolerant species from the 30 annual values as the design elevation at the gage location. In order to determine this elevation at the Project location, an appropriate duration profile was used to linearly interpolate from the gage. The upper limit for the tree planting elevation was based upon the 25% exceedance probability for the minimally tolerant growing season inundation criteria (25-day inundation duration), which is 575.2 feet at RM 504.5. The lower limit for minimally tolerant tree planting elevation was determined based upon the 25% exceedance probability for the moderately tolerant growing season inundation criteria (35-day inundation duration), which is 574.6 feet at RM 504.5. As discussed later in this section and in Section X of this appendix, these elevations were further revised upward to provide greater resiliency based on consideration of observed 30-year trends.

During site visits in April and June 2018, the PDT forester provided GPS coordinates for desirable tree species that were located in the field, which were verified using data from a partial forest inventory of the Project area. The different desirable tree species were grouped into the inundation duration growing season tolerance categories and are shown in Figure H-40 with the HEC-EFM profiles. The profiles were created by taking the HEC-EFM results at the Camanche gage and the L&D 14 gage and then interpolating between the 2004 UMRSFFS 50% chance exceedance event, 20% chance exceedance event, or exceedance duration profiles. With a few exceptions, the trees identified in the site visits are located at or above the corresponding lower limit profiles. More tolerant species can occur in areas where less tolerant species grow, but less tolerant species are much less likely to grow at lower elevations.

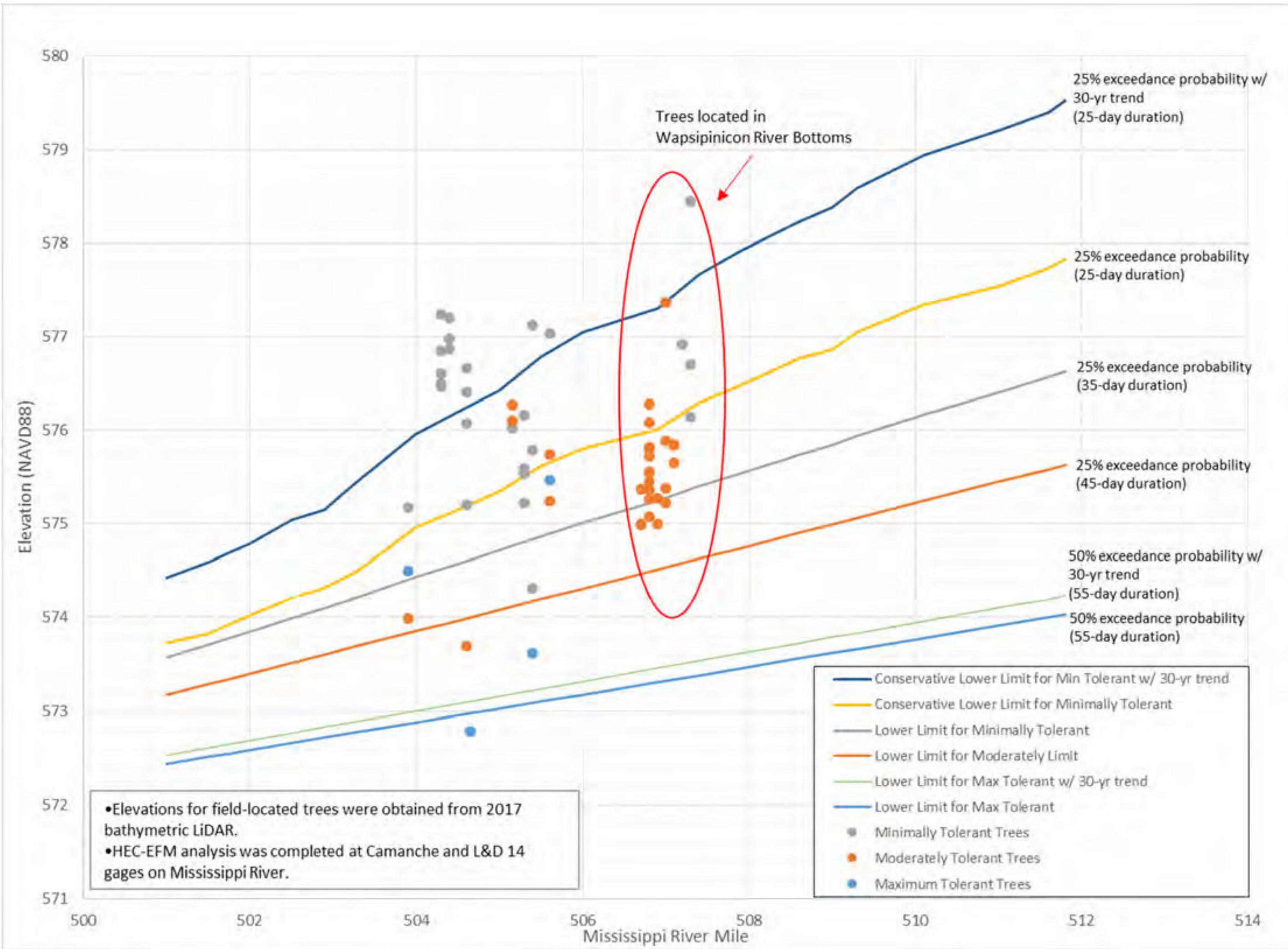

Figure H-40: HEC-EFM Profiles with Existing Desirable Tree Locations

As stated in USACE guidance document Engineering Construction Bulletin 2018-14, *Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects,* "Consideration of climate change in all current and future studies to reduce vulnerabilities and enhance resilience of our water resources infrastructure" is required (USACE, 2018). Although the current guidance requires only a qualitative assessment, upward trends in streamflow and stage suggest that increasing the design elevation for floodplain forest plantings will increase the likelihood of survival for the 50-year project life. Observed changes in HEC-EFM analysis results for 25-day, 35-day, 45-day, and 55-day inundation durations between the current 30-year analysis period (1987-2016) and the previous 30-year analysis period (1957-1986) were computed and linearly forecast to extrapolate potential 50-year future results. Table H-15 shows the HEC-EFM results at the Camanche gage, the forecast rate, and design elevations for floodplain forest plantings with this 30-year trend considered. When selecting the final design elevation, the PDT considered the design elevations based on the current 30-year period and the potential future 50-year design elevation, in addition to elevation and soil types for existing desirable species within the Project area. Ultimately, the PDT selected the extrapolated potential 50-year future elevation, due to the presence of desirable trees already located at or above this elevation (Figure H-40) and low risk of tree mortality associated with a high uncertainty in the "rate" of inundation duration increase.

Table H-15: Design Metrics at Camanche Gage, RM 511.8 (Elevations in MSL 1912 unless noted)

	1957-1986 POR	1987-2016 POR	Change Over 30-yr Period (ft)	"Rate" (ft/yr)	50-yr Future	Revised Design	Elevation at RM 504.5 (NAVD 88)
50% EFM 55-day	574.7	574.8	0.1	0.003	0.167	575.0	**573.1**
Lower limit for maximum tolerant trees (scrub-shrub)-55-day inundation duration elevation exceeded 1/2 years (50% Exceedance Probability).							
25% EFM 45-day	576.7	576.4	-0.3	Maintain current elevation		576.4	**574.0**
Lower limit for moderately tolerant trees - 45-day inundation duration elevation exceeded 1/4 years (25% Exceedance Probability).							
25% EFM 35-day	576.8	577.4	0.6	0.019	0.968	578.4	**575.1**
Lower limit for minimally tolerant trees - 35-day inundation duration elevation exceeded 1/4 years (25% Exceedance Probability).							
25% EFM 25-day	577.6	578.6	1.0	0.033	1.667	580.3	**576.2**
Conservative lower limit for minimally tolerant trees - 25-day inundation duration elevation exceeded 1/4 years (25% Exceedance Probability).							

1. Topographic Diversity Measure (Upper Steamboat Island Head). The USI head has experienced significant erosion over time. USI Head will be restored with fill material to an elevation of 576.2 feet (based on EFM results) with rock protection at the 50% chance exceedance event (2-year) elevation of 575.3 feet. This measure was included in the AdH model to determine if there were any mussel impacts and for riprap sizing. More information on the HREP mussel model can be found in Appendix M, *Engineering Design,* Attachment C. CHANLPRO was used to size required stone for the bankline protection design based upon the side slope, flow depth and velocity under 50% and 1% chance exceedance conditions (Maynord et. al., 1998). Velocities for the 50% and 1% chance exceedance were 4.7 ft/s and 5.2 ft/s, respectively. A specific weight of 165 lb/cf and a design factor of safety of 1.1 resulted in a D100 of 36 lbs for both conditions. However, given ice flow durability considerations, a standard Iowa Class B gradation of top size of 650 lbs was selected. This recommendation can be revisited during the implementation phase.

2. Topographic Diversity Measure (West SE Island). The West SE Island has also experienced a significant amount of erosion. The West SE Island will be restored with fill material to an elevation of 576.2 feet (based on EFM results) with rock protection at the 50% chance exceedance event (2-year) elevation of 575.3 feet. This measure was included in the AdH model to determine where riprap placement would be needed as protection. The velocity and shear stress output from the AdH model for the 2-year event were evaluated in this analysis but more emphasis was given to velocity. Figure H-41 displays the velocity output near the West SE Island with the outline of the proposed design.

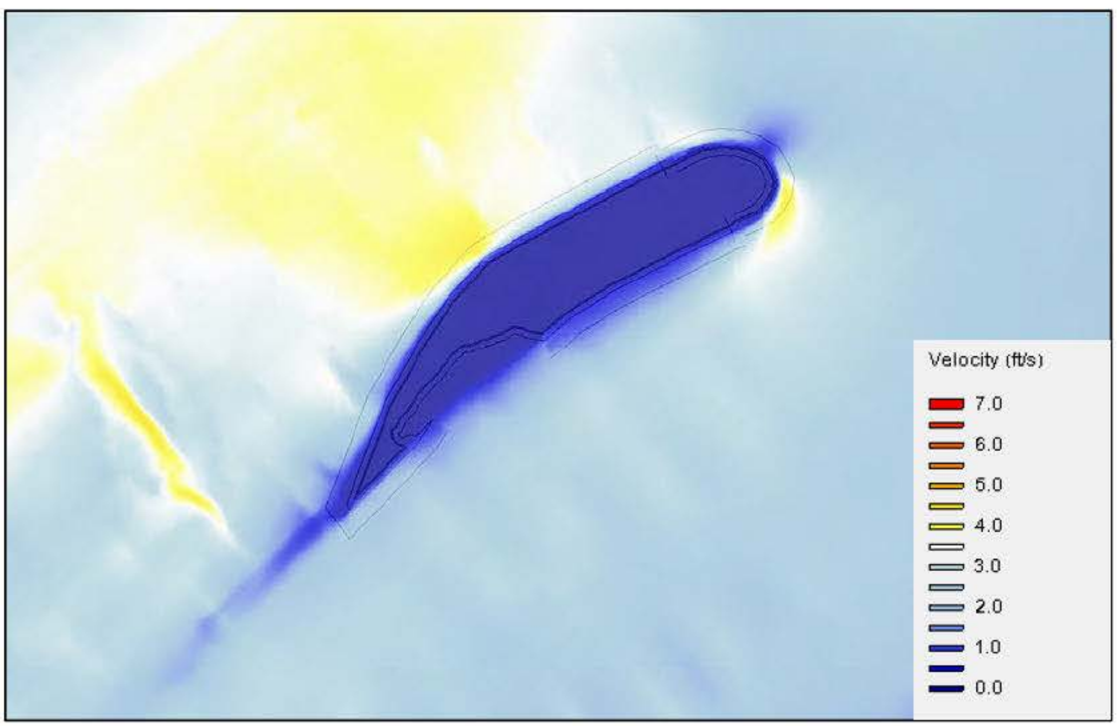

Figure H-41: 2-year AdH Velocity Output

Table 2-5 in Engineer Manual 110-2-1601, *Hydraulic Design of Flood Control Channels*, provides the max permissible velocities for different channel materials and is shown (Figure H-42, USACE, 1994). Table 2-5 was utilized to access whether or not rock protection was needed around the island. The permissible velocity for the material specific to the Project was 5 ft/s. Due to velocities near 5 ft/s at the head of the island (4.4 ft/s) and near the midpoint of the western side (4.3 ft/s), rock protection is recommended at those locations.

Table 2-5
Suggested Maximum Permissible Mean Channel Velocities

Channel Material	Mean Channel Velocity, fps
Fine Sand	2.0
Coarse Sand	4.0
Fine Gravel[1]	6.0
Earth	
Sandy Silt	2.0
Silt Clay	3.5
Clay	6.0
Grass-lined Earth (slopes less than 5%)[2]	
Bermuda Grass	
Sandy Silt	6.0
Silt Clay	8.0
Kentucky Blue Grass	
Sandy Silt	5.0
Silt Clay	7.0
Poor Rock (usually sedimentary)	10.0
Soft Sandstone	8.0
Soft Shale	3.5
Good Rock (usually igneous or hard metamorphic)	20.0

Notes:
1. For particles larger than fine gravel (about 20 millimetres (mm) = 3/4 in.), see Plates 29 and 30.
2. Keep velocities less than 5.0 fps unless good cover and proper maintenance can be obtained.

Figure H-42: Suggested Maximum Permissible Velocities From EM 1110-2-1601

Using AdH output for the 2-year event, the velocity and depth were used to calculate the bed shear stress. In the calculation of shear stress, an assumption of Manning's n of 0.013, which represents a roughness height of about 1.5 mm, was used. The shear stress output is shown in Figure H-43.

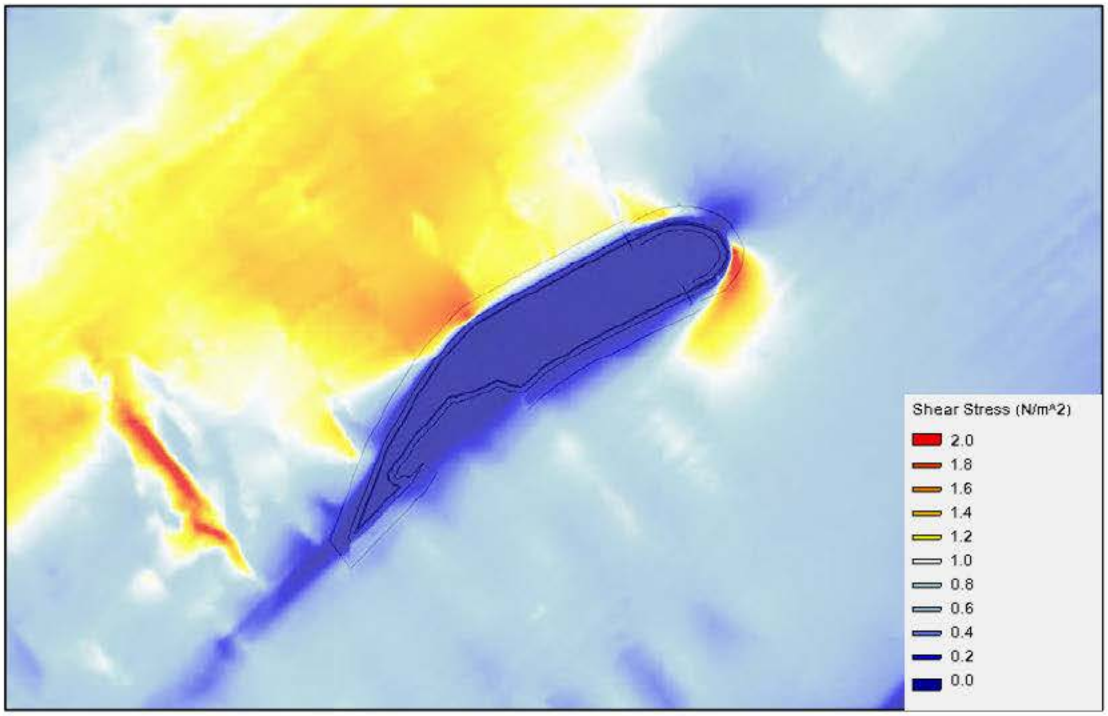

Figure H-43: 2-year AdH Shear Stress Output

Initially, the critical shear bed shear stress values used to determine the mobility of the sediment from the island was from the USGS Scientific Investigations Report 2008-5093 (Table H-16, Berenbrock & Tranmer, 2008). Using the critical shear stress range of 0.194-0.27 N/m^2 for medium sand, the results from AdH show that most of the area around the island would be above that critical threshold. Even though shear stress values may be greater than the critical bed shear stress for sediment mobility, it doesn't necessarily mean that the particles would move. There may be some particles that move, but only locally. The likelihood of transport/erosion is a function of many conditions including the duration which critical shear stress values are exceeded and by how much critical shear stress is exceeded. Other factors such as the material type and construction methods could limit the sediment mobility. Due to these reasons, shear stress was considered in the rock protection recommendation but more emphasis was given to the velocity criteria.

Table H-16: USGS Scientific Investigations Report 2008-5093 Table of Values

Particle classification name	Ranges of particle diameters		Shields parameter (dimensionless)	Critical bed shear stress (τ_c) (N/m^2)
	φ	mm		
Coarse cobble	-7 – -8	128 – 256	0.054 – 0.054	112 – 223
Fine cobble	-6 – -7	64 – 128	0.052 – 0.054	53.8 – 112
Very coarse gravel	-5 – -6	32 – 64	0.05 – 0.052	25.9 – 53.8
Coarse gravel	-4 – -5	16 – 32	0.047 – 0.05	12.2 – 25.9
Medium gravel	-3 – -4	8 – 16	0.044 – 0.047	5.7 – 12.2
Fine gravel	-2 – -3	4 – 8	0.042 – 0.044	2.7 – 5.7
Very fine gravel	-1 – -2	2 – 4	0.039 – 0.042	1.3 – 2.7
Very coarse sand	0 – -1	1 – 2	0.029 – 0.039	0.47 – 1.3
Coarse sand	1 – 0	0.5 – 1	0.033 – 0.029	0.27 – 0.47
Medium sand	2 – 1	0.25 – 0.5	0.048 – 0.033	0.194 – 0.27
Fine sand	3 – 2	0.125 – 0.25	0.072 – 0.048	0.145 – 0.194
Very fine sand	4 – 3	0.0625 – 0.125	0.109 – 0.072	0.110 – 0.145
Coarse silt	5 – 4	0.0310 – 0.0625	0.165 – 0.109	0.0826 – 0.110
Medium silt	6 – 5	0.0156 – 0.0310	0.25 – 0.165	0.0630 – 0.0826
Fine silt	7 – 6	0.0078 – 0.0156	0.3 – 0.25	0.0378 – 0.0630

The locations of recommended rock placement on the West SE Island due to hydrodynamic conditions are shown in Figure H-44. The approximate length along the western side is 200 feet and approximately 375 feet at the head of the island. This is a feasibility design recommendation and the final design placement locations could be refined when the shape and angle of the island has been finalized and should be coordinated with H&H.

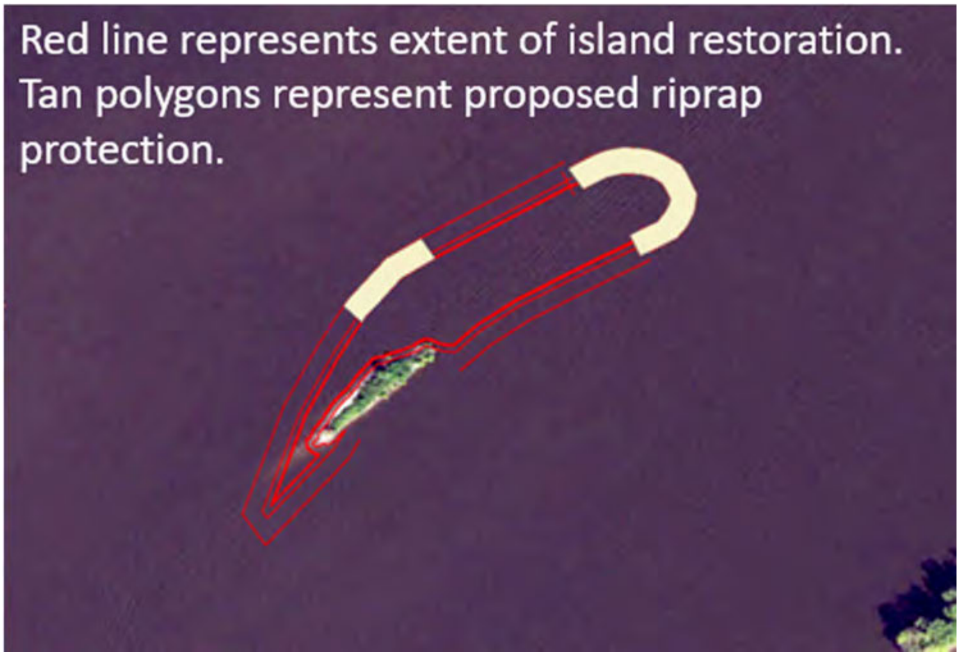

Figure H-44: Recommended Rock Placement Locations

Wind-driven waves are also not likely to be the cause. Vessel position density data do not support erosion due to navigational mooring or wave-action. It is likely that sustained high water results in soil saturation and subsequent felled trees are impacting the bankline stability. CHANLPRO was used to size required stone for the bankline protection design based upon the side slope, flow depth and velocity under 50% and 1% chance exceedance conditions. Velocities for the 50% and 1% chance exceedanace were 4.4 ft/s and 4.2 ft/s, respectively. A specific weight of 165 lb/cf and a design factor of safety of 1.1 resulted in a D100 of 36 lbs for both conditions. However, given ice flow durability considerations, a standard Iowa Class B gradation of top size of 650 lbs was selected. This recommendation can be revisited during the implementation phase.

3. **Topographic Diversity Measure (Grade Control Structure).** The GCS located at the northwest end of the Cut-Through Channel will provide topographic diversity as well as protect Lower Lake from sediment deposition. This measure was included in the AdH model to evaluate riprap sizing. CHANLPRO was used to size required stone for the bankline protection design based upon the side slope, flow depth and velocity under 50% and 1% chance exceedance conditions. Velocities for the 50% and 1% chance exceedance were 3.3 ft/s and 3.4 ft/s, respectively. A specific weight of 165 lb/cf and a design factor of safety of 1.1 resulted in a D100 of 36 lbs for both conditions. However, given ice flow durability considerations, a standard Iowa Class E gradation of top size of 250 lbs was selected. This recommendation can be revisited during the implementation phase.

There was concern about the stability of bankline on the west side of Steamboat Island proper. The velocity and shear stress output for the 2-year event was also used to evaluate the need for rock protection on the west side of Steamboat Island proper. There was a concern that the side of the island downstream of the Cut-Through Channel was experiencing bankline erosion and the GCS could further increase erosion. Figure H-45 shows the velocity output with the GCS included and the maximum velocity near the west side bank is about 3.4 ft/s, which is below the maximum permissible velocity of 5 ft/s.

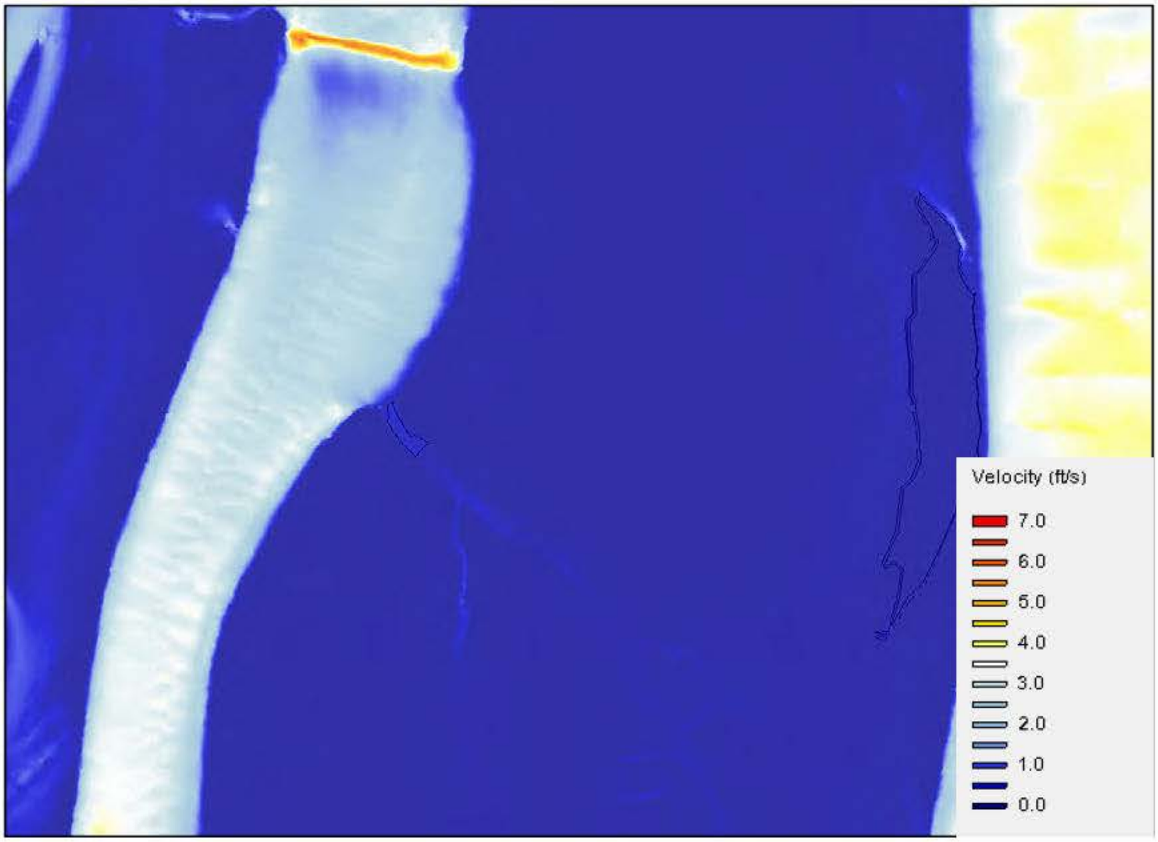

Figure H-45: 2-year AdH Velocity Output at the West Side of Steamboat Island

Figure H-46 displays the 2-year event output for shear stress on the west side of Steamboat Island. Again, the critical bed shear stressed was exceeded throughout this area of concern but for the same reasons as the West SE Island, velocities were given more emphasis in the analysis.

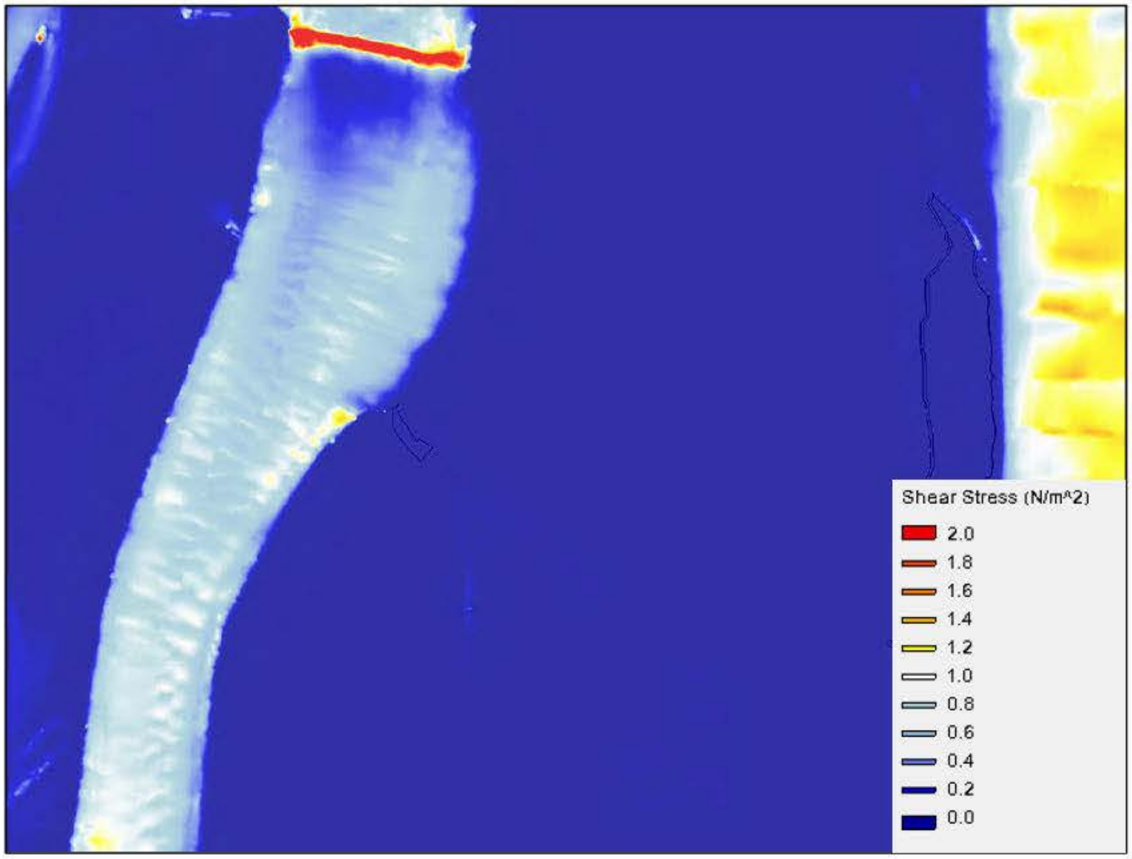

Figure H-46: 2-year AdH Shear Stress Output at the West Side of Steamboat Island

The feasibility design recommendation is that the west side of Steamboat Island does not require rock protection due to the lower velocities.

4. Topographic Diversity Measure (NE Bank). The NE Bank measure is located on the upper portion of Steamboat Island proper on the right descending bank of the main channel. The NE Bank will fill a breach in the island caused by high water and erosion to an elevation of 576.2 ft based on EFM results. This measure will protect Upper Lake by repairing the breach with fill material and protecting the bankline with riprap at the 50% chance exceedance event (2-year) elevation of 575.3 feet. The NE bank was included in the model to assess if there were an impacts to mussels as well as evaluating riprap sizing. CHANLPRO was used to size required stone for the bankline protection design based upon the side slope, flow depth and velocity under 50% and 1% chance exceedance conditions. Velocities for the 50% and 1% chance exceedance were 3.5 ft/s and 4.1 ft/s, respectively. A specific weight of 165 lb/cf and a design factor of safety of 1.1 resulted in a D100 of 36 lbs. However, given ice flow durability considerations, a standard Iowa Class C gradation of top size of 450 lbs was selected. This recommendation can be revisited during the implementation phase.

5. Topographic Diversity Measure (Grant Slough Placement 1). The Grant Slough Placement 1 will be filled with dredged material to 573.1 ft based on EFM results. Google Earth imagery from 2005 to 2017 suggests that the area is stable. However, due to sponsor concern, wind wave impacts at

Grant Slough Placement 1 were investigated to determine if rock protection would be needed (Figure H-47). The computer program Coastal Engineering Design and Analysis System (CEDAS) was used to approximate wave parameters.

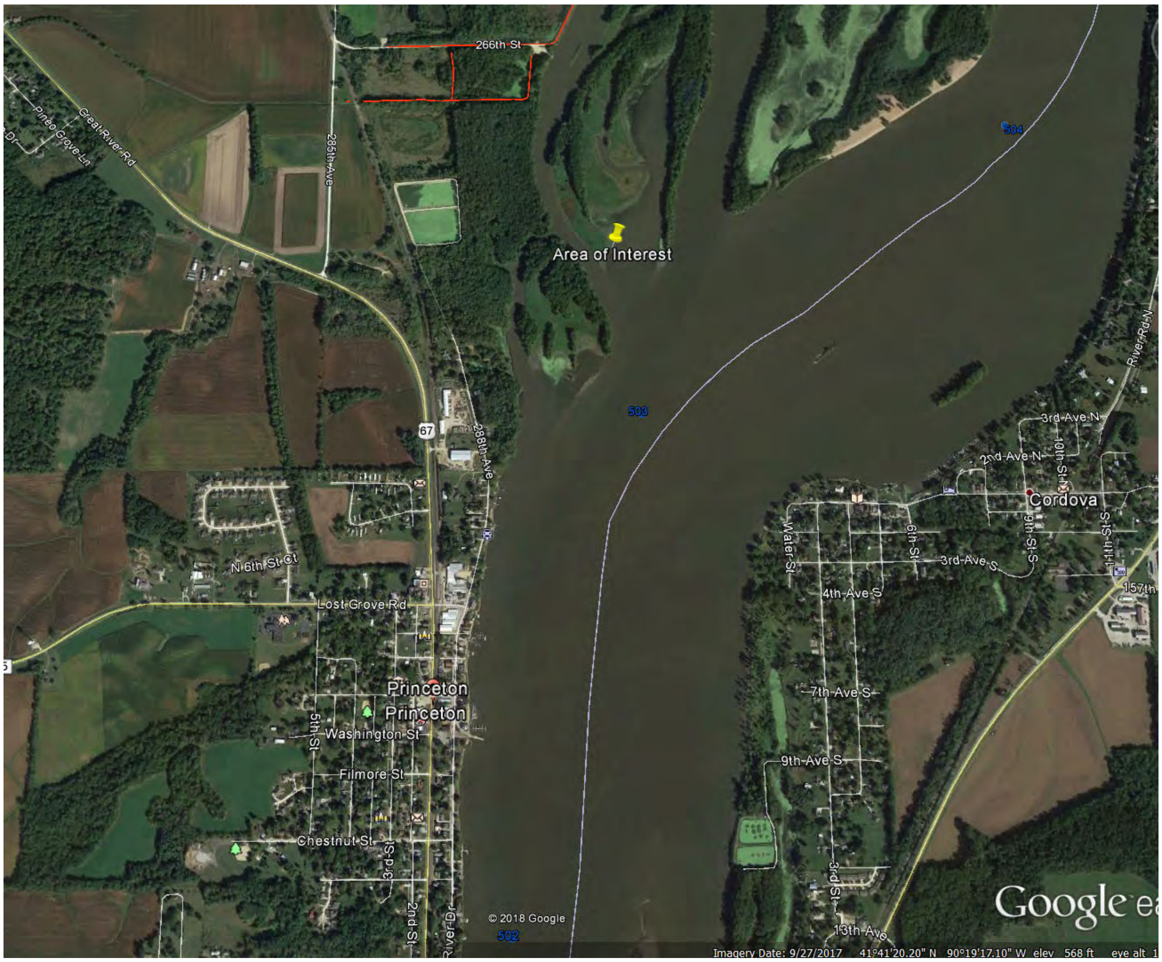

Figure H-47: Area of Interest for Wind Wave Impacts

CEDAS Version 4 was used to approximate characteristics of the significant wave in the vicinity of the area of interest. Assuming a 50% chance exceedance event (water surface elevation of 575.5 feet) and using Project bathymetry, an average fetch depth of 10.33 feet was determined. Depending on angle of approach, fetch lengths varied from 0.09 to 1.92 miles (Figure H-48). Maximum wind speed input was determined from data collected by USACE Water Control Section at L&D 13 and 14 from 2014 to 2018. The maximum wind gust observed at 5-minute intervals was 65 mph. No clear wind direction was determined at high wind speeds, so this parameter was adjusted within CEDAS to determine the "worst case scenario". CEDAS computed a wave height of 3.02 feet, a wave period of 3.14 seconds, and a wave length of 44.45 feet.

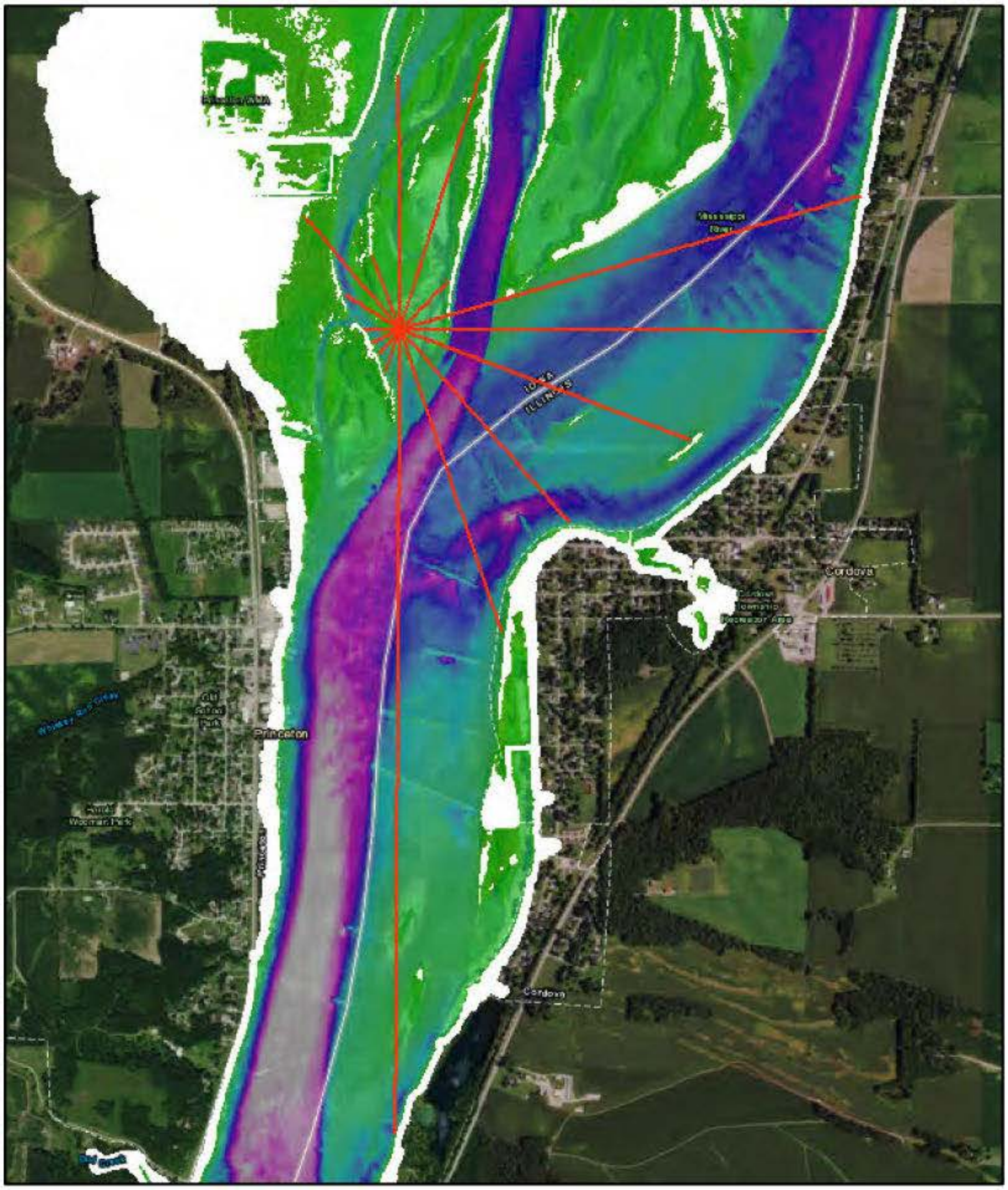

Figure H-48: Fetch Lines for Area of Interest Shown in Red
Project bathymetry also shown.
Elevations above 575.5 feet are shown in white and were considered "land".

Riprap sizing for wave wash impacts was calculated following the publication "Design Guideline 17: Riprap Design for Wave Attack" (FHWA, 2009). Weight and diameter of the median riprap particle size was calculated by both the Hudson Method and the Pilarczyk Method using inputs from slope, characteristics of the riprap and the CEDAS outputs of significant wave height and design wave length. Table H-17 shows inputs and outputs for these equations. The median riprap particle size calculated is 594 pounds. Therefore, this analysis suggests that a very large riprap gradation is required to protect this area of interest from wind wave impacts.

Table H-17: Riprap Sizing Parameters for Wave Wash Concerns

Hudson Method		**Pilarczyk Method**	
Inputs:		**Inputs:**	
Unit weight of riprap (lb/ft^3)	165	Unit weight of riprap (lb/ft^3)	165
Tangent of slope	0.5	Tangent of slope	0.5
Significant wave height (ft)	3.02	Significant wave height (ft)	3.02
Design wave height, 10% wave (ft)	3.84	Wave length (ft)	44.45
Kd, empirical coefficient	2.2	Dimensionless breaker parameter	1.92
Outputs:		**Outputs:**	
D_{50}: minimum diameter of the median riprap particle size (in):	21.2	D_{50}: minimum diameter of the median riprap particle size (in)	22.8
W_{50}: minimum weight of the median riprap particle size (lb):	476	W_{50}: minimum weight of median riprap particle size (lb)	594

As shown in Figures H-49 to H-52, Google Earth imagery dated 2005 to 2017 suggest that the area of interest is fairly stable and the results of the above analysis overestimate wave impacts to an unreasonable degree. CEDAS is used primarily for coastal engineering applications. It is useful for determining the upper bounds of wind wave impacts. However, CEDAS does not consider two wave dampening mechanisms relevant to this area: bathymetric heterogeneity and vegetation (Rohweder et al. 2012). Wind waves crossing the navigation channel (approximately 20 to 30 feet deep) will cross a shallow area approximately 500 feet long (and approximately 5 feet deep) before impacting the shoreline of interest. Based on aerial imagery and field observations, this area is heavily vegetated and vegetation has been stable for approximately the last 15 years. Vegetation has been shown to limit wave impacts (Anderson et al. 2011). The feasibility recommendation is that Grant Slough Placement 1 does not require rock protection but may be investigated further during the implementation phase.

Figure H-49: Area of Interest, Imagery Dated 6/30/2005

Figure H-50: Area of Interest, Imagery Dated 7/8/2008

Figure H-51: Area of Interest, Imagery Dated 9/27/2012

Figure H-52: Area of Interest, Imagery Dated 9/27/2017

6. Topographic Diversity Measure (Grant Slough Placement 2). The Grant Slough Placement 2 will be filled with dredged material to 576.2 feet based on EFM results. No rock protection was needed due to velocities under 5 ft/s.

7. Topographic Diversity Measure (Grant Slough Placement 4). The Grant Slough Placement 4 will be filled with dredged material to 576.2 feet based on EFM results. No rock protection was needed due to velocities under 5 ft/s.

8. Topographic Diversity Measure (Grant Slough Placement 5). The Grant Slough Placement 5 will be filled with dredged material to 576.2 feet based on EFM results. No rock protection was needed due to velocities under 5 ft/s.

C. Screened Measures

1. Flow Diversity Structure. A rock structure in Steamboat Slough was proposed to create flow diversity in the channel. An island previously existed downstream of the Cut-Through Channel but has eroded away. The structure with a 4-foot top width at elevation 574.0 feet and 2H:1V slopes in all directions was added into the AdH model in a location with higher elevations to assess impacts to Steamboat Island proper. The Recommended Plan does not include this measure.

2. Lower Steamboat Island Deflection Structure. The Sponsor raised concerns over material from the dredged material placement site Historic Bankline Placement Site RM 503.5-504.1R traveling downstream and recirculation of flow back into the Lower Lake, which could result in sediment deposition in the Lower Cut excavated channel. An evaluation of existing conditions was initially undertaken. Under median discharge existing conditions, very little flow comes down the interior lake while flow from the main channel expands into the Lower Lake interior, mixing with the slack water and resulting in an eddy that propagates upstream within the interior channel. In order to more closely evaluate the likelihood of deposition under these flow conditions, shear stresses were computed. Based on Berenbrock & Tranmer (2008), the critical shear stress to determine if sediment is mobile for medium sand was 0.194 – 0.27 Pa. The critical shear stress does not determine the potential for erosion or deposition, but it was assumed that shear stresses below the critical threshold may cause deposition and shear stresses larger than the critical shear stress may cause erosion. Deposition and erosion are a function of convergence and divergence as well as well as the timing and duration of the flow conditions. Under existing conditions, the resulting shear stresses near the Lower Lake outlet are below the critical shear stress threshold and deposition has the potential to occur (under median flow conditions). Current bathymetry data shows higher elevations near Steamboat Island proper where lower shear stresses occur. Figure H-53 shows shear stress values of 0.194 Pa and higher under existing median discharge conditions near the Lower Lake outlet.

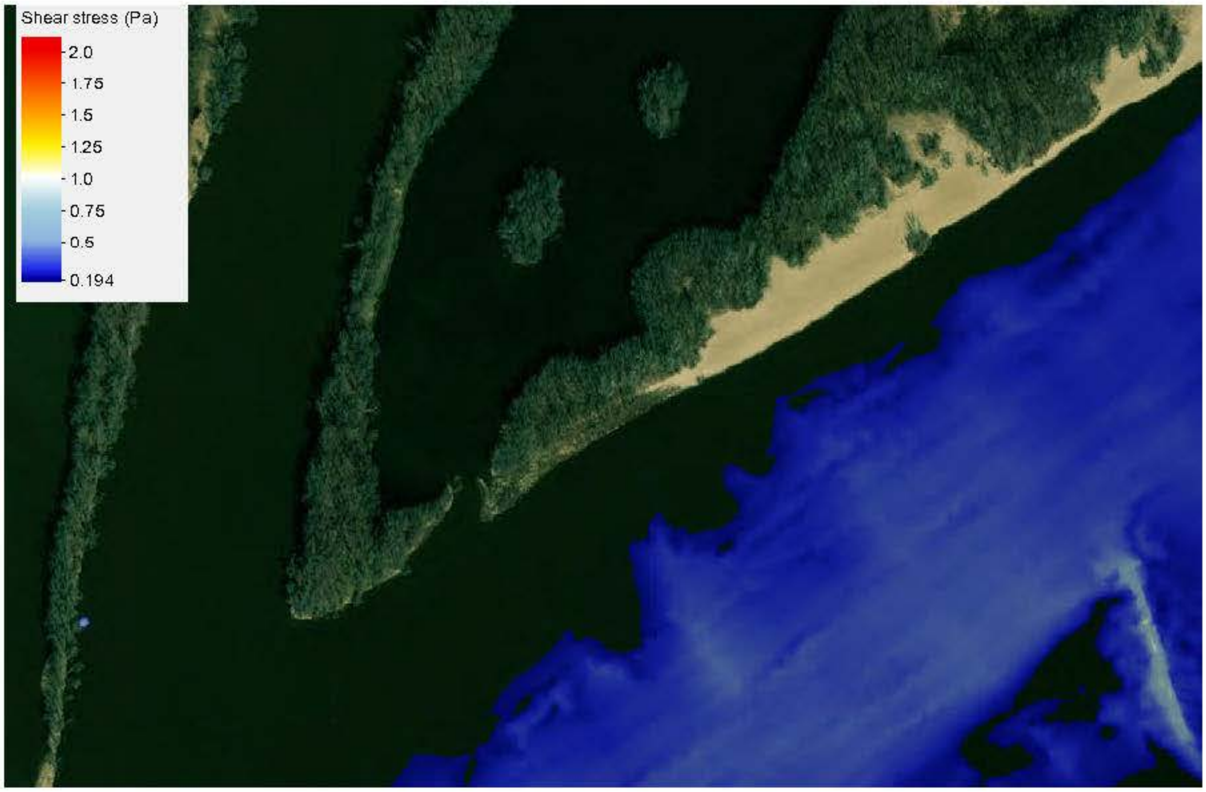

Figure H-53: Existing Conditions Shear Stress (Pa) Under Median Discharge Conditions

An emergent deflection structure was evaluated for effectiveness in reducing sediment deposition at the Lower Lake outlet. A proposed structure was incorporated into the AdH model approximately one hundred feet upstream of the outlet and perpendicular to flow. The structure was modeled with an elevation of 572 feet so that it would be emergent under median discharge. Elevations adjacent to the structure were between 568 to 571 feet. Figure H-54 shows the modeled shear stress results with the deflection structure under median discharge conditions. The output suggests that there is little change to the shear stress at the Lower Lake outlet and the proposed structure does not reduce the likelihood for deposition under median discharge conditions.

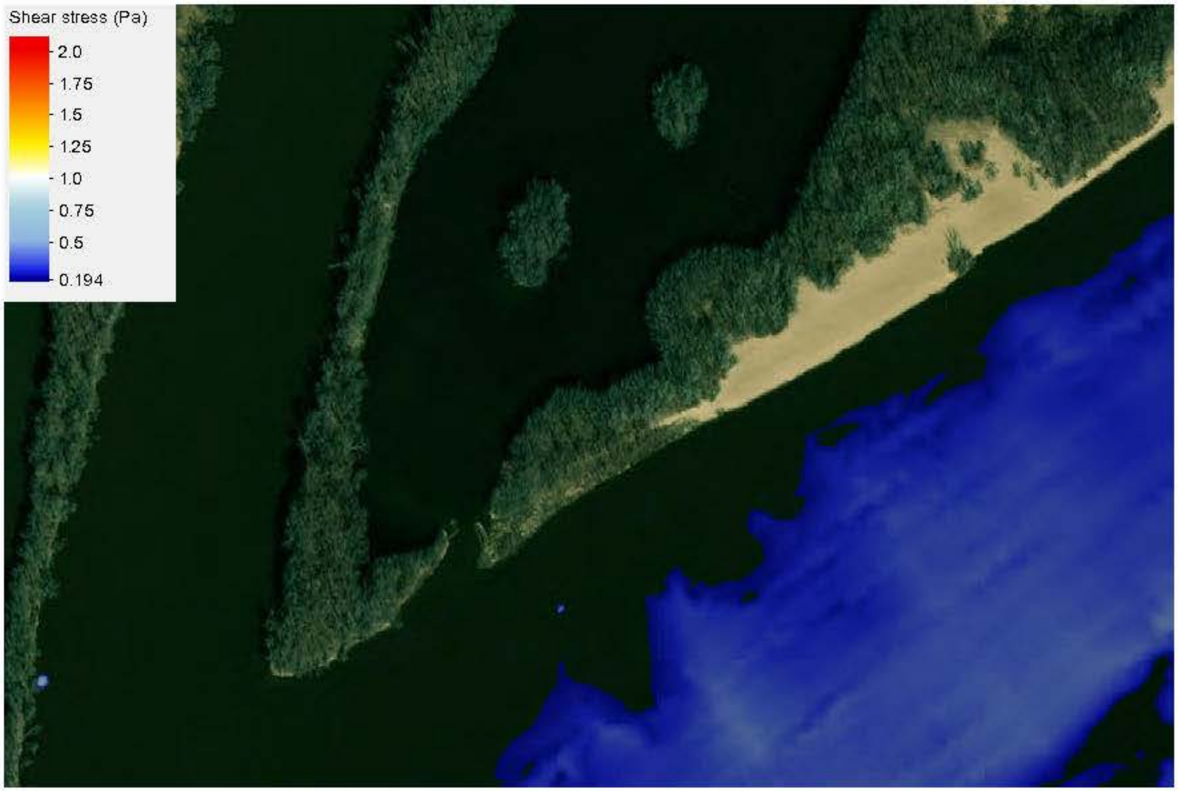

Figure H-54: Shear Stresses (Pa) with Deflection Structure Under Median Discharge Conditions

Since sediment transport is a dynamic process, an unsteady model simulation was completed to evaluate the existing conditions under higher flow conditions. The boundary conditions used in the unsteady simulation were from the high water event in 2019. The results were analyzed and a discharge of approximately 168,000 cfs at L&D 13 was required to create shear stress values at the Lower Lake outlet greater than the critical shear stress. Figure H-55 shows the shear stresses greater than 0.194 Pa under existing conditions and a discharge of 168,000 cfs.

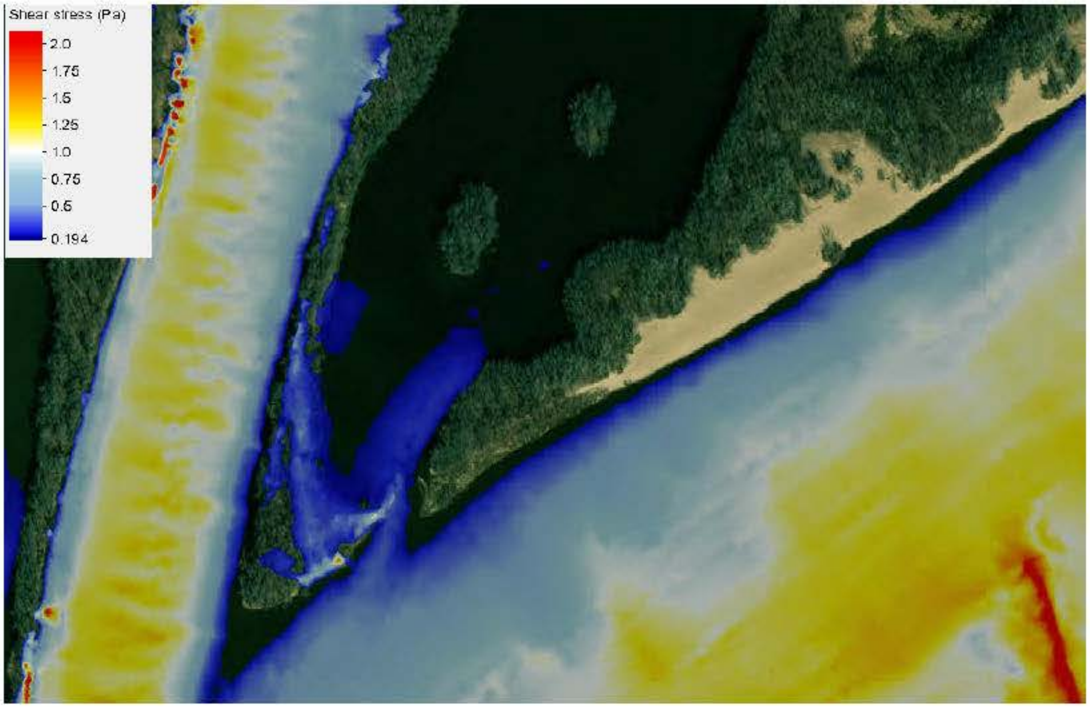

Figure H-55: Existing Conditions Shear Stresses (Pa) at Discharge of 168,000 cfs

In conclusion, the analysis has shown the deflection structure does not reduce the likelihood of sediment deposition under median discharge and therefore not recommended. The Recommended Plan does not include this measure.

IX. MUSSEL HABITAT SUITABILITY MODEL INPUT

The AdH model was utilized to evaluate any potential impacts to existing mussel beds in Pool 14. Hydrodynamic output from each node in the AdH model was input into the HREP mussel model to determine if mussel presence or absence is impacted by the Project measures (Appendix M, *Engineering Design,* Attachment C). AdH model output for the 'existing conditions' and 'with-project conditions' under ~Q5 and ~Q50 discharges included velocity, shear stress, depth, Reynolds number and Froude number. 'With-project conditions' includes the addition of USI Head, NE Bank, West SE Island, and GCS to the AdH model.

The equation and parameters used to calculate shear stress are as follows:

Tau = Density*Gravity*n^2*V^2/d^(1/3)
Tau= shear stress (Pascals)=
Density= 1000 kg/m^3
Gravity=9.8m/s^2
N= Manning's n of 0.013 (Roughness height of ~1.5 mm)
v= Velocity (m/s)
d= Depth (m)

The following equation and parameters were used to calculate Reynolds number:

Re= v*d/viscosity
Re= Reynolds number (dimensionless)
Viscosity= 0.000012625 ft^2/sec

The viscosity was determined at the 2016 average water temperature at the Camanche gage of 57 degrees Fahrenheit. The following equation and parameters were used to calculate Froude number.

Fr = v/(gravity*d)^0.5
Fr= Froude number (dimensionless)

X. CLIMATE CHANGE RESILIENCY

Engineering Construction Bulletin No. 2018-14, *Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects,* (USACE, 2018) provides guidance on conducting a qualitative assessment of climate change impacts related to inland hydrologic analyses for civil works studies, designs and projects. Figure H-56 is a flow chart illustrating the qualitative assessment process. The intent of the qualitative analysis is to assess potential climate change threats and impacts relevant to the specific hydrologic analyses used to support the study goals and engineering design. Consideration of both past (observed) changes as well as potential future (projected) changes to relevant climatic and hydrologic variables is required as part of this qualitative assessment.

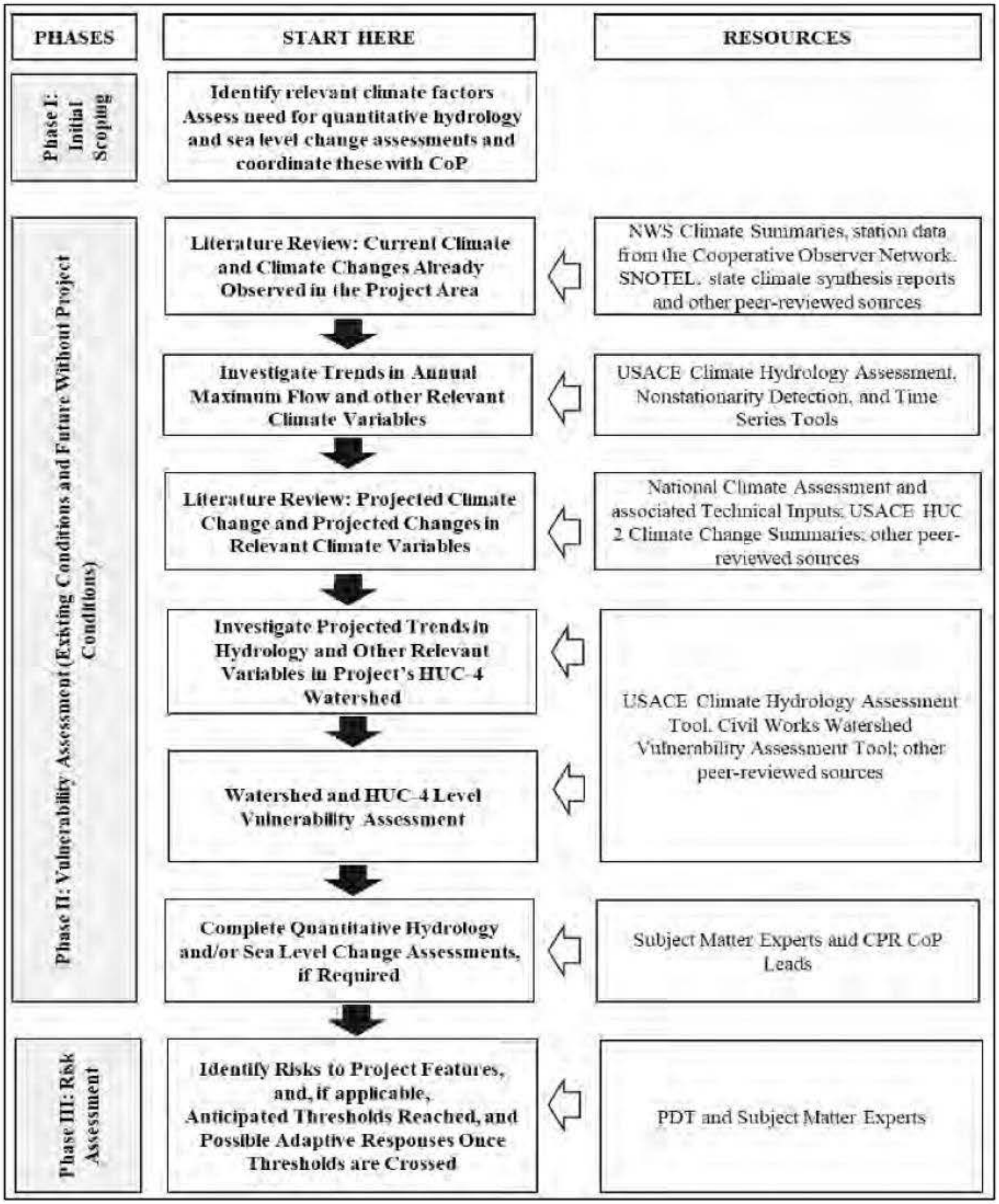

Figure H-56: Flowchart for Incorporating Climate Change Impacts to an Inland Hydrologic Analysis (USACE, 2018)

A. Phase I Assessment: Relevant Climate Factors. Successful floodplain forest restoration is dependent on limiting flood inundation duration during the growing season (March to November). The climate variables relevant to this objective include seasonal temperatures and precipitation as they relate to growing season hydrology. Seasonal temperatures relating to snowmelt timing and duration of ice-cover are relevant to restoring aquatic overwintering habitat. Changes in temperature, precipitation and hydrology that could result in increased flooding, increased flood frequencies, and/or increased flood duration are relevant to the success of island restoration measures. The assessment of observed and projected hydrometeorologic data that follows concentrated on these climate variables, relevant to the Project's objectives.

B. Phase II Assessment: Literature Review. The literature review focused on observed and projected hydrometeorologic data relevant to the Project to assess potential changes to climate over the 50-year project life, considering the future, without the Project. Observed changes described in the literature review that follows as well as the climate summary data provided in Section II, *Climate*, characterize existing conditions. As illustrated, hydrometeorologic variables with the potential to impact performance of the Project examined in the literature review include temperature, precipitation, and streamflow.

1. Temperature Observations and Projections. Regional summary reports prepared by the Corps in 2015 summarize observed and projected trends reported in the literature. Findings for Water Resources Region 07, the Upper Mississippi Region , which includes the Project area, include statistically significant increases in mean air temperature during winter, spring, and summer; however, a slight decreasing trend was observed for fall mean air temperatures (Wang et al., 2009) (USACE, 2015). Westby et al. (2013) found during the period of 1949 to 2011, statistically significant warming occurred in the northern Upper Mississippi Region.

In the Upper Mississippi Region, spring onset is occurring at least a few days earlier for the current period (2001 to 2010), as compared to an earlier baseline reference decade (1951 to 1960). This denotes an apparent small shift in seasons, with spring warming occurring earlier than in the past (Schwartz et al., 2013). Increases in air and water temperature across the Upper Mississippi Region over the past few decades have led to earlier ice-out dates and later ice-in dates for lakes and earlier spring runoff (Johnson and Stefan, 2006).

Regional results from the U.S. Global Research Program's *Third National Climate Assessment for the Upper Midwest* (NCA3) suggest the rate of warming in the Midwest has markedly accelerated over the past few decades (Pryor et al., 2014). Between 1900 and 2010, the average Midwest air temperature increased by more than 1.5°F (Figure H-57). However, between 1950 and 2010, the average temperature increased twice as quickly, and between 1980 and 2010, it increased three times as quickly as it did from 1900 to 2010. Warming has been more rapid at night and during winter. The literature shows consensus among authors indicating increasing trends in observed air temperatures for the Midwest and Upper Mississippi Region.

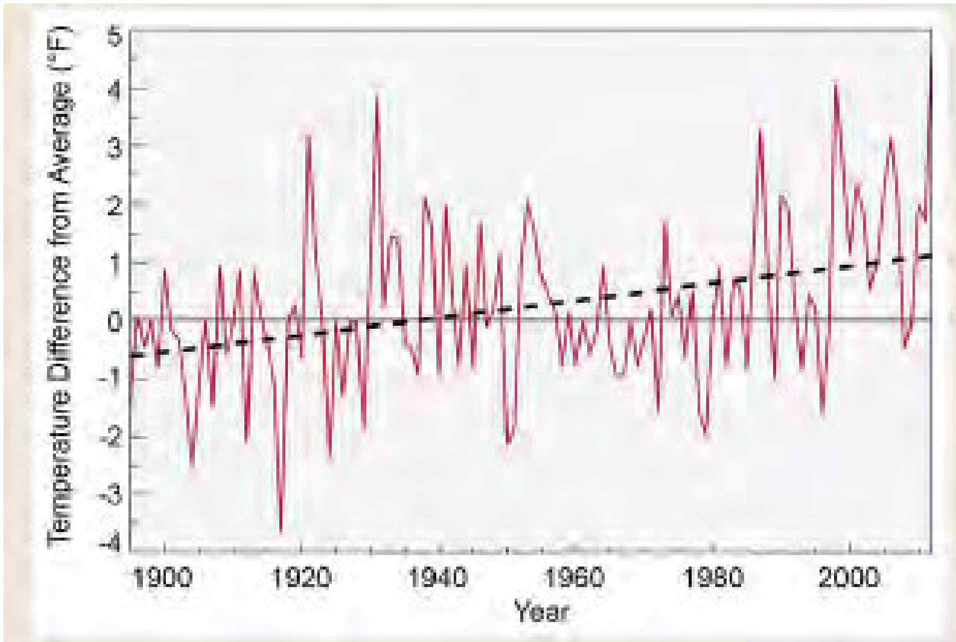

Figure H-57: Increasing Annual Average Temperatures in the Midwest (NCA3)

There is a high level of consensus across multiple Global Circulation Models (GCMs) and emissions scenarios projecting a significant warming trend across the entire Upper Mississippi Region. Compared to the baseline time frame of 1971 to 2000, a study by Liu et al. (2013) using a single GCM and assuming an A2 greenhouse gas emissions scenario (worst case) projected an increase in maximum air temperature of 1.5 to 4.5 ºC (2.7 to 8.1 ºF) for a 2055 planning horizon in the Upper Mississippi Region. Additionally, the study predicted an increase in the Keetch Byrum Drought Index, which is a measure of soil moisture index.

In 2014, Scherer and Diffenbaugh published a study in which they projected a steady increase in both summer and winter air temperatures throughout the whole 21st century for the Upper Mississippi Region, using a multi-member GCM and assuming an A1B emissions scenario (middle of the road). Compared to a baseline timeframe of 1980 to 2009, the study projected that by the year 2090, the air temperature would increase by 5.7°C (10.3°F) in the summer and 3.6°C (6.5°F) during the winter. Cai et al. (2009) and Wilson and Weng (2011) both produced similar results when evaluating central Illinois using GCMs and shorter planning horizons.

Using two different GCMs and assuming high greenhouse gas emissions (A2 and A1f), Kunkel et al. (2010) projected a 4.0 to 6.5 ºC (7.2 to 11.7 ºF) increase in 3-day heat wave temperatures and a 15- to 50-day increase in the annual number of heat wave days for a 2090 planning horizon compared to a recent historical baseline for the Upper Mississippi Region.

Projections of future extreme climate events were summarized in the report. Gao et al. (2012) used a planning horizon of 2058 and a single GCM with a high greenhouse gas emission assumption to project increases in heat wave intensity, duration, and frequency. Results show an increase of up to 4.0 ºC (7.2 ºF) in extreme heat wave temperatures in the Upper Mississippi Region and the duration of heat waves is projected to increase by 2 to 4 days per event, compared to the baseline period of 2001 to 2004. The overall frequency of heat waves are projected to increase by 1 to 4 events per year. Pryor et al. (2014) used GCMs to project statistically significant mid-century increases in both annual average temperature and the number of extreme heat days for the Midwest (Figure H-58). Additionally, projections are presented showing an increase in the frost free season and an increase in the number of "cooling degree days," defined as the number of degrees that a day's average temperature is above 65 °F (18.3 °C).

According to the NCA3, the amount of future warming will depend on changes in the atmospheric concentration of heat-trapping gases. Projections for regionally-averaged temperature increases by the middle of the century (2046-2065) relative to 1979-2000 are approximately 3.8°F for a scenario with substantial emissions reductions (B1) and 4.9°F with continued growth in global emissions (A2). The projections for the end of the century (2081-2100) are approximately 5.6°F for the lower emissions scenario and 8.5°F for the higher emissions scenario.

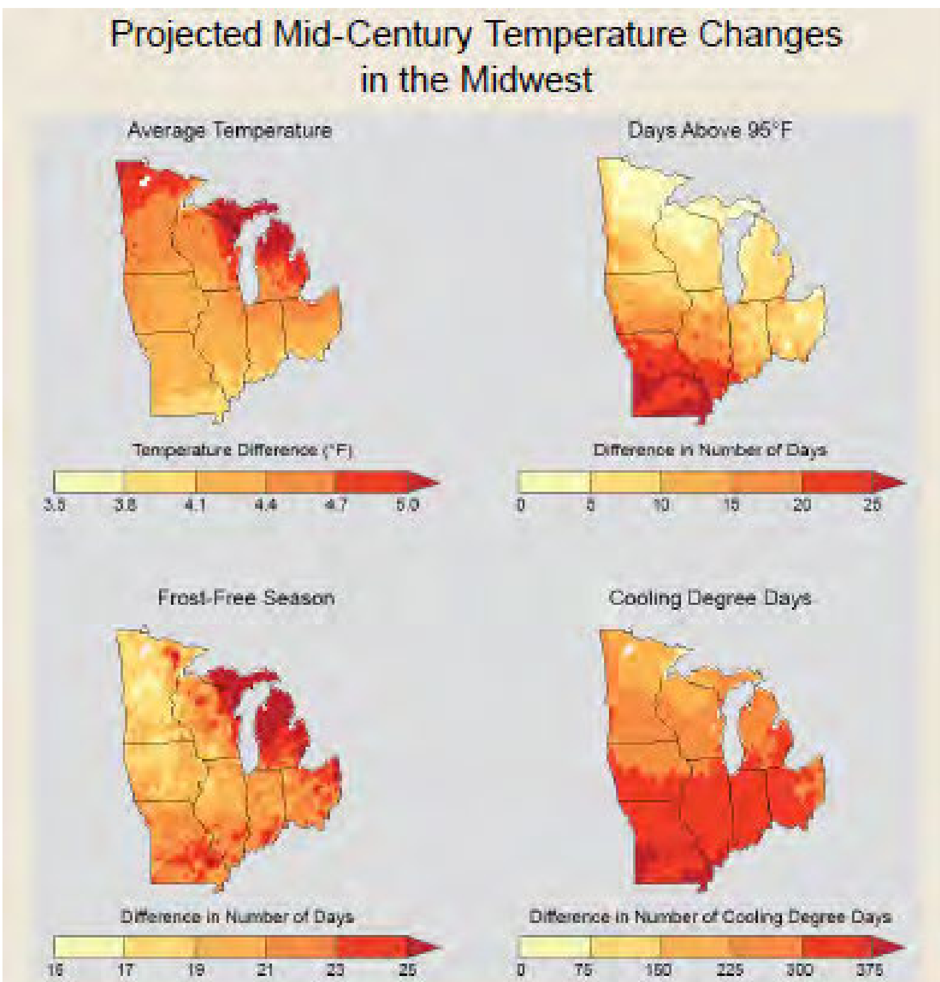

Figure H-58: GCM Projections Showing Increasing Annual Average Temperatures, Number of Hottest Days, Length of Frost-Free Season, and Cooling Degree Days (Pryor et al., 2014)

Figure H-59 illustrates a long term upward trend in temperature and further documents that long-term winter temperatures have increased six times more than summer temperatures and since 1970, nighttime temperatures have increased more than daytime temperatures (Iowa Climate Change Impacts Committee). The NOAA's *2017 State Climate Summary* for Iowa reported an increase in average annual temperatures of about 1°F over the last two decades (Frankson et al.). Average annual temperatures are projected to increase, resulting in projections of increased intensity of future droughts.

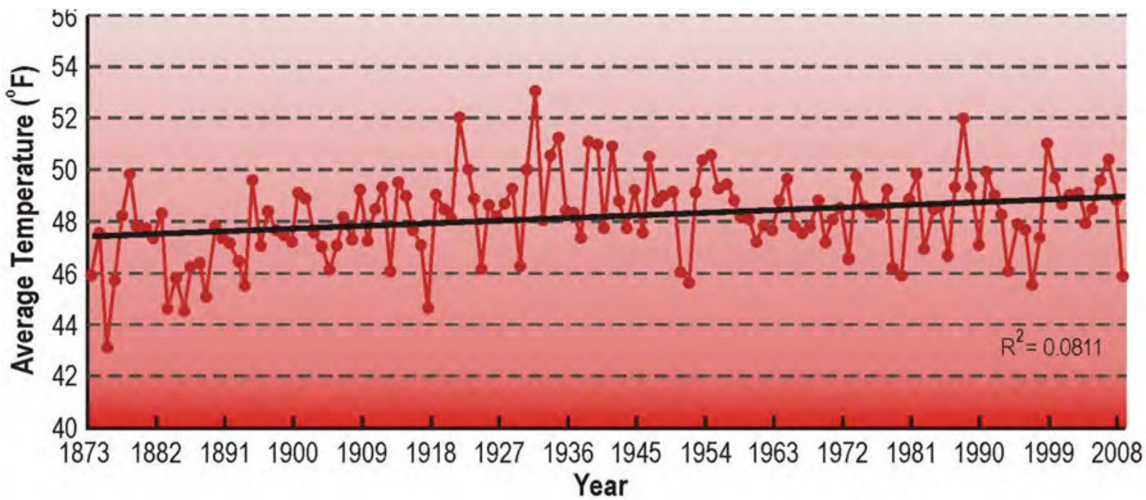

Figure H-59: Annual Average of Iowa's State-wide Daily Average Temperatures (°F) from 1873-2008 (Source: 2010 *Climate Change Impacts on Iowa* report)

2. Precipitation Observations and Projections. Statistically significant increasing trends in total annual precipitation have been reported in several studies. An increasing trend in winter storm precipitation total (1972-2002) was observed by Palecki et al. (2005), while Grundstein (2009) identified positive linear trends in both total annual precipitation and soil moisture index during the 1895-2006 period. During the 1950 to 2000 period, a significant increasing trend in precipitation, particularly in the summer and fall, was observed for the Upper Mississippi Region (Wang et al., 2009). During the winter and spring, a mild decreasing trend was identified for the northern half of the Upper Mississippi Region. McRoberts and Nielsen-Gammon (2011) quantified an increasing trend in annual precipitation (1895-2009) for the Upper Mississippi Region as between 5% to 10% per century.

Moderate increases (33%) in the frequency of 20-year storm events in the Upper Mississippi Region where observed by Wang and Zhang (2008) when comparing the period 1949 to 1976, to the period 1977 to 1999. Within the Upper Mississippi Region, statistical analysis of 20th century rainfall data showed generally increasing and statistically significant trends in total annual precipitation and the number of precipitation days per year (Pryor et al., 2009). For multiple climate stations in the Upper Mississippi Region with at least 50 years of historical record, statistically significant increasing trends in the frequency of occurrence of heavy rainfall were identified by Villarini et al. (2013).

The NCA3 report concluded that annual precipitation increased during the past century (by up to 20% in some locations), with much of the increase driven by intensification of the heaviest rainfalls. Multiple authors have identified a mild upward trend in observed precipitation for the Midwest and the Upper Mississippi Region.

Projections of future changes in precipitation in the Upper Mississippi Region generally concur that both annual precipitation and extreme precipitation totals are going to increase. Using a planning horizon of 2055, Liu et al. (2013) projects an increase in spring, summer, and winter precipitation. Despite the projected increase in precipitation, the study also projects an increase in the severity of future droughts.

Applying a planning horizon of 2058 to a GCM, Gao et al. (2012) generally projects increases in the magnitude of annual and daily extreme (defined as 95th percentile) storm events, and in the frequency of precipitation events.

A study of the Illinois watershed by Wilson and Weng (2011) used A1B and B1 emission scenarios and a 2020 planning horizon to project changes in monthly precipitation. Results indicate a general agreement of drier summer months and wetter winter months.

Multiple studies present future projections of extreme events, which include storm events and droughts. Tebaldi (2006), Wang and Zhang (2008), Wang et al. (2011), Schuster et al. (2012), and Joetzjer et al. (2013) generally predict increases in the number of high (>10 mm) precipitation days for the region, the number of storm events greater than the 95th percentile of the historical record, and the daily precipitation intensity index (annual total precipitation divided by number of wet days. In other words, the projections forecast small increases in the occurrence and intensity of storm events by the end of the 21st century for the general study region. Wang and Zhang (2008) used downscaled GCMs and a high emissions scenario (A2) to quantify a significant increase (50 to 100%) in the recurrence of the current 20-year, 24-hour storm event for the planning horizon of 2075. In 2011, Wang et al. used multiple Regional Climate Models and two emissions scenarios to characterize the intensity and frequency of projected droughts in Illinois for the end of the 21st century using the Standardized Precipitation Index. Results show significant increases in the frequency and intensity of short duration (1 to 4 weeks) droughts due primarily to increased air temperatures. Joetzjer et al. (2013) did a similar study, but focused on the whole Upper Mississippi Region, with results concurring with Wang et al.'s earlier study. These results reflect the impacts of projected temperature and evapotranspiration increases in the basin, which appear to exceed the projected impacts of increased precipitation.

Pryor et al. (2014) focused their efforts on precipitation projections in the Midwest. Results generally support all of the other studies' findings. Climate model projections presented in this study indicate a statistically significant increase in annual average precipitation (2.4 to 4.0 inches), wettest 5-day total (0.4 to 1.0 inches), and the number of heavy precipitation days by the middle of this century. Additionally, the duration of consecutive dry days is expected to increase by up to 3 days.

According to the NCA3, projections indicate increased spring precipitation (9% in 2041-2062 relative to 1979-2000) and decreased summer precipitation (by an average of about 8% in 2041-2062 relative to 1979-2000), particularly in the southern portions of the Midwest. Increases in the frequency and intensity of extreme precipitation are projected across the entire region, and these increases are generally larger than the projected changes in average precipitation. Although the total amount of water from rainfall and snowfall is projected to increase across the entire Midwest, models also indicate an increase in consecutive dry days and chances of drought.

The *Climate Change Impacts on Iowa* report describes a long-term upward trend in precipitation and an increase in heavy precipitation in summer over the last 40 years. Increased extreme precipitation events have the potential to cause increased erosion of agricultural fields and runoff of nutrients, pesticides and herbicides. NOAA's *State Climate Survey* for Iowa reports an increase in the frequency of extreme precipitation events and projects increased precipitation and an increase in the frequency of extreme precipitation.

3. Streamflow Observations and Projections. From 1939 to 1998, the Mississippi River watershed saw an increase in river flow (Mauget, 2004). An increase in surplus flow days increased and the number of drought incidence decreased for the Upper Mississippi Region during the same study period, with the greatest change occurring during the latter part of the century. A majority of the 42 gage stations in the Upper Mississippi Region showed statistically positive trends in both annual streamflow and baseflow (Duan et al., 2006). Mean flow and peak flows showed the same positive trend during the period 1913 to 2002.

Statistically significant increasing trends in both annual 7-day low flow and annual mean flow were detected for multiple sites. These were based on analysis of USGS stream gage data, part of the Hydroclimatologic Data Network. Studies of surface water trends, including runoff, for the Mississippi River Region, which includes the Upper Mississippi Region, quantified statistically increasing trends in runoff in the region for the period 1948 to 2004 (Qian et al., 2007).

The NCA3 assessment looked at climate change impacts on the water cycle. It found river flows have increased across the Midwest, however, the length of dry spells and the number of short term droughts have also increased. The timing of peak river levels has changed in response to warming trends. Snowpack and snowmelt-fed rivers in much of the western U.S. have earlier peak flow trends since the middle of the last century, including the past decade. The change in total annual precipitation and heavy precipitation is projected to lead to an increase in the magnitude and frequency of flooding, especially flash floods.

The USGS evaluated observed changes in flooding attributes across 400 km square grid cell regions across the United States in *Fragmented patterns of flood change across the United States* (Archfield et al., 2016). Flooding attributes evaluated in the study included frequency, duration, peak magnitude and volume. Results indicated some regional (grid cell) trends; however, there is little geographic cohesion at the physiographic regional scale among these observed trends. The Project area is near the border of two grid cell regions, each showing a different statistically significant trend in flooding frequency (Figure H-60). The northernmost grid cell shows a decreasing trend in flooding frequency and no statistically significant trends in flood duration, peak magnitude or volume. The southernmost grid cell in close proximity to the Project area shows an increasing trend in flooding frequency as well as duration, peak magnitude, and volume. The report concludes that the watershed scale may be the best resolution to attribute patterns of flood change, as the regional or global explanatory variables evaluated provide little explanatory power.

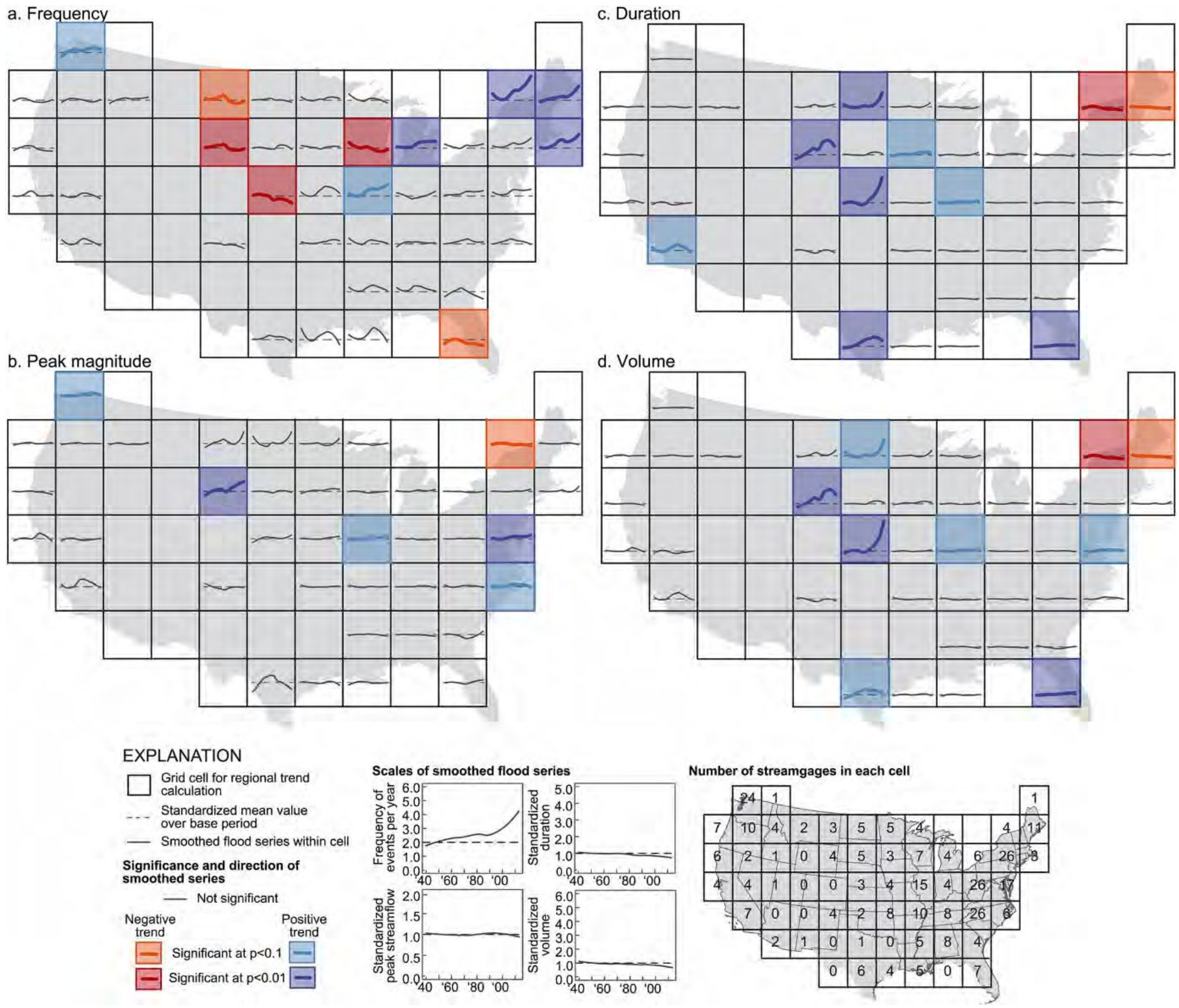

Figure H-60: Regional Flood Trends Across the United States for the Period 1940-2013 (from Archfield et al., 2016).

In order to project future climate trends in hydrology, many studies of the Upper Mississippi Region have relied upon the use of GCMs and macro-scale hydrologic models. There is no clear consensus in the literature, with some studies projecting an increase in future streamflow as a result of increased precipitation in the Upper Mississippi Region, while others project a decrease in flows as a result of increased evapotranspiration. Seasonally, multiple studies suggest increased flows in the winter and spring and decreased flows in the summer. An example of contradictory projections can be found in the study performed by Thomson in 2005, where two GCMs with one set of input assumptions, yielded different results. One model predicts significant decreases in water yield, the other projects significant increases in water yield. Studies by Hagemann et al. (2013) and Döll and Zhang (2010) illustrate how climate change is expected to have as much, or more, of an impact to ecologically relevant flow characteristics as dams and withdrawals over the next century. For the Upper

Mississippi Region, projections show mild (relative to global results) impacts to both low and average annual flows.

Results of other studies such as Jha (2006) and Wu et al. (2012) highlight the significant uncertainty associated with future hydrologic projections. However, these studies can be used to show the potential for large-scale changes in either direction.

Projected changes to streamflow are not covered in great detail for the Project area within the NCA3 report; however, the report does highlight projected changes in spring peak river flows as a result of shifts of the amount and timing of snow pack and snow melt in much of the U.S. This shift is in response to warming trends. The NCA3 notes that projecting future flooding is difficult due to variables such as river level and soil moisture prior to a rain event, yet data suggests an increase in flooding frequency.

4. **Consensus in Literature.** There is strong consensus that air temperatures will increase in the Upper Mississippi Region, with studies generally agreeing 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. A reasonable consensus is also seen on projected increases in extreme temperature events. This includes more frequent, longer, and more intense summer heat waves in the long-term future compared to the recent past.

A majority of the precipitation projections in the studies forecast an increase in both annual precipitation and in the frequency of large storm events. Seasonally, though, some studies indicate a potential for drier summers despite the overall increase in annual precipitation totals. As a result of increased air temperature and evapotranspiration rates, droughts are also projected to increase in the Upper Mississippi Region.

In regards to streamflow and hydrology projections, there is no clear consensus in the literature. Projections generated by coupling GCMs with macro scale hydrologic models in some cases indicate a reduction in future streamflow, but in other cases indicate a potential increase in streamflow. Figure H-61 summarizes the trends and literary consensus of observed and projected primary variables of temperature, temperature extremes, precipitation, precipitation extremes, and streamflow (hydrology).

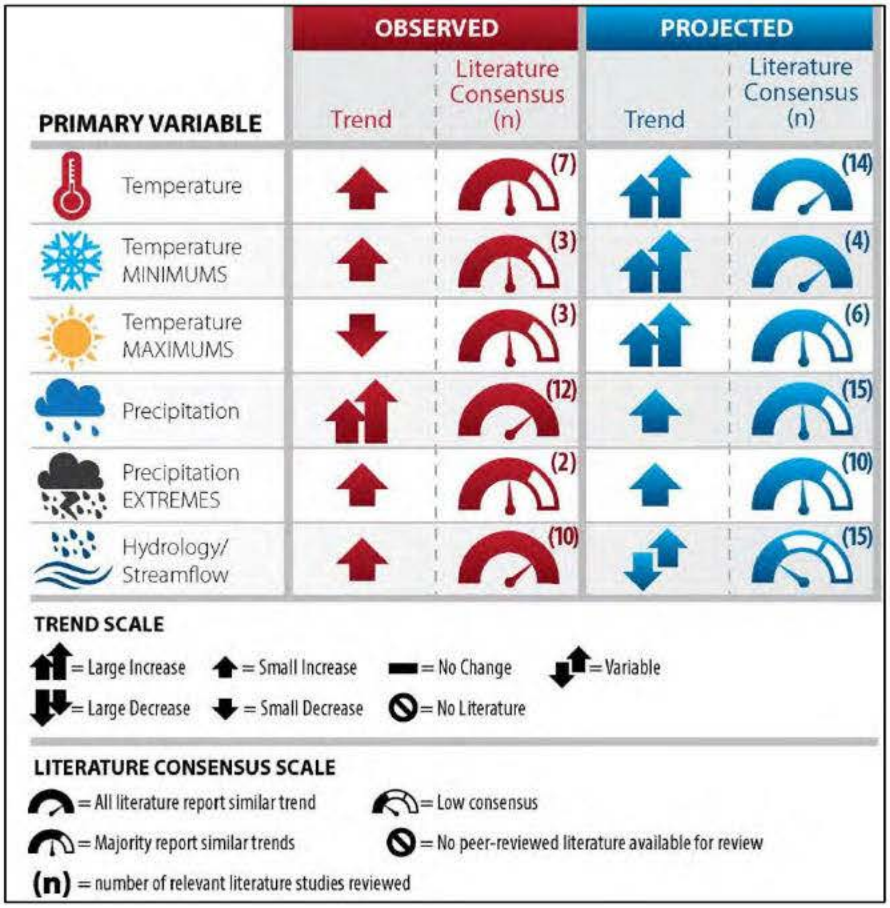

Figure H-61: Summary and Literature Consensus of Observed and Projected Trends in Important Meteorologic Variables Potentially Impacted by Climate Change

C. Phase II Assessment: Trends in Observed Streamflow Records. Flood elevation, frequency and duration are the driving hydrologic variables impacting performance of the Project. Factors other than climate change can influence changes in flood frequency and duration over time including changes in land use and long term geomorphic change. Consequently, identifying impacts to local hydrology attributable exclusively to climate change presents a challenge. The intent of the analysis described herein is to determine whether the hydrologic variables most relevant to Project performance have changed throughout the observed hydrologic record or are projected to change in the future. This assessment focuses on a first order statistical analysis using streamflow records observed at the USGS Gage 05420500, Mississippi River at Clinton, Iowa.

1. Detection of Nonstationarities in Observed Streamflow Records. The Non-Stationarity Detection Tool was used to analyze the 1940-2014 water year (WY) discharge record at the USGS Gage 05420500, Mississippi River at Clinton, Iowa, using 12 different statistical tests to detect nonstationarities in peak annual streamflow record. The gage is located in the middle of Pool 14; therefore, the analysis period for the Non-Stationarity Detection Tool was restricted to 1940-2014 WY following initial operation of L&D 13 in May 1939 and L&D 14 in June of 1939.

The Energy Divisive Method detected a change point in the distribution in 1982 and the Lombard Wilcoxon Test detected a change point in the mean in 1963 (Figure H-62). However, the identified change points lack consensus and robustness necessary to define a strong change point.

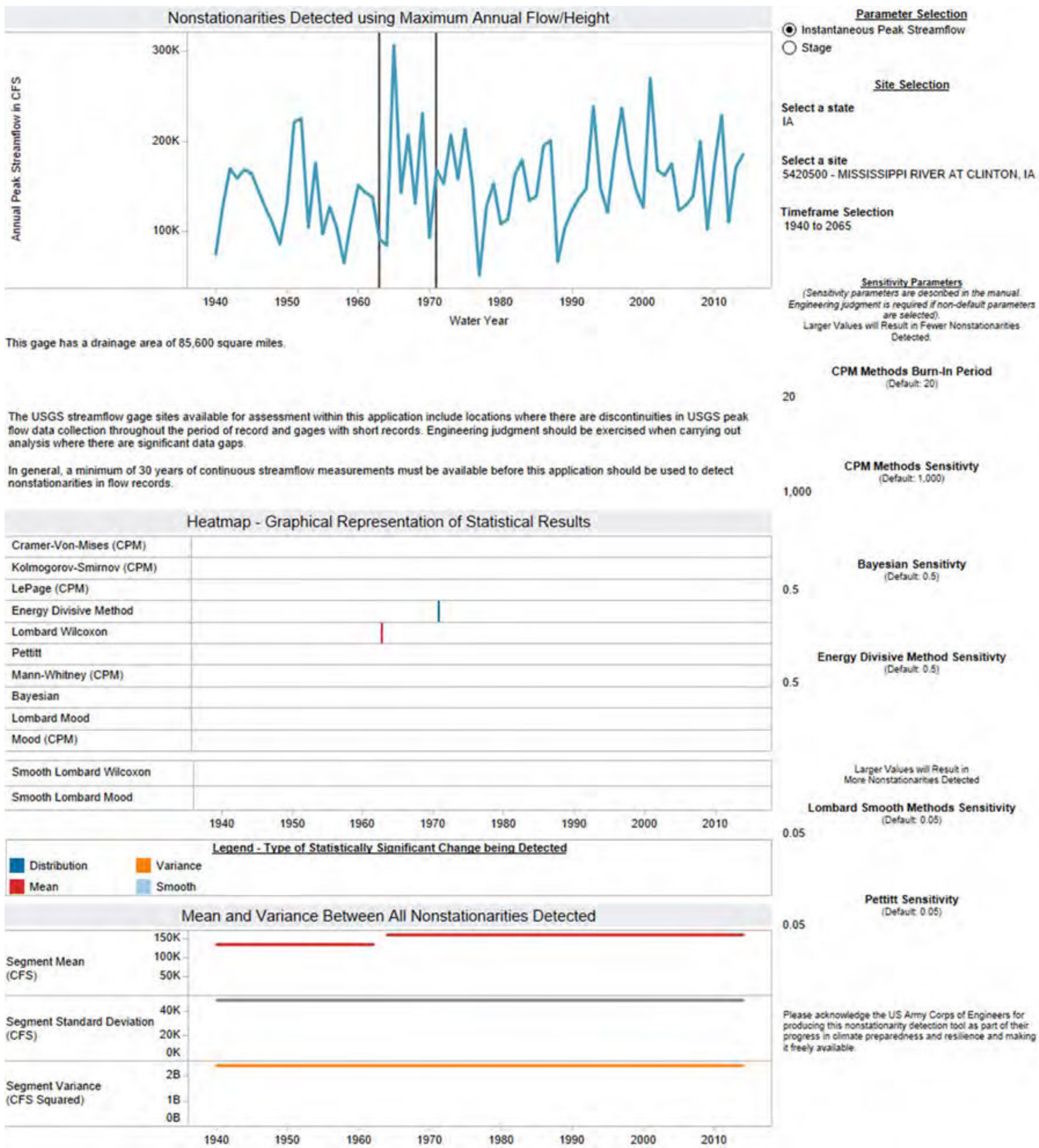

Figure H-62: Nonstationary Analysis of Peak Annual Discharge for the Mississippi River at Clinton, Iowa, (USGS gage 05420500) for the 1940 to 2014 WY period.

Figure H-63 shows the Monotonic Trend Analysis results that include a p-value of 0.084 for the Mann-Kendall Test and a p-value of 0.066 for the Spearman Rank-Order Test. that did not identify any statistically significant trends in peak annual discharge at the Clinton gage. Statistical significance was assessed based on a rejection of the null hypothesis for p-value < 0.05, with 95% confidence that the slope was not equal to zero. Therefore the results for the Monotonic Trend Analysis suggest that upward trends in peak annual discharge at the Clinton Gage are not statistically significant. The results of this monotonic trend analysis suggest that the existing conditions at the Project do not appear to have been shaped by a trend in peak annual discharge. It is worth noting that if a 93% level of confidence were acceptable (p-value < 0.07), the Spearman Rank Order Test results would have identified a statistically significant trend. Without a compelling reason to depart from the typical significance threshold, a p-value < 0.05 was maintained for significance testing throughout this analysis. The results from this analysis are qualitative.

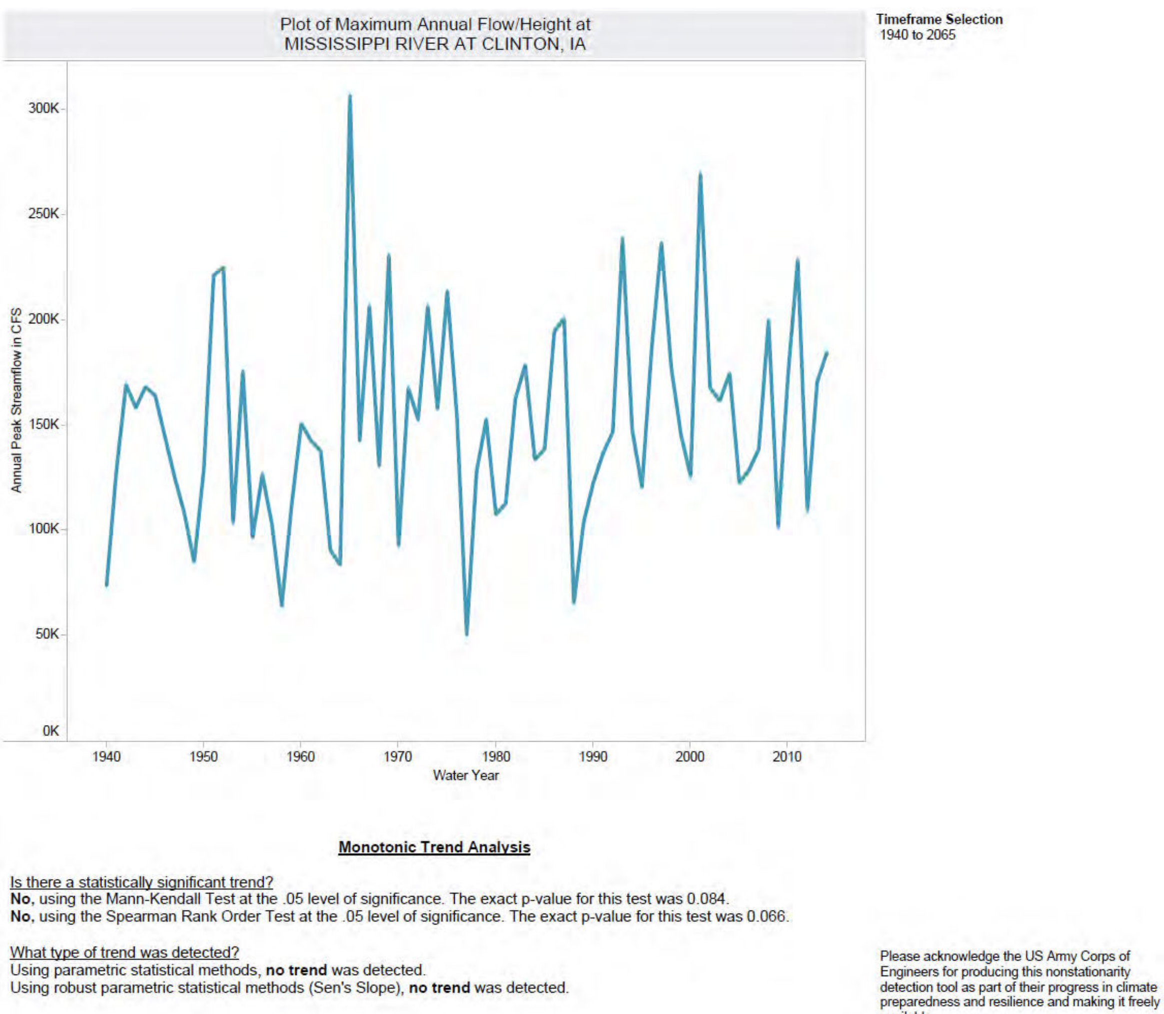

Figure H-63: Monotonic Trend Analysis of Peak Annual Discharge for the Mississippi River at Clinton, Iowa, (USGS gage 05420500) for the 1940 to 2014 WY period.

The Time Series Toolbox (TST) was used to evaluate .four annual growing season inundation duration time series (1940-2016) that inform the design criteria for floodplain forest restoration elevations. The time series data were generated based on the inundation duration criteria established for the different floodplain forest species as described in Section VIII, B. *Topographic Diversity Measures,* and summarized in Table H-14. Results from the TST are summarized in Table H-18. The test for simple linear regression indicated statistically significant upward trends for the 35, 45 and 55-day inundation duration time series (α=0.05 level of significance). However, statistically significant upward trends in the various inundation duration time series were not consistently identified among the three tests (linear regression, Mann-Kendall and Spearman Rank-Order) An upward trend in the 25-day inundation duration time series did not show statistical significance based on any of the three tests. For the 55-day inundation duration time-series, the test for simple linear regression found a statistically significant upward trend (p-value = 0.031) and the Spearman Rank Order Test identified a statistically significant upward trend (p-value = 0.046). Although the Lombard-Wilcoxon method identified non-stationarities in each of the datasets, there was a lack of consensus and a lack of robustness necessary to identify a strong change point in any of the inundation duration time-series.

2. Climate Hydrology Assessment of Observed Data. Observed annual peak instantaneous streamflow for the Mississippi River at Clinton, Iowa, (USGS gage 05420500) evaluated using the USACE Climate Hydrology Assessment Tool indicates no statistically significant trends for the period 1874-2016 WY (p-value =0.132987) (Figure H-64). This suggests that the existing conditions are not likely to have been shaped by a trend in annual peak instantaneous flow.

Table H-18: Summary of Time Series Detection Tool Results for Duration Time Series

	Monotonic Trend Significance			Nonstationarity Detection Analysis		
Time Series Dataset	**Linear Regression (p-value)**	**Mann-Kendall Test (p-value)**	**Spearman Rank-Order Test (p-value)**	**Test**	**Parameter**	**Year**
Annual Maximum 25-day Inundation Elevation	Not significant (0.097)	Not significant (0.242)	Not significant (0.200)	Lombard-Wilcoxon	Mean	1991
Annual Maximum 35-day Inundation Elevation	Upward Trend (0.048)	Not significant (0.117)	Not significant ((0.111)	Lombard-Wilcoxon	Mean	1989
Annual Maximum 45-day Inundation Elevation	Upward Trend (0.033)	Not significant (0.093)	Not significant (0.064)	Lombard-Wilcoxon	Mean	1963
Annual Maximum 55-day Inundation Elevation	Upward Trend (0.031)	Not significant (0.062)	Upward Trend (0.046)	Lombard-Wilcoxon	Mean	1963

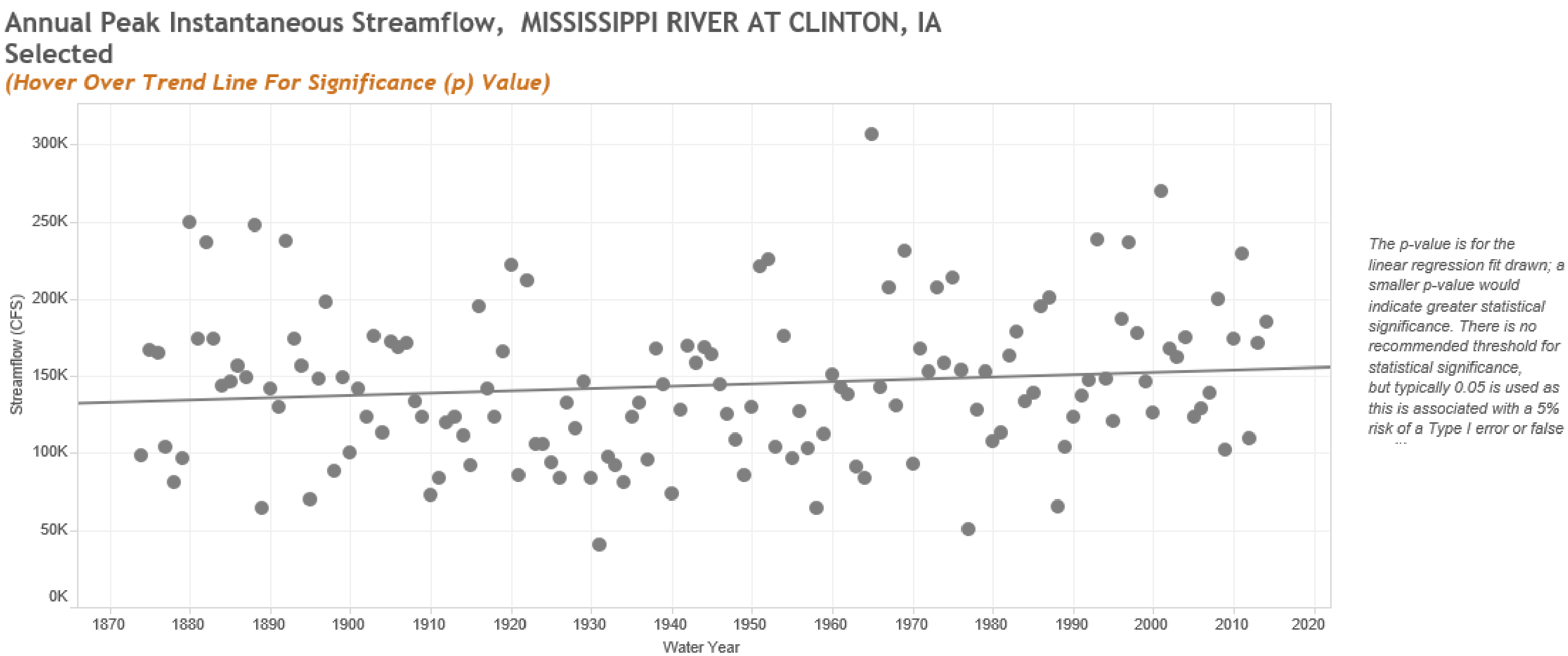

Figure H-64: Observed Annual Peak Instantaneous Streamflow for Mississippi River at Clinton, Iowa (p-value=0.132987).

D. Phase II: Projected Changes to Watershed Hydrology and Assessment of Vulnerability to Climate Change

1. USACE Climate Hydrology Assessment for Projected Data. In order to evaluate projected trends in hydrology for the Project area and assess future without project conditions, the USACE Climate Hydrology Assessment Tool was used to analyze streamflow for the Upper Mississippi-Iowa-Skunk-Wapsipinicon watershed (HUC 0708) (Figure H-65). The Climate Hydrology Assessment Tool provides qualitative information at the HUC 4 watershed level about future climate conditions and allows the Corps to produce repeatable analytical results using consistent information.

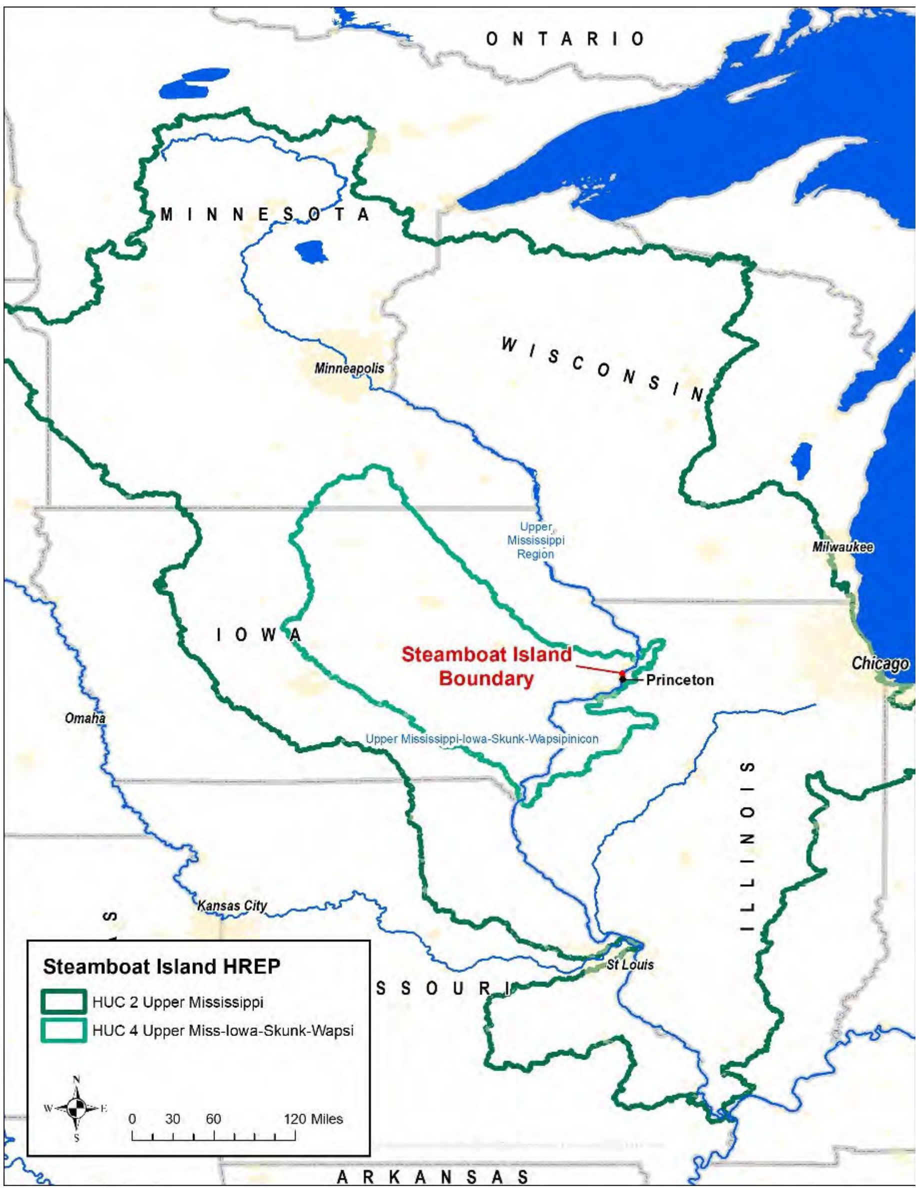

Figure H-65: Location of Project Area Within HUC2 and HUC4

Projected hydrology under future climate conditions is generated using a hydrologic model with precipitation and temperature input parameters derived from GCM output. The range in projected annual maximum monthly streamflow is computed based on 93 different climate changed hydrologic model simulations for the 1981-2099 WY period. Results for the Upper Mississippi-Iowa-Skunk-Wapsipinicon watershed shown in Figure H-66 indicate there is a lot of uncertainty in projected climate changed hydrology. Nevertheless, there is a statistically significant increasing trend in the mean projected annual maximum monthly streamflow (Figure H-67). Based on the trendline, over the 50-year project life, annual maximum monthly flows could increase by nearly 2,020 cfs (Figure H-67. The range in annual maximum monthly discharge over the most recent 30-year period (1987-2016) for USGS gage 05420500 (Mississippi River at Clinton, Iowa) is 62,750 cfs (1988) to 257,000 cfs (2001),. Therefore, the mean projected increase in annual maximum monthly streamflow (~3% of 62,750) is not considered to have operationally significant impacts over the life of the project. These results are qualitative only.

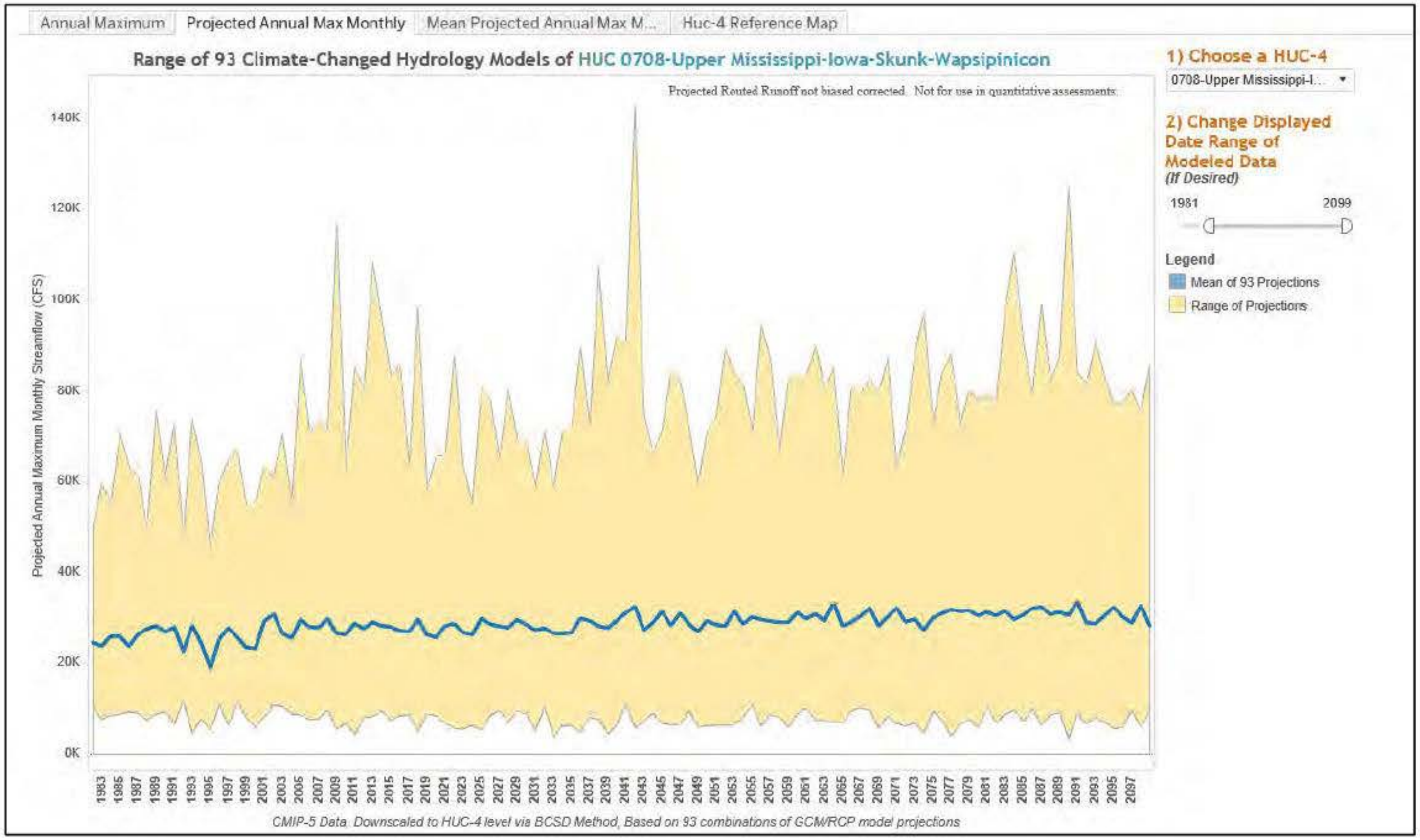

Figure H-66: Range in Projected Annual Maximum Monthly Streamflow for the Upper Mississippi-Iowa-Skunk-Wapsipinicon Watershed (HUC 0708)

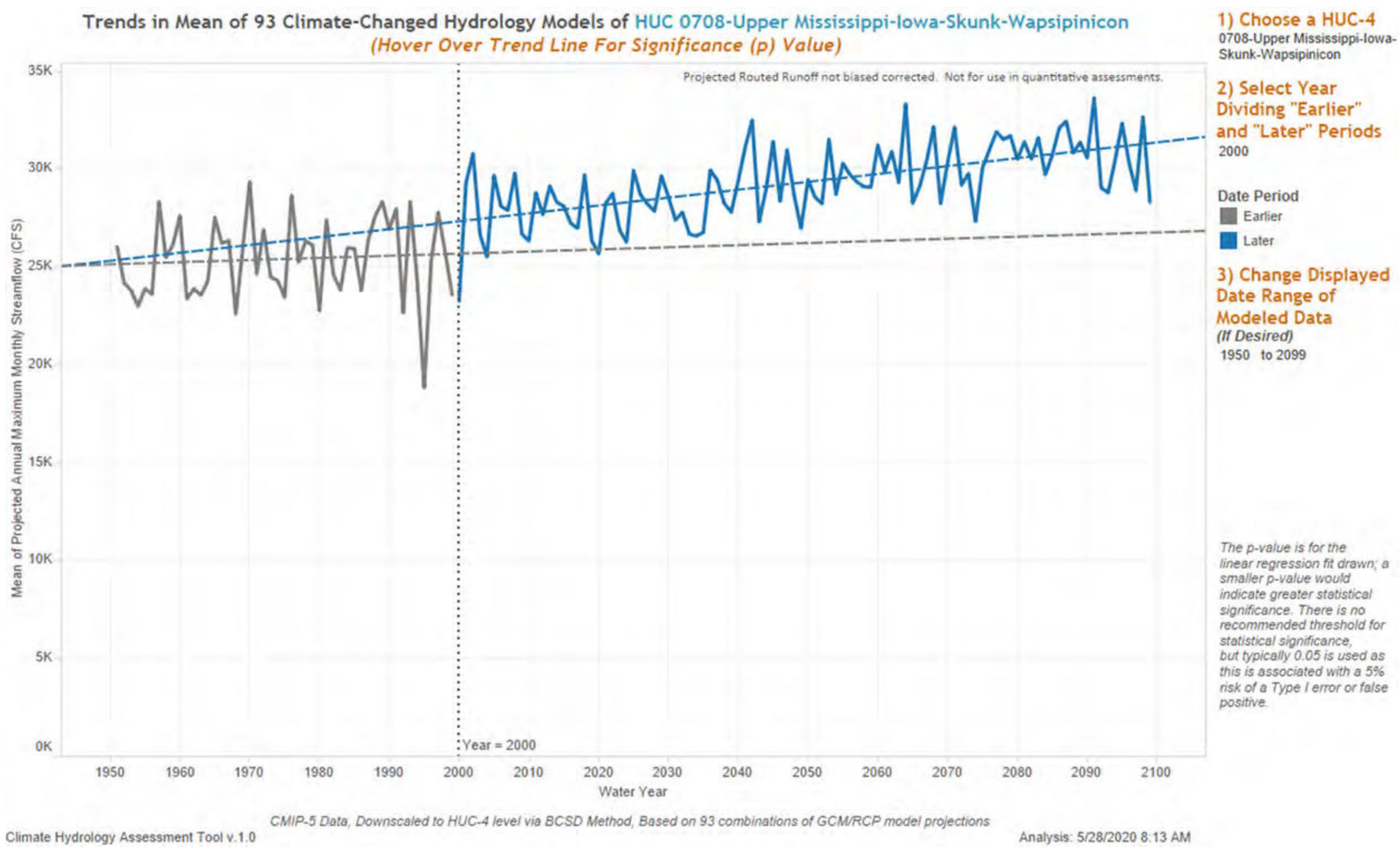

Figure H-67: Mean Projected Annual Maximum Monthly Streamflow for the Upper Mississippi-Iowa-Skunk-Wapsipinicon Watershed (HUC 0708)
[Trendline Equation: Q = 40.3183*(Water Year) – 53326.3, $p < 0.0001$]

2. USACE Watershed Climate Vulnerability Assessment Tool. The purpose of the USACE Watershed Climate Vulnerability Assessment Tool is to compare the relative vulnerability of the Project's HUC 04 watershed to climate change with that of the other 202 HUC 04 watersheds throughout the continental United States (CONUS). The tool provides a screening level comparative assessment of vulnerability to climate change according to business line. The tool is intended to identify climate threats and vulnerabilities for a specified region and business line using the Weighted Order Weighted Average (WOWA) method to calculate a composite index (Vulnerability Score).

The Project is located within HUC 0708, the Upper Mississippi-Iowa-Skunk-Wapsipinicon watershed and the UMRR Program is part of the "Ecosystem Restoration" business line (Figure H-68). Indicators including change in sediment load, short-term variability in hydrology, runoff elasticity (ratio of streamflow runoff to precipitation), macroinvertebrate index (sum score of six metrics indicating biotic condition), two indicators of flood magnification (indicator of how much high flows are projected to change overtime), mean annual runoff, change in low runoff, and percent of at risk freshwater plant communities are used to calculate WOWA scores under Ecosystem Restoration. HUC-4 watersheds with the top 20% of WOWA scores are flagged as being vulnerable. The default National Standards setting was used when conducting this vulnerability assessment.

Results of the Vulnerability Assessment Tool suggest that ecosystem restoration efforts in HUC0708, the Upper Mississippi-Iowa-Skunk-Wapsipinicon watershed, are relatively less vulnerable to climate change compared to the other 202 HUC 04 watersheds in the CONUS (Figure H-68). Vulnerability scores for the two 30 year epochs indicate little change between epochs and little change between the wet and dry traces (Table H-19). Contributions to the overall vulnerability score from each of the different indicators for the ecosystem restoration business line and the 2050 epoch are shown in Table H-20. The dominant indicators contributing to the HUC0708 vulnerability scores are At-Risk Freshwater Plants (38%), Runoff Elasticity (24%), and Macroinvertebrate Index (12%).

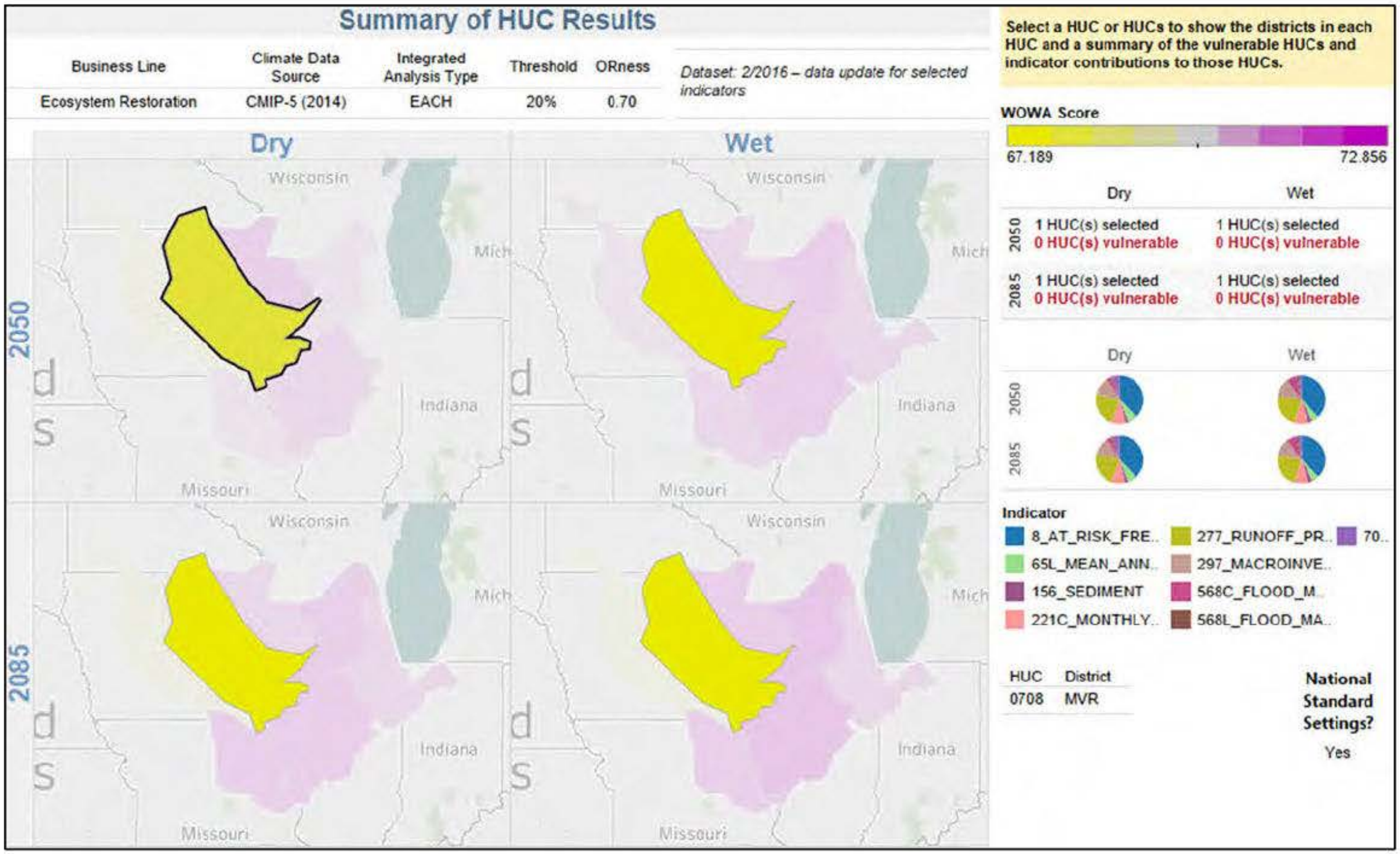

Figure H-68: Projected Vulnerability for Ecosystem Restoration Within the Upper Mississippi-Iowa-Skunk-Wapsipinicon (0708)

Table H-19: Projected Vulnerability for Ecosystem Restoration Business Line

	Ecosystem Restoration Vulnerability Score			
HUC 04 Watershed	**2050 Dry**	**2050 Wet**	**2085 Dry**	**2085 Wet**
Mississippi River (0708)	67.965	67.189	67.540	67.779

Table H-20: Individual Indicator Contributions Related to Ecosystem Restoration

2050 Epoch	**Mississippi River 0708**	
	Dry	**Wet**
Indicator	**Contribution to WOWA Ecosystem Restoration Vulnerability Score**	
Sediment	1.45	2.21
Monthly Covariance	6.17	5.97
Runoff Elasticity	16.02	15.28
Macroinvertebrate	8.36	8.27
Flood Magnification - Cumulative	1.99	4.32
Flood Magnification - Local	0.82	1.02
Mean Annual Runoff	4.36	3.23
Change in Low Runoff	3.12	1.48
At Risk Freshwater Plants	25.68	25.41

E. Phase III: Risk Assessment and Conclusions

1. Observed and Projected Changes. Available literature suggests a wetter and warmer climate in the future for the Project area. The streamflow record nearest the Project area, at the Clinton, Iowa gage, did not indicate any statistically significant trends in observed peak annual streamflow for the 1940-2014 time period. As described previously, design elevations for floodplain forest restoration are driven by growing season inundation durations, rather than peak annual streamflow. Annual growing season inundation duration records indicate statistically significant upward trends in the 35 and 45-day time series based on simple linear regression, while a statistically significant upward trend in the 55-day inundation duration record was identified by both the simple linear regression and the Spearman Rank-Order tests (Table H-18). Observed increases in stage duration, as illustrated in Figures H-8 and H-10 and described in Section V, B. *Flood Condition*s, further support the need for a more resilient floodplain forest design in an uncertain future hydrologic regime.

Hydrologic projections based on future climate conditions indicate significant uncertainty; however, mean projected annual maximum monthly streamflow illustrates a statistically significant upward trend over the project life and the next 80 years.

2. Recommendations. Flooding attributes such as duration, frequency, depth and timing have been identified throughout the literature as being among the primary drivers of floodplain forest ecology. As described in Section VIII, B. *Topographic Diversity Measures,* elevations supportive of hard mast tree recruitment were characterized for this study based on growing season inundation duration and annual exceedance probability. Statistical significance was identified for increasing upward trends in the 35, 45 and 55-day annual inundation duration time series. Furthermore, as illustrated in Figures H-8 and H-10, stage durations have increased over time at the Camanche gage. If stage durations continue to increase, inundation duration of forested areas will increase, resulting in associated tree mortality and greater loss of floodplain forest diversity. To account for this uncertain future, an approach that evaluated the design elevation criteria for the current and historic 30-year periods was used to extrapolate potential design elevations for a future 50-year period, as detailed in Section VIII, B. *Topographic Diversity Measure* (Table H-15). The difference in the elevation meeting the specified inundation duration criteria based on the historic 30-year period relative to the current 30-year period was used to compute a rate of change. This rate of change in inundation duration was assumed into the future and design elevations for floodplain forest and scrub-shrub pollinator habitat considered this potential 50-year future condition. Table H-15 summarizes the inundation duration-based design criteria with and without the extrapolated trend.

Table H-21 shows a summary of climate risks posed to the Project. Project measures supporting the topographic diversity objective are at risk to increased flood frequency and duration. However, increasing the design elevation for these measures as described in Section VIII, B. *Topographic Diversity Measures*, provides resiliency in an uncertain hydrologic future.

Table H-21: Climate Risk Summary

Objective	Trigger	Hazard	Harm	Qualitative Likelihood & Uncertainty
Topographic Diversity (Floodplain Forest Diversity)	Increased precipitation from larger, slower moving storms	Future flood events may be larger than present and occur more frequently and potentially have an increased duration	Long duration and more frequent flood events increase risk of flood-induced tree mortality and increase risk for invasives like reed canary grass	Somewhat Likely
Aquatic Diversity	Increased precipitation from larger, slower moving storms	Extreme precipitation events may be increasing in frequency and intensity	Heavy rain can increase the risk of erosion that may contribute to higher suspended sediment concentrations and increase sediment deposition rates reducing overwintering depths	Uncertain
Aquatic Diversity	Earlier seasonal snowmelt and longer ice-free periods resulting from increased temperatures	Lack of ice cover supports good light penetration, photosynthesis and dissolved oxygen concentration	Reduced duration of ice cover may decrease the risk for periods of low dissolved oxygen for overwintering fish species	Somewhat Likely
Topographic Diversity (Bankline Restoration & Island Restoration)	Increased precipitation from larger, slower moving storms	Future flood events may be larger than present and occur more frequently potentially have an increased duration	Long duration and more frequent flooding can increase the risk of saturated soils, felled trees, and subsequent bankline erosion and island loss	Somewhat Likely

XI. FLOODPLAIN ASSESSMENT OF THE RECOMMENDED PLAN

The Project area is located in both Iowa and Illinois, with much of the Project area located in the Mississippi River floodway. In order to demonstrate that the Project complies with the Federal Emergency Management Agency's (FEMA) "no-rise" requirement, and requirements necessary to obtain state floodplain permits, flood profile effects due to the Recommended Plan were assessed based on both State of Iowa and State of Illinois criteria. The State of Iowa interprets this as limiting the rise to the 0.01AEP water surface profile to 0.009 feet per Iowa Administrative Code 567 (2019). The State of Illinois requires evaluation of water surface profiles under a range of discharge conditions to ensure no rise exceeds 0.04 feet.

In order to model the water surface profile impacts due to the Recommended Plan, HEC-RAS v5.0.6 (USACE, 2016) was used to compute the water surface profiles resulting from 'existing conditions' and 'with-Project'. The 2004 effective floodway HEC-RAS model for the Mississippi River Navigation Pool 14 (RM 592.4-RM 493.3) served as the starting point for this modeling effort. This effective model was updated to convert the vertical datum to NAVD 88 and the projection to Illinois West State Plane. Twenty-one additional cross sections were added (between RS 506-502.5) to create a base condition model that more accurately represents existing (current) conditions within the Project reach and better captures the rise due to the Recommended Plan. The resulting cross-section layout within the Project reach and the 'with-Project' terrain are shown in Figure H-69. For the State of Iowa analysis, base model cross-section elevations were determined based on recommendations from the IA DNR Floodplain Management Engineer. Base condition model cross-section elevations throughout most of the Pool 14 model reach are from the effective model, with the exception of most all of the cross-sections throughout the Project reach (RS 506-RS 502.5) whose elevations came from the refined 'existing conditions' elevation model (terrain). Within the Project reach, only RS 506 and RS 505.5, located immediately upstream of and at the location of the USI measure, maintained elevations from the effective model. Additional and updated cross-sections included in the base condition geometry adopted Manning's roughness values that most closely represent the values assigned within the effective model. 'With-Project' model cross-section elevations came from a 'with-Project' terrain. The 'with-Project' terrain includes all Recommended Plan features, therefore both dredge cut features and placement features are included in the "with-Project" geometry. Manning's roughness values for Steamboat Slough were decreased from 0.03 to 0.029 in the 'with-Project' geometry to account for the increased depth and conveyance relative to the effective model.

The State of Illinois analysis used the same refined cross-section layout as defined for the State of Iowa base condition model. Similarly, cross-section elevations throughout most of the Pool 14 model reach are from the effective model, with the exception of the cross-sections throughout the Project reach (RS 506-RS 502.5),where elevations were defined based on the refined 'existing conditions' terrain. Like the State of Iowa analysis, additional and updated cross-sections included in the base condition geometry for the State of Illinois analysis adopted Manning's roughness values that most closely represent the values assigned within the effective model and 'with-Project' model cross-section elevations came from the 'with-Project' terrain. Manning's roughness values for Steamboat Slough were decreased from 0.03 to 0.029 in the 'with-Project' geometry to account for the increased depth and conveyance relative to the effective model.

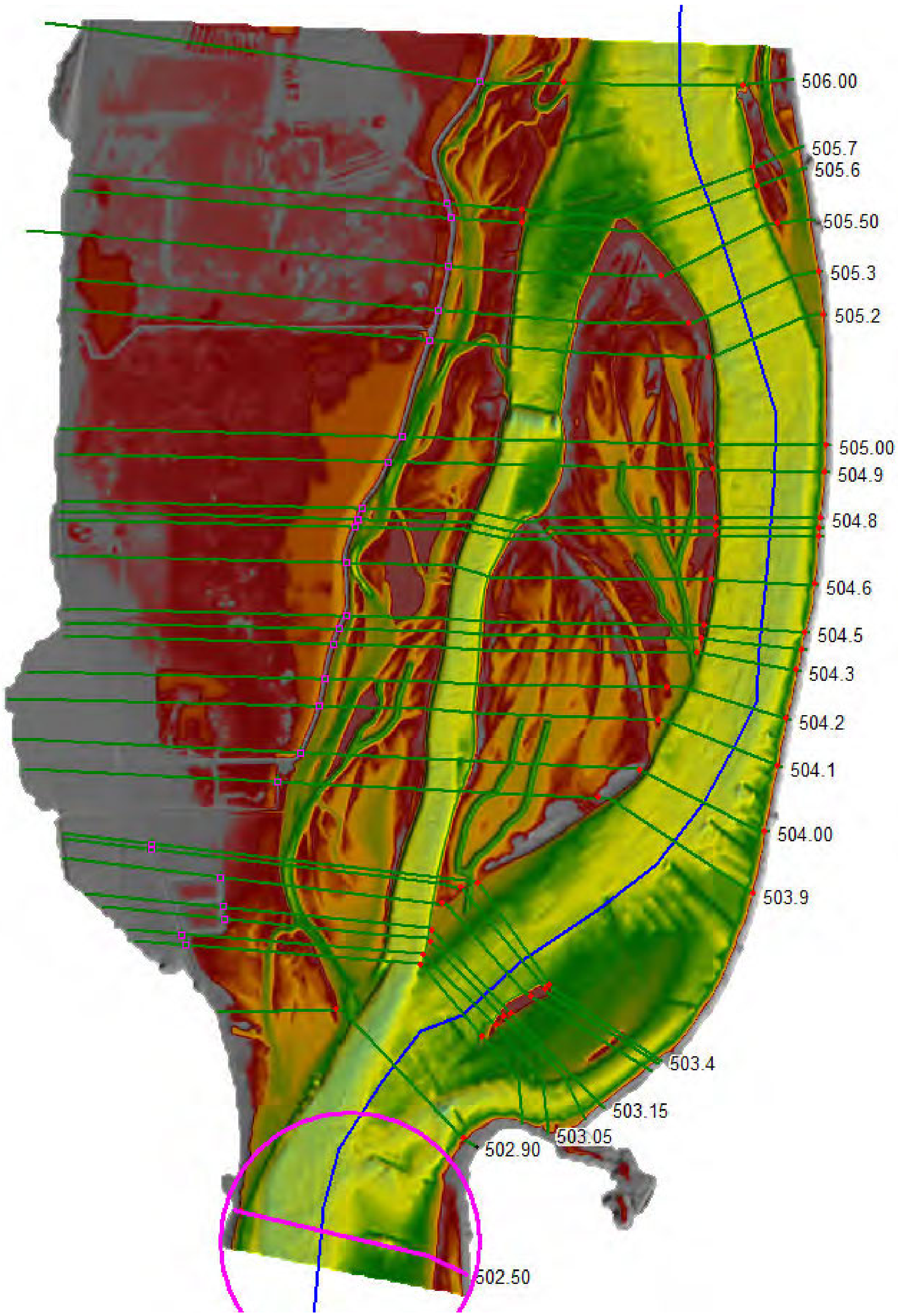

Figure H-69: Base Condition and With-Project Model Cross-Section Locations

For the State of Iowa analysis, the 0.01 AEP discharge was simulated for both the base condition and the with-Project condition. The results from the ‘with-Project’ simulation indicate that the Recommended Plan results in “no-rise” per Iowa Administrative Code 567 and the State’s allowable rise of 0.009’ (2019). A maximum rise of 0.007 foot occurred at RS 503.4. Figure H-70 shows the base condition and ‘with-Project’ 0.01 AEP water surface profiles. During further coordination with the IA DNR Floodplain Management office, it was discovered that even though the District must demonstrate compliance with FEMA’s “no-rise” requirement, the State of Iowa would not be issuing a floodplain permit for the Steamboat Island HREP because the Project is 100% federally-owned.

For the State of Illinois analysis, a range of flow conditions (0.5, 0.2, 0.1, 0.04, 0.02, 0.01 AEP) were simulated for both the base condition and the ‘with-Project’ condition. The results from the ‘with-Project’ simulations show that the Recommended Plan produces “no-rise” based on the State’s allowable rise of 0.04 foot. A maximum rise of 0.04 foot occurred under 0.1 AEP flows at RS 506 and RS 505.7. Figure H-71 shows the base condition and ‘with-Project’ 0.1 AEP water surface profiles. Coordination with the State of Illinois will take place during Plans and Specifications to ensure Project features (placement and dredge cut features) are appropriately modeled. A floodplain permit application will be filed with the State of Illinois once final design drawings are complete.

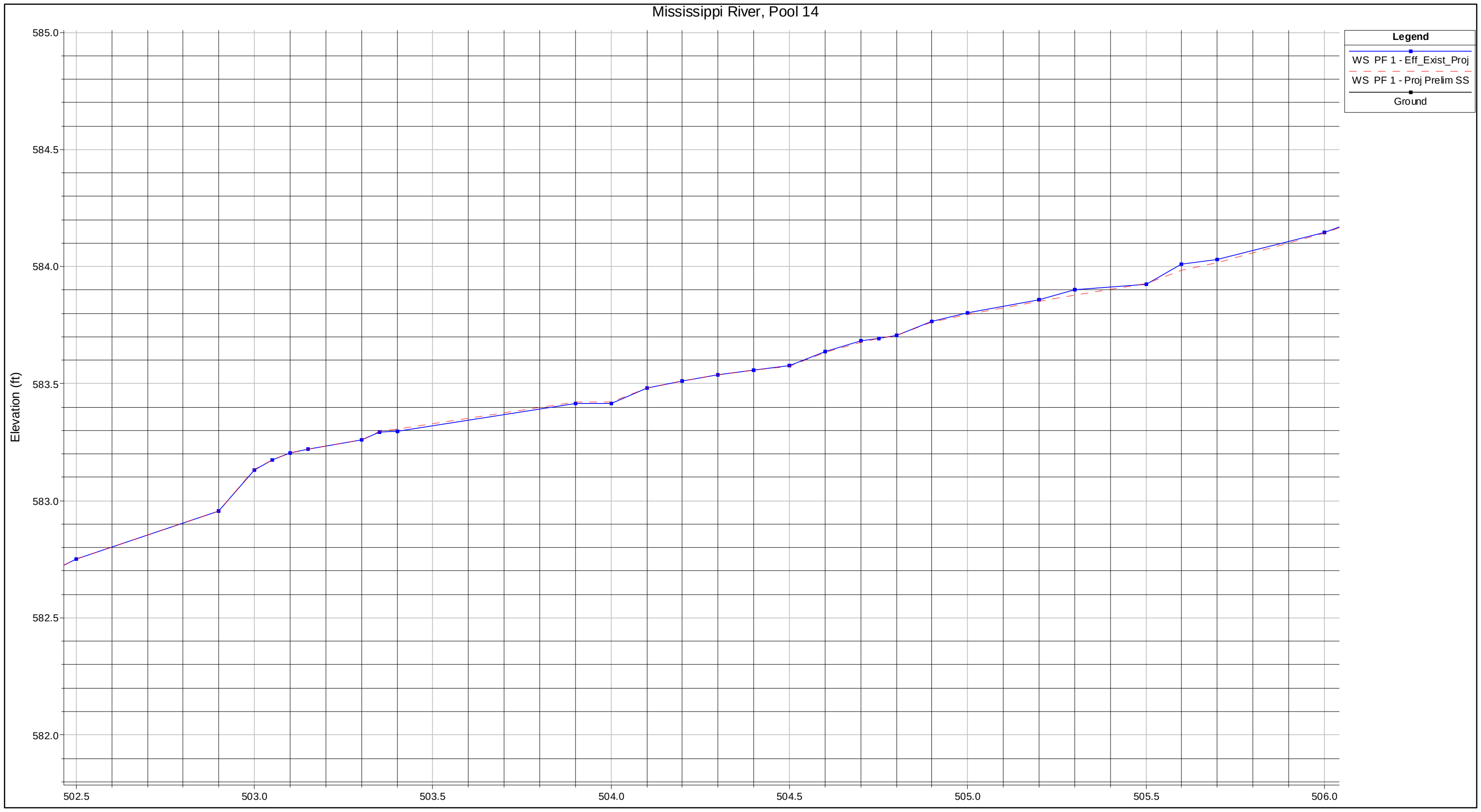

Figure H-70: Base Condition (Blue) and With-Project Condition (Red) 0.01 AEP Water Surface Profiles Throughout the Project Reach (RS 506-RS 502.5)

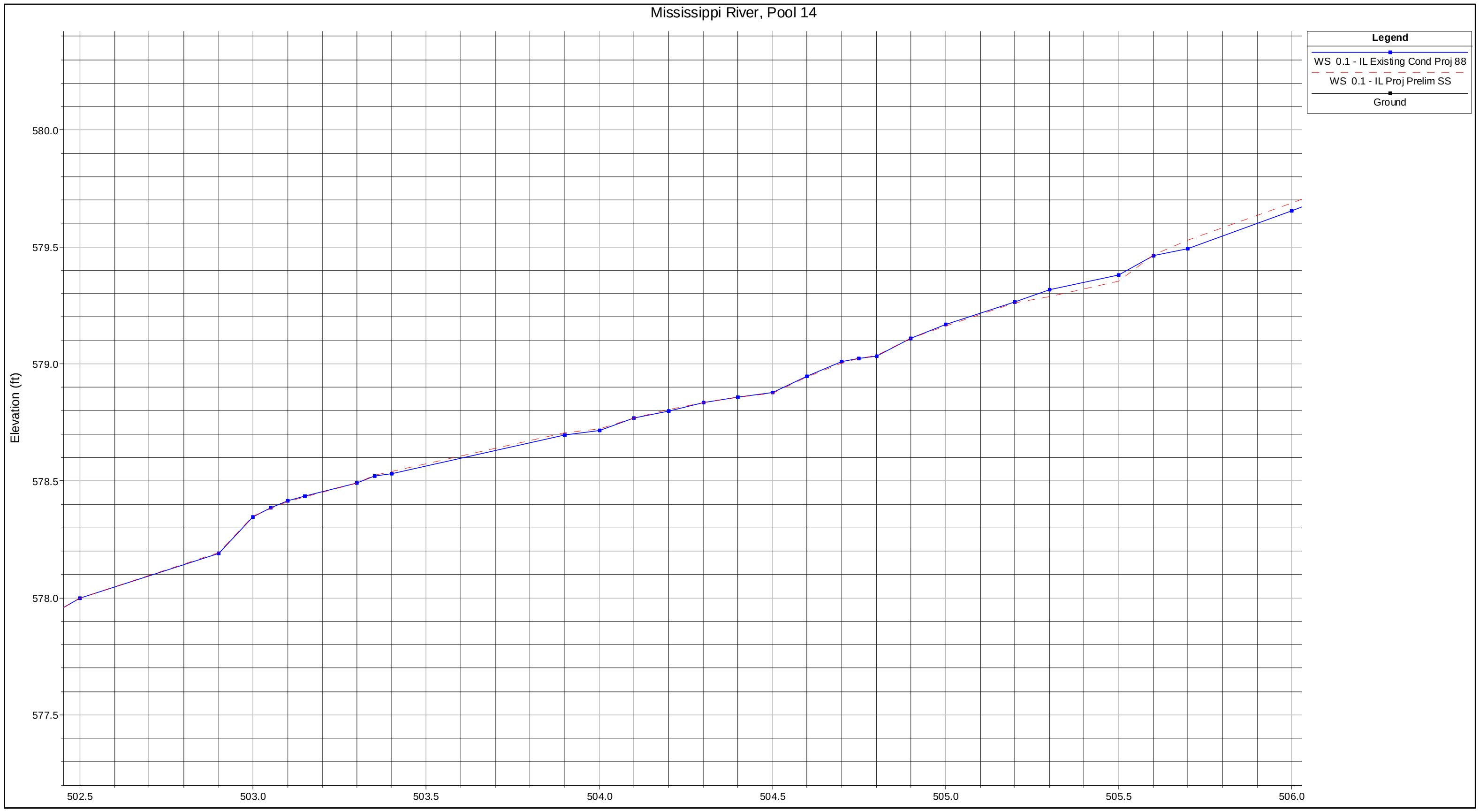

Figure H-71: Base Condition (Blue) and With-Project Condition (Red) 0.1 AEP Water Surface Profiles Throughout the Project Reach (RS 506-RS 502.5)

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
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STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA, AND
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APPENDIX I

COST ESTIMATE

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APPENDIX I

COST ESTIMATE

I. INTRODUCTION

This appendix contains a Total Project Cost Summary (TPCS) prepared for the *Steamboat Island Habitat Rehabilitation and Enhancement Project* (Project). The Project is located in Clinton and Scott Counties, Iowa, and Rock Island County, Illinois, in the middle section of Pool 14 of the UMR, between RM 502.5 and 508.0. The vast majority of the Project area is owned by the U.S. Army Corps of Engineers in fee, with the remaining area owned by the U.S. Fish and Wildlife Service (USFWS) in fee (see Appendix J, *Real Estate Plan*).

II. PROJECT DESCRIPTION

A description of the Project area and scope can be found in the Main Report, Sections I, *Introduction*, and II, *Affected Environment*.

Project goals and objectives can be found in the Main Report, Section III, *Problems and Opportunities*. Information on enhancement measures that were considered to achieve the Project goals and objectives can be found in the Main Report, Section IV, *Potential Project Measures*.

Once construction is complete, the Project will be monitored and various adaptive management processes may be implemented to improve designed measures/systems, if required. Additional information on Project performance monitoring and adaptive management can be found in the Main Report, Section X, *Project Performance Assessment Monitoring*, and Appendix K, *Monitoring and Adaptive Management Plan*

III. COST METHODOLOGY

A. General. This Fully Funded Estimate (FFE) has been prepared to February 2020 price levels. The costs are considered to be fair and reasonable to a well-equipped and capable contractor and include overhead and profit. The preparation of this estimate was created in accordance with Engineering Regulation (ER) 110-1-1300, *Cost Engineering Policy and General Requirements* (26 March 1993) and ER 1110-2-1302, *Civil Works Cost Engineering* (30 June 2016). The FFE was completed in accordance with Engineering Manual (EM) 110-2-1304, *Civil Works Construction Cost Index System (CWCCIS)*, revised 31 March 2018

The estimate was developed using Micro Computer Aided Cost Estimate System MII v4.4 cost estimating software. Applicable crews and equipment were applied in the estimate to correspond with the work being performed. Material prices were developed using the MII Cost Book; R.S. Means references and quotes obtained from suppliers. The midpoint of construction is anticipated to be the 3rd quarter of 2025.

This Project is assumed to be a restricted Small Business Competitive-type contract and properly evaluated in the determination of what contingency value to apply.

B. Direct Cost. Direct costs are based on the anticipated material, equipment and labor needed to construct the Project based on the current scope of work. Material price quotes were obtained for the riprap. Tree and shrub material and planting prices were based on past District tree planting contracts provided by the Project forester. Direct costs were calculated independent of the contractor assigned to perform the work. Contractor assignments were determined after the formulation of the direct costs. The majority of the work is assumed to be done by an earthwork contractor, with the remaining specialized work being performed by several subcontractors. It is assumed the prime contractor will perform Project coordination and oversight with construction work.

1. Labor-Rate Determination. Labor Rates are based on 2019 Davis-Bacon Wage Rates General Decision Heavy and Highway IA20190001 11/01/2019 and Heavy River Work IA20190002 11/01/2019 for Scott County, IA.

2. Equipment Rates. All equipment costs are from MII Equipment Region 5 2016 and MII English Cost Book 2016.

3. Fuel Rates. Rates have been updated as of May 2020. Current fuel prices are based on Midwest averages from www.eia.gov/petroleum/gasdiese and includes gasoline, on-road diesel, and off-road diesel.

4. Overtime Considerations. Overtime was considered for all construction, including dredging operations. A 10-hour/5 days per week shift was assumed for most construction and a 12-hour/5 days per week shift was assumed for dredging.

5. Sales Tax. Sales tax has not been included or applied to material costs. Sales tax is not applicable in the cost estimate for the States of Iowa or Illinois. The contractors will likely receive reimbursement for construction materials from these states.

6. Productivity. Production rates were created based on historical rates used in the Cost Engineering Section in Rock Island District and on what was determined reasonable by the Cost Estimator. In addition, user crews were created using the Estimator's judgment.

C. Indirect Costs. Contractor assignments were determined after the formulation of the direct costs. Each of the contracts were assigned a Prime Contractor with the associated subcontractors. Due to different construction schedules and scope of work the percentages for the markups may vary between the contracts.

Prime Contractor: Will perform mechanical dredging operations, including barge delivery of dredge material to placement sites, placement, and pushing/shaping. Will also deliver by truck and barge and place riprap, perform some excavation for key trenches, install temporary access ramp and culverts, and provide erosion control.

Tree and Shrub Planting Subcontractor: Will perform tree and shrub cutting and clearing, processing, and hauling of tree/shrub debris, and deliver and plant containerized grass forbs, bare root seedling and rooted cuttings, trees, and shrubs for dredge placement sites. Will also perform tree cutting and clearing, processing, and hauling of tree/shrub debris, and deliver and plant containerized trees for TSI sites, native species establishment seeding, and cover crop seeding.

Surveying Subcontractor: Will perform all Surveying Work.

QC Subcontractor: Will perform all Quality Control Work.

1. **Prime Contractor**

a. Job Office Overhead. Overhead rate for Job Office Overhead (JOOH) was calculated with itemized costs, based on the developed construction schedule. In this case, a value of 13% was calculated for the Prime Contractors. This is higher than the recommended rate of 9% for a job this size, but the costs associated with a field office environment that is located in a remote backwater area is assumed to call for a somewhat higher percentage.

b. Home Office Overhead. Overhead rate for Home Office Overhead (HOOH) was applied as a running percentage. In this case, a value of 8% was applied for the Prime Contractor. Home Office Overhead includes such items as office rental/ownership costs, utilities, office equipment ownership/maintenance, office staff (managers, accountants, clerical, etc.), insurance, and miscellaneous costs. In reality, the range of home office overhead can be quite broad and depends largely on the contractor’s annual volume of work and the type of work that is generally performed by the contractor (own work and subcontracted work).

c. Profit. Profit has been included and was applied using the profit weighted guidelines. In this case, a value of 8.7% was calculated for the Prime Contractor (own work and subcontracted work) due to the medium level difficulty for the type of work involved.

d. Bond. Bond was included based on the Bond Table as class B. In this case, a value of just over 0.7% was calculated for the Prime Contractor (own work and subcontracted work).

e. Insurance. Insurance was included and applied as a running percentage. A value of 3% was applied for the Prime Contractor.

2. Subcontractors

a. Job Office Overhead. Overhead rates for JOOH were applied as a running percentage. In this case, a value of 10% was applied to the Tree and Shrub Planting Subcontractor (for items without a historical cost) and, based on past projects, a value of 48% for the Survey and QC Subcontractors.

b. Home Office Overhead. Overhead rates for HOOH were applied as a running percentage. In this case, a value of 7% was applied to the Tree and Shrub Planting Subcontractor (for items without a historical cost) and, based on past projects, a value of 105% for the Survey and QC Subcontractors.

c. Profit. Profit has been included and was applied as a running percentage. In this case, a value of 8% was assumed for the Tree and Shrub Planting Subcontractor (for items without a historical cost) and, based on past projects, a value of 11% for the Survey and QC Subcontractors.

D. Escalation. In the TPCS Reports, the Project costs have been escalated to the midpoint of construction for each contract.

E. Contingency. After review of Project documents and PDT discussion, an informal risk analysis was conducted, resulting in the development of a 34% contingency and Total Project Cost greater than $40 million. A Crystal Ball study was performed in January and February 2020, resulting in a reduction of the contingency for all Project construction measures to 20%. This contingency was developed to reflect the uncertainty associated with the work measures and includes the development of the contingencies applied to Planning, Engineering, and Design (PED) as well as Construction Management measure accounts. Appendix I-B shows the Crystal Ball Risk Analysis Contingency Determination Report and two tabs from the calculations spreadsheet.

F. Other Assumptions

1. Mobilization. Equipment needs were identified from work items in the MII estimate. Equipment was assumed to be mobilized within 150 miles for land based equipment. Marine equipment was assumed to be mobilized within a distance consistent with this type of work in this region. Different periods for mobilization were created based on the construction schedule.

2. Government Furnished Materials. The estimate is based on no government furnished materials.

3. Site Access. It is assumed that the site can be accessible from March 15 to December 5 of each year for most construction, except in the event of a flood. However, clearing work will take place between October 1 and March 31.

4. Waste Disposal. For crop tree release, trees and brush debris cleared on the site will be "slashed and scattered". For tree clearing work, the debris will be chipped and hauled offsite. Disposal fees are not necessary since the wood chips can likely be sold. It is assumed that there will be no other disposal removal from the site, except for possibly the temporary culverts.

5. Construction Restraints. There is to be no work performed during the period of December 5 through March 31, except tree clearing. There is to be no clearing of trees during the period of April 1 through September 30 due to the federally-endangered Indiana bat and northern long-eared bat maternity season of April 1 to September 30. There is an active bald eagle nest located at the northern end of Steamboat Island. Any tree thinning would be minimal near this area to avoid disturbance. Seasonal limitations will be in compliance with USFWS regulations and adhere to buffer restrictions (660 feet) during critical nesting periods. The following are restricted time periods for tree and shrub planting:

- Containerized trees planting season would be from mid-October to December 5th (prior to frozen ground conditions).
- Bare root seedlings planting season would be April 1 to May 20.
- Native direct seeding would be April 1 to May 20.
- Cover Crop direct seeding would be April 1 to May 20 and August 20 to September 20.

IV. PROJECT MEASURE ACCOUNTS

A. (01) Lands and Damages. The estimated lands and damages is $0 (typically includes contingency factor added during real estate appraisal process). This figure represents what the USFWS will have to pay for the necessary real estate interest (Permanent Flowage Easement). Incidental USFWS costs associated with acquiring real estate interest (survey, title, appraisal, negotiations, etc.) is $0.

B. (06) Fish and Wildlife Facilities. The items included in this account are mechanical dredging operations, including barge delivery of dredge material to placement sites, placement, and pushing/shaping. Other tasks include pre- and post-dredging surveys, install temporary access ramp and culverts, and provide erosion control. Also included are adaptive management and monitoring and TSI measures to include tree clearing, processing and hauling of tree debris, native species establishment seeding, cover crop seeding, and bare root seedling and rooted cuttings, grass forb, tree, and shrub planting over a period of eight years. Other items in this account are miscellaneous tasks such as, staking out tree locations and tree clearing limits.

C. (16) Bank Stabilization. The items included in this account are delivery by truck and barge and placement of riprap. Other items in this account are miscellaneous tasks such as, some excavation for key trenches and pre- and post-surveys.

D. (30) Planning, Engineering, and Design. The work covered under this account includes the Project Management and the Planning, Engineering, and Design (PED) costs spent to date as well as the remaining estimated costs that will be associated with the engineering and design for this Project. The Project Manager determined the percentages for PED.

E. (31) Construction Management. The work covered under this account includes the expected costs for contract supervision, contract and construction administration, technical management activities, district office supervision, and administration costs. The Project Engineer and Project Manager determined the percentages for Construction Management.

V. PROJECT SCHEDULE

For the Recommended Plan, the estimated duration of the Project is from 1st quarter Fiscal Year (FY) 22 to 4th quarter FY 25 (not including tree planting) and 1st quarter FY 29 (including tree planting), which is based on the construction starting in FY 22. The schedule was created following the durations for crews and equipment in the MII estimate. Any clearing or construction dates take into account the restrictions to construction activity because of the Indiana bat migration/nesting schedule. In addition, the Project duration also includes the execution of the planting of timber stand improvements over a four-year period. Due to the size of this Project and the sequencing of construction measures it has been assumed that the Recommended Plan may be procured by separate contracts. Appendix I-C shows the Construction Duration Schedule.

VI. TOTAL PROJECT COST

For the Recommended Plan construction, PED, and construction management costs, the total Estimated Cost for the Current Working Estimate is $33,609,859 (includes contingency). The Constant Dollar Basis cost is $36,264,235 (includes contingency and escalation). The Total Project Cost for the FFE is $38,995,092 at 2020 fiscal year pricing (includes contingency, escalation, and inflation). Based on the construction schedule, work will commence in November, 2021.

There is no cost sharing on this Project. Appendix I-A shows the TPCS.

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX I-A

TOTAL PROJECT COST SUMMARY

PROJECT: **Steamboat Island HREP Major Rehabilitation**
PROJECT NO: **P2 335105**
LOCATION: **Scott and Clinton Counties, IA and Rock Island County, IL - Mississippi River, Pool 14, RM 502.5-508.0**

DISTRICT: **MVR District** PREPARED: **3/30/2020**
POC: **CHIEF, COST ENGINEERING, Charles Van Laarhoven**

This Estimate reflects the scope and schedule in report; Steamboat Island HREP Design Report - Appendix M December, 2019

Civil Works Work Breakdown Structure		**ESTIMATED COST**				**PROJECT FIRST COST (Constant Dollar Basis)**						**TOTAL PROJECT COST (FULLY FUNDED)**			
							Program Year (Budget EC):			2021					
							Effective Price Level Date:			1-Oct- 20					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	REMAINING COST ($K)	Spent Thru: 7-Jan-20 ($K)	**TOTAL FIRST COST ($K)**	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
06	FISH & WILDLIFE FACILITIES	$11,384	$2,277	20%	$13,661	3.1%	$11,734	$2,347	$14,080		$14,080	8.8%	$12,771	$2,554	$15,325
06	FISH & WILDLIFE FACILITIES	$2,919	$584	20%	$3,503	3.1%	$3,009	$602	$3,610		$3,610	11.1%	$3,342	$668	$4,010
06	ADAPTIVE MANAGEMENT	$212	$42	20%	$255	3.1%	$219	$44	$263		$263	14.3%	$250	$50	$300
16	BANK STABILIZATION	$7,479	$1,496	20%	$8,975	3.1%	$7,708	$1,542	$9,250		$9,250	5.9%	$8,161	$1,632	$9,793
			-			-						-			
	CONSTRUCTION ESTIMATE TOTALS:	$21,994	$4,399		$26,393	3.1%	$22,670	$4,534	$27,203		$27,203	8.2%	$24,524	$4,905	$29,429
01	LANDS AND DAMAGES		-			-						-			
30	PLANNING, ENGINEERING & DESIGN	$3,765	$753	20%	$4,518	3.8%	$3,909	$782	$4,691	$1,568	$6,259	4.5%	$4,084	$817	$6,469
31	CONSTRUCTION MANAGEMENT	$2,249	$450	20%	$2,699	3.8%	$2,335	$467	$2,802		$2,802	10.6%	$2,582	$516	$3,098
	PROJECT COST TOTALS:	$28,008	$5,602	20%	$33,610		$28,914	$5,783	$34,696	$1,568	**$36,264**	7.9%	$31,189	$6,238	$38,995

CHIEF, COST ENGINEERING, Charles Van Laarhoven

PROJECT MANAGER, Julie Millhollin

CHIEF, REAL ESTATE, Jody Rowe

CHIEF, PLANNING, XXX

CHIEF, ENGINEERING, XXX

CHIEF, OPERATIONS, XXX

CHIEF, CONSTRUCTION, XXX

CHIEF, CONTRACTING, XXX

CHIEF, PM-PB, xxxx

CHIEF, DPM, XXX

ESTIMATED TOTAL PROJECT COST:	100%	**$37,427**
ESTIMATED FEDERAL COST:		
ESTIMATED NON-FEDERAL COST:		
PLANNING SPENT COSTS:		**$1,568**
ESTIMATED TOTAL FEDERAL PROJECT COST:		**$38,995**

	$K
O&M OUTSIDE OF TOTAL PROJECT COST:	**$7**
PERFORMANCE MONITORING OUTSIDE OF TOTAL PROJECT COST:	**$469**
LONG-TERM MONITORING OUTSIDE OF TOTAL PROJECT COST:	**$1,080**

**** CONTRACT COST SUMMARY ****

PROJECT: Steamboat Island HREP Major Rehabilitation
LOCATION: Scott and Clinton Counties, IA and Rock Island County, IL - Mississippi River, Pool 14, RM 502.5-508.0
This Estimate reflects the scope and schedule in report; Steamboat Island HREP Design Report - Appendix M December, 2019

DISTRICT: MVR District
POC: CHIEF, COST ENGINEERING, Charles Van Laarhoven
PREPARED: 3/30/2020

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 14-Jan-20				Program Year (Budget EC): 2021								
		Estimate Price Level: 1-Oct-19				Effective Price Level Date: 1 -Oct-20								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 1 or CONTRACT 1													
06	FISH & WILDLIFE FACILITIES			20.0%										
06	FISH & WILDLIFE FACILITIES	$542	$108	20.0%	$650	3.1%	$558	$112	$670	2022Q1	3.0%	$575	$115	$690
06	ADAPTIVE MANAGEMENT			20.0%										
16	BANK STABILIZATION			20.0%										
	CONSTRUCTION ESTIMATE TOTALS:	$542	$108	20.0%	$650		$558	$112	$670			$575	$115	$690
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$11	$2	20.0%	$13	3.8%	$11	$2	$14	2021Q2	0.9%	$12	$2	$14
	Planning & Environmental Compliance			20.0%										
8.0%	Engineering & Design	$43	$9	20.0%	$52	3.8%	$45	$9	$54	2021Q2	0.9%	$45	$9	$54
	Reviews, ATRs, IEPRs, VE	$3	$1	20.0%	$4	3.8%	$3	$1	$4	2021Q2	0.9%	$3	$1	$4
	Life Cycle Updates (cost, schedule, risks)	$0.4	$0	20.0%	$0	3.8%	$0	$0	$0	2021Q2	0.9%	$0	$0	$0
	Contracting & Reprographics	$1	$0	20.0%	$1	3.8%	$1	$0	$1	2022Q1	3.9%	$1	$0	$1
6.0%	Engineering During Construction	$32	$6	20.0%	$38	3.8%	$33	$7	$40	2022Q1	3.9%	$35	$7	$41
	Planning During Construction			20.0%										
	Adaptive Management & Monitoring	$2	$0	20.0%	$2	3.8%	$2	$0	$2	2021Q2	0.9%	$2	$0	$2
	Project Operations			20.0%										
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$54	$11	20.0%	$65	3.8%	$56	$11	$67	2022Q1	3.9%	$58	$12	$70
	As-Builts & O&M Manual:	$1	$0	20.0%	$1	3.8%	$1	$0	$2	2022Q1	3.9%	$1	$0	$2
	Project Management			20.0%										
	CONTRACT COST TOTALS:	$689	$138		$827		$711	$142	$853			$732	$146	**$878**

**** CONTRACT COST SUMMARY ****

PROJECT: Steamboat Island HREP Major Rehabilitation
LOCATION: Scott and Clinton Counties, IA and Rock Island County, IL - Mississippi River, Pool 14, RM 502.5-508.0
This Estimate reflects the scope and schedule in report; Steamboat Island HREP Design Report - Appendix M December, 2019

DISTRICT: MVR District
POC: CHIEF, COST ENGINEERING, Charles Van Laarhoven
PREPARED: 3/30/2020

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			14-Jan-20	Program Year (Budget EC):			2021					
		Estimate Price Level:			1-Oct-19	Effective Price Level Date:			1 -Oct-20					
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 2 or CONTRACT 2													
06	FISH & WILDLIFE FACILITIES			20.0%										
06	FISH & WILDLIFE FACILITIES			20.0%										
06	ADAPTIVE MANAGEMENT			20.0%										
16	BANK STABILIZATION	$5,798	$1,160	20.0%	$6,958	3.1%	$5,976	$1,195	$7,172	2022Q4	5.3%	$6,296	$1,259	$7,555
	CONSTRUCTION ESTIMATE TOTALS:	$5,798	$1,160	20.0%	$6,958		$5,976	$1,195	$7,172			$6,296	$1,259	$7,555
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$116	$23	20.0%	$139	3.8%	$120	$24	$145	2021Q2	0.9%	$122	$24	$146
	Planning & Environmental Compliance			20.0%										
8.0%	Engineering & Design	$464	$93	20.0%	$557	3.8%	$482	$96	$578	2021Q2	0.9%	$486	$97	$583
	Reviews, ATRs, IEPRs, VE	$34	$7	20.0%	$41	3.8%	$36	$7	$43	2021Q2	0.9%	$36	$7	$43
	Life Cycle Updates (cost, schedule, risks)	$4	$1	20.0%	$5	3.8%	$4	$1	$5	2021Q2	0.9%	$4	$1	$5
	Contracting & Reprographics	$8	$2	20.0%	$9	3.8%	$8	$2	$10	2022Q4	6.9%	$9	$2	$11
6.0%	Engineering During Construction	$348	$70	20.0%	$418	3.8%	$361	$72	$434	2022Q4	6.9%	$386	$77	$463
	Planning During Construction			20.0%										
	Adaptive Management & Monitoring	$18	$4	20.0%	$22	3.8%	$19	$4	$23	2021Q2	0.9%	$19	$4	$23
	Project Operations			20.0%										
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$580	$116	20.0%	$696	3.8%	$602	$120	$723	2022Q4	6.9%	$643	$129	$772
	As-Builts & O&M Manual:	$13	$3	20.0%	$16	3.8%	$14	$3	$16	2022Q4	6.9%	$15	$3	$18
	Project Management			20.0%										
	CONTRACT COST TOTALS:	$7,384	$1,477		$8,861		$7,623	$1,525	**$9,147**			$8,016	$1,603	**$9,619**

**** CONTRACT COST SUMMARY ****

PROJECT: Steamboat Island HREP Major Rehabilitation
LOCATION: Scott and Clinton Counties, IA and Rock Island County, IL - Mississippi River, Pool 14, RM 502.5-508.0
This Estimate reflects the scope and schedule in report; Steamboat Island HREP Design Report - Appendix M December, 2019

DISTRICT: MVR District
POC: CHIEF, COST ENGINEERING, Charles Van Laarhoven
PREPARED: 3/30/2020

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 14-Jan-20 Estimate Price Level: 1-Oct-19				Program Year (Budget EC): 2021 Effective Price Level Date: 1 -Oct-20								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 3 or CONTRACT 3													
06	FISH & WILDLIFE FACILITIES			20.0%										
06	FISH & WILDLIFE FACILITIES			20.0%										
06	ADAPTIVE MANAGEMENT			20.0%										
16	BANK STABILIZATION	$1,681	$336	20.0%	$2,017	3.1%	$1,732	$346	$2,079	2023Q3	7.7%	$1,865	$373	$2,239
	CONSTRUCTION ESTIMATE TOTALS:	$1,681	$336	20.0%	$2,017		$1,732	$346	$2,079			$1,865	$373	$2,239
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$34	$7	20.0%	$41	3.8%	$35	$7	$42	2021Q2	0.9%	$36	$7	$43
	Planning & Environmental Compliance			20.0%										
8.0%	Engineering & Design	$134	$27	20.0%	$161	3.8%	$139	$28	$167	2021Q2	0.9%	$140	$28	$168
	Reviews, ATRs, IEPRs, VE	$10	$2	20.0%	$12	3.8%	$10	$2	$12	2021Q2	0.9%	$10	$2	$12
	Life Cycle Updates (cost, schedule, risks)	$1	$0	20.0%	$1	3.8%	$1	$0	$1	2021Q2	0.9%	$1	$0	$1
	Contracting & Reprographics	$2	$0	20.0%	$3	3.8%	$2	$0	$3	2023Q3	9.9%	$3	$1	$3
6.0%	Engineering During Construction	$101	$20	20.0%	$121	3.8%	$105	$21	$126	2023Q3	9.9%	$115	$23	$138
	Planning During Construction			20.0%										
	Adaptive Management & Monitoring	$5	$1	20.0%	$6	3.8%	$6	$1	$7	2021Q2	0.9%	$6	$1	$7
	Project Operations			20.0%										
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$168	$34	20.0%	$202	3.8%	$174	$35	$209	2023Q3	9.9%	$192	$38	$230
	As-Builts & O&M Manual:	$4	$1	20.0%	$5	3.8%	$4	$1	$5	2023Q3	9.9%	$4	$1	$5
	Project Management			20.0%										
	CONTRACT COST TOTALS:	$2,140	$428		$2,568		$2,209	$442	$2,651			$2,373	$475	$2,847

**** CONTRACT COST SUMMARY ****

PROJECT: Steamboat Island HREP Major Rehabilitation
LOCATION: Scott and Clinton Counties, IA and Rock Island County, IL - Mississippi River, Pool 14, RM 502.5-508.0
This Estimate reflects the scope and schedule in report; Steamboat Island HREP Design Report - Appendix M December, 2019

DISTRICT: MVR District
POC: CHIEF, COST ENGINEERING, Charles Van Laarhoven
PREPARED: 3/30/2020

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			14-Jan-20	Program Year (Budget EC):			2021					
		Estimate Price Level:			1-Oct-19	Effective Price Level Date:			1 -Oct-20					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 4 or CONTRACT 4													
06	FISH & WILDLIFE FACILITIES	$4,248	$850	20.0%	$5,098	3.1%	$4,379	$876	$5,255	2023Q1	6.1%	$4,645	$929	$5,575
06	FISH & WILDLIFE FACILITIES			20.0%										
06	ADAPTIVE MANAGEMENT			20.0%										
16	BANK STABILIZATION			20.0%										
	CONSTRUCTION ESTIMATE TOTALS:	$4,248	$850	20.0%	$5,098		$4,379	$876	$5,255			$4,645	$929	$5,575
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$85	$17	20.0%	$102	3.8%	$88	$18	$106	2021Q2	0.9%	$89	$18	$107
	Planning & Environmental Compliance			20.0%										
8.0%	Engineering & Design	$340	$68	20.0%	$408	3.8%	$353	$71	$424	2021Q2	0.9%	$356	$71	$428
	Reviews, ATRs, IEPRs, VE	$25	$5	20.0%	$30	3.8%	$26	$5	$31	2021Q2	0.9%	$26	$5	$32
	Life Cycle Updates (cost, schedule, risks)	$3	$1	20.0%	$3	3.8%	$3	$1	$4	2021Q2	0.9%	$3	$1	$4
	Contracting & Reprographics	$6	$1	20.0%	$7	3.8%	$6	$1	$7	2023Q1	7.8%	$6	$1	$8
6.0%	Engineering During Construction	$255	$51	20.0%	$306	3.8%	$265	$53	$318	2023Q1	7.8%	$286	$57	$343
	Planning During Construction			20.0%										
	Adaptive Management & Monitoring	$14	$3	20.0%	$16	3.8%	$14	$3	$17	2021Q2	0.9%	$14	$3	$17
	Project Operations			20.0%										
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$425	$85	20.0%	$510	3.8%	$441	$88	$530	2023Q1	7.8%	$476	$95	$571
	As-Builts & O&M Manual:	$10	$2	20.0%	$12	3.8%	$10	$2	$12	2023Q1	7.8%	$11	$2	$13
	Project Management			20.0%										
	CONTRACT COST TOTALS:	$5,410	$1,082		$6,492		$5,585	$1,117	**$6,702**			$5,913	$1,183	**$7,096**

**** CONTRACT COST SUMMARY ****

PROJECT: Steamboat Island HREP Major Rehabilitation
LOCATION: Scott and Clinton Counties, IA and Rock Island County, IL - Mississippi River, Pool 14, RM 502.5-508.0
This Estimate reflects the scope and schedule in report; Steamboat Island HREP Design Report - Appendix M December, 2019

DISTRICT: MVR District PREPARED: 3/30/2020
POC: CHIEF, COST ENGINEERING, Charles Van Laarhoven

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 14-Jan-20				Program Year (Budget EC): 2021								
		Estimate Price Level: 1-Oct-19				Effective Price Level Date: 1 -Oct-20								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 5 or CONTRACT 5													
06	FISH & WILDLIFE FACILITIES			20.0%										
06	FISH & WILDLIFE FACILITIES	$604	$121	20.0%	$725	3.1%	$623	$125	$747	2023Q1	6.1%	$661	$132	$793
06	ADAPTIVE MANAGEMENT			20.0%										
16	BANK STABILIZATION			20.0%										
	CONSTRUCTION ESTIMATE TOTALS:	$604	$121	20.0%	$725		$623	$125	$747			$661	$132	$793
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$12	$2	20.0%	$14	3.8%	$12	$2	$15	2021Q2	0.9%	$13	$3	$15
	Planning & Environmental Compliance			20.0%										
8.0%	Engineering & Design	$48	$10	20.0%	$58	3.8%	$50	$10	$60	2021Q2	0.9%	$50	$10	$60
	Reviews, ATRs, IEPRs, VE	$4	$1	20.0%	$4	3.8%	$4	$1	$4	2021Q2	0.9%	$4	$1	$4
	Life Cycle Updates (cost, schedule, risks)	$0.4	$0	20.0%	$0	3.8%	$0	$0	$1	2021Q2	0.9%	$0	$0	$1
	Contracting & Reprographics	$1	$0	20.0%	$1	3.8%	$1	$0	$1	2023Q1	7.8%	$1	$0	$1
6.0%	Engineering During Construction	$36	$7	20.0%	$43	3.8%	$37	$7	$45	2023Q1	7.8%	$40	$8	$48
	Planning During Construction			20.0%										
	Adaptive Management & Monitoring	$2	$0	20.0%	$2	3.8%	$2	$0	$2	2021Q2	0.9%	$2	$0	$2
	Project Operations			20.0%										
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$60	$12	20.0%	$72	3.8%	$62	$12	$75	2023Q1	7.8%	$67	$13	$81
	As-Builts & O&M Manual:	$1	$0	20.0%	$2	3.8%	$1	$0	$2	2023Q1	7.8%	$2	$0	$2
	Project Management			20.0%										
	CONTRACT COST TOTALS:	$768	$154		$922		$793	$159	$952			$840	$168	**$1,007**

****** CONTRACT COST SUMMARY ******

PROJECT: Steamboat Island HREP Major Rehabilitation
LOCATION: Scott and Clinton Counties, IA and Rock Island County, IL - Mississippi River, Pool 14, RM 502.5-508.0
This Estimate reflects the scope and schedule in report; Steamboat Island HREP Design Report - Appendix M December, 2019

DISTRICT: MVR District
POC: CHIEF, COST ENGINEERING, Charles Van Laarhoven

PREPARED: 3/30/2020

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			14-Jan-20	Program Year (Budget EC):			2021					
		Estimate Price Level:			1-Oct-19	Effective Price Level Date:			1 -Oct-20					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 6 or CONTRACT 6													
06	FISH & WILDLIFE FACILITIES			20.0%										
06	FISH & WILDLIFE FACILITIES	$671	$134	20.0%	$805	3.1%	$691	$138	$830	2023Q4	8.5%	$750	$150	$900
06	ADAPTIVE MANAGEMENT			20.0%										
16	BANK STABILIZATION			20.0%										
	CONSTRUCTION ESTIMATE TOTALS:	$671	$134	20.0%	$805		$691	$138	$830			$750	$150	$900
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$13	$3	20.0%	$16	3.8%	$13	$3	$16	2021Q2	0.9%	$14	$3	$16
	Planning & Environmental Compliance			20.0%										
8.0%	Engineering & Design	$54	$11	20.0%	$65	3.8%	$56	$11	$67	2021Q2	0.9%	$57	$11	$68
	Reviews, ATRs, IEPRs, VE	$4	$1	20.0%	$5	3.8%	$4	$1	$5	2021Q2	0.9%	$4	$1	$5
	Life Cycle Updates (cost, schedule, risks)	$0.5	$0	20.0%	$1	3.8%	$0	$0	$1	2021Q2	0.9%	$0	$0	$1
	Contracting & Reprographics	$1	$0	20.0%	$1	3.8%	$1	$0	$1	2023Q4	10.9%	$1	$0	$1
6.0%	Engineering During Construction	$40	$8	20.0%	$48	3.8%	$42	$8	$50	2023Q4	10.9%	$46	$9	$55
	Planning During Construction			20.0%										
	Adaptive Management & Monitoring	$2	$0	20.0%	$3	3.8%	$2	$0	$3	2021Q2	0.9%	$2	$0	$3
	Project Operations			20.0%										
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$67	$13	20.0%	$80	3.8%	$70	$14	$83	2023Q4	10.9%	$77	$15	$93
	As-Builts & O&M Manual:	$2	$0	20.0%	$2	3.8%	$2	$0	$2	2023Q4	10.9%	$2	$0	$2
	Project Management			20.0%										
	CONTRACT COST TOTALS:	$854	$171		$1,025		$881	$176	**$1,058**			$953	$191	**$1,144**

**** CONTRACT COST SUMMARY ****

PROJECT: Steamboat Island HREP Major Rehabilitation
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DISTRICT: MVR District
POC: CHIEF, COST ENGINEERING, Charles Van Laarhoven
PREPARED: 3/30/2020

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			14-Jan-20	Program Year (Budget EC):			2021					
		Estimate Price Level:			1-Oct-19	Effective Price Level Date:			1 -Oct-20					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 7 or CONTRACT 7													
06	FISH & WILDLIFE FACILITIES	$4,511	$902	20.0%	$5,413	3.1%	$4,649	$930	$5,579	2024Q1	9.3%	$5,080	$1,016	$6,096
06	FISH & WILDLIFE FACILITIES			20.0%										
06	ADAPTIVE MANAGEMENT			20.0%										
16	BANK STABILIZATION			20.0%										
	CONSTRUCTION ESTIMATE TOTALS:	$4,511	$902	20.0%	$5,413		$4,649	$930	$5,579			$5,080	$1,016	$6,096
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$90	$18	20.0%	$108	3.8%	$93	$19	$112	2021Q2	0.9%	$94	$19	$113
	Planning & Environmental Compliance			20.0%										
8.0%	Engineering & Design	$361	$72	20.0%	$433	3.8%	$375	$75	$450	2021Q2	0.9%	$378	$76	$454
	Reviews, ATRs, IEPRs, VE	$27	$5	20.0%	$32	3.8%	$28	$6	$33	2021Q2	0.9%	$28	$6	$34
	Life Cycle Updates (cost, schedule, risks)	$3	$1	20.0%	$4	3.8%	$3	$1	$4	2021Q2	0.9%	$3	$1	$4
	Contracting & Reprographics	$6	$1	20.0%	$7	3.8%	$6	$1	$8	2024Q1	11.9%	$7	$1	$9
6.0%	Engineering During Construction	$271	$54	20.0%	$325	3.8%	$281	$56	$338	2024Q1	11.9%	$315	$63	$378
	Planning During Construction			20.0%										
	Adaptive Management & Monitoring	$14	$3	20.0%	$17	3.8%	$15	$3	$18	2021Q2	0.9%	$15	$3	$18
	Project Operations			20.0%										
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$451	$90	20.0%	$541	3.8%	$468	$94	$562	2024Q1	11.9%	$524	$105	$629
	As-Builts & O&M Manual:	$10	$2	20.0%	$12	3.8%	$11	$2	$13	2024Q1	11.9%	$12	$2	$14
	Project Management			20.0%										
	CONTRACT COST TOTALS:	$5,744	$1,149		$6,893		$5,930	$1,186	**$7,116**			$6,457	$1,291	**$7,749**

**** CONTRACT COST SUMMARY ****

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DISTRICT: MVR District
POC: CHIEF, COST ENGINEERING, Charles Van Laarhoven
PREPARED: 3/30/2020

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 14-Jan-20				Program Year (Budget EC): 2021								
		Estimate Price Level: 1-Oct-19				Effective Price Level Date: 1 -Oct-20								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 8 or CONTRACT 8													
06	FISH & WILDLIFE FACILITIES	$2,625	$525	20.0%	$3,150	3.1%	$2,706	$541	$3,247	2025Q1	12.6%	$3,045	$609	$3,654
06	FISH & WILDLIFE FACILITIES			20.0%										
06	ADAPTIVE MANAGEMENT			20.0%										
16	BANK STABILIZATION			20.0%										
	CONSTRUCTION ESTIMATE TOTALS:	$2,625	$525	20.0%	$3,150		$2,706	$541	$3,247			$3,045	$609	$3,654
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$53	$11	20.0%	$64	3.8%	$55	$11	$66	2021Q2	0.9%	$56	$11	$67
	Planning & Environmental Compliance			20.0%										
8.0%	Engineering & Design	$210	$42	20.0%	$252	3.8%	$218	$44	$262	2021Q2	0.9%	$220	$44	$264
	Reviews, ATRs, IEPRs, VE	$16	$3	20.0%	$19	3.8%	$16	$3	$19	2021Q2	0.9%	$16	$3	$20
	Life Cycle Updates (cost, schedule, risks)	$2	$0	20.0%	$2	3.8%	$2	$0	$2	2021Q2	0.9%	$2	$0	$2
	Contracting & Reprographics	$4	$1	20.0%	$4	3.8%	$4	$1	$4	2025Q1	16.3%	$4	$1	$5
6.0%	Engineering During Construction	$158	$32	20.0%	$190	3.8%	$164	$33	$197	2025Q1	16.3%	$191	$38	$229
	Planning During Construction			20.0%										
	Adaptive Management & Monitoring	$8	$2	20.0%	$10	3.8%	$9	$2	$10	2021Q2	0.9%	$9	$2	$11
	Project Operations			20.0%										
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$263	$53	20.0%	$316	3.8%	$273	$55	$328	2025Q1	16.3%	$318	$64	$381
	As-Builts & O&M Manual:	$6	$1	20.0%	$7	3.8%	$6	$1	$7	2025Q1	16.3%	$7	$1	$9
	Project Management			20.0%										
	CONTRACT COST TOTALS:	$3,344	$669		$4,013		$3,452	$690	$4,143			$3,868	$774	$4,641

**** CONTRACT COST SUMMARY ****

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DISTRICT: MVR District
POC: CHIEF, COST ENGINEERING, Charles Van Laarhoven
PREPARED: 3/30/2020

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			14-Jan-20	Program Year (Budget EC):			2021					
		Estimate Price Level:			1-Oct-19	Effective Price Level Date:			1 -Oct-20					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 9 or CONTRACT 9													
06	FISH & WILDLIFE FACILITIES			20.0%										
06	FISH & WILDLIFE FACILITIES	$159	$32	20.0%	$190	3.1%	$163	$33	$196	2024Q4	11.8%	$183	$37	$219
06	ADAPTIVE MANAGEMENT			20.0%										
16	BANK STABILIZATION			20.0%										
	CONSTRUCTION ESTIMATE TOTALS:	$159	$32	20.0%	$190		$163	$33	$196			$183	$37	$219
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$3	$1	20.0%	$4	3.8%	$3	$1	$4	2021Q2	0.9%	$3	$1	$4
	Planning & Environmental Compliance			20.0%										
8.0%	Engineering & Design	$13	$3	20.0%	$16	3.8%	$13	$3	$16	2021Q2	0.9%	$14	$3	$16
	Reviews, ATRs, IEPRs, VE	$1	$0	20.0%	$1	3.8%	$1	$0	$1	2021Q2	0.9%	$1	$0	$1
	Life Cycle Updates (cost, schedule, risks)	$0.1	$0	20.0%	$0	3.8%	$0	$0	$0	2021Q2	0.9%	$0	$0	$0
	Contracting & Reprographics	$0.2	$0	20.0%	$0	3.8%	$0	$0	$0	2024Q4	15.2%	$0	$0	$0
6.0%	Engineering During Construction	$10	$2	20.0%	$12	3.8%	$10	$2	$12	2024Q4	15.2%	$12	$2	$14
	Planning During Construction			20.0%										
	Adaptive Management & Monitoring	$1	$0	20.0%	$1	3.8%	$1	$0	$1	2021Q2	0.9%	$1	$0	$1
	Project Operations			20.0%										
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$16	$3	20.0%	$19	3.8%	$17	$3	$20	2024Q4	15.2%	$19	$4	$23
	As-Builts & O&M Manual:	$0.4	$0	20.0%	$0	3.8%	$0	$0	$0	2024Q4	15.2%	$0	$0	$1
	Project Management			20.0%										
	CONTRACT COST TOTALS:	$203	$41		$243		$209	$42	$251			$233	$47	$279

**** CONTRACT COST SUMMARY ****

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DISTRICT: MVR District PREPARED: 3/30/2020
POC: CHIEF, COST ENGINEERING, Charles Van Laarhoven

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			14-Jan-20	Program Year (Budget EC):			2021					
		Estimate Price Level:			1-Oct-19	Effective Price Level Date:			1 -Oct-20					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 10 or CONTRACT 10													
06	FISH & WILDLIFE FACILITIES			20.0%										
06	FISH & WILDLIFE FACILITIES	$184	$37	20.0%	$221	3.1%	$189	$38	$227	2025Q4	15.1%	$218	$44	$262
06	ADAPTIVE MANAGEMENT			20.0%										
16	BANK STABILIZATION			20.0%										
	CONSTRUCTION ESTIMATE TOTALS:	$184	$37	20.0%	$221		$189	$38	$227			$218	$44	$262
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$4	$1	20.0%	$5	3.8%	$4	$1	$5	2021Q2	0.9%	$4	$1	$5
	Planning & Environmental Compliance			20.0%										
8.0%	Engineering & Design	$15	$3	20.0%	$18	3.8%	$16	$3	$19	2021Q2	0.9%	$16	$3	$19
	Reviews, ATRs, IEPRs, VE	$1	$0	20.0%	$1	3.8%	$1	$0	$1	2021Q2	0.9%	$1	$0	$1
	Life Cycle Updates (cost, schedule, risks)	$0.1	$0	20.0%	$0	3.8%	$0	$0	$0	2021Q2	0.9%	$0	$0	$0
	Contracting & Reprographics	$0.3	$0	20.0%	$0	3.8%	$0	$0	$0	2025Q4	19.6%	$0	$0	$0
6.0%	Engineering During Construction	$11	$2	20.0%	$13	3.8%	$11	$2	$14	2025Q4	19.6%	$14	$3	$16
	Planning During Construction			20.0%										
	Adaptive Management & Monitoring	$1	$0	20.0%	$1	3.8%	$1	$0	$1	2021Q2	0.9%	$1	$0	$1
	Project Operations			20.0%										
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$18	$4	20.0%	$22	3.8%	$19	$4	$22	2025Q4	19.6%	$22	$4	$27
	As-Builts & O&M Manual:	$0.4	$0	20.0%	$1	3.8%	$0	$0	$1	2025Q4	19.6%	$1	$0	$1
	Project Management			20.0%										
	CONTRACT COST TOTALS:	$234	$47		$281		$242	$48	$290			$277	$55	$332

****** CONTRACT COST SUMMARY ******

PROJECT: Steamboat Island HREP Major Rehabilitation
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PREPARED: 3/30/2020

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			14-Jan-20	Program Year (Budget EC):			2021					
		Estimate Price Level:			1-Oct-19	Effective Price Level Date:			1 -Oct-20					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	B	C	D	E	F	G	H	I	J	P	L	M	N	O
	PHASE 11 or CONTRACT 11													
06	FISH & WILDLIFE FACILITIES			20.0%										
06	FISH & WILDLIFE FACILITIES	$270	$54	20.0%	$324	3.1%	$278	$56	$334	2026Q4	18.6%	$330	$66	$396
06	ADAPTIVE MANAGEMENT			20.0%										
16	BANK STABILIZATION			20.0%										
	CONSTRUCTION ESTIMATE TOTALS:	$270	$54	20.0%	$324		$278	$56	$334			$330	$66	$396
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$5	$1	20.0%	$6	3.8%	$5	$1	$6	2021Q2	0.9%	$5	$1	$6
	Planning & Environmental Compliance			20.0%										
8.0%	Engineering & Design	$22	$4	20.0%	$26	3.8%	$23	$5	$27	2021Q2	0.9%	$23	$5	$28
	Reviews, ATRs, IEPRs, VE	$2	$0	20.0%	$2	3.8%	$2	$0	$2	2021Q2	0.9%	$2	$0	$2
	Life Cycle Updates (cost, schedule, risks)	$0.2	$0	20.0%	$0	3.8%	$0	$0	$0	2021Q2	0.9%	$0	$0	$0
	Contracting & Reprographics	$0.4	$0	20.0%	$0	3.8%	$0	$0	$0	2026Q4	24.2%	$0	$0	$1
6.0%	Engineering During Construction	$16	$3	20.0%	$19	3.8%	$17	$3	$20	2026Q4	24.2%	$21	$4	$25
	Planning During Construction			20.0%										
	Adaptive Management & Monitoring	$1	$0	20.0%	$1	3.8%	$1	$0	$1	2021Q2	0.9%	$1	$0	$1
	Project Operations			20.0%										
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$27	$5	20.0%	$32	3.8%	$28	$6	$34	2026Q4	24.2%	$35	$7	$42
	As-Builts & O&M Manual:	$1	$0	20.0%	$1	3.8%	$1	$0	$1	2026Q4	24.2%	$1	$0	$1
	Project Management			20.0%										
	CONTRACT COST TOTALS:	$344	$69		$412		$355	$71	$426			$418	$84	$501

**** CONTRACT COST SUMMARY ****

PROJECT: Steamboat Island HREP Major Rehabilitation
LOCATION: Scott and Clinton Counties, IA and Rock Island County, IL - Mississippi River, Pool 14, RM 502.5-508.0
This Estimate reflects the scope and schedule in report; Steamboat Island HREP Design Report - Appendix M December, 2019

DISTRICT: MVR District PREPARED: 3/30/2020
POC: CHIEF, COST ENGINEERING, Charles Van Laarhoven

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			14-Jan-20	Program Year (Budget EC):			2021					
		Estimate Price Level:			1-Oct-19	Effective Price Level Date:			1 -Oct-20					
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 12 or CONTRACT 12													
06	FISH & WILDLIFE FACILITIES			20.0%										
06	FISH & WILDLIFE FACILITIES	$270	$54	20.0%	$324	3.1%	$279	$56	$334	2027Q4	22.1%	$340	$68	$408
06	ADAPTIVE MANAGEMENT			20.0%										
16	BANK STABILIZATION			20.0%										
	CONSTRUCTION ESTIMATE TOTALS:	$270	$54	20.0%	$324		$279	$56	$334			$340	$68	$408
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$5	$1	20.0%	$6	3.8%	$5	$1	$6	2021Q2	0.9%	$5	$1	$6
	Planning & Environmental Compliance			20.0%										
8.0%	Engineering & Design	$22	$4	20.0%	$26	3.8%	$23	$5	$27	2021Q2	0.9%	$23	$5	$28
	Reviews, ATRs, IEPRs, VE	$2	$0	20.0%	$2	3.8%	$2	$0	$2	2021Q2	0.9%	$2	$0	$2
	Life Cycle Updates (cost, schedule, risks)	$0.2	$0	20.0%	$0	3.8%	$0	$0	$0	2021Q2	0.9%	$0	$0	$0
	Contracting & Reprographics	$0.4	$0	20.0%	$0	3.8%	$0	$0	$0	2027Q4	28.9%	$0	$0	$1
6.0%	Engineering During Construction	$16	$3	20.0%	$19	3.8%	$17	$3	$20	2027Q4	28.9%	$21	$4	$26
	Planning During Construction			20.0%										
	Adaptive Management & Monitoring	$1	$0	20.0%	$1	3.8%	$1	$0	$1	2021Q2	0.9%	$1	$0	$1
	Project Operations			20.0%										
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$27	$5	20.0%	$32	3.8%	$28	$6	$34	2027Q4	28.9%	$36	$7	$43
	As-Builts & O&M Manual:	$1	$0	20.0%	$1	3.8%	$1	$0	$1	2027Q4	28.9%	$1	$0	$1
	Project Management			20.0%										
	CONTRACT COST TOTALS:	$344	$69		$413		$355	$71	$426			$430	$86	**$516**

**** CONTRACT COST SUMMARY ****

PROJECT: Steamboat Island HREP Major Rehabilitation
LOCATION: Scott and Clinton Counties, IA and Rock Island County, IL - Mississippi River, Pool 14, RM 502.5-508.0
This Estimate reflects the scope and schedule in report; Steamboat Island HREP Design Report - Appendix M December, 2019

DISTRICT: MVR District
POC: CHIEF, COST ENGINEERING, Charles Van Laarhoven
PREPARED: 3/30/2020

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 14-Jan-20				Program Year (Budget EC): 2021								
		Estimate Price Level: 1-Oct-19				Effective Price Level Date: 1 -Oct-20								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 13 or CONTRACT 13													
06	FISH & WILDLIFE FACILITIES			20.0%										
06	FISH & WILDLIFE FACILITIES	$220	$44	20.0%	$264	3.1%	$227	$45	$272	2028Q4	25.8%	$285	$57	$342
06	ADAPTIVE MANAGEMENT			20.0%										
16	BANK STABILIZATION			20.0%										
	CONSTRUCTION ESTIMATE TOTALS:	$220	$44	20.0%	$264		$227	$45	$272			$285	$57	$342
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$4	$1	20.0%	$5	3.8%	$4	$1	$5	2021Q2	0.9%	$4	$1	$5
	Planning & Environmental Compliance			20.0%										
8.0%	Engineering & Design	$18	$4	20.0%	$22	3.8%	$19	$4	$22	2021Q2	0.9%	$19	$4	$23
	Reviews, ATRs, IEPRs, VE	$1	$0	20.0%	$2	3.8%	$1	$0	$2	2021Q2	0.9%	$1	$0	$2
	Life Cycle Updates (cost, schedule, risks)	$0.2	$0	20.0%	$0	3.8%	$0	$0	$0	2021Q2	0.9%	$0	$0	$0
	Contracting & Reprographics	$0.3	$0	20.0%	$0	3.8%	$0	$0	$0	2028Q4	34.0%	$0	$0	$1
6.0%	Engineering During Construction	$13	$3	20.0%	$16	3.8%	$13	$3	$16	2028Q4	34.0%	$18	$4	$22
	Planning During Construction			20.0%										
	Adaptive Management & Monitoring	$1	$0	20.0%	$1	3.8%	$1	$0	$1	2021Q2	0.9%	$1	$0	$1
	Project Operations			20.0%										
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$22	$4	20.0%	$26	3.8%	$23	$5	$27	2028Q4	34.0%	$31	$6	$37
	As-Builts & O&M Manual:	$1	$0	20.0%	$1	3.8%	$1	$0	$1	2028Q4	34.0%	$1	$0	$1
	Project Management			20.0%										
	CONTRACT COST TOTALS:	$280	$56		$336		$289	$58	$347			$360	$72	**$432**

**** CONTRACT COST SUMMARY ****

PROJECT: Steamboat Island HREP Major Rehabilitation
LOCATION: Scott and Clinton Counties, IA and Rock Island County, IL - Mississippi River, Pool 14, RM 502.5-508.0
This Estimate reflects the scope and schedule in report; Steamboat Island HREP Design Report - Appendix M December, 2019

DISTRICT: MVR District
POC: CHIEF, COST ENGINEERING, Charles Van Laarhoven
PREPARED: 3/30/2020

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 14-Jan-20 Estimate Price Level: 1-Oct-19				Program Year (Budget EC): 2021 Effective Price Level Date: 1-Oct-20								
				RISK BASED										
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 14 or CONTRACT 14													
06	FISH & WILDLIFE FACILITIES			20.0%										
06	FISH & WILDLIFE FACILITIES			20.0%										
06	ADAPTIVE MANAGEMENT	$212	$42	20.0%	$255	3.1%	$219	$44	$263	2025Q3	14.3%	$250	$50	$300
16	BANK STABILIZATION			20.0%										
	CONSTRUCTION ESTIMATE TOTALS:	$212	$42	20.0%	$255		$219	$44	$263			$250	$50	$300
01	LANDS AND DAMAGES													
30	PLANNING, ENGINEERING & DESIGN													
2.0%	Project Management	$4	$1	20.0%	$5	3.8%	$4	$1	$5	2025Q1	16.3%	$5	$1	$6
	Planning & Environmental Compliance			20.0%										
8.0%	Engineering & Design	$17	$3	20.0%	$20	3.8%	$18	$4	$21	2025Q1	16.3%	$21	$4	$25
	Reviews, ATRs, IEPRs, VE	$1	$0	20.0%	$2	3.8%	$1	$0	$2	2025Q1	16.3%	$2	$0	$2
	Life Cycle Updates (cost, schedule, risks)	$0.1	$0	20.0%	$0	3.8%	$0	$0	$0	2025Q1	16.3%	$0	$0	$0
	Contracting & Reprographics	$0.3	$0	20.0%	$0	3.8%	$0	$0	$0	2025Q3	18.5%	$0	$0	$0
6.0%	Engineering During Construction	$13	$3	20.0%	$16	3.8%	$13	$3	$16	2025Q3	18.5%	$16	$3	$19
	Planning During Construction			20.0%										
	Adaptive Management & Monitoring	$1	$0	20.0%	$1	3.8%	$1	$0	$1	2025Q1	16.3%	$1	$0	$1
	Project Operations			20.0%										
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$21	$4	20.0%	$25	3.8%	$22	$4	$26	2025Q3	18.5%	$26	$5	$31
	As-Builts & O&M Manual:	$0.5	$0	20.0%	$1	3.8%	$1	$0	$1	2025Q3	18.5%	$1	$0	$1
	Project Management			20.0%										
	CONTRACT COST TOTALS:	$270	$54		$324		$279	$56	$335			$321	$64	**$385**

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX I-B

CRYSTAL BALL RISK ANALYSIS CONTINGENCY DETERMINATION

US Army Corps of
Engineers®

STEAMBOAT ISLAND HREP
PROJECT COST AND SCHEDULE RISK ANALYSIS REPORT

PREPARED FOR:
U.S. ARMY CORPS OF ENGINEERS,
ROCK ISLAND DISTRICT

PREPARED BY:
WALLA WALLA DISTRICT, U.S. ARMY CORPS OF ENGINEERS

FEBRUARY 13, 2020

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Appendix

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (USACE), Rock Island District, presents this cost and schedule risk analysis (CSRA) report regarding the risk findings and recommended contingencies for the Steamboat Island Habitat Rehabilitation and Enhancement Project (HREP). In compliance with Engineer Regulation (ER) 1110-2-1302 Civil Works Cost Engineering, dated September 15, 2008, a *Monte Carlo*-based risk analysis was conducted by the Project Development Team (PDT) on remaining costs. The purpose of this risk analysis study is to present the cost and schedule risks considered, those determined, and respective project contingencies at a recommended 80 percent confidence level of successful execution to project completion.

The objective of the Steamboat Island HREP project is to enhance and restore areal coverage and diversity of forest stands and habitat, increase year-round aquatic habitat diversity, restore and protect island acreage, and protect and enhance backwater and interior wetland areas. These objectives are to be accomplished using dredging and fill placement, stone placement to reduce and prevent areas identified as having high scour potential, the installation of timber stands, and tree clearing efforts.

The current project base cost estimate, pre-contingency, approximates $21M. The Walla Walla Cost MCX facilitated a CSRA meeting on 30 Jan 2020 and assisted the PDT in identifying risks that could impact cost and schedule. Follow up meetings were conducted with specific PDT members to further clarify and quantify the identified risks and associated likelihoods. It is recommended that a contingency value of approximately $5M or 20% be used for this project to encompass foreseen cost growth. A schedule contingency of 5 months (5%) is also recommended.

Cost estimates fluctuate over time. During this period of study, minor cost fluctuations can and have occurred. For this reason, contingency reporting is based in cost and percent values. Should cost vary to a slight degree with similar scope and risks, contingency percent values will be reported, cost values rounded.

Table ES-2. Construction Contingency Results

Contingency on Base Estimate	80% Confidence Project Cost	
Base Construction Estimate	**$21,408,138**	**20%**
Baseline Estimate Cost Contingency Amount ->	$4,281,628	
Baseline Estimate Construction Cost (80% Confidence) ->	**$25,689,766**	

KEY FINDINGS/OBSERVATIONS/RECOMMENDATIONS

The key external risk identified for the Steamboat HREP project is that the project includes a very dynamic river that both scours and deposits material in undetermined locations. However, this project possesses the ability to adjust scope and schedule to stay within budget and on time. Approximately 14 independent contracts are foreseen to be utilized which means that slippage of one schedule will not necessarily impact the entire project. The main drivers of cost risk correspond to uncertainty in the pricing that will exist at the time of bid.

Cost Risks: From the CSRA, the key Cost Risk items include:

- **Estimate and Schedule (ES)1 – Dredging Historical Pricing** – Historical unit pricing for this project has been investigated using both a comparison to the Cost Engineering Dredge Estimating Program (CEDEP) and historical construction costs. Pricing was within reason of this benchmark, but pricing can vary depending upon bidding conditions. Historically, bidding on work of this type in this area has been competitive. Even though this is one of the largest risks of this project, it is a relatively small risk in comparison to other projects with greater levels of risk.

- **ES2 – Stone Placement Historical Pricing** – Variation of stone pricing was also vetted with the Rock Island construction branch. Unit pricing is within the boundaries of historical pricing. As with ES1, this is a relatively mild risk when compared to other projects containing more risk.

Schedule Risks: The anticipated schedule for this project is projected to consist of at least 14 separate contracts that are awarded as seasons/weather permits. Because the project area is large and the contracts are separate, it is currently believed that a slip in schedule in one contract will not directly impact the greater overall project schedule. The main schedule risk identified is listed below.

- **Construction Risks (CO)1 Change in Water Elevation** – Flood conditions in the work area could delay an individual contractor (but not necessarily the project as a whole) for up to three months. Once flooding conditions have ended, work may proceed as planned. This is a relatively mild schedule risk and is already mitigated by using multiple contracts for project delivery.

RECOMMENDATIONS

The cost and schedule risks encountered by this project are mild. The disconnected contracting plan and ability to change scope to meet budget allow for the flexibility to make the needed alterations to keep on schedule for both time and cost.

MAIN REPORT

1.0. PURPOSE

Within the authority of the U.S. Army Corps of Engineers (USACE), Rock Island District, this report presents the efforts and results of the cost and schedule risk analysis for the Steamboat Island HREP. The report includes risk methodology, discussions, findings, and recommendations regarding the identified risks and the necessary contingencies to confidently administer the project, presenting a cost and schedule contingency value with an 80 percent confidence level of successful execution.

2.0. BACKGROUND

The Steamboat Island HREP project is to enhance and restore areal coverage and diversity of forest stands and habitat, increase year-round aquatic habitat diversity, restore and protect island acreage, and protect and enhance backwater and interior wetland areas. These objectives are to be accomplished using dredging and fill placement, stone placement to reduce and prevent areas identified as having high scour potential, the installation of timber stands, and tree clearing efforts.

3.0. REPORT SCOPE

The scope of the risk analysis report is to identify cost and schedule risks, with a resulting recommendation for contingencies at the 80 percent confidence level, using the risk analysis processes, as mandated by U.S. Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter (ETL) 1110-2-573, Construction Cost Estimating Guide for Civil Works. The report presents the contingency results for cost risks for construction features. The CSRA includes Real Estate costs and does not include consideration for life cycle costs.

3.1. Project Scope

The formal process included extensive involvement of the PDT for risk identification and the development of the risk register. The analysis process evaluated the Micro-Computer Aided Cost Estimating System (MCACES) cost estimate, project schedule, and funding profiles using Crystal Ball software, an add-in to Microsoft Excel, to conduct a *Monte Carlo* simulation and statistical sensitivity analysis, per the guidance in ETL 1110-2-573, Construction Cost Estimating Guide for Civil Works, dated September 30, 2008.

The project technical scope, estimates, and schedules were developed and presented by the Rock Island District. Consequently, these documents serve as the basis for the risk analysis.

The scope of this study addresses the identification of concerns, needs, opportunities, and potential solutions that are viable from an economic, environmental, and engineering viewpoint.

3.2. USACE Risk Analysis Process

The risk analysis process for this study follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering MCX. The risk analysis process reflected within this report uses probabilistic cost and schedule risk analysis methods within the framework of the Crystal Ball software. Furthermore, the scope of the report includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

Risk analysis results are also intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as the project progresses through planning and implementation. To fully recognize its benefits, cost and schedule risk analysis should be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting and scheduling.

In addition to broadly defined risk analysis standards and recommended practices, this risk analysis was performed to meet the requirements and recommendations of the following documents and sources:

- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering MCX.
- ER, 1110-2-1302, Civil Works Cost Engineering, dated Sept 15, 2008.
- ETL, 1110-2-573, Construction Cost Estimating Guide for Civil Works, dated Sept 30, 2008.

4.0. METHODOLOGY/PROCESS

The Cost Engineering MCX performed the Cost and Schedule Risk Analysis, relying on local Rock Island District staff to provide expertise and gather information. The Rock Island PDT conducted an initial risk identification via a teleconference CSRA meeting with the Walla Walla Cost Engineering MCX facilitator on 30 January 2020. The initial risk identification meeting also included qualitative analysis to produce a risk register that served as the draft framework for the risk analysis.

Table 1. Attendee List 30 January 2020

Name	Office	Representing
Julie Millhollin	MVR	Project Management
Rachel Perrine	MVP	Study Manager
Davi Michl	MVR	Biologist
Kyle Nerad	MVR	Technical Lead
Anton Stork	MVR	H&H
John Lacina	MVR	Cost Engineering
Chris Thennes	MVR	Construction
Ben Vandermyde	MVR	Forester
Scott DeSomber	NWW	Cost Engineering

The CSRA risk register was populated during the 30 January 2020 CSRA meeting. A draft of the register was distributed to the team on 31 January 2020. During the CSRA meeting, impacts and potential ranges were discussed, and the MCX risk facilitator made additional contact with team members over the next several days in order to develop risk ranges. Probabilities and impacts were discussed primarily during the 30 January 2020 CSRA meeting, but all impacts were finalized 13 February 2020.

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve the desired level of cost confidence. Per regulation and guidance, the P80 confidence level (80 percent confidence level) is the normal and accepted cost confidence level. District Management has the prerogative to select different confidence levels, pending approval from Headquarters, USACE.

In simple terms, contingency is an amount added to an estimate to allow for items, conditions or events for which the occurrence or impact is uncertain and that experience suggests will likely result in additional costs being incurred or additional time being required. The amount of contingency included in project control plans depends, at least in part, on the project leadership's willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency should be applied in the project control plans. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

The Cost MCX guidance for cost and schedule risk analysis generally focuses on the 80 percent level of confidence (P80) for cost contingency calculation. It should be noted that use of P80 as a decision criteria is a risk averse approach (whereas the use of P50 would be a risk neutral approach, and use of levels less than 50 percent would be risk seeking). Thus, a P80 confidence level results in greater contingency as compared to a P50 confidence level. The selection of contingency at a particular confidence level is ultimately the decision and responsibility of the project's District and/or Division management.

The risk analysis process uses *Monte Carlo* techniques to determine probabilities and contingency. The *Monte Carlo* techniques are facilitated computationally by a commercially available risk analysis software package (Crystal Ball) that is an add-in to Microsoft Excel. Cost estimates are packaged into an Excel format and used directly for cost risk analysis purposes. The level of detail recreated in the Excel-format schedule is sufficient for risk analysis purposes that reflect the established risk register, but generally less than that of the native format.

The primary steps, in functional terms, of the risk analysis process are described in the following subsections. Risk analysis results are provided in Section 6.

4.1. Identify and Assess Risk Factors

Identifying the risk factors via the PDT is considered a qualitative process that results in establishing a risk register that serves as the document for the quantitative study using the Crystal Ball risk software. Risk factors are events and conditions that may influence or drive uncertainty in project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions, such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule.

A formal PDT meeting was held with the Rock Island District office for the purposes of identifying and assessing risk factors. The meeting (conducted 30 January 2020) included capable and qualified representatives from multiple project team disciplines and functions, including project management, cost engineering, design, and environmental compliance. All land for the project area is Federally owned.

The formal CSRA risk register was pre-populated using risks identified during the selection of alternatives process. Since the formal CSRA meeting incorporated additional team members from the previous meetings, several new risks were identified and quantified.

4.2. Quantify Risk Factor Impacts

The quantitative impacts (putting it to numbers of cost and time) of risk factors on project plans were analyzed using a combination of professional judgment, empirical data, and analytical techniques. Risk factor impacts were quantified using probability distributions (density functions), because risk factors are entered into the Crystal Ball software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involved multiple project team disciplines and functions. However, the quantification process relied more extensively on collaboration between cost engineering and risk analysis team members with lesser inputs from other functions and disciplines. This process used an iterative approach to estimate the following elements of each risk factor:

- Maximum possible value for the risk factor
- Minimum possible value for the risk factor
- Most likely value (the statistical mode), if applicable
- Nature of the probability density function used to approximate risk factor uncertainty
- Mathematical correlations between risk factors
- Affected cost estimate and schedule elements

The resulting product from the PDT discussions is captured within a risk register, as presented in section 6 for both cost and schedule risk concerns. Note that the risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

4.3. Analyze Cost Estimate and Schedule Contingency

Contingency is analyzed using Crystal Ball software, an add-in to the Microsoft Excel format of the cost estimate and schedule. *Monte Carlo* simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT. Contingencies are calculated by applying only the moderate and high level risks identified for each option (i.e., low-level risks are typically not considered, but remain within the risk register to serve historical purposes, as well as to support follow-on risk studies as the project and risks evolve).

For the cost estimate, the contingency is calculated as the difference between the P80 cost forecast and the baseline cost estimate. Each option-specific contingency is then allocated on a civil works feature level, based on the dollar-weighted relative risk of each feature, as quantified by *Monte Carlo* simulation. Standard deviation is used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

5.0. PROJECT ASSUMPTIONS

The following data sources and assumptions were used in quantifying the costs associated with the project.

a. The Rock Island District provided MII MCACES files electronically. The final MII report file transmitted and downloaded on 28 January 2020 was the basis for the final cost and schedule risk analyses.

b. The cost comparisons and risk analyses performed and reflected within this report are based on design scope and estimates that are at feasibility level.

c. Schedules are analyzed for impact to the project cost in terms of delayed funding, uncaptured escalation (variance from OMB factors and the local market), unavoidable fixed contract costs, and/or languishing federal administration costs incurred throughout delay.

d. Per the CWCCIS Historical State Adjustment Factors in EM 1110-2-1304, State Adjustment Factor for the State of Iowa is 0.99, meaning that the average inflation for the project area is assumed to be 1 percent lower than the national average for inflation. Therefore, it is assumed that the project inflations experienced are similar (or better) to OMB inflation factors for future construction. Thus, the risk analyses accounted for no escalation over and above the national average; however, recent experience in the past five years does indicate a construction inflation above the standard OMB rates published. This risk was considered with the delay impacts.

e. The Cost Engineering MCX guidance generally focuses on the 80 percent level of confidence (P80) for cost contingency calculation. For this risk analysis, the 80 percent level of confidence (P80) was used. It should be noted that the use of P80 as a decision criteria is a moderately risk-averse approach, generally resulting in higher cost contingencies. However, the P80 level of confidence also assumes a small degree of risk that the recommended contingencies may be inadequate to capture actual project costs.

f. No high risks were identified, only moderate risk level impacts. These were considered for the purposes of calculating cost contingency. Low-level risk impacts should be maintained in project management documentation and reviewed at each project milestone to determine if they should be placed on the risk "watch list."

6.0. RESULTS

The cost and schedule risk analysis results are provided in the following sections. In addition to contingency calculation results, sensitivity analyses are presented to provide decision makers with an understanding of variability and the key contributors to the cause of this variability.

6.1. Risk Register

A risk register is a tool commonly used in project planning and risk analysis. The actual risk register is provided in Appendix A. The complete risk register includes low-level risks, as well as additional information regarding the nature and impacts of each risk.

It is important to note that a risk register can be an effective tool for managing identified risks throughout the project life cycle. As such, it is generally recommended that risk registers be updated as the designs, cost estimates, and schedule are further refined, especially on large projects with extended schedules. Recommended uses of the risk register going forward include:

- Documenting risk mitigation strategies being pursued in response to the identified risks and their assessment in terms of probability and impact
- Providing project sponsors, stakeholders, and leadership/management with a documented framework from which risk status can be reported in the context of project controls
- Communicating risk management issues
- Providing a mechanism for eliciting feedback and project control input
- Identifying risk transfer, elimination, or mitigation actions required for implementation of risk management plans

6.2. Cost Contingency and Sensitivity Analysis

The result of risk or uncertainty analysis is quantification of the cumulative impact of all analyzed risks or uncertainties, as compared to probability of occurrence. These results, as applied to the analysis herein, depict the overall project cost at intervals of confidence (probability).

Table 2 provides the construction cost contingencies calculated for the P80 confidence level and rounded to the nearest thousand. The construction cost contingencies for the P5, P50 and P90 confidence levels are also provided for illustrative purposes only. Cost contingency for the Construction risks (including schedule impacts converted to dollars) was quantified as approximately $4.2M at the P80 confidence level (20 percent of the baseline construction cost estimate). Figure 1 graphically shows the cost confidence level contingencies.

Table 2. Construction Cost Comparison Summary (Uncertainty Analysis)

Base Case Estimate (Excluding 01)	**$21,408,138**	
Confidence Level	**Contingency Value**	**Contingency**
0%	**-642,244**	**-3%**
10%	**1,284,488**	**6%**
20%	**1,712,651**	**8%**
30%	**2,140,814**	**10%**
40%	**2,568,977**	**12%**
50%	**2,997,139**	**14%**
60%	**3,425,302**	**16%**
70%	**3,853,465**	**18%**
80%	**4,281,628**	**20%**
90%	**4,923,872**	**23%**
100%	**8,777,337**	**41%**

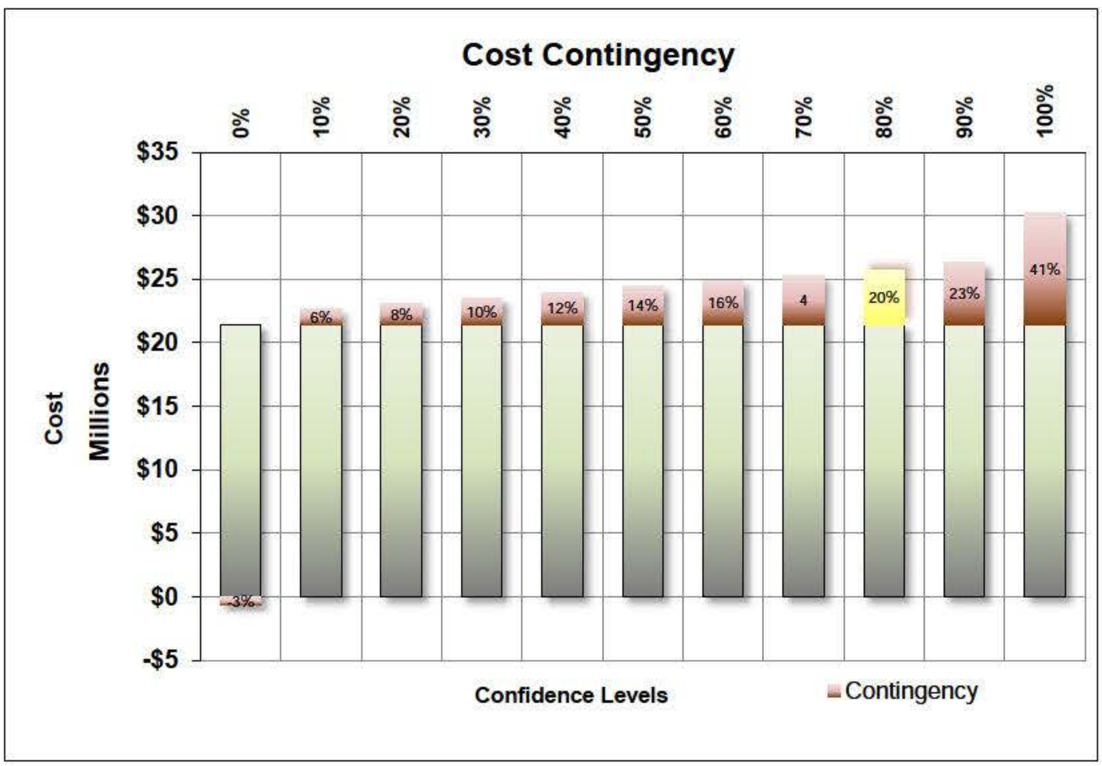


Figure 1. Cost Contingency Graph

Table 3 is the Construction Cost Contingency Summary, showing the Base Construction amount used, which is the USACE estimate, the Contingency Amount and Percentage, and the Baseline Estimate Construction Cost at the 80 percent Confidence Level.

Table 3. Construction Cost Contingency Summary

Contingency on Base Estimate	80% Confidence Project Cost	
Base Construction Estimate	**$21,408,138**	
Baseline Estimate Cost Contingency Amount ->	$4,281,628	**20%**
Baseline Estimate Construction Cost (80% Confidence) ->	**$25,689,766**	

6.2.1. Sensitivity Analysis

Sensitivity analysis generally ranks the relative impact of each risk/opportunity as a percentage of total cost uncertainty. Crystal Ball software uses a statistical measure (contribution to variance) that approximates the impact of each risk/opportunity contributing to variability of cost outcomes during *Monte Carlo* simulation.

Key cost drivers identified in the sensitivity analysis can be used to support development of a risk management plan that will facilitate control of risk factors and their potential impacts throughout the project lifecycle. Together with the risk register, sensitivity analysis results can also be used to support development of strategies to eliminate, mitigate, accept, or transfer key risks.

6.2.2. Sensitivity Analysis Results

The risks/opportunities considered as key or primary cost drivers and the respective value variance are ranked in order of importance in contribution to variance bar charts. Opportunities that have a potential to reduce project cost are shown with a negative sign; risks are shown with a positive sign to reflect the potential to increase project cost. A longer bar in the sensitivity analysis chart represents a greater potential impact to project cost.

Figure 2 presents a sensitivity analysis for cost growth risk from the high-level cost risks identified in the risk register. Likewise, Figure 3 presents a sensitivity analysis for schedule growth risk from the high-level schedule risks identified in the risk register.

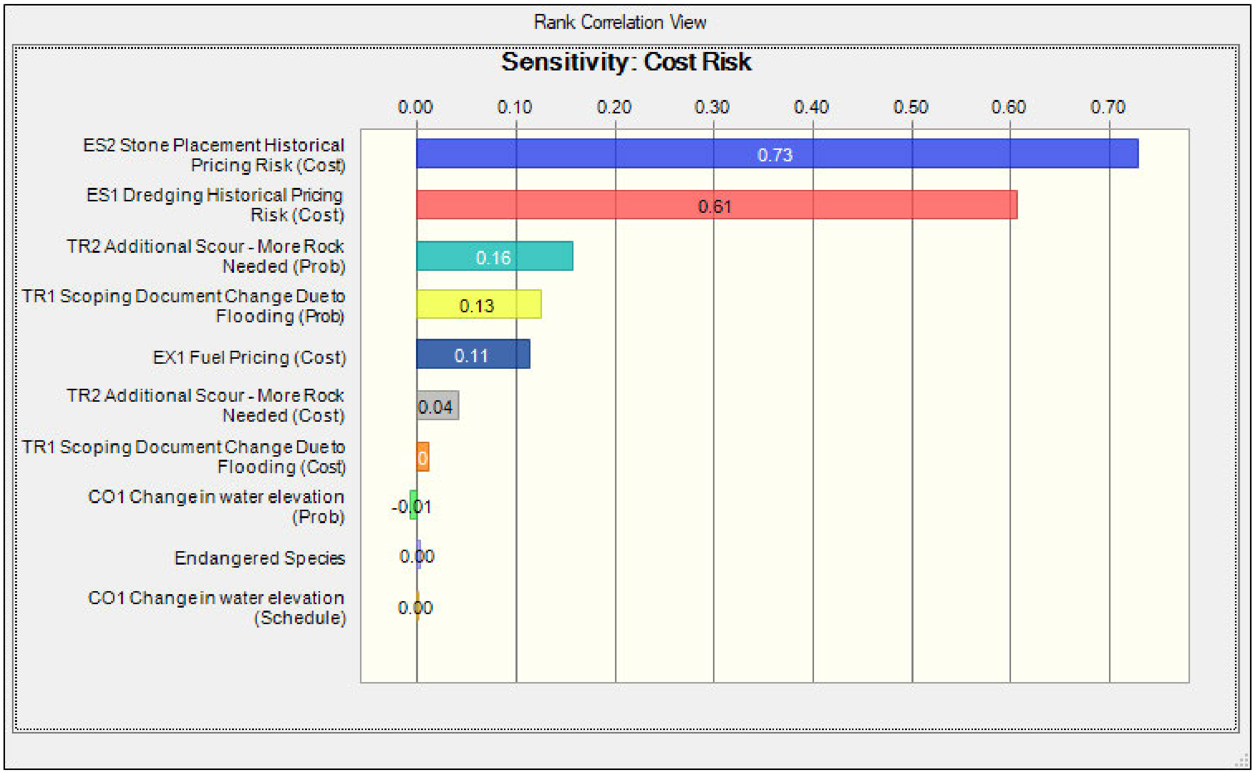


Figure 2. Cost Sensitivity Analysis

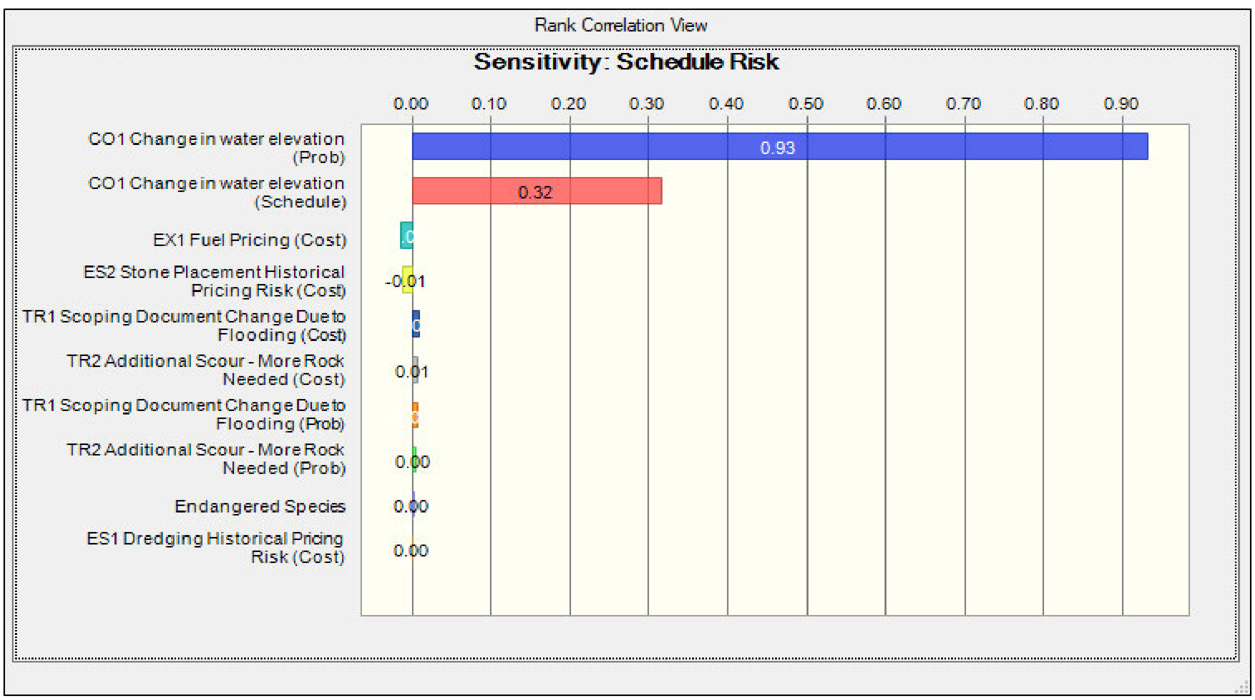


Figure 3. Schedule Sensitivity Analysis

6.3. Schedule and Contingency Risk Analysis

The result of risk or uncertainty analysis is quantification of the cumulative impact of all analyzed risks or uncertainties, as compared to probability of occurrence. These results, as applied to the analysis herein, depict the overall project duration at intervals of confidence (probability).

Table 4 provides the schedule duration contingencies calculated for the P80 confidence level. The schedule duration contingencies for the P50 and P90 confidence levels are also provided for illustrative purposes.

Schedule duration contingency was quantified as 5 months, based on the P80 level of confidence. These contingencies were used to calculate the projected residual fixed cost impact of project delays that are included in the Table 2 presentation of total cost contingency. The schedule contingencies were calculated by applying the high-level schedule risks identified in the risk register for each option to the durations of critical path and near-critical path tasks.

The schedule was not resource-loaded and contained open-ended tasks and non-zero lags (gaps in the logic between tasks) that limit the overall utility of the schedule risk analysis. These issues should be considered as limitations in the utility of the schedule contingency data presented. Schedule contingency impacts presented in this analysis are based solely on projected residual fixed costs. Figure 4 graphically shows the schedule confidence level contingencies.

Table 4. Construction Schedule Comparison Summary (Uncertainty Analysis)

Base Case Schedule	**98.3 Months**	
Confidence Level	**Contingency Value**	**Contingency**
0%	**0 Months**	**0%**
10%	**0 Months**	**0%**
20%	**2 Months**	**2%**
30%	**2 Months**	**2%**
40%	**2 Months**	**2%**
50%	**3 Months**	**3%**
60%	**3 Months**	**3%**
70%	**4 Months**	**4%**
80%	**5 Months**	**5%**
90%	**6 Months**	**6%**
100%	**16 Months**	**16%**

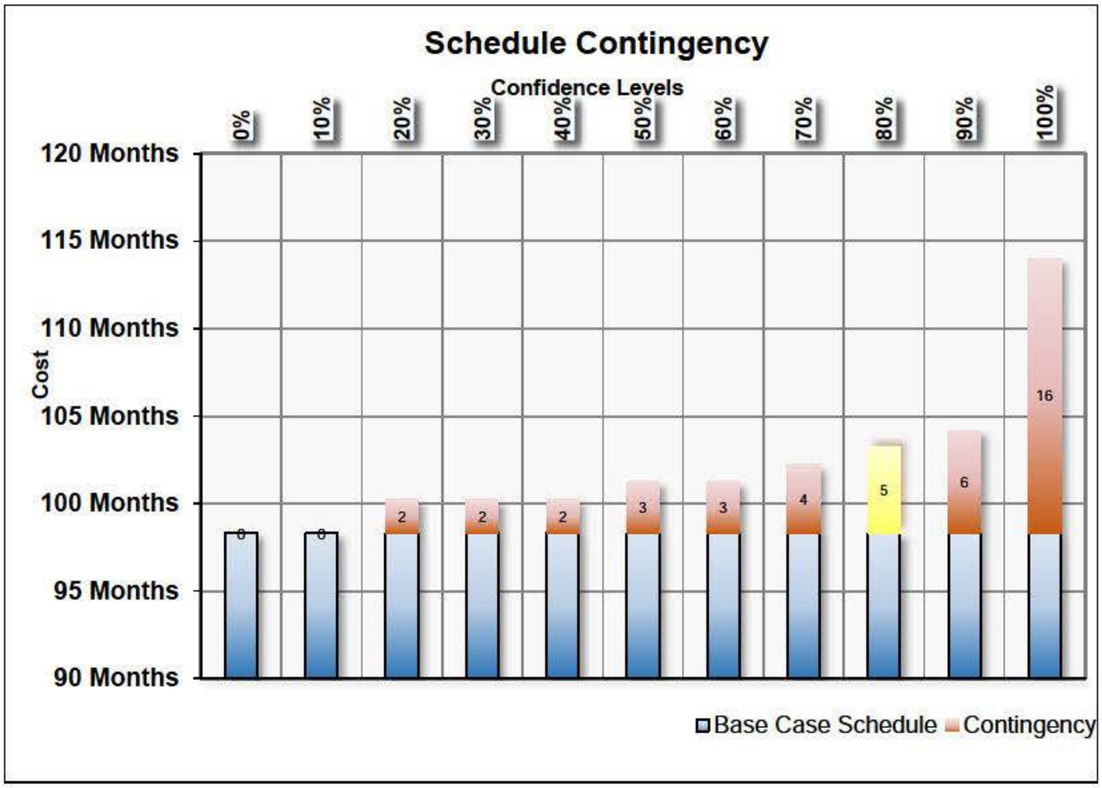


Figure 4. Schedule Contingency Graph

Table 5 is the Schedule Duration Contingency Summary, showing the Project Base Schedule Duration used (which is from the Project Book), the Schedule Duration Contingency and Percentage, and the Project Schedule Duration at the 80 percent Confidence Level.

Table 5. Schedule Duration Contingency Summary

Contingency on Schedule	80% Confidence Project Schedule	
Project Base Schedule Duration ->	**98.3 Months**	
Schedule Contingency Duration ->	4.9 Months	5%
Project Schedule Duration (80% Confidence) ->	**103.2 Months**	

7.0. MAJOR FINDINGS/OBSERVATIONS/RECOMMENDATIONS

This section provides a summary of significant risk analysis results that are identified in the preceding sections of the report. Risk analysis results are intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as projects progress through planning and implementation. Because of the potential for use of risk analysis results for such diverse purposes, this section also reiterates and highlights important steps, logic, key assumptions, limitations, and decisions to help ensure that the risk analysis results are appropriately interpreted.

7.1. Major Findings/Observations

Project cost and schedule comparison summaries are provided in Table 2 and Table 3, respectively. Additional major findings and observations of the risk analysis are listed below.

The key external risk identified for the Steamboat HREP project is that the project includes a very dynamic river that both scours and deposits material in undetermined locations. However, this project possesses the ability to adjust scope and schedule to stay within budget. Approximately 14 independent contracts are foreseen to be utilized which means that slippage of one schedule will not necessarily impact the entire project. In conclusion, the main drivers of cost risk correspond to uncertainty in the pricing that will exist at the time of bid.

Cost Risks: From the CSRA, the key Cost Risk items include:

- **ES1 – Dredging Historical Pricing –** Historical unit pricing for this project has been investigated using both a comparison to the Cost Engineering Dredge Estimating Program (CEDEP) and historical construction costs. Pricing was within reason of this benchmark, but pricing can vary depending upon bidding conditions. Historically, bidding on work of this type in this area has been competitive. Even though this is the largest risk of this project, it is a relatively small risk in comparison to other projects with greater levels of risk.

- **ES2 – Stone Placement Historical Pricing –** Variation of stone pricing was also vetted with the Rock Island construction branch. Unit pricing is within the boundaries of historical pricing. As with ES1, this is a relatively mild risk when compared to other projects.

Schedule Risks: The anticipated schedule for this project is projected to consist of at least 14 separate contracts that are awarded as seasons/weather permits. Because the project area is large and the contracts are separate, it is currently believe that a slip in schedule in one contract will not directly impact the greater overall project schedule.

- **CO1 Change in Water Elevation –** Flood conditions in the work area could delay an individual contractor (but not necessarily the project as a whole) for up to three months. Once flooding conditions have ended, work may proceed as planned. This is a relatively mild schedule risk and is already mitigated by using multiple contracts for project delivery.

7.2. Recommendations

Risk Management is an all-encompassing, iterative, and life-cycle process of project management. The Project Management Institute's *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, *4th edition*, states that "project risk management includes the processes concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project." Risk identification and analysis are processes within the knowledge area of risk management. Their outputs pertinent to this effort include the risk register, risk quantification (risk analysis model), contingency report, and the sensitivity analysis.

The intended use of these outputs is implementation by the project leadership with respect to risk responses (such as mitigation) and risk monitoring and control. In short, the effectiveness of the project risk management effort requires that the proactive management of risks not conclude with the study completed in this report.

The CSRA produced by the PDT identifies issues that require the development of subsequent risk response and mitigation plans. This section provides a list of recommendations for continued management of the risks identified and analyzed in this study. Note that this list is not all inclusive and should not substitute a formal risk management and response plan.

Risks to this project are relatively mild. Historically, the Rock Island District has executed a lot of work of this variety with very good success. The contracting plan and ability to adjust scope to fit budget constraints allows the flexibility for this job to stay on schedule within a set budget.

The CSRA study serves as a “road map” towards project improvements and reduced risks over time. Timely coordination and risk resolution between the Sponsor, Railroad, and USACE is needed in areas of right-of-way (ROW), mobile home relocations, site access and staging, and funding needs and updates, as applicable. The PDT must include the recommended cost and schedule contingencies and incorporate risk monitoring and mitigation on those identified risks. Further iterative study and update of the risk analysis throughout the project life-cycle is important in support of remaining within an approved budget and appropriation.

Risk Management: Project leadership should make use of the outputs created during the risk analysis effort as tools in future risk management processes. The risk register should be updated at each major project milestone. The results of the sensitivity analysis may also be used for response planning strategy and development. These tools should be used in conjunction with regular risk review meetings.

Risk Analysis Updates: Project leadership should review risk items identified in the original risk register and add others, as required, throughout the project life cycle. Risks should be reviewed for status and re-evaluation (using qualitative measure, at a minimum) and placed on risk management watch lists if any risk’s likelihood or impact significantly increases. Project leadership should also be mindful of the potential for secondary (new risks created specifically by the response to an original risk) and residual risks (risks that remain and have unintended impact following response).

APPENDIX A

RISK REGISTER

				PROJECT COST			PROJECT SCHEDULE		
CREF	**Risk/Opportunity Event**	**Risk Event Description**	**PDT Discussions on Impact and Likelihood**	**Likelihood**	**Impact**	**Risk Level**	**Likelihood**	**Impact**	**Risk Level**
Organizational and Project Management Risks (PM)									
PM1	Indefinite Scope for Diversion Structure	Additional material may need to be dredged for maintaining the life of a cut. During a drought year, additional access dredging may be required. Additional hydraulic modeling is needed to determine if a diversion structure near Lower Lake is necessary to protect dredge cuts.	**SUMMARY -** Feature already considered and eliminated. H&H Has looked at this. No benefit to reducing sediment deposition. No further consideration needed. Chances of a drought year fairly low based on recent climate conditions. The impact would be moderate if more dredging is required and the likelihood is possible.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
PM2	Bank Stabilization (Stone Protection) - Upper Steamboat Island Head/NE Bank	Some features may affect others such as a feature causing erosion elsewhere. Area and quantity of stone placement can change due to a dynamic river system.	Moved to TR1. Duplicate risk/opportunity.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
PM3	Scope Changes Impact Design Costs	The design of this project is currently at 35% feasibility design and may change during plans and specs. Design changes may cause cost and schedule impacts.	Captured under TR1. There will likely be changes from 35% feasibility design to P&S. The impact would be marginal because the scope is currently well defined and potential scope changes, such mussel impacts, will be captured in design early.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
PM4	Cash flow concerns?	Federal cash flow could possibly slow schedule and/or increase costs due to inefficiencies.	Not a risk. This program has experienced adequate funding with no major delays over the past several years.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
PM5	No concern on lands and damages	All land is federal. No concerns procuring new land.	Not a risk.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
Contract Acquisition Risks (CA)									
CA1	Small Business Contracts	Small business and 8a programs could impact cost/schedule.	**SUMMARY -** Any impacts due to this are already included the base estimates. Not considered a risk. Anticipating small business IFB. Local bid climate has a history of competitive bids. No risk anticipated at this time. Survey work could be subcontracted. Change any survey to a subcontractor (already done in estimate - no need to change). Historic bids on this program have been extremely competitive in the last three years. 8a contracts have not come in to play due to contract magnitude. 8a not anticipated due to historic experience.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
CA2	Limited Bidder Interest	Few bidders for work due to current booming economy in the area.	Not a risk per historic bidding climate. District has seen competitive bidder interest on this type of work. Historic bids on this program have been extremely competitive in the last three years.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
CA3	Schedule Slips	IFB contracts anticipated. Bidder inquiries anticipated but already not anticipated to be to the threshold required for CSRA modeling.	Schedule is likely to change, but magnitude anticipated to be negligible. MVR executes this type of work frequently with no major delays.	Likely	Negligible	**Low**	Likely	Negligible	**Low**
CA	Multiple Contracts	Multiple contracts could increase costs and slow schedule.	Not considered a risk. Estimate already captures multiple contracts. Current estimate has 12-14 contracts already considered. Bank stabilization, planting, etc. categorized by year.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**

				PROJECT COST			PROJECT SCHEDULE		
CREF	**Risk/Opportunity Event**	**Risk Event Description**	**PDT Discussions on Impact and Likelihood**	**Likelihood**	**Impact**	**Risk Level**	**Likelihood**	**Impact**	**Risk Level**
General Technical Risks (TR)									
TR1	Scoping Document Change Due to Flooding	River is very dynamic. Head of island area is 14 acres in size with 180k CY of placement. (big feature). Since design has started things have changed in this area. Survey data is possibly outdated. Highly variable scour vs. deposition. This could be an opportunity or a risk.	**COST IMPACT** Sand quantities could increase or decrease due to scour or sediment deposition. No major potential to increase dredging quantities to a large degree. Shape of island could change slightly if needed. Project has ability to change scope to control cost. Will need additional design time to alter design. ($150k-$300k cost increase for redesign of documents - assume 10 year event will require this alteration - Expected effort to rework design would be 2 to 4 weeks with 2 week review. No major schedule impact) Discussed the possibility for needing additional environmental surveys for mussels. No additional survey needed. $0	Very Likely	Marginal	**Medium**	Very Likely	Negligible	**Low**
TR2	Additional Scour - More Rock Needed	River is very dynamic. Head of island area is 14 acres in size with 180k CY of placement. (big feature). Since design has started things have changed in this area. Survey data is possibly outdated. Highly variable scour vs. deposition. This could be an opportunity or a risk.	**PRIMARILY COST IMPACT** Additional rock quantities could be needed (or reduced) based upon the actions of the river. This may result in an increased quantity of stone. If/when erosion does occur. Bank stabilization (rock) is extended 50'. Not anticipated to be major cost. Rough calculations indicate cost impact of up to $350k increase (marginal). Erosion is very likely to occur based on last few months. Schedule will add only a few weeks to obtain rock. Schedule can "reset" each year and not impact future years.	Very Likely	Marginal	**Medium**	Very Likely	Negligible	**Low**
TR3	Timber Stand Delays	A change in design and quantities, due to prolonged high water followed by high wind, would cause a delay in TSI prescription execution. Endangered species limit work windows. This is mostly a schedule risk. However, this task is independent from other features.	TSI likely to be independent of other work. Schedule slips here would not impact overall schedule. Even if this is delayed it is not on the critical path, so it is possible that schedule will not be impacted even if there is a delay. Non TSI - Trees in dredge placement. Dredge delay will cause delay to this feature of work. However, the duration of this feature will not increase due to dredging.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
TR4	Cultural Areas Encountered	Upon survey of work area, it is possible that unknown cultural areas will be encountered.	No cultural survey completed at current moment. High water has prevented surveys from being completed. Typically in these projects, avoidance of cultural areas is utilized. May have design and schedule impacts, but only minor impacts (design will move work area). Anticipated cultural areas would only impact tree planting feature. Rock/dredge work are not anticipated to be impacted. No planting of trees would occur if this happens. Cost reduced and schedule is not changed. This is a cost opportunity but of only a very small magnitude.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
Lands and Damages (LD)									
LD1	Land Acquisition		All land is Federal. No additional land or easements required. All areas are accessible by public land.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
Regulatory Environmental Risks (RG)									
RG1	Endangered Species	Bats, eagles, and mussels need to be avoided.	**SUMMARY -** Cost and schedule risks are minor and need not be modeled. Risk already bought down for mussels. Surveys have already been done, and the plan is to avoid these areas. Eagles may impact schedule. 660' standoff for nests. Possible 2-3 nests anticipated over the course of construction. If they're there, work will occur elsewhere and nesting areas will be avoided. Project will be improving conditions for bats. Tree clearing will occur in winter months. Surveys will be conducted prior to clearing and areas containing bats will be avoided. Bat surveys are typically $20k-$30k. Bats are not anticipated to impact cost or schedule.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**

				PROJECT COST			PROJECT SCHEDULE		
CREF	**Risk/Opportunity Event**	**Risk Event Description**	**PDT Discussions on Impact and Likelihood**	**Likelihood**	**Impact**	**Risk Level**	**Likelihood**	**Impact**	**Risk Level**
Construction Risks (CO)									
CO1	Change in water elevation	Flood in work area/drought in work area.	**SCHEDULE IMPACT PRIMARILY** Low water could impact cost (below $100k). Schedule impact - KTR cannot access work area. If this happens, USACE stops work and waits until conditions improve. This has not been encountered historically. 3 month delay for summer. Possible. High water no cost impact. Schedule - high water generally remains in the area for about 2 weeks. Major event would be a month or two. Flood event more likely than low water. Likely.	Possible	Negligible	**Low**	Likely	Marginal	**Medium**
CO2	Quantity Changes/Differing site conditions	Already captured under TR1	Already captured under TR1	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
CO3	Tree Planting	Too much water or too little water could cause additional tree mortality. Phased planting approach will be utilized to "buy down" risk of losing all trees. Estimate currently does not include any tree mortality.	Not considered a schedule risk. Cost impact would be minor. Mortality not expected to exceed negligible ($50k-$60k worst case).	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
CO4	Mass Balance	Could dredged material exceed placement areas? Could placement areas exceed dredged material availability?	Not a risk. Loss of area to put dredged could occur, but if it did, dredge quantities could be reduced to maintain cut/fill balance. The same goes in reverse.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
CO5	Contractor Schedule	Could rushed schedule impact KTR's ability to meet deadlines/milestones?	Multiple years provided to complete work. Time constraints are relaxed. Funds do not expire. 30 & 31 not anticipated to exceed 0.5% threshold for cost.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
Estimate and Schedule Risks (ES)									
ES1	Dredging Historical Pricing Risk	Unit costs for dredging and placement may not reflect actual bids.	**COST IMPACT ONLY** Cost estimate is based on current quantities provided by MVR Technical Lead and other UMRR HREP projects/historical cost data. Cost estimator checked dredging unit cost using a dredging program CEDEP. The impact is moderate and the likelihood is possible. Pricing from Historical Obtained from construction: QTY = 487,000 CY Avg. Estimated Unit Price = $13.09 Assumed High = $17 (~30%) Assumed Low = $12.50 (~7%) Total Dredge Magnitude (no placement or shaping) = $6,376,000	Possible	Moderate	**Medium**	Unlikely	Negligible	**Low**

				PROJECT COST			PROJECT SCHEDULE		
CREF	**Risk/Opportunity Event**	**Risk Event Description**	**PDT Discussions on Impact and Likelihood**	**Likelihood**	**Impact**	**Risk Level**	**Likelihood**	**Impact**	**Risk Level**
ES2	Stone Placement Historical Pricing Risk	Unit costs for stone placement may not reflect actual bids.	**COST IMPACT ONLY** Cost estimate is based on current quantities provided by MVR Technical Lead and other UMRR HREP projects/historical cost data. The impact is moderate and the likelihood is possible. Avg. Estimated Unit Price = ~$52.00/ton Historic low is $50/ton while historic high is $61/ton. Assumed $70/ton is worst case imaginable. QTY = 132k tons.	Possible	Moderate	**Medium**	Unlikely	Negligible	**Low**
ES3	Design Changes	The design of this project is currently at 35% feasibility design and may change during plans and specs.	Assumed that major design changes would be quantities. See TR1.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**
External Risks (EX)									
EX1	Fuel Pricing	Change in fuel price could impact overall cost	**COST IMPACT ONLY** Estimate altered fuel pricing by ±$0.60. Project can swing ±$250k.	Possible	Marginal	**Low**	Unlikely	Negligible	**Low**
EX2	Bid Protests	Bid protests could delay schedule and increase USACE cost of doing business.	Are not a typical event. Recently experienced protest, but not the norm. Norm is good bid climate. Adequate number of contractors that eventually all contractors can win an award.	Unlikely	Negligible	**Low**	Unlikely	Negligible	**Low**

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

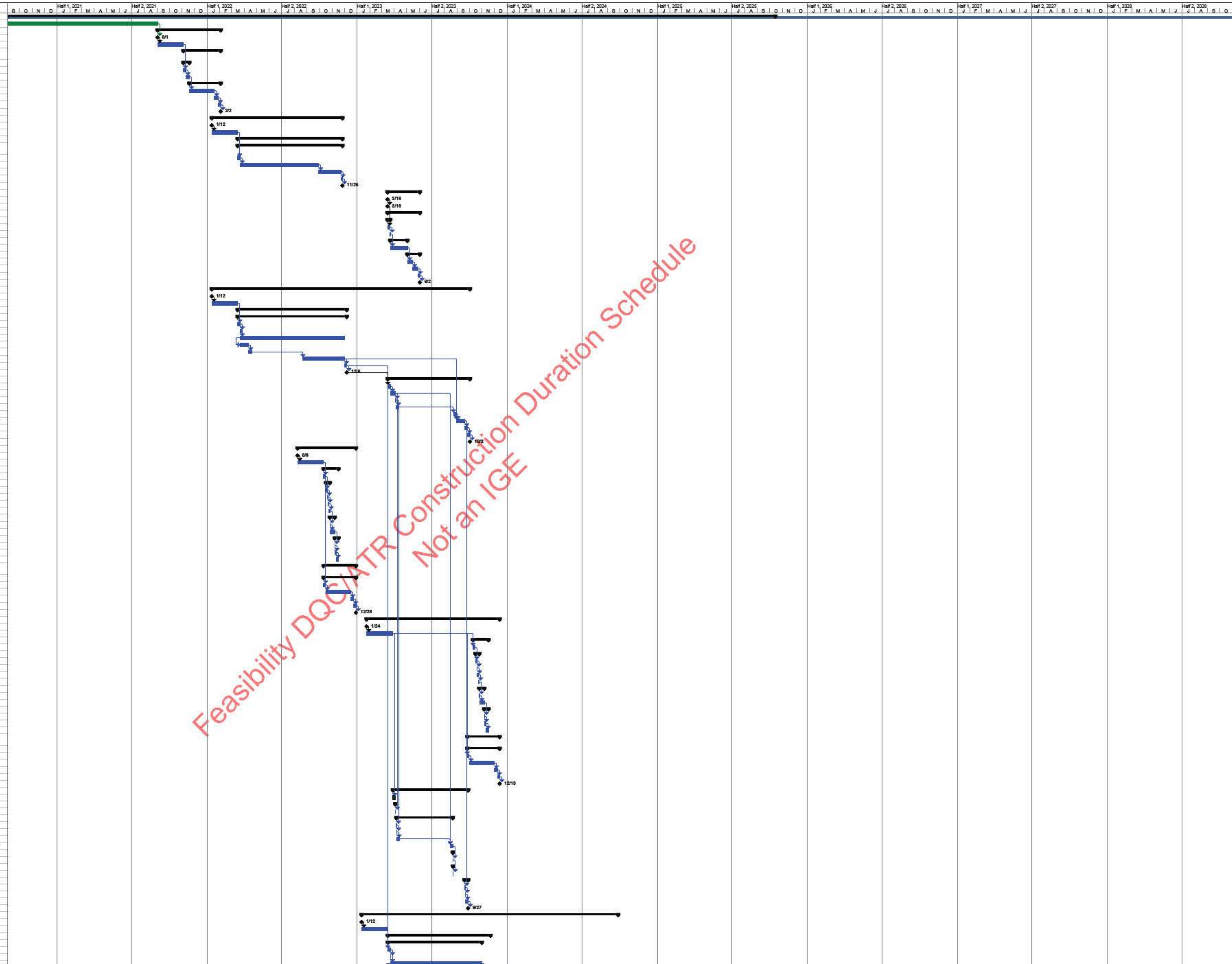
STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA AND ROCK ISLAND COUNTY, ILLINOIS

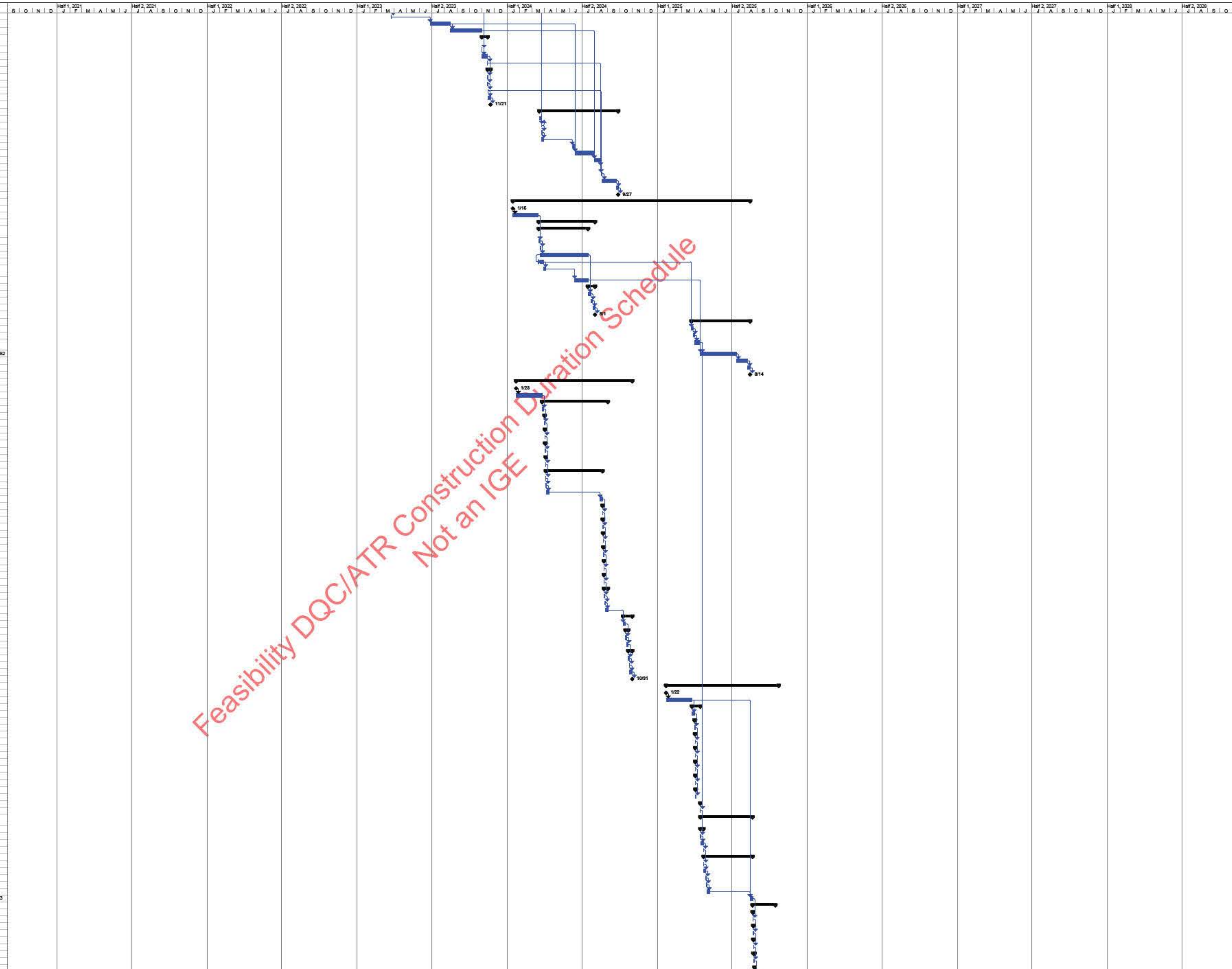
APPENDIX I-C

CONSTRUCTION DURATION SCHEDULE

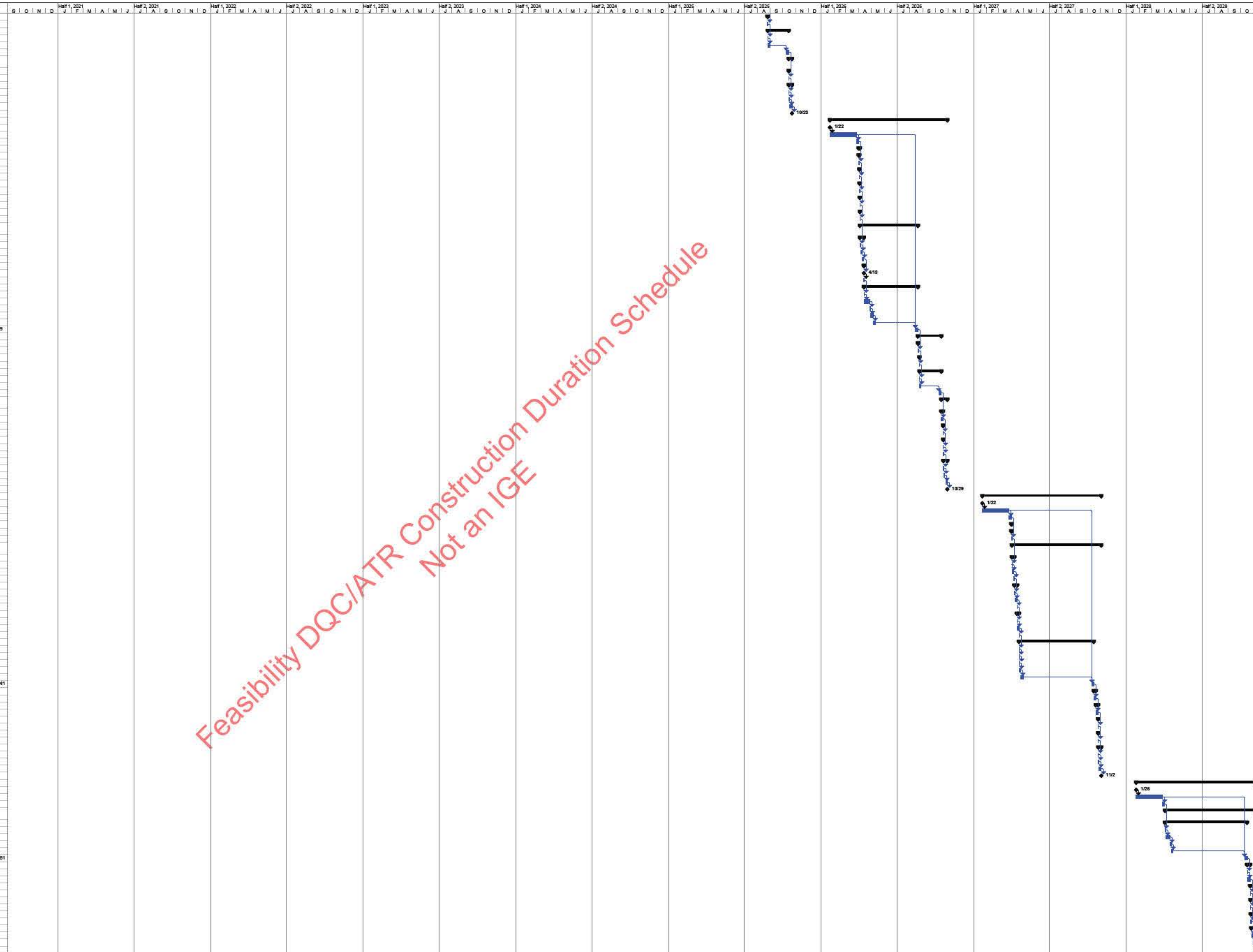
ID	Task Name	Duration	Start	Finish	Predecessors
1	**Steamboat Island HREP - Alternative 27**	**1338 days**	**Tue 9/1/20**	**Tue 10/14/25**	
2	Design (Plans and Specs)	262 days	Tue 9/1/20	Wed 9/1/21	
3	Contract 1 - 2021 to early 2022	**109.5 days**	**Wed 9/1/21**	**Wed 2/2/22**	
4	Notice to Proceed	0 days	Wed 9/1/21	Wed 9/1/21	2
5	Submittals	45 days	Thu 9/2/21	Wed 11/3/21	4
6	Tree Cutting/Clearing (Year 1)	**64.6 days**	**Thu 11/4/21**	**Wed 2/2/22**	
7	**Temporary Access (GS 4 & 6)**	**10.6 days**	**Thu 11/4/21**	**Thu 11/18/21**	
8	Mobilization (Clearing)	4 days	Thu 11/4/21	Tue 11/9/21	5
9	Clearing	6.5 days	Wed 11/10/21	Thu 11/18/21	8
10	**TSI Cutting Year 1 - Units 01, 03 , and 04**	**54 days**	**Thu 11/18/21**	**Wed 2/2/22**	
11	TSI Tree Cutting	43 days	Thu 11/18/21	Tue 1/18/22	9
12	Adverse weather days	7 days	Tue 1/18/22	Thu 1/27/22	11
13	Demobilization	4 days	Thu 1/27/22	Wed 2/2/22	12
14	Substantial Completion	0 days	Wed 2/2/22	Wed 2/2/22	13
15	Contract 2 - 2022	**228 days**	**Wed 1/12/22**	**Fri 11/25/22**	
16	Notice to Proceed	0 days	Wed 1/12/22	Wed 1/12/22	
17	Submittals	45 days	Wed 1/12/22	Tue 3/15/22	16
18	Stone Placement	**183 days**	**Wed 3/16/22**	**Fri 11/25/22**	
19	**Restore and Protect Upper of Steamboat Island - Upper Steamboat Island**	**183 days**	**Wed 3/16/22**	**Fri 11/25/22**	
20	Mobilization	4 days	Wed 3/16/22	Mon 3/21/22	17
21	Stone Placement	137 days	Tue 3/22/22	Wed 9/28/22	20
22	Adverse weather days	38 days	Thu 9/29/22	Mon 11/21/22	21
23	Demobilization	4 days	Tue 11/22/22	Fri 11/25/22	22
24	Substantial Completion	0 days	Fri 11/25/22	Fri 11/25/22	23
25	Contract 3 - 2023	**56.6 days**	**Thu 3/16/23**	**Fri 6/2/23**	
26	Notice to Proceed	0 days	Thu 3/16/23	Thu 3/16/23	
27	Submittals	0 days	Thu 3/16/23	Thu 3/16/23	26
28	Stone Placement	**56.6 days**	**Thu 3/16/23**	**Fri 6/2/23**	
29	**Grade Control Structure**	**4.4 days**	**Thu 3/16/23**	**Wed 3/22/23**	
30	Mobilization	4 days	Thu 3/16/23	Tue 3/21/23	27
31	Stone Placement	0.4 days	Wed 3/22/23	Wed 3/22/23	30
32	**NE Bank Stone Protection**	**29.9 days**	**Wed 3/22/23**	**Wed 5/3/23**	
33	Stone Placement	29.9 days	Wed 3/22/23	Wed 5/3/23	31
34	**Restore West SE Island**	**22.2 days**	**Wed 5/3/23**	**Fri 6/2/23**	
35	Stone Placement	8.2 days	Wed 5/3/23	Mon 5/15/23	33
36	Adverse weather days	10 days	Mon 5/15/23	Mon 5/29/23	35
37	Demobilization	4 days	Mon 5/29/23	Fri 6/2/23	36
38	Substantial Completion	0 days	Fri 6/2/23	Fri 6/2/23	37
39	Contract 4 - 2022 (Shaping 2023)	**448.5 days**	**Wed 1/12/22**	**Mon 10/2/23**	
40	Notice to Proceed	0 days	Wed 1/12/22	Wed 1/12/22	
41	Submittals	45 days	Wed 1/12/22	Tue 3/15/22	40
42	Dredging and Dredge Material Placement	**189.8 days**	**Wed 3/16/22**	**Tue 12/6/22**	
43	**Aq Div - SI Upper Lake Dredge Cut**	**189.8 days**	**Wed 3/16/22**	**Tue 12/6/22**	
44	Mobilization	4 days	Wed 3/16/22	Mon 3/21/22	41
45	Install Fiber Rolls and Silt Curtain	3.9 days	Tue 3/22/22	Fri 3/25/22	44
46	Dredging	181.7 days	Tue 3/22/22	Wed 11/30/22	44
47	Transport and Placement at NE Bank	14.8 days	Tue 3/22/22	Mon 4/11/22	46SS
48	Transport and Placement Topo Diversity SI UL	5.2 days	Mon 4/11/22	Mon 4/18/22	47
49	Transport and Placement Upper Head of Steamboat Isl	72.8 days	Mon 8/22/22	Wed 11/30/22	48FS+89 days
50	Demobilization	4 days	Wed 11/30/22	Tue 12/6/22	49
51	Substantial Completion	0 days	Tue 12/6/22	Tue 12/6/22	50
52	Dredge Material Shaping/Pushing	**141.7 days**	**Thu 3/16/23**	**Mon 10/2/23**	
53	Mobilization	4 days	Thu 3/16/23	Wed 3/22/23	51FS+72 days
54	Dredge Material Shaping NE Bank	7.8 days	Wed 3/22/23	Mon 4/3/23	53
55	Dredge Material Shaping SI UL	2.7 days	Mon 4/3/23	Thu 4/6/23	54
56	Demobilization	4 days	Thu 4/6/23	Wed 4/12/23	55
57	Mobilization	4 days	Wed 8/23/23	Tue 8/29/23	56FS+95 days
58	Dredge Material Shaping Upper Steamboat Island	13.7 days	Wed 8/30/23	Tue 9/19/23	49FS+195 days,57
59	Adverse weather days	5 days	Tue 9/19/23	Tue 9/26/23	58
60	Demobilization	4 days	Tue 9/26/23	Mon 10/2/23	59
61	Substantial Completion	0 days	Mon 10/2/23	Mon 10/2/23	60
62	Contract 5 - 2022	**102 days**	**Tue 8/9/22**	**Wed 12/28/22**	
63	Notice to Proceed	0 days	Tue 8/9/22	Tue 8/9/22	
64	Submittals	45 days	Tue 8/9/22	Mon 10/10/22	63
65	TSI Tree and Shrub Planting (Year 1)	**26.8 days**	**Tue 10/11/22**	**Wed 11/16/22**	
66	Mobilization	4 days	Tue 10/11/22	Fri 10/14/22	64
67	**Unit 01**	**7.4 days**	**Mon 10/17/22**	**Wed 10/26/22**	
68	Site 01A Tree Planting	2.9 days	Mon 10/17/22	Wed 10/19/22	66
69	Site 01B Tree Planting	1.8 days	Wed 10/19/22	Fri 10/21/22	68
70	Site 02 Tree Planting	1 day	Fri 10/21/22	Mon 10/24/22	69
71	Site 03 Tree Planting	1.7 days	Mon 10/24/22	Wed 10/26/22	70
72	**Unit 03**	**7.7 days**	**Wed 10/26/22**	**Mon 11/7/22**	
73	Site 02 Tree Planting	0.6 days	Wed 10/26/22	Wed 10/26/22	71
74	Site 03 Bare Root Seedlings	7.1 days	Thu 10/27/22	Mon 11/7/22	73
75	**Unit 04**	**7.7 days**	**Mon 11/7/22**	**Wed 11/16/22**	
76	Site 04 Tree Planting	0.7 days	Mon 11/7/22	Mon 11/7/22	74
77	Adverse weather days	3 days	Mon 11/7/22	Thu 11/10/22	76
78	Demobilization	4 days	Thu 11/10/22	Wed 11/16/22	77
79	Tree Cutting/Clearing (Year 2)	**67 days**	**Tue 10/11/22**	**Wed 12/28/22**	
80	**Units 01, 03 , and 04**	**67 days**	**Tue 10/11/22**	**Wed 12/28/22**	
81	Mobilization (Clearing)	4 days	Tue 10/11/22	Fri 10/14/22	64
82	TSI Tree Cutting	44 days	Mon 10/17/22	Thu 12/15/22	81
83	Adverse weather days	5 days	Fri 12/16/22	Thu 12/22/22	82
84	Demobilization	4 days	Fri 12/23/22	Wed 12/28/22	83
85	Substantial Completion	0 days	Wed 12/28/22	Wed 12/28/22	84
86	Contract 6 - 2023	**232 days**	**Tue 1/24/23**	**Wed 12/13/23**	
87	Notice to Proceed	0 days	Tue 1/24/23	Tue 1/24/23	
88	Submittals	45 days	Tue 1/24/23	Mon 3/27/23	87
89	TSI Tree and Shrub Planting (Year 2)	**27.8 days**	**Tue 10/10/23**	**Thu 11/16/23**	
90	Mobilization	4 days	Tue 10/10/23	Fri 10/13/23	88FS+140 days
91	**Unit 01**	**7.4 days**	**Mon 10/16/23**	**Wed 10/25/23**	
92	Site 01A Tree Planting	2.9 days	Mon 10/16/23	Wed 10/18/23	90
93	Site 01B Tree Planting	1.8 days	Wed 10/18/23	Fri 10/20/23	92
94	Site 02 Tree Planting	1 day	Fri 10/20/23	Mon 10/23/23	93
95	Site 03 Tree Planting	1.7 days	Mon 10/23/23	Wed 10/25/23	94
96	**Unit 03**	**7.7 days**	**Wed 10/25/23**	**Mon 11/6/23**	
97	Site 02 Tree Planting	0.6 days	Wed 10/25/23	Wed 10/25/23	95
98	Site 03 Bare Root Seedlings	7.1 days	Thu 10/26/23	Mon 11/6/23	97
99	**Unit 04**	**8.7 days**	**Mon 11/6/23**	**Thu 11/16/23**	
100	Site 04 Tree Planting	0.7 days	Mon 11/6/23	Mon 11/6/23	98
101	Adverse weather days	4 days	Mon 11/6/23	Fri 11/10/23	100
102	Demobilization	4 days	Fri 11/10/23	Thu 11/16/23	101
103	Tree Cutting/Clearing (Year 3)	**67 days**	**Tue 9/26/23**	**Wed 12/13/23**	
104	**Units 01, 03 , and 04**	**67 days**	**Tue 9/26/23**	**Wed 12/13/23**	
105	Mobilization (Clearing)	4 days	Tue 9/26/23	Fri 9/29/23	88FS+130 days
106	TSI Tree Cutting	44 days	Mon 10/2/23	Thu 11/30/23	105
107	Adverse weather days	5 days	Fri 12/1/23	Thu 12/7/23	106
108	Demobilization	4 days	Fri 12/8/23	Wed 12/13/23	107
109	Substantial Completion	0 days	Wed 12/13/23	Wed 12/13/23	108
110	Cover Crop Seeding	**130.9 days**	**Wed 3/29/23**	**Wed 9/27/23**	
111	Mobilization	4 days	Wed 3/29/23	Mon 4/3/23	88
112	**Protect Upstream Interior Lakes - NE Bank**	**0.8 days**	**Mon 4/3/23**	**Tue 4/4/23**	
113	Seeding (1st Year 1st Planting)	0.8 days	Mon 4/3/23	Tue 4/4/23	54
114	**SI UL**	**97.3 days**	**Thu 4/6/23**	**Mon 8/21/23**	
115	Seeding (1st Year 1st Planting)	0.4 days	Thu 4/6/23	Thu 4/6/23	55
116	Adverse weather days	1 day	Thu 4/6/23	Fri 4/7/23	115
117	Demobilization	4 days	Fri 4/7/23	Thu 4/13/23	116
118	Mobilization	4 days	Tue 8/15/23	Mon 8/21/23	54FS+96 days,117
119	**Protect Upstream Interior Lakes - NE Bank**	**0.8 days**	**Mon 8/21/23**	**Tue 8/22/23**	
120	Seeding (1st Year 2nd Planting)	0.8 days	Mon 8/21/23	Tue 8/22/23	118
121	**SI UL**	**0.4 days**	**Tue 8/22/23**	**Tue 8/22/23**	
122	Seeding (1st Year 2nd Planting)	0.4 days	Tue 8/22/23	Tue 8/22/23	120
123	**Upper Steamboat Island**	**6.4 days**	**Tue 9/19/23**	**Wed 9/27/23**	
124	Seeding (1st Year 1st Planting)	1.4 days	Tue 9/19/23	Wed 9/20/23	58
125	Adverse weather days	1 day	Wed 9/20/23	Thu 9/21/23	124
126	Demobilization	4 days	Thu 9/21/23	Wed 9/27/23	125
127	Substantial Completion	0 days	Wed 9/27/23	Wed 9/27/23	126
128	Contract 7 - 2023 (Shaping 2024)	**446.4 days**	**Thu 1/12/23**	**Fri 9/27/24**	
129	Notice to Proceed	0 days	Thu 1/12/23	Thu 1/12/23	
130	Submittals	45 days	Thu 1/12/23	Wed 3/15/23	129
131	Dredging and Dredge Material Placement	**177.9 days**	**Thu 3/16/23**	**Tue 11/21/23**	
132	**Aq Div - SI Lower Lake Dredge Cut**	**162.7 days**	**Thu 3/16/23**	**Tue 10/31/23**	
133	Mobilization	4 days	Thu 3/16/23	Wed 3/22/23	50FS+72 days
134	Install Fiber Rolls and Silt Curtain	0.4 days	Wed 3/22/23	Thu 3/23/23	133
135	Dredging	158.7 days	Wed 3/22/23	Tue 10/31/23	133
136	Transport and Placement SI LL SSP	1.4 days	Wed 3/22/23	Fri 3/24/23	135SS



ID	Task Name	Duration	Start	Finish	Predecessors
137	Transport and Placement Grade Control Structure	0.3 days	Fri 3/24/23	Fri 3/24/23	136
138	Transport and Placement to SE Isl	35.2 days	Tue 6/27/23	Tue 8/15/23	137FS+67 days
139	Transport and Placement Upper Head of Steamboat Isl	54.6 days	Tue 8/15/23	Tue 10/31/23	138
140	**Access Dredge Cut Quantity - Grant Slough Access Dredging**	**10 days**	**Tue 10/31/23**	**Tue 11/14/23**	
141	Install Fiber Rolls and Silt Curtain	0.1 days	Tue 10/31/23	Tue 10/31/23	135
142	Dredging	10 days	Tue 10/31/23	Tue 11/14/23	135
143	Transport and Placement SW GS SSP	1.5 days	Mon 11/13/23	Tue 11/14/23	142FS-1.5 days
144	**Restore SE Island**	**5.2 days**	**Tue 11/14/23**	**Tue 11/21/23**	
145	Install Fiber Rolls and Silt Curtain	1.1 days	Tue 11/14/23	Wed 11/15/23	142
146	Dredging	0.8 days	Tue 11/14/23	Wed 11/15/23	142
147	Transport and Placement from SE Isl	0.4 days	Wed 11/15/23	Wed 11/15/23	146
148	Demobilization	4 days	Wed 11/15/23	Tue 11/21/23	147
149	Substantial Completion	0 days	Tue 11/21/23	Tue 11/21/23	148
150	**Dredge Material Shaping/Pushing**	**137.9 days**	**Tue 3/19/24**	**Fri 9/27/24**	
151	Mobilization	4 days	Tue 3/19/24	Mon 3/25/24	152FS-4 days
152	Dredge Material Shaping SI LL SSP	0.3 days	Mon 3/25/24	Mon 3/25/24	136FS+261 days
153	Dredge Material Shaping Grade Control Structure	0.2 days	Mon 3/25/24	Mon 3/25/24	152
154	Demobilization	4 days	Mon 3/25/24	Fri 3/29/24	153
155	Mobilization	4 days	Fri 6/7/24	Thu 6/13/24	154FS+50 days
156	Dredge Material Shaping SE Island	31.5 days	Fri 6/14/24	Tue 7/30/24	138FS+218 days
157	Dredge Material Shaping Upper Steamboat Island	10.9 days	Wed 7/31/24	Thu 8/15/24	139FS+196 days
158	Dredge Material Shaping SW GS SSP	1.5 days	Thu 8/15/24	Fri 8/16/24	143FS+197 days
159	Dredge Material Shaping SE Isl	0.7 days	Fri 8/16/24	Mon 8/19/24	147FS+197 days
160	Adverse weather days	25 days	Mon 8/19/24	Mon 9/23/24	159
161	Demobilization	4 days	Mon 9/23/24	Fri 9/27/24	160
162	Substantial Completion	0 days	Fri 9/27/24	Fri 9/27/24	161
163	**Contract 8 - 2024 (Shaping 2025)**	**413.5 days**	**Mon 1/15/24**	**Thu 8/14/25**	
164	Notice to Proceed	0 days	Mon 1/15/24	Mon 1/15/24	
165	Submittals	45 days	Mon 1/15/24	Fri 3/15/24	164
166	**Dredging and Dredge Material Placement**	**99 days**	**Mon 3/18/24**	**Thu 8/1/24**	
167	**Overwintering Dredge Cut Quantity - Northwest Grant Slough Lake Dredging**	**88 days**	**Mon 3/18/24**	**Mon 7/15/24**	
168	Mobilization	4 days	Mon 3/18/24	Thu 3/21/24	165
169	Install Fiber Rolls and Silt Curtain	0.6 days	Fri 3/22/24	Fri 3/22/24	168
170	Dredging	82 days	Fri 3/22/24	Mon 7/15/24	168
171	Transport and Placement Topo Diversity GS 2	5.7 days	Fri 3/22/24	Fri 3/29/24	170SS
172	Transport and Placement Topo Diversity 4 & 5 Temporary Access	3.4 days	Fri 3/29/24	Thu 4/4/24	171
173	Transport and Placement Topo Diversity GS 4 & 5	22.6 days	Thu 6/13/24	Mon 7/15/24	172FS+50 days
174	**Topo Diversity GS 4 & 5 Temporary Acess**	**13 days**	**Tue 7/16/24**	**Thu 8/1/24**	
175	Dredging/Removal	5 days	Tue 7/16/24	Mon 7/22/24	170
176	Transport and Placement Upper Head of Steamboat Isl	4 days	Tue 7/23/24	Fri 7/26/24	175
177	Demobilization	4 days	Mon 7/29/24	Thu 8/1/24	176
178	Substantial Completion	0 days	Thu 8/1/24	Thu 8/1/24	177
179	**Dredge Material Shaping/Pushing**	**102.8 days**	**Mon 3/24/25**	**Thu 8/14/25**	
180	Mobilization	4 days	Mon 3/24/25	Fri 3/28/25	171FS+256 days
181	Dredge Material Shaping Topo Diversity GS 2	2.1 days	Fri 3/28/25	Tue 4/1/25	180
182	Dredge Material Shaping Topo Diversity 4 & 5 Temporary Access	9.6 days	Tue 4/1/25	Tue 4/15/25	181
183	Dredge Material Shaping GS 4 & 5	62.8 days	Tue 4/15/25	Fri 7/11/25	173FS+196 days,182
184	Adverse weather days	20 days	Fri 7/11/25	Fri 8/8/25	183
185	Demobilization	4 days	Fri 8/8/25	Thu 8/14/25	184
186	Substantial Completion	0 days	Thu 8/14/25	Thu 8/14/25	185
187	**Contract 9 - 2024**	**202.84 days**	**Tue 1/23/24**	**Thu 10/31/24**	
188	Notice to Proceed	0 days	Tue 1/23/24	Tue 1/23/24	
189	Submittals	45 days	Tue 1/23/24	Mon 3/25/24	188
190	**Cover Crop Seeding**	**114.24 days**	**Tue 3/26/24**	**Mon 9/2/24**	
191	Mobilization	4 days	Tue 3/26/24	Fri 3/29/24	189
192	**Protect Upstream Interior Lakes - NE Bank**	**0.8 days**	**Mon 4/1/24**	**Mon 4/1/24**	
193	Seeding (2nd Year 1st Planting)	0.8 days	Mon 4/1/24	Mon 4/1/24	191
194	**SI UL**	**0.4 days**	**Mon 4/1/24**	**Tue 4/2/24**	
195	Seeding (2nd Year 1st Planting)	0.4 days	Mon 4/1/24	Tue 4/2/24	193
196	**Upper Steamboat Island**	**1.4 days**	**Tue 4/2/24**	**Wed 4/3/24**	
197	Seeding (1st Year 2nd Planting)	1.4 days	Tue 4/2/24	Wed 4/3/24	195
198	**SI LL SSP**	**0.6 days**	**Wed 4/3/24**	**Thu 4/4/24**	
199	Seeding (1st Year 1st Planting)	0.6 days	Wed 4/3/24	Thu 4/4/24	197
200	**Grade Control Structure**	**98.02 days**	**Thu 4/4/24**	**Tue 8/20/24**	
201	Seeding (1st Year 1st Planting)	0.02 days	Thu 4/4/24	Thu 4/4/24	199
202	Adverse weather days	1 day	Thu 4/4/24	Fri 4/5/24	201
203	Demobilization	4 days	Fri 4/5/24	Thu 4/11/24	202
204	Mobilization	4 days	Wed 8/14/24	Tue 8/20/24	203FS+89 days
205	**SE Island**	**0.5 days**	**Tue 8/20/24**	**Tue 8/20/24**	
206	Seeding (1st Year 1st Planting)	0.5 days	Tue 8/20/24	Tue 8/20/24	204
207	**Protect Upstream Interior Lakes - NE Bank**	**0.8 days**	**Tue 8/20/24**	**Wed 8/21/24**	
208	Seeding (2nd Year 2nd Planting)	0.8 days	Tue 8/20/24	Wed 8/21/24	206
209	**SI UL**	**0.4 days**	**Wed 8/21/24**	**Wed 8/21/24**	
210	Seeding (2nd Year 2nd Planting)	0.4 days	Wed 8/21/24	Wed 8/21/24	208
211	**Upper Steamboat Island**	**1.4 days**	**Wed 8/21/24**	**Fri 8/23/24**	
212	Seeding (2nd Year 1st Planting)	1.4 days	Wed 8/21/24	Fri 8/23/24	210
213	**SI LL SSP**	**0.5 days**	**Fri 8/23/24**	**Fri 8/23/24**	
214	Seeding (1st Year 2nd Planting)	0.5 days	Fri 8/23/24	Fri 8/23/24	212
215	**Grade Control Structure**	**0.02 days**	**Fri 8/23/24**	**Fri 8/23/24**	
216	Seeding (1st Year 2nd Planting)	0.02 days	Fri 8/23/24	Fri 8/23/24	214
217	**SW GS SSP**	**6.4 days**	**Fri 8/23/24**	**Mon 9/2/24**	
218	Seeding (1st Year 1st Planting)	0.4 days	Fri 8/23/24	Mon 8/26/24	216
219	Adverse weather days	1 day	Mon 8/26/24	Tue 8/27/24	218
220	Demobilization	4 days	Tue 8/27/24	Mon 9/2/24	219
221	**TSI Tree and Shrub Planting (Year 3)**	**16.4 days**	**Wed 10/9/24**	**Thu 10/31/24**	
222	Mobilization	4 days	Wed 10/9/24	Tue 10/15/24	220FS+27 days
223	**Unit 01**	**4.7 days**	**Tue 10/15/24**	**Mon 10/21/24**	
224	Site 01A Tree Planting	2.9 days	Tue 10/15/24	Fri 10/18/24	222
225	Site 01B Tree Planting	1.8 days	Fri 10/18/24	Mon 10/21/24	224
226	**Unit 03**	**7.7 days**	**Mon 10/21/24**	**Thu 10/31/24**	
227	Site 03 Tree Planting	2.7 days	Mon 10/21/24	Thu 10/24/24	225
228	Adverse weather days	1 day	Thu 10/24/24	Fri 10/25/24	227
229	Demobilization	4 days	Fri 10/25/24	Thu 10/31/24	228
230	Substantial Completion	0 days	Thu 10/31/24	Thu 10/31/24	229
231	**Contract 10 - 2025**	**196.12 days**	**Wed 1/22/25**	**Thu 10/23/25**	
232	Notice to Proceed	0 days	Wed 1/22/25	Wed 1/22/25	
233	Submittals	45 days	Wed 1/22/25	Tue 3/25/25	232
234	**Cover Crop Seeding**	**14.6 days**	**Wed 3/26/25**	**Tue 4/15/25**	
235	Mobilization	4 days	Wed 3/26/25	Mon 3/31/25	233
236	**Upper Steamboat Island**	**1.4 days**	**Tue 4/1/25**	**Wed 4/2/25**	
237	Seeding (2nd Year 2nd Planting)	1.4 days	Tue 4/1/25	Wed 4/2/25	235
238	**SI LL SSP**	**0.5 days**	**Wed 4/2/25**	**Wed 4/2/25**	
239	Seeding (2nd Year 1st Planting)	0.5 days	Wed 4/2/25	Wed 4/2/25	237
240	**Grade Control Structure**	**0.02 days**	**Wed 4/2/25**	**Wed 4/2/25**	
241	Seeding (2nd Year 1st Planting)	0.02 days	Wed 4/2/25	Wed 4/2/25	239
242	**SE Island**	**0.5 days**	**Wed 4/2/25**	**Thu 4/3/25**	
243	Seeding (1st Year 2nd Planting)	0.5 days	Wed 4/2/25	Thu 4/3/25	241
244	**SW GS SSP**	**0.4 days**	**Thu 4/3/25**	**Thu 4/3/25**	
245	Seeding (1st Year 2nd Planting)	0.4 days	Thu 4/3/25	Thu 4/3/25	243
246	**Topo Diversity GS 2**	**0.4 days**	**Thu 4/3/25**	**Fri 4/4/25**	
247	Seeding (1st Year 1st Planting)	0.4 days	Thu 4/3/25	Fri 4/4/25	245
248	**Topo Diversity 4 & 5 Temporary Access**	**0.1 days**	**Tue 4/15/25**	**Tue 4/15/25**	
249	Seeding (1st Year 1st Planting)	0.1 days	Tue 4/15/25	Tue 4/15/25	182
250	**Native Species Planting, Bare Root Seedling Planting, Plant Forbes/Grasses, and Containerized Planting**	**91.3 days**	**Tue 4/15/25**	**Wed 8/20/25**	
251	**Protect Upstream Interior Lakes - NE Bank**	**6 days**	**Tue 4/15/25**	**Wed 4/23/25**	
252	Native Species Planting	0.8 days	Tue 4/15/25	Wed 4/16/25	249
253	Bare Root Seedling Planting	4.5 days	Wed 4/16/25	Tue 4/22/25	252
254	Plant Forbs/Grasses	0.7 days	Tue 4/22/25	Wed 4/23/25	253
255	**SI UL**	**85.3 days**	**Wed 4/23/25**	**Wed 8/20/25**	
256	Native Species Planting	0.4 days	Wed 4/23/25	Wed 4/23/25	254
257	Bare Root Seedling Planting	2.4 days	Wed 4/23/25	Mon 4/28/25	256
258	Plant Forbs/Grasses	1.5 days	Mon 4/28/25	Tue 4/29/25	257
259	Adverse weather days	2 days	Tue 4/29/25	Thu 5/1/25	258
260	Demobilization	4 days	Thu 5/1/25	Wed 5/7/25	259
261	Mobilization	4 days	Thu 8/14/25	Wed 8/20/25	260FS+71 days,233
262	**Cover Crop Seeding**	**39.42 days**	**Wed 8/20/25**	**Wed 10/15/25**	
263	**Topo Diversity GS 4 & 5**	**1.4 days**	**Wed 8/20/25**	**Fri 8/22/25**	
264	Seeding (1st Year 1st Planting)	1.4 days	Wed 8/20/25	Fri 8/22/25	261
265	**SI LL SSP**	**0.6 days**	**Fri 8/22/25**	**Fri 8/22/25**	
266	Seeding (2nd Year 2nd Planting)	0.6 days	Fri 8/22/25	Fri 8/22/25	264
267	**Grade Control Structure**	**0.02 days**	**Fri 8/22/25**	**Fri 8/22/25**	
268	Seeding (2nd Year 2nd Planting)	0.02 days	Fri 8/22/25	Fri 8/22/25	266
269	**SE Island**	**0.5 days**	**Fri 8/22/25**	**Mon 8/25/25**	
270	Seeding (2nd Year 1st Planting)	0.5 days	Fri 8/22/25	Mon 8/25/25	268
271	**SW GS SSP**	**0.4 days**	**Mon 8/25/25**	**Mon 8/25/25**	
272	Seeding (2nd Year 1st Planting)	0.4 days	Mon 8/25/25	Mon 8/25/25	270



ID	Task Name	Duration	Start	Finish	Predecessors
273	Transport and Placement Topo Diversify GS 2	0.4 days	Mon 8/25/25	Tue 8/26/25	
274	Seeding (1st Year 2nd Planting)	0.4 days	Mon 8/25/25	Tue 8/26/25	272
275	Transport and Placement Topo Diversify 4 & 6 Temporary Acce	38.1 days	Tue 8/26/25	Wed 10/15/25	
276	Seeding (1st Year 2nd Planting)	0.1 days	Tue 8/26/25	Tue 8/26/25	274
277	Demobilization	4 days	Tue 8/26/25	Mon 9/1/25	276
278	Mobilization	4 days	Thu 10/9/25	Wed 10/15/25	277FS+28 days
279	Native Species Planting, Bare Root Seedling Planting, Plant Forbes/Grasses, and Containerized Planting	5.9 days	Wed 10/15/25	Thu 10/23/25	
280	Protect Upstream Interior Lakes - NE Bank	0.6 days	Wed 10/15/25	Wed 10/15/25	
281	Plant Container Trees - Fast Growing	0.6 days	Wed 10/15/25	Wed 10/15/25	278
282	SI UL	5.3 days	Wed 10/15/25	Thu 10/23/25	
283	Plant Container Trees - Fast Growing	0.3 days	Wed 10/15/25	Thu 10/16/25	281
284	Adverse weather days	1 day	Thu 10/16/25	Fri 10/17/25	283
285	Demobilization	4 days	Fri 10/17/25	Thu 10/23/25	284
286	Substantial Completion	0 days	Thu 10/23/25	Thu 10/23/25	285
287	Contract 11 - 2026	201 days	Thu 1/22/26	Thu 10/29/26	
288	Notice to Proceed	0 days	Thu 1/22/26	Thu 1/22/26	
289	Submittals	45 days	Thu 1/22/26	Wed 3/25/26	288
290	Mobilization	4 days	Thu 3/26/26	Tue 3/31/26	289
291	Cover Crop Seeding	2.8 days	Wed 4/1/26	Fri 4/3/26	
292	Topo Diversify GS 4 & 6	1.4 days	Wed 4/1/26	Thu 4/2/26	
293	Seeding (1st Year 2nd Planting)	1.4 days	Wed 4/1/26	Thu 4/2/26	290
294	SE Island	0.5 days	Thu 4/2/26	Thu 4/2/26	
295	Seeding (2nd Year 2nd Planting)	0.5 days	Thu 4/2/26	Thu 4/2/26	293
296	SW GS SSP	0.4 days	Thu 4/2/26	Fri 4/3/26	
297	Seeding (2nd Year 2nd Planting)	0.4 days	Thu 4/2/26	Fri 4/3/26	295
298	Topo Diversify GS 2	0.4 days	Fri 4/3/26	Fri 4/3/26	
299	Seeding (2nd Year 1st Planting)	0.4 days	Fri 4/3/26	Fri 4/3/26	297
300	Topo Diversify 4 & 6 Temporary Access	0.1 days	Fri 4/3/26	Fri 4/3/26	
301	Seeding (2nd Year 1st Planting)	0.1 days	Fri 4/3/26	Fri 4/3/26	299
302	Native Species Planting, Bare Root Seedling Planting, Plant Forbes/Grasses, and Containerized Planting	98.8 days	Fri 4/3/26	Thu 8/20/26	
303	SI LL SSP	5.4 days	Fri 4/3/26	Mon 4/13/26	
304	Native Species Planting	0.6 days	Fri 4/3/26	Mon 4/6/26	301
305	Bare Root Seedling Planting	3.3 days	Mon 4/6/26	Thu 4/9/26	304
306	Plant Forbs/Grasses	1.5 days	Thu 4/9/26	Mon 4/13/26	305
307	Grade Control Structure	0.1 days	Mon 4/13/26	Mon 4/13/26	
308	Native Species Planting	0 days	Mon 4/13/26	Mon 4/13/26	306
309	Bare Root Seedling Planting	0.1 days	Mon 4/13/26	Mon 4/13/26	308
310	Upper Steamboat Island	93.3 days	Mon 4/13/26	Thu 8/20/26	
311	Native Species Planting	1.4 days	Mon 4/13/26	Tue 4/14/26	309
312	Bare Root Seedling Planting	8.6 days	Tue 4/14/26	Mon 4/27/26	311
313	Plant Forbs/Grasses	1.3 days	Mon 4/27/26	Tue 4/28/26	312
314	Adverse weather days	5 days	Tue 4/28/26	Tue 5/5/26	313
315	Demobilization	4 days	Tue 5/5/26	Mon 5/11/26	314
316	Mobilization	4 days	Fri 8/14/26	Thu 8/20/26	315FS+69 days,289
317	Cover Crop Seeding	39.9 days	Thu 8/20/26	Thu 10/15/26	
318	Topo Diversify GS 4 & 6	1.4 days	Thu 8/20/26	Fri 8/21/26	
319	Seeding (2nd Year 1st Planting)	1.4 days	Thu 8/20/26	Fri 8/21/26	316
320	Topo Diversify GS 2	0.4 days	Mon 8/24/26	Mon 8/24/26	
321	Seeding (2nd Year 2nd Planting)	0.4 days	Mon 8/24/26	Mon 8/24/26	319
322	Topo Diversify 4 & 6 Temporary Access	38.1 days	Mon 8/24/26	Thu 10/15/26	
323	Seeding (2nd Year 2nd Planting)	0.1 days	Mon 8/24/26	Mon 8/24/26	321
324	Demobilization	4 days	Mon 8/24/26	Fri 8/28/26	323
325	Mobilization	4 days	Fri 10/9/26	Thu 10/15/26	324FS+30 days
326	Native Species Planting, Bare Root Seedling Planting, Plant Forbes/Grasses, and Containerized Planting	10.6 days	Thu 10/15/26	Thu 10/29/26	
327	Protect Upstream Interior Lakes - NE Bank	2 days	Thu 10/15/26	Mon 10/19/26	
328	Plant Container Trees - Slow Growing	2 days	Thu 10/15/26	Mon 10/19/26	325
329	SI UL	1.1 days	Mon 10/19/26	Tue 10/20/26	
330	Plant Container Trees - Slow Growing	1.1 days	Mon 10/19/26	Tue 10/20/26	328
331	Grade Control Structure	0.2 days	Tue 10/20/26	Tue 10/20/26	
332	Plant Container Trees - Fast Growing	0.1 days	Tue 10/20/26	Tue 10/20/26	330
333	Plant Container Trees - Willow Cuttings	0.1 days	Tue 10/20/26	Tue 10/20/26	332
334	Upper Steamboat Island	7.2 days	Tue 10/20/26	Thu 10/29/26	
335	Plant Container Trees - Fast Growing	1.2 days	Tue 10/20/26	Wed 10/21/26	333
336	Adverse weather days	2 days	Thu 10/22/26	Fri 10/23/26	335
337	Demobilization	4 days	Mon 10/26/26	Thu 10/29/26	336
338	Substantial Completion	0 days	Thu 10/29/26	Thu 10/29/26	337
339	Contract 12 - 2027	202.8 days	Fri 1/22/27	Tue 11/2/27	
340	Notice to Proceed	0 days	Fri 1/22/27	Fri 1/22/27	
341	Submittals	45 days	Fri 1/22/27	Thu 3/25/27	340
342	Mobilization	4 days	Fri 3/26/27	Wed 3/31/27	341
343	Cover Crop Seeding	1.4 days	Thu 4/1/27	Fri 4/2/27	
344	Topo Diversify GS 4 & 6	1.4 days	Thu 4/1/27	Fri 4/2/27	
345	Seeding (2nd Year 2nd Planting)	1.4 days	Thu 4/1/27	Fri 4/2/27	342
346	Native Species Planting, Bare Root Seedling Planting, Plant Forbes/Grasses, and Containerized Planting	162.4 days	Fri 4/2/27	Tue 11/2/27	
347	SW GS SSP	4.2 days	Fri 4/2/27	Thu 4/8/27	
348	Native Species Planting	0.4 days	Fri 4/2/27	Fri 4/2/27	345
349	Bare Root Seedling Planting	2.6 days	Fri 4/2/27	Wed 4/7/27	348
350	Plant Forbs/Grasses	1.2 days	Wed 4/7/27	Thu 4/8/27	349
351	SE Island	4.2 days	Thu 4/8/27	Wed 4/14/27	
352	Native Species Planting	0.5 days	Thu 4/8/27	Fri 4/9/27	350
353	Bare Root Seedling Planting	3.2 days	Fri 4/9/27	Wed 4/14/27	352
354	Plant Forbs/Grasses	0.5 days	Wed 4/14/27	Wed 4/14/27	353
355	Topo Diversify GS 2	2.8 days	Wed 4/14/27	Mon 4/19/27	
356	Native Species Planting	0.4 days	Wed 4/14/27	Thu 4/15/27	354
357	Bare Root Seedling Planting	2.1 days	Thu 4/15/27	Mon 4/19/27	356
358	Plant Forbs/Grasses	0.3 days	Mon 4/19/27	Mon 4/19/27	357
359	Topo Diversify 4 & 6 Temporary Access	129 days	Mon 4/19/27	Fri 10/15/27	
360	Native Species Planting	0.1 days	Mon 4/19/27	Mon 4/19/27	358
361	Bare Root Seedling Planting	0.8 days	Mon 4/19/27	Tue 4/20/27	360
362	Plant Forbs/Grasses	0.1 days	Tue 4/20/27	Tue 4/20/27	361
363	Adverse weather days	3 days	Tue 4/20/27	Fri 4/23/27	362
364	Demobilization	4 days	Fri 4/23/27	Thu 4/29/27	363
365	Mobilization	4 days	Mon 10/11/27	Fri 10/15/27	364FS+117 days,341
366	SI LL SSP	2.5 days	Fri 10/15/27	Wed 10/20/27	
367	Plant Container Trees - Fast Growing	2.5 days	Fri 10/15/27	Wed 10/20/27	365
368	Upper Steamboat Island	3.9 days	Wed 10/20/27	Mon 10/25/27	
369	Plant Container Trees - Slow Growing	3.9 days	Wed 10/20/27	Mon 10/25/27	367
370	SE Island	0.4 days	Tue 10/26/27	Tue 10/26/27	
371	Plant Container Trees - Fast Growing	0.4 days	Tue 10/26/27	Tue 10/26/27	369
372	Topo Diversify 4 & 6 Temporary Access	0.1 days	Tue 10/26/27	Tue 10/26/27	
373	Plant Container Trees - Fast Growing	0.1 days	Tue 10/26/27	Tue 10/26/27	371
374	Topo Diversify GS 2	5.3 days	Tue 10/26/27	Tue 11/2/27	
375	Plant Container Trees - Fast Growing	0.3 days	Tue 10/26/27	Tue 10/26/27	373
376	Adverse weather days	1 day	Tue 10/26/27	Wed 10/27/27	375
377	Demobilization	4 days	Wed 10/27/27	Tue 11/2/27	376
378	Substantial Completion	0 days	Tue 11/2/27	Tue 11/2/27	377
379	Contract 13 - 2028	207.2 days	Tue 1/25/28	Thu 11/9/28	
380	Notice to Proceed	0 days	Tue 1/25/28	Tue 1/25/28	
381	Submittals	45 days	Tue 1/25/28	Mon 3/27/28	380
382	Mobilization	4 days	Tue 3/28/28	Fri 3/31/28	381
383	Native Species Planting, Bare Root Seedling Planting, Plant Forbes/Grasses, and Containerized Planting	158.2 days	Mon 4/3/28	Thu 11/9/28	
384	Topo Diversify GS 4 & 6	140.8 days	Mon 4/3/28	Mon 10/16/28	
385	Native Species Planting	1.4 days	Mon 4/3/28	Tue 4/4/28	382
386	Bare Root Seedling Planting	8.2 days	Tue 4/4/28	Fri 4/14/28	385
387	Plant Forbs/Grasses	1.2 days	Fri 4/14/28	Mon 4/17/28	386
388	Demobilization	4 days	Mon 4/17/28	Fri 4/21/28	387
389	Mobilization	4 days	Tue 10/10/28	Mon 10/16/28	388FS+122 days,381
390	Topo Diversify GS 4 & 6	4.8 days	Mon 10/16/28	Mon 10/23/28	
391	Plant Container Trees - Fast Growing	1.1 days	Mon 10/16/28	Tue 10/17/28	389
392	Plant Container Trees - Slow Growing	3.7 days	Tue 10/17/28	Mon 10/23/28	391
393	Topo Diversify GS 2	1 day	Mon 10/23/28	Tue 10/24/28	
394	Plant Container Trees - Slow Growing	1 day	Mon 10/23/28	Tue 10/24/28	392
395	Topo Diversify 4 & 6 Temporary Access	0.3 days	Tue 10/24/28	Tue 10/24/28	
396	Plant Container Trees - Slow Growing	0.3 days	Tue 10/24/28	Tue 10/24/28	394
397	SW GS SSP	1.9 days	Tue 10/24/28	Thu 10/26/28	
398	Plant Container Trees - Slow Growing	1.9 days	Tue 10/24/28	Thu 10/26/28	396
399	SE Island	9.4 days	Thu 10/26/28	Thu 11/9/28	
400	Plant Container Trees - Slow Growing	1.4 days	Thu 10/26/28	Mon 10/30/28	398
401	Adverse weather days	4 days	Mon 10/30/28	Fri 11/3/28	400
402	Demobilization	4 days	Fri 11/3/28	Thu 11/9/28	401
403	Substantial Completion	0 days	Thu 11/9/28	Thu 11/9/28	402



UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX J

REAL ESTATE PLAN

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
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APPENDIX J

REAL ESTATE PLAN

EXHIBITS

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
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STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX J
REAL ESTATE PLAN

I. PURPOSE

The purpose of this Real Estate Plan (REP) is to ensure that adequate real estate analysis has been conducted during planning to support the Recommended Plan for the Steamboat Island Habitat Rehabilitation and Enhancement Project (Project) and associated restoration measures in the Project area.

The REP is tentative in nature; it is for planning purposes only and both the final real property acquisition lines and the real estate cost estimates provided are subject to change even after approval of the Feasibility Report.

Steamboat Island proper is in Pool 14 of the Mississippi River, wholly within the scope of the Upper Mississippi River Restoration Program (UMRR). Immediately west of Steamboat Island proper lies Steamboat Slough. Steamboat Slough is contained to the west by a long, north-south running strip of marshlands and small islands just off the Iowa shoreline, separated by a much smaller course of water, Grant Slough. The Project area also encompasses the small islands southeast of Steamboat Island proper, as well as a large tract of inland property adjacent to the Wapsipinicon River on the Iowa shore. See Exhibit J-1 for associated Real Estate tracts.

Historically, Steamboat Island contained a number of small backwater lakes, sloughs, cuts, and other valuable habitats for a variety of native plants and migratory birds, as well as centrachidae (a family of freshwater ray-finned fish native to only to North America) and other freshwater fish. However, years of silt deposition and permanently higher water tables have degraded these habitats. In order to restore and enhance these habitats, as well as facilitate a more natural interaction between the river processes and the various habitats, the Project proposes backwater dredging, which will provide critical overwintering environments for multiple species of fish. This in turn will restore natural feeding habitat for resident and migratory bird species. The Project will utilize the resultant dredge material to create topographic diversity in the Project area, provide sediment control, and restore and protect island acreage. Topographic diversity measures will elevate portions of the Project area, facilitating forest diversity through the planting of hardwoods and forest management actions.

In accordance with the WRDA of 1986 and its various amendments, this Project is being undertaken in partnership with the United States Fish and Wildlife Service (USFWS), under the auspices of the UMRR Program.

II. DESCRIPTION OF THE LANDS, EASEMENTS, AND RIGHTS-OF-WAY REQUIRED FOR CONSTRUCTION, OPERATION AND MAINTENANCE OF THE PROJECT

A. Description of Lands, Easements and Rights-of-Way (LER). The Project area, located approximately one mile above Princeton, Iowa, between River Miles (RM) 502.5 and 508.0, encompasses Steamboat Island, Steamboat Slough, the adjacent secondary channel complex Grant Slough, two smaller islands in the southeast portion of the Project area, and the forested areas south and north of the Wapsipinicon River. The Project is east of the Princeton Wildlife Management Area and is within the boundaries of the Upper Mississippi River National Wildlife and Fish Refuge (UMR NWFR). The total estimated Project footprint is 2,620 acres.

The vast majority of the Project's footprint is managed by the U.S. Army Corps of Engineers (Corps) and owned in fee by the Federal Government (See Exhibit J-2). The only exception to this is a significant tract in the very heart of the Project's measures, identified as "X2" in Exhibit J-2, which is managed by the U.S. Fish and Wildlife Service (USFWS).

Seven tracts within the Project footprint are encumbered by easements that were present at the time of acquisition (see Exhibits J-1 and J-4):

- Two Utility Easements for pipeline and overhead power lines in Tracts FIA-217 and FIA-219.
- Four Levee Easements in Tracts FIA-224, FIA-225, FIA-226, FIA-227.
- One Building Easement for two buildings located in Tract FIA-243.

The Utility Easements in Tracts FIA-217 and FIA-219 (located at the southernmost tip of Iowa shoreline portion of the Project) are held by Great Lakes Pipeline Company. The Easements permit pipelines and one overhead power line on the Tracts. Real Estate is completing a full assessment of the potential impact these Easements may have on the Project.

The Levee Easements in Tracts FIA-224, FIA-225, FIA-226 and FIA-227 are held by the following individuals: Helen Fuhr, John Fuhr, Albert Fuhr, Katherine Bartemeier, and A.E. Carroll (and their heirs, etc.). The same Easements are also held by Guaranty Life Insurance Company. The Easements permit the operation, maintenance and repair of an already-existing levee.

The Building Easement in Tract FIA-243 is held by a Charles P. Chase and permits two buildings, identified as "Building No. 14.214" and "Building No. 14.215" to remain on the Tract. It appears both buildings no longer exist.

An overhead power line crosses Project-area parcels FIA-227 and IAIS-010. No easement appears to exist to allow this encroachment upon this Government-owned land.

Site Access. The Project site is on land in- or bordering-on the Mississippi River. All access will be made via boat on the River. Seven public boat ramps located within convenient distance to the Project area are available to gain initial site access (See Exhibit J-3).

Subordination of Rights. Real Estate has coordinated with Project Engineering regarding the seven easements discussed in Section II-A above. Project Engineering is of the opinion the above easements will not impact the Project's construction or operation. Therefore, Real Estate does not believe subordination of rights for the above easements will be necessary. However, Real Estate will continue to coordinate with Project Engineering and Project Management should this assessment change.

Similarly, the encroaching overhead power lines are not believed to impact the Project construction or operation, and no subordination of rights will be necessary.

B. Number of Owners/Acres and Type of Estate

Owner	Number of Acres	Type of Estate
United States of America	1,707	Fee Simple
United States of America	913	Fee Simple

C. Estates to Be Acquired. The following standard estates are required:

All necessary land is owned in fee by the Federal government, or subject to use by the Federal government through Navigation Servitude.

III. SPONSOR-OWNED LANDS

There is no non-Federal Sponsor. USFWS, the Federal sponsor, manages approximately 913 acres of US-fee-owned land within the Project area.

IV. PROPOSED NON-STANDARD ESTATES

The proposed Project does not require the use of any non-standard estates.

V. EXISTING FEDERAL PROJECTS WITHIN THE LANDS, EASEMENTS, AND RIGHT-OF-WAY REQUIRED FOR THE PROJECT

The Project area lies entirely within the boundaries of the UMR NWFR, which is managed by the USFWS, the Federal Sponsor on this Project. USFWS also manages Tract X-2. See Exhibits J-1 and J-2 for Real Estate tracts and ownership.

VI. FEDERALLY OWNED LAND REQUIRED FOR THE PROJECT

The entirety of the land included in the Project is owned by the US Government.

VII. NAVIGATION SERVITUDE

All lands currently included in the Project are already owned by the Federal government in fee, so Navigation Servitude will not be relied upon.

Restoration of the island within the Tract's footprint, or within the natural accretion track of the island, would not involve any non-federally owned land.

VIII. MAPS DEPICTING THE AREA

A Project area map is attached as Exhibit J-1. A map depicting the government-owned tracts is attached as Exhibit J-2. A map depicting the location of public boat ramps to be used for River access is attached as Exhibit J-3. A map depicting the location of the existing easements within the Project area is attached as Exhibit J-4.

IX. POSSIBILITY OF INDUCED FLOODING DUE TO THE PROJECT

The Project is not projected to induce or exacerbate any flooding on non-Federal owned lands.

X. BASELINE COST ESTIMATE

There is no estimated cost for real estate acquisition for the Project as all relevant land is owned in fee by the Federal government. Real Estate costs for clearing Easements (see Section XVI) are currently estimated to be $7,500.00. Real Estate will continue to investigate the potential need to relocate or terminate the Easements referenced in Section XVI, as well as the potential extent and expense of work to do so. Real Estate will continue to review this Baseline Cost Estimate and revise where indicated by additional information.

XI. RELOCATION ASSISTANCE BENEFITS

No persons, farms, or businesses will be displaced by this Project. Therefore, the provisions for relocation assistance benefits under the Uniform Act are not applicable.

XII. MINERAL ACTIVITY/ TIMBER HARVESTING IN THE PROJECT AREA

There is no active mineral activity or timber harvesting occurring or anticipated on the Project lands. There are no known existing third party mineral rights or interests including oil, gas, or timber that may need to be resolved for the construction, operation, and maintenance of the project.

XIII. NON-FEDERAL SPONSOR'S LEGAL AND PROFESSIONAL ACQUISITION CAPABILITY TO ACQUIRE LANDS, EASEMENTS, AND RIGHT-OF-WAY

Not applicable.

XIV. ZONING ORDINANCES

Zoning is not an issue as the Project footprint lies entirely within Federal lands (Exhibits J-1 and J-2) and there are no application or enactment of zoning ordinances that are required for this Project, therefore, no zoning restrictions exist.

XV. SCHEDULE OF LAND ACQUISITION MILESTONES

Not applicable.

XVI. FACILITY OR UTILITY RELOCATIONS

While all lands within the Project footprint are owned in fee by the Federal government, seven tracts are encumbered by easements that were present at the time of acquisition (see Exhibit J-4):

- Two Utility Easements for pipeline and overhead power lines in Tracts FIA-217 and FIA-219.
- Four Levee Easements in Tracts FIA-224, FIA-225, FIA-226, FIA-227.
- One Building Easement for two buildings located in Tract FIA-243.

The Utility Easements in Tracts FIA-217 and FIA-219 (located at the southernmost tip of Iowa shoreline portion of the Project) are held by Great Lakes Pipeline Company. The Easements permit pipelines and one overhead power line on the Tracts. Real Estate is completing a full assessment of the potential impact these Easements may have on the Project.

The Levee Easements in Tracts FIA-224, FIA-225, FIA-226 and FIA-227 are held by the following individuals: Helen Fuhr, John Fuhr, Albert Fuhr, Katherine Bartemeier, and A.E. Carroll (and their heirs, etc.). The same Easements are also held by Guaranty Life Insurance Company. The Easements permit the operation, maintenance and repair of an already-existing levee. Real Estate is completing a full assessment of this issue currently.

The Building Easement in Tract FIA-243 is held by a Charles P. Chase and permits two buildings, identified as “Building No. 14.214” and “Building No. 14.215” to remain on the Tract. It appears both buildings no longer exist. Real Estate is completing a full assessment of this issue.

In coordination with Project Engineering, we have tentatively determined these easements will not impact the Project construction or operation. Therefore, relocation of these easements will not be required. Real Estate will continue to coordinate with Project Engineering and Project Management, and will address relocation of these easements should conditions change.

Additionally, an overhead power line crosses tracts FIA-227 and IAIS-010. In coordination with Project Engineering, we have tentatively determined this overhead power line will not impact the Project construction or operation. Therefore, relocation of this power line will not be required. Real Estate will continue to coordinate with Project Engineering and Project Management, and will address relocation of this power line should conditions change.

XVII. IMPACTS OF SUSPECTED OR KNOWN CONTAMINANTS

There are no known or suspected contaminants within the Property site. A Phase I HTRW ESA for the Project was conducted. The Phase I ESA revealed no evidence of a REC that could potentially affect the Project area.

XVIII. LANDOWNER SUPPORT OR OPPOSITION TO THE PROJECT

Public comment on this Project was invited and received through an open house event held on March 26, 2018. The comments expressed were positive, and no specific comments on any real estate aspect of the Project were received. At this time, the District is unaware of any significant landowner support of, or opposition to this Project.

XIX. NOTIFICATION OF RISKS OF ACQUIRING LANDS BEFORE EXECUTION OF THE PROJECT PARTNERSHIP AGREEMENT

Not applicable.

XX. OTHER RELEVANT REAL ESTATE ISSUES

The Corps does have a Cottage Program site located on the Island itself. However, this Cottage site will neither impede nor be impacted by the Project.

BAILEY.SAMUEL.R.1555531849 Digitally signed by BAILEY.SAMUEL.R.1555531849 Date: 2020.08.13 13:55:08 -05'00'

Date: ____________________________
Prepared by:

Samuel R. Bailey
Realty Specialist
Acquisition Branch, Real Estate Division
U.S. Army Corps of Engineers, Rock Island District

Matthew A. Quinn Digitally signed by Matthew A. Quinn Date: 2020.08.13 13:52:14 -05'00'

Date: ____________________________
Approved by:

Matthew Quinn
Chief, Acquisition Branch, Real Estate Division
U.S. Army Corps of Engineers, Rock Island District

Jody R. Rowe Digitally signed by Jody R. Rowe Date: 2020.08.13 18:37 21 -05'00'

Date: ____________________________
Approved by:

Jody R. Rowe
Chief, Real Estate Division
Real Estate Contracting Officer
U.S. Army Corps of Engineers, Rock Island District

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

APPENDIX J
REAL ESTATE PLAN

EXHIBITS

EXHIBIT J-1

WORK AREA AND REAL ESTATE

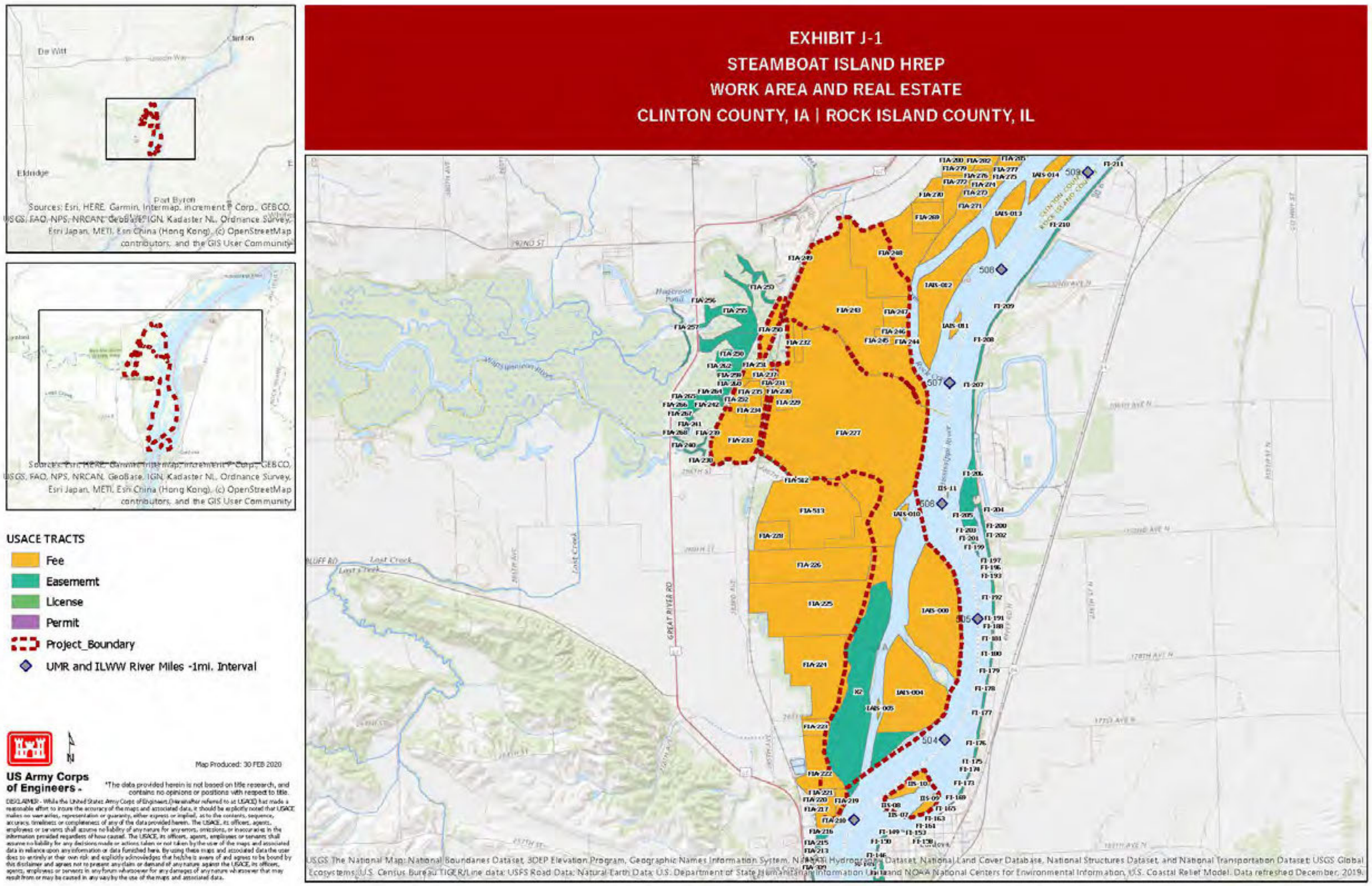


EXHIBIT J-2

TRACT OWNERSHIP

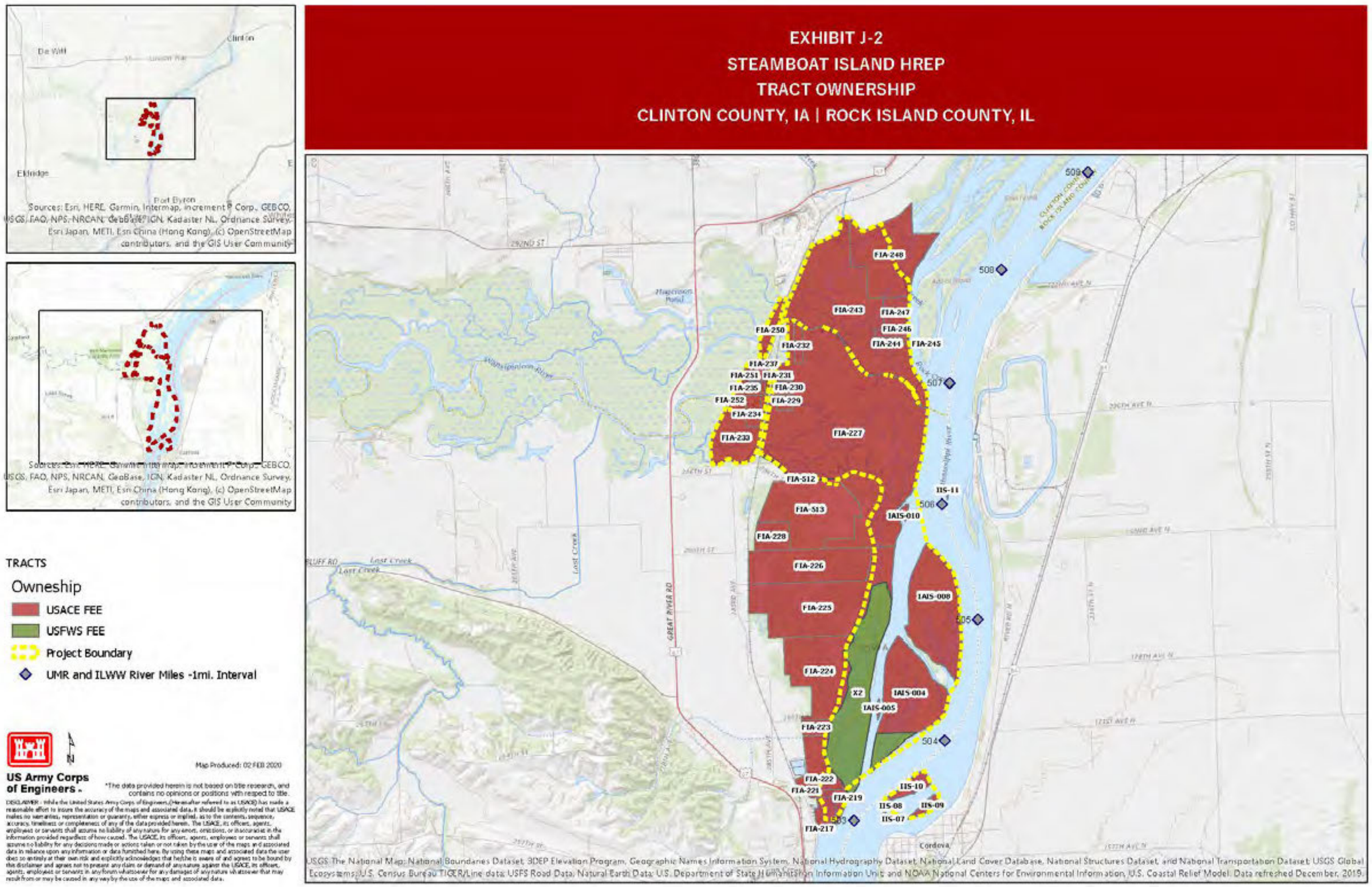


EXHIBIT J-3

LOCATION OF PUBLIC BOAT RAMPS FOR RIVER ACCESS

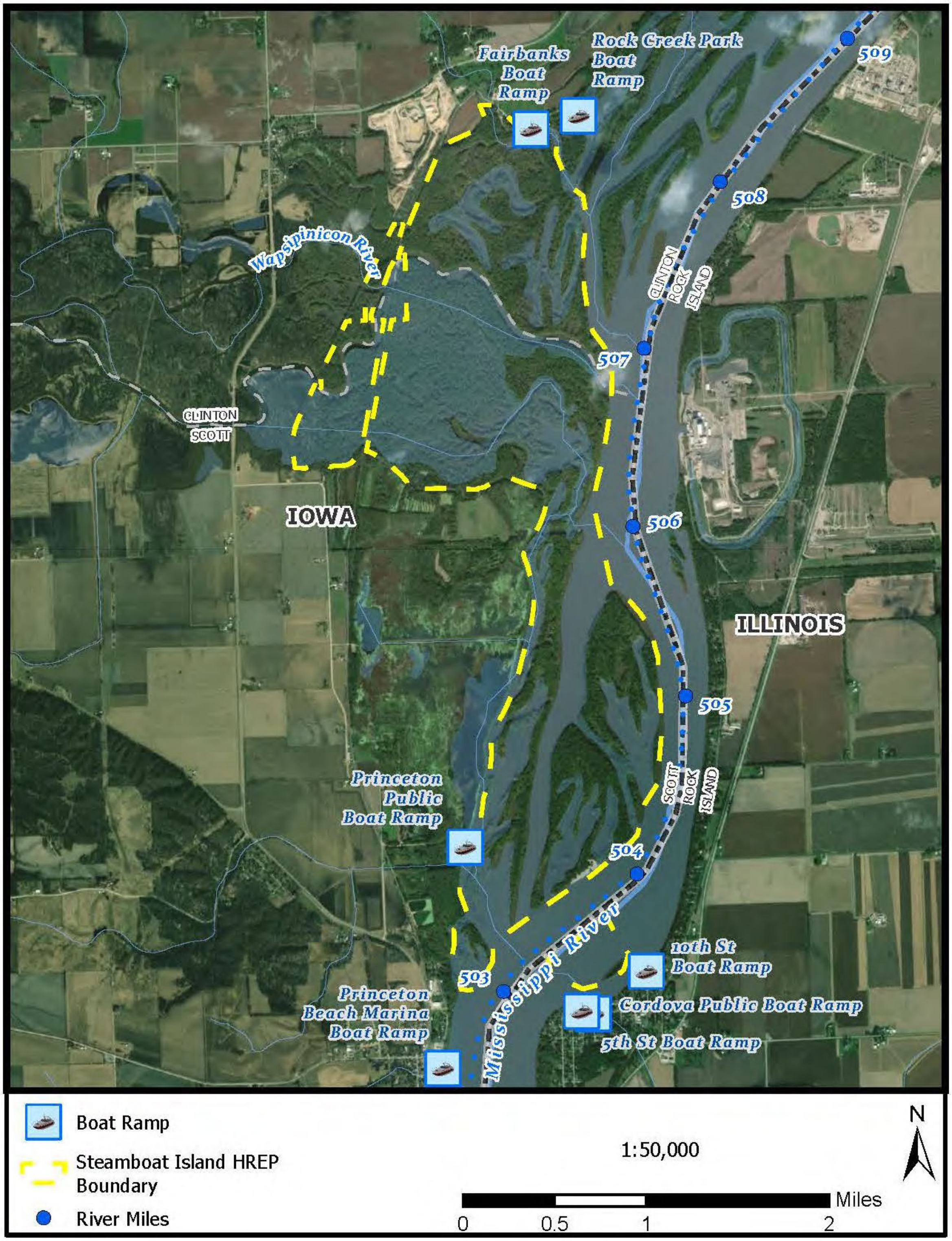
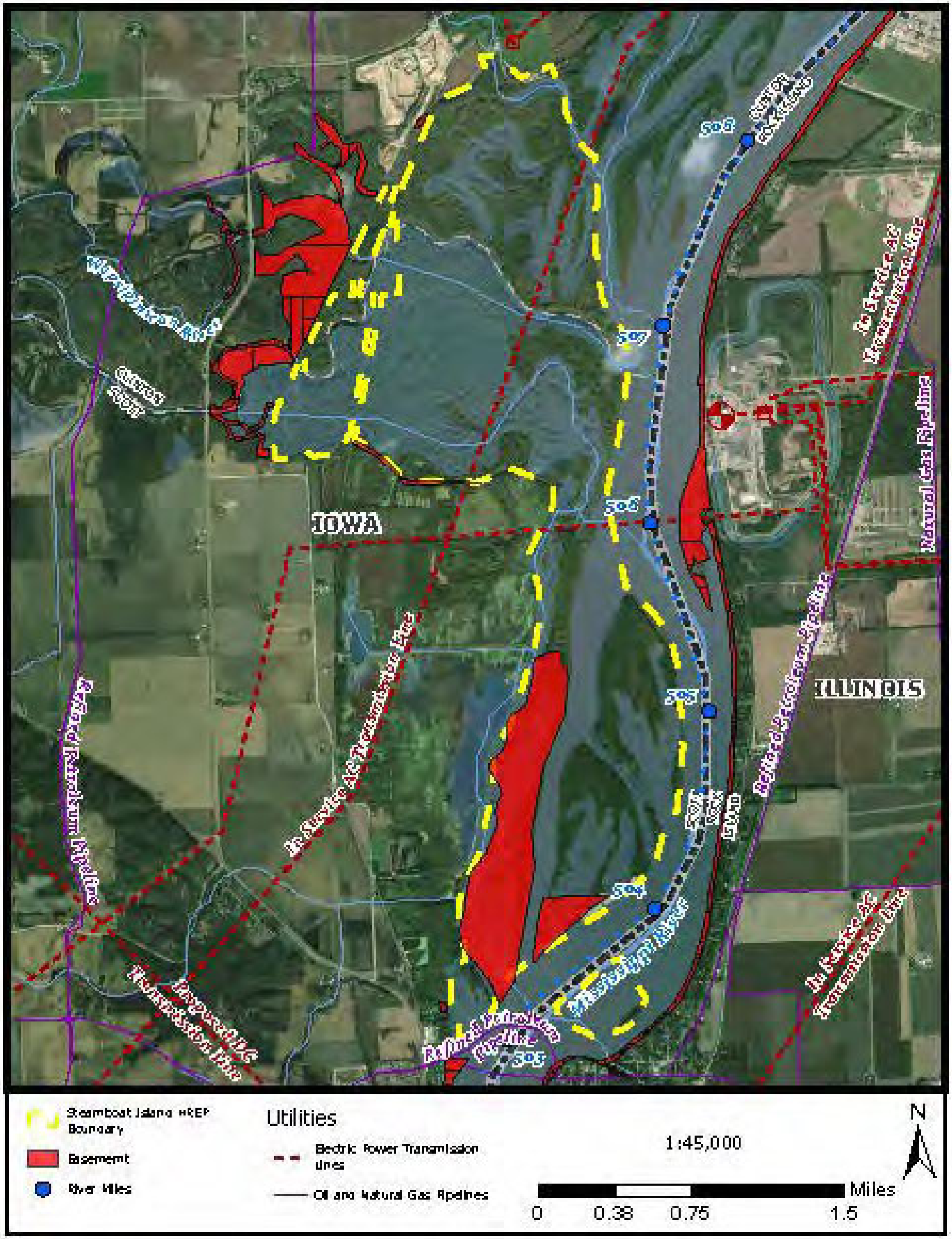


EXHIBIT J-4

LOCATION OF EXISTING EASEMENTS WITHIN PROJECT AREA



UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX K

MONITORING AND ADAPTIVE MANAGEMENT PLAN

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
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STEAMBOAT ISLAND
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APPENDIX K

MONITORING AND ADAPTIVE MANAGEMENT PLAN

I. INTRODUCTION

This appendix presents the feasibility level monitoring and adaptive management plan for the Steamboat Island HREP (Project). This plan identifies and describes the monitoring and adaptive management activities proposed for the Project and estimates associated costs and duration. This plan will be further developed in the planning, engineering, and design (PED) phase as specific details are made available.

Adaptive management provides a process for making decisions in the face of uncertainty. The primary incentive for implementing a monitoring and adaptive management plan is to increase the likelihood of achieving desired project outcomes given the identified uncertainties, which can 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.

A. Authorization. Section 2039 of the Water Resources Development Act (WRDA) of 2007 directs the Secretary of the Army to ensure, when conducting a feasibility study for a project (or component of a project) for ecosystem restoration that the recommended project includes a plan for monitoring the success of the ecosystem restoration. The implementation guidance for Section 2039, in the form of a CECW-PB Memo dated 31 August 2009, also requires an adaptive management plan be developed for all ecosystem restoration projects. Section 1161 of WRDA 2016 amends Section 2039 of WRDA 2007, to specify information required to be included in monitoring plans for ecosystem restoration projects, and to direct when non-federal operation and maintenance (O&M) responsibilities of these projects may cease.

At the programmatic level for UMRR, knowledge gained from monitoring one HREP can be applied to other HREPs. Opportunities for this type of adaptive management are common within the UMRR, which builds upon lessons learned from other HREP projects and Long Term Resource Monitoring (LTRM). These lessons have been incorporated into the planning and design of the Project to ensure the proposed plan represents the most effective design and operation to achieve Project goals and objectives.

B. Procedure: Drafting the Plan. The UMRR Coordinating Committee (UMRR CC) collaborated to establish a general framework for adaptive management to be applied to all UMRR projects as part of the Implementation Issues Assessment. The framework for adaptive management is consistent with the implementation guidance provided in Section 1161 of the 2016 WRDA. The UMRR adaptive management framework includes systemic, set-up, and implementation phases (Figure K-1).

C. Adaptive Management Team Structure. To execute a systemic adaptive management strategy for the UMRR, a communication structure has been identified (Figure K-2). The structure establishes clear lines of communication and data exchange between UMRR Management, HREP Planning and Sequencing Framework Teams, LTRM, PDTs, and stakeholders. Successful implementation will require the right resources being coupled at the right time to support the framework components.

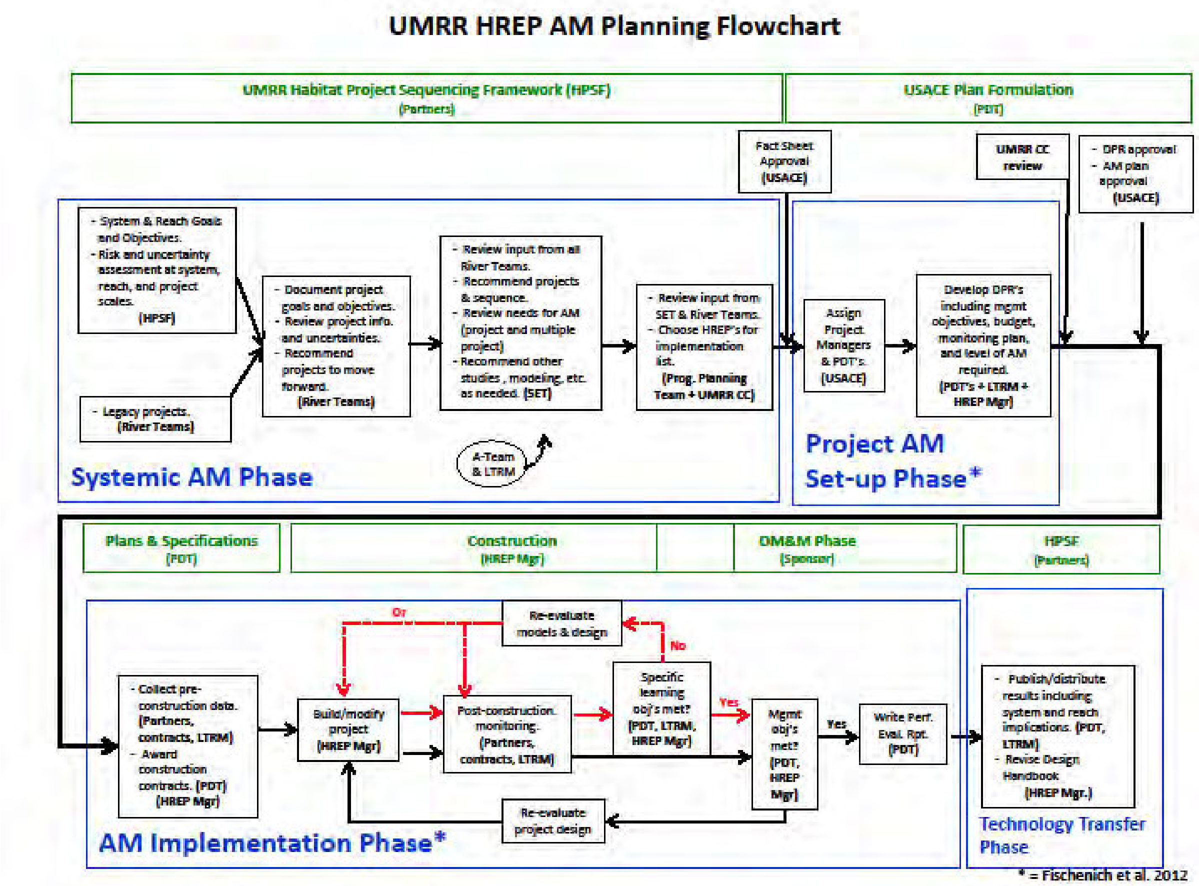

Figure K-1: UMRR HREP Adaptive Management Planning Flowchart

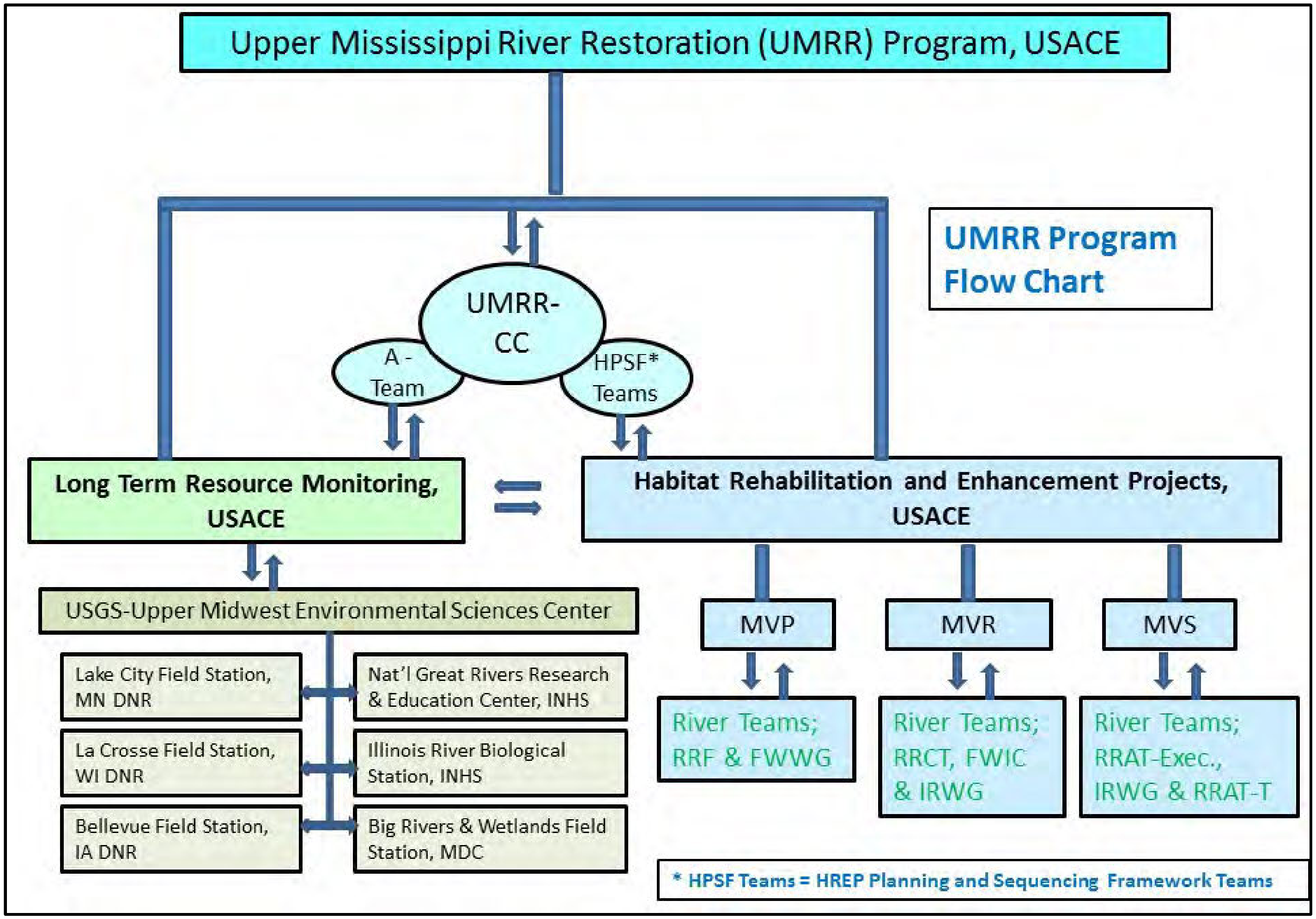

Figure K-2: UMRR Communication Structure

II. PROJECT ADAPTIVE MANAGEMENT PLANNING

The resulting monitoring and adaptive management plan for the Project describes and discusses whether adaptive management is needed in relation to the Recommended Plan identified in the Feasibility Study. The plan also identifies how adaptive management would be conducted and who would be responsible for specific adaptive management actions. The developed plan outlines how the results of performance monitoring within the first 10 years following construction would be used to adaptively manage the Project, including specification of conditions that will define Project success.

Specific items identified in this plan are either labeled "Performance Monitoring" or "Adaptive Management" which indicate how their assessment will be used. Performance monitoring activities assume that the outcome of specific restoration actions will be monitored in order to obtain information about outcomes, and further actions may be undertaken based on the results of that monitoring (see Main Report, Section X, *Project Performance Monitoring*). Adaptive management assumes that if an identified objective or restoration action isn't meeting its desired performance criteria that a follow up action may be implemented to improve the performance of a designed construction measure. As part of the monitoring and adaptive management plan, the Corps can spend up to 3% for the adaptive management plan and 1% for monitoring of the total construction costs (not the total project costs) incurred from the Project.

The monitoring and adaptive management plan reflects a level of detail consistent with the Project feasibility study. The primary intent was to develop performance monitoring and adaptive management actions appropriate for the Project's restoration goals and objectives. The specified management actions permit estimation of the adaptive management program costs and duration. This section:

- identifies the restoration goals and objectives;
- lists sources of uncertainty that would recommend the use of adaptive management ; and; and
- presents a conceptual ecological model that relates management actions to desired Project outcomes.

Subsequent sections describe performance monitoring, assessment, and decision-making in support of adaptive management. The level of detail in this plan is based on currently available data and information developed during plan formulation as part of the feasibility study. Uncertainties remain concerning the exact Project features, monitoring elements, and adaptive management opportunities. Components of the monitoring and adaptive management plan, including costs, were similarly estimated using currently available information.

A. Project Goals and Objectives. The Project is unique in that the features included in the Recommended Plan are interconnected to restore not only certain habitat types but the natural system processes within the island complex as well. The goal of the Project is to restore the missing distinguishing features that collaboratively restore the interconnected transitional gradient of habitats characteristic of lacustrine and riverine systems. The PDT will use monitoring to measure the following objectives:

- enhance and restore areal coverage and diversity of forest stands and habitat and increase diversity of bottomland hardwood forest, as measured in forested acres suitable to support hard mast species and structure, age, and species composition
- increase year-round aquatic habitat diversity, as measured by acres and limnophilic native fish use of overwintering habitat, as this habitat is the most limiting of seasonal habitats
- restore 50% of island acreage and topography lost since the 1950s and protect from erosion within the Project area, as measured by acres
- protect existing backwater habitat from sediment deposition and enhance backwater and interior wetland areas, as measured by acres of backwater and survivability of scrub-shrub/pollinator habitat

The strategic locations and design of the measures included for each objective work together to restore the missing characteristics of the Project. Beginning at the lowest elevation, deep water habitat will be restored for critical overwintering fish habitat. With increasing elevation on the dredged material placement site, habitat characteristics change from semi-permanently inundated to seasonally inundated emergent and scrub-shrub wetland. Finally, temporarily inundated forested wetland is incorporated.

The transitional structure between one habitat type and other functions provide overall habitat that is currently missing in the Project area. This gap in the system has had an effect on everything from overwintering fish to mast tree production. The restoration of the missing distinguishing characteristics provides overarching habitat at the ecosystem level with fish, migratory birds, and everything in-between benefiting.

B. Sources of Uncertainty. Adaptive management provides a coherent process for making decisions in the face of uncertainty. Scientific uncertainties and technological challenges are inherent with any ecosystem restoration project. Following is a list of uncertainties associated with restoration of aquatic fish and floodplain habitat in the Project area.

- **Floodplain Forest Diversity**
  - The District evaluated the level of uncertainty and risk in the floodplain forest measure and determined it did not require using Adaptive Management to address the potential of the measure to meet performance criteria. A phased planting and monitoring schedule, which is part of the construction plan and budget, was devised to determine timing and quantity of additional tree plantings. This extensive knowledge of relevant forest ecosystem structure and function is a result of UMRR Forestry Monitoring efforts, having produced decades of monitoring data to understand relationships among project management actions and corresponding outcomes. Furthermore, the Huron Island and Beaver Island HREPs are currently in construction and have an adaptive management and monitoring design for forestry. Information gained from the Huron Island and Beaver Island HREPs will be used to guide floodplain forest restoration elsewhere. Monitoring at Steamboat will be conducted to determine Project success.

- **Aquatic Diversity**
  - It is expected that overwintering and summer habitat in the dredged backwater will not be limited by dissolved oxygen or flow. Furthermore, the Beaver Island HREP is currently in construction and has an adaptive management and monitoring design for aquatic diversity and backwater fish habitat. However, sediment transport and deposition may occur in the aquatic diversity sites, depending on river conditions and function of Project measures. This expectation remains uncertain. If performance monitoring demonstrates a need for reduced sediment transport, an adaptive management measure to modify the NE Bank and/or GCS will be implemented.

- **Island Restoration and Protection**
  - The District evaluated the level of uncertainty and risk in the island restoration and protection measure and determined it did not require using Adaptive Management to address the potential of the feature to meet performance criteria. It is expected that implementation of the island protection features will not significantly alter hydraulic forces within the Project area and will continue to provide stabilization of Steamboat Island and the West SE Island.

- **Backwater Protection and Backwater and Interior Wetland Enhancement**
  - It is expected that existing and restored backwater and interior wetlands will be protected and enhanced by implementation of the Recommended Plan. However, this expectation remains uncertain. If performance monitoring demonstrates a need for further protection and/or sediment reduction, an adaptive management measure to modify the NE Bank and/or GCS will be implemented.

C. Conceptual Model. Figure K-3 shows the conceptual ecological model.

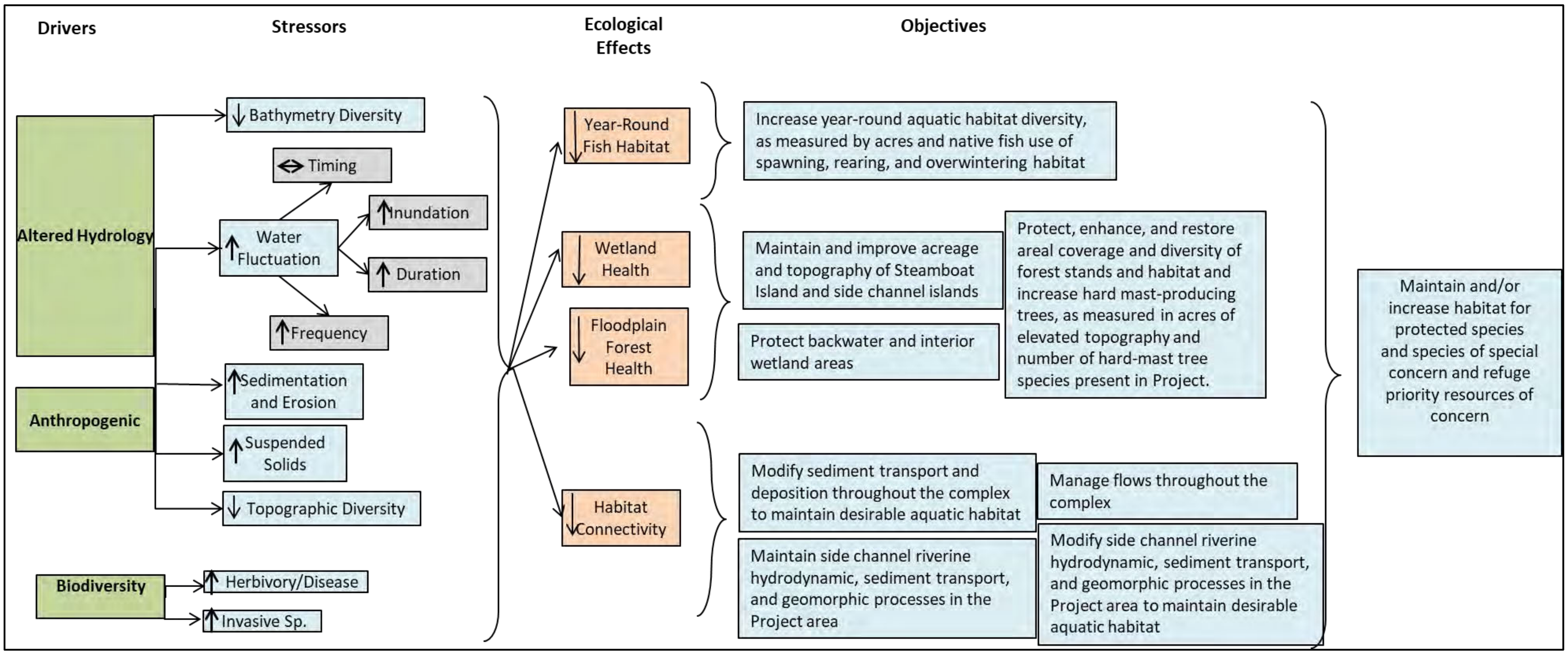

Figure K-3: Steamboat Island Conceptual Ecological Model

III. MONITORING OF OBJECTIVES TO DETERMINE PROJECT SUCCESS AND ADAPTIVE MANAGEMENT MEASURES

The power of a monitoring program developed to support determinations of Project success and inform adaptive management lies in the establishment of feedback between continued Project monitoring and corresponding project management.

A. Floodplain Forest Diversity

1. Objective. Enhance and restore areal coverage and diversity of forest stands and habitat and increase diversity of bottomland hardwood forest, as measured in forested acres suitable to support hard mast species and structure, age, and species composition.

Floodplain forest on the UMR is typically dominated by a few species that are a similar age-class. This type of imbalance is generally unhealthy and leaves forest susceptible to invasive species. Forests have also become wetter over time, reducing the coverage of hardwood species and limiting the diversity of tree species. The Project will aim to improve the quality and quantity (areal coverage) of forest habitat, including forest health and growth.

Floodplain forest is a very important goal of the Project. The following section provides methodology and success criterion for the performance monitoring. When monitoring this Project, the team should consider these factors to help enhance floodplain forest designs in the future.

2. Methodology. Timber inventory monitoring will be conducted by fixed radius forest plot sampling to determine trees per acre (TPA) and by transect surveys to determine survivability. Monitoring will be conducted annually for the first 5 years, as a phased planting approach will be implemented to determine timing and quantity of additional tree plantings, and then in Years 7 and 9 to ensure continued survival. Table K-1 shows the anticipated monitoring schedule and goals

Table K-1: Forest Plot and Transect Survey Monitoring Schedule

Monitoring Year	Goal(s)
Years 1 & 2	Monitor density and growth of cover crop plantings
Year 3	Monitor Spring direct seeding and bare root planting and determine which areas require containerized early successional trees
Year 4	Monitor containerized stock and plant late-successional trees
Year 5	Monitor to determine survival of trees planted and TPA
Year 7	Monitor to determine survival of trees planted and TPA
Year 9	Monitor to ensure continued survival of trees planted

Trees would be counted and measured in stratified random transects located across the restoration site using original planting locations of late successional trees. Within each transect, tree survivability, condition, height, and diameter will be measured from all late successional species. Monitoring targets will be to sample up to 30% of what was planted to derive an estimate of percent survival by species. Estimates of total percent survival by tree species and TPA will be determined.

Structure, age, and species composition per prescription (see Appendix M, *Engineering Design*, for full prescription information) will be assessed by a whole Project forest inventory completed at Year 6, and then in future years as part of the long-term monitoring of the UMRR Program. Standard forest inventory metrics will be used to compare pre-Project inventory (conducted in 2018) and the change that occurs at implemented areas.

> ***Success Criteria.*** An assumed success criterion of 60% tree survival at Year 9 of planted species only. Corps' foresters will monitor for 5 consecutive years to determine survivability and plant more trees if needed to meet the Year 9 threshold for success. Tree survival less than 60% at Years 5 and 7 will determine the need for additional planting.

> ***Success Criteria.*** An assumed success criterion of 800 TPA that includes early-successional and late-successional (including hard-mast) species identified at Year 9. Targets for tree density and diversity will be calibrated and validated based on reference forest stand. Corps' foresters will monitor for 5 consecutive years to determine densities and plant more trees if needed to meet the Year 9 threshold for success. Tree densities less than 800 TPA at Years 5 and 7 will determine the need for additional planting.

B. Aquatic Diversity

1. Objective. Increase year-round aquatic habitat diversity, as measured by acres and limnophilic native fish use of overwintering habitat, as this habitat is the most limiting of seasonal habitats.

The planned locations for aquatic diversity will be assessed individually, rather than collectively. Each location has different variables that may affect whether success criteria is met, these variables will be included in the analysis of each site (Steamboat Lower Lake, Steamboat Upper Lake, and NW Grant Slough Lake).

2. Methodology. Bathymetric surveys will be conducted upon Project completion to determine base depth conditions and construction compliance. A comparison survey will be conducted at Year 5 to map and quantify the amount of backwater area greater than 4 feet deep. The results of this study will inform Project success, inform adaptive management triggers and measures, and inform future HREPs by demonstrating the need for specific habitat types or ways to improve existing habitat. Improvements could lead to greater fish habitat quality, including overwintering habitat. Water quality data collected from the site annually for the first 5 years post-construction will be used to determine dissolved oxygen concentrations, water flow, and temperature throughout the year.

Sediment transport and deposition may occur in the aquatic diversity sites, depending on river conditions and function of Recommended Plan. If monitoring demonstrates that sediment transport is still occurring from the NE Bank and/or GCS, an adaptive management measure to modify those measures will be implemented.

> ***Success Criteria.*** Retain 28 acres of overwintering and summer backwater habitat at Year 5. This measurement takes into account water depth greater than or equal to 4 feet in depth, average winter water velocity less than or equal to 1 cm/sec, DO concentrations greater than

or equal to 5 mg/L on average in winter, and temperatures greater than or equal to 1°C in winter.

Adaptive Management Trigger and Measure. If monitoring demonstrates that sediment deposition is still occurring from the NE Bank and/or GCS and is affecting the water quality success criteria outlined above for 2 consecutive years and further demonstrated by the bathymetric survey at Year 5, an adaptive management measure to modify those measures will be implemented.

In addition to the aforementioned monitoring and success criteria, supplemental fish monitoring will occur to further support Project success. Fish abundance during the year will be compared with pre-Project fish abundance within the Project area and UMR backwater lakes to aid in determining Project success. The IADNR will complete the fish surveys used to conduct this comparison. Fish collection methods will be similar to those used by the UMRR LTRM element protocols and will occur once during each LTRM sampling period, including an additional sampling period when waters are less than 10 degrees C before ice up (for a total of 4 sampling events per year). This sampling will occur annually for the first 10 years post-construction. Sufficient sites will be sampled pre- and post-Project in restored areas and in control sites (i.e., sites without restoration). All collected fish will be identified and measured for length and weight.

C. Island Restoration and Protection

1. Objective. Restore 50% of island acreage and topography lost since the 1950s and protect from erosion within the Project area, as measured by acres.

The planned locations for island restoration and protection will be assessed individually, rather than collectively. The function of each location varies, but all will restore and protect island habitat at USI Head and the West SE Island.

2. Methodology. Topographic surveys of the Project area will be conducted upon Project completion to determine base conditions and construction compliance. Post-construction comparison surveys will be conducted at Years 3, 5, and 10 to map and quantify acreage of the islands and determine structural persistence of the Project components. Depending on river conditions and Program budget, a topographical survey, LiDAR survey, and/or remote sensing/aerial imagery comparison will be used

Success Criteria. The island restoration measures will be considered successful if after 10 years, the acreage of affected areas is not less than the as-built acreage.

D. Backwater Protection and Backwater and Interior Wetland Enhancement

1. Objective. Protect existing backwater habitat from sediment deposition and enhance backwater and interior wetland areas, as measured by acres of backwater and survivability of scrub-shrub/pollinator habitat.

The planned locations for backwater and interior island wetland protection and enhancement will be assessed individually. The function of each location varies, but will protect and enhance wetland habitat in Upper Lake Aquatic Diversity (via restoration and protection of the NE Bank) and Lower Lake Aquatic Diversity (via construction of the GCS).

2. Methodology

a. Backwater Habitat Protection and Enhancement. In order to monitor success of the protection of existing backwater habitat from sediment deposition, topographic surveys of the Project area will be conducted upon Project completion to determine base conditions and construction compliance. Post-construction topographic comparison surveys will be conducted at Years 3, 5, and 10 to determine structural persistence of the Project components (NE Bank and GCS). Depending on river conditions and Program budget, a topographical survey and/or LiDAR survey will be used.

Bathymetric surveys of the Project area will also be conducted upon Project completion to determine base conditions and construction compliance. The monitoring accomplished for Section III.B, *Aquatic Diversity*, should be used to determine success and continued function of the measures.

Success Criteria. The backwater protection measures will be considered successful if after 5 years, the measures are intact and reducing sediment transport at those locations. The success criteria listed for Section III.B, *Aquatic Diversity*, should also be used to determine success and continued function of the measures.

Adaptive Management Trigger and Measure. If after Year 5, monitoring results indicate an inability to reach success criteria, modifications to the NE Bank will be implemented to increase protection of Upper Lake Aquatic Diversity. Modifications may include placing more stone protection or dredged material. The data and surveys obtained from monitoring should be considered in determining what modifications should be made.

Adaptive Management Trigger and Measure. If after Year 5, monitoring results indicate an inability to reach success criteria, modifications to the GCS will be implemented to increase protection of Lower Lake Aquatic Diversity. Modifications may include placing more stone protection, dredged material, or additional plantings. The data and surveys obtained from monitoring should be considered in determining what modifications should be made.

b. Interior Wetland Enhancement. In order to monitor the enhancement of the interior wetland areas, scrub-shrub/pollinator (SSP) monitoring will be conducted annually for the first 5 years, as a phased planting approach will be implemented, and then in Years 7 and 9. Table K-2 shows the anticipated monitoring schedule and goals.

Table K-2: Scrub-Shrub/Pollinator Monitoring Schedule

Monitoring Year	Goal(s)
Years 1 & 2	Monitor density and growth of cover crop plantings
Year 3	Monitor Spring direct seeding and bare root planting to determine which areas require containerized pollinator shrubs and trees
Year 4	Monitor containerized stock and plant pollinator shrubs and trees
Year 5	Monitor to determine survival of shrubs
Year 7	Monitor to determine survival of shrubs
Year 9	Monitor to ensure continued survival of shrubs planted

Shrubs would be counted and measured in stratified random transects located across the restoration site using original planting locations. Within each transect, shrub survivability, condition, and height will be measured from all species. Monitoring targets will be to sample up to 30% of what was planted to derive an estimate of percent survival by species.

Success Criteria. An assumed success criterion of established SSP habitat at the higher elevations at 573.1 ft was identified as 60% plant survival of SSP species at Year 9. Corps' foresters will monitor for 5 consecutive years to determine survivability and plant more SSP species if needed to meet the Year 9 threshold for success. SSP survival less than 60% at Years 5 and 7 will determine the need for additional planting.

IV. DOCUMENTATION, IMPLEMENTATION COSTS, RESPONSIBILITIES, AND PROJECT CLOSE-OUT

A. Documentation, Reporting, and Coordination. The PDTs will document each of the performed assessments and communicate the results to the HREP program manager and partners designated for the Project. Periodic reports will be produced to measure progress towards the Project goals and objectives as characterized by the selected performance measures.

B. Costs. The costs associated with implementing monitoring and adaptive management measures were estimated based on currently available data and information developed during plan formulation as part of the feasibility study. Because uncertainties remain as to the exact Project measures, monitoring elements, and adaptive management opportunities, the estimated costs in Table K-3 will need refinement in PED during the development of the detailed monitoring and adaptive management plans.

Table K-3: Estimated Performance Monitoring and Adaptive Management Costs ($) (February 2020 Price Level)

				Post-Construction Years									
Objective	**Work Category**	**Activity**	**PED**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**Total**
Floodplain Forest Diversity	Monitoring, Analysis, Reporting	Forest Plot Survey Monitoring [2]	-	$6,000	$6,000	$8,000	$8,000	$12,000	-	$12,000	$12,000		$64,000
												Floodplain Forest Diversity Subtotal:	***$64,000***
Aquatic Diversity	Monitoring, Analysis, Reporting	Backwater Bathymetry[1]	-	-	-	-	-	$30,000	-	-	-	$30,000	$60,000
		Water Quality/ Data Analysis	-	$4,000	$4,000	$4,000	$4,000	$6,500	-	-	-	-	$22,500
	AM: NE Bank/GCS modification								$255,000				$255,000
												Aquatic Diversity Subtotal:	***$337,500***
Island Restoration/Protection	Monitoring, Analysis, Reporting	Topographic, LiDAR, or Remote Sensing surveys [2]	-	-	-	$30,000	-	$30,000	-	-	-	$60,000	$120,000
												Island Restoration and Restoration Subtotal:	***$120,000***
Backwater/ Interior Wetlands Protection	Monitoring, Analysis, Reporting	Topographic or LiDAR surveys [2]	-	-	-	$30,000	-	$30,000	-	$60,000	-	-	$120,000
		Backwater Bathymetry	-	-	-	-	-	$30,000	-	-	-	$30,000	$60,000
		Water Quality/Data Analysis	-	$4,000	$4,000	$4,000	$4,000	$6,500	-	-	-	-	$22,500
		Scrub-Shrub/Pollinator Habitat Monitoring [3]	-	-	-	-	-	-	-	-	-	-	(footnote 3)
	AM: NE Bank modification								$191,000				(footnote 4)
												Backwater/Interior Wetlands Protection Subtotal:	***$202,500***
												TOTAL	***$724,000***

[1] Fish surveys completed by the IADNR will aid in determining success of the aquatic habitat component.

[2] Topographic, LiDAR, or Remote Sensing surveys will be conducted for the whole Project concurrently, the cost of which is $60,000. This survey will assess Island Protection/Restoration and Backwater/Interior Wetlands Protection objectives; distribution of costs between objectives is reflected in the Table.

[3] Forestry monitoring cost estimates include SSP monitoring costs, as surveys are conducted concurrently.

[4] Backwater/Interior Wetlands Protection Adaptive Management (NE Bank Modification) costs are accounted for in Aquatic Diversity Adaptive Management

C. Responsibilities

1. Floodplain Forest Diversity. Feasibility and PED activities are limited to one pre-construction evaluation of the existing forest characteristics in the Project area. Planting tillage (tuber) cover crops will occur over 2 years and then tree planting will occur and follow for 2 additional years. Post-planting monitoring will be conducted annually for the first 5 years and then in Years 7 and 10. Responsibility for these features will be a coordinated effort between the Corps', the IADNR, and the USFWS.

2. Aquatic Diversity. Feasibility and PED data collection will consist of pre-Project data collection and analyses. Following construction, a backwater bathymetric survey will be conducted at Years 5 and 10 and water quality sampling will occur annually for 5 years. Fish community sampling is scheduled annually for 10 years (IADNR). The need for changes will regularly be evaluated and, if needed, will occur within 5 years of construction. Responsibility for these efforts will be a coordinated effort between the Corps, the IADNR, and the USFWS.

3. Steamboat Island and West SE Island Restoration and Protection. PED activities will be limited to one evaluation to reassess existing hydraulics. Following construction, island restoration and protection performance will be evaluated at years 3, 5, and 10. Responsibility for these features will be coordinated by the Corps.

4. Backwater Protection and Backwater and Interior Wetland Enhancement

- **PED Activities.** These will be limited to one evaluation to reassess existing hydraulics. Following construction, performance of protection and enhancement measures will be evaluated at Years 3, 5, and 10. Responsibility for these features will be a coordinated by the Corps.

- **SSP Monitoring.** Feasibility and PED activities are limited to one pre-construction evaluation of the scrub/shrub habitat characteristics in the Project area. Planting will occur over 2 consecutive years and post-planting monitoring will occur annually for the first 5 years and then in Years 7 and 10. Responsibility for these features will be coordinated by the Corps.

D. Project Close-Out. Close-out would occur when it is determined that the Project has successfully met the Project success criteria described in Section III, *Monitoring of Objectives To Determine Project Success and Adaptive Management Measures*. Success would be considered to have been achieved when the Project objectives have been met, or when it is clear that they will be met based upon the trends for the site conditions and processes. Project success would be based on the following:

- Success criteria met
- Continued site inspections to determine continued Project status
- Continued O&M into the future

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX M

ENGINEERING DESIGN

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA, AND
ROCK ISLAND COUNTY, ILLINOIS

APPENDIX M

ENGINEERING DESIGN

Appendix M
Engineering Design

TABLES

FIGURES

PHOTOGRAPHS

DESIGN ATTACHMENTS

UPPER MISSISSIPPI RIVER RESTORATION
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STEAMBOAT ISLAND
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POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA, AND
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APPENDIX M

ENGINEERING DESIGN

I. PROJECT DESCRIPTION

Refer to the Main Report, Section I, *Introduction*.

A. Summary. A Project summary is provided in Table M-1.

Table M-1: Project Summary

Project Engineer	Kyle Nerad E.I.
Project Name	Steamboat Island Habitat Rehabilitation and Enhancement Project
Project Measures	Mechanical excavation/dredging of channels for aquatic diversity, dredged material placement and plantings for forest and scrub-shrub/pollinator habitat, small island restoration, timber stand improvement, and stone protection incorporating mussel substrate.
Project Location	Scott and Clinton Counties, IA and Rock Island County, IL in Pool 14 between Upper Mississippi River, River Miles 502.5 to 508.0.
Project Map Location	See Figure M-1 & M-2
Project Description	The work includes, but is not limited to, tree clearing, tree disposal off-site, excavation/dredging of channels, transporting the material to the placement site, shaping the placed material, vegetation planting and stone protection.

B. Project Location and Site Map. See Figures M-1 and M-2.

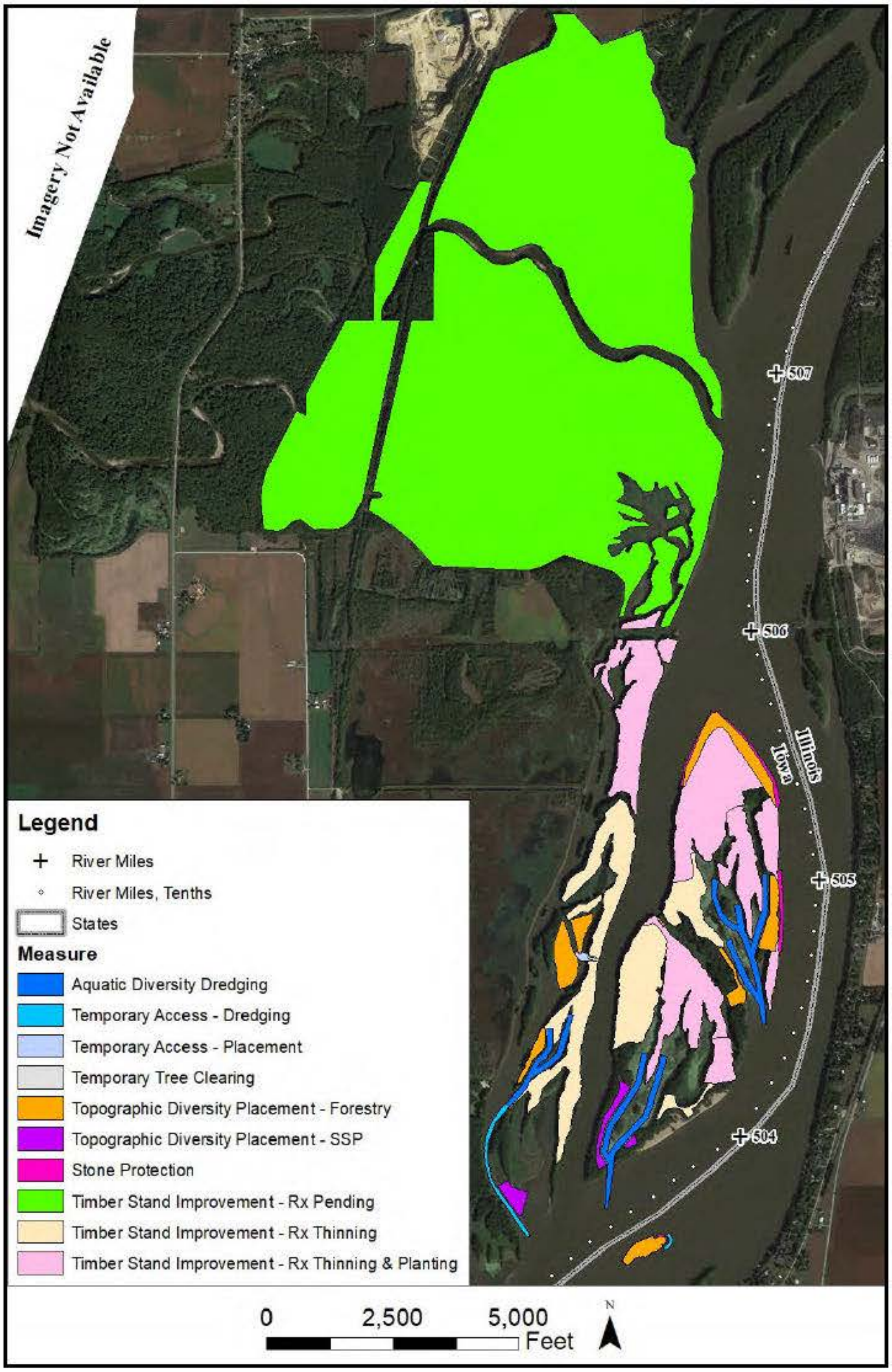

Figure M-1: Site Location and Measures

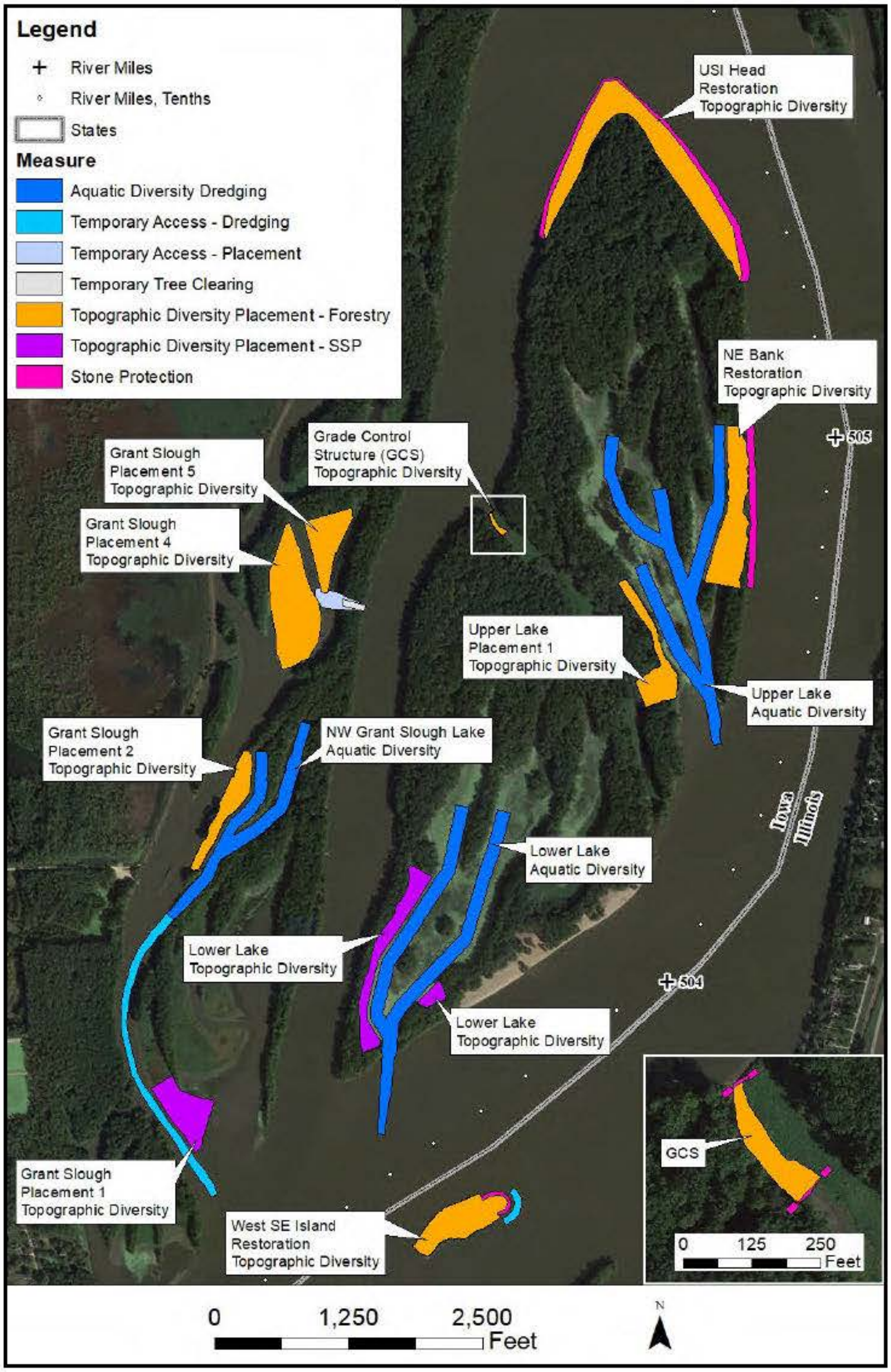

Figure M-2: Steamboat Island Measures

C. Project Authority, Background, Description

1. Authority. The original authorizing legislation was the Water Resources Development Act (WRDA) of 1986 (Public Law 99-662), Section 1103. The Upper Mississippi River Restoration (UMRR) was originally comprised of five elements:

- Habitat Rehabilitation and Enhancement Projects (HREPs)
- Long-Term Resource Monitoring (LTRM)
- Recreation Projects
- Economic Impacts of Recreation
- Navigation Monitoring

Currently, the UMRR is comprised of two elements: 1) plan, construct, and evaluate measures for fish and wildlife habitat improvement through HREPs; and 2) monitor the natural resources of the river system through the LTRM. The other UMRR elements have been either successfully completed or are now carried out under other authorities.

The original authorizing legislation has been amended several times since its enactment. The 1990 WRDA, Section 405, extended the original UMRR authorization an additional five years to fiscal year 2002, which allowed for ramping up of the program. The 1992 WRDA, Section 107, amended the original authorization by allowing limited flexibility in how funds are allocated between the HREP program and the LTRM element. The 1992 WRDA also assigned sole responsibility for operation and maintenance (O&M) of habitat projects to the agency that manages the lands on which the project is located. The 1999 WRDA, Section 509, reauthorized UMRR as a continuing authority with reports to Congress every 6 years and changed the cost sharing percentage from 25 percent to 35 percent. Steamboat Island is located on federally-owned refuge lands so the Project is 100 percent federally funded. 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.

2. Background. Refer to the Main Report, Section I, *Introduction*.

3. Description. Refer to the Main Report, Section I, *Introduction*.

II. REFERENCES

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III. DESIGN DELIVERABLES

The design will involve the submission of multiple design deliverables over the course of the Project including:

- Plans and Specifications (P&S)
- Design Documentation Report (DDR)
- Engineering Considerations and Instructions for Field Personnel (ECIFP)

- Bidability, Constructability, Operability, Environmental, Sustainability (BCOES) Review and Certification
- District Quality Control Review (DQCR) and Certification
- Value Engineering Studies
- Agency Technical Review and Certification
- Calculations
- Quantity Take-Offs
- Cost Estimates

IV. ENGINEERING – DESIGN

A. Civil Design

1. Survey Data

a. Survey data has come from contracted collection of topobathymetric LiDAR, OD-T hydro survey (several events), EC-G hydro survey via autonomous survey vessel and EC-T ground survey. A .tif surface was created using all the survey data sources and was used in ArcGIS for measure layout, design and preliminary quantity calculations. A .dtm surface was created from the .tif for CAD usage for measure layout, design, and quantity calculations.

b. Project is in NAVD88 GEOID 12A (converted from MSL1912, which is what the river gages use). For vertical datum conversion, see Attachment A, *Survey Data*. Conversion at RM 504.5 (~ middle of Project area) is NAVD88 = MSL1912 – 0.85'.

c. NAD83 Illinois West – 1202, US Survey Feet

d. Flat Pool at the Project location (RM 504.5) is 571.2 NAVD88

e. Topobathymetric LiDAR data is located on the EGIS server at: \\mvrdfs\egis\Data\Elevation\MVR\LiDAR\UMR\2017_Topobathy_Steamboat

f. OD-T hydro survey data is located on the EGIS server at: \\mvrdfs\egis\Data\Elevation\MVR\HydroSurvey\2018\Z_HypackExports, sub folders: UMR_14_5028-5045_18A, UMR_14_5030-5045_18A, UMR_14_5043-5063_18A and UMR_14_5050-5052_18A

g. EC-G hydro survey report is located in ProjectWise under Steamboat HREP. Links to the data can be found in the survey report.

h. EC-T Survey data is located in ProjectWise under 03_Survey_Map and 03_Survey_Map.

i. Survey control drawing is included in Appendix P, *Plates*. For conversions between survey datums, refer to Plate 3, V-101.

2. Historic Dredging. Dredging has occurred around Steamboat Island proper for many years, including recent dredging in 2014. Steamboat Island proper contains a historic Bankline Placement

Site locally known as "Princeton Beach". Historically, the West SE Island has occasionally been used as a dredged material placement site. The active dredge cut for this reach is adjacent to the placement sites. Figure M-3 shows historical dredge cuts and dredge placement sites in relation to the Project site.

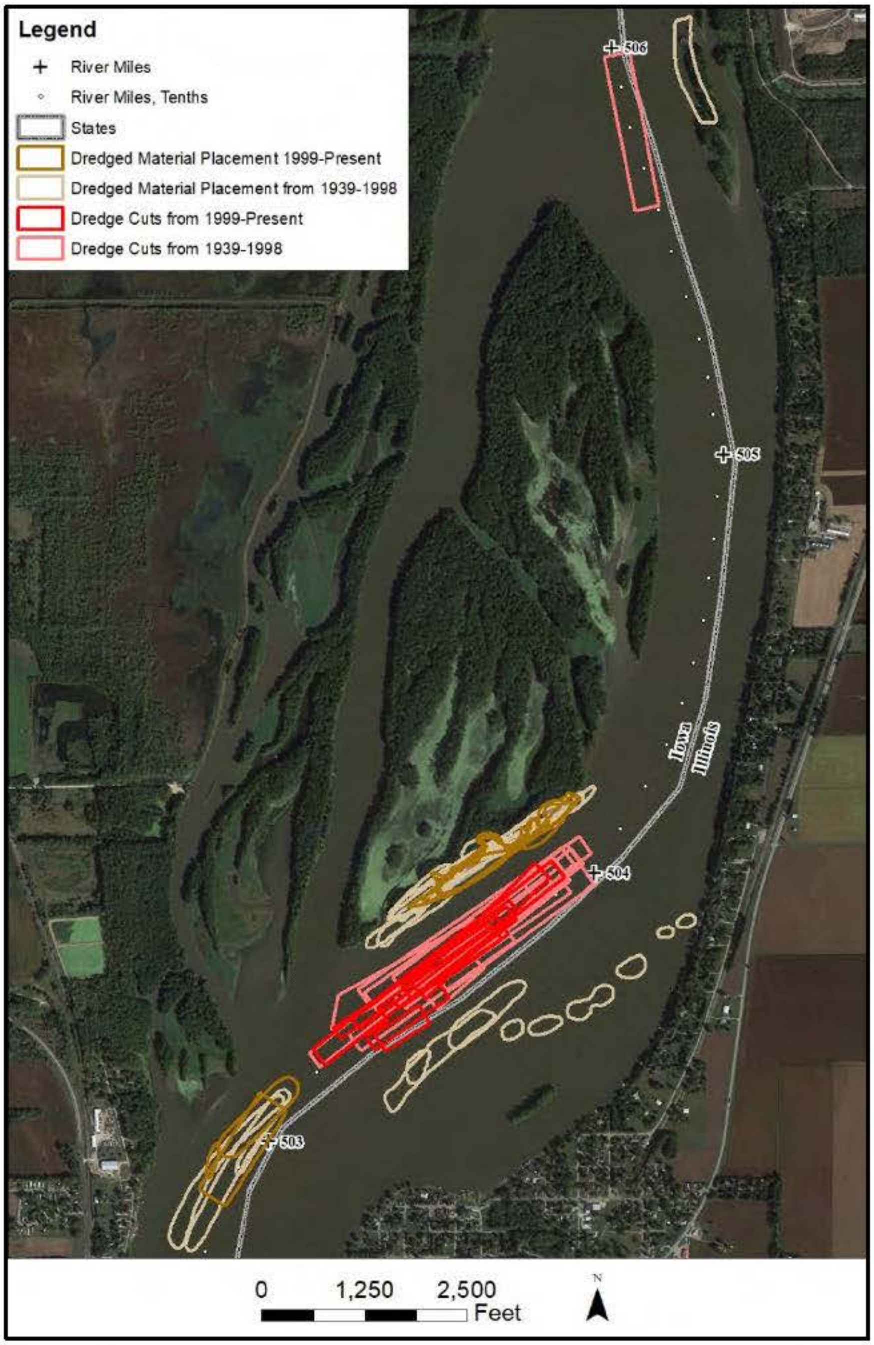


Figure M-3: Historical Dredge Cuts and Placement Sites Near Steamboat Island

3. Project Access. The Project is located on an island in the Mississippi River, so all access will be by water. Refer to Figure M-4 for nearby boat ramps. All ramps shown are public boat ramps that the contractor may use. For planning and design purposes, it is assumed the contractor will utilize these area access points. Some ramps may have limits in terms of size and weight of equipment that may be launched. The Contractor will need to abide by local boat ramp usage regulations.

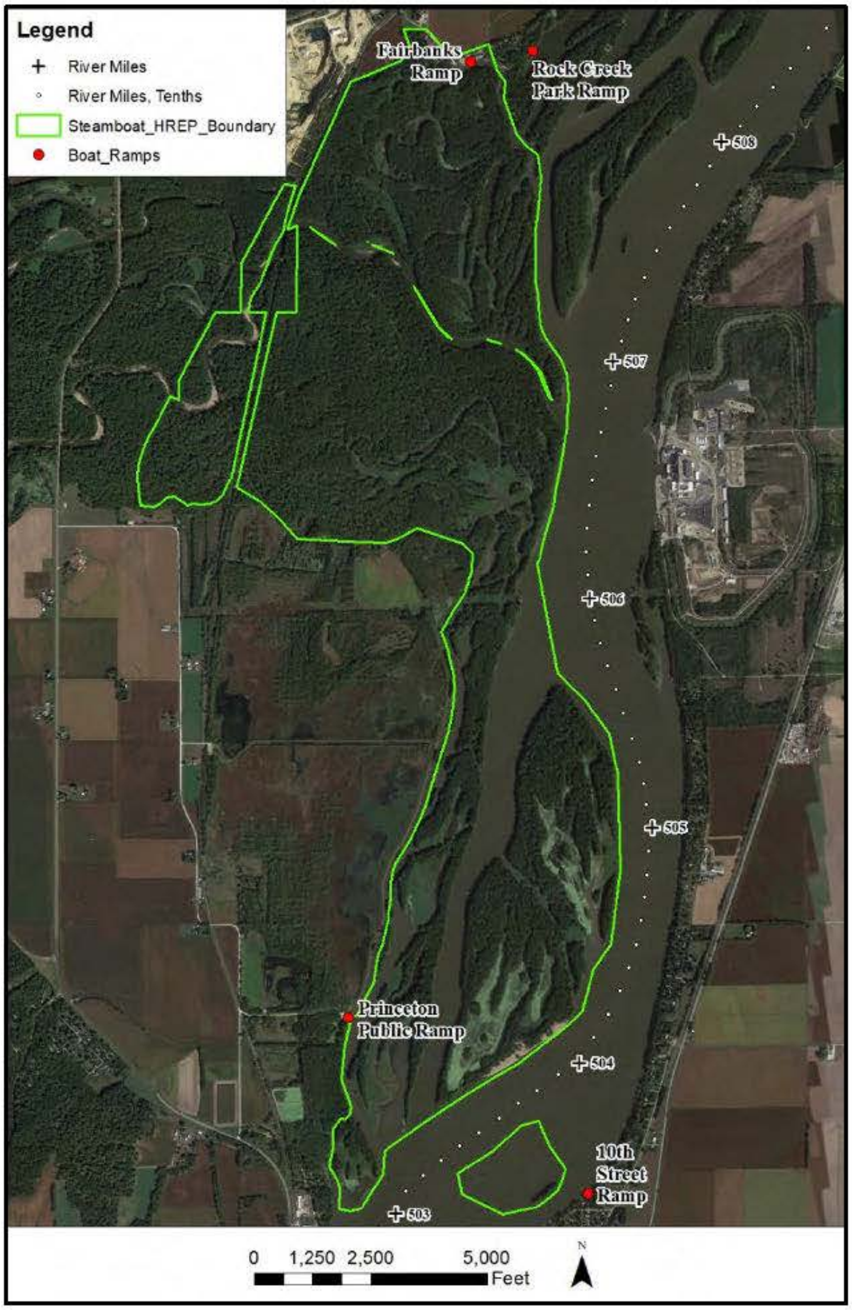


Figure M-4: Nearby Boat Ramps

4. Project Staging Area. To Be Determined.

5. Public Access and Security. Safety and security are important parameters that would be detailed during the Design Phase. Of specific concern will be the coordination of regional hunting seasons with the construction season as well as heavy recreational boat use during the summer months. A summary of limitations is provided in the Main Report, Section II, *Affected Environment*. Additionally, the Project area lies within the Upper Mississippi National Wildlife & Fish Refuge. Attachment B, *U.S. Fish & Wildlife Service Refuge Boundaries*, outlines Refuge lands in proximity to the Project area.

6. Water Quality Sampling. Water quality sampling may be required during dredging and excavation activities.

7. Water Level Information. Water level information is available at Rivergages.com and in Appendix H, *Hydrology and Hydraulic*s.

8. Project Measure Names. The names of the backwater areas were generated from navigation maps and historic maps. Unnamed areas were given unofficial names by the PDT for correspondence purposes, i.e. Upper Lake**.**

9. Permits. Refer to the Main Report, Section VI, *Recommended Plan: Description with Design, Construction, and Operation and Maintenance Considerations*, for details regarding applicable permits.

10. Utilities. A pipeline and overhead power lines bisect the Steamboat Island Project area. Refer to Appendix J, *Real Estate Plan*, for more information and maps. No Project measures selected in the Tentatively Selected Plan (TSP) will impact these utilities.

B. Water Quality Design, Geotechnical Design and Hydraulic Design. The complete water quality report can be found in Appendix F, *Water Quality*. The complete geotechnical report can be found in Appendix G, *Geotechnical Considerations*. The complete hydraulics report along with a discussion of sediment deposition within the Project area can be found in Appendix H, *Hydrology and Hydraulics*. A summary of sediment transect information collected by Bill Aspelmeier of the .IA DNR.) can be found in Attachment D, *Aspelmeier Sedimentation Study*.

V. MEASURES

This section discusses potential enhancement measures that will meet the goals and objectives outlined in the Main Report, Section III, *Problems and Opportunities*. Numerous iterations of measures were identified through the Project process. These potential enhancement measures were initially screened based on their contribution to the Project goals and objectives, engineering considerations, and local restrictions or constraints. Measures that were determined not feasible or did not meet the Project objectives were not subject to further evaluation. Further design of these measures was not completed and therefore not referenced in this Engineering Design Appendix. For more information on all considered measures is provided in the Main Report, Section IV, *Potential Project Measures*.

A. General Design Criteria

- Comply with the Program Authority
- Comply with NEPA
- Meet Project goals and objectives
- Meet Sponsor needs
- Meet Public needs and minimize impacts to the public
- Use topobathymetric LiDAR, ground survey, and hydrosurvey information for quantities
- Adjust LIDAR/Bathymetry based on ground truth surveys
- Stay in USACE recommended survey datum
- Incorporate other scientific data sources including fish, bat, forestry and mussel surveys, monitoring data and analysis to avoid impacts to and enhance those habitats
- Minimize tree clearing
- Avoid utilities
- Design and consider climate change
- Ensure constructability
- Work with existing material types
- Design with nature, using existing topography where applicable and make Project measures look natural

B. Aquatic Diversity and Topographic Diversity Forestry and Scrub-Shrub/Pollinator (SSP) Habitat.

Excavation and dredging has been proposed as a potential measure to create aquatic diversity to provide suitable year-round habitat for fish, which includes critical overwintering habitat for centrarchid fish species. Excavation and dredging will also provide material to increase topographic diversity by providing floodplain forest and scrub-shrub/pollinator habitat. Several potential areas in the Project area were evaluated for excavation.

1. General Design Criteria

- Increase aquatic diversity
- Increase forest habitat
- Increase SSP habitat
- Balance cut and fill
- Design and plan for sedimentation over the Project life through adjusting dredging depths

2. Aquatic Diversity Design Criteria. Aquatic diversity sites were laid out in existing backwater areas. Where possible, dredge cuts were aligned with the deepest parts of the existing backwater to minimize dredging and to design with nature. It was assumed that naturally deeper areas are deeper for a reason, and placing a dredge cut in those locations may help with the longevity of a dredge cut. Where possible, aquatic diversity and topographic diversity site layouts were designed adjacently to allow for side casting of material. Other design considerations are as follows:

- Preferred minimum bottom width of 60 feet when allowed by existing topography (or full channel width if less than 60 feet). Absolute minimum of 30 feet for constructability.

- Side slopes of 4H:1V.

- Offset of 30 feet from dredge cut to placement site.

- Allowable overwintering flow, no flow or as close to 0 as possible preferred

- Connect dredge cuts to deep water

- Place dredge cuts in areas fish use

- Excavate dredge cuts deep enough that they do not freeze (habitat benefits for water depths over 4 feet)

- Excavate dredge cuts deep enough that they do not fill in during the 50-year period of analysis (expect 1.6 feet of sediment deposition in 50 years)
  - Flat pool is elevation 571.2 for the Project area.
  - Overwintering depth of 6 feet plus 2 additional feet for sediment deposition, 8 feet total below flat pool
  - Connection depth of 4 feet plus 2 additional feet for sediment deposition, 6 feet total below flat pool
  - Deep hole depth 8 feet plus 2 additional feet for sediment deposition, 10 feet total below flat pool

- Information regarding fishery substrate recommended by the IA DNR is located in Attachment E, *Fish Habitat.*

3. Hydraulic Dredging. Dredging for measure construction was considered using a hydraulic dredge. A small dredge could be used to allow for dredging narrow channel widths. This would reduce the amount of return water created. Irregular shapes and small sizes of the placement sites would make it inefficient to hydraulically dredge. Larger placement sites would be needed to allow for proper settlement of material and adequate water return. This measure will not be retained for further evaluation.

4. Mechanical Dredging. Dredging for measure construction was considered using a mechanical dredge. Mechanical dredging would necessitate adjacent placement, or handling materials multiple times. Where possible, aquatic diversity and topographic diversity site layouts were designed adjacently to allow for side casting of material. A high buoyancy excavator, barge mounted crane or barge mounted excavator could be used. This method will be retained for further evaluation.

Photographs M-1, M-2, and M-3 are of mechanical excavation methods that could be used.

Photograph M-1: High Buoyancy Excavator (Lake Odessa HREP)

Photograph M-2: Barge-mounted Excavator (Lake Odessa HREP)

Photograph M-3: Barge-mounted Crane with Clamshell Bucket (Peoria Islands)

5. Topographic Diversity Design Criteria. Topographic diversity sites were laid out at sites that currently host low value vegetation, mainly reed canary grass. Additional sites were determined based on Project objectives. Where possible, aquatic diversity and topographic diversity site layouts were designed adjacently to allow for side casting of dredged material. Other design considerations are as follows:

- Design to heights for planting survivability
- Channel side slopes 6H:1V.
- Backside slopes not flatter than 6H:1V and not steeper than 3H:1V
- Offset of 30 feet from dredge cut to placement site.
- Do not impact the floodplain
- Consider flatter slopes for erosion and rodent control
- Provide sufficient capacity for dredge cuts
- Ensure sites can be constructed using typical construction equipment

Optimum elevations for tree survival were developed based on forestry expertise and hydrologic data. Table M-2 is a summary of inundation duration criteria for different floodplain forest habitats. A complete description of this analysis is included in Appendix H, *Hydrology and Hydraulics*. Reference water surface elevations near RM 504.5 are outlined in Table M-3.

Table M-2: Topographic Diversity Elevations at River Mile 504.5.

Design Criteria	Elevation -30-yr Trends (NAVD88)
EFM 25% Exceedance Probability. Lower limit for moderately tolerant trees – 45 days inundation during growing season 10 Mar to 5 Nov	574.0
EFM 25% Exceedance Probability. Lower limit for minimally tolerant trees – 35 days inundation during growing season 10 Mar to 5 Nov	575.1
EFM 25% Exceedance Probability. Conservative lower limit for minimally tolerant trees – 25 days inundation during growing season 10 Mar to 5 Nov	576.2

Table M-3: Water Surface Elevations at River Mile 504.5

Item	Elevation (NAVD88)
Flat Pool	571.2
Aquatic habitat benefits	<571.7
Floodplain habitat benefits	>571.7
50% chance exceedance of flood (2 year)	575.3
20% chance exceedance of flood (5 year)	576.8
10% chance exceedance of flood (10 year)	578.8

Access to Grant Slough topographic diversity forestry sites 4 and 5 will require 1.3 acres of existing trees to be removed, if still present at time of construction. Photographs M-4 through M-7 show typical tree clearing operations and equipment.

Photograph M-4: Typical Cleared Area (Huron Island HREP)

Photograph M-5: Tree Clearing Equipment (Huron Island HREP)

Cleared trees shall be removed from site, or utilized as fishery structures on site. Material excavated from the channels within Steamboat Island and Grant Slough aquatic diversity dredge cuts will be placed to construct topographic diversity sites to an optimum elevation for tree survival (Photographs M-6 and M-7). The sites will either be sloped to drain, or will have elevation (+0' to -1.5') changes to create swales across the wider sites. Once shaping is complete, initial seeding efforts of organic material building cover crops including turnips, radishes, and rapeseed will be employed. Multiple direct seeding efforts of cover crops will be implemented prior to native plant and tree planting efforts. Cover crops and soil will be tilled to incorporate and distribute organic material into the soil prior to subsequent plantings.

Photograph M-6: Transporting Excavated Material from Adjacent Placement Site to Forest Enhancement Site (Huron Island HREP)

Photograph M-7: Shaping Material Transported to Forest Diversity Site (Huron Island HREP)

6. Scrub-Shrub/Pollinator Habitat Design Criteria. Scrub-shrub/pollinator habitat sites were laid out at sites that currently host low value vegetation, mainly reed canary grass, but are near existing healthy SSP habitat. Where possible, aquatic diversity and SSP habitat site layouts were designed adjacently to allow for side casting of dredged material. Other design considerations are as follows:

- Design to heights for planting survivability
- Channel side slopes 6H:1V.
- Backside slopes not flatter than 6H:1V and not steeper than 3H:1V
- Offset of 30 feet from dredge cut to placement site.
- Do not impact the floodplain
- Consider flatter slopes for erosion and rodent control
- Provide sufficient capacity for dredge cuts
- Ensure sites can be constructed using typical construction equipment

Optimum elevations for tree survival were developed based on forestry expertise and hydrologic data. Inundation duration criteria for SSP habitat is included in Table M-4. A complete description of this analysis is included in Appendix H, *Hydrology and Hydraulics*.

Table M-4: Scrub-Shrub/Pollinator Habitat Elevations at River Mile 504.5.

Design Criteria	Elevation - 30-yr Trends (NAVD88)
EFM 50% Exceedance Probability. Lower limit for maximum tolerant trees (Scrub-Shrub) – 55 days inundation during growing season 10 Mar to 5 Nov	573.1

7. Planting Plans. The Project has three planting plans based on the habitat type and measure. These include forestry planting, SSP planting, and timber stand improvement planting.

a. Topographic Diversity Planting – Forestry. After final grading of a site, the seed bed will be conditioned and worked prior to seeding. The top 1 to 2 inches of soil will be tilled to remove heavy equipment tracks, creating a smooth seed bed to maximize soil to seed contact. Sites will be planted in phases to increase soil quality and reduce the risk of tree mortality. The phases of planting efforts are anticipated to occur over 4 years, approximately as shown in Table M-5. Before each cover crop planting, and before the native species planting, the seed bed preparation will require tillage to a depth of 1 to 2 inches.

Table M-5: Topographic Diversity Planting Timeline - Forestry

Year	Planting Effort	Timing
1	1st Cover Crop Planting	1 Apr to 20 May
1	2nd Cover Crop Planting	20 Aug to 20 Sep
2	3rd Cover Crop Planting	1 Apr to 20 May
2	4th Cover Crop Planting	20 Aug to 20 Sep
3	Native Species Planting	1 Apr to 20 May
3	Bare Root Seedling Planting	Day after native species seeding
3	Herbaceous Species Planting	Day after native species seeding
3	1st Containerized Tree Planting	15 Oct to 5 Dec
4	2nd Containerized Tree Planting	15 Oct to 5 Dec

The first seedings of cover crops were selected to improve growing conditions for later planted trees. Species including tillage turnip, tillage radish, rape seed, and seed oats or annual rye will be used to aid in moisture retention, build organic material, combat compaction, and increase nutrient uptake. They will also help combat erosion. For best results, seeding should be conducted by drilling, however broadcast seeding and cultipacking or hydroseeding are also effective if seed rates are altered. Recommended seeding rates are in Table M-6.

Table M-6: Cover Crop Seeding Rates

Seeding Method	Tillage Turnip	Tillage Radish	Rape Seed	Seed Oats or Annual Rye
Drilling	1.0 lb/ac	1.5 lb/ac	1.0 lb/ac	50 lb/ac
Broadcasting	2.0 lb/ac	2.5 lb/ac	2.0 lb/ac	80 lb/ac
Hydroseeding	2.0 lb/ac	2.5 lb/ac	2.0 lb/ac	60 lb/ac

The native species seeding is a direct seeding of native tree seeds including river birch, sycamore, black cherry and boxelder and native herbaceous seeds including Virginia wild rye, swamp milk weed, prairie cordgrass, prairie dock, foxglove beardtongue, wild quinine and blueflag iris. Seed oats will be included with the mixture to act as a cover for the native plants to promote effective establishment and combat erosion. Recommended seeding rates are in Table M-7.

Table M-7: Native Species Seeding Rates

Species	Seeding Rate
River Birch	2 oz/ac
Sycamore	2 oz/ac
Black Cherry	4 oz/ac
Boxelder	1 oz/ac
Virginia Wild Rye	20 lb/ac
Seed Oats	30 lb/ac

The day after native species seeding is complete bare root seedlings will be planted. Bare root seedlings will be approximately 18 inches tall and the roots will be dipped with a root mycorrhizal fungi water solution. The root dip is to include ectomycorrhizae fungi and co-polymer gel to aid in water absorption and retention. Bare root seedlings should be planted randomly throughout the sites. Recommended seedling/acre rates are in Table M-8.

Table M-8: Bare Root Tree Rates

Species	Seedlings per Acre
River Birch	80
Green Ash	50
Black Cherry	30
Eastern Redbud	20
Silky Dogwood	20

Planting of native herbaceous species will be done immediately post native direct seeding (that day or next day of direct seeding). Containerized plant species will include: swamp milk weed, prairie cordgrass, greater water dock, wild quinine, and smooth white aster. Containerized plants will be in 1 gallon pots and be approximately 20 inches tall. Containerized plants are to be planted in clumps of 3 to 5 plants per clump. Each plant is to be no closer than 2 feet to any other planted plant. Clumps are to be no closer than 40 feet apart and no more than 65 feet apart. A minimum of eight clumps an acre is the minimum target for planting. Clumps are to only include same species planted within the planted clump. A total of 30 plants an acre are to be planted. Recommended plants/acre rates are in Table M -9.

Table M-9: Herbaceous Species Rates

Species	Plants per Acre
Swamp Milkweed	6
Prairie Cordgrass	8
Greater Water Dock	5
Wild Quinine	6
Smooth White Aster	5

The first containerized tree planting is intended to plant faster growing species to fill in areas that had lower success to the native species seeding and bare root seeding efforts. Lower success is defined as areas that are more open and have lower tree densities. Containerized trees will be a minimum height of 3 feet tall. 1,000 containerized trees will be planted as needed throughout all sites. No more than 30 containerized trees per acre will be planted in any given location. Containerized trees will be planted no closer than 25 feet from any other containerized tree. Containerized trees should be planted randomly throughout the planting areas. All containerized trees will have a GPS location recorded. Recommended breakout of tree species are in Table M-10.

Table M-10: Faster Growing Containerized Tree Schedule

Species	Total Trees to Plant
Eastern Cottonwood	600
Black Willow	300
River Birch	100

The final containerized tree planting is intended to randomly incorporate slower growing species throughout the planting areas. Containerized trees have a minimum height requirement depending on species. Target planting rate is 60 trees total per acre. Containerized trees will be planted with a minimum spacing between any containerized trees of 15 feet, and a maximum spacing of 24 feet. Planting will be at least 10 feet from any previously planted containerized eastern cottonwood, black willow, or river birch. The slower growing containerized trees require bark protection installed. All containerized trees will have a GPS location recorded. Recommended tree planting rates and heights are in Table M-11.

Table M-11: Slower Growing Containerized Tree Schedule

Species	Trees Per Acre	Minimum Tree Height
Pin Oak	10	4 feet
Swamp White Oak	10	4 feet
Bur Oak	10	4 feet
Kentucky Coffeetree	5	1 foot
Bitternut Hickory	8	2 feet
Northern Pecan	10	2 feet
Black Walnut	7	1 foot

In total, there will be 15 tree species planted under this strategy. All species are selected to improve suitable conditions to increase survivability and promote productive growth of slower growing trees; primarily hard mast tree species. This strategy is intended to reduce risk of mortality of slower growing tree species planted into dredge placement sites and will in turn protect the established trees and promote viable growth.

b. Topographic Diversity Planting - Scrub-Shrub/Pollinator. After final grading of a site, the seed bed will be conditioned and worked prior to seeding. The top 1 to 2 inches of soil will be tilled to remove heavy equipment tracks, creating a smooth seed bed to maximize soil to seed contact. Sites will be planted in phases to increase soil quality and reduce the risk of tree mortality. The phases of planting efforts are anticipated to occur over 4 years, approximately as shown in Table M-12. Before each cover crop planting, and before the native species planting, the seed bed preparation will require tillage to a depth of 1 to 2 inches.

Table M-12: Topographic Diversity Planting Timeline – Scrub-Shrub/Pollinator

Year	Planting Effort	Timing
1	1st Cover Crop Planting	1 Apr to 20 May
1	2nd Cover Crop Planting	20 Aug to 20 Sep
2	3rd Cover Crop Planting	1 Apr to 20 May
2	4th Cover Crop Planting	20 Aug to 20 Sep
3	Native Species Planting	1 Apr to 20 May
3	Containerized Native Species Planting	Day after native species seeding
3	1st Containerized Tree Planting	15 Oct to 5 Dec
4	2nd Containerized Tree Planting	15 Oct to 5 Dec

The first seedings of cover crops were selected to improve growing conditions for later planted trees. Species including tillage turnip, tillage radish, rape seed, and seed oats or annual rye will be used to aid in moisture retention, build organic material, combat compaction, and increase nutrient uptake. They will also help combat erosion. For best results, seeding should be conducted by drilling, however broadcast seeding and cultipacking or hydroseeding are also effective if seed rates are altered. Recommended seeding rates are in Table M-13.

Table M-13: Cover Crop Seeding Rates

Seeding Method	Tillage Turnip	Tillage Radish	Rape Seed	Seed Oats or Annual Rye
Drilling	1.0 lb/ac	1.5 lb/ac	1.0 lb/ac	50 lb/ac
Broadcasting	2.0 lb/ac	2.5 lb/ac	2.0 lb/ac	80 lb/ac
Hydroseeding	2.0 lb/ac	2.5 lb/ac	2.0 lb/ac	60 lb/ac

The native species seeding is a direct seeding of native shrub seeds, including buttonbush, elderberry, and native herbaceous seeds including Virginia wild rye. Seed oats will be included with the mixture to act as a cover for the native plants to promote effective establishment and combat erosion. Recommended seeding rates are in Table M-14.

Table M-14: Native Species Seeding Rates

Species	Seeding Rate
Common Buttonbush	2 oz/ac
Common Elderberry	1 oz/ac
Virginia Wild Rye	30 lb/ac
Seed Oats	30 lb/ac

The day after native species seeding is complete, containerized native plants will be planted. Containerized plants will be approximately 20 inches tall. Containerized plants are to be planted in clumps of 3 to 5 plants per clump. Each plant is to be no closer than 2 feet to any other planted plant. Clumps are to be no closer than 30 feet apart and no more than 45 feet apart. A minimum of 20 clumps an acre is the minimum target for planting. Clumps are to include only same species planted within the planted clump. Ninety plants an acre are to be planted. Recommended plants/acre rates are in Table M-15.

Table M-15: Containerized Plant Rates

Species	Plants per Acre
Swamp Milkweed	15
Prairie Cordgrass	15
Greater Water	10
Foxglove	6
Wild Quinine	6
Blueflag Iris	14
Beggarsticks	12
Smooth White	12

The first containerized shrub and tree planting is intended to plant approximately half of the total containerized shrubs and trees in the first year. Containerized shrubs and trees will be a minimum height of 3 feet tall. Containerized shrubs and trees are to be planted in clusters of five. Each planted shrub or tree is to be planted 5 feet from any planted shrub or tree. Clusters are to be planted randomly across the planted area. No planted cluster is to be closer than 40 feet from any planted cluster center. A total of 75 shrubs and trees are to be planted per acre. Clusters are to only include the same species planted within the cluster. All shrub and tree clusters will have a single GPS location recorded. Recommended breakout of shrub and tree species are in Table M-16.

Table M-16: Containerized Shrub and Tree Schedule

Species	Shrubs/Trees per Acre
Eastern Redbud	15
Eastern Wahoo	10
Common Buttonbush	5
False Indigo Bush	10
Strawberry Bush	5
Green Hawthorn	10
Gray Dogwood	10
American Plum	5
Common Elderberry	5

The final containerized shrub and tree planting is intended to plant approximately half of the total containerized shrubs and trees in the second year. Containerized shrubs and trees will be a minimum height of 3 feet tall. Containerized shrubs and trees are to be planted in clusters of five. Each planted shrub or tree is to be planted 5 feet from any planted shrub or tree. Clusters are to be planted randomly across the planted area. No planted cluster is to be closer than 40 feet from any planted cluster center. A total of 50 shrubs and trees are to be planted per acre. Clusters are to only include the same species planted within the cluster. All shrub and tree clusters will have a single GPS location recorded. Recommended breakout of shrub and tree species are in Table M-17.

Table M-17: Containerized Shrub and Tree Schedule

Species	Shrubs/Trees per Acre
Eastern Redbud	5
Eastern Wahoo	10
Buttonbush	5
False Indigo Bush	5
Strawberry Bush	5
Green Hawthorn	5
Gray Dogwood	5
American Plum	5
Common Elderberry	5

There will be nine shrub and tree species planted under this strategy. All species are selected to improve suitable conditions to increase survivability and promote productive growth of slower growing trees; primarily hard mast tree species. This strategy is intended to reduce risk of mortality of slower growing tree species planted into dredge placement and will in turn protect the established trees and promote viable growth.

c. Topographic Diversity Planting – Grade Control Structure. After final grading of a site, the seed bed will be conditioned and worked prior to seeding. The top 1 to 2 inches of soil will be tilled to remove heavy equipment tracks, creating a smooth seed bed to maximize soil to seed contact. Sites will be planted in phases to increase soil quality and reduce the risk of tree mortality. The phases of planting efforts are anticipated to occur over 4 years, approximately as shown in Table M-18. Before each cover crop planting, and before the native species planting, the seed bed preparation will require tillage to a depth of 1 to 2 inches.

Table M-18: Topographic Diversity Planting Timeline – Grade Control Structure

Year	Planting Effort	Timing
1	1st Cover Crop Planting	1 Apr to 20 May
1	2nd Cover Crop Planting	20 Aug to 20 Sep
2	3rd Cover Crop Planting	1 Apr to 20 May
2	4th Cover Crop Planting	20 Aug to 20 Sep
3	Native Species Planting	1 Apr to 20 May
3	Rooted Cutting and Bare Root Seedling Planting	Day after native species seeding
3	Containerized Tree Planting	15 Oct to 5 Dec
4	2nd Willow Cutting Planting	15 Oct to 5 Dec

The first seedings of cover crops were selected to improve growing conditions for later planted trees. Species including tillage turnip, tillage radish, rape seed, and seed oats or annual rye will be used to aid in moisture retention, build organic material, combat compaction, and increase nutrient uptake. They will also help combat erosion. For best results, seeding should be conducted by drilling, however broadcast seeding and cultipacking or hydroseeding are also effective if seed rates are altered. Recommended seeding rates are in Table M-19.

Table M-19: Cover Crop Seeding Rates

Seeding Method	Tillage Turnip	Tillage Radish	Rape Seed	Seed Oats or Annual Rye
Drilling	1.0 lb/ac	1.5 lb/ac	1.0 lb/ac	50 lb/ac
Broadcasting	2.0 lb/ac	2.5 lb/ac	2.0 lb/ac	80 lb/ac
Hydroseeding	2.0 lb/ac	2.5 lb/ac	2.0 lb/ac	60 lb/ac

The native species seeding is a direct seeding of native shrub seeds, including buttonbush, river birch, sycamore and boxelder, and native herbaceous seeds including Virginia wild rye. Seed oats will be included with the mixture to act as a cover for the native plants to promote effective establishment and combat erosion. Recommended seeding rates are in Table M-20.

Table M-20: Native Species Seeding Rates

Species	Seeding Rate
Common Buttonbush	1 oz/ac
River Birch	2 oz/ac
Sycamore	1 oz/ac
Boxelder	1 oz/ac
Virginia Wild Rye	20 lb/ac
Seed Oats	30 lb/ac

The day after native species seeding is complete bare root seedlings and rooted cutting species will be planted. Bare root seedlings will be approximately 18 inches tall and the roots will be dipped with a root mycorrhizal fungi water solution. The root dip is to include ectomycorrhizae fungi and co-polymer gel to aid in water absorption and retention. Bare root seedlings should be planted randomly throughout the sites. Recommended seedlings/acre are in Table M-21.

Table M-21: Bare Root Tree Rates

Species	Seedlings per Acre
River Birch	20
Black Willow	40
Sandbar Willow	20
Cottonwood	40

Containerized trees will be a minimum height of 5 feet tall. Containerized trees are to be planted randomly in areas that are less dense or are void of establishing trees from previous tree planting efforts. Each containerized planted tree is to not be any closer than 12 feet from any other planted containerized tree. All containerized trees will have a single GPS location recorded. Recommended trees/acre rates are in Table M-22.

Table M-22: Containerized Tree Rates

Species	Trees per Acre
Silver Maple	20
River Birch	30
Sycamore	10
Cottonwood	20

The second willow cutting planting will consist of black willow cuttings. The cuttings will need to be harvested to a length of 4 feet and are to be greater than ½-inch diameter at the small end and less than 3½ inches at the big end. Willow cuttings are to only be harvested when the trees are completely dormant. Cuttings are to be planted to a depth of 1½ feet into the ground having the remaining 2½ feet above ground surface. Black willow cuttings are to be dipped with a rooting hormone completed on the planted portion of the cutting, the below ground portion of the cutting. Cuttings are not permitted to be driven into the ground. A hole is to be dug by hand, auger, or hydro-spade and then fully backfilled once in the ground. The cutting must have full soil contact from being planted to all sides of the cutting flush to the ground surface. Black willow cuttings are to be planted within 6 hours of being cut. If cuttings are unable to be planted within 6 hours of being cut, they will be required to be stored in a manor the keeps, at least, the butt end of the cutting saturated. Temporary storage of the cutting prior to planting is to not exceed 24 hours post being cut. Recommended willow cutting placement rates are in Table M-23.

Table M-23: Willow Cutting Placement Rates

Species	Trees per Acre
Black Willow	150

In total, there will be seven tree and one shrub species planted under this strategy. All species are selected to maximize established dense forest thicket conditions quickly. This strategy is intended to reduce risk of mortality to planted early successional tree species planted into dredge placement. In addition to fast establishment of dense forest cover, planted trees will improve soil conditions over time enhancing the survivability of all planted species.

8. Specific Measures. Areas, distances and other measurements for inputs for the Incremental Cost Analysis (ICA) were measured using ArcMap. Depths and elevations were obtained from the Topobathymetric LiDAR flown over the Steamboat Island Project area December 13, 2017. A TIFF surface was created with the Topobathymetric LiDAR elevation information. Measures were laid out in ArcMap and assigned elevations. The Raster Surface Cut/Fill tool in ArcMap was used to calculate quantities of cut (dredging/excavation) and fill (placement sites) by comparing the designs of these potential measures to the TIFF surface.

Following the ICA, the TSP (see Main Report, Section VI, *Recommended Plan: Description with Design, Construction, and Operation and Maintenance Considerations*) measures were designed in MicroStation resulting in different layouts as compared to the ArcMap layouts. Areas, distances and other measurements were measured using MicroStation. The layouts and measurements in MicroStation were higher precision compared to the ArcMap layouts. Additionally, some layout geometries and cross sections were updated to meet site needs. As such, measurements and quantities changed. Depths and elevations were obtained from the Topobathymetric LiDAR flown over the Steamboat Island Project area December 13, 2017. A DTM was created with the Topobathymetric LiDAR elevation information. InRoads was used to calculate quantities of cut (dredging/excavation) and fill (placement sites) where possible. End area calculations were performed otherwise.

a. Steamboat Island Upper Lake Aquatic Diversity (Upper Lake)

Potential Measure. The dredge cut would be excavated to provide aquatic diversity through the direct act of dredging and to provide sufficient material for floodplain forest topographic diversity. The dredge cut was designed to a 60-foot bottom width. Side slopes of the dredge cut were designed at 3H:1V where channel width allowed. Excavation would be to 8 feet below flat pool, or elevation 563.2 ft. The cut was aligned to follow naturally deeper areas and tie into the deeper water of the Mississippi River channel. Material excavated from this site will be transported to a topographic diversity site. Refer to Table M-24 for more details.

Table M-24: Upper Lake Input for the ICA

Item	Quantity	Unit
Length (all channels)	6,692	FT
Acres Dredged	15.9	AC
Acres Below 4 Feet	12.6	AC
Quantity Excavated	150,570	CY
Bottom Width	60	FT
Side Slopes	3	H:1V
Average Bottom Elevation	563.2	FT

ICA. This measure was retained for further evaluation.

TSP. The TSP is the same as the potential measure described above. This measure passed the ICA, and was later revised in the TSP to address the following:

- Narrow channel widths (bank to bank) in Right Finger near NE Bank reduced channel bottom widths from 60 feet to 30 feet wide near the NE Bank.
- Side slopes lessened from 3H:1V to 4H:1V
- Overall length increased from 6,692 feet to 6,902 feet.
- Assumption added that Contractor will dredge 20% more (overdredging) than required to ensure bottom elevation specified is met.
- Overall dredging quantity increased from 150,570 CY to 162,356 CY

Refer to Table M-25 for more details.

Table M-25: Upper Lake Input for the TSP

Item	Quantity	Unit
Length	6,902	FT
Acres Dredged	17.8	AC
Acres Below 4 Feet	12.7	AC
Target Quantity Excavated	162,356	CY
Quantity with 20% Overdredging	194,828	CY
Bottom Width (9+00 to end, Right Finger)	30	FT
Bottom Width (rest of cut)	60	FT
Side Slopes	4	H:1V
Average Bottom Elevation	563.2	FT

b. Steamboat Island Lower Lake Aquatic Diversity (Lower Lake)

Potential Measure. The dredge cut would be excavated to provide aquatic diversity through the direct act of dredging and to provide sufficient material for floodplain forest topographic diversity and SSP habitat. The dredge cut was designed to a 60-foot bottom width. Side slopes of the dredge cut were designed at 3H:1V where channel width allowed. Excavation would be to 8 feet below flat pool, or elevation 563.2 ft. The cut was aligned to follow naturally deeper areas and tie into the deeper water of the Mississippi River channel. Material excavated from this site will be transported to topographic diversity sites. Refer to Table M-26 for more details.

Table M-26: Lower Lake Input for the ICA

Item	Quantity	Unit
Length (all channels)	5,389	FT
Acres Dredged	13.4	AC
Acres Below 4 Feet	10.4	AC
Quantity Excavated	126,302	CY
Bottom Width	60	FT
Side Slopes	3	H:1V
Average Bottom Elevation	563.2	FT

ICA. This measure was retained for further evaluation.

TSP. The TSP is the same as the potential measure described above. This measure passed the ICA, and was later revised in the TSP to address the following:

- Side slopes lessened from 3H:1V to 4H:1V
- Overall length increased from 5,389 ft to 5,758 ft.
- Assumption added that Contractor will dredge 20% more (overdredging) than required to ensure bottom elevation specified is met.
- Overall dredging quantity increased from 126,302 CY to 141,798 CY.

Refer to Table M-27 for more details.

Table M-27: Lower Lake Input for the TSP

Item	Quantity	Unit
Length	5,758	FT
Acres Dredged	15.6	AC
Acres Below 4 Feet	11.4	AC
Target Quantity Excavated	141,798	CY
Quantity with 20% Overdredging	170,158	CY
Bottom Width	60	FT
Side Slopes	4	H:1V
Average Bottom Elevation	563.2	FT

c. Northwest Grant Slough Lake Aquatic Diversity (NW Grant Slough Lake)

Potential Measure. The dredge cut would be excavated to provide aquatic diversity through the direct act of dredging and to provide sufficient material for floodplain forest topographic diversity and SSP habitat. The dredge cut was designed to a 60-foot bottom width. Side slopes of the dredge cut were designed at 3H:1V where channel width allowed. Excavation would be to 8 feet below flat pool, or elevation 563.2 ft. The cut was aligned to follow naturally deeper areas and tie into the deeper water of the Grant Slough channel. Material excavated from this site will be transported to topographic diversity sites. Refer to Table M-28 for more details.

Table M-28: NW Grant Slough Lake Input for the ICA

Item	Quantity	Unit
Length (all channels)	3,318	FT
Acres Dredged	7.3	AC
Acres Below 4 Feet	6.0	AC
Quantity Excavated	75,082	CY
Bottom Width	60	FT
Side Slopes	3	H:1V
Average Bottom Elevation	563.2	FT

ICA. This measure was retained for further evaluation.

TSP. The TSP is the same as the potential measure described above. This measure passed the ICA, and was later revised in the TSP to address the following:

- Narrow channel widths (bank to bank) reduced channel bottom widths from 60 feet to 30 feet wide for the entire cut except in the Right Finger from Station 0+00 to 11+99.9 which is 60 feet wide.
- Side slopes lessened from 3H:1V to 4H:1V
- Overall length increased from 3,3181 ft to 3,377 ft
- Assumption added that Contractor will dredge 20% more (overdredging) than required to ensure bottom elevation specified is met.
- Overall dredging quantity decreased from 75,082 CY to 73,086 CY

Refer to Table M-29 for more details.

Table M-29: NW Grant Slough Lake Input for the TSP

Item	Quantity	Unit
Length	3,377	FT
Acres Dredged	8.4	AC
Acres Below 4 Feet	5.9	AC
Target Quantity Excavated	73,086	CY
Quantity with 20% Overdredging	87,704	CY
Bottom Width (0+00 to 12+00, Right Finger)	60	FT
Bottom Width (rest of cut)	30	FT
Side Slopes	4	H:1V
Average Bottom Elevation	563.2	FT

d. Grant Slough Access Dredging

Potential Measure. The dredge cut would be excavated to provide access to Grant Slough through the direct act of dredging and is considered necessary in order to construct NW Grant Slough Lake. Grant Slough access dredging would also provide sufficient material for floodplain forest topographic diversity and SSP habitat. The dredge cut was designed to a 60-foot bottom width. Side slopes of the dredge cut were designed at 3H:1V where channel width allowed. Excavation would be to 6 feet below flat pool, or elevation 565.2 ft. The cut was aligned to follow naturally deeper areas and tie into the deeper water of the Grant Slough channel. Material excavated from this site will be transported to topographic diversity sites. Refer to Table M-30 for more details.

Table M-30: Grant Slough Access Dredging Input for the ICA

Item	Quantity	Unit
Length	3,358	FT
Acres Dredged	7.3	AC
Quantity Excavated	13,556	CY
Bottom Width	60	FT
Side Slopes	3	H:1V
Average Bottom Elevation	565.2	FT

ICA. This measure was retained for further evaluation.

TSP. The TSP is the same as the potential measure described above. This measure passed the ICA, and was later revised in the TSP to address the following:

- Side slopes lessened from 3H:1V to 4H:1V
- Overall length decreased from 3,358 ft to 3,017 ft
- Assumption added that Contractor will dredge 20% more (overdredging) than required to ensure bottom elevation specified is met.
- Overall quantity decreased from 13,556 CY to 8,935 CY

Refer to Table M-31 for more details.

Table M-31: Grant Slough Access Dredging Input for the TSP

Item	Quantity	Unit
Length	3,017	FT
Acres Dredged	5.0	AC
Target Quantity Excavated	8,935	CY
Quantity with 20% Overdredging	10,721	CY
Bottom Width	60	FT
Side Slopes	4	H:1V
Average Bottom Elevation	565.2	FT

e. USI Head Topographic Diversity (USI Head)

Potential Measure. This site, located at the head of Steamboat Island Proper is open water placement and is designed to create floodplain forest topographic diversity in an area that has lost forest habitat over the years due to high water events, erosion, and competition from invasive species. The material for placement could come from any of the aquatic diversity or access dredging sites, but will most likely come from dredging in the main channel of the Mississippi due to its proximity to other aquatic diversity sites. By protecting this placement site with stone the topographic diversity site and existing Steamboat Island will be protected from further erosion. Since the site is currently open water, it has no forest diversity, but it is adjacent to higher diversity areas. This site would be constructed to optimum tree survival elevations. This area would be planted with various forested wetland trees, forested wetland shrubs, and non-woody wetland plants. Refer to Table M-32 for more details.

ICA. This measure was retained for further evaluation.

Table M-32: USI Head Input for the ICA

Item	Quantity	Unit
Topographic Diversity – Forest Habitat	14.2	AC
Approximate Tree Clearing	0	AC
Quantity Capacity	310,491	CY
Placement Slope to Top Elevation	3	H:1V
Average Dredged Material Top Elevation	576.2	FT
Stone Protection Tonnage	106,800	TN
Stone Protection Length	3,863	FT
Stone Protection Slope (R/S)	3	H:1V
Stone Protection Slope (L/S)	1.5	H:1V
Stone Protection Top Width	4	ft
Average Stone Top Elevation	575.25	FT

TSP. The TSP is the same as the potential measure described above. This measure passed the ICA, and was later revised in the TSP to address the following:

- Stone protection tonnage decreased from 106,800 TN to 102,941 TN
- Placement slopes to top elevation decreased from 3H:1V to 6H:1V
- Placement capacity decreased from 310,491 CY to 274,530 CY

Refer to Table M-33 for more details.

Table M-33: USI Head Input for the TSP

Item	Quantity	Unit
Topographic Diversity – Forest Habitat	14.4	AC
Approximate Tree Clearing	0	AC
Quantity Capacity	274,530	CY
Placement Slope to Top Elevation	6	H:1V
Average Dredged Material Top Elevation	576.2	FT
Stone Protection Tonnage	102,941	TN
Stone Protection Length	3,863	FT
Stone Protection Slope (R/S)	3	H:1V
Stone Protection Slope (L/S)	1.5	H:1V
Stone Protection Top Width	4	ft
Average Stone Top Elevation	575.25	FT

f. NE Bank Topographic Diversity

Potential Measure. This site, located at the northeast bank of Steamboat Island Proper is a combination of open water placement and placement on low value vegetation, mainly reed canary grass and is designed to create floodplain forestry topographic diversity in an area that has lost forest habitat over the years due to high water events, erosion, and competition from invasive species. The site will also provide protection to Upper Lake and adjacent interior wetlands. The material for placement could come from any of the aquatic diversity or access dredging sites, but will most likely come from dredging Upper Lake due to its proximity. By protecting this placement site with stone the topographic diversity site and existing Steamboat Island will be protected from further erosion. The site currently has no forest diversity, but it is adjacent to higher diversity areas. This site would be constructed to optimum tree survival elevations. This area would be planted with various forested wetland trees, forested wetland shrubs, and non-woody wetland plants. Refer to Table M-34 for more details.

ICA. This measure was retained for further evaluation.

Table M-34: NE Bank Input for the ICA

Item	Quantity	Unit
Topographic Diversity – Forest Habitat	8.3	AC
Approximate Tree Clearing	0	AC
Placement Slope to Top Elevation	3	H:1V
Quantity Capacity	31,787	CY
Average Dredged Material Top Elevation	576.2	FT
Stone Protection Tonnage	8,853	TN
Stone Protection Length	1,615	FT
Stone Protection Slope	3	H:1V
Average Stone Top Elevation	575.25	FT

TSP. The TSP is the same as the potential measure described above. This measure passed the ICA, and was later revised in the TSP to address the following:

- Stone protection length shortened from 1,615 feet to 1,589 feet
- Stone protection tonnage increased from 8,853 TN to 22,403 TN
- 30-foot offset between dredge cut and start of placement added
- Placement slopes to top elevation decreased from 3H:1V to 6H:1V
- Placement capacity decreased from 31,787 CY to 30,990 CY

Refer to Table M-35 for more details.

Table M-35: NE Bank Input for the TSP

Item	Quantity	Unit
Topographic Diversity – Forest Habitat	7.6	AC
Approximate Tree Clearing	0	AC
Quantity Capacity	30,990	CY
Placement Slope to Top Elevation	6	H:1V
Average Dredged Material Top Elevation	576.2	FT
Stone Protection Tonnage	22,403	TN
Stone Protection Length	1,589	FT
Stone Protection Slope	3	H:1V
Average Stone Top Elevation	575.25	FT

g. Steamboat Island Upper Lake Placement 1 Topographic Diversity

Potential Measure. This site, located between Upper Lake and the Cut-Through Channel is placement on low value vegetation, mainly reed canary grass and is designed to create floodplain forest topographic diversity in an area that has lost forest habitat over the years due to high water events, erosion, and competition from invasive species. The site will also provide protection to the Cut-Through Channel and ultimately Lower Lake and adjacent interior wetlands. The material for placement could come from any of the aquatic diversity or access dredging sites, but will most likely come from dredging Upper Lake due to its proximity. The site currently has no forest diversity, but it is adjacent to higher diversity areas. This site would be constructed to optimum tree survival elevations. This area would be planted with various forested wetland trees, forested wetland shrubs, and non-woody wetland plants. Refer to Table M-36 for more details.

ICA. This measure was retained for further evaluation.

Table M-36: Upper Lake Placement 1 Input for the ICA

Item	Quantity	Unit
Topographic Diversity – Forest Habitat	5.3	AC
Approximate Tree Clearing	0	AC
Quantity Capacity	13,969	CY
Placement Slope to Top Elevation	3	H:1V
Average Dredged Material Top Elevation	576.2	FT

TSP. The TSP is the same as the potential measure described above. This measure passed the ICA, and was later revised in the TSP to address the following:

- 30-foot offset between dredge cut and start of placement added
- Placement slopes to top elevation decreased from 3H:1V to 6H:1V
- Placement capacity decreased from 13,969 CY to 10,972 CY

Refer to Table M-37 for more details.

Table M-37: Upper Lake Placement 1 Input for the TSP

Item	Quantity	Unit
Topographic Diversity – Forest Habitat	4.1	AC
Approximate Tree Clearing	0	AC
Quantity Capacity	10,972	CY
Placement Slope to Top Elevation	6	H:1V
Average Dredged Material Top Elevation	576.2	FT

h. Grade Control Structure Topographic Diversity (GCS)

Potential Measure. This site, located at the west end of the Cut-Through Channel is a combination of open water placement and placement on low value vegetation, mainly reed canary grass and is designed to create floodplain forest topographic diversity in an area that has lost forest habitat over the years due to high water events, erosion, and competition from invasive species. The site will also provide protection to Lower Lake and adjacent interior wetlands. The material for placement could come from any of the aquatic diversity or access dredging sites, but will most likely come from dredging in Grant Slough (access or aquatic diversity), Steamboat Slough, or the main channel of the Mississippi due to its proximity. By protecting this placement site with stone the topographic diversity site will be protected from further erosion. The site currently has no forest diversity, but it is adjacent to higher diversity areas. This site would be constructed to optimum tree survival elevations. This area would be planted with various forested wetland trees, forested wetland shrubs, and non-woody wetland plants. Refer to Table M-38 for more details.

ICA. This measure was retained for further evaluation.

Table M-38: GCS Input for the ICA

Item	Quantity	Unit
Topographic Diversity – Forest Habitat	0.3	AC
Approximate Tree Clearing	0	AC
Quantity Capacity	610	CY
Average Dredged Material Top Elevation	574.0	FT
Stone Protection Tonnage	59	TN
Stone Protection Length	190	FT
Stone Protection Slope (R/S)	3	H:1V
Stone Protection Slope (L/S)	3	H:1V
Average Stone Top Elevation	574.0	FT

TSP. The TSP is the same as the potential measure described above. This measure passed the ICA, and was later revised in the TSP to address the following:

- Stone protection length lengthened from 190 feet to 264 ft
- Stone protection tonnage increased from 59 TN to 162 TN to include deeper key-in.
- Placement capacity decreased from 610 CY to 561 CY

Refer to Table M-39 for more details.

Table M-39: GCS Input for the TSP

Item	Quantity	Unit
Topographic Diversity – Forest Habitat	0.2	AC
Approximate Tree Clearing	0	AC
Quantity Capacity	561	CY
Average Dredged Material Top Elevation	574.0	FT
Stone Protection Tonnage	162	TN
Stone Protection Length	264	FT
Stone Protection Slope (R/S)	3	H:1V
Stone Protection Slope (L/S)	3	H:1V
Average Stone Top Elevation	574.0	FT

i. Grant Slough Placement 2 Topographic Diversity (Grant Slough Placement 2)

Potential Measure. This site, located between to NW Grant Slough Lake and Grant Slough is placement on low value vegetation, mainly reed canary grass and is designed to create floodplain forest topographic diversity in an area that has lost forest habitat over the years due to high water events, erosion, and competition from invasive species. The site will also provide protection to NW Grant Slough Lake and adjacent interior wetlands. The material for placement could come from any of the aquatic diversity or access dredging sites, but will most likely come from dredging NW Grant Slough Lake and access dredging to Grant Slough due to its proximity. The site currently has no forest diversity, but it is adjacent to higher diversity areas. This site would be constructed to optimum tree survival elevations. This area would be planted with various forested wetland trees, forested wetland shrubs, and non-woody wetland plants. Refer to Table M-40 for more details.

ICA. This measure was retained for further evaluation.

Table M-40: Grant Slough Placement 2 Input for the ICA

Item	Quantity	Unit
Topographic Diversity – Forest Habitat	5.4	AC
Approximate Tree Clearing	0	AC
Quantity Capacity	19,468	CY
Placement Slope to Top Elevation	3	H:1V
Average Dredged Material Top Elevation	576.2	FT

TSP. The TSP is the same as the potential measure described above. This measure passed the ICA, and was later revised in the TSP to address the following:

- 30-foot offset between dredge cut and start of placement added
- Placement slopes to top elevation decreased from 3H:1V to 6H:1V
- Placement capacity decreased from 19,468 CY to 11,886 CY

Refer to Table M-41 for more details.

Table M-41: Grant Slough Placement 2 Input for the TSP

Item	Quantity	Unit
Topographic Diversity – Forest Habitat	3.6	AC
Approximate Tree Clearing	0	AC
Quantity Capacity	11,886	CY
Placement Slope to Top Elevation	6	H:1V
Average Dredged Material Top Elevation	576.2	FT

j. Grant Slough Placement 4 and 5 Topographic Diversity (Grant Slough Placement 4 and 5)

Potential Measure. These sites, located north of NW Grant Slough Lake between Grant Slough and Steamboat Slough are placement on low value vegetation, mainly reed canary grass and is designed to create floodplain forest topographic diversity in an area that has lost forest habitat over the years due to high water events, erosion, and competition from invasive species. The material for placement could come from any of the aquatic diversity or access dredging sites, but will most likely come from dredging NW Grant Slough Lake and access dredging to Grant Slough or from Lower Lake due to its proximity. To minimize access dredging, tree clearing and temporary access of filling a side channel will be required, but will be restored and replanted. Access will be from Steamboat Slough. The site currently has no forest diversity, but it is adjacent to higher diversity areas. This site would be constructed to optimum tree survival elevations. This area would be planted with various forested wetland trees, forested wetland shrubs, and non-woody wetland plants. Refer to Table M-42 for more details.

ICA. This measure was retained for further evaluation.

Table M-42: Grant Slough Placement 4 & 5 Input for the ICA

Item	Quantity	Unit
Topographic Diversity – Forest Habitat	16.8	AC
Approximate Tree Clearing	0.3	AC
Quantity Capacity (Original)	124,752	CY
Quantity Capacity (Revised)	60,358	CY
Placement Slope to Top Elevation	3	H:1V
Average Dredged Material Top Elevation	576.2	FT

TSP. The TSP is the same as the potential measure described above. This measure passed the ICA, and was later revised in the TSP to address the following:

- Error found in quantity capacity. Revised to correct error. Quantity was inadvertently listed at 124,752 CY, resulting in higher estimated cost for benefits. Quantity should have been listed as 60,358 CY which would have resulted in lower cost for the benefits.
- 30-foot offset between dredge cut and start of placement added
- Placement slopes to top elevation decreased from 3H:1V to 6H:1V
- Placement capacity corrected from 124,752 CY to 60,358 CY then decreased from 60,358 CY to 47,503 CY

Refer to Table M-43 for more details.

Table M-43: Grant Slough Placement 4 & 5 Input for the TSP

Item	Quantity	Unit
Topographic Diversity – Forest Habitat	13.8	AC
Approximate Tree Clearing	1.3	AC
Quantity Capacity	47,503	CY
Placement Slope to Top Elevation	6	H:1V
Average Dredged Material Top Elevation	576.2	FT

k. Lower Lake Scrub-Shrub/Pollinator Habitat

Potential Measure. These sites, located in Lower Lake are open water placement and placement on low value vegetation, mainly reed canary grass and is designed to create SSP habitat in an area that has lost forest and SSP habitat over the years due to high water events, erosion, and competition from invasive species. The material for placement could come from any of the aquatic diversity or access dredging sites, but will most likely come from dredging Lower Lake due to its proximity. The site currently has no SSP habitat, but it is adjacent to higher diversity areas. This site would be constructed to optimum SSP survival elevations. This area would be planted with various forested wetland trees, forested wetland shrubs, and non-woody wetland plants. Refer to Table M-44 for more details.

ICA. This measure was retained for further evaluation.

Table M-44: Lower Lake SSP Input for the ICA

Item	Quantity	Unit
Scrub-Shrub/Pollinator Habitat	5.3	AC
Approximate Tree Clearing	0	AC
Quantity Capacity	3,352	CY
Placement Slope to Top Elevation	3	H:1V
Average Dredged Material Top Elevation	573.1	FT

TSP. The TSP is the same as the potential measure described above. This measure passed the ICA, and was later revised in the TSP to address the following:

- 30-foot offset between dredge cut and start of placement added
- Placement capacity decreased from 3,352 CY to 2,988 CY
- Placement slopes to top elevation decreased from 3H:1V to 6H:1V

Refer to Table M-45 for more details.

Table M-45: Lower Lake SSP Input for the TSP

Item	Quantity	Unit
Scrub-Shrub/Pollinator Habitat	5.6	AC
Approximate Tree Clearing	0	AC
Quantity Capacity	2,988	CY
Placement Slope to Top Elevation	6	H:1V
Average Dredged Material Top Elevation	573.1	FT

l. Grant Slough Placement 1 Scrub-Shrub/Pollinator Habitat

Potential Measure. This site, located at the downstream end of Grant Slough is placement on low value vegetation, mainly reed canary grass and was designed to create SSP habitat in an area that has lost forest and SSP habitat over the years due to high water events, erosion, and competition from invasive species. When running the ICA, the preferred habitat type was still being considered, but was ran as forest habitat. The material for placement could come from any of the aquatic diversity or access dredging sites, but will most likely come from access dredging to Grant Slough due to its proximity. The site currently has no forest diversity or SSP habitat, but it is adjacent to higher diversity areas. This site would be constructed to optimum tree or SSP survival elevations. This area would be planted with various forested wetland trees, forested wetland shrubs, and non-woody wetland plants. Refer to Table M-46 for more details.

ICA. This measure was retained for further evaluation.

Table M-46: Grant Slough Placement 1 Input for the ICA

Item	Quantity	Unit
Topographic Diversity - SSP	7.4	AC
Approximate Tree Clearing	0	AC
Quantity Capacity	30,732	CY
Placement Slope to Top Elevation	3	H:1V
Average Dredged Material Top Elevation	576.2	FT

TSP. The TSP is the same as the potential measure described above but refined to be SSP habitat only. This measure passed the ICA, and was later revised in the TSP to address the following:

- Change from forest habitat site to SSP site
    - Resultant decrease in average dredged material top elevation
    - Resultant decrease in quantity capacity

- 30-foot offset between dredge cut and start of placement added
- Placement capacity decreased from 30,732 CY to 3,077 CY
- Placement slopes to top elevation decreased from 3H:1V to 6H:1V

Refer to Table M-47 for more details.

Table M-47: Grant Slough Placement 1 SSP Input for the TSP

Item	Quantity	Unit
Topographic Diversity - SSP	4.3	AC
Approximate Tree Clearing	0	AC
Quantity Capacity	3,077	CY
Placement Slope to Top Elevation	6	H:1V
Average Dredged Material Top Elevation	573.1	FT

C. Small Island Restoration and Protection, Small Island Creation, and Flow Diversity. Placing dredged material on banklines of existing small islands to restore them, placing dredged material to create small islands, placing stone at existing or created small islands to protect them and placing stone in open water were proposed as potential measures to restore, protect and create small islands as well as increase flow diversity. Island restoration and creation through dredged material placement would result in construction of areas with increased topographic diversity, which will be planted to floodplain forest species. Several potential areas in the Project area were evaluated for excavation.

1. General Design Criteria

- Select sites with existing islands or historical islands
- Restore or create islands to historical footprints
- Increase topographic diversity
- Balance cut and fill

2. Small Island Restoration and Protection Design Criteria. Small island restoration sites were selected to build off existing islands and restore lost island footprint that has been lost from erosion. Stone was incorporated to protect the restored island from erosion. Other design considerations are:

- Design to heights for planting survivability
- Channel side slopes 6H:1V
- Backside slopes not flatter than 6H:1V and not steeper than 3H:1V
- Offset of 30 feet from dredge cut to placement site
- Do not impact the floodplain
- Consider flatter slopes for erosion and rodent control
- Provide sufficient capacity for dredge cuts
- Ensure sites can be constructed using typical construction equipment
- Design adequate protection from erosion

3. Small Island Creation Design Criteria. Small island creation sites were selected to build islands where islands were historically present. Small island creation was designed to recreate the historical footprint of the island. Stone was incorporated to protect the restored island from erosion. Other design considerations are as follows:

- Select sites in shallow water to reduce stone and dredging quantities and costs.
- Design to heights for planting survivability
- Channel side slopes 6H:1V.
- Backside slopes not flatter than 6H:1V and not steeper than 3H:1V
- Offset of 30 feet from dredge cut to placement site
- Do not impact the floodplain
- Consider flatter slopes for erosion and rodent control
- Provide sufficient capacity for dredge cuts
- Ensure sites can be constructed using typical construction equipment
- Design adequate protection from erosion

4. Flow Diversity Design Criteria. Flow diversity sites were selected to create flow diversity structures where islands were historically present. Stone was used for ease of construction and erosion resistance. Other design considerations are as follows:

- Select sites in shallow water to reduce stone quantities and costs.
- Side slopes 2H:1V
- Do not impact the floodplain.
- Do not impact adjacent existing and new measures (don't cause erosion elsewhere)
- Ensure sites can be constructed using typical construction equipment.

5. Planting Plans. Refer to Section V.B.7.a, *Topographic Diversity Planting – Forestry* for island planting plan.

6. Specific Measures

a. West Southeast Island (West SE Island)

Potential Measure. This site, the west of two unnamed islands southeast of Steamboat Island proper, is a combination of open water placement bankline placement. It is designed to restore island footprint and create floodplain forest topographic diversity in an area that has lost forest habitat over the years due to high water events, erosion, and competition from invasive species. The site will also increase flow diversity. The material for placement could come from any of the aquatic diversity or access dredging sites, but will most likely come from access dredging for stone placement, dredging in Grant Slough (access or aquatic diversity), Lower Lake, or the main channel of the Mississippi due to its proximity. By protecting this placement site with stone the island will be protected from further erosion. Access dredging may be required to place the stone protection if stone needs to be placed before placing dredged material. The dredge cut was designed to a 60-foot bottom width. Side slopes of the dredge cut were designed at 3H:1V where channel width allowed. Excavation would be to 6 feet below flat pool, or elevation 565.2 ft. The site currently has no forest diversity, but it is adjacent to higher diversity areas. This site would be constructed to optimum tree survival elevations. This area would be planted with various forested wetland trees, forested wetland shrubs, and non-woody wetland plants. Refer to Table M-48 for more details.

ICA. This measure was retained for further evaluation.

Table M-48: West SE Island Input for the ICA

Item	Quantity	Unit
Topographic Diversity – Forest Habitat	3.5	AC
Approximate Tree Clearing	0	AC
Quantity Capacity	59,079	CY
Placement Slope to Top Elevation	3	H:1V
Average Dredged Material Top Elevation	576.2	FT
Stone Protection Tonnage	6,014	TN
Stone Protection Length	373	FT
Stone Protection Slope (R/S)	3	H:1V
Stone Protection Slope (L/S)	1.5	H:1V
Stone Protection Top Width	4	ft
Average Stone Top Elevation	575.25	FT
Quantity Access Dredging	679	CY
Length Access Dredging	350	FT
Acres Dredged	0.49	AC
Bottom Width	60	FT
Average Bottom Elevation	565.2	FT

TSP. The TSP is the same as the potential measure described above. This measure passed the ICA, and was later revised in the TSP to address the following:

- Access dredging length increased from 350 ft to 372 ft
- Access dredging area increased from 0.49 ac to 0.57 ac
- Assumption added that Contractor will dredge 20% more (overdredging) than required to ensure bottom elevation specified is met.
- Access dredging volume increased from 679 CY to 713 CY
- Stone protection length increased from 373 ft to 418 ft
- Stone protection tonnage increased from 6,014 TN to 6,115 TN
- 30-foot offset between dredge cut and start of placement added
- Placement slopes to top elevation decreased from 3H:1V to 6H:1V
- Placement capacity increased from 59,079 CY to 76,020 CY

Refer to Table M-49 for more details.

Table M-49: West SE Island Input for the TSP

Item	Quantity	Unit
Topographic Diversity – Forest Habitat	5.4	AC
Approximate Tree Clearing	0	AC
Quantity Capacity	76,020	CY
Placement Slope to Top Elevation	6	H:1V
Average Dredged Material Top Elevation	576.2	FT
Stone Protection Tonnage	6,115	TN
Stone Protection Length	418	FT
Stone Protection Slope (R/S)	3	H:1V
Stone Protection Slope (L/S)	1.5	H:1V
Stone Protection Top Width	4	ft
Average Stone Top Elevation	575.25	FT
Target Quantity Access Dredging	713	CY
Quantity with 20% Overdredging	855	CY
Length Access Dredging	372	FT
Acres Dredged	0.57	AC
Bottom Width	60	FT
Average Bottom Elevation	565.2	FT

b. East Southeast Island (East SE Island)

Potential Measure. This site, the east of two unnamed islands southeast of Steamboat Island proper, is a combination of open water placement bankline placement. It is designed to restore island footprint and create floodplain forest topographic diversity in an area that has lost forest habitat over the years due to high water events, erosion, and competition from invasive species. The site will also increase flow diversity. The material for placement could come from any of the aquatic diversity or access dredging sites, but will most likely come from access dredging for stone placement, dredging in Grant Slough (access or aquatic diversity), Lower Lake, or the main channel of the Mississippi due to its proximity. By protecting this placement site with stone the island will be protected from further erosion. Access dredging may be required to place the stone protection if stone needs to be placed before placing dredged material. The site currently has no forest diversity, but it is adjacent to higher diversity areas. This site would be constructed to optimum tree survival elevations. This area would be planted with various forested wetland trees, forested wetland shrubs, and non-woody wetland plants. Refer to Table M-50 for more details.

ICA. This measure was retained for further evaluation.

Table M-50: East SE Island Input for the ICA

Item	Quantity	Unit
Topographic Diversity – Forest Habitat	3.5	AC
Approximate Tree Clearing	0	AC
Quantity Capacity	59,079	CY
Placement Slope to Top Elevation	3	H:1V
Average Dredged Material Top Elevation	576.2	FT
Stone Protection Tonnage	6,014	TN
Stone Protection Length	373	FT
Stone Protection Slope (R/S)	3	H:1V
Stone Protection Slope (L/S)	1.5	H:1V
Stone Protection Top Width	4	ft
Average Stone Top Elevation	575.25	FT
Quantity Access Dredging	4,611	CY
Length Access Dredging	836	FT
Acres Dredged	1.1	AC
Bottom Width	60	FT
Average Bottom Elevation	565.2	FT

TSP. This measure passed the ICA, however following ICA concerns were expressed regarding the close proximity to the Cordova mussel EHA. Because of this, it was removed from consideration and not retained.

c. Flow Diversity Structure

Potential Measure. This site, located in Steamboat Slough adjacent to lower Steamboat Island between the Cut-Though Channel and tail of Steamboat Island is open water stone placement. It is designed to create flow diversity by placing stone where a historical island used to be present. Refer to Table M-51 for more details.

ICA. This measure was retained for further evaluation.

Table M-51: Flow Diversity Structure Input for the ICA

Item	Quantity	Unit
Stone Tonnage	2,484	TN
Stone Length	100	FT
Stone Protection Slope (R/S)	3	H:1V
Stone Protection Slope (L/S)	1.5	H:1V
Stone Protection Top Width	4	ft
Average Stone Top Elevation	574.0	FT

TSP. This measure passed the ICA, however it was decided that not enough habitat benefit was created for the cost. Because of this, it was removed from consideration and not retained.

D. Forest Habitat (TSI). TSI includes a variety of measures that improve forest habitat health, diversity, and resilience for tracts of timber. Prescriptions are based on current environmental and forest conditions. Traditional methods include thinning treatments, tree plantings, and invasive species management.

1. General Design Criteria

- Improve forest habitat health, diversity, and resilience for timber tracts
- Target areas at higher risk of forest decline
- Areas identified to have low or no risk to having no feature development of implementing timber stand improvements not included

2. TSI Design Criteria. TSI for the Project will include various thinning treatments and planting densities (see Attachment F, *Forest Dat*a) express the risk associated without the TSI. Other design considerations are as follows:

- Project area broken down into 13 forest management areas derived from four Units (U), subdivided into Sites (S). Figure M-5 shows the forest management areas.
- Silvicultural prescriptions written to the Site or Stand Level
- Target health promotion for already healthy individuals and target trimming/cutting to less-healthy individuals (help the “winners” by removing the “losers”)
- All tree cutting and thinning treatments are intended to occur outside the bat tree roosting season
- Containerized stock for planting to be a minimum of 4 feet tall from root collar to terminal leader except for specific species that may have a minimum height of 14 inches.

3. Planting Plans, Refer to Attachment F, *Forest Data*, for TSI planting plans by site.

4. Specific Measures. Refer to Attachment F, *Forest Data*, for more detailed descriptions of measures and current forest conditions for the sites.

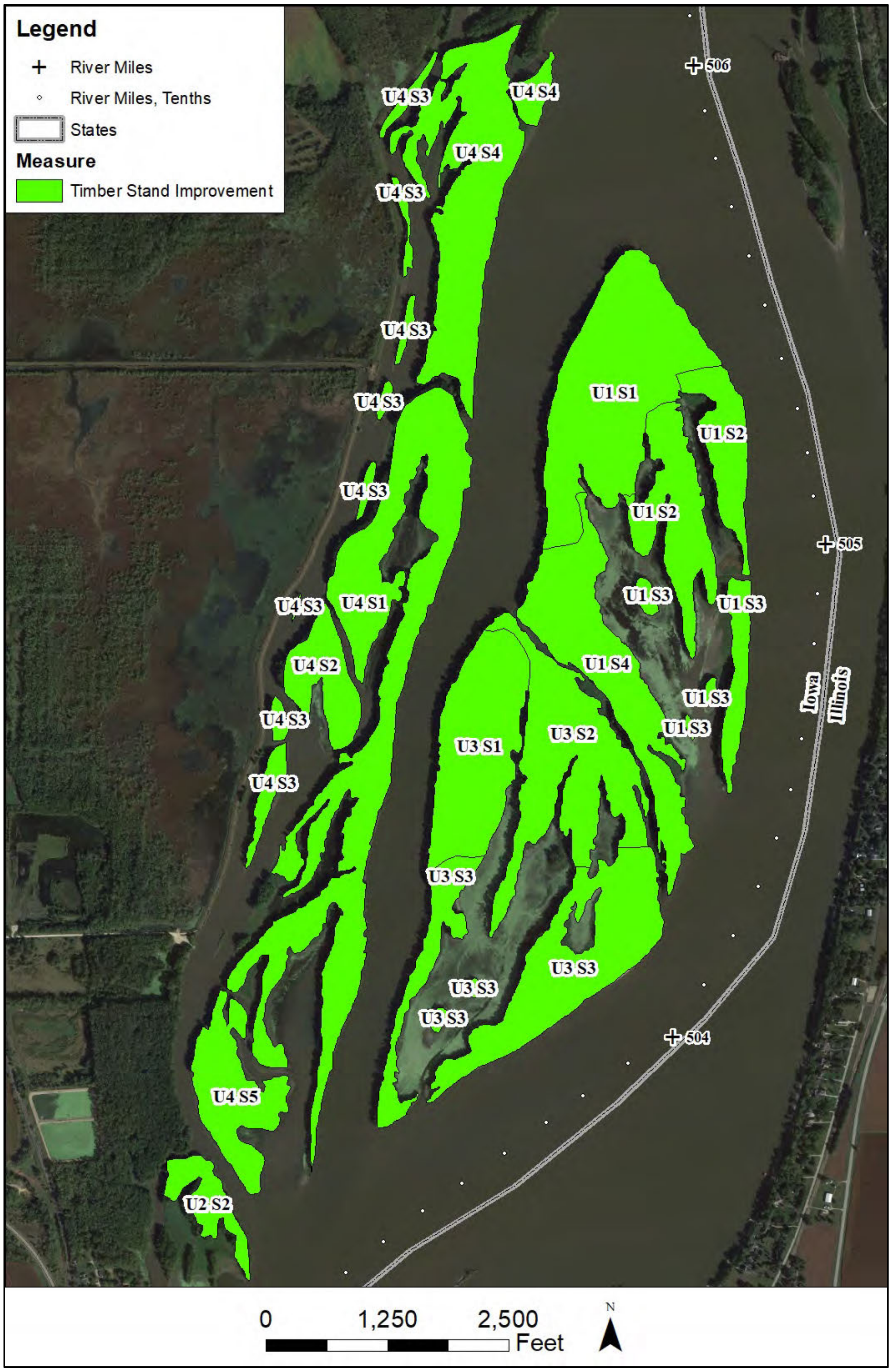


Figure M-5: Forest Habitat Measures – Timber Stand Improvement Units

B. Fish and Mussel Habitat Incorporation. Creating habitat measures for fish such as rock piles or deep holes while constructing other measures such as stone protection or aquatic diversity channel was proposed as a potential measure to enhance fish habitat. More details on fish habitat measures, as well as recommendations from the USFWS and IA DNR are in Attachment E, *Fish Habitat*. Placing preferred mussel substrate such as river stone when constructing other measures like stone protection or dredged material placement sites was proposed as a potential measure to enhance and maintain existing mussel habitat. Photographs M-8 through M-12 show typical bank preparation and stone placement. Mussel substrate may be incorporated to stone protection on the slopes and toe of stone placement in the water.

Photograph M-8: Bankline Shaping Prior to Receiving Rock Protection (Gardner Division HREP)

Photograph M-9: Rock Barge (Gardner Division HREP)

Photograph M-10: Rock Placement Following Shaping (Gardner Division HREP)

Photograph M-11: Transporting Rock from Barge to Bankline (Gardner Division HREP)

Photograph M-12: Riprap on Bedding Stone (Gardner Division HREP)

1. General Design Criteria

- Select sites that are suitable for mussel habitation.
- Select sites were stone protection is planned.

2. Incorporating Mussel Substrate Design Criteria. Incorporating mussel substrate sites were selected based on the need for stone protection at the location, and suitability of the location to otherwise host mussels. Other design considerations are as follows:

- Use a substrate that mussels tend to utilize
- Use a substrate that will not actively erode or be lost.

3. Specific Measures

a. USI Head

Potential Measure. This site, located at the head of Steamboat Island Proper is outlined in Section B, *Aquatic Diversity and Topographic Diversity*. This site was selected because it includes stone protection which mussel substrate may be incorporated into and is predicted to be a suitable location for mussels based on the HREP Mussel Model (https://mpdougherty.github.io/HREP-Mussel-Manual/index.html). Refer to Attachment C, *HREP Mussel Model,* for more detailed technical analyses specific to the Project.

Table M-52 shows the feasibility design stone protection for USI Head which mussel substrate may be incorporated into.

ICA. This measure was not formally evaluated during ICA but was assumed to be incorporated. As such, this measure was not designed at the feasibility level, but will be designed during the plans and specs phase. It was assumed that changing material types for the stone protection would not affect the outcome of the ICA. This measure retained for further evaluation.

Table M-52: Incorporate Mussel Habitat at USI Head Input for the ICA

Item	Quantity	Unit
Stone Protection Tonnage	106,800	TN
Stone Protection Length	3,863	FT
Stone Protection Slope (R/S)	3	H:1V
Stone Protection Slope (L/S)	1.5	H:1V
Stone Protection Top Width	4	ft
Average Stone Top Elevation	575.25	FT

TSP. The TSP is the same as the potential measure described above. This measure passed the ICA, and was later revised in the TSP to address the following:

- Stone protection tonnage decreased from 106,800 TN to 102,941 TN

Table M-53 shows the TSP design stone protection for USI Head into which mussel substrate may be incorporated.

Table M-53: Incorporate Mussel Habitat at USI Head Input for the TSP

Item	Quantity	Unit
Stone Protection Tonnage	102,941	TN
Stone Protection Length	3,863	FT
Stone Protection Slope (R/S)	3	H:1V
Stone Protection Slope (L/S)	1.5	H:1V
Stone Protection Top Width	4	ft
Average Stone Top Elevation	575.25	FT

b. NE Bank

Potential Measure. This site, located at the northeast bank of Steamboat Island Proper is outlined in Section B, *Aquatic Diversity and Topographic Diversity*. This site was selected because it includes stone protection which mussel substrate may be incorporated into and is predicted to be a suitable location for mussels based on the HREP Mussel Model (Attachment C, *HREP Mussel Model*).

Table M-54 shows the feasibility design stone protection for NE Bank which mussel substrate may be incorporated into.

ICA. This measure was not formally evaluated during ICA but was assumed to be incorporated. As such, this measure was not designed at the feasibility level, but will be designed during the plans and specs phase. It was assumed that changing material types for the stone protection would not affect the outcome of the ICA. This measure retained for further evaluation.

Table M-54: Incorporate Mussel Habitat at NE Bank Input for the ICA

Item	Quantity	Unit
Stone Protection Tonnage	8,853	TN
Stone Protection Length	1,615	FT
Stone Protection Slope	3	H:1V
Average Stone Top Elevation	575.25	FT

TSP. The TSP is the same as the potential measure described above. This measure passed the ICA, and was later revised in the TSP to address the following:

- Stone protection length shortened from 1,615 feet to 1,589 feet
- Stone protection tonnage increased from 8,853 TN to 22,403 TN

Table M-55 shows the TSP design stone protection for NE Bank into which mussel substrate may be incorporated.

Table M-55: Incorporate Mussel Habitat at NE Bank Input for the TSP

Item	Quantity	Unit
Stone Protection Tonnage	22,403	TN
Stone Protection Length	1,589	FT
Stone Protection Slope	3	H:1V
Average Stone Top Elevation	575.25	FT

c. West Southeast Island (West SE Island)

Potential Measure. This site, the west of two unnamed islands southeast of Steamboat Island proper, is outlined in Section B, *Aquatic Diversity and Topographic Diversity*. This site was selected because it includes stone protection into which mussel substrate may be incorporated and is predicted to be a suitable location for mussels based on the HREP Mussel Model (Attachment C, *HREP Mussel Model*).

Table M-56 shows the feasibility design stone protection for West SE Island into which mussel substrate may be incorporated.

ICA. This measure was not formally evaluated during ICA but was assumed to be incorporated. As such, this measure was not designed at the feasibility level, but will be designed during the plans and specs phase. It was assumed that changing material types for the stone protection would not affect the outcome of the ICA. This measure retained for further evaluation.

Table M-56: Incorporate Mussel Habitat at West SE Island Input for the ICA

Item	Quantity	Unit
Stone Protection Tonnage	6,014	TN
Stone Protection Length	373	FT
Stone Protection Slope (R/S)	3	H:1V
Stone Protection Slope (L/S)	1.5	H:1V
Stone Protection Top Width	4	ft
Average Stone Top Elevation	575.25	FT

TSP. The TSP is the same as the potential measure described above. This measure passed the ICA, and was later revised in the TSP to address the following:

- Stone protection length increased from 373 ft to 418 ft
- Stone protection tonnage increased from 6,014 TN to 6,115 TN

Table M-57 shows the TSP design stone protection for West SE Island into which mussel substrate may be incorporated.

Table M-57: Incorporate Mussel Habitat at West SE Island Input for the TSP

Item	Quantity	Unit
Stone Protection Tonnage	6,115	TN
Stone Protection Length	418	FT
Stone Protection Slope (R/S)	3	H:1V
Stone Protection Slope (L/S)	1.5	H:1V
Stone Protection Top Width	4	ft
Average Stone Top Elevation	575.25	FT

VI. ENVIRONMENTAL COORDINATION

A. Cultural Resources. Refer to the Steamboat Island Feasibility Report for a summary of cultural resources and any restrictions for working in these areas. Project measures were developed to avoid impact to these sites.

B. Endangered Species. Refer to the Main Report, Section II.E, for Threatened and Endangered Species that have potential to occur in Clinton and Scott Counties, IA, and Rock Island County, IL, as well as any restrictions for construction activities. Project measures, described in the Main Report, Section IV, *Potential Project Measures*, were developed to avoid adverse impacts.

C. Hazardous, Toxic, and Radioactive Waste (HTRW). As with all earth working projects in the Rock Island District, the Environmental Protection specification section includes requirements for HTRW testing of any material brought onto or removed from the site to ensure the material is not contaminated. If contaminated material is identified, the Corps would stop work and follow the steps outlined in ER 1165-2-132.

Historic photographs are included in this appendix and in Attachment G, *Photographs*.

A Phase I HTRW ESA and screening samples were performed. No concerns were identified. For more detailed information, refer to Appendix E, *Hazardous Toxic and Radioactive Waste.* If any evidence of recognized environmental conditions is discovered during construction activities, operations should cease until an assessment is performed at which the Phase I ESA will be revisited.

The Contractor will be responsible for ensuring all construction equipment is cleaned and free of soil residues, plant, pests, noxious weeds and seeds.

No soils can be removed from the Project site unless tested. Table M-58 shows the analytical parameters that will be run on the soil.

Table M-58: Soil and Materials Analytical Parameters

Volatiles Testing Requirements	
Item	**Method**
Volatiles	SW-8260B

Semi-Volatiles Testing Requirements	
Item	**Method**
Base/Neutrals Extractable Organics	SW-8270C
Acid Extractable Organics	SW-8270C

PCB Testing Requirements	
Item	**Method**
PCBs	SW-8082

Pesticides Testing Requirements	
Item	**Method**
Pesticides	8081A

Herbicides Testing Requirements	
Item	**Method**
Herbicides	8151

Metals Testing Requirements	
Item	**Method**
Antimony	6010 B
Arsenic	6010 B
Barium	6010 B
Beryllium	6010 B
Cadmium	6010 B
Chromium, total	6010 B
Chromium, hexavalent	6010 B
Cobalt	6010 B
Copper	6010 B
Lead, total	6010 B
Manganese	6010 B
Mercury	7471A
Nickel	6010 B
Selenium	6010 B
Silver	6010 B
Thallium	6010 B
Vanadium	6010 B
Zinc	6010 B
Boron	6010 B
Molybdenum	6010 B
Strontium	6010 B

TCLP Testing Requirements	
Item	**Method**
Arsenic	6010B
Barium	6010B
Benzene	8021
Cadmium	6010B
Chlordane	8081A
Chlorobenzene	8260B
Chloroform	8260B
Chromium	6010B
o-Cresol	8270C
m-Cresol	8270C
p-Cresol	8270C
2,4,D	8151A
1,4-Dichlorobenzene	8260B
1,2-Dichloroethane	8260B
1,1-Dichloroethylene	8260B
2,4 Dinitrotoluene	8270C
Endrin	8081A
Heptachlor	8081A
Hexachlorobenzene	8270C
Nitrobenzene	8270C
Pentachlorophenol	8270C
Pyridine	8270C
Trichloroethylene	8270C
2,4,5-Trichlorophenol	8270C
Methoxychlor	8081A
Methyl ethyl ketone	8260B
Mercury	7471A
Lindane	8081A
Lead	6010B
Hexachlorethane	8270C
Hexachlorobutadine	8270C
Tetrachloroethylene	8260B
Toxaphene	8081A
Silver	6010B
Selenium	6010B
2,4,6-Trichlorophenol	8270C
2,4,5-TP	8151A
Vinyl Chloride	8260B

VII. PROJECT SEQUENCING, QUANTITY ESTIMATE, COST, AND DURATION

A. Project Sequencing. Refer to Appendix I, *Cost Estimate*, Attachment I-C.

B. Quantity Estimate. A detailed quantity estimate has been developed for all work.

C. Project Costs. Project Costs are summarized in the Main Report, Section VIII, *Cost Estimates*, and Appendix I, *Cost Estimate*.

D. Project Duration. Refer to Appendix I, *Cost Estimate,* Section V.

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX M

ENGINEERING DESIGN

DESIGN ATTACHMENTS

STEAMBOAT ISLAND HREP

APPENDIX M
DESIGN ENGINEERING

Attachment A
Survey Data

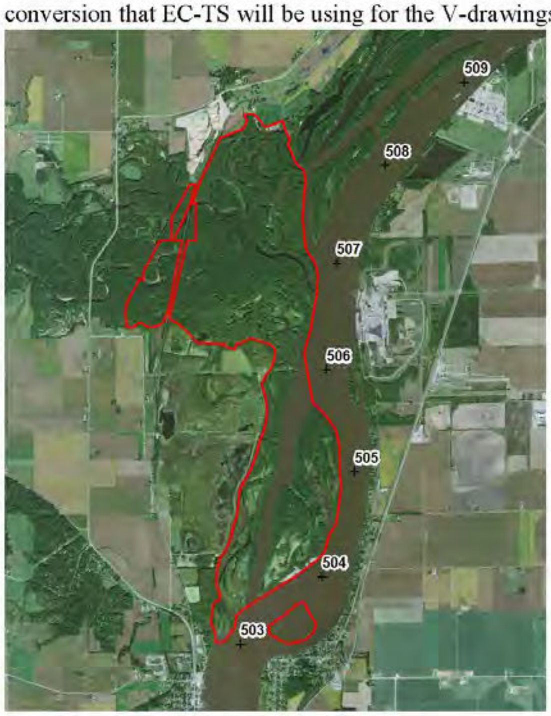
CEMVR-EC-HQ (Sawyer) 2018-05-31

Memorandum for Record

Subject: Steamboat Vertical Datum Conversion Discussion May 24, 2018

1. The following people were in attendance at the meeting:
   a. Lucie Sawyer, EC-HQ
   b. Anton Stork, EC-HH
   c. Mike Scudder, EC-T

2. EC-TS recommends a value of -0.85' for the conversion of MSL1912 to NAVD88 for the entire HREP project boundary, shown in red below (~RM 503 to 508). This is the conversion that EC-TS will be using for the V-drawings.



3. The table below summarizes EC-TS's recommendations for conversions at L&D13, L&D14, the mid-pool gage, the Steamboat Island HREP area and the conversion used at the nearby Beaver Island HREP area.

Location	**RM**	**EC-TS Recommended Conversions* (ft)**
L&D 14	493.3	-0.73
Steamboat Island HREP	~503-508	-0.85
Camanche Gage	511.8	-0.77
Beaver Island HREP	513-517	-0.88
L&D 13	522.4	-0.98

*Conversion from MSL1912 to NAVD88

For the purposes of developing a bathymetric surface for the 2D model reach, which extends from RM 493.3 to 510, a linear conversion of -0.73' from L&D 14 at RM 493.3 to -0.77' at Camanche (RM 511.8) will be applied to all MSL1912 data that needs to be converted to NAVD88 (primarily OD-T hydrosurvey data).

4. Recommendations for future projects. At the time of the PMP, best available MSL1912 to NAVD88 conversions for the benchmarks relevant to the project area and hydraulic modeling reach should be obtained from EC-TS and documented in an MFR and the PMP for reference throughout the feasibility study. EC-TS, EC-H, EC-DN and PM-GIS should be coordinated with at a minimum.

Lucie Sawyer, P.E.

CEMVR-EC-HQ

CF via email:

Johnson

Scudder

Stork

Manasco

Hunemuller

Nerad

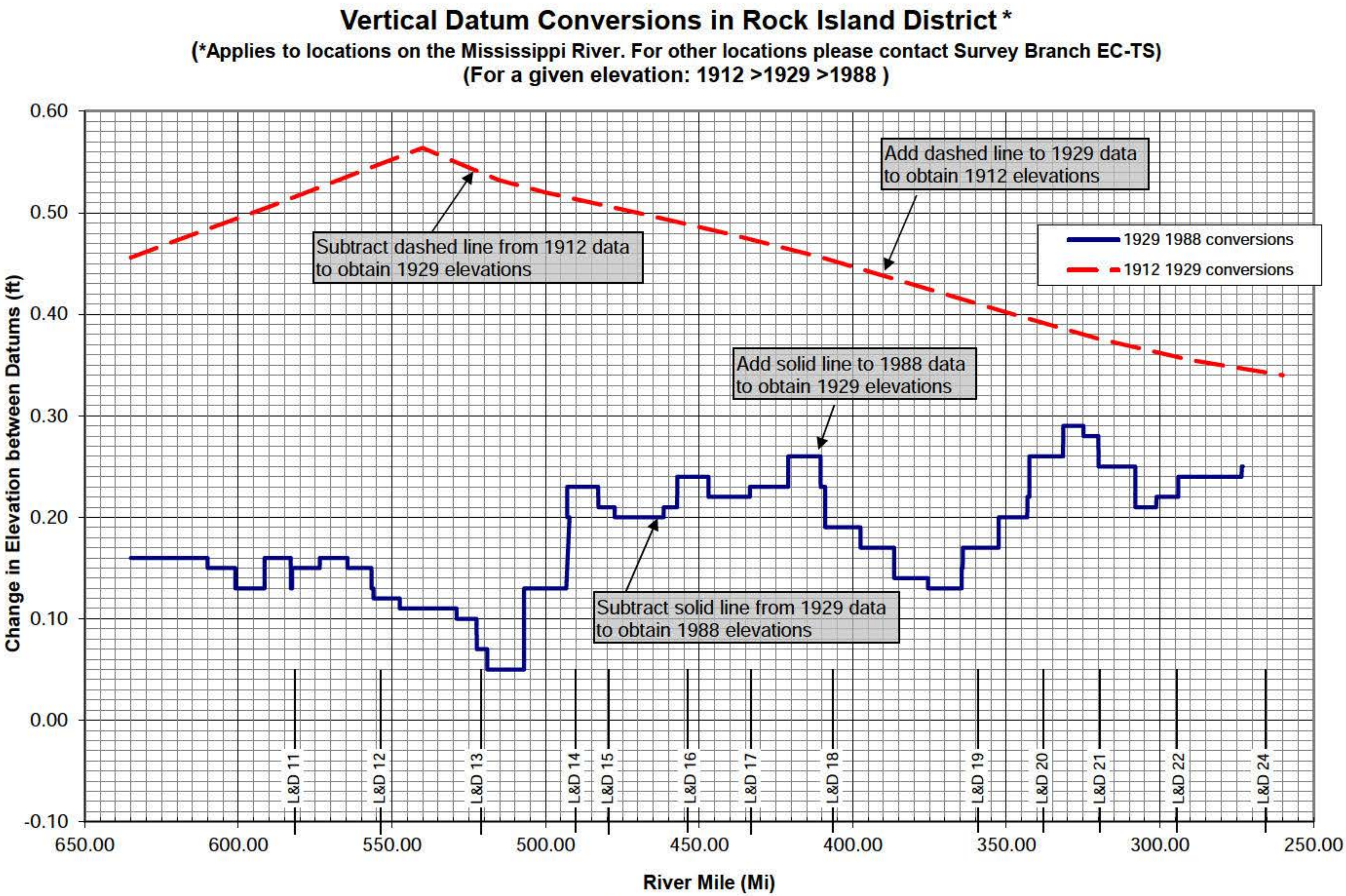
Hawes

Darby

Gerdes

Perrine

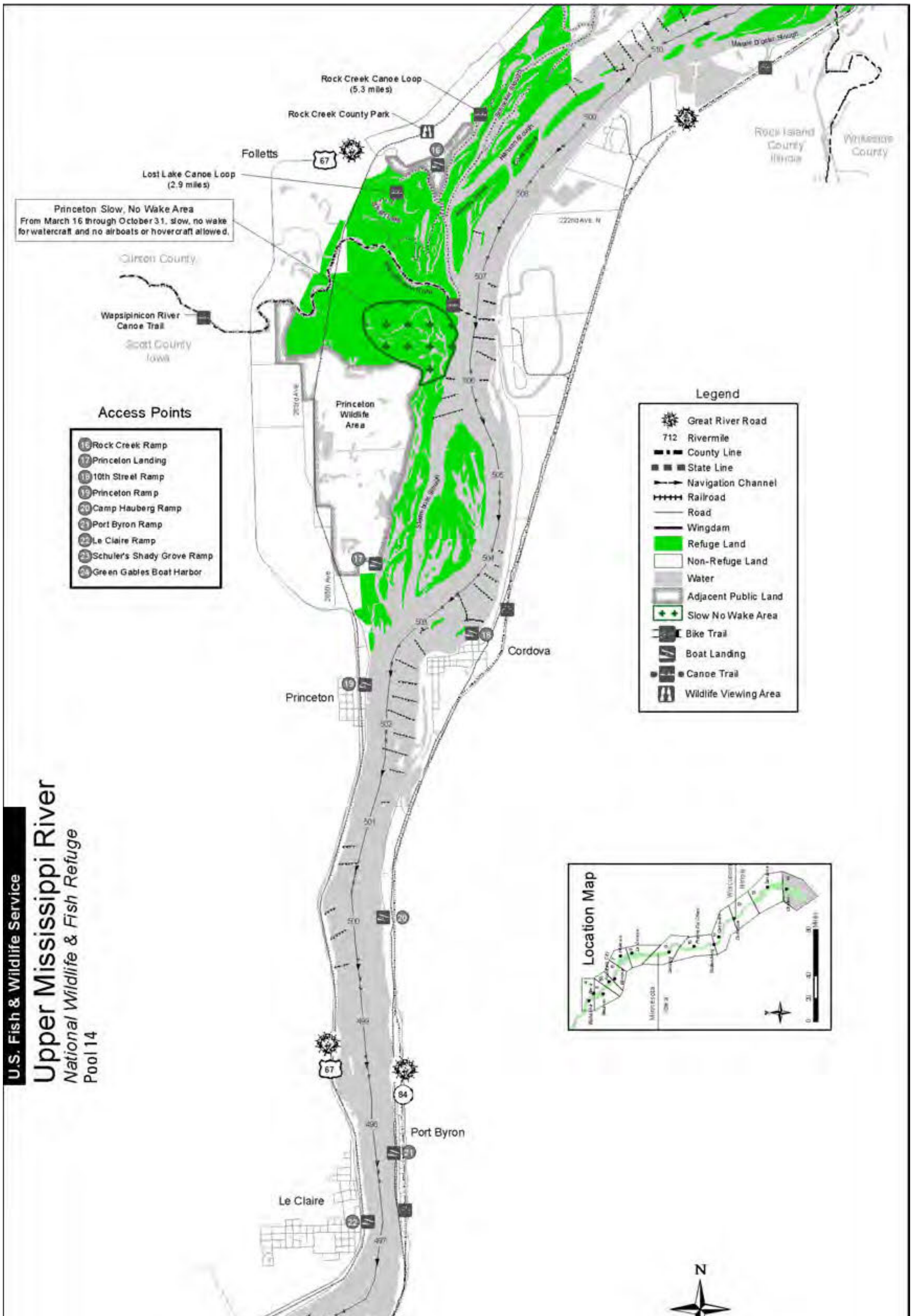
Millhollin


Vertical Datum Conversions in Rock Island District *
(*Applies to locations on the Mississippi River. For other locations please contact Survey Branch EC-TS)
(For a given elevation: 1912 >1929 >1988)
Change in Elevation between Datums (ft)
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
Add dashed line to 1929 data to obtain 1912 elevations
Subtract dashed line from 1912 data to obtain 1929 elevations
1929 1988 conversions
1912 1929 conversions
Add solid line to 1988 data to obtain 1929 elevations
Subtract solid line from 1929 data to obtain 1988 elevations
L&D 11
L&D 12
L&D 13
L&D 14
L&D 15
L&D 16
L&D 17
L&D 18
L&D 19
L&D 20
L&D 21
L&D 22
L&D 24
650.00
600.00
550.00
500.00
450.00
400.00
350.00
300.00
250.00
River Mile (Mi)

STEAMBOAT ISLAND HREP

APPENDIX M
DESIGN ENGINEERING

Attachment B
U.S. Fish & Wildlife Service Refuge Boundaries


U.S. Fish & Wildlife Service
Upper Mississippi River
National Wildlife & Fish Refuge
Pool 14
Rock Creek Canoe Loop
(5.3 miles)
Rock Creek County Park
Folletts
Lost Lake Canoe Loop
(2.9 miles)
Princeton Slow, No Wake Area
From March 16 through October 31, slow, no wake for watercraft and no airboats or hovercraft allowed.
Clinton County
Wapsipinicon River Canoe Trail
Scott County
Iowa
Rock Island County
Illinois
Whiteside County
222nd Ave. N
Princeton Wildlife Area
Access Points
16 Rock Creek Ramp
17 Princeton Landing
18 10th Street Ramp
19 Princeton Ramp
20 Camp Hauberg Ramp
21 Port Byron Ramp
22 Le Claire Ramp
23 Schuler's Shady Grove Ramp
24 Green Gables Boat Harbor
Legend
Great River Road
712 Rivermile
County Line
State Line
Navigation Channel
Railroad
Road
Wingdam
Refuge Land
Non-Refuge Land
Water
Adjacent Public Land
Slow No Wake Area
Bike Trail
Boat Landing
Canoe Trail
Wildlife Viewing Area
Cordova
Princeton
Location Map
Port Byron
Le Claire
Rapids City
Lock and Dam 14
N
0 0.5 1 2 Miles
Boundaries posted in the field supersede all boundaries shown on maps.

STEAMBOAT ISLAND HREP

APPENDIX M
ENGINEERING DESIGN

Attachment C
HREP Mussel Model

Michael Dougherty, Geographer, US Army Corps of Engineers, Rock Island District
Davi Michl, Biologist, US Army Corps of Engineers, Rock Island District
Dan Kelner, Fisheries Biologist, US Army Corps of Engineers, St. Paul District

I. INTRODUCTION

This document describes a new method for evaluating mussel habitat in UMRR HREP feasibility studies. This approach was designed to take advantage of UMRR Partnership organizations' previous investments in mussel surveys and hydraulic modeling. This methodology is currently under development and being evaluated through application to several HREPs currently in the planning phase. This approach inductively derives a spatially explicit model of mussel habitat suitability directly from study area data (i.e., mussel occurrences, site-scale modeled hydraulic conditions). This method results in a mussel habitat suitability model for the entire HREP study area, allowing the feasibility team to see how habitat varies across different existing and proposed conditions. Mapping mussel habitat suitability across the Project area will enable biologists and engineers make more risk-informed planning and design decisions.

Extensive research on mussel habitat utilization has been conducted on the UMR in Pool 10 (Steuer, Newton, and Zigler 2008), Pool 8 (Zigler et al. 2008, Newton et al. (2011)) and Pool 18 (Zigler et al. 2012). Among other factors, these studies demonstrate that hydraulic conditions are strongly influencing mussel habitat. USACE has extensive experience building hydraulic models and they are often built for HREPs to support the design and evaluation of project measures.
This approach seeks to apply the findings of these previous studies to the construction of species distribution models (Elith, Leathwick, and Hastie 2008, Elith and Leathwick (2009)) built specifically for the HREP study area. Modeled hydraulic conditions are used to inductively map mussel habitat suitability across the Project area. This approach seeks to leverage USACE investments in hydraulic modeling and mussel monitoring to develop a technique to use best available science (Murphy and Weiland (2016)) to estimate biotic outcomes (mussel habitat) from abiotic project alterations (flow alterations).

The purpose of this analysis is to help evaluate if proposed HREP features are affecting mussel habitat.

II. METHODS

This section provides a brief overview of the methods used in this analysis. Detailed instructions for reproducing this analysis are included in the HREP Mussel Modeling document online (https://mpdougherty.github.io/HREP-Mussel-Manual/index.html).

III. WORKFLOW

The following workflow was used prepare the input data, train and test the model, and evaluate alternatives. Elements of these workflow steps are further described in the following sections.

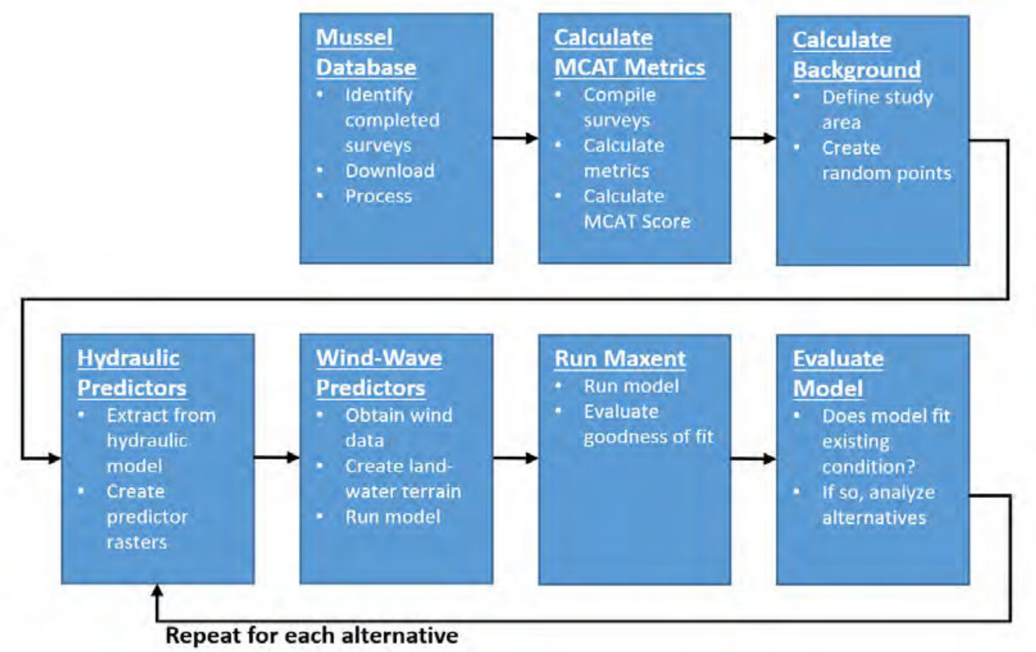


Figure M-C-1: HREP Mussel Modeling Workflow

- Mussel Database - Identify surveys completed for the study area, download, and assemble datasets.
- Calculate MCAT Metrics - Perform quality assurance (QA) of mussel survey data and calculate MCAT metrics.
- Calculate Background - Calculate background environmental condition points that will be used by Maxent to create the model.
- Hydraulic Predictors - Convert the Adaptive Hydraulic (AdH) model outputs to rasters and assign these variable values to mussel occurrence points.
- Wind-Wave Predictors - Calculate the wind and wave variables for the study area (optional) and assign these variable values to mussel occurrence points.
- Run Maxent - Build the Maxent model.
- Evaluate Model - Evaluate the goodness of fit of the model for the existing condition scenario and determine if the model fits the existing condition scenario.
- Repeat for each Alternative - Use the existing condition model parameters to predict mussel habitat suitability for each project alternative.

IV. USACE MUSSEL DATABASE

The USACE maintains the USACE Freshwater Mussel Database as a repository of freshwater mussel surveys on the UMR. This database contains thousands of surveys and is therefore an invaluable source of mussel occurrence data for building and training inductive mussel models on the UMR.

The USACE mussel database contains surveys of the Cordova, IL, EHA conducted in 2010 and 2014. An additional mussel survey was conducted for this HREP in 2018 to cover areas to the south of Steamboat Island not covered by the Cordova, IL EHA surveys. Over 1,200 individual mussels were collected during these three surveys using quantitative methods, resulting in 206 unique sample site locations.

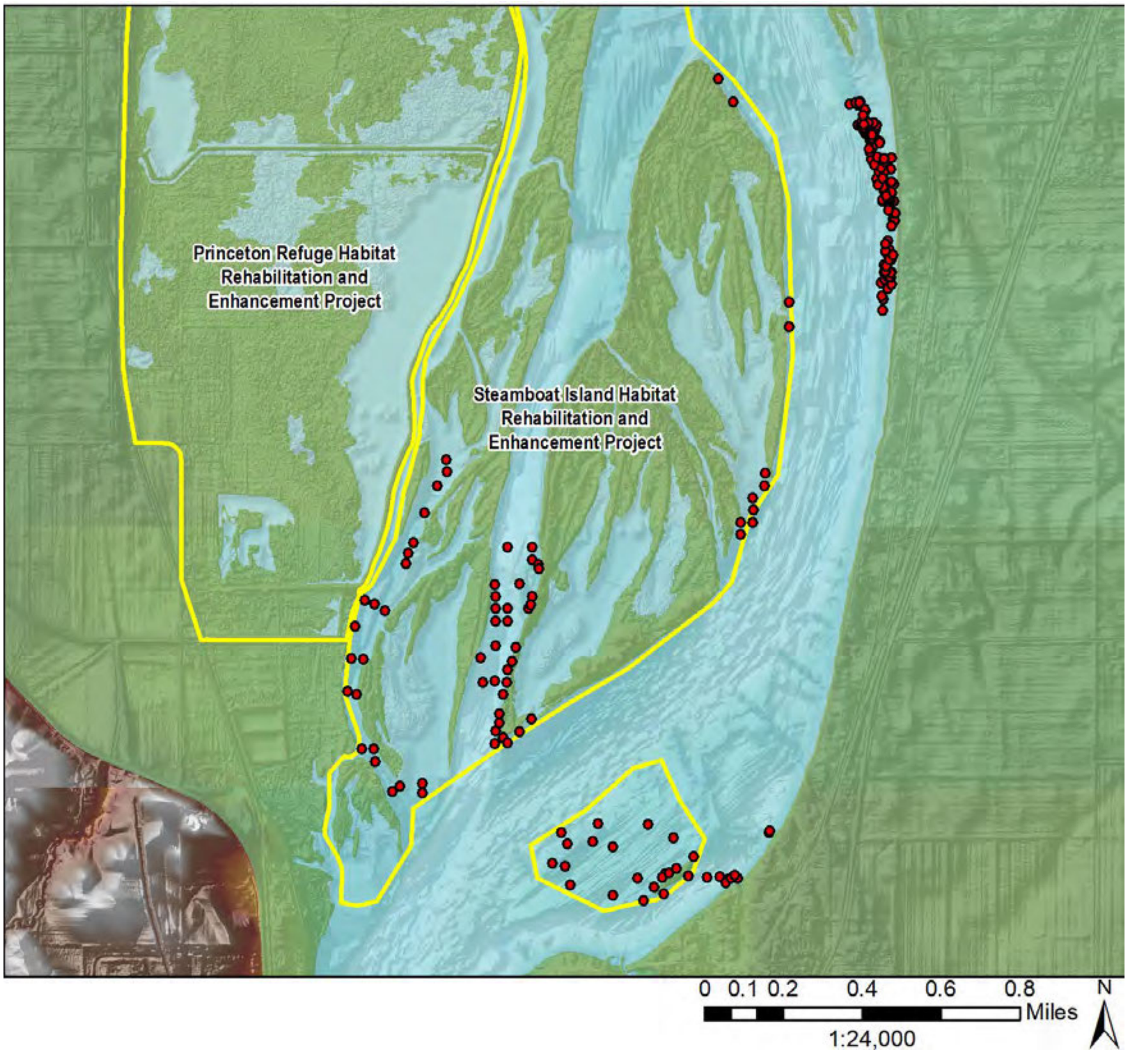


Figure M-C-2: Quantitative Mussel Survey Locations in the Steamboat Island HREP Study Area

V. ADAPTIVE HYDRAULICS (AdH)

Since Steuer, Newton, and Zigler (2008) and Zigler et al. (2008) found that hydraulic conditions strongly shape mussel habitat suitability, detailed hydraulic models of HREP study areas have the potential to predict freshwater mussel habitat suitability at the site scale. The USACE-developed hydraulic modelling software Adaptive Hydraulics (AdH) was used in this study to estimate 2D river hydraulic conditions. AdH has the ability to estimate the following five variables: depth, velocity, sheer stress, reynolds number, and froude number. As a sixth variable, slope can be calculated from depth, representing the river bed slope as calculated from the water surface. These six variables were calculated for both a high flow scenario (Q5 flow exceedance frequency, where only 5% of flows exceed this flow value) and the low flow scenario (Q95 flow exceedance frequency, where 95% of flows exceed this flow value). This results in a total of 12 hydraulic variables (6 high flow and 6 low flow) that are available to serve as predictor variables for mussel habitat suitability modeling. These 12 variables are represented by raster datasets that cover the entire study area.

The Mussel Modeling Toolbox (https://github.com/mpdougherty/Mussel-Modeling-Toolbox) was created to streamline the conversion of AdH outputs at model mesh nodes to raster datasets needed for calculating spatially explicit habitat models.

VI. MUSSEL COMMUNITY ASSESSMENT TOOL (MCAT)

To ensure that high quality freshwater mussel habitat sites are selected as model training data, the Mussel Community Assessment Tool (MCAT) developed by Dunn, Zigler, and Newton (2016) was used to select only those sites that met the criteria found in healthy mussel communities. The mcat R package (https://github.com/mpdougherty/mcat) was created to streamline and standardize the calculation of the MCAT metrics. The following MCAT metrics were selected for use in this study:

- percent listed species - Percent of listed threatened or endangered species (federal or bordering states) is a measure of sensitive species.
- percent tolerant - Percent of tolerant species (Amblema plicata, Quadrula quadrula, and Obliquaria reflexa) is a measure of a highly disturbed mussel assemblage (i.e., dominated by species tolerant of unstable substrates, silt accumulation, low current velocities, and fluctuating flow conditions).
- percent tribe Lampsilini - Percent of assemblage that falls within tribe Lampsilini is a measure of species composition, life history, and behavioral characteristics.
- percent juveniles - Percent of mussels <= 5 years-old is a measure of recruitment into an assemblage over the past five years.
- percent >= 15 yrs - Percent of mussels >= 15 years-old is a measure of age distribution in an assemblage.
- abundance - A measure of abundance calculated as the density (no./m^2).
- species evenness - Species evenness represents the dominance of an assemblage by a few species using Pielou’s evenness index (range 0 to 1).
- tribe evenness - Tribe evenness represents the dominance of a particular taxonomic group using Pielou’s evenness index (range 0 to 1).
- ES_100 - The expected number of species with a sample size of 100 estimated by rarefaction is a measure of a healthy mussel assemblage.

Of the 206 surveyed sites, only those sites that met four or more of the above MCAT criteria were deemed to be healthy mussel communities. This resulted in 72 sites that met four or more of the above criteria. The choice of the number of criteria needing to be met to represent a healthy mussel community was based on biologist best professional judgment and the desire to retain sufficient samples for model training and testing. These 72 sites representing healthy mussel communities were used for habitat modeling.

Values for the 12 hydraulic raster variables calculated in the AdH section above were then assigned to each of the 72 healthy mussel community sites. This step defines the values of the 12 hydraulic raster variables at healthy mussel community sites within the study area.

VII. BACKGROUND

All species distribution modeling approaches need to define the background environmental conditions that organisms can possibly occupy. For this study, aquatic areas where mussels can exist were defined using the UMRR LTRM Aquatic Areas 2010 (https://www.sciencebase.gov) dataset following the procedures in the HREP Mussel Model, Create Mask section (https://mpdougherty.github.io/HREP-Mussel-Manual/prepare-hydraulic-data.html#create-mask). Ten thousand background points were randomly distributed within this aquatic area.

Values for the 12 hydraulic raster variables calculated in the AdH section above were then assigned to each of the 10,000 background points. This step defines the values of the 12 hydraulic variables at locations available to freshwater mussels to occupy within the study area.

VIII. MAXENT

The Maxent (https://biodiversityinformatics.amnh.org/open_source/maxent/) software for modeling species niches and distributions was used in this study to estimate freshwater mussel habitat suitability (Phillips, Anderson, and Schapire 2006). Maxent has been widely used over the past 10 years for modeling species distributions. Maxent estimates the geographic distribution of a species or taxa groups by finding the distribution which has maximum entropy (i.e., is closest to geographically uniform) subject to constraints derived from environmental conditions (i.e., AdH modeled hydraulic variables) at recorded occurrence locations (Phillips et al. 2017). Model performance is determined using background data to estimate performance measures such as the Area Under the Curve (AUC) of the Receiver Operating Characteristic (ROC) (Phillips and Dudík 2008). See Elith and Leathwick (2009) for a more detailed discussion of the species distribution modeling process which this study follows. Maxent version 3.4.1 was used for this analysis (Phillips et al. 2017).

IX. MODEL TRAINING AND TESTING

To determine if a freshwater mussel model of the Steamboat Island HREP Project area is valid we must answer the following question: Do AdH modeled hydraulic variables adequately explain current mussel distribution? To answer this question, we must test if the AdH modeled hydraulic variables adequately describe the existing condition scenario. To do this, the 72 healthy mussel community sites were partitioned into training and testing groups. Twenty-five percent (n = 18) were extracted for testing and 75% (n = 54) were used for training the model. Partitioning the available samples into training and testing allows the validity of the model to be evaluated by using the test set to measure how well a model built using the training set is performing. To strengthen this model validation approach, this process was replicated ten times using bootstrap resampling (i.e., each test set was drawn for each replicate from the total number of samples with replacement). Replication with bootstrap resampling helps to prevent model over fitting by ensuring that model parameters are not selected that take advantage of idiosyncratic characteristics of a particular sample. Model goodness of fit statistics were then compiled across the 10 replicates.

X. RESULTS

This section describes the workflow step "Evaluate Model" in Figure M-C-1. Goodness of fit statistics are shown in Figure M-C-3 for the existing condition scenario model built using the 12 AdH modeled hydraulic variables. The Area Under the Curve (AUC) of the Receiver Operating Characteristic (ROC) graph shows that the mean AUC across the 10 replicates was 0.947. Random occurrence data has on average an AUC of 0.5, while a perfect set of occurrences achieves the best possible AUC of 1.0 (Phillips and Dudík 2008). Models with values above 0.75 are considered potentially useful (Elith et al. 2006). Test AUC varied between 0.890 and 0.940 across the 10 replicates (0.940, 0.890, 0.918, 0.924, 0.878, 0.918, 0.909, 0.924, 0.923, 0.925). This is a strong indication that the 12 AdH modeled hydraulic variables are able to explain the variation in freshwater mussel occurrence in the existing condition scenario in the Steamboat Island HREP Project area. Since these results show that the existing condition is well modeled, the study was able to proceed with the analysis of alternatives.

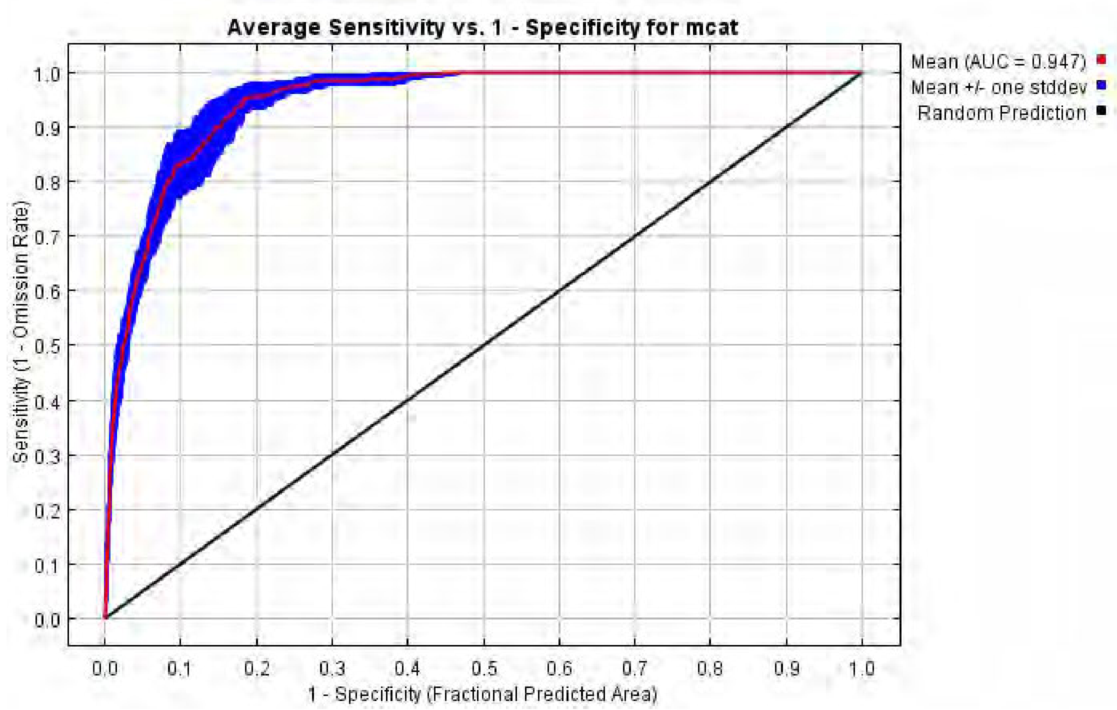


Figure M-C-3: Existing Condition Model Area Under the Curve (AUC) of the Receiver Operating Characteristic (ROC) Graph

Figure M-C-4 displays the projection of the Maxent existing condition model onto the environmental raster variables for the study area. Warm colors represent areas of high mussel habitat suitability while cool colors represent areas of low mussel habitat suitability. Values of habitat suitability range from zero, low suitability, to one, high suitability.

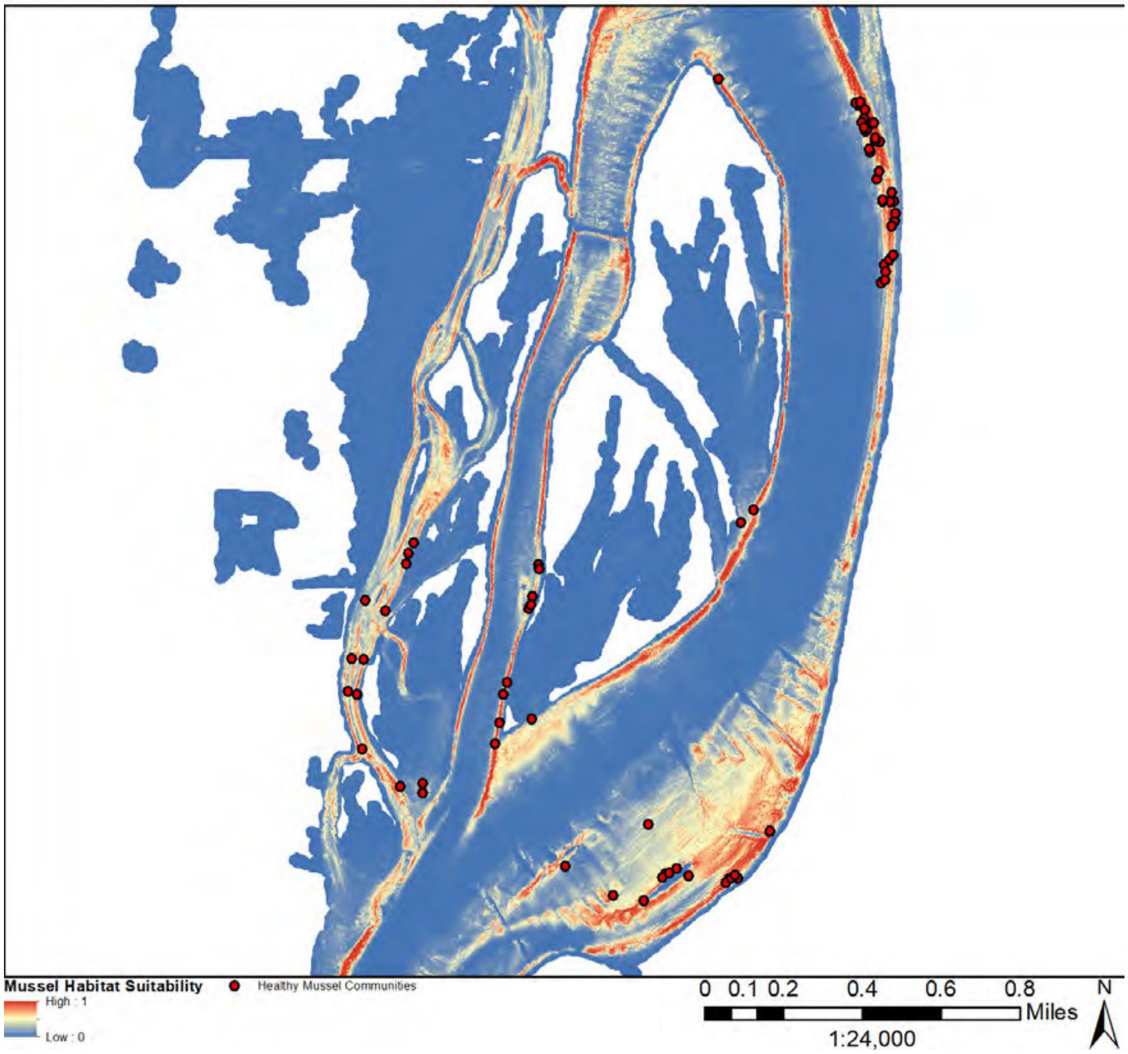


Figure M-C-4: Existing Condition Model with Healthy Mussel Community Sample Locations

XI. VARIABLE IMPORTANCE

Measures of variable importance can be derived from Maxent models, but absolute values of variable contributions must be interpreted with caution when the predictor variables are correlated (hydraulic variables are highly correlated). Permuted variable importance indicates that the three most important variables for these samples in this study area are Q5 Velocity, Q5 Sheer Stress, and Q95 Velocity. Figure M-C-5 show the results of the jackknife test of variable importance. This test runs a model for each variable by itself and without the variable and measures the difference in model performance to provide another measure of variable importance. The y-axis lists the 12 AdH modeled variables while the x-axis displays model performance as measured by regularized training gain. This approach also indicates that Q5 Velocity and Q5 Shear Stress are important variables in this study area (Figure M-C-5, “With only variable”, royal blue bars). However, because the 12 variables are highly correlated, removing any one variable does not greatly reduce model performance (Figure M-C-5, “Without variable”, aqua bars). This indicates that although the variables are highly correlated, they each contain unique information not present in the other variables and thus each marginally improve model predictive power.

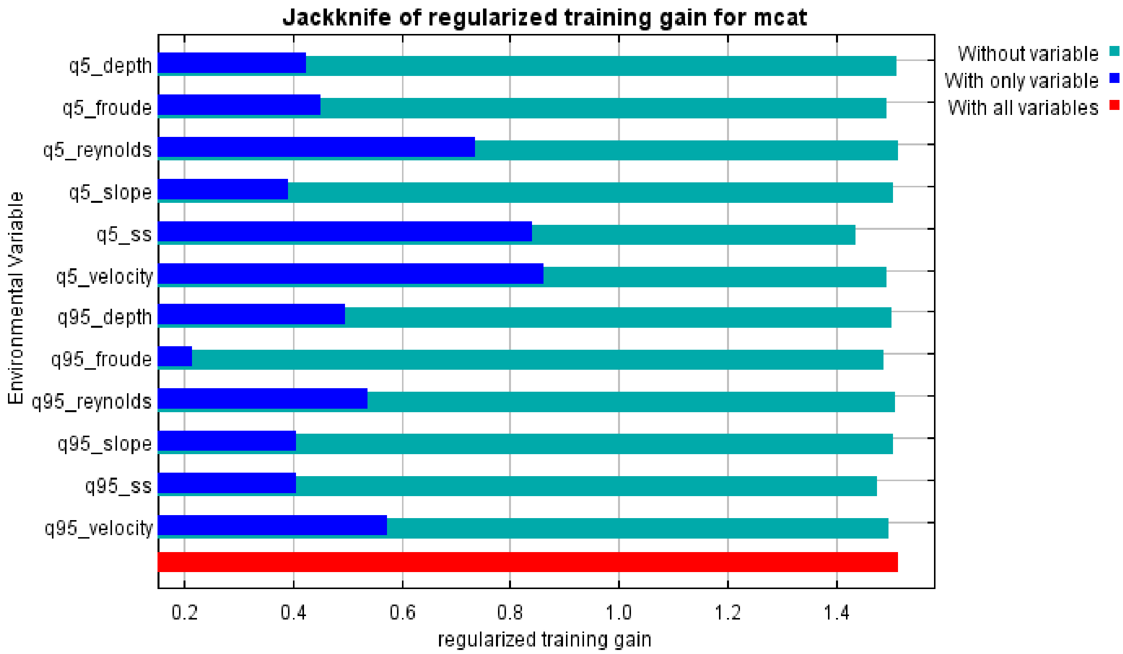


Figure M-C-5: Existing Condition Model Jackknife of Regularized Training Gain Graph

Maxent is also able to produce response curves that display how modeled habitat suitability (y-axis, Figure M-C-6 and 7) changes when a model is built with just one predictor variable (x-axis). Response curves can be useful for identifying the range of values over which a predictor variable is positively or negatively affecting habitat suitability. Figures 6 and 7 display the mean habitat suitability (red line) across the 10 replicates and +/- one standard deviation (royal blue area).

Figure M-C-6 displays the response curve for Q5 Velocity and Figure M-C-7 displays the response curve for Q5 Shear Stress. These graphs can be interpreted as habitat suitability increasing above zero until some maximum value is reached and then habitat suitability declines until some value is reached above which is no longer suitable habitat for freshwater mussels in this sample.

Figure M-C-6: Response Curve for the Variable q5_velocity

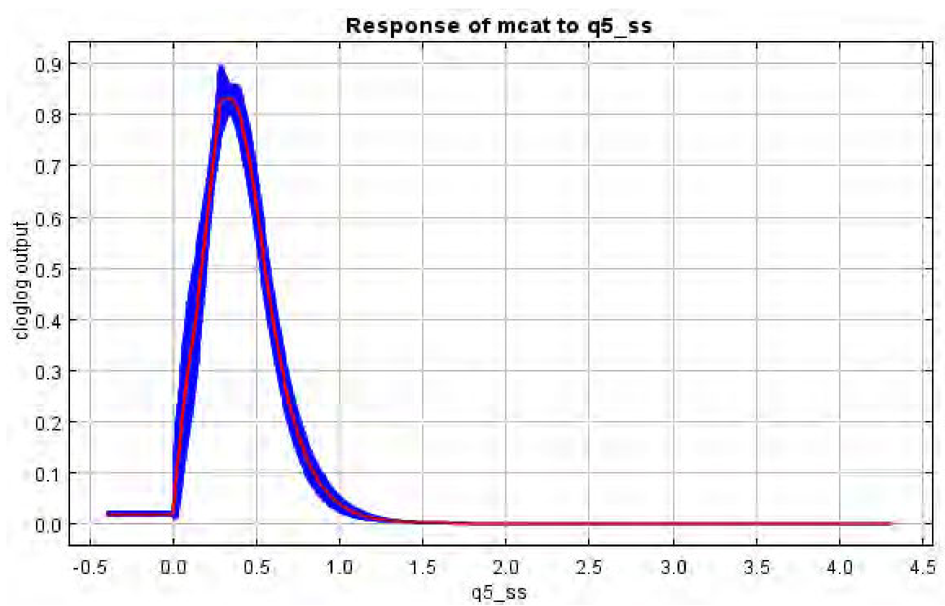


Figure M-C-7: Response Curve for the Variable q5_ss (Shear Stress)

XII. ANALYSIS

This section describes the workflow step of using the model to analyze each measure. Since the existing condition model was determined to be valid, then that model can be used to predict freshwater mussel habitat suitability for modeled measures. The results presented here are for the measures included in the TSP. Figures M-C-8 through M-C-11 display the projection of the Maxent existing condition model onto the 12 AdH modeled environmental raster variables for the TSP scenario.

XIII. UPPER STEAMBOAT ISLAND (USI) HEAD MEASURE

Figure M-C-8 displays the existing condition scenario habitat suitability model on the left and the TSP scenario habitat suitability model displayed on the right. The location of the USI Head measure can be seen in the TSP model. Notice that mussel habitat suitability in the area of the reshaped island head remains very similar to the distribution of suitable habitat in the existing condition model. An increase in suitable mussel habitat has been created at the head of USI, upstream from the proposed measure.

Notice that mussel habitat suitability along the eastern bank of the Mississippi River in the area of the Cordova EHA remains unaffected by the USI Head measure.

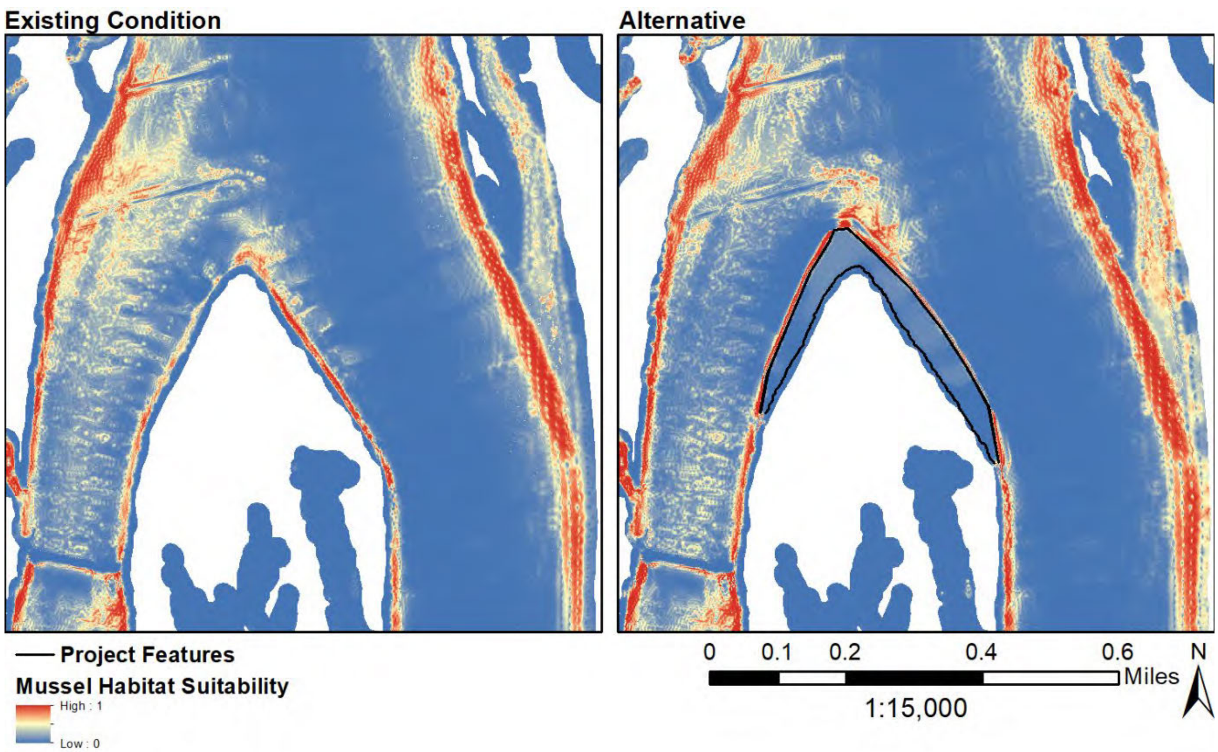


Figure M-C-8: Estimated Mussel Habitat Suitability for the USI Head Measure Compared to the Existing Condition Scenario

XIV. NE BANK PROTECTION MEASURE

The location of the NE Bank Protection measure can be seen in Figure M-C-9 along the northeastern bank of Steamboat Island. Notice that habitat suitability is unchanged in the area of the NE Bank Protection measure along the Mississippi River channel, indicating that this measure is not negatively affecting mussel habitat suitability in that area. Notice that mussel habitat suitability is somewhat reduced within Steamboat Island due to the reduction of flow caused by the NE Bank Protection measure. Notice that mussel habitat suitability along the eastern bank of the Mississippi River in the area of the Cordova EHA remains unaffected by the NE Bank Protection measure.

Grade Control Structure (GCS) Measure. The location of the GCS measure can be seen along the western bank of Steamboat Island along Steamboat Slough in Figure M-C-10. Notice that habitat suitability is unchanged along the left descending bank of Steamboat Slough in the area of the measure.

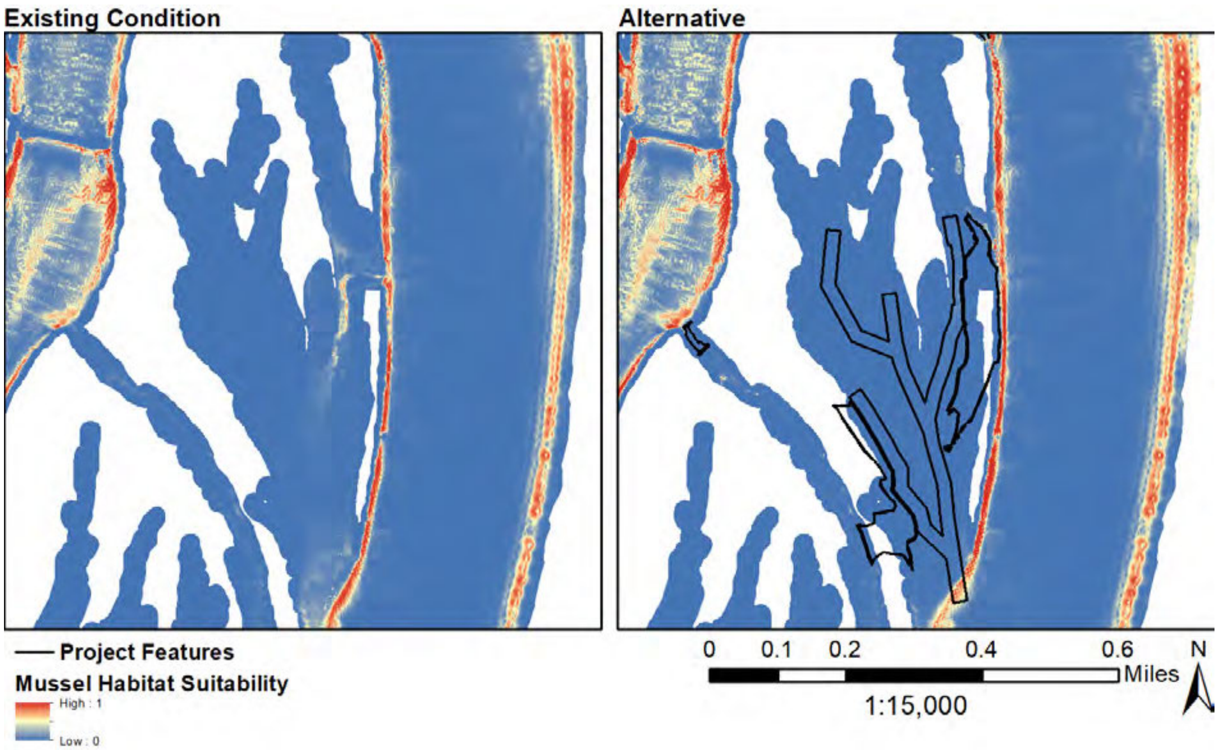


Figure M-C-9: Estimated Mussel Habitat Suitability for the NE Bank Protection Measure Compared to the Existing Condition Scenario

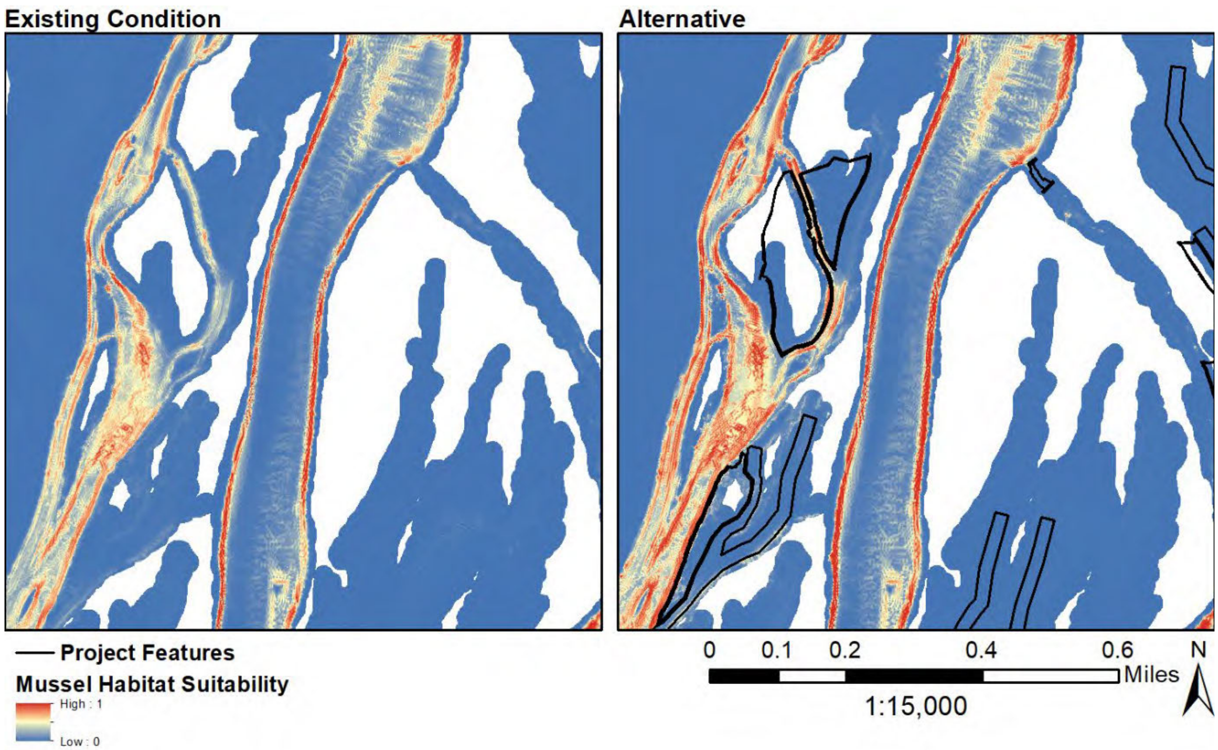


Figure M-C-10: Estimated Mussel Habitat Suitability for the GCS Measure Compared to the Existing Condition Scenario

XV. WEST SE ISLAND MEASURE

The location of the West SE Island can be seen in the middle of the Mississippi River in the middle of Figure M-C-11. Notice the creation of suitable mussel habitat around the margins of the new island. Notice that mussel habitat suitability along the eastern bank of the Mississippi River in the area of the Cordova EHA remains unaffected by the West SE Island measure.

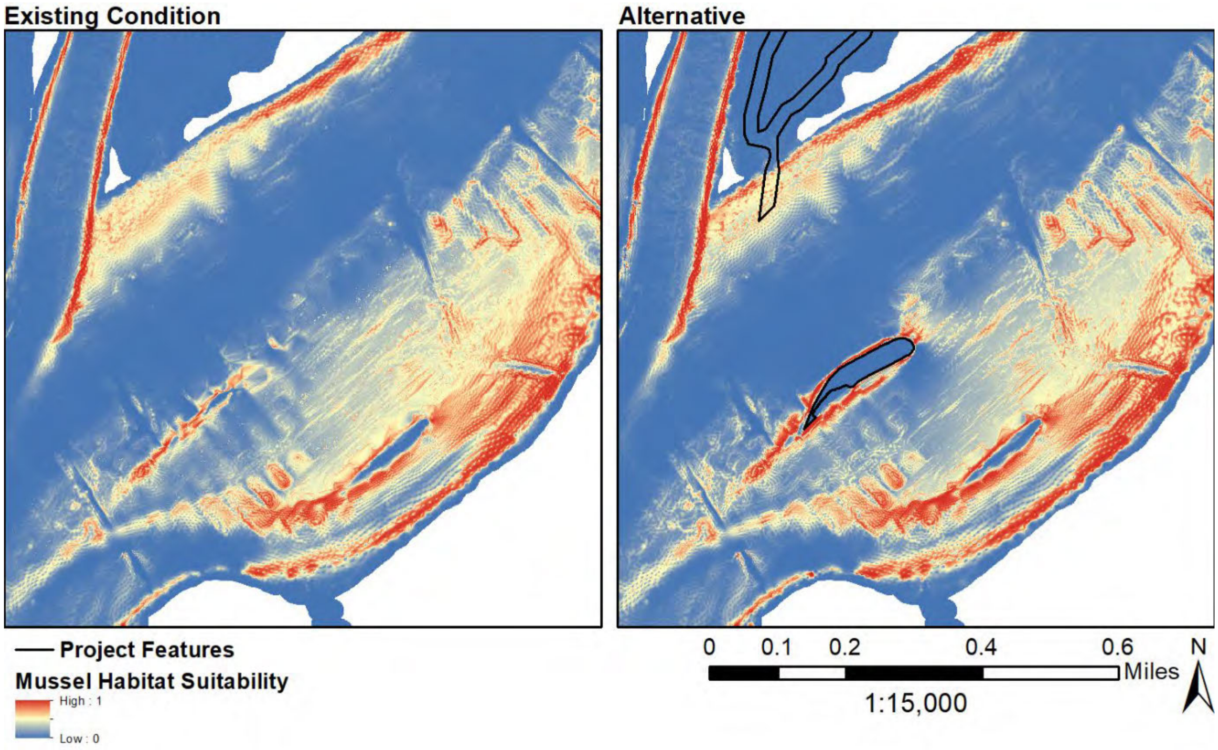


Figure M-C-11: Estimated Mussel Habitat Suitability for the West SE Island Measure Compared to the Existing Condition Scenario

XVI. DISCUSSION

For the purpose of this study the authors have chosen to interpret Maxent model results as an index of habitat suitability rather than estimating probability of presence. We believe that this less strict interpretation is more appropriate until further application of these methods to a wider variety of sites and environmental predictor variables can be completed. This more conservative interpretation is still extremely useful for evaluating the mussel habitat benefits and impacts of potential HREP features.

XVII. CONCLUSION

The novel application of this inductive species distribution modeling technique to HREP mussel feature design has demonstrated its potential on this Project. It is hoped that gaining more experience with this approach on future HREPs will help to determine how widespread this approach is useful and further refine techniques. Application of this approach to the Project resulted in the following benefits:

- Provided a spatially explicit method for determining site-specific mussel habitat from mussel surveys and hydraulic models
- Helped select among Project measures
- Assessed the impact of Project measures on mussel habitat
- Informed how the design of measures will likely affect mussel habitat
- Made the most of existing data investments (in mussel surveys and hydraulic modeling) to make best available science decisions

XVIII. REFERENCES

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STEAMBOAT ISLAND HREP

APPENDIX M
DESIGN ENGINEERING

Attachment D
Aspelmeier Sedimentation Study

SEDIMENTATION STUDY

1984 - 1994

Sedimentation data was taken on the Mississippi River during the summer of 1994. This information was added to the study that was carried out from 84 to 89. The results of these studies have been broken down into two segments, 84-89 and 89-94

Data is given for each station in Pools 9 thru 19 with the exception of Pool 15 which was omitted from the study.

The Pools have from 5 to 12 stations and each station has from 2 to 5 substations. The figures presented here are the average of the substation readings. All readings are in feet. A + preceding the number indicates sediment buildup. A - indicates scouring. "No data" indicates the station was abandon or lost.

Maps are included in this report to identify station locations. The arrows show the location of the station and the direction from shore that the readings are taken.

Annual photo records are taken at each station to record vegetive changes.

Observations & Comments

Five of the Pools - 9, 10, 13, 16, and 18 have sedimentaion rates above the ten year average of the remaining Pools. Each of these five Pools have a relatively large tributary entering it. It could be concluded that these tributaries contribute to the higher sedimentation rate.

Pool 14, with the Wapsipinicon River entering at mid-pool, was only slightly below the ten year average.

Sedimentation in Pools 11, 12, and 17 was almost non-existatnt. These Pools have no major tributaries.

The average sedimentation for Pool 19, over the ten year period, is 0.00. This is hard to understane as this Pool has a large tributary that carries a heavy silt load. One theory could be that the Pool was created 35 to forty years ahead of the others and that an equalibrium has been reached or is approaching and the silt load passes on through without settling out. -- only a thought.

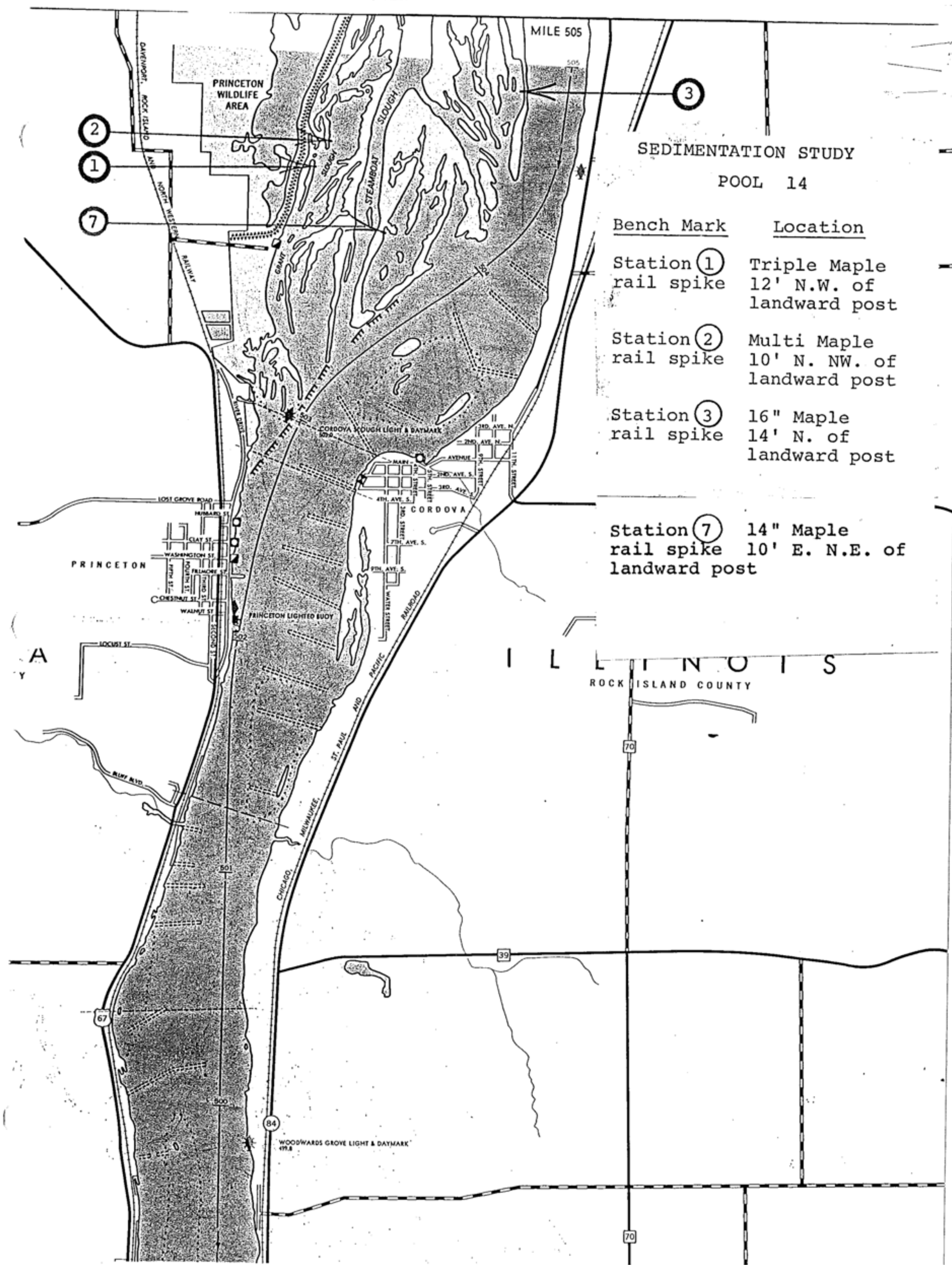
If this study is continued, in future years, it is suggested that more time be alloted so that the stations can be upgraded by installing new post or by replacement of the bench marks. In some cases it might be advisable to add new stations or delite some of the existing ones.

Submitted by,

WHAspelmeier

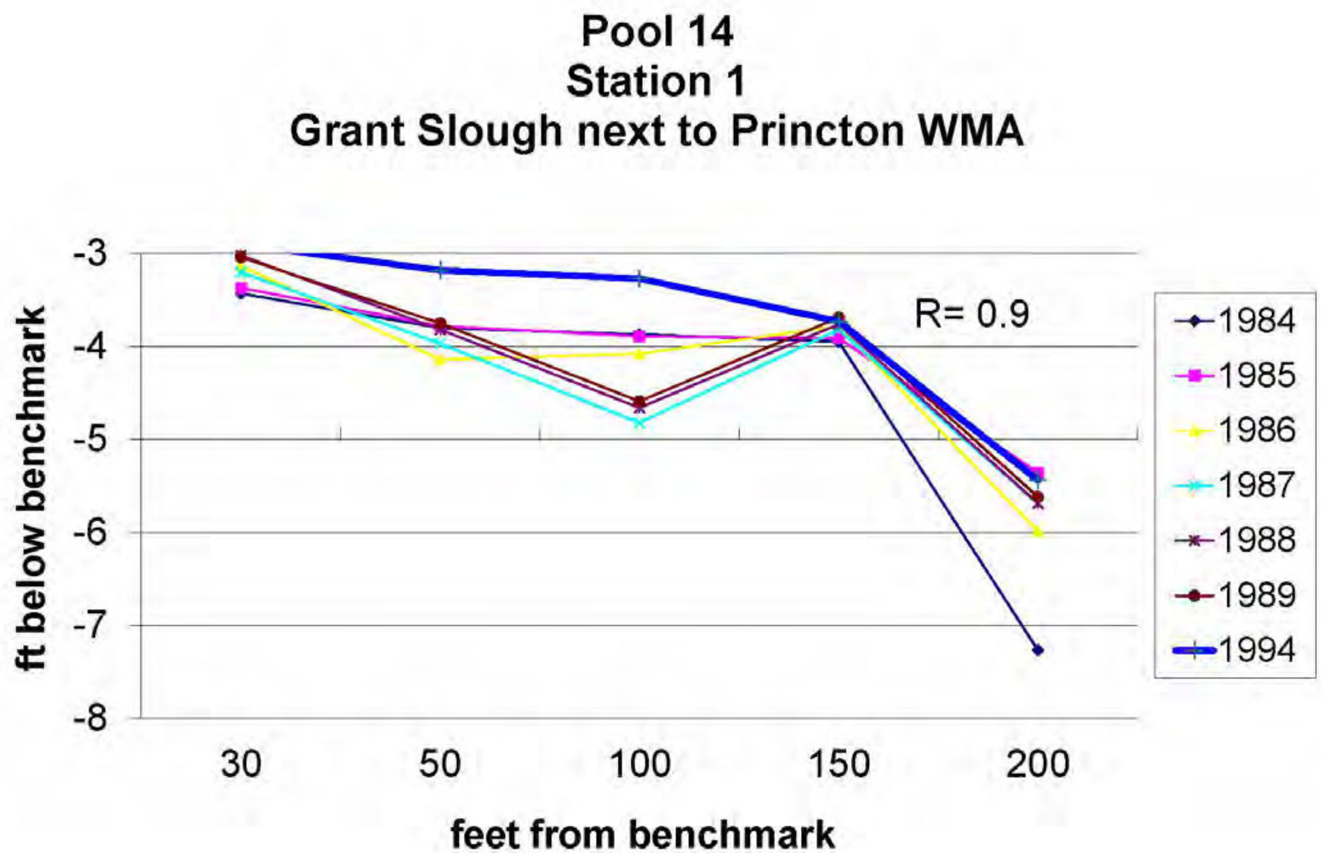
W. H. Aspelmeier
Professional RiverRat - Retired

IOWA DEPARTMENT OF NATURAL RESOURCES
SEDIMENTATION DATA
POOL 14


MILE 505
PRINCETON WILDLIFE AREA
SEDIMENTATION STUDY
POOL 14
Bench Mark
Location
Station 1 rail spike
Triple Maple 12' N.W. of landward post
Station 2 rail spike
Multi Maple 10' N. NW. of landward post
Station 3 rail spike
16" Maple 14' N. of landward post
Station 7 rail spike
14" Maple 10' E. N.E. of landward post
PRINCETON
CORDOVA
PRINCETON LIGHTED BUOY
CORDOVA SLOUGH LIGHT & DAYMARK
STEAMBOAT SLOUGH
LOST GROVE ROAD
LOCUST ST.
ROCK ISLAND COUNTY
CHICAGO, MILWAUKEE, ST. PAUL AND PACIFIC RAILROAD
WOODWARDS GROVE LIGHT & DAYMARK

Pool 14			-0.2	0.9	-0.2	0.6	0.4	0.8	0.5	0.4
	Station 1	10/11/1984			1984	1994		Rate		
30	2.22	5.65	-3.43		-3.43	-2.9	0.636	0.9		
50	2.22	6.02	-3.8		-3.8	-3.18	0.744			
100	2.22	6.09	-3.87		-3.87	-3.27	0.72			
150	2.22	6.17	-3.95		-3.95	-3.73	0.264			
200	2.22	9.49	-7.27		-7.27	-5.44	2.196			
		8/19/1985								
30	3.24	6.61	-3.37							
50	3.24	7.02	-3.78							
100	3.24	7.13	-3.89							
150	3.24	7.15	-3.91							
200	3.24	8.6	-5.36							
		8/19/1986								
30	3.26	6.39	-3.13							
50	3.26	7.4	-4.14							
100	3.26	7.34	-4.08							
150	3.26	7.04	-3.78							
200	3.26	9.25	-5.99							
		6/11/1987								
30	2.51	5.71	-3.2							
50	2.51	6.48	-3.97							
100	2.51	7.33	-4.82							
150	2.51	6.33	-3.82							
200	2.51	8.2	-5.69							
		5/25/1988								
30	2.77	5.79	-3.02							
50	2.77	6.59	-3.82							
100	2.77	7.43	-4.66							
150	2.77	6.53	-3.76							
200	2.77	8.46	-5.69							
		6/28/1989								
30	2.84	5.88	-3.04							
50	2.84	6.59	-3.75							
100	2.84	7.43	-4.59							
150	2.84	6.53	-3.69							
200	2.84	8.46	-5.62							
		7/6/1994								
30	2.97	5.87	-2.9							
50	2.97	6.15	-3.18							
100	2.97	6.24	-3.27							
150	2.97	6.7	-3.73							
200	2.97	8.41	-5.44							
		2000 Lost								


14-1/1994


Pool 14
Station 1
Grant Slough next to Princton WMA
ft below benchmark
-3
-4
-5
-6
-7
-8
30
50
100
150
200
feet from benchmark
R= 0.9
1984
1985
1986
1987
1988
1989
1994

	Station 2	10/11/1984	
50	2.88	7.22	-4.34
100	2.88	6.82	-3.94
150	2.88	6.68	-3.8
200	2.88	6.75	-3.87
		8/19/1985	
50	3.5	7.77	-4.27
100	3.5	7.44	-3.94
150	3.5	7.25	-3.75
200	3.5	7.24	-3.74
		8/21/1986	
50	3.35	7.74	-4.39
100	3.35	7.29	-3.94
150	3.35	7.01	-3.66
200	3.35	6.95	-3.6
		6/11/1987	
50	3.47	7.77	-4.3
100	3.47	7.48	-4.01
150	3.47	7.15	-3.68
200	3.47	6.87	-3.4
		5/25/1988	
50	3.29	7.62	-4.33
100	3.29	7.32	-4.03
150	3.29	7.17	-3.88
200	3.29	6.8	-3.51
		6/28/1989	
50	3.4	7.62	-4.22
100	3.4	7.45	-4.05
150	3.4	7.17	-3.77
200	3.4	6.91	-3.51
		7/6/1994	
50	3.51	8.49	-4.98
100	3.51	7.85	-4.34
150	3.51	7.4	-3.89
200	3.51	6.94	-3.43

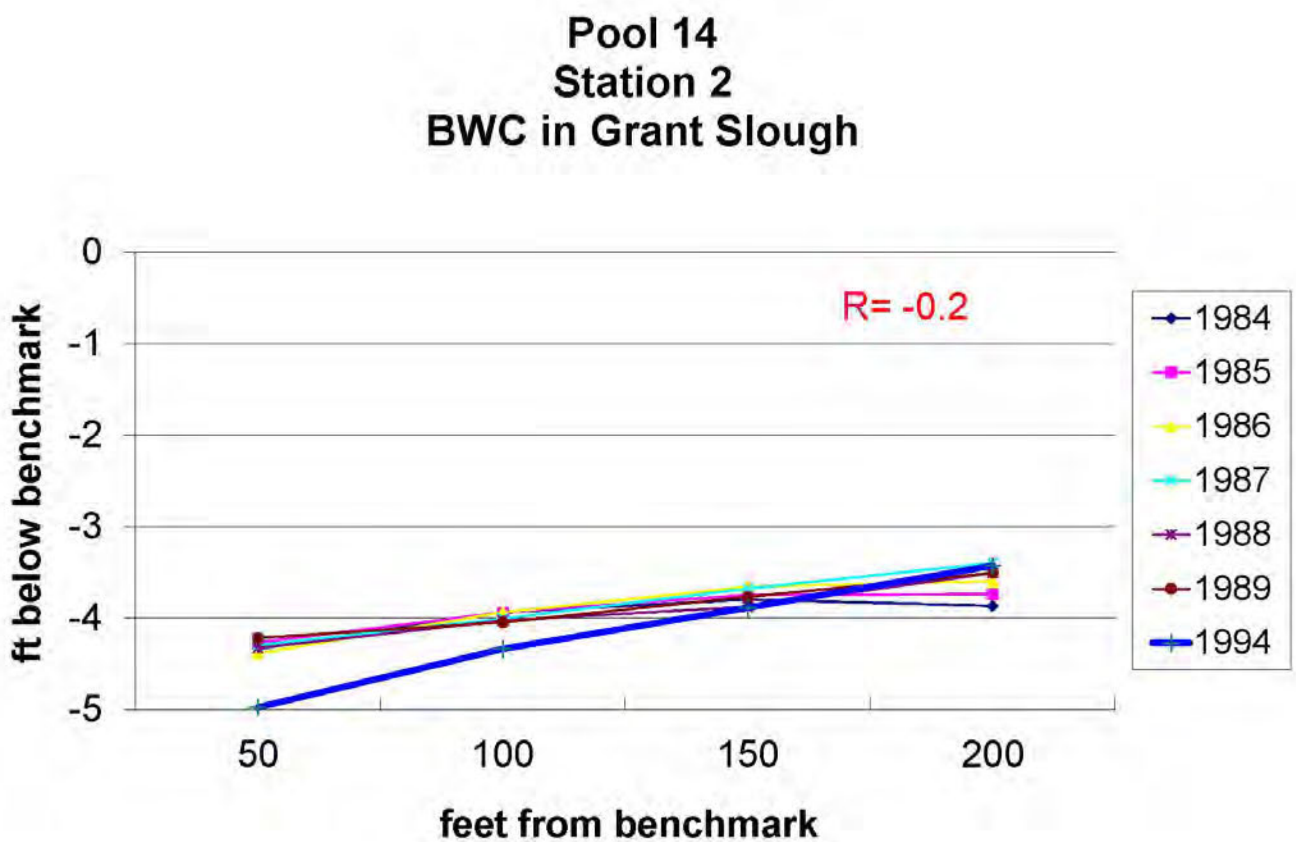
2000 lost

1984	1994		Rate
-4.34	-4.98	-0.768	-0.2
-3.94	-4.34	-0.48	
-3.8	-3.89	-0.108	
-3.87	-3.43	0.528	

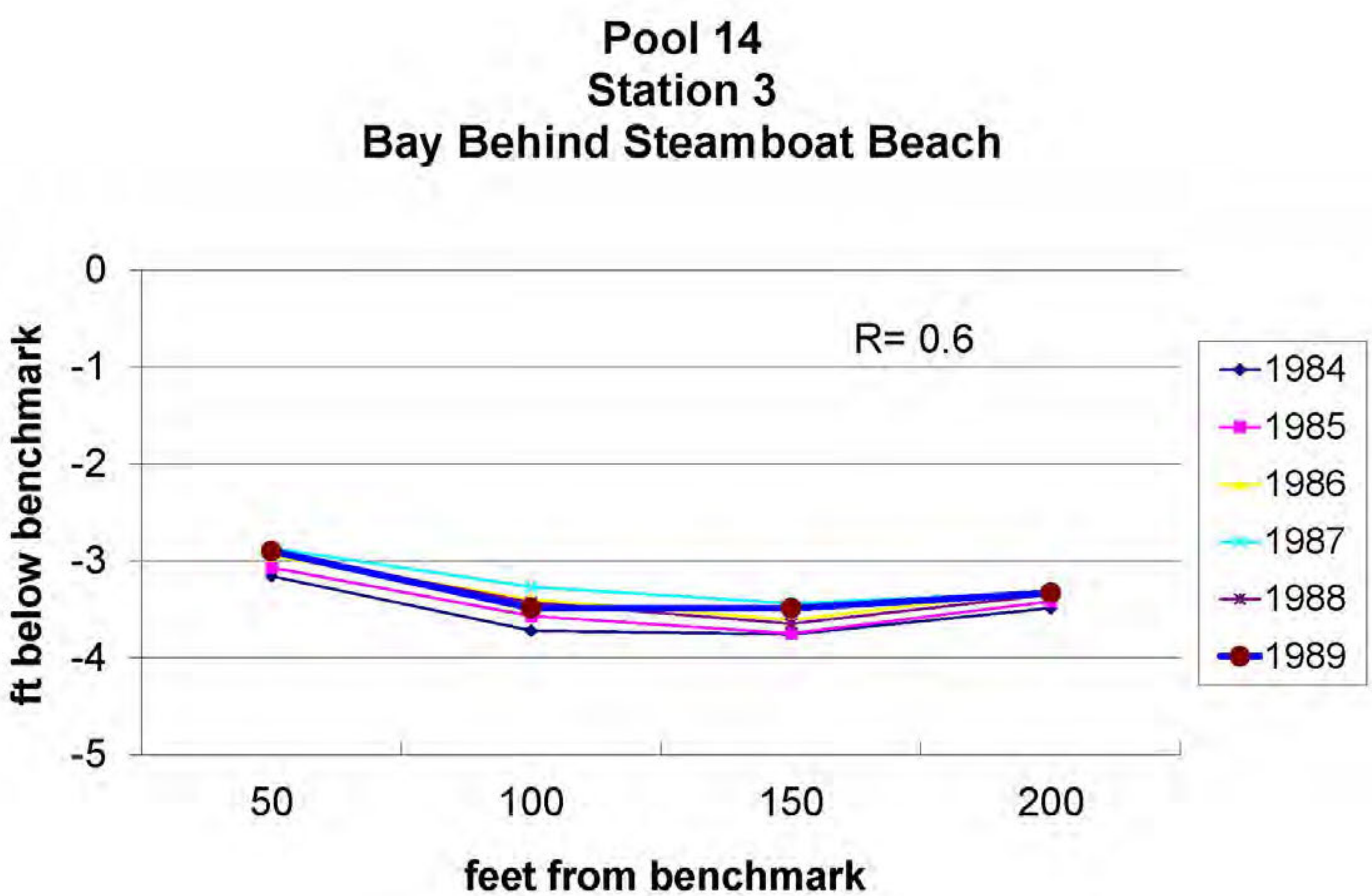

14-2/ 198


14-2 198


14-2/1994


Pool 14
Station 2
BWC in Grant Slough
R= -0.2
ft below benchmark
0
-1
-2
-3
-4
-5
50
100
150
200
feet from benchmark
1984
1985
1986
1987
1988
1989
1994

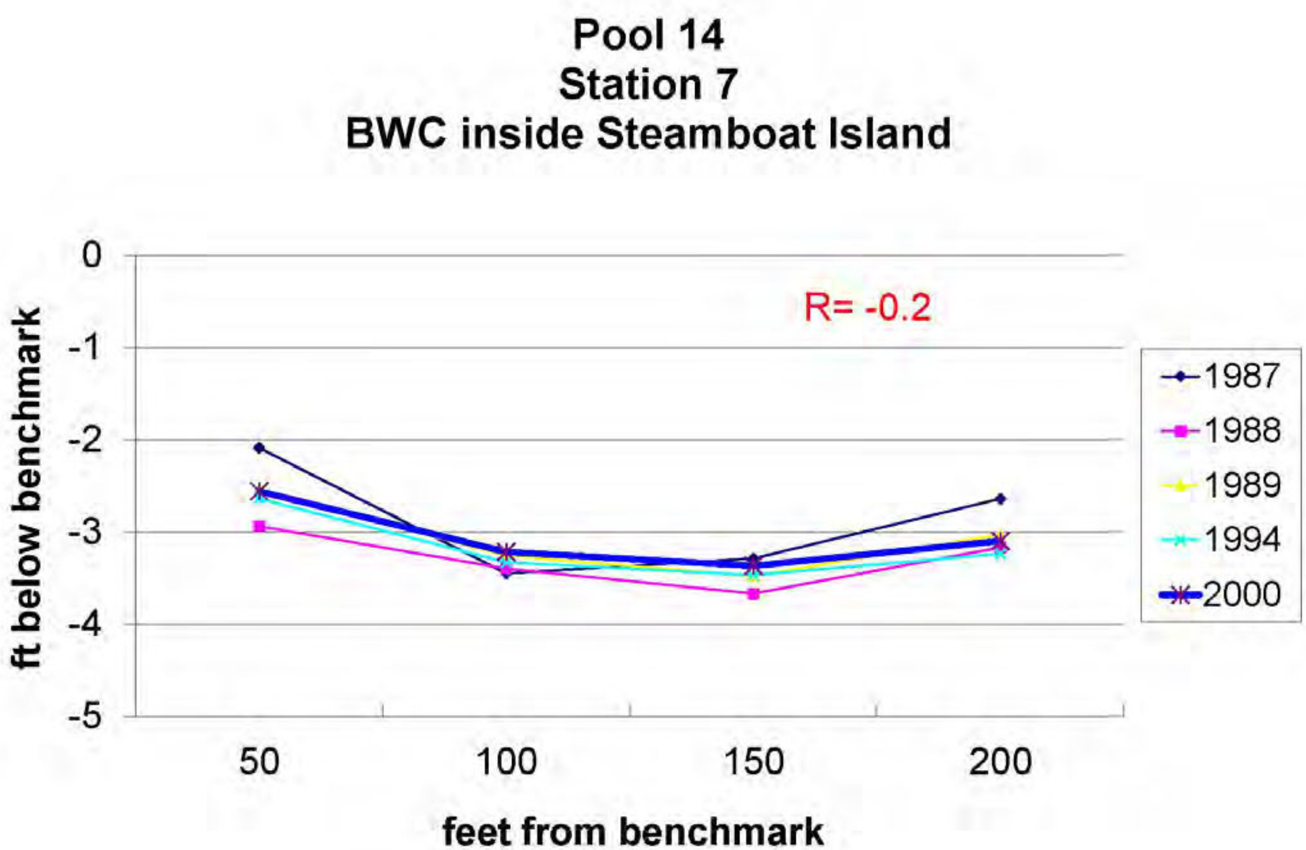
	Station 3	10/11/1984			1984	1989		Rate
50	2.45	5.61	-3.16		-3.16	-2.9	0.624	0.6
100	2.45	6.17	-3.72		-3.72	-3.49	0.552	
150	2.45	6.21	-3.76		-3.76	-3.49	0.648	
200	2.45	5.94	-3.49		-3.49	-3.33	0.384	
		8/14/1985						
50	2.49	5.56	-3.07					
100	2.49	6.06	-3.57					
150	2.49	6.24	-3.75					
200	2.49	5.91	-3.42					
		8/21/1986						
50	2.65	5.6	-2.95					
100	2.65	6.05	-3.4					
150	2.65	6.26	-3.61					
200	2.65	5.95	-3.3					
		6/11/1987						
50	2.13	5	-2.87					
100	2.13	5.4	-3.27					
150	2.13	5.57	-3.44					
200	2.13	5.45	-3.32					
		5/25/1988						
50	2.15	5.07	-2.92					
100	2.15	5.58	-3.43					
150	2.15	5.8	-3.65					
200	2.15	5.5	-3.35					
		6/28/1989						
50	3.07	5.97	-2.9					
100	3.07	6.56	-3.49					
150	3.07	6.56	-3.49					
200	3.07	6.4	-3.33					
	1994 lost							
	2000 lost							



Pool 14
Station 3
Bay Behind Steamboat Beach
0
-1
-2
-3
-4
-5
ft below benchmark
R= 0.6
1984
1985
1986
1987
1988
1989
50
100
150
200
feet from benchmark

Station 7		6/11/1987	
50	3.21	5.3	-2.09
100	3.21	6.66	-3.45
150	3.21	6.5	-3.29
200	3.21	5.85	-2.64
		5/25/1988	
50	2.33	5.27	-2.94
100	2.33	5.73	-3.4
150	2.33	6	-3.67
200	2.33	5.5	-3.17
		6/28/1989	
50	2.97	5.52	-2.55
100	2.97	6.23	-3.26
150	2.97	6.45	-3.48
200	2.97	6	-3.03
		7/6/1989	
50	3.41	6.05	-2.64
100	3.41	6.74	-3.33
150	3.41	6.88	-3.47
200	3.41	6.65	-3.24
		8/2/2000	
50	2.96	5.52	-2.56
100	2.96	6.18	-3.22
150	2.96	6.33	-3.37
200	2.96	6.06	-3.1

1987	2000		Rate
-2.09	-2.56	-0.43385	-0.2
-3.45	-3.22	0.212308	
-3.29	-3.37	-0.07385	
-2.64	-3.1	-0.42462	



Pool 14
Station 7
BWC inside Steamboat Island
R= -0.2
0
-1
-2
-3
-4
-5
ft below benchmark
50
100
150
200
feet from benchmark
1987
1988
1989
1994
2000

STEAMBOAT ISLAND HREP

APPENDIX M
DESIGN ENGINEERING

Attachment E
Fish Habitat

From: Schmuecker, Sara
To: Nerad, Kyle R CIV USARMY CEMVR (US)
Cc: Perrine, Rachel E CIV USARMY CEMVP (USA)
Subject: Re: [EXTERNAL] RE: [Non-DoD Source] Steamboat Island Overwintering Fish and Mussel Features
Date: Wednesday, March 20, 2019 4:08:59 PM

Thank you for your feedback, Kyle. All excellent points. I will share with the rest of the IA DNR and FWS group that took part in this discussion for everyone to keep in mind in future conversations as we continue to refine project features.

- Sara

Sara Schmuecker
U.S. Fish and Wildlife Service
Illinois - Iowa Field Office
1511 47th Avenue, Moline, IL 61265
309-757-5800 x203

On Wed, Mar 20, 2019 at 12:34 PM Nerad, Kyle R CIV USARMY CEMVR (US) <Kyle.R.Nerad@usace.army.mil> wrote:

> Thanks Rachel and thanks Sara and team for the feature ideas.
>
> At first glance I think these are all constructible at Steamboat and would be good to incorporate as we continue along. I like the tiered design and what that can do for different species. I also like the idea of the little deeper pocket lakes instead of a mono-form channel.
>
> I do have a few concerns with this though, that we'll want to think about as we move forward. In Upper Lake, the map shows going less deep on the majority of the lake for access only. From a constructability stand point this can be fine, other than it will alter our current dredge/placement balance, and it will decrease our overwintering fish habitat that we can claim. Also, in the downstream most finger of Upper Lake, I'm not sure we can remove the one area of the dredge cut, as then there won't be access to the rest of that cut, unless we access dredge through that area only. Just some things to keep in mind. I realize these are not final designs and we will hone in during plans and specs, but I don't want my concerns to be a complete surprise when we get there.
>
> Thanks!
>
> Kyle Nerad, E.I.
>
> Civil & Environmental Engineering Section (CEMVR-EC-DN)
> Clock Tower Building, PO Box 2004
> Rock Island, IL 61204
>
> ☎ Office Phone: (309) 794-5245
>
> -----Original Message-----
> From: Perrine, Rachel E CIV USARMY CEMVP (USA)

Sent: Wednesday, March 20, 2019 10:19 AM
To: Nerad, Kyle R CIV USARMY CEMVR (US) <Kyle.R.Nerad@usace.army.mil>
Cc: Sara Schmuecker <sara_schmuecker@fws.gov>
Subject: FW: [Non-DoD Source] Steamboat Island Overwintering Fish and Mussel Features

Kyle,
See attached for notes from IADNR/FWS discussion on potential designs and locations for fish and mussel habitat incorporation.

Sara,
Thanks so much for providing this!

Rachel E. Perrine
Water Resource Planner
U.S. Army Corps of Engineers
Plan Formulation Branch
Regional Planning and Environment Division - North Rock Island Arsenal Clock Tower Building P.O. Box 2004 Rock Island, IL 61204
Office: (309) 794-5403
Mobile: (309) 430-7990

-----Original Message-----
From: Schmuecker, Sara [mailto:sara_schmuecker@fws.gov]
Sent: Monday, March 11, 2019 8:04 AM
To: Perrine, Rachel E CIV USARMY CEMVP (USA) <Rachel.E.Perrine@usace.army.mil>; Michl, Davi E CIV USARMY CEMVP (US) <Davi.E.Michl@usace.army.mil>
Cc: Kirk Hansen <kirk.hansen@dnr.iowa.gov>; Nathan Williams <nathan_williams@fws.gov>; Tyler Porter <tyler_porter@fws.gov>; Gritters, Scott [DNR] <Scott.Gritters@dnr.iowa.gov>; Baylor, Sharonne <sharonne_baylor@fws.gov>; Ed Britton <ed_britton@fws.gov>
Subject: [Non-DoD Source] Steamboat Island Overwintering Fish and Mussel Features

Hi Rachel,

As we discussed, I wrote up the attached notes summarizing the IA DNR and FWS's Feb 20, 2019 discussion of potential designs and locations for overwintering fish and mussel features for the Steamboat Island HREP. Please let me know if you have any questions.

- Sara

Sara Schmuecker
U.S. Fish and Wildlife Service
Illinois - Iowa Field Office
1511 47th Avenue, Moline, IL 61265
309-757-5800 x203

Steamboat Island Fish and Mussel Feature Discussion Summary

February 20, 2019

USACE Mississippi River Project Office, Pleasant Valley, IA

Participants: Kirk Hansen (IA DNR), Nate Williams (FWS), Sara Schmuecker (FWS) and Tyler Porter (FWS)
Cc: Scott Gritters (IA DNR), Sharonne Baylor (FWS) and Ed Britton (FWS)

Please note, these are preliminary ideas and do not constitute final design recommendations.

<u>Fish Overwintering Habitat</u>

The team would like to consider incorporating areas of a tiered step-wise design (approximate depths pictured) versus a trapezoid shape, focusing on creating a larger littoral zones and promoting aquatic vegetation growth within select areas of the Upper and Lower Lake dredge cuts. Wider dredge cut designs are preferred, as utilized at Beaver Island.

The team would like to see shallow entrances at a couple of the backwater dredging locations, similar to those included in the design at Pool 12 HREP.

Preliminary dredge cut design ideas (See attached map):

Grant Slough: Classic trapezoid dredging design throughout cut.

Upper Lake: Sections of tiered design, modeled after Huron Island and Conway Lake HREPs, with shallower access channels (approx. 4ft depth). Consider removing a small section of the dredge cut design bordering the branch of the dredge cut furthest downstream.

Lower Lake: Sections of tiered design, with shallower access channels.

<u>Mussel Substrate</u>

Incorporate mussel substrate, similar to the bench design at Beaver Island but with slight variations at select rock placement/bankline protections locations throughout the project. Specific designs were not discussed, but the group did discuss including variations to the Beaver Island design to learn as much as we can through post-construction monitoring.

Preliminary mussel substrate design ideas (See attached map):

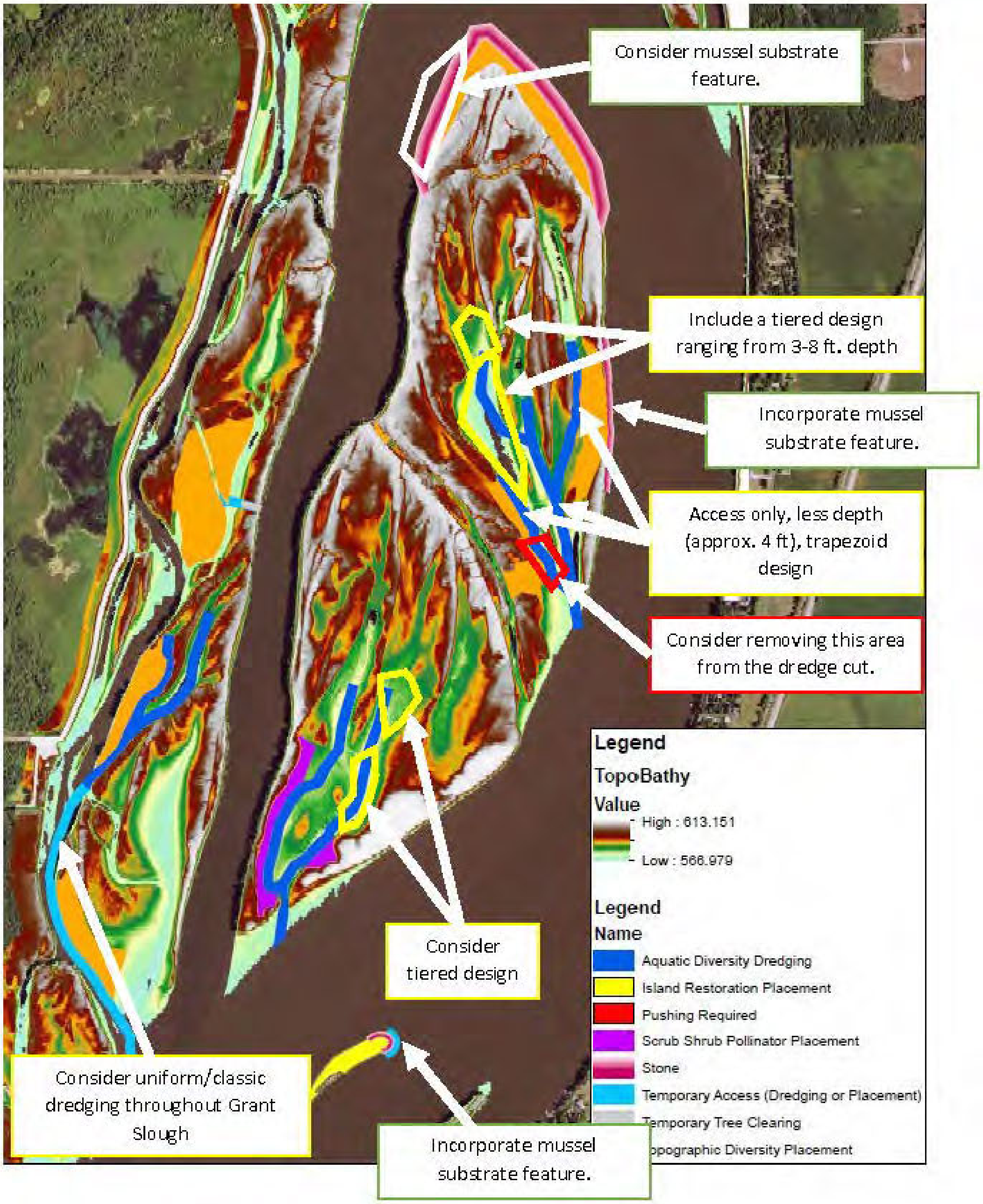
NE Bank Protection: Incorporate mussel substrate along the length of this feature design.

SE Island: Incorporate mussel substrate into any rockwork that is included into the design at this feature location.

Head of Steamboat Island: Consider integrating mussel substrate into the rock placement bordering Steamboat Slough. Mussel monitoring associated with the Cordova Exelon Nuclear Plant indicates a moderate quality mussel bed exists along the Iowa bankline in this location of Steamboat Slough and hatchery work indicates elevated temperatures, such as those present in this location, may increase juvenile mussel growth rates.

<u>Overall Thoughts</u>

Specific designs for the fish overwintering dredge cuts and mussel substrate were not discussed, but variations in designs would allow for a good opportunity to learn what works and what doesn't due to large quantity of pre-project data on both freshwater mussel and fish resources in this project location.


Consider mussel substrate feature.
Include a tiered design ranging from 3-8 ft. depth
Incorporate mussel substrate feature.
Access only, less depth (approx. 4 ft), trapezoid design
Consider removing this area from the dredge cut.
Consider tiered design
Consider uniform/classic dredging throughout Grant Slough
Incorporate mussel substrate feature.
Legend
TopoBathy
Value
High : 613.151
Low : 566.979
Legend
Name
Aquatic Diversity Dredging
Island Restoration Placement
Pushing Required
Scrub Shrub Pollinator Placement
Stone
Temporary Access (Dredging or Placement)
Temporary Tree Clearing

Document Recieved From IA DNR February 2016

Fish Habitat Enhancements

The Iowa DNR Fisheries staff has used several habitat enhancements on Iowa waters to improve catch rates for anglers. Some of the enhancements are constructed on the dry or frozen bottom while others can be placed from a boat in existing water. Each habitat enhancement brings its own limitations and benefits that are usually directed towards a specific species, season, or angling type. Some of the common enhancements are tree piles, rock reefs and mounds, spawning attracting areas, stake beds, benched jetties, bank hides, and other???? Material for small scale projects can be salvaged from other uses at little or no cost. Cement blocks, cable spools, old picnic tables, metal trash cans and broken concrete from construction sites as well as many other materials can be turned into excellent fish habitat. Volunteer labor can be utilized to minimize the time and effort to construct many types of enhancements.

Tree Piles

Description

Tree piles can provide cover for several species and are readily available near most water bodies. Some prey species use the cover for shelter from predators while others use the piles as possible ambush sights.

Site Selection

Placement locations can vary widely. All depths and locations can offer some benefits to many species during some period of the year. Site selection should be based on a combination of factors. Those might include the natural bottom contour, where angling activity would best occur to avoid conflicts with other activities, siltation, behavior patterns of the desired fish species, as well as any other concerns. Anglers can find submerged locations easier when some of the branches are left exposed. Deeper piles offer shelter during summer months and piles placed in the deepest areas can provide excellent cover for winter panfish.

Construction

Securing the trees to the bottom can be done by either staking with fence posts or weighting with heavy objects, commonly concrete blocks. Number 9 soft steel wire can be used to tie the trees to the anchoring devices and will last for 3 to 5 years. Copper or aluminum wire will last indefinitely but is more expensive. Polypropylene rope works well also but wave movement may cause abrasion. Screw-in fence anchors and steel cable have been used to secure large brush piles to the bottom of dry lake bottoms. Weighted trees can be placed in the ice and will likely sink in the general vicinity but may move when ice melts or cause hazards to other winter uses.

Placement

Placement of trees in open water requires a large boat or working platform. Trees can be weighted then either hauled or towed out to needed areas. This method is labor intensive and smaller trees are requires but four people can readily place up to 30 trees during a half days effort.

Considerations

Cedar trees are usually abundant on the surrounding public property or from neighboring road ditches. Trees that have grown alone usually have a bushier shape and provide more cover per tree. Trees grown in tight groups often lack the side branches that provide the shelter. Other tree species can be beneficial but have drawbacks. Hedge trees, (Osage Orange) are quite bushy and contain very long lasting branches but the thorns are difficult to work with and often puncture tires. Hardwoods such as oaks can also be a source of trees. They are usually more desirable as timber and therefore may have offer greater aesthetic benefits if left. Surplus Christmas trees do not offer long term habitat and their branches are thin and break down quickly.

Spawning Areas

Description

Male panfish make shallow depressions in the loose bottom material to create a site for the female to lay eggs. Usually many males frequent a small area. Sand, pea gravel, and limestone chips have been used to create areas in many Iowa lakes.

Site Selection

Water depths should be 18 to 42 inches depending on expected water clarity, near existing shoreline access areas when possible, and where sediments will not eventually cover the site. Areas with deeper water, submerged rock, and or flooded timber nearby can be even more productive because the additional sheltered areas offer places for pre-spawn fish to stage or other to safely retreat should danger arise. Excellent areas would be the corners on each side of an existing jetty where the jetty connects to the shoreline, areas near submerged road crossings, the sides of small steep side coves, or the corners of the dam.

Construction

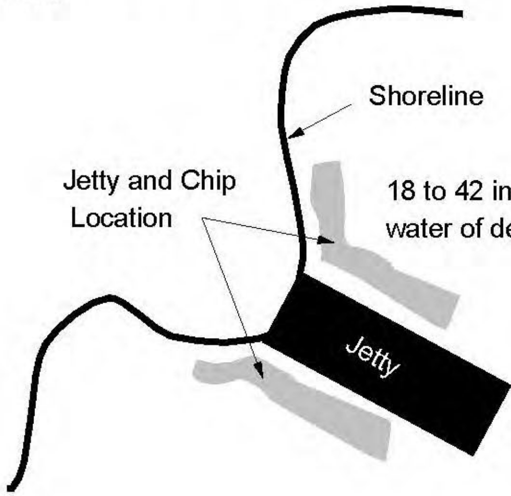
Limestone chips from local quarries work well for this purpose and are readily available near most locations. The chips are commonly used to resurface "Oil and Chip" roads. Pea gravel mined from river beds is best but delivery to remote areas may escalate the cost to above feasible limits. A typical dump truck load will cover an area approximately 30 feet by 60 feet approximately 6 inches thick. Length and width can vary but long, narrow areas that follow the bottom contour would offer greater angler access.

Placement

Spawning areas on dry or frozen bottoms are easy to construct. Very little site preparation is needed and many times the material is only dumped from a truck then shaped to the desired depth by a small tractor and blade. Placement in open water can be done by an excavator. The machine can reach several feet form shore and easily sprinkle and shape the material with the bucket. Material can be placed on the ice but movement during the thaw can occur.

Considerations

Material transportation can become a large portion of the final cost. Pea gravel provides excellent habitat characteristics but availability is usually dependant on local river mining. The limestone chips are common in many parts of the state. Quarries commonly crush them in early summer but usually make only quantities needed for local road projects. Therefore availability may be a problem during the off season. They are also available with or without fines. The material without fines would be less likely to pack and panfish may prefer this over the material with fines. Sand is readily available throughout the state but course sand is sometimes harder to find. The course sand particles will not pack together and will offer characteristics similar to that of pea gravel or limestone chips. The cost of each material type delivered to the site must be evaluated to create the largest benefits possible. An illustration of a typical location is shown below.



Shallow Rock Piles

Description

Shallow Rock Piles will hold many species of fish during all open water seasons. The rock surfaces attract many invertebrate species and the cavities provide shelter areas to fish.

Site Selection

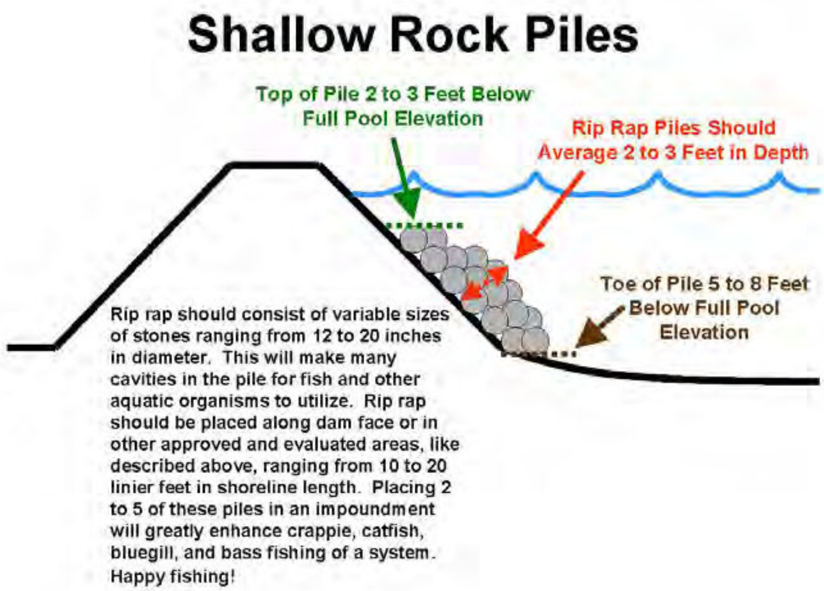
Sites in clear water, away from possible silt sources, and adjacent to additional submerged rock flats work well. The face of the dam or areas along armored shoreline stretches can offer these characteristics and can be easily utilized by both boat and shore anglers.

Construction

These piles usually consist of two to three typical dump truck loads of screened riprap or clean salvaged concrete.

Placement

Material placed to form a reef six feet wide perpendicular to shore starting in two feet and extending into eight feet of water works well. A long reaching excavator would easily reach both the unloading area and the outer edges of the reef. The top should be at least two feet under the normal pool level. Several piles can be placed along a given stretch of shoreline. An illustration of a Shallow Rock Pile is shown below.



Considerations

These piles should last many years if placed below the typical wave and ice line. Impacts to boating traffic should be minimal because they are very close to existing shoreline. Screened riprap is slightly more expensive but the extra cavities offered by the lack of fine material should attract more fish.

Rock Fields

Description

The face of a dam or a stretch of armored shoreline can attract many fish species throughout the year. The rock surfaces and cavities provide excellent attachment areas for invertebrates. These cavities provide sites for higher food chain members or fish to find shelter from even larger predators. Larger predators in turn, frequent these areas searching for prey. The areas thus become popular angling sites. The addition of rock covered areas to other parts of a water body should also attract fish.

Site Selection

The recommended characteristics of a possible area would be a location large and open enough to freely troll or drift across, with naturally occurring drop-offs nearby, and or gradually deepening water depths of four feet descending into eight or nine feet. These areas should also be located such that any deposited or suspended sediments would not cover the site.

Construction

The material can be dumped over a dry or frozen bottom or barges can be used when available to place material in open water. The rock used at these locations does not usually freeze so softer, less expensive rock could be purchased.

Placement

The rock should nearly completely cover the bottom but does not need to be excessively thick and in many cases spreading is minimal. Any irregularities left during placement would further accent the area. The material should not be packed into the bottom.

Considerations

Screened riprap, when available, might be a better choice than non-screened or pit run rock because of its ability to provide more cavities with fewer fines. The screening process would also remove any excessively large pieces whereby allowing the available tonnage to cover a larger area. Native field stone also works well when available. Rock Field locations are submerged and sometimes difficult to locate. Therefore, they should be as large as feasible.

Stake Beds

Description

Fish attracting areas made from individual oak stakes or fiberglass strips have been placed in many locations of several Iowa water bodies. These areas often contain from several hundred to a few thousand pieces. This type of configuration allows crankbaits to be pulled through the stake bed with minimal snagging or perpendicular bobber fishing to occur with ease. Panfish and largemouth bass commonly utilize these areas during early and mid summer months.

<u>Site Selection</u>

Stakes should be placed in areas with approximately eight feet of water depth. Potential stake bed sites with adequate water depths within casting distance of shore usually do not naturally occur. Excavation for fill material used in jetty construction often creates suitable areas. The stake bed can cover a varied water depth but shorter stakes should be used in shallower areas. A clearance of two feet over the top of the stakes at normal pool to avoid damage by boats should be targeted.

<u>Construction</u>

Two methods of construction have been used in the past. Individual pieces can be pressed into the bottom sufficiently as to not float away or fall over. Spacing should be approximately twelve inches. Individual stakes can also be nailed together into individual rows with shorter stakes serving as the cross links. Several constructed rows can be nailed together to form an eight foot cube. These cubes can then be weighted with cement blocks and sunk in open water.

<u>Placement</u>

Pressing individual stakes into the soft lake bottom is the fastest method of placement. Individual stakes can also be placed from a boat or while wading. This method works well during a drawdown where the potential site is partially flooded. Cubes can be lowered into open water from a boat or placed on the ice. Both of these methods are more labor intensive and are only used when other methods are not an option.

<u>Considerations</u>

Oak stakes are readily available from the State Forest Sawmill but are heavy, may float out, and may need to be pointed before pressing in the bottom. Transportation can become a problem because of the weight of the stakes. Surplus fiberglass step ladder legs acquired from the manufacturer have been used in several southern Iowa lakes. The fiberglass stakes will last indefinitely, will not float, and should be less susceptible to hook snagging. Availability is unpredictable and transportation from the factory to the desired location can be expensive because of the distance.

Benched Jetty Modification

Description

Fishing jetties are popular access points for the shoreline angler. The riprap and deepened sides attract fish of several species. The addition of a bench or shelf below the water's surface for spawning panfish can further enhanced the jetty's fish attracting ability. This bench also helps stabilize some of the jetty's side erosion.

Site Selection

Benches are most beneficial on calm jetty sides with no siltation sources nearby. Natural or man-made deepened areas nearby also enhance the site. Water depths over the bench can vary and should be approximately equivalent to with the typical water clarity available during the panfish spawning season. Any deep flooded timber or trees nearby may further enhance the attracting ability of the area.

Construction

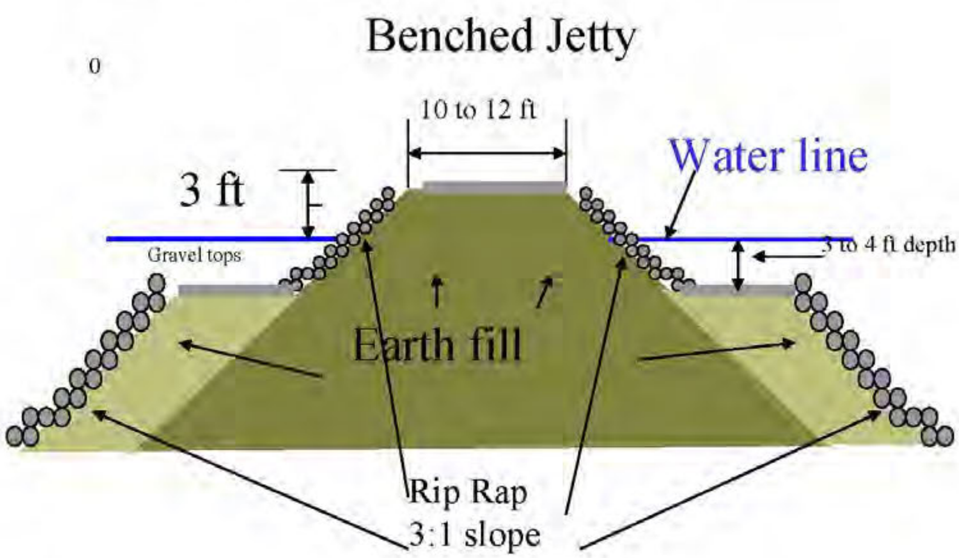
Benches can be part of the design of newly constructed jetties with little additional cost. Jetties constructed on dry bottoms are usually earthen fill from the immediate area and barrow areas can be specified that result with the formation of the bench. Benches at least ten feet wide can then be topped with limestone chips or pea gravel similar to that used when constructing spawning beds. The jetty sides and toe areas below the bench should be riprapped. Benches can be added to existing jetties either while dry or submerged. Dry construction is easiest because fill or excavation of the surrounding area is readily visible and accessible.

Placement

Placement usually requires heavy construction equipment and is part of a contract with a private construction contractor.

Considerations

Benches are an inexpensive addition to a newly constructed jetty that brings the fish to the angler's feet. Water clarity and siltation are two important factors that affect the life expectancy and attracting ability of the bench. When incorporated into the jetty's initial design, have little or no influence on the final cost. This combination of features adds a variety of high quality habitat to an area the angler frequents. An illustration of a typical benched jetty is shown below.



Catfish Hotels

Description

Channel catfish are one of the most sought after fish species in Iowa. Channel catfish prefer hollow areas to rest and spawn. Enhancements of an area to attract them near angler access points can improve angling. Construction of this type of complex, (a Catfish Hotel), is easily done on a dry lake bottom with readily available materials. These Hotels would increase the number of catfish in an area and the drifting scent of baits would draw the catfish from their resting areas to the angler.

Site Selection

Areas near existing shoreline access areas with five to ten feet of water depths and possibly a creek channel meander nearby work well for this purpose. Boat anglers often prefer more secluded locations.

Construction

Salvaged sections of plastic field tile twelve to eighteen inches in diameter cut approximately 40 inches long then weighted with riprap serve this purpose quite well. Plastic field tile rolls when shipped are wound around a large diameter center tube. These plastic center tubes are often available as scrap at little or no cost from agconstruction companies. They are normally 7 feet long and when shortened to half length can become excellent catfish shelters. A tractor loader or skid-steer can be used to cover one end of the tube with riprap. Individual tubes can protrude from different sides of a common pile. A normal sized dump truck load of riprap may cover up to ten tubes

Placement

Placement on a dry bottom is a requirement. This would only be possible at newly constructed or temporarily drained locations. Riprap delivery to site is usually possible through local contractors. The local DNR Fisheries staff in conjunction with volunteers can readily select sites, operate needed equipment, and construct these Hotel complexes.

Considerations

Catfish are somewhat territorial and multiple tube openings near one another may be utilized by only one fish. Openings should be directed away from one another to minimize these conflicts and a common riprap pile may weight down as many as four or five tubes. Water depths over the top of the riprap should be such as to not create a boating hazard. The rock and plastic materials would last for many years if placed in areas of minimal sedimentation.

Pallet Structures

Description

Cubes or other shaped structures made from scrap shipping pallets can be used to attract panfish and largemouth bass. Weights to hold the structure in place are usually the only purchased items needed.

Site Selection

These structures are usually placed in water depths of five to eight feet near shoreline access if possible. Shallower areas can be used but boating traffic could cause problems. Several individual structures when clumped together have a greater cumulative ability to attract fish. Creek channel edges or nearby rock piles ad additional features which further enhance the structure's ability to attract fish.

Construction

Pallets of similar dimensions can be quickly nailed together with an air powered nail gun to form shapes of various sizes. Some designs have been formed cubes while others have slots. Some have tops and others have no tops. Variety seems to be the key characteristic. Construction on the dry or frozen bottom is easiest but they can be built on shore and hauled to the final location with a boat. Either method requires some sort of weighting to hold the structure in place. Salvaged concrete blocks are the most common weight used but riprap can be hand placed in each structure and also works well.

Placement

Many structures are constructed at the final location and no addition placement is required. Structures constructed on shore and placed in open water from a boat may be quite heavy and could be difficult to handle. Some of these may bob when dumped overboard and may require additional weights.

Considerations

These structures will usually last up to five to eight years underwater. Other forms of artificial habitat usually last longer. Construction material costs are usually low but labor can be intensive. Often, community or sportsman groups will gladly volunteer to help build these structures. Many times they have access to pallets or any needed tools. Minimal guidance to select the best sites will result with a fish attracting structure that is highly valued by the local community.

STEAMBOAT ISLAND HREP
APPENDIX M
DESIGN ENGINEERING

Attachment F
Forest Data

Steamboat Island and Wapsipinicon Bottoms HREP

Description Summary of Silvicultural Prescription Features

28 May 2019

GENERAL INFORMATION

Timber Inventory collected:	2018 growing season
Data summarized to:	13 forest management areas (Site level)
Acres included within HREP:	463 acres – Steamboat Island and Grant Slough
Acres identified for features:	294 acres – overview map included
Silvicultural Feature count:	11 prescriptions within 9 Sites
No action determination:	4 Sites
Stand Walk Recon:	April 2019 – 2 ½ days (all by boat, during high water)
Foresters on Recon:	Ben Vandermyde, Andy Beebe, Lauren McNeal
Assisting with Recon:	Nate Williams, Kyle Nerad, Zach Hall

Stand walk recons were performed in April 2019 to determine prescriptions for each of the 13 forest management areas. Areas included in the stand walk recon are all located in Pool 14, Compartment 2, and are in Units 1 (Upper Steamboat), 3 (Lower Steamboat), and 4 (Grant Slough). The silvicultural prescriptions are written to the Site or Stand level (subdivisions of Unit) for recommendation to project features. All 11 recommendations for timber stand improvements include a thinning treatment to achieve a forest growth response to meet desirable forest health, diversity, and resilience best suited for that area based on current environmental and forest conditions. Thinning treatments or timber harvest are the only corrective options to alter long term impacts of an overstocked forest. For multiple considerations, thinning treatments are the recommended option to provide adequate growing space and to increase tree health, structural diversity, and sustainable longevity. Beyond thinning, the other recommended prescription is tree planting. In total, four silvicultural prescriptions do not include any tree planting recommendation to achieve forest growth response. Figure M-F-1 shows a breakdown of prescriptions by forest management area.

As shown, some areas (no colored polygon) do not need any treatment. Those areas were determined to currently be in good health or not expected to degrade within the next 50 years without action. The areas in beige color are recommended to have tree thinning only. As seen in Grant Slough, thinning will be in strips diagonally across the area. Areas in rose are recommended to have both tree thinning and tree planting.

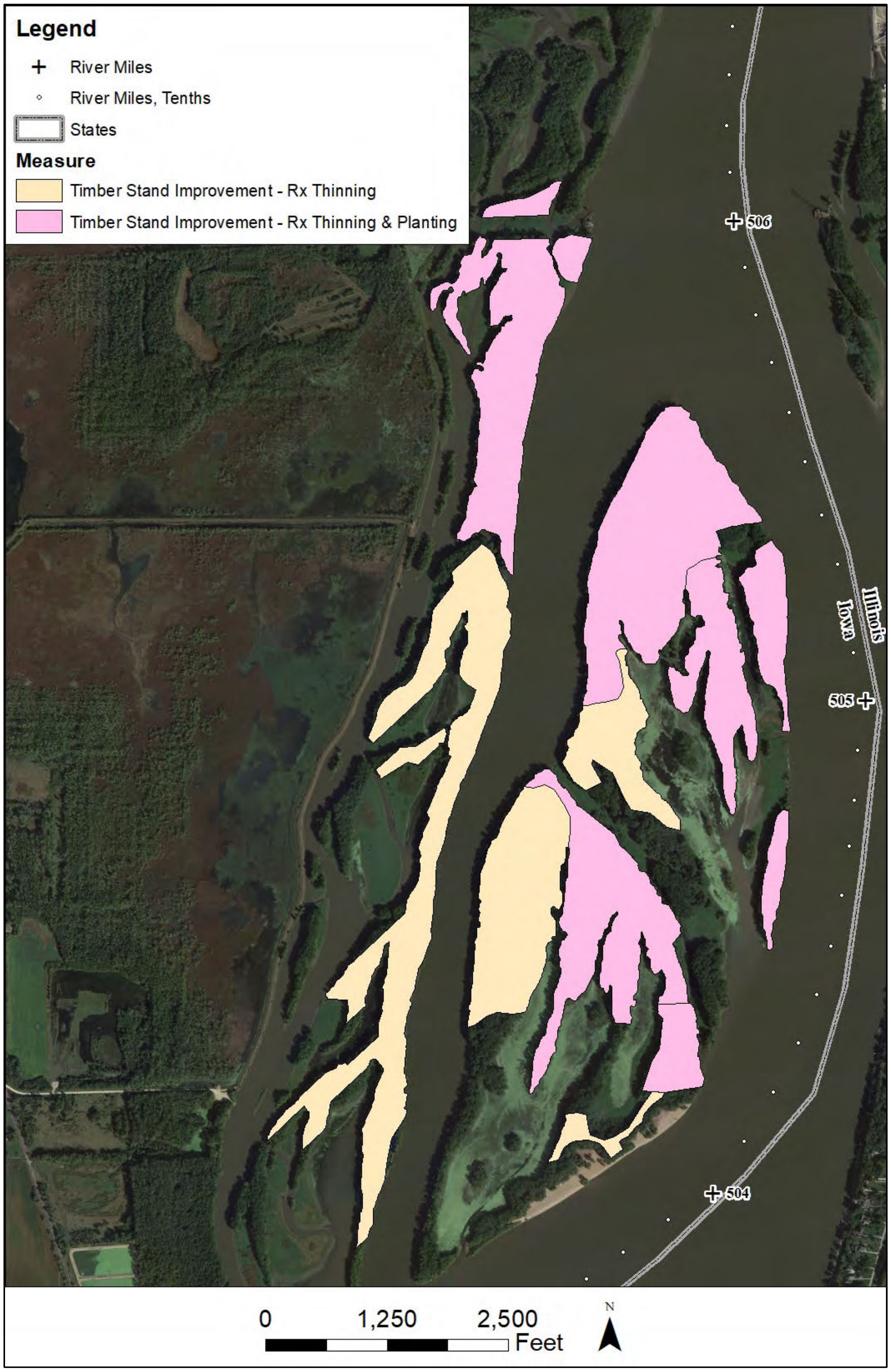


Figure M-F-1. Timber Stand Improvement Prescriptions

Areas identified during the stand walk recon to have low or no risk to having no feature development of implementing timber stand improvements are not included in this summary. Only areas that will degrade or continue to degrade for the next 50 years without action (implemented silvicultural prescription) are described in this summary.

The entire stand walk recon area in general is comprised of mature forest having well-established trees in the canopy. The primary forest community types are silver maple and mixed silver maple with very limited natural regeneration and desirable understory establishment. Overall, the summarized forest management areas collectively have trees in the canopy that will not persist past life of this HREP project. The main consideration of concern is that there is limited or no adequate stocking of trees to replace the expected mortality of trees in the canopy that are reaching expected maximum age of the most prevalent tree species.

For life of this project, in general, there is the expectation that the forest structure dynamics will alter greatly with reduction in forest canopy at unpredictable rates and patterns. This is primarily a result of the overall condition of the forest being well pass overstocked tree densities. Areas well past overstocked have a negative effect on new, developing, and mature trees alike. The condition of overstocked forest should be considered as a measure that represents a chronic condition not providing adequate growing space to promote natural recruitment and to the healthy establishment of trees below the forest canopy. The only corrective option to alter long-term impacts of an overstocked forest is through reduction of trees by thinning treatments or timber harvest. For multiple considerations, thinning treatments are the recommended option to provide adequate growing space and to increase tree health, structural diversity, and sustainable longevity.

Most prescriptions will require the contractor to first mark trees to cut and/or mark trees to save prior to any actual tree cutting occurs to meet the prescription targets. Following approval of tree cutting selection, the contractor will then be capable to proceed with the actual tree cutting. Prescriptions that specify that the government will mark trees will be done so by project forester and PDT members prior to contract award. Tree planting varies by species, stock type, and density depending on identified area capability, priority considerations to forest growth, and anticipated risk to natural regeneration limitations.

All tree cutting for thinning treatments is intended to only occur outside the bat tree roosting season; from October 1st to March 31st. The anticipated method of tree cutting is to be conducted by hand crews and chainsaw operation. Areas that are anticipated to have use of heavy equipment during tree thinning efforts will be addressed specifically. Otherwise, the general assumption is that work will be conducted by hand crews to implement the silvicultural prescription.

Tree and/or shrub planting efforts are primarily intended to be conducted using containerized stock. In general, containerized stock is expected to be at minimal height of 4 feet tall from the root collar to the terminal leader. Species that are known to not reach this height at the nursery include species of hickory, walnut and Kentucky coffeetree – for these species, the minimum intended tree height is 14 inches. All containerized tree planting is expected to occur from middle of October up to one week prior to frozen ground conditions – most years this would be the first week of December. Trees and shrubs are likely to only have a soil disturbance of a depth of 14 inches at the maximum. If conditions are anticipated to be different or different planting stock is used, that will specifically be addressed for that prescription. Otherwise, the general assumption is to be that tree and shrubs will be containerized and planted in the fall planting season. Utility vehicles are likely to be used to transport trees and shrubs.

The following area summary information further details specific to each described area beyond what has been addressed under the general information. Unless otherwise expressed, current forest condition descriptions are considered to be reflective to the overall general information discussed thus far.

Silvicultural Prescriptions – Timber Stand Improvement (TSI) Features

UNIT 1 – UPPER STEAMBOAT ISLAND

SITE 1 **p014c002u001st01**

I. Current Forest Condition **63 acres**

- The forest structure diversity is the most unique throughout this site in comparison to all other areas seen during the stand walk recon. Forest structure changes greatly within a short distance; i.e. variance in forest development and structure dynamics change approximately every 100 feet.
- The timber inventory only captures 6 tree species (none are hard mast) in this stand, so the tree species diversity is very low even though the area has elevation thresholds that are supportive to a diverse range of tree species.
- This area has some of the better snags seen during the recon that have the potential to provide maternity roost for bats.
- Average stand health and age is reflective to the overstory: healthy and mature
- Variance of size class distribution is very abrupt throughout this area and not consistent. There is continual transition from dense understory to no understory and ranges of multiple age cohorts mixed sporadically throughout.

II. Risk to Forest without TSI Feature

- There is currently no hard mast trees within this area that could provide a seed source to recruitment of naturally established hard mast seedlings. This area has suitable areas for establishment of hard mast trees. Without planting hard mast tree species, species diversity will remain low within this area.
- Planting hard mast trees across the entire area would require a significant amount of tree cutting. This would be detrimental to the current sporadic, complex structural diversity of the area. The forest structural diversity is desirable important to maintain.
- Native shrubs are in decline across all forested areas within pool 14. This area has a diverse mixture of native shrubs. Conditions are not favorable for the continual natural establishment of native shrubs with the current pattern of canopy closure and spatially position of native shrub remnants.
- Mature trees are likely to die unpredictably throughout the area. Specifically, clusters of mature silver maple trees that are limited to individual growing space. Individual selection of trees within these large clusters by creating bat roosting trees could be incorporated to reduce individual mature tree growth stress. Without selecting potential bat roosting trees, mature trees will continue to stress out in large clumps and potentially all die at the same time instead of a staggered pattern; this would lead to forest gap creation without favoring which trees remain.

III. Silvicultural Prescription (2 Rx's including 40 acres maximum)

A. Species Diversity Establishment — 20 acres

- Free Thinning with tree and shrub planting
- Government marked – project forester with PDT members
- Targeted to higher elevations within site forest managed area. 10 to 5 patches total to be selected to for thinning treatments. Patch size is to vary from smallest being 2 acres and up to 4 acres in size. Maximum of 20 acres total.
- Within the majority of the patch, cutting is to reduce the canopy to only 30% of canopy trees remaining. Trees below the canopy: target to keep up to 5 trees per acre (TPA). All other trees are to be cut down.
- Selection of canopy trees to keep will favor cottonwood, green ash, and hackberry as priority – then by all additional species. Desired canopy structure of remaining canopy trees will be full crown, large upper limbs, and location to maintain an average of 30% canopy closure. All trees of poor structural development are to be selected first for cutting.
- Selection of patches will be done to avoid potential maternity roost trees
- Selection of trees below the canopy layer to keep will be based on overall tree vigor and structural development. Target is to retain only the best in form.
- The north and eastern edge of the patch will have limited canopy tree removal. Trees selected to be cut will be at approximately a maximum extent of 60 feet past the 70% canopy reduction in a halo fashion of the northeastern edge of the patch. Selection of canopy trees to cut will be based on impediment to establishment of native shrubs. Target is to increase understory development. Maximum removal of canopy trees within halo area will be 40%.
- Tree species to plant: black walnut, swamp white oak, bur oak, pin oak, northern pecan, bitternut hickory, river birch, sycamore, and Kentucky coffeetree.
- Shrub species to plant: eastern wahoo, eastern redbud, American plum, gray dogwood, common elderberry, strawberry bush, indigo bush, and buttonbush
- Planting is to be a third of total planting density across three planting years.
- Trees are to be planted at a density of 36 per acre
- Shrubs are to be planted at a density of 60 per acre

B. Maternity Bat Roosting Habitat Creation — 20 acres

- Free Thinning and shellbark hickory planting
- Government marked – project forester with PDT members
- Targeted to dense, overstocked areas of mature silver maple in the canopy. The mature silver maple trees will need to be greater than 20 inches in diameter at breast height (dbh). Identify mature silver maple groups of 2 to 3 acres in size. 10 to 6 locations are to be selected for thinning treatments.
- Within selected thinning area, selection of 4 silver maple trees greater than 20" dbh will be double girdled and treated with herbicide. Silver maple trees with large upper limbs are priority to selection of being girdled.
- All tree cutting is to occur from October 1st to December 31st.
- All trees that are less than 12" dbh are to cut down expect for select individuals. Only up to 10 individual trees are to be selected within the thinning area that are under 12" dbh are to remain. Only cut mulberry is to be treated with herbicide. The target is to only cut trees within an established patch extending out 65 feet from the main stem of the 4 girdled silver maple trees.

- All trees greater than 12" dbh will remain uncut except for the 4 selected silver maple trees to be girdled for future potential bat roosting.
- Only shellbark hickory will be planted within the tree cutting extents. A total of 60 hickory trees will be planted per acre favoring canopy opening position.
- Planting is to be a third of total planting density across three planting years.

IV. Measurement of Impact

- Tree densities vary greatly across entire site. The average trees per acre across the site is 134 TPA. Cutting is most likely to be less than the average TPA and more importantly, will not exceed the potential tree cutting average. Cutting in the species diversity patches, will include up to 72% of trees or an average of 96 TPA: total of 20 acres within the 63 acre site. Cutting for the maternity bat roosting habitat creation, will include up to 45% of trees or an average of 45 TPA: total of 20 acres within the 63 acre site.
- Tree cutting for both treatments will include trees of all diameter sizes.
- Areas outside of the patch thinning and maternity bat roost habitat creation may require limited clearing of small diameter trees for contractor access to and from each cutting area for planting efforts. Intent will be to utilized routes that are the most open to minimize need for clearing for access paths.

SITE 2 **p014c002u001st02**

I. Current Forest Condition **39 acres**

- Minor and scattered canopy gaps are currently existing without any significance to natural tree regeneration success. Lighting conditions appear to be collectively too low for recruitment.
- Pin oak, sycamore, and Kentucky coffeetree well distributed in western finger of the site. This location of diversity is less than 8 acres of the recon area.
- Silver maple includes an average of 70% of total trees present within the recon area. There are 8 other tree species captured during the inventory, however, evenness and distribution of those species is very low.
- Overall, trees in the canopy are on average in good health and have the capability to continue to grow and persist during the life of project.

II. Risk to Forest without TSI Feature

- Individual tree health, development, and growth below the canopy is in high decline and in poor condition. Without reduction in tree stocking, this condition will continue and increase in severity over time. If and when canopy trees have mortality, there is very limited suitable trees to re-establish the canopy.
- Current canopy shading is likely to be hindering the ability for new trees to establish. To not reduce competition and create adequate growing space, this will continue to occur and the best case natural response is for small patches of trees to establish versus evenly throughout the walk area.
- Location of diverse tree species is unlikely to provide adequate seed source to increase diversity throughout the site. Without planting a diversity of tree species there is no expectation that an increase in forest diversity will occur.
- Trees in the canopy currently are, on average, healthy. Comparatively this area is a few decades behind in average canopy age development to other recon areas in the HREP footprint. It is expected, based on what has been observed in further established canopies, that health will follow the pattern of mature trees declining due to lack of available growing space.

III. Silvicultural Prescription

- Geometric Thinning with tree planting
- Target is to cut only silver maple and some hackberry and American elm.
- Objective is to reach an average basal area (BA) threshold of 110 BA; allowing to mark between a residual of 100 BA to 120 BA per any given location.
- BA threshold is to be achieved by targeting and only cutting trees having poor crown development, significant lean, broken tops, and major defect. Trees selected for cutting will need to be greater than 12"dbh and under 34"dbh.
- Planting trees will then be focused to specific conditions: favoring canopy gaps (created and naturally existing), at least 40' from the main stem of any tree greater than 18"dbh, and to avoid obviously low, poorly drained areas.
- Tree species to plant: pin oak, swamp white oak, northern pecan, sycamore, Kentucky coffeetree, cottonwood, and river birch.
- Planting a total amount of 462 trees throughout the treatment area.
- Half of the total trees are to be planted during two separate planting years.
- Planting effort will include additional tree cutting as needed. All mulberry and silver maple under 12"dbh within 10 feet of any planted tree will need to be cut. Requirement will be to plant to avoid and reduce the need for further cutting.

IV. Measurement of Impact

- A total of 36 acres is to be included in the treatment implementation.
- Tree density is relatively even throughout the site; average TPA is 88. Tree cutting will include up to 31% of trees or an average of 27 TPA.
- Reduction of the canopy will include only cutting silver maple, hackberry, and American elm ranging from 12"dbh to 34"dbh.
- Planting effort may include limited tree cutting of all mulberry and potentially silver maple under 12"dbh. This will depend on adequate space to under plant into canopy gaps without the need to cut. Expectation is that approximately 100 to 350 trees total would need to be cut during planting efforts.
- All cut mulberry would be treated with herbicide.

SITE 3, Stand 10 **p014c002u001st03s010**

I. Current Forest Condition **5 acres**

- The average TPA for Site 3 is the lowest in comparison to all other walk areas. For the majority of the HREP boundary, the TPA on average is well below half of all other areas. Trees below the forest canopy are almost non-existent.
- The average canopy tree is very large in diameter (quadratic mean diameter is extremely high - 24" - and very old.) Stand age is averaged at 1920; trees are not expected to live the duration of project.
- Silver maple is the only tree species in the canopy for this stand, which is also unique to only this area for the entire stand walk recon assessment.
- Very few trees in the understory exist, none of which are silver maple. Only buttonbush, mulberry, and American elm exist sparsely throughout.

II. Risk to Forest without TSI Feature

- Trees in the canopy are very old and very large within Stand 10. These individuals in the canopy have significantly impeded the growth and form of any tree in the understory. Without action, this stand is very unlikely to remain in forest cover. Development of a closed canopy over 80 feet tall is not expected to occur naturally.
- None of the trees below the canopy are capable to replace trees that will die out of the canopy. Without management, this stand will continue to degrade.
- The establishment of non-native herbaceous vegetation and scraggly mulberry is very likely to occur as natural succession to the area. Rate of change is expected to be unpredictable and the duration of transition to a lessor forested condition is difficult to foresee.
- Complete removal of canopy is not desirable for wildlife utilization and evenly spaced residual trees is problematic to wind throw. Tree selection for residual seed dispersal and structural dynamics needs to be conducted to maximize sunlight availability for tree establishment and to reduce risk to wind throw.

III. Silvicultural Prescription

- Free Thinning with tree planting
- Government marked – project forester with PDT members
- Target clusters of up to 10 silver maple trees to remain as a group of trees for potential seed dispersal. Selection of residual trees is to favor trees with best health, full crown, and without major defect at the base.
- Target is to maintain, on average, 35 TPA throughout the stand.
- Trees with significant cavities are to be favored to keep.
- All trees less than 16"dbh are to cut with the intent of coppice. Tree stumps are to be a clean, flush cut with a target stump height of 3 inches. The intent is to promote viable stump sprouts.
- All mulberry is to be cut and treated with herbicide.
- Maximum distance between remaining groups of trees is to be 200 feet from canopy edge to canopy edge.
- All slash from cut trees is to be removed. This will be needed to maximize capability and execution of tree planting efforts.
- Trees species to plant: sycamore, river birch, cottonwood, and silver maple.
- A total of 752 trees are to be planted evenly throughout the stand. Target is to remain 10 feet from any stump under 18" in diameter and past the remaining tree canopies.
- Half of the total trees are to be planted during two separate planting years.

IV. Measurements of Impact

- A total of 5 acres is to be included in the treatment implementation.
- Tree density is relatively even throughout the site; average TPA is 56. Tree cutting will include up to 38% of trees or an average of 21 TPA.
- Tree cutting will include trees of all diameter sizes.
- All cut mulberry would be treated with herbicide.
- Heavy equipment for the removal of all tree slash for the stand is likely. This is expected to include access to the stand by barge.

SITE 4, Stand 18 **p014c002u001st04s018**

I. Current Forest Condition **18 acres**

- The canopy trees on average for Stand 18 are in healthy condition and are just over 50 years old. This is very unique to the collective recon areas. This area has the best condition of trees in the canopy measured by overall tree health condition and average canopy age.
- Understory trees include very few trees that have not been suppressed or showing signs of decline. That small percentage of understory trees that are in favorable condition to continue to develop are scattered throughout.

II. Risk to Forest Without TSI Feature

- Currently, this is the area has a canopy in the best condition. However, this stand is currently well past available growing space in the measure of being overstocked. To not favor the winners in the canopy now, nature will select at random which trees will have decline and potentially mortality.
- Currently, this stand is at a condition that requires very little modification to change growing conditions for the better that will promote vigorous growth for several decades. To not thin here now is an opportunity that will be missed to provide a lasting positive effect in forest growth.
- To evenly cut throughout the stand will require too much cutting. Selective cutting is the best overall strategy to minimize impact and provide results.
- If there is no thinning of the canopy, the few individuals in the understory that are in good condition will be expected to decline. Additionally, there is no expectation for any new trees to establish under the current shade and available growing space. Thinning the canopy to favor the trees in the canopy will have a secondary effect to improving conditions for the understory.

III. Silvicultural Prescription

- Crown Thinning
- Selection of individuals in the canopy is to be conducted at a rate of 5 to 10 TPA. All species will be considered for selection. Selected trees are to have a healthy crown, not having a lean greater than 20%, and no major defects.
- Targeted trees selected for release are to range from 12”dbh to 18”dbh.
- Thinning is intended to have trees cut that are over 30 feet tall within proximity to the selected release tree. Any crown of any tree within 10 feet of the selected release tree is in consideration to be cut. A reduction of 50% to 80% of said competing trees is to be cut down.
- No herbicide application. Cut trees are to be allowed to stump sprout.

IV. Measures of Impact

- A total of 18 acres is to be included in the treatment implementation.
- Tree density is relatively even throughout the site; average TPA is 128. Tree cutting will include up to 39% of trees or an average of 50 TPA.
- Reduction of the canopy will include all tree species and all diameter sizes.

UNIT 3 – LOWER STEAMBOAT ISLAND

SITE 1 p014c002u003st01

I. Current Forest Condition 39 acres

- The canopy at this site is on the extreme end of average stand age for the recon areas. The canopy age on average is just over 80 years old.
- The understory conditions are very poor. The overall condition of any tree below the canopy is in significant decline. These trees are not favorable to replace and establish into the canopy.

II. Risk to Forest without TSI Feature

- The average tree in the canopy is expected to continue to be under stress and collectively the rate of mortality will rapidly increase within the next 20 years. Silver maple average life expectancy is 100 years. Without reducing the stress of canopy trees by creating space by implementing a thinning treatment, canopy trees will not likely persist longer than the average life expectancy.
- Without a reduction of trees to create available growing space, there is no expectation that conditions for the understory will improve evenly across the site. Without available growing space and adequate sunlight to the forest floor conditions will not be favorable for the establishment of advanced natural regeneration to a sustainable population density.

III. Silvicultural Prescription

- Geometric Thinning
- Target is to cut only silver maple. No other trees species will be cut.
- Objective is to reach an average basal area (BA) of silver maple to be at a threshold of 60 BA; allowing to mark between a residual of 50 BA to 70 BA per any given location for silver maple trees.
- BA threshold is to be achieved by targeting first to cut silver maple trees having poor crown development, significant lean, broken tops, and major defect. Then silver maple trees are to be selected at random to reach the BA threshold of 60.
- Trees selected for cutting will need to be greater than 8”dbh.
- No herbicide application. Cut trees are to be allowed to stump sprout.

IV. Measurement of Impact

- A total of 39 acres is to be included in the treatment implementation.
- Tree density is relatively even throughout the site; average TPA is 132. Tree cutting will include up to 34% of trees or an average of 45 TPA.
- Reduction of silver maple will include all trees greater than 8”dbh.

SITE 2 p014c002u003st02

I. Current Forest Condition 45 acres

- The tree species diversity for this site is the highest for all of the recon areas. Specifically, the amount of Kentucky coffeetree is noteworthy. There is a very well distribution of coffeetree and all individuals are in good form and health. To a lessor occurrence, and not captured in the inventory, there are black walnut, eastern redbud, and northern catalpa in the northern edge of the site near the slough that divides the northern and southern portion of Steamboat Island. In total, there were 12 tree species captured in the timber inventory.

- Even with the species richness to the site, silver maple is the dominant tree species. Over 50% of the trees for this site are silver maple.
- The canopy at this site is on the extreme end of average stand age for the recon areas. The canopy age on average is just over 80 years old.
- The understory is a random mixture of trees that are without significant decline and individuals that are suppressed and in decline.

II. Risk to Forest without TSI Feature

- The average tree in the canopy is expected to continue to be under stress and collectively the rate of mortality will rapidly increase within the next 20 years. Silver maple average life expectancy is 100 years. Without reducing the stress of canopy trees by creating space by implementing a thinning treatment, canopy trees will not likely persist longer than the average life expectancy.
- Without a reduction of trees to create available growing space, there is no expectation that conditions for the understory will improve evenly across the site. Without available growing space and adequate sunlight to the forest floor conditions will not be favorable for the establishment of advanced natural regeneration to a sustainable population density.
- Tree species diversity is currently high; 15 tree species currently known to occur, more may be present. Without available growing space created through a thinning effort, there is no expectation that species distribution will occur naturally or expand upon current tree distribution and evenness.
- Tree planting will be needed to ensure maximum gain will occur from the minimal amount of tree thinning. The majority of the slower growing tree species require ample sunlight and space for natural establishment. Without planting, there is the expectation that only a minimal recruitment of slower growing species will occur prior to fast growing tree species filling in any created growing space. The risk without planting also includes an opportunity missed to increase the actual evenness of tree species throughout the site.

III. Silvicultural Prescription

- Geometric Thinning with tree planting
- Target is to cut only silver maple and some hackberry. No other trees species will be cut to reach stocking and creation of available growing space.
- Objective is to reach a total basal area (BA) of 100 BA; allowing to mark between a residual of 90 BA to 120 BA per any given location.
- BA threshold is to be achieved by targeting first to cut silver maple trees having poor crown development, significant lean, broken tops, and major defect. Then silver maple and hackberry trees are to be selected at random to reach the overall BA threshold of 100.
- Exception to the selection of trees to be cut; a maximum of 40 TPA is to be a limit of how many trees can be cut for any given acre. Target is to cut less than 40 TPA across the treatment area.
- Trees selected for cutting are to range between 10"dbh to 18"dbh.
- No herbicide application. Cut trees are to be allowed to stump sprout.
- Tree planting will follow thinning treatment. Target is to plant trees into canopy gaps; naturally occurring and created.
- Planted trees are to be no closure than 40 feet from the main stem of any tree greater than 18"dbh. Additionally, trees must be at least 10 feet away from any planted tree. Distribution is to be evenly throughout at random within gaps.

- Planting is to focus to the higher elevations of the site; approximately 14 acres in total – concentrated mostly to the upstream end of the site.
- Tree species to plant include: Kentucky coffeetree, swamp white oak, pin oak, bur oak, northern pecan, bitternut hickory, and black walnut.
- A total of 280 trees are to be planted. Planting half of the total amount is to occur over the course of two planting seasons.

IV. Measurement of Impact

- A total of 44 acres is to be included in the treatment implementation.
- Tree density is relatively even throughout the site; average TPA is 155. Tree cutting will include up to 26% of trees or a maximum of 40 TPA.
- Reduction of silver maple and hackberry will include trees 10"dbh to 18"dbh.

SITE 3, Stand 46 **p014c002u003st03s046**

I. Current Forest Condition **9 acres**

- The average canopy tree is large in diameter and very old for Stand 46. This area is very different by forest structure for the average metrics identified for other stands on average within Site 3. The Site 3 summary information is not reflective for Stand 46. Trees in the canopy are not expected to live half way past the duration of the HREP project.
- Isolated hard mast trees are present; however, these trees are mature and a very few individuals. There is no hard mast regeneration, saplings, or pole size trees; no hard mast tree exist below the canopy.
- Silver maple is the primary tree species in the canopy for this stand.
- Very few trees in the understory exist, none of which are silver maple. Trees that are present are in very poor development form and are stressed. The majority of understory trees are near the forested edge.

II. Risk to Forest without TSI Feature

- Trees in the canopy are very old and very large within Stand 46. These individuals in the canopy have significantly impeded the growth and form of any tree in the understory. Without action, this stand is very unlikely to remain in forest cover. Development of a closed canopy over 80 feet tall is not expected to occur naturally back to the stand's current condition.
- None of the trees below the canopy are capable to replace trees that will die out of the canopy. Without management, this stand will continue to degrade.
- The establishment of non-native herbaceous vegetation and scraggly mulberry is very likely to occur as a natural succession to the area. Rate of change is expected to be unpredictable and the duration of transition to a lessor forested condition is difficult to foresee.
- Complete removal of canopy is not desirable for wildlife utilization and evenly spaced residual trees is problematic to wind throw. Tree selection for residual seed dispersal and structural dynamics needs to be conducted to maximize sunlight availability for tree establishment and to reduce risk to wind throw.

III. Silvicultural Prescription

- Free Thinning with tree planting
- Government marked – project forester with PDT members

- Target clusters of 10 to 20 trees to remain as a group of trees for potential seed dispersal. Selection of residual trees is to favor trees with best health, full crown, and without major defect at the base.
- Target is to maintain, on average, 80 TPA near 75 BA throughout the stand.
- Trees with significant cavities are to be favored to keep as an exception.
- All trees less than 16"dbh are to cut with the intent of coppice. Tree stumps are to be a clean, flush cut with a target stump height of 3 inches. The intent is to promote viable stump sprouts.
- All mulberry is to be cut and treated with herbicide.
- Minimum distance between remaining groups of trees is to be 80 feet from canopy edge to canopy edge. No maximum extent.
- All slash from cut trees is to be removed. This will be needed to maximize capability and execution of tree planting efforts.
- Trees will be planted post thinning treatment. There will be three years of planting; 1st and 2nd year will be planting 18" tall bare root seedlings and the 3rd year will be planting containerized trees.
- Bare root seedling tree species to plant: river birch, silver maple, green ash, and sycamore. A total of 2,400 bare root seedlings will be planted each year. The bare root seedling planting will occur from March 20th to May 20th.
- Containerized tree species to plant: river birch, cottonwood, sycamore, swamp white oak, and northern pecan. A total of 600 containerized trees are to be planted evenly throughout the established bare root seedlings.
- A total of 5,400 trees are to be planted evenly throughout canopy gaps over the course of three tree planting seasons. Target is to remain 10 feet from any stump under 18" in diameter and past the remaining tree canopies.

IV. Measurement of Impact

- A total of 9 acres is to be included in the treatment implementation.
- Tree density is variable across Site 3; Stand 46 is to be considered to have less trees than the site average TPA of 188. Tree cutting, based on Site 3 average, would include up to 59% of trees or an average of 110 TPA. Expectation is that a much lower amount of trees will be cut per acre; however, impact of canopy openness will still be reflective to including over half of the canopy removal.
- Tree cutting will include trees of all diameter sizes.
- All cut mulberry would be treated with herbicide. All other tree species are to be allowed to stump sprout.
- Heavy equipment for the removal of all tree slash for the stand is likely. This is expected to include access to the stand by barge.

SITE 3, Stand 48 **p014c002u003st03s048**

I. Current Forest Condition **4 acres**

- Stand 48 is very uniform to having primarily pole sized trees evenly throughout the stand. The Site 3 timber summary information is not likely to be reflective for Stand 48; the forest metrics are likely to be close, however, lower on average. Understory rating, tree species diversity, and average canopy age is definitely lower than the Site 3 average.
- The trees in the canopy for the most part are very well developed structurally and on average in good health. However, there is a fair portion of the trees showing signs of stress and

decline. All signs of decline is a direct and common correlation to a stand at this developmental stage being overstocked.

- There is limited to no understory development throughout the stand.

II. Risk to Forest without TSI Feature

- Currently, canopy for this stand is in good condition in comparison with the collective recon area. However, this stand is currently well past available growing space in the measure of being overstocked. To not favor the winners in the canopy now, nature will select at random which trees will have decline and potentially mortality.
- Currently, this stand is at a condition that requires very little modification to change growing conditions for the better that will promote vigorous growth for several decades. To not thin here now is an opportunity that will be missed to provide a lasting positive effect in forest growth.
- There is no expectation for any new trees to establish under the current shade and available growing space. Thinning the canopy to favor the trees in the canopy will have a secondary effect to improving conditions for potential natural regeneration to occur.

III. Silvicultural Prescription

- Crown Thinning
- A maximum target of a 40% reduction to the canopy is to be conducted.
- Tree species to cut will include primarily silver maple and some American elm and hackberry.
- Trees to cut will first be selected on the basis of having poor crown development, signs of stress, and major defect. Then trees will be selected at random, if needed, to create an evenly distributed canopy reduction of 40%.
- Trees to cut will range from 8”dbh to 18”dbh.
- No herbicide application. Cut trees are to be allowed to stump sprout.

IV. Measurement of Impact

- A total of 4 acres is to be included in the treatment implementation.
- Tree density is relatively even throughout the site. Stand 48 is to be considered to have less trees than the Site 3 average TPA of 188. Tree cutting, based on Site 3 average, would include up to 21% of trees or an average of 40 TPA.
- Reduction of silver maple, American elm, and hackberry will include trees 8”dbh to 18”dbh.

UNIT 4 – GRANT SLOUGH

SITE 1 **p014c002u004st01**

I. Current Forest Condition **96 acres**

- The canopy at this site is on the extreme end of average stand age for the recon areas. The canopy age on average is just over 80 years old.
- The understory conditions are marginal. The overall condition of trees below the canopy are for the most part in significant decline and suppressed. These trees are not favorable to replace and establish into the canopy.
- Silver maple consists of 90% of the tree species present in the entire area. There are eight other tree species within the stand (no hard mast species), however, those species abundance is greatly less than that of silver maple.

II. Risk to Forest without TSI Feature

- The average tree in the canopy is expected to continue to be under stress and collectively the rate of mortality will rapidly increase within the next 20 years. Silver maple average life expectancy is 100 years. Without reducing the stress of canopy trees by creating space by implementing a thinning treatment, canopy trees will not likely persist longer than the average life expectancy.
- In order to reach a threshold favorable to stimulate the opportunity and likely recruitment of natural regeneration would require a significant amount of tree cutting. This is not desirable for such a large area. By taking advantage of the long, narrow shape of the area, thinning trees in an orientation facing southwest will reduce the amount of trees needed to cut to meet needed levels of sunlight favorable to promote natural regeneration.
- Without a reduction of trees to create available growing space, there is no expectation that conditions for the understory will improve evenly across the site. Without available growing space and adequate sunlight to the forest floor conditions will not be favorable for the establishment of advanced natural regeneration to a sustainable population density.

III. Silvicultural Prescription

- Geometric Thinning
- The objective will be to cut trees in a systematic method evenly throughout the site to maximize sunlight availability to the forest floor, increase available growing space to the winners, and minimize the amount of trees to be cut.
- Cutting will occur in chevron swaths orientated at a direction of southwest to northeast. The width of the chevron will be 100 feet wide and chevrons will be offset by 60 feet apart as a buffer between cutting areas.
- Tree cutting is to only occur within the chevron swath. Only silver maple will be targeted to cut. The target is to reduce 25% of silver maple trees greater than 12"dbh within each designated chevron swath.
- Selection of cutting priority of silver maple will first consider: greater than 30% lean, major defect to the lower 25' of the tree, stressed or significant decline in health, poor crown development, and significant sweeps in the main stem. Then, selection to cut silver maple trees will be selected at random to meet the target of 25% removal.
- Objective is to target selection of trees as evenly as possible throughout the chevron swath. No clump of trees greater than 3 total shall be selected to avoid creation of large canopy gaps.
- No trees are to be cut in the buffer areas between the chevron swaths.
- Avoidance to snags greater than 18"dbh will be a priority.
- Objective is to favor trees with well-developed crowns and large upper limbs.

IV. Measurement of Impact

- A total of 48 acres is to be included in the treatment implementation.
- Tree density is relatively even throughout the site; average TPA is 128. Tree cutting will include up to 13% of trees or an average of 16 TPA.
- Reduction of silver maple will include trees greater than 12"dbh.
- A total of 48 acres will not have any tree cutting conducted. This reflects only half of the site having trees cut to implement the thinning treatment.

SITE 4 **p014c002u004st04**

I. Current Forest Condition 57 acres

- Snags are at a much lower occurrence than what is reflected in the timber inventory. In general, observations were such that snags are under 6" dbh on average and provided extremely limited roost potential for bats. Observations during the recon depict that 4 snags an acre is more reflective than 28 TPA.
- Silver maple consists of 86% of the TPA for this site. There is a very low tree species diversity and very low richness of species other than silver maple. The site has elevation that is supportive of tree diversity, however, there is no seed source for many tree species. There is currently no hard mast tree species.
- The mature trees in the canopy are on average over 70 years old. This recon area is not in the extreme end of life span, however, the abundance of old silver maple paired with suppressed understory trees and low regeneration is a high concern. This site is at high risk of negative, long-term forest structural and composition degradation.

II. Risk to Forest without TSI Feature

- Trees are likely to persist an average of 30 years prior to high levels of mortality. There is unlikely to be any suitable maternity roosting trees for bats without this thinning treatment in the interim.
- Trees in the canopy that are in good health condition and potential for growth are likely to transition to a stressed and significant decline without an increase to available growing space. To not conduct a thinning now will be a missed opportunity to improve growing conditions by means of minimal influence. Targeting the older and further mature trees will allow this area to remain in a closed canopy condition throughout the life of the HREP project.
- Without a reduction of trees to create available growing space, there is no expectation that conditions for the understory will improve evenly across the site. Without available growing space and adequate sunlight to the forest floor conditions will not be favorable for the establishment of advanced natural regeneration to a sustainable population density.
- Without planting additional tree species to increase site diversity, there is no expectation that said species will establish naturally. To not plant in pairing with a thinning treatment would be a missed window of opportunity to increase tree species diversity. The site is favorable for planting hard mast species.

III. Silvicultural Prescription

- Geometric Thinning with tree planting
- Target is to cut only silver maple. No other trees species will be cut to reach stocking and creation of available growing space.
- Objective is to reach a total basal area (BA) of 110 BA; allowing to mark between a residual of 100 BA to 120 BA per any given location.
- BA threshold is to be achieved by targeting first to cut silver maple trees having large upper limbs, significant lean, broken tops, and major defect. Then to target silver maple trees at random to reach the overall BA threshold of 110.
- Consideration is to be made in selection of silver maple trees to cut that will favor and benefit all tree species that have well established crowns, canopy position, and no major defect. These trees are to be considered to continue to grow for the next 40 to 50 years when provided adequate growing space.

- All selected silver maple trees to cut that are greater than 12”dbh and less than 18”dbh are to be cut down. Silver maple trees selected to be cut that are greater than 18”dbh are to be double girdled to create large diameter snags. Snag creation is to favor silver maple with large upper limbs by priority. Target is to have up to 5 created snags per acre; not to exceed 250 snags total. Trees that are greater than 18”dbh not selected to become a snag are to be cut down.
- No herbicide application will be applied to trees cut down. Cut down trees are to be allowed to stump sprout. All trees that are double girdled are to be treated with herbicide. Tree cutting is intended to only occur from October 1st to December 31st; this will increase effectiveness to herbicide application.
- Tree planting will follow thinning treatment. Target is to plant trees into canopy gaps; canopy gaps that are naturally occurring and created. A total of 300 trees will only be planted within this treatment area. This will allow for avoidance to obvious low areas and general proximity to any created snag.
- Planted trees are to be no closer than 40 feet opposite of the lean and 100 feet of the lean to the main stem of any double girdled tree. Planted trees are to be no closer than 30 feet from any tree greater than 8”dbh. Additionally, trees must be at least 10 feet away from any planted tree. Distribution is to be spread out, favor canopy openings, and avoidance to obvious low areas.
- Tree species to plant include: swamp white oak, pin oak, and northern pecan.
- A total of 300 trees are to be planted. Planting half of the total amount is to occur over the course of two planting seasons.

IV. Measurement of Impact

- A total of 51 acres is to be included in the treatment implementation.
- Tree density is relatively even throughout the site; average TPA is 176. Tree cutting will include up to 20% of trees or an average of 35 TPA.
- Reduction of silver maple will include trees greater than 12”dbh.

STEAMBOAT ISLAND HREP

APPENDIX M
DESIGN ENGINEERING

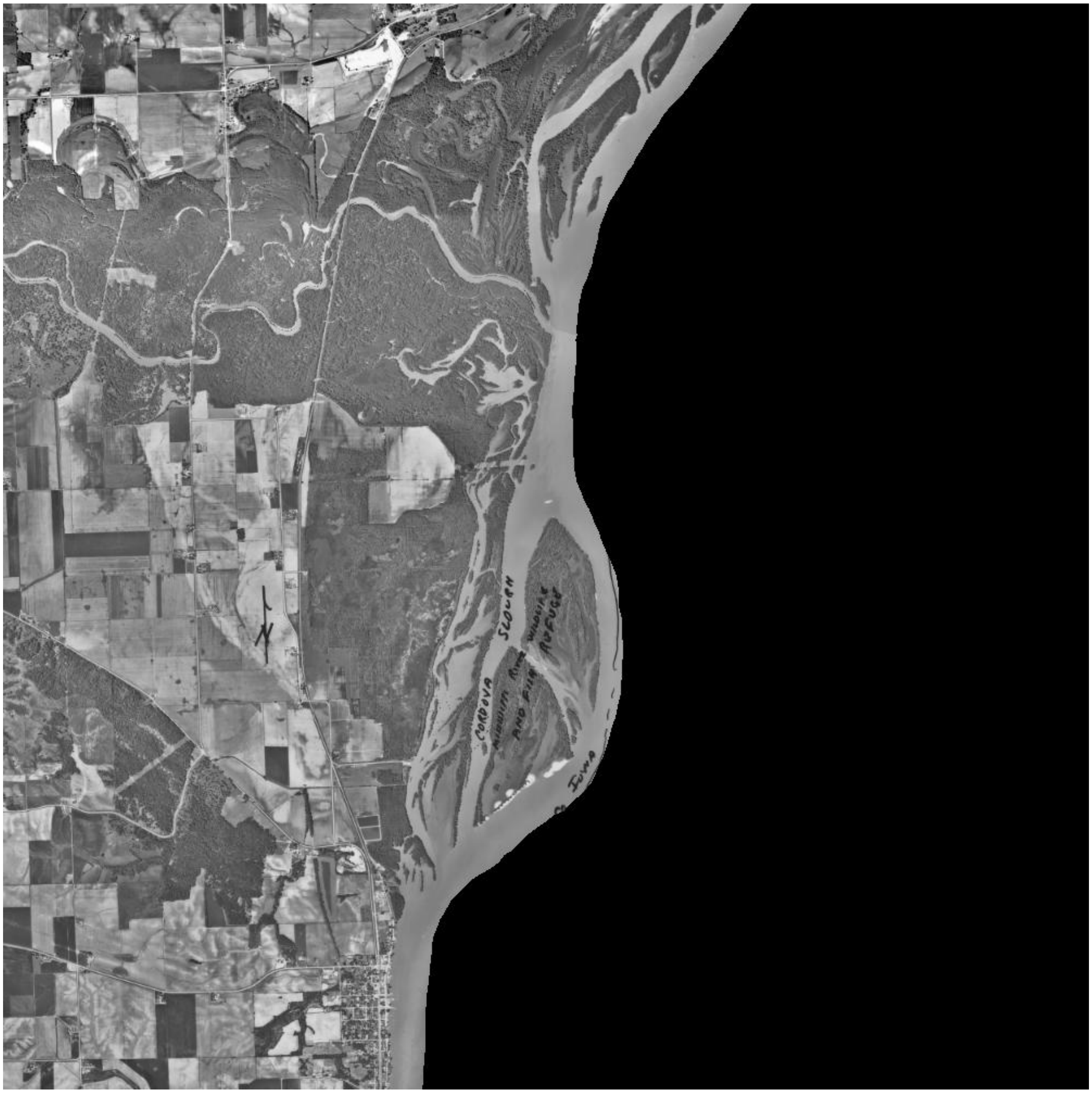
Attachment G
Photographs and Upper Mississippi River Navigation Charts

1927

1930s

1950s

1960s

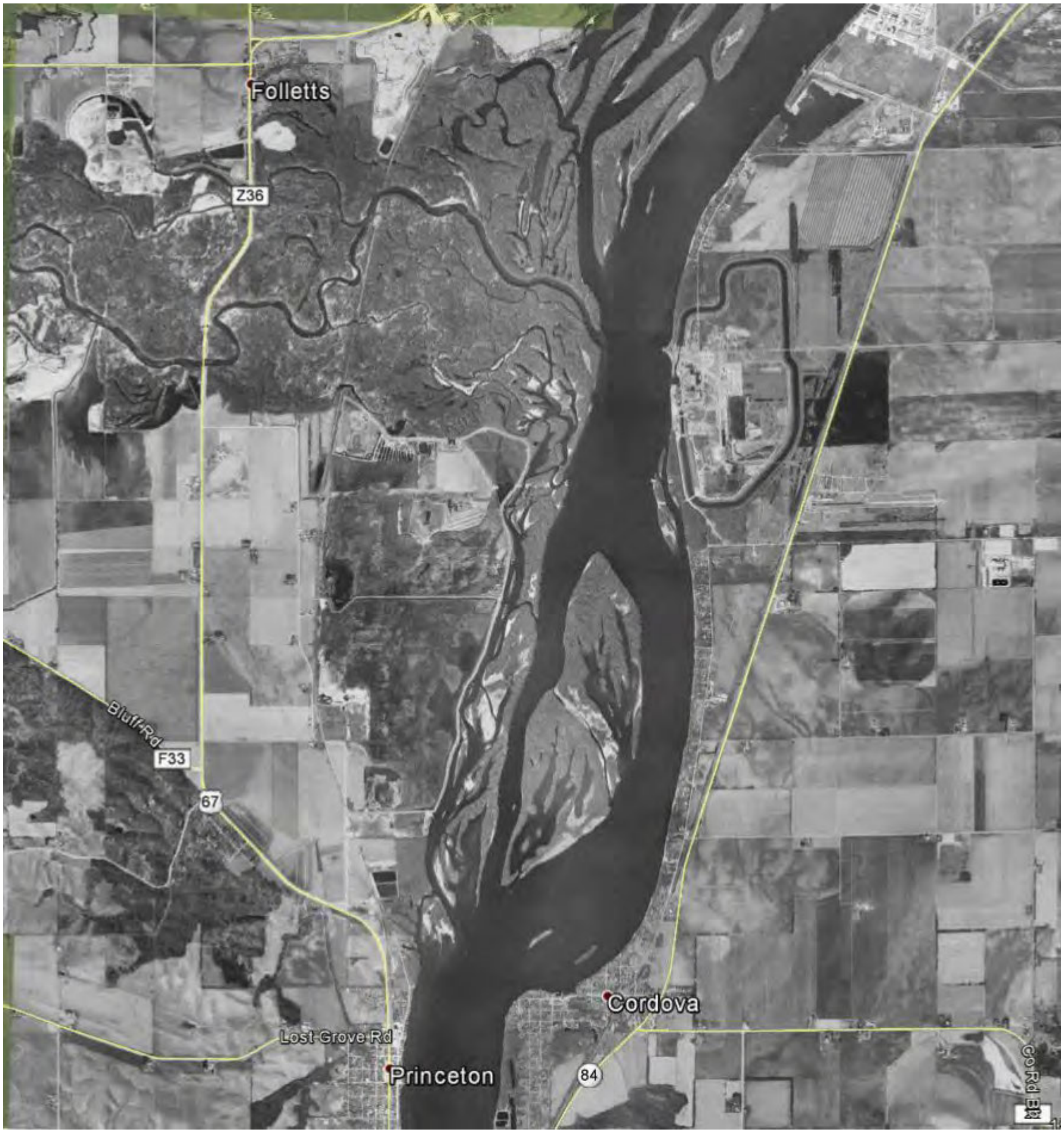


1970s

1980s


Folletts
Z36
Bluff Rd
F33
67
84
F45
Lost Grove Rd
Princeton
Cordova
Co Rd B

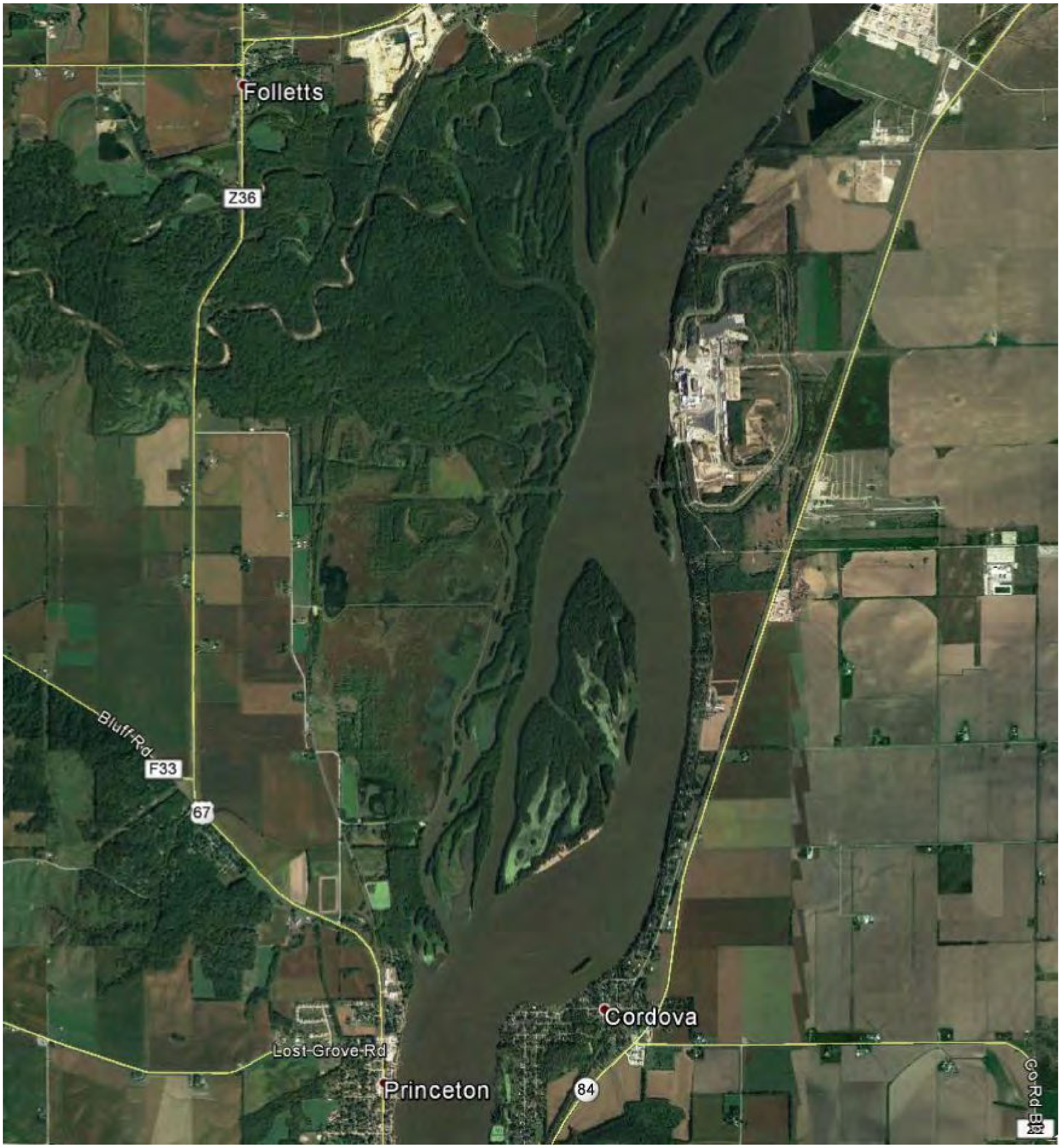
1990s


Folletts
Z36
Bluff Rd
F33
67
Cordova
Lost Grove Rd
Princeton
84

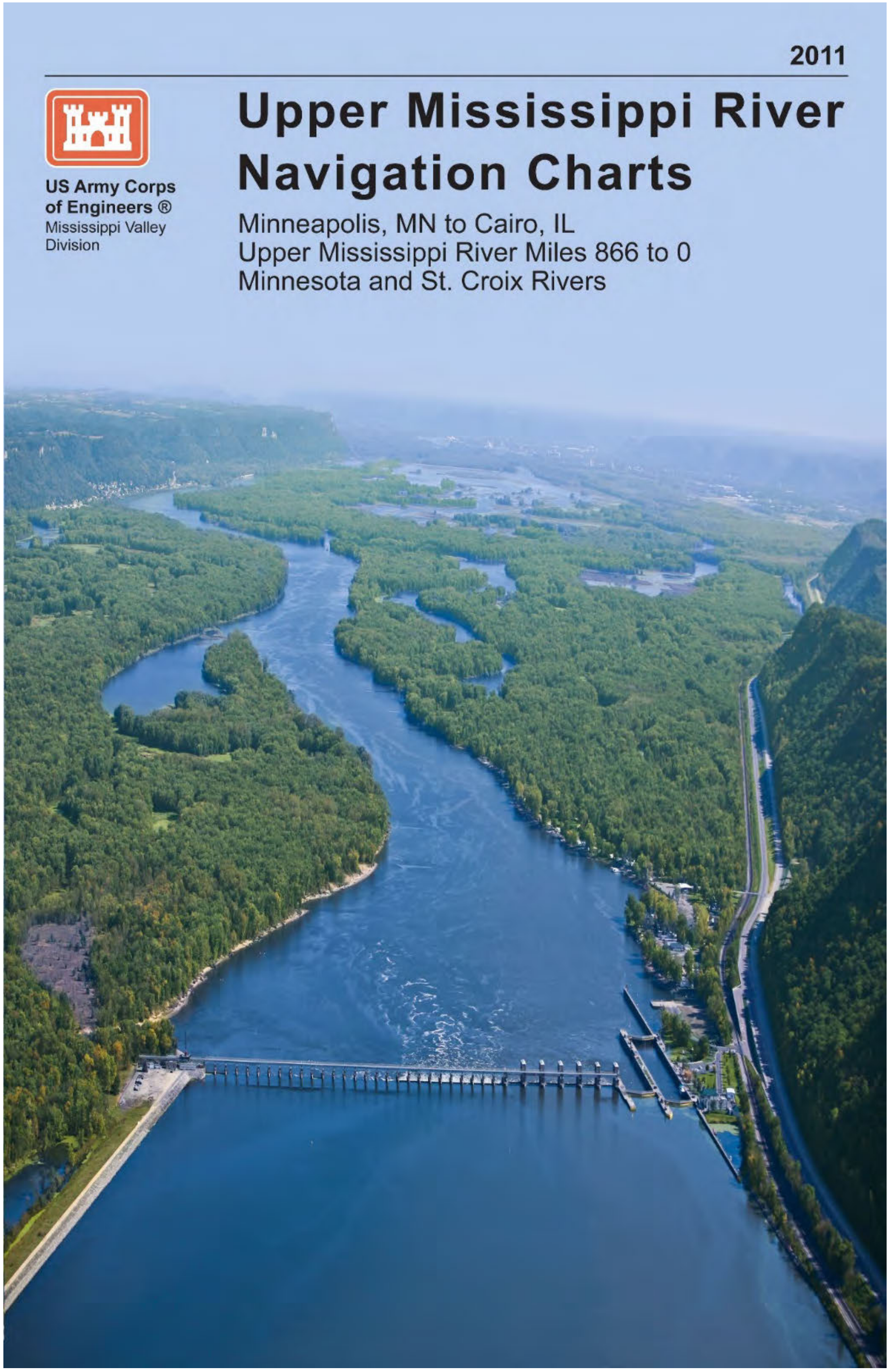
2000s


Folletts
Z36
Bluff Rd
F33
67
Lost Grove Rd
Princeton
84
Cordova
Co Rd BB

2010s



9/27/2017 (most recent aerial imagery)


2011
Upper Mississippi River Navigation Charts
US Army Corps of Engineers ®
Mississippi Valley Division
Minneapolis, MN to Cairo, IL
Upper Mississippi River Miles 866 to 0
Minnesota and St. Croix Rivers

NAVIGATION CHARTS OF THE UPPER MISSISSIPPI RIVER

prepared under the direction of the

U.S. ARMY ENGINEERS, MISSISSIPPI VALLEY DIVISION

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Charts were prepared from Inland Electronic Navigation Chart (IENC) data, supplemented by information surveys by the U.S. Army Corps of Engineers offices and from aerial photography taken 2008-2010.

Information denoted on these charts can change and, therefore, anyone utilizing the Upper Mississippi River must exercise caution and acknowledge the ever-present hazards of this natural resource.

Mariners are urged to report any conditions found to differ from those shown on the charts to the U.S. Army Engineer District, Rock Island.

Mileage as shown along the channel thalweg is measured from the intersection of the Ohio and Mississippi rivers near Cairo, Illinois. The mileage does not represent distances along the present sailing line.

The shoreline is for full pool at dams and discharges that are equaled or exceeded 90 percent of the time.

Locations of Navigation Aids are changed from time to time. The type of aid may also be changed; for example, a daymark may be replaced by a flashing light. The latest information concerning the aids may be obtained from the Commander, Eighth Coast Guard District, Hale Boggs Federal Building, 500 Poydras Street, New Orleans, Louisiana 70130.

The vertical clearance shown as high water indicates the approximate stage at which navigation ceases.

Channel widths generally 200 to 400 feet are available throughout the Upper Mississippi River.

The average navigation season from Rock Island, Illinois, to Minneapolis is 1 April to 1 December.

Remember it is not lawful to throw, discharge, or deposit from any barge or other floating craft of any kind, any refuse matter of any kind including oil, into any navigable stream of the United States.

Buoys or markers are placed along the sides of the channel at turns, at points where channels divide, at harbor and marina entrances, and to mark certain obstructions. Those along a given channel are placed in an increasing numbered sequence moving upstream or from seaward with the even-numbered markers on the starboard (right hand) side and odd numbers on the port (left hand). Buoys are set to mark the maximum navigation channel available considering channel alignments, the prevailing river stage, and obstruction. They do appear on the charts upstream of Mel Price Lock and Dam. Since buoys are moved frequently as channel changes occur, locations shown on these charts are only approximate. Mariners should review the Coast Guard Local Notice to Mariners for additional information.

TO PRESERVE THE RESOURCE

In each Mississippi River pool, lands acquired by the Corps of Engineers for the navigation project are managed in the public interest in accordance with a Master Plan for Resource Management. These plans are prepared by the respective District Engineers at St. Paul, Minnesota; Rock Island, Illinois; and St. Louis, Missouri. They are guides for the orderly development and management of all project lands for any purpose, including public park and recreational use, fish and wildlife enhancement, agricultural activities, soil and forest conservation, and the protection of the health and safety of the visiting public. The Corps solicits the cooperation and assistance of all interested Federal, State and local agencies in developing the Master Plans and providing the needed facilities.

The Master Plans recognize the unique, wild character of the Upper Mississippi River bottomlands and the desirability of preserving their wildlife resources. Consequently, most of the lands acquired for the navigation project have been made available for concurrent administration by the U.S. Fish and Wildlife Service for waterfowl management. Some of these same lands, in turn, have been made available to the States for fish and wildlife management purposes, including public hunting. Generally, except for areas which are posted at times as waterfowl sanctuaries, these same lands may be used for recreational activities. All other Corps lands not zoned for specific purposes are also open to free public use. Camping activity is normally restricted to designated recreation areas along state shorelines. Primitive camping is allowed on river island areas where dredge material beaches exist, unless the area is otherwise posted. Title 36 of the Code of Federal Regulations apply to such primitive camping activities with special concern for sections involving littering and sanitation, the cutting of the live vegetation, the construction of structures, and camping limitations involving camp for a period longer than 14 days during any 30 consecutive day period.

Attracted by the unique natural beauty and outstanding recreational opportunities of the Upper Mississippi River, ever-increasing numbers of visitors come to this valley each year. To facilitate their enjoyment of the river and, at the same time, to protect the natural resources of the project, the Corps of Engineers have developed a limited number of public access points, at selected sites. In relation to that program, special effort has been made in the preparation of the navigation charts to show roads leading to the river, all Federally owned lands under the jurisdiction of the Corps of Engineers and the U.S. Fish and Wildlife Service, and all established river access points, including those on private lands.

FOR GREATER ENJOYMENT

The right to use freely the lands and waters of the Upper Mississippi River Project is a privilege which carries with it some responsibilities. The area is large but the number of users is so great that there is competition for space. There are also certain hazards involved in water recreation. Under these circumstances it is considered necessary to suggest two guidelines for behavior in order that the resources of the project may be conserved and the public welfare protected. These are as follows:

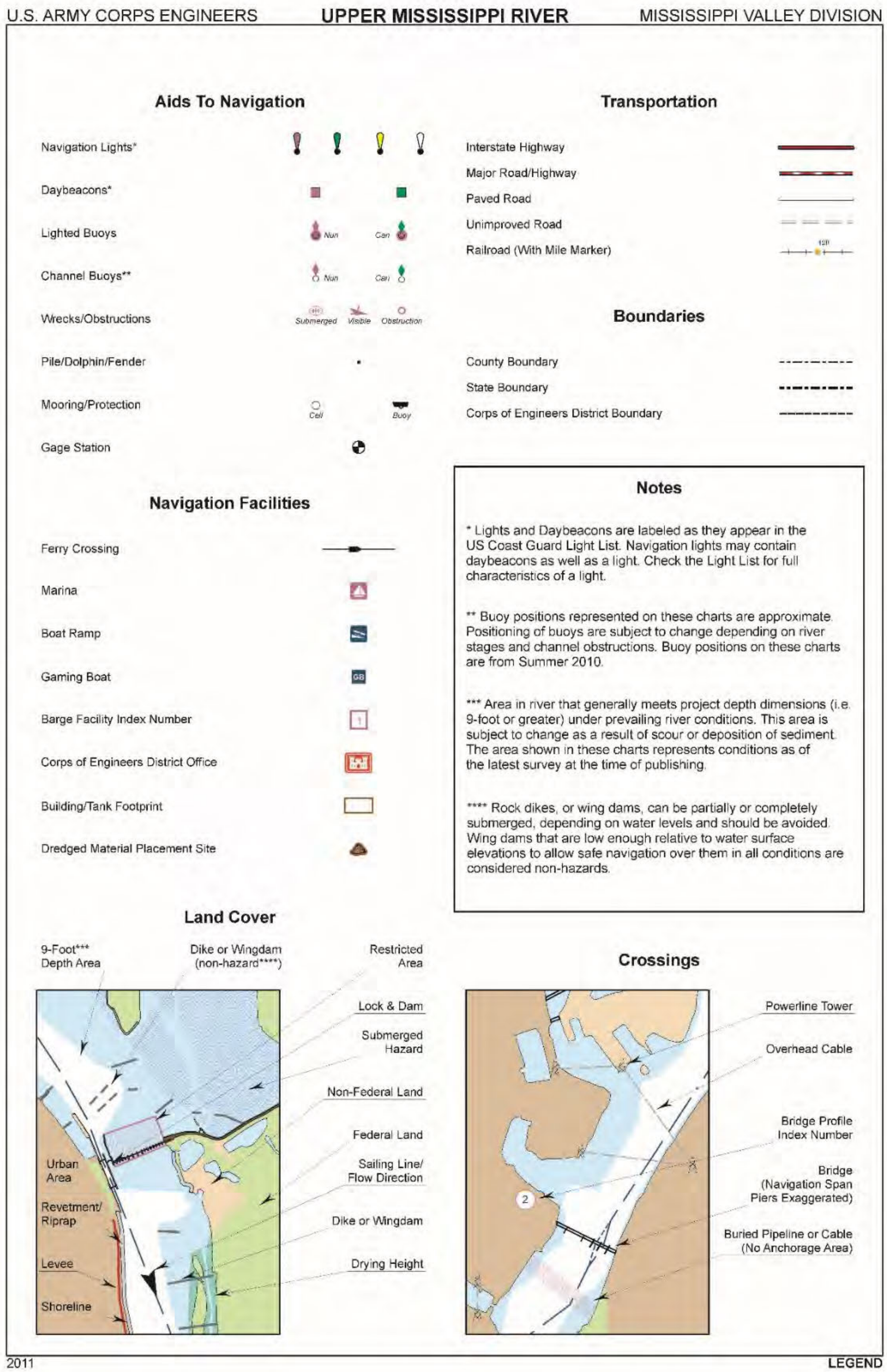
1. *Boating Safety* – The waters immediately above and below each lock and dam are hazardous for small boats because of dangerous currents and commercial barge traffic. These waters should be entered with extreme caution. Warning signs and signals should be observed and lockmasters' instructions must be followed when locking through or boating in the vicinity.

   Most named slough, chutes and cuts, shown on the charts are considered generally safe for small boats. However, outside the Nine-Foot Channel, navigation hazards may occur in any waters. Because all of these submerged features cannot be shown and because depths and hazards change from time to time, boating in unfamiliar waters should be done with care.

2. *Waste Disposal* – Rusty cans, broken glass, and other by-products of intensive use could become serious hazards to continued enjoyment of the Mississippi River for recreational purposes. Waste disposal facilities cannot be provided for all access points or public areas particularly the River islands. On the basis of long experience, therefore, it is suggested that the only practical method of waste disposal is for each visitor to transport such wastes to established mainland points where adequate disposal facilities are provided. Burying wastes or sinking them in the river are not considered satisfactory methods of disposal.

PERMITS: CORPS OF ENGINEERS REGULATORY PROGRAM

The Corps of Engineers is charged by Congress with the regulation of many activities involving the Upper Mississippi River, its tributaries, and wetlands. Anyone wishing to undertake a project in, under, over, or adjacent to a water of the United States (including wetlands) should inquire to the appropriate Corps of Engineers District regarding permit needs. In addition to the Corps of Engineers, other Federal, state, county, or local agencies may also have permit requirements.


U.S. ARMY CORPS ENGINEERS
UPPER MISSISSIPPI RIVER
MISSISSIPPI VALLEY DIVISION
Aids To Navigation
Navigation Lights*
Daybeacons*
Lighted Buoys
Nun
Can
Channel Buoys**
Nun
Can
Wrecks/Obstructions
Submerged
Visible
Obstruction
Pile/Dolphin/Fender
Mooring/Protection
Cell
Buoy
Gage Station
Transportation
Interstate Highway
Major Road/Highway
Paved Road
Unimproved Road
Railroad (With Mile Marker)
Boundaries
County Boundary
State Boundary
Corps of Engineers District Boundary
Navigation Facilities
Ferry Crossing
Marina
Boat Ramp
Gaming Boat
GB
Barge Facility Index Number
Corps of Engineers District Office
Building/Tank Footprint
Dredged Material Placement Site
Notes
* Lights and Daybeacons are labeled as they appear in the US Coast Guard Light List. Navigation lights may contain daybeacons as well as a light. Check the Light List for full characteristics of a light.
** Buoy positions represented on these charts are approximate. Positioning of buoys are subject to change depending on river stages and channel obstructions. Buoy positions on these charts are from Summer 2010.
*** Area in river that generally meets project depth dimensions (i.e. 9-foot or greater) under prevailing river conditions. This area is subject to change as a result of scour or deposition of sediment. The area shown in these charts represents conditions as of the latest survey at the time of publishing.
**** Rock dikes, or wing dams, can be partially or completely submerged, depending on water levels and should be avoided. Wing dams that are low enough relative to water surface elevations to allow safe navigation over them in all conditions are considered non-hazards.
Land Cover
9-Foot*** Depth Area
Dike or Wingdam (non-hazard****)
Restricted Area
Lock & Dam
Submerged Hazard
Non-Federal Land
Federal Land
Sailing Line/ Flow Direction
Dike or Wingdam
Drying Height
Urban Area
Revetment/ Riprap
Levee
Shoreline
Crossings
Powerline Tower
Overhead Cable
Bridge Profile Index Number
Bridge (Navigation Span Piers Exaggerated)
Buried Pipeline or Cable (No Anchorage Area)
2
2011
LEGEND

U.S. ARMY CORPS ENGINEERS **UPPER MISSISSIPPI RIVER** MISSISSIPPI VALLEY DIVISION

How to Calulate Bridge Clearances

All bridge spans crossing the navigation channel have corresponding profile drawings, like the example below, shown on supplemental sheets. Each profile drawing lists the following key peices of information:

(A) Channel or Navigation Span
(B) Name
(C) River Mile
(D) Elevation of Bridge for Clearance
(E) Elevation of Reference Water Surface *(Pooled Reaches)*
(F) Vertical and Horizontal Clearances
(G) Reference Gage for Actual Vertical Clearance

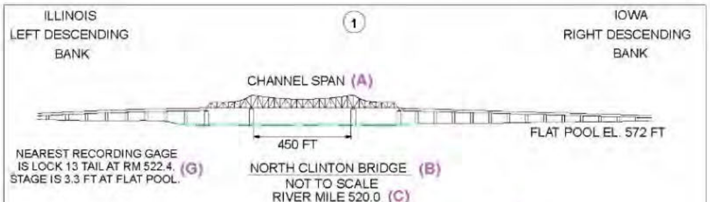
Vertical clearance values at "pool stage" are the maximum possible clearance at the location where low steel could impact a vessel in the designated channel or navigation span. The location of low steel within the navigation span varies from bridge to bridge, and actual clearances will be lower than the "vertical clearance at pool stage".

To estimate actual verticle clearance based on a reporting gage value:

(Pool Stage Clearance) - ((Gage reading) - (Flat Pool Stage))
(F) (G)

For the example bridge profile below, if the stage at L&D 13 Tail was 11.3 ft, then the actual vertical clearance would be:

65' - (11.3' - 3.3') = 57'



FLAT POOL ELEVATION	572.0'	(E)
ELEVATION OF LOW STEEL	637.0'	(D)
VERTICAL CLEARANCE AT POOL STAGE	65.0'	(F)
HORIZONTAL CLEARANCE	450.0'	

Notes on Chart Production and Use

-Maps were prepared from the latest IENC data by Corps of Engineers offices.

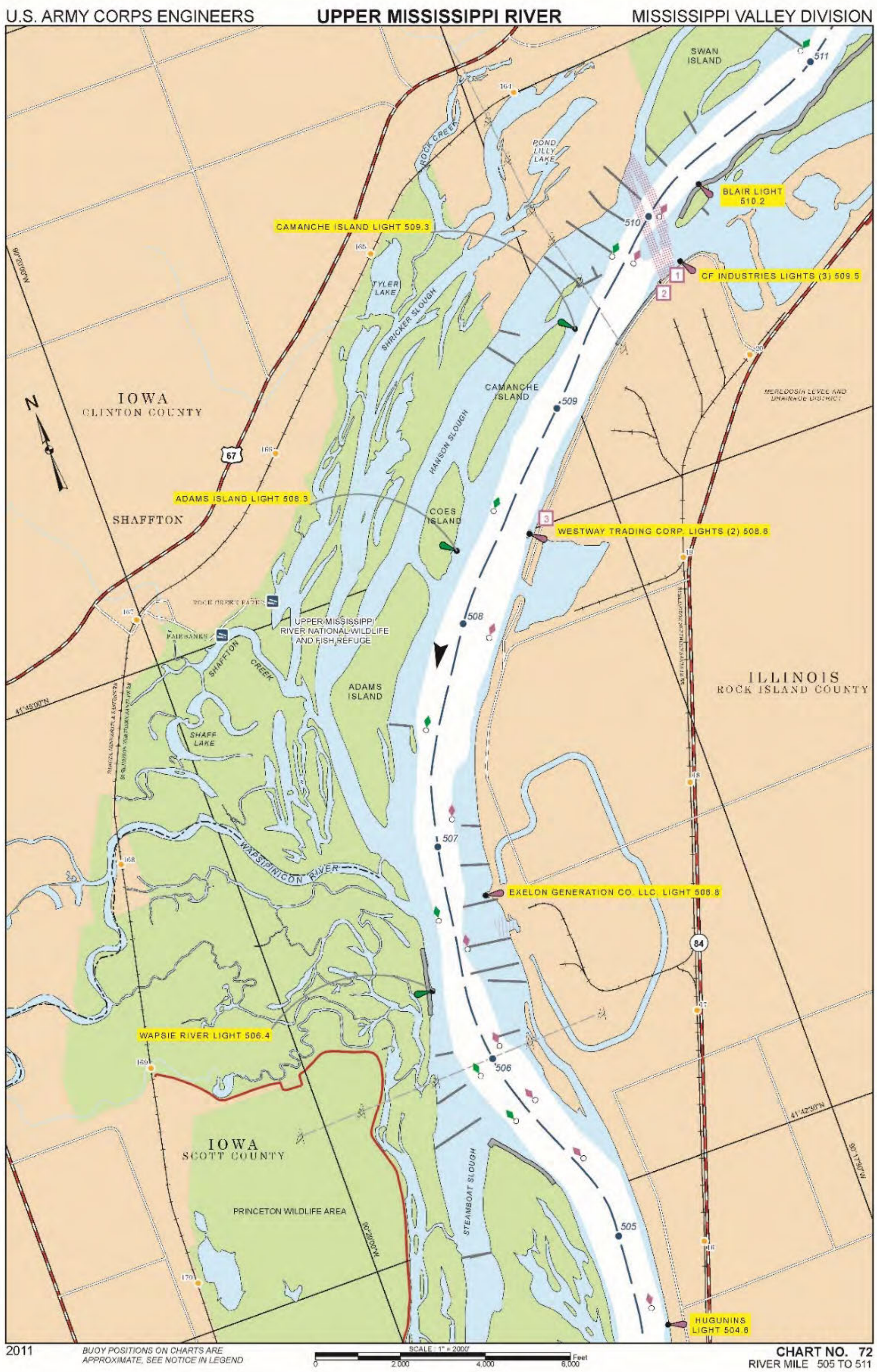
-Geodetic positions refer to North American Datum 1983.

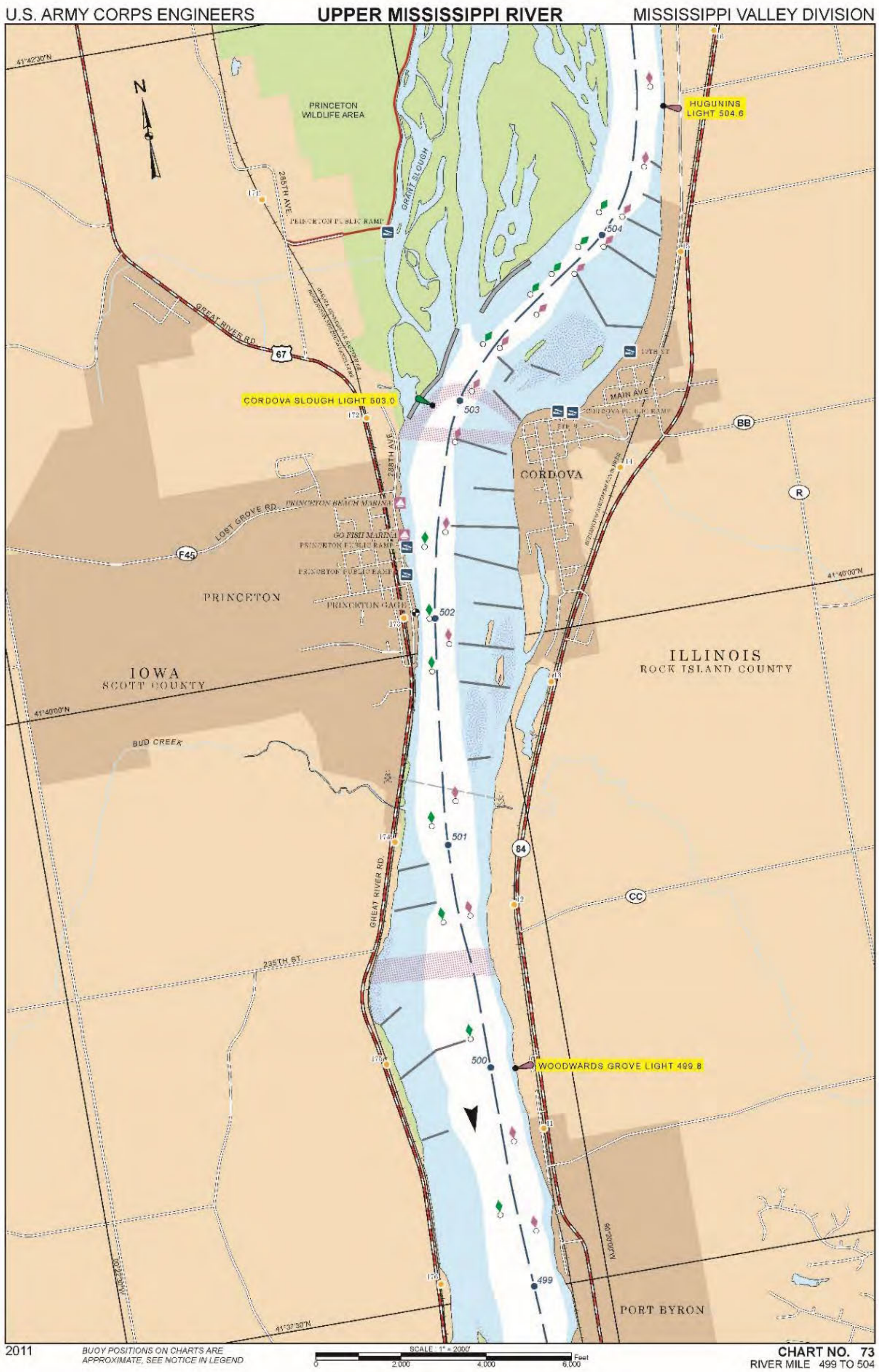
-Shorelines and depth areas are from the most recent aerial photography and survey data available at the time of production.

-Charts are oriented to show the river channel from upstream to downstream, from the top of the page to the bottom.

-River miles start at zero at the confluence of the Ohio and Mississippi Rivers near Cairo, IL, and they increase going upstream.

2011 **SUPPLIMENTAL LEGEND**


U.S. ARMY CORPS ENGINEERS
UPPER MISSISSIPPI RIVER
MISSISSIPPI VALLEY DIVISION
SWAN ISLAND
BLAIR LIGHT 510.2
CAMANCHE ISLAND LIGHT 509.3
CF INDUSTRIES LIGHTS (3) 509.5
TYLER LAKE
SHRICKER SLOUGH
POND LILLY LAKE
ROCK CREEK
IOWA
CLINTON COUNTY
CAMANCHE ISLAND
HANSON SLOUGH
ADAMS ISLAND LIGHT 508.3
SHAFFTON
COES ISLAND
WESTWAY TRADING CORP. LIGHTS (2) 508.6
UPPER MISSISSIPPI RIVER NATIONAL WILDLIFE AND FISH REFUGE
ADAMS ISLAND
ILLINOIS
ROCK ISLAND COUNTY
SHAFFTON CREEK
SHAFF LAKE
WAPSIPINICON RIVER
EXELON GENERATION CO. LLC. LIGHT 506.8
WAPSIE RIVER LIGHT 506.4
IOWA
SCOTT COUNTY
STEAMBOAT SLOUGH
PRINCETON WILDLIFE AREA
HUGUNINS LIGHT 504.6
2011
BUOY POSITIONS ON CHARTS ARE APPROXIMATE, SEE NOTICE IN LEGEND
CHART NO. 72
RIVER MILE 505 TO 511


U.S. ARMY CORPS ENGINEERS
UPPER MISSISSIPPI RIVER
MISSISSIPPI VALLEY DIVISION
PRINCETON WILDLIFE AREA
HUGUNINS LIGHT 504.6
CORDOVA SLOUGH LIGHT 503.0
WOODWARDS GROVE LIGHT 499.8
CORDOVA
PRINCETON
IOWA
SCOTT COUNTY
ILLINOIS
ROCK ISLAND COUNTY
PORT BYRON
BUD CREEK
GREAT RIVER RD.
504
503
502
501
500
499
2011
BUOY POSITIONS ON CHARTS ARE APPROXIMATE, SEE NOTICE IN LEGEND
SCALE : 1" = 2000'
CHART NO. 73
RIVER MILE 499 TO 504

STEAMBOAT ISLAND HREP

APPENDIX M
DESIGN ENGINEERING

Attachment H
High Water Investigation

CEMVR-EC-DN 13 September 2018

Trip Report

Subject: Steamboat Island HREP – High Water Investigation – 9/8/18

Present: Kyle Nerad (EC-DN), Steve Gustafson (EC-DN)

Purpose: To gather information and data, including Secchi readings and qualitative observations, about the Steamboat Island complex during a high water event.

1. **Caveats.** The findings from this trip report represent only a snapshot of one high water event. The data and observations can be used to help inform decisions only. Hydraulic modeling, further investigation, and other data sources should be used for the decision making and plan selection process.

2. **Background.** Following the PDT meeting on 6 Sept 2018, Steve and Kyle were further discussing the April 2014 imagery Kirk Hanson (IADNR) brought up that showed clear water in Lower Lake during a high water event. Steve mentioned it would be beneficial to be on site during a high water event to determine water clarity, directions of flow, etc. Kyle offered to go out on 8 Sept 2018, as a non-work site reconnaissance. River stage measured at Camanche gage was 15.70ft. The April 2014 imagery corresponds to river stage of 16.72ft. Flood Stage is 17ft. Gage zero is 563.21ft MSL1912.

3. **Safety.** Steve and Kyle discussed float plans with their spouses prior to going. They took Kyle's boat, which is annually serviced and kept in good working order. The boat was outfitted with a gas motor, electric motor, paddles, anchors, fire extinguisher, first aid kit, VHF/WX radio and throwable floatation device. Coast guard approved personal floatation devices were worn the entirety of the trip. Both Steve and Kyle were familiar with the area they were going to, and Kyle (boat operator) had taken a boat safety course, aside from his ten plus years of experience operating watercraft.

4. **Locations:** The investigation began in Lower Lake, including the west finger of Lower Lake. Following that, the cut-through channel was entered from the Navigation Channel side and was passable approximately 75% of the way. Next, Upper Lake was explored, and then around the head of the Island. The cut-through channel was entered from the Steamboat Slough side until it was impassable. The trip ended back in Lower Lake to explore the east finger. Figure 1 shows locations visited and GPS points taken.

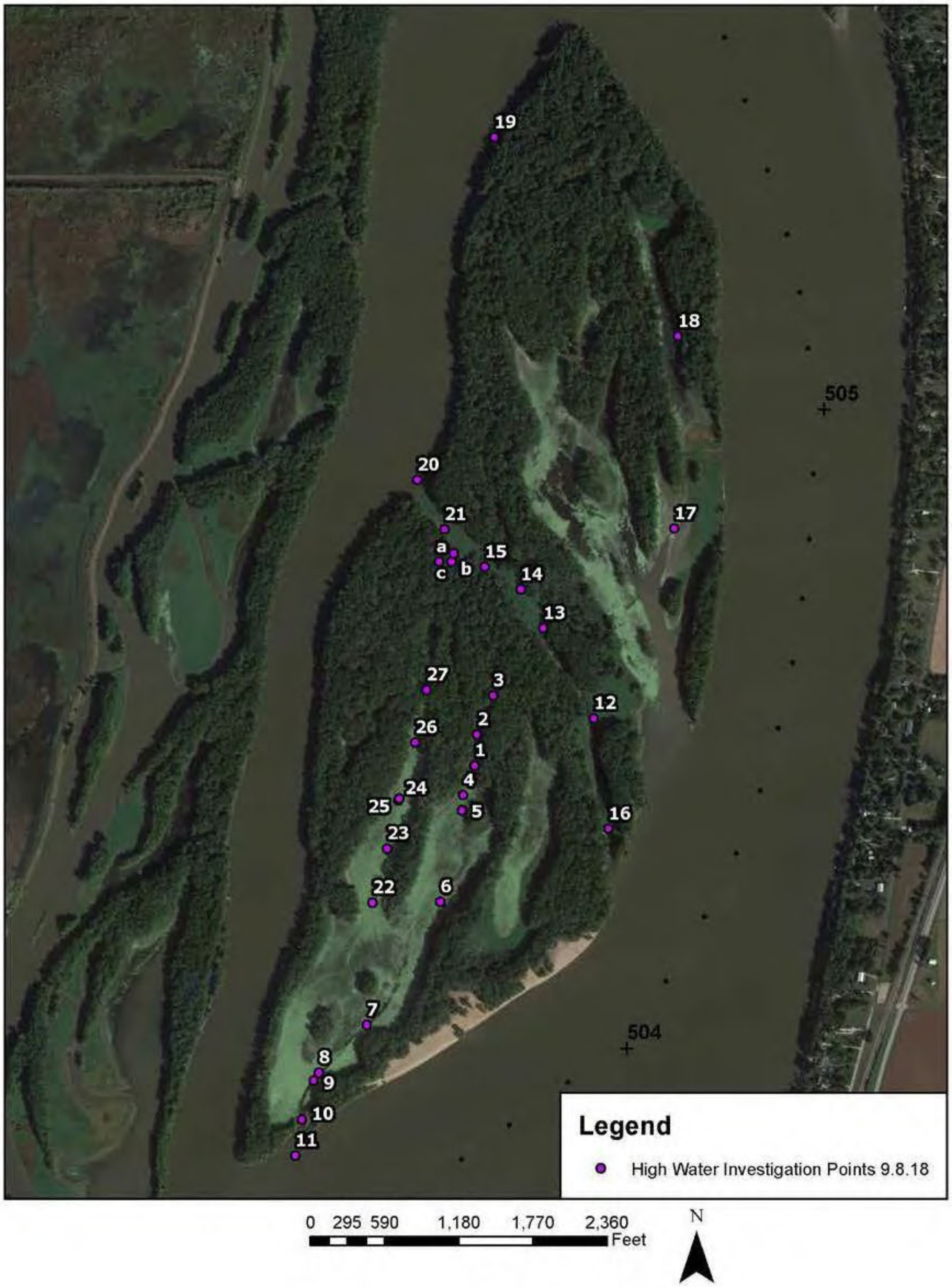


Figure 1. Locations Visited (9/28/17 Imagery).

5. **Lower Lake (Figure 2).** Upon entering Lower Lake, there was an immediate break in the water clarity, showing brown, sediment laden water from the Navigation Channel suddenly clearing up to blue/clear water in the lake. This was between points 8 and 9. The main body of the lake stayed clear until between points 4 and 5 in the east finger, and between points 23 and 26 in the west finger. At these locations, the water became brown and sediment laden again.

Figure 2. Lower Lake (9/28/17 Imagery).

6. **Cut Through Channel (Figure 3).** The cut-through channel was entered from the Navigation Channel side first. It was passable up to point 15 on the map before the channel was choked out with willows and it became impassible by boat. The water in the channel looked brown the entire distance. When entered from the Steamboat Slough Side, it was passable to point 21 before the channel was again choked out by willows and impassible by boat. The water here was also brown. At this point, Steve went up onto the island to look for the channel connecting the cut-through channel and Lower Lake. A water clarity sample was taken near point a, which appeared to be a settled pond in the flooded timber. A GPS coordinate was not taken, but the point below is estimated. The water looked clear. Water clarity samples were also taken in the channel connecting the cut-through channel to Lower Lake, near points b and c. GPS coordinates were not taken, but the points below were estimated. The water looked brown in these locations. Also near these locations, Steve found Pink Turtlehead (*Chelone obliqua*) which is on IADNR's list of species of special concern.

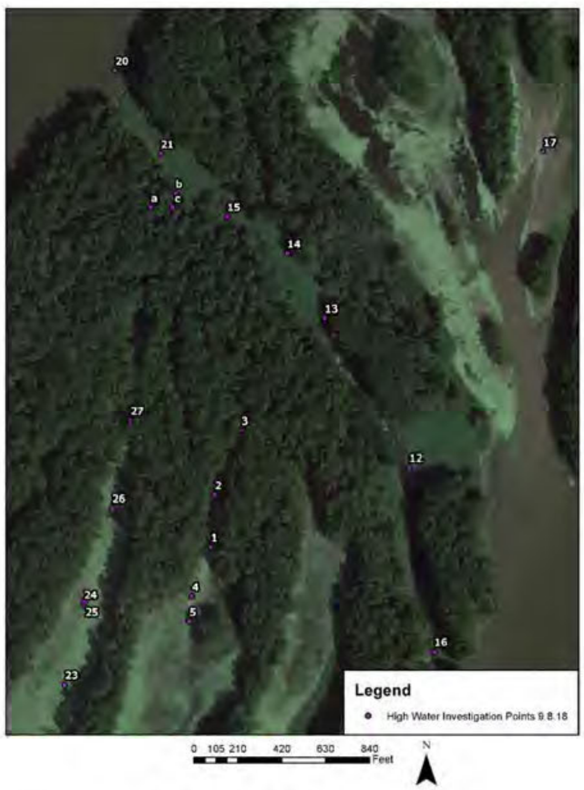


Figure 3. Cut-Through Channel (9/28/17 Imagery).

4

7. **Upper Lake (Figure 4).** Upper Lake was investigated beginning near the downstream entrance. Water was flowing through the lake from the NE Bank breach and was brown and sediment laden. At point 18, upstream of the breach area, the water was still brown and sediment laden, but was more clear than at point 17.

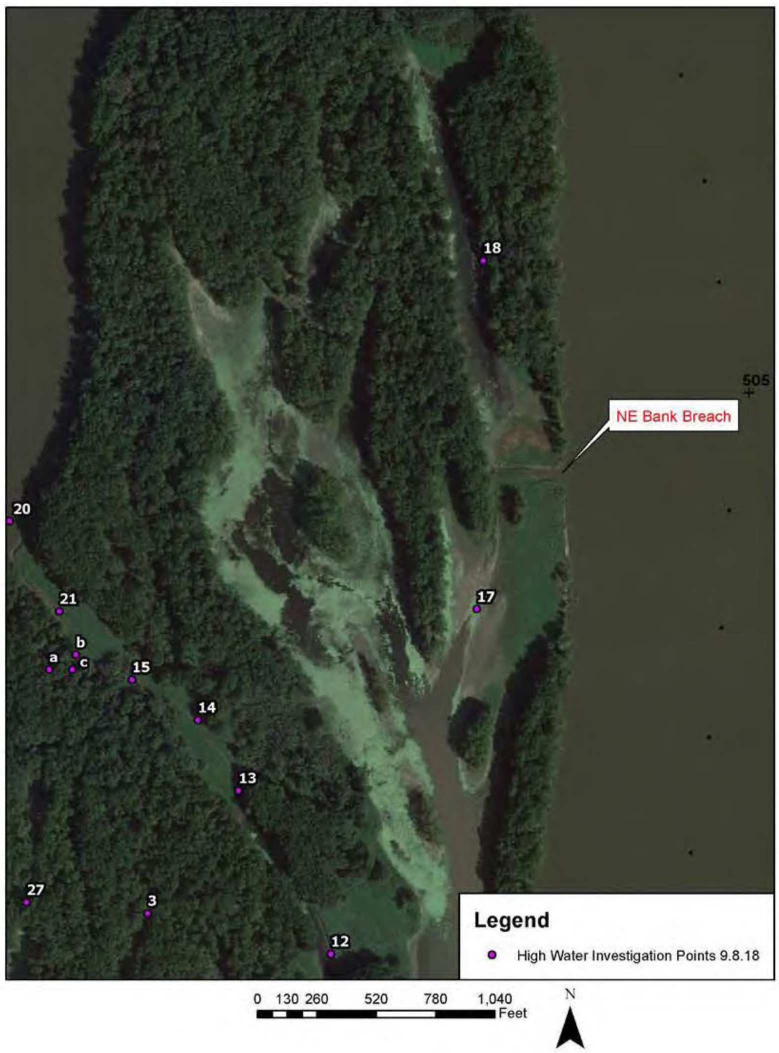


Figure 4. Upper Lake (9/28/17 Imagery).

8. **Data.** Table 1 shows the Secchi reading at each point where data was collected.

Table 1. Data collected.

Point Location	Secchi Disk or Tube (cm)	Coordinates	Notes
1	16.5	41.69739, -90.32291	
2	12.0	41.69807, -90.32284	
3	N/A	41.69892, -90.32238	Heavy Duckweed. Unable to get clear reading. Water brown and sediment laden.
4	N/A	41.69674, -90.32324	Heavy Duckweed. Unable to get clear reading. Water brown and sediment laden.
5	34.0	41.69641, -90.32328	
6	43.5	41.69442, -90.32391	
7	94.0	41.69173, -90.32603	Very clear. Used Secchi disk
8	81.0	41.69068, -90.32743	Very clear. Used Secchi disk
9	16.0	41.69051, -90.32758	
10	10.5	41.78966, -90.32792	
11	7.0	41.68887, -90.32812	
12	20.0	41.69844, -90.31944	
13	15.0	41.70040, -90.32092	
14	15.0	41.70125, -90.32158	
15	11.0	41.70173, -90.32263	Choked out by willows
16	20.0	41.69602, -90.31900	
17	7.0	41.70259, -90.31710	Navigation channel flowing in
18	12.0	41.70679, -90.31701	
19	8.0	41.71112, -90.32237	
20	7.0	41.70364, -90.32381	
21	10.0	41.70255, -90.32381	Choked out by willows
22	34.0	41.69440, -90.32588	
23	40.0	41.69558, -90.32546	
24	N/A	41.69664, -90.32513	Heavy Duckweed. Unable to get clear reading.
25	N/A	41.69664, -90.32513	Heavy Duckweed. Unable to get clear reading.
26	26.0	41.67900, -90.32464	
27	14.0	41.69905, -90.32432	
a	45.0 +	41.70185, -90.32396	Location Approximate. Secchi Tube filled and could see full length. Did not have Secchi disk was left in the boat and not used. Pool of water spreading to SW. Very clear. Approximately 1ft deep, no flow.
b	7.0	41.70203, -90.32354	Location Approximate. Observable stream flow spreading out into adjacent surrounding vegetation.
c	9.0	41.70185, -90.32359	Location Approximate. Observable stream flow spreading out into adjacent surrounding vegetation.

The Secchi depths were plotted next to the points where taken, and overlain on the Topobathymetric LiDAR. This is shown in Figure 5 and Figure 6.

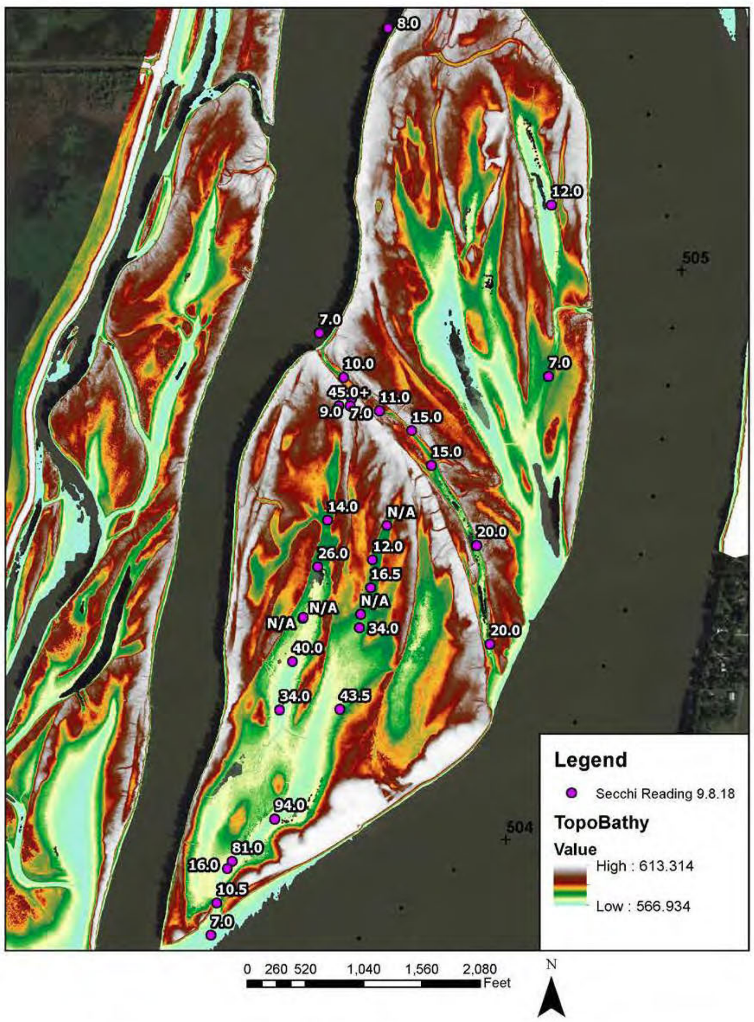


Figure 5. Secchi reading points overlain with Topobathymetric LiDAR.

7

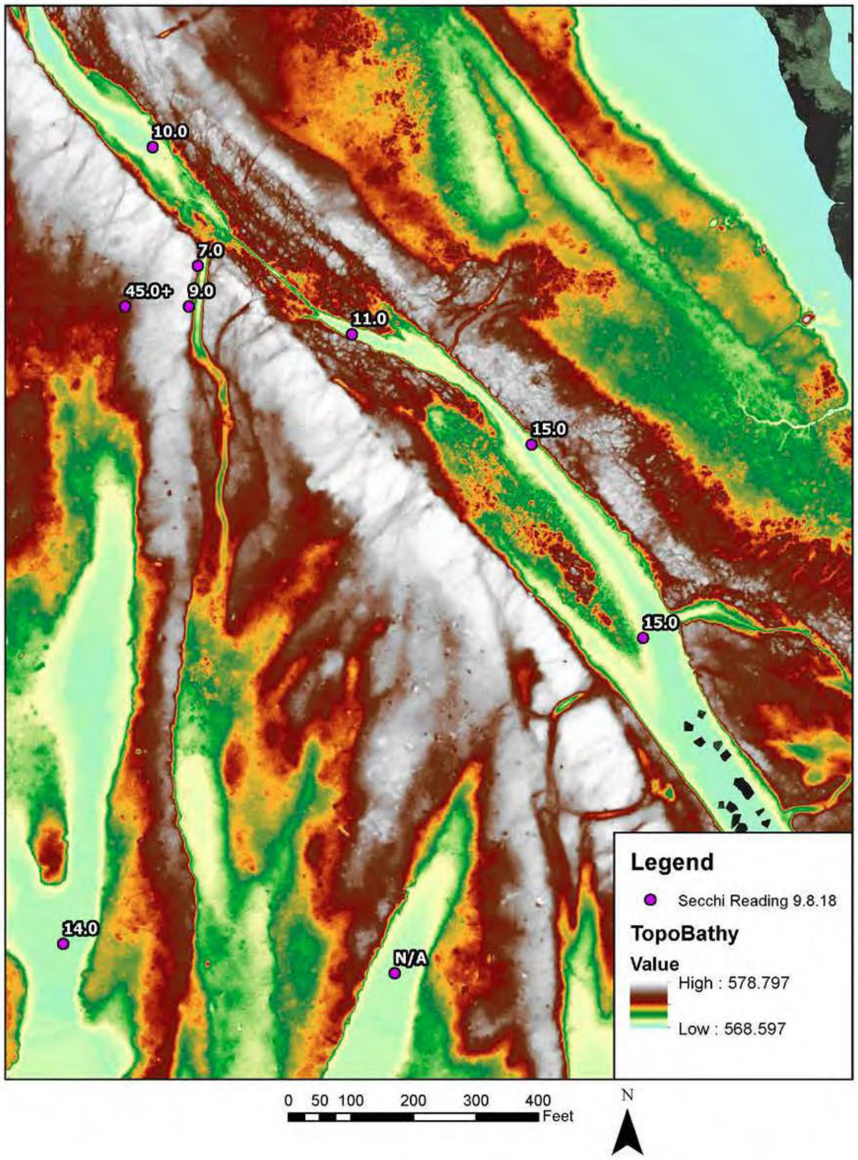


Figure 6. Detail of Secchi reading points overlain with Topobathymetric LiDAR.

8

9. **Further Observations.** It was noticed that most of the island land was inundated, but there were locations where land was still visible. The river stage of 15.70ft at Camanche is right around a 2-year event. This was converted to NAVD88, which corresponds to elevation 575.3ft at RM 504.5, near the middle of Steamboat Island. The Annual % Time Elevation Equaled or Exceeded is about 4.9%. Figure 7 shows the 575.3 contour and thus inundation of the Steamboat Island area. Note, if an area is ponded and surrounded by land, it may not actually be inundated unless it was previously overtopped, there was significant rain fall, or if there was underground seepage.

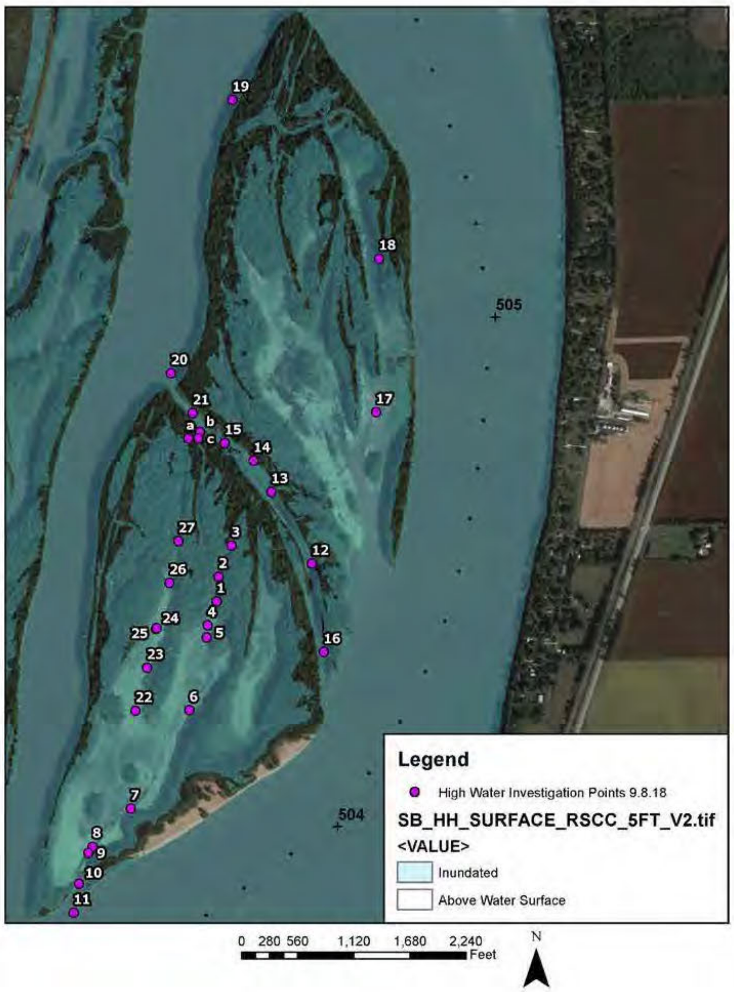


Figure 7. 575.3 contour inundation (9/28/17 Imagery).

9

Flow measuring equipment was not available and therefore flows were not measured in any locations. In some locations, the wind was blowing in the same direction of any perceived flow, so it was not possible to distinguish flows from wind for vegetation movement on the water. In other locations, there was no wind due to the shelter from the trees, and flows were observed, but quantitative date could not be collected.

In the cut-through channel, it was not possible to locate the closing structure. However, the narrow point upstream of it (LiDAR) was filled with established willows. Some willows appeared to be 2-3 inches in diameter and 15-20 ft tall.

10. **Plotting Against Other Data.** The data points collected were overlain with the April 2014 aerial imagery (Figure 8) to see how the points and water clarity data collected corresponded to similar high water events. The April 2014 aerial imagery corresponds to a stage of 16.72 at the Camanche gage. At RM 504.5, this corresponds to 576.0ft NAVD88 and the Annual % Time Elevation Equaled or Exceeded is about 3.2%.

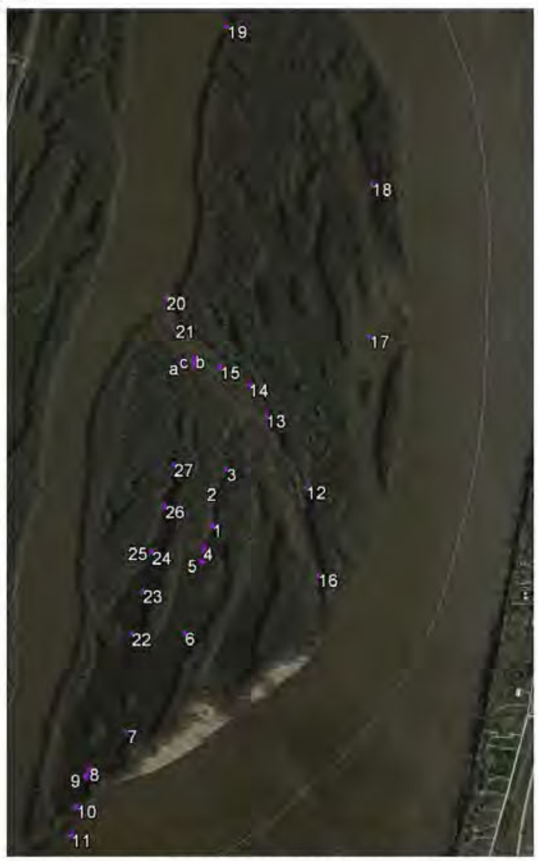


Figure 8. Points overlain with April 21, 2014 high water aerial imagery.

11. **Conclusions.** Based on the data collected, and the changes in the clarity of the water at different locations, it is apparent that water flows into the cut-through channel from the Steamboat Slough Side during this type of high water event. Some water continues through the channel, appearing to settle out sediments as it gets closer to the navigation channel side. Some water flows into the surrounding forested areas and parts of the island. Some water flows southward through the channel that connects the cut-through channel and Lower Lake. As it flows south, it spreads out and flows through trees and other vegetation. As it spreads out and slows down, it appears sediments are settling out of the water column. Likewise, water flows from the navigation channel into the inlet of Lower Lake. It appears that as the sediment laden water from the navigation channel slows down and sediments settle out of the water column. At a certain point, sediments drop out significantly enough that a dramatic color change (clarity) in the water can be observed, similar to what is shown in Figure 8 above and in Photo 1 and Photo 2 below. This is supported by the Secchi data collected.

12. **Site Photos.**

Photo 1. Lower Lake inlet sediment plume looking toward Mississippi River.

Photo 2. Lower Lake inlet sediment plume looking toward Mississippi River.

Photo 3. Lower Lake adjacent inundated forest.

Photo 4. Lower Lake adjacent inundated forest.

	
Photo 5. Middle of Lower Lake looking east.	**Photo 6. Lower Lake west finger looking north.**
	
Photo 7. Cut-through Channel willows from east side.	**Photo 8. Cut-through Channel willows from east side.**

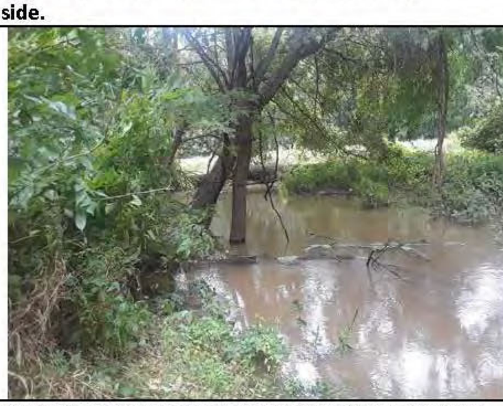



Photo 9. Convergence of Cut-through Channel and Channel to Lower Lake.	**Photo 10. Channel to Lower Lake.**

Photo 11. Channel to Lower Lake.	**Photo 12. Pink Turtlehead (*Chelone obliqua*) found near points a, b & c.**

STEAMBOAT ISLAND HREP

APPENDIX M
DESIGN ENGINEERING

Attachment I
Island Erosion Analysis

Aerial imagery was used to determined approximate erosion rates of the Southeast Islands. First, imagery from Google Earth was looked at to determine what dates the photos were captured. Following that, the River Gage at Camanche, Iowa was looked at to determine the stage at each date that an image was available. The dates and stages are summarized in Table M-I-1 below.

Table M-I-1: Summary of Imagery Dates and River Stages

Imagery Date	River Stage (ft)
5/18/1994	13.76
3/29/2000	9.98
8/4/2004	9.77
12/30/2004	9.41
3/27/2005	9.54
6/22/2005	12.13
6/22/2006	10.21
7/5/2006	9.37
6/6/2007	10.73
6/14/2007	10.19
7/8/2008	11.16
4/7/2009	13.48
6/19/2009	10.01
6/27/2009	9.76
6/23/2010	12.67
9/28/2010	13.31
8/11/2011	13.10
9/12/2011	9.71
9/14/2011	9.68
9/27/2012	9.17
12/30/2012	9.03
4/21/2014	16.72
5/12/2015	10.25
10/8/2016	15.49
9/27/2017	10.00

The data was then sorted by stage and the absolute difference between stages was determined. The lowest differences show the water events that were similar in magnitude. For the events with the absolute stage difference less than 0.05ft, the absolute difference between the associated dates was determined. The longer the time between two similar events, the better the average for that timeframe. Any timespans over 4 years were considered. This is shown in Table M-I-2 with events of interest in **bold** text.

Table M-I-2: Summary of Imagery Dates and River Stages

Imagery Date	River Stage (ft)	Stage Difference (ft)	Time Lapsed (years)
12/30/2012	9.03		
		0.14	
9/27/2012	9.17		
		0.20	
7/5/2006	9.37		
		0.04	1.5
12/30/2004	9.41		
		0.13	
3/27/2005	9.54		
		0.14	
9/14/2011	9.68		
		0.03	0.0
9/12/2011	9.71		
		0.05	
6/27/2009	**9.76**		
		0.01	**4.9**
8/4/2004	**9.77**		
		0.21	
3/29/2000	**9.98**		
		0.02	**17.5**
9/27/2017	**10.00**		
		0.01	**8.3**
6/19/2009	**10.01**		
		0.18	
6/14/2007	10.19		
		0.02	1.0
6/22/2006	**10.21**		
		0.04	**8.9**
5/12/2015	**10.25**		
		0.48	
6/6/2007	10.73		
		0.43	
7/8/2008	11.16		
		0.97	
6/22/2005	12.13		
		0.54	
6/23/2010	12.67		
		0.43	
8/11/2011	13.10		
		0.21	
9/28/2010	13.31		
		0.17	
4/7/2009	13.48		
		0.28	
5/18/1994	13.76		
		1.73	
10/8/2016	15.49		
		1.23	
4/21/2014	16.72		

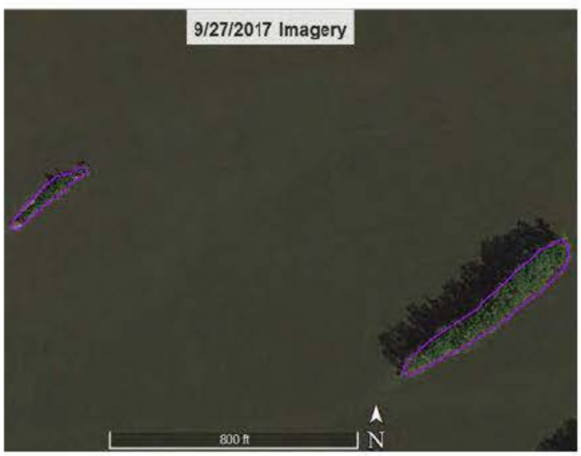
The shortened list of data (see Table M-I-3) was analyzed to determine if any of the events fit inside a bigger event.

Table M-I-3: Events of Interest

Event	Imagery Date	River Stage (ft)	Stage Difference (ft)	Time Lapsed (years)
1	6/27/2009	9.76		
			0.01	4.9
	8/4/2004	9.77		
2	3/29/2000	9.98		
			0.02	17.5
	9/27/2017	10.00		
3	9/27/2017	10.00		
			0.01	8.3
	6/19/2009	10.01		
4	6/22/2006	10.21		
			0.04	8.9
	5/12/2015	10.25		

Event 2 spans the largest timeframe of March 29, 2000, to September 27, 2017. All other events fall into this timeframe. Because of this, only the imagery from March 29, 2000, and September 27, 2017 was used to determine an average erosion rate of the Southeast Islands.

The geometry of the two islands was traced in Google Earth on the two image years, and rough acreages were determined. Images of the polygons are in Figure M-I-1. The data from the two dates are in Table M-I-4.



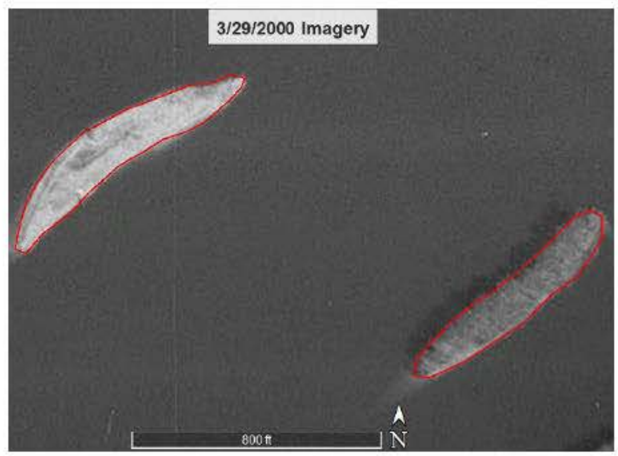


Figure M-I-1: Imagery with Island Geometries Traced

Table M-I-4: Imagery Data

Imagery Date	River Stage (ft)	Stage Difference (ft)	Time Lapsed (years)	East Island Size (ac)	East Island Difference (ac)	West Island Size (ac)	West Island Difference (ac)
3/29/2000	9.98			2.1		2.5	
		0.02	17.5		-0.9		-2.2
9/27/2017	10.00			1.2		0.3	

With this, the erosion rates were determined as follows.

East SE Island: -0.9ac/17.5yr = -0.5ac/yr (loss of 0.5ac/yr on average)
West SE Island: -2.2ac/17.5yr = -0.13ac/yr (loss of 0.13ac/yr on average)

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

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UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX O

PROGRAMMATIC AGREEMENT
FOR CULTURAL RESOURCES

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX O

PROGRAMMATIC AGREEMENT FOR CULTURAL RESOURCES

APPENDICES

PROGRAMMATIC AGREEMENT AMONG THE UNITED STATES ARMY CORPS OF ENGINEERS ROCK ISLAND DISTRICT, THE IOWA STATE HISTORIC PRESERVATION OFFICE, AND THE UNITED STATES FISH AND WILDLIFE SERVICE REGARDING THE STEAMBOAT ISLAND HABITAT REHABILITATION AND ENHANCEMENT PROJECT, CLINTON AND SCOTT COUNTIES, IOWA, AND ROCK ISLAND COUNTY, ILLINOIS

WHEREAS, the U.S. Army Corps of Engineers, Rock Island District (District) is proposing a habitat rehabilitation and enhancement project (Project) in the middle section of Pool 14 of the Upper Mississippi River, in Clinton and Scott Counties, Iowa and Rock Island County, Illinois (Appendix O-A). Areas considered as part of this Project and described as the Project area include Steamboat Island, Steamboat Slough, the adjacent secondary channel complex Grant Slough, smaller islands in the southeast portion of the Project area (West Southeast and East Southeast Islands), and the forested areas north and south of the Wapsipinicon River; and,

WHEREAS, the District has determined that the proposed Project constitutes an Undertaking subject to the requirements of 36 CFR Part 800, the regulations implementing Section 106 of the National Historic Preservation Act (NHPA; 54 USC § 306108); and,

WHEREAS, the District has determined that the proposed Project is the type of Undertaking that has the potential to affect historic properties listed in or eligible for listing on the National Register of Historic Places (NRHP), and therefore will consult with the Advisory Council on Historic Preservation (ACHP), the Iowa State Historic Preservation Officer (IA SHPO), the Illinois State Historic Preservation Officer (IL SHPO), the U.S. Fish and Wildlife Service (USFWS), Indian tribes, the Iowa Office of the State Archaeologist (OSA), and other Interested and Consulting Parties (hereinafter, Consulting Parties; see Appendix O-B) pursuant to 36 CFR § 800.14(b) of the regulations implementing Section 106 of the NHPA (54 U.S.C. § 306108) and Section 110(f) of the same Act (54 U.S.C. § 306107); and,

WHEREAS, the identification and evaluation of historic properties and determinations of effect will not be completed prior to the completion of the environmental document needed for compliance with the National Environmental Policy Act (NEPA), making execution of this Programmatic Agreement (PA) for the Project appropriate pursuant to 36 CFR § 800.14(b)(1)(ii); and,

WHEREAS, in recognition of the unique government-to-government relationship between the Federal government and the Indian tribes, the District will notify the tribes (see Appendix O-B) of the Undertaking, and of the potential for effects that the Undertaking may have upon historic properties which may be of particular interest to them, and has invited the tribes to participate as concurring parties to this agreement, with seven tribes responding in the affirmative, these being the Fort Peck Assiniboine and Sioux Tribes, Iowa Tribe of Kansas and Nebraska, Miami Tribe of Oklahoma, Ponca Tribe of Nebraska, Rosebud Sioux Tribe, Sac and Fox Tribe of the Mississippi in Iowa, and the Winnebago Tribe of Nebraska; and,

WHEREAS, the USFWS, has designated the District as the lead Federal agency for this undertaking but will participate as a Signatory to this PA due to the fact that the USFWS will need to issue an Archaeological Resources Protection Act permit for work on Federal lands under the agency's jurisdiction; and,

WHEREAS, the District has not fully determined the scope of activity and Area of Potential Effect (APE) for the Undertaking (Appendix O – A) but will consult with the Signatories and Consulting Parties in a timely manner prior to implementation in order to determine the APE for all of the actions subject to the terms of this agreement, and shall propose and document modifications to the APE throughout the duration of this PA in accordance with the stipulations of this PA; and,

WHEREAS, the District shall seek and consider the views of the public and shall provide information to the public about the Undertaking and its effects on historic properties following agency procedures pursuant to 36 CFR § 800.2(d); and in a manner that observes confidentiality requirements pursuant to Section 304 of the Act and applicable state laws; and,

WHEREAS, the parties to this agreement have agreed to certain programmatic mitigation measures (Appendix O-E) but in so doing also recognize that not all effects can be mitigated programmatically and therefore have agreed to re-enter consultation in order to devise appropriate remedial measures when the need arises; and,

WHEREAS, in accordance with 36 CFR § 800.6(a)(1), the District has notified the ACHP and IL SHPO of this PA. The IL SHPO, having completed consultation in accordance to procedures outlined in 36 CFR 800 for that portion of the Undertaking that falls within Illinois' jurisdiction, and the ACHP having chosen not to participate in the consultation pursuant to 36 CFR § 800.6(a)(1)(iii);

NOW, THEREFORE, the District, the IA SHPO, and the USFWS (hereinafter Signatories), agree that the Undertaking shall be implemented in accordance with the following stipulations of this PA to satisfy the District's Section 106 responsibilities for the Undertaking.

The District shall ensure that the following stipulations of this PA are carried out:

STIPULATIONS

I. GENERAL RESPONSIBILITIES

A. The Signatories to this PA are the District, the IA SHPO, and the USFWS. Collectively, the Signatories, and Consulting Parties are referred to in this PA as "Parties". The Signatories and the Concurring signatories have rights as defined under 36 CFR § 800.6.

B. The District is responsible for oversight of performance under this PA and shall carry out compliance with Section 106 of the NHPA, including leading consultation as it pertains to identification and evaluation of historic properties and findings of effect.

C. The District's consultants shall provide to the District completed cultural resource reports with fully documented eligibility determination recommendations and other requirements as noted in the contractual work order statement.

D. Unanticipated Discoveries (Appendix O-C), Historic Properties Identification and Procedures for Project Review (Appendix O-D), Programmatic Mitigation of Effects (Appendix O-E) are detailed in the appendices as listed.

II. THE DISTRICT'S RESPONSIBILITIES

A. The District shall serve as the principal authority in matters concerning the interpretation of this agreement, its appendices, and the routine execution of its terms, all subject to the Dispute Resolution, Stipulation VII. The District, at its discretion, may consult directly with the USFWS, IA SHPO, and ACHP.

B. The District shall ensure that the procedures for Project-specific consultation, historic properties identification and evaluation, assessment of effects, mitigation of adverse effects, and treatment of historic properties are implemented in accordance with procedures outlined in Appendices O-D and O-E.

C. The District shall ensure that all historic properties investigations, evaluations, treatment plans, and data recovery efforts devised and conducted pursuant to this agreement shall be performed by or under the direct supervision of an individual that meets the Secretary of the Interior's Qualifications Standards (36 CFR Part 61); and, shall be performed in a manner that is consistent with Secretary of the Interior's Standards and the most recent version of the *Guidelines for Archaeological Investigations in Iowa*, and all other Federal or State standards as appropriate.

D. The District shall ensure that documentation submitted to IA SHPO for review meets the standards outlined at 36 CFR 800.11. Pursuant to Section 304 of the NHPA (54 U.S.C. § 307103), the Freedom of Information Act (FOIA; 5 U.S.C. § 552), the District shall withhold from disclosure to the public information relating to the location or character of historic resources when, in consultation with the Iowa State Archaeologist, it has been determined that disclosure of such information may create a substantial risk of harm, theft, or destruction to such resources or to the area or place where such resources are located, to the extent such withholding is authorized under the FOIA and other Federal laws applicable to the District, or unless directed to release such information by Court Order.

E. The District shall ensure that all archeological reports resulting from actions pursuant to this agreement shall be consistent with the most recent version of the *Guidelines for Archaeological Investigations in Iowa*, and to the Department of the Interior's Format Standards for Final Reports of Data Recovery Programs (42 FR 5377-79). Precise location data should be provided only in a separate appendix if it appears that release of such data could jeopardize archeological deposits.

F. The District shall invite the participation of consulting parties in all activities authorized under this agreement as listed in Appendix O-B. (Note: The District must invite tribal consultation for all activities, even those excluded by regulation or agreement from IA SHPO review, unless a previous arrangement with individual or united tribes has been made). Parties that have a consultative role in the Section 106 process include, but are not limited to, the following: federally-recognized Indian tribes; representatives of local governments; county and municipal historic preservation commissions including those established under the Certified Local Governments program; the Public; the National Trust for Historic Preservation; the Preservation Iowa organization; and individuals and organizations who, due to the nature of their legal or economic relation to the Undertaking or their concern with the Undertaking's effects on historic properties, demonstrate a legitimate interest.

G. The District shall ensure that artifacts, samples, and associated materials (ecofacts) recovered during data recovery mitigation from Federally-owned lands shall be curated, along with all associated records, at a facility in the Illinois State Museum that meets standards established in 36 CFR 79, all shall ensure reasonable availability to future professional and academic research. Artifacts, samples, and associated materials (ecofacts) recovered during data recovery mitigation from USFWS-owned lands in Iowa shall be curated, along with all associated records, at a facility in the Iowa Office of the State Archaeologist that meets standards established in 36 CFR 79.

III. THE IOWA STATE HISTORIC PRESERVATION OFFICER RESPONSIBILITIES

The IA SHPO shall comment on all activities designated for its review in a timely and efficient manner and in accordance with procedures outlined in Appendices O-C, O-D, and O-E.

IV. UNANTICIPATED DISCOVERIES

The District shall ensure that the procedures outlined in Appendix O-C are observed in the event that human remains, non-mortuary archeological material, and architectural properties are encountered during construction or archaeological investigations.

V. HISTORIC PROPERTIES IDENTIFICATION AND PROJECT REVIEW

The District shall ensure that the procedures outlined in Appendix O-D are observed for all cultural resource investigations, historic properties identification, and project review.

VI. PROGRAMMATIC MITIGATION OF EFFECTS

The District shall ensure that the procedures outlined in Appendix O-E are observed in the event that the Project will have an adverse effect on historic properties.

VII. DISPUTE RESOLUTION

A. Should any signatory or concurring party to this PA object at any time to any actions proposed or the manner in which the terms of this agreement are implemented, the District shall consult with such party to resolve the objection. If the District determines that such objection cannot be resolved, the District will:

1. Forward all documentation relevant to the dispute, including the District's proposed resolution, to the ACHP. The ACHP shall provide the District with its advice on the resolution of the objection within 30 days of receiving adequate documentation. Prior to reaching a final decision on the dispute, the District shall prepare a written response that takes into account any timely advice or comments regarding the dispute from the ACHP, signatories and concurring parties, and provide them with a copy of this written response. The District will then proceed according to its final decision.

2. If the ACHP does not provide its advice regarding the dispute within the 30-day time period, the District may make a final decision on the dispute and proceed accordingly. Prior to reaching such a final decision, the District shall prepare a written response that takes into account any timely comments regarding the dispute from the signatories and concurring parties to the Agreement, and provide them and the ACHP with a copy of such written response.

3. The District's responsibility to carry out all other actions subject to the terms of this PA that are not subject of the dispute remain unchanged.

B. If the District and the IA SHPO (and, as appropriate, the THPOs/Tribes) do not agree on NRHP eligibility, or if the Signatories, ACHP, or the National Park Service so request, the District will request a formal determination of eligibility from the Keeper of the NRHP, National Park Service, whose determination shall be final.

VIII. DURATION

This agreement will become void if its terms are not carried out within five years from the date of its execution. Six months prior to the fifth anniversary of the agreement execution date, the District shall consult with the other signatories to reconsider the terms of the agreement and amend it in accordance with Stipulation X., *Amendments*. The terms of this Agreement shall remain in-force for a period of five years commencing at the date of its execution. At the end of this period the District shall review the necessity of this Agreement in order to determine whether it should be reissued or allowed to expire. If the Agreement requires reissue, the District shall consult with the IA SHPO in order to ensure compliance with the most current version of the Federal regulations (36 CFR Part 800) implementing Sections 106 and 110(f) of the NHPA (54 U.S.C. § 306108 and 306107). Extension of this agreement duration requires written amendment by all Signatories.

IX. TERMINATION

Any of the Signatories to this PA may request a reconsideration of its terms or revoke the agreement upon written notification to the other Signatories by providing 30 days' notice to the other Signatories, provided that the Signatories will consult during the period prior to termination to seek agreement on amendments or other actions that would avoid termination. In the advent of termination, the District will comply with 36 CFR 800.3 through 800.7 with regard to individual actions covered by this PA.

X. AMENDMENTS

Any of the Signatories to this PA may request that any or all of its articles be amended subsequent to the PA's execution, whereupon the other Signatories will consult in accordance with 36 CFR 800.13, to consider such amendment. The District must notify the ACHP of its intent to amend the Agreement and invite the ACHP's review and comment. The amendment will be effective on the date a copy signed by all of the Signatories is filed with the ACHP. The District shall ensure that copies of the amended Agreement are provided to all of the signatories. The District shall follow the above procedures for amendment in the event that the Undertaking is redefined by the selection of a different alternative or through the adoption of multiple alternatives. Revisions to the appendices shall not require notification of and review by the ACHP. The appendices to the PA can be changed by written concurrence by the District, the IA SHPO, and the USFWS. However, the District shall ensure that the ACHP and consulting parties are provided file copies of finalized versions that reflect all revisions.

XI. ANTI-DEFICIENCY ACT

The parties to this agreement acknowledge the District's fiduciary responsibilities pursuant to the Anti-Deficiency Act (31 USC § 1341). This notwithstanding, the District's responsibilities to fulfill the terms of this agreement and to comply with the requirements of the NHPA remain unchanged regardless of the availability or level of funding appropriated for its purposes.

XII. EXECUTION OF THE AGREEMENT

This agreement will become effective upon the District's receipt of signatures on this agreement by all Signatories. Execution of this agreement by the District, IA SHPO, and USFWS and the implementation of its terms evidence that the District has taken into account program effects on historic properties and has afforded the ACHP an opportunity to comment.

SIGNATORIES

PROGRAMMATIC AGREEMENT AMONG THE UNITED STATES ARMY CORPS OF ENGINEERS ROCK ISLAND DISTRICT, THE IOWA STATE HISTORIC PRESERVATION OFFICE, AND THE UNITED STATES FISH AND WILDLIFE SERVICE REGARDING THE STEAMBOAT ISLAND HABITAT REHABILITATION AND ENHANCEMENT PROJECT, CLINTON AND SCOTT COUNTIES, IOWA, AND ROCK ISLAND COUNTY, ILLINOIS

SIGNATORY:

UNITED STATES ARMY CORPS OF ENGINEERS, ROCK ISLAND DISTRICT

Digitally signed by LTC John M. Fernas, MVR DDC, for COL Steven Sattinger
Date: 2020.08.21 15:09:41 -05'00'

BY: ______________________________ Date: ______________

Steven M. Sattinger
Colonel, US Army
Commander and District Engineer

PROGRAMMATIC AGREEMENT AMONG THE UNITED STATES ARMY CORPS OF ENGINEERS ROCK ISLAND DISTRICT, THE IOWA STATE HISTORIC PRESERVATION OFFICE, AND THE UNITED STATES FISH AND WILDLIFE SERVICE REGARDING THE STEAMBOAT ISLAND HABITAT REHABILITATION AND ENHANCEMENT PROJECT, CLINTON AND SCOTT COUNTIES, IOWA, AND ROCK ISLAND COUNTY, ILLINOIS

SIGNATORY:

IOWA STATE HISTORIC PRESERVATION OFFICER

BY: ______________________ Date: 9/22/2020

Susan Kloewer
Iowa State Historic Preservation Officer
State Historical Society of Iowa

PROGRAMMATIC AGREEMENT AMONG THE UNITED STATES ARMY CORPS OF ENGINEERS ROCK ISLAND DISTRICT, THE IOWA STATE HISTORIC PRESERVATION OFFICE, AND THE UNITED STATES FISH AND WILDLIFE SERVICE REGARDING THE STEAMBOAT ISLAND HABITAT REHABILITATION AND ENHANCEMENT PROJECT, CLINTON AND SCOTT COUNTIES, IOWA, AND ROCK ISLAND COUNTY, ILLINOIS

SIGNATORY:

U.S. FISH AND WILDLIFE SERVICE

BY: ______________________________ Date:______________

Sabrina Chandler
Refuge Manager, Upper Mississippi River National Wildlife and Fish Refuge
U.S. Fish and Wildlife Service

CONCURRING PARTIES

PROGRAMMATIC AGREEMENT AMONG THE UNITED STATES ARMY CORPS OF ENGINEERS ROCK ISLAND DISTRICT, THE IOWA STATE HISTORIC PRESERVATION OFFICE, AND THE UNITED STATES FISH AND WILDLIFE SERVICE REGARDING THE STEAMBOAT ISLAND HABITAT REHABILITATION AND ENHANCEMENT PROJECT, CLINTON AND SCOTT COUNTIES, IOWA, AND ROCK ISLAND COUNTY, ILLINOIS

CONCURRING PARTY:

FORT PECK ASSINIBOINE AND SIOUX TRIBES

BY: ____ Date:________________

Floyd Azure
Chairman
Fort Peck Assiniboine and Sioux Tribes

CONCURRING PARTIES

PROGRAMMATIC AGREEMENT AMONG THE UNITED STATES ARMY CORPS OF ENGINEERS ROCK ISLAND DISTRICT, THE IOWA STATE HISTORIC PRESERVATION OFFICE, AND THE UNITED STATES FISH AND WILDLIFE SERVICE REGARDING THE STEAMBOAT ISLAND HABITAT REHABILITATION AND ENHANCEMENT PROJECT, CLINTON AND SCOTT COUNTIES, IOWA, AND ROCK ISLAND COUNTY, ILLINOIS

CONCURRING PARTY:

IOWA TRIBE OF KANSAS AND NEBRASKA

BY: ____ Date:_______________

Timothy Rhodd
Chairman
Iowa Tribe of Kansas and Nebraska

CONCURRING PARTIES

PROGRAMMATIC AGREEMENT AMONG THE UNITED STATES ARMY CORPS OF ENGINEERS ROCK ISLAND DISTRICT, THE IOWA STATE HISTORIC PRESERVATION OFFICE, AND THE UNITED STATES FISH AND WILDLIFE SERVICE REGARDING THE STEAMBOAT ISLAND HABITAT REHABILITATION AND ENHANCEMENT PROJECT, CLINTON AND SCOTT COUNTIES, IOWA, AND ROCK ISLAND COUNTY, ILLINOIS

CONCURRING PARTY:

MIAMI TRIBE OF OKLAHOMA

BY: ______________________________ Date: ______________

Douglas G. Lankford
Chief
Miami Tribe of Oklahoma

CONCURRING PARTIES

PROGRAMMATIC AGREEMENT AMONG THE UNITED STATES ARMY CORPS OF ENGINEERS ROCK ISLAND DISTRICT, THE IOWA STATE HISTORIC PRESERVATION OFFICE, AND THE UNITED STATES FISH AND WILDLIFE SERVICE REGARDING THE STEAMBOAT ISLAND HABITAT REHABILITATION AND ENHANCEMENT PROJECT, CLINTON AND SCOTT COUNTIES, IOWA, AND ROCK ISLAND COUNTY, ILLINOIS

CONCURRING PARTY:

PONCA TRIBE OF NEBRASKA

BY: ______________________________ Date:______________

Larry Wright, Jr.
Chairman
Ponca Tribe of Nebraska

CONCURRING PARTIES

PROGRAMMATIC AGREEMENT AMONG THE UNITED STATES ARMY CORPS OF ENGINEERS ROCK ISLAND DISTRICT, THE IOWA STATE HISTORIC PRESERVATION OFFICE, AND THE UNITED STATES FISH AND WILDLIFE SERVICE REGARDING THE STEAMBOAT ISLAND HABITAT REHABILITATION AND ENHANCEMENT PROJECT, CLINTON AND SCOTT COUNTIES, IOWA, AND ROCK ISLAND COUNTY, ILLINOIS

CONCURRING PARTY:

ROSEBUD SIOUX TRIBE

BY: ____ Date:________________

Rodney M. Bordeaux
President
Rosebud Sioux Tribe

CONCURRING PARTIES

PROGRAMMATIC AGREEMENT AMONG THE UNITED STATES ARMY CORPS OF ENGINEERS ROCK ISLAND DISTRICT, THE IOWA STATE HISTORIC PRESERVATION OFFICE, AND THE UNITED STATES FISH AND WILDLIFE SERVICE REGARDING THE STEAMBOAT ISLAND HABITAT REHABILITATION AND ENHANCEMENT PROJECT, CLINTON AND SCOTT COUNTIES, IOWA, AND ROCK ISLAND COUNTY, ILLINOIS

CONCURRING PARTY:

SAC AND FOX TRIBE OF THE MISSISSIPPI IN IOWA

BY: ____ Date:________________

Judith Bender
Chairwoman
Sac and Fox Tribe of the Mississippi in Iowa

CONCURRING PARTIES

PROGRAMMATIC AGREEMENT AMONG THE UNITED STATES ARMY CORPS OF ENGINEERS ROCK ISLAND DISTRICT, THE IOWA STATE HISTORIC PRESERVATION OFFICE, AND THE UNITED STATES FISH AND WILDLIFE SERVICE REGARDING THE STEAMBOAT ISLAND HABITAT REHABILITATION AND ENHANCEMENT PROJECT, CLINTON AND SCOTT COUNTIES, IOWA, AND ROCK ISLAND COUNTY, ILLINOIS

CONCURRING PARTY:

WINNEBAGO TRIBE OF NEBRASKA

BY: ____ Date:________________

Coly Brown
Chairman
Winnebago Tribe of Nebraska

PROGRAMMATIC AGREEMENT AMONG THE UNITED STATES ARMY CORPS OF ENGINEERS ROCK ISLAND DISTRICT, THE IOWA STATE HISTORIC PRESERVATION OFFICE, THE UNITED STATES FISH AND WILDLIFE SERVICE, AND THE ADVISORY COUNCIL ON HISTORIC PRESERVATION REGARDING THE STEAMBOAT ISLAND HABITAT REHABILITATION AND ENHANCEMENT PROJECT, CLINTON AND SCOTT COUNTIES, IOWA, AND ROCK ISLAND COUNTY, ILLINOIS

CONCURRING PARTY:

THE UNIVERSITY OF IOWA

BY: ______________________ Date: 10-5-2020

John Doershuk, Ph.D
State Archaeologist
Office of the State Archaeologist

APPENDIX O-A

AREA OF POTENTIAL EFFECT AND
PROJECT ACTIVITIES HAVING AN EFFECT ON CULTURAL RESOURCES

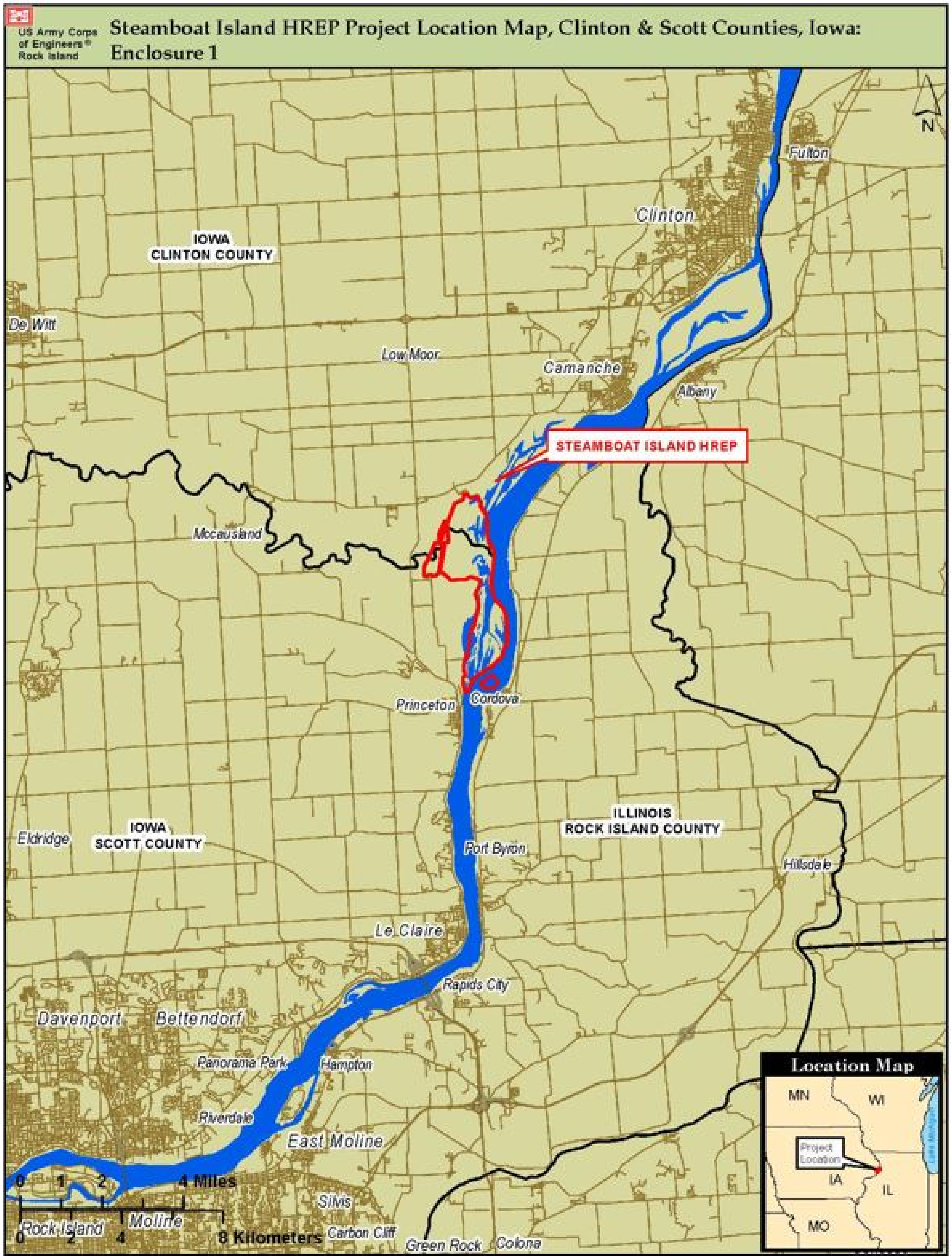

Figure 1. Project Location Map

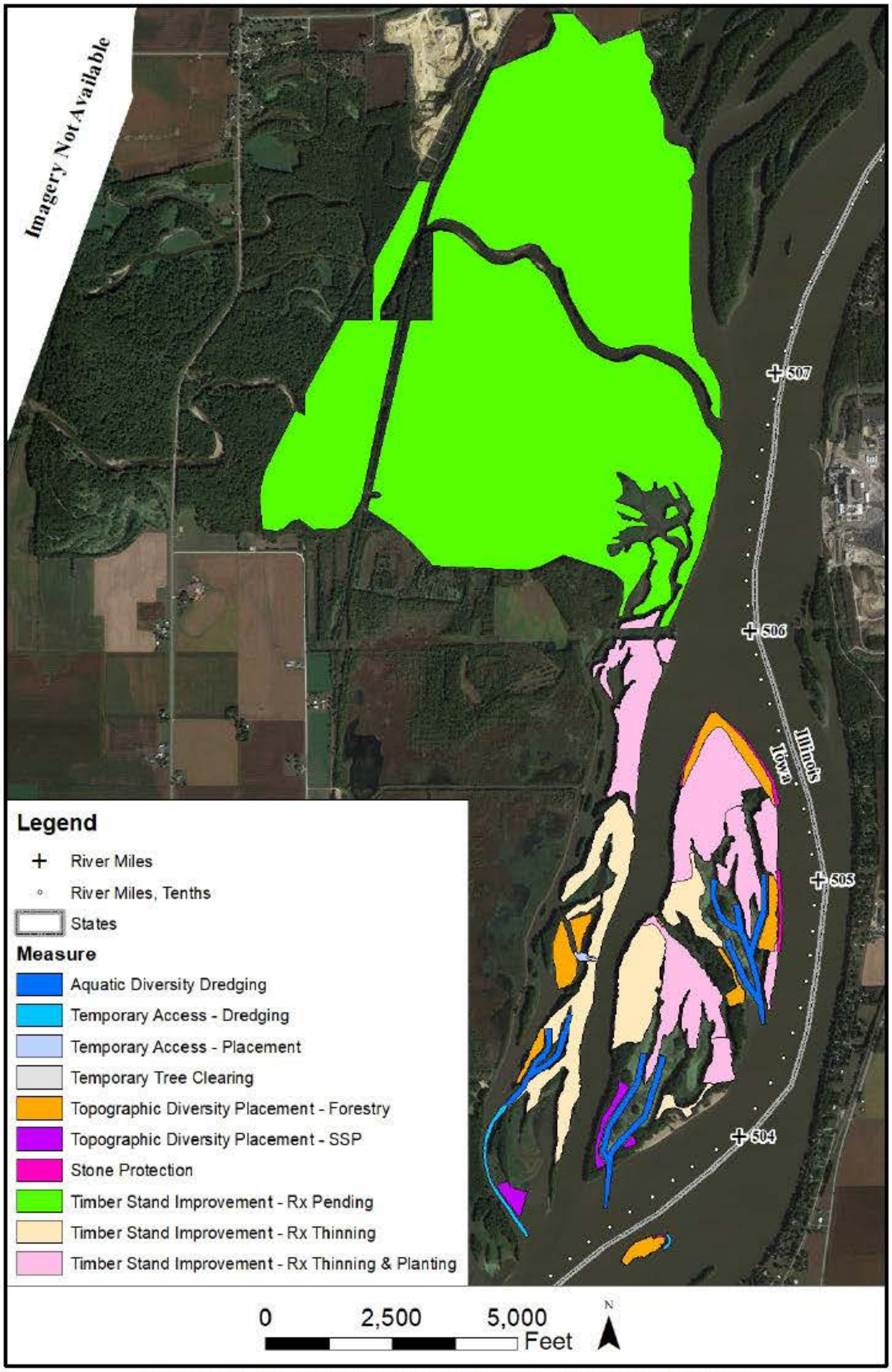

Figure 2. Project Features and Area of Potential Effect

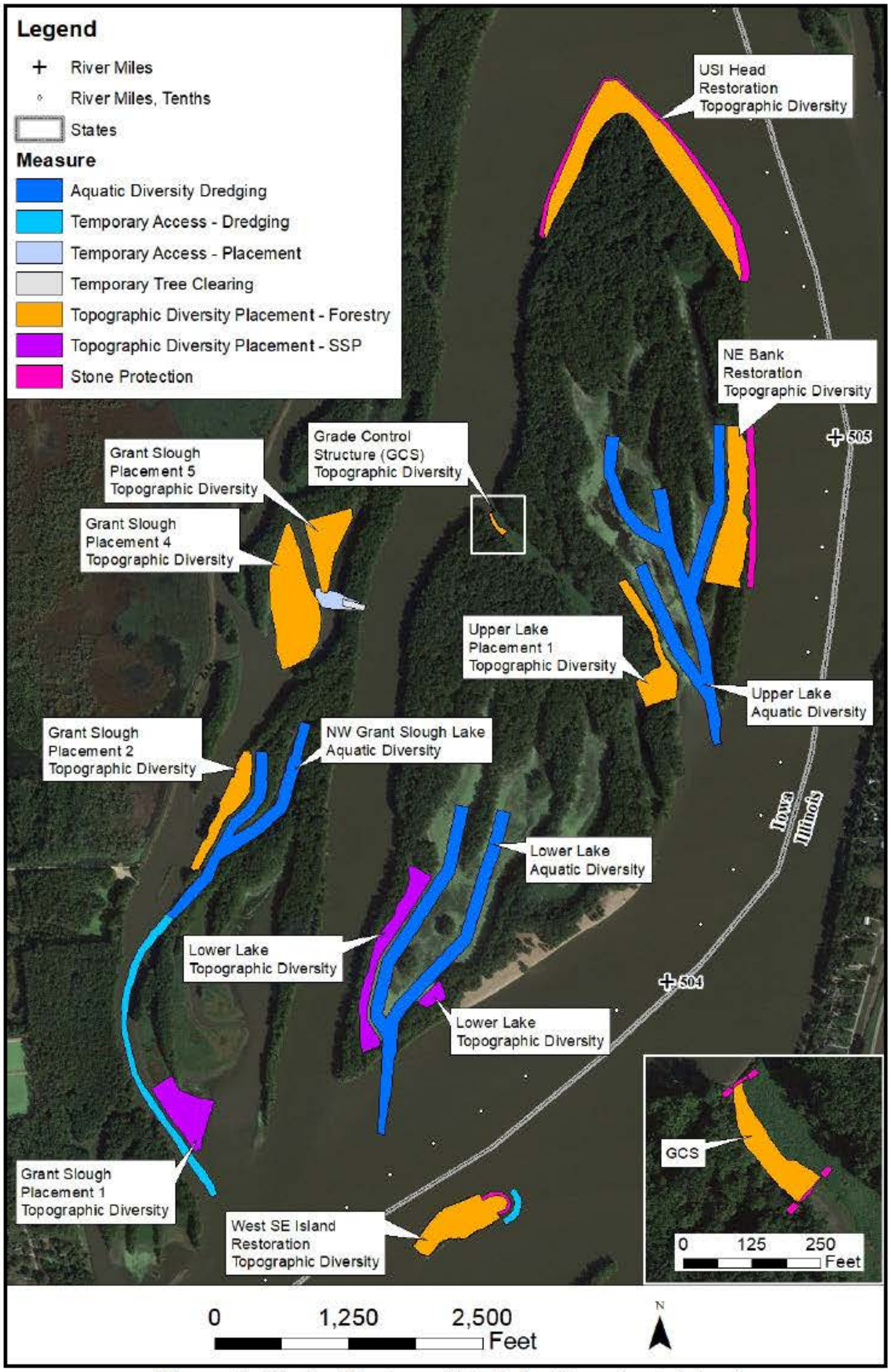

Figure 3. Project Features Detail for Steamboat Island

Table O-A-1. Outline of Project Measures Having the Potential to Impact Cultural Resources

Project Measure	Action	Potential Impact	Impact Level
Aquatic Diversity Dredging	Mechanical dredging	Dredging of materials within natural backwater area	Low
Temporary Access in Grant Slough	Tree clearing 1.3 acres; heavy machinery	Maximum depth of disturbance is 3 feet	Moderate-to-High
Topographic Diversity Measures – Forest Habitat	Placing dredge material	Grading top 1-2 inches prior to dredge material placement; seeding/planting	Low
Timber Stand Improvement	Tree thinning and planting (specific acreages and locations for this action are yet to be determined)	Most holes for planting will be 18 inches in depth, with maximum depth of disturbance is 3 feet due to root growth; tree cutting will leave fallen tree in place, use of skid steer to remove trees on east side of Steamboat Island only	Moderate-to-High
Island Restoration and Protection	Dredge material and stone placement on submerged island to restore historic footprint; tree planting	Material placement and tree planting	Low
Topographic Diversity Measures - Scrub-Shrub/Pollinator Habitat	Dredge material placement, planting	Grading top 1-2 inches prior to dredge material placement; seeding/planting	Low
Stone Placement	Stone placement	Placement of stone on dredge material	Low

APPENDIX O-B

INTERESTED AND CONSULTING PARTIES LIST

Pursuant to 36 CFR 800.2(d), 800.3, 800.5(c), and 800.6(a)(2), 800.8(c)(1)(iv) of the NHPA and to meet the responsibilities under the National Environmental Policy Act of 1969 Act (NEPA) (42 U.S.C. 4321-4335) , the District has developed an Interested and Consulting Parties List comprised of 35 THPOs/Tribes and six other organizations or agencies. The District will comply with any requests to be removed from, or added to, the Interested and Consulting Parties List and will continue to develop and maintain the following Interested and Consulting Parties List.

AGENCIES, SOCIETIES, AND INDIVIDUALS

Advisory Council on Historic Preservation
Mr. Christopher Daniel, Program Analyst
401 F Street NW, Suite 308
Washington, D.C. 20001-2637

Iowa State Historic Preservation Office
Mr. Daniel Higginbottom, Archaeologist
Capitol Complex
600 E Locust
Des Moines, IA 50319

Iowa State Historic Preservation Office
Ms. Heather Gibb, R&C Coordinator
600 East Locust
Des Moines, IA 50319

City of Clinton
Historic Preservation Commission
Jan Hansen
611 S. 3rd St. PO Box 2958
Clinton, IA 52732

Illinois State Historic Preservation Office
Mr. Jeff Kruchten, Archaeologist
1 Old State Capitol Plaza
Springfield, IL 62701

US Fish and Wildlife Service
Mr. James Myster, Regional Archaeologist/RHPO
5600 American Blvd W Ste 1049
Bloomington, MN 55437

Office of the State Archaeologist
Dr. John Doershuk
700 South Clinton St.
The University of Iowa
Iowa City, IA 52242

TRIBES

Cheyenne River Sioux Tribe
Mr. Steven Vance, THPO
PO Box 590
Eagle Butte, SD 57625

Citizen Potawatomi Nation
Dr. Kelli Mosteller, THPO
1601 S Gordon Cooper Drive
Shawnee, OK 74801

Crow Creek Sioux Tribe
Mr. Merle Marks, THPO
PO Box 50
Ft. Thompson, SD 57339-0050

Flandreau Santee Sioux Tribe
Mr. Garrie Killsahundred, THPO
P.O. Box 283
Flandreau, SD 57028

Forest County Potawatomi Community
Mr. Michael LaRonge, THPO
5320 Wensaut Lane
P.O. Box 340
Crandon, WI 54520

Fort Peck Assiniboine and Sioux Tribes
Ms. Dyan Youpee, THPO
501 Medicine Bear Road
PO Box 1027
Poplar, Montana 58255

Ho-Chunk Nation
Mr. Bill Quackenbush, THPO
P.O. Box 667
Black River Falls, WI 54615

Iowa Tribe of Kansas and Nebraska
Mr. Lance Foster, THPO
3345 B Thrasher Rd.
White Cloud, KS 66094

Iowa Tribe of Oklahoma
Mr. Eagle McClellan, Cultural Preservation Director
Cultural Preservation Office
335588 E. 750 Rd.
Perkins, OK 74059

Kaw Nation
Ms. Crystal Douglas, THPO
Drawer 50
Kaw City, OK 74641

Kickapoo Tribe in Kansas
Mr. Curtis Simon, NAGPRA Representative
1107 Goldfind Rd.
Horton, KS 66439

Kickapoo Tribe in Oklahoma
Mr. Kent Collier, NAGPRA Representative
PO Box 70
Mcloud, OK 74851

Lower Sioux Indian Community
Ms. Cheyanne St. John, THPO
39527 Res. Highway 1
P.O. Box 308
Morton, MN 56270

Menominee Indian Tribe of Wisconsin
Mr. David Grignon, THPO
PO Box 910
Keshena, WI 54135-0910

Miami Tribe of Oklahoma
Ms. Diane Hunter, THPO
PO Box 1326
Miami, OK 74355

Oglala Sioux Tribe
Mr. Thomas Brings, THPO
P.O. Box 320
Pine Ridge, SD 57770

Omaha Tribe of Nebraska
Mr. Thomas Parker, THPO
Omaha Tribe of Nebraska
P.O. Box 368
Macy, NE 68039

Osage Nation
Mr. Jess Hendrix, Archeologist
627 Grandview Ave.
Pawhuska, OK 74056

Otoe-Missouria Tribe
Ms. Elsie Whitehorn, THPO
8151 Hwy 177
Red Rock OK 74651

Peoria Tribe of Oklahoma
Mr. Logan Pappenfort, NAGPRA Representative
PO Box 1527
Miami, OK 74355

Ponca Tribe of Nebraska
Mr. Nicholas Mauro, THPO
P.O. Box 288
Niobrara, NE 68760

Ponca Tribe of Oklahoma
Ms. Halona Cabe, THPO
20 White Eagle Drive
Ponca City, OK 74601

Prairie Band Potawatomi Nation
Ms. Hattie Mitchell, NAGPRA Representative
16281 Q Road
Mayetta, KS 66509

Prairie Island Indian Community
Mr. Noah White, THPO
5636 Sturgeon Lake Road
Welch, MN 55089

Rosebud Sioux Tribe
Mr. Ben Rhodd, THPO
PO Box 809
Rosebud, SD 57570-0809

Sac and Fox Nation of Missouri in Kansas
and Nebraska
Chairperson Tiauna Carnes
305 North Main Street
Reserve, KS 66434

Sac and Fox Nation of Oklahoma
Chris Boyd, NAGPRA Coordinator
920883 S. Hwy. 99, Bldg. A
Stroud, OK 74079

Sac and Fox Tribe of the Mississippi in Iowa
Johnathan Buffalo, Director
Historic Preservation Department
303 Meskwaki Road
Tama, IA 52339

Santee Sioux Tribe of Nebraska
Mr. Duane Whipple, THPO
108 Spirit Lake Avenue West
Niobara, NE 68760

Sisseton-Wahpeton Oyate
Ms. Dianne Desrosiers, THPO
P.O. Box 907
Sisseton, SD 57262

Spirit Lake Tribe
Dr. Erich Longie, THPO
PO Box 359
Fort Totten, ND 58335

Standing Rock Sioux Tribe
Mr. Jon Eagle, THPO
PO Box D
Ft. Yates, ND 58538-0522

Upper Sioux Community, Minnesota
Ms. Samantha Odegard, THPO
P.O. Box 147
Granite Falls, MN 56241

Winnebago Tribe of Nebraska
Mr. Eben Crawford, NAGPRA Assistant
PO Box 687
Winnebago, NE 68071

Yankton Sioux Tribe
Mr. Kip Spotted Eagle, THPO
PO Box 1153
Wagner, SD 57380

APPENDIX O-C

UNANTICIPATED DISCOVERY

Here, and throughout Appendix O-C, actions taken pursuant to this agreement will occur in consultation with the Signatories and Consulting Parties.

A. Human Remains. Iowa law protects all human remains regardless of their historical age, sex, or cultural/ethnic affiliation.

1. In the event that human remains are encountered during archeological investigations or construction activities, work shall cease within 100 feet of the remains, appropriate steps shall be taken to secure the site, and officials at the District, the USFWS, the Bioarchaeology Program at OSA, and the IA SHPO shall be notified and, to the best of their ability, shall respond within three (3) working days to such notification in order to determine the next course of action that ensures the applicable Iowa law is followed. At the District, this official shall be an Archeologist in the Environmental Compliance or Planning branches, or their designee. At the USFWS, this official shall be the Regional Historic Preservation Office/Archaeologist and the Savanna District Wildlife Refuge Manager. At the OSA, this official shall be the Bioarchaeology Program Director or their designee. At the IA SHPO, this official shall be a Review Archaeologist.

2. If the remains appear to be ancient (i.e., older than 150 years), and are determined to be ethnically Native American, the District shall be responsible for adhering to the Native American Graves Protection and Repatriation Act [NAGPRA (Pub.L. 101-601; 25 U.S.C. 3001-3013;104 Stat. 3048-3058)]. The OSA shall have jurisdiction to ensure that the appropriate procedures in accordance with applicable Iowa law (Code of Iowa, Sections 263B, 523I.316.6 and 716.5; IAC 685, Ch.11.1) are observed, but are not financially responsible for costs incurred during this process. The disposition of the remains will be arranged in accordance with NAGPRA and Chapter 263B of the Iowa Code.

3. Human remains less than 150 years old that are determined to be ethnically Native American are protected under the Native American Graves Protection and Repatriation Act (Pub.L. 101-601; 25 USC 3001-3013) and Chapter 523I of the Iowa Code. The District shall be responsible for adhering to these laws. In the event that human remains appearing less than 150 years in age are encountered, the District shall ensure that appropriate law enforcement authorities and the Iowa Department of Health be notified. The OSA shall ensure that appropriate procedures in accordance with applicable Iowa law are observed, but are not financially responsible for costs incurred during this process.

4. Before work can resume within 100 feet of the human remains, the District must determine the NRHP eligibility of the archeological resource in consultation with the IA SHPO and tribal representatives, as applicable.

5. Upon a determination of eligibility, and decision to preserve in place by the OSA, or designee, the District shall submit a plan for avoidance and protection to the District for review and comment. The District will provide the proposed plan to all Consulting Parties. The IA SHPO and Consulting Parties will have seven (7) working days to provide comments to the OSA on the proposed plan for final approval.

6. Upon a determination of eligibility, and decision to remove the human remains by the OSA, or their designee, the District shall submit a plan for relocation and recovery of information to the District for review and comment. The District will provide the proposed plan to all Consulting Parties. The IA SHPO and Consulting Parties will have seven (7) working days to provide comments to the OSA on the proposed plan for final approval.

7. Work within 100 feet of the human remains shall resume upon the development and implementation of an appropriate relocation and data recovery plan, other recommended mitigation procedures, or agreement among the District, OSA and IA SHPO that the site does not warrant mitigation.

B. Archaeological Material (non-mortuary related). The District shall ensure that the following procedures are observed in the event that previously undetected non-mortuary-related archeological materials are encountered.

1. All activities within 100 feet of the unanticipated discovery shall cease immediately, appropriate steps shall be implemented to secure the site, and the District and IA SHPO shall be notified of the discovery and shall respond within five working days to such notification. Construction work may continue in the area outside the 100 feet of the unanticipated discovery.

2. An archeologist retained by the District will inspect the work site and determine the extent of the affected archeological resource within five working days of its discovery.

3. Before work can resume within 100 feet of the unanticipated discovery, the District must determine the NRHP eligibility of the archeological resource in consultation with the IA SHPO and other Consulting Parties, as applicable.

4. Upon a determination of eligibility, the District or their designee shall submit a plan for avoidance, protection, recovery of information, or destruction without data recovery to the District for review and comment within 20 working days. The District will notify all Consulting Parties of the unanticipated discovery and provide the proposed treatment plan for their consideration. The IA SHPO and Consulting Parties will have seven working days to provide comments on the proposed treatment plan upon receipt of the information.

5. Work within 100 feet of the unanticipated discovery shall resume upon either:

a. The development and implementation of an appropriate data recovery plan, other recommended mitigation procedures, or agreement among the District and the IA SHPO that the site does not warrant mitigation; or,

b. Agreement by the IA SHPO and the District that the newly located archeological materials are not eligible for inclusion on the NRHP.

c. If the District and IA SHPO object to any part of the treatment plan and they are not able to reach resolution of the objection within seven working days of when the objection is raised, the District shall follow the procedures outlined in Stipulation VII, Dispute Resolution.

C. Adverse Effects upon Architectural Properties. The District shall ensure that the following procedures are observed in the event that post-review effects to historic buildings, structures, objects, or districts are identified.

1. Work within 100 feet of the unanticipated discovery shall cease and the District shall notify the IA SHPO of the discovery and the IA SHPO will respond within five working days to such notification. Construction work may continue in the area outside the 100 feet of the unanticipated discovery.

2. An architectural historian retained by the District will inspect the work site and evaluate the National Register eligibility of the property within seven working days. The District, in consultation with the District, shall assess the project effects. The District shall provide its report of findings and determination of effect to the IA SHPO who shall have seven working days to provide comments.

3. Upon assessment of adverse effect, the District shall submit a plan for after-the-fact mitigation to the District for review and comment. The District will notify all Consulting Parties of the unanticipated discovery and provide the plan for their consideration. The IA SHPO and Consulting Parties will have seven working days to provide comments on the plan upon its receipt. The District may implement the plan if IA SHPO fails to respond within the allotted timeframe.

4. Work within 100 feet of the unanticipated discovery shall resume upon either:

a. Agreement by the District and the IA SHPO that the effects are not adverse; or,

b. The development and implementation of an appropriate plan, or agreement among the District and the IA SHPO that the site does not warrant mitigation.

c. If the District and IA SHPO object to any part of the plan and they are not able to reach resolution of the objection within seven working days of when the objection is raised, the District shall follow the procedures outlined in Stipulation VII, Dispute Resolution.

D. Failure to Act within Specified Timeframe. If any principal signatory fails to meet the timeframes set in Appendix O-C, Unanticipated Discoveries, the District may proceed to final decision-making.

APPENDIX O-D

HISTORIC PROPERTIES IDENTIFICATION AND PROCEDURES FOR PROJECT REVIEW

I. HISTORIC PROPERTY SURVEYS AND TESTING

Here, and throughout Appendix O-D, actions taken pursuant to this agreement will occur in consultation with the Signatories. The District will make a reasonable and good faith effort to identify historic properties that are within the APE, and provide this information, and associated studies or reports to the Signatories. This shall be accomplished through the implementation of historic property surveys and testing, and agreed upon treatments of historic properties. The District, in consultation with the Signatories, will ensure that the following measures are implemented:

A. The District, in consultation with the Signatories, will provide scholarly evidence of stewardship (typically documented in a technical report written by a qualified archeologist or architectural historian) in the recordation, protection, and management of historic properties within the APE through systemic research and studies which have been finalized and approved, then placed in the permanent files of the IA SHPO and OSA (as necessary) as evidence of compliance promulgated under Section 106 of the NHPA, as amended and its implementing regulations 36 C.F.R. Part 800: "Protection of Historic Properties."

B. No archeological historic property survey will be required where the District has documented and IA SHPO concurs that:

1. Profound ground surface disturbances have so completely altered the landform as to make the existence of historic properties impossible (e.g., complete stripping of all soils down to sterile subsoil); or,

2. Geomorphological investigations indicate deeply buried deposits deeper than project impacts or very low potential for near surface cultural deposits; or,

3. An area previously has been surveyed at the appropriate level of investigation necessary to cover the entire APE utilizing methods consistent with the Secretary of the Interior's *Standards and Guidelines for Identification and Evaluation* (48 FR 44720-23) and taking into account the National Park Service publication *The Archaeological Survey: Methods and Uses* (1978) and the most recent version of the *Guidelines for Archaeological Investigations in Iowa* (2018) and has been recommended for acceptance by the IA SHPO.

C. The District will ensure that the necessary surveys are performed on all other areas within the APE indirectly and directly affected by the Undertaking. The District will evaluate historic properties relative to past surveys and reports and properties deemed ineligible with IA SHPO's concurrence based upon the evaluation of the most recent survey; surveys occurring within the last five years that have been recommended for acceptance by the IA SHPO and provide full vertical and horizontal coverage of the APE will not be reevaluated. If a survey results in the identification of properties that are eligible to the NRHP, the District, in consultation with the Signatories and/or Consulting Parties, shall develop and implement plans for the appropriate treatment of historic properties.

D. All surveys will be conducted in a manner consistent with the Secretary of the Interior's *Standards and Guidelines for Identification and Evaluation* (48 FR 44720-23) and take into account the National Park Service publication *The Archaeological Survey: Methods and Uses* (1978) and the most recent version of the *Guidelines for Archaeological Investigations in Iowa* (2017). The reconnaissance surveys and subsurface testing will be implemented and reported by the District. The District will then distribute the reports to IA SHPO and other parties, as appropriate, for review and comment.

E. In consultation with the IA SHPO, and, as appropriate, the THPOs/Tribes, the District shall evaluate for eligibility all properties by applying the NRHP criteria (36 CFR 60.4).

1. For those properties that the District and the IA SHPO (and in consultation with the THPOs/Tribes, as appropriate) agree are not eligible for nomination to or inclusion in the NRHP, no further investigations of those properties will be required, and the project may proceed in those areas.

2. If the survey results in the identification of properties that the District and the IA SHPO (and, as appropriate, the THPOs/Tribes) agree are eligible for inclusion on the NRHP, such properties shall be treated in accordance with Section II below, *Treatment of Historic Properties*.

II. TREATMENT OF HISTORIC PROPERTIES

The District will ensure that the following guidelines are implemented when dealing with historic properties in the APE. In order of preference:

A. Avoidance. The preferred treatment for all archeological, historical, and architectural historic properties is avoidance of direct and indirect effects resulting from the Undertaking. All work shall, to the extent feasible, avoid historic properties either through project design changes, use of temporary fences or barricades during construction, realignments, landscaping, or other measures that the Signatories agree will adequately protect historic properties in both the short- and long-term.

B. Reduction of Effects on Properties Preserved in Place. When the District determines that complete avoidance of historic properties is not feasible, the District shall ensure that alternatives are explored to reduce the magnitude of the effects on the historic properties. Exploration of ways to reduce adverse effects will include the consideration of preservation of historic properties or the protection of historic properties against impacts by project-related activities in close proximity to the property.

C. Treatment Plans. Proposed treatment plan should endeavor to minimize effects to historic resources to the greatest extent possible. Proposed plans will be provided to all Signatories for review and comment. Unless the IA SHPO (and, in consultation with the THPOs/Tribes, as appropriate) objects within 30 days of receipt of any plan, the District shall ensure that the treatment plans are implemented. The District shall revise treatment plans in response to comments and recommendations provided by the IA SHPO, THPOs/Tribes, and other Consulting Parties so long as the Signatories can agree in writing that they equitably mitigate project effects. Should Signatories not agree, the District will request the ACHP's comments in accordance with Stipulation VII*,* Dispute Resolution, of this PA.

D. Mitigation. When the District, in consultation with the IA SHPO and Consulting Parties as appropriate, determines that project activities will have an adverse effect on a historic property(ies), and that avoidance or in-place preservation is not feasible, the District, in consultation with the Signatories, shall ensure that a mitigation plan is developed for these properties in accordance with Appendix O-E of this PA. The District will forward such plans onto the IA SHPO and Consulting Parties as appropriate, for their review and comment.

E. Buildings and Structures. When avoidance or in-place preservation is not feasible, treatment plans for NRHP listed or eligible objects, structures or buildings shall adhere to the following guidelines:

1. Documentation. The District will engage a qualified architectural historian to conduct intensive-level survey and prepare HABS/HAER-standard documentation of the building, structure, or object in accordance with this PA with the understanding that documentation may not represent the only mitigation measure employed in resolving the adverse effect. HABS/HAER-standard documentation means products acceptable for inclusion in the Historic American Buildings Survey (HABS) / Historic American Engineering Record (HAER) / Historic American Landscapes Survey (HALS) collection at the Library of Congress in accordance with the Secretary of the Interior's Standards and Guidelines for Architectural and Engineering Documentation.

2. Relocation. The District shall ascertain, in consultation with the Signatories and other Consulting Parties, whether it is feasible and prudent to move the historic building or structure to a new location where it can be preserved. Adverse effects upon an object, structure or building contributing to a Historic District will include consideration of effects to the object, structure or building, as well as to the entire Historic District.

3. Property Transfer/Marketing. Any sale and removal/demolition of an historic object, structure or building that is leveraged by the Undertaking becomes part of the Undertaking and is subject to the terms of this agreement.

4. Demolition. If, following consultation, the Signatories agree that relocation is not feasible, or if there are no offers for the historic property and no other prudent and feasible creative alternatives present themselves, the District, in consultation with the signatories shall engage a qualified architectural historian to conduct intensive-level survey and prepare HABS/HAER-standard documentation of the historic property.

F. Archeological Data Recovery. The District shall ensure that any NRHP-eligible or -listed archaeological site whose preservation in-place is not feasible is subject to data recovery, following a data recovery plan developed in consultation with the IA SHPO, and THPOs/Tribes as appropriate, and subject to a 30-day review and comment period. All data recovery plans shall be consistent with the Secretary of the Interior's *Standards and Guidelines for Archeological Documentation* (48 FR 44734-37), the *Guidelines for Archaeological Investigations in Iowa* (2017), and take into account the ACHP's publication: *Treatment of Archeological Properties*. Each data recovery plan shall specify, at a minimum:

1. the property, properties, or portions of properties where data recovery is to be carried out;

2. the research questions to be addressed through the data recovery, with an explanation of their relevance and importance;

3. the methods to be used, with an explanation of their relevance to the research questions;

4. the methods to be used in analysis, data management, and dissemination of data, including a schedule;

5. the proposed disposition of recovered materials and records;

6. proposed methods for involving the interested public in the data recovery; and

7. a proposed schedule for the submission of progress reports to the IA SHPO, and, where applicable, Consulting Parties.

G. Historic Properties of Traditional Religious and Cultural Significance

1. If a property of traditional religious and cultural significance to Tribes and/or any other groups, or societies is identified within the APE, the District shall develop a treatment plan for that property in consultation with the Signatories and the Consulting Parties that could be affected by proposed activities at the specific historic site or property involved. The plan will cover analysis of treatment options (including consideration of a no build alterative) and selection of a recommended treatment for the property and the measures which will be undertaken by the District to ensure that the plan is implemented.

2. The District shall submit the plan to the IA SHPO and to the affected Consulting Parties and shall implement the plan in accordance with the procedures outlined in the plan, if responses are not received within 30 days of receipt of the plan by the IA SHPO, affected Consulting Parties.

3. Should a formal objection to the final plan be submitted within 30 days following its distribution, the District, the IA SHPO, and the affected Consulting Parties shall attempt to resolve the objection. If the objection is not resolved within 90 days, the District shall request the comments of the ACHP or Keeper in accordance with Stipulation VII, Dispute Resolution.

H. Construction. Construction proposed for the Undertaking on or adjacent to significant historic properties (including those properties deemed eligible to be, or listed on the NRHP), the District shall ensure that the design and specifications for new construction are developed in consultation with Signatories and Consulting Parties; the District will forward the plans to the IA SHPO for their review and comment. The District shall ensure that the project design for new construction is technically feasible and economically prudent; is compatible with the historic and architectural qualities of the historic property or district in question in terms of style, scale, massing, color, and materials; and is responsive to the recommended approaches to new construction set forth in the Secretary of the Interior's *Standards for Rehabilitation* (National Park Service 1983). The District acknowledges that project measures have not been finalized and may change or be modified since economical, operational, engineering, and environmental studies are ongoing. The District will therefore determine effects as directed under Section 106 of the NHPA, as amended and its implementing regulations 36 Part 800: "Protection of Historic Properties." Also, the District will:

1. consider the Undertaking's direct and indirect effects, such as all construction areas, including the construction zones footprints for dredging, dredge material placement, planting, riprap placement, and any other project-related features and ancillary features proposed.

2. consider and coordinate with the IA SHPO, areas with the potential for containing submerged historic properties.

APPENDIX O-E

PROGRAMMATIC MITIGATION OF EFFECTS

PROCEDURES

A. Here, and throughout Appendix O-E, actions taken pursuant to the agreement will occur in consultation with the Signatories. The District shall provide the IA SHPO, THPOs/Tribes, and Consulting Parties with letter reports summarizing the alternatives considered to avoid, minimize, or mitigate adverse effects to affected properties in the event adverse effects to such properties cannot be avoided. The IA SHPO, THPOs/Tribes, and Consulting Parties may request that the District consider other alternatives to avoid, minimize or mitigate adverse effects.

B. After the Signatories agree on a proposed alternative to mitigate adverse effects, the Signatories will develop a Memorandum of Agreement (MOA) to memorialize the mutually agreed upon strategy. Once these parties have finalized the MOA and as appropriate, received comment from the Consulting Parties, a copy will be filed with the ACHP. The District shall ensure that all provisions set forth in each MOA will be carried out. Unanticipated Discoveries are addressed in Appendix O-C.

C. Standard mitigation measures to be considered include, but are not limited to, the following:

1. **Documentation**

a. The District, in consultation with the Signatories, will ensure that the appropriate level of documentation is performed prior to the substantial alteration, relocation, or demolition of any historic building or structure. Documentation shall be consistent with the Secretary of the Interior's *Standards for Architectural and Engineering Documentation* and the *Standards for Historical Documentation* and at a minimum will include: photographs of external façades and internal and external character-defining features, and the completion of new or updated Iowa Site Inventory forms.

b. Unless otherwise agreed to by the IA SHPO in an MOA, the District shall ensure that all documentation is completed and the District shall ensure this documentation is submitted to the IA SHPO and recommended for acceptance prior to the demolition, alteration, or relocation of the historic building or structure.

c. The District will provide copies of the documentation to the IA SHPO, appropriate THPOs/Tribes, and other local, county, or state organizations which the IA SHPO recommends.

2. **Mitigation for Archeological Sites Eligible Other than or in Addition to Criterion D.** If preservation in place is not feasible, the District shall consult with the IA SHPO, THPOs/Tribes as appropriate, to develop a mitigation plan for any archeological site that is eligible to the NRHP under criteria other than, or in addition to, Criterion D of 36 C.F.R. Part 60. The District shall submit the plan to the IA SHPO and THPOs/Tribes as appropriate for review and comment.

3. **Alteration and Flood Risk Management Measures Not Adhering to the Standards.** The District shall consult with the Signatories and Consulting Parties to develop alternate treatment or mitigation plans for those features which cannot meet the Secretary of the Interior's *Standards for Rehabilitation*. The District shall submit these plans to the IA SHPO for review and comment.

4. **Other Mitigation Strategies.** The District, IA SHPO, THPOs/Tribes, and Consulting Parties shall consult to devise other mitigation strategies in instances where those included in this agreement do not satisfactorily mitigate adverse effects to historic properties. It may be necessary to develop separate MOAs for effects on specific historic properties.

UPPER MISSISSIPPI RIVER RESTORATION
FEASIBILITY REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STEAMBOAT ISLAND
HABITAT REHABILITATION AND ENHANCEMENT PROJECT

POOL 14, UPPER MISSISSIPPI RIVER MILES 502.5-508.0
CLINTON & SCOTT COUNTIES, IOWA,
AND ROCK ISLAND COUNTY, ILLINOIS

APPENDIX P

PLATES

US Army Corps of Engineers®

MISSISSIPPI RIVER BASIN

STEAMBOAT ISLAND HREP

CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL

RIVER MILES 502.5 - 508.0

FEASIBILITY REPORT

UMRR - UPPER MISSISSIPPI RIVER RESTORATION

Solicitation:

Contract:

THIS PROJECT WAS DESIGNED BY THE ROCK ISLAND DISTRICT CORPS OF ENGINEERS. THE INITIALS OR SIGNATURES AND REGISTRATION DESIGNATIONS OF INDIVIDUALS APPEAR ON THESE PROJECT DOCUMENTS WITHIN THE SCOPE OF THEIR EMPLOYMENT AS REQUIRED BY ER 1110-1-8152. SIGNATURES INDICATE OFFICIAL RECOMMENDATION OF ALL DRAWINGS IN THIS SET.

APPROVAL RECOMMENDED BY:

CHIEF, DESIGN BRANCH	DATE
CHIEF, HYDROLOGY & HYDRAULICS BRANCH	DATE
CHIEF, GEOTECHNICAL BRANCH	DATE
CHIEF, TECHNICAL SERVICES BRANCH	DATE
CHIEF, ENGINEERING & CONSTRUCTION DIVISION	DATE

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD		DATE:
DWN BY: E. JOHNSON	CKD BY: R. FELLMAN	SOLICITATION NO.:
SUBMITTED BY: A. HEDDLESTEN		CONTRACT NO.:
PLOT SCALE: N.T.S.	PLOT DATE:	PROJECT CODE: B5STMBTI202001
SIZE: ANSI D	FILE NAME: B5STMBTI202001	

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT
COVER SHEET

SHEET ID

G-001

REVIEW

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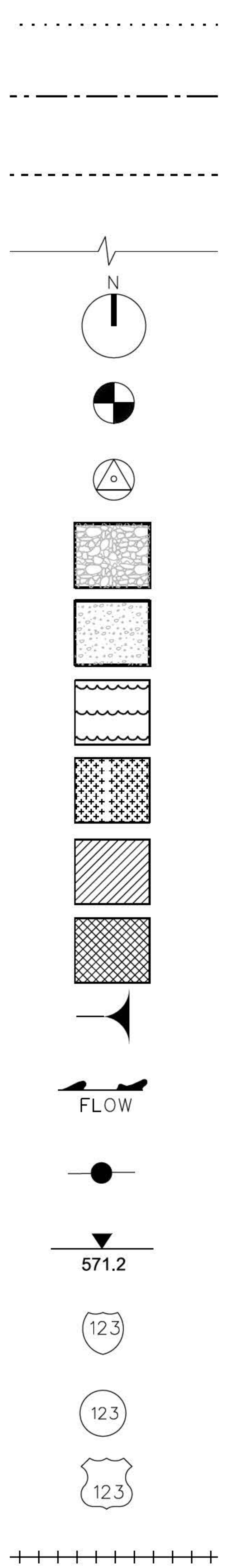
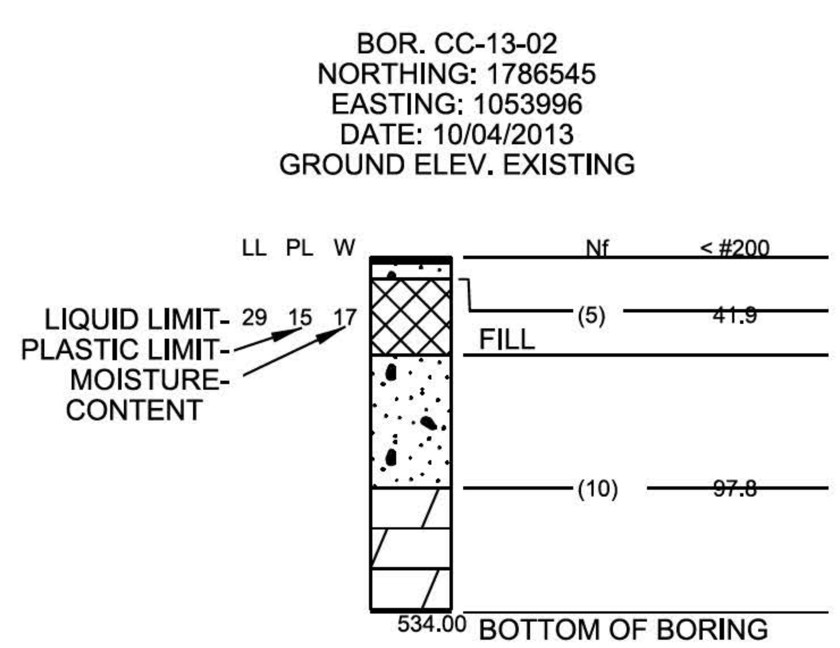
LEGEND



- EXISTING GROUND
- CENTERLINE
- CLEARING LIMITS
- BREAKLINE
- NORTH INDICATOR
- BORING LOCATION
- CONTROL POINT
- RIPRAP
- BEDDING STONE
- TSI - PRESCRIPTIONS DETERMINED
- TSI - PRESCRIPTIONS TO BE DETERMINED
- TOPOGRAPHIC DIVERSITY FORESTRY
- TOPOGRAPHIC DIVERSITY SCRUB SHRUB POLLINATOR
- SLOPE
- FLOW ARROW
- RIVERMILE
- FLAT POOL
- INTERSTATE HIGHWAY
- STATE HIGHWAY
- US HIGHWAY
- RAILROAD



-BORING NUMBER
-COORDINATE LOCATION
-DATE DRILLED
-EXISTING GROUND SURFACE ELEVATION

-NUMBER OF BLOWS TO DRIVE STANDARD SPLIT SPOON ONE FOOT WITH 140 LB HAMMER AND 30-INCH DROP

-PERCENT PASSING #200 SIEVE

- CH - USCS FAT CLAY
- CL - USCS LEAN CLAY
- SC - CLAYEY SAND
- SP - SAND, POORLY GRADED

ABBREVIATIONS

A	
APPROX	APPROXIMATE
AVE	AVENUE
B	
BM	BENCHMARK
C	
CL	CENTERLINE
CMP	CORRUGATED METAL PIPE
COR	CONTRACTING OFFICER REPRESENTATIVE
CY	CUBIC YARDS
D	
DIA	DIAMETER
DNR	DEPARTMENT OF NATURAL RESOURCES
E	
EL	ELEVATION
F	
FT	FEET
H	
H	HORIZONTAL
HTRW	HAZARDOUS TOXIC RADIOACTIVE WASTE
I	
INV	INVERT
M	
MAX	MAXIMUM
MSL	MEAN SEA LEVEL
MIN	MINIMUM
N	
NAD	NATIONAL GEODETIC SURVEY
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NAVD	NORTH AMERICAN VERTICAL DATUM
P	
PI	POINT OF INTERCEPTION
PVC	POINT OF VERTICAL CURVATURE
PVI	POINT OF VERTICAL INTERSECTION
PVT	POINT OF VERTICAL TANGENCY
R	
R	RADIUS
RCP	REINFORCED CONCRETE PIPE
RD	ROAD
RM	RIVERMILE
RR	RAILROAD
S	
S.S.P.	SCRUB SHRUB POLLINATOR
ST	STREET
STA	STATION
T	
TYP	TYPICAL
V	
V	VERTICAL

US Army Corps of Engineers®

MARK	DATE	DESCRIPTION	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD | DWN BY: E. JOHNSON | CKD BY: R. FELLMAN | SUBMITTED BY: A. HEDDLESTEN | PLOT SCALE: N.T.S. | PLOT DATE: | SIZE: ANSI D | FILE NAME: B5STMBTI202001 | DATE: | SOLICITATION NO.: | CONTRACT NO.: | PROJECT CODE: B5STMBTI202001

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

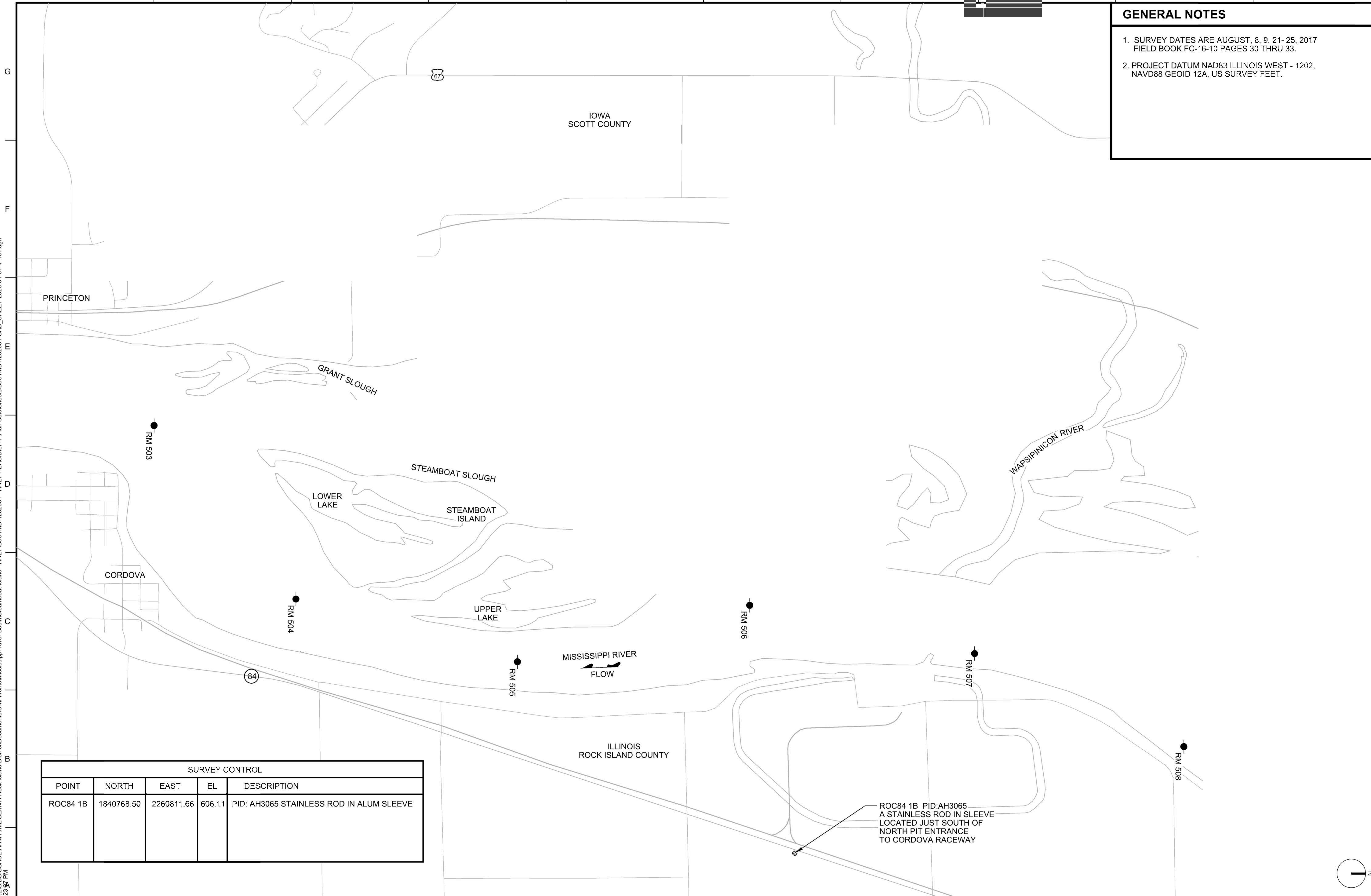
LEGEND AND ABBREVIATIONS

SHEET ID
G-002

REVIEW

GENERAL NOTES

1. SURVEY DATES ARE AUGUST, 8, 9, 21- 25, 2017
   FIELD BOOK FC-16-10 PAGES 30 THRU 33.
2. PROJECT DATUM NAD83 ILLINOIS WEST - 1202,
   NAVD88 GEOID 12A, US SURVEY FEET.



SURVEY CONTROL

POINT	NORTH	EAST	EL	DESCRIPTION
ROC84 1B	1840768.50	2260811.66	606.11	PID: AH3065 STAINLESS ROD IN ALUM SLEEVE

A1 SURVEY CONTROL

SCALE : 1"=1000'-0"

0 1000' 2000'

US Army Corps of Engineers®

MARK | DESCRIPTION | DATE | APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: M. SCUDDER
DWN BY: M. SCUDDER
CKD BY: ECTS
SUBMITTED BY: D. JOHNSON
PLOT SCALE: AS SHOWN
PLOT DATE:
SIZE: ANSI D
FILE NAME: B5STMBTI202001
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PROJECT CODE: B5STMBTI202001

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT
PLAN
SURVEY CONTROL

SHEET ID

V-101

REVIEW

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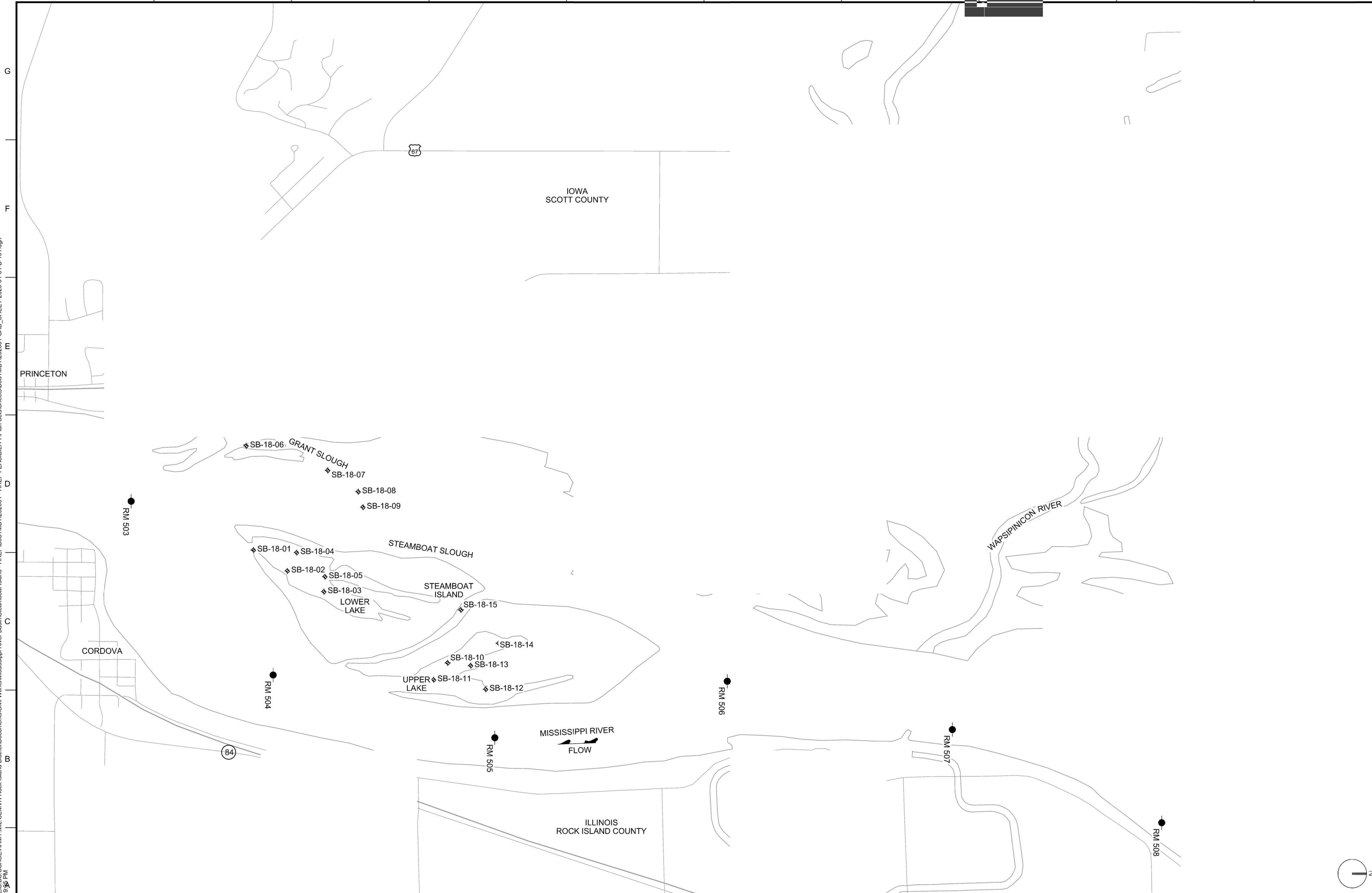

A1 BORING LOCATIONS

SCALE : 1"=1000'-0"

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US Army Corps of Engineers

MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: F. CASTRO
DWN BY: W. TAGUE
CKD BY: C. BISHOP
SUBMITTED BY: C. BISHOP
PLOT SCALE: AS SHOWN
PLOT DATE:
SIZE: ANSI D
FILE NAME: B5STMBTI202001
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PROJECT CODE: B5STMBTI202001

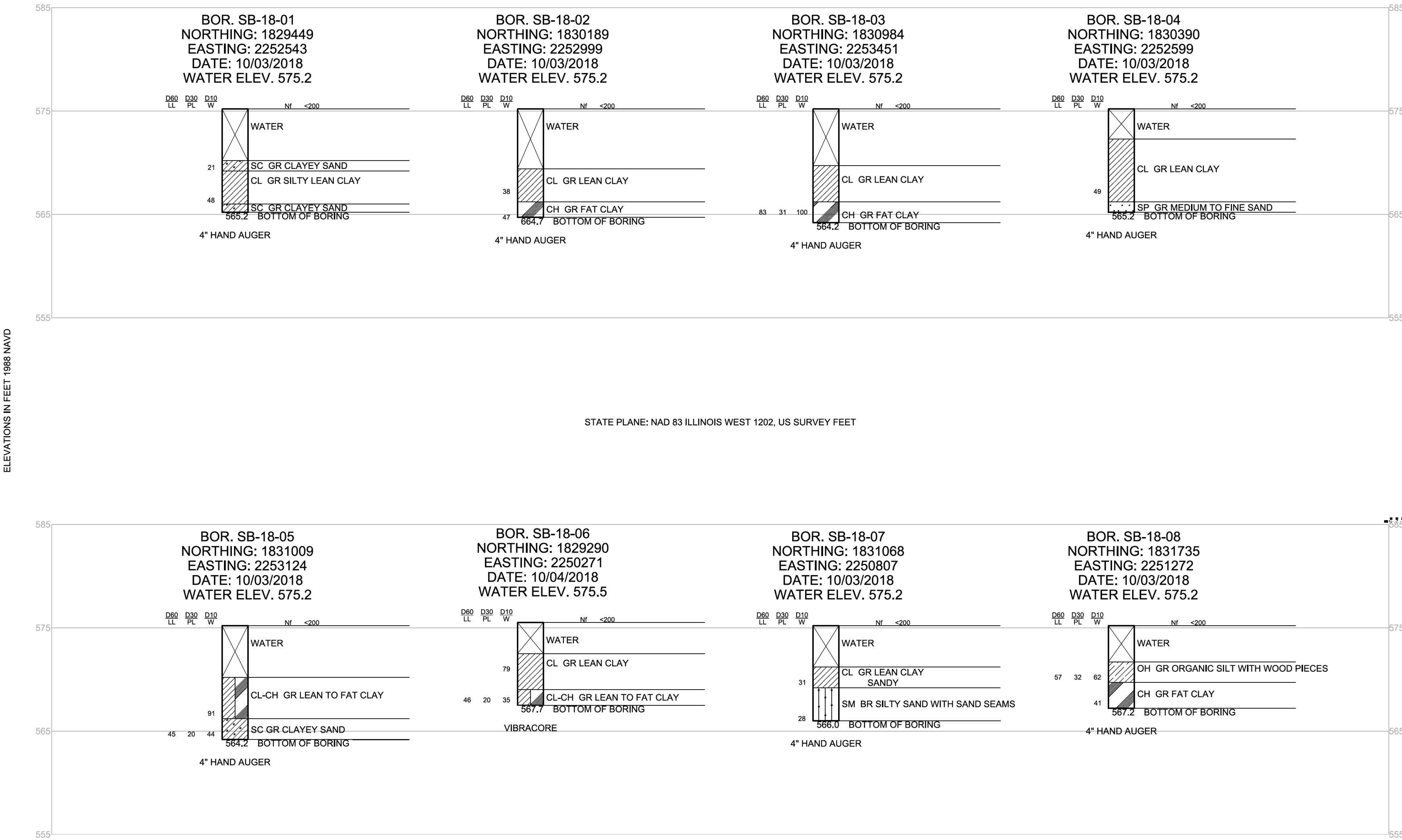
U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

PLAN
BORING LOCATIONS

SHEET ID
B-101

REVIEW



A1 BORING LOGS

SCALE : 1"=5'-0"

0 5' 10'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: F. CASTRO
DWN BY: W. TAGUE
CKD BY: C. BISHOP
SUBMITTED BY: C. BISHOP
PLOT SCALE: AS SHOWN
PLOT DATE:
SIZE: ANSI D
FILE NAME: B5STMBTI202001
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PROJECT CODE: B5STMBTI202001

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT
DIAGRAM
BORING LOGS

Sheet ID
B-601

REVIEW

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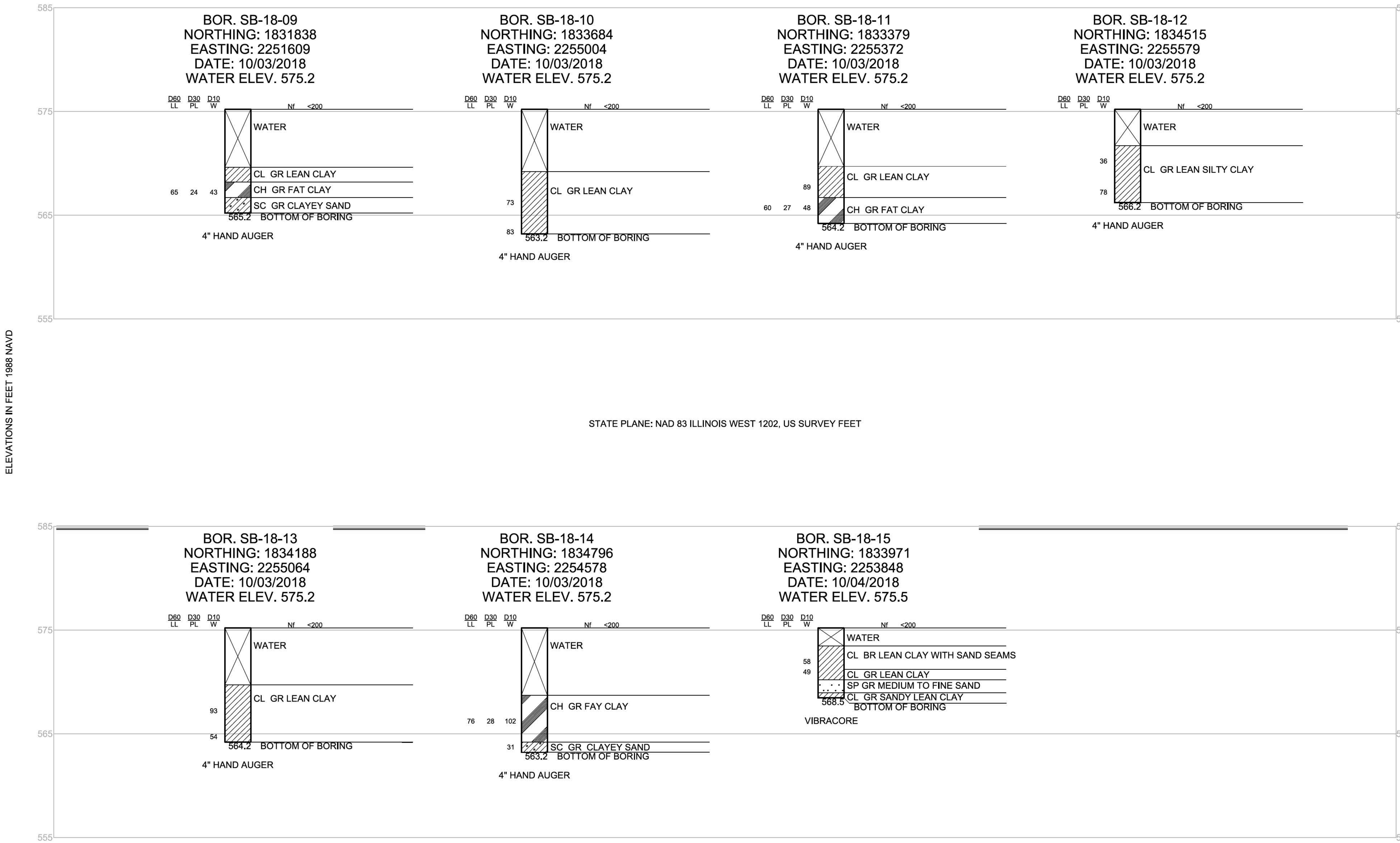

A1 BORING LOGS

SCALE : 1"=5'-0"

0 5' 10'

US Army Corps of Engineers

MARK | DATE | DESCRIPTION | APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: F. CASTRO
DWN BY: W. TAGUE
CKD BY: C. BISHOP
SUBMITTED BY: C. BISHOP
PLOT SCALE: AS SHOWN
PLOT DATE:
SIZE: ANSI D
FILE NAME: B5STMBTI202001
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PROJECT CODE: B5STMBTI202001

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT
DIAGRAM
BORING LOGS

SHEET ID
B-602

REVIEW

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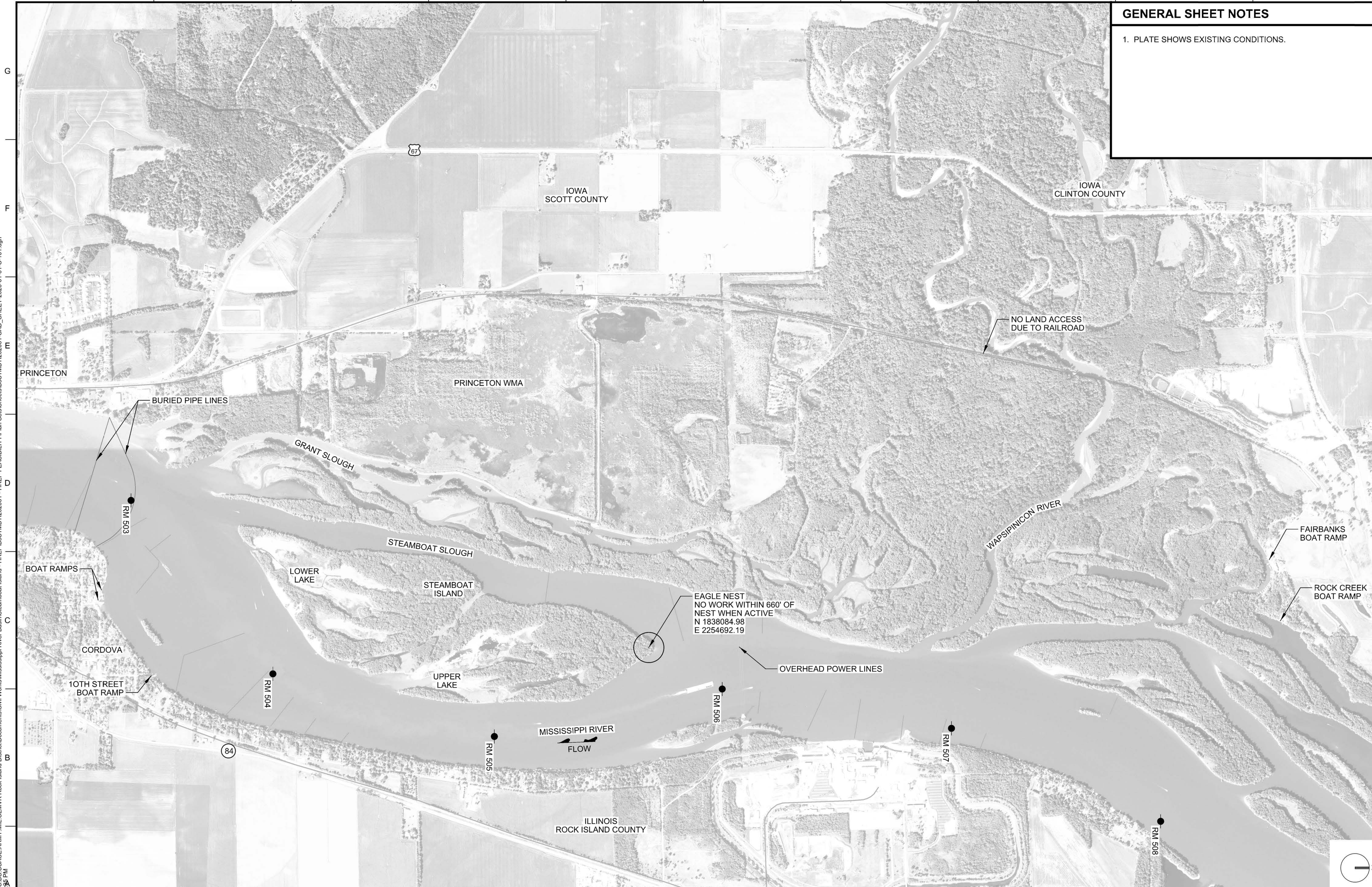
GENERAL SHEET NOTES

1. PLATE SHOWS EXISTING CONDITIONS.



A1 SITE PLAN

SCALE : 1"=1000'-0"

0 1000' 2000'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD		DATE:
DWN BY: E. JOHNSON	CKD BY: R. FELLMAN	SOLICITATION NO.:
SUBMITTED BY: A. HEDDLESTEN		CONTRACT NO.:
PLOT SCALE: AS SHOWN	PLOT DATE:	PROJECT CODE: B5STMBTI202001
SIZE: ANSI D	FILE NAME: B5STMBTI202001	

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

SITE PLAN

SHEET ID

C-101

REVIEW

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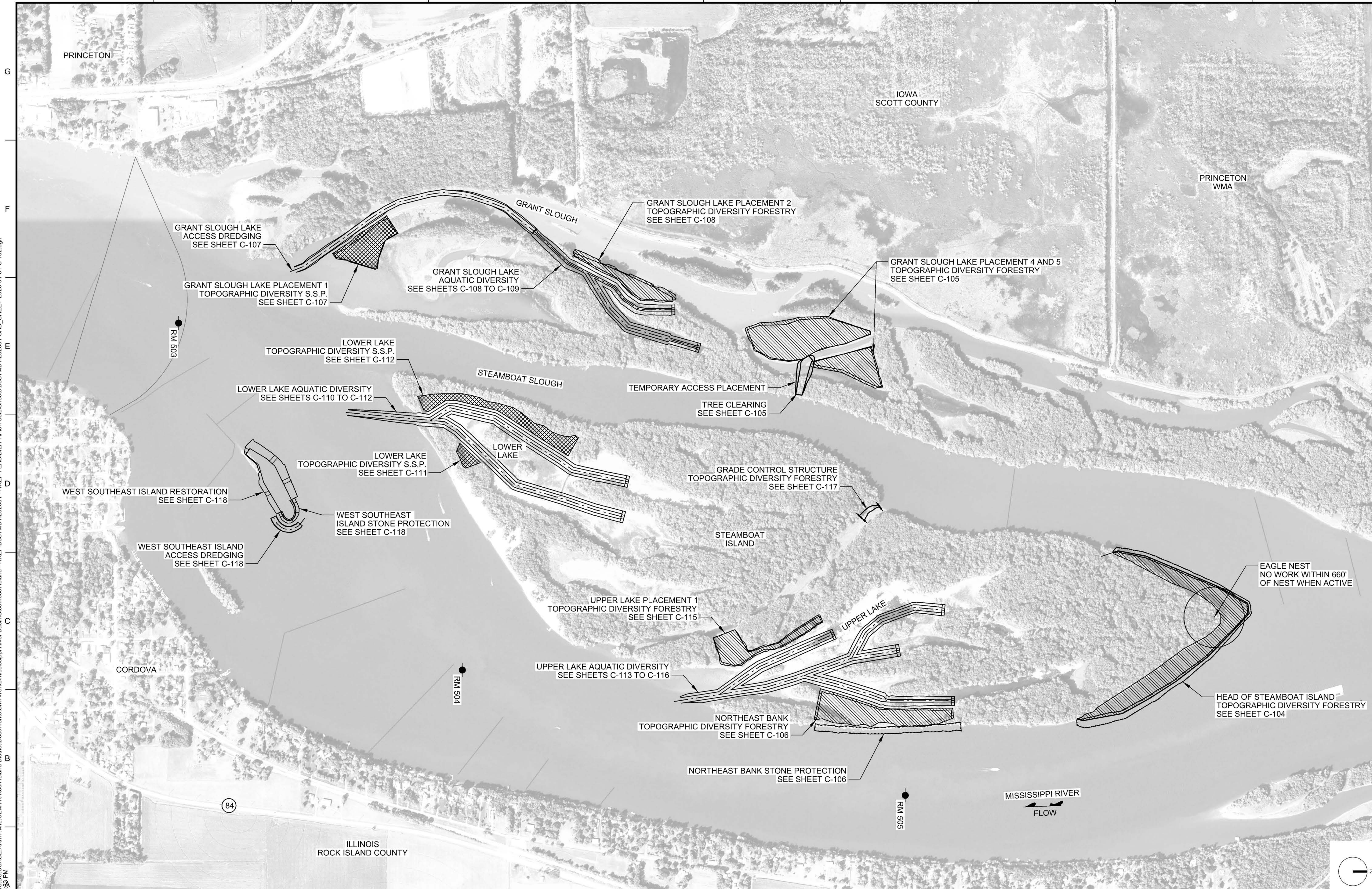

A1 TENTATIVELY SELECTED PLAN OMITTING TIMBER STAND IMPROVEMENT

SCALE : 1"=500'-0"

0 500' 1000'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD		DATE:
DWN BY: E. JOHNSON	CKD BY: R. FELLMAN	SOLICITATION NO.:
SUBMITTED BY: A. HEDDLESTEN		CONTRACT NO.:
PLOT SCALE: AS SHOWN	PLOT DATE:	PROJECT CODE: B5STMBTI202001
SIZE: ANSI D	FILE NAME: B5STMBTI202001	

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

TENTATIVELY SELECTED PLAN OMITTING TIMBER STAND IMPROVEMENT

SHEET ID

C-102

REVIEW

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A1 TENTATIVELY SELECTED PLAN TIMBER STAND IMPROVEMENT

SCALE : 1"=1000'-0"

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD		DATE:
DWN BY: E. JOHNSON	CKD BY: R. FELLMAN	SOLICITATION NO.:
SUBMITTED BY: A. HEDDLESTEN		CONTRACT NO.:
PLOT SCALE: AS SHOWN	PLOT DATE:	PROJECT CODE: B5STMBTI202001
SIZE: ANSI D	FILE NAME: B5STMBTI202001	

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

TENTATIVELY SELECTED PLAN
TIMBER STAND IMPROVEMENT

SHEET ID

C-103

REVIEW

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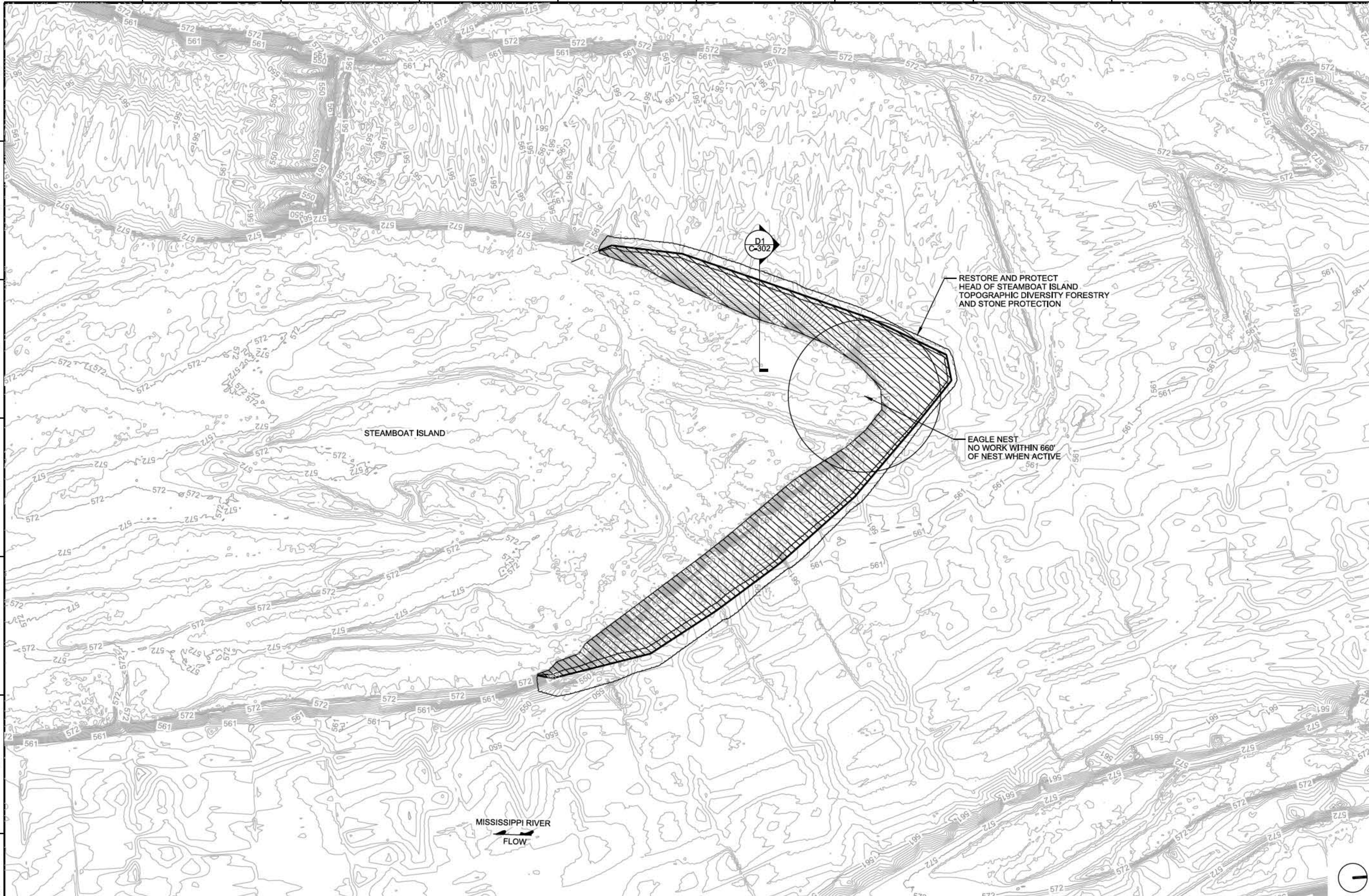

A1 HEAD OF STEAMBOAT ISLAND

SCALE : 1"=200'-0"

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD		DATE:
DWN BY: E. JOHNSON	CKD BY: R. FELLMAN	SOLICITATION NO.:
SUBMITTED BY: A. HEDDLESTEN		CONTRACT NO.:
PLOT SCALE: AS SHOWN	PLOT DATE:	PROJECT CODE: B5STMBTI202001
SIZE: ANSI D	FILE NAME: B5STMBTI202001	

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

PLAN
HEAD OF STEAMBOAT ISLAND

SHEET ID
C-104

REVIEW

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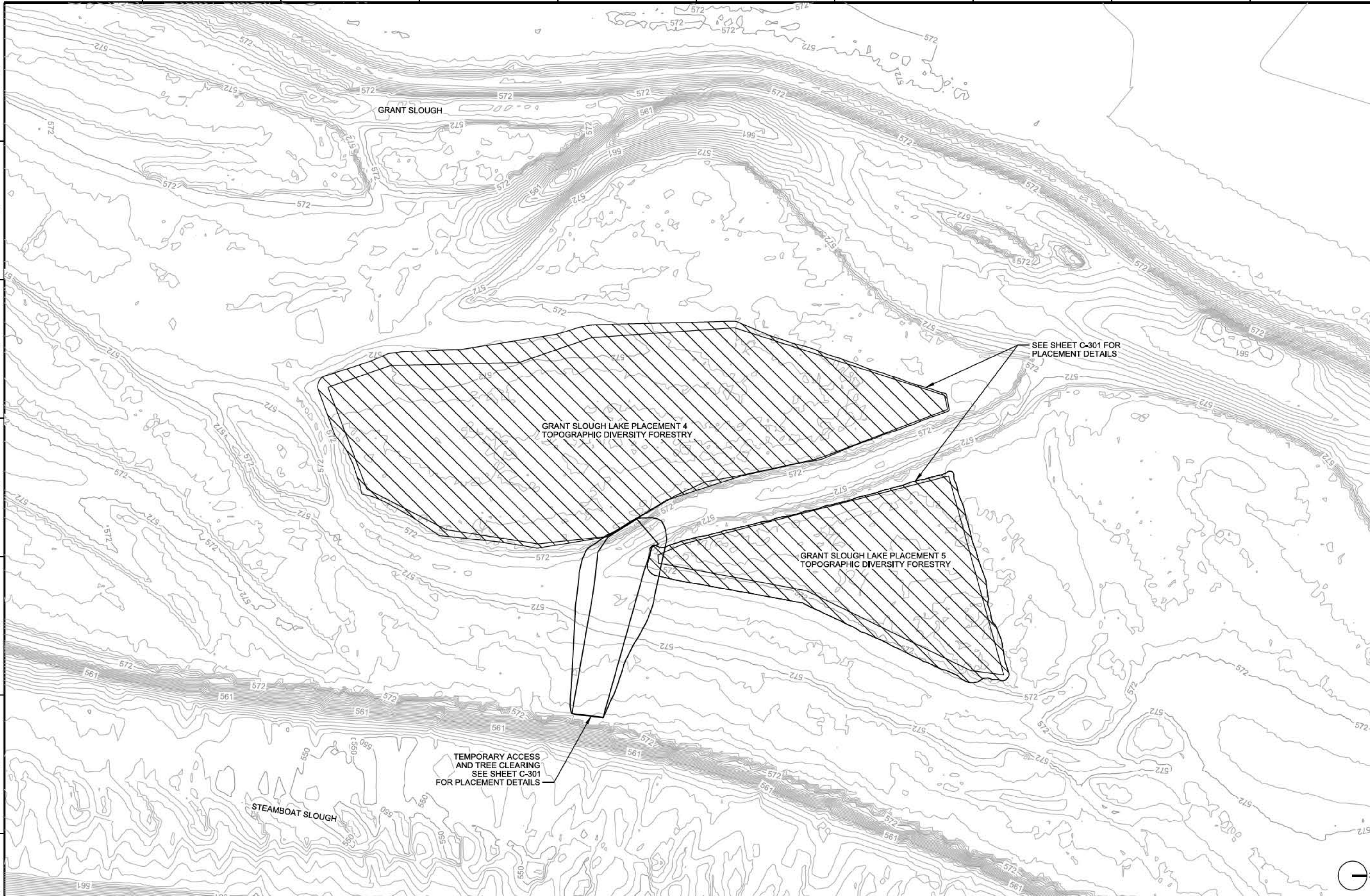

A1 GRANT SLOUGH LAKE TOPOGRAPHIC DIVERSITY FORESTRY AND TREE CLEARING

SCALE : 1"=100'-0"

0 100' 200'

US Army Corps of Engineers

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD		DATE:
DWN BY: E. JOHNSON	CKD BY: R. FELLMAN	SOLICITATION NO.:
SUBMITTED BY: A. HEDDLESTEN		CONTRACT NO.:
PLOT SCALE: AS SHOWN	PLOT DATE:	PROJECT CODE: BSSTMBTI202001
SIZE: ANSI D	FILE NAME: BSSTMBTI202001	

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

PLAN
GRANT SLOUGH LAKE TOPOGRAPHIC
DIVERSITY FORESTRY AND TREE CLEARING

SHEET ID
C-105

REVIEW

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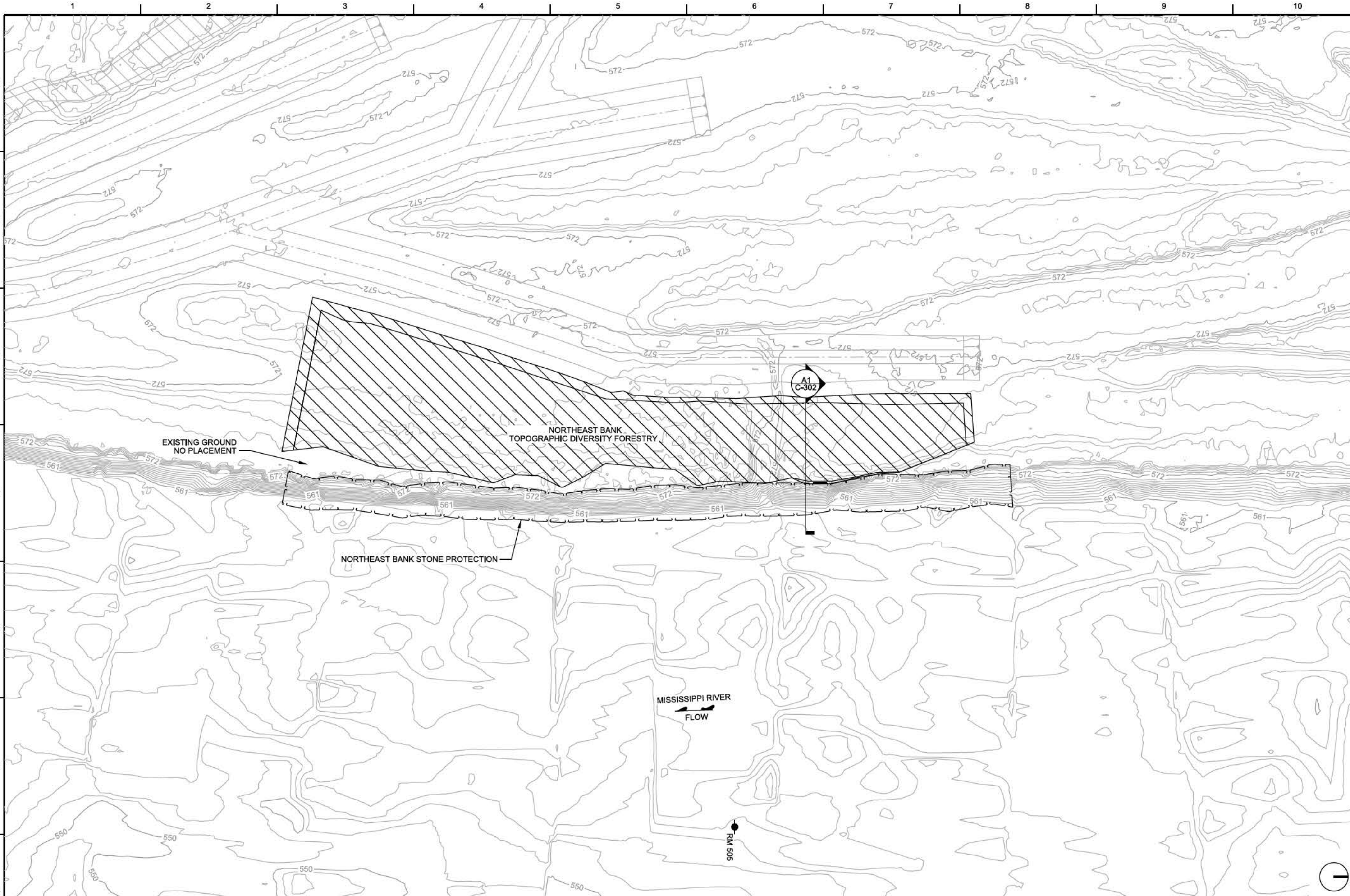

A1 NORTHEST BANK AND STONE PROTECTION

SCALE : 1"=500'-0"

0 500' 1000'

US Army Corps of Engineers

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD		DATE:
DWN BY: E. JOHNSON	CKD BY: R. FELLMAN	SOLICITATION NO.:
SUBMITTED BY: A. HEDDLESTEN		CONTRACT NO.:
PLOT SCALE: AS SHOWN	PLOT DATE:	PROJECT CODE: BSSTMBTI202001
SIZE: ANSI D	FILE NAME: BSSTMBTI202001	

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

PLAN
NORTHEAST BANK AND STONE PROTECTION

SHEET ID
C-106

REVIEW

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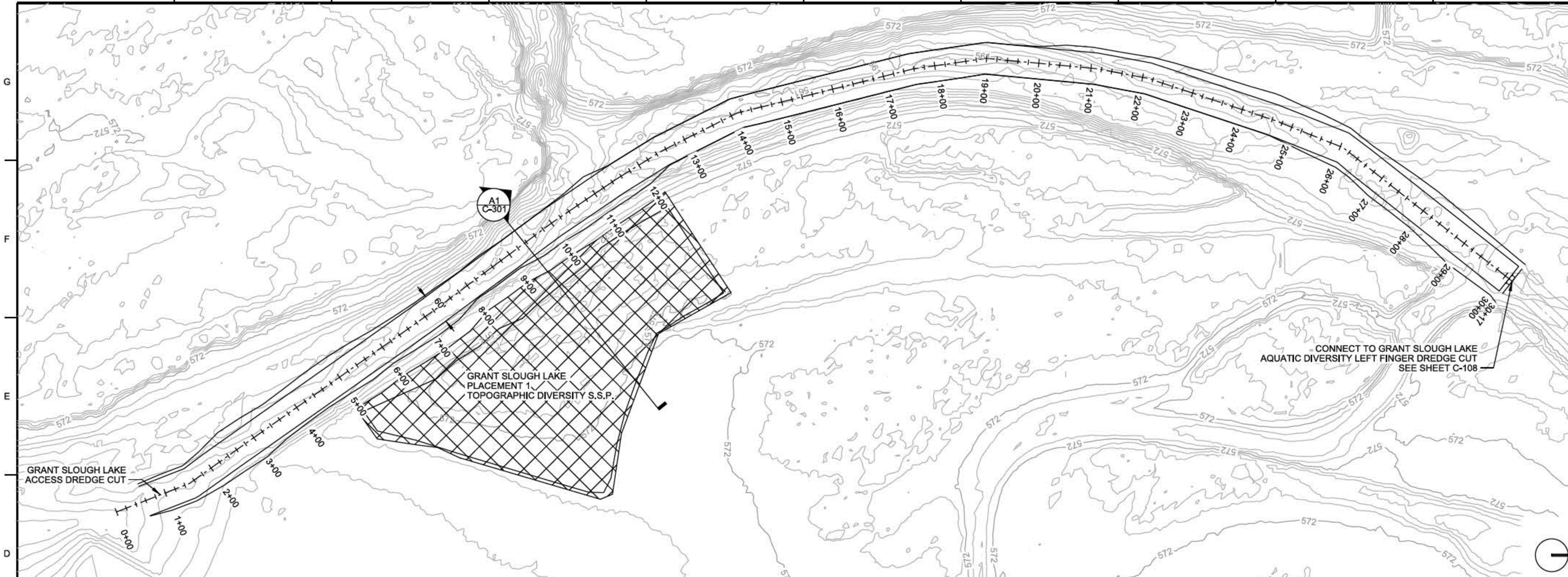
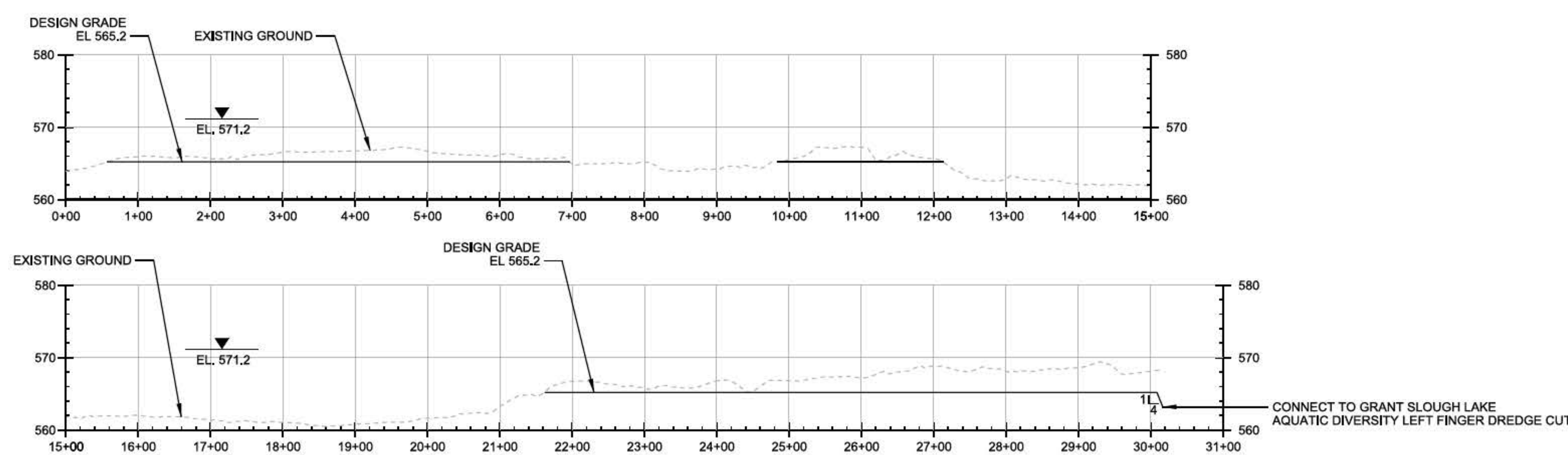


D1 PLAN GRANT SLOUGH LAKE ACCESS DREDGE CUT AND GRANT SLOUGH LAKE PLACEMENT 1 TOPOGRAPHIC DIVERSITY S.S.P.

SCALE : 1"=100'-0"



A1 PROFILE GRANT SLOUGH LAKE ACCESS DREDGE CUT

SCALE: HORIZONTAL 1"=100'-0" VERTICAL 1"=10'-0"

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD		DATE:
DWN BY: E. JOHNSON	CKD BY: R. FELLMAN	SOLICITATION NO.:
SUBMITTED BY: A. HEDDLESTEN		CONTRACT NO.:
PLOT SCALE: AS SHOWN	PLOT DATE:	PROJECT CODE: BSSTMBTI202001
SIZE: ANSI D	FILE NAME: BSSTMBTI202001	

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT
PLAN AND PROFILE
GRANT SLOUGH LAKE
ACCESS DREDGE CUT

SHEET ID
C-107

REVIEW

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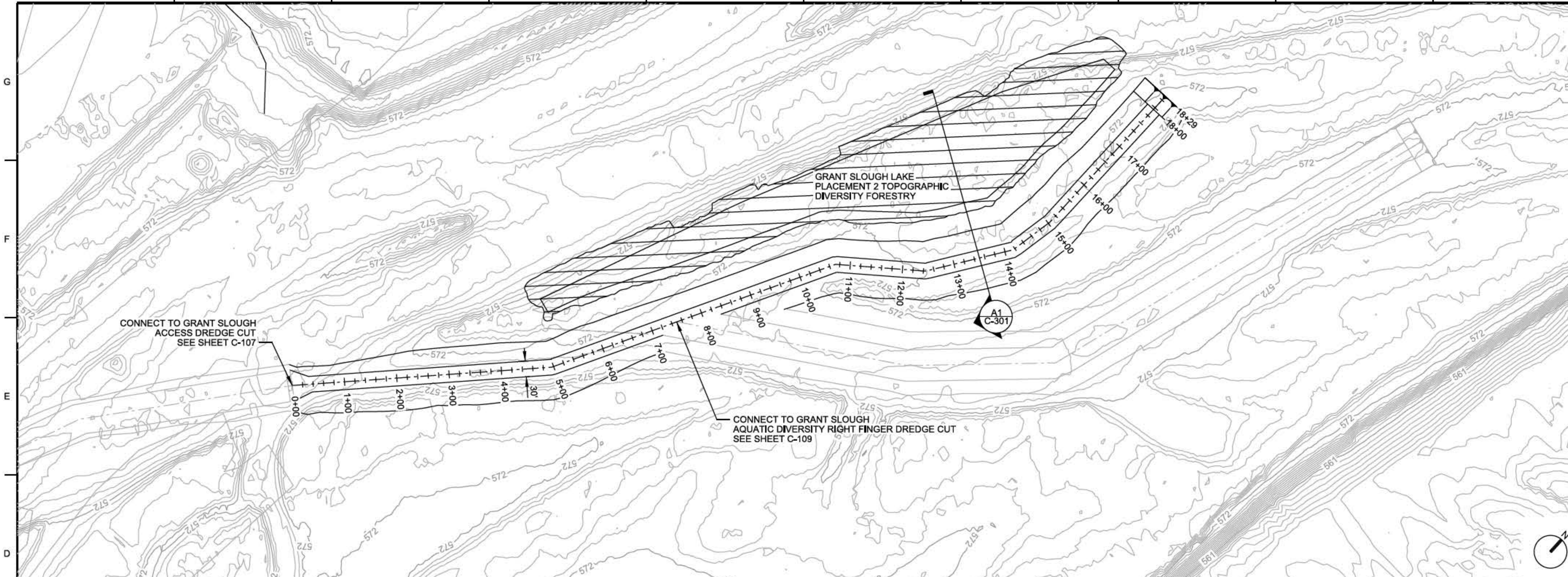
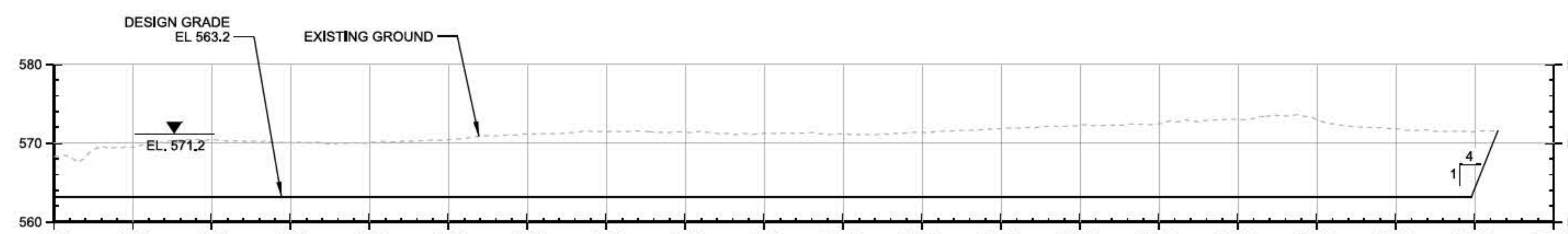


D1 PLAN GRANT SLOUGH AQUATIC LAKE DIVERSITY LEFT FINGER DREDGE CUT AND GRANT SLOUGH LAKE PLACEMENT 2 TOPOGRAPHIC DIVERSITY FORESTRY

SCALE : 1"=100'-0"



A1 PROFILE GRANT SLOUGH LAKE AQUATIC DIVERSITY LEFT FINGER DREDGE CUT

SCALE: HORIZONTAL 1"=100'-0" VERTICAL 1"=10'-0"

US Army Corps of Engineers

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD		DATE:
DWN BY: E. JOHNSON	CKD BY: R. FELLMAN	SOLICITATION NO.:
SUBMITTED BY: A. HEDDLESTEN		CONTRACT NO.:
PLOT SCALE: AS SHOWN	PLOT DATE:	PROJECT CODE: BSSTMBTI202001
SIZE: ANSI D	FILE NAME: BSSTMBTI202001	

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

PLAN AND PROFILE
GRANT SLOUGH LAKE AQUATIC DIVERSITY
LEFT FINGER DREDGE CUT

SHEET ID
C-108

REVIEW

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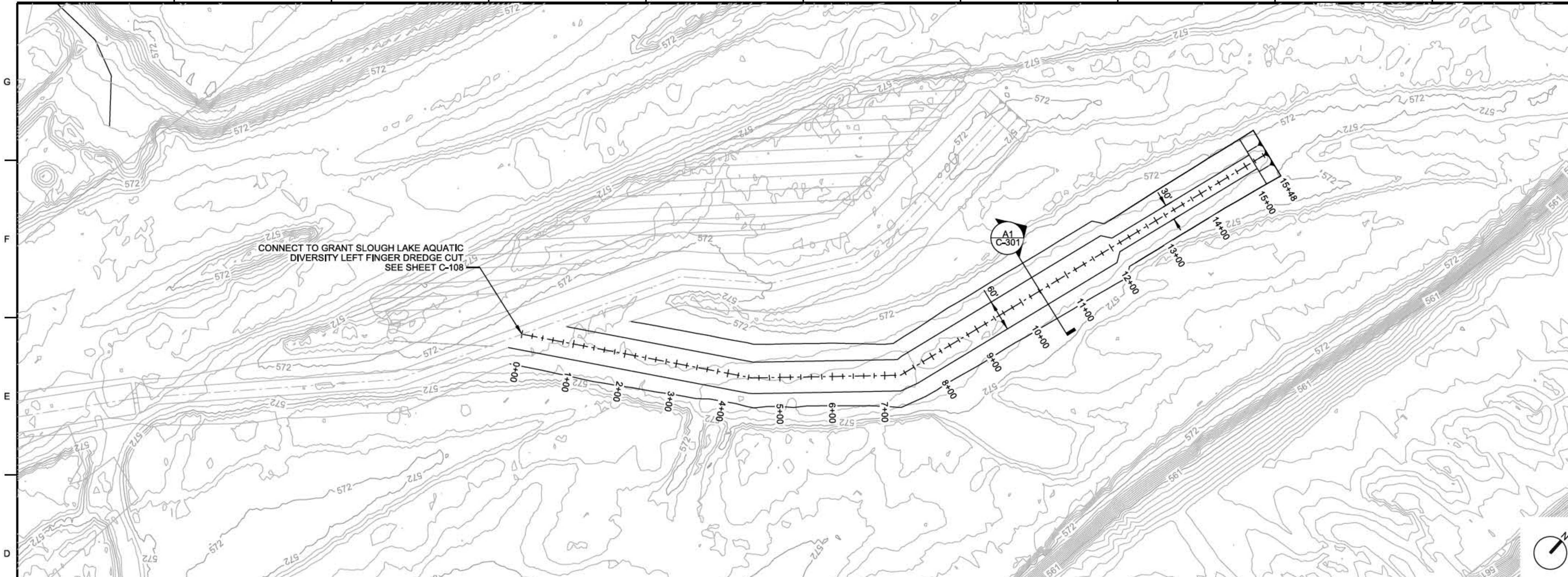
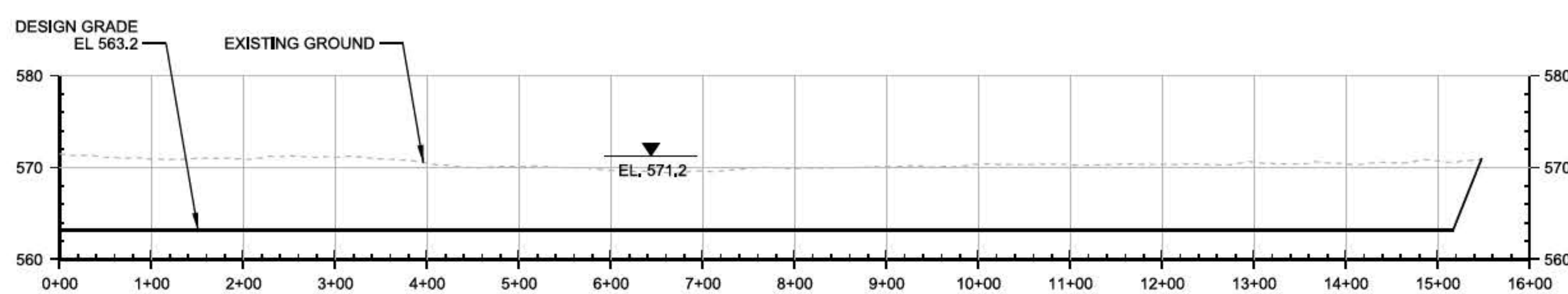


D1 PLAN GRANT SLOUGH AQUATIC DIVERSITY RIGHT FINGER DREDGE CUT

SCALE : 1"=100'-0"



A1 PROFILE GRANT SLOUGH AQUATIC DIVERSITY RIGHT FINGER DREDGE CUT

SCALE: HORIZONTAL 1"=100'-0" VERTICAL 1"=10'-0"

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD		DATE:
DWN BY: E. JOHNSON	CKD BY: R. FELLMAN	SOLICITATION NO.:
SUBMITTED BY: A. HEDDLESTEN		CONTRACT NO.:
PLOT SCALE: AS SHOWN	PLOT DATE:	PROJECT CODE: B5STMBTI202001
SIZE: ANSI D	FILE NAME: B5STMBTI202001	

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

PLAN AND PROFILE
GRANT SLOUGH LAKE AQUATIC DIVERSITY
RIGHT FINGER DREDGE CUT

SHEET ID

C-109

REVIEW

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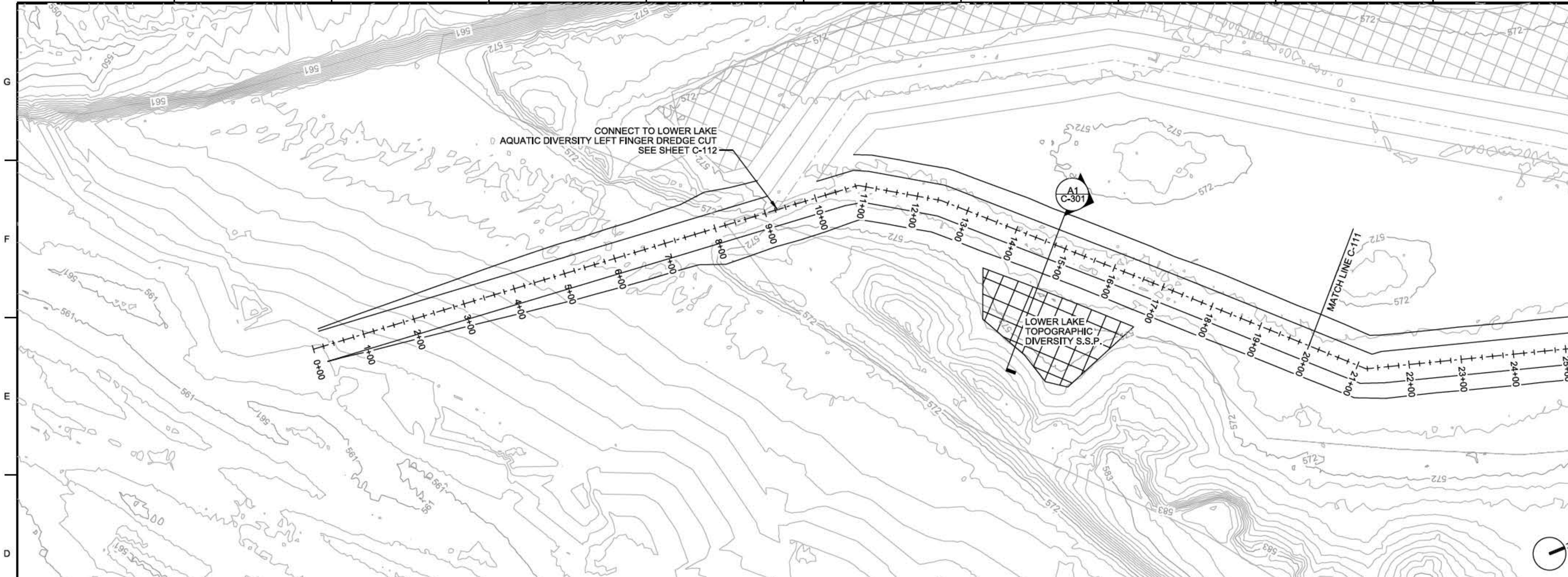
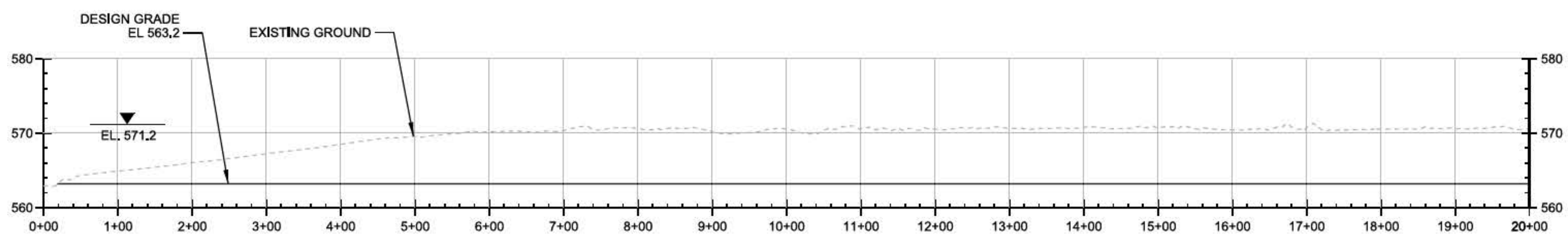


D1 PLAN LOWER LAKE AQUATIC DIVERSITY LEFT FINGER DREDGE CUT AND LOWER LAKE TOPOGRAPHIC DIVERSITY S.S.P.

SCALE : 1"=100'-0"

0 100' 200'



A1 PROFILE LOWER LAKE AQUATIC DIVERSITY LEFT FINGER DREDGE CUT

SCALE: HORIZONTAL 1"=100'-0" VERTICAL 1"=10'-0"

0 100' 200' 0 10' 20'

US Army Corps of Engineers

MARK	DESCRIPTION	DATE	APPR.

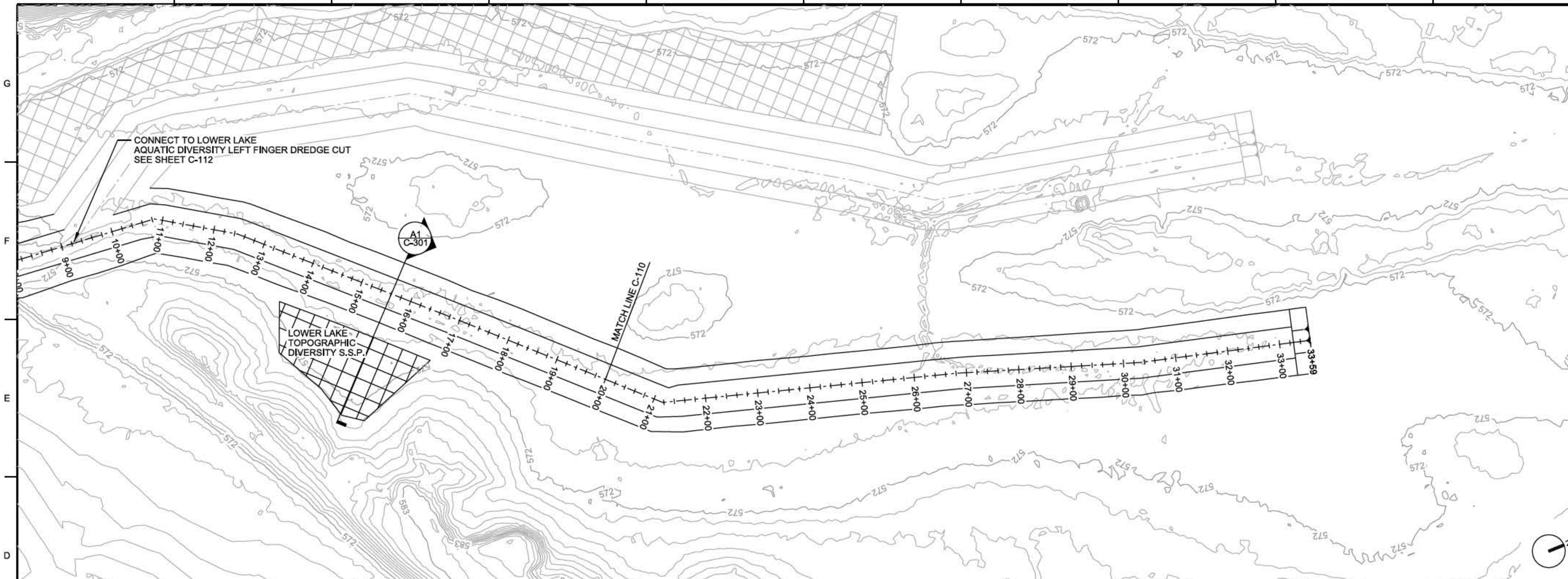
U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD		DATE:
DWN BY: E. JOHNSON	CKD BY: R. FELLMAN	SOLICITATION NO.:
SUBMITTED BY: A. HEDDLESTEN		CONTRACT NO.:
PLOT SCALE: AS SHOWN	PLOT DATE:	PROJECT CODE: BSSTMBTI202001
SIZE: ANSI D	FILE NAME: BSSTMBTI202001	

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT
PLAN AND PROFILE
LOWER LAKE AQUATIC DIVERSITY
RIGHT FINGER DREDGE CUT

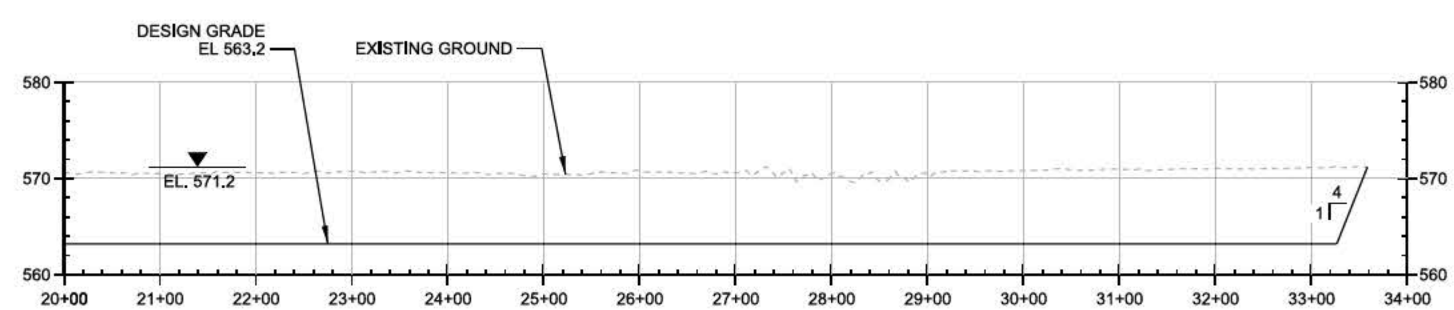
SHEET ID
C-110

REVIEW



D1 PLAN LOWER LAKE AQUATIC DIVERSITY LEFT FINGER DREDGE CUT AND LOWER LAKE TOPOGRAPHIC DIVERSITY S.S.P.

SCALE : 1"=100'-0"



A1 PROFILE LOWER LAKE AQUATIC DIVERSITY LEFT FINGER DREDGE CUT

SCALE: HORIZONTAL 1"=100'-0" VERTICAL 1"=10'-0"

US Army Corps of Engineers

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

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SIZE: ANSI D	FILE NAME: BSSTMBTI202001	

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

PLAN AND PROFILE
LOWER LAKE AQUATIC DIVERSITY
RIGHT FINGER DREDGE CUT

SHEET ID
C-111

REVIEW

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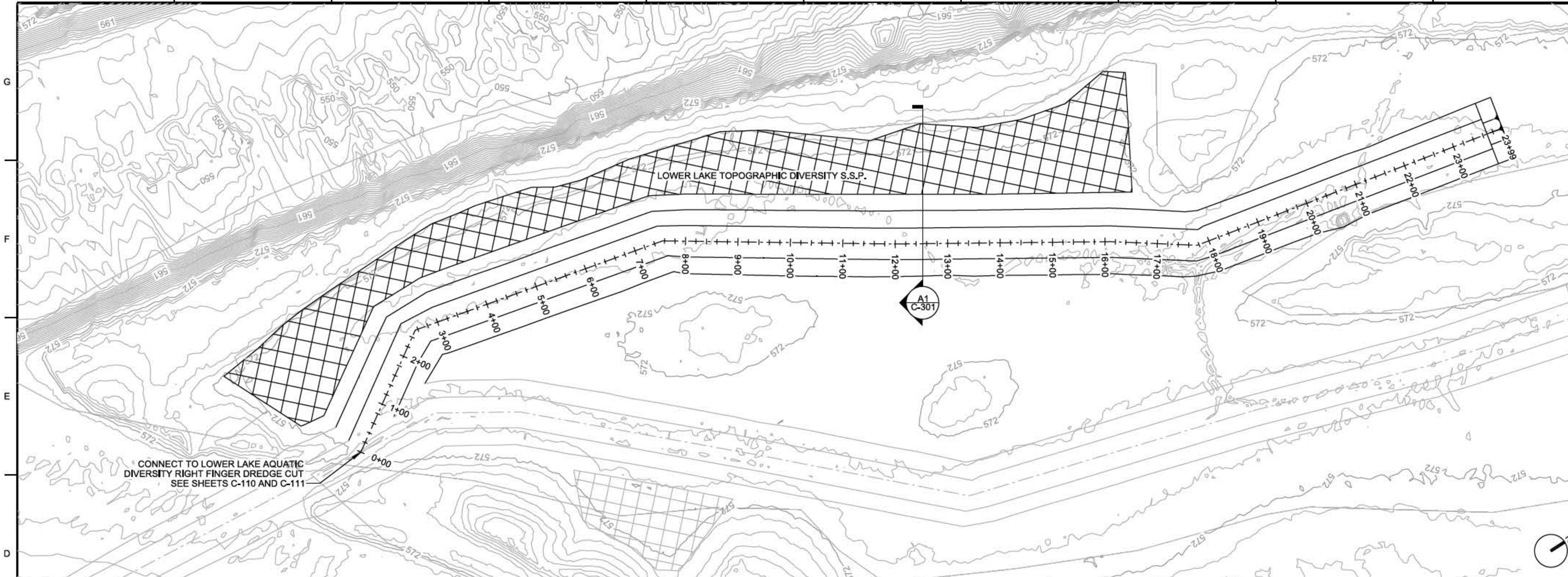
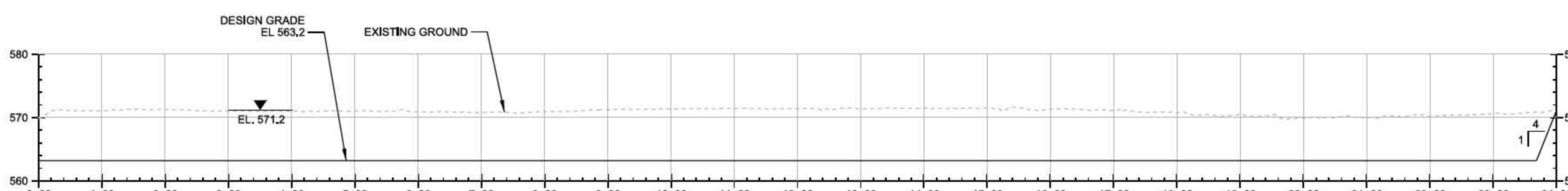


D1 PLAN LOWER LAKE AQUATIC DIVERSITY LEFT FINGER DREDGE CUT AND LOWER LAKE TOPOGRAPHIC DIVERSITY S.S.P.

SCALE : 1"=100'-0"

0 100' 200'



A1 PROFILE LOWER LAKE AQUATIC DIVERSITY LEFT FINGER DREDGE CUT

SCALE: HORIZONTAL 1"=100'-0" VERTICAL 1"=10'-0"

0 100' 200' 0 10' 20'

US Army Corps of Engineers

MARK | DESCRIPTION | DATE | APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD
DWN BY: E. JOHNSON
CKD BY: R. FELLMAN
SUBMITTED BY:
PLOT SCALE: AS SHOWN
PLOT DATE:
SIZE: ANSI D
FILE NAME: BSSTMBTI202001
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PROJECT CODE: BSSTMBTI202001

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT
PLAN AND PROFILE
LOWER LAKE AQUATIC DIVERSITY
LEFT FINGER DREDGE CUT

SHEET ID
C-112

REVIEW

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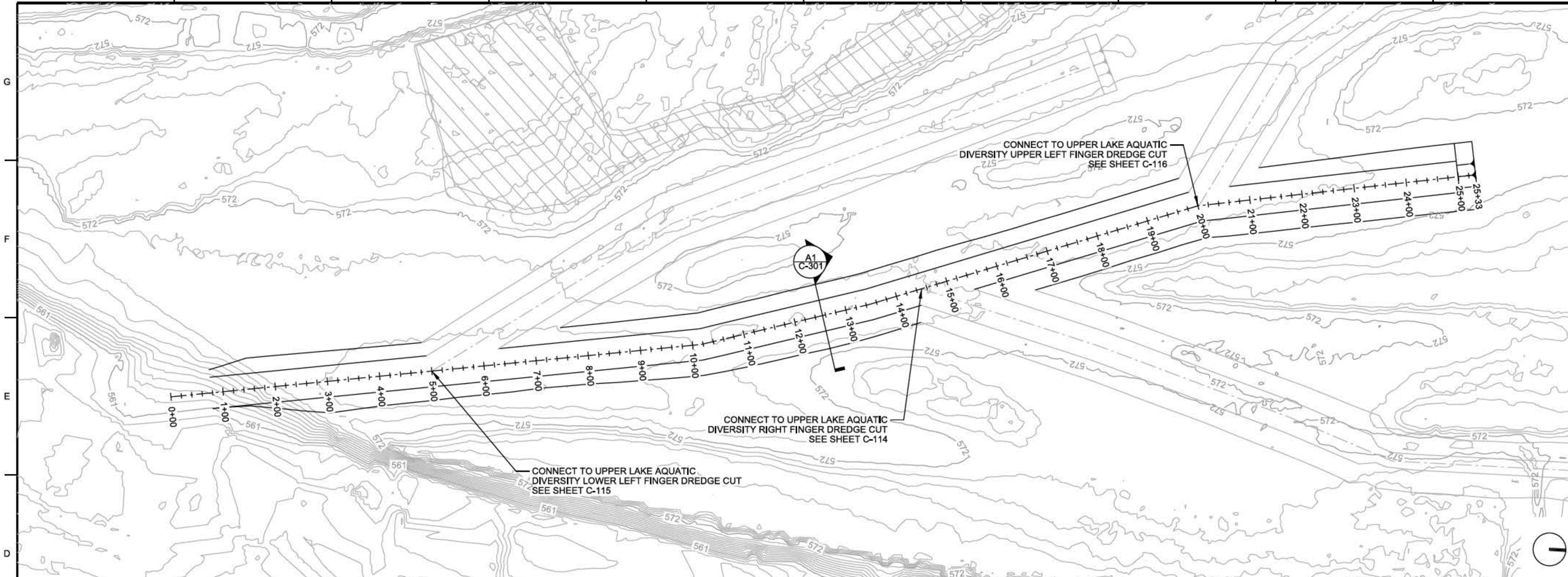
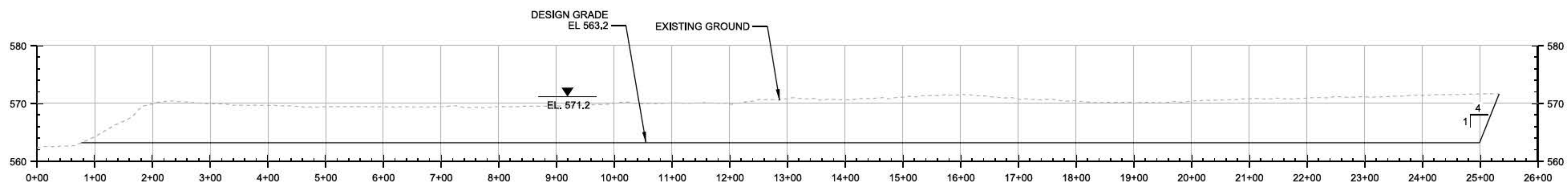


D1 PLAN UPPER LAKE AQUATIC DIVERSITY MAIN DREDGE CUT

SCALE : 1"=100'-0"

0 100' 200'



A1 PROFILE UPPER LAKE AQUATIC DIVERSITY MAIN DREDGE CUT

0 100' 200' 0 10' 20'

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US Army Corps of Engineers

MARK | DESCRIPTION | DATE | APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

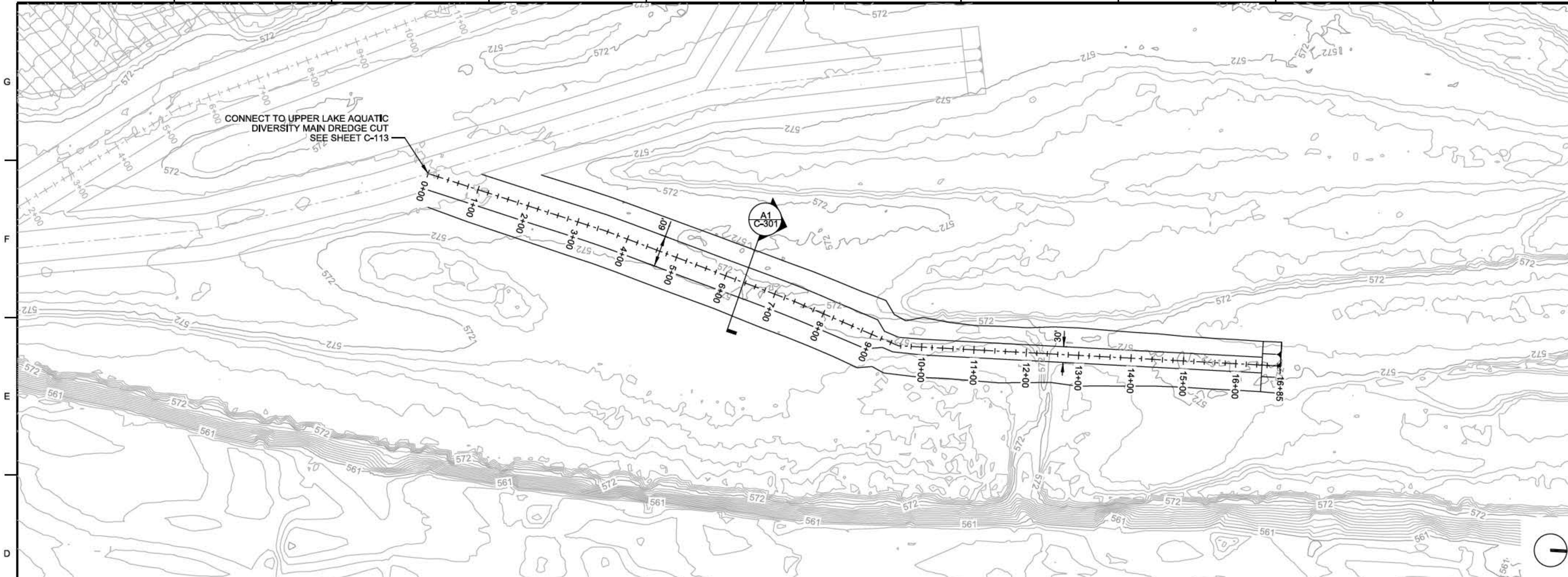
DESIGNED BY: K. NERAD
DWN BY: E. JOHNSON
CKD BY: R. FELLMAN
SUBMITTED BY: A. HEDQUIESTEN
PLOT SCALE: AS SHOWN
PLOT DATE:
SIZE: ANSI D
FILE NAME: BSSTMBTI202001
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PROJECT CODE: BSSTMBTI202001

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

PLAN AND PROFILE
UPPER LAKE AQUATIC DIVERSITY
MAIN DREDGE CUT

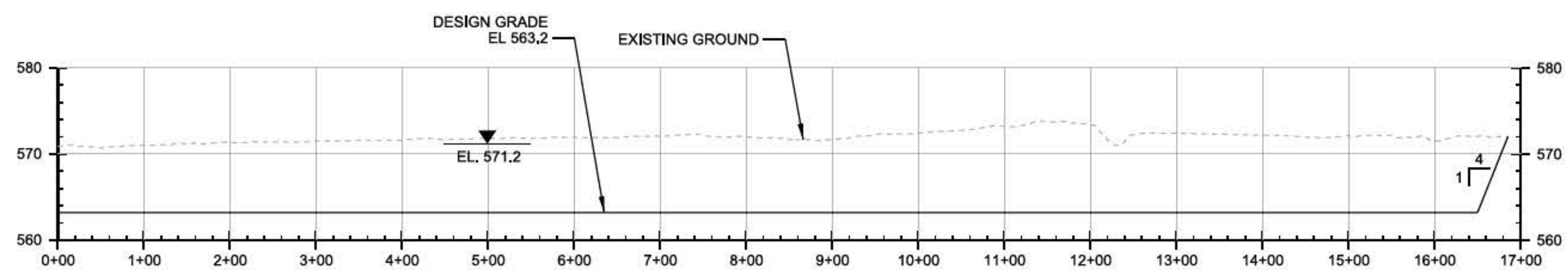
SHEET ID
C-113

REVIEW



D1 PLAN UPPER LAKE AQUATIC DIVERSITY RIGHT FINGER DREDGE CUT

SCALE : 1"=100'-0"



A1 PROFILE UPPER LAKE AQUATIC DIVERSITY RIGHT FINGER DREDGE CUT

SCALE: HORIZONTAL 1"=100'-0" VERTICAL 1"=10'-0"

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

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SUBMITTED BY: A. HEDDLESTEN		CONTRACT NO.:
PLOT SCALE: AS SHOWN	PLOT DATE:	PROJECT CODE: BSSTMBTI202001
SIZE: ANSI D	FILE NAME: BSSTMBTI202001	

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

PLAN AND PROFILE
UPPER LAKE AQUATIC DIVERSITY
RIGHT FINGER DREDGE CUT

SHEET ID

C-114

REVIEW

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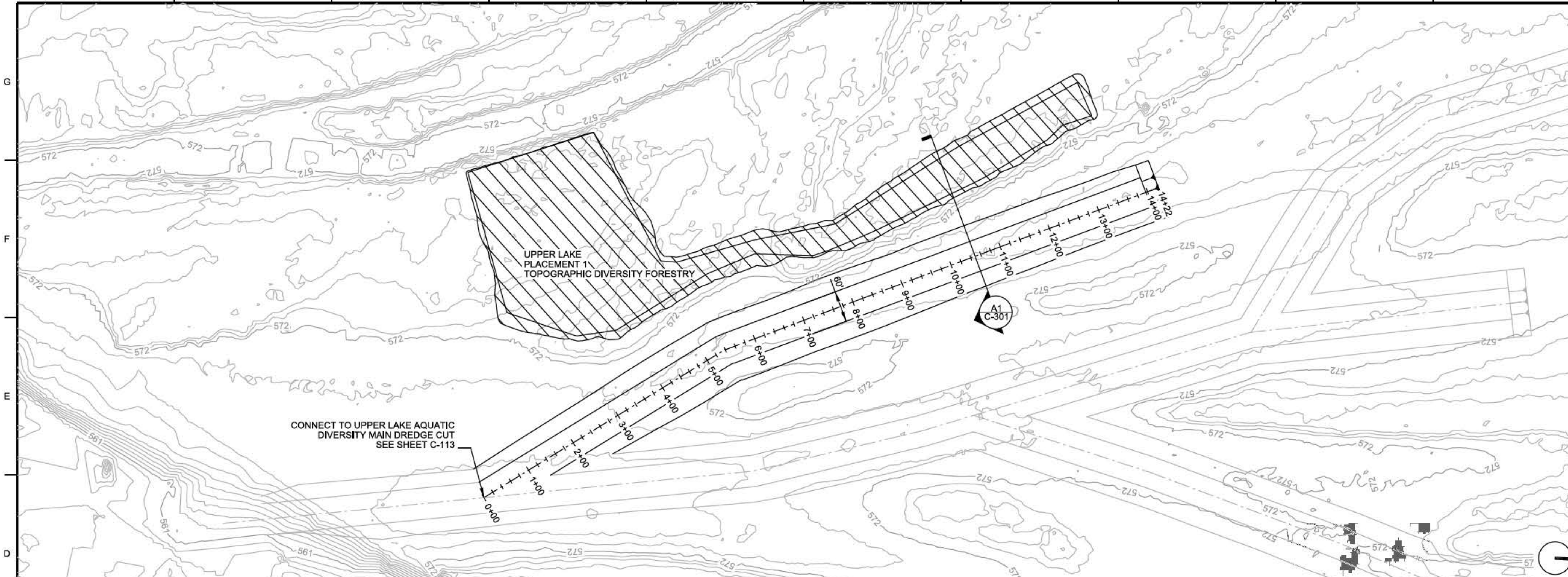
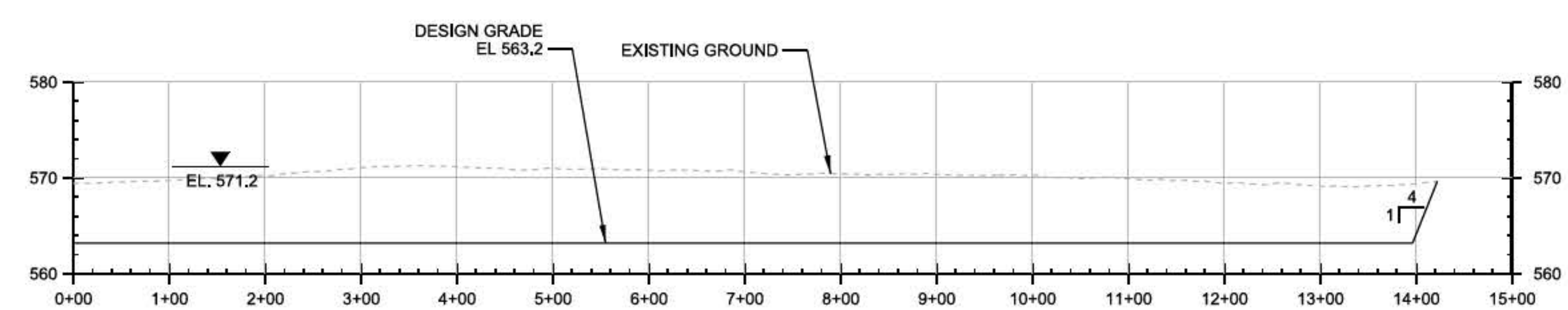


D1 PLAN UPPER LAKE AQUATIC DIVERSITY LOWER LEFT FINGER DREDGE CUT AND UPPER LAKE PLACEMENT 1 TOPOGRAPHIC DIVERSITY FORESTRY

SCALE : 1"=100'-0"



A1 PROFILE UPPER LAKE AQUATIC DIVERSITY LOWER LEFT FINGER DREDGE CUT

US Army Corps of Engineers

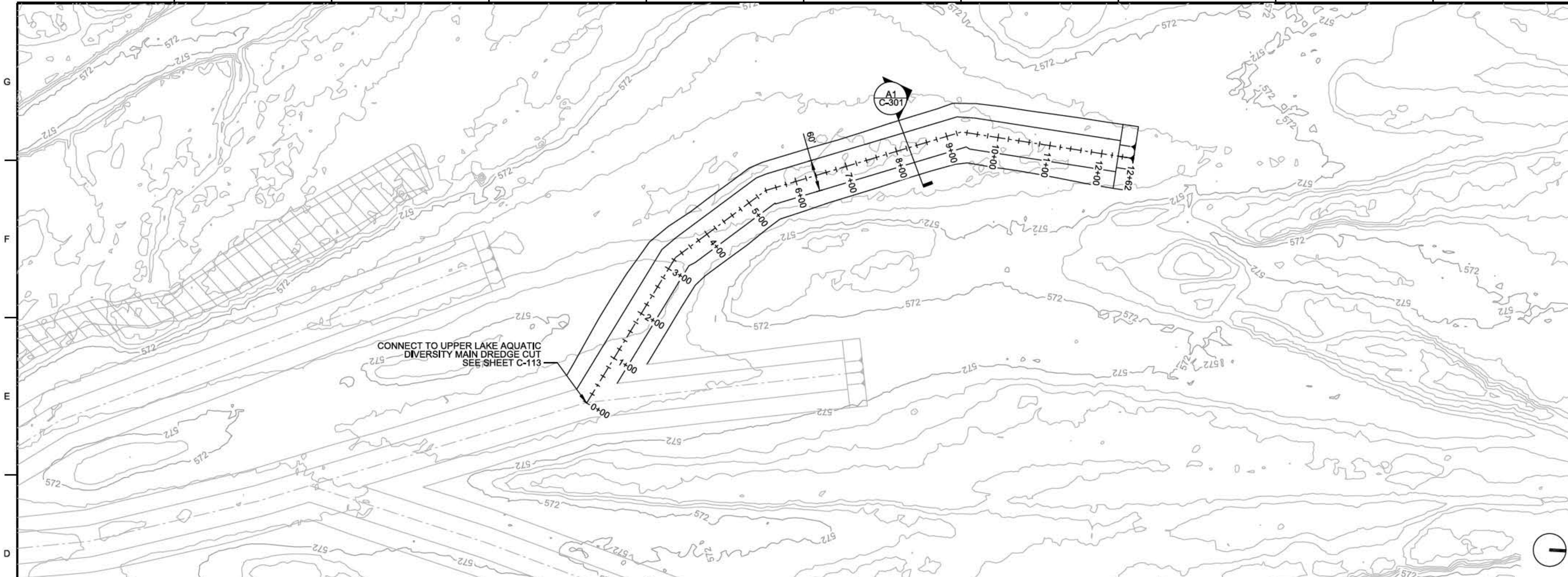
U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD
DWN BY: E. JOHNSON
CKD BY: R. FELLMAN
SUBMITTED BY: A. HEDDLESTEN
PLOT SCALE: AS SHOWN
SIZE: ANSI D
FILE NAME: BSSTMBTI202001
PROJECT CODE: BSSTMBTI202001

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT
PLAN AND PROFILE
UPPER LAKE AQUATIC DIVERSITY
LOWER LEFT FINGER DREDGE CUT

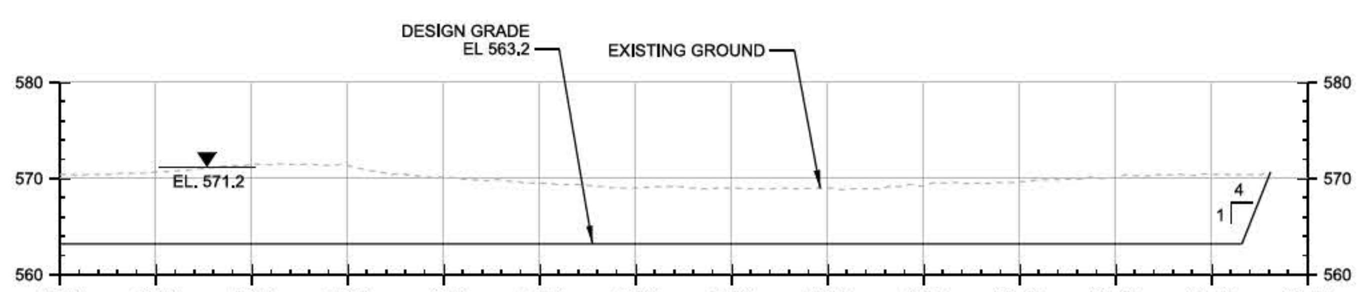
SHEET ID
C-115

REVIEW



D1 PLAN UPPER LAKE AQUATIC DIVERSITY UPPER LEFT FINGER DREDGE CUT

SCALE : 1"=100'-0"



A1 PROFILE UPPER LAKE AQUATIC DIVERSITY UPPER LEFT FINGER DREDGE CUT

SCALE: HORIZONTAL 1"=100'-0" VERTICAL 1"=10'-0"

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD		DATE:
DWN BY: E. JOHNSON	CKD BY: R. FELLMAN	SOLICITATION NO.:
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PLOT SCALE: AS SHOWN	PLOT DATE:	PROJECT CODE: BSSTMBTI202001
SIZE: ANSI D	FILE NAME: BSSTMBTI202001	

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

PLAN AND PROFILE
UPPER LAKE AQUATIC DIVERSITY
UPPER LEFT FINGER DREDGE CUT

SHEET ID
C-116

REVIEW

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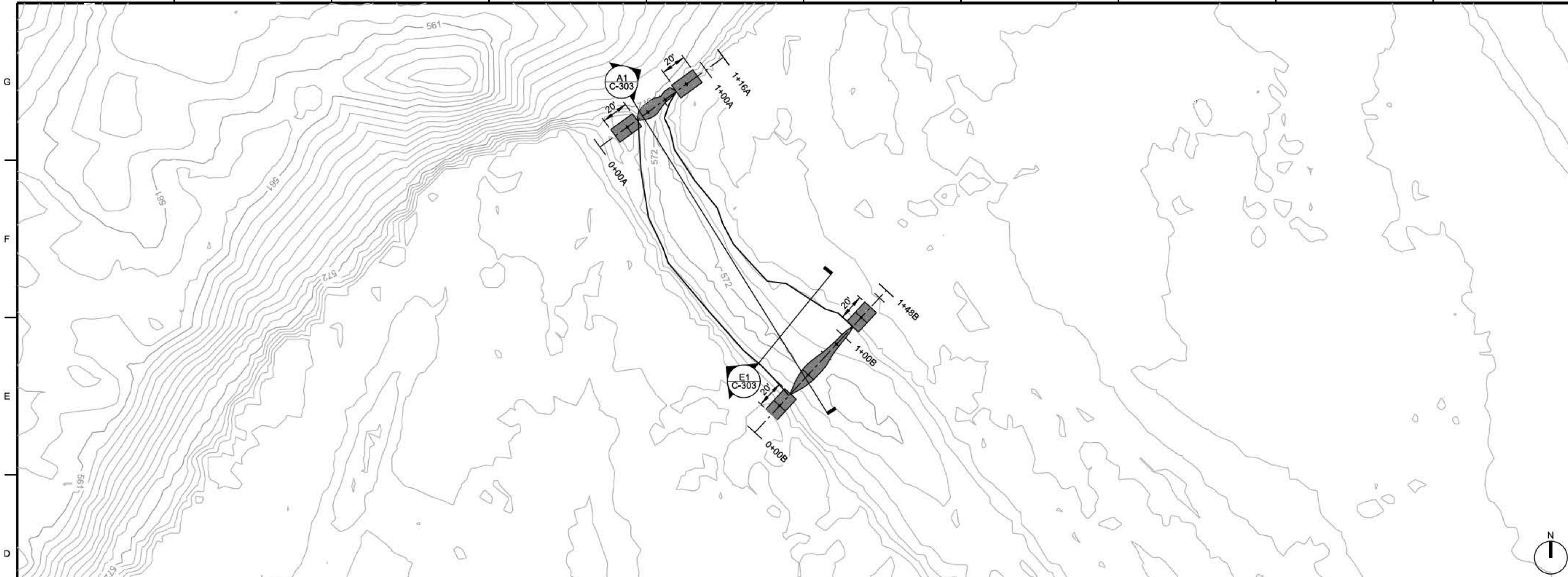
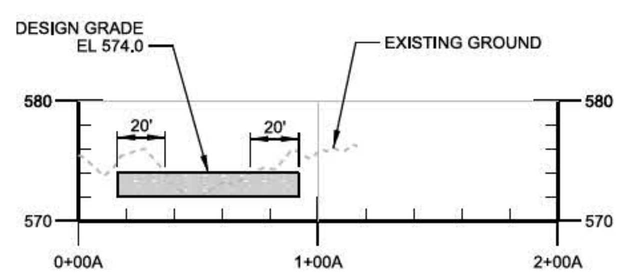
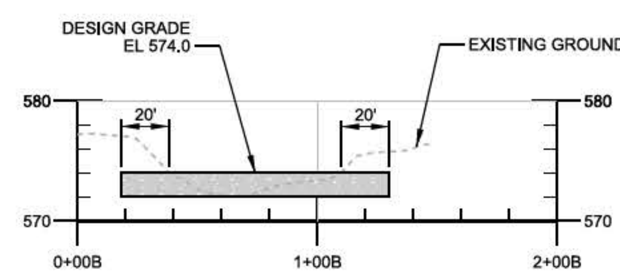


D1 PLAN GRADE CONTROL STRUCTURE

SCALE : 1"=40'-0"



NORTH ROCK



SOUTH ROCK

A1 PROFILE GRADE CONTROL STRUCTURE

SCALE: HORIZONTAL 1"=40'-0" VERTICAL 1"=8'-0"

0 40' 80' 0 8' 16'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD
DWN BY: E. JOHNSON
CKD BY: R. FELLMAN
SUBMITTED BY: A. HEDDLESTEN
PLOT SCALE: AS SHOWN
PLOT DATE:
SIZE: ANSI D
FILE NAME: BSSTMBTI202001
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PROJECT CODE: BSSTMBTI202001

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

PLAN AND PROFILE
GRADE CONTROL STRUCTURE

SHEET ID
C-117

REVIEW

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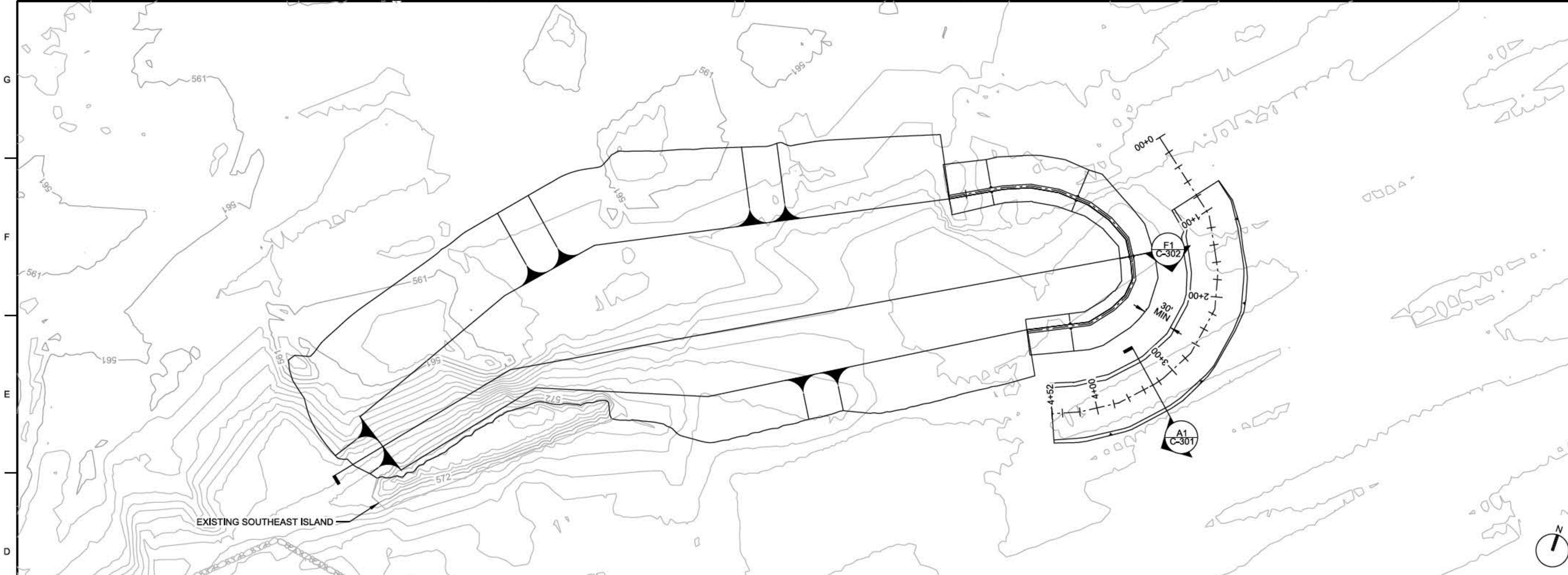
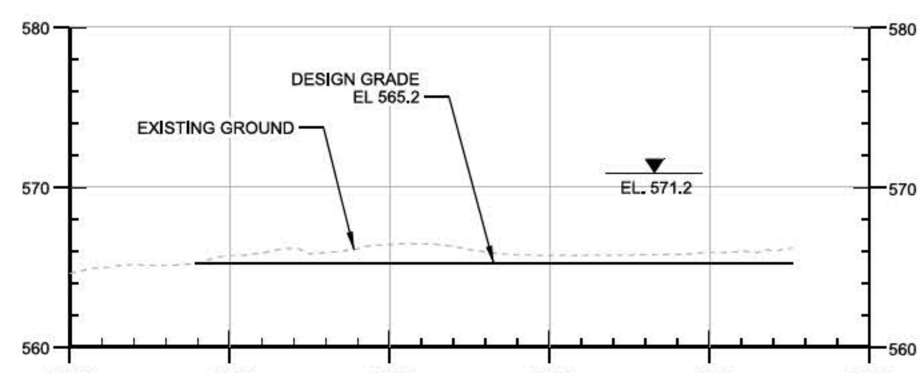


D1 PLAN WEST SOUTHEAST ISLAND

SCALE : 1"=60'-0"



A1 PROFILE WEST SOUTHEAST ISLAND ACCESS DREDGE

SCALE: HORIZONTAL 1"=60'-0" VERTICAL 1"=6'-0"

US Army Corps of Engineers

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD | DATE:
DWN BY: E. JOHNSON | CKD BY: R. FELLMAN | SOLICITATION NO.:
SUBMITTED BY: A. HEDDLESTEN | CONTRACT NO.:
PLOT SCALE: AS SHOWN | PLOT DATE: | PROJECT CODE: B5STMBTI202001
SIZE: ANSI D | FILE NAME: B5STMBTI202001

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT
PLAN AND PROFILE
WEST SOUTHEAST ISLAND

SHEET ID
C-118

REVIEW

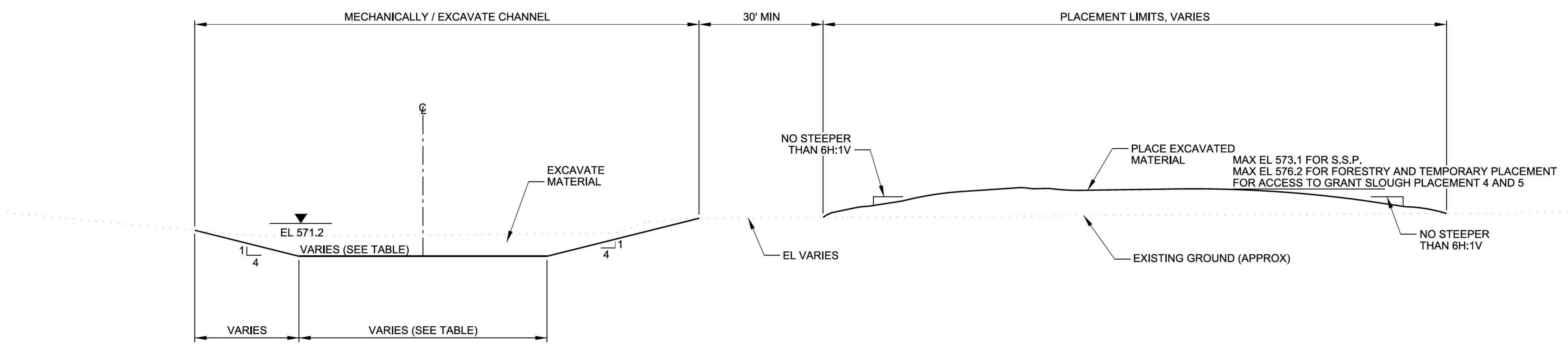
Dredge Cut Location	Length (LF)	Bottom EL (FT)	Width (FT)
Grant Slough Access Dredge	3,017.00	565.2	60.00
Grant Slough AD Left Finger	1,829.00	563.2	30.00
Grant Slough AD Right Finger	1,548.00	563.2	
	0+00 to 12+00	563.2	60.00
	12+00 to end	563.2	30.00
Lower Lake AD Right Finger	3,359.00	563.2	60.00
Lower Lake AD Left Finger	2,399.00	563.2	60.00
Upper Lake AD Main	2,533.00	563.2	60.00
Upper Lake AD Right Finger	1,548.00	563.2	
	0+00 to 9+00	563.2	60.00
	9+00 to end	563.2	30.00
Upper Lake AD Upper Left	1262.00	563.2	60.00
Upper Lake AD Lower Left	1422.00	563.2	60.00
SE Island Access Dredge	452.00	565.2	60.00

E1 DREDGE CUT TABLE

SCALE : NTS

GENERAL SHEET NOTES

1. CLEARING SHALL BE PERFORMED.
2. CHANNELS ARE TO BE MECHANICALLY EXCAVATED/DREDGED.
3. PLACEMENT CANNOT EXCEED THE ELEVATION AND WIDTHS SHOWN. OPTIMIZING THE TOP ELEVATION OF THE PLACEMENT SITE WILL OCCUR TO IMPROVE TREE SURVIVABILITY DURING THE DESIGN PHASE.
4. AREAS WITHOUT ADJACENT PLACEMENT SITES SHALL HAVE THE MATERIAL TRANSPORTED TO A TOPOGRAPHIC DIVERSITY SITE.
5. RIVER ELEVATION SHOWN CORRESPONDS TO FLAT POOL FOR THE PROJECT AREA.



A1 DREDGE CUT SHAPING

SCALE : 1"=15'-0"

0 15' 30'

US Army Corps of Engineers

MARK | DESCRIPTION | DATE | APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD | DATE: | SOLICITATION NO.: | CONTRACT NO.: | PROJECT CODE: B5STMBTI202001
DWN BY: E. JOHNSON | CKD BY: R. FELLMAN | SUBMITTED BY: | PLOT SCALE: AS SHOWN | PLOT DATE: | SIZE: ANSI D | FILE NAME: B5STMBTI202001

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT
TYPICAL DREDGE CUTS

SHEET ID
C-301

REVIEW

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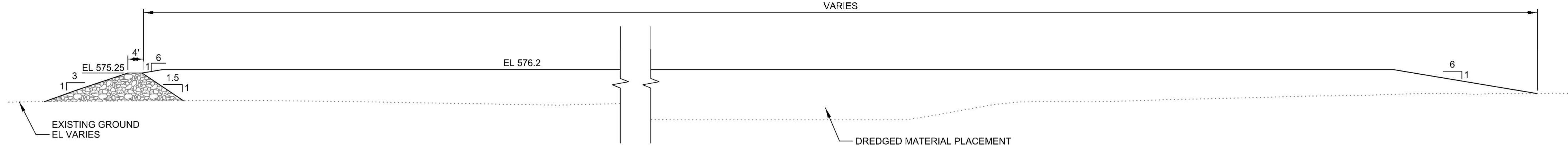
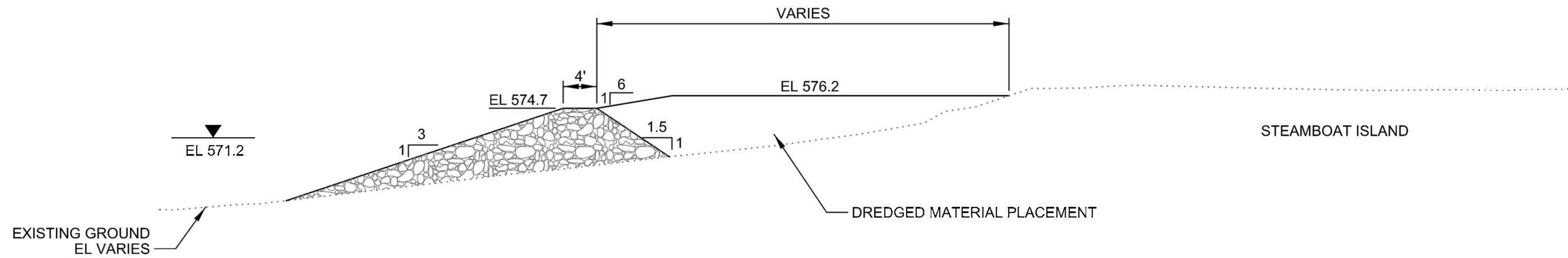


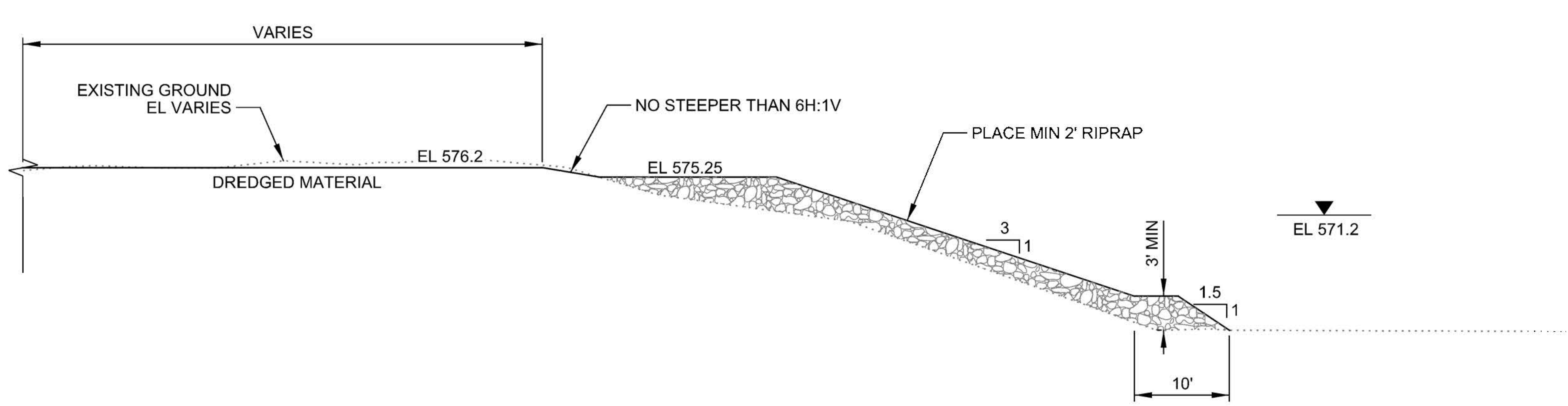
F1 TYPICAL SECTION SE ISLAND STONE PROTECTION

SCALE : 1"=15'-0"



D1 TYPICAL SECTION HEAD OF STEAMBOAT ISLAND STONE PROTECTION

SCALE : 1"=10'-0"



A1 TYPICAL SECTION NORTHEAST BANK AND STONE PROTECTION

SCALE : 1"=10'-0"

US Army Corps of Engineers

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD		DATE:
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SUBMITTED BY: A. HEDDLESTEN		CONTRACT NO.:
PLOT SCALE: AS SHOWN	PLOT DATE:	PROJECT CODE: B5STMBTI202001
SIZE: ANSI D	FILE NAME: B5STMBTI202001	

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

TYPICAL SECTIONS

SHEET ID

C-302

REVIEW

pw:\\PWINT-CPC.EIS.DS.USACE.ARMY.MIL:CEMVR Rock Island District\Documents\Civil Works\Mississippi River Basin\Steamboat Island - HREP\B5STMBTI202001 - HREP FEASIBILITY\Plan Sets\Sheets\B5STMBTI202001-CAD_SHEET-2020-01-C-302.dgn
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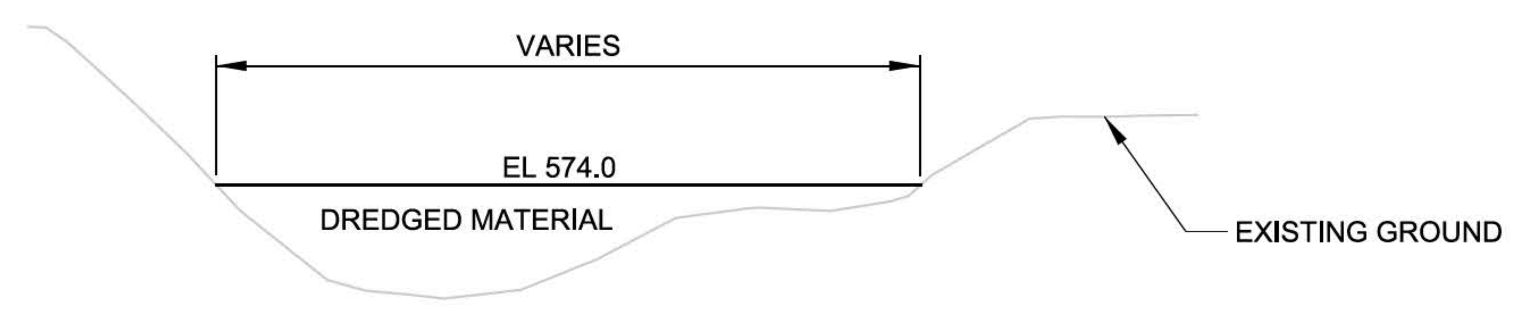
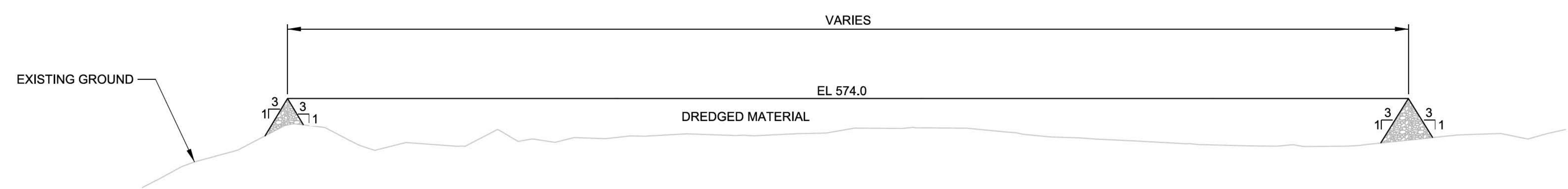


E1 SECTION GRADE CONTROL STRUCTURE

SCALE: HORIZONTAL 1"=15'-0" VERTICAL 1"=3'-0"

0 15' 30' 0 3' 6'



A1 SECTION GRADE CONTROL STRUCTURE

SCALE: HORIZONTAL 1"=15'-0" VERTICAL 1"=3'-0"

0 15' 30' 0 3' 6'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD | DWN BY: E. JOHNSON | CKD BY: R. FELLMAN | SUBMITTED BY: A. HEDDLESTEN | PLOT SCALE: AS SHOWN | PLOT DATE: | SIZE: ANSI D | FILE NAME: B5STMBTI202001

DATE: | SOLICITATION NO.: | CONTRACT NO.: | PROJECT CODE: B5STMBTI202001

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

SECTIONS
GRADE CONTROL STRUCTURE

SHEET ID
C-303

REVIEW

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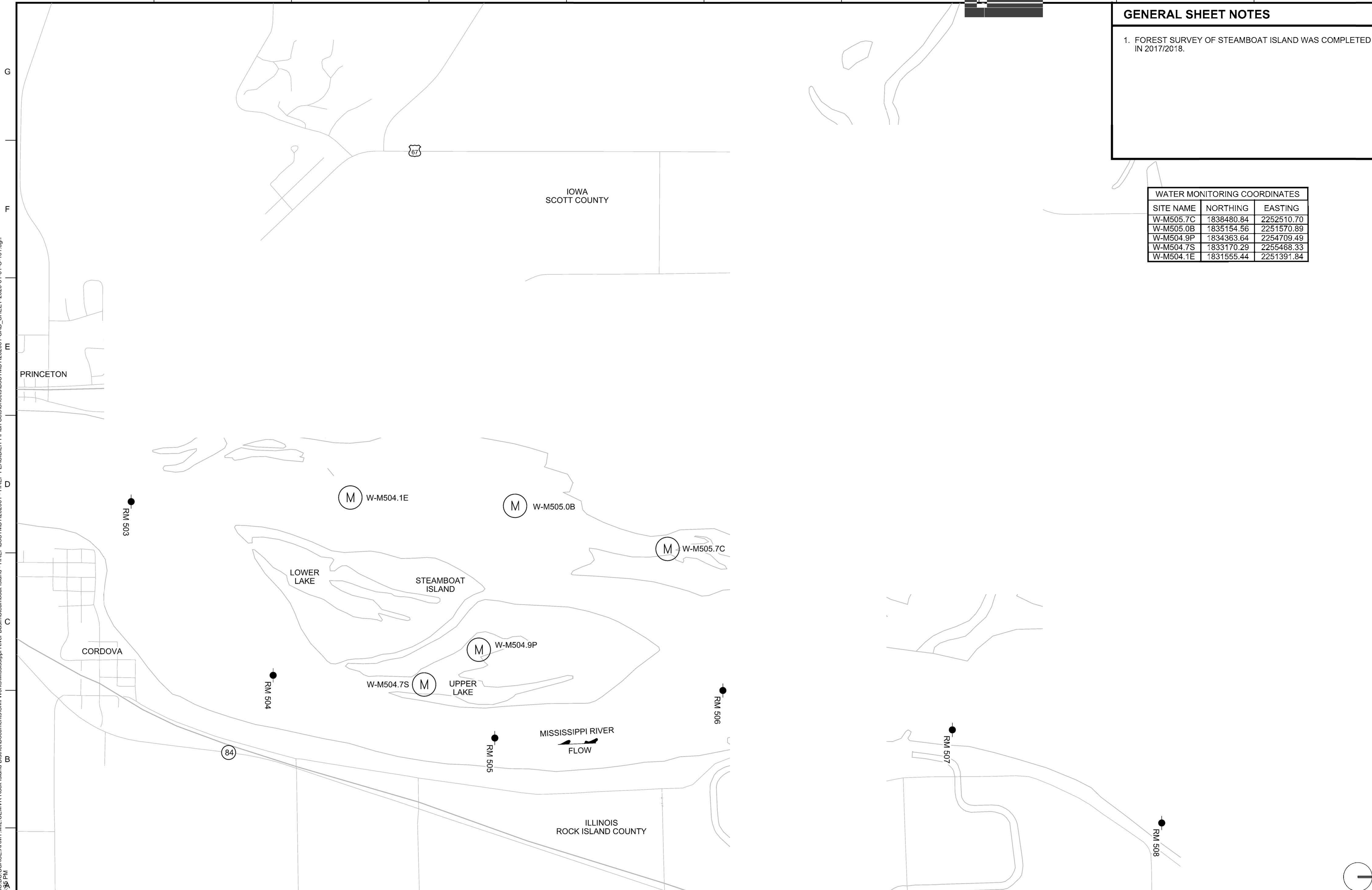

GENERAL SHEET NOTES

1. FOREST SURVEY OF STEAMBOAT ISLAND WAS COMPLETED IN 2017/2018.

WATER MONITORING COORDINATES		
SITE NAME	NORTHING	EASTING
W-M505.7C	1838480.84	2252510.70
W-M505.0B	1835154.56	2251570.89
W-M504.9P	1834363.64	2254709.49
W-M504.7S	1833170.29	2255468.33
W-M504.1E	1831555.44	2251391.84

A1 PRE-CONSTRUCTION MONITORING

SCALE : 1"=1000'-0"

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

DESIGNED BY: K. NERAD
DWN BY: E. JOHNSON
CKD BY: R. FELLMAN
SUBMITTED BY: A. HEDDLESTEN
PLOT SCALE: AS SHOWN
PLOT DATE:
SIZE: ANSI D
FILE NAME: B5STMBTI202001
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PROJECT CODE: B5STMBTI202001

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT

PLAN
PRE-CONSTRUCTION MONITORING

SHEET ID
O-101

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REVIEW

GENERAL SHEET NOTES

1. POST CONSTRUCTION WATER QUALITY DATA MAY NOT BE COLLECTED EVERY YEAR FOR THE FULL 10 YEARS.
2. FISH SAMPLING BY THE SPONSOR WILL BEGIN AFTER COMPLETION OF THE ADAPTIVE MANAGEMENT AND MONITORING. THE SPONSOR'S SAMPLING DATA WILL BE USED TO EVALUATE PROJECT EFFECTIVENESS AND RESULTS OBTAINED FROM ADAPTIVE MANAGEMENT AND MONITORING ACTIVITIES.
3. MAST TREE SURVEYS WILL BE CONDUCTED AS BEST DETERMINED BY FORESTERS 25 YEARS INTO THE PROJECT TO DETERMINE TREE PLANTING EFFECTIVENESS.
4. AERIAL IMAGERY WILL BE OBTAINED AT NO COST FROM GIS RESOURCES SUCH AS NATIONAL AGRICULTURE IMAGERY PROGRAM. A REVIEW OF THE AERIAL IMAGERY WILL ASSIST WITH DETERMINING OVERALL PROJECT EFFECTIVENESS.

WATER MONITORING COORDINATES

SITE NAME	NORTHING	EASTING
W-M505.7C	1838480.84	2252510.70
W-M505.0B	1835154.56	2251570.89
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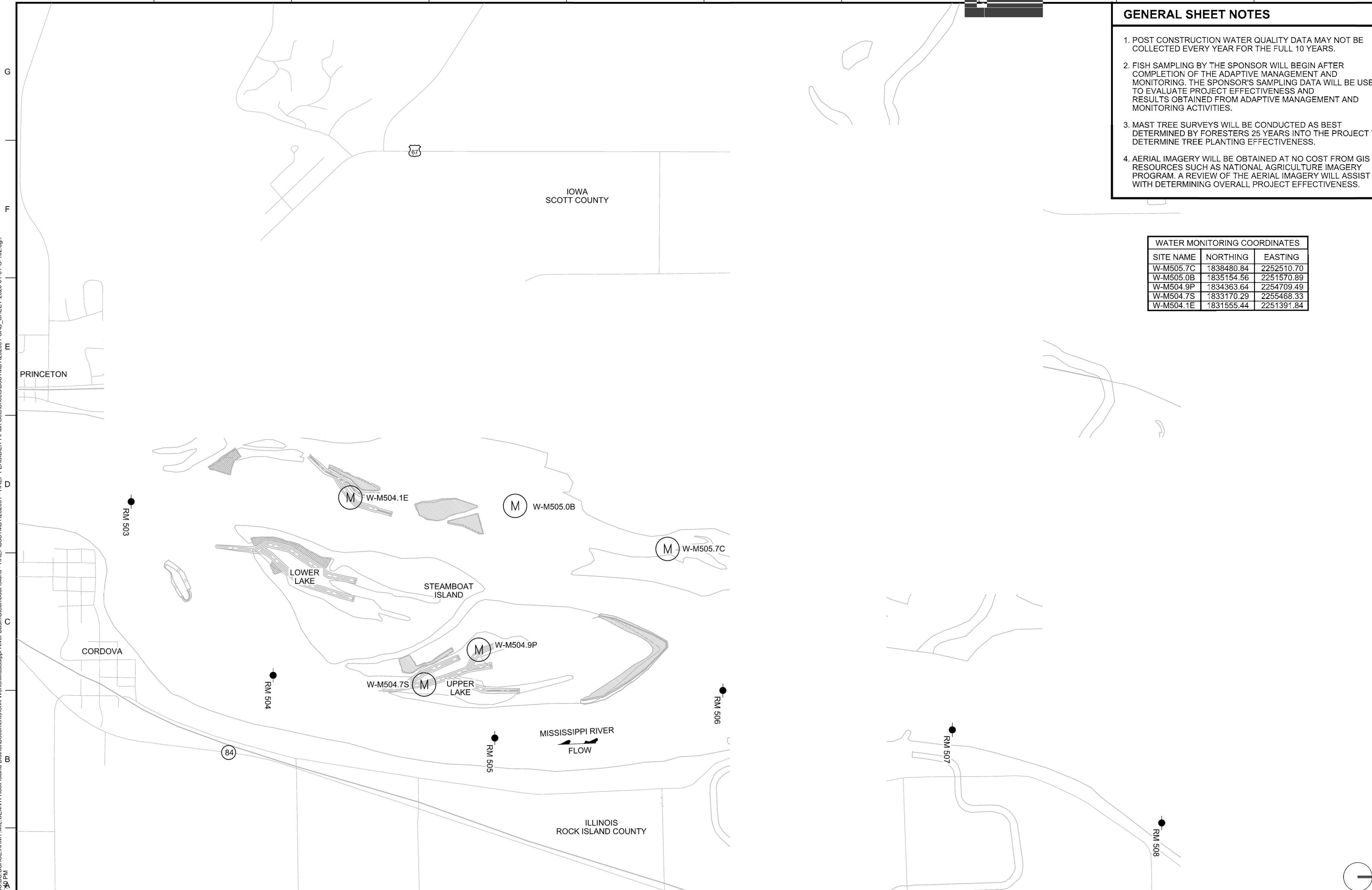

A1 POST-CONSTRUCTION MONITORING

SCALE : 1"=1000'-0"

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MARK | DATE | DESCRIPTION | APPR.

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U.S. ARMY CORPS OF ENGINEERS
ROCK ISLAND DISTRICT
ROCK ISLAND, ILLINOIS

MISSISSIPPI RIVER BASIN
STEAMBOAT ISLAND HREP
CLINTON, SCOTT CO, IA - ROCK ISLAND CO, IL
RIVER MILES 502.5 - 508.0
FEASIBILITY REPORT
PLAN
POST-CONSTRUCTION MONITORING

SHEET ID
O-102

REVIEW

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