ILLINOIS RIVER BASIN RESTORATION
SECTION 519
PROJECT IMPLEMENTATION REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STARVED ROCK POOL
CRITICAL RESTORATION PROJECT

FINAL

DECEMBER 2013

US Army Corps
of Engineers®
Rock Island District

ILLINOIS RIVER BASIN RESTORATION
SECTION 519
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STARVED ROCK POOL CRITICAL RESTORATION PROJECT
LASALLE COUNTY, ILLINOIS

EXECUTIVE SUMMARY

The *Starved Rock Pool Illinois River Basin Critical Restoration Project* (Project) is located in LaSalle County, Illinois, approximately 65 miles downstream of Chicago, IL, in the Illinois River at river miles (RM) 231 and 235. Current stressors include sedimentation and increased water levels due to construction of the lock and dam system. These stressors are likely to continue and the quality of aquatic habitat will decline. The opportunity exists to protect and restore habitat for fish and resident and migratory birds before it is lost.

The goals of the Project are to:

1. Restore Submerged Aquatic Vegetation in Starved Rock Pool.
2. Increase Area and Quality of Resting and Feeding Habitat for Migratory Waterfowl.
3. Improve Spawning and Nursery Habitat for Native Fish.

The objectives of the Project are to:

1. Increase shallow low current velocity habitat in Project area by 2015.

2. Reduce wind fetch lengths and provide areas that are sheltered from wind and wave action by 2015 in the Project area.

3. Increase water clarity in Project area (TSS<25 mg/l, Turbidity < 20 NTU, light extinction< 3. 42 m^{-1}, Secchi disk depth >0.5m) by 2015.

The following enhancement feature was considered to achieve the Project objectives:

- construct a breakwater in the project area

The design life for this Project is 50 years. Cost and habitat benefits were estimated. Habitat benefits were estimated using Habitat Evaluation Procedures. Cost-effectiveness and incremental analyses were conducted to identify cost-effective plans and reveal changes in cost for increasing levels of environmental outputs. The Recommended Plan provides 361.8 net Average Annual Habitat Units of habitat.

The Recommended Plan would restore aquatic habitat by constructing a riprap breakwater on the submersed Delbridge Island to reduce water velocities to protect aquatic vegetation.

Implementation of the Recommended Plan would increase the quality and quantity of preferred habitat at this location. The Project outputs meet management goals and objectives and support the overall goals and objectives of the Illinois River Basin Restoration Section 519 Program.

Section 519 of the 2000 Water Resources Development Act (WRDA) specifies that first cost funding will be 65% percent Federal and 35% non-Federal. All Project features would be located on state-owned lands managed by the Illinois Department of Natural Resources (IL DNR); responsibility for the operation, maintenance, and repair of the lands is the IL DNR at an estimated average annual cost of $30,432.

The Corps of Engineers, Rock Island District, District Engineer has reviewed the Project outputs, a gain of 361.8 net average annual habitat units, and determined that the implementation of the Recommended Plan is in the Federal interest. Therefore, the District Engineer recommends construction approval for the Starved Rock Project at an estimated construction expense of $3 million, including contingency and adaptive management measures. The estimated Total Project Cost, including; planning, engineering and design; adaptive management measures; contingency; and escalation is $4.2 million.

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* Denotes section required for Environmental Assessment/NEPA Compliance

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SECTION 1 - INTRODUCTION

1.1. Authority

The Rock Island, St. Louis, Chicago, and Detroit Districts of the Corps of Engineers along with the Illinois Department of Natural Resources (IL DNR) as the non-Federal Sponsor (NFS) completed the *Illinois River Basin Restoration Comprehensive Plan with Integrated Environmental Assessment* (2007) that addresses two complementary authorities investigating the Federal and state interest in ecosystem restoration within the Illinois River Basin. A Reconnaissance Study identifying a Federal interest in restoration was completed in February of 1999. Study efforts were then initiated in the basin through the Illinois River Ecosystem Restoration Feasibility Study conducted under Section 216 of the 1970 Flood Control Act. That Study was initiated pursuant to the provision of funds in the Energy and Water Development Appropriations Act, 1998. The Study was authorized by Section 216 of the 1970 Flood Control Act and states:

> *The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to significant changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest*

Congress provided additional authority for Illinois River Basin Restoration in Section 519 of WRDA 2000.Additional authority was provided in Section 5071 of WRDA 2007. Authority was granted in Sections (b) & (c) of Section 519 of the Water Resources Development Act 2000 (as amended; WRDA 2007) to complete a comprehensive plan and identify, evaluate, and implement critical restoration projects in the Illinois River Basin. The authority states: *SEC.519 (WRDA 2000 as amended). ILLINOIS RIVER BASIN RESTORATION.*

> *(a) ILLINOIS RIVER BASIN DEFINED- In this section, the term `Illinois River basin' means the Illinois River, Illinois, its backwaters, its side channels, and all tributaries, including their watersheds, draining into the Illinois River.*

(b) COMPREHENSIVE PLAN-

(1) DEVELOPMENT- The Secretary shall develop, as expeditiously as practicable, a proposed comprehensive plan for the purpose of restoring, preserving, and protecting the Illinois River basin.

(2) TECHNOLOGIES AND INNOVATIVE APPROACHES- The comprehensive plan shall provide for the development of new technologies and innovative approaches--

(A) to enhance the Illinois River as a vital transportation corridor;

(B) to improve water quality within the entire Illinois River basin;

(C) to restore, enhance, and preserve habitat for plants and wildlife; and

(D) to increase economic opportunity for agriculture and business communities.

(3) SPECIFIC COMPONENTS- The comprehensive plan shall include such features as are necessary to provide for--

(A) the development and implementation of a program for sediment removal technology, sediment characterization, sediment transport, and beneficial uses of sediment;

(B) the development and implementation of a program for the planning, conservation, evaluation, and construction of measures for fish and wildlife habitat conservation and rehabilitation, and stabilization and enhancement of land and water resources in the basin;

(C) the development and implementation of a long-term resource monitoring program; and

(D) the development and implementation of a computerized inventory and analysis system.

(4) CONSULTATION- The comprehensive plan shall be developed by the Secretary in consultation with appropriate Federal agencies, the State of Illinois, and the Illinois River Coordinating Council.

(5) REPORT TO CONGRESS- Not later than 2 years after the date of enactment of this Act, the Secretary shall transmit to Congress a report containing the comprehensive plan.

(6) ADDITIONAL STUDIES AND ANALYSES- After transmission of a report under paragraph (5), the Secretary shall continue to conduct such studies and analyses related to the comprehensive plan as are necessary, consistent with this subsection.

(c) CRITICAL RESTORATION PROJECTS-

(1) IN GENERAL- If the Secretary, in cooperation with appropriate Federal agencies and the State of Illinois, determines that a restoration project for the Illinois River basin will produce independent, immediate, and substantial restoration, preservation, and protection benefits, the Secretary shall proceed expeditiously with the implementation of the project.

(2) AUTHORIZATION OF APPROPRIATIONS- There is authorized to be appropriated to carry out projects under this subsection $100,000,000 for fiscal years 2001 through 2010.

(3) FEDERAL SHARE- The Federal share of the cost of carrying out any project under this subsection shall not exceed $20,000,000.

(d) GENERAL PROVISIONS-

(1) WATER QUALITY- In carrying out projects and activities under this section, the Secretary shall take into account the protection of water quality by considering applicable State water quality standards.

(2) PUBLIC PARTICIPATION- In developing the comprehensive plan under subsection (b) and carrying out projects under subsection (c), the Secretary shall implement procedures to facilitate public participation, including providing advance notice of meetings, providing adequate opportunity for public input and comment, maintaining appropriate records, and making a record of the proceedings of meetings available for public inspection.

(e) COORDINATION- The Secretary shall integrate and coordinate projects and activities carried out under this section with ongoing Federal and State programs, projects, and activities, including the following:

(1) Upper Mississippi River System-Environmental Management Program authorized under Section 1103 of the Water Resources Development Act of 1986 (33 U.S.C. 652).

(2) Upper Mississippi River Illinois Waterway System Study.

(3) Kankakee River Basin General Investigation.

(4) Peoria Riverfront Development General Investigation.

(5) Illinois River Ecosystem Restoration General Investigation.

(6) Conservation Reserve Program (and other farm programs of the Department of Agriculture).

(7) Conservation Reserve Enhancement Program (State) and Conservation 2000 Ecosystem Program of the Illinois Department of Natural Resources.

(8) Conservation 2000 Conservation Practices Program and the Livestock Management Facilities Act administered by the Illinois Department of Agriculture.

(9) National Buffer Initiative of the Natural Resources Conservation Service.

(10) Nonpoint source grant program administered by the Illinois Environmental Protection Agency.

(f) JUSTIFICATION-

(1) IN GENERAL- Notwithstanding Section 209 of the Flood Control Act of 1970 (42 U.S.C. 1962-2) or any other provision of law, in carrying out activities to restore, preserve, and protect the Illinois River basin under this section, the Secretary may determine that the activities--

(A) are justified by the environmental benefits derived by the Illinois River basin; and

(B) shall not need further economic justification if the Secretary determines that the activities are cost-effective.

(2) APPLICABILITY- Paragraph (1) shall not apply to any separable element intended to produce benefits that are predominantly unrelated to the restoration, preservation, and protection of the Illinois River basin.

(g) COST SHARING-

(1) IN GENERAL- The non-Federal share of the cost of projects and activities carried out under this section shall be 35 percent.

(2) OPERATION, MAINTENANCE, REHABILITATION, AND REPLACEMENT- The operation, maintenance, rehabilitation, and replacement of projects carried out under this section shall be a non-Federal responsibility.

(3) IN-KIND SERVICES- The Secretary may credit the value of in-kind services provided by the non-Federal interest for a project or activity carried out under this section toward not more than 80 percent of the non-Federal share of the cost of the project or activity if such services are provided not more than 5 years before the date of initiation of the project or activity. In-kind services shall include all State funds expended on programs and projects that accomplish the goals of this section, as determined by the Secretary. The programs and projects may include the Illinois River Conservation Reserve Program, the Illinois Conservation 2000 Program, the Open Lands Trust Fund, and other appropriate programs carried out in the Illinois River basin.

(4) CREDIT-

(A) VALUE OF LANDS- If the Secretary determines that lands or interests in land acquired by a non-Federal interest, regardless of the date of acquisition, are integral to a project or activity carried out under this section, the Secretary may credit the value of the lands or interests in land toward the non-Federal share of the cost of the project or activity. Such value shall be determined by the Secretary.

(B) WORK- If the Secretary determines that any work completed by a non-Federal interest, regardless of the date of completion, is integral to a project or activity carried out under this section, the Secretary may credit the value of the work toward the non-Federal share of the cost of the project or activity. Such value shall be determined by the Secretary.

(h) Monitoring – The Secretary shall develop an Illinois River basin monitoring program to support the plan developed under subsection (b). Data collected under the monitoring program shall incorporate data provided by the State of Illinois and shall be publicly accessible through electronic means, including on the Internet.

Therefore, this Project Implementation Report is being conducted as a Critical Restoration Project under the authority of Section 519 from the Illinois River Ecosystem Restoration Study. The construction of the Project, if approved, will occur solely under the Section 519 authority.

1.2. Study Purpose and Scope

This Project Implementation Report (PIR) presents the feasibility analysis and resulting detailed proposal for the restoration of aquatic habitat in Starved Rock Pool. It provides planning, engineering, and limited construction details of the recommended restoration plan. This PIR is a decision document; approval of the report will allow the Project to proceed to implementation subject to funding. The report provides sufficient engineering and construction details of the Recommended Plan to allow final design and construction to proceed following report approval. The PIR meets the requirements of the National Environmental Policy Act (NEPA) and related environmental laws and regulations.

The PIR is organized to follow a general problem-solving format. Existing conditions and anticipated future conditions are reviewed. Project goals and objectives are identified. Restoration alternatives are formulated to address the goals and objectives. Costs and benefits of the restoration alternatives are identified and the Alternatives are compared on this basis. A single restoration plan is recommended for implementation. A detailed analysis of the Recommended Plan is presented. The detailed analysis includes design and construction considerations; operation, maintenance, and rehabilitation considerations; a detailed cost estimate; a plan for monitoring the performance of the restoration; real estate requirements; environmental effects; and a detailed schedule for implementation.

Due to the broad scope, multiple objectives and time frame of the Section 519 authority, this PIR serves as an interim response to the overall authority. Further, the specific language addressing critical restoration projects is partially satisfied by this study.

The Corps proposes to rehabilitate and enhance Starved Rock Pool through construction measures which will increase the quality of year-round habitat for the fish community, increase submerged aquatic vegetation (SAV), and improve habitat for waterfowl. This PIR with an integrated Environmental Assessment (EA) presents a detailed account of the planning, engineering, construction details, and environmental considerations which resulted in the Recommended Plan.

The need for rehabilitation and enhancement of the Project is based on the fact that the existing aquatic habitat is generally higher velocity, turbid, and lacks aquatic vegetation important for year-round habitat functioning. Without action the existing aquatic habitat will cease to function as fish and waterfowl habitat.

1.3. Organization of Project Implementation Report

This PIR has separately bound supporting appendices. The purpose of the main report is to concisely summarize the multidisciplinary efforts of the Corps and the IL DNR that lead to the final study recommendations. This process involves the public.

This PIR is organized into the following six sections:

1 **Introduction:** highlights the study authority, study area, purpose and scope of study efforts, and the background of the Project

2 **Plan Formulation:** covers a descriptions of the study process, an assessment of problems, opportunities and constraints, and summaries of the formulation and evaluation of alternatives for Starved Rock Pool

3 **Description of the Selected Plan:** details various components and considerations

4 **Plan Implementation:** includes institutional requirements, division of plan responsibility, views of the NFS and other agencies with implementation responsibilities

5 **Summary of Coordination, Public Views, and Comments**

6 **Study Recommendations**

1.4. Study Area

Starved Rock Pool is a 16-mile section of the Illinois River located approximately 65 miles southwest of Chicago. It extends from Starved Rock Lock and Dam (L&D), River Mile (RM) 231, eastward to the base of Marseilles Dam (RM 247). The pool is located in La Salle County and has the communities of Ottawa, South Ottawa and Marseilles located along its length. Starved Rock State Park lies along a portion of its left descending bank, and the Fox River (the pool's primary tributary) enters midway down its right descending bank. Several major islands (totaling approximately five miles in length) remain in the Starved Rock Pool including Sheehan, Mayo, Hitt, Scherer, Bulls, and Bell's Island.

The proposed study area for the Starved Rock 519 project currently includes Starved Rock Pool, from RM 231 to RM 235 (figure 1). This area includes Delbridge Island, Leopold Islands, and Gypsy Island, which are all currently submerged, and some small unnamed islands near RM 234 that are above the normal pool elevation. Starved Rock State Park is located on the left descending (south) bank of the Illinois River adjacent to the Project area. The islands in the lower pool including Leopold Islands, Gypsy Island, and the majority of Delbridge Island are currently owned by the State of Illinois. Three islands located near RM 234 are privately owned. See Appendix J for a preliminary map of land ownership. The Starved Rock L&D is located on the downstream end of the Project area at RM 231. Two recreational boat marinas are located between RM 233 and RM 234, along the right descending (north) bank. The confluence of the Fox River, located in Ottawa, IL, is approximately 6 miles upstream of the Project location. It is the third largest tributary to the Illinois River.

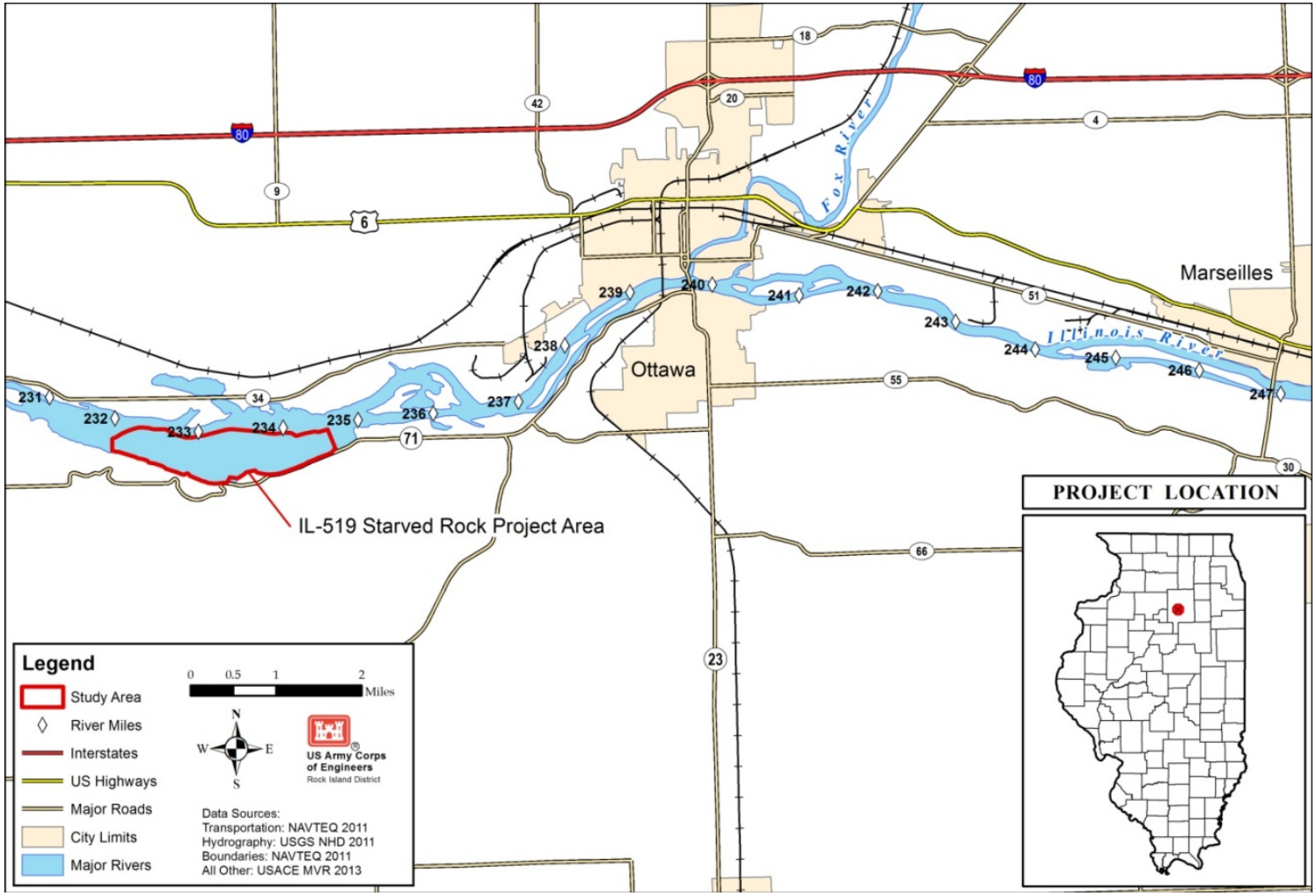


Figure 1. Project Location

1.5. Eligibility Criteria

The authorizing legislation (Section 519 of the WRDA of 2000, paragraph (c)(1)), identified the following minimum eligibility criteria for the critical restoration projects: "If … a restoration project for the Illinois River Basin will produce independent, immediate and substantial restoration, preservation and protection benefits, the Secretary shall proceed expeditiously with the implementation of the Project. "

Consistency with these criteria is reviewed in Section 2.6, *Evaluation and Comparison of Alternatives*, of this report.

The Starved Rock Pool Critical Restoration Project addresses several ecosystem restoration goals identified in the Illinois River Basin Restoration Comprehensive Plan. The goals of the Comprehensive Plan are as follows:

> **Overarching Goal:** Restore and maintain ecological integrity, including habitats, communities, and populations of native species and the processes that sustain them;
>
> **Goal 1:** Reduce sediment delivery to the Illinois River from upland areas and tributary channels with the aim of eliminating excessive sediment load;
>
> **Goal 2:** Restore aquatic habitat diversity of side channels and backwaters, including Peoria Lakes, to provide adequate volume and depth for sustaining native fish and wildlife communities;
> **Goal 3:** Improve floodplain, riparian, and aquatic habitats and functions;
>
> **Goal 4:** Restore aquatic connectivity (fish passage) on the Illinois River and its tributaries, where appropriate, to restore or maintain healthy populations of native fish;
>
> **Goal 5:** Naturalize Illinois River and tributary hydrologic regimes and conditions to restore aquatic and riparian habitat; and
>
> **Goal 6:** Improve water and sediment quality in the Illinois River and its watershed.

The proposed Starved Rock Pool Critical Restoration Project is consistent with the ecosystem restoration goals of restoring and maintaining ecological integrity (Overarching Goal), restoring the aquatic habitat diversity of side channels and backwaters (Goal 2), improving aquatic habitats and function (Goal 3), and improving water and sediment quality in the Illinois River (Goal 6).

1.6. Selection Process

The *Starved Rock Side Channels and Islands Critical Restoration Project* was proposed during the development of the Illinois River Basin Restoration Comprehensive Plan. The proposed Project was intended to address the perceived problem of a loss of side channel and island habitat in Starved Rock Pool.

The study team initiated planning efforts to gather data about the existing conditions of side channels and islands in Starved Rock Pool. Data from hydrographic surveys showed adequate side channel

depths for overwintering fish. Evaluation of island erosion did not identify locations experiencing severe island erosion. An analysis of Woermann maps from the early 1900s as compared to current aerial photographs show that the primary loss of island habitat was located in Starved Rock Pool due to inundation after construction of the Starved Rock L&D in 1933.

Through analysis and discussions with the biologists from the IL DNR and Illinois Natural History Survey, the primary ecological limiting factor was identified as a lack of SAV. The lack of SAV in Starved Rock Pool is considered to be limiting to both waterfowl and fisheries. This habitat type is found in areas protected from flow and wind fetch, and can typically be found in protected areas near islands and in backwaters. SAV does not currently occur in the Illinois River below Starved Rock Pool and is generally limited throughout the Illinois River. Measures to restore physical structures and processes would help create suitable conditions for the growth of SAV, thereby benefiting fish and waterfowl.

1.7. Resource Significance

The benefits of ecosystem restoration and protection projects are difficult to measure in monetary terms. When determining Federal interest, it is important that the significance of the resources being studied for restoration be clearly identified. The Corps of Engineers' Principles and Guidelines defines significance in terms of institutional, public, and technical recognition of the resources. For years, the State of Illinois and other agencies have been engaged in activities that clearly demonstrate the institutional, public, and technical recognition of the resources of the Illinois River Basin. The Starved Rock Pool of the Illinois River has institutional, public, and technical significance both as an individual pool and as part of the larger system of the Illinois River Basin.

1.7.1. Significance of the Illinois River Basin

1.7.1.1. Institutional. The formal recognition of the Illinois River Basin in laws, adopted plans, and other policy statements of public agencies and private groups illustrate the significance of the basin to a variety of institutions. At the Federal level, the Illinois River's importance as an environmental and economic resource has long been recognized by congressional action and through the activities of several agencies. The U.S. Congress recognized the Illinois River, part of the Upper Mississippi River System (UMRS), as a unique, "nationally significant ecosystem and a nationally significant commercial navigation system…" in Section 1103 of the Water Resources Development Act of 1986 (WRDA 86). The Upper Mississippi River Restoration - Environmental Management Program (UMRR-EMP) was established in 1986 and has been conducting monitoring and habitat restoration activities along portions of the main stem of the Illinois River. The EMP brings together the expertise of the U.S. Army Corps of Engineers, the U. S. Fish and Wildlife Service (USFWS), the U.S. Geological Survey, and the U.S. Environmental Protection Agency (EPA). Congress reaffirmed the significance of the Upper Mississippi River System by reauthorizing the UMRR-EMP in 1999.

The U.S. Department of Agriculture selected the Illinois River Basin as one of the first seven areas in the country for the Conservation Reserve and Enhancement Program (CREP), a program allowing enhanced Federal and State partnership opportunities to implement land conservation practices. The Midwest Natural Resources Group (MVRG) is an ongoing partnership of 12 Federal Agencies, bringing focus and excellence to Federal activities supporting the vitality and sustainability of natural resources and the environment. On May 10, 2000, the U.S. Departments of Agriculture (USDA), Army, and Interior; the U.S. EPA, Federal Highway Administration, Maritime Administration and the

U.S. Coast Guard signed an Intergovernmental Partnership Agreement stating that they shall work, in partnership with State and local governments, non-governmental organizations, private landowners and individuals, to restore and protect the ecological integrity of the Illinois River Basin in a manner consistent with reducing flood damage, protection of private property rights and maintaining an effective navigation system. More than $450 million in Federal and State funding has been targeted to improve the Illinois River through the CREP, which uses State funding to enhance existing USDA Conservation Reserve Program (CRP) activities. The CREP initiative will help preserve up to 232,000 acres of sensitive land surrounding the Illinois River and its tributaries, including upland areas. From 1998 to 2004, 110,000 acres were enrolled in Federal CRP easements and 73,000 acres in state CREP easements. While most state assets were acquired on lands enrolled in the Federal program, the State also acquired State-only easements on numerous adjacent areas and now holds roughly 28,000 acres in these State only easements.

In August 2005, the State of Illinois announced that its budget for the upcoming year included $10 million to leverage $40 million in Federal funds allowing for CREP easements on approximately 15,000 more acres. The State of Illinois has clearly demonstrated its institutional recognition of the Illinois River Basin as a significant resource. The state has developed, adopted, and begun implementation of the *Integrated Management Plan for the Illinois River Watershed* (1997); enacted the Illinois River Watershed Restoration Act; invested $51 million to match $271 million in Federal dollars in implementing the CREP on 110,000 acres with the potential to expand to 232,000 acres; and set the vision for Illinois Rivers 2020, a proposed $2.5 billion, 20-year Federal and State program to restore the Illinois River Basin. The *Integrated Management Plan for the Illinois River Watershed* (1997) was the culmination of several years of effort by local and State governments in Illinois to build a consensus-based partnership with citizens and interest groups to address the issues that face the Illinois River Basin. The plan identifies 33 goals addressing restoration, economics, recreation, etc. Conservation groups, environmental groups, industry, and Federal, State, regional and local governments participated in shaping a vision for the future of the basin. In July 1997, the State of Illinois enacted the Illinois River Watershed Restoration Act. The legislative purposes of the Act are to: (1) create a group of leaders representing agriculture, business, conservation, and the environment to encourage the implementation of efforts to restore the Illinois River Watershed in accordance with the recommendations of the *Integrated Management Plan for the Illinois River Watershed Technical Report;* (2) work with local communities to develop projects and regional strategies; and (3) make recommendations to appropriate State and Federal agencies.

In 2000, the Governor of Illinois set the vision for the Illinois Rivers 2020, a proposed $2.5 billion restoration effort. Illinois Rivers 2020 seeks to bring together the efforts of the Illinois Department of Natural Resources (DNR), Illinois Department of Agriculture, and Illinois EPA with Federal agencies. It is a voluntary, incentive-based approach that is much broader and more inclusive for the entire Illinois River and its tributaries than previous efforts. The support for implementation of Illinois Rivers 2020 is very broad, including hundreds of individuals, elected officials, organizations, and businesses that officially support this effort.

In addition to Federal and State recognition, local communities, counties, and non-governmental organizations have also focused attention on the Illinois River Basin. More than 35 management plans have been developed that call for restoration of all or a portion of the Illinois River Basin. Many communities and groups have begun implementation of restoration projects. Both The Nature Conservancy and The Wetlands Initiative have made major investments by purchasing levee and drainage districts for the purpose of restoration. In total, they have recently acquired more than 11,000

acres of Illinois River floodplain and adjacent habitats. This is in addition to the 135,000 acres in State and Federal ownership within the Illinois River Basin.

Another example of the institutional significance is the Thirteenth Biennial Governor's Conference on the Management of the Illinois River System was held from October 4 h through the 6, 2011, in Peoria, Illinois. The conference focused on a systems approach to river management. Over 350 individuals from Federal, State, and local governments, as well as private citizens, attended the conference. The diversity of the groups attending demonstrates the importance of the Illinois River Basin to not only policy makers, but to the public as well.

1.7.1.2. Public. The Illinois River Basin is significant based on wide public recognition of the environmental resources present in the basin. The basin is noteworthy in that, while encompassing approximately 44 percent of the land area of the State, it includes nearly 90 percent of Illinois' population approximately 11 million people. Some level of significance of the Illinois River Basin to the public is measured through the actions of elected officials and policy makers who have forwarded legislation and enacted laws mentioned above to protect and enhance the watershed. A further recognition of the value of the basin is the amount of participation by landowners in conservation programs. Approximately 138,000 acres of land have been enrolled in the Federal and State CREP and CRP programs. Each year, more Illinois landowners apply for the CREP program than are accepted. This demonstrates a willingness on the part of the landowners to set aside farmland to aid in the conservation of the Illinois River Basin.

1.7.1.3. Technical. Numerous scientific analyses and long-term evaluations of the Illinois River Basin have documented its significant ecological resources. Since the early 20th century, researchers, government agencies, and private groups have studied the large river floodplain system and proposed ecosystem restoration in the Illinois River Basin. A few examples of the efforts to identify, quantify, and understand the ecological significance of the basin is described in the following text. In a 1995 report, the U.S. Department of the Interior (DOI) listed large streams and rivers as endangered ecosystems in the United States. The U.S. DOI documented an 85 to 98 percent decline in this ecosystem type since European settlement. In particular, large floodplain-river ecosystems, have become increasingly rare worldwide. Two of the large floodplain-river ecosystems lie within the UMRS, namely, the Upper Mississippi and Illinois Rivers. These two ecosystems still retain seasonal flood pulses, and more than half of their original floodplains remain unleveed and open to the rivers (Sparks et al. 1998). The UMRS is one of the few areas in the developed world where ecosystem restoration can be implemented on large floodplain-river ecosystems (Sparks 1995). The Nature Conservancy (TNC) has developed basin-level planning documents to guide restoration efforts. In these documents, the TNC states, "The Illinois River remains one of a handful of world-class floodplain-river ecosystems. These include the Nile, Amazon, the Mekong and portions of the Mississippi, where biological productivity is enhanced by annual flood pulses that advance and retreat over the floodplain and temporarily expand backwaters and floodplain lakes." (TNC 1998). The UMRR-EMP conducted a Habitat Needs Assessment (HNA) in 2000 to help guide future habitat projects on the UMRS. The HNA highlighted the need to restore depth to 25 percent of the existing backwaters on the Illinois River, increase depth diversity and connectivity, and restore hydrologic conditions needed to restore and maintain backwater habitats.

The Illinois River has historically hosted a vast fishery, including numerous ancient fishes, and, at the turn of the century, produced 10 percent of the nation's catch of freshwater fish (yielding 178 pounds per acre in 1908). The Illinois River and its tributaries are currently home to over 100 species of fish.

Side channels and backwaters serve as nurseries and spawning areas. Sport fish at home in the Illinois include: white bass, largemouth bass, bluegill, black crappie, channel catfish, carp, buffalo, bullhead, walleye, sauger, and many other warm-water species. Game fish in the upper river include largemouth bass, black bullheads and white bass, especially around Starved Rock State Park in Utica, IL. The middle river has historically been the most productive because of the aquatic habitat in the backwater lakes and wetlands along its banks. The lower river, from Beardstown to Grafton, features approximately the same mix of fish species as the middle river, but populations are smaller.

The Illinois River is a major component of the internationally significant Mississippi River Flyway, a route followed by migratory waterfowl between Canada and the Gulf Coast. The Mississippi River Flyway, is utilized by 40 percent of all North American waterfowl and 326 total bird species, representing 60 percent of all species in North America. A survey conducted by the Illinois Natural History Survey in the fall of 1994 found that 81 percent of the fall waterfowl migration in the Mississippi Flyway utilized the Illinois River. Approximately 20 species of waterfowl, primarily ducks and geese, make their home in the Illinois River Basin. Hundreds of thousands of birds migrate along the Illinois River each year, resting temporarily in the wetlands, sloughs, and backwater lakes in the basin. The Illinois River has also been historically important to a multitude of avian species. The backwaters of the Illinois River serve as habitat for 20 to 30 species of shorebirds, 15 species of gulls and terns, and several species of marsh birds. The cottonwoods and black willows along the middle and the lower river and its wetlands are host to various types of herons, egrets, plovers, sandpipers, and other migrating wading shorebirds, as well as gulls and terns. Wading shorebirds represent the farthest ranging visitors to the Illinois River Valley, traveling annually between the Arctic and South America, specifically Chile and Argentina. The river valley is a major wintering ground for the endangered bald eagle. In recent years, as many as 375 bald eagles have been counted annually, which represents about 3 percent of the total wintering population of bald eagles in the lower 48 states.

Over 4.26 million acres of Illinois land is in forest. Much of it is located adjacent to the Illinois River and its tributaries. Forest product utilization and management is important to the Illinois economy and environment. Forested riparian areas adjacent to the Illinois River and its tributaries provide a necessary buffer for surface water drainage and serve as the transition zone between land and water. Water quality benefits associated with the riparian forest are critical to the well-being of the tributary watershed. Many aquatic and terrestrial wildlife species utilize and depend upon the riparian forest found in the Illinois River Valley.

The Illinois River also serves as one of the sources for the public water supply system serving Peoria, which uses three well fields. The cities of Aurora, Elgin, Kankakee, Pontiac, Streator, Decatur, Taylorville, Springfield, Jacksonville, and Canton use water from tributaries of the Illinois River. Numerous industrial and utility providers also utilize Illinois River Basin waters for cooling purposes. The Illinois River is a major conduit for the transport of treated wastewater throughout Illinois. It is estimated that 2,109 outfalls are currently located in the Illinois River Basin. Illinois has taken significant steps to obtain compliance for effluent limitations by dischargers in the basin. From the municipal facility perspective, approximately $5.6 billion has been expended for treatment facility construction in the Illinois River Basin alone. It can be safely estimated that several hundred million dollars have also been expended by industrial dischargers.

Archaeological and historical sites and fossil localities are found throughout the basin. Archaeological sites—localities once occupied by prehistoric or historic peoples—have been documented along the river shoreline, on the floodplain, and in valley margin and upland settings. Camps and villages

established near the river by Native Americans are buried in river-deposited sediment. Major villages were often established along the river valley margin. Over the millennia, sediments eroding from nearby bluffs slowly accumulated. Preserved in these deposits, separated by lenses of sediment, are the remains of village sites representing centuries of cultural development.

1.7.2. Significance of Starved Rock Pool. The Starved Rock Pool of the Illinois River has institutional, public, and technical significance both as an individual pool and as part of the larger system of the Illinois River Basin. Coordination with the IL DNR, Illinois Natural History Survey, Non-Governmental Organizations, institutions, and the public will help to further describe the significance of the Starved Rock Pool Critical Restoration Project. The Starved Rock Pool Critical Restoration Project would greatly benefit numerous avian species. The site is located along the Illinois River basin, a critical mid-migration resting and feeding area of the internationally significant Mississippi River Flyway, utilized by 40 percent of all North American waterfowl and 326 total bird species, representing 60 percent of all species in North America. A survey conducted by the Illinois Natural History Survey in the fall of 1994 found that 81 percent of the fall waterfowl migration in the Mississippi flyway utilized the Illinois River. Twenty-six avian species are state listed as threatened or endangered; one of which is a candidate for Federal listing and four others are species of concern. Many of these species are associated with wetlands or grasslands, and are also sensitive to landscape fragmentation. Restoration activities would also benefit the Federally threatened decurrent false aster *(Blotonia decurrens)* and recently delisted bald eagle *(Haliaeetus leucocephalus),* and provide habitat for a number of state threatened and endangered amphibians, reptiles, invertebrates, birds, fish, and plants.

1.7.2.1. Institutional Significance. Bald Eagle nests are located around the study area, this is institutionally recognized as significant by the Bald and Golden Eagle Act. North American Waterfowl use the Starved Rock Pool as resting area during migration; this is institutionally recognized as significant by the Migratory Bird Treaty Act.

1.7.2.2. Public Significance. Waterfowl migration that utilizes Starved Rock Pool as a feeding and resting area is publicly recognized as significant by Starved Rock Audubon Society and other conservation organizations. The Starved Rock Pool is publicly recognized as significant since the adjacent Starved Rock State Park is visited by over 1,500,000 people annually and provides recreation in the form of waterfowl hunting and fishing.

1.7.2.3. Technical Significance. Aquatic vegetation is technically recognized as significant in the Illinois River since plant communities of native submerged aquatic vegetation beds are prominent vegetation species that create cover and breeding areas for fish, amphibians and provide food for waterfowl.

1.8. Concise Discussion of Studies, Reports, and Existing Water Projects

Section 519 Initial Assessment. In February 2002, an Initial Assessment was completed. Section 519 of WRDA 2000 authorizes both completion of a Comprehensive Plan for the basin and the identification, evaluation, and selection of Critical Restoration Projects. The purposes of this Initial Assessment are to: (1) identify watershed needs and present a framework to develop and implement a Comprehensive Plan, including long-term resource monitoring and 2) identify procedures and responsibilities for the identification and evaluation of Critical Restoration Projects.

Illinois River Basin Restoration Comprehensive Plan with Integrated Environmental Assessment, March 2007. The draft Comprehensive Plan provides the overall plan for the restoration of the Illinois River Basin, including system needs and recommendations describing the restoration program, long term resource monitoring, computerized inventory and analysis system, and innovative dredging technologies and beneficial use of dredged material.

Dredged Material Management Plan for Dredged Material Placement: Illinois River Navigation Project, Site Plan for Delbridge Island and Starved Rock Upper Dredge Cuts, River Miles 230.2-230.8, U. S. Army Corps of Engineers, Rock Island District. This document records the process used to develop a Dredged Material Management Plan (DMMP) by evaluating the potential for alternative placement locations for dredged materials in this reach.

Upper Mississippi River - Illinois Waterway System Navigation Study: Ecological Risk Assessment of the Effects of Incremental Increase of Commercial Navigation Traffic (25, 50, 75, and 100% Increase of 1992 Base line Traffic) on Submerged Aquatic Plants in the Main Channel and Main Channel Borders. U. S. Army Corps of Engineers, Rock Island District, September 2000. This report discusses the risk associated with commercial traffic on submerged aquatic plants in the main channel and borders of the Upper Mississippi River System.

Upper Mississippi River System-Environmental Management Program, Peoria Lake, Habitat Rehabilitation and Enhancement Project. U. S. Army Corps of Engineers, Rock Island District, July 1990. This EMP HREP is located downstream of the study area. Construction of this project enhanced migratory waterfowl habitat value by increasing the seasonal availability of reliable water, food resources, and resting, loafing, and nesting opportunities.

Peoria Riverfront Development, U. S. Army Corps of Engineers, Rock Island District, October 2003. T his IL Section 519 project is located downstream of the study area. This report discusses the potential habitat enhancement features along Farm Creek, with ancillary benefits to recreational boating and fishing.

SECTION 2 - PLAN FORMULATION

2.1. Description of the Study Process

Development of this Feasibility Study followed the Corps of Engineers' six-step planning process specified in *Engineering Regulation (ER) 1105-2-100*.

The process identifies and responds to problems and opportunities associated with the Federal objective and specified state and local concerns. The process provides a flexible, systematic, and rational framework to make determinations and decisions at each step. This allows the interested public and decision makers to be fully aware of the basic assumptions employed; the data and information analyzed; the areas of risk and uncertainty; and the significant implications of each alternative plan. As part of identifying the Recommended Plan, a number of Alternatives were developed and compared with the "No Action" alternative, allowing for the ultimate identification of the National Ecosystem Restoration (NER) Plan. The NER Plan reasonably maximizes ecosystem restoration benefits compared to costs, considering the cost effectiveness and incremental cost of implementing other restoration options. In addition to considering the system benefits and costs, the

NER will consider information that cannot be quantified, such as environmental significance and scarcity, socioeconomic impacts, and historic properties information.

The steps used in the plan formulation process are outlined below and presented in figure 2.

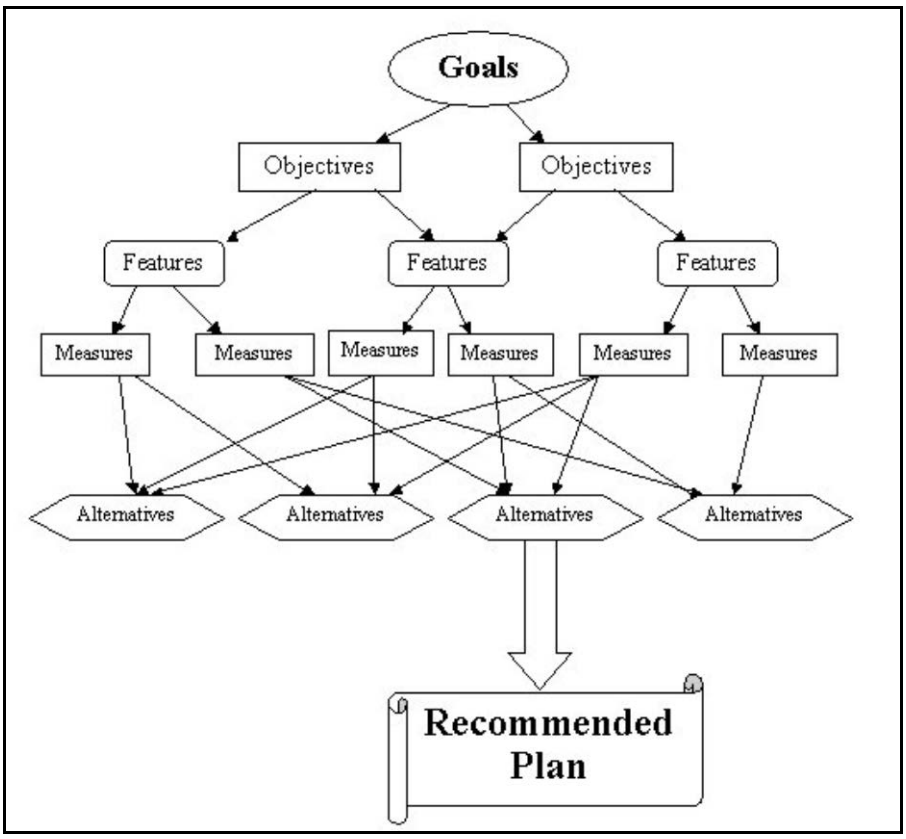


Figure 2. Schematic Diagram of Formulation Process

1. Identify Problems and Opportunities. The specific problems and opportunities are identified, and the causes of the problems discussed and documented. Specific goals and objectives to solve the identified problems are outlined.

2. Inventory and Forecast Resource Conditions. This step characterizes and assesses existing conditions in the study area and forecasts the most probable *future without-project condition*, also known as the *No Action Alternative*, over the period of analysis. The without-project condition describes the area and its uses as anticipated over a 50-year period of analysis without any restoration implemented as a result of this study. The with-project condition describes the area and its uses as anticipated if restoration measures are implemented. This assessment gives the basis by which to compare various Alternatives and their impacts.

3. Formulate Alternative Plans. Potential features are proposed to meet the identified objectives. Specific design measures are developed for these features. These measures are combined into Alternatives in a systematic manner to ensure that reasonable alternatives are evaluated.

4. Evaluate Alternative Plans. The evaluation of each alternative consists of measuring or estimating the environmental benefits, costs, technical considerations, and social and economic effects of each plan, and determining the difference between the without- and with-project conditions. A key measure for evaluation of Alternatives is a cost-effectiveness incremental cost analysis and evaluation of significance.

5. Compare Alternative Plans. Alternatives are compared, focusing on the differences among the plans identified in the evaluation phase and public comment. As part of the evaluations, the *Best Buy* plans—those plans that provide the greatest increase in benefits for the least increase in cost—are identified.

6. Select Recommended Plan. A Recommended Plan, or NER Plan, is selected. If a viable plan is not identified, the Recommended Plan will be the No Action Alternative. In most cases, the NER Plan will be selected from among the Best Buy plans and should be evaluated based on acceptability, completeness, effectiveness, and efficiency.

The PIR is organized to follow the planning process and therefore does not follow exactly the planning steps as they occurred. The planning process is iterative. As such, as additional information was learned in subsequent steps, it was necessary to revisit and repeat portions of the previous step(s).

2.2. Affected Environment

2.2.1. Resource History. The Illinois River has been an important environmental and social resource for thousands of years. Ecological response to the multiple and continued disturbances of the Illinois River has been well documented through time (see Starrett 1972, Sparks 1984, Theiling 1999, and USGS 1999 for comprehensive assessment), but is reviewed very briefly here for illustrative purposes.

The glacial origin of the Illinois River Valley promotes its alluvial characteristics. Alluvial filling over 18,000 years has created a low, flat floodplain that is quite oversized relative to the current river hydrology. The upper river including the Starved Rock study area has a steeper gradient but shares the alluvial characteristics of the lower valley.

Native cultures were well established and early explorers documented abundant fish and wildlife. The abundant fish and wildlife attracted settlers (Starrett 1972), commercial fishers (Fremling et al. 1989), shellers (Carlander 1954), and market hunters (Rahn 1983). Increasing human demands on the Illinois River began to change physical conditions which had repercussions on the river-floodplain ecosystem. The first substantial change was completion of the Illinois and Michigan (I&M) Canal which diverted small amounts of water to establish a shipping connection from Lake Michigan past the shallows of the upper Illinois River. The second major change was the completion of the Starved Rock L&D in 1933 (figure 3).

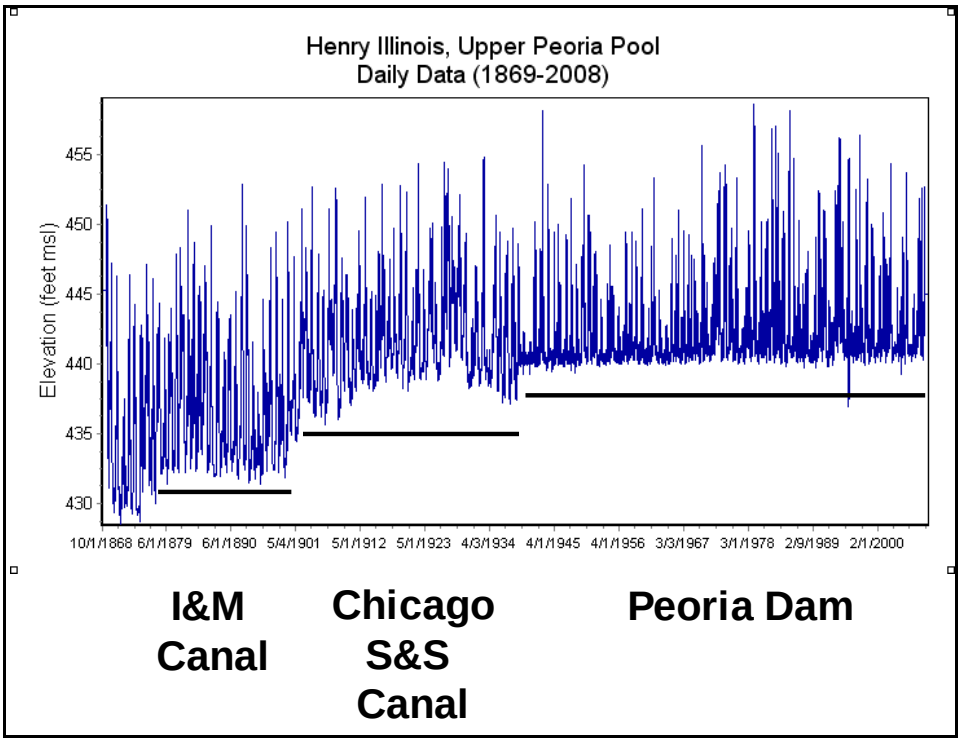
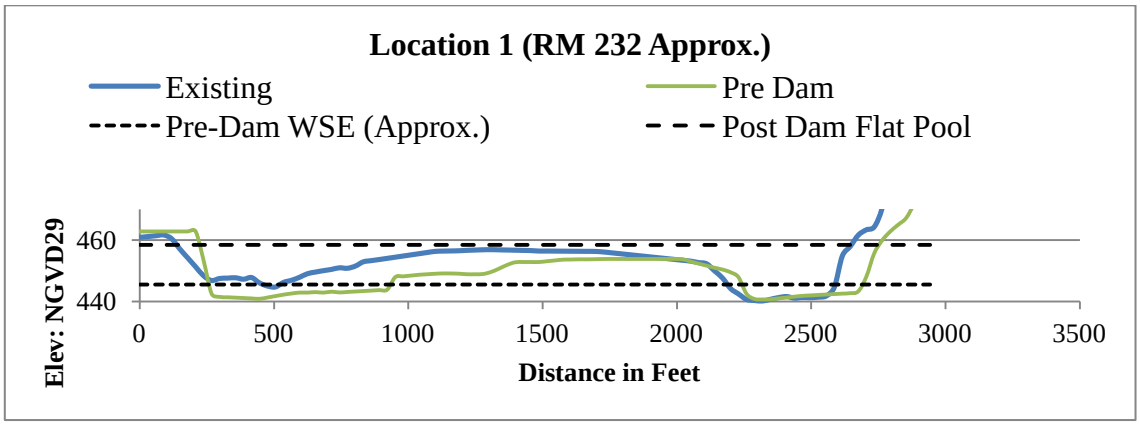


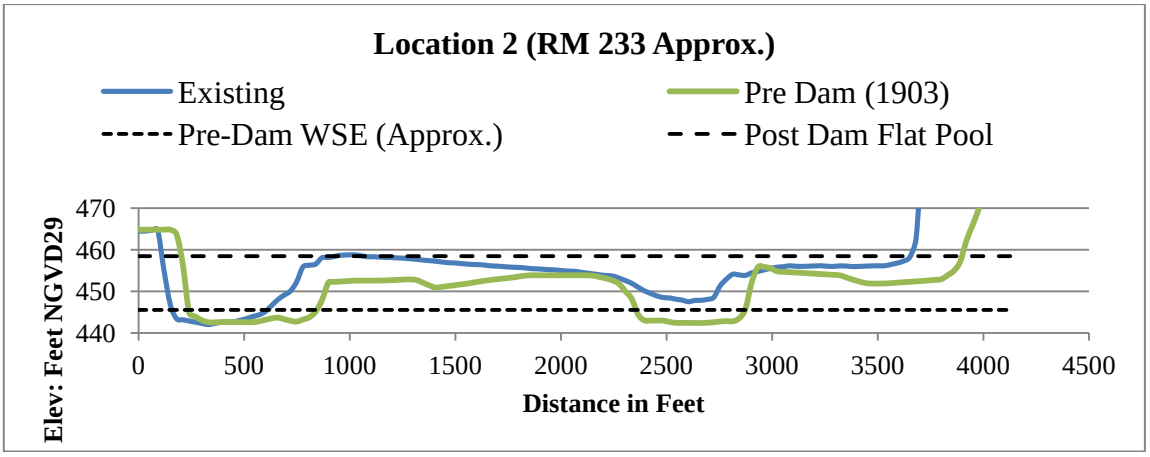
Figure 3. Changes in River Stage Relative to Development Including the Illinois & Michigan Canal, the Chicago Sanitary and Ship Canal, and the 9-Foot Channel Project.

The Starved Rock reach was transformed from two shallow firm substrate and sandbed channels surrounding a large terrestrial island to a large, open water channel border habitat when the L&D was put in. Physical effects included increased water depths by 17 feet at the L&D, decreased current velocity, island loss to inundation, channel border habitat creation, and a transformed sediment transport environment. Water depth over the island ranged from 1 to 5 feet deep (figure 4). Submersed aquatic plants colonized shallow areas to create valuable feeding and resting areas for migratory waterfowl for many years. High rates of sedimentation, sediment resuspension, and turbidity led to a significant decline in aquatic vegetation throughout the lower Illinois River since the 1960s (Sparks et al. 1990). Submersed aquatic vegetation was common in the project area until the 1990s when the effects of sedimentation, wind-wave sediment resuspension, and currents from the channel began to exceed SAV tolerance. Submersed aquatic plants are uncommon since the mid-1990s, and now only occurs when one of the environmental stressors (i.e., turbidity, current, waves, or herbivores) is alleviated.

Physical changes in the study area can be broadly represented by the degree of lateral hydraulic connectivity (Kondolf et al. 2006, Paillex et al. 2009, Elosegi et al. 2010) for several reference conditions (figure 5). The island and channel habitat in the pre-dam reference condition has low connectivity from the right descending bank to the left bank because the island separates the secondary channel and navigation channel. The post-dam 1939 reference as represented by the pool stage overlay on the pre-dam topography (Woerman maps 1903) and the existing bathymetry have high aquatic habitat connectivity. The post dam distance between river banks is five times greater than the pre-dam distance (figure 4).

Starved Rock Channel Profiles





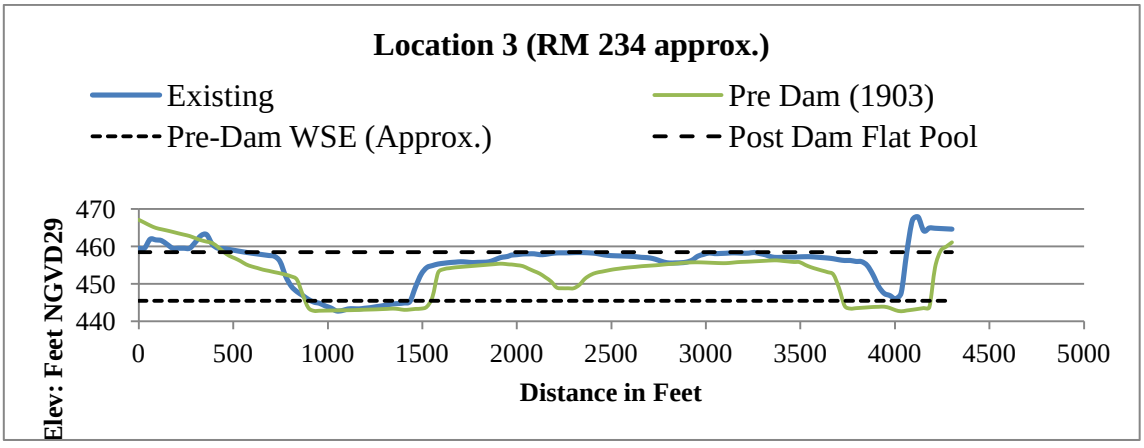


Figure 4. Schematic Representation of Pre-Dam, Post Dam, and Existing River Bed Elevations and River Stage in Starved Rock Study Area, Illinois River

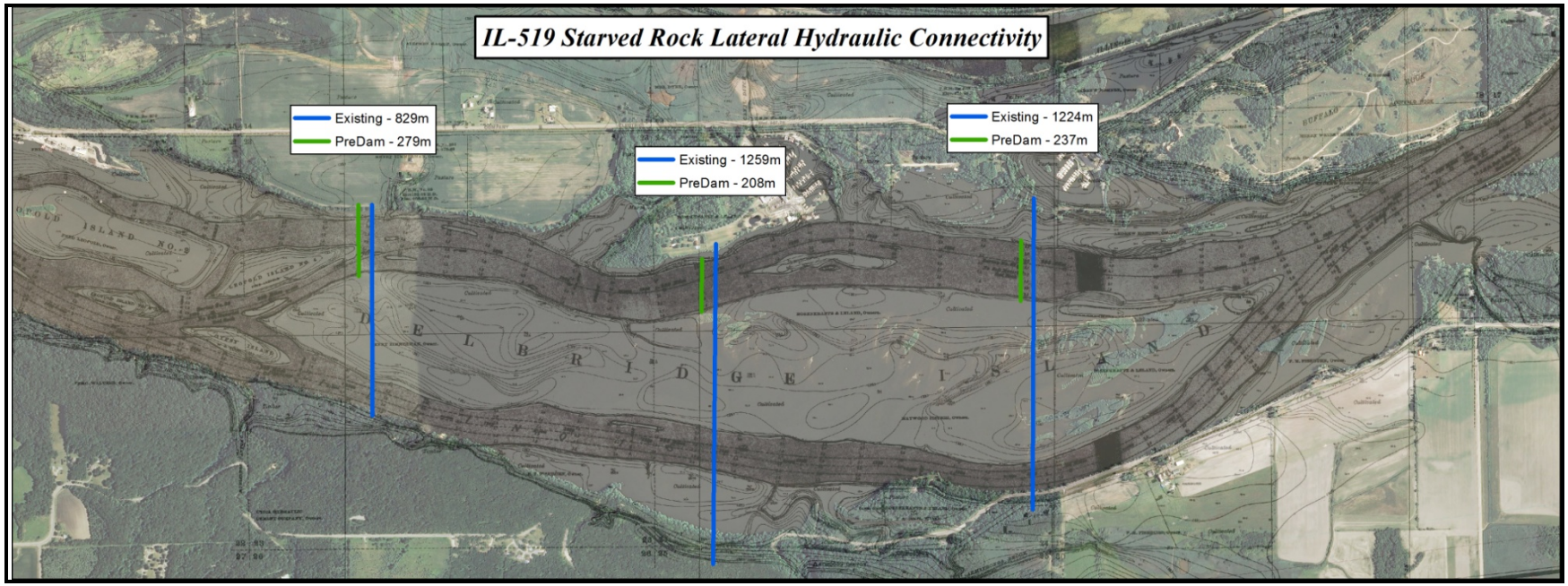


Figure 5. Lateral Hydraulic Connectivity Metrics for Pre-Dam and Existing Conditions

2.2.2. Hydraulics. The Starved Rock L&D is operated to provide a nine-foot navigation channel between RM 231 and RM 244.5 on the Illinois River. The Starved Rock L&D is located approximately 1. 8 miles downstream of the Project and was placed into operation in 1933. In addition, the L&D was authorized for hydropower generation in 1995.

The total drainage area of the Illinois River at Starved Rock L&D is 11,056 square miles. The Fox River, with a drainage area of 2,658 square miles, accounts for more than 95 percent of this area. It enters the Illinois River approximately 6 miles upstream of the Project.

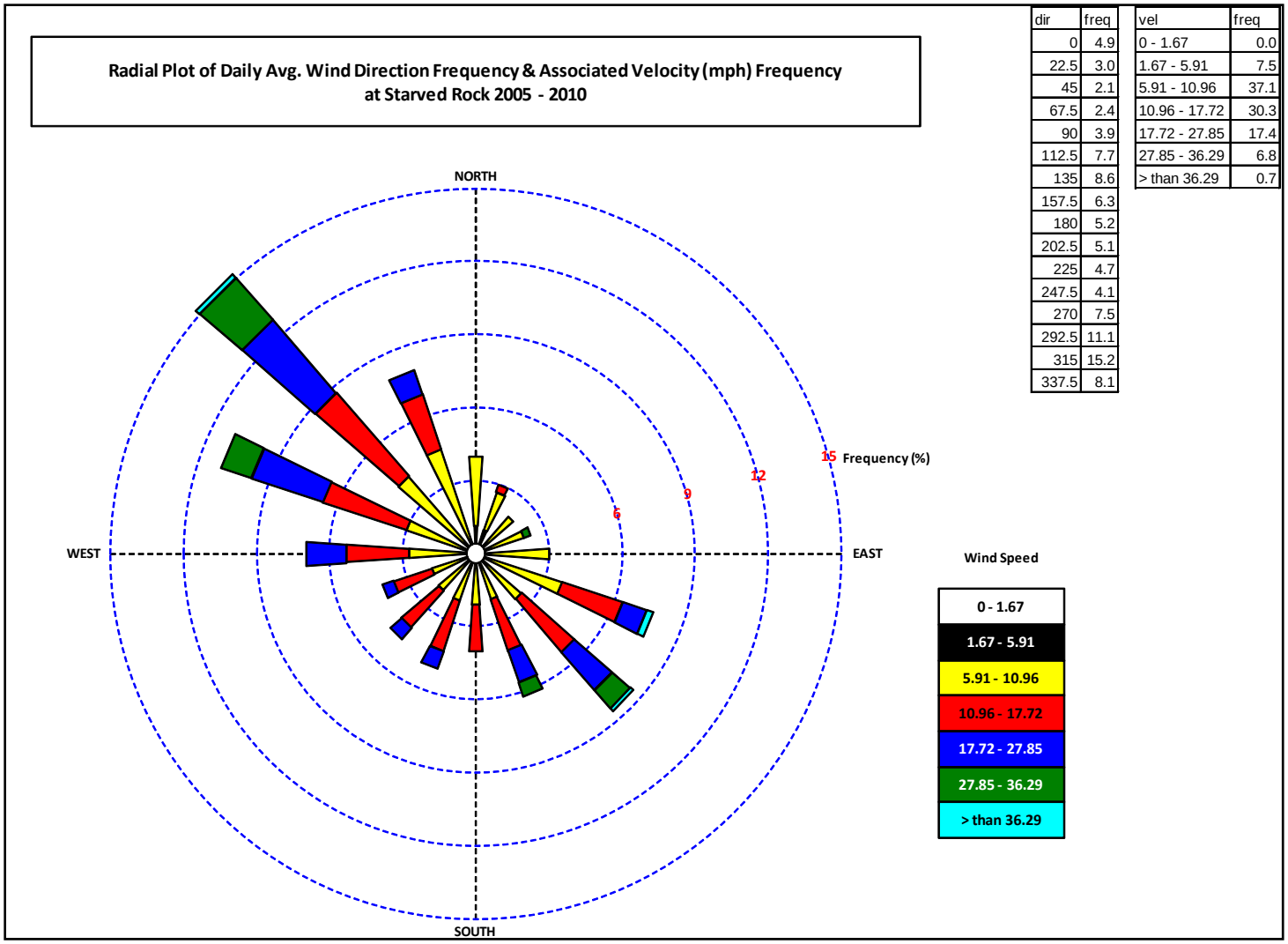
The Starved Rock Pool flat pool elevation is 458.52 feet NGVD 1929, all elevations referred to herein are NGVD 1929 datum, (tailwater flat pool of 440.3 29) and the L&D is operated to maintain a pool elevation between 458.75 feet and 458.95 feet in order to provide a nine-foot navigation channel between RM 231 and RM 244. 5 (Master Water Control Manual, Starved Rock Lock and Dam, USACE, 1996). The maximum pool elevation for navigation in Starved Rock Pool is 461.5 feet. The dam goes out of operation when the tail reaches an elevation of 460 feet and the pool is at 461.5 feet (1. 5 foot swell head).

The annual elevation-duration information at the Starved Rock Pool gage indicates a median river elevation of 458.8 feet (period of record 1980-2011). The water surface elevations in the lower reach of the pool are very stable. Significant precipitation events in northeast Illinois cause short periods of high water to occur. The 1 percent chance exceedance flood elevation is 468.0 at Starved Rock Dam/RM 231.1 (137,000 cfs). The highest flood (Pool) on record occurred on September 16, 2008 at a river elevation of 468.0 feet (from 2-hr. readings at Starved Rock Dam gage). This pool elevation was equivalent to a 1 percent annual exceedance probability (100-yr flood) stage.

The average annual flow of the Illinois River in Starved Rock Pool is 12,680 cubic feet per second. Flows rarely fall below 3,000 cfs because of the diversion from the Lake Michigan Basin. The maximum instantaneous flow at Starved Rock study area is estimated to have been 135,000 cfs on September 16, 2008 (slightly less than the 1 percent annual exceedance probability (100-yr flood) discharge). For additional detail, see Appendix H, Section 4.

2.2.3. Wind. The Starved Rock Pool open water condition is subject to wind generated waves. Wind speed and direction were monitored at two locations close to the Project area—at the Starved Rock L&D near RM 231.1 and on a small island near RM 233.4. Data were collected on the small island from August-October 2007 and compared to the L&D station data for the same time period. The results showed that the data collected from the dam was representative of the data collected from the island, which is closer to the proposed Project area. Since a longer period of record has been collected at the L&D and the two sites show very similar results, data from the L&D provide a better record of long-term wind patterns near the Project area.

Wind data collection efforts indicated that winds from the northwest and southeast are the most prevalent in the Starved Rock Pool, as shown in figure 6. In this reach, the river generally flows from east to west. The navigation channel flows along the northern edge of the pool, but the pool extends south of the navigation channel. Due to the large expanse of open water in this pool, fetch lengths in the study area, especially along lines from the east/west and east-southeast/west-northwest, can be as much as 2 to 3 miles.



dir	freq
0	4.9
22.5	3.0
45	2.1
67.5	2.4
90	3.9
112.5	7.7
135	8.6
157.5	6.3
180	5.2
202.5	5.1
225	4.7
247.5	4.1
270	7.5
292.5	11.1
315	15.2
337.5	8.1

vel	freq
0 - 1.67	0.0
1.67 - 5.91	7.5
5.91 - 10.96	37.1
10.96 - 17.72	30.3
17.72 - 27.85	17.4
27.85 - 36.29	6.8
> than 36.29	0.7

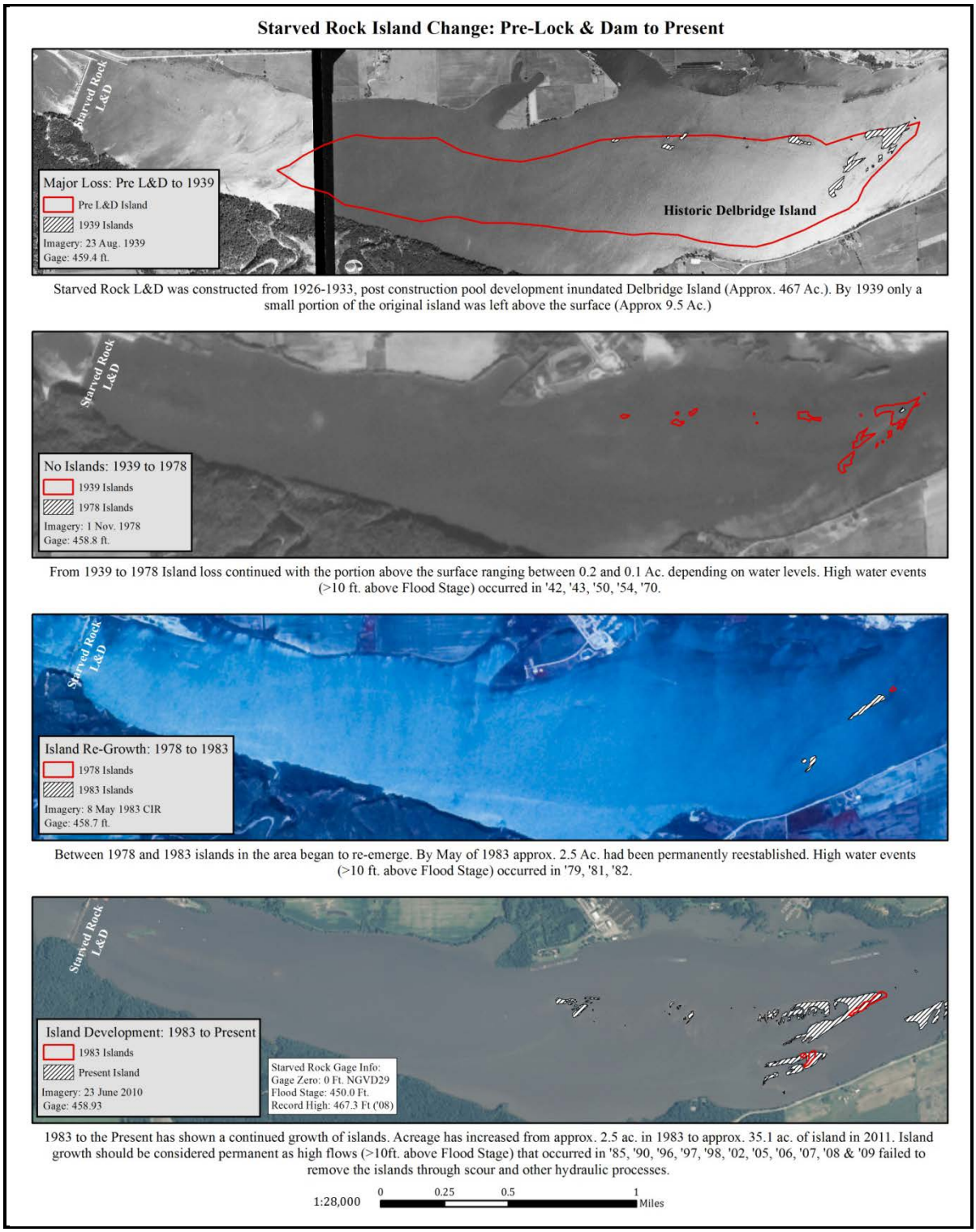
Figure 6. Wind Speed and Direction from Starved Rock Lock and Dam, 2005-2010

2.2.4. Waves. Wave heights of up to 2 to 3 feet are experienced in the pool due to wind and vessel wakes (Mark Witalka, personal communication, January 11, 2013). Although wind-generated waves can affect the study area over a longer period of time than recreational boat and navigation tow-induced waves, vessel waves likely have a larger impact on the area. In addition to producing higher wave heights, vessel waves can extend deeper into the water column and likely create high velocities and turbulence in the shallow study area (Tom Gambucci, personal communication, December 3, 2012).

2.2.5. Ice. Starved Rock Pool typically experiences heavy ice buildup during the winter. It is not uncommon for the ice coverage in Starved Rock Pool to extend all the way up to Marseilles Lock, a distance of approximately 13.5 miles, with 100 percent coverage. Ice formation in the pool depends on the winter (Mark Witalka, personal communication, January 11, 2013). Ice can form in large sheets covering the pool. Ice thickness in the Starved Rock Pool can grow to 1 ft or more. Because of a dam on the Fox River, broken ice enters from this tributary and can break up ice sheets in the pool (Kathy Higdon, personal communication, December 17, 2012). Tow traffic keeps ice broken up as well.

2.2.6. Sedimentation. Before impoundment of Starved Rock Pool in 1933 there were several additional islands in between the current navigation channel and left descending side channel, from RM 231.1 to RM 235. Results from an aerial photo analysis illustrate some historic and more recent changes to island areas within the Project area. Figure 7 shows the submergence of Delbridge Island after impoundment in 1933. From 1978 to 1983, there was a small amount of island re-growth. Over the past few decades, sediment has been aggrading in the Project area within Starved Rock Pool. From 1983 to present, there have been approximately 32. 5 acres of additional island growth and this trend seems to be continuing. Island growth is expected to continue immediately upstream of the Project area and is thought to occur in this area due to recent flood events. A vegetated island just upstream of the dam has also formed in recent years.

The navigation channel maintained by the Corps is 300 feet wide (U. S. Army Corps of Engineers, 1996). Channel maintenance is a continuing effort and has been performed throughout the 13.5 river miles in the Starved Rock Pool. However, there is only one area since 2006 between RM 231.1 and RM 235 that has required dredging in the navigation channel. It is located approximately between RM 232.2 and RM 232.7 (Figure 8).



Starved Rock L&D was constructed from 1926-1933, post construction pool development inundated Delbridge Island (Approx. 467 Ac.). By 1939 only a small portion of the original island was left above the surface (Approx 9.5 Ac.)

From 1939 to 1978 Island loss continued with the portion above the surface ranging between 0.2 and 0.1 Ac. depending on water levels. High water events (>10 ft. above Flood Stage) occurred in '42, '43, '50, '54, '70.

Between 1978 and 1983 islands in the area began to re-emerge. By May of 1983 approx. 2.5 Ac. had been permanently reestablished. High water events (>10 ft. above Flood Stage) occurred in '79, '81, '82.

1983 to the Present has shown a continued growth of islands. Acreage has increased from approx. 2.5 ac. in 1983 to approx. 35.1 ac. of island in 2011. Island growth should be considered permanent as high flows (>10ft. above Flood Stage) that occurred in '85, '90, '96, '97, '98, '02, '05, '06, '07, '08 & '09 failed to remove the islands through scour and other hydraulic processes.

Figure 7. Geomorphic Change since Impoundment in Starved Rock Pool

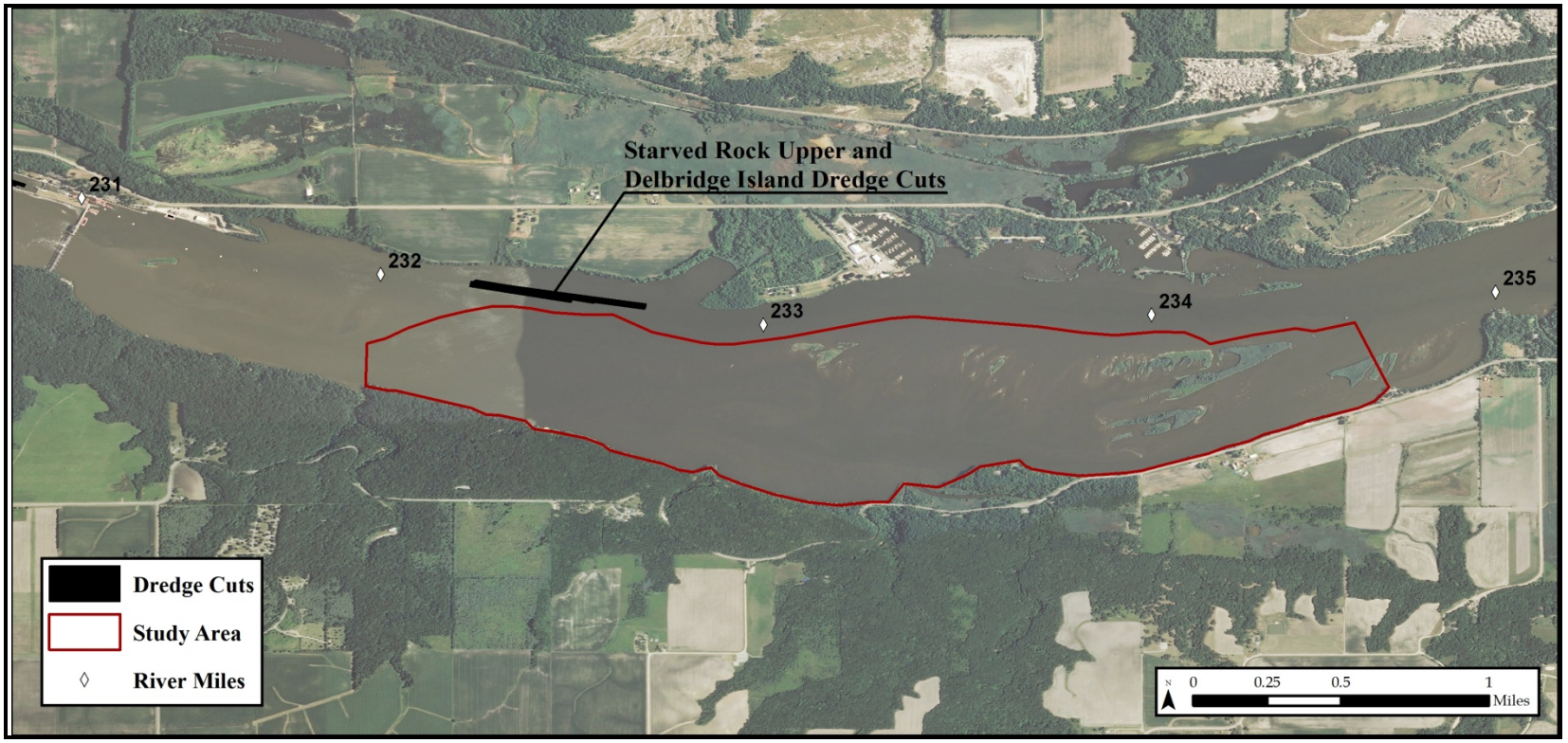


Figure 8. Dredge Cuts Near Project Area

Sedimentation in the Project area seems to be continuing to shift toward a more uniform depth through sediment focusing (scouring of higher elevations and deposition of lower elevations). When Delbridge Island was inundated in 1933 there were high ridges and low swales providing depth diversity and new aquatic habitat. Since impoundment, lower elevations within Delbridge Island have seen deposition and higher elevations have changed locations in response to altered hydrodynamics as shown in figure 4.

Survey transects and sediment samples collected in 2013 within the Project area indicate that the near-surface material closer to the navigation channel contains a greater amount of sands/bedload-type material, with gradually increasing fines-content as you move toward the left descending side channel. Sands are dropping out of suspension at the channel margin and finer sediments are transported laterally across Delbridge Island. It is believed that erosion resulting from wind and navigation-induced waves as well as high water events is moving some of the bedload from the navigation channel laterally into the middle portion of the pool. Qualitative sedimentation analysis indicates an equilibrium condition or slight sedimentation in the region which may be balanced by scouring flows during floods or more frequent vessel-induced currents.

2.2.7. Water Quality. Several authors have documented the poor water quality of the Illinois River during the early part of the 20th century (Mills et al., 1966, starrett 1972, Sparks 1984, and Lerczac et al., 1994; Greenfield et al., 1925). The Upper Illinois River was so polluted by 1912 that it was practically devoid of all fish life. The river carried waste equivalent to the volume produced by 6.2 million people in 1922. Parts of the river were hypoxic (i. e., almost totally devoid of oxygen), especially in the summer months (Chicago Metropolitan Water Reclamation District).

2.2.8. Water Quality Sampling. During the summer months of 2007 and 2008, water quality monitoring was performed at two sites in Starved Rock Pool in order to establish pre-Project baseline data. Site SR-1 is located closer to the study area approximately near RM 233, and Site SR-2 is located further downstream approximately near RM 231.6, as shown in figure 9. Parameters measured include: weather conditions, depth, light penetration, dissolved oxygen (DO), pH, water temperature, specific conductance, chlorophyll, total suspended solids, soluble organic carbon, turbidity, transparency tube, and Secchi disk depth.

Analytical results of grab samples and field measurements taken at sites SR-1 and SR-2 are discussed in detail in Appendix F, *Water Quality*. Instantaneous field measurement data of Secchi disk depth, turbidity and total suspended solids for sites SR-1 and SR-2 are shown in tables 1a and 1b, respectively. Instantaneous field measurements of light intensity at sites SR-1 and SR-2 were used to compute light extinction coefficients (K_d), which are also shown in the tables 1a and 1b.

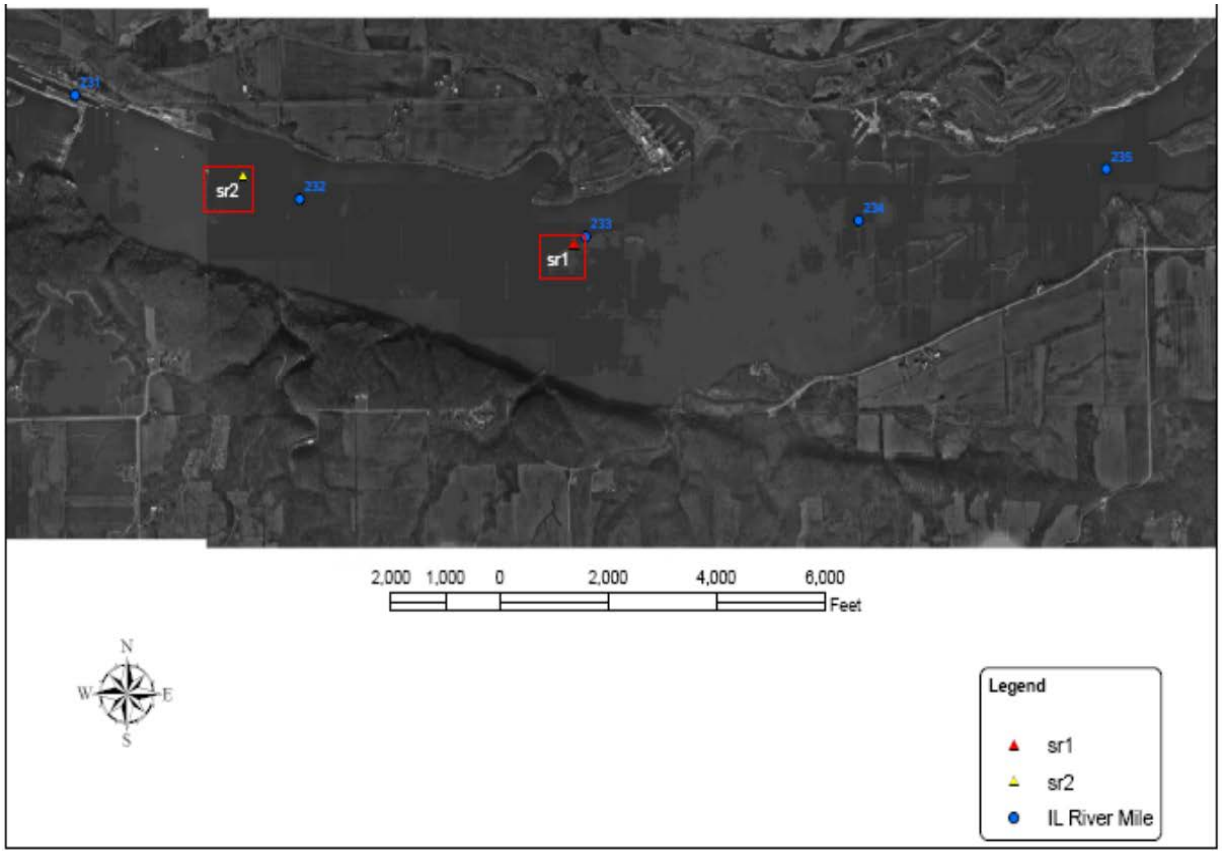


Figure 9. Starved Rock Pool Water Quality Monitoring Sites

Table 1a. Water Quality Monitoring Data for Site SR-1

	Secchi (cm)	**TSS (mg/l)**	**Turbidity (NTU)**	**K_d (m^{-1})**
Mean	47.3	32	21.	3.43
Min.	38.0	15	8.2	2.08
Max.	53.3	86	56.8	6.78

Table 1b. Water Quality Monitoring Data for Site SR-2

	Secchi (cm)	**TSS (mg/l)**	**Turbidity (NTU)**	**K_d (m^{-1})**
Mean	54.4	25	17.2	3.32
Min.	45.0	12	8.2	2.07
Max.	59. 0	96	50.1	6.93

Continuous monitoring field measurements were generally consistent with a productive, nutrient enriched waterway, including significant diurnal swings in DO (supersaturated concentrations were common) and relatively high pH values. Turbidity was positively correlated with flow and light extinction coefficients and negatively correlated with DO and pH. In a 2003 UMR Conservation Committee Report criteria necessary for sustaining SAV in the UMRS were identified as TSS<25 mg/l, Turbidity < 20 NTU, light extinction< 3. 42 m^{-1}, Secchi disk depth >0.5m).

2.2.9. Subsurface Soil Characterization. The Corps conducted subsurface exploration to characterize the composition and engineering properties of soils present at the study area. Borings were taken at locations shown on Plate 5. All subsurface exploration was done in accordance with Engineer Manual 1110-1-1804. Subsurface exploration was done at two different time periods; 14 hand auger borings were taken during October 2011 and February 2013. The borings were generally 7 to 8 ft deep into the river bottom. An additional 10 samples were taken from the interior area of the Project in February 2013.

Samples taken from borings along the left descending edge of the submerged Delbridge Island were generally found to be firm sandy lean to medium clays (CL and CL-CH), overlain by approximately 1 ft of soft sediments. Soils located at and near the surface contained within the interior of the Project area were generally sandy to clayey-sands to the depth of 1-3 feet, underlain by sandy clays (Appendix G).

2.2.10. Aquatic Vegetation. Submersed aquatic vegetation (SAV) is an important indicator of the ecological health of the impounded river reaches of the Illinois River. SAV provides food and structure for invertebrates, fish and waterfowl, and also serves an important function in recycling nutrients (USGS 1999).

Historically, numerous areas along the Illinois River provided suitable conditions for SAV growth. The expanded backwaters and channel borders were vegetated with about 50 percent cover of pondweeds (*Potamogeton sp*), hornwort *(Ceratophyllum sp*), bulrush (*Scirpus sp),* and wild celery (*Vallisneria)* (Sparks 1984) until organic pollution effects, between 1916 and 1922, resulted in the severe decline of aquatic plants. A majority of this was recovered from a positive response to early waste treatment efforts (Starrett 1972). From 1958 to 1961, increases in turbidity and sediment resuspension led to a further decline in aquatic vegetation in the Illinois River (Sparks *et al*. 1990). Although water quality in the Illinois River has improved significantly since the 1970s, SAV has not returned to most parts of the river. In the lower Illinois River, most SAV beds are currently located in isolated floodplain areas. In the upper Illinois River, persistent SAV beds occur primarily in Dresden pool, approximately 40 RM's upstream of the Project area.

Although declined, persistent beds of SAV occurred in the Starved Rock study area as late as the early 1990s (Tom Beissell, IL DNR, Sterling, Illinois, personal communication, LTRMP 1989 and 2000 land cover database). Changes in physical conditions such as sedimentation and low light transparency caused a system-wide decline in submersed plants in most of the UMRS during the early 1990s (Rogers 1994, Fischer and Claflin 1995). With thresholds surpassed in Starved Rock pool SAV beds collapsed.

Since its collapse, positive SAV response has been detected when any single stressor is released as occurs during drought, herbivore exclosure experiments (Sass 2009), or navigation system closure. The last formally sampled occurrences of SAV were captured by the aerial photos and subsequent land cover maps developed through the UMRR – EMP for 1989, 2000, and 2010 (figure 10). Approximately 60-80 acres of SAV has been recorded during these infrequent occurrences.

Several of the physical factors affecting plant growth are at or near their maximum tolerance thresholds in Starved Rock Pool (see section 2.2.8). Depths and substrates over most of the study area are suitable for SAV to occur under most light conditions. High current velocity and wind-generated waves, however, add additional stressors with regard to tearing plant stems or sheering roots from the substrate. Seasonally high turbidity can also limit SAV distribution and abundance if low water clarity

in the spring prevents SAV germination. Lastly, grazing pressure from herbivores like Canada geese and grass carp can stunt SAV growth and physical disturbance from foraging European carp can uproot SAV.

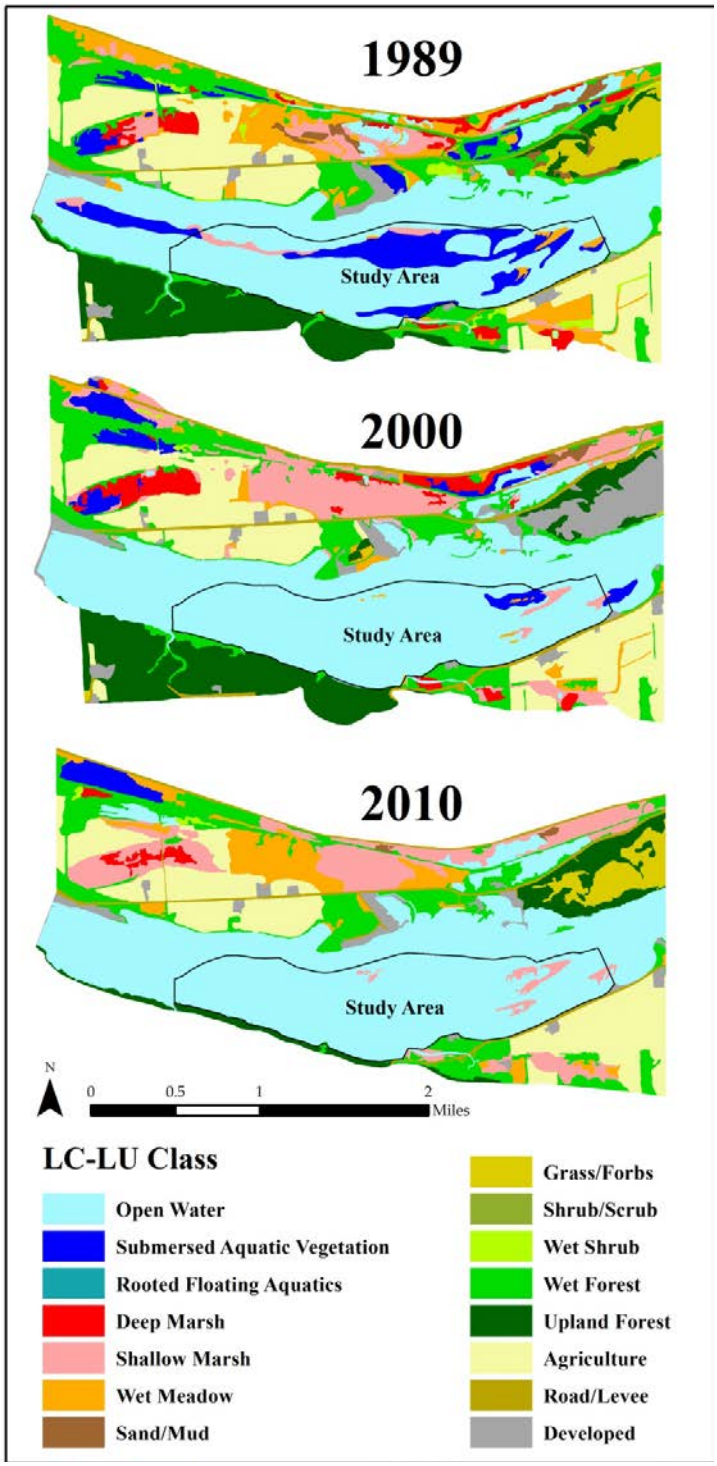


Figure 10. Areas of Submersed Aquatic Vegetation

2.2.11. Fishery Resources. Despite the severe pollution that occurred during much of the 19th and 20th centuries, water quality in the Illinois River has improved primarily as a result of the Clean Water Act, and the biota has at least partially recovered. Lerczak et al. (1994) compared the results of fish collected from the Illinois River in 1963 to those collected in 1992 and determined that the river now supports a much healthier fish population than it did in the 1960s. The earlier collection was dominated by pollution-tolerant, nonnative species such as carp and goldfish. Recent collections included a more balanced population of native species. The improvement was most evident in the Illinois River above the Starved Rock Lock and Dam, at which 95. 8 percent of the fish collected in 1963 consisted of only four species. In 1992, 13 species comprised 95. 4 percent of the fish collected, and the pollution-tolerant, non-native species were reduced to a minor component of the collection. Lerczak et al. (1994) also noted that the occurrence of external abnormalities, such as sores and tumors, was much lower in 1992 compared to 1963. A key to the improvement in the ecological conditions has been the increase in dissolved oxygen.

In general, the study area can be described as shallow channel border habitat lacking aquatic vegetation. Water quality is generally acceptable for adult bluegills, but current velocity exceeds optimum levels (tables 1a and 1b) for rearing centrarchids depending on river discharge during early summer. High spring discharge coincides with spawning season and reduces spawning habitat quality. The lack of structure and potential for current and wind- or boat-generated waves further limits spawning habitat potential.

2.2.12. Mussel Resources. There are currently 10 known mussel species living in Starved Rock Pool. Historically a mussel bed has been recorded along the shore of the right descending bank near RM 233. Adults and juvenile mussels comprising common species were recorded during the 1997 survey as shown below. The historic bed is outside of the project area and would not be influenced by the potential project features. Within the project footprint high quality mussel habitat is not likely.

Species	Common Name
Potamilus ohiensis	pink papershell
Leptodea fragilis	fragile papershell
Actinonaias ligamentina	mucket
Pyganodon grandis	giant floater
Lasmigona complanata	white heelsplitter
Arcidens confragosus	rock pocketbook
Anodonta suborbiculata	flat floater
Quadrula pustulosa	pimpleback
Quadrula quadrula	mapleleaf
Amblema plicata	threeridge

2.2.13. Waterfowl The value of the Illinois River Valley to migratory waterfowl has been widely documented. A survey conducted by the Illinois Natural History Survey (INHS) in the fall of 1994 found that 81 percent of the fall waterfowl migration in the Mississippi Flyway utilized the Illinois River. Approximately 20 species of waterfowl, primarily ducks and geese, make their home in the Illinois River Basin. As indicated in figure 11, duck numbers have declined significantly since the 1950s. These declines have been linked to the loss of the emergent and submergent aquatic plant beds and a decline in fingernail clams, a major dietary component. (Mills et al., 1966; Sparks 1984)

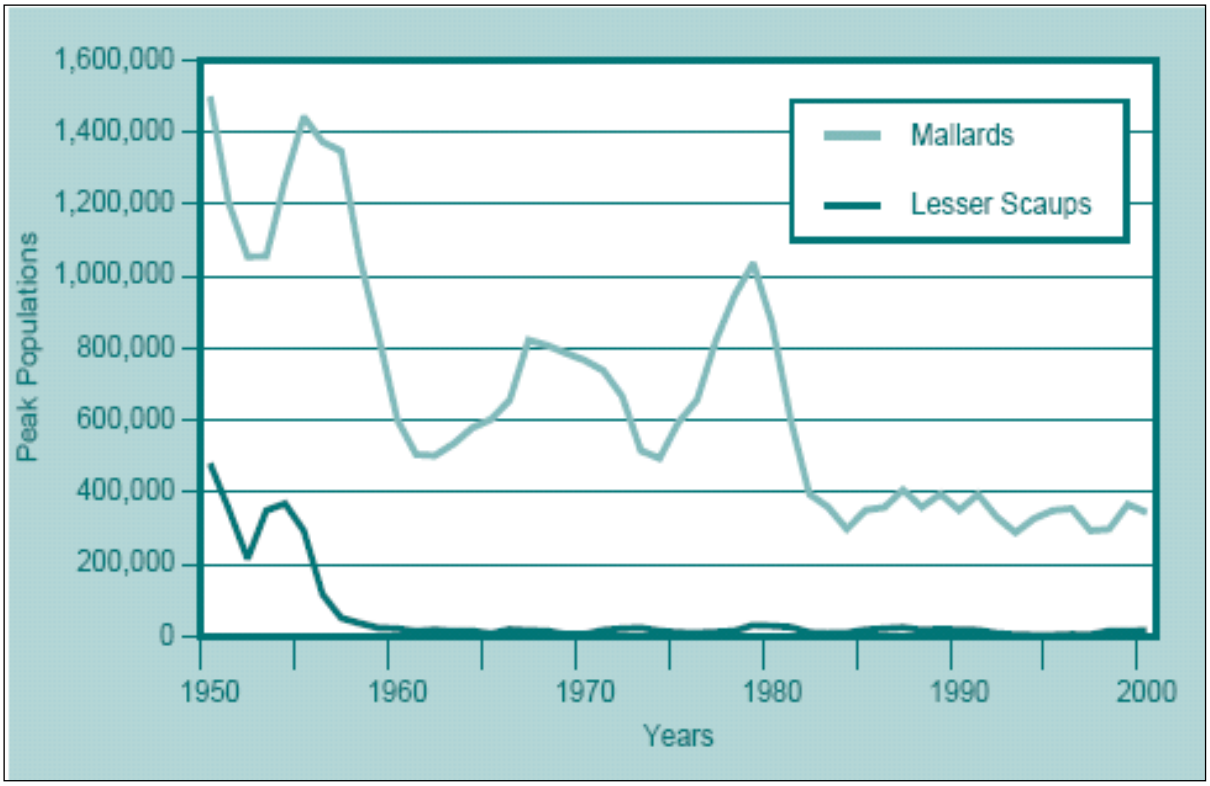


Figure 11. Three Year Moving Average of the Peak Numbers of Mallards and Lesser Scaups in the Illinois River Valley During the Fall, 1950-2000 (INHS).

The most important SAV species for migratory diving ducks are sago pondweed (*Potamogeton pectinatus)*, pondweeds (*Potamogeton spp.*), wildcelery (*Vallisneria americana*) and coontail (*Ceratophyllum demersum*). In addition, feeding habits of diving ducks are adapted more to deeper water depths. Redheads and ring-necked ducks will feed as dabblers in shallower water (1-2 feet in depth) while scaup and canvasback generally feed more by diving (Bellrose 1980). An area that would be suitable for all species of diving duck would have a range of water depths from 18 inches to 6 feet (Diving Duck Migratory Habitat Model, USACE).

A majority of mallards in the US use the UMR flyway and stay an average of 28 days on traditional fall migration areas in Illinois. Mallard display an area of activity around each migration area of approximately 30 miles. Consequently, waterfowl refuges used by migrating birds should be about 50 miles apart. There are several large waterfowl refuges along the Illinois River including Lake Chautauqua (USFWS), Banner Marsh (USFWS), Hennepin and Hopper Lakes (Private), the Emiquon Preserve (TNC), and numerous others operated by the State of Illinois, such as the Marshall-Woodford State Fish and Wildlife, located approximately 50 miles downriver from the Starved Rock project area. Most of these areas are located downstream of Peoria Lake, where the Illinois River floodplain is broad and expansive, or in moist soil management areas.

The current habitat available for migratory waterfowl in Starved Rock Pool is limited. There is a large expanse of shallow open water habitat directly upstream of the lock and dam, but the area does not currently support aquatic vegetation, therefore, there is minimal food available for migratory waterfowl.

2.2.14. Shorebirds. Starved Rock Pool is mostly channel and deep aquatic habitat not suitable for shorebirds. Interior wetlands and mudflats on Delbridge Island may have supported shorebirds in the past, and opportunities for shorebirds will increase with continued growth of emergent islands in the future.

2.2.15. Wading Birds. Starved Rock Pool is mostly channel and deep aquatic habitat not suitable for wading birds. Interior wetlands and mudflats on Delbridge Island may have supported wading birds in the past, and opportunities for wading birds will increase with continued growth of emergent islands in the future.

2.2.16. Endangered Species. The USFWS has identified the Indiana bat *Myotis sodalis*, prairie bush clover *Lespedeza leptostachya*, eastern prairie fringed orchid *Platanthera leucophaea*, decurrent false aster *Boltonia decurrens*, and sheepnose mussel *Plethobasus cyphyus* as federally-endangered, threatened, or candidate species in LaSalle County, Illinois (table 2a). While these species have the potential to occur in LaSalle County, there is no suitable habitat for the Indiana bat, eastern prairie fringed orchid, and prairie bush clover. No presence of decurrent false aster was noted in the project area. The sheepnose mussel was historically known to occur in the Illinois River however there are no known mussel beds within the project area.

Table 2a. Federally-listed Species for LaSalle County

Mammals			
Indiana bat	*Myotis sodalis*	Endangered	Caves, mines (hibernacula); Small stream corridors with well developed riparian woods; upland forests (foraging)
Mussels			
Sheepnose mussel	*Plethobasus cyphyus*	Endangered	Rivers
Plants			
Eastern prairie fringed orchid	*Platanthera leucophaea*	Threatened	Mesic to wet prairies
Prairie bush clover	*Lespedeza leptostachya*	Threatened	Dry to mesic prairies with gravelly soil
Decurrent false aster	*Boltonia decurrens*	Threatened	Disturbed alluvial soils

State Threatened or Endangered Species. In addition to federally-listed species, the IL DNR identified state threatened or endangered species that have the potential to occur within LaSalle County, Illinois (table 2b). The greater redhorse and river redhorse may indirectly benefit from the Project, although the shallow aquatic habitat is not their preferred habitat type.

Table 2b. State of Illinois-listed Species for La Salle County

Mammals		
Gray Bat	*Myotis grisescens*	Endangered
Indiana Bat	*Myotis sodalis*	Endangered
Birds		
Henslow's Sparrow	*Ammodramus henslowii*	Threatened
Cerulean Warbler	*Dendroica cerulea*	Threatened
Loggerhead Shrike	*Lanius ludovicianus*	Threatened
Upland Sandpiper	*Bartramia longicauda*	Endangered
Reptiles		
Timber Rattlesnake	*Crotalus horridus*	Threatened
Blanding's Turtle	*Emydoidea blandingii*	Threatened
Four-toed Salamander	*Hemidactylium scutatum*	Threatened
Fish		
Banded Killifish	*Fundulus diaphanus*	Threatened
River Redhorse	*Moxostoma carinatum*	Threatened
Greater Redhorse	*Moxostoma valenciennesi*	Endangered
Mussels		
Slippershell	*Alasmidonta viridis*	Threatened
Insects		
Regal Fritillary	*Speyeria idalia*	Threatened
Plants		
Shadbush	*Amelanchier sanguinea*	Endangered
Forked Aster	*Aster furcatus*	Threatened
Decurrent False Aster	*Boltonia decurrens*	Threatened
Fibrous-rooted Sedge	*Carex communis*	Threatened
Plantain- leaved Sedge	*Carex plantaginea*	Endangered
Bunchberry	*Cornus canadensis*	Endangered
Golden Corydalis	*Corydalis aurea*	Endangered
Pink Corydalis	*Corydalis sempervirens*	Endangered
Hemlock Panic Grass	*Dicanthelium portoricense*	Endangered
Spike	*Elliptio dilatata*	Threatened
Queen-of-the-prairie	*Filipendula rubra*	Endangered
Hairy Woodrush	*Luzula acuminata*	Endangered
Long Beech Fern	*Phegopteris connectilis*	Endangered
Red Pine	*Pinus resinosa*	Endangered
Weak Bluegrass	*Poa languida*	Endangered
Red-berried Elder	*Sambucus racemosa ssp. pubens*	Endangered
Cliff Goldenrod	*Solidago sciaphila*	Threatened
Snowberry	*Symphoricarpos albus var. albus*	Endangered
American Brooklime	*Veronica americana*	Endangered

2.2.17. Invasive and Exotic Species. Starved Rock Pool is subject to several invasive species moving between the Great Lakes and Illinois River (Veraldi et al. 2012). Asian and European carp are the most prominent exotic fish species, but round gobies and white perch are also invading the region from the Great Lakes. Starved Rock Pool is the "leading edge" of the movement of massive Asian carp populations toward Lake Michigan. Massive amounts of Asian carp are being removed by

commercial fishers from this site as a control measure, but the effects on total population size are minimal. Ecosystem restoration is unlikely to affect invasive species, but may help native species compete more effectively.

The plankton eating big head and silver carp do not upset SAV growth and while the Asian grass carp eat plants and have inhabited the Illinois River since the 1970's they are not expected to impact the project since their abundance isn't known to be sufficient enough to impede SAV growth. This is evident based on the periodic episodes of SAV growth that have occurred on the Illinois River where herbivory conditions haven't changed.

Phragmites is an aggressive invasive plant colonizing new island habitat. Local fisheries managers observe large mats of reeds falling into the river to trap sediment and increase island growth.

Natural resource 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.

2.2.18. Hazardous, Toxic, and Radioactive Waste (HTRW). There is a history of contamination from industrial activities in Starved Rock Pool. The Bull's Island Phase I Environmental Site Assessment identified several sites in Ottawa and the surrounding area. Some fisheries biologists have noted that bottom-dwelling fish in the area have lesions on their scales and/or barbels, which may indicate contaminated sediment. A contract to prepare a Phase I Environmental Site Assessment was done in FY07. No additional investigation is necessary since river sediments are not being moved or disturbed.

2.2.19. Public Use. The study area is heavily used by the public for recreational purposes. Water based activities dominate recreation use, with boating, boat fishing, hunting and sightseeing being the most popular activities. There are duck hunting blinds, two marinas (north), and Starved Rock State Park (south) all less than a mile away from the study area. Starved Rock State Park was voted the number one attraction in Illinois for 2012 and on average has between 1,500,000 and 2,000,000 visitors per year. Some of the main activities the park highlights are fishing, boating, hiking, camping, and cross country skiing. Also upstream of the Project area is Buffalo Rock State Park, located approximately 3 miles west of Ottawa in LaSalle County. This 298 acre park offers picnicking, trails, and camping.

Based off of 2011 data provided from the Starved Rock L&D there were 2,537 commercial vessels, 1,201 recreational vessels, and 321 others that went through the lock. These numbers do not include the boats, personal watercraft, and other vessels that launch at the marinas or at the Starved Rock State Park boat ramp that did not lock through the lock and dam.

2.2.20. Historic and Cultural Resources. The District archeological site and survey Geographic Information Systems (GIS) databases indicated that there are approximately 60 previously recorded archaeological sites within a mile of the study area. There are four previously conducted cultural resource surveys within a mile of the study area. None of the surveys or sites is located within or adjacent to the current study area. In addition, there are no shipwrecks identified in the vicinity of the Project.

The Project footprint is in the location of the submerged Delbridge Island. Though Delbridge Island was inundated prior to the time archaeological sites were recorded, it was thought there would be a strong likelihood that archaeological deposits were present on the island. However, based on the auger probes used for geotechnical analysis of the river bed, it is the opinion of the District that little integrity remains as a result of the inundation and scouring of the surface of the former Delbridge Island.

2.2.21. Future Without-Project Conditions. Future without project (FWOP) conditions for the Starved Rock study area are expected to remain as shallow open water habitat with little diversity or growth of aquatic vegetation except during drought conditions or navigation closures. It is likely that sedimentation will continue in the lower pool, resulting in continued growth of the fluvial delta islands forming at the upstream end of the study area. Based on analysis of historic and existing aerial imagery, the average rate of growth at Delbridge Island is approximately 1 acre per year in the "crab claw" form typical of UMRS islands. Island growth will reduce the areas available for SAV over 100 years or more, but SAV abundance is anticipated to stay constant as SAV beds get redistributed in response to sedimentation. Wind generated waves and waves from towboats and recreational boats are expected to stay the same or increase. With all of these factors considered, it is likely that SAV will not occur on a permanent basis in Starved Rock Pool.

Bluegill rearing habitat is nonexistent now. Island growth will increase the amount of low current velocity areas, but this will occur in small patches inside and between islands. Migratory waterfowl resources and available habitat will stay the same or increase slightly as more land is developed in the area if beneficial emergent plant communities colonize island shorelines. Recent experience indicates, however, that the aggressive invasive plant *Phragmites australis* (i. e., common reed) has colonized developing islands and contributes to their increased growth by trapping sediment and adding significant biomass without adding nutritional value.

2.2.22. Problems and Opportunities. Human activity over the past two centuries within the Illinois River basin, floodplain, and channel has altered the hydrology, topography, and biotic communities historically present in the study area. These alterations have reduced native plant and animal populations, degraded the quality of remaining natural resources and plant communities, impaired ecosystem functions, and threaten the future sustainability of the river-floodplain ecosystem.

PROBLEM: Decreased Reliability of Aquatic Vegetation . SAV occurrence is sporadic and related to events that change turbidity, current velocity, or grazing pressure. SAV was present during 1989 and 2012 droughts which typically have low turbidity, low current velocity and stable water levels. SAV also appeared in 1993 during a navigation closure that reduced current velocity over the site and reduced sediment resuspension. In an experimental setting, aquatic plants colonized cages that excluded grazers and other physical disturbances (Sass 2008).

OPPORTUNITY: Although the exact combination of conditions favoring the growth of SAV in Starved Rock Pool is not known, periodic occurrence of SAV when stressors are released suggests that a restoration project could improve conditions in the study area for SAV.

PROBLEM: Loss of Migratory Waterfowl Habitat. Duck numbers on the Illinois River have declined significantly since the 1950s. These declines have been linked to the loss of aquatic plant beds and a decline in fingernail clams. Increasing the abundance and availability of SAV to

migrating waterfowl is a common resource management objective of state and Federal conservation agencies along the UMRS (USGS 1999).

OPPORTUNITY: There is an opportunity to improve migratory waterfowl habitat by decreasing the negative factors impacting SAV growth.

PROBLEM: Loss of Spawning and Nursery Habitat. Starved Rock Pool is open water habitat subject to wind waves and currents from the navigation channel, commercial tows, and recreational boats. Current velocities across the study area limits spawning and nursery habitat available for fish such as bluegill and bass. The resuspension and deposition of sediments by wind and current has resulted in shallow water depths, with little variability in velocity or depth. When coupled with the loss of submerged aquatic vegetation in Starved Rock Pool, the study area has experienced a decline in habitat quality. The deep side channel south of the study area provides a good overwintering site and adequate depths for fish, but flow diversity, and aquatic vegetation would improve the habitat quality.

OPPORTUNITY: Starved Rock Pool currently supports a healthy fishery, however biologists from the IL DNR, the INHS, and the Corps agree that high current velocity is the limiting factor for fish in Starved Rock Pool. An opportunity exists to increase the availability of low velocity for spawning and nursery habitat.

This Project would produce benefits consistent with the North American Waterfowl Management Plan, U. S. Shorebird Conservation Plan's Upper Mississippi Valley/Great Lakes Regional Shorebird Conservation Plan, Partners in Flight Bird Conservation Plan, Clean Water Action Plan, and Mississippi River/Gulf of Mexico Watershed Nutrient Task Force.

2.2.23. Goals and Objectives. The goals, objectives, and potential enhancement features are identified in table 3.

Table 3. Project Goals, Objectives, and Potential Features

Goal	Objectives	Potential Measures
Restore Submerged Aquatic Vegetation in Starved Rock Pool Increase Area and Quality of Resting and Feeding Habitat for Migratory Waterfowl Improve Spawning and Nursery Habitat For Native Fish	1. Increase shallow low current velocity habitat in Project area by 2015. 2. Reduce wind fetch lengths and provide areas that are sheltered from wind and wave action by 2015 in the Project area. 3. Increase water clarity in Project area (TSS<25 mg/l, Turbidity < 20 NTU, light extinction< 3. 42 m^{-1}, Secchi disk depth >0.5m) by 2015.	Place rock to protect existing islands Construct a rock breakwater parallel to navigation channel to protect from current velocities and waves Construct a closure structure along left descending bank Construct "seed islands," by placing rock in locations that would encourage natural deposition of sediment Place rock or geotextile tubes to form outline of island, and fill Plant submersed aquatic vegetation Drawdowns Exclosure structures Floating breakwater structures

2.3. Planning Constraints

The principal focus of this study is to identify opportunities for restoring degraded ecosystem structures and functions, taking into account the sites hydrology, plant, fish, and wildlife communities. Several constraints must be taken into account in developing alternatives to achieve the above focus. In addition to the Sponsor's management goals, general criteria were considered as constraints when formulating the Project alternatives:

- No increase in flood elevations as required by Illinois law. Illinois State law specifies that any action in the floodplain that increases flood heights is not allowable or must be accompanied by mitigation of adverse effects.
- No significant adverse impact on the 9-Foot Channel Navigation Project on the Illinois River.
- Avoid or minimize impacts to existing species, but especially species of concern
- Avoid or minimize impacts to cultural sites.
- Avoid or minimize impacts to hydropower.
- Minimize adverse impacts to visitors of Starved Rock State Park.
- Minimize impacts to the side channel south of the Project area.

2.4. Identify Measures and Formulate Alternative Plans

Before Alternatives were formulated, the first step taken was to identify general locations and categories of potential improvements that would satisfy the goals and objectives established previously. A Regional Team consisting of IL DNR site managers, regional biologists and Corps personnel met to formulate these alternatives. The process began with several discussions concerning the management goals and objectives established in the Illinois River Basin Restoration Comprehensive Plan. This yielded an array of *general measures* from which *specific measures* were developed. The formulation of these specific measures involved an assessment of the measures as to whether they met the goals and objectives of the study and how likely they were to produce measurable habitat benefits. Obviously, this is a subjective process requiring further trade off analysis and habitat evaluation procedures of Alternatives; however, the depth of professional experience and first-hand management knowledge by many members of the team was invaluable in defining specific measures.

Finally, several specific measures were screened for a variety of reasons. They are not included as specific measures but are described in the screening section below, along with necessary justification for their elimination from consideration. Upon finalization of specific measures, alternatives were developed through combination of specific measures. This development of Alternative Plans is described in Section 2.4.4, *Description of Alternative Plans*.

2.4.1. General Measures. In order to accomplish the objectives, potential features (figure 12) were proposed that would be considered in the feasibility phase. The alternatives focus on developing and protecting submerged aquatic vegetation and the associated sheltered shallow water areas to improve habitat conditions for fish and migratory waterfowl. These potential enhancement features were initially screened based on their contribution to the Project goals and objectives, engineering considerations, and local restrictions or constraints. Features that were determined not feasible or did

not meet the Project objectives were not subject to further evaluation and are shown on Plate 8, Appendix L. Measures that will be evaluated further are found on Plate 7, Appendix L.

Protect existing islands - The existing islands near RM 233 and 234.5 provide some habitat value and protected aquatic area. Rock could be placed around these islands to protect them from erosion and ensure that they will be stable. This measure was not retained for further evaluation since existing conditions do not show erosion is a problem and would not contribute to the Project objectives.

Construct breakwater - A breakwater could be constructed using rock, or other materials along the historic Delbridge Island contour and parallel to the navigation channel. This breakwater would provide protected aquatic habitat by protecting the shallow water from the current and waves generated by wind, tow boats and recreational boats. Additional berms could be constructed within the protected area to further reduce wind fetch lengths and provide additional habitat. This measure was retained for further evaluation.

Construct closure structure - A closing structure along the left descending bank between Delbridge Island and the south bankline would provide sheltered aquatic habitat and would reduce the flow of sediment through the area. Preliminary hydraulic modeling results show that a closure structure would cause unacceptable rises in flood elevations so this measure was not retained for further evaluation.

Construct seed islands - Place rock or geotextile tubes along outlines of submerged islands to create sheltered areas for aquatic plant production. Hydraulic modeling results show that seed islands cause unacceptable rises in flood elevations so this measure was not retained for further evaluation.

Restore historic islands - Construct islands using dredged material from the navigation channel or off-channel areas to restore islands, sheltered aquatic habitat, and topographic diversity. The islands could potentially be planted with trees to provide a barrier from the navigation channel and also help to reduce wind fetch. Hydraulic modeling results show that restoration of islands causes unacceptable rises in flood elevations. This measure was not retained for further evaluation.

Drawdown - A change in the water level fluctuations at Starved Rock L&D could potentially simulate historic water fluctuations. These water level fluctuations have the potential to increase aquatic vegetation growth. This measure was not retained for further evaluation since the hydropower dam at the Starved Rock L&D has to maintain a certain water level for nearby areas.

Plantings and Exclosures – Planting and protecting submerged aquatic vegetation has the potential to increase the potential of plant survivability due to predation by herbivores. Based on the fact that submerged aquatic vegetation was once prevalent the PDT determined that other stressors such as wind, waves, and light penetration were more likely the limiting factors influencing submerged aquatic vegetation growth. This measure was not retained for further evaluation as a stand-alone measure but is discussed further in section 2.5, risk and uncertainty.

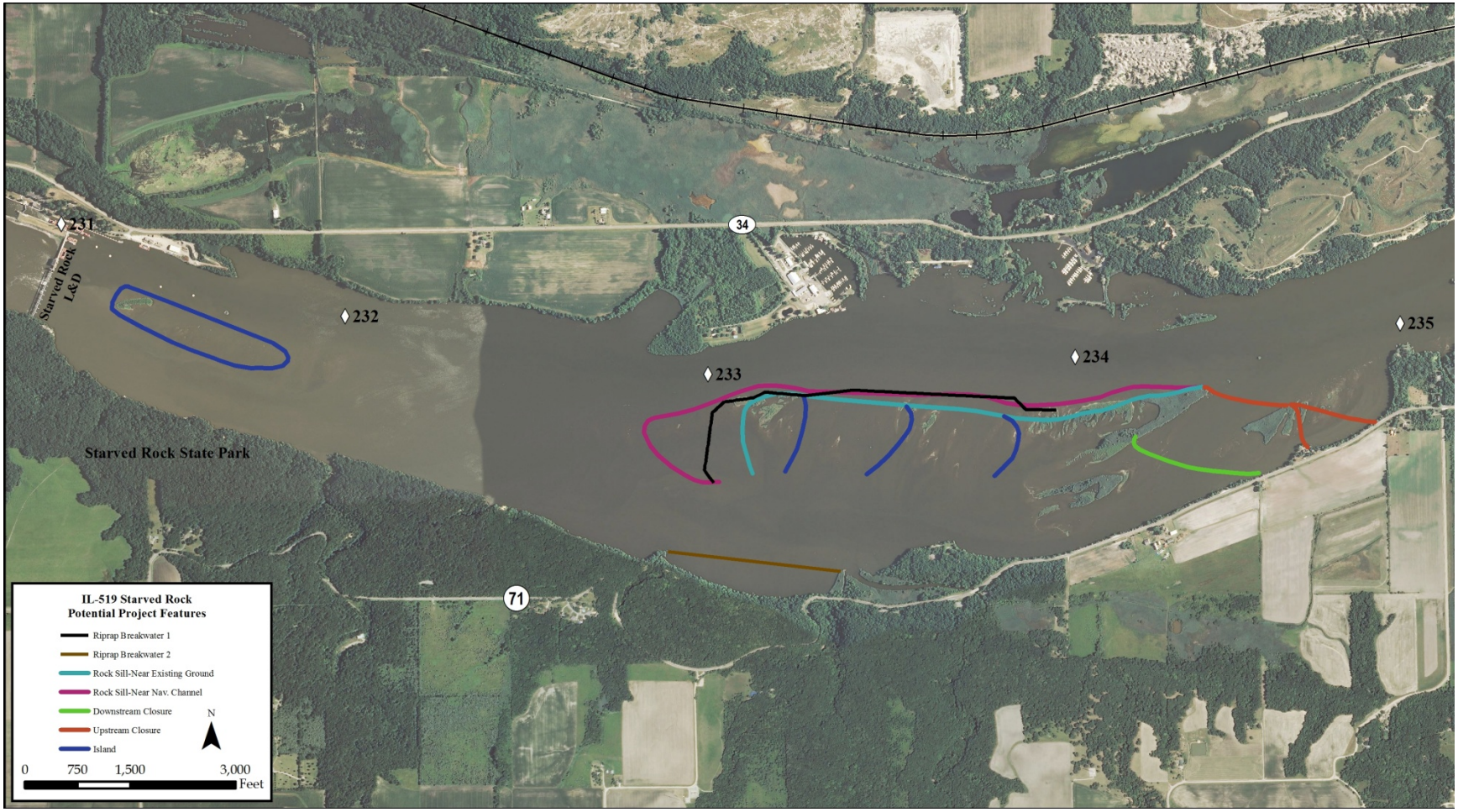


Figure 12. Potential Project Features

2.4.2. Specific Measures. Reflecting the criteria for success and constraints present at the Project area, specific measures were developed within the broad categories of potential measures. These measures are intended to satisfy the objectives and reach the goals of the Project study.

Measure 1 - Riprap Breakwater involves protection in the form of riprap (photograph 1). This measure is included to reduce waves, velocities and turbulence to allow for the growth of SAV.



Photograph 1. Rock Riprap

Measure 2 - Floating Island Breakwater involves protection in the form of floating islands (Photograph 2) along the northern edge of former Delbridge Island. This measure would be anchored into the bedrock. This measure is included to reduce waves, velocities and turbulence to allow for the growth of submersed aquatic vegetation.



Photograph 2. Floating Islands

Measure 3 - Floating Breakwater involves protection in the form of floating barriers (Photograph 3). This measure would be anchored into the bedrock. This measure is included to reduce waves, velocities and turbulence to allow for the growth of submersed aquatic vegetation.



Photograph 3. Floating Barriers or Breakwaters

2.4.3. Selection and Combination of Measures into Alternative Plans. Alternatives were developed that combined the best measures to provide a broad range of alternatives. Based on discussions with the NFS and a study team review of goals and objectives, these alternatives are supported and suitable for evaluation and comparison analysis.

2.4.4. Description of Alternative Plans. The goals for Starved Rock study area are to improve aquatic habitats through restoration that provides spawning and nursery areas for fish, waterfowl migration habitat, and improved conditions for SAV growth. Wind and wave detraction measures, riprap, floating barriers and floating islands were matched with a range of placement measures. The placement of measures was determined to be the optimal spatial locations within the study area to meet the goal and objectives of the Project. The area where potential alternatives were evaluated is called the Project area. The range of riprap placement options were categorized into two general areas; Delbridge Island and Delbridge Island Side Channel. Figure 13 shows the final array of alternatives.

Alternative 1 - Delbridge Island Riprap Breakwater involves protection in the form of riprap along the northern edge of former Delbridge Island. This measure is included to reduce waves, velocities and turbulence to allow for the growth of submersed aquatic vegetation. The breakwater would be approximately 6,100 feet long and constructed to a design elevation 461.85 feet with a 3-foot top width and 2. 5H: 1V side slopes, see Plate 12, Appendix L. Flat pool elevation is 458.52 feet.

Alternative 2 - Side Channel Riprap Breakwater involves protection in the form of riprap along the left descending side of the Delbridge Island side channel. This measure is included to

reduce waves, velocities and turbulence to allow for the growth of submersed aquatic vegetation. The breakwater would be approximately 2,500 feet long and constructed to a design elevation 461.85 feet with a 3-foot top width and 2.5H: 1V side slopes, see Plate 12, Appendix L. Flat pool elevation is 458.52 feet.

Alternative 3 - Delbridge Island and Side Channel Riprap Breakwaters involves protection in the form of riprap along the northern edge of former Delbridge Island as well as along the left descending side of the Delbridge Island side channel. This measure is included to reduce waves, velocities and turbulence to allow for the growth of submersed aquatic vegetation. The breakwater would be approximately 6,100 feet long and 2,500 feet long respectively. The breakwaters would be constructed to a design elevation 461.85 feet with a 3-foot top width and 2. 5H: 1V side slopes, see Plate 12, Appendix L. Flat pool elevation is 458.52 feet.

Alternative 4 - Delbridge Island Floating Island Breakwater involves protection in the form of floating islands along the northern edge of former Delbridge Island. This measure would be anchored into the Delbridge Island bedrock. This measure is included to reduce waves, velocities and turbulence to allow for the growth of submersed aquatic vegetation. The floating island breakwater would be approximately 6,100 feet long.

Alternative 5 - Delbridge Island Floating Breakwater involves protection in the form of floating barriers along the northern edge of former Delbridge Island. This measure would be anchored into the Delbridge Island bedrock. This measure is included to reduce waves, velocities and turbulence to allow for the growth of submersed aquatic vegetation. The floating barrier breakwater would be approximately 6,100 feet long.

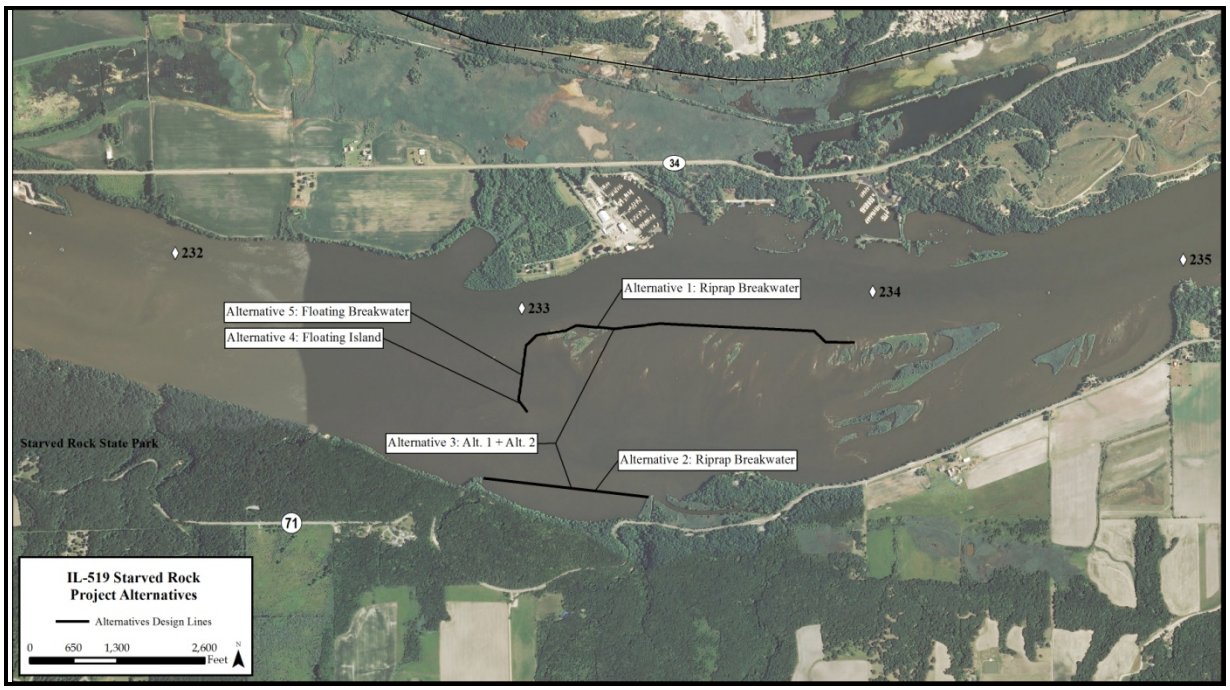


Figure 13. Final Array of Alternatives

2.5. Risk and Uncertainty

2.5.1 Sedimentation. Sedimentation uncertainty was minimized by completing a qualitative sediment analysis of the Project area by engineers with experience in sedimentation. This analysis included predicted future sedimentation conditions for the with- and without-scenarios (Appendix H, Section 8). Risk was also minimized by collecting additional sediment samples within the Project area. Originally, sediment samples were taken along the footprint of the proposed Delbridge Island breakwater structure. In February 2013, 10 additional sediment samples were taken near the proposed Project area in order to better understand existing conditions and assess future erosion and deposition. Additional bathymetric data was obtained in February 2013 to determine sedimentation patterns in the Project area since 2006/2007, when bathymetric data was last collected in the Project area.

Uncertainty was also reduced by comparing various aerial photos from before the impoundment of Starved Rock Pool to the present to determine trends and numbers of acres of island growth.

2.5.2 Herbivory. The team determined that because there has been documented SAV growth when physical conditions changed in Starved Rock Pool the limiting factor in SAV growth was not herbivory so all measures mitigating herbivory were not included in the specific alternatives. Although the team determined there was a moderate to low risk that herbivory would have a negative impact on the project it was decided to minimize the risks associated with herbivory and exclosures and plantings were incorporated into the Projects adaptive management measures.

2.5.3 Invasive Species. The effect of this project on invasive species distribution and abundance were considered throughout the planning process. State and Federal natural resource agencies have weighed the benefits that this project will have on non-native organisms, as well as to the native communities that it is intended to help sustain, and fully support this project.

Invasive fish species such as the silver carp (*Hypophthalmichthys molitrix*) and bighead carp (*H. nobilis*) will likely use the project area as nursery areas as they have been for several years (Kolar et al. 2005). Although it may be utilized by bighead and silver carp it will not negatively impact SAV production or survival. Round goby (*Neogobius* melanostomus) and white perch (*Morone americana*) are much less common, but may also currently occur in 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 Starved Rock Pool and the Upper Illinois River reach.

2.6. Evaluation and Comparison of Alternatives

This section describes the Alternatives and the process used to determine the potential costs, habitat benefits, incremental cost/cost effectiveness, and other factors leading to a Recommended Plan.

2.6.1. Habitat Evaluation Procedures

2.6.1.1. Centrarchid Habitat. Table 4 provides a summary of the existing, future with, and FWOP conditions for the primary parameters affecting distribution and abundance of centrarchid fish habitat. Water quality data was collected by USACE (2007-2008), cover data was obtained

through field surveys and available land cover maps, and velocities were generated from H&H modeling and field collections. Future with and without-project data was estimated using 2-D hydrodynamic modeling (Appendix H), a U. S. Geological Survey (USGS) submersed aquatic vegetation predictive model (Section 2.6.1.8), and best professional judgment of the evaluation team when applicable. A description of how these parameters influence fish life history and habitat quality is included in Section 2, *Plan Formulation.*

Table 4. Aquatic Evaluation Areas With Associated Field Data for Food, Water Quality, Cover, Reproduction, and Water Velocity Parameters.

Evaluation Scenario	Avg. Turbidity	% Cover (vegetation)	% Cover (Rock)	% Pool/ Backwater	Velocity cm/s
Existing	30	0	0	0	24
FWOP	30	0	0	0	24
Alternative 1	15	8	1	24	24
Alternative 2	30	1	0	3	24
Alternative 3	15	9	1	27	24
Alternative 4	20	0	0	0	24
Alternative 5	20	0	1	0	24

2.6.1.2. Mallard Habitat. Waterfowl benefits were estimated using the Duck-Use-Day environmental output model (Heitmeyer 2010), which is a Corps HQ approved regional model. The model is being used outside of its approved region, but it is a robust model and many of the plant and invertebrate species in the model occur throughout the entire Mississippi River, not just the Mississippi Alluvial Plain. The model author concurs with its extension for use on this Project (Mickey Heitmeyer, Greenbrier Wetland Service, Advance, Missouri, personal communication) so the team is seeking approval from HQ for one-time use. The Duck-Use-Day model estimates the potential food value of existing or predicted land cover classes and uses known caloric needs of waterfowl species to calculate the potential carrying capacity of a site. Only the aquatic land cover classes were included in the evaluation: aquatic invertebrates for the existing condition with no plants and invertebrates, aquatic plant seeds, and aquatic plants for the future alternative conditions.

2.6.1.3. Habitat Benefit Evaluation Methods. The purpose of the habitat benefit evaluation is to evaluate and quantify, to the extent possible, environmental benefits of Alternatives for aquatic and floodplain habitat improvements. Centrarchid benefits were quantified through the use of the Habitat Evaluation Procedures (HEP; USFWS 1980). Mallard benefits were calculated using a habitat-based waterfowl bioenergetics model (Heitmeyer 2010).

2.6.1.4. 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 Starved Rock Pool Critical Restoration Project uses acres to represent the quantity. The Project area is defined as the footprint of the historic Delbridge Island and the side channel area south of the island. Potential restoration measures include alternative breakwater structures along an identical alignment, so the quantity of habitat affected is similar across all planning scenarios.

2.6.1.5. 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 Habitat Suitability Index (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). Habitat Units are calculated for select target years (existing, 1, 10, 20, 30, 40, 50) and annualized (using IWR Planning Suite NER Annualizer) over the life of the project to derive Average Annual Habitat Units (AAHUs). Average Annual Habitat Units are used as the output measurement to compare the features and alternatives for the proposed Project.

The bluegill (Stuber et al. 1982) and Duck-Use-Day (DUD) (Heitmeyer 2011) USACE approved (per EC 1105-2-412) HSI models were used to assess the Project alternatives. 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 spawning and rearing habitat and aquatic vegetation.

Assumptions made in the application of the HSI models include the following:

2.6.1.6. Baseline Condition. Water quality data collected during summers of 2007 and 2008 at two monitoring stations in Starved Rock Pool were representative of the entire evaluation area.

2.6.1.7. Future Without-Project Conditions. Futures without project (FWOP) conditions were based on a net equilibrium sedimentation rate across most of the study area over the next 50 years (section 2.2.21). Island growth at the upstream end of the evaluation area is anticipated to occur at a rate of 1 acre/yr. Emergent islands will continue to form in the developing fluvial delta as exhibited during the last 20 years (figure 8).

The assumption for FWOP benefits is based on vegetation occurrence in one of ten years based on the frequency of occurrence with recent droughts or navigation closures. With- project SAV abundance estimates (see below) were divided by 10 to represent the episodic habitat benefits provided when plants occur during favorable climatic or navigation system operating conditions.

2.6.1.8. Future With-Project Conditions. The net benefit of restoration measures is expected to remain constant through the 50-year evaluation period because no net sedimentation is projected in the backwater habitat area. Projected areas of deposition and erosion have been identified (see Section 8 in Appendix H) and the net sedimentation is not expected to be significantly different than the existing conditions in the next 50 years. It is also not expected that increased flood events due to climate change would cause heavier bedload material from the navigation channel to increase within the project area. Water quality estimates were based on field measurements sampled during summer low flow because the breakwater will create similar conditions by reducing wind-waves and current across the Project area. Rock cover was measured as the footprint of the structure. The percent backwater area created was estimated as the area represented by bluegill fry habitat suitability of 1. Velocity was estimated from the high flow simulations for each alternative because changes at

low flow were insignificant and it is likely that the higher discharge would occur during spring early summer spawning periods through May and June.

Potential SAV distribution and abundance was estimated using multiple lines of evidence pointing to the same general conclusion that plants occupy about 60 to 80 acres when physical stressors are reduced. The first evidence for the potential for SAV was in its reputed historical abundance attracting waterfowl to Starved Rock Pool. Recent evidence for the site to support SAV comes from its occurrence during droughts in 1989 and 2012, during a navigation closure in 1993, and inside of cages excluding herbivores (Sass 2009), when light limitation, current velocity, or herbivory stressors, respectively, were alleviated. The last line of evidence supporting our estimate for potential SAV distribution and abundance is output from a USGS SAV model developed for Pool 8, UMR, Wisconsin. The model was developed and calibrated for a clearer water system, but for very similar restoration project planning.

The USGS SAV model was used to compare estimates of potential vegetation among multiple reference conditions at the Starved Rock Project area (Appendix D-1). The model is not calibrated for Illinois River conditions, so the results may not be an accurate estimate of response. Model developers recommended using SAV probability of abundance >50 percent as the level likely to reflect a response in the field. SAV estimates for several years did, however, seem to emulate field conditions. The SAV response predicted by the model is a 35 percent SAV increase in the Project area of influence behind the breakwater versus 20 percent coverage of vegetation over the entire study site during 1989 drought conditions.

The SAV model was also used in a sensitivity analysis to evaluate potential SAV response to Alternative 4 and 5 which reduce wave action but not current velocity. USGS modelers were asked to simulate flow reductions of 5, 15, and 25 percent from installation of floating barriers based on recommendations from hydraulic modelers. No plant response greater than 50 percent probability of occurrence was predicted, so floating barriers were assumed to not support conditions favorable for SAV.

2.6.2. Habitat Evaluation Results. Section 2, *Plan Formulation*, describes each potential Project measure in detail. Tables 5 and 6 provide summaries of the results of the habitat benefit evaluation.

Centrarchid Benefits. Table 5 shows the HSI for bluegill, acres for each alternative, HUs, gross AAHUs, and net AAHUs (lift) for each target year under consideration.

Mallard Benefits. Table 6 provides estimated mallard DUD's gross average annual duck-use-days (AADUDs) and net AADUDs (lift) for each target year under consideration.

2.6.3. Cost Estimates for Habitat Improvement Measures. Project first cost estimates were developed to conduct the cost effectiveness and incremental cost analysis of the various Alternatives. The cost estimates (table 7) were prepared using May 2013 price levels and include construction; planning, engineering and design (PED); construction management (CM); adaptive management (AM); operations, maintenance, repair, replacement and rehabilitation(OMRR&R); and monitoring costs. Project features are on state land however Navigational Servitude applies so there are no lands and damage costs associated with the Project. Total Project costs were annualized based on the Fiscal Year 2013 discount rate of 3.75 percent and a 50-year project life.

Table 5. Benefit Evaluation Results for the Starved Rock Project Area Alternatives

		OUTPUT				
Description	**Year**	**SI Final**	**Acres**	**HUs**	**AAHUs**	**Net AAHUs**
No Action	0	0.00	670.00	0.0	0.0	
FWOP	1	0.00	670.00	0.0	36.2*	**0**
	10	0.00	670.00	0.0		
	20	0.00	670.00	0.0		
	30	0.00	670.00	0.0		
	40	0.00	670.00	0.0		
	50	0.00	670.00	0.0		
Alternative 1	0	0.00	670.00	0.0	398.0	**361.8**
	1	0.60	670.00	402.0		
	10	0.60	670.00	402.0		
	20	0.60	670.00	402.0		
	30	0.60	670.00	402.0		
	40	0.60	670.00	402.0		
	50	0.60	670.00	402.0		
Alternative 2	0	0.00	670	0.0	258.7	**222.5**
	1	0.39	670.00	261.3		
	10	0.39	670.00	261.3		
	20	0.39	670.00	261.3		
	30	0.39	670.00	261.3		
	40	0.39	670.00	261.3		
	50	0.39	670.00	261.3		
Alternative 3	0	0.00	670.00	0.0	404.6	**368.4**
	1	0.61	670.00	408.7		
	10	0.61	670.00	408.7		
	20	0.61	670.00	408.7		
	30	0.61	670.00	408.7		
	40	0.61	670.00	408.7		
	50	0.61	670.00	408.7		
Alternative 4	0	0.00	670.00	0.0	0.0	**0.0**
	1	0.00	670.00	0.0		
	10	0.00	670.00	0.0		
	20	0.00	670.00	0.0		
	30	0.00	670.00	0.0		
	40	0.00	670.00	0.0		
	50	0.00	670.00	0.0		
Alternative 5	0	0.00	670.00	0.0	0.0	**0.0**
	1	0.00	670.00	0.0		
	10	0.00	670.00	0.0		
	20	0.00	670.00	0.0		
	30	0.00	670.00	0.0		
	40	0.00	670.00	0.0		
	50	0.00	670.00	0.0		

*****See Section 3.3 in Appendix D for model assumptions

Table 6. Benefit Evaluation Results for the Starved Rock Project Area Alternatives

Description	Year	DUDs	AADUDs	Net AADUDs
No Action	0	41814	41814	
FWOP	1	41814	41814	**0**
	10	41814		
	20	41814		
	30	41814		
	40	41814		
	50	41814		
Alternative 1	0	41814	58241	**16427**
	1	58407		
	10	58407		
	20	58407		
	30	58407		
	40	58407		
	50	58407		
Alternative 2	0	41814	43456	**1642**
	1	43473		
	10	43473		
	20	43473		
	30	43473		
	40	43473		
	50	43473		
Alternative 3	0	41814	59883	**18069**
	1	60066		
	10	60066		
	20	60066		
	30	60066		
	40	60066		
	50	60066		
Alternative 4	0	41814	41814	**0**
	1	41814		
	10	41814		
	20	41814		
	30	41814		
	40	41814		
	50	41814		
Alternative 5	0	41814	41814	**0**
	1	41814		
	10	41814		
	20	41814		
	30	41814		
	40	41814		
	50	41814		

Table 7. Cost of Alternatives

(May 2013 Price Level – 50 year period of analysis using 3.75 discount rate)

	Feature	Construction	Planning Engineering Design	Real Estate	Construction Management	Adaptive Management & Monitoring	Contingency [1]	Annual Cost [2]	OMRR&R [3]	Total Annual Costs
Alt 0	No Action	0	0	0	0	0	0	0	0	0
Alt 1	Delbridge Riprap	$2,922,976	$283,500	0	$283,500	$316,973	20%	$169,692	$30,432	$200,124
Alt 2	Side Channel Riprap	$1,582,415	$165,900	0	$165,900	$316,973	20%	$ 99,453	$15,580	$115,033
Alt 3	Delbridge and Side Channel Riprap	$4,492,930	$421,050	0	$421,050	$316,973	20%	$251,934	$46,012	$297,946
Alt 4	Floating Islands	$16,155,101	$ 1,244,418	0	$1,216,950	$377,193	43%	$846,638	$ 142,057	$988,695
Alt 5	Floating Barriers	$3,398,505	$289,899	0	$289,500	$369,735	40%	$193,793	$46,447	$240,240

[1] Contingencies have been added to costs.
[2] Annualized cost is based on a 50-year project life, 3.75 percent interest rate.
[3] Annualized cost of O&M cost is based on a 50-year project life, 3.75 percent interest rate.

2.7. Incremental Cost/Cost Effectiveness Analysis Process

Cost effectiveness analysis was used to determine what Project features should be built, based on habitat benefits (outputs) that meet the goals and objectives of the project and at the same time are the most cost effective. The Corps has incorporated cost effectiveness analysis into its planning process for all ecosystem restoration planning efforts. A cost effectiveness analysis is conducted to ensure that least cost alternatives are identified for various levels of output. After the cost effectiveness of the alternatives has been established, incremental cost analysis is conducted to reveal and evaluate changes in cost for increasing levels of environmental output.

Cost effectiveness and incremental analysis is a three-step procedure: (1) calculate the environmental outputs of each alternative; (2) determine a cost estimate for each alternative; (3) combine the alternatives to evaluate the best overall project alternative based on habitat benefits and cost. While cost and environmental outputs are necessary factors, other factors such as the ability to construct, schedule, likelihood to achieve projected results, immeasurable environmental benefits, ancillary benefits etc., are very important in alternative selection.

Environmental outputs were calculated as AAHUs as well as DUDs. The annualized costs were calculated by applying a 3.75 percent annual interest rate to the construction costs over the 50-year period of analysis. The incremental analysis for each alternative was accomplished using the Corps Institute for Water Resources tool. Further information on the analysis can be found in Appendix D of this report.

2.8. Results of Incremental Cost/Cost Effectiveness Analysis

Two incremental cost/cost effectiveness analyses were run. The first looked at the bluegill target species in the HEP analysis. The second model DUDs was run to ensure that the selected alternative was including the benefits associated with waterfowl as well as benefits for the fisheries. The results of the two analyses are shown on table 8.

Adaptive Management costs associated with the alternatives are relatively the same. They were included in the analysis but did not assist in comparing the alternatives to one another. Both bluegill AAHU and AADUD analyses showed that Alternatives 1, 2, and 3 were cost effective (figures 14 and 15). Alternative plan 4 and alternative plan 5 exhibited the highest cost per bluegill AAHU and AADUD. This occurred, as stated in the habitat analysis section, because the floating breakwaters did not decrease the velocities enough to improve spawning habitat or support SAV growth so did not change the current duck usage or habitat suitability of bluegill. Therefore alternative 4 and alternative 5 were not considered further in the evaluation of the final array of alternatives. A comparison of Alternatives 1, 2 and 3 are shown on figures 16 and 17, as well as tables 9 and 10.

Table 8. Alternative Plan Evaluation
(May 2013 Price Level – 50 year period of analysis using 3.75 discount rate)

Alternative Plan	AADUD[1]	AAHU[1]	First Cost Construction	Annual Cost/ AAHU	Annual Cost/ AADUD
0	0	0	0	0	0
2	1,642	222.5	$ 2,231,188	$ 517	$ 70
1	16,427	361.8	$ 3,806,949	$ 553	$ 12
3	18,069	368.4	$ 5,652,003	$ 809	$ 16
4	0	0	$18,993,662	$ 982,951	-
5	0	0	$ 4,347,639	$ 238,662	-

[1] Outputs are calculated as net Average Annual Habitat Units (AAHUs) and net Average Annual Duck Use Days (AADUD).

Table 9. Comparison of Incremental Costs per of Alternatives (HU)
(May 2013 Price Level – 50 year period of analysis using 3.75 discount rate)

Alternative Plans	(HU) Incremental Cost	Incremental HU	Incremental Cost per HU
0	0	0	0
2	$ 115,033	222. 5	$ 517
1	$ 85,090	139. 3	$ 611
3	$ 97,822	6. 6	$ 14,822

Table 10. Comparison of Incremental Costs per of Alternatives (DUD)
(May 2013 Price Level – 50 year period of analysis using 3.75 discount rate)

Alternative Plans	(DUD) Incremental Cost	Incremental DUD	Incremental Cost per DUD
0	0	0	0
2	$115,033	1,642	$70
1	$85,090	14,785	$6
3	$97,822	1,642	$60

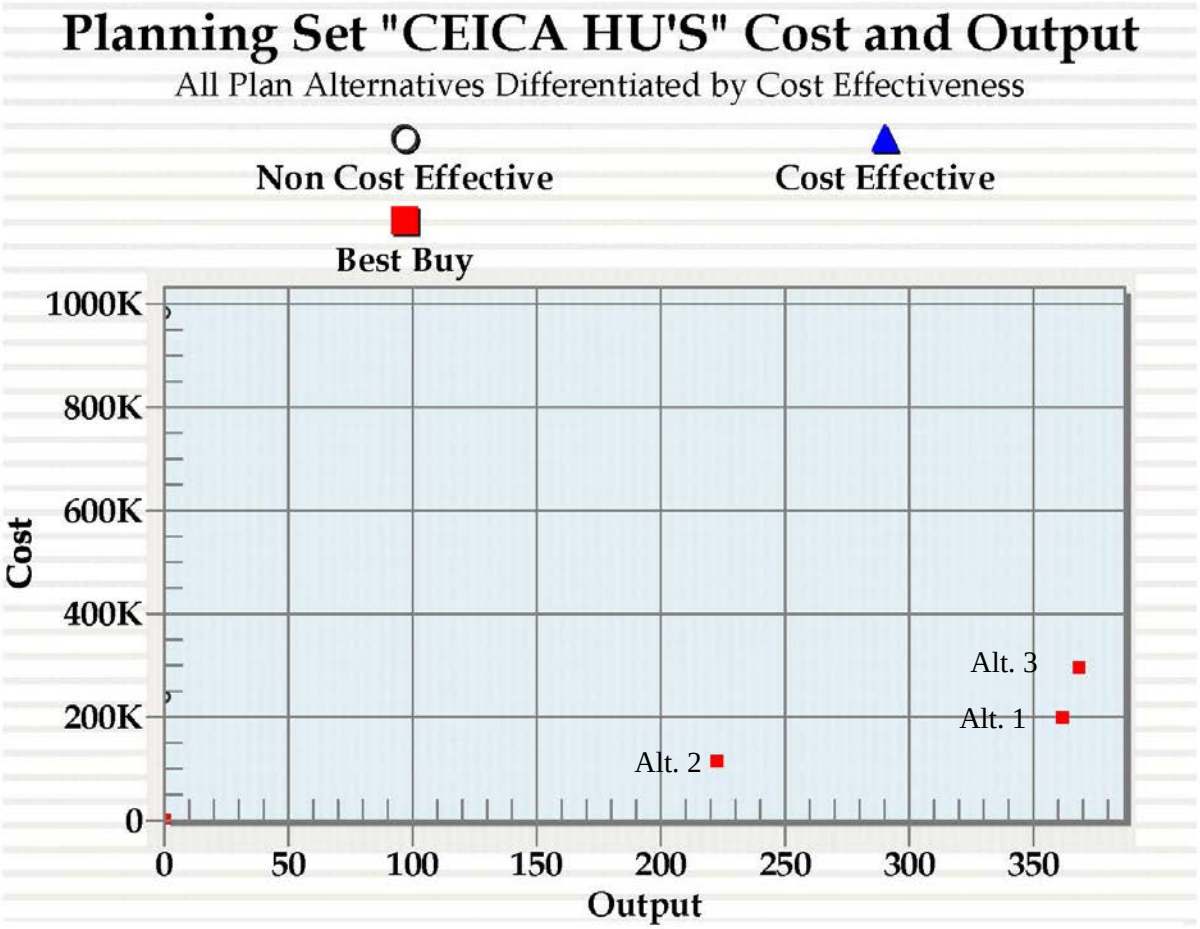


Figure 14. Cost Effectiveness of Alternatives for Bluegill Net AAHUs

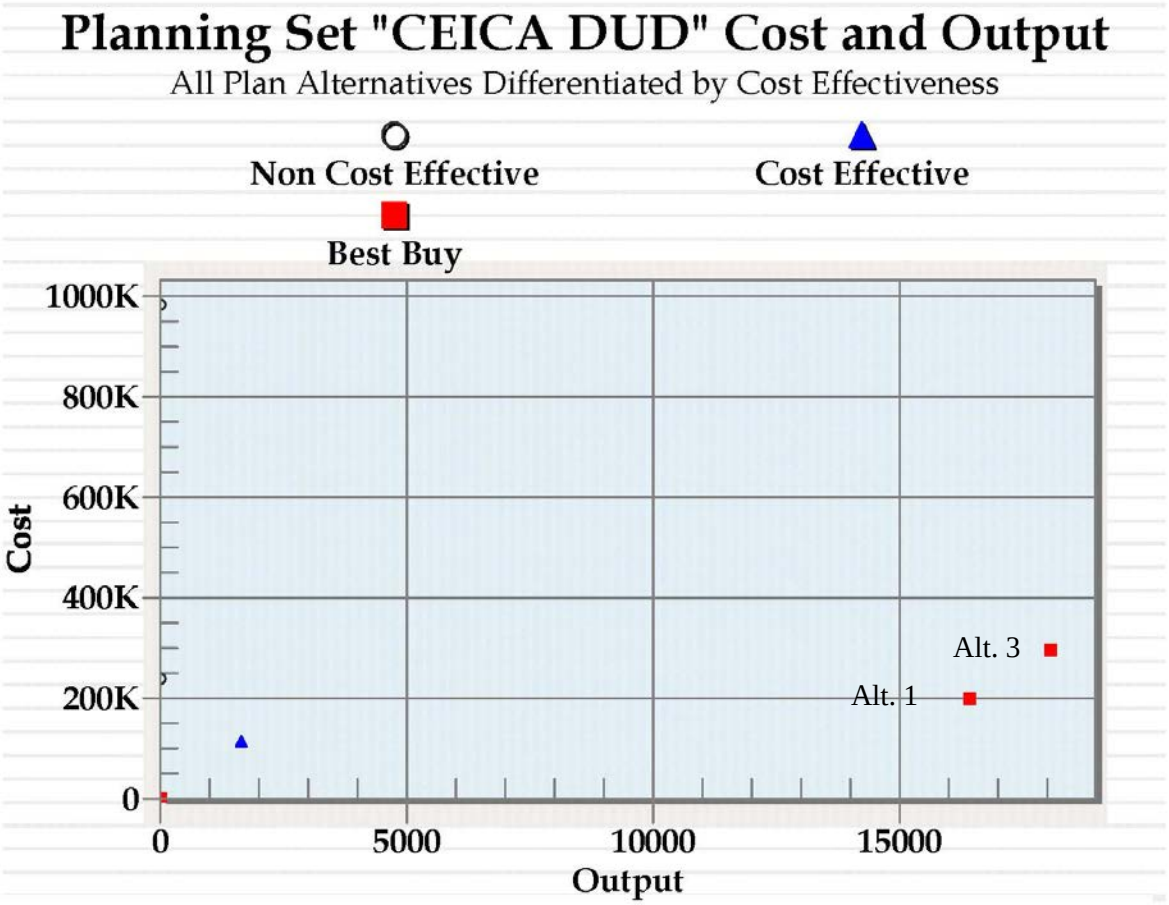


Figure 15. Cost Effectiveness of Alternatives for Net DUD's

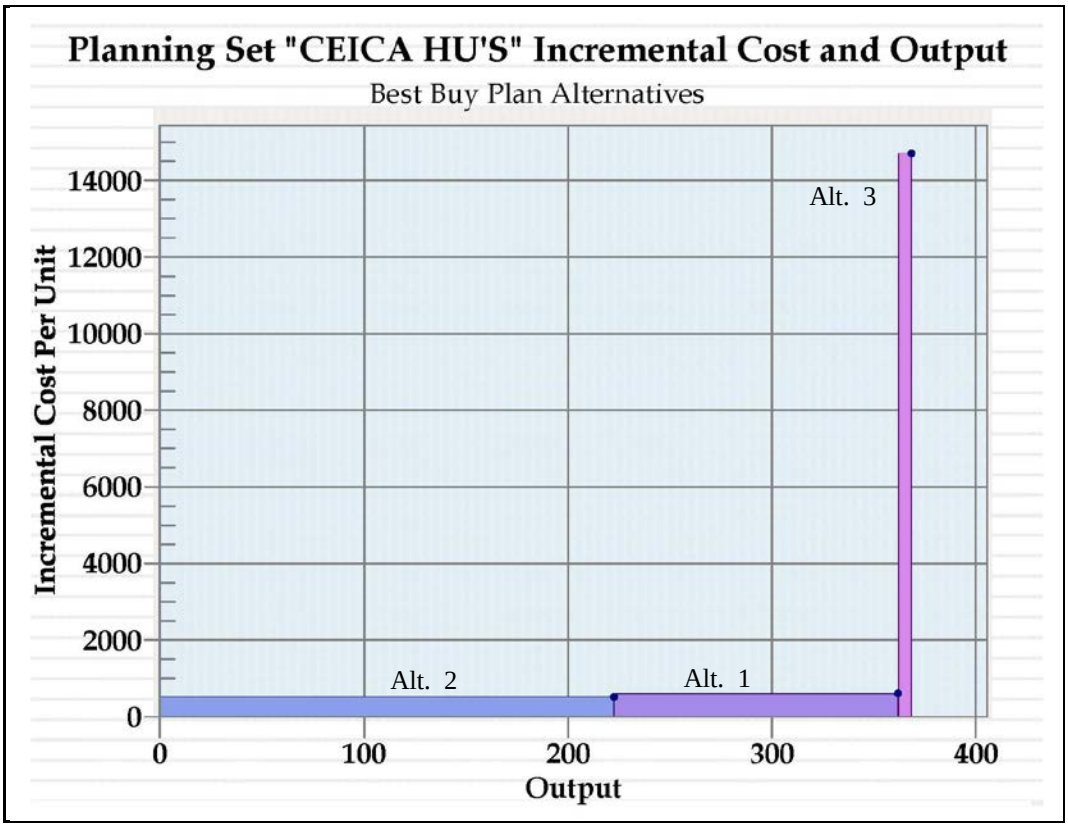


Figure 16. Incremental Cost Analysis of AAHUs

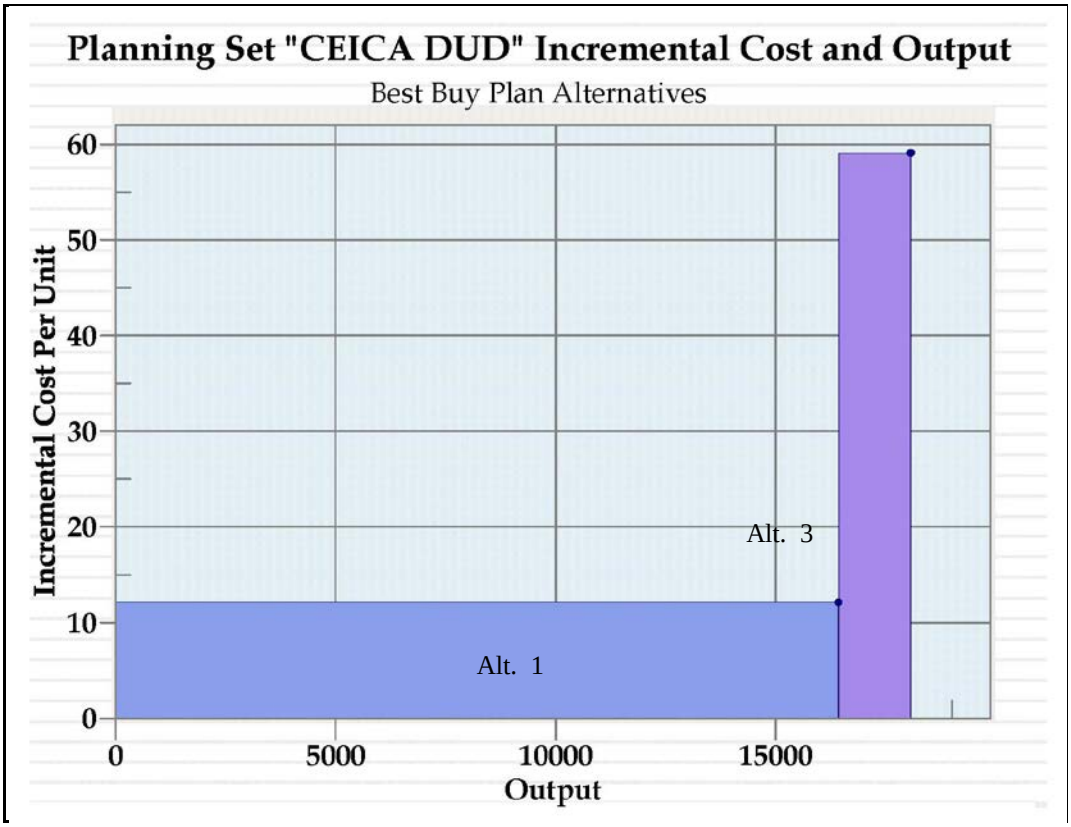


Figure. 17. Incremental Cost Analysis of DUDs

2.9. Other Factors

2.9.1. Cost. The team reviewed all best buy plans based off of AAHU's (figures 17 and table 9) and determined that the cost to implement the first iteration of best buy plans, Alternative 2, above the no action plan, was worth the incremental investment above the no action plan since it provides an acceptable level of restoration for an acceptable cost. It provides 222.5 habitat units for an incremental cost of $513.97. This alternative consists of a riprap breakwater parallel to the bank line in the side channel adjacent to the submersed Delbridge Island which would decrease velocities due to wind and waves to provide conditions necessary for SAV growth. The PDT determined that the next plan, Alternative 1, was also worth the incremental investment. This alternative includes a riprap breakwater adjacent to the main channel of the Mississippi River on the submerged Delbridge Island which would also decrease velocities due to wind and waves to provide conditions necessary for SAV growth. Its incremental investment of 139.3 habitat units at an incremental cost of $607.43 is considered worth the investment since it optimizes habitat units while only increasing the incremental cost by $93 per habitat unit. The team analyzed alternative 3, combination of alternative 1 and alternative 2, and determined that although there would be additional benefits, it was not worth the incremental cost of $97, 264 for the additional 6.6 habitat units. The DUD model yielded similar results except that alternative 2 was not considered a best buy plan since it yielded 1,642 DUDs for $70 and alternative 3 offers 1,642 DUDs for $60.

2.9.2. Hydrological/Sustainability. The alternatives that have been evaluated would not produce significant impacts to flood heights (Appendix H).

2.9.3. Public Acceptability. The public was very receptive to the proposed project during the public review period and open house.

2.9.4. Recreation. The use of the Starved Rock Pool for boating, fishing, and waterfowl hunting activities has been well documented. The opportunity exists, through riprap placement, to enhance these recreational opportunities as a function of habitat improvements.

2.9.5. Real Estate. All of the land for the proposed alternative is owned by the State of Illinois.

2.10. Selection of the Recommended Plan

Further evaluation of the remaining final array of alternatives, alternatives 1, 2 and 3, occurred to aide in the selection of the Recommended Plan. Federal planning for water resources development was conducted in accordance with the requirements of the *Planning Guidance Notebook* (ER 1105-2-100).

> *"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 (table 11) suggested by the U. S. Water Resources Council (completeness, effectiveness, efficiency, and acceptability, defined below) was used to aide in the selection of the Recommended Plan as well as socioeconomic factors, environmental significance, and an alternatives potential to impact historic properties.

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.

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 defined in terms of acceptance of the plan by the NFS and the concerned public. After completing the alternative formulation briefing, the Recommended Plan is presented to stakeholders to determine its acceptability.

Table 11. Comparison of the Final Array of Alternatives

Criteria	Alternative 0	Alternative 1	Alternative 2	Alternative 3
Plan Description	No Action	Delbridge Island Riprap	Side Channel Riprap	Delbridge Island Riprap and Side Channel
Completeness	There are no actions for this plan.	This plan is ***COMPLETE*** since all necessary actions and investments have been accounted for in this plan.	This plan is ***COMPLETE*** since all necessary actions and investments have been accounted for in this plan.	This plan is ***COMPLETE*** since all necessary actions and investments have been accounted for in this plan.
Acceptability	This alternative is ***ACCEPTABLE*** to Federal and state agencies.	This alternative is ***ACCEPTABLE*** to the Federal and state agencies.	This alternative is ***ACCEPTABLE*** to the Federal and state agencies.	This alternative is ***ACCEPTABLE*** to the Federal and state agencies.
Effectiveness	This plan ***DOES NOT*** address any project objectives.	This plan ***DOES*** address all project objectives.	This plan ***DOES*** address all project objectives	This plan ***DOES*** address all project objectives.
Efficiency	***No*** net benefits are realized.	This alternative ***IS*** incrementally the most cost effective plan at a given level of output.	This alternative ***IS NOT*** incrementally the most cost effective plan at a given level of output.	This alternative ***IS NOT*** incrementally the most cost effective plan at a given level of output.
Socioeconomic Factors	This alternative ***DOES NOT*** have the potential to impact socioeconomic factors	This alternative ***DOES*** have the potential to influence socioeconomic factors through public awareness	This alternative ***DOES*** have the potential to influence socioeconomic factors through public awareness	This alternative ***DOES*** have the potential to influence socioeconomic factors through public awareness
Environmental Significance & Scarcity	This alternative ***IS NOT*** environmentally significant	This alternative ***IS*** environmentally significant because SAV is scarce in the Illinois River	This alternative ***IS*** environmentally significant because SAV is scarce in the Illinois River	This alternative ***IS*** environmentally significant because SAV is scarce in the Illinois River
Historic Properties	This alternative ***DOES NOT*** have an impact on historic properties	This alternative ***DOES NOT*** have an impact on historic properties	This alternative ***DOES NOT*** have an impact on historic properties	This alternative ***DOES NOT*** have an impact on historic properties

Based on the results of the CE/ICA, planning criteria, risk assessment and other essential criteria the PDT recommends Alternative Plan 1, Delbridge Island riprap breakwater, as the Recommended Plan. This alternative best meets the Project goals. It would result in less wave impact and lower current velocities to improve the habitat for spawning of centrarchids. It would also increase the potential for SAV growth and increase feeding opportunities for waterfowl. This measure is innovative for the Illinois River. It has the potential to determine whether altering the physical parameters of an area has the potential to restore SAV or if it is necessary to account for herbivory as a key factor impacting SAV growth.

In cooperation with the USFWS and IL DNR, the Corps has planned a project that serves the needs of the resource agencies. The preferred alternative plan has an overall output of 361. 88 AAHUs as well as 16,427 DUDs for a total cost of approximately $3,807,000.

SECTION 3 – DESCRIPTION OF THE RECOMMENDED PLAN

3.1. General Description

The Recommended Plan for the Project (table 12) includes placement of a riprap breakwater along the northern edge of former Delbridge Island adjacent to the navigation channel between RMs 233 and 234 in Starved Rock Pool, see Plate 9, Appendix L. The breakwater will be approximately 6,100 feet long and constructed to a design elevation 461. 85 feet with a 3-foot top width and 2.5H:1V side slopes. The bottom width varies with a maximum width of approximately 30 feet. See Plate 12, Appendix L. Riprap shall conform to the requirements of Gradation RR-5 of the Illinois Department of Transportation (IL DOT).

Rock placement would be accomplished by floating plant. It is anticipated that rock will be transported from a quarry by barge to the Project area. The riprap breakwater will be placed in close proximity to the navigation channel so that the riprap can be easily placed. The riprap breakwater is positioned to protect the area behind it from wind and wave action to support submergent aquatic vegetation.

Table 12. Starved Rock Recommended Plan Summary

Riprap Breakwater	Measurement	Unit
Length	6,100	Feet
Top Elevation	461. 85	Feet NGVD
Crown Width	3	Feet
Side Slopes	2. 5:1	H:V
Volume	38,300	Ton

3.2. Design Implementation

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

3.2.2. Design Quality Control & Quality Assurance. As appropriate during the design stage, the project delivery team (PDT) will ensure that adequate peer review is performed as the P&S are being developed. PDT members will seek guidance from their functional supervisors on the appropriate level of district quality review required. The Project Engineer will conduct an on-board (35 percent) review when the design has adequately progressed for substantive comment and drawings are sufficient for conceptual understanding of Project features. A District Quality Control Review will be conducted at the 65 percent design level followed by an Agency Technical Review (ATR) at the 95 percent design level. For these reviews, comments and resolutions will be entered into DrChecks. A Biddability, Constructability, Operability, and Environmental Review will be conducted at the final design level, after all ATR comments have been resolved and incorporated. The review documents will include a complete set of P&S (with special clauses) as well as engineering considerations with all comments and resolutions entered into DrChecks.

3.2.3. Design Considerations. The Project's horizontal datum is state plane coordinate system IL West, NAD 83, US Survey Foot. Vertical datum is NGVD 1929. It is recommended that the Project area be resurveyed during design in order to obtain more accurate quantities for the Government estimate unless a preconstruction quantity survey of existing conditions will be required by the Contractor per the construction contract.

The effect that this Project may have on navigation will need to be addressed during design to include coordination with Illinois River Carrier Association (IRCA), state and Federal agencies. A slight increase in velocities within the navigation channel is anticipated so how this increase may affect dredging, mooring and towing will need to be evaluated.

Safety and security are important parameters which would be detailed during the design stage. Of specific concern will be the consideration of regional hunting seasons with the anticipated construction season. Another safety consideration would be the closeness of the L&D facility and any additional requirements that would be imposed on any vessel, boat or other floating plant within the restricted area.

3.3. Hydrology and Hydraulics

The Recommended Plan is to construct a riprap breakwater on the right-descending bank of the historic Delbridge Island. The objective of the Section 519 project is to protect the Project area from wind and navigation waves thereby reducing turbidity and providing conditions for submersed aquatic vegetation.

The elevation of the top of the rock structure was set to 461.85 feet. This elevation was chosen because it is 3 feet above the average of the pool operating elevation limits and is also slightly less than the 50 percent chance exceedance (2 yr) elevation at RM 234.5, which is the upstream end of the Recommended Plan. This height above water surface for rock placement is common practice within the District.

A 2-D model was built to assess project effects on flood stage. It was also used to add validity to the ecological evaluation process. Velocity output was also utilized for a navigation- and wind-wave study. There was also a need to evaluate potential impacts to existing archeological sites, the navigation channel, and the left descending side channel within the project river reach. Additionally,

output was utilized for a qualitative sedimentation study (Appendix H, Section 8). For additional 2-D hydraulic modeling detail, see Appendix H, Section 5.

The Starved Rock Project area is subject to State of Illinois floodplain impact requirements. The State of Illinois requires that any action in the floodplain that increases flood heights is not allowable or must be accompanied by mitigation of adverse effects. Mitigation actions include purchase of easements, land acquisition, etc. Due to the potential high cost associated with mitigation actions, one of the project constraints is to avoid increasing flood heights. In other words, the Project is restricted to "no rise" (equal to or less than 0.04' of increase). The Recommended Plan was analyzed using an unsteady flow model UNET (1D Unsteady Flow Through a Full Network of Open Channels) and found to have a floodplain elevation impact within the acceptable limit (Appendix H, Attachment H-1).

Anticipated wave heights in the Project area were researched in order to characterize the waves caused by wind, navigation traffic, and recreational boats and to verify the anecdotal evidence provided by Corps personnel (Appendix H, Section 6).

Wind fetch in the Project area can be as much as 2 to 3 miles. With this fetch length, wave heights can reach 1-2 ft, depending on depth, for the 1 percent exceedance wind. With the project in place, wind fetch would decrease by about half in the protected area, resulting in smaller wind waves.

One study found that on the Upper Mississippi River – Illinois Waterway System, navigation traffic generally produces wave heights of less than 1 foot with a wave period of 1 to 5 seconds. However, due to the frequency of navigation traffic on the system, a location can experience daily cumulative exposures to waves of 30 to 75 minutes (Stewart, McFarland, Ward, Martin, & Barko, 1997). Another study developed wave height relationships with vessel speed and blockage ratio (defined as the cross-sectional area of the channel divided by the cross-sectional area of the submerged barge tow) and found that wave height increases exponentially with vessel speed for different blockage ratios in confined channels. For the blockage ratio most similar to that of the narrowest cross-section near the Recommended Plan alignment, wave heights ranged from 0.5 to 3.5 ft for speeds of 7-9 mph (Martin, 1992).

A study of waves generated by recreational traffic on the Upper Mississippi River – Illinois Waterway System developed an equation to estimate maximum wave height based on speed, draft, and length of the boats, and their distance from the measuring point. Test runs at two sites, one on the Illinois River and one on the Mississippi River, indicated that recreational boats can generate from 4 to 40 waves per pass, with a mean of about 10 to 20 waves. The waves lasted from 6 to 40 seconds or more. The average wave heights varied from 0.01 to 0.25 meter (0.03 to 0.82 ft), with a median of about 0.06 to 0.12 meter (0.2 to 0.39 ft). The maximum wave height was 0.6 meter (1.97 ft) (Bhowmik, Soong, Reichelt, & Seddik, 1991).

Vessel waves likely have a larger impact on the subject site than wind waves. The riprap breakwater would block these deeper waves to reduce the velocity and turbulence effects in the Project area. Although the Recommended Plan will reduce the effects in the protected area of waves induced by vessels and recreational boats operating in the navigation channel, there is still a risk of waves induced by recreational boats utilizing the side channel.

A boat ramp is located on the left descending bank of the pool near RM 233. 6, and two marinas are located off the navigation channel on the right descending bank between RM 233-234, but the frequency, speed, and types of recreational boaters utilizing the side channel is unknown.

Starved Rock Pool typically experiences heavy ice buildup during the winter. Ice thickness in the Starved Rock Pool can grow to 1 ft or more (Mark Witalka, personal communication, January 11, 2013). The alignment of the proposed riprap breakwater is oriented parallel with the flow alongside the navigation channel, so ice would be expected to generally flow along the structure, generating a sliding or lateral force on the structure. The structure could perhaps experience more direct forces caused by thermal expansion of ice sheets, wind-driven ice sheets or tows pushing ice aside out of the navigation channel. Flow from the side channel could cause ice to accumulate in the west end of the protected area due to the alignment; however, the exact position will be evaluated during the design phase to address this potential issue. A potential increase in ice flow to the Starved Rock L&D will need to be evaluated during design.

3.4. Geotechnical

The Recommended Plan was designed to increase durability from ice flow forces with a wider base, shallower slopes, and narrow crown. The rock size, ILDOT Gradation RR-5 (400 lb) riprap was found to be sufficient for ice flow and river current. Common book values were used to determine an approximate riprap settlement of 8 inches and slope stability requirements. A detailed Geotechnical analysis can be found in Appendix G.

3.5. Construction Implementation

3.5.1. Site Access & Staging. The Project is located within the floodway of the Illinois River, so access to the site will be by water. A public boat ramp is located at the Starved Rock State Park. The staging area for temporary construction offices will be located at the Starved Rock L&D and will need to be coordinated with L&D personnel. No material storage will be allowed at the staging area. The boat ramp and staging area are identified on Plate 9, Appendix L.

3.5.2. Site Elevations. Flat pool elevation at Starved Rock L&D is 458.52 feet (tailwater flat pool of 440.3) and the dam is operated to maintain a pool elevation between 458.75 feet and 458.95 feet. The annual elevation-duration information at the Starved Rock Pool gage indicates a median river elevation of 458.8 feet (period of record 1980-2011). The crest elevation of the Recommended Plan riprap breakwater is 461. 85 ft. This elevation was chosen because it will not be overtopped by the maximum anticipated wave (3. 5 ft wave height as measured crest to trough) during the 5 percent exceedance duration stage (460.0 ft), it is slightly less than the 50 percent exceedance probability (2-yr) elevation at the upstream end of the alignment, and is 3 feet above the average of the pool operating limits (458.85 ft). In general, the existing ground elevation along the alignment of the riprap breakwater falls between 456 and 458 feet, see Plates 10 and 11, Appendix L.

3.5.3. Construction Considerations. Only common construction materials are required for this Project and can likely be obtained from local sources. Riprap will be barged to the site. Refer to the Geotechnical Appendix for information on gradation sizes.

Coordination with the IL DNR personnel may be required prior to working during the waterfowl hunting seasons. During peak hunting weekends or dates, all or some construction activities may be required to cease for a short period of time.

3.5.4. Monitoring During Construction. The Contractor will be required to furnish the use of boats and/or laborers to the Corps as may be reasonably necessary for inspecting and monitoring the work from all points on shore to and from the various pieces of floating plant.

During construction, prior to materials being delivered to the job site, visual inspections of the riprap may be performed by the Corps. If during these inspections, it is suspected that the material quality, gradation, or weights of riprap being furnished are not as specified, supplemental sampling and testing by the Contractor may be required.

3.5.6. Construction Sequence. It is recommended that the Contractor initiate riprap placement at the upstream end to establish the tie in to higher ground. However, no construction sequence will be required contractually. All construction should be accomplished within one construction season.

3.5.7. Permits

Section 401/404 Permits. Construction in the floodway requires compliance with Section 404 of the Clean Water Act. The purpose of the Clean Water Act was to restore and maintain the integrity of the Nation's waters. Section 404 requires mitigating for loss of wetlands. For this Project, there are no affected wetlands; therefore, mitigation is not required. Section 404 also requires compliance with Section 401 of the Clean Water Act. The Illinois Environmental Protection Agency (IL EPA) reviews the Section 401 portion of the joint permit application. The permit application will include the P&S. These permits are typically obtained by the Corps prior to award of the construction contract and provided to the Contractor.

Floodway Permit. The IL DNR issues permits for construction activities in the floodways of rivers, lakes and streams. The permit application includes the hydraulic modeling of the proposed Project to evaluate its affect on flood heights, refer to Appendix H. Flood heights cannot be adversely affected by new projects. This permit is typically obtained by the Corps prior to award of the construction contract and provided to the Contractor.

National Pollutant Discharge Elimination System (NPDES) Permit. A storm water discharge or NPDES permit is required when construction activities disturb more than one acre. The Contractor will need to apply for this permit as part of the construction contract. In addition to this permit, the Corps will require an environmental protection plan that includes an erosion and sediment control plan or Storm Water Pollution Prevention Plan.

Other Permits. The contractor may be required to comply with other local permit requirements and ordinances.

3.6. Operation, Maintenance, Repair, Rehabilitation, and Replacement

3.6.1. Operation. In general, operation requirements will be limited to routine annual inspections to ensure that the breakwater is performing as designed. The estimated annual operation costs are provided in the Cost Estimate section.

3.6.2. Maintenance. The Project will have low annual maintenance requirements. Maintenance for the breakwater will include replacing riprap and removing debris. The estimated annual maintenance costs are presented in the Cost Estimate section. Maintenance requirements will be further detailed in the Project's Operation and Maintenance (O&M) Manual published after construction is finished.

3.6.3. Repair, Rehabilitation and Replacement Considerations. Repair, rehabilitation and replacement considerations may extend outside of the typical 50 year period of analysis, as the Sponsor is expected to operate and maintain the Project until it is no longer authorized. Rehabilitation is the reconstructive work that significantly exceeds the annual operation and maintenance requirements and is needed as a result of major storms or flood events. Estimates of rehabilitation costs will be included in the operation and maintenance manual.

3.7. Cost Estimates

Table 13 compares costs for the fully funded estimate (FFE) and the current work estimate (CWE), see Cost Estimate Appendix for additional details. 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 Project construction. Quantities and costs may vary during design. All cost estimates are calculated using present worth.

Table 13. Project Design and Construction Cost Estimates
(May 2013 Price Level – 50 year period of analysis using 3.75 discount rate)

Account	Feature	FFE [1]	CWE
10	Breakwater & Seawalls	$3,025,000	$2,970,000
10	Adaptive Management	$690,000	$611,000
01	Lands and Damages	$0	$0
22	Feasibility Studies	$840,316	$0
30	Planning, Engineering & Design	$304,000	$302,000
31	Construction Management	$313,000	$302,000
Project Costs Subject to Cost Sharing		**$5,172,000**	**$4,186,000**
Non-Federal Cost [2]		**$1,810,200**	**$1,465,000**
Federal Cost [2]		**$3,361,800**	**$2,721,000**

[1] Fully funded estimate is based on the presumed midpoint of construction, FY15 Quarter 3.
[2] All Project features are subject to 65 percent Federal and 35 percent non-Federal cost share.

The annual O&M costs are the responsibility of the NFS. Therefore these costs are independent of the aforementioned Project costs. The estimated annual O&M costs are $30,432 as indicated in table 14. These quantities and costs may change during design.

Table 14. Annual O&M Cost Estimates
(May 2013 Price Level – 50 year period of analysis using 3.75 discount rate)

Task	Quantity	Unit	Unit Price	Total Cost
Operation				
Site Inspection	34	HR	$50	$1,702
Maintenance				
Riprap Replacement	371	TN	$73	$27,028
Debris Removal	34	HR	$50	$1,702
Total O&M Costs				**$30,432**

3.7.1. Schedule for Design and Construction. Scheduling of the design stage and award of the construction contract would largely depend on availability of funds (table 15).

Table 15. Starved Rock Implementation Schedule

Milestone	Date
ATR of Draft Report	July 2013
IPR #4 of Draft Report	August 2013
MVD IPR Guidance Memo	August 2013
Public Review of Draft Report	September 2013
Submit Final Draft	October 2013
Construction Approval by MVD	November 2013
Initiate permit application	November 2013
Obtain permits	May 2014
Final Plans and Specifications	May 2014
Execute the Project Partnership Agreement	June 2014
Advertise Contract	August 2014
Award Contract	September 2014
Complete Construction	February 2015

3.7.2. Monitoring and Adaptive Management Costs. Monitoring the changes at a project site is not a simple task. Ecosystems are dynamic systems where populations of macroinvertebrates, fish, birds, and other organisms fluctuate with natural cycles. Water quality also varies, particularly as seasonal and annual weather patterns change. The task of tracking environmental changes can be difficult. This is why the monitoring plan, although a significant portion of the total Project cost, is essential to determine ecological success. Annualized costs for monitoring and adaptively managing the Project are summarized in tables 16 and 17, respectively. The estimated total annual adaptive management cost is cost $611,000. More information regarding monitoring and adaptive management can be found in Section 3, Appendix C, *Adaptive Management and Monitoring.*

Table 16. Monitoring Costs
(May 2013 Price Level – 50 year period of analysis using 3.75 discount rate)

Monitoring Element	Total Cost	Measure
SAV Evaluations (annually for 10 years)	$134,862	Project Monitoring Costs
Water Quality Monitoring (annual for 10 years)	$252,867	
Topographic Survey (every 5 years)	$16,650	
Reports (annually for 10 years)	$109,576	
Cost	**$513,955**	

Table 17. Adaptive Management Costs
(May 2013 Price Level – 50 year period of analysis using 3.75 discount rate)

Monitoring Element	Total Cost	Measure
Plant production, years 1-5	$25,287	Adaptive Management Costs
Materials, years 1-5	$16,858	
Planting, years 1-5	$42,144	
Cost	**$84,298**	

3.8. Project Performance Assessment. The Project performance assessment will allow measurement of differences from baseline conditions for key physical and biological factors. This should allow a quantitative determination of improvement and assessment of whether features are functioning as intended.

3.8.1. Monitoring Matrix. Table 18 presents overall types, purposes, and responsibilities of monitoring and data collection.

3.8.2. Data Collection Summary. Table 19 presents actual monitoring and data parameters grouped by Project phase, as well as data collection intervals.

3.8.3. Adaptive Management and Monitoring Plan. An effective monitoring program is necessary to assess the status of ecological health and biota richness and abundance per project. The achievement of the project success criteria are based on water clarity, velocity and abundance of SAV. Measurement of these parameters over a 1-5 year period, given the variability of the system, is not likely to result in discernible trends leading to a conclusion of success. Therefore additional time is required to reduce this uncertainty. If conditions are favorable within the first 5 years to determine that the project is successful, then additional monitoring will not be undertaken. Information gathered under this monitoring plan will provide insights into the effectiveness of the Project and indicate if goals have been met, if actions should continue, and whether adaptive management measures are warranted. Since little is known about SAV survival monitoring will also provides important feedback for future SAV projects. Adaptive management and monitoring are discussed in more detail in Appendix C, *Adaptive Management and Monitoring.* Table 20 presents the adaptive management and monitoring plan, which displays parameters for Project success and adaptive management measures.

Table 18. Monitoring Matrix

Project Phase	Type of Activity	Purpose	Responsible Agency	Implementing Agency	Funding Source
Feasibility	Resource Monitoring	Establish baselines for problem identification and performance evaluation	Corps/Sponsor	Corps/Sponsor	Corps/Sponsor
	Problem Analysis	Identify system-wide problems based on data and observations. Identify site-specific problems consistent with project goals and objectives	Corps/Sponsor	Corps/Sponsor	Corps/Sponsor
	Project Feature Data Collection	Establish need of proposed project features consistent with goals and objectives	Corps	Corps	Corps/Sponsor
Design	Data Collection for Design	Include quantification of project objectives, design of project, and development of Performance Evaluation Plan	Corps	Corps	Corps
Construction	Construction Monitoring	Assess construction impacts; assure permit conditions are met	Corps	Corps	Corps
Post-Construction	Adaptive Management	Determine success of project as related to goals and objectives	Corps/Sponsor	Corps/Sponsor	Corps/Sponsor

Table 19. Resource Monitoring and Data Collection Summary [1]

	WATER QUALITY DATA			ENGINEERING DATA			NATURAL RESOURCE DATA				
	Pre-Project Phase	Design Phase	Post-Construction Phase	Pre-Project Phase	Design Phase	Post-Construction Phase	Pre-Project Phase	Design Phase	Post-Construction Phase		
Type Measurement	**Jun-Sep**	**Jun-Sep**	**Jun-Sep**							**Agcy**	**Remarks**
Point Measurements											
Water Quality Stations [2]										Corps	
Air Temperature	2W	2W	2W								
Wind Direction	2W	2W	2W								
Wind Velocity	2W	2W	2W								
Percent Cloud Cover	2W	2W	2W								
Wave Height	2W	2W	2W								
Water Depth	2W	2W	2W								
Velocity	2W	2W	2W								
Dissolved Oxygen	2W	2W	2W								
Water Temperature	2W	2W	2W								
pH	2W	2W	2W								
Specific Conductance	2W	2W	2W								
Total Alkalinity	2W	2W	2W								
Secchi Disk Transparency	2W	2W	2W								
Turbidity	2W	2W	2W								
Suspended Solids	2W	2W	2W								
Chlorophyll	2W	2W	2W								
Photosynthetically Active Radiation	2W	2W	2W								
Boring Stations [3]											
Geotechnical Borings				1	1					Corps	
Survey											
Vegetation Survey[4]							1	1	Y	Corps IL DNR	
Topographic Survey[5]				1	1	5Y				Corps	
Mapping											
Aerial Imagery[6]							Y	Y	Y	Corps	

Legend for Table 16

W = Weekly	nW = n-Week Interval
M = Monthly	nY = n-Year Interval
Y = Yearly	1,2,3 = Number of times data is collected within designated Project phase

1 See Plate 16 for post construction phase monitoring Note that the information presented in this table includes data obtained to develop the project (Pre-Project Phase), during the project design, and Post Construction phase.

2 Pre-Project water quality stations are shown on Plate 15.

Post-Construction water quality stations are shown on Plate 16. Post Construction Monitoring of water quality will stop after the adaptive management period of 10 years.

3 See Plate 5 for geotechnical boring locations and Plates 6 for boring logs and dates.

4 Vegetation survey will begin as Adaptive Management after construction and after year 11 as O&M monitoring to determine the effectiveness of planting measures following construction.

5 Topographic surveys will be conducted similar to the past survey in the Project area. Post Construction Monitoring of topographic surveys will stop after the adaptive management period of 10 years.

6 Aerial imagery will be obtained at no cost from GIS resources such as National Agriculture Imagery Program (NAIP). A review of the aerial imagery will assist with determining overall project effectiveness.

Table 20. Ecological Success Criteria

Goal	Criteria	Success	Monitoring	Adaptive Management
Restore Submerged Aquatic Vegetation in Starved Rock Pool	Coverage of Submerged Aquatic	>30 acres	Vegetation Survey	Plantings Materials Exclosures
	Water Velocity	5 cm/sec	water quality	
	Water Clarity	TSS < 25 mg/l Turbidity < 20 NTU Light Extinction < 3.42 m^{-1} Secchi disk depth > 0.5 m	water quality stations	
Improve Spawning and Nursery Habitat for Native Fish	Coverage of Submerged Aquatic Vegetation	>30 acres	vegetation survey	
	Water Velocity	5 cm/sec	water quality stations	
	Turbidity	< 20 NTU	water quality stations	
Increase Area and Quality of Resting and Feeding Habitat for Migratory Water Birds	Coverage of Submerged Aquatic Vegetation	>30 acres	vegetation survey	
Water depth supports SAV	>1 1/2 ft	Sedimentation behind breakwater is not increased	Topographic Survey	NA

3.9. Real Estate Considerations

Lands within the Project area are presently owned by the State of Illinois however, navigation servitude does apply for this Project. No credit will be given for lands that are available to the project through the exercise of navigation servitude. Access to the site will be by water (Illinois River). A public boat ramp is located at Starved Rock State Park. The staging area for temporary construction offices will be located at the Starved Rock L&D and will need to be coordinated with L&D personnel. No material storage will be allowed at the staging area. A map showing the Project area is included on figure 1 of this report. There are no proposed Public Law 91-646 relocations as there are no acquisitions required. There are no known hazardous, toxic, or radioactive sites within the Project area.

3.10. Environmental Effects

The following sections describe the potential environmental effects the proposed Project, non-preferred alternatives and the future without project conditions may have on the resources addressed in Section 2.2, *Assessment of Problems and Existing Conditions*. The discussion is organized by potential direct, indirect, and cumulative effects on the impaired resources: submerged aquatic vegetation, resting and feeding habitat for migratory water birds, and improved spawning and rearing habitat for native fish.

3.10.1. Submersed Aquatic Vegetation. Potential SAV distribution and abundance was estimated using multiple lines of evidence pointing to the same general conclusion that plants will occupy about 60 to 80 acres when physical stressors are reduced. Indirect effects may extend slightly downstream to improve opportunities for SAV near the Project area. Cumulative effects of increased SAV should be positive because they improve ecosystem productivity and physical structure.

Non-preferred alternatives reduce wind-wave physical effects on SAV, but do not reduce current velocity sufficiently to support SAV. Environmental effects from No Action would likely be infrequent SAV occurrence during drought or navigation closures.

3.10.2. Centrarchid Fishes. Centrarchids were represented using bluegill sunfish habitat suitability in alternative analysis. The rock breakwater will reduce current velocity to acceptable levels in 160 acres within the total Project area during the spring and summer spawning and rearing seasons. Creating slackwater habitat will potentially increase centrarchid populations through increased reproduction. Increased SAV abundance will provide adult fish habitat that is largely absent now. Indirect effects of improved reproduction should be expressed as increased centrarchid populations in the Starved Rock Pool.

Non-preferred alternatives do not reduce current velocity sufficiently to support centrarchid spawning and would not likely effect local populations. Environmental effects from No Action include current and boat waves that introduce flow into the project area.

3.10.3. Migratory Waterfowl. Migratory waterfowl benefits accrue from the anticipated increase in SAV. A waterfowl bioenergetic model used to evaluate alternatives estimated an increased carrying capacity of 16,000 DUDs. Indirect benefits of improved migratory waterfowl feeding opportunities may translate to increased fitness on the nest and better reproductive rates.

Non-preferred alternatives reduce wind-wave physical effects on SAV, but do not reduce current velocity sufficiently to support SAV which provides waterfowl habitat. Environmental effects from No Action would likely be infrequent SAV occurrence during drought or navigation closures.

3.10.4. Invasive Species. All project alternatives considered do not authorize or carry-out any actions which are likely to promote invasive species proliferation (i. e., silver carp, bighead carp, round goby, white perch, reed canary grass, zebra mussel, etc) beyond the no action alternative. The addition of hard substrate has potential for colonization by zebra mussels, but zebra mussel density is greatly reduced since their initial invasion during the 1990s. We do not anticipate a large population response from zebra mussels beyond the no project alternative. Any subsequent occurrence of any invasive species in the Project vicinity should not be the result of the implementation of this Project.

The Recommended Plan is consistent with Strategy 3.2.3 indentified 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 resource managers decide if the native biological communities are more sustainable with or without specific projects to enhance the aquatic environment.

3.10.5. Endangered and Threatened Species. All project alternatives considered will have no effect on Federal or state listed endangered or threatened species. The USFWS concurred with these determinations through a coordination letter dated September 25, 2013.

3.10.6. Direct Effects

- **Indiana bat.** All project alternatives considered have no direct impacts to the Indiana Bat since there is no suitable habitat for the Indiana bat in the Project area.
- **Sheepnose mussels.** All project alternatives considered have no direct impact on sheepnose mussel since they historically occurred in the Illinois River but there are no known populations currently in Starved Rock Pool. Mussels occur along the project alignment sporadically but do not appear to be a significant aggregation.
- **Decurrent false aster**. All project alternatives considered have no direct impacts to the decurrent false aster since a visual inspection shows they are not present in the Project area.
- **Eastern prairie fringed orchid.** All project alternatives considered have no direct impacts to the eastern prairie fringed orchid because they are not an aquatic species.
- **Prairie bush clover.** All project alternatives considered have no direct impacts to the prairie bush clover because they are not an aquatic species.
- **State-listed Species.** None of the State-listed endangered or threatened species listed in table 2b and no rare natural communities are expected to be adversely affected by any project alternative considered.

3.10.7. Indirect Effects. There are no indirect effects to endangered species caused by or resulting from the proposed action or any project alternative considered.

3.10.8. Hazardous, Toxic, and Radioactive Waste. Implementation of this Project and all project alternatives considered will not have an effect on current conditions of hazardous, toxic, and radiological waste in the Project area (*see* Appendix E, *Hazardous, Toxic, and Radioactive Waste*).

3.10.9. Historic and Cultural Resources. The District has determined there will be no historic properties affected by the proposed Project or all project alternatives considered. The District provided this determination to the Illinois SHPO by letter dated January 15, 2013. After reviewing this information, the SHPO concurred with the Corps determination by letter dated January 25, 2013 (IHPA# 016011813) (Appendix A).

The District also received requests from the Ho-Chunk Nation and the Forest County Potawatomi Community to remain interested parties in the Project because the Project area is within the aboriginal area of the two Tribes. Initially, the Ho-Chunk Nation had requested a Memorandum of Agreement be completed to address the Tribes concerns. In follow up discussions Tribal representatives from the Ho-Chunk Nation indicated there is no longer need for a Memorandum of Agreement (e-mail communications with MVR Cultural Resources).

3.10.10. Hydrology and Hydraulics

3.10.10.1. Water Velocity. High discharge current velocities common during spawning season will be reduced in 160 acres behind the breakwater structure by the proposed project, whereas floating breakwater alternatives did not reduce current impacts..

3.10.10.2. Sedimentation. The proposed Project or alternatives considered will not change the rate of sedimentation in the Project area. Geotechnical and hydraulic experts concur that most of the site is in a dynamic equilibrium of sediment transport that prevents vertical accretion in the Project area except during floods. Island growth is expected to continue at a rate of approximately 1 acre each year.

3.10.11. Socioeconomic Resources

All conclusions regarding socioeconomic resources apply equally to all alternatives considered.

3.10.11.1. Community and Regional Growth. No short-term or long-term impacts to the growth of the neighboring community or region would be realized as a result of the Project. The Project would improve recreation opportunities at the Starved Rock State Park, and maintain the attractiveness of the area for wildlife observation, waterfowl hunting, sport fishing, boating, photography, and commercial fishing.

3.10.11.2. Community Cohesion. The proposed aquatic 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.

3.10.11.3. Displacement of People. There are no residential properties in the study area that would be displaced by the proposed Project.

3.10.11.4. Property Values and Tax Revenues. The Starved Rock Pool Project area is state-owned land. No change in property values or tax revenues would occur.

3.10.11.5. Public Facilities and Services. The proposed Project would positively impact public facilities and services by increasing habitat diversity, resulting in additional opportunities for recreational use of the area.

3.10.11.6. Life, Health, and Safety. The Project poses no threats to the life, health, or safety of persons in the area. An HTRW assessment was conducted and no obvious indications of potential contamination sources were noted.

3.10.11.7. Business and Industrial Activity. No overall changes in business and industrial activities would occur during Project construction. Long-term impacts to business and industrial development would be related to tourism and recreational activities. The Project poses a possible temporary impact to navigation during construction.

3.10.11.8. Employment and Labor Force. The Project would not directly affect permanent employment of the labor force in LaSalle County, Illinois.

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

3.10.11.10. Aesthetic Values. A rock breakwater to create backwater habitat would be visible above the water line. The enhancement of habitat areas would make the area more aesthetically pleasing to Starved Rock State Park visitors viewing waterfowl attracted to the site.

3.10.9.11. Noise Levels. Heavy machinery would generate a temporary increase in noise levels during Project construction, disturbing wildlife and recreationists in the area.

3.10.12. 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. Cumulative impacts for the Illinois River Basin Restoration Program can be found in Section 5C of the Illinois River Basin Restoration Comprehensive Plan (2007).

The primary area considered for the cumulative effects analysis for this study is limited to Starved Rock Pool for the period since impoundment (ca. 1930s) and 50 years into the future. Cumulative impacts apply equally across all alternatives considered in this study unless noted.

3.10.12.1 Past Actions. The most significant action in Starved Rock Pool was the authorization, construction, and operation and maintenance of the 9-foot channel project. Construction of Starved Rock L&D raised water levels by 17 feet. Floodplains in the reach are now permanently inundated. Temporarily inundated wetlands were converted to permanently inundated lakes and sloughs. Several fluvial processes were disrupted, which include sediment transport and hydrologic fluctuations. The effects from the construction can still be seen today with decreased vegetation diversity and shallow channel border habitat resulting from “pool aging” (Lubinski 1999).

3.10.12.2 Present and Foreseeable Actions. The Corps continues the operation and maintenance of the 9-foot channel project. This includes continuation of dredging and placement of material within the study area.

3.10.12.3 Probable Adverse Impacts Which Cannot Be Avoided. The loss of some benthic organisms currently inhabiting the footprint areas of rip rap placement is a likely effect of the proposed action. Following construction, benthic organisms should rapidly colonize the new rock structure, especially the added habitat created with stone placement and aquatic vegetation restoration. Loss of habitat would be less with floating wave barrier alternatives, but they would also not support benthic invertebrates as rip rap rock does. The No Action alternative would not induce additional impacts.

3.10.12.4 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 the Project. Long-term productivity would be enhanced through increased submersed aquatic vegetation and providing more dependable reproduction, foraging and resting areas for migratory, 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 nonconsumptive users would realize heightened opportunities for recreational use of the reach. Negative long-term impacts are expected to be minimal on all ecosystems associated with the Project.

Non-preferred alternatives would not increase biological productivity of the project area.

3.10.12.5 Irreversible or Irretrievable Resource Commitments. The purchase of materials and the commitment of man-hours, fuel, and machinery to perform the Project are irretrievable. Other than the aforementioned, none of the proposed actions are considered irreversible.

3.10.12.6 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 District does not expect the proposed action to alter or conflict with other authorized Corps projects.

3.10.13 Compliance with Environmental Statutes. Table 21 illustrates compliance with environmental statutes.

Table 21. 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 U.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. 4321, et seq.	Full Compliance
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 required.

3.11. Environmental Operating Principles (EOP) (2012)

Throughout the study the team incorporated the seven Corps EOPs by fostering sustainability, considering the environmental consequences of the alternatives, create mutually supporting economic and environmentally sustainable solutions, continue to meet our corporate responsibility and account for activities which may impact human and natural environments, employing a risk management and systems approach to the environment, used scientific, economic, and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner, employ an open, transparent process that respects views of individuals and groups interested in Corps activities.

SECTION 4 – PLAN IMPLEMENTATION

This section presents the requirements for implementing the Recommended Plan, including Federal and non-Federal cost sharing, and the division of responsibilities between the Federal Government, the Sponsor, the IL DNR. It also lists the major milestones necessary for project approval and a schedule of milestones associated with designing and constructing the Recommended Plan.

4.1. Division of Plan Responsibility

4.1.1. Recommended Plan Cost Sharing. Federal and non-Federal cost sharing for the Recommended Plan is in accordance with Section 519 of the Water Resources Development Acts of 2000 and 2007 (table 22). Ecosystem restoration projects require that the NFS share of the first cost of the project or the separable element be 35 percent. Non-Federal Sponsors would provide 100 percent of any lands, easements, rights-of-way, relocations of utilities or other existing structures, and disposal areas (LERRDs). The value of LERRDs would be included in the non-Federal 35 percent share. Where the LERRDs exceed the NFS 35 percent share, the NFS would be reimbursed for the value of the LERRDs that exceed the 35 percent share. The NFS is also responsible for 100 percent of the costs for operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) of Project features.

Table 22. Project Cost Sharing
(May 2013 Price Level – 50 year period of analysis using 3.75 discount rate)

Starved Rock Pool Side Channels and Islands					
		Non-Federal Sponsor		**Federal**	
Project Feature	**Cost**	**%**	**Cost**	**%**	**Cost**
First Cost of Construction	$2,970,000	35%	$1,039,500	65%	$1,930,500
Monitoring and Adaptive Mgmt	$611,000	35%	$213,850	65%	$397,150
PED	$302,000	35%	$105,700	65%	$196,300
Construction Management	$302,000	35%	$105,700	65%	$196,300
Total Project Cost	**$4,186,000**	**35%**	**$1,465,000**	**65%**	**$2,721,000**
LERRD Credit	$0	100%	$0	0%	$0
Cash			$1,465,000		$2,721,000
OMRR&R (average annual)	$30,432	100%	$30,432	0%	$0

4.1.2. Federal Responsibility. The Federal Government would provide 65% of the first cost of implementing the Recommended Plan including Preconstruction Engineering and Design (PED), construction, and construction management, which is estimated to total $4,186,000. In addition to its financial responsibility, the Federal Government would:

- design and prepare P&S for construction of the Recommended Plan; and
- administer and manage contracts for construction and supervision of the project after authorization, funding, and execution of a Project Partnership Agreement (PPA) with the IL DNR.

4.1.3. Non-Federal Responsibility. The IL DNR would be responsible for providing 35% of the First Cost of implementing the Recommended Plan. The 35% share of the Project cost includes the IL DNR's responsibility for providing all LERRDs. The estimated costs are $1,465,000 in cash with $0 in LERRD credit.

The IL DNR also would be responsible for OMRR&R of Project features. The operation and maintenance costs are anticipated to be over the 50-year period of analysis, at an average annual cost of $30,432.

The IL DNR also would be required to provide certain local cooperation items based on Federal law and policies. The items of local cooperation are:

(a). Provide a minimum of 35 percent of total project costs as further specified below:

(1) Provide, during the first year of construction, any additional funds needed to cover the non-Federal share of design costs;

(2) Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material that the Government determines to be necessary for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project;

(3) Provide, during construction, any additional funds necessary to make its total contribution equal to 35 percent of the total project costs allocated to the project;

(b). Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project;

(c). Not use funds provided by a Federal agency under any other Federal program, to satisfy, in whole or in part, the non-Federal share of the cost of the project unless the Federal agency that provides the funds determines that the funds are authorized to be used to carry out the study or project;

(d). Not use project or lands, easements, and rights-of-way required for the project as a wetlands bank or mitigation credit for any other project;

(e). For as long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the project, or functional portion of the project, including mitigation, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and state laws and regulations and any specific directions prescribed by the Federal Government;

(f). Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal Sponsor, now or hereafter, owns or controls for access to the project for the purpose of inspecting, operating, maintaining, repairing, replacing, rehabilitating, or completing the project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal Government shall relieve the non-Federal Sponsor of responsibility to meet its obligations, or to preclude the Federal Government from pursuing any other remedy at law or equity to ensure faithful performance;

(g). Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the United States or its contractors;

(h). Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public

Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the initial construction, periodic nourishment, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal Sponsor with prior specific written direction, in which case the non-Federal Sponsor shall perform such investigations in accordance with such written direction;

(i). Assume, as between the Federal Government and the non-Federal Sponsor, complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the initial construction, periodic nourishment, operation, or maintenance of the project;

(j). Agree that, as between the Federal Government and the non-Federal Sponsor, the non-Federal Sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, and repair the project in a manner that would not cause liability to arise under CERCLA;

(k). Prevent obstructions of or encroachments on the project (including prescribing and enforcing regulations to prevent such obstruction or encroachments) which might reduce ecosystem restoration benefits, hinder operation and maintenance, or interfere with the project's proper function, such as any new developments on project lands or the addition of facilities which would degrade the benefits of the project;

(l). Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as would properly reflect total costs of construction of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33. 20;

(m). Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5), and Section 103 of the WRDA of 1986, Public Law 99-662, as amended (33 U.S.C. 2213), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal Sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

(n). Comply with all applicable Federal and state laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army," and all applicable Federal labor standards and requirements, including but not limited to 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying, and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c et seq.); and

(o). Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for the initial construction, periodic nourishment, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

4.2. Institutional Requirements

4.2.1. Sponsorship Agreement. Prior to the start of construction, the IL DNR will be required to enter into a PPA with the Federal Government and satisfy state laws and all applicable regulations. A number of the items required in the PPA have been outlined in the previous paragraphs.

4.2.2. Financial Analysis. The Non-Federal Sponsor's Self-Certification of Financial Capability was provided on TBD and can be found in Appendix A, *Pertinent Correspondence*.

4.2.3. Local Cooperation. The Letter of Intent from the IL DNR is pending.

4.2.4. Project Management Plan. A Project Management Plan (PMP) for implementation of the Recommended Plan was prepared. The PMP describes activities, responsibilities, schedules, and costs required for the P&S phase and construction of the project. The P&S phase will last for an estimated 8 months at a total cost of $302,000.

4.2.5. Project Implementation Schedule. The schedule for the feasibility study is for the final report to be forwarded to MVD in September 2013. Initiation of Plans & Specs will occur in October 2013. The PED phase will continue, pending receipt of additional CG funds. Stage I Plans & Spec is complete. The PED phase includes refinements to the design of the Recommended Plan, detailed bathymetric and topographic surveys, habitat and species surveys, bioassay surveys, and chemical, grain size, and density tests of the material to be dredged. Acquisition of LERRDs by the Sponsor is anticipated to take 0 months and be completed already. An advertisement in the Federal Business Opportunities (FedBusOps) will be prepared during August 2014for the solicitation of bids for construction, and the process of receiving bids and awarding construction will be completed by September 2014. Construction could begin in October 2014 and be completed by February 2014.

4.2.6. Views of the NFS and Any Other Agencies with Implementation Responsibilities. The State of Illinois, through the IL DNR as the NFS, supports the Recommended Plan.

4.2.7. Compliance with Environmental Requirements. This document is an integrated environmental assessment with a Clean Water Act Section 404(b)(1) Evaluation and was submitted for 30-day public review. That document can be found in Appendix B.

SECTION 5 – SUMMARY OF COORDINATION, PUBLIC VIEWS, AND COMMENTS

5.1. Coordination

Throughout a feasibility study, the Corps strives to inform, educate, and involve the many groups who may have an interest in the study. This coordination is paramount to assuring that all interested parties have the opportunity to be part of the study process.
One process used for coordination is the public involvement process. Public involvement is the exchange of information with various segments of the public. It attempts to reduce unnecessary conflict and achieve consensus. The goal of public involvement and coordination is to open and maintain channels of communication with the public in order to give full consideration to public views and information in the planning process (ER 1105-2-100, Appendix B, *Public Involvement, Collaboration and Coordination*).

An effective public involvement program must identify and respond to as many affected publics as possible throughout the study and consider their input in the study's decision-making process. Content analysis is the method employed to identify public opinion, study concerns, and potential controversy. It ensures that the public involvement plan is responsive to the level of interest and concern expressed by the public, and it assesses the effectiveness of the public involvement techniques.

As stated in Section 1.1 of this report the Starved Rock Pool Side Channel and Islands was determined to be a critical restoration project during the Illinois River Basin Restoration Comprehensive Plan (2007). The public for this study refers to the IL DNR; elected congressional representatives; Federal, state, county, and city governmental agencies; environmental groups/organizations; farm bureaus; levee and drainage districts; businesses; media; and the unaffiliated general public. Public involvement included such things as newsletters, open houses, and public meetings. All public comments are part of the Illinois River Basin Restoration Comprehensive Plan (2007).

The Starved Rock Pool Side Channel and Island Critical Restoration The public for this study refers to the project cost share holder IL DNR; elected congressional representatives; Federal, state, county, and city governmental agencies; environmental groups/organizations; farm bureaus; levee and drainage districts; businesses; media; and the unaffiliated general public. Correspondence from Federal and state agencies can be found in Appendix A. A public meeting was held on September 4, 2013.

5.2. Public Views and Comments – September 04, 2013 Public Meeting

The *Starved Rock Pool Critical Restoration Project Draft PIR with Integrated Environmental Assessment* was distributed for a 30-day public, state, and agency review on August 27, 2013. During the public review we received comments from the. See Appendix A for more details.

During the public review period, an open house was held (September 04, 2013) in Ottawa, Illinois, to discuss the draft Recommended Plan with interested members of the public and to gather public input. Representatives from the Corps and IL DNR were present to talk one-on-one with attendees. Maps of the Recommended Plan and copies of the report were arranged around the room. In addition, hand-outs of the Project Summary, a project map, and comment sheet were available for each attendee. Nineteen members of the public attended the evening session. Eighteen comment sheets were returned.

Respondents indicated they used the area for recreation, fishing, boating, and hunting. Generally, the responses from the open house were positive.

SECTION 6 – RECOMMENDATION

I have weighed the outputs to be obtained from the full implementation of this ecosystem restoration project 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 Mississippi Valley Division Commander approve the proposed Project in Starved Rock Pool.

The Recommended Plan consists of a riprap breakwater along the northern edge of former Delbridge Island adjacent to the navigation channel between RMs 233 and 234 in Starved Rock Pool. The breakwater will be approximately 6,100 feet long and constructed to a design elevation 461.85 feet providing adequate protection to allow for submerged aquatic vegetation growth. Riprap shall conform to the requirements of Gradation RR-5 of the Illinois Department of Transportation.

The current estimated first cost of the Recommended Plan is $4,186,000. This total estimated Project cost includes construction of the Project features; planning, engineering, and design; construction management; real estate; and monitoring. Implementation would be cost shared 65 percent by the Federal Government and 35 percent by the Illinois Department of Natural Resources, the non-Federal Sponsor. The Federal contribution is estimated at $2,721,000 and the non-Federal contribution is estimated at $1,465,000. It is the IL DNR's responsibility to provide the real estate and conduct operation and maintenance. The operation and maintenance of these features is estimated to cost $30,432 annually.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of the National Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding.

12-5-13
Date

Mark J. Deschenes
Colonel, US Army
Commander & District Engineer

ILLINOIS RIVER BASIN RESTORATION
STARVED ROCK POOL
CRITICAL RESTORATION PROJECT
LA SALLE COUNTY, ILLINOIS

PROJECT IMPLEMENTATION REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

FINDING OF NO SIGNIFICANT IMPACT

In accordance with the National Environmental Policy Act, the U.S. Army Corps of Engineers, Rock Island District assessed the environmental impacts of the Project. The intent of this Project is to manage hydraulic connectivity for the promotion of submersed aquatic vegetation growth and centrarchid spawning. Starved Rock Pool is located in La Salle County, IL, 65 miles southwest of Chicago, IL. The project is adjacent to Starved Rock State Park which is the most highly visited state park in Illinois.

The Recommended Plan includes:

6100 ft rock breakwater

The finding of no significant impact is based on the following factors:

A. the Project will increase submersed aquatic vegetation

B. the Project will increase fish spawning potential

C. the Project will increase fish spawning opportunities

D. no significant social, economic, environmental, or cultural impacts are anticipated as a result of this Project

The environmental review process indicates the proposed action does not constitute a major federal action significantly affecting the environment. Therefore, preparation of an environmental impact statement is not required. This determination may be reevaluated if warranted by later developments.

12-5-13
Date

Mark J. Deschenes
Colonel, US Army
Commander & District Engineer

ILLINOIS RIVER BASIN RESTORATION
SECTION 519
PROJECT IMPLEMENTATION REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STARVED ROCK POOL CRITICAL RESTORATION PROJECT
LASALLE COUNTY, ILLINOIS

APPENDIX A

PERTINENT CORRESPONDENCE

CARMACK/vdc/5286

MAY 1 6 2008

Planning, Programs, and
Project Management Division

SEE DISTRIBUTION LIST

The Rock Island District, U.S. Army Corps of Engineers (Corps) is preparing a Project Implementation (Feasibility) Report and Supplemental Environmental Assessment (SEA) for the Starved Rock Pool Side Channels and Islands Critical Restoration Project, which is a site specific project under the Illinois River Basin Restoration Program. The project's sponsor is the Illinois Department of Natural Resources (DNR). This letter is being provided to request comments in accordance with the provisions of the Endangered Species Act of 1973, as amended, and the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661, et seq.) regarding any significant resources that may be impacted by the proposed project.

In March 2007, the Corps released the Final Illinois River Basin Restoration Comprehensive Plan (Plan) with Integrated Programmatic Environmental Assessment (EA). The programmatic EA discussed the programmatic actions and the associated beneficial and adverse effects that could result from implementation of this Plan. The EA also discussed cumulative effects associated with past, present and potential future actions within the river and associated floodplain and its basin. The EA that is being prepared for this project is tiered from the programmatic EA and will address the specific impacts of project implementation at this location.

The Illinois River Basin Restoration Program was authorized by Section 519 of the Water Resources Development Act of 2000. Section 519 authorized the identification and implementation of projects within the watershed and along the course of the river to repair past and ongoing ecological damage so that a more highly functioning, self-regulating ecosystem can develop within the existing basin context.

Starved Rock Pool is a 16-mile section of the Illinois River located approximately 65 miles southwest of Chicago. It extends from Starved Rock Lock and Dam (River Mile 231) eastward to the base of Marseilles Dam (River Mile 247). The pool is located entirely within La Salle County and has the communities of Ottawa, South Ottawa and Marseilles located along its length. The Fox River (the pool's primary tributary) enters the pool midway down its right descending bank. Several major islands (totaling approximately five miles in length) are located in the Starved Rock Pool, including Sheehan, Mayo, Hitt, Scherer, Bulls, and Bell's Island (enclosure 1).

The proposed project area for the Starved Rock Pool Side Channels and Islands Critical Restoration Project currently includes only lower Starved Rock Pool, from River Mile 231 to 235 (enclosure 2). This area includes Delbridge Island, Leopold Islands, and Gypsy Island, which are all primarily submerged, and three small unnamed islands near River Mile 234 that are above the normal pool elevation. Starved Rock State Park is located on the left descending (south) bank of the Illinois River adjacent to the project area. Leopold Islands, Gypsy Island, and the majority of Delbridge Island are currently owned by the State of Illinois. The three small unnamed islands located near River Mile 234 are privately owned. The Starved Rock Lock and Dam is located on the downstream end of the project area at River Mile 231. Two recreational boat marinas are located between River Miles 233 and 234, along the right descending (north) bank.

Through discussions with the biologists from the Illinois DNR and Illinois Natural History Survey, the primary ecological limiting factor for Starved Rock Pool was identified as a lack of Submerged Aquatic Vegetation (SAV). The lack of SAV in Starved Rock Pool is considered to be limiting both waterfowl and fisheries. This habitat type is found in areas protected from flow and wind fetch, and can typically be found in protected areas near islands and in backwaters. Currently, SAV does not occur in the Illinois River below Starved Rock Pool and is generally limited throughout the Illinois River.

The majority of the project area consists of the three small unnamed islands and a broad expanse of shallow water (1-2 feet deep). The islands are vegetated with native and non-native forbs, grasses, and volunteer trees. The navigation channel of the Illinois Waterway is located north of the primary area, and a deep side channel (10-12 feet deep) runs along the bluff south of the project area, adjacent to Starved Rock State Park. The primary project area is susceptible to sediment resuspension from wind-generated waves, tow boats, and recreational boats. Water levels in the project area remain relatively constant due to control of the navigation pool at Starved Rock Lock and Dam. The Illinois DNR has duck blinds permitted in the project area that are utilized by duck hunters.

The study team has initiated efforts to identify preliminary alternatives for measures to improve habitat conditions in lower Starved Rock Pool. The topographic diversity provided by deflection embankments or islands would help create suitable conditions for the growth of SAV, thereby benefiting fish and waterfowl. At this time, the study is focused on restoration/creation of narrow embankments or other similar features in Lower Starved Rock Pool. Deflection embankments could help to improve topographic diversity and improve habitat for fish and waterfowl. These embankments would reduce velocity and wind fetch, and provide sheltered areas, which would improve water quality conditions and potentially lead to growth of SAV. The areas delineated in yellow in enclosure 2 depict the primary areas under consideration, although other areas within the lower pool are still under consideration.

Federally-listed endangered and threatened species known to occur or potentially occurring in LaSalle County include the Indiana bat (*Myotis sodalis*), eastern prairie fringed orchid, prairie bush clover, and decurrent false aster. At this time, suitable habitat for these species does not exist within the project area. For this reason, we have determined that the proposed action will not affect these species. One candidate species for Federal listing, the sheepnose mussel (*Plethobasus cyphus*) historically occurred within the Illinois River in LaSalle County. While the sheepnose was historically documented as occurring within LaSalle County, there are no current or recent records of occurrence in or near the project area. For this reason, we have determined that the proposed project is not likely to adversely affect this species. If new information becomes available or if project plans change, these determinations will be reviewed and revised as necessary.

At this time, we are requesting your comments regarding any significant resources that might be impacted by the proposed actions. Federal- and/or State-listed threatened or endangered species are of particular concern. Also we request your assistance in identifying any additional existing significant resources that may be impacted such as mussel resources, wetlands, prime farmlands, eagle nests, conflicts with known land-use plans, floodplain issues, etc. This letter and any comments received in response serve as the initial interagency coordination required under the Fish and Wildlife Coordination Act and the Endangered Species Act.

Please provide any comments you may have regarding this proposal within 30 days of the date of this letter. A timely review of this information and a written response will be greatly appreciated. If you have any questions, please call Ms. Charlene Carmack of our Economic and Environmental Analysis Branch at 309/794-5570. Written comments may be sent to our address, ATTN: Planning, Programs, and Project Management Division (Charlene Carmack).

Sincerely,

ORIGINAL SIGNED BY

Kenneth A. Barr
Chief, Economic and
Environmental Analysis Branch

Enclosures

MFR: Initial Coordination Letter for the
Illinois River Ecosystem Restoration
GI/519 Study, Starved Rock
Pool, Illinois River Basin, IL.

CF (w/encls):
Dist File (PM)
PM-A (Hagerty/Deiss/Bollman/Jackson)
PM-F (Plumley/Thompson)
EC-DN (Hythecker)
EC-HH (Bishop/Lacina)
OD-I (Cox)
OC
RE (Cole)
EC-HQ (Beckert)
Starved Rock Lockmaster

MARK BARAN
DISTRICT CONSERVATIONIST
LA SALLE COUNTY
USDA NATURAL RESOURCES CONSERVATION SVC
1691 N 31ST RD
OTTAWA IL 61350

EDWARD BUIKEMA
DIRECTOR
FEDERAL EMERGENCY MGMT AGENCY - REG V
536 S CLARK ST 6TH FLR
CHICAGO IL 60605-1509

GARY JOHNSON
ACTING DIRECTOR
US DEPT OF INTERIOR-US GEOLOGICAL SURVEY
1201 W UNIVERSITY AVE STE 100
URBANA IL 61801

CDR PAUL MAHLER III
COMMANDING OFFICER
US COAST GUARD - MSU CHICAGO
16W 215 W 83RD ST STE D
BURR RIDGE IL 60527-7956

RICHARD NELSON
FIELD SUPERVISOR
US FISH AND WILDLIFE SERVICE
1511 47TH AVE
MOLINE IL 61265

MATT SPRENGER
REFUGE MANAGER
US FISH AND WILDLIFE SERVICE
19031E CR 2110N
HAVANA IL 62644

KEN WESTLAKE
CHIEF
ENVIRON, PLNG, & EVALUATION BR
US ENVIRONMENTAL PROTECTION AGENCY - REG 5
77 W JACKSON BLVD
CHICAGO IL 60604

HONORABLE PAT QUINN
LIEUTENANT GOVERNOR
207 STATE HOUSE
SPRINGFIELD IL 62706

DR BRIAN ANDERSON
CHIEF
IL NATURAL HISTORY SURVEY
1816 S OAK ST
CHAMPAIGN IL 61820

GARY CLARK
DIRECTOR
OFFICE OF WATER RESOURCES
IL DEPT OF NATURAL RESOURCES
ONE NATURAL RESOURCE WAY
SPRINGFIELD IL 62702-1271

KEN CLODFELTER
HENNEPIN CANAL PKWY STATE PK
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SHEFFIELD IL 61361

MIKE CONLIN
DIRECTOR
OFFICE OF RESOURCE CONSERVATION
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ONE NATURAL RESOURCES WAY
SPRINGFIELD IL 62702-1271

SAM FLOOD
ACTING DIRECTOR
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ONE NATURAL RESOURCES WAY
SPRINGFIELD IL 62702-1271

SCOTT JACOBY
GREEN RIVER SWA
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375 GAME RD
HARMON IL 61042

TOM LEVY
STARVED ROCK STATE PARK
PO BOX 509
UTICA IL 61373

RICK MOLLAHAN
CORPS OF ENGRS ECOSYS PROG
OFFICE OF RESOURCE CONSERVATION
IL DEPT OF NATURAL RESOURCES
ONE NATURAL RESOURCES WAY
SPRINGFIELD IL 62702-1271

DR GREG SASS
DIRECTOR
IL RIVER BIOLOGICAL STATION
IL NATURAL HISTORY SURVEY
704 N SCHRADER
HAVANA IL 62644

ROBERT SCHANZLE
PERMIT PROGRAM MANAGER
OFC OF REALTY AND ENVIRON PLANNING
IL DEPT OF NATURAL RESOURCES
ONE NATURAL RESOURCES WAY
SPRINGFIELD IL 62702-1271

DR JOSH STAFFORD
IL NATURAL HISTORY SURVEY
704 N SCHRADER AVE PO BOX 590
HAVANA IL 62644

MIKE WEFER
OFFICE OF WILDLIFE/MARSHALL SFWA
IL DEPT OF NATURAL RESOURCES
236 STATE RTE 26
LACON IL 61540

BRUCE YURDIN
MANAGER
WATERSHED MANAGEMENT SECTION
IL ENVIRONMENTAL PROTECTION AGENCY
1021 N GRAND AVE E
SPRINGFIELD IL 62794-9276

JERRY HICKS
CHAIRPERSON
LA SALLE CO BOARD OF SUPERVISORS
707 E ETNA RD
OTTAWA IL 61350

WAYNE EICHELKRAUT JR
COMMISSIONER OF PUBLIC PROPERTY
CITY OF OTTAWA
301 W MADISON ST
OTTAWA IL 61350

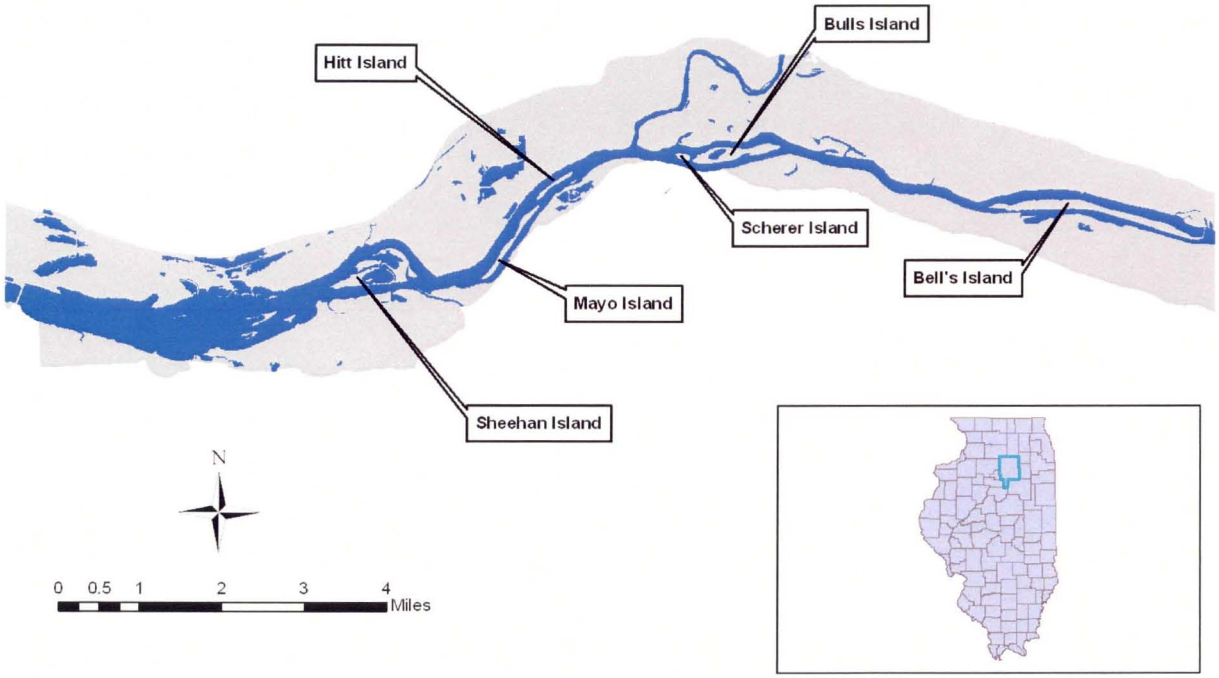
WAYNE HERNDON
JAKE WOLF FISH HATCHERY
25410 N FISH HATCHERY RD
TOPEKA IL 61567

DOUG BLODGETT
IL RVR PROJECT DIR-THE NATURE CONSERVANCY
11304 N PRAIRIE RD
LEWISTOWN IL 61542

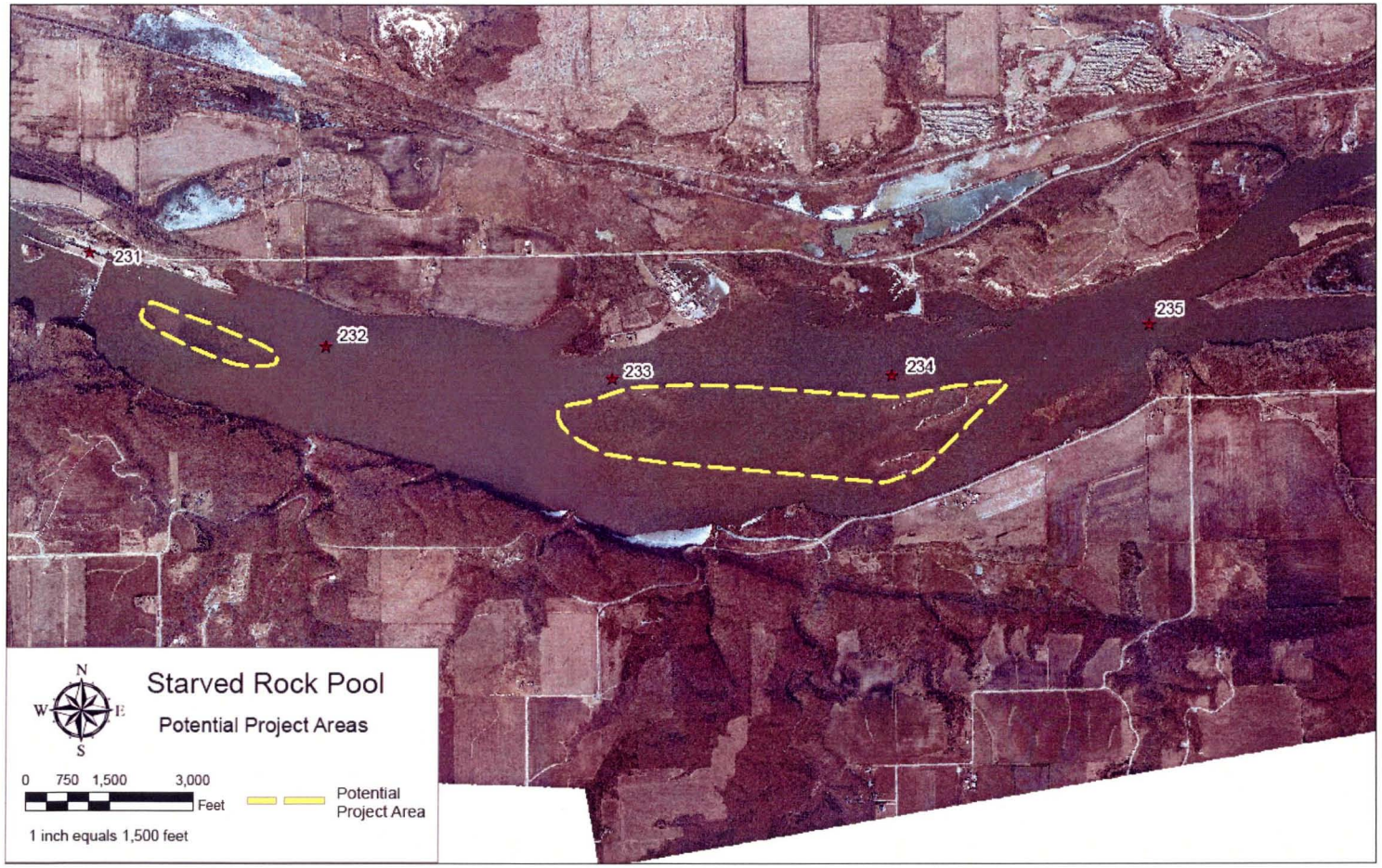
JOE LASZLO
CHAIR
HEART OF ILLINOIS SIERRA CLUB
330 S BARNEWOLT DR
PEORIA IL 61604

ROBERT SHEPHERD
PRESIDENT
ILLINOIS DIVISION
IZAAK WALTON LEAGUE
16 JULIET AVE
ROMEOVILLE IL 60446

HOLLY STOERKER
DIRECTOR
UPPER MISSISSIPPI RIVER BASIN ASSOC (UMRBA)
415 HAMM BLDG 408 ST PETER ST
ST PAUL MN 55102



Enclosure 1. General Location Map



Enclosure 2. Potential Project Areas

POTAWATOMI
(Keeper of the Fire)

Forest County Potawatomi

Cultural Center and Museum

January 31, 2012

Brant Vollman
Department of the Army
Corps of Engineers-Rock Island District
Attn; Planning, Programs, and Project Management Division
Clock Tower Building
PO Box 20604
Rock Island, Illinois 61204-2004

Re: Starved Rock Pool Side Channel and Islands Critical Restoration Project, La Salle County, Illinois

Dear Brant Vollman:

This letter is in response to the project referenced above, as provided in the letter from Kenneth Barr, dated January 15, 2013. As this project occurs within Potawatomi ancestral and previously occupied lands, we would like to express our concerns with any impacts to historic and cultural properties located within the project area of potential effect for the project mentioned above.

We appreciate receiving results of an archival review, cultural resource investigation studies, and archaeological reports. We do request to be notified when ground disturbing activities occur, and afforded the opportunity to participate in the monitoring of the project as determined by the Tribe. If any inadvertent find of cultural resources or human remains occurs, and should there be an impact or effect to these cultural properties as a result of this project, we will request consultation pursuant to Section 106 of the National Historic Preservation Act, as amended and will request adherence to Native American Graves Protection and Repatriation Act (NAGPRA).

You may send the results of the archival review, cultural resource assessments, and archaeological report to:

Forest County Potawatomi Community
Attn: Melissa Cook, Tribal Historic Preservation Officer
8130 Mish ko swen Drive
P.O. Box 340
Crandon, WI 54520
Melissa.Cook@fcpotawatomi-nsn.gov (for digital format)

If you have any questions or concerns, please contact me at 715-478-7248 or email at Melissa.Cook@fcpotawatomi-nsn.gov.

Respectfully,

Melissa Cook

Melissa Cook
Tribal 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 15, 2013

Regional Planning and Environmental
Division North (RPEDN)

SEE DISTRIBUTION LIST

The U.S. Army Corps of Engineers, Rock Island District (District) is preparing a study for the *Starved Rock Pool Side Channel and Islands Critical Restoration Project* (Project) (Enclosure 1). The Project is a component of the Illinois River Basin Restoration Program. This program was authorized by Section 519 of the Water Resources Development Act of 2000. The feasibility phase of this Project is cost shared 65/35 with the Project Sponsor, the Illinois Department of Natural Resources.

Excessive sedimentation and island erosion is causing a dramatic loss in productive backwaters, side channels, and island areas in the Illinois River basin. This loss of critical side channel and island habitat is limiting ecological health and altering the character of this unique floodplain river system. As a result of the increased sedimentation and erosion, the Illinois River has lost much of its backwater aquatic plant communities; critical spawning, nursery, and overwintering areas for fish; and habitat for diving ducks and other aquatic species. Side channels support this critical habitat because they offer shelter to aquatic plant and animal species from the main channel flow of the river. Since side channels are associated with islands, side channel restoration is directly linked to island protection and restoration. A related problem is the need for timely action. If restoration is not undertaken soon, additional productive backwater and side channel aquatic areas will be converted to lower value, and increasingly common, mudflat and extremely shallow water habitats.

Prior to inundation, the islands in Starved Rock Pool would have created diverse flow and depth conditions for fish, resting and feeding habitat for waterfowl, and would have likely provided suitable conditions for the growth of submerged aquatic vegetation (SAV). After construction of Starved Rock Lock and Dam, most of the islands were inundated. Over time, the loss of the island complex exposed aquatic plant beds to increased wind and wave action and turbidity, and eventually led to the decline of SAV in Lower Starved Rock Pool.

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 this Project has potential to cause effects to archeological and architectural historic properties [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 APE for the proposed Project is the Illinois River pool from approximately mile marker 231 to mile marker 234 (Enclosure 1). Starved Rock State Park is located on the left descending bank of the Illinois River adjacent to the Project area.

The primary goals identified for the Project are 1) restore island and associated sheltered aquatic habitat in Lower Starved Rock Pool; and 2) restore SAV in Lower Starved Rock Pool. To achieve the required conditions to promote SAV growth the following potential features are being considered in the alignment shown on the enclosure:

- Placement of a rock wall in the alignment shown. The rock wall would extend approximately 3 feet above flat pool to account for flooding.
- Placement of a floating wave barrier that is anchored to the bottom. The waver barrier floats at the surface and extends below the surface to break wave energy.
- Placement of floating islands in the alignment shown. The islands would be anchored to the bottom of the river and provide a similar structure to the wave barrier.

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.

State Historic Preservation Officer (SHPO) Invitation

The District invites the SHPO 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's plan to involve the public by utilizing the Corps' 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).

Identification of Historic Properties

Review of Existing Information and Level of Future Identification Efforts:

The Corps queried the most updated Geographic Information Systems site file database and reviewed the report entitled *An Investigation of the Submerged Historic Properties in the Upper Mississippi River and Illinois Waterway*, dated October 1997 (Contract Number DACW25-93-D-0-012, Order No. 27) for historic properties potentially affected by this Project.

There are a substantial number of previously recorded historic properties along the Illinois River adjacent to or in the APE including the Starved Rock Lock and Dam, the Zimmerman/Kaskaskia Village, and the Corbin Farm/Salt Well sites all of which have been previously listed on or determined eligible for listing on the National Register of Historic Places (NRHP) (Enclosure 2). However, none are located within the footprint of the Project and there are no shipwrecks located in the vicinity of the Project. Prior to the construction of the Starved Rock Lock and Dam during the 1930s this portion of the river was the location of Delbridge Island (Enclosure 3).

Though Delbridge Island was inundated prior to the time records of archaeological sites were recorded, there is a strong likelihood archaeological deposits were present on the island. However, based on the auger probes used for geotechnical analysis of the river bed, it is the opinion of the District that little integrity remains as a result of the inundation and scouring of the surface of the former Delbridge Island.

Hydraulic modeling was undertaken to determine if the Project could result in any increase in velocity that could in turn lead to an increase in erosion on the river banks / edge of the APE. On the right descending / north bank which is more susceptible to erosion the model revealed a slight decrease in velocity along the majority of the bank. West of the Project footprint, along the left descending or south bank of the river, which is mostly rock bluff, small areas of increased velocity were noted. Sites located in this area are mostly on the rock bluff and therefore at a higher elevation and are less susceptible to the slight increase in velocity. The portion of the APE immediately south of the Project footprint will actually receive an increase in protection because of the reduced wave action as a result of the Project.

Based on the hydraulic modeling and geotechnical analysis conducted for the Project it is the opinion of the District that there will be no adverse effect to historic properties eligible for or listed on the NRHP in the APE of the Project.

Request for Information from Consulting Parties:

The District is seeking information from all consulting parties regarding their concerns with issues relating to this undertaking's potential effects on historic properties and, particularly, the tribes' concerns with identifying properties that may be of religious and cultural significance to them and may be eligible for the NRHP [36 CFR 800.4(a)(3-4)].

Concerns about confidentiality [36 CFR 800.11(c)] regarding locations of properties can be addressed under Section 304 of the NHPA which provides withholding from public disclosure the location of properties under several circumstances, including cases where it would cause a significant invasion of privacy, impede the use of a traditional religious site by practitioners, endanger the site, etc.

The District has identified the consulting parties for this undertaking as set out in 36 CFR 800.2 and invites them by copy of this letter to participate in the Section 106 process (See Distribution List). All information gathered from this consultation shall be incorporated into the Districts decision making process.

If you have any questions regarding this matter, please call Mr. Brant Vollman of our Economic and Environmental Analysis Branch at 309/794-5857, or you may write to our address, ATTN: Planning, Programs, and Project Management Division (Brant Vollman).

Sincerely,

Kenneth A. Barr
Chief, Environmental Planning Branch RPEDN

Enclosures (3)

DISTRIBUTION LIST

Chairperson
Kickapoo of Kansas Tribal Council
1107 Goldfinch Rd
Horton, KS 66349

Chairperson
Citizen Band Potawatomi Indian Tribe of
Oklahoma Business Committee
1601 South Gordon Cooper Drive
Shawnee, OK 74801

Chairperson
Winnebago Tribal Council
P.O. Box 687
Winnebago, NE 68071

Historic Preservation Coordinator
Sac & Fox Tribe of the Mississippi in Iowa
349 Meskwaki Road
Tama, IA 52339-9629

Chairperson
Huron Potawatomi Nation
2221 1&1/2 Mile Road
Fulton, MI 49052

Chief, The Peoria Tribe of Oklahoma
P.O. Box 1527
Miami, OK 74355

Chairperson
Kickapoo Traditional Tribe of Texas
HC 1, Box 9700
Eagle Pass, TX 78853

Ms. Anne E. Haaker
Deputy State Historic Preservation Officer
Illinois Historic Preservation Agency
1 Old State Capitol Plaza
Springfield, IL 62701-1507

Tribal Historic Preservation Office
The Ho-Chunk Nation
P.O. Box 667
Black River Falls, WI 54615-0667

Chief, Miami Tribe of Oklahoma
P.O. Box 1326
Miami, OK 74355

Chairperson
Hannahville Indian Community Council
N14911 Hannahville B1 Road
Wilson, MI 49896-9728

Chairperson
Prairie Band Potawatomi Tribal Council
16281 Q Road
Mayetta, KS 66509

Chairperson
Kickapoo of Oklahoma Business Council
P.O. Box 70
McCloud, OK 74851

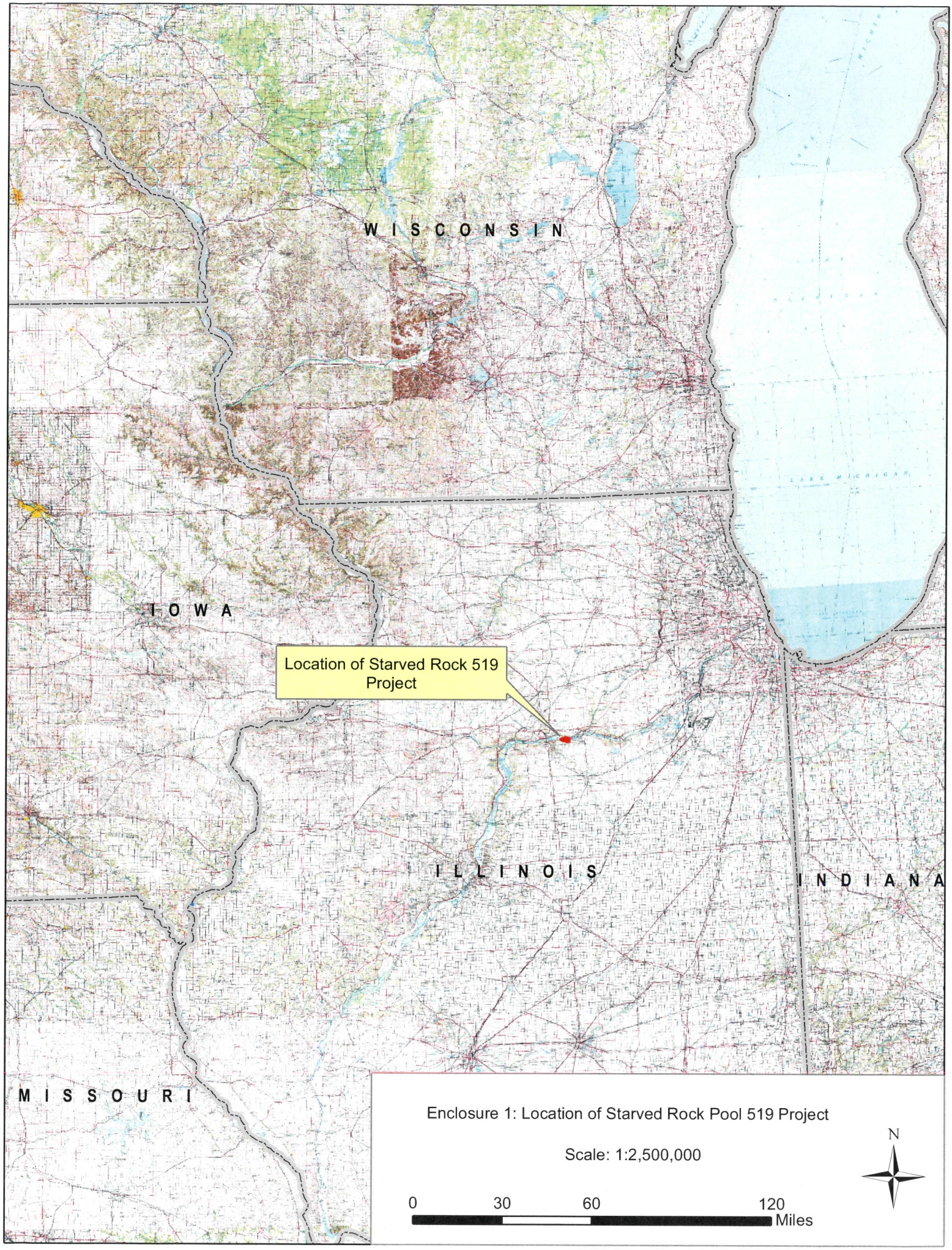
Kickapoo Tribe of Indians of the
Kickapoo Reservation in Kansas
P.O. Box 270
Horton, KS 66439

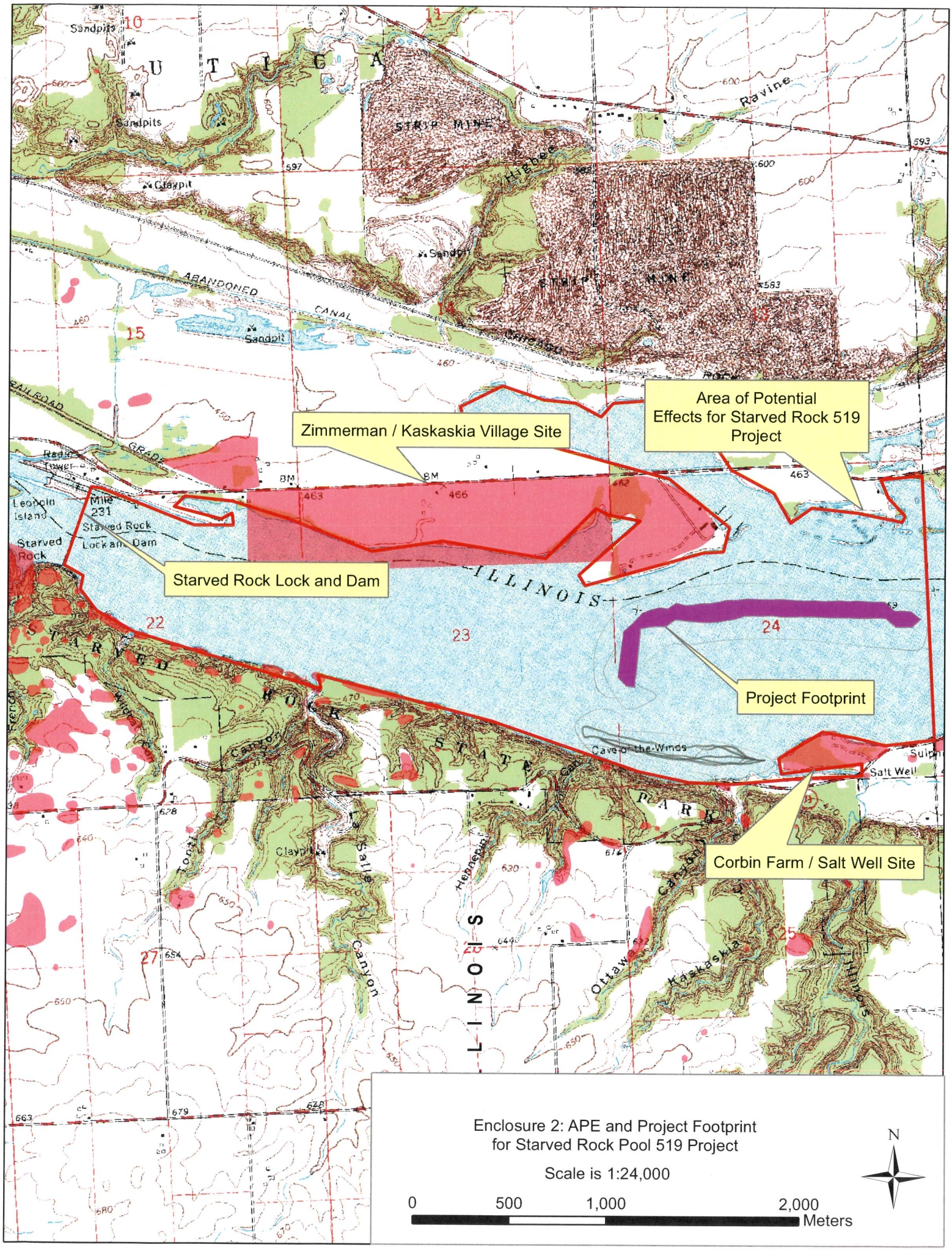
Cultural Preservation Officer
Winnebago Tribe of Nebraska
Tribal Council
P.O. Box 687
Winnebago, NE 68071

Forest County Potawatomi Cultural Center
P.O. Box 340
Crandon, WI 54520

Chairperson
Pokagon Band of Potawatomi Indians
53237 Town Hall Road
Dowagiac, MI 49047

Dr. Harold Hassen
Illinois Department of Natural Resources
Lincoln Tower Plaza, Room 310
524 South Second Street
Springfield, Illinois 62701-1787


WISCONSIN
IOWA
Location of Starved Rock 519 Project
ILLINOIS
INDIANA
MISSOURI
Enclosure 1: Location of Starved Rock Pool 519 Project
Scale: 1:2,500,000
N
0
30
60
120
Miles


Area of Potential Effects for Starved Rock 519 Project
Zimmerman / Kaskaskia Village Site
Starved Rock Lock and Dam
Project Footprint
Corbin Farm / Salt Well Site
Enclosure 2: APE and Project Footprint for Starved Rock Pool 519 Project
Scale is 1:24,000
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500
1,000
2,000
Meters
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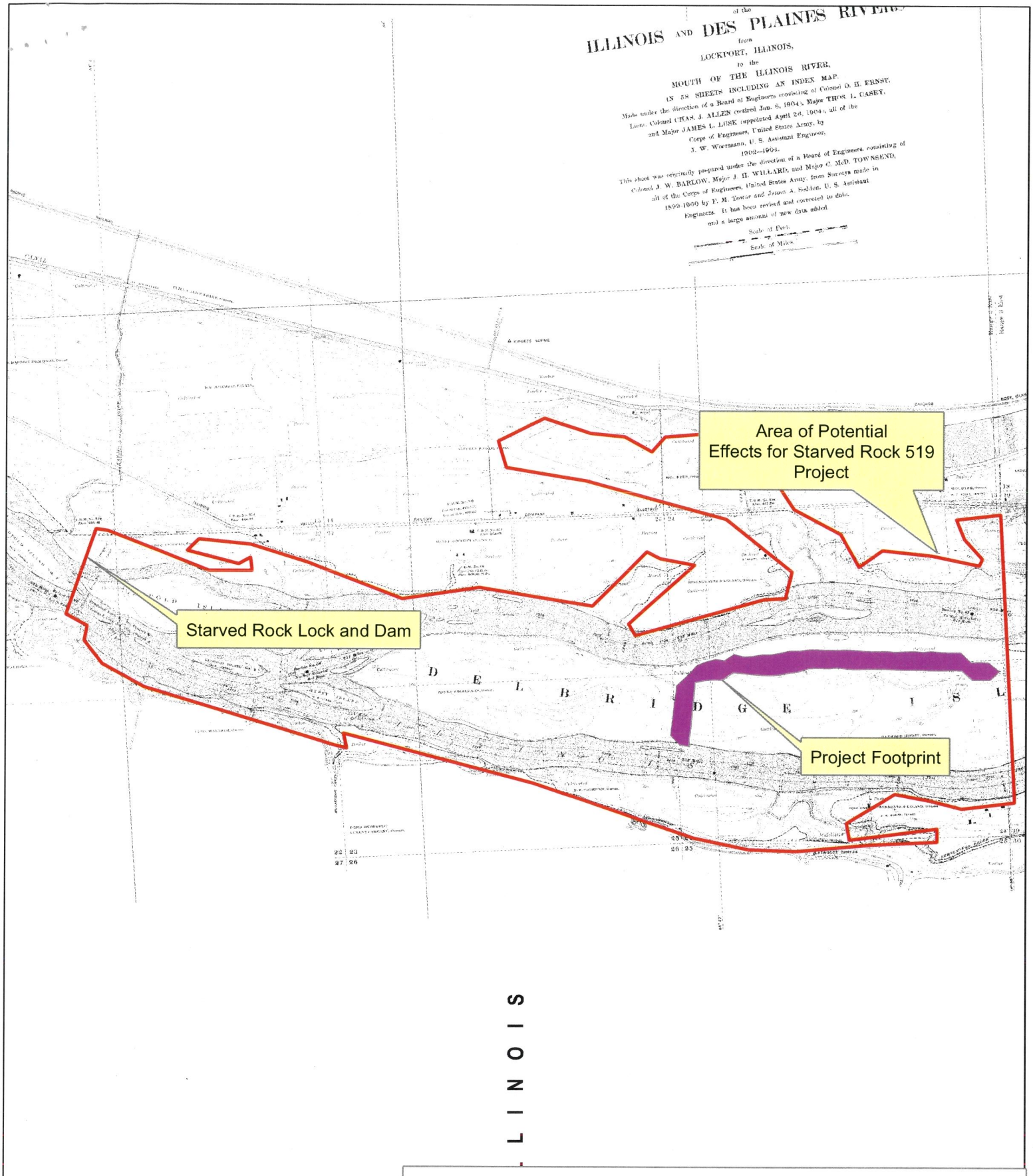

Enclosure 3: APE and Project Footprint for Starved Rock Pool 519 Project on the Woermann Map from 1904

Scale is 1:24,000

0 500 1,000 2,000 Meters

N

Ho-Chunk Department of Heritage Preservation
Cultural Resources Division
Post Office Box 667
Black River Falls, WI 54615-0667
(800) 561-9918 or (715) 284-7181 FAX (715) 284-7449

January 18, 2013

Keith A. Barr
Chief, Environmental Planning Branch RPEDN
Colonel, Corps of Engineers – Rock Island District
Clock Tower Building – P. O. Box 2004
Rock Island, Illinois 61204-2004

Re: Starved Rock Pool Side Channel and Islands Critical Restoration Project

Dear Mr. Barr,

We have reviewed the information regarding your proposed project known as "Starved Rock Pool Side Channel and Islands Critical Restoration Project, and do consider this to be within the aboriginal areas of the Ho-Chunk Nation. At this time, we request to remain as an interested party throughout the duration of your project, as afforded for compliance with Section 106 of the National Historic Preservation Act and 36 CFR Part 800.

We would like to meet on sight to discuss through consultation, certain aspects in regards preservation processes we feel needs to be addressed before the project is to proceed.

Please feel free to contact me to begin the consultation process at your convenience. You can reach me via email at bill.quackenbush@ho-chunk.com or you can call me direct at 715-284-7181 Ext. 1121.

Thank you for your time in these regards.

Respectfully,

William Quackenbush
Tribal Historic Preservation Officer
Cultural Resource Division Manager
Ho-Chunk Nation

Cc File
Robert Mann, HCN Heritage Preservation Director
Jon Greendeer, HCN President

Attached: DOA CORPS correspondence letter dated: January 15, 2013

Illinois Historic
Preservation Agency

1 Old State Capitol Plaza • Springfield, Illinois 62701-1512 • www.illinois-history.gov

LaSalle County PLEASE REFER TO: IHPA LOG #016011813
Utica
Illinois River Pool mile marker 231 to 234
COERI-519 Project
Sedimentation and island erosion restoration, Starved Rock Pool Side Channel & Islands

January 25, 2013

Kenneth A. Barr
U.S. Army Corps of Engineers, Rock Island District
Chief, Economic and Environmental Analysis Branch
Clock Tower Building - Post Office Box 2004
Rock Island, IL 61204-2004

Dear Mr. Barr:

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.

Sincerely,

Anne E. Haaker

Anne E. Haaker
Deputy State Historic
Preservation Officer

CEMVR-PD-F 30 JAN 2013

MEMORANDUM FOR RECORD
SUBJECT: Starved Rock

1. The subject meeting was held on 30 JAN 2013. The following representatives were in attendance:

Monique Savage	USACE	John Lacina	USACE
Rachel Fellman	USACE	Elizabeth Bruns	USACE
Marshall Plumley	USACE	Chuck Theiling	USACE
Trent Thomas	IL DNR	Lucie Sawyer	USACE
Dan Sallee	IL DNR	Ken Clodfelter	IL DNR

2. 519 Overview
    1) Marshall briefed 519
        - Starved rock is the first 519 to be given approval at the Division level
        - Monique will email IL DNR handouts and weekly meeting call in information

3. Existing Conditions and Models
    1) Chuck briefed current and historical conditions, and models being used to predict outputs
        - Aquatic vegetation has decreased over time in starved rock pool
        - Islands have grown significantly in the last 30 yrs 3-26 acres
        - Fisheries and migratory habitat has decreased

    2) IL DNR is on board with reviewing Chuck's initial quantification of habitat units from the Bluegill and Duck Use Day models

    3) Models used
        - 2-d Hydraulic model
        - USGS SAV regression model
        - Bluegill Bluebook
        - Duck Use Days

    4) IL DNR questioned the use of a physical model (ex. Peoria Islands)
        - Costly and timely
        - Not worth the output

4. Problems and Objectives were briefed by Monique
    1) Aquatic Vegetation – waves get 3 ft high, light penetration, herbivory
    2) Spawning and nursery habitat – velocity and waves impact spawning habitat.
    3) Migratory Waterfowl – vegetation will increase waterfowl usage
    4) IL DNR on board with problems and objectives

5. Issues highlighted by IL DNR
    1) Island is only 1 ft deep in a lot of places – longevity

2) Phragmites
3) Side channel siltation – Ensure that project has no or impact or positive impacts on side channel habitat

6. Schedule is extremely tight but issues highlighted by IL DNR need to be addressed and discussed prior to moving ahead with plan formulation

7. POC for this memorandum is Monique Savage at (309) 794-5342

8. Attendees' comments were incorporated and minutes finalized on 15FEB13

Starved Rock Pool Critical Restoration Project

1. Introduction. This document serves as the after-action report for the Starved Rock Pool Critical Restoration Project open house 4 September 2013

2. Open House Objective. The objective of the open house was to discuss and gather comments from the public on the draft report findings.

3. Open House Location. The public meeting was held at the Illinois Waterway Visitor Center, 950 N 27th Rd, Ottawa, IL

4. Medium. An announcement was mailed to approximately 229 addressees including congressional interests, federal, state and local governmental agencies; businesses, environmental organizations, media and the general public inviting them to attend. The Public Affairs Office also sent a news release to area television and radio stations and newspapers.

5. Public Meeting Format.

a. Date/Time: The public meeting was held on 4 September from 5:00pm-7:00pm.

b. Corps and IL DNR were present to talk one-to-one with the attendees during the open house and to answer any questions. The representatives were:

Rock Island/St. Paul District.

Monique Savage – PD-F
Chuck Theiling – PD-E
Marsha Dolan – PD-E
Hank DeHaan – PM-

Project Sponsors:

Doug Carney – Illinois DNR
L. Mick – Illinois DNR

c. Displays. Maps of the study area and proposed project were on display.

6. Attendance. There were approximately 19 attendees which included four newspaper reporters a representative from Senator Rezin's office. The attendees were offered a comment sheet and a copy of the executive summary of the draft report. Results of the returned comments are shown in paragraph 7 below.

7. Public Comments. Public meeting attendees were asked to fill out a comment sheet. A total of 18 comments sheets were received. (Should we discuss the results of questions 1-5 on the comment sheets here?)

DRAFT

Summary of Additional Responses: The comment sheet also provided space for additional participant comments.

Questions 1-5	Strongly Agree	Agree	Disagree	Strongly Disagree	Totals
This open house meeting provided an opportunity to gain information and a better understanding of	8.0 88.9%	1.0 11.1%	0.0 0.0%	0.0 0.0%	9.0 100.0%
This open house provided an opportunity for everyone to offer comments about the project	7.0 77.8%	2.0 22.2%	0.0 0.0%	0.0 0.0%	9.0 100.0%
The displays/materials provided were informative	9.0 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	9.0 100.0%
I had a chance to talk to a study team member	8.0 88.9%	1.0 11.1%	0.0 0.0%	0.0 0.0%	9.0 100.0%
This open house was worth my time.	9.0 100.0%	0.0 0.0%	0.0 0.0%	0.0 0.0%	9.0 100.0%
Whole Group Percentage	8.2 91.1%	0.8 8.9%	0.0 0.0%	0.0 0.0%	9.0 100.0%

Comments regarding the project:

Question 5: Do you have other comments or concerns regarding this project:

- Will this narrow the main channel any?
- No, just anxious to see it started and help better the fishing and hunting.
- The proposed project needs more public awareness. I accidently heard about the meet and greet yesterday (9-3-13)
- This was an important open house. The presenters were excellent and well informed.
- Well thought out - should work well and accomplish your goal. Look forward to seeing the results.
- Needed a "power point" type of demo to explain the time lines of the project. Individual project reps should introduce themselves and their type. Was informative although. Reps were nice.

DRAFT

8. Summary. The open house met the objective of providing information on the proposed project. The discussion between the study team personnel and the public was informative. Attendees were generally supportive of the open house format. This report is being distributed to the study team members for their consideration and analysis.

MARSHA DOLAN
Public Involvement Specialist
Economic & Environmental Analysis Branch

CF:
PD-F (M. SAVAGE)
PD-E (C. THEILING)
PM-M (H. DEHAAN)
PD-E (M. DOLAN)

DRAFT

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

Illinois Department of **Natural Resources**

One Natural Resources Way Springfield, Illinois 62702-1271
www.dnr.illinois.gov

Pat Quinn, Governor
Marc Miller, Director

September 9, 2013

Mr. Joseph P. Kellett
Deputy District Engineer for
Programs and Project Management
U.S. Army Corps of Engineers, St. Louis District
1222 Spruce Street
St. Louis, MO 63103 - 2833

Dear Mr. Kellett:

The Illinois Department of Natural Resources (IDNR) supports the U.S. Army Corps of Engineers' recommended restoration plan for the Starved Rock Pool Critical Restoration Project as presented in the August 2013 Draft Starved Rock Pool Project Implementation Report with Integrated Environmental Assessment. The project would result in long term benefits to fish, birds, and other species that utilize the ecosystem in and around the Starved Rock Pool. The Recommended Plan would restore aquatic habitat by constructing a riprap breakwater on the submersed Delbridge Island to reduce water velocities to protect aquatic vegetation. This work is currently planned to be accomplished under the authority of Section 519 (b) and (c) of the WRDA 2000 as amended by Section 5071, WRDA 2007.

It is IDNR's understanding that the current estimated project costs are $4.2 million with the IDNR being responsible for 35% of these costs after execution of a Project Partnership Agreement. The current estimated total cost for the IDNR is $1,470,000. As the project sponsor, IDNR would be responsible for operation, maintenance, repairs, replacements and rehabilitation (OMRR&R) of project features at an estimated average annual cost of $30,432.

We continue to support development of the Starved Rock Pool Critical Restoration Project subject to the State Legislature providing adequate and appropriate funds for this project.

IDNR looks forward to working with the U.S. Army Corps of Engineers on the Starved Rock Pool Critical Restoration Project. If you have any questions or require more information, please contact Ms. Debbie Bruce in the Office of Resource Conservation at 217-524-4111.

Sincerely,

Marc Miller
Director

Bcc: Jim Herkert, ORC
Debbie Bruce, ORC Fisheries
Dan Stephenson, ORC Fisheries
Jim Mick, ORC Fisheries

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

SEP 18 2013

REPLY TO THE ATTENTION OF:

E-19J

Monique Savage
U.S. Army Corps of Engineers – Rock Island District
P.O. Box 2004
Rock Island, Illinois 61204

RE: Draft Environmental Assessment: Starved Rock Pool Critical Restoration Project; LaSalle County, Illinois

Dear Ms. Savage:

The U.S. Environmental Protection Agency (EPA) has reviewed a Draft Environmental Assessment (Draft EA) and Draft Finding of No Significant Impact (FONSI) prepared by the U.S. Army Corps of Engineers (USACE) for a proposed critical restoration project in the Starved Rock Pool of the Illinois River in LaSalle County, Illinois. This letter provides our comments on the Draft EA and FONSI, pursuant to our authorities under the National Environmental Policy Act (NEPA), the Council on Environmental Quality's NEPA Implementing Regulations (40 CFR 1500-1508), and Section 309 of the Clean Air Act.

The Starved Rock Pool is a 16-mile section of the Illinois River, extending from the Starved Rock Lock and Dam at River Mile (RM) 231 eastward (upstream) to the base of the Marseilles Dam (RM 247). The Critical Restoration project is proposed between RM 231 and 235, just upstream of the Starved Rock Lock and Dam. Starved Rock State Park is adjacent to the project area along the south bank of the river. The Starved Rock Pool Critical Restoration project was proposed to address ecosystem restoration goals previously identified in the Illinois River Basin Restoration Comprehensive Plan (Plan), and was proposed during the development of the Plan.

This reach of the Illinois River was transformed from two distinct shallow sandbed channels surrounding a terrestrial island (known as Delbridge Island) to a large, open water channel when the Starved Rock Lock and Dam were installed in 1939. This resulted in increased water depths, loss of Delbridge Island to inundation, and loss of submerged aquatic vegetation in the area. Current stressors continue to include increased water levels and sedimentation, which have, and continue to affect, the quality of aquatic habitat in the area.

The goals of the Starved Rock Pool Critical Restoration project are to: restore submerged aquatic vegetation (SAV) in the Starved Rock Pool; increase the area and quality of resting/feeding

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habitat for migratory waterfowl; and improve spawning and nursery habitat for native fish. Objectives of the project are to: increase shallow, low current velocity habitat in the project area by 2015; reduce wind fetch lengths and provide areas within the project area that are sheltered from wind and wave action by 2015; and increase water clarity in the project area by 2015.

The Draft EA indicates that the preferred plan is construction of a riprap[1] breakwater between RM 233 and 234, along the north and west edges of the historic Delbridge Island contour, parallel to the USACE navigation channel that is located north of the Island. This breakwater would provide protected aquatic habitat by protecting the shallower areas over the submerged Delbridge Island from the current and waves generated by wind and both tow and recreational boats. Such reduction of waves, water velocity, and turbulence would allow for better conditions for the growth of SAV and also for fish spawning. The breakwater would be approximately 6,100 feet long, with a three-foot top width and 2.5:1 side slopes.

Additional measures, including additional riprap breakwaters, a floating island breakwater, and a floating barrier breakwater, were identified and preliminarily studied. However, these options were determined to be less efficient and cost effective than the preferred plan.

EPA's comments on the Draft EA primarily relate to the project purpose/need and description; threatened, endangered, and invasive species; permits; and unclear information. Comments are categorized by topic and are as follows.

PROJECT DESCRIPTION, PURPOSE, AND NEED

1. While the Draft EA discusses project goals and objectives, the discussion of project of purpose and need does not appear to be a component of the EA.
   Recommendation: EPA recommends the Final EA include a discussion of project need and project purpose.

2. Page 8 of the Draft EA states that the Starved Rock Pool is the "lynchpin between the upper and lower Illinois River."
   Recommendation: EPA recommends that, in the Final EA, USACE clarify what is meant by "lynchpin;" include a discussion on what defines the upper and lower portions of the River; and provide additional information on why the Starved Rock Pool ties portions of the River together.

3. The Draft EA (p. 63) states that vessel waves (from non-recreational boating) will be blocked by the riprap breakwater. However, recreational boats using the side channel (the existing channel located to the south of the submerged Delbridge Island) will likely send wave action north into protected areas. The Draft EA does not discuss how these recreational boats and their waves may affect SUV rooting and growth.
   Recommendation: EPA recommends that, in the Final EA, USACE include additional information about how use of the south channel by recreational boat traffic could affect SUV rooting and growth in areas to be more protected by the riprap breakwater.

[1] Riprap will conform to requirements of the Illinois Department of Transportation (IDOT) Gradation RR-5.

4. Page 73 of the Draft EA states that the rock breakwater will "reduce current velocity to acceptable levels in 160 acres within the total project area..." It is unclear if this means that, as a result of riprap breakwater implementation, that 160 acres of SAV habitat will be created. Additionally, page C-2 of the Draft EA states a hypothesis that the project will increase SAV distribution and abundance to >60 acres behind a breakwater structure.
Recommendation: EPA recommends that, in the Final EA, the EA include a discussion of the number of potential acres of SAV that could be created by project implementation. Additionally, it is not clear if 160 acres, or 60 acres, of habitat for SAV will be created by project implementation. Please clarify the number of acres of SAV expected; that information should be included in multiple areas of the Final EA, where appropriate.

THREATENED/ENDANGERED SPECIES

1. Page 31 of the Draft EA states that there are currently 10 mussel species living in Starved Rock Pool, and that a 1997 survey documented a mussel bed in the pool that, at the time, constituted "the early formation of a viable mussel bed." The Draft EA was silent as to what species were present, whether or not any of them were state or Federally-endangered, threatened, or candidate species, and whether or not the proposed project would affect these mussels.
Recommendation: EPA recommends that, in the Final EA, USACE provide additional information, including: the location of the mussels and mussel beds within the Starved Rock Pool; a list of the species present and their listing status (if applicable); and information on whether or not the proposed project will detrimentally affect any species. Furthermore, if any of the species are state or Federally-endangered or threatened, the Final EA should include correspondence from the Illinois Department of Natural Resources (IDNR) and/or the U.S. Fish and Wildlife Service (USFWS) stating if the project will, or will not, affect any listed or candidate species.

2. Pages 33-34 of the Draft EA include lists of Federally-listed and state-listed species for LaSalle County; however, the Draft EA fails to discuss if any of these species are present within the project area.
Recommendation: EPA recommends that, in the Final EA, USACE include specific information on which species are, or are not, present within the project area. For those species that are present within the project area, please include correspondence from IDNR and USFWS as noted above in Comment 1.

3. Page 74 of the Draft EA states that all project alternatives considered will have no effect on Federally or state-listed endangered or threatened species, and also states that "The USFWS concurred with these determinations through a coordination letter dated TBD." However, it is not clear to reviewers if any state or Federally-endangered or threatened species are present in the project vicinity (see comments 1 and 2, above) or if they will or will not be detrimentally affected.
Recommendation: EPA recommends that, in the Final EA, correspondence sent to the IDNR and the USFWS be included in an Appendix to the Final EA. Additionally, please include correspondence and coordination from both IDNR and USFWS in the Final EA.

4. Page B-4 of the Draft EA states that correspondence from USFWS is enclosed in Appendix A. However, no correspondence from USFWS is enclosed in Appendix A or anywhere else in the document.
   Recommendation: EPA recommends that, in the Final EA, USFWS correspondence be included in an Appendix, and all references to this correspondence be correct.

INVASIVE SPECIES

1. Page 74 of the Draft EA states that all project alternatives considered do not carry out actions which are likely to promote invasive species proliferation. However, the Draft EA is silent as to whether or not the riprap breakwater could, or would, be a place that zebra mussels could proliferate.
   Recommendation: EPA recommends that, in the Final EA, the discussion on Invasive Species be expanded to include additional information on the potential for zebra mussels to proliferate on the proposed breakwater, and any effects that could be expected therein.

PERMITS

1. Page 65 of the Draft EA includes a discussion of required permits.
   Recommendation: EPA recommends that, in the Final EA, USACE include an update on the status of all required permits.

2. Page 67 of the Draft EA includes a design and construction schedule. However, the obtaining of required permits was not noted in this schedule.
   Recommendation: EPA recommends that, in the Final EA, the timeframes for applying for and obtaining required permits be added into the schedule.

OTHER

1. Page H-25 of the Draft EA states that the riprap breakwater is designed with a three-foot top width and an approximate 30' bottom width. This is the only location in the entire Draft EA where the bottom width was stated. With a width of 30' and a length of 6,100', fill impacts are approximately 183,000 ft^2 (4.20 acres).
   Recommendation: EPA recommends that, in the Final EA, the bottom width be included in earlier descriptions of the proposed breakwater, particularly in the EA itself (not just this mention in the Appendix). The proposed fill footprint (square feet or acres) should also be clearly stated in the Final EA.

2. Sheet ID C-301 (plate 12) of the construction plans provided shows the A1 typical breakwater section as having a three-foot top width, and 2:5:1 slopes; this matches information provided elsewhere in the Draft EA. However, using the scale provided on this sheet to measure the bottom width of the typical breakwater section, EPA measured a bottom width of approximately 20 feet; this does not match statements on page H-25 of the Draft EA (see comment 1, above) where the bottom width was noted as 30 feet.
   Recommendation: EPA recommends that USACE clarify and rectify these discrepancies throughout the Final EA.

Thank you for the opportunity to review and comment on the Draft EA. We are available to discuss our comments with you in further detail if requested. Please send us a CD and paper copy of the Final EA once it becomes available. If you have any questions about this letter, please contact Ms. Liz Pelloso, PWS, of my staff at 312-886-7425 or via email at pelloso.elizabeth@epa.gov.

Sincerely,

Kenneth A. Westlake, Chief
NEPA Implementation Section
Office of Enforcement and Compliance Assurance

cc: Mark McConnaughhay, Starved Rock State Park
Thaddeus Faught, IEPA
Pat Malone, Illinois DNR
Richard Nelson, USFWS-Rock Island Field Office

United States Department of the Interior

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

IN REPLY REFER TO:
FWS/RIFO

September 25, 2013

Colonel Mark J. Deschenes
District Engineer
U.S. Army Corps of Engineers
Rock Island District
Attn: Mr. Ken Barr, Chief, Planning
Clock Tower Building, P.O. Box 2004
Rock Island, Illinois 61204-2004

Dear Colonel Deschenes:

This document provides our Draft Fish and Wildlife Coordination Act Report (CAR) for the Starved Rock Pool Critical Restoration Project. The proposed study area for the Starved Rock 519 project currently includes Starved Rock Pool, from Illinois River Mile (RM) 231 to RM 235 located in LaSalle County Illinois. The project is authorized under Section 519 of the Water Resources Development Act of 2000.

The Corps of Engineers is proposing to construct a lateral berm in this river reach with a goal of restoring critical aquatic habitat. The berm:

> "include(s) placement of a riprap breakwater along the northern edge of former Delbridge Island adjacent to the navigation channel between RMs 233 and 234 in Starved Rock Pool... The breakwater will be approximately 6,100 feet long and constructed to a design elevation 461.85 feet with a 3-foot top width and 2.5H:1V side slopes... Rock placement would be accomplished by floating plant. It is anticipated that rock will be transported from a quarry by barge to the project area. The riprap breakwater will be placed in close proximity to the navigation channel so that the riprap can be easily placed. The riprap breakwater is positioned to protect the area behind it from wind and wave action to support submergent aquatic vegetation."

Existing Conditions – Historically the Illinois River supported very diverse and abundant populations of fish, freshwater mussels, waterfowl, shorebirds, furbearers and other non-game species. Floodplain wetlands and lakes bordering the river were among the most productive in

the world. With the reversal of the Chicago River flow in the early 20th century, water quality rapidly declined. Aquatic habitat degraded along with riverine and floodplain wetlands. Several aquatic and wetland dependent species declined or were extirpated. Shoreline and agricultural development also impacted floodplain wetlands. Despite improvements in wastewater treatment, non-point pollution (e.g. sedimentation, nutrient enrichment, and herbicide/pesticide) continues to hinder aquatic resource recovery efforts. Due to the close proximity of the navigation channel, commercial towboats and recreational craft degrade water quality by resuspending sediment that retards plant growth and reproduction, and generating waves that uproot aquatic vegetation.

The project area is characterized by a large expanse of mostly shallow water with a sand/ silt substrate mostly devoid of vegetation. Conditions are often lake-like due to the impoundment of the river by the downstream Starved Rock Lock and Dam. Bathymetric diversity is low due to ongoing sedimentation. The most notable deep-water habitat is the main navigation channel. The lack of aquatic vegetation, rooted submergent vegetation (e.g. *Vallisneria spp.* and *potamogeton spp.*) in particular, creates a critical deficiency in the local ecology. The lack of aquatic vegetation makes the area unsuitable for most fish spawning, nesting and migrating birds, furbearers, amphibians, and reptiles.

Extensive aquatic vegetation beds tend to create conditions that enhance their long term persistence. For example, the vegetation around the bed perimeter tends to trap suspended sediment, thus increasing light penetration in the interior. It also dampens wave action that uproots plants and resuspends sediments. However, once aquatic vegetation disappears it can be difficult to reestablish. The inability of submergent aquatic vegetation to recolonize the project area is likely due to a combination of factors. These include: 1) wind generated waves, 2) boat induced waves, 3) unstable substrate, 4) plankton blooms induced by nutrient rich water, 5) extended periods of high water, and 6) herbivory from several fish and wildlife species. Of the stressors listed above, wind and boat generated waves are likely the primary cause for the deficiency of aquatic vegetation in the project area. The project location is immediately adjacent to the commercial navigation channel. Studies have shown that towboats and large recreational craft generate waves sufficient to uproot plants, and resuspend sediment.

Increased depths beyond about 3 feet result in decreased light penetration such that plants can no longer photosynthesize. Extended periods of high water can eliminate submergent vegetation. Even in depths less than 3 feet, plant growth is often compromised by high densities of epiphyton (caused by excessive nutrients) covering plant leaves and stems which decrease light availability. Excessive nutrients in the water column are likely contributing to an abundance of phytoplankton, further decreasing light penetration.

Studies in Illinois' Swan Lake, Lake Peoria and Mississippi River Pool 16 have shown that herbivory from fish and geese can be a significant cause of vegetation disappearance. When exclosures were installed in shallow aquatic areas vegetation soon recovered. Herbivory can be especially problematic when attempting to restore an area totally devoid of vegetation. High populations of herbivores can overgraze an area, preventing recolonization, until some event allows vegetation coverage sufficient to withstand grazing. Herbivory is likely contributing to the lack of vegetation in the project area, but its significance is unknown.

Exotic Asian carp are common throughout the project area. The bighead carp (*Hypophthalmichthys nobilis*) and the silver carp (*Hypophthalmichthys molitrix)* are probably having little to no effect on vegetation since they are filter feeders. However, the presence of the grass carp (*Ctenopharyngodon idella*) is of particular concern since it subsists on aquatic vegetation. The abundance of grass carp in the project area and its role in the scarcity of vegetation is unknown.

The invasive common reed (*Phragmites australis*) is colonizing Illinois River wetlands and eliminating native wetland plants. Along the more elevated head of Delbridge Island, it forms an almost impenetrable wall of vegetation. The draft report predicts that the acreage of shallow water available for aquatic plant growth will remain more or less constant over the project life. However, as the island becomes more terrestrial over time, *P. australis* will likely expand its coverage and decrease the acreage of open water available for submergent vegetation. Extended periods of low water (e.g. drought) are likely to exacerbate this trend.

A very sparse aggregation of freshwater mussels was observed along the project alignment. However, they are too low in abundance and species diversity to be considered a significant mussel bed. Exotic zebra mussels are present but their abundance fluctuates.

Endangered Species - There are five potential federally listed species in the project area. These include Indiana bat (*Myotis sodalis*), sheepnose mussel (*Plethobasus cyphyus*), eastern prairie fringed orchid (*Platanthera leucophaea*), prairie bush clover (*Lespedeza leptostachya*), and decurrent false aster (*Boltonia decurrens*). There is no suitable habitat for the Indiana bat, eastern prairie fringed orchid, and prairie bush clover. Therefore the Service concurs with the draft report that there will be no project impacts on those species. Although the decurrent false aster is not an aquatic species, it is known to occur on the Illinois River floodplain. Suitable habitat for the decurrent false aster may exist on the upper head of Delbridge Island, but it is unlikely. A field visit to the island on September 18, 2013 did not observe any plants. The Service concurs that the project is not likely to affect the decurrent false aster. The sheepnose mussel was historically known to occur in the Illinois River. There are no known mussel beds within the project area. However, a historical record for a mussel bed along the right bank just outside of the project area does exist. This mussel bed was not surveyed, but will not be affected by the project. Mussels occur sporadically along the project alignment, but they do not appear to be part of any ecologically significant aggregation. Based on this observation, we concur that the sheepnose mussel is not likely to be adversely affected.

Project Effects - The recommended alternative is predicted to result in the reduction of wind and wave action sufficient to allow for the growth of submergent vegetation. As discussed above, wind and wave action are likely the primary reason for the lack of submergent vegetation in the project area. Sediments should become more cohesive (stable), particularly if they have a chance to dry. Project construction will improve the likelihood that submergent vegetation will colonize and persist. Uncertainty remains however, with respect to the cumulative effect of the other stressors (e.g. herbivory, nutrient enrichment, and river hydrograph). Sedimentation will continue, although the coarser components (e.g. sand) should decrease due to the berm blocking the transport of bedload material from the navigation channel.

Conclusions/Recommendations - There are multiple factors affecting the abundance of submergent vegetation in the project area. Several of which could be causing the scarcity of submergent vegetation. Wind fetch , tow generated waves, and river currents are probably the leading cause for this absence. It is uncertain however, that reduction of wind/wave factors alone is sufficient to overcome other influences negatively affecting vegetation growth and allow growth of a more persistent submergent vegetation bed.

One of the alternatives eliminated from consideration was lowering the pool level for a period of time. This alternative was eliminated because of the detrimental effect such an action would have on hydropower at Starved Rock dam and other pool infrastructure. Such drawdowns have been implemented on the Mississippi River with great success. Lowering the pool level for even a few days would enhance the probability of project success by allowing sediment consolidation. We recommend that this alternative be given closer scrutiny and periodically revisited if operational constraints should change.

New plants usually originate from the seed bank in the substrate, or deposition from upstream plant sources. Based on a previous study conducted by the Illinois Natural History Survey, it is predicted such natural recolonization will occur. If post-construction monitoring does not indicate successful submergent plant growth, a seed bank study may be needed to determine if this remains a reasonable expectation. In addition, there are no project elements requiring artificial seeding or planting during the construction phase. Rather than waiting several years to gauge the success of natural recolonization, plantings could speed up submergent plant colonization. Plantings of submergent vegetation propagules are relatively inexpensive compared to the cost of the berm, and should be reconsidered as part of the initial construction phase.

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. Questions concerning this letter should be directed to Mr. Jon Duyvejonck (telephone 309-757-5800, ext. 207).

Sincerely,

Richard C. Nelson
Field Supervisor

cc: Doug Carney
Illinois DNR

Mr. Ken Westlake, Chief NEPA Implementation Section
Environmental Protection Agency

From: Savage, Monique E MVR
To: "Pelloso, Elizabeth"
Subject: RE: Extension to provide NEPA comments - Starved Rock Pool Critical Restoration Project (UNCLASSIFIED)
Date: Thursday, September 26, 2013 10:40:00 AM

Classification: UNCLASSIFIED
Caveats: NONE

<VIEW IN HTML>

Liz,

We received a hard copy of the USEPA's comments of the draft EA prepared for the Starved Rock Pool Critical Habitat with integrated EA. The Rock Island District appreciates your time and diligence in reviewing the Starved Rock Pool Critical Habitat with integrated EA Draft. The project's Biologist, Chuck Theiling, and myself the study manager reviewed your comments, our responses are below. Thank you, USEPA's feedback provided for a more coherent and complete final document.

Respectfully,

Monique Savage
Geographer, PD-F
US Army Corps of Engineers
P.O. Box 2004
Rock Island, IL 61204-2004
monique.e.savage@usace.army.mil
309.794.5342

Clarification from the letter (3rd paragraph), the plant bed was maintained until the 1990s when its occurrence became sporadic with favorable environmental conditions. SAV seems to respond now when any single stressor, turbidity, velocity, wind-waves, or herbivory is reduced. This is evidenced by plant appearance during drought, navigation closure, and in herbivore exclosures experiment.

Specific Comments

Project Description, Purpose, and Need

1. We revised the purpose to emphasize the project need as recommended, the following text was added to the report.

   The Corps proposes to rehabilitate and enhance Starved Rock Pool through construction measures which will increase the quality of year-round habitat for the fish community, increase submerged aquatic vegetation (SAV), and improve habitat for waterfowl. This PIR with an integrated Environmental Assessment (EA) presents a detailed account of the planning, engineering, construction details, and environmental considerations which resulted in the Recommended Plan.

The need for rehabilitation and enhancement of the Project is based on the fact that the existing aquatic habitat is generally higher velocity, turbid, and lacks aquatic vegetation important for year-round habitat functioning. Without action the existing aquatic habitat will cease to function as fish and waterfowl habitat.

2. The term 'lynchpin" and discussion of connecting upper and lower river reaches was removed because it is not affected by the project.

3. We don't anticipate recreational boat impacts. There is a potential risk for impacts to plants from recreation traffic, but the team feels this risk is minimal. A boat ramp is located on the left descending bank of the pool near RM 233. 6, and two marinas are located off the navigation channel on the right descending bank between RM 233-234, but the frequency, speed, and types of recreational boaters utilizing the side channel is unknown. Although we have no formal documentation regarding recreational boat use of the south channel the channel is too shallow to navigate in its upper end which we feel will limit boat activity significantly.

Vessel waves likely have a larger impact on the subject site than wind waves. The riprap breakwater would block these deeper waves to reduce the velocity and turbulence effects in the Project area. Although the Recommended Plan will reduce the effects in the protected area of waves induced by vessels and recreational boats operating in the navigation channel, there is still a risk of waves induced by recreational boats utilizing the side channel.

4. The potential acres affected by vegetation response were explained in Section 2.6.1.8 Future With Project Condition (copied below). The SAV estimated 35 percent coverage of the 160 acre area behind the breakwater, which is about 60 acres. The 160 acres value refers to potential fish spawning habitat in Section 3.10.2.

Potential SAV distribution and abundance was estimated using multiple lines of evidence pointing to the same general conclusion that plants occupy about 60 to 80 acres when physical stressors are reduced. The first evidence for the potential for SAV was in its reputed historical abundance attracting waterfowl to Starved Rock Pool. Recent evidence for the site to support SAV comes from its occurrence during droughts in 1989 and 2012, during a navigation closure in 1993, and inside of cages excluding herbivores (Sass 2009), when light limitation, current velocity, or herbivory stressors, respectively, were alleviated. The last line of evidence supporting our estimate for potential SAV distribution and abundance is output from a USGS SAV model developed for Pool 8, Upper Mississippi River, Wisconsin. The model was developed and calibrated for a clearer water system, but for very similar restoration project planning.

Threatened and Endangered Species

1. Page 31 of the Draft EA states that there are currently 10 mussel species living in Starved Rock Pool, and that a 1997 survey documented a mussel bed in the pool that, at the time, constituted "the early formation of a viable mussel bed." The Draft EA was silent as to what species were present, whether or not any of them were state or Federally-endangered, threatened, or candidate species, and whether or not the proposed project would affect these mussels.

The following text was added:

There are currently 10 known mussel species living in Starved Rock Pool. Historically a mussel bed has been recorded along the shore of the right descending bank near RM 233. Adults and juvenile mussels comprising common species were recorded during the 1997 survey (table 2). The historic bed is outside of the project area and would not be influenced by the potential project features. Within the project footprint high quality mussel habitat is not likely.

Table 2. Starved Rock Pool mussel species and their status.

Species	*Common name*	*Status*
Potamilus ohiensis	*pink papershell*	*common*
Leptodea fragilis	*fragile papershell*	*rare*
Actinonaias ligamentina	*mucket*	*rare*
Pyganodon grandis	*giant floater*	*common*
Lasmigona complanata	*white heelsplitter*	*rare*
Arcidens confragosus	*rock pocketbook*	*rare*
Anodonta suborbiculata	*flat floater*	*rare*
Quadrula pustulosa	*pimpleback*	*abundant*
Quadrula quadrula	*mapleleaf*	*abundant*
Amblema plicata	*threeridge*	*abundant*

2. Pages 33-34 of the Draft EA include lists of Federally-listed and state-listed species for LaSalle County; however, the Draft EA fails to discuss if any of these species are present within the project area.

Illinois DNR fisheries and wildlife staff were continuously involved in project planning. Endangered mussels were never raised as a concern. Requests for coordination letters will be met with the submittal of the CAR and a letter of intent from the ILDNR. Most of the coordination was done in the field and on conference calls which ILDNR and FWS participated in. We also reviewed this response with the Illinois DNR mussel biologist, Rich Lewis, who agreed with our conclusion for little potential effect on mussels.
The following text was added:

2.2.16. Endangered Species. *The USFWS has identified the Indiana bat Myotis sodalis, prairie bush clover Lespedeza leptostachya, eastern prairie fringed orchid Platanthera*

leucophaea, decurrent false aster Boltonia decurrens, and sheepnose mussel Plethobasus cyphyus as federally-endangered, threatened, or candidate species in LaSalle County, Illinois (Table 2a). While these species have the potential to occur in LaSalle County, there is no suitable habitat for the Indiana bat, eastern prairie fringed orchid, and prairie bush clover. No presence of decurrent false aster was noted in the project area. The sheepnose mussel was historically known to occur in the Illinois River however there are no known mussel beds within the project area.

3. Page 74 of the Draft EA states that all project alternatives considered will have no effect on Federally or state-listed endangered or threatened species, and also states that "The USFWS concurred with these determinations through a coordination letter dated TBD." However, it is not clear to reviewers if any state or Federally-endangered or threatened species are present in the project vicinity (see comments 1 and 2, above) or if they will or will not be detrimentally affected.

See response to question 2 above, hopefully this clarifies that there are no T&E species located in the project area.

Invasive Species

The following text was added:
The addition of hard substrate has potential for colonization by zebra mussels, but zebra mussel density is greatly reduced since their initial invasion during the 1990s. We do not anticipate a large population response from zebra mussels beyond the no project alternative.

Rich Lewis, Illinois DNR mussel biologist, commented that zebra mussels are now very uncommon in the upper Illinois River based on a large survey of Marseilles Pool upstream.

Permits

1. Page 65 of the Draft EA includes a discussion of required permits.
Final EA will include an update on the status of all required permits.

2. Page 67 of the Draft EA includes a design and construction schedule.
However, the obtaining of required permits was not noted in this schedule.

Added timeframes for applying and obtaining required permits into the schedule.

Other

1. Page H-25 of the Draft EA states that the riprap breakwater is designed with a three-foot top width and an approximate 30' bottom width. This is the only location in the entire Draft EA where the bottom width was stated. With a width of 30' and a length of 6,100', fill impacts are approximately 183,000 ft^2 (4.20 acres).

The following text was added:
The bottom width varies with a maximum width of approximately 30 feet.

2. Sheet ID C-301 (plate 12) of the construction plans provided shows the Al typical breakwater section as having a three-foot top width, and 2:5:1 slopes; this matches information provided elsewhere in the Draft EA. However, using the scale provided on this sheet to measure the bottom width of the typical breakwater section, EPA measured a bottom width of approximately 20 feet; this does not match statements on page H-25 ofthe Draft EA (see comment 1, above) where the bottom width was noted as 30 feet.

Since the existing ground elevation varies along the centerline of the breakwater, the bottom width will vary with a maximum of approximately 30 feet. Plate 12 was revised to read "EXISTING GROUND VARIES".

Classification: UNCLASSIFIED
Caveats: NONE

-----Original Message-----
From: Pelloso, Elizabeth [mailto:Pelloso.Elizabeth@epa.gov]
Sent: Monday, September 16, 2013 9:09 AM
To: Savage, Monique E MVR
Cc: Westlake, Kenneth
Subject: [EXTERNAL] Extension to provide NEPA comments - Starved Rock Pool Critical Restoration Project

Monique,

Thanks for your time this morning – and thank you also for an extension to provide NEPA comments to USACE on this project. Our plan is to have a letter out to you by September 25th. In the interest of timeframes, I'll be sure to email you a copy of the comment letter the day it goes out in the mail.

Thanks again for the extension and I look forward to working with you on this project!

Regards,

Liz Pelloso

Elizabeth M. Pelloso, PWS

Wetland/Environmental Scientist

NEPA Implementation Section

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Classification: UNCLASSIFIED
Caveats: NONE

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1. PROJECT DESCRIPTION

1.1. Location. The area of investigation for the Starved Rock 519 Project includes lower Starved Rock Pool, from river mile (RM) 231 to 235. Starved Rock Pool is a 16-mile section of the Illinois River located approximately 65 miles southwest of Chicago. It extends from Starved Rock Lock and Dam (RM 231) to the Marseilles Dam (RM 247). The pool is located in La Salle County with the communities of Ottawa, South Ottawa, and Marseilles located along its length.

1.2. General Description. The U.S. Army Corps of Engineers, Rock Island District (District) proposes to rehabilitate and enhance lower Starved Rock Pool through construction of measures which will increase opportunities for aquatic plant growth, year-round habitat quality for fish, and increase feeding and resting habitat for migratory and resident waterbirds. The purpose of this Project Implementation 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.

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

- The existing channel border aquatic habitat is generally shallow, turbid, influenced by river current, wind-waves, and boat waves, and lacks aquatic vegetation important for year-round habitat functioning.
- The existing condition in Lower starved Rock Pool is open water affected by wind and boat generated waves that disturb substrates and cloud the water with fine sediment.
- Submersed aquatic plants were historically present following impoundment, but their occurrence now is rare and related to changes in ambient turbidity from drought or navigation closure.
- Without action, the existing degraded aquatic habitat conditions will persist for the Project planning horizon of 50 years.

1.3. Authority and Purpose. The Starved Rock Pool Side Channels and Islands Critical Restoration Project is a component of the Illinois River Basin Restoration Program. This Program was authorized by Section 519 of the Water Resources Development Act of 2000.

Section 519 authorized the identification and implementation of projects within the watershed and along the course of the river that repair past and ongoing ecological damage so that a more highly functioning, self-regulating ecosystem can develop within the existing basin context.

1.4. General Description of Dredged and Fill Material. The rock rip rap breakwater will be approximately 6,100 feet long and will be constructed to a design elevation 461.85 feet with a 3-foot top width, 2.5H:1V side slopes, and use 29,000 tons of rock See Plate 12.

1.5. Description of the Proposed Placement Sites. Plate 12 shows the placement sites for all Project features in the recommended plan. The proposed placement site is adjacent to the main channel to block flows across the Project site.

1.6. Description of the Placement Method. Rip rap placement for the barrier island will be barged to the site then placed mechanically.

2. FACTUAL DETERMINATIONS

2.1. Physical Substrate Determinations

2.1.1. Substrate Elevation and Slope. Flat pool in the Project area is approximately elevation 459 feet (NGVD.). The Project area is a submerged island that creates a shallow, current-swept channel border habitat. The submerged island has a natural levee forming on the channel side where it is shallowest and growing emergent islands. Bedload sediment drops across the island such that coarse material occurs on the channel side become finer across the island as is typical for levee formation (Leopold et al. 1964). The island slopes toward the secondary channel.

2.1.2. Sediment Type. Surficial substrates within the placement sites are generally sand, sand-silt, and silt depending on fluvial characteristics. Coarser material occurs in current and fines in sheltered areas.

2.1.3. Dredged/Fill Material Movement. Rock placement should experience minimal material movement. Adequate rock size and bedding material is proposed to reduce settling and material movement during high flow events.

2.1.4. 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.

2.1.5. Actions Taken to Minimize Impacts. The construction footprint was kept as small as possible minimizes impacts to the benthic community. Construction materials to be used are physically stable and clean, reducing the chances for impacting the river.

2.2. Water Circulation, Fluctuation, and Salinity Determinations

2.2.1. 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.

2.2.2. Current Patterns and Circulation. The barrier island will reduce flow across a portion of the channel border area. Reduced flow in the channel border area is intended to improve conditions for submersed aquatic vegetation. The Project is not expected to change flow through the secondary channel.

2.2.3. Normal Water Level Fluctuation. No changes in normal water level fluctuations are anticipated to result from the proposed Project.

2.2.4. Salinity Gradient. This consideration is not applicable in the location of the proposed Project.

2.2.5. Actions Taken to Minimize Impacts. The construction footprint was kept as small as possible to minimize impacts on flood stage.

2.3. Suspended Particulate/Turbidity Determinations

2.3.1. 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 rock placement. A return to ambient conditions should occur shortly after completion of construction. No long-term negative impacts to suspended solids and turbidity levels are anticipated and values are expected to decrease in the Project area following construction**.**

2.3.2. 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, ambient turbidity and associated light penetration would be expected to return to pre-construction levels and increase in the Project area.
- **Dissolved Oxygen (DO).** Placement of rip rap should have no short- or long-term adverse impacts on DO levels. Aquatic features 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 rip rap.
- **Aesthetics.** The Project was coordinated with Illinois DNR staff to minimize visual impacts from Starved Rock State Park. The addition of a narrow line of rock was determined acceptable to increase the abundance of wildlife benefiting from the area in close proximity to park visitors.

2.3.3. Effects on Biota. Minor disturbances to organisms present in the construction zone could occur as a result of breakwater construction. No long-term adverse effects to biota would be anticipated to result from this action. The overall long-term impact of the aquatic restoration project is expected to be beneficial to biota in the Project area and the river system.

2.4. Contaminant Determinations. Possible introduction of 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.

2.5. Aquatic Ecosystem and Organism Determinations

2.5.1. Effects on Plankton. No significant impacts to plankton are expected.

2.5.2. Effects on Benthos. No significant impacts to benthos at the placement site are anticipated. Existing benthic fauna would be buried by the breakwater, but rip rap would provide abundant rock substrate that would promote macroinvertebrate communities not present in abundance previously. Recolonization of benthic organisms should occur quickly.

2.5.3. Effects on Nekton. Reducing flow to increase aquatic plants would substantially improve the quality of fish habitat in this area. The primary factor that is limited at present is centrarchid spawning habitat, due to exposure to river currents in the channel border area. Diverting flow from the aforementioned channel border area would ensure that areas of suitable depth and flow would be available for fish spawning in the future.

2.5.4. Effects on Aquatic Food Web. The loss of the benthic organisms within the footprint of the riprap breakwater island would 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 habitat protection, and increased hard substrate 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.

2.5.5. Effects on Special Aquatic Sites

- **Sanctuaries and Refuges.** The Project area is on state land adjacent to Starved Rock State Park.

- **Wetlands, Mud Flats and Vegetated Shallows.** Approximately 60 acres of submersed aquatic vegetation and 160 acres of centrarchid spawning habitat would be directly or indirectly created by construction of a breakwater island. Improvements through aquatic vegetation restoration, rock placement, and flow reduction in the channel border would have an overall positive effect on lentic fishes and waterbirds.

- **Threatened and Endangered Species.** Correspondence from the USFWS (see Appendix A) indicates no impacts are envisioned to threatened or endangered species or their habitats, provided construction activities are scheduled and monitored to avoid direct impacts, conservation measures described in the Biological Assessment and Biological Opinion are implemented, and conditions do not change significantly.

- **Other Wildlife.** Backwater fish and waterfowl are the intended targets benefitting from this Project. Wading birds feeding on rip rap would benefit also, but other wildlife would be minimally impacted by the small footprint of the breakwater.

2.6. Proposed Placement Site Determinations

2.6.1. Mixing Zone Determinations. Not Applicable

2.6.2. Determination of Compliance with Applicable Water Quality Standards. A joint application for State water quality certification under Section 401 and discharge of dredged or fill material under Section 404 of the Clean Water Act would be submitted to the USACE and Illinois EPA.

2.6.3. Potential Effects on Human-Use Characteristics. Implementation of the proposed Project would 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. Boating across the Project site is presently prevented by shallow water, so a barrier island does not impede recreational boat use.

2.6.4. Determination of Cumulative Effects on the Aquatic Ecosystem. The District continues the operation and maintenance of the 9-foot channel project. This includes continuation of dredging and disposal of sediment.

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.

2.6.5. Determination of Secondary Effects on the Aquatic Ecosystem. No significant secondary effects should result from construction of the proposed Project.

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1. No significant adaptations of the 404(b)(1) guidelines were made relative to this evaluation.

2. Alternatives considered for the proposed action are as follows:

Alternative 0: No Federal Action

Alternative 1 - Delbridge Island Riprap Breakwater involves protection in the form of riprap along the northern edge of former Delbridge Island. This measure is included to reduce waves, velocities and turbulence to allow for the growth of submersed aquatic vegetation. The breakwater would be approximately 6,100 feet long and constructed to a design elevation 461.85 feet with a 3-foot top width and 2. 5H: 1V side slopes, see Plate 12. Flat pool elevation is 458.52 feet.

Alternative 2 - Side Channel Riprap Breakwater involves protection in the form of riprap along the left descending side of the Delbridge Island side channel. This measure is included to reduce waves, velocities and turbulence to allow for the growth of submersed aquatic vegetation. The breakwater would be approximately 2,500 feet long and constructed to a design elevation 461.85 feet with a 3-foot top width and 2. 5H: 1V side slopes, see Plate 12. Flat pool elevation is 458.52 feet.

Alternative 3 - Delbridge Island and Side Channel Riprap Breakwaters involves protection in the form of riprap along the northern edge of former Delbridge Island as well as along the left descending side of the Delbridge Island side channel. This measure is included to reduce waves, velocities and turbulence to allow for the growth of submersed aquatic vegetation. The breakwater would be approximately 6,100 feet long and 2,500 feet long respectively. The breakwaters would be constructed to a design elevation 461.85 feet with a 3-foot top width and 2. 5H: 1V side slopes, see Plate 12. Flat pool elevation is 458.52 feet.

Alternative 4 - Delbridge Island Floating Island Breakwater involves protection in the form of floating islands along the northern edge of former Delbridge Island. This measure would be anchored into the Delbridge Island bedrock. This measure is included to reduce waves, velocities and turbulence to allow for the growth of submersed aquatic vegetation. The floating island breakwater would be approximately 6,100 feet long.

Alternative 5 - Delbridge Island Floating Breakwater involves protection in the form of floating barriers along the northern edge of former Delbridge Island. This measure would be anchored into the Delbridge Island bedrock. This measure is included to reduce waves, velocities and turbulence to allow for the growth of submersed aquatic vegetation. The floating barrier breakwater would be approximately 6,100 feet long.

3. Certification under Section 401 of the Clean Water Act would be obtained prior to initiation of Project construction and would be in compliance with the water quality requirements of the State of Illinois.

4. The Project would not introduce toxic substances into nearby waters or result in appreciable increases in existing levels of toxic materials.

5. No significant impact to federally-listed endangered species would result from this Project. The U.S. Fish and Wildlife Service, Ecological Services Office, Moline, Illinois supports this determination.

6. The Project is located along a freshwater inland river system. No marine sanctuaries are involved or would be affected, and no degradation of waters of the U. S. is anticipated.

7. No municipal or private water supplies would be affected. There would be no adverse impact to recreational fishing, and no unique or special aquatic sites are located in the Project area. No long-term adverse changes to the ecology of the river system would result from this action.

8. Project construction materials would be chemically and physically stable. No contamination of the river is anticipated.

9. No other practical alternatives have been identified. The proposed Project is in compliance with the guidelines for Section 404(b)(1) of the Clean Water Act, as amended. The proposed Project would not significantly impact water quality or the integrity of the aquatic ecosystem.

12-9-13
(Date)

Mark J. Deschenes
Colonel, US Army
Commander & District Engineer

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ADAPTIVE MANAGEMENT AND MONITORING

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ADAPTIVE MANAGEMENT AND MONITORING

1. INTRODUCTION

This appendix outlines the feasibility level monitoring and Adaptive Management Plan for the Starved Rock Pool Critical Restoration 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 preconstruction, engineering, and design (PED) phase as specific design details are made available.

1.1. Authorization. Section 2039 of the Water Resource 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, 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.

1.2. Procedure: Drafting the Plan. The Rock Island District, the Illinois Department of Natural Resources, and the U.S. Fish and Wildlife Service collaborated to establish a general framework for adaptive management to be applied for Starved Rock. This framework is consistent with the implementation guidance provided in Section 2039 of WRDA 2007.

2. PROJECT ADAPTIVE MANAGEMENT PLANNING

The resulting Adaptive Management Plan for the Starved Rock Pool describes and justifies whether adaptive management is needed in relation to the tentatively selected plan (TSP) identified in the Feasibility Study. The plan also identifies how adaptive management would be conducted for the project and who would be responsible for this project specific adaptive management. The developed plan outlines how the results of this project-specific monitoring program would be used to adaptively manage the Project, including specification of conditions that will define Project success.

The Adaptive Management Plan for this Project reflects a level of detail consistent with the Project feasibility study. The primary intent was to develop 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 for the Project.

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.

2.1. Project Goals and Objectives. The Starved Rock Project is similar to many island construction projects completed by the Upper Mississippi River Restoration Environmental Management Program. Although this Program's success has been demonstrated repeatedly in the clear water Upper Impounded Reaches, the outcome has been less certain in the high ambient turbidity of the Illinois River. Success of the Starved Rock Pool Project will be detected through monitoring the response of Submersed Aquatic Vegetation (SAV).

The goal of the Starved Rock Pool Project is to restore SAV to support local fish and migratory waterfowl. The following objectives are included in this Project:

- Restore submerged aquatic vegetation in lower Starved Rock Pool
- Increase area and quality of resting and feeding habitat for migratory waterfowl
- Improve spawning and nursery habitat for native fish

The strategic locations and design of the breakwater will alter the channel border structure to create backwater habitat over a portion of the Project area. Alleviating physical stressors on SAV will increase SAV potential occurrence and value as waterfowl food and fish habitat.

2.2. 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 vegetation, aquatic fish habitat, and floodplain habitat in the Starved Rock Pool.

- Aquatic Vegetation
  - viability of propagules and seeds in seed bed
  - species specific effects of turbidity on growth
  - species specific effects of current velocity on growth
  - species specific herbivory tolerance

- Aquatic Animals
  - adult fish species response to SAV
  - fish spawning and rearing success

- Waterfowl
  - Waterfowl response to SAV

2.3. Hypothesis. SAV distribution and abundance will increase to >60 acres behind a breakwater structure.

3. MONITORING

3.1. Performance Measure: Aquatic Vegetation Diversity and Areal Coverage

Desired Outcome: Increase diversity, abundance, and areal coverage of native submerged or floating-leaved aquatic vegetation in the Project area

Decision Criteria: Occurrence of >30 acres of SAV

Monitoring Design: SAV will be visually surveyed by boat annually for 10 years following Project completion. If plants are detected all SAV beds will be mapped and characterized by species composition and their relative abundance.

Analysis and Use of Monitoring Results: Annual reports of results will determine the need for additional adaptations to promote SAV distribution and abundance. If SAV do not reoccur naturally then high density direct planting of tubers will be attempted. High density plantings will be coupled with exclosure experiments to assess herbivory effects (Sass 2007).

3.2. Performance Measure: Water Clarity

Desired Outcome: Increase water clarity in the Project area to support SAV survival and improve spawning and nursery habitat for native fish

Decision Criteria: TSS < 25 mg/l, turbidity < 20 NTU, light extinction < 3.42 m^{-1}, Secchi disk depth > 0.5 m at site W-I233.4P

Monitoring Design: Water quality monitoring will occur at two sites of similar depth: one on the south side of the riprap breakwater (site W-I233.4P) and a control site outside of the protected area on the north side of the breakwater (site W-I234.0L). See Plate O-102 for site locations. Monitoring will be performed during the summer months with a combination of surface grab samples taken every two weeks and continuous monitoring devices. The decision criteria parameters will be measured along with other typical water quality parameters.

Analysis and Use of Monitoring Results: Annual reports of results will compare the decision criteria parameters between the protected Project area and the control site to determine if the Project's water clarity objective is being met. If SAV does not reoccur naturally or survive after adaptive management measures are taken, water quality monitoring will provide insight into the reasons for failure. This information could also influence the design of future habitat enhancement projects.

3.3. Performance Measure: Current Velocity

Desired Outcome: Increase shallow low current velocity habitat in the Project area to support SAV survival and improve spawning and nursery habitat for native fish.

Decision Criteria: Velocity < 5 cm/sec at site W-I233.4P

Monitoring Design: Water quality monitoring will occur at sites W-I233.4P and W-I234.0L. Velocity measurements will be taken every two weeks during the summer months along with other typical water quality parameters.

Analysis and Use of Monitoring Results: Annual reports of results will determine if the Project successfully created backwater habitat that is sheltered from wave-induced and current-induced velocities for spawning and rearing of native fish and for SAV growth and survival. Lessons learned will be applied in future habitat enhancement projects.

4. ASSESSMENT

4.1. Assessment Process. Starved Rock Pool's Project Assessment Team will identify a combination of qualitative (i.e., professional judgment) and quantitative methods for comparing the values of the performance measures produced by monitoring with the selected values of these measures that define criteria for evaluating Project effectiveness.

4.2. Variances and Success. The Project Assessment Team will collaborate with Project Managers and decision-makers to define magnitudes of difference (e.g., statistical differences, significance levels) between the values of monitored performance measures and the desired values (i.e., decision criteria) that will constitute variances. Meaningful comparisons between monitoring results and desired performance will require characterization of historical and current spatial-temporal variability that define baseline conditions. Variances (or their absence) will be used to recommend adaptive management actions including (1) continuation of the Project without modification, (2) modification of the Project within original design specifications, (3) development of new alternatives, or (4) apply lessons learned to future projects.

4.3. Documentation, Reporting, and Coordination. The PDT will document performed assessments and communicate the results of its deliberations to the Project Managers and decision-makers designated for the project. The Assessment Team will work with the project monitoring team and monitoring workgroup to produce annual reports that will evaluate submersed aquatic plant establishment using the selected performance measures. The results of the assessments will be communicated regularly to the Project Managers, decision-makers, stakeholders, and the Illinois River Work Group.

5. DECISION MAKING

5.1. Decision Process. Adaptive management is distinguished from more traditional monitoring in part through implementation of an organized, coherent, and documented decision process. For the Starved Rock Project, the decision process included (1) anticipating the kinds of management decisions that are possible within the original project design, (2) specifying values of performance measures that will be used as decision criteria, (3) establishing a consensus approach to decision making, and (4) a mechanism to document, report, and archive decisions made.

5.2. Decision Criteria and Potential Adaptive Management Measures. Decision criteria, also referred to as adaptive management triggers, are used to determine whether and when adaptive management opportunities should be implemented. These criteria are usually ranges of expected and/or desirable outcomes. They can be qualitative or quantitative based on the nature of the performance measure and the level of information necessary to make a decision. Desired outcomes can be based on reference sites, predicted values, or comparison to historic conditions. More specific decision criteria will be developed during the pre-construction engineering and design phase of the project.

6. IMPLEMENTATION COSTS, SCHEDULE, AND RESPONSIBILITIES FOR MONITORING AND ADAPTIVE MANAGEMENT

6.1. Costs. The costs associated with implementing these monitoring and adaptive management plans 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 features, monitoring elements, and adaptive management opportunities, the costs estimated in table C-1 will be need to be refined in the PED phase during the development of the detailed monitoring and adaptive management plans. The costs are presented as first costs from the current working estimate.

Table C-1. Adaptive Management and Monitoring Measures and Costs

Monitoring Element	Cost	Measure
Plant production, years 1-5	$25,287	Adaptive Management Costs
Materials, years 1-5	$16,858	
Planting, years 1-5	$42,144	
SAV Evaluations (annually for 10 years)	$134,862	Monitoring Costs
Water Quality Monitoring (annual for 10 years)	$252,867	
Topographic Survey (every 5 years)	$16,650	
Reports (annually for 10 years)	$109,576	
Total Cost	**$598,244**	

6.2. Schedule and Responsibilities - Aquatic Vegetation. Preconstruction, engineering, and design activities will be limited to one evaluation to reassess existing vegetation at the Project site, gathering data needed for engineering and design, and one season of water quality monitoring. Following construction, monitoring will be performed and active adaptive management activities will be evaluated and implemented during the first 10 years. Yearly evaluations of SAV at the peak of the growing season (July - August) and water quality monitoring during the growing season will be required during this time. Years 5 and 10 will also include topographic surveys. Responsibility for aquatic vegetation adaptive management and monitoring will be with the Corps.

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1. INTRODUCTION

This appendix presents an ecological assessment of the project area and quantification, to the extent possible, of the aquatic and floodplain ecological benefits resulting from the proposed project alternatives. 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 US Fish and Wildlife Service (USFWS), the Illinois Department of Natural Resources (ILDNR) and the Corps of Engineers.

2. EXISTING AND FUTURE WITHOUT PROJECT BIOLOGICAL CONDITIONS

2.1. Centrarchid Habitat. Table D-1 provides a summary of the existing conditions, future without project (FWOP) conditions, and five project alternative conditions for the primary parameters affecting distribution and abundance and centrarchid fish habitat. These parameters include food, water quality, cover, reproduction, and water velocity. Water quality data was collected by USACE (2007-2008), cover data was obtained through field surveys and available land cover maps, and velocities were generated from H&H modeling and field collections. Future with- and without-project data was estimated using 2-d hydrodynamic modeling (see Appendix H, *Hydrology and Hydraulics*, Section 5.1.3), project design data (see Section 3.1 of the Main Report), a U.S. Geological Survey submersed aquatic vegetation predictive model, and best professional judgment of the evaluation team when applicable. Inherent in best professional judgment are the underlying assumptions, which are described in section 3. A description of how these parameters influence fish life history and habitat quality was included in the Main Report, Section 2, *Plan Formulation*.

Table D-1. Aquatic Evaluation Areas with Associated Parameters for 7 Reference Conditions

Evaluation Scenario	Avg. Turbidity	% Cover (vegetation)	% Cover (rock)	% Pool/Backwater	Velocity cm/s
Existing	30	0	0	0	24
FWOP	30	0	0	0	24
Alternative 1	15	8	1	24	24
Alternative 2	30	1	0	3	24
Alternative 3	15	9	1	27	24
Alternative 4	20	0	0	0	24
Alternative 5	20	0	1	0	24

2.2. Mallard Habitat. Waterfowl benefits were estimated using the Duck-Use-Day environmental output model (Heitmeyer 2010), which is a Corps HQ approved regional model (certification memo reference). The model is being used outside of its approved region, but it is a robust model and many of the plant and invertebrate species in the model occur throughout the entire Mississippi River, not just the Alluvial Plan. The model author concurs with its extension for use on this project (Mickey Heitmeyer, personal communication). The Duck-Use-Day model estimates the potential food value of existing or predicted land cover classes and uses known caloric needs of waterfowl species to calculate the potential carrying capacity of a site. Only the aquatic land cover classes were included in the evaluation: aquatic invertebrates for the existing condition with no plants and invertebrates, aquatic plant seeds, and aquatic plants for the future alternative conditions.

3. HABITAT BENEFIT EVALUATION METHODS

The purpose of the habitat benefit evaluation is to evaluate and quantify, to the extent possible, environmental benefits of alternatives for aquatic and floodplain habitat improvements. The evaluation was conducted by a multi-agency team which included representatives from the USFWS, IL DNR, and Corps. Centrarchid benefits were quantified through the use of the Habitat Evaluation Procedures [(HEP) USFWS 1980]. Mallard benefits were calculated using a habitat-based waterfowl bioenergetics model (Heitmeyer 2010).

3.1. Quantity Component. Traditionally, USACE has used the quantity and quality of habitat jointly, in the form of habitat units, 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 Starved Rock Critical Restoration Project uses acres to represent the quantity. The project area is defined as the footprint of the historic Delbridge Island and the side channel area south of the island. Potential restoration measures include alternative breakwater structures along an identical alignment, so the quantity of habitat affected is similar across all planning scenarios.

3.2. 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 Habitat Suitability Index (HSI). This index value (on a scale from 0.0 to 1.0) is multiplied by the area of applicable habitat to obtain Habitat Units (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 (existing, 1, 10, 20, 30, 40, 50) and annualized (using IWR Planning Suite NER Annualizer) over the life of the project to derive Average Annual Habitat Units (AAHUs). AAHUs are used as the output measurement to compare the features and alternatives for the proposed Project.

3.3. Backwater Habitat. The bluegill (Stuber et al. 1982) and Duck Use Day [(DUDs) Heitmeyer 2011] USACE approved (per EC 1105-2-412) HSI models were used to assess the

backwater habitat benefits resulting from breakwater construction. 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 spawning and rearing habitat and aquatic vegetation. Assumptions made in the application of the HSI models include the following:

- **Baseline Condition.** Water quality data collected during summer 2006-2007 at two monitoring stations in lower Starved Rock Pool were representative of the entire evaluation area.

- **Future Without-Project Conditions.** FWOP conditions were based on a net equilibrium sedimentation rate across most of the study area over the next 50 years. See Appendix H, *Hydrology and Hydraulics*, Section 8,2, *Existing Conditions*. Island growth at the upstream end of the evaluation area is anticipated to occur at a rate of 1 acre/yr. Emergent islands will continue to form in the developing fluvial delta as exhibited during the last 20 years (See Figure 12, *Geomorphic Change Since Impoundment in Lower Starved Rock Pool,* in the Main Report).

  The assumption for vegetation occurrence is once in ten years based on the frequency of occurrence with recent droughts or navigation closures. With project SAV abundance estimates were divided by 10 to represent the episodic habitat benefits provided when plants occur during favorable climatic or navigation system operating conditions.

- **Future With-Project Conditions.** The net benefit of restoration measures is expected to remain constant through the 50-year evaluation period because no net sedimentation is projected in the backwater habitat created by the breakwater.

4. HABITAT EVALUATION RESULTS

In the Main Report, Section 2, *Plan Formulation*, describes each potential Project measure in detail. Tables D-2 and D-3 provide summaries of the results of the habitat benefit evaluation.

4.1. Centrarchid Benefits. Table D-2provides the HSI for bluegill; acres for each alternative, habitat units; gross AAHUs; and net AAHUs (lift) for each target year under consideration.

4.2. Centrarchid Benefits. Table D-3 provides estimated duck-use-days (DUD); gross average annual duck-use-days (AADUDs); and net AADUDs (lift) for each target year under consideration.

Table D-2. Bluegill Habitat Suitability Benefit Evaluation Results for the Starved Rock Pool Protection Measure

		OUTPUT				
Description	**Year**	**SI Final**	**Acres**	**HUs**	**AAHUs**	**Net AAHUs**
No Action	0	0.00	670.00	0.0	0.0	**0.0**
	1	0.00	670.00	0.0		
	10	0.00	670.00	0.0		
	20	0.00	670.00	0.0		
	30	0.00	670.00	0.0		
	40	0.00	670.00	0.0		
	50	0.00	670.00	0.0		
FWOP	1	0.00	670.00	0.0	36.2	**36.2**
	10	0.00	670.00	0.0		
	20	0.00	670.00	0.0		
	30	0.00	670.00	0.0		
	40	0.00	670.00	0.0		
	50	0.00	670.00	0.0		
Alternative 1	1	0.60	670.00	0.0	398.0	**398.0**
	10	0.60	670.00	0.0		
	20	0.60	670.00	0.0		
	30	0.60	670.00	0.0		
	40	0.60	670.00	0.0		
	50	0.60	670.00	0.0		
Alternative 2	1	0.39	670.00	0.6	258.7	**258.7**
	10	0.39	670.00	0.6		
	20	0.39	670.00	0.6		
	30	0.39	670.00	0.6		
	40	0.39	670.00	0.6		
	50	0.39	670.00	0.6		
Alternative 3	1	0.61	670.00	23.9	404.6	**404.6**
	10	0.61	670.00	24.0		
	20	0.61	670.00	24.2		
	30	0.61	670.00	24.3		
	40	0.61	670.00	24.4		
	50	0.61	670.00	24.4		
Alternative 4	1	0.00	670.00	23.9	0.0	**0.0**
	10	0.00	670.00	24.0		
	20	0.00	670.00	24.2		
	30	0.00	670.00	24.3		
	40	0.00	670.00	24.4		
	50	0.00	670.00	24.4		
Alternative 5	0	0.00	670.00	3.1	0.0	**0.0**
	1	0.00	670.00	2.8		
	10	0.00	670.00	0.0		
	20	0.00	670.00	0.0		
	30	0.00	670.00	0.0		
	40	0.00	670.00	0.0		
	50	0.00	670.00	0.0		

Table D-3. Mallard Duck Use Day Benefit Evaluation Results for the Starved Rock Pool Protection Measure

Description	Year	DUDs	AADUDs	Net AADUDs
No Action	0	41814.0	41814.0	**0.0**
	1	41814.0		
	10	41814.0		
	20	41814.0		
	30	41814.0		
	40	41814.0		
	50	41814.0		
FWOP	1	41814.0	41840.0	**0.0**
	10	41814.0		
	20	41814.0		
	30	41814.0		
	40	41814.0		
	50	41814.0		
Alternative 1	1	58407.0	58407.0	**16593.0**
	10	58407.0		
	20	58407.0		
	30	58407.0		
	40	58407.0		
	50	58407.0		
Alternative 2	1	43473.0	43373.0	**1559.0**
	10	43473.0		
	20	43473.0		
	30	43473.0		
	40	43473.0		
	50	43473.0		
Alternative 3	1	60066.0	60066.0	**18252.0**
	10	60066.0		
	20	60066.0		
	30	60066.0		
	40	60066.0		
	50	60066.0		
Alternative 4	1	41814.0	41814.0	**0.0**
	10	41814.0		
	20	41814.0		
	30	41814.0		
	40	41814.0		
	50	41814.0		
Alternative 5	1	41814.0	41814.0	**0.0**
	10	41814.0		
	20	41814.0		
	30	41814.0		
	40	41814.0		
	50	41814.0		
	1	41814.0		

5. COST EFFECTIVENESS AND INCREMENTAL ANALYSIS OF ALTERNATIVES

5.1. Cost Estimates for Habitat Improvement Measures. Project first cost estimates were developed to conduct the cost effectiveness and incremental cost analysis of the various alternatives (Table D-4). The cost estimates were prepared using February 2013 price levels and include construction; planning, engineering and design (PED); construction management (CM); adaptive management (AM); operations, maintenance, repair, replacement and rehabilitation(OMRR&R); and monitoring costs. Project features are on state-owned land; however, Navigational Servitude applies so there are no lands and damage costs associated with the Project. Total Project costs were annualized based on the Fiscal Year 2013 discount rate of 3.75 percent and a 50-year project life.

Table D-4. Cost of Alternatives

Alt.	Features	Construction	PED	CM	AM	Cont.[1]	Annual[2]	OMRR[3]	Total
0	No Action	0	0	0	0	0	0	0	0
1	Delbridge Riprap	$2,922,976	$283,500	$283,500	$316,973	20%	$169,692	$30,432	$200,124
2	Side Channel Riprap	$1,582,415	$165,900	$165,900	$316,973	20%	$99,453	$15,580	$115,033
3	Delbridge & Side Channel Riprap	$4,492,930	$421,050	$421,050	$316,973	20%	$ 251,934	$46,012	$297,946
4	Floating Islands	$16,155,101	$1,244,418	$1,216,950	$377,193	43%	$846,638	$142,057	$988,695
5	Floating Barriers	$3,398,505	$289,899	$289,500	$369,735	40%	$ 193,793	$46,447	$240,240

[1] Contingencies are part of annual costs.
[2] Annualized cost are based on a 50-year project life, 3.75% interest rate.
[3] Annualized cost is O&M cost based on a 50-year project life, 3.75% interest rate.

5.2. Incremental Cost/Cost Effectiveness Analysis Process. Cost effectiveness analysis was used to determine what project features should be built, based on habitat benefits (outputs) that meet the goals and objectives of the project and at the same time are the most cost effective. The Corps has incorporated cost effectiveness analysis into its planning process for all ecosystem restoration planning efforts. A cost effectiveness analysis is conducted to ensure that least cost alternatives are identified for various levels of output. After the cost effectiveness of the alternatives has been established, incremental cost analysis is conducted to reveal and evaluate changes in cost for increasing levels of environmental output.

Cost effectiveness and incremental analysis is a three-step procedure: (1) calculate the environmental outputs of each alternative; (2) determine a cost estimate for each alternative; (3) combine the alternatives to evaluate the best overall project alternative based on habitat benefits and cost. While cost and environmental outputs are necessary factors, other factors such as the ability to construct, schedule, likelihood to achieve projected results, immeasurable environmental benefits, ancillary benefits etc., are very important in alternative selection.

Environmental outputs were calculated as AAHUs as well as DUDs. The annualized costs were calculated by applying a 3.75 percent annual interest rate to the construction costs over the 50-year period of analysis. The incremental analysis for each alternative was accomplished using the Corps Institute for Water Resources tool.

5.3. Results of Incremental Cost/Cost Effectiveness Analysis. Two incremental cost/cost effectiveness analyses were run. The first looked at the bluegill target species in the HEP analysis. The second model DUDs was run to ensure that the selected alternative was including the benefits associated with waterfowl as well as benefits for the fisheries. The results of the two analyses are shown in table D-5.

Table D-5. Alternative Evaluation

Alternative	AAHU	DUD	First Cost Construction	Annual Cost/AAHU	Annual Cost/DUD
0	0	0	0	0	0
2	222.5	1,642	$2,231,188	$ 517	$ 70
1	361.8	16,427	$3,806,949	$ 553	$ 12
3	368.4	18,069	$5,652,003	$ 809	$ 16
4	0	0	$18,993,662	$ 982,951	-
5	0	0	$4,347,639	$ 238,662	-

Adaptive Management costs associated with the alternatives are relatively the same. They were included in the analysis but did not assist in comparing the alternatives to one another. Both bluegill AAHU and AADUD analyses showed that Alternatives 1, 2, and 3 were cost effective. Alternatives 4 and 5 exhibited the highest cost per bluegill AAHU and AADUD (Table D-6, Figure D-1, and Figure D-2). This occurred, as stated in the habitat analysis section, because the floating breakwaters did not decrease the velocities enough to improve spawning habitat or support SAV growth so did not change the current duck usage or habitat suitability of bluegill. Therefore, Alternatives 4 and 5 were not considered further in the evaluation of the final array of alternatives.

Table D-6. Comparison by Output of Incremental Cost of Best Buy Plans

Alt. Plans	(AAHU) Inc. Cost	Incremental AAHU	Inc. Cost per AAHU	(DUD) Inc. Cost	Incremental DUD	Inc. Cost per DUD
0	0	0	0	0	0	0
2	$115,033	222. 5	$517	$115,033	1,642	$70
1	$85,090	139.3	$611	$85,090	14,785	$6
3	$97,822	6.6	$14,822	$97,822	1,642	$60

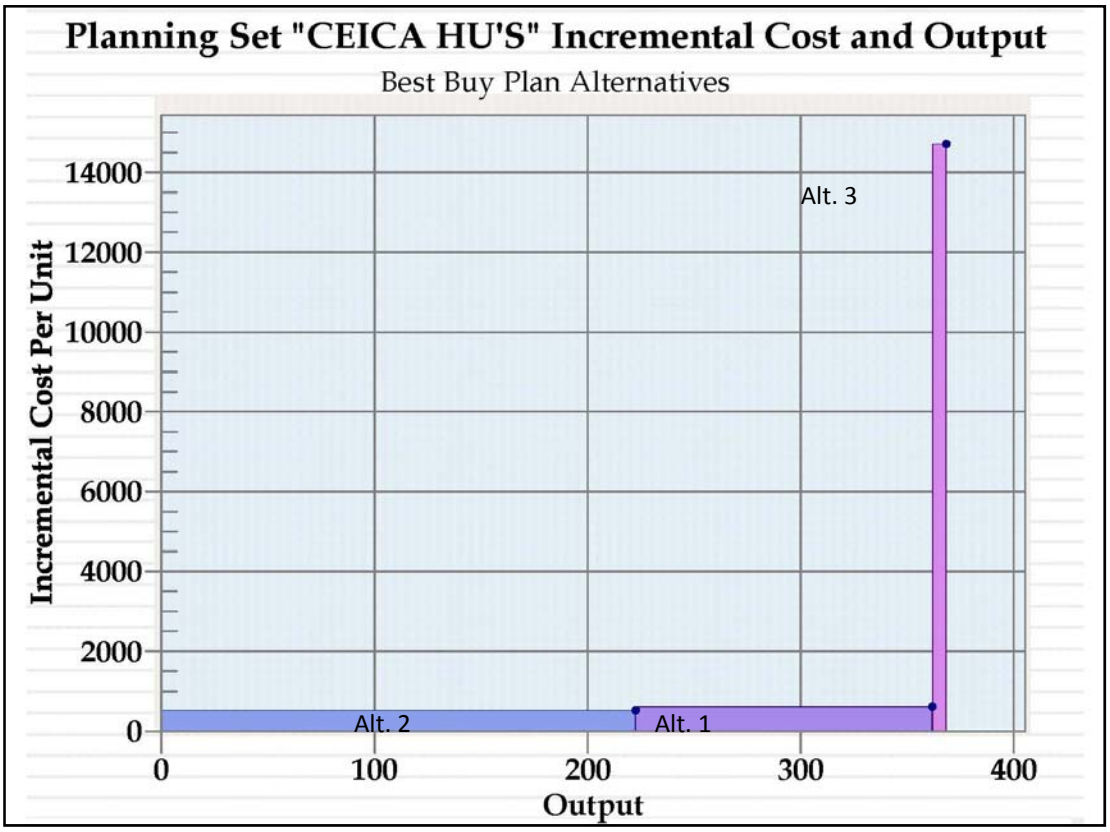

Figure D-1. Incremental Cost Analysis of Best Buy Alternatives for Bluegill AAHUs

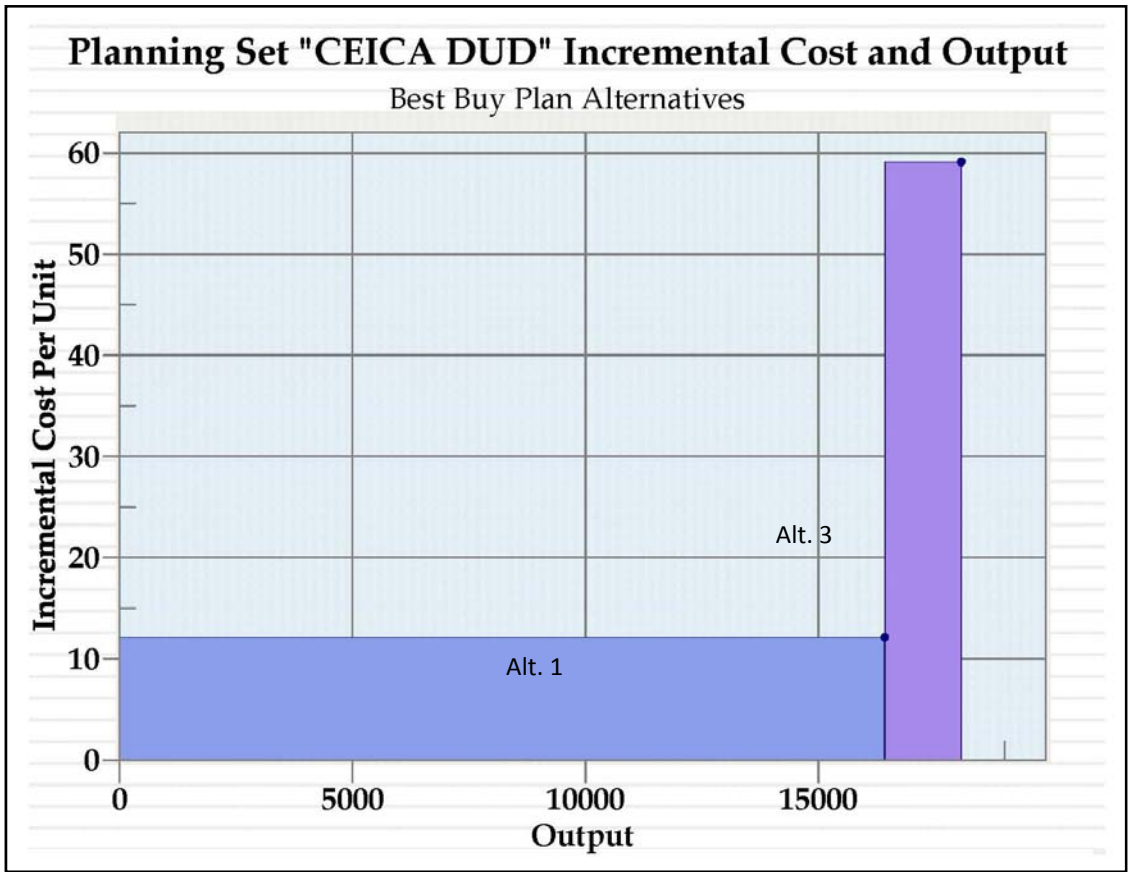

Figure D-2. Incremental Cost Analysis of Best Buy Alternatives for DUDs

6. TENTATIVELY SELECTED PLAN DISCUSSION

Further evaluation of the remaining final array of alternatives, Alternatives 1, 2 and 3, occurred to aide in the selection of the Tentatively Selected Plan (TSP; Table D-7). Federal planning for water resources development was conducted in accordance with the requirements of the *Planning Guidance Notebook* (ER 1105-2-100).

> *"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 U.S. Water Resources Council was used to aide in the selection of the TSP. The criteria are as follows

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.

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 defined in terms of acceptance of the plan by the non-Federal sponsor and the concerned public. After completing the alternative formulation briefing, the TSP is presented to stakeholders to determine its acceptability.

Based on the results of the CE/ICA, planning criteria, risk assessment and other essential criteria the PDT recommends Alternative 1, Delbridge Island riprap breakwater, as the TSP. This alternative best meets the Project goals. It would result in less wave impact and lower current velocities to improve the habitat for spawning of centrarchids. It would also increase the potential for SAV growth and increase feeding opportunities for waterfowl. This measure is innovative for the IWW. It has the potential to determine whether altering the physical parameters of an area has the potential to restore SAV or if it is necessary to account for herbivory as a key factor impacting SAV growth.

In cooperation with the USFWS and IL DNR, the Corps has planned a project that serves the needs of the resource agencies. The preferred alternative has an overall output of 361.88 AAHUs as well as 16,427 DUDs for a total cost of approximately $3,807,000.

Table D-7. Comparison of the Final Array of Alternatives

Criteria	Alternative 0	Alternative 1	Alternative 2	Alternative 3
Plan Description	No Action	Delbridge Island Riprap	Side Channel Riprap	Delbridge Island Riprap and Side Channel
Completeness	There are no actions for this plan.	This plan is ***COMPLETE*** since all necessary actions and investments have been accounted for in this plan.	This plan is ***COMPLETE*** since all necessary actions and investments have been accounted for in this plan.	This plan is ***COMPLETE*** since all necessary actions and investments have been accounted for in this plan.
Acceptability	This alternative is ***ACCEPTABLE*** to Federal and state agencies.	This alternative is ***ACCEPTABLE*** to the Federal and state agencies.	This alternative is ***ACCEPTABLE*** to the Federal and state agencies.	This alternative is ***ACCEPTABLE*** to the Federal and state agencies.
Effectiveness	This plan ***DOES NOT*** address any project objectives.	This plan ***DOES*** address all project objectives.	This plan ***DOES*** address all project objectives	This plan ***DOES*** address all project objectives.
Efficiency	***NO*** Net Benefits are realized.	Cost effectiveness ***IS*** maximized by Net Benefits.	Cost effectiveness ***IS NOT*** maximized by Net Benefits.	Cost effectiveness ***IS*** maximized by Net Benefits.

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APPENDIX E

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE DOCUMENTATION REPORT

HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE PHASE I ESA DOCUMENTATION REPORT

STARVED ROCK POOL, ILLINOIS WATERWAY
SECTION 519
CRITICAL RESTORATION PROJECT
LA SALLE COUNTY, ILLINOIS

January 2013

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Executive Summary

1. Background. This report documents the Phase I Hazardous, Toxic, and Radioactive Waste (HTRW) Environmental Site Assessment (ESA) for the proposed restoration activities located in the Starved Rock Pool of the Illinois Waterway, La Salle County, Illinois (Study Area), in accordance with Engineering Regulation (ER) 1165-2-132, HTRW Guidance for Civil Works Projects, and ER 405-1-12, Real Estate Handbook. The Phase I ESA was performed in conformance with the scope and limitations of the American Society for Testing and Materials Standards (ASTM) E 1527-05 and E 1528-06.

The Study Area is the lower Starved Rock Pool of the Illinois River in La Salle County, Illinois. Proposed restoration activities in the Study Area include the construction of closure structures and J-hook breakwaters to restore submerged aquatic vegetation and improve conditions for fish habitat. The structures will be constructed in the central portion of Starved Rock Pool adjacent and parallel to the existing navigation channel.

This Phase I ESA is being conducted to determine if there is any risk of HTRW concerns with the Study Area, prior to restoration activities by the U.S. Government.

2. Conclusions. This report has revealed evidence of Recognized Environmental Conditions (REC) that could potentially affect the Study Area. The REC's consist of contaminated river sediments and potential overspray of herbicides near the Study Area. The assessment was performed in conformance with scope and limitations of the ASTM Standard E 1527-05.

3. Recommendations. No additional assessment or investigation of the Study Area is recommended, based on the fact that no river sediments are planned to be manipulated or moved in the Study Area.

4. 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. Continuing the Environmental Due Diligence Audit process beyond this Phase I ESA to a Phase II ESA may reduce uncertainty, or reveal unidentified environmental liabilities. If any previously unaddressed recognized environmental condition should arise, this Phase I ESA will be revisited.

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Appendix G: Questionnaire Forms

1.0 General

1.1. Authority. The Starved Rock Pool Side Channels and Islands Critical Restoration Project is a component of the Illinois River Basin Restoration Program. This Program was authorized by Section 519 of the Water Resources Development Act of 2000. Section 519 authorized the identification and implementation of projects within the watershed and along the course of the river that repair past and ongoing ecological damage so that a more highly functioning, self-regulating ecosystem can develop within the existing basin context. Critical restoration projects would produce immediate habitat and sediment reduction benefits; will help evaluate the effectiveness of various restoration methods before application system wide; and make best use of the current strong local and State interest in ecosystem restoration within the basin. The Corps of Engineers will implement these critical restoration projects in collaboration with the non-Federal sponsor and with other Federal and local agencies. The feasibility phase of the Starved Rock Critical Restoration Project is cost shared 65/35 with the project cost share sponsor, the Illinois Department of Natural Resources.

1.2. Guidance and Policy. The Corps' Engineering Regulation (ER) providing guidance for the conduct of Civil Works Planning Studies is contained in ER 1105-2-100. 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. American Society for Testing and Materials (ASTM) Standards E1527-05 and E1528-06 provide a comprehensive guide for conducting Phase I Environmental Site Assessments (ESA). These references provide information on what considerations are to be factored into project planning and implementation. The policy of the U.S. Army Corps of Engineers is to avoid construction of Civil Works projects when HTRW is located within project boundaries or may affect or be affected by such projects.

2.0 Introduction

2.1. Purpose and Scope. This HTRW inquiry is required in order to minimize and prevent Federal liability under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and to reduce any threats to project workers and avoid costly delays associated with environmental abatement activities. Appendix A contains a list of acronyms used in this report.

Phase I ESA's use only practically reviewable information. This investigation and assessment of the property is guided by the level appropriate for the type of property, information developed in the course of the assessment, project requirements, regulatory agency requirements, and potential risks. The screening methods used to prepare the Phase I ESA have been selected based on the location, physical setting, surrounding land uses, and particular nature of the Study Area. Intrusive field sampling and lab analyses are not used for the Phase I ESA, but are reserved for the Phase II ESA when required.

2.2. Limiting Conditions and Methodologies Used. The techniques used to assess HTRW contamination within and adjacent to the Site consisted of review of aerial photographs and

topographic maps, conducting interviews and site visits. Also, a search of federal and state environmental databases was conducted. 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. This Phase I ESA was completed by the Corps Environmental Engineering Section (CEMVR-EC-DN).

3.0 Study Area Description

The Study Area is the lower Starved Rock Pool of the Illinois River in La Salle County, Illinois. Proposed restoration activities in the Study Area include the construction of closure structures and J-hook breakwaters to restore submerged aquatic vegetation and improve conditions for fish habitat. The structures will be constructed in the central portion of Starved Rock Pool adjacent and parallel to the existing navigation channel.

3.1 Geographic Description. The Study Area comprises a portion of the Starved Rock Pool of the Illinois River Waterway from approximately River 233 to 235. This area includes Delbridge Island, Leopold Islands, and Gypsy Island, which are all currently submerged, and some small unnamed islands near River Mile 234 that are above the normal pool elevation. Starved Rock State Park is located on the left descending (south) bank of the Illinois River adjacent to the project area. The islands in the lower pool including Leopold Islands, Gypsy Island, and the majority of Delbridge Island are currently owned by the State of Illinois. Three islands located near River Mile 234 are privately owned. The Starved Rock Lock and Dam is located on the downstream end of the project area at River Mile 231. Two recreational boat marinas are located between River Miles 233 and 234, along the right descending (north) bank. See Appendix B, Site Vicinity Map, for the Study Area location.

3.2 Site History. Based on aerial photos (1938, 1970, 1978, 1988, 1998, 2004, 2009), topographic maps (1915, 1970, 1980, 2010) and interviews, Starved Rock Pool developed upon completion of the Starved Rock Lock and Dam in 1933. The Study Area has remained as part of the Pool, surrounded by agricultural fields and conservation woodlands since the Dam construction. Areas of surface strip mining were observed on the north and northeast shores of the Pool, however no strip mining is currently taking place. Development has been minimal, consisting of light residential and commercial, with more intense development upstream and downstream of the Study Area. Four small islands are present in the Pool, remnants of Delbridge Island which was submerged upon completion of the Dam. Prior to the Dam construction, Delbridge Island was used for agricultural purposes and hunting.

Currently the Study Area is used for commercial and recreational purposes.

4.0. User Provided Information

4.1 Title Records. Chain of title information will be researched by the U.S. Army Corps of Engineers Rock Island District (CEMVR) Real Estate Division.

4.2 Environmental Liens or Activity and Use Limitations. Environmental liens and Activity and Use limitations will be researched by the U.S. Army Corps of Engineers Rock Island District (CEMVR) Real Estate Division.

4.3 Specialized Knowledge. Marshall Plumley, Planner (PD-F) relayed specialized knowledge indicative of potential or actual recognized environmental conditions (REC's) or historic REC's. He provided information regarding potential overspray of herbicides from LaSalle County roads adjacent to the Study Area. He also indicated the possibility for contaminated sediments in the Illinois River located in the Study Area.

4.4. Commonly Known or Reasonably Ascertainable Information. Marshall Plumley, Planner (PD-F), provided an Illinois Sustainable Technology Center report documenting contaminant issues in Illinois River backwater lakes.

4.5. Valuation Reduction for Environmental Issues. Marshall Plumley, Planner (PD-F) indicated there is no information that indicates any valuation reduction on the subject site.

4.6. Indicators of Contamination at the Site. Marshall Plumley, Planner (PD-F) provided an Illinois Sustainable Technology Center report documenting contaminant issues in Illinois River backwater lakes.

5.0. Records Review

The purpose of a records review is to obtain and review records that will help identify recognized environmental conditions concerning the property. Some of the records reviewed pertain not just to the property, but also to properties within an approximate minimum search distance, in order to help assess the likelihood of problems from migrating hazardous substance or petroleum products. Factors considered in determining the approximate minimum search distance include the density of the setting, the distance that the hazardous substances or petroleum products are likely to migrate based on local geologic or hydrogeologic conditions, and other reasonable factors. This records review included the site assessment report from various state and federal environmental databases, maps, and air photos. Appendix C contains a printout of results of the database search.

5.1 EnviroMapper. EnviroMapper, created by the Environmental Protection Agency (EPA), is a database warehouse implemented in the Oracle Relational Database Management System and is available through the Internet for public access. It has the ability to retrieve information from several environmental databases, such as TRI (Toxic Release Inventory), Hazardous Waste (RCRAinfo), Brownfields (ACRES), Air Emissions (AIRS/AFS) and Water Discharges (PCA).

An EnviroMapper database query was conducted on January 3, 2013. Three facilities were identified within a 1 mile radius. Cargill Inc is AIRS and RCRA regulated industry located upstream of the Study Area in Ottawa, Illinois. The Starved Rock Lock and Dam is a RCRA regulated facility located downstream of the Study Area. State Lands Improvement LLC is an

AIRS regulated industry located upstream of the Study on Ottawa, Illinois. No impact the Study Area is anticipated due to the separation distance and lack of documented releases of spills from these facilities. Appendix C contains a printout of results of the database search.

5.2 Cleanups in My Community. Cleanups in My Community, created by the EPA, is a database warehouse implemented in the Oracle Relational Database Management System and is available through the Internet for public access. It is a mapping and listing tool that shows sites where pollution is being or has been cleaned up throughout the United States. It maps, lists and provides cleanup progress profiles for sites, facilities and properties that have been contaminated by hazardous materials and are being, or have been, cleaned up under EPA's Superfund, RCRA and/or Brownfields cleanup programs and Federal facilities that have been contaminated by hazardous materials and are being, or have been, cleaned up under EPA's Superfund and/or RCRA cleanup programs.

A 'Cleanups in My Community' database query was conducted on January 4, 2013. No cleanups were identified within a 1 mile radius of the Site. Appendix C contains a printout of results of the database search.

5.3. Illinois Environmental Protection Agency Leaking Underground Storage Tank (LUST) Database. LUST Section is responsible for the regulation of underground storage tank systems used for the storage of regulated substances, primarily petroleum products. Staff in the section work with the owners of sites on the detection, prevention and correction of releases of products from underground tanks.

A database query indicated two LUST sites adjacent to the Study Area. The Starved Rock Lock and Dam LUST site (#900015) was classified as No Further Remediation in August 1990. The Bernardoni LUST site (#922321) located in Ottawa, Illinois was classified as No Further Remediation in July 1993. These releases are not anticipated to have an influence on the Study Area. Appendix C summarizes the details and results of the database search.

5.4 Illinois Environmental Protection Agency Site Remediation Program (SRP). The SRP cleanup program provides Remediation Applicants (i.e., any persons seeking to perform investigative or remedial activities) the opportunity to receive IEPA review, technical assistance and no further remediation determinations from the Illinois EPA. The SRP database identifies the status of all voluntary remediation projects administered through the Pre-Notice Site Cleanup Program (1989 to 1995) and the Site Remediation Program (1996 to the present).

A database query indicated no SRP projects in the Study Area.

5.5. Illinois Department of Mines and Minerals Database (ArcIMS). The ArcIMS database displays past and current surface and subsurface mining activities in Illinois.

An ArcIMS database query was conducted on January 4, 2013. No active surface or subsurface mines are preset within 1 mile radius of the Study Area. Former surface strip mines include Buffalo Rock Coal mine located on the northeastern shore of the Study Area, Osage Coal mine located approximately 0.5 miles north of the Study Area, and Hydraulic Press Brick Company clay mine located 0.5 southwest of the Study Area.

The former surface mining areas do not appear to have a direct impact on the Study Area, however there is potential for past acid mine drainage from the mines to the Study Area waters and sediments. Appendix C contains a printout of results of the database search.

5.6. National Response Center. The National Response Center (NRC) is the sole federal point of contact for reporting oil and chemical spills. The NRC supports an online query system that makes all oil and chemical spill data reported to the NRC available via the internet.

A NRC database query was conducted on January 4, 2013. Several incidents and releases were identified within 1 mile of the Site. Further review of the incidents indicates they were dealt with in a timely manner and do not appear to have an influence on the Study Area. Appendix C contains a printout of results of the database search.

5.7 Physical Setting Sources. The Starved Rock Quadrangle 7.5 minute series topographical maps from 1970, 1991 and 2009 were used for records review. Surface elevation for the Study Area is the surface elevation of the Starved Rock Pool, approximately 459 feet above mean sea level (NGVD 1929). The valley bluffs increase in elevation to approximately 550 to 600 feet above mean seal level. See Appendix D for a topographic map of the Study Area. There were no indications of additional REC's in the topographic maps other than the presence of strip mining activity and industrial/commercial activity in the town of Naplate upstream of the Study Area.

Maps provided by the Illinois State Geological Survey indicated surface materials consist of unconsolidated glacial till, sands, silts, clay and gravel (Cahokia Formation) at a thickness of 50-200 feet. Bedrock geology consists of Pennsylvanian age coal, limestone and sandstones and Ordovician age sandstones.

According to the USDA Natural Resources Conservation Service Web Soil Survey, soils surrounding the Study Area consist of silty-clay loams from the Marseilles, Northfield and Ritchey association.

5.8 Historical Use Information. Historic aerial photos of the Study Area and surrounding area were obtained from the Illinois Natural Resources Geospatial Database. Three aerial photos were obtained, one each from 1939, 1998, and 2009. Historical topographic maps from 1932, 1945, 1971 and 1993 were utilized. The topographic maps and air photos indicate the Study Area's usage has been as agricultural (row crop production) and have been surrounded by agricultural lands and woodland since at least the 1930's. See Appendices C and D for

topographic maps. See Appendix E for aerial photos. Obvious indications of REC's were not observed in the aerial photographs or topographic maps.

No Sanborn Fire Insurance Maps were found for the Study Area and immediate surrounding properties.

Based on interviews, research was conducted into the possibility of contaminated sediments within Starved Rock Pool, United States Geological Survey (USGS) Circular 1209: "Water Quality in the Lower Illinois River Basin, Illinois, 1995-98" (2000) was reviewed. The Circular indicated that organochlorides and polycyclic aromatic hydrocarbons are present have been detected in Lower Illinois River sediments. The Circular also indicated that the sediments in the reach of the Illinois River near Ottawa has the highest concentrations of chromium, copper, lead, mercury, nickel, selenium, and zinc in the entire basin.

6.0 Site Reconnaissance

6.1 Methodology and Limiting Conditions. A site visit was conducted by Corps representatives Steve Gustafson (EC-DN), Rachel Fellman (EC-DN), Chris Haring (PD-F), Matt Afflerbaugh (PM-A) and Jason Appel (RE) on Wednesday, October 5, 2011. A reconnaissance was performed with visual inspection of surrounding properties.

6.2 General Site Setting. Riverine with several small islands, surrounded by sandstone bluffs, woodlands, and some minor residential and commercial development.

6.3 Interior Observations. No structures are present.

6.4 Exterior Observations. The following is a list of exterior items or features that were looked for during the site visit:

> *Landfills, emergency generators, evidences of above ground or underground storage tanks/equipment, drums, barrels, sumps, cisterns, catch basins, dry wells, septic tanks and/or leach fields, pipeline markers, transformers, capacitors, generators, stressed vegetation, stained soil, stained pavement, leachate or waste seeps, trash, debris or waste materials, dumping or disposal areas, construction/demolition debris, fill dirt, surface water discoloration, odor sheen or free floating product, exterior pipe discharges and /or effluent discharges, discharged from roof drains, quarries or pits, wells, hazardous materials and petroleum products.*

All accessible areas of the Study Area were observed during the site visit. See Appendix F for site visit photos. The following observations were made:

- The Study Area is utilized by waterfowl, for recreation and for commercial navigation. Some minor flood debris was noted.

No REC's were identified during site reconnaissance activities.

7.0 Interviews

Interviews were completed by Steve Gustafson from EC-DN in order to complete the Phase I assessment.

- Date: January 2, 2013
  Name: Marshall Plumley, Planner, U.S Army Corps of Engineers, PD-F, Rock Island, Illinois (knowledgeable member of Project Management).
  Topic: Discussed knowledge of site history, environmental issues, spills, cleanups, environmental liens and activity and use limitations (AUL's) in and around the Site. Mr. Plumley indicated he had no knowledge of any spills, cleanups, environmental liens and activity and use limitations (AUL's). He indicated the potential for contaminated sediment is Illinois River, and the potential for herbicides drifting from placement on county roads adjacent to the Study Area.

- Date: January 7, 2013
  Name: Connie Brooks, Director, La Salle Emergency Management Agency, Ottawa, Illinois (local government official).
  Topic: Discussed knowledge of site history, environmental issues, spills, and cleanups in and around the Study Area. Ms. Brooks indicated she had no knowledge of any environmental issues, cleanups or major spills, however, minor bilge or fuel leaks from marine traffic has probably occurred in the past.

- Date: August 25, 2011
  Name: Raymond Ulm, landowner, three islands in Starved Rock Pool.
  Topic: Discussed knowledge of Study Area history, environmental issues, spills, cleanups, environmental liens and activity and use limitations (AUL's) in and around the three islands. Mr. Ulm indicated he had no knowledge of any releases, spills, cleanups, environmental liens and activity and use limitations (AUL's).

See Appendix G for interview questionnaire forms.

8.0 Findings

This assessment has revealed two REC's in the Study Area. The first REC is the potential of contaminated sediments in the Starved Rock Pool. The second REC is the potential for herbicide contamination from overspray on county roads adjacent to the Study Area.

9.0 Opinion, Conclusion, Data Gaps and Recommendations

We have performed a Phase I Environmental Site Assessment in conformance with the scope and limitations of ASTM Practice E 1527-05 for the Study Area [Starved Rock Pool of the Illinois River]. Any exceptions to, or deletions from, this practice are described in Section 10 of this report.

No data gaps were identified.

As there are no plans for the removal of sediments from the Starved Rock pool, the risk from the REC's is negated. No additional assessment of investigation of the Study Area is recommended.

10.0 Deviations and Limitations

One material deviation from the standard was made in the preparation of this report. Chain of title, environmental lien, and AUL research will be conducted by others prior to Planning and Design activities.

No data gaps were identified.

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. Continuing the Environmental Due Diligence Audit process beyond this Phase I ESA to a Phase II ESA may reduce uncertainty, or reveal unidentified environmental liabilities. If any previously unaddressed recognized environmental condition should arise, this Phase I ESA will be revisited. The findings of this report are valid as of the date of the report.

11.0 References

U. S. Army Corps of Engineers, Lower Mississippi Valley Division, ER 1165-2-9, Hazardous, Toxic, and Radioactive Waste Policy for Civil Works Projects, 14 June 1996.

U. S. Army Corps of Engineers, Rock Island District, ER 1165-2-132, Hazardous, Toxic, and Radioactive Waste Guidance for Civil Works Projects, 26 June 1992.

U. S. Army Corps of Engineers, Policy Guidance Letter ER 1105-2-100 No. 34, CECW-PA, Non-CERCLA Regulated Contaminated Materials at Civil Works Projects, 5 May 1992.

U. S. Army Corps of Engineers, ER 385-1-92, Safety and Occupational Health Document Requirements for Hazardous, Toxic, and Radioactive Waste (HTRW) and Ordnance and Explosive Waste (OEW) Activities, 18 March 1994.

U. S. Army Corps of Engineers, ER 405-1-12, Real Estate Handbook, Chapter 8.

U. S. Army Corps of Engineers, ER 500-1-1, Natural Disaster Procedures.

ASTM E 1527-05, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process.

ASTM E 1528-06, Standard Practice for Environmental Site Assessments: Transaction Screen Process.

Terracon Consulting Engineers and Scientists, Naperville, IL. Final Phase 1 Environmental Site Assessment, Starved Rock Section 519 Project, Starved Rock Pool, Illinois Waterway, La Salle County, Illinois, Terracon Project No. 11077846. February 19, 2008.

United States Geological Survey, Circular 1209, Water Quality in Lower Illinois River Basin, Illinois, 1995-98. 2000

12.0 Signatures and Qualifications

I declare that to the best of my professional knowledge and belief, I meet the definition of Environmental professional as defined in 312.10 of 40 CFR 312 and I have the specific qualifications based on education, training, and experience to assess a property of the nature, history and setting of the subject property. I have developed and performed the all appropriate inquires in conformance with the standards and practices set forth in 40 CFR Part 312.

CEMVR-EC-DN representative Steve Gustafson, P.G., was responsible for the preparation of this Phase I Environmental Site Assessment.

Prepared by _____

Date 1/11/2013

CEMVR-EC-DN representative Kara Mitvalsky, P.E., conducted review activities for this Phase I Environmental Site Assessment.

Reviewed by Kara N. Mitvalsky

Date 1/11/2013

APPENDIX A

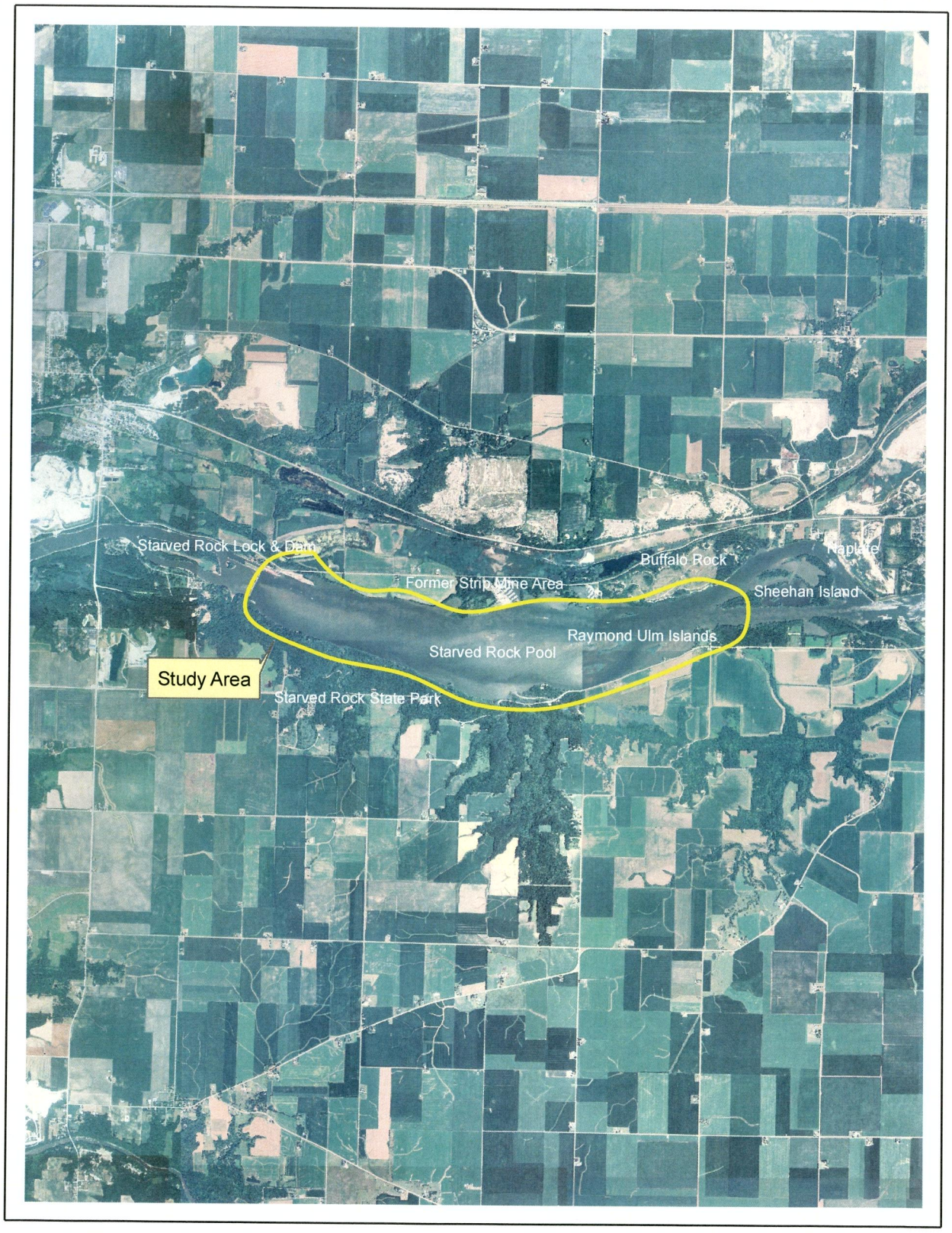
Acronyms

APPENDIX A
ACRONYMS

AIRS/AFS	Aerometric Information Retrieval System/AIRS Facility Subsystem
ASTM	American Society for Testing and Materials
BRS	Biennial Reporting System
CERCLA Act	Comprehensive Environmental Response, Compensation, and Liability
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CEMVR	Corps of Engineers, Mississippi Valley Division, Rock Island District
DOD	Department of Defense
ED-DN	Engineering Division - Environmental Engineering Section
EM	Engineering Manual
EMCI	EnviroFacts Master Chemical Integrator
EPA	Environmental Protection Agency
ER	Engineering Regulation
FII	Facility Identification Initiative
GICS	Grants Information and Control System
GIS	Geographic Information System
HTRWDR	HTRW Documentation Report
HTRW	Hazardous, Toxic, and Radioactive Waste
ICR	Information Collection Rule
ILEPA	Illinois Environmental Protection Agency
L	Left Descending Bank
LUST	Leaking Underground Storage Tanks
NCOD	National Contaminant Occurrence Database
NPL	National Priorities List
PCS	Permit Compliance System
R	Right Descending Bank
RCRA	Resource Conservation and Recovery Act
RCRIS	Resource Conservation and Recovery Information System
RM	River Mile
SDWIS	Safe Drinking Water Information System
SEIDS	Site Environmental Information Data System
SRP	Site Remediation Program
SSHP	Site Specific Safety and Health Plan
TRIS	Toxic Release Inventory System
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

APPENDIX B

Site Vicinity Map



Site Vicinity Map
Starved Rock Section 519 Study Area

N

Imagery Source: USDA NAIP, 2009

APPENDIX C

Environmental Database Searches

EPA United States Environmental Protection Agency

Cleanups In My Community

Cleanups In My Community Map

Define Your Community: Street Address | Enter address: | Radius (mi): 1 | List It | or | Map It

Cleanup Types: Brownfields Properties | Hazardous Waste | Superfund | Removals

Filter Cleanup Type

Brownfields Grants Jurisdictions: Job Training Grants | Job Training Pilot | Assessment Grants | Assessment Pilots | RLF Grants | RLF Pilots | State and Tribal 128(a) G

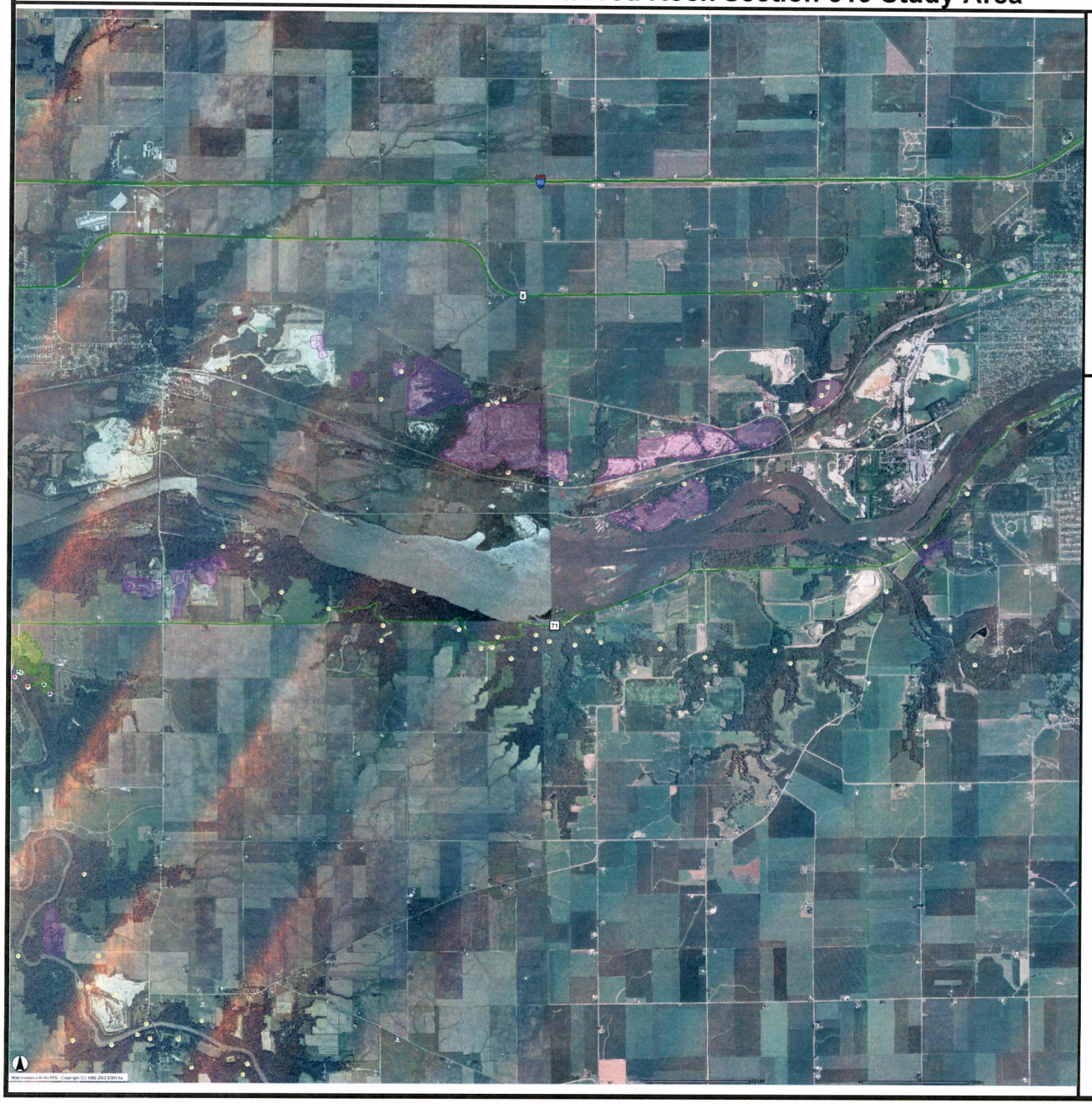
Grant Filters

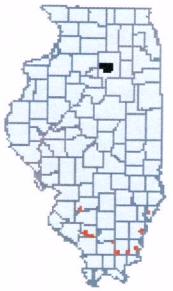
Other Data: STORET Water Monitoring Stations | Tribal Lands | Impaired Waters | Congressional Districts

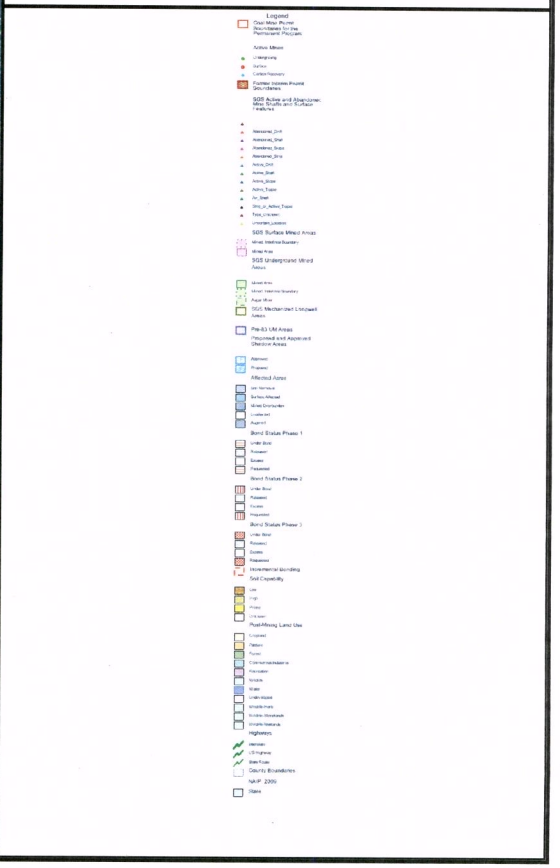
Click on a site for more information (Pop-up hyperlink will link to additional site specific information)



Starved Rock Section 519 Study Area







United States National Library of Medicine

TOXMAP® Environmental Health e-Maps

Home | TRI Facilities | TRI Releases | TRI Trends | Superfund | Combo | Search | Help | Contact Us

Search | Define Map | ▸ Display Map | Set Region | Other Data | Download

Start over

TRI State Fact Sheets

Current State Air Quality

Map Other Data
- US Census Data
- Income Data
- Health Data
- Reference Data

Chemical Information
- Search NLM TOXNET®
- CDC

Health Risk Information
- CDC ToxFAQs
- NJ Hazardous Substance Fact Sheets
- California Proposition 65 Chemicals
- EPA Risk Screening Tool

Toxicology References for this Map

Search NLM TOXLINE®

- What is the Toxics Release Inventory (TRI)?
- What is the "Superfund" Program?
- Does TOXMAP show all sources of toxic chemicals released into or present in the environment?
- What data sources does TOXMAP use?
- Whom do I contact with questions and/or suggestions?

more...

Search Results [Edit Search] [Save Results: TRI]

Start over

All TRI Reporting Facilities: All Chemicals

TRI - Map shows **1** of **20,587** TRI facilities reporting nationwide in 2010. View in: Google maps Google earth

All Superfund NPL Sites: All Chemicals

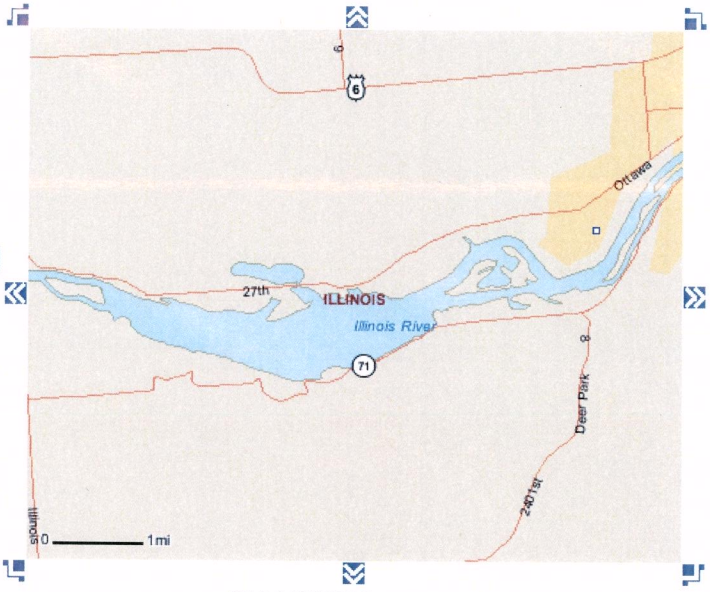
Superfund - Map shows **0** of **1,673** NPL sites nationwide

Print this map

ZOOM TO

Zoom to a place

Switch to small map



MAP DETAILS

TRI facility details

Superfund site details

Other sources of chemicals

Click on the links above to see details for this map.

MAP CONTROLS

TRI [Save results]
- None
- Facilities : 2010
- Releases : 2010
- Trends

Superfund
- None
- All NPL
- NPL Final
- NPL Deleted
- NPL Proposed

Demographic
- None
- Population Density - 2000

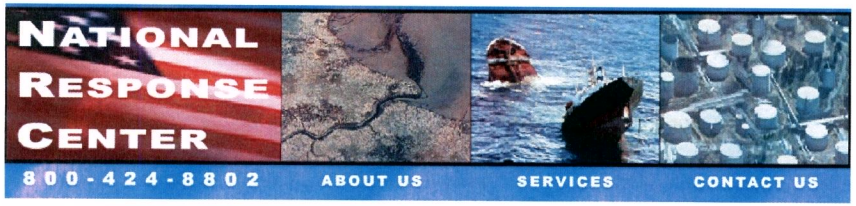
Apply other demographics

Search chemical | Define a combo map | Start over

Legend

TRI Facility

NPL Final | NPL Deleted | NPL Proposed



| NRC Home

QUERY RESULTS

BACK TO ENTER QUERY
CREATE NEW QUERY
row(s) 1 - 20 of 24 - Next >

Click here to view query results in spreadsheet

View Report	Materials Page	NRC Report #	Type of Call	Date/Time Received	Description Of Incident	Type Of Incident	Incident Cause	Incident Date/Time	Location	State	Nearest City	County	Suspected Responsible Company	Medium Affected	Material Name
View	Materials	34043	INCIDENT	04-AUG-1990 18:49	RED MATERIAL IN SMALL STREAM BEHIND HOUSE	UNKNOWN SHEEN	UNKNOWN	04-AUG-1990 17:30	200 E GROVE NUMBER 3	IL	UTICA	LA SALLE		WATER	UNKNOWN MATERIAL
View	Materials	75467	INCIDENT	13-JUN-1991 12:43	SUMP / WHILE TRANSFERRING MATERIAL FROM AN ABOVEGROUND STORAGE TANK TOTHE SUMP, THE SUMP WAS OVERFILLED.	FIXED	OPERATOR ERROR	13-JUN-1991 03:00	340 EAST GROVE ST.	IL	UTICA	LA SALLE	THE P.Q. CORPORATION	LAND	METASILICATE
View	Materials	108874	INCIDENT	02-MAR-1992 15:00	EPSOM SALT REACTOR / DEVELOPED A HOLE	FIXED	EQUIPMENT FAILURE	02-MAR-1992 08:45	340 EAST GROVE ST.	IL	UTICA	LA SALLE	THE P.Q. CORPORATION	LAND	SULFURIC ACID
View	Materials	108874	INCIDENT	02-MAR-1992 15:00	EPSOM SALT REACTOR / DEVELOPED A HOLE	FIXED	EQUIPMENT FAILURE	02-MAR-1992 08:45	340 EAST GROVE ST.	IL	UTICA	LA SALLE	THE P.Q. CORPORATION	LAND	EPSOM SALTS
View	Materials	153778	INCIDENT	18-JAN-1993 10:32	GASKET ON A SILICON TRANSFER LINE/FAILED	FIXED	EQUIPMENT FAILURE	18-JAN-1993 05:30	340 E GROVE ST	IL	UTICA	LA SALLE	THE P.Q. CORPORATION	LAND	SODIUM SILICATE
View	Materials	167302	INCIDENT	13-APR-1993 16:52	VALVE ON A 6" PIPELINE/VIBRATED OPEN	PIPELINE	OTHER	13-APR-1993 15:30	340 EAST GROVE ST.	IL	UTICA	LA SALLE	THE P.Q. CORPORATION	LAND	SODIUM SILICATE
View	Materials	182060	INCIDENT	22-JUN-1993 23:00	TRACTOR TRAILOR/REFRIDGERATION TANK WAS PUNCTURED	MOBILE	EQUIPMENT FAILURE	22-JUN-1993 14:00	402 MILL ST	IL	UTICA	LA SALLE	A & M EXPRESS	LAND	OIL: DIESEL
View	Materials	182190	INCIDENT	23-JUN-1993 13:41	MATERIAL WAS RELEASED WHILE LOADING A RAIL TANKCAR WHEN A TRANSFERLINE SUPPORT WIRE BROKE	RAILROAD	EQUIPMENT FAILURE	23-JUN-1993 11:10	340 EAST GROVE ST.	IL	UTICA	LA SALLE	THE P.Q. CORPORATION	WATER	SODIUM SILICATE
View	Materials	192371	INCIDENT	13-AUG-1993 19:01	PROCESS WATER TRENCH/LEAKED INTO THE GROUND DUE TO A CRACK	FIXED	EQUIPMENT FAILURE	13-AUG-1993 08:10	340 EAST GROVE ST.	IL	UTICA	LA SALLE	THE P.Q. CORPORATION	LAND	ALKALINE PROCESS WATER
View	Materials	254820	INCIDENT	11-AUG-1994 16:19	TRANSMISSION PIPELINE//MATERIAL RELEASED AFTER PIPELINE DISCONNECTEDFROM FLANGE AT REACTOR	PIPELINE	EQUIPMENT FAILURE	11-AUG-1994 13:40	340 EAST GROVE ST.	IL	UTICA	LA SALLE	THE P.Q. CORPORATION	LAND	SULFURIC ACID(93%)
View	Materials	281438	INCIDENT	28-FEB-1995 08:11	M/V NANCY S.// ALLIDED WITH MOORING CELL// DAMAGED STERN AND BARGEBARGE CARRYING CORN// VSL PUMPED VOID TANK AND SOME OIL CAME OUT	VESSEL	TRANSPORT ACCIDENT	28-FEB-1995 02:00	MILE IL 231	IL	UTICA	LA SALLE	ARCO	WATER	
					LOADING HOSE ON TANKER				340 E						

View	Materials	350656	INCIDENT	06-JUL-1996 12:08	TRUCK / UNKNOWN(HOSE FAILURE)	MOBILE	EQUIPMENT FAILURE	05-JUL-1996 22:15	GROVE ST	IL	UTICA	LA SALLE	LUCKY TRUCKING	LAND	SULFURIC ACID
View	Materials	482537	INCIDENT	04-MAY-1999 12:21	VALVE ON RAIL TANK CAR/VALVE WAS DEFECTIVE	RAILROAD	EQUIPMENT FAILURE	04-MAY-1999 06:30	340 EAST GROVE STREET	IL	UTICA	LA SALLE	THE PQ CORPORATION	WATER	MAGNESIUM HYDROXIDE
View	Materials	524884	INCIDENT	02-APR-2000 17:39	SEWER LIFT STATION / SEWER PUMPS AND EMERGENCY ALARM FAILED	FIXED	EQUIPMENT FAILURE	02-APR-2000 14:40	N/A 340 E GROVE ST	IL	UTICA	LA SALLE	P Q CORP	WATER	SANITARY SEWER AND WATER
View	Materials	578241	INCIDENT	30-AUG-2001 07:29	THE CALLER IS REPORTING A BURST TRANSFER HOSE.	VESSEL	EQUIPMENT FAILURE	30-AUG-2001 06:00	ILLINOIS RIVER	IL	UTICA	LA SALLE	MARATHON ASHLAND	WATER	ASPHALT
View	Materials	584744	INCIDENT	31-OCT-2001 07:09	WHILE DISCHARGING CARGO FROM A BARGE TO THE PLANT, A PLUG IN THE HOSE CAUSED A PINHOLE LEAK RELEASING ASPHALT INTO THE ILLINOIS RIVER.	FIXED	EQUIPMENT FAILURE	31-OCT-2001 06:05	2ND FACILITY DOWN FROM THE RTE 178 BRIDGE. NORTH 27TH RD	IL	UTICA	LA SALLE	UTICA TERMINAL INC.	WATER	ASPHALT
View	Materials	602528	INCIDENT	06-MAY-2002 16:04	THE CALLER IS REPORTING A SIGHTING OF AN UNKNOWN MATERIAL ON WINDOW SEALS AND AUTOMOBILES IN A NEIGHBORING TOWN OF THE FACILITY.	FIXED	UNKNOWN	06-MAY-2002 09:00	340 EAST GROVE STREET	IL	UTICA	LA SALLE		OTHER	UNKNOWN MATERIAL
View	Materials	650533	INCIDENT	10-JUL-2003 19:30	CALLER STATED THAT THERE IS A PIT OUTSIDE OF THEIR OIL STORAGE AREA THAT WAS DISCOVERED CONTAINING OIL. THE CAUSE OF THIS OIL IS UNKNOWN AT THIS TIME. THE OIL IS LOCATED IN A CONTAINED AREA.	FIXED	UNKNOWN	10-JUL-2003 15:00	DIRECTLY SOUTH OF OIL STORAGE TANKS 340 E GROVE ST	IL	UTICA	LA SALLE		LAND	UNKNOWN OIL
View	Materials	733177	INCIDENT	26-AUG-2004 17:05	REPORTING AN UNKNOWN SHEEN SIGHTING.	UNKNOWN SHEEN	UNKNOWN	26-AUG-2004 07:30	ILLINOIS RIVER, BY STARVE ROCK DAM	IL	UTICA	LA SALLE		WATER	UNKNOWN OIL
View	Materials	739888	INCIDENT	29-OCT-2004 13:13	CALLER IS REPORTING A MATERIAL RELEASE DUE TO A HOSE RUPTURE.	STORAGE TANK	EQUIPMENT FAILURE	29-OCT-2004 11:45	3000 11TH ROAD	IL	UTICA	LA SALLE	UTICA ELEVATOR CO	AIR	AMMONIA, ANHYDROUS

Click here to view query results in spreadsheet

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BACK TO ENTER QUERY

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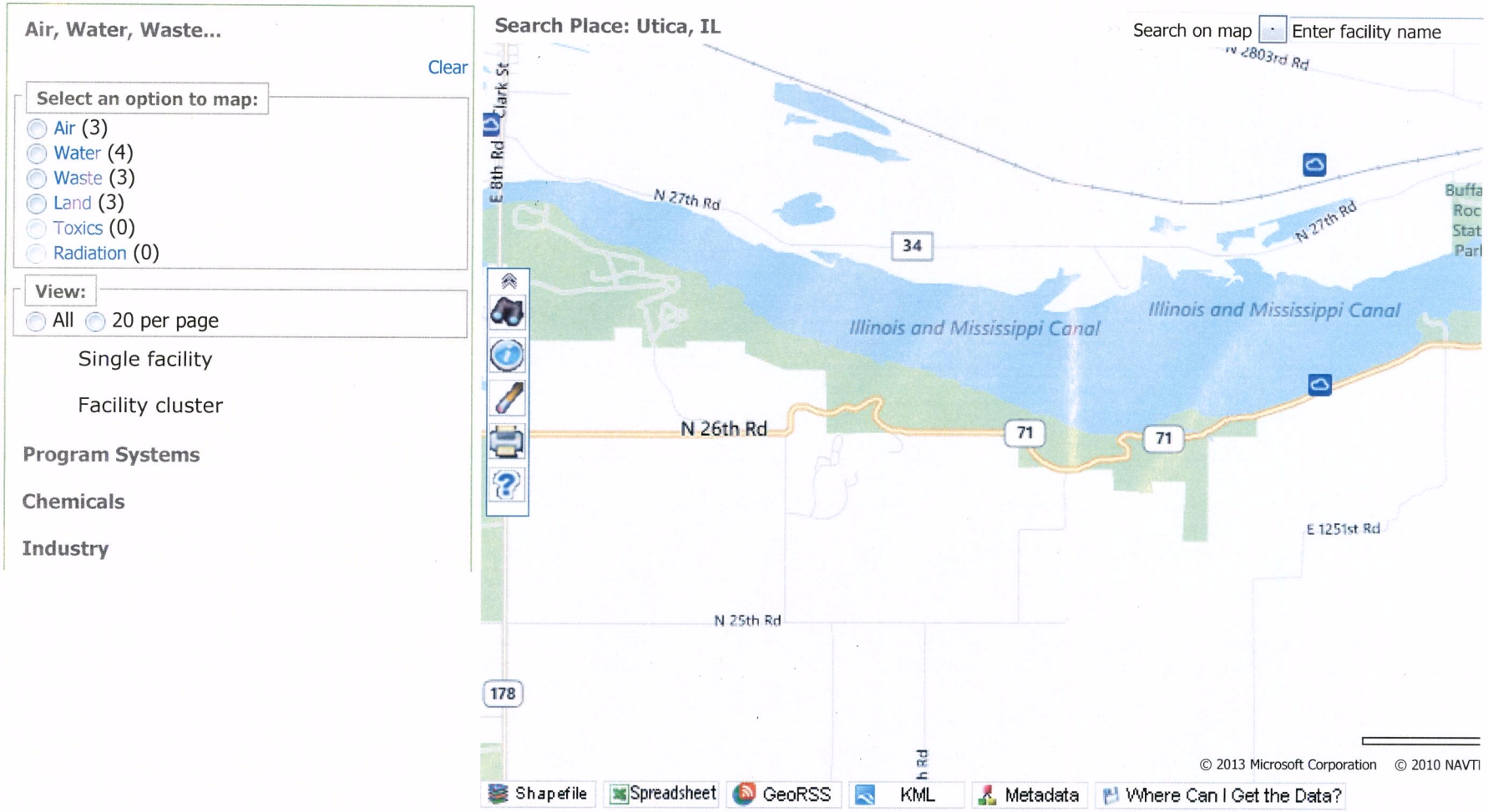

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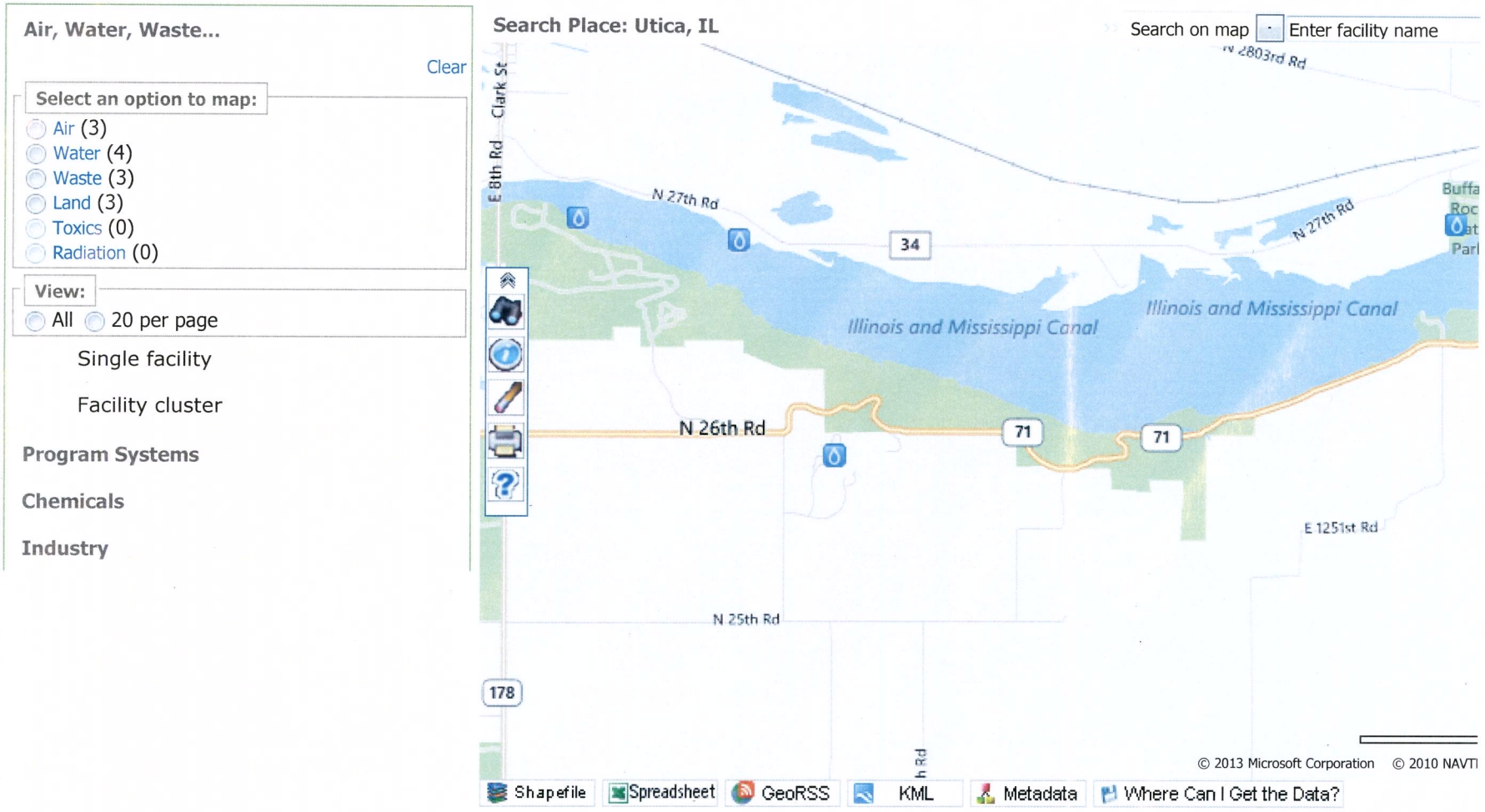
SOUTHERN PRECISION SANDS LLC FRS ECHO 1232 N 2803RD ST OTTAWA, IL 61350	View Report	-	-	-	-	-	-	-	-
UTICA TERMINAL INC FRS ECHO NORTH 27TH RD UTICA, IL 61373	View Report	-	-	-	-	-	-	-	View Report

EPA: United States Environmental Protection Agency

EnviroMapper for Envirofacts



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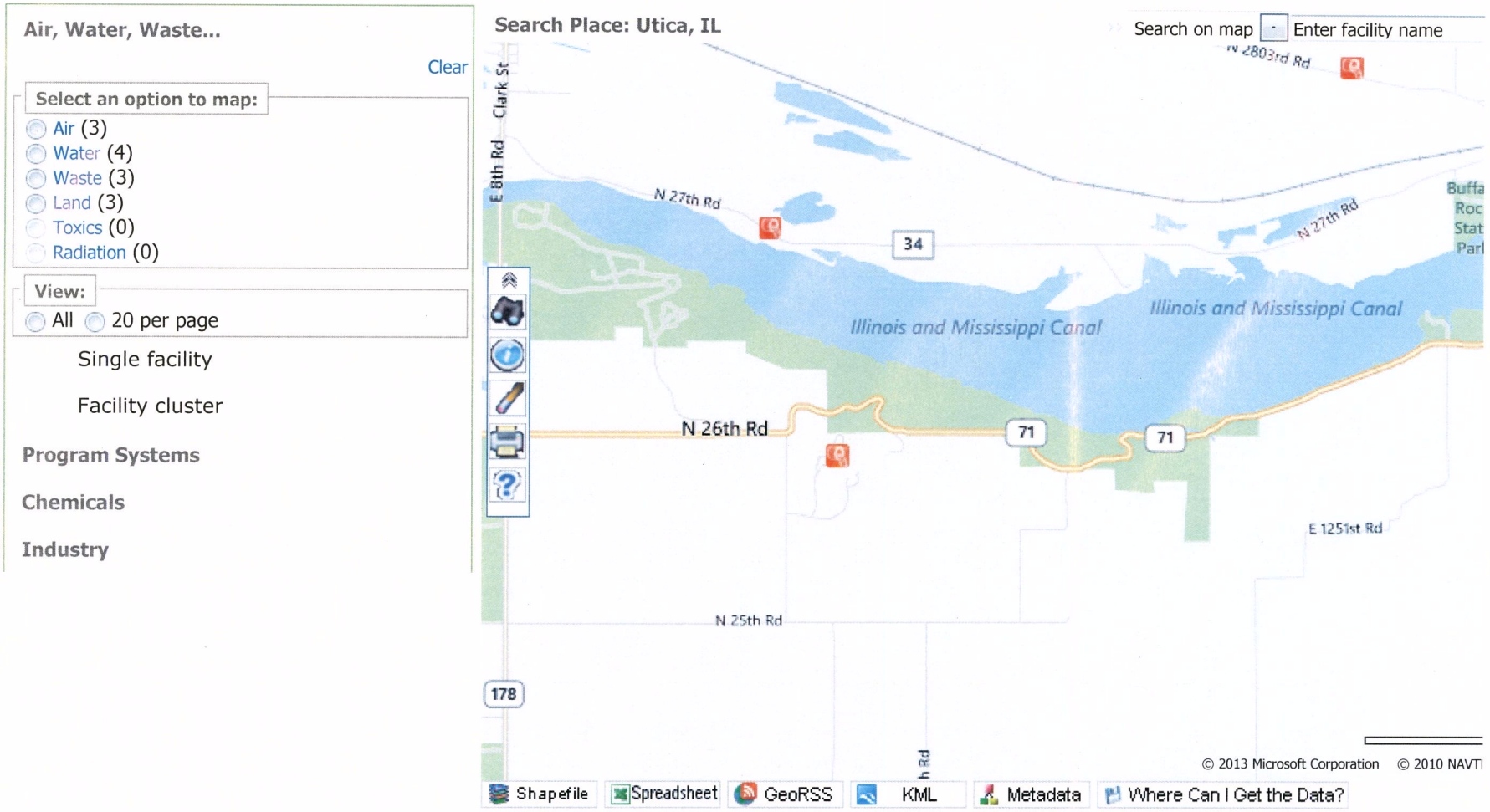
IL&MICH CANAL STATE TRAIL STP FRS ECHO DEE BENNETT ROAD OTTAWA, IL 61350	-	-	-	-	View Report	-	-	-	-
PERU-STARVED ROCK HYDROELECT FRS ECHO DEE BENNET ROAD UTICA, IL 61373	-	-	-	-	View Report	-	-	-	-
STARVED ROCK STATE PARK FRS ECHO RTE 178 & RTE 71 UTICA, IL 61373	-	-	View Report	-	View Report	-	View Report	-	-

EPA: United States Environmental Protection Agency

EnviroMapper for Envirofacts



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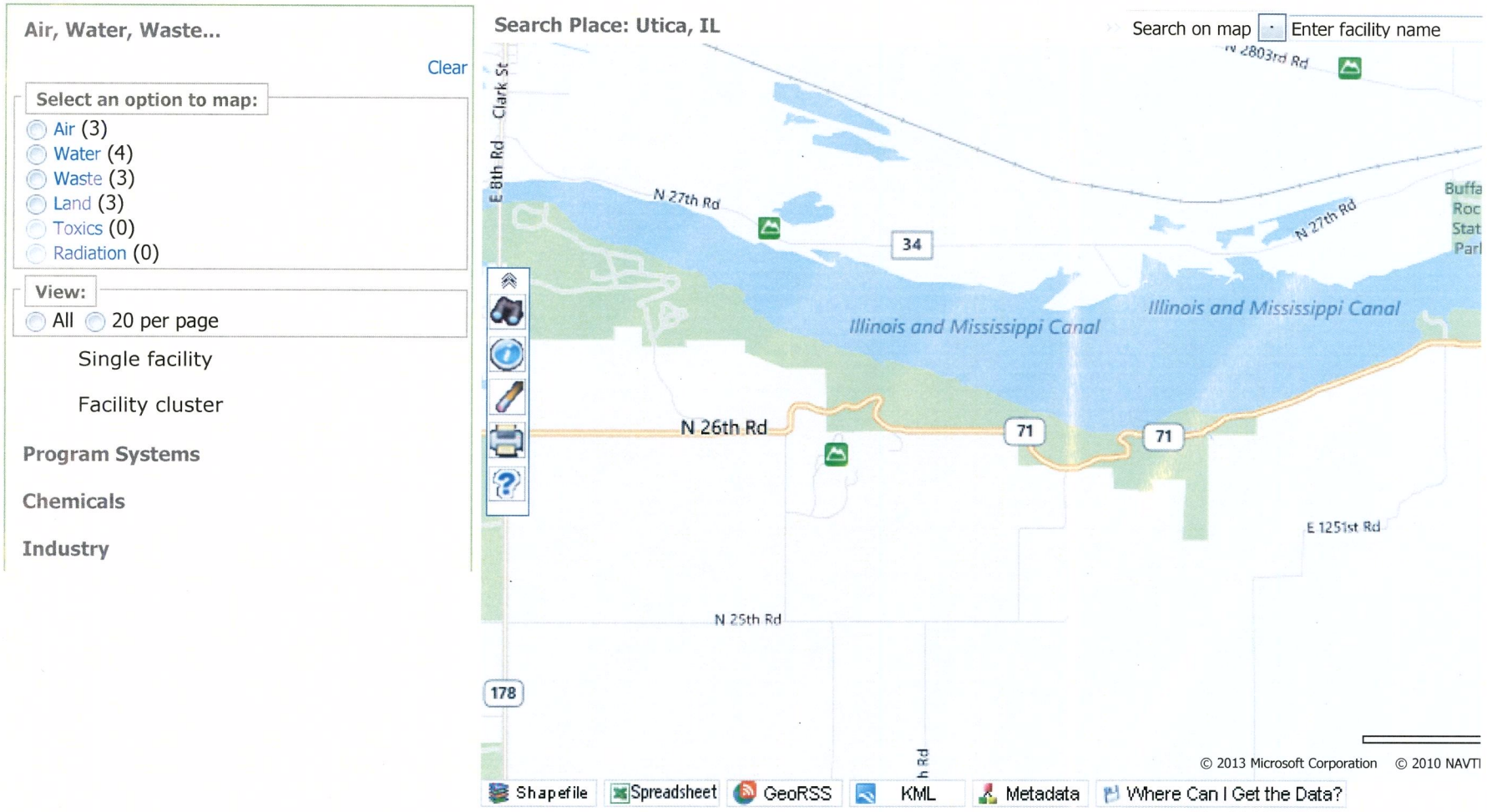
ARMY COE LOCK DAM 06 FRS ECHO 950 N 27TH RD OTTAWA, IL 61350	-	-	-	-	-	-	View Report	-	-
DIRT GEAR KTM INC FRS ECHO 1252 N 2803 RD OTTAWA, IL 61350	-	-	-	-	-	-	View Report	-	-
STARVED ROCK STATE PARK FRS ECHO RTE 178 & RTE 71 UTICA, IL 61373	-	-	View Report	-	View Report	-	View Report	-	-

EPA: United States Environmental Protection Agency

EnviroMapper for Envirofacts



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DIRT GEAR KTM INC FRS ECHO 1252 N 2803 RD OTTAWA, IL 61350	-	-	-	-	-	-	View Report	-	-
STARVED ROCK STATE PARK FRS ECHO RTE 178 & RTE 71 UTICA, IL 61373	-	-	View Report	-	View Report	-	View Report	-	-

APPENDIX D

Topographic Map



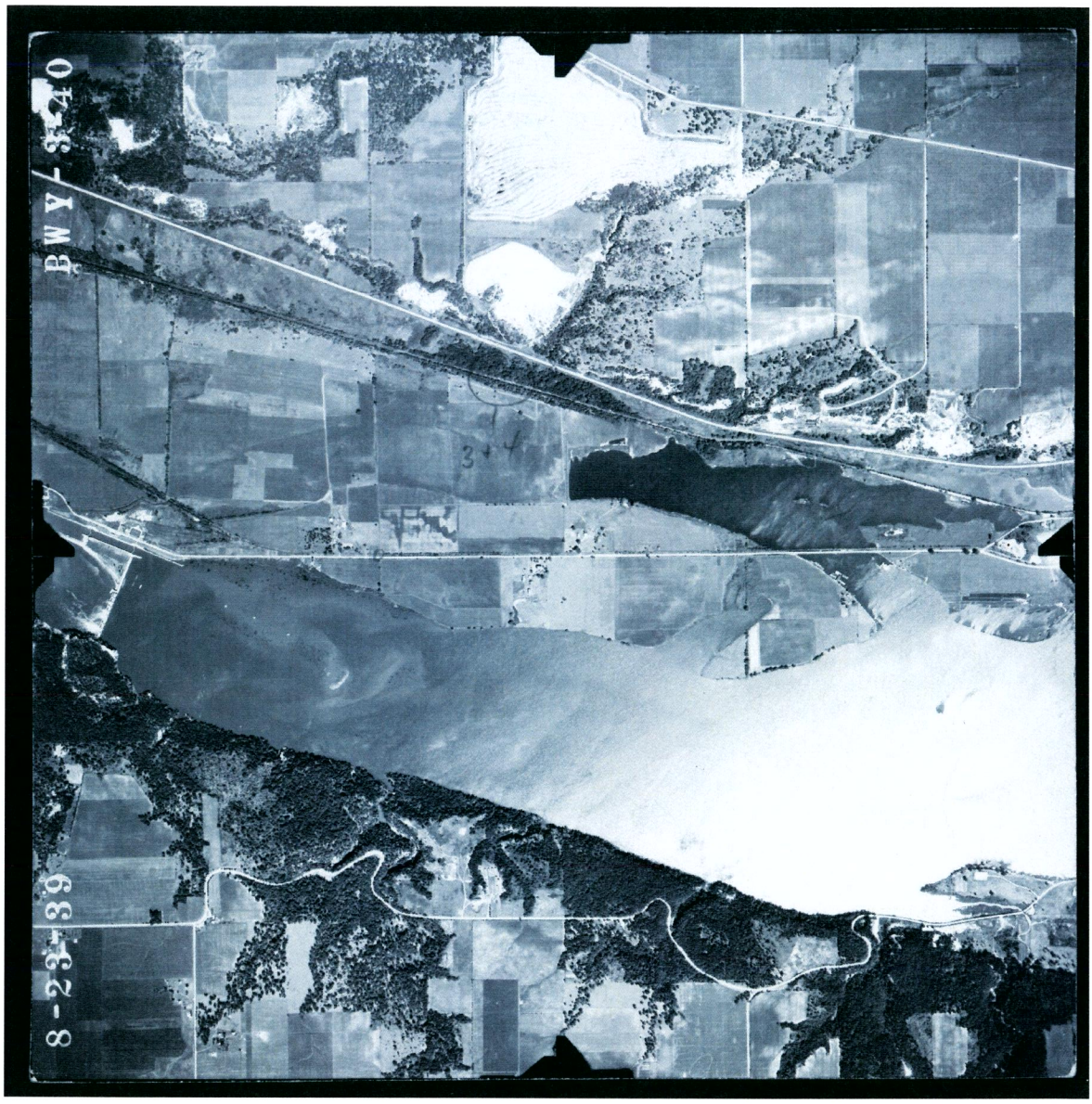
Topographic Map
Starved Rock Section 519 Study Area

Imagery Source: USGS, 1970
Contour Interval 10 feet
Starved Rock Quadrangle 7.5" Series

N

APPENDIX E

Aerial Photos



1939 Air Photo-West Portion of Study Area
Starved Rock Section 519

N

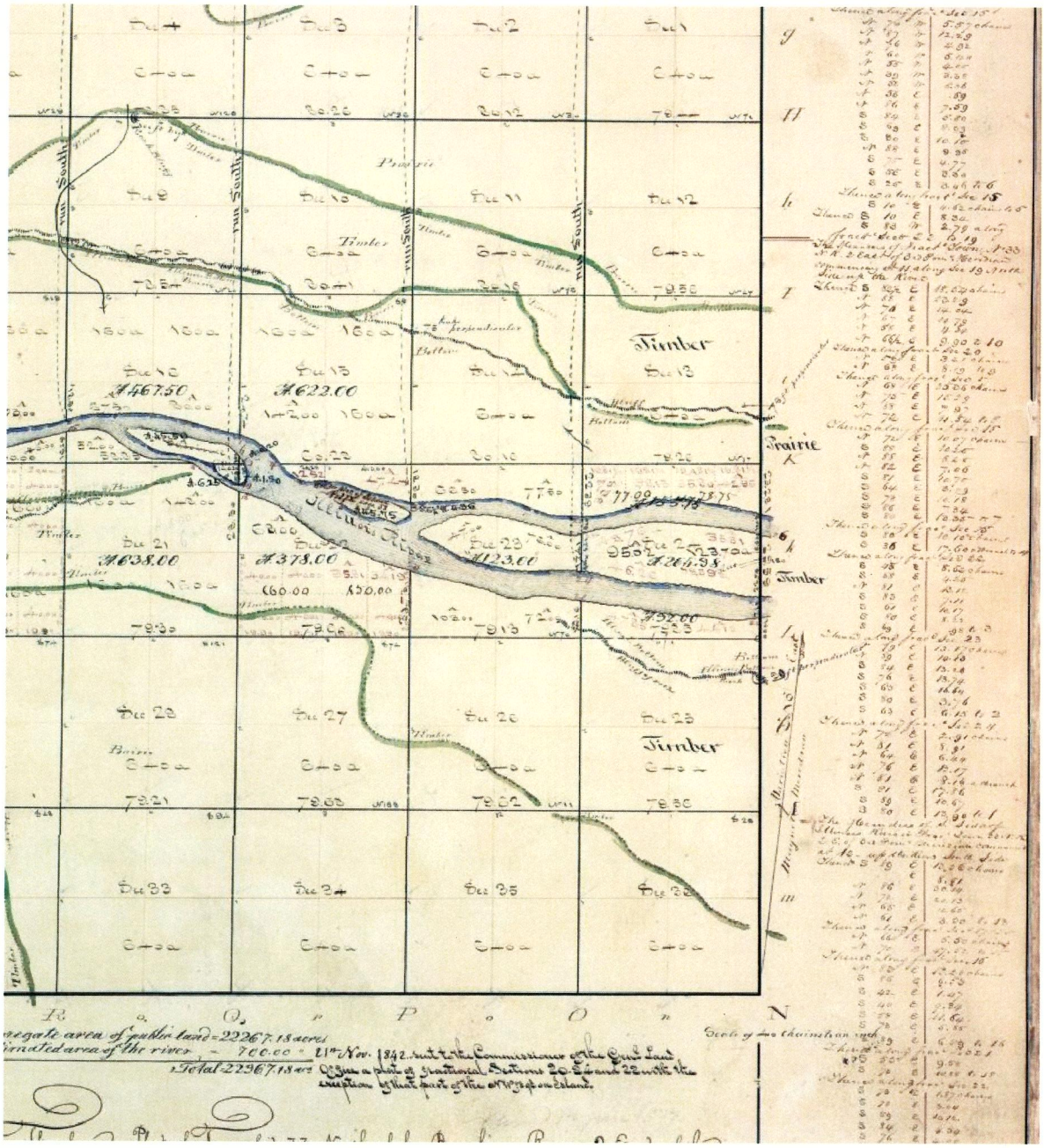
Imagery Source: Illinois Natural Resources Geospatial Data Clearinghouse



1939 Air Photo-East Portion of Study Area
Starved Rock Section 519

N

Imagery Source: Illinois Natural Resources Geospatial Data Clearinghouse



1834 Land Survey Map-West Portion of Study Area
Starved Rock Section 519

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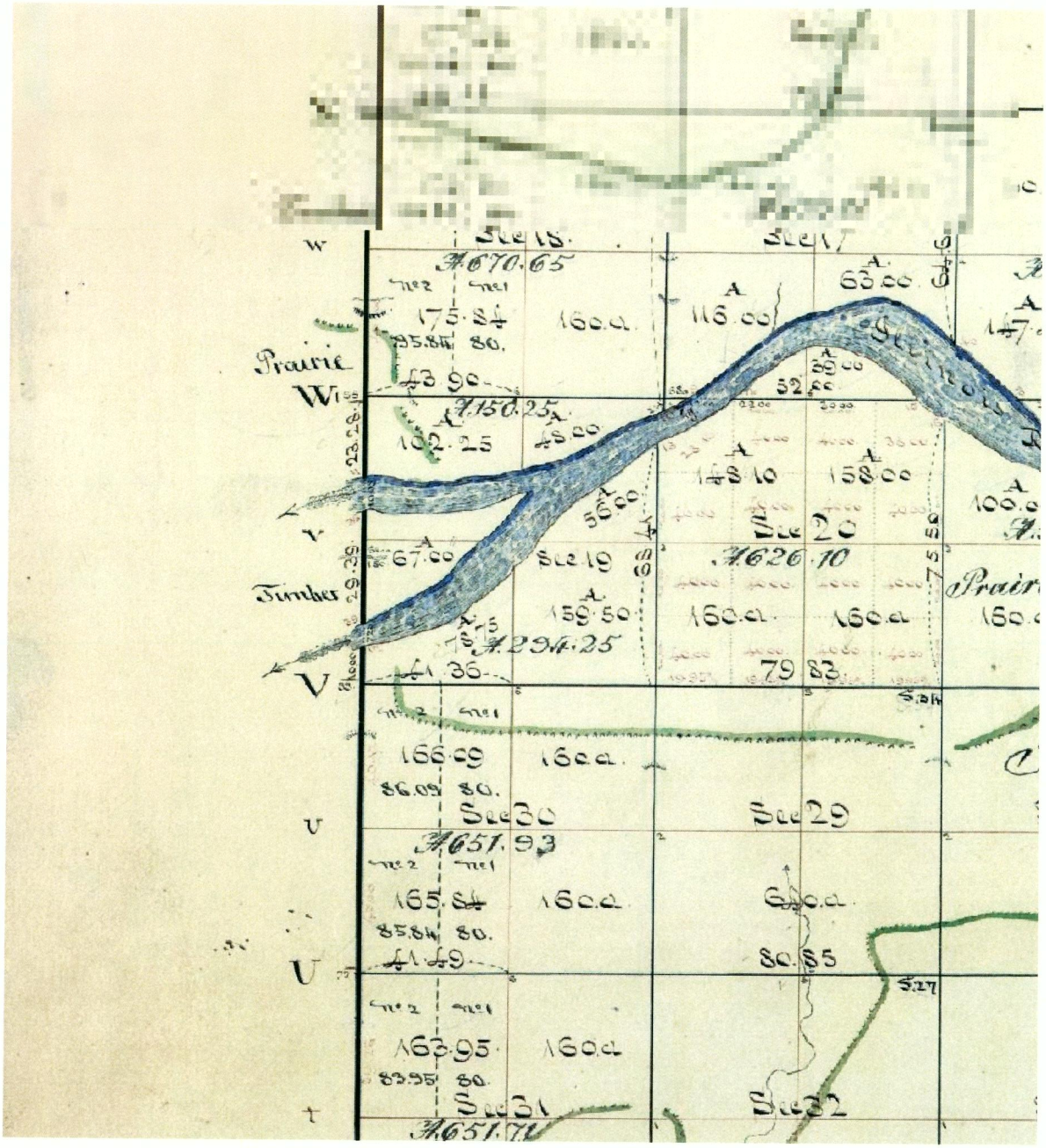
Imagery Source: Illinois State Archives



1834 Land Survey Map-East Portion of Study Area
Starved Rock Section 519

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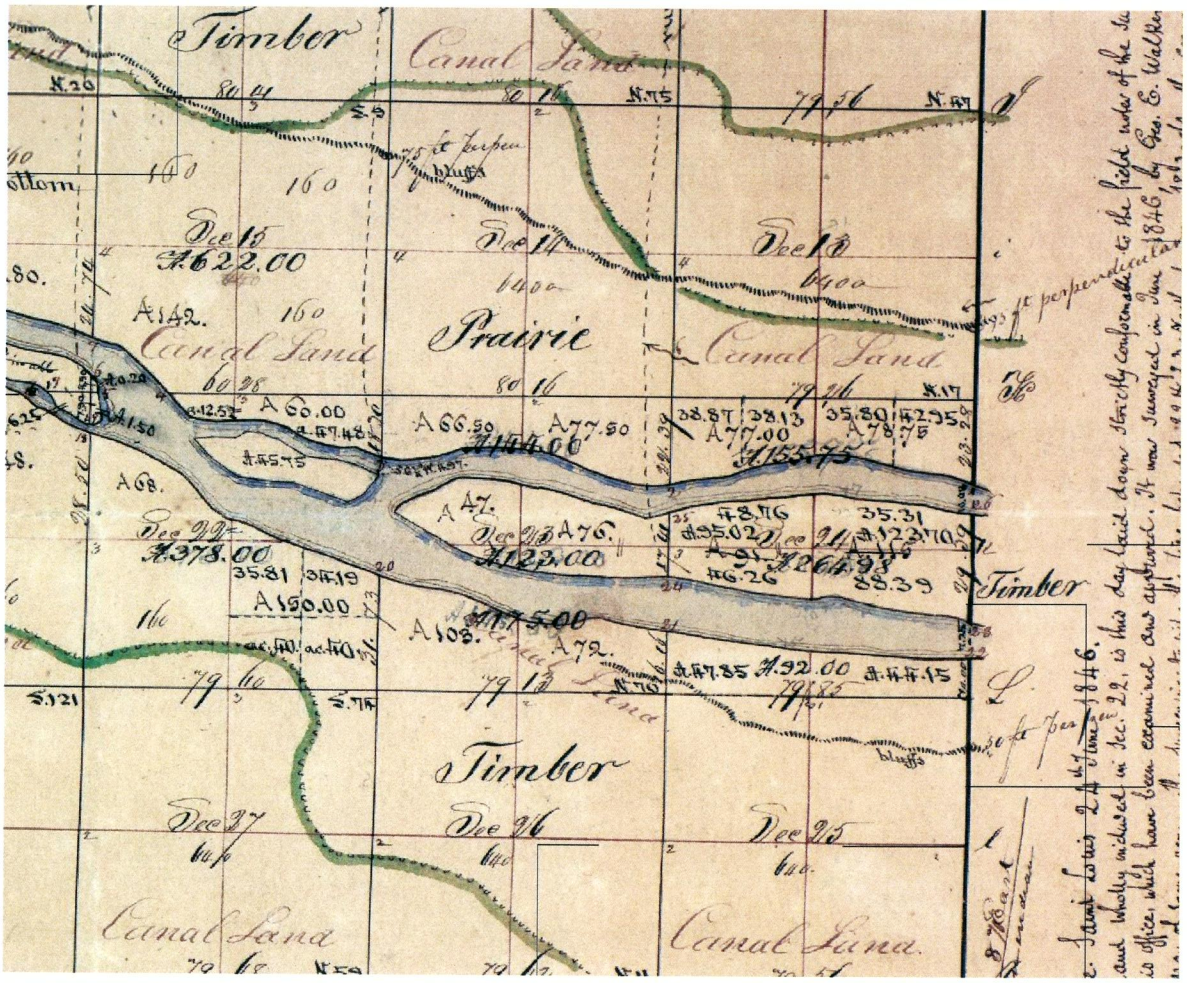
Imagery Source: Illinois State Archives



1822 Land Survey Map-West Portion of Study Area
Starved Rock Section 519

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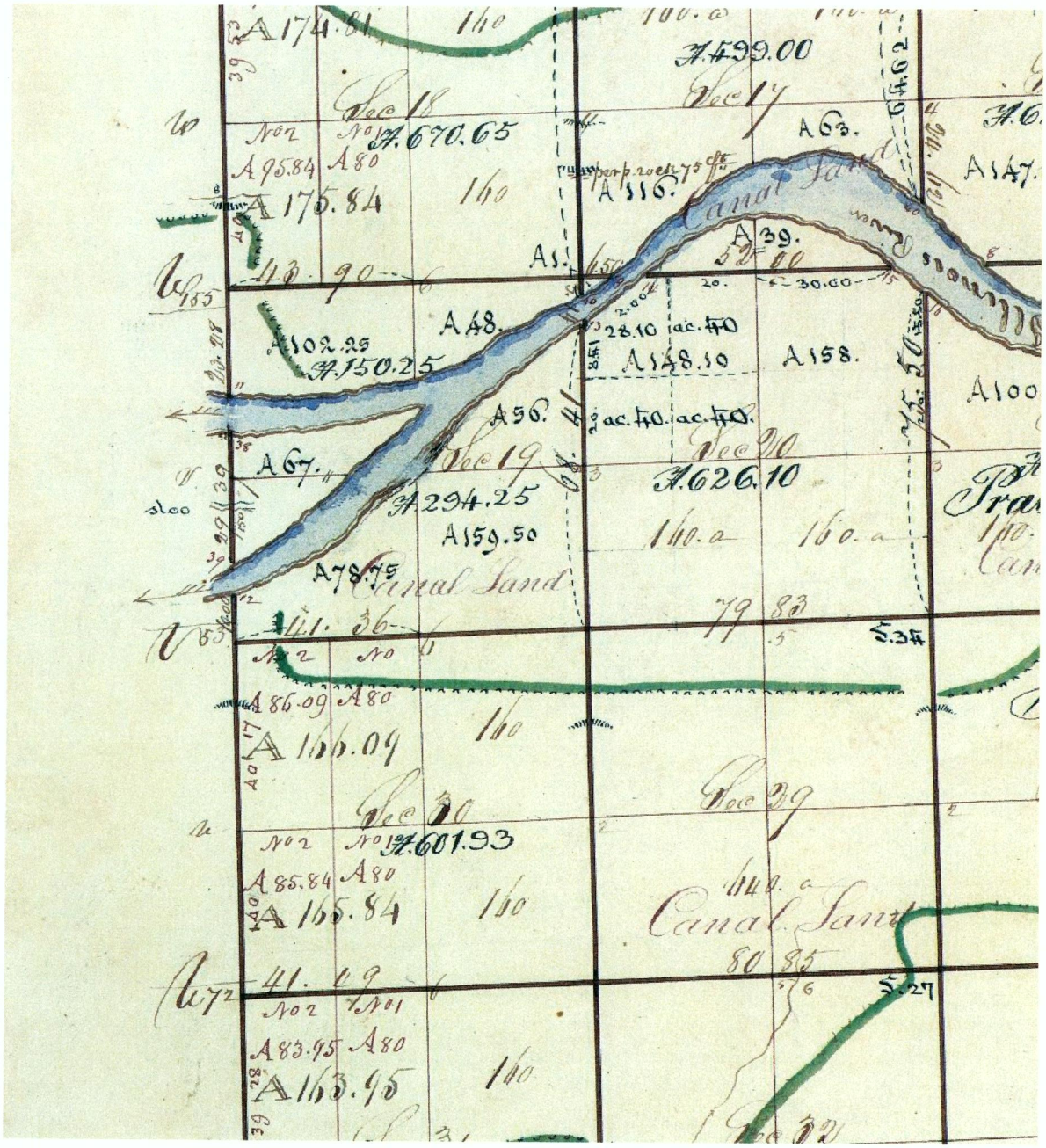
Imagery Source: Illinois State Archives



1822 Land Survey Map-East Portion of Study Area
Starved Rock Section 519

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Imagery Source: Illinois State Archives

APPENDIX F

Site Photographs

Photo 1: Starved Rock Pool (Remnant Island) looking east.



Photo 2: North shore Starved Rock Pool, looking north.



Photo 3: Starved Rock Pool (duck blind center of photo), looking south.



Photo 4: Starved Rock Pool, Starved Rock Marina, looking north.



Photo 5: Starved Rock Pool, south side of remnant island with duck blind.



Photo 6: Starved Rock Pool, center of pool looking southeast.



APPENDIX G

Questionnaire Form

Interview Date: January 2, 2013
Name: Marshall Plumley
Title: Project Manager
Company/Organization: Rock Island District Corps of Engineers
Status:
Client/Owner
Site Manager
Occupant
Government Official X
Other NGO Partner

During what time period were you the site manager of the property?

Not applicable

What is the current use of the property?
Illinois Waterway

Who are the occupants of the property?

None

Do you have any other knowledge or experience with the property that may be pertinent to the environmental professional?
Yes
No
If yes describe:

As a subject matter expert on the Illinois River Basin I am aware of varying types and distribution of pollutants in the Illinois River and particularly its backwaters. For the Starved Rock Project, I served as study manger for two years, completing the draft feasibility report through existing conditions and preliminary measures. During that time the only recognized environmental condition I was made aware of related to the potential for overspray of chemicals on adjacent county roads drifting into the project area. We were conducting a Submersed Aquatic Vegetation enclosure experiment which suffered a complete die off coinciding with chemical application. No confirmation was made of this however.

Are you aware of any environmental cleanup liens against the property that are filed or recorded under federal, tribal, state or local law?
Yes
No
If yes describe:

Are you aware of any Activity and Use Limitations, such as engineering controls, land use restrictions or institutional controls that are in place at the site and/or have been filed or recorded in a registry?
Yes
No
If yes describe:

Do you know the past uses and general history of the property?
Yes
No
If yes describe:

See above

Do you know of specific chemicals that are present or once were present at the property?
Yes
No
If yes describe:

See above

Do you know of spills or other chemical releases that have taken place at the property?
Yes
No
If yes describe:

Do you know of any environmental cleanups that have taken place at the property?
Yes
No
If yes describe:

Based on your knowledge and experience related to the property are there any indicators that point to the presence or likely presence of contamination at the property?
Yes
No
If yes describe:

The Illinois Sustainable Technology Center, Investigation of Metal and Organic Contaminant Distributions and Sedimentation Rates in Backwater Lakes along the Illinois River, 2008, while evaluating Peoria and LaGrange pools, clearly correlates the presence of various contaminants increases with proximity to the urbanized Chicago Metro Area. It may be reasonable to assume Starved Rock Pool continues this pattern.

Interview Date: 8-25-11
Name: R. ULM
Title: OWNER
Company/Organization: _____
Status:
Client/Owner
Site Manager
Occupant
Government Official
Other NGO Partner

During what time period were you the site manager of the property?

1985 TO PRESENT

What is the current use of the property?

HUNTING

Who are the occupants of the property?

MYSELF

Do you have any other knowledge or experience with the property that may be pertinent to the environmental professional?
Yes
(No)
If yes describe:

Are you aware of any environmental cleanup liens against the property that are filed or recorded under federal, tribal, state or local law?
Yes
(No)
If yes describe:

Are you aware of any Activity and Use Limitations, such as engineering controls, land use restrictions or institutional controls that are in place at the site and/or have been filed or recorded in a registry?
Yes
(No)
If yes describe:

Do you know the past uses and general history of the property?
(Yes)
No
If yes describe:

TO MY KNOWLEDGE IT WAS A FARM

Interview Date: January 7, 2013
Name: Connie Brooks
Title: Director
Company/Organization: La Salle County EMA
Status:
Client/Owner
Site Manager
Occupant
Government Official X
Other NGO Partner

During what time period were you the site manager of the property?

Not applicable

What is the current use of the property?
Illinois Waterway

Who are the occupants of the property?

None

Do you have any other knowledge or experience with the property that may be pertinent to the environmental professional?
Yes
No
If yes describe:

Minor releases from bilge or fuel leaks from marine traffic have occurred in the past.

Are you aware of any environmental cleanup liens against the property that are filed or recorded under federal, tribal, state or local law?
Yes
No
If yes describe:

Are you aware of any Activity and Use Limitations, such as engineering controls, land use restrictions or institutional controls that are in place at the site and/or have been filed or recorded in a registry?
Yes
No
If yes describe:

Do you know the past uses and general history of the property?
Yes
No
If yes describe:

Do you know of specific chemicals that are present or once were present at the property?
Yes
No
If yes describe:

Do you know of spills or other chemical releases that have taken place at the property?
Yes
No
If yes describe:

Do you know of any environmental cleanups that have taken place at the property?
Yes
No
If yes describe:

Based on your knowledge and experience related to the property are there any indicators that point to the presence or likely presence of contamination at the property?
Yes
No
If yes describe:

ILLINOIS RIVER BASIN RESTORATION
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PROJECT IMPLEMENTATION REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STARVED ROCK POOL CRITICAL RESTORATION PROJECT
LASALLE COUNTY, ILLINOIS

APPENDIX F

WATER QUALITY

ILLINOIS RIVER BASIN RESTORATION
SECTION 519
PROJECT IMPLEMENTATION REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STARVED ROCK POOL CRITICAL RESTORATION PROJECT
LASALLE COUNTY, ILLINOIS

APPENDIX F

WATER QUALITY

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ILLINOIS RIVER BASIN RESTORATION
SECTION 519
PROJECT IMPLEMENTATION REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STARVED ROCK POOL CRITICAL RESTORATION PROJECT
LASALLE COUNTY, ILLINOIS

APPENDIX F

WATER QUALITY

1. EXECUTIVE SUMMARY

Submerged aquatic vegetation (SAV) has largely disappeared from the Illinois River downstream of Starved Rock Dam, while upstream of the dam SAV success is variable both temporally and spatially. Other studies of large rivers have shown that numerous stressors can play a role in determining SAV survival, including water clarity. Subsurface light characteristics of lower Starved Rock pool were monitored at two locations during the summers of 2007 and 2008 using Photosynthetic Active solar Radiation (PAR) sensors. Ancillary water quality and meteorological data were also gathered. Findings show that during the majority of the monitoring period, water clarity was adequate for SAV growth as compared to several proposed water quality criteria. There was also a brief but very significant hydrologic event during August of 2007 which resulted in conditions adverse for SAV survival. The scarcity of SAV throughout the study reach suggests that stressors other than water clarity, such as chemical inhibition, predation or physical disturbance of the substrate as a result of wave action, may play a role in limiting SAV survival in Starved Rock pool.

2. INTRODUCTION

Historically, SAV played a critical role in the ecology of the Illinois River. Large SAV beds were common and provided food and shelter for a variety of organisms. They also served to govern physical disruption of the shallow backwaters caused by wave action. Around 1955 SAV began to disappear from entire river reaches for extended periods of time (U.S. Geological Survey, 1999). Gradually over the next two decades SAV became less prevalent, especially in Peoria and LaGrange pools. Since 1970 SAV has rarely been found downstream of Starved Rock dam. SAV success in the pools upstream of the dam has been sporadic and subject to stressors not completely understood. Factors thought to have lead to SAV disappearance and influence the year-to-year success on the Upper Mississippi River include changed hydrologic regime, predation, light regime and chemical inhibition (UMRCC, 2003).

The focus of this study was to:

1. quantify subsurface light characteristics near the lower portion of Starved Rock pool;
2. quantify meteorological conditions near the lower portion of Starved Rock pool; and
3. quantify water quality conditions near the lower portion of Starved Rock pool.

To that end, PAR, water quality and meteorological measurements were taken from lower Starved Rock pool during the summers of 2007 and 2008. Both instantaneous and continuous measurements were made in order to capture trends in SAV-relevant conditions occurring over the course of the two growing seasons.

Research on the Mississippi River has shown that several measures of water clarity can be used to assess the suitability of a stream for SAV survival (UMRCC, 2003), including light extinction coefficient, Secchi disk depth, total suspended solids and turbidity. In this study all of these parameters were measured and compared to recommended light-related water quality criteria proposed by the UMRCC (2003).

3. MATERIALS AND METHODS

3.1 Location. Figure F-1 shows the downstream portion of Starved Rock Pool. Water quality monitoring was performed at stations SR-1 and SR-2. Meteorological data were collected at the dam and a small island near station SR-1. Stage and discharge data were gathered at the dam.

3.2 Hydrology. River stage and discharge records were obtained from gages located at the Starved Rock Lock and Dam. Values are recorded at 6:00 am daily and are available at http://www.rivergages.com. Electronic data exist for the period 1982 – 2011 and 1987 – 2011, respectively.

3.3. Meteorology. Wind speed and direction were monitored at two locations proximate to the project site; at the Starved Rock Lock and Dam and on a small island near River Mile 233.4. The meteorological station at the Lock and Dam is positioned on top of the dam, approximately 20 feet above the surface of the Starved Rock pool. Wind data from the dam were recorded every 30 seconds and averaged over two hours. Data are available from 2005 – 2011. The wind sensor placed on the small island near River Mile 233.4 was approximately ten feet above the water surface of the Starved Rock pool. Data were collected from Aug 2007 - Oct 2007. Data were also collected at 30 second intervals and averaged over 2 hours. These two data sets were compared in order to determine if the data collected from the dam was representative of the data collected from the island, which is closer to the proposed project site.

3.4. Continuous Water Quality Monitoring. At station SR-1, continuous water quality monitoring was conducted from 2 Jun 2007 – 19 Sept 2007 and 28 May 2008 – 6 Aug 2008 using a YSI 6600 V2 data sonde equipped with dissolved oxygen (D.O.), pH, water temperature, specific conductance, turbidity, depth and flat Licor PAR sensors. The sonde was programmed to collect data every two hours. Prior to placing the sonde in the field the probes were calibrated, and every two weeks when data were retrieved, drift checks were performed so corrections could be made to the data to compensate for probe drift during deployment. Prior to redeployment, the sondes were thoroughly cleaned and recalibrated.

The YSI sonde was deployed in the field by sliding a metal "sleeve", clamped to the sonde, over a pipe driven vertically into the river bottom. A "stop" on the pipe kept the sonde positioned at a fixed distance from the bottom. If the water surface elevation of the river changed, the deployment depths also changed; however the Starved Rock pool water surface elevation was fairly stable during the study period.

The sonde was oriented so the PAR sensors were south of the mounting system, thus shadows cast by the mounting system did not influence light sensor readings. This resulted in the top and bottom flat Licor sensors being 45 cm and 86 cm, respectively beneath the water surface.

3.5. Instantaneous Water Quality Monitoring. Water quality grab samples and field measurements were taken every two weeks between 21 Jun 2007 – 19 Aug 2007 and 28 May 2008 – 6 Aug 2008. Field measurement of weather conditions, D.O., pH, water temperature and specific conductance were performed using handheld meters. Surface grab samples were placed in plastic bottles, refrigerated and shipped overnight to a contract laboratory for analysis of total suspended solids, chlorophyll and soluble organic carbon (SOC).

A vertical water profile of light penetration was taken every two weeks using a Licor model LI1400 handheld data logger equipped with a spherical PAR sensor. Readings were taken at ten cm increments beneath the water surface. At each depth, measurements were taken for 60 seconds and a single average value was computed. Profiles were measured at both collection sites.

4. RESULTS

4.1. Hydrology. Starved Rock pool elevation for the study period is shown in Figure F-2. Discharge measured at the dam is also shown in Figure F-2. Data shown are daily 6 a.m. readings. For the entire period of record, data may be downloaded from http://www.rivergages.com.

Pool stage during the study period was relatively stable during the growing seasons, except for one episode in August of 2007 which followed heavy rainfall. Discharge, on the other hand, varied from a low of less than 1,000 ft^3/second to a high of over 90,000 ft^3/second. In August 2007 the Starved Rock pool rose approximately 4.5 feet and fell to near normal levels over a period of 5 days. During this time conditions were not favorable to SAV's due to high velocity and poor water clarity. On many other occasions when flow increased but stage remained relatively stable, velocities in the navigation channel and channel border areas were still quite high. It is highly unlikely these conditions would favor SAV survival. During these periods of extremely high water velocity, turbidity increased and light penetration dropped. These hydrologic responses typically do not favor SAV survival. Unfortunately, the magnitude of the stream response to these events was so great that meteorological and water quality monitoring equipment was damaged, thus it is not known exactly how long undesirable conditions persisted.

4.2. Meteorology. Wind speed and direction collected from the immediate project site were compared to data collected at the Starved Rock Lock and Dam. Figure F-3 shows results from both meteorological stations. The two data sets agree very closely. Since a longer period of record has been collected at the Lock and Dam, and the two sites show very similar results, data from the Lock and Dam provide a better record of long-term wind patterns near the project site.

Figure F-4 shows results from the meteorological station located at the Lock and Dam for the entire period of record. Figure F-5 shows results from the meteorological station located at the Lock and Dam for the months of April – July for years 2006 – 2009. Both data sets show that winds from the northwest are the most common, with velocities occasionally exceeding 36 mph. Winds from the

southeast are the second most abundant, with wind speeds also exceeding 36 mph on occasion. Winds from other directions do not commonly occur. This alignment of the most common wind directions nearly parallels the direction of the river channel in lower Starved Rock pool, which generally flows from east to west and which is bordered by bluffs along the south bank.

4.3. Continuous Monitoring. Results of continuous monitoring of water temperature, D.O., pH, specific conductance, turbidity and PAR are shown in Figures F-6 through F-11. Data generally were consistent with a productive, nutrient enriched waterway, including significant diurnal swings in D.O. (supersaturated concentrations were common) and relatively high pH values. Good agreement was seen between parameters indicative of primary productivity, while negative relationships were observed between measures of productivity and turbidity. Turbidity was also positively correlated to flow and negatively correlated with D.O. and pH, indicating light availability may limit productivity at times of high flow.

4.4. Instantaneous Water Quality Monitoring. Analytical results of grab samples and field measurements taken at sites SR-1 and SR-2 can be found in Tables F-1 and F-2. Mean Secchi disk depths were 47.3 and 54.4 cm, respectively at sites SR-1 and SR-2. These values border the 50 cm recommended Secchi disk depth necessary to support and sustain SAV in the Upper Mississippi River as described in UMRCC (2003). Light-related criteria for total suspended solids (25 mg/l) and turbidity (20 ntu) were also recommended in UMRCC (2003). Mean values for these two parameters at sites SR-1 and SR-2 were also close to the criteria: 32 and 25 mg/l, respectively, for total suspended solids and 21.2 and 17.2 ntu, respectively, for turbidity.

Light penetration measurements taken in a vertical profile of the water column at sites SR-1 and SR-2 are shown in Figures F-12 through F-24. Each point on the graphs represents the average light intensity value recorded over a 60-second time interval at each depth. The two data series shown in each plot represent two sampling sites slightly over one mile apart. Light extinction coefficients were calculated using the following formula:

$$K_d = -2.3*[\log(L_o) - \log(L_z)]/z$$

where:

K_d = light extinction coefficient (m^{-1})
L_o = light measurement near the surface (umol s^{-1} m^{-2})
L_z = light measurement at depth z (umol s^{-1} m^{-2})
z = depth interval between upper and lower light measurements (m)

5. DISCUSSION

Starved Rock pool is the most downstream pool on the Illinois River which produces significant SAV beds. During the summers of 2007 and 2008 little evidence of SAV was seen in lower Starved Rock pool, as shown in Figures F-25 through F-30. Any improvement of conditions which limit SAV could result in greater SAV survival. Water quality conditions were examined to determine if specific parameters could be identified which limit SAV survival.

Continuous and instantaneous monitoring of water quality parameters was conducted during the summer months of 2007-2008 at 2 locations in the lower Starved Rock pool. Supporting meteorological data were also collected. River flow conditions were near normal during most of the study period, however episodic high flows were observed. Wind speed and direction was recorded at the Lock and Dam. The highest magnitude wind velocities and most frequently observed wind direction was from the northwest and, to lesser extent, from the southeast. This may be partially due to the high bluffs of Starved Rock State Park which border the south side of the lower pool area.

Continuous water quality monitoring results were unremarkable given the river basin characteristics and flow conditions. Results were consistent with instantaneous field measurements taken periodically throughout the study period.

Instantaneous field measurements of Secchi disk depth, turbidity and total suspended solids at sites SR-1 and SR-2 were compared to recommended values to support SAV growth in the Upper Mississippi River as described in UMRCC (2003). Average values for these parameters during the summers of 2007 and 2008 were very close to the values recommended for supporting SAV growth.

Instantaneous field measurements of light intensity at sites SR-1 and SR-2 were used to compute light extinction coefficients. Mean growing season light extinction values averaged $3.43m^{-1}$ and $3.32m^{-1}$ at sites SR-1 and SR-2, respectively. From research on the Upper Mississippi River it is recommended that light extinction values should be less than $3.42m^{-1}$ in order for SAV to survive. It appears that Starved Rock pool is very close to this goal on average, but as indicated by the plot of light extinction coefficients calculated from continuous monitor PAR readings from site SR-1 (see Figure F-31), there are many times when this goal is not met. The chart in Figure F-31 also indicates there is a strong correlation between periods of high flows and high light extinction values.

Of the 13 instances when water column light penetration measurements were taken during the summers of 2007 and 2008 at sites SR-1 and SR-2, on seven occasions there was little difference in light penetration between the two sites; while on three occasions each, one site generally had better light penetration than the other. Thus, there is no consistent trend of one site exhibiting better light penetration than the other.

When considering all light related parameters that were measured in lower Starved Rock Pool during the summers of 2007 and 2008, it appears that if light availability was the only factor impacting SAV growth, then the lower pool is on the borderline of being able to consistently support SAV growth, with success more likely when growing season flow values in the Illinois River are below average. High flow values would negatively impact light penetration and thus be detrimental to SAV growth. Any potential habitat enhancement project in the lower Starved Rock Pool which essentially isolates a portion of the pool from the effects of the main channel and wave action would likely result in improved light penetration. Determining whether the improved light penetration is sufficient to support SAV growth in the presence of other stressors such as predation and chemical contamination is difficult to predict.

6. REFERENCES

Upper Mississippi River Conservation Committee (UMRCC). (2003). *Proposed Light-Related Water Quality Criteria Necessary to Sustain Submersed Aquatic Vegetation in the Upper Mississippi River.*

U.S. Geological Survey. (1999). *Ecological Status and Trends of the Upper Mississippi River System 1998: A Report of the Long Term Resource Monitoring Program.* La Crosse: U.S. Geological Survey, Upper Midwest Environmental Sciences Center.

ILLINOIS RIVER BASIN RESTORATION
SECTION 519
DEFINITE PROJECT IMPLEMENTATION REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STARVED ROCK
CRITICAL RESTORATION PROJECT

APPENDIX F
WATER QUALITY

TABLES AND FIGURES

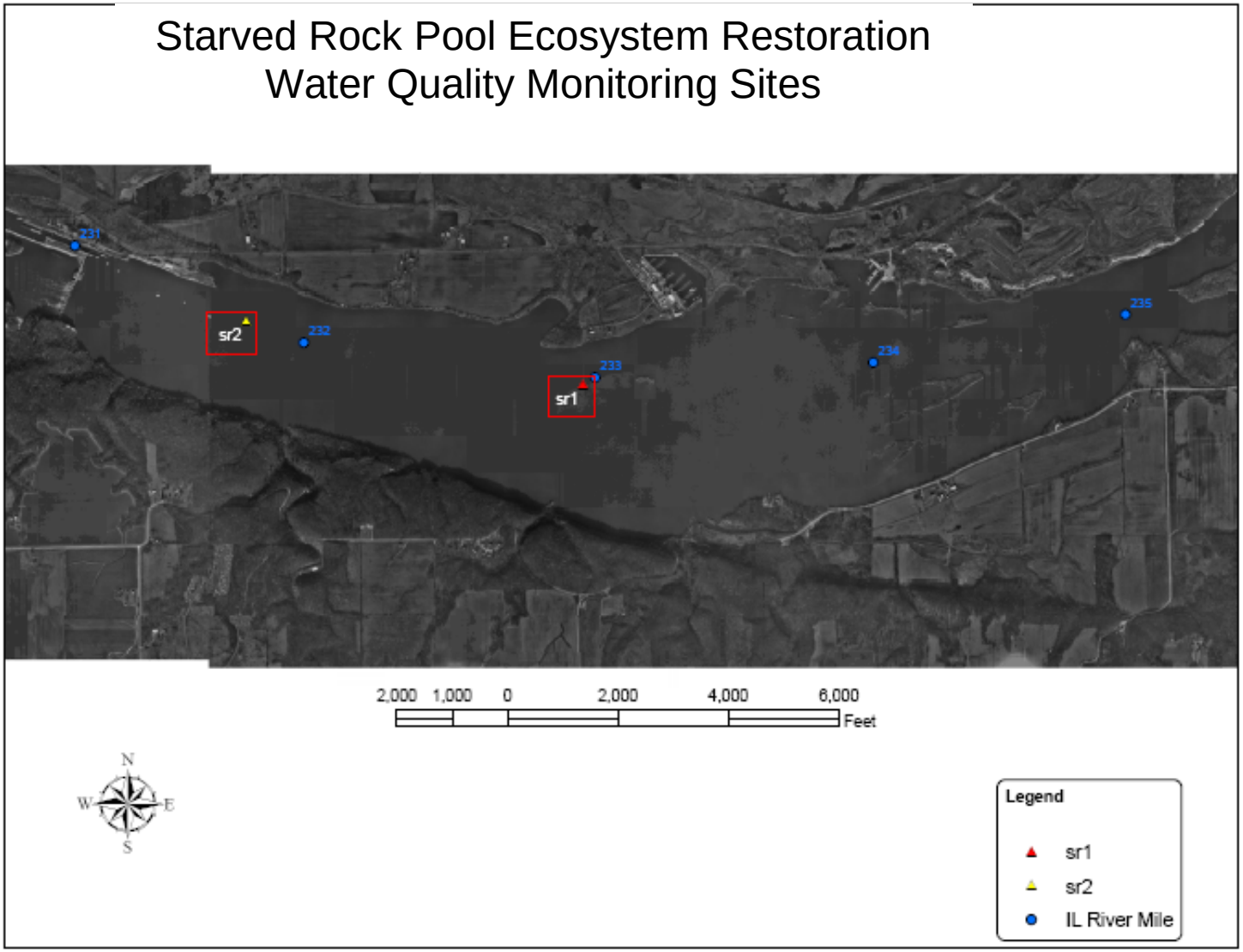


Figure F-1. Location of Water Quality Monitoring Sites

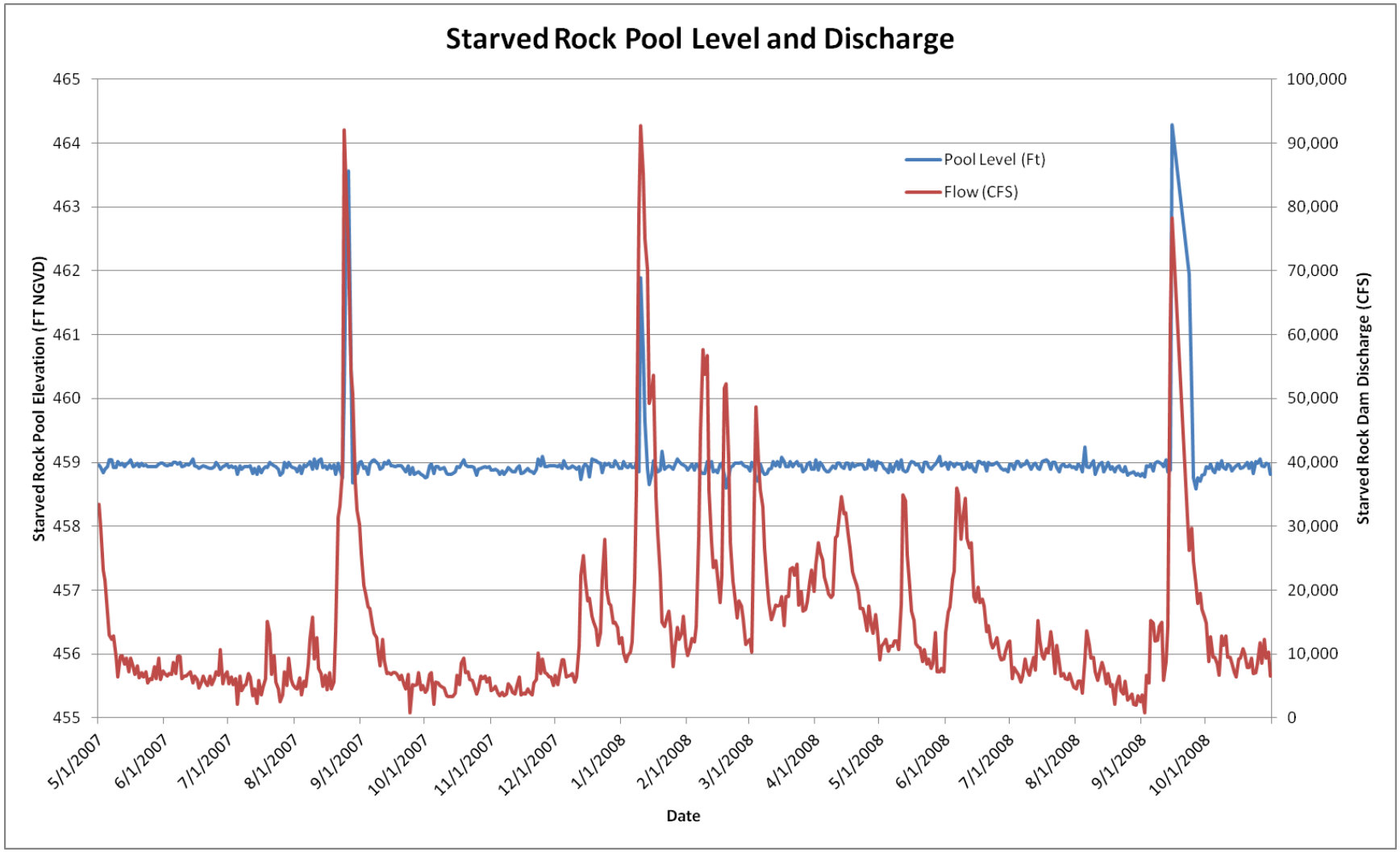
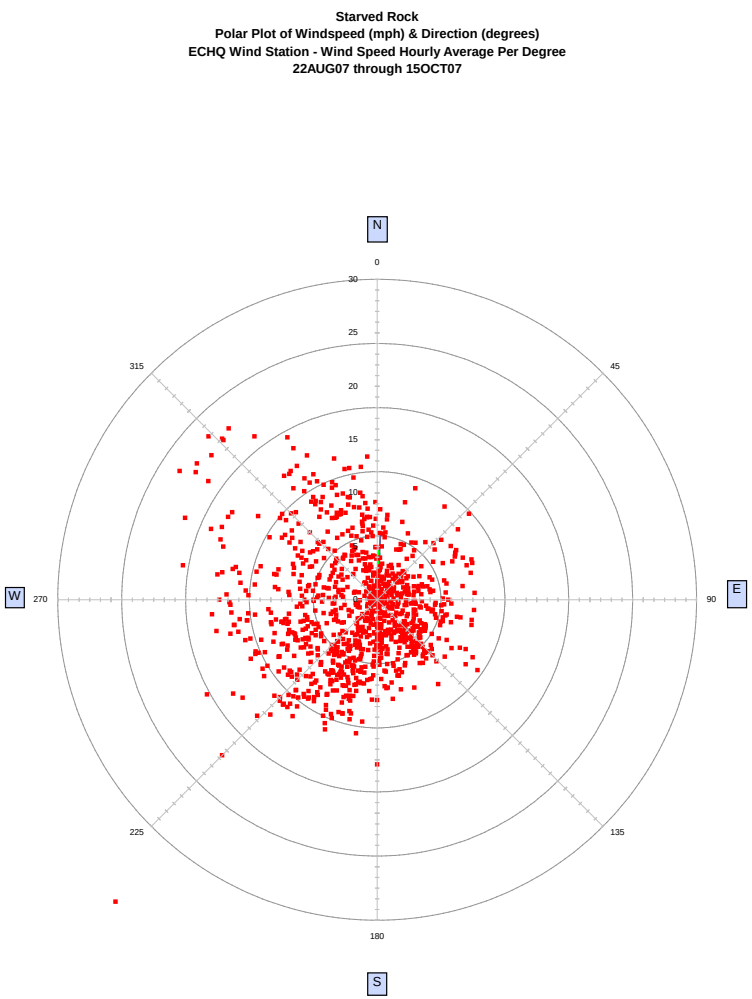


Figure F-2. Starved Rock Pool Level and Discharge



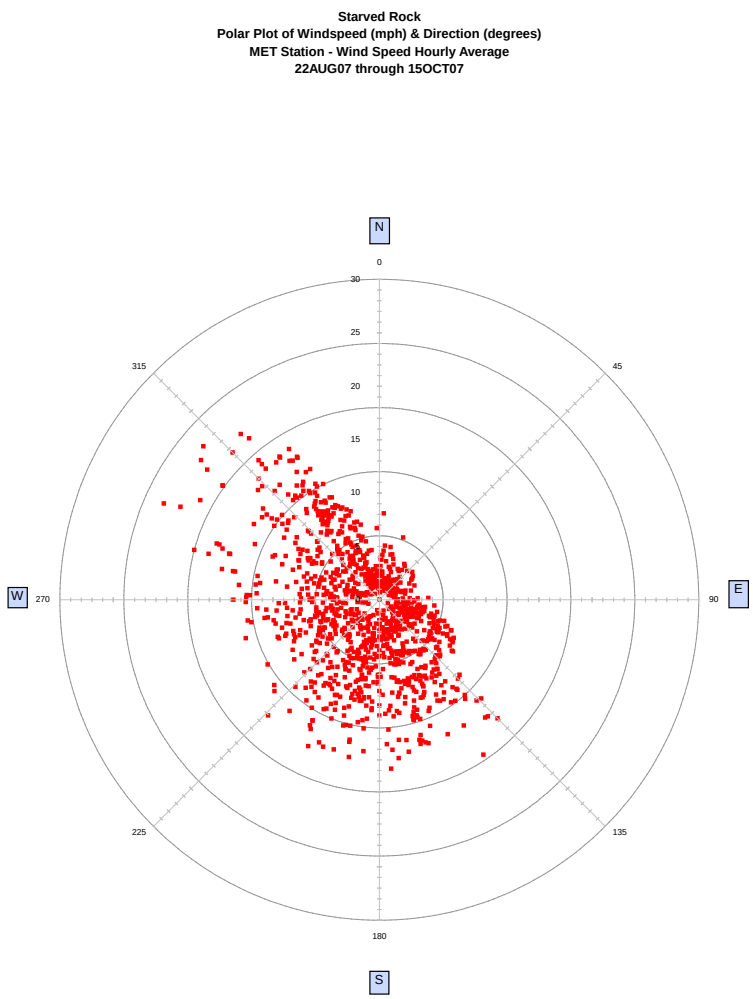
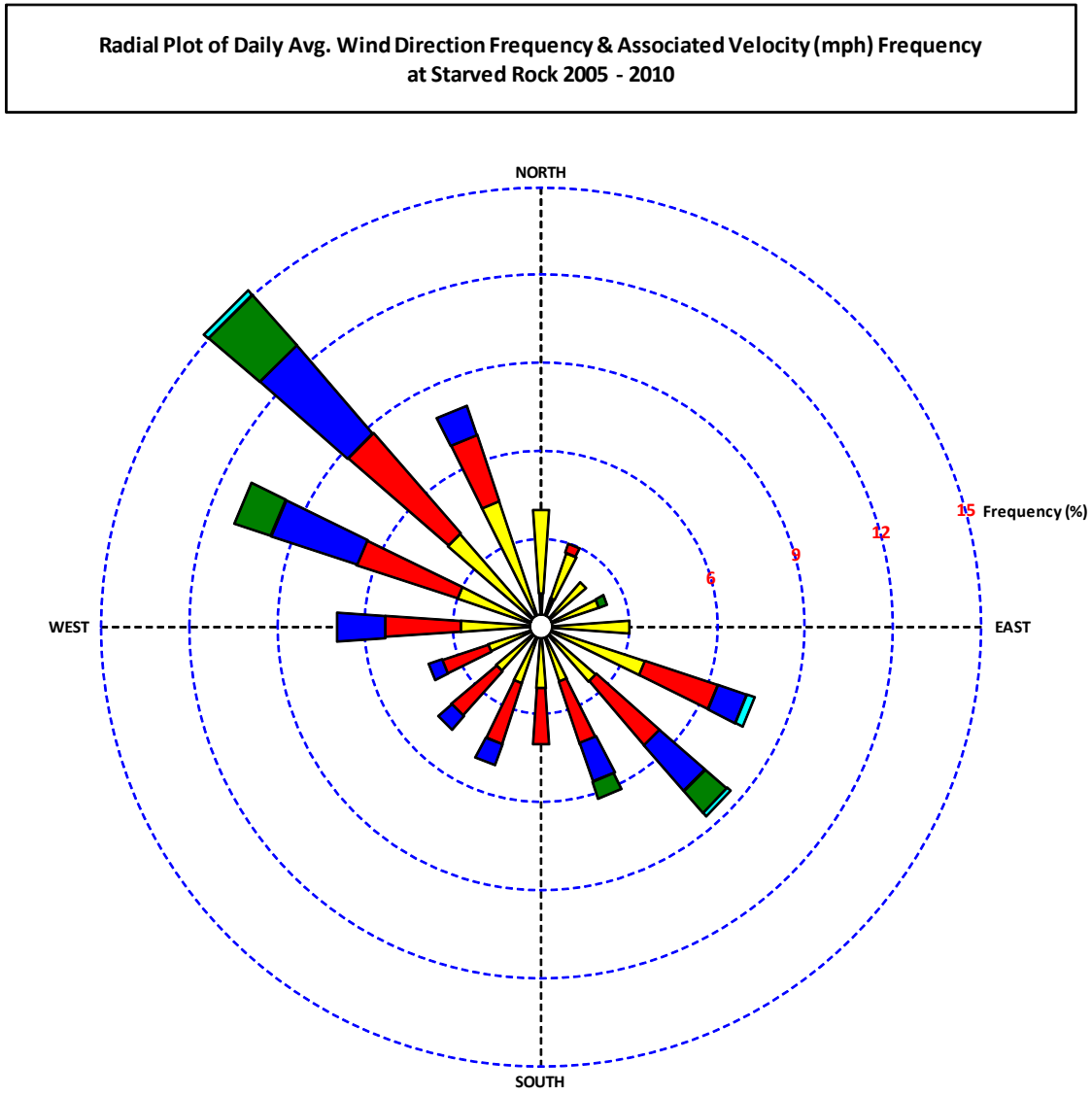


Figure F-3. Comparison of Hourly Average Wind Speed and Direction from Project Area Wind Station (left) and Starved Rock Lock and Dam Wind Station (right), August 22 – October 15, 2007

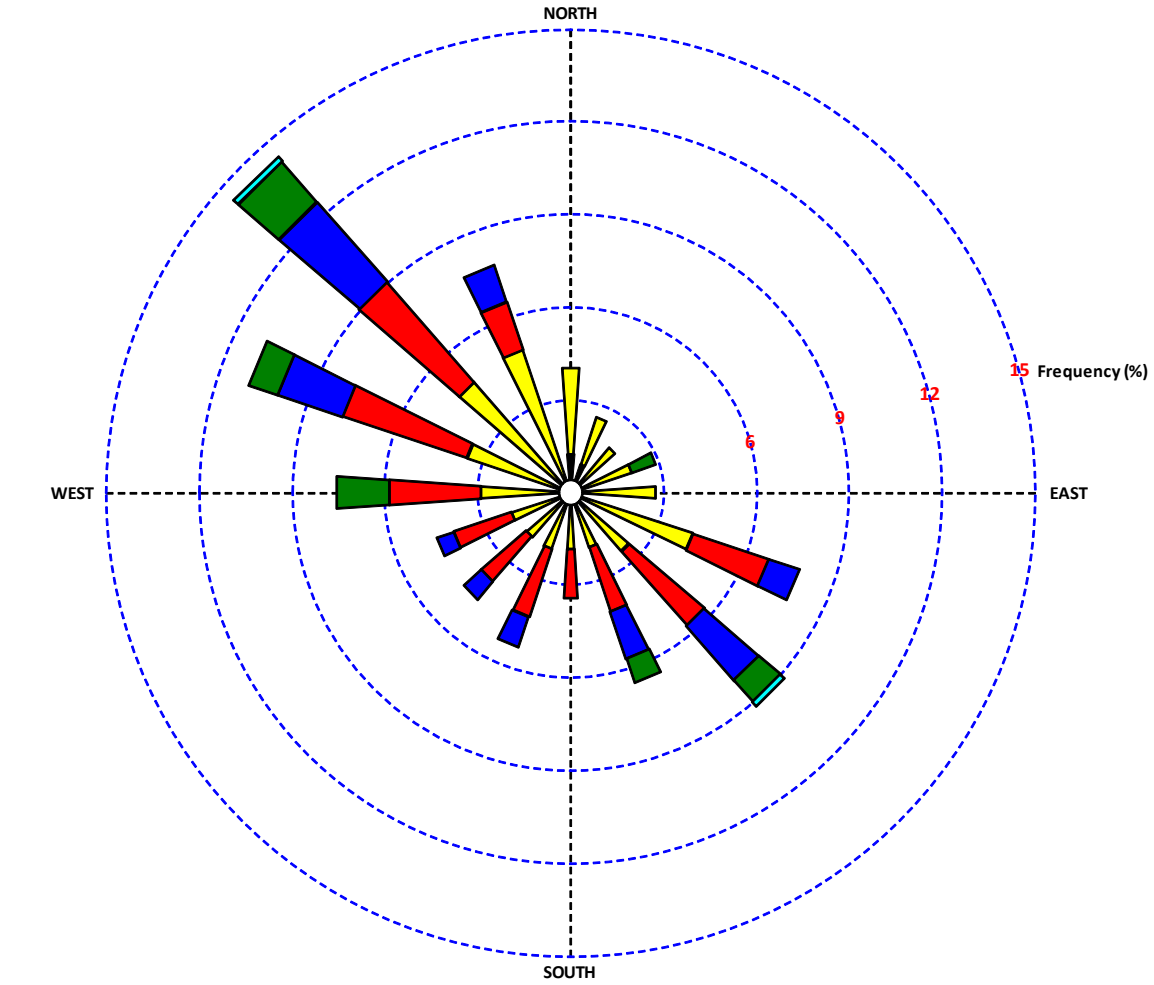
Appendix F
Water Quality
Tables and Figures



dir	freq
0	4.9
22.5	3.0
45	2.1
67.5	2.4
90	3.9
112.5	7.7
135	8.6
157.5	6.3
180	5.2
202.5	5.1
225	4.7
247.5	4.1
270	7.5
292.5	11.1
315	15.2
337.5	8.1

vel	freq
0 - 1.67	0.0
1.67 - 5.91	7.5
5.91 - 10.96	37.1
10.96 - 17.72	30.3
17.72 - 27.85	17.4
27.85 - 36.29	6.8
> than 36.29	0.7

Figure F-4. Starved Rock Lock and Dam Wind Data, 2005-2010



dir	freq
0	4.6
22.5	2.8
45	2.0
67.5	2.9
90	3.1
112.5	7.9
135	9.2
157.5	6.7
180	4.9
202.5	5.5
225	4.7
247.5	4.6
270	7.6
292.5	11.0
315	14.4
337.5	8.0

vel	freq
0 - 1.67	0.0
1.67 - 5.91	7.6
5.91 - 10.96	38.2
10.96 - 17.72	29.9
17.72 - 27.85	17.2
27.85 - 36.29	6.5
> than 36.29	0.7

Figure F-5. Starved Rock Lock and Dam Wind Data for the Months of April – July, 2006-2009

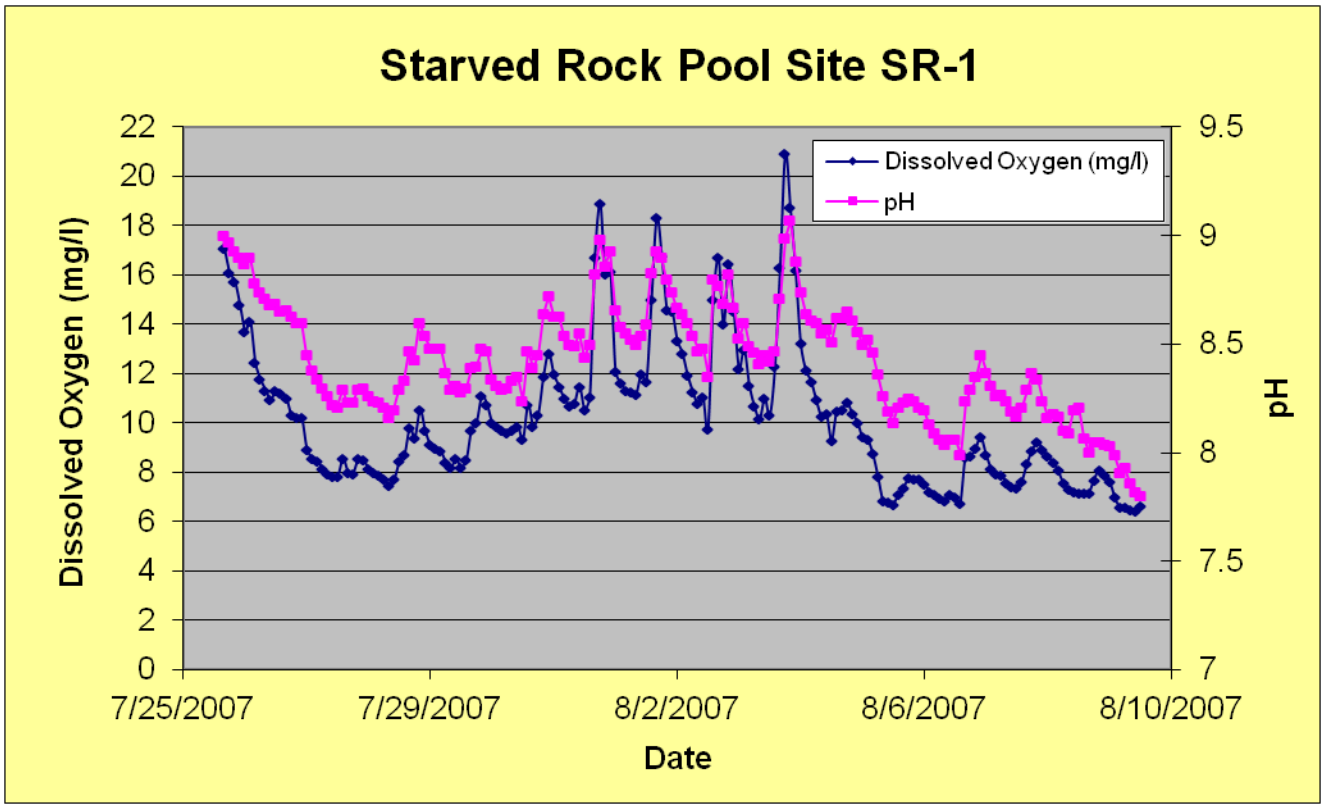


Figure F-6. Dissolved Oxygen and pH Measurements at Site SR-1, July 25 – August 9, 2007

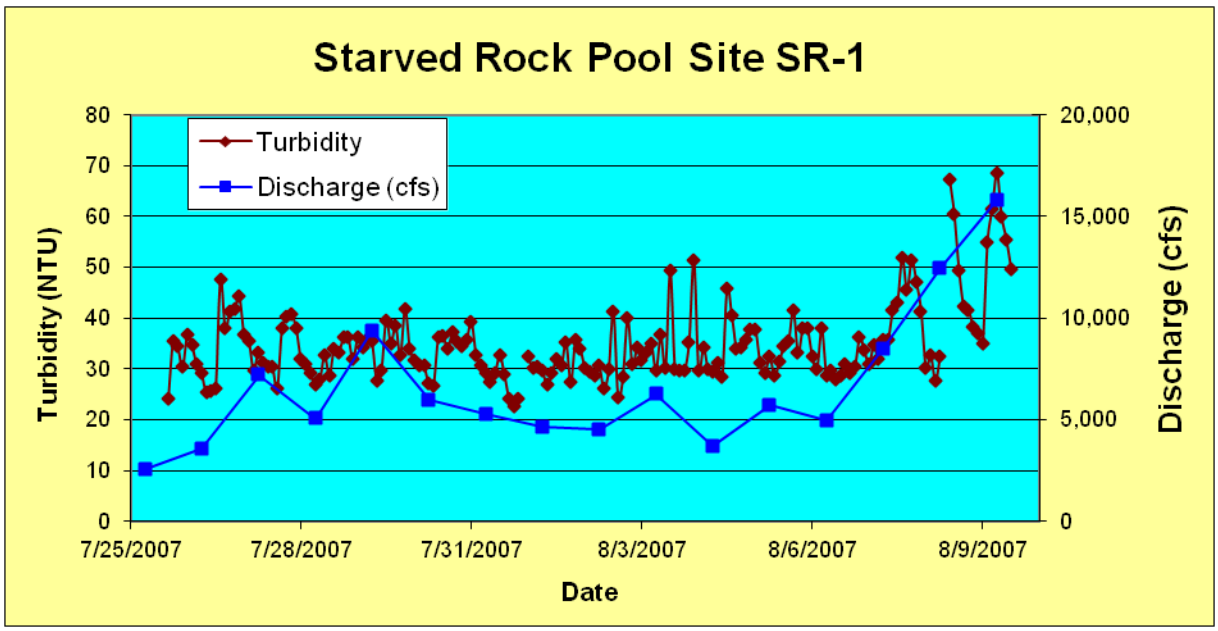


Figure F-7. Turbidity Measurements at Site SR-1 and Starved Rock Dam 6AM Daily Discharge, July 25 – August 9, 2007

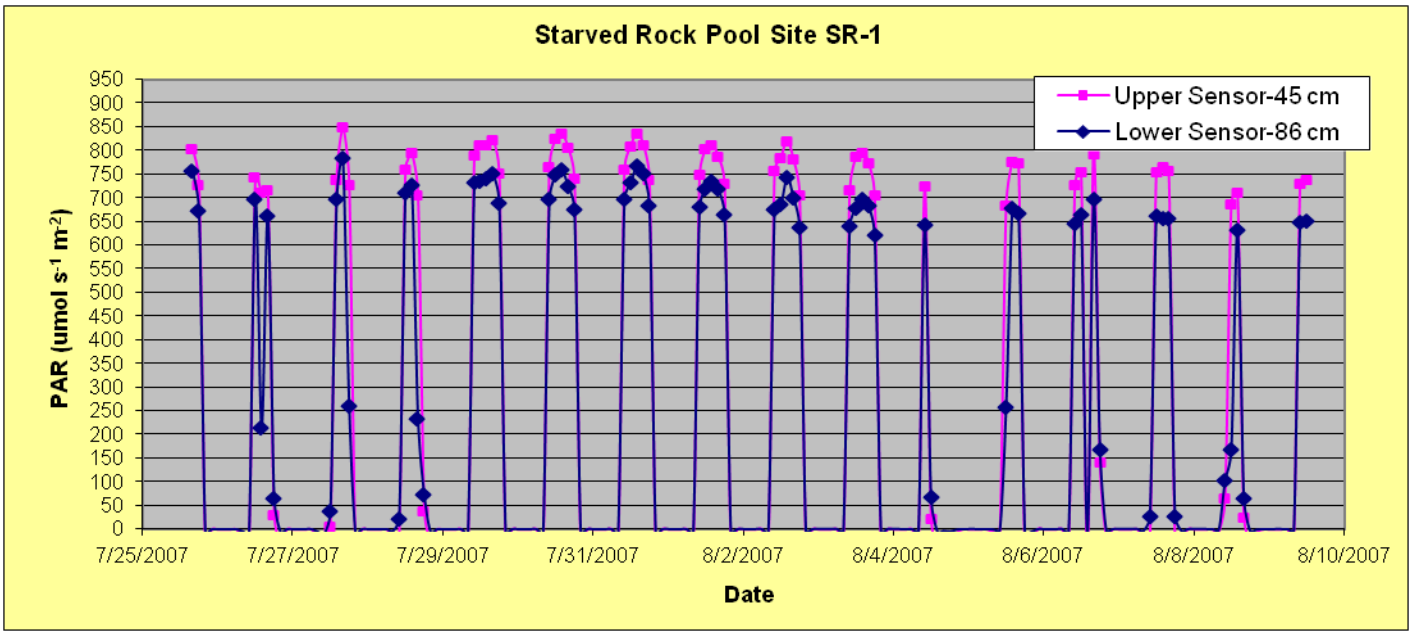


Figure F-8. PAR Measurements at Site SR-1, July 25 – August 9, 2007

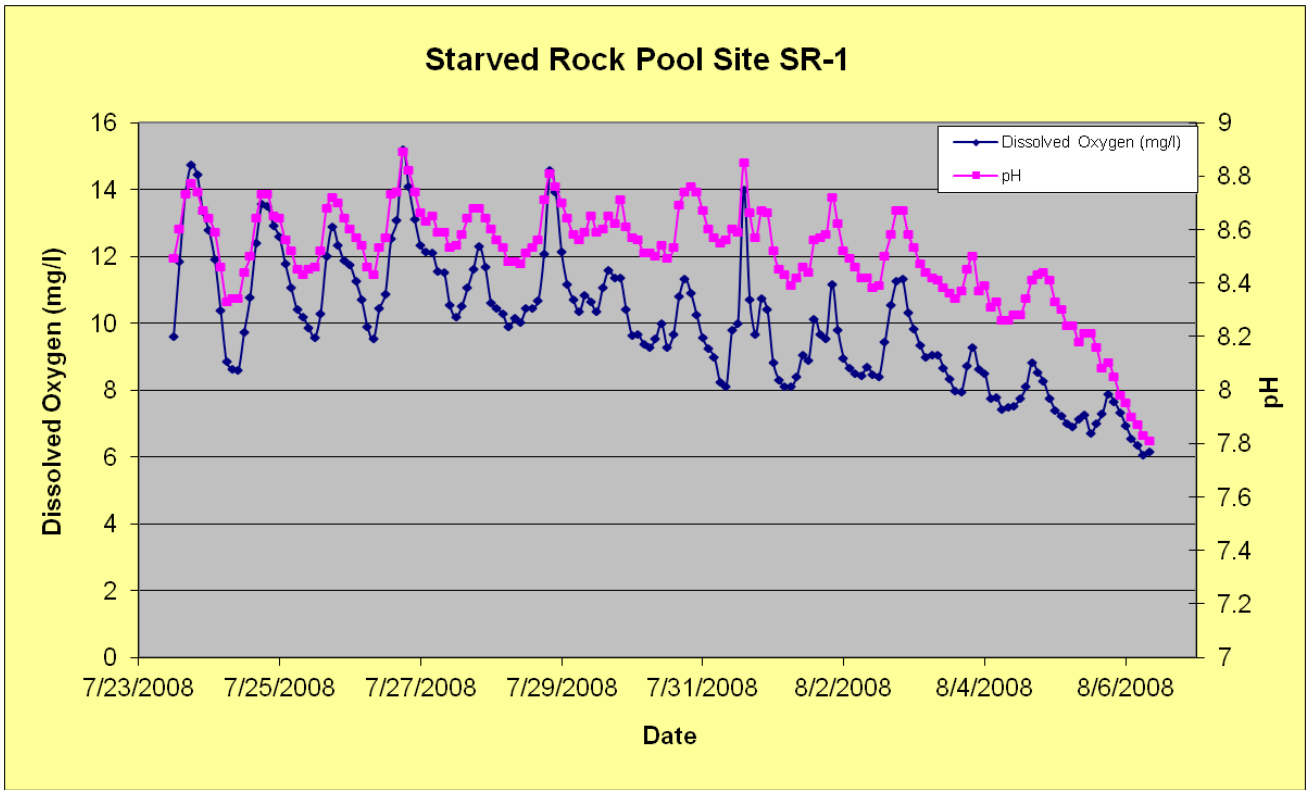


Figure F-9. Dissolved Oxygen and pH Measurements at Site SR-1, July 23 – August 6, 2008

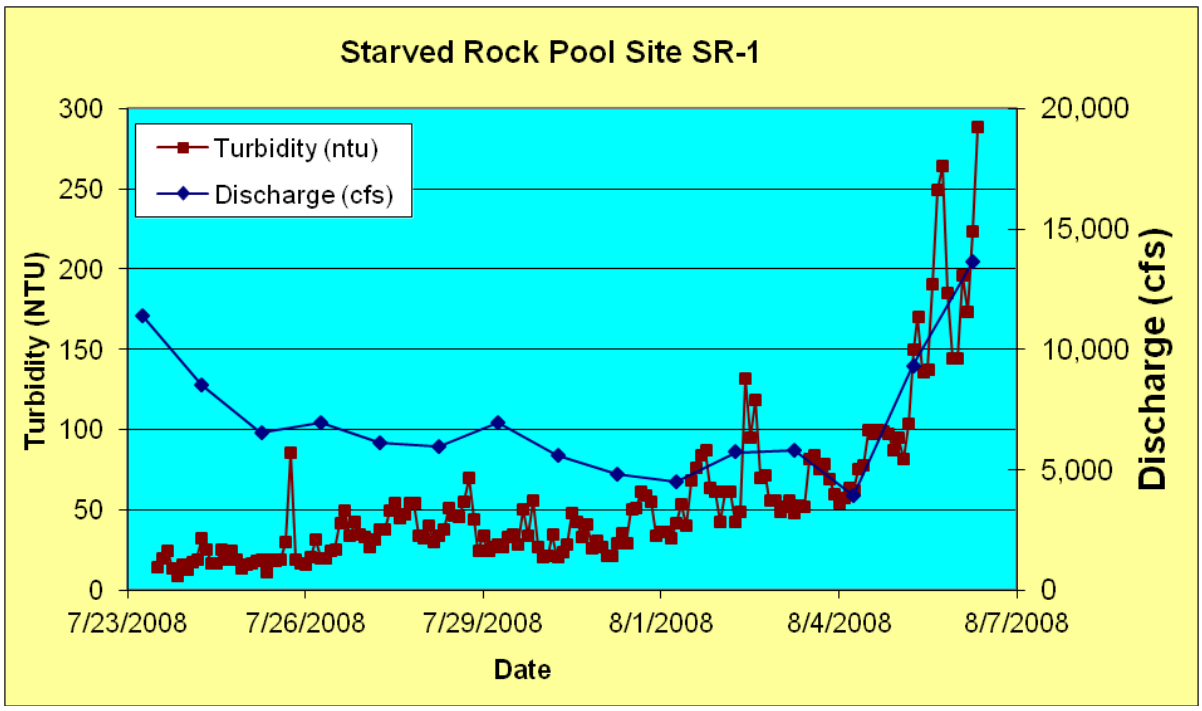


Figure F-10. Turbidity Measurements at Site SR-1 and Starved Rock Dam 6AM Daily Discharge, July 23 – August 6, 2008

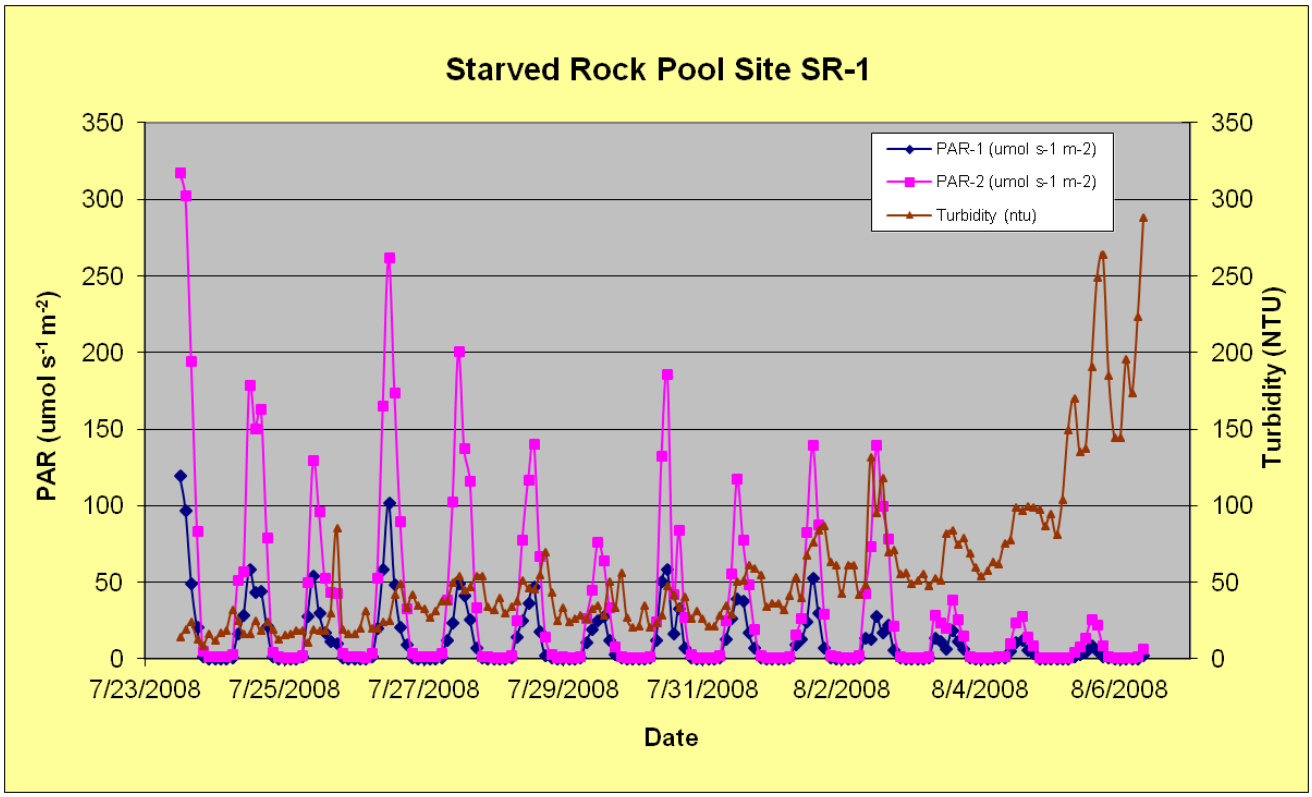


Figure F-11. PAR and Turbidity Measurements at Site SR-1, July 23 – August 6, 2008

Table F-1. Instantaneous Water Quality Monitoring Results from Site SR-1

SR-1 (Upstream)

Date	Time	A. Temp.	W. Temp.	Wind Sp.	Wind	Depth	Secchi	pH	TSS	SOC	D.O.	Turb.	Chl a	Chl b	Chl c	Corr. a	Pheo. a	Sp. Cond.	Trans Tube	Wave H	Cloud Cov	K_d
		(deg. C)	(deg. C)	(mph)	Dir.	(m)	(cm)		(mg/l)	(mg/l)	(mg/l)	(ntu)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	umhos/cm	(cm)	(cm)	(%)	(m^{-1})
6/21/07	1130	23.9	27.7	0	-	1.22	50.3	8.50	30	5.5	11.40	11.3	124	3	11	106	23	853	-	-	-	3.67
7/11/07	1030	20.1	28.4	10	NE	1.04	53.3	8.80	39	5.4	9.50	25.0	148	0	11	130	21	821	-	-	-	3.40
7/25/07	1145	27.8	26.3	5	W	1.07	42.1	-	29	5.3	-	12.7	132	4	10	116	21	-	-	-	-	2.71
8/8/07	1200	28.3	30.3	0	-	-	-	8.07	23	5.4	7.22	-	87	3	5	80	7	830	-	-	-	2.08
8/23/07	1220	24.9	-	-	W	-	-	7.88	86	5.8	8.13	-	18	1	1	11	11	-	-	-	-	6.78
9/5/07	1130	-	26.0	7	SE	-	-	8.68	32	8.7	8.26	-	47	0	4	38	12	725	-	-	-	2.35
9/19/07	1030	23.9	23.7	4	W	-	-	8.39	15	6.2	7.24	-	54	0	4	45	11	808	-	-	-	2.20
5/28/08	1145	-	18.5	4	ENE	1.52	38.0	8.65	-	-	13.79		-	-	-	-	-	996	29.8	8	-	3.36
6/11/08	-	-	-	-	-	2.59	-	8.09	32	-	12.68	56.8	116	0	10	103	14	708	23.8	-	-	5.21
6/25/08	1115	21.1	25.0	5	SW	1.22	-	8.26	33	-	12.08	18.6	71	0	5	61	12	747	-	-	40	3.10
7/9/08	1030	22.2	27.1	8	NW	1.12	-	8.00	16	-	12.84	16.0	132	1	10	116	20	872	31.1	-	0	3.55
7/23/08	-	25.6	27.8	3.6	NNW	-	53.0	8.68	24	-	8.49	8.2	128	0	10	117	11	820	45	3	0	2.47
8/6/08	1000	25.6	28.9	0.5	E	-	-	9.19	25	-	8.63	-	46	2	3	35	16	835	30.8	0	0	3.68
Mean	1107	24.3	26.3	4.3	-	1.40	47.3	-	32	6.0	10.02	21.2	91.9	1.2	7.0	79.8	14.9	820	32.1	3.7	10	3.43
Min.	1000	20.1	18.5	0	-	1.04	38.0	7.88	15	5.3	7.22	8.2	18	0	1	11	7	708	23.8	0	0	2.08
Max.	1220	28.3	30.3	10	-	2.59	53.3	9.19	86	8.7	13.79	56.8	148	4	11	130	23	996	45	8	40	6.78

Appendix F
Water Quality
Tables and Figures

Table F-2. Instantaneous Water Quality Monitoring Results from Site SR-2

SR-2 (Downstream)

Date	Time	A. Temp.	W. Temp.	Wind Sp.	Wind	Depth	Secchi	pH	TSS	SOC	D.O.	Turb.	Chl a	Chl b	Chl c	Corr. a	Pheo. a	Sp. Cond.	Trans Tube	Wave H	Cloud Cov	K_d
		(deg. C)	(deg. C)	(mph)	Dir.	(m)	(cm)		(mg/l)	(mg/l)	(mg/l)	(ntu)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	umhos/cm	(cm)	(cm)	(%)	(m^{-1})
6/21/07	1230	23.9	28.5	4	W	3.16	55.5	8.80	16	6.4	14.00	11.4	131	2	12	109	29	840	-	-	-	3.01
7/11/07	1220	20.1	28.9	5	NE	2.65	58.5	8.90	12	5.3	10.80	12	117	0	9	104	14	818	-	-	-	2.31
7/25/07	1230	28.3	26.9	5	W	-	53.9	-	18	5.4	-	10	121	4	9	106	18	-	-	-	-	3.18
8/2/07	1245	27.8	30.3	0	-	-	-	8.28	25	5.4	7.68	-	105	5	6	99	4	835	-	-	-	3.90
8/23/07	1130	24.5	-	-	W	-	-	8.04	96	6	7.91	-	15	1	2	9	10	-	-	-	-	6.93
9/5/07	1200	-	26.3	3	SE	-	-	8.48	16	8.5	8.36	-	34	1	3	30	5	728	-	-	-	2.47
9/19/07	1100	23.9	23.6	4	W	-	-	8.40	12	6.5	7.68	-	52	1	5	42	15	809	-	-	-	2.94
5/28/08	1245	-	18.6	3	ENE	3.35	45.0	8.67	-	-	15.40	-	-	-	-	-	-	965	27.8	8	-	3.21
6/11/08	-	-	-	-	-	-	-	8.15	28	-	14.20	50.1	109	0	10	95	17		26.3	-	-	4.95
6/25/08	1215	21.1	25.0	5	SW	2.74	-	8.32	16	-	13.13	13.4	66	0	5	61	5	744	-	-	40	3.00
7/9/08	1140	22.2	27.3	3	NW	-	-	8.04	22	-	11.85	15.6	124	1	9	111	15	858	33.2	-	0	2.85
7/23/08	-	26.7	27.9	4.5	NNW	-	59.0	8.80	19	-	8.77	8.22	112	0	8	103	9	818	44	5	0	2.07
8/6/08	1100	25.6	28.7	0.5	E	-	-	9.11	17	-	8.78	-	55	1	4	41	21	833	32.5	0	0	2.34
Mean	1187	24.4	26.5	3.4	-	2.98	54.4	-	25	6.2	10.71	17.2	86.8	1.3	6.8	75.8	13.5	825	32.8	4	10	3.32
Min.	1100	20.1	18.6	0.0	-	2.65	45.0	8.04	12	5.3	7.68	8.2	15.0	0.0	2.0	9.0	4.0	728	26.3	0	0	2.07
Max.	1245	28.3	30.3	5	-	3.35	59.0	9.11	96	8.5	15.4	50.1	124	5	10	111	21	965	44	8	40	6.93

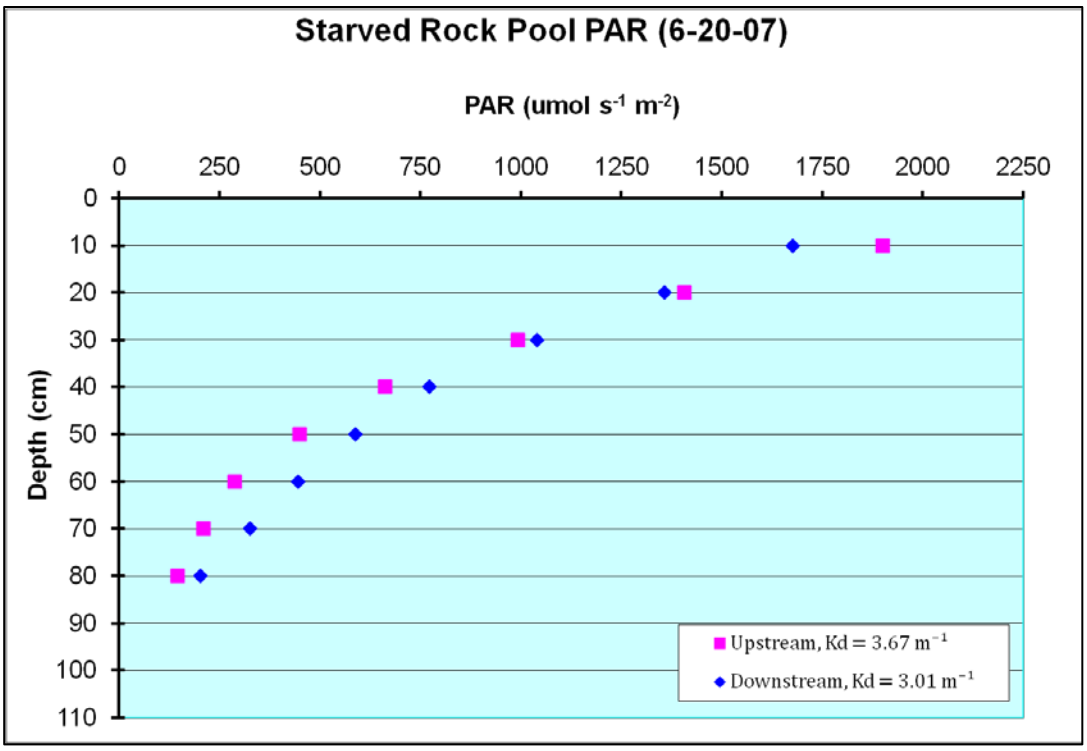


Figure F-12. Light Penetration Measurements in a Vertical Water Column at Sites SR-1 (Upstream) and SR-2 (Downstream), June 20, 2007.

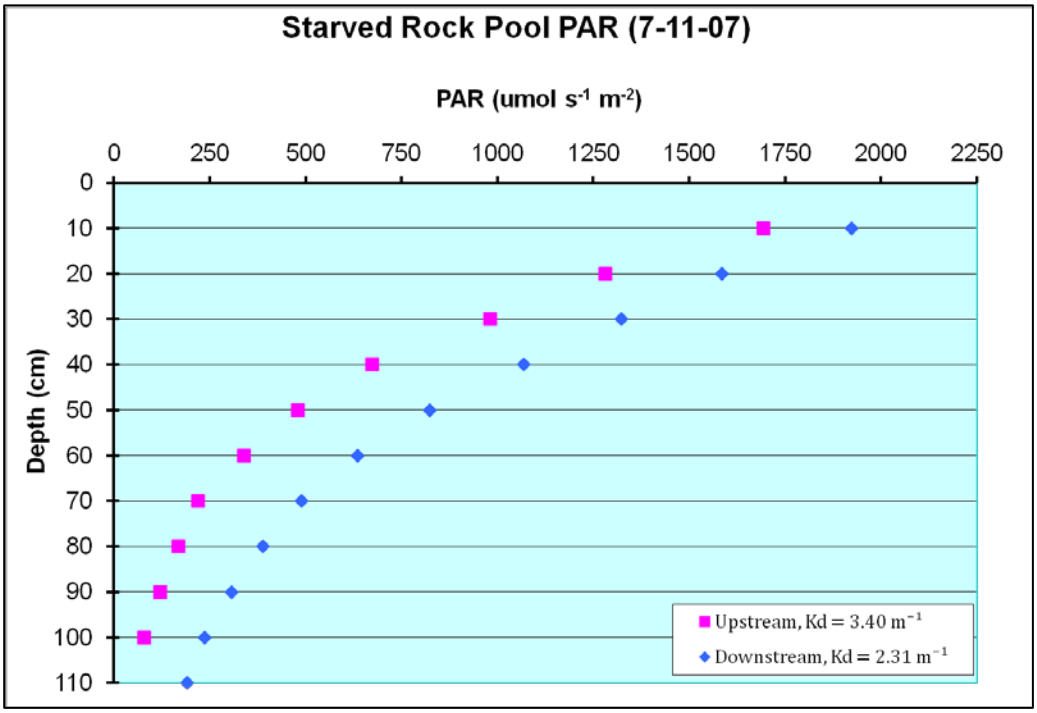


Figure F-13. Light Penetration Measurements in a Vertical Water Column at Sites SR-1 (Upstream) and SR-2 (Downstream), July 11, 2007.

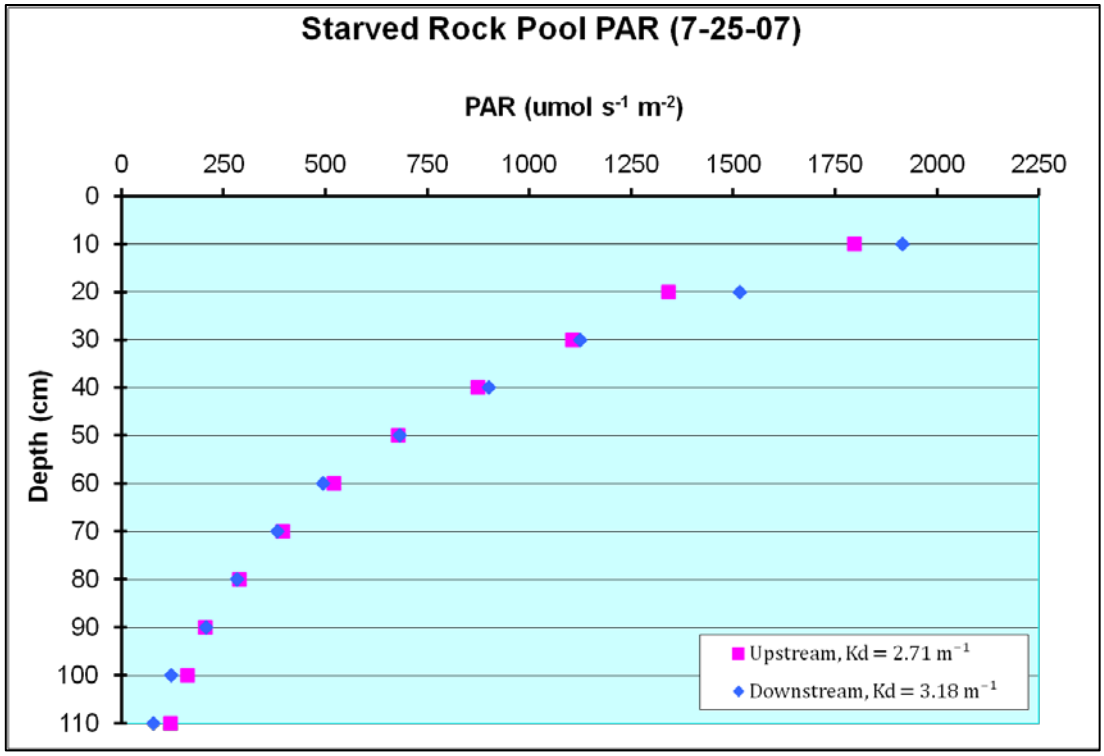


Figure F-14. Light Penetration Measurements in a Vertical Water Column at Sites SR-1 (Upstream) and SR-2 (Downstream), July 25, 2007.

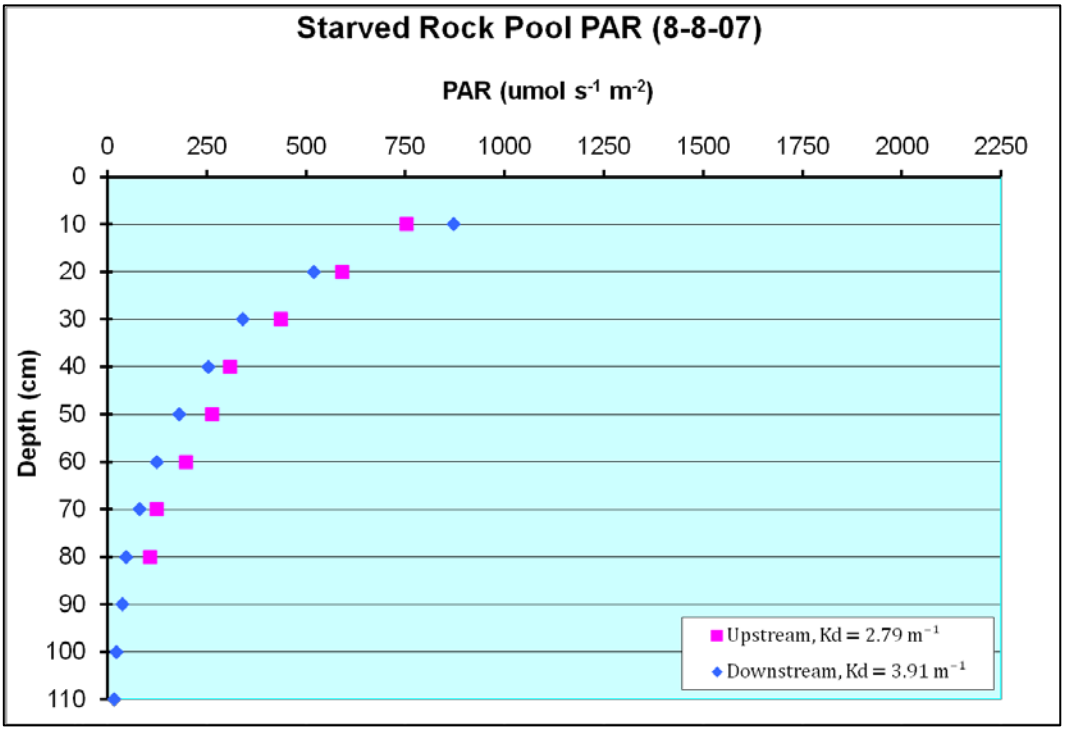


Figure F-15. Light Penetration Measurements in a Vertical Water Column at Sites SR-1 (Upstream) and SR-2 (Downstream), August 8, 2007.

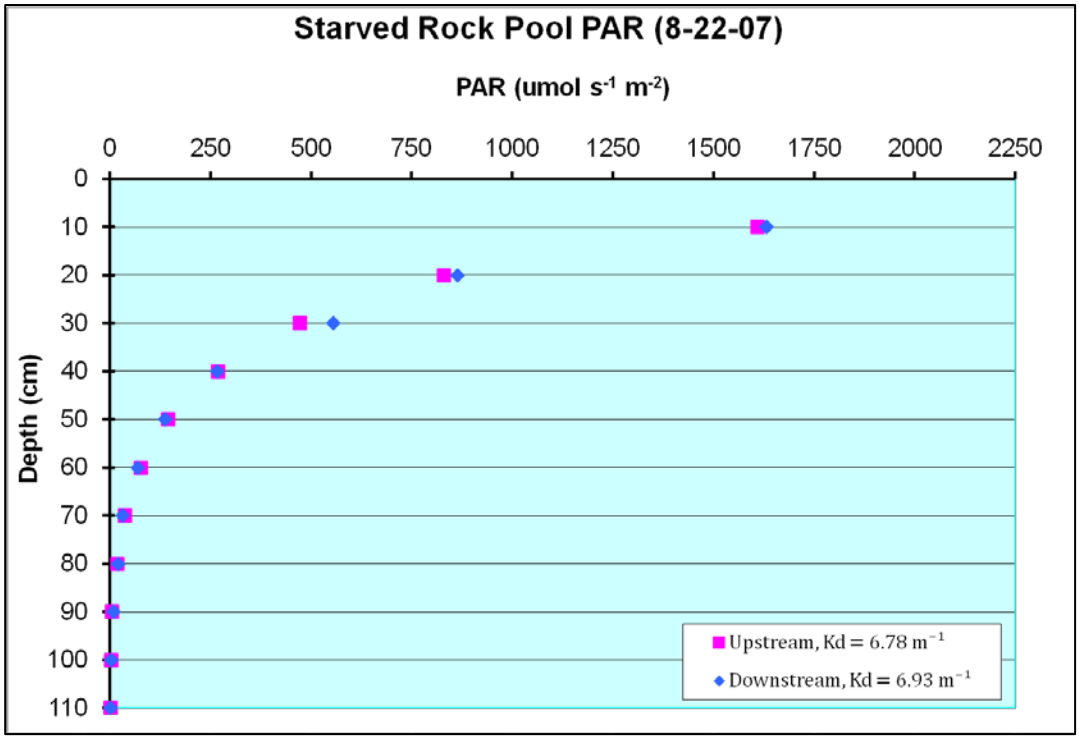


Figure F-16. Light Penetration Measurements in a Vertical Water Column at Sites SR-1 (Upstream) and SR-2 (Downstream), August 22, 2007.

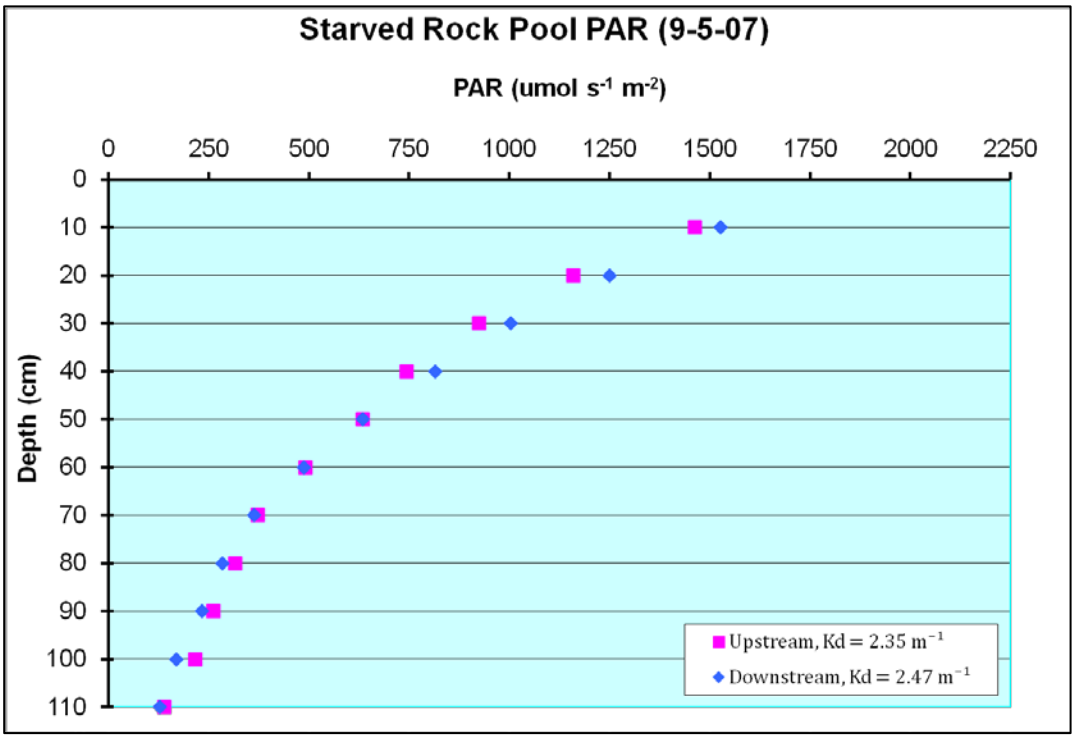


Figure F-17. Light Penetration Measurements in a Vertical Water Column at Sites SR-1 (Upstream) and SR-2 (Downstream), September 5, 2007.

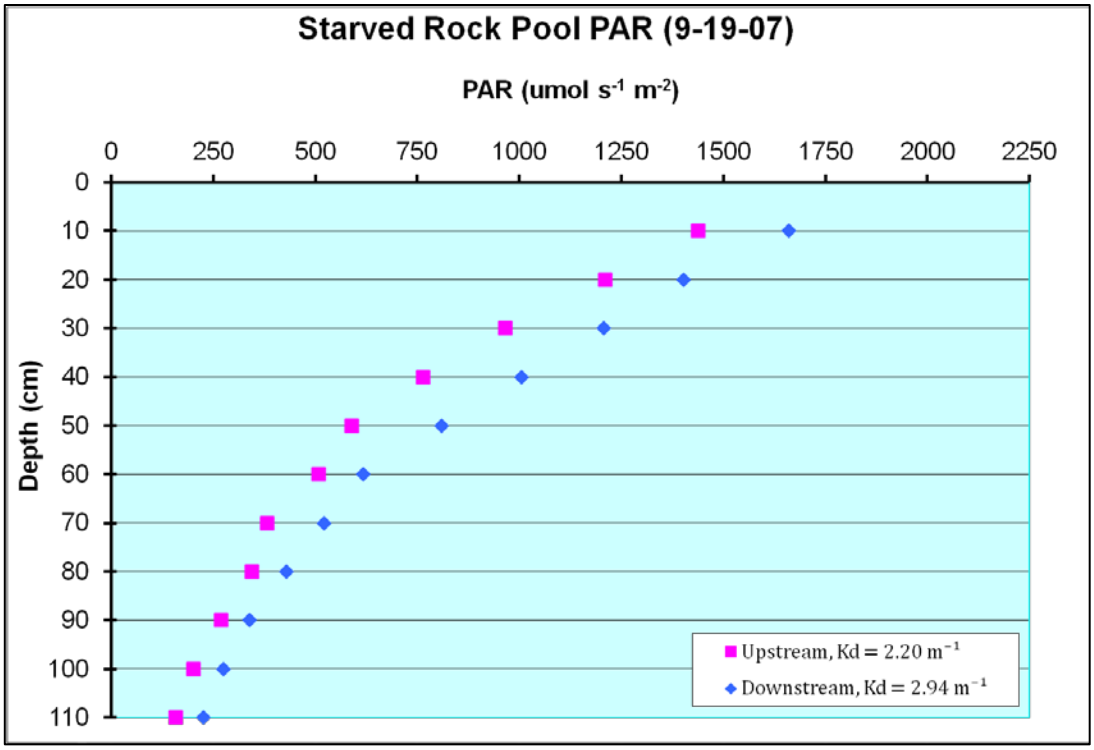


Figure F-18. Light Penetration Measurements in a Vertical Water Column at Sites SR-1 (Upstream) and SR-2 (Downstream), September 19, 2007.

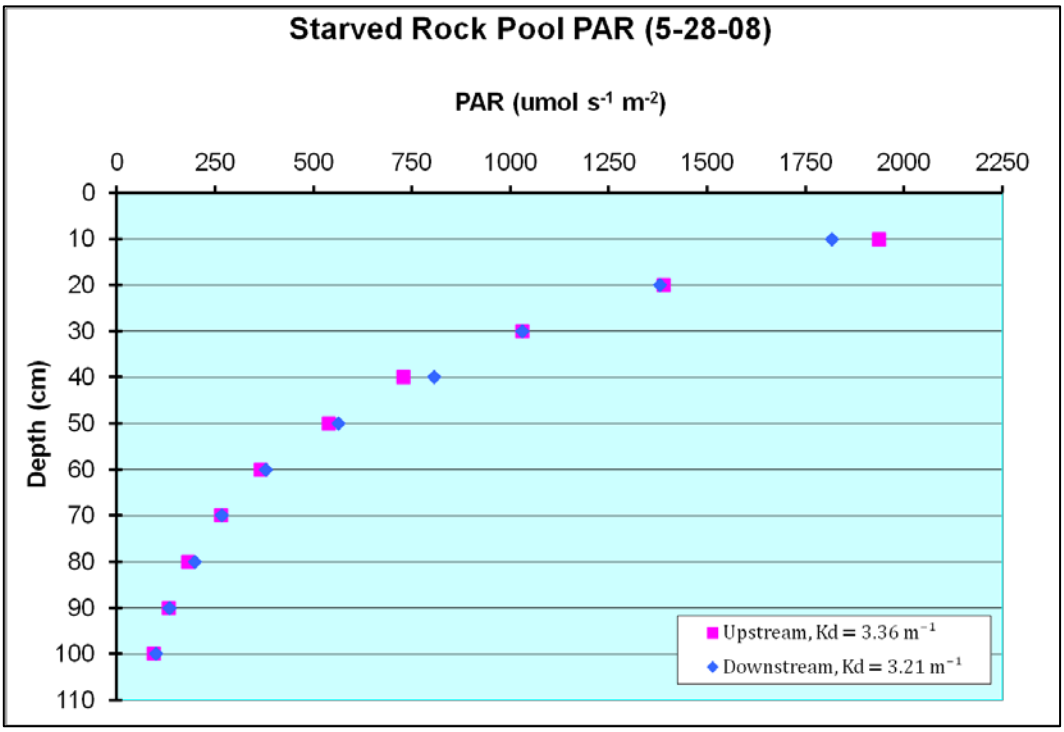


Figure F-19. Light Penetration Measurements in a Vertical Water Column at Sites SR-1 (Upstream) and SR-2 (Downstream), May 28, 2008.

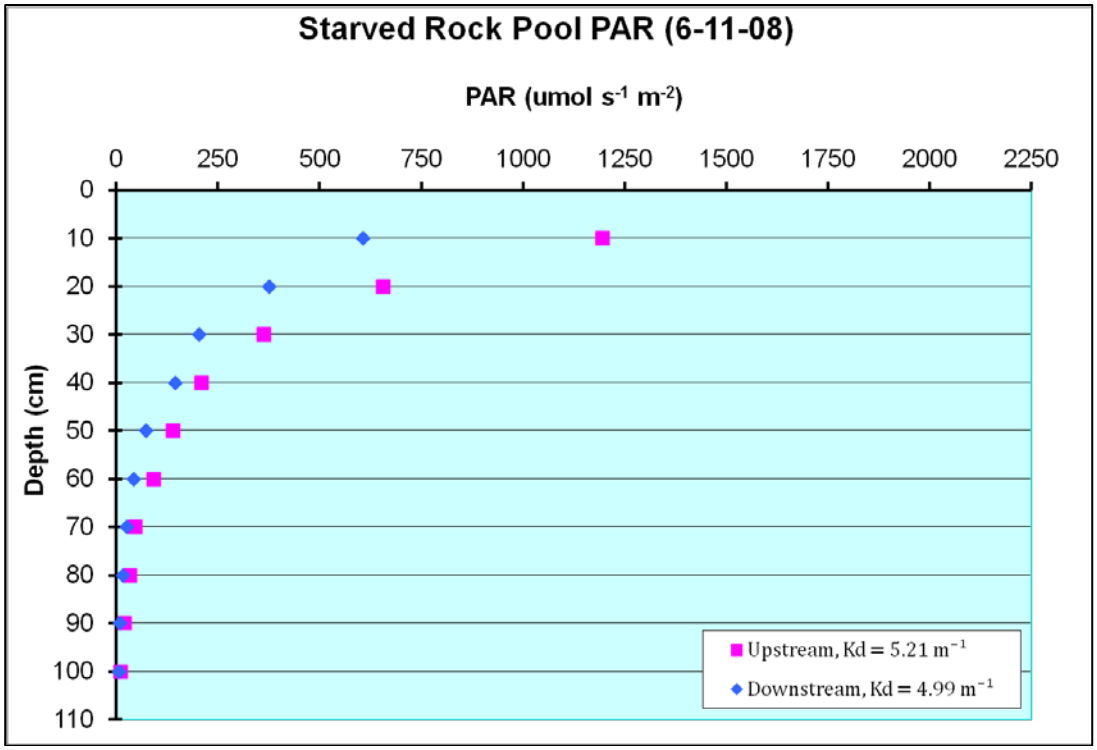


Figure F-20. Light Penetration Measurements in a Vertical Water Column at Sites SR-1 (Upstream) and SR-2 (Downstream), June 11, 2008.

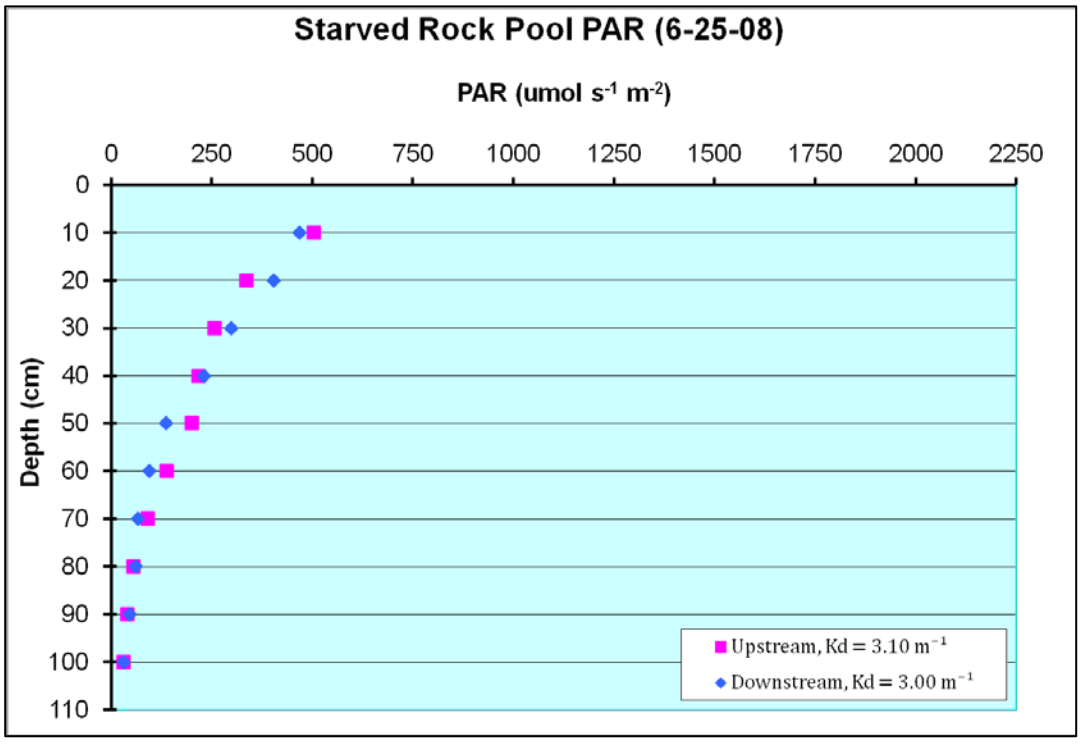


Figure F-21. Light Penetration Measurements in a Vertical Water Column at Sites SR-1 (Upstream) and SR-2 (Downstream), June 25, 2008.

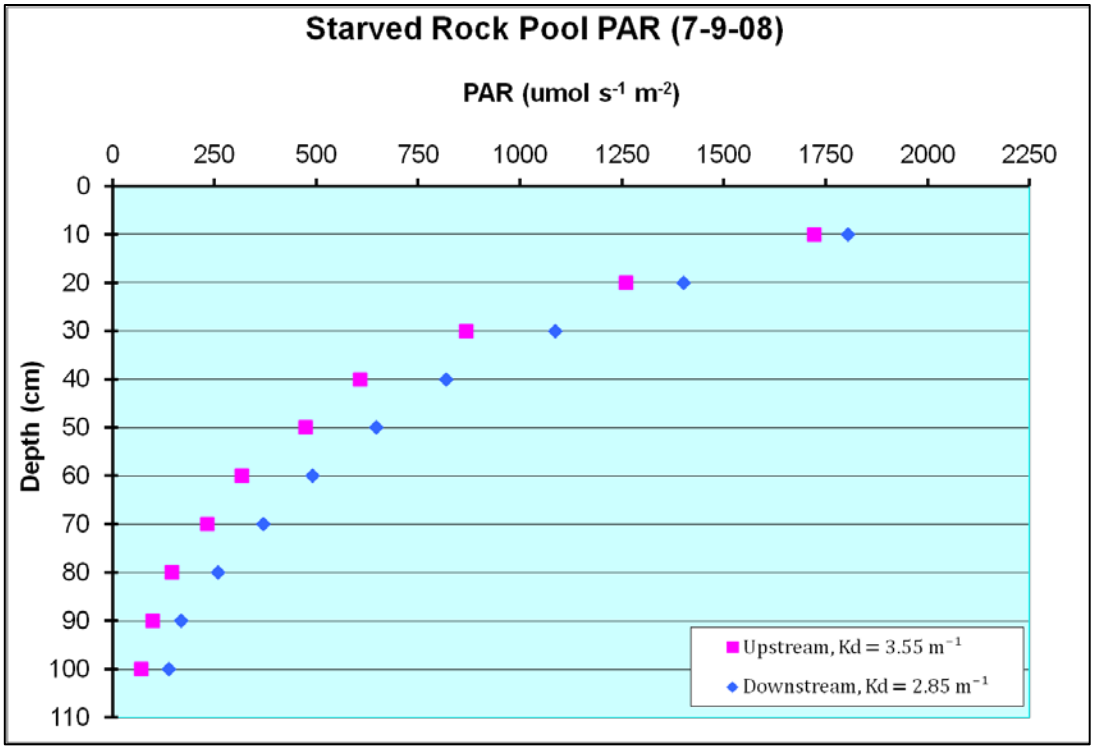


Figure F-22. Light Penetration Measurements in a Vertical Water Column at Sites SR-1 (Upstream) and SR-2 (Downstream), July 9, 2008.

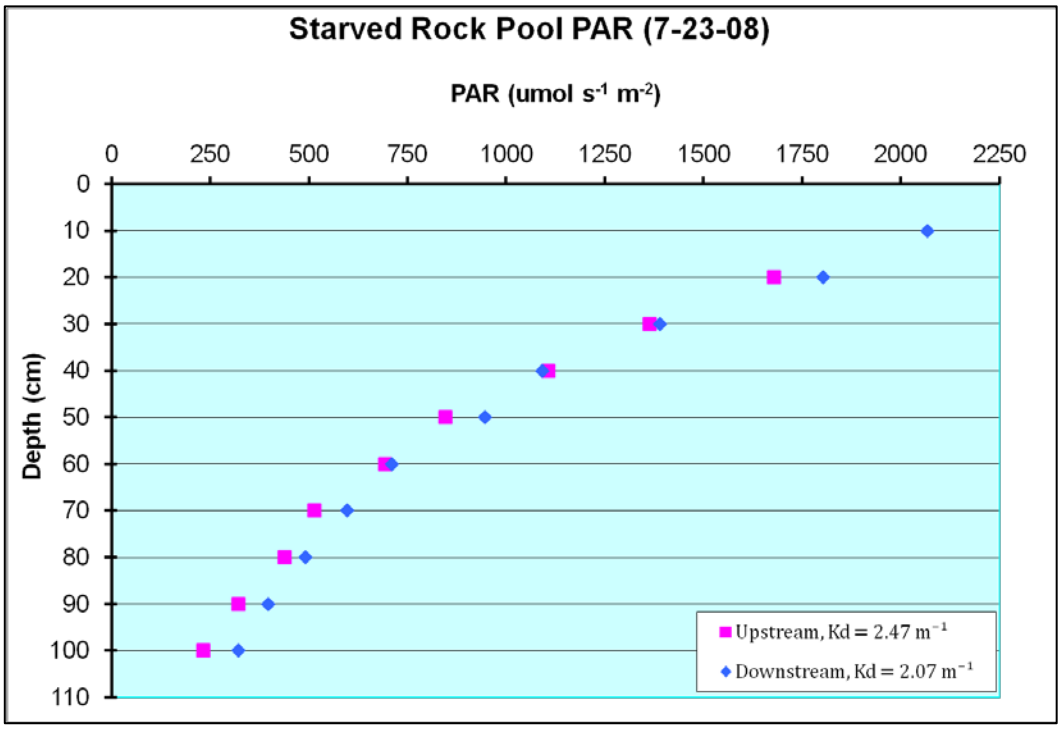


Figure F-23. Light Penetration Measurements in a Vertical Water Column at Sites SR-1 (Upstream) and SR-2 (Downstream), July 23, 2008.

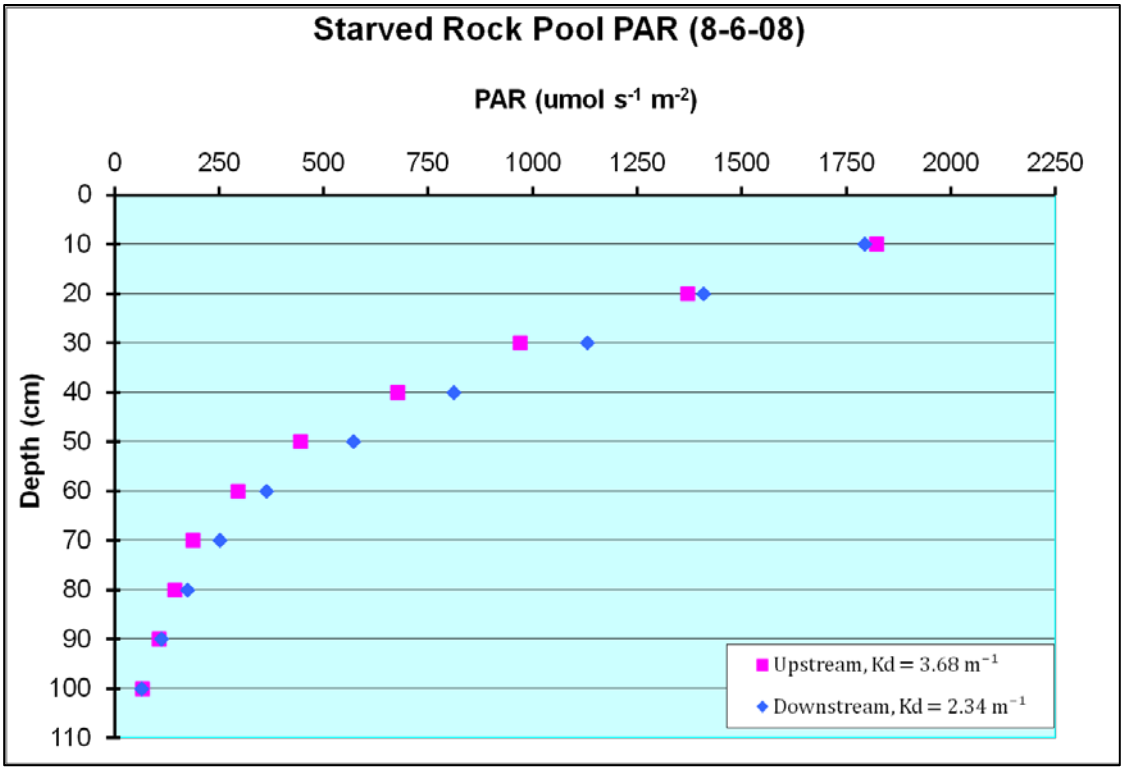


Figure F-24. Light Penetration Measurements in a Vertical Water Column at Sites SR-1 (Upstream) and SR-2 (Downstream), August 6, 2008.



Figure F-25. Site SR-2 (Downstream) Looking Downstream.



Figure F-26. Site SR-1 (Upstream) Looking Upstream.



Figure F-27. Near-Shore Vegetation (Non-Aquatic)



Figure F-28. Incidental SAV near Project Site.



Figure F-29. Incidental SAV near Project Site.



Figure F-30. Close-Up of SAV Taken from near Project Site.

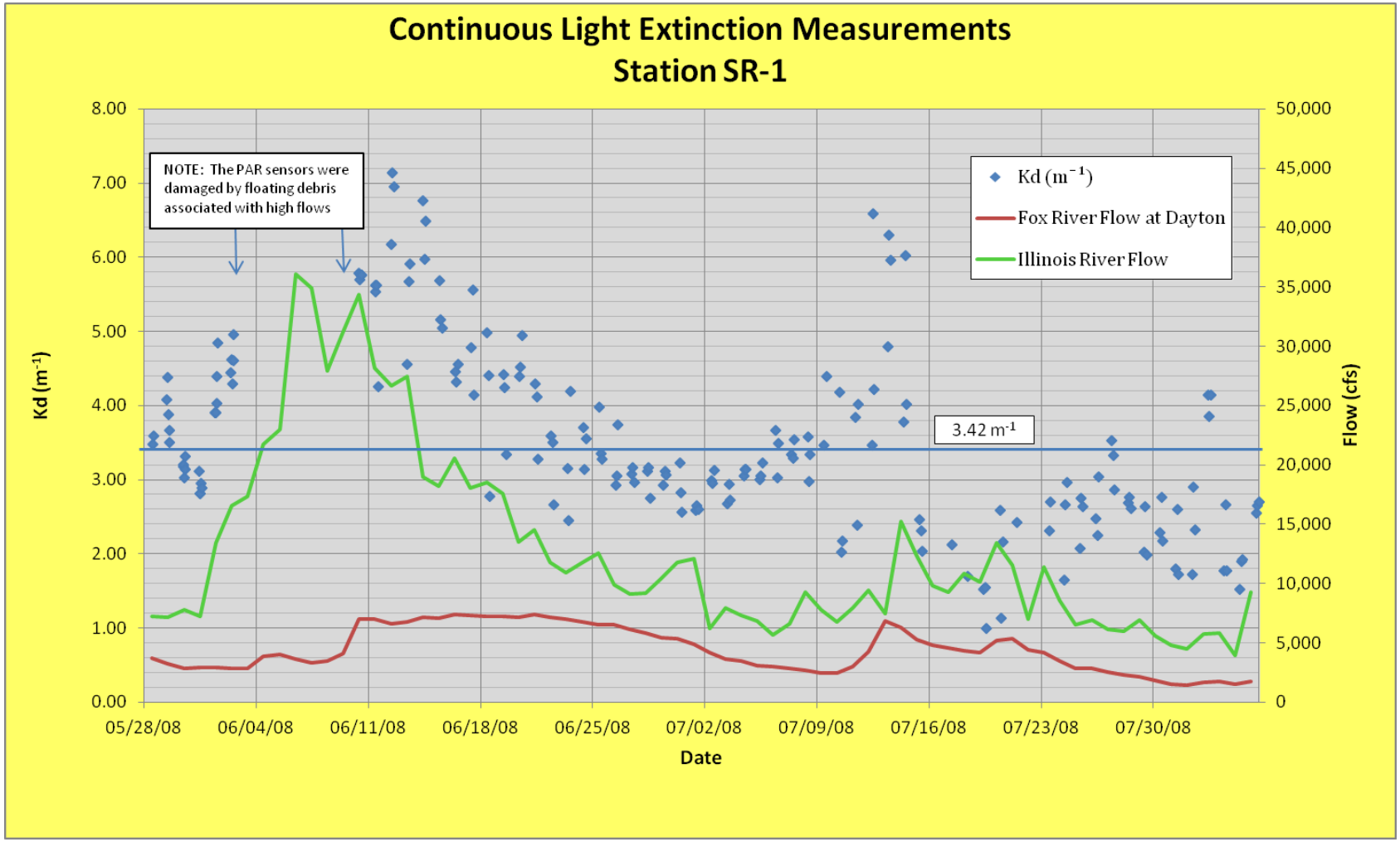


Figure F-31. Light Extinction Measurements at Site SR-1 and 6AM Daily Discharges on the Illinois River at Starved Rock Dam and on the Fox River at Dayton, May 28 – August 6, 2008.

BASIN RESTORATION
SECTION 519
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APPENDIX G

GEOTECHNICAL CONSIDERATIONS

1. PURPOSE

The study purpose is to evaluate the Federal and State interest in enhancing aquatic habitat and within the Starved Rock pool, more specifically Delbridge Island. This appendix presents site geology and specific geotechnical analyses relevant to the study. To support the preparation of this appendix, Rock Island District, Engineering Division, Geotechnical Branch personnel reviewed literature, obtained soil samples, performed laboratory analysis and interpretation, and provided geotechnical analyses and recommendations.

2. LOCATION

The Project study area is located in Starved Rock Pool between Illinois River Mile 233 and River Mile 234, upstream of Starved Rock lock and dam. Refer to the main report for detailed study area locations.

3. PROJECT FEATURES

The proposed Project features include the following: constructing a breakwater out of riprap parallel to the river, placing floating islands, placing floating breakwaters, and others and described in the main report.

4. PHYSIOGRAPHY

The physiographic setting of the Project is the southern portion of the relatively broad, bottomland Illinois River Valley, the ancient glacial flood plain of the river. This swath, cut in the glacial till plains of the region, is not the result of lateral erosion of a meandering river, but was created by floods which covered the valley floor from bluff to bluff during the glacial era. The width of the valley in this vicinity is approximately 1.5 miles. The general ground elevation of the bottomland area which lies mostly to the north of the Project is approximately 450.0 feet. The Illinois River with its own recent floodplain occupies a relatively narrow portion of the valley, this flood plain is usually 5 to 10 feet above the low water elevation of the river whereas the glacial flood plain terrace is situated some 10 to 20 feet above this level. Just west (downstream) of the are the relatively steep valley walls rising some 150 feet to elevations approaching 600 feet and above. The steepness of the valley walls is generally inherited from glacial times: however, in places, significant alterations by erosion have since occurred. Beyond the crest of the valley slopes both to the north and south are upland plain areas, mostly of a flat lake plain origin. Agriculture and strip mining are the general modes of land utilization.

5. GEOLOGY

For Discussion purposes, the geologic history has been divided into two brief segments: pre-glacial and post-glacial.

5.1. Pre-glacial. The Ottawa, Illinois area lies within the central interior basin. This basin was low-lying throughout the Paleozoic era and was frequently flooded by epicontinental seas. The intermittent elevation and depression of the area relative to the sea level created alternate epochs of deposition and erosion. The sediments deposited in the area were derived from the Lake Superior Region in the north with minor contribution from the Ozark Highland and the Appalachian Highland. Conditions remained stable during the deposition of the St. Peters sandstone and resulted in the deposition of thick beds of sandstone which form the highlands adjacent to the Illinois River at Ottawa. The St. Peters sandstone has been divided into 2 members; the Starved Rock member, approximately 90 feet thick and the underlying Tonti member which rests on the Shakopee formation.

5.2. Post-glacial. The valley of the Illinois River at Starved Rock is essentially a product of meltwater outflow from the various loves of Woodfordian Glaciers in addition to glacial Lake Chicago. The present deep gorge was cut mainly during two major stages of erosion. The first occurred during the retreat of the Valparaiso glacier about 14,000 years ago, when large amounts of water were discharged down the valley. The Valparaiso Morainic System lies 10 to 20 miles west and southwest of Lake Michigan and parallels the shore. In such a position, the ice margin contributed most of its meltwater to the valley of the Kankakee River about 40 miles southeast of Ottawa, Illinois where it flowed into the Illinois River. At the height of the flood, which was named the Kankakee Flood (Willman and Frye, I.S.G.S. 1970), waters backed up between moraines and formed several large lakes: Lake Ottawa, Lake Pontiac, Lake Wauponsee, and Lake Kankakee. As floodwaters slackened, the valley of the Illinois River was cut to the level of the top of Starved Rock.

The second stage of downward cutting took place when glacial Lake Chicago, the ancestor of present-day Lake Michigan, overflowed down the valley, deepening it approximately another 60 feet in the intercal from about 13,500 to 3,000 years ago. Lake Chicago resulted from the trapping of water between the Tinley Moraine on the back side of the Valparaiso Morainic System and the front of the glacier that occupied the Lake Michigan basin. The Ottawa Terrace represents the lowest level cut by the Chicago Outlet River. A deep groove low in the cliffs of Starved Rock and Buffalo Rock marks the level of the floodwaters. Since then, the modern river has cut its inner valley another 30 feet to reach its present level.

6. SOILS

Overburden materials outside the Illinois valley are, generally, lacustrine clays developed by the Kankakee Torrent which inundated the then existent morainal type deposits. The deposition of the lacustrine clays on the outwash sands, clays and gravels produced a complex mixture of soils which were then subject to further weathering, erosion and reworking

The principal deposits of the overburden soils in the valley in the Ottawa-Starved Rock area in the immediate river channel are recent alluvial sands and gravel with some thin beds of clay and silt located at the margins. Silt deposits form the major surface deposit on the river flood plains.

In general, soils along the breakwater alignment were found to be sandy lean to medium clays (CL and CL-CH) that were found to be firm, overlain by approximately 1 ft of soft sediments. Soils located at and near the surface contained within the interior of the Project area were generally sandy to clayey-sands to the depth of 1-3 feet, underlain by sandy clays.

7. SUBSURFACE EXPLORATION

Subsurface exploration was done to obtain foundation material samples for determination of their engineering characteristics. All subsurface exploration was done in accordance with Engineer Manual 1110-1-1804.

Personnel from the Rock Island District's Geotechnical Branch performed subsurface exploration during two different time periods as the Project feature scope evolved. 14 hand auger borings were taken on three separate days in October 2011 and February 2013. The hand augers were taken with a 4-inch Iwan auger.

12 borings were taken next to the alignment adjacent to the main river channel (Alternative 1), and 2 borings were taken along the back water alignment (Alternative 2). The borings were generally 7 to 8 ft deep into the riverbottom.

At an additional 10 locations samples were also taken from the interior area of the Project in February 2013 by request of EC-H in order to better characterize possible sediments.

8. LABORATORY TESTING

The results of the laboratory testing are listed with each individual boring log. All laboratory testing on samples taken from the borings located and shown on plates B-101 and B-301 was done in accordance with Engineer Manual 1110-2-1906.

Samples taken from borings consisted largely of sandy lean clays and medium clay (CL and CL-CH). These borings were taken from the river bottom surface to depths of approximately 7 to 8 feet. Atterberg limit testing done on samples from these borings generally plotted above and sometimes near the "A" line. The average of all liquid limit and plastic limit tests done on these borings is shown in Table F-1.

Table F-1: Starved Rock Atterberg Limit Data

Boring	LL	PL	PI
SR-11-01	50	26	24
SR-11-02	52	28	24
SR-11-02	42	19	23
SR-11-04	43	20	23
SR-11-05	49	29	20
SR-11-06	37	23	14
SR-11-06	32	16	16
SR-11-08	34	18	16
SR-11-10	31	18	13
SR-13-12	51	24	27
SR-13-12	47	25	22
SR-13-14	57	28	29
Average	**43.75**	**22.83**	**20.92**

The average water content of all samples taken from these borings was 35.3%. The soils were soft to medium when handled in the lab.

9. PROJECT FEATURES DESIGN

General. Several alternatives were considered for construction of the Project features at the Starved Rock Pool Project site. The primary goal of the Project is to create submerged aquatic vegetation habitat by reducing negative influencing factors, primarily wave action and river current that stirs up sediment, thus increasing turbidity and decreasing sunlight penetration through the water. Detailed drawings of proposed Project features are found in the main report.

9.1. Riprap Breakwater

9.1.1. General. The design of the riprap breakwater was limited by how the placed rock would affect the water elevation during a flood. Several different geometries were checked. A wider base with shallower slopes and narrow crown was chosen as the preferred design because the shallower slopes will deflect some of the ice flow forces upward, thus increasing durability of the breakwater. The recommended geometry is to have 2.5 horizontal to 1 vertical slopes with a 3 foot crown.

9.1.2. Slope Stability. No undisturbed soil samples were taken to run strength tests on. Common book values for the foundation clays suggest a strength range between 250 and 750 psf. Two stability models were run to determine the sensitivity of the analysis, one with a conservative value of 400 psf, and one with a very low value of 200 psf. It was found that both strengths meet slope stability requirements. These analyses can be found at the end of this appendix.

9.1.3. Settlement and Over Build. No undisturbed soil samples were taken to run settlement tests on. However, using common book values the approximate settlement was found to be 8 in. Therefore, it is recommended to use an overbuild of approximately 1 ft in order to account for the settlement and construction tolerances.

9.1.4. Rock Size. Minimum rock size required to satisfactorily perform against ice flow was determined by EC-H. It was found that Illinois Department of Transportation (ILDOT) gradation R-5 (400 lb) riprap would be sufficient for both ice flow and river current.

9.2. Floating Islands and Breakwater. The design of the floating islands and floating breakwater would be proprietary, and main geotechnical issue would be anchoring of the islands. This could be accomplished many different ways including dead weights and auger anchors. The number of anchors can be adjusted to meet the required resistance to the forces exerted on the floating islands and/or floating breakwater. Whatever method is ultimately chosen, the foundation appears to be suitable.

10. REFERENCES

USACE (1970), "Engineer Manual EM 1110-2-1902: Stability of Earth and Rockfill Dams," U.S. Army Corps of Engineers, Washington, DC.

(1970), "Engineer Manual EM 1110-2-1906: Laboratory Soils Testing," U.S. Army Corps of Engineers, Washington, DC.

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(1990), "Engineer Manual EM 1110-1-1904 Settlement Analysis," U.S. Army Corps of Engineers, Washington, DC.

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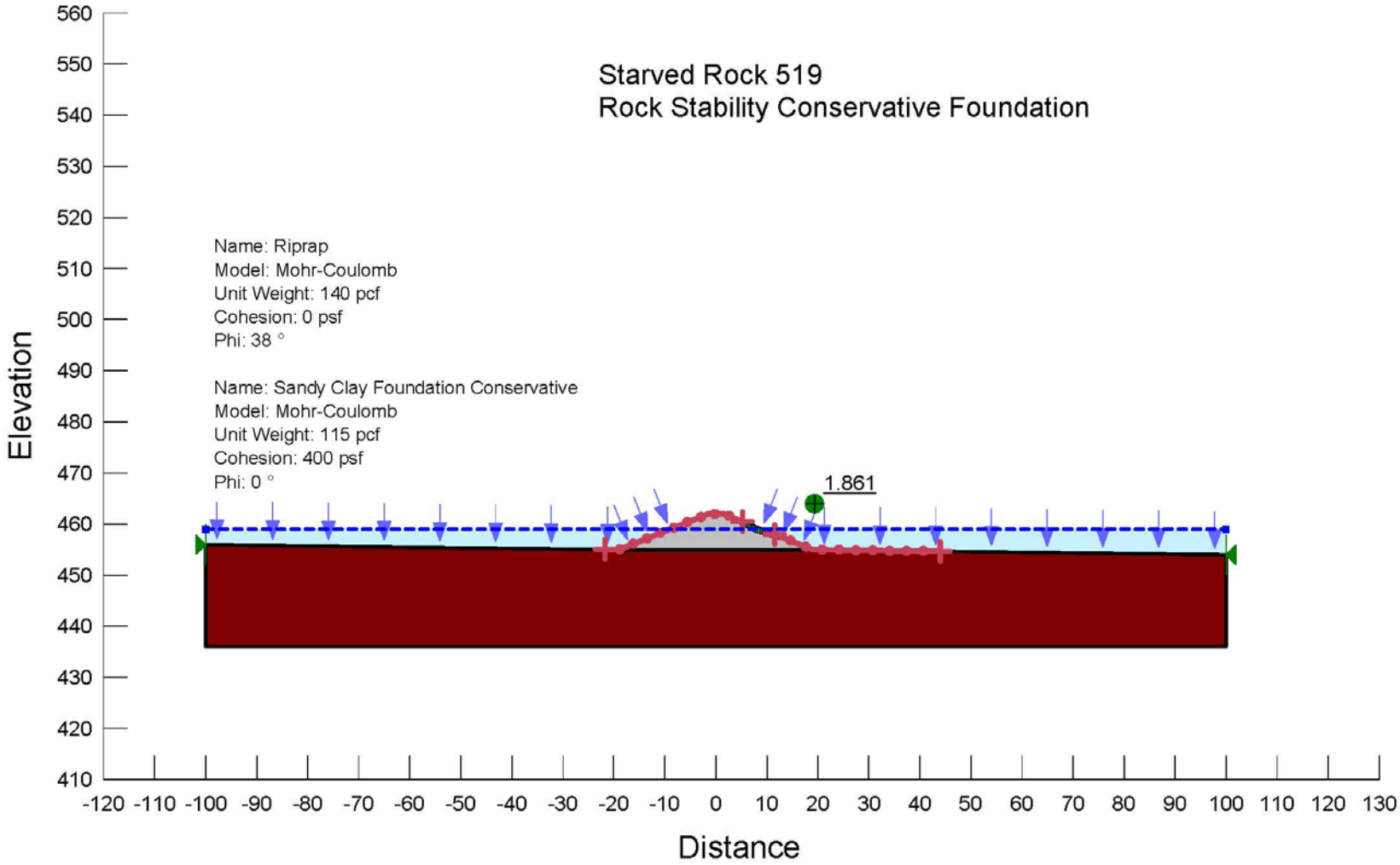
(November, 1973), "APPENDIX A, Soils and Geology for Structural Stability Analysis, Starved Rock Lock and Dam, Illinois Waterway," Department of the Army, Corps of Engineers, Chicago District.


Starved Rock 519
Rock Stability Conservative Foundation
Name: Riprap
Model: Mohr-Coulomb
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 38 °
Name: Sandy Clay Foundation Conservative
Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 400 psf
Phi: 0 °
1.861
Elevation
Distance
560
550
540
530
520
510
500
490
480
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460
450
440
430
420
410
-120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130

Rock Stability Conservative Foundation

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File Information

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Created By: Povich, Jotham K MVR
Revision Number: 8
Last Edited By: Povich, Jotham K MVR
Date: 3/22/2013
Time: 1:58:49 PM
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View: 2D

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Rock Stability Conservative Foundation

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- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

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- Use Passive Mode: No
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- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

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FOS Calculation Option: Constant
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Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1
Driving Side Maximum Convex Angle: 5 °
Resisting Side Maximum Convex Angle: 1 °

Materials

Riprap

Model: Mohr-Coulomb
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sandy Clay Foundation Conservative

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 400 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (-21.69302, 455.03325) ft
Left-Zone Right Coordinate: (5.25, 460.5) ft
Left-Zone Increment: 10
Right Projection: Range
Right-Zone Left Coordinate: (11.52046, 457.99182) ft
Right-Zone Right Coordinate: (44, 454.69136) ft
Right-Zone Increment: 10
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (-100, 456) ft
Right Coordinate: (100, 454) ft

Piezometric Lines

Piezometric Line 1
Coordinates

X (ft)	Y (ft)
-100	459
100	459

Regions

	Material	Points	Area (ft²)
Region 1	Riprap	3,1,2,4	143.5
Region 2	Sandy Clay Foundation Conservative	3,5,6,7,8,4	3800

Points

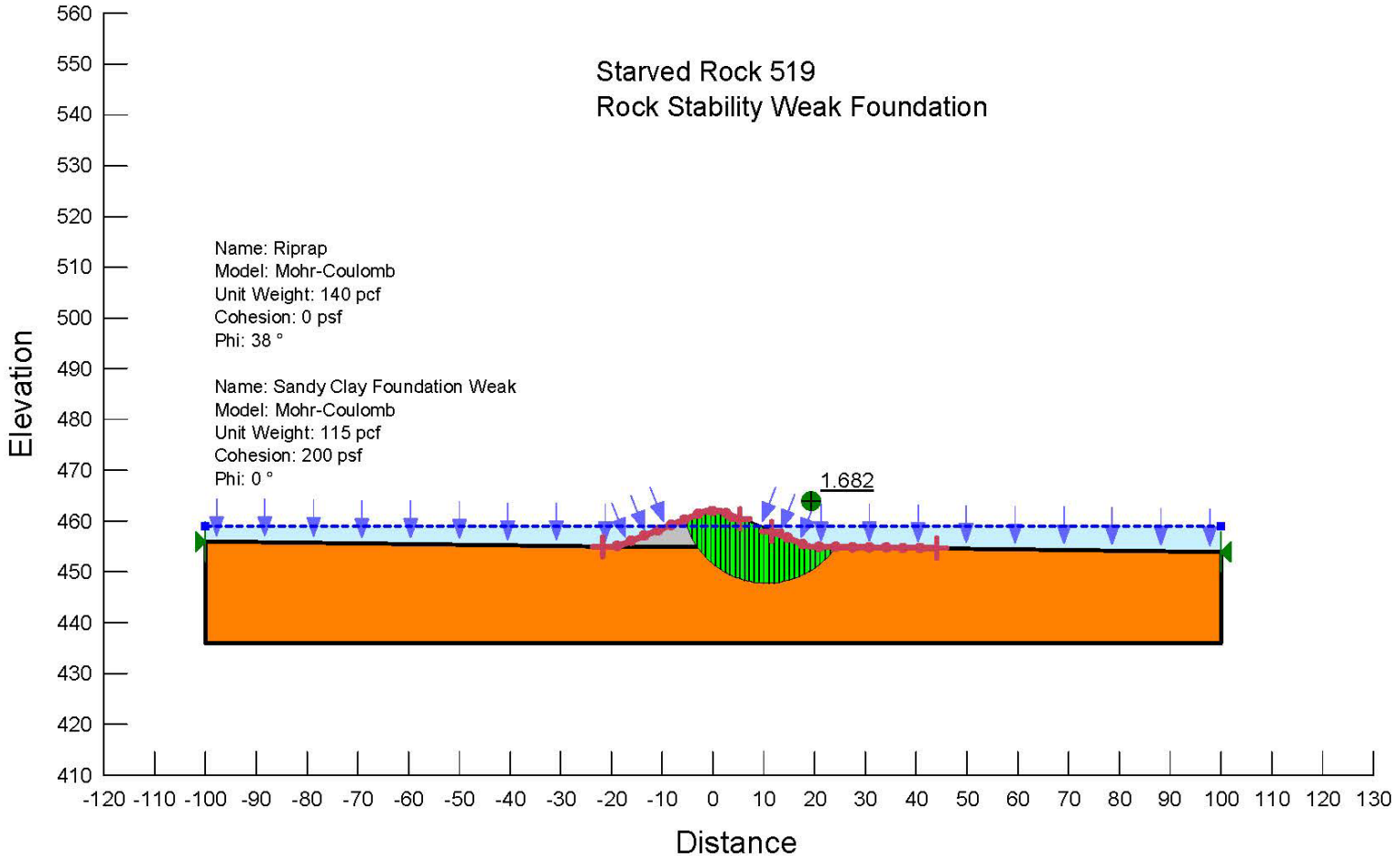
	X (ft)	Y (ft)
Point 1	-1.5	462
Point 2	1.5	462
Point 3	-19	455
Point 4	19	455
Point 5	-100	456
Point 6	-100	436
Point 7	100	436
Point 8	100	454

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	1103	1.861	(16.108, 477.951)	21.241	(2.5964, 461.561)	(14.5898, 456.764)

Slices of Slip Surface: 1103

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	1103	2.79228	461.4038	-149.99824	7.7370528	6.0448481	0
2	1103	3.1840455	461.096	-130.78841	22.891212	17.884575	0
3	1103	3.5758105	460.80265	-112.48283	37.103404	28.988356	0
4	1103	3.967576	460.523	-95.035293	50.360851	39.346209	0
5	1103	4.3593415	460.25645	-78.404979	62.654235	48.950854	0
6	1103	4.7511065	460.00245	-62.552725	73.97399	57.794815	0
7	1103	5.142872	459.7604	-47.450907	84.310289	65.870417	0
8	1103	5.5346375	459.5299	-33.067127	93.65588	73.171993	0
9	1103	5.9264025	459.3105	-19.373863	102.00036	79.691413	0
10	1103	6.318168	459.10175	-6.348516	109.33329	85.420526	0
11	1103	6.7212135	458.89795	6.3689427	116.32625	85.908062	0
12	1103	7.135538	458.69935	18.762799	122.73217	81.229778	0
13	1103	7.5498625	458.51155	30.479171	127.72624	75.977736	0
14	1103	7.9641875	458.3343	41.536878	131.30905	70.137709	0
15	1103	8.3785125	458.16735	51.954913	133.48305	63.696765	0
16	1103	8.7928375	458.0104	61.747823	134.24051	56.637491	0
17	1103	9.199635	457.86575	70.776591	138.48613	52.900492	0
18	1103	9.598905	457.73285	79.07186	146.4571	52.647116	0
19	1103	9.998175	457.6086	86.823363	153.35612	51.981085	0
20	1103	10.397445	457.4929	94.0427	159.17349	50.885753	0
21	1103	10.796715	457.3856	100.73899	163.90274	49.34893	0
22	1103	11.195985	457.28655	106.91604	167.52811	47.35534	0
23	1103	11.595255	457.1957	112.58683	170.03907	44.886616	0
24	1103	11.994525	457.1129	117.75376	171.42026	41.928867	0
25	1103	12.393795	457.03805	122.42568	171.65636	38.463221	0
26	1103	12.793065	456.97105	126.60789	170.72695	34.469586	0
27	1103	13.192335	456.9118	130.30196	168.61133	29.930557	0
28	1103	13.591605	456.8603	133.51561	165.28858	24.823764	0
29	1103	13.990875	456.8165	136.25021	160.73004	19.125741	0
30	1103	14.390145	456.7803	138.51066	154.90926	12.811993	0


Starved Rock 519
Rock Stability Weak Foundation
Name: Riprap
Model: Mohr-Coulomb
Unit Weight: 140 pcf
Cohesion: 0 psf
Phi: 38 °
Name: Sandy Clay Foundation Weak
Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 0 °
1.682
Elevation
Distance
560
550
540
530
520
510
500
490
480
470
460
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440
430
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410
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Rock Stability Weak Foundation

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Pressure(p) Units: psf
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Unit Weight of Water: 62.4 pcf
View: 2D

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Rock Stability Weak Foundation

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- Use Staged Rapid Drawdown: No

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- Direction of movement: Left to Right
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- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
FOS Calculation Option: Constant
Advanced
Number of Slices: 30
Optimization Tolerance: 0.01
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Optimization Convergence Tolerance: 1e-007
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Resisting Side Maximum Convex Angle: 1 °

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Phi: 38 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Sandy Clay Foundation Weak

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 200 psf
Phi: 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

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Left Coordinate: (-100, 456) ft
Right Coordinate: (100, 454) ft

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Piezometric Line 1
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	Material	Points	Area (ft²)
Region 1	Riprap	3,1,2,4	143.5
Region 2	Sandy Clay Foundation Weak	3,5,6,7,8,4	3800

Points

	X (ft)	Y (ft)
Point 1	-1.5	462
Point 2	1.5	462
Point 3	-19	455
Point 4	19	455
Point 5	-100	456
Point 6	-100	436
Point 7	100	436
Point 8	100	454

Critical Slip Surfaces

	Slip Surface	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	779	1.682	(10.537, 464.458)	16.627	(-5.57898, 460.368)	(24.1669, 454.936)

Slices of Slip Surface: 779

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	779	-5.3736755	459.6842	-42.694506	39.598652	30.937858	0
2	779	-4.660644	457.835	72.69707	222.10436	116.72977	0
3	779	-3.645192	455.835	197.49707	485.54881	225.05068	0
4	779	-2.7280995	454.45705	283.47768	765.53384	0	200
5	779	-1.9093665	453.4512	346.24108	947.1847	0	200
6	779	-1	452.5057	405.24264	1099.0521	0	200
7	779	0	451.61295	460.95038	1222.289	0	200
8	779	1	450.85235	508.41392	1327.967	0	200
9	779	1.96875	450.2198	547.88549	1391.4886	0	200
10	779	2.90625	449.69545	580.60567	1415.388	0	200
11	779	3.84375	449.24695	608.58783	1429.3525	0	200
12	779	4.78125	448.86765	632.26439	1434.5402	0	200
13	779	5.71875	448.5526	651.91983	1431.549	0	200
14	779	6.65625	448.29805	667.79975	1420.9388	0	200
15	779	7.59375	448.10115	680.08693	1403.279	0	200
16	779	8.53125	447.9598	688.91228	1378.7564	0	200
17	779	9.5	447.87155	694.4145	1359.0471	0	200
18	779	10.5	447.8392	696.43861	1344.0973	0	200
19	779	11.5	447.8671	694.69084	1322.0749	0	200
20	779	12.5	447.9556	689.17134	1292.9845	0	200
21	779	13.5	448.1057	679.80997	1256.8337	0	200
22	779	14.5	448.31905	666.49056	1213.3549	0	200
23	779	15.5	448.5983	649.06248	1162.5099	0	200
24	779	16.5	448.947	627.31192	1103.842	0	200
25	779	17.5	449.36995	600.91815	1036.9111	0	200
26	779	18.5	449.8737	569.4861	961.16797	0	200
27	779	19.516695	450.47855	531.74131	884.45787	0	200
28	779	20.550085	451.20065	486.6754	816.98148	0	200
29	779	21.58347	452.05095	433.62024	736.76991	0	200
30	779	22.616855	453.0585	370.74968	641.70207	0	200
31	779	23.650245	454.2711	295.08376	528.66922	0	200

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APPENDIX H

HYDROLOGY AND HYDRAULICS

This appendix presents the hydrologic and hydraulic assessment of the project area and summarizes the hydrologic and hydraulic evaluations of various project features considered as part of the Starved Rock Section 519 Project.

1. INTRODUCTION, PURPOSE, AND LOCATION

The purpose of this study is to determine the impacts to the environment and navigation as the result of the construction of a proposed breakwater structures in Starved Rock Pool between River Miles (RM) 231.1 and 234. The objective of this project as Authorized by the Section 519 project is to protect the historical Delbridge Island area from wind and navigation waves thereby reducing turbidity and providing conditions for submersed aquatic vegetation (SAV). The tentatively selected plan (TSP) is to construct a riprap breakwater on the right-descending bank of the historic Delbridge Island (Figure H-1). This study includes hydrology information, 1 and 2-Dimensional hydraulic modeling, and a sedimentation analysis. For the hydraulic modeling and sedimentation, existing conditions, with project, and future without project are presented. Available data, past studies, flow and stage data, topographic/cross-section data, Acoustic Doppler Current Profiler (ADCP) velocity data, gauging station data, wind and wave data, water quality data, and other hydrologic/hydraulic data were utilized.

The Starved Rock pool, which is near the City of Utica, Illinois, extends 13.5 miles from RM 231.0 (Starved Rock Dam) to Marseilles Lock at RM 244.5. The Starved Rock Pool from RM 231.1 to RM 235 consists of a navigation channel on the right descending bank, a side channel on the left descending bank, and a shallow area with some small islands in between the channels. The shallow area in between the channels is the location of the historic Delbridge Island. From RM 235 to RM 237, the original channel flowed to the north of Sheehan Island (between RMs 235.1 and 236). For easier navigation access, a channel was cut to the south of Sheehan Island. Sheehan Island was used as a gravel pit in the past (Figure H-1).

All elevations referred to herein reference the NGVD 1929 datum. The coordinate system is NAD 83, IL State Plane West, FIPS 1202, feet.

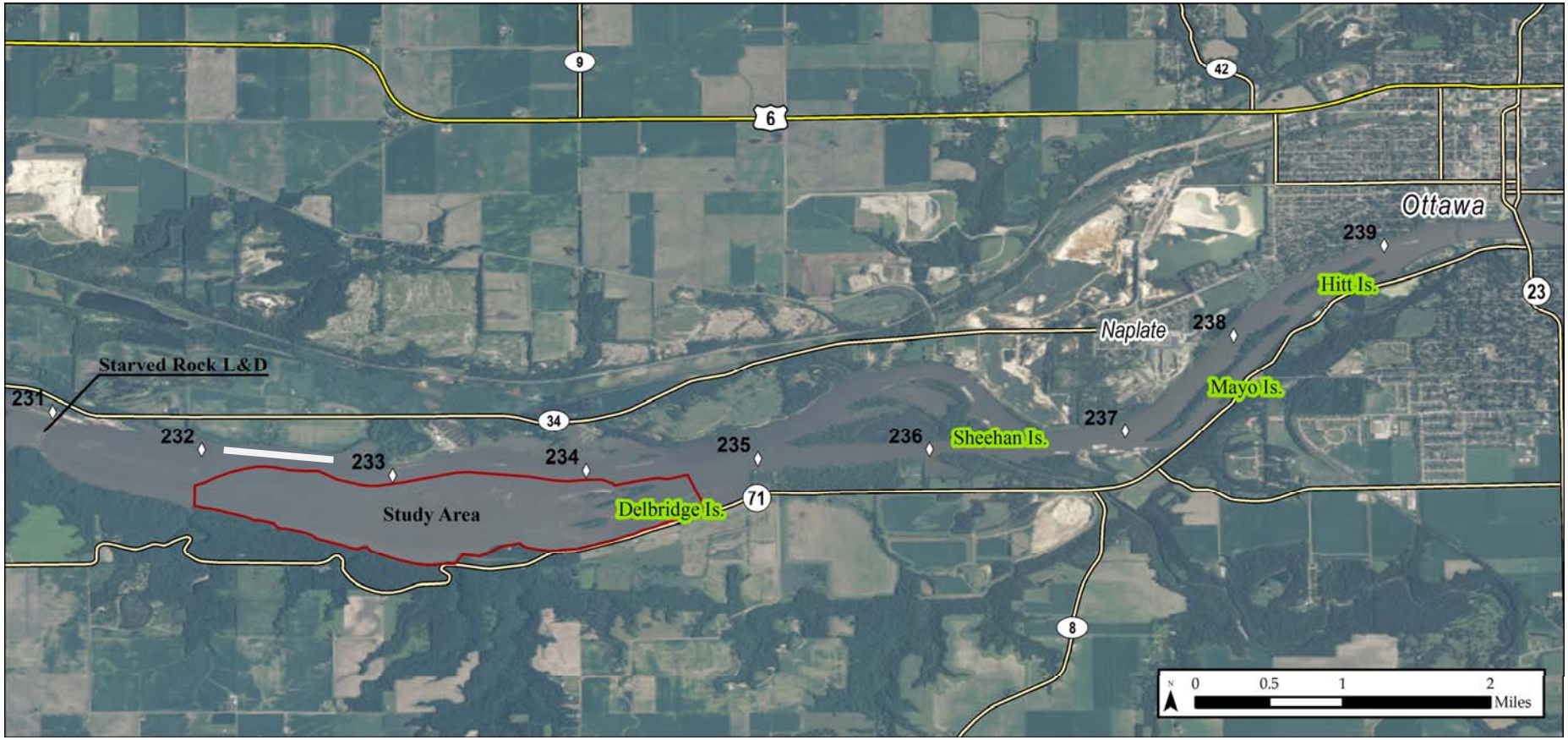

Figure H-1. 2000 Aerial Photograph of Starved Rock Pool from RM 231-236

2. CLIMATE

Annual climate data for the Ottawa, IL U.S. Cooperative Network Station (gage #116526) provides precipitation and snowfall data used for the Starved Rock project site (Table H-1). Temperature data was also obtained from the Ottawa, IL U.S. Cooperative Network Station (gage #116526) (Table H-2). The period of record for the average values reported at the gage begins in 1981 and continues through 2011. Minimum and maximum precipitation and snowfall values at the gage include the period of record between 1889 and February, 2013. Minimum and maximum temperature values at the gage include the period of record between 1981 and 2011.

Table H-1. Average and Extremes of Monthly Precipitation and Snowfall (Ottawa 5 SW, IL gage)

	Precipitation					Snow		
	Average	Maximum		Minimum		Average	Maximum	
Month	(in)	(in)	Year	(in)	Year	(in)	(in)	Year
Jan	1.52	5.98	1897	T	1917	7.9	30.5	1979
Feb	1.36	4.76	1997	T	1987	5.3	35.4	1900
Mar	2.46	6.79	1948	0.12	1917	2.6	24.9	1926
Apr	3.15	9.67	1950	T	1917	0.5	22.4	1926
May	4.10	13.09	1892	T	1917	0.0	0.3	1923
Jun	3.83	10.56	1892	0.29	1988	0.0	-	-
Jul	3.85	14.85	1958	0.08	1916	0.0	-	-
Aug	3.92	14.27	2007	0.27	1950	0.0	-	-
Sep	3.28	14.28	1926	0.31	1956	0.0	-	-
Oct	2.80	9.67	1941	0.01	1964	0.0	2.0	1967
Nov	3.07	9.66	1985	T	2007	0.2	12.6	1895
Dec	2.09	5.77	1895	T	1918	5.5	21.2	1951
Annual	**35.41**					**22.2**		

T = Trace

Table H-2. Average Monthly Temperature (Ottawa 5 SW, IL gage)

	Temperature		
	Average	Maximum	Minimum
Month	(°F)	(°F)	(°F)
Jan	23.9	32.2	15.6
Feb	28.2	37.0	19.4
Mar	39.3	49.2	29.5
Apr	51.3	62.6	40.0
May	61.9	73.0	50.7
Jun	70.9	81.3	60.5
Jul	74.4	84.4	64.5
Aug	72.7	82.9	62.5
Sep	65.5	77.1	54.0
Oct	53.6	65.1	42.2
Nov	41.2	50.2	32.2
Dec	27.7	35.8	19.5
Annual	**50.9**		

The average annual daily minimum temperature was 40.9 degrees Fahrenheit (F), while the average annual daily maximum temperature was 60.9 degrees F. However, fluctuation of temperatures in North Central Illinois can be extreme. Average monthly temperatures range from a maximum of 84.4 degrees F in July to a minimum of 15.6 degrees F in January. The precipitation is moderate, with an average annual value of 35.4 inches (in). The average annual snowfall is 22.2 in.

3. TOPOGRAPHY

The Illinois River Waterway (IWW) follows a westerly course from Marseilles to Starved Rock. The City of Ottawa straddles the Waterway at, and just downstream from, the mouth of the Fox River. The town of Naplate is on the right bank a short distance downstream from Ottawa. Steep bluffs, composed of St. Peter sandstone and shale, rise on both sides of the flood plain. These are especially evident at Starved Rock State Park where sheer cliffs face the IWW along the left bank. Small streams cutting through the bluffs have steep valley walls. Along the right bank, the flood plain varies from about 0.8 to 1.2 miles in width. Strip mines occur along the right bank bluff line from Naplate to Starved Rock. There are numerous sand pits and clay pits along the flood plain. Bluffs along each bank vary from about 50 to more than 150 feet in height above the flood plain. The width of the valley between bluffs varies from about 1.2 to 2.0 miles.

The navigation channel maintained by the Corps is 300 feet wide (USACE, 1996). Channel maintenance is a continuing effort and has been performed throughout the 13.5 river miles in the Starved Rock Pool. However, there is only one area since 2006 between RM 231.1 and RM 235 that has required dredging in the navigation channel. It is located approximately between RM 232.2 and RM 232.7, delineated by the solid white line on Figure H-1 and the solid black line in Figure 9 of the Main Report. The thalweg has a gentle slope of less than a foot per mile. Hitt, Mayo, Sheehan, and Delbridge Islands are located along this reach of the IWW (Figure H-1 and attachment H-3).

There have been several changes over the past 100+ year period, including several major system disturbances that took place throughout this time period (i.e. impoundment from construction of the lock and dam, land use change, flooding, and drought). Attachment H-4 shows changes in island size from pre-lock and dam to present and the submergence of Delbridge Island after impoundment in 1933. From 1978 to 1983, there was a small amount of island re-growth. From 1983 to present, there has been approximately 32.5 acres of additional island growth.

4. ILLINOIS RIVER - STARVED ROCK POOL

4.1. Historic and Current Illinois River. The IWW has undergone numerous and extensive modifications in the interest of navigation, the most recent of which is the 1933 9-foot navigation channel project. Starved Rock Lock and Dam is a unit of a system comprised of one lock and eight locks and dams linking the Mississippi River with Lake Michigan. The dam is operated to provide a nine-foot navigation channel between RM 231 and 244.5 on the IWW. The lock permits passage of river traffic from the lower to the upper pool and vice versa. The maximum lift is about 19 feet and the average lift is 15.7 feet. It is located approximately 1.8 miles downstream of the Project and was placed into operation in 1933. In addition, the Peru Hydroelectric Facility was authorized for

hydropower generation on August 4, 1995, according to the Operating Memorandum of Agreement signed by the Corps of Engineers and the City of Peru.

4.2. Drainage Area and Inflow. A large portion of the inflow to Starved Rock Dam comes from releases made by the Lockport Powerhouse, Lockport Controlling Works, and Fox River Hydropower Plant. The Lockport Hydropower Plant is operated by the Metropolitan Water Reclamation District of Greater Chicago which not only regulates this structure for hydropower, but also releases storm water from the City of Chicago. Releases at this facility can vary rapidly and the pool above Lockport can be dropped as much as 10 feet in just several hours in advance of an anticipated rainfall event in the Chicago area. Such release changes are notified to Brandon Road Dam and, in turn, relayed down river to Starved Rock Dam. The travel time for these flow changes is about six hours; therefore, no changes are made at the dam until the pool starts to fluctuate. Fox River Hydropower Plant does not report flow changes to Starved Rock Lock and Dam. The Fox River Hydropower Plant does not affect river stages in Starved Rock Pool. The total drainage area of the Illinois River at Starved Rock Lock and Dam is 11,056 square miles.

4.3. Stage, Discharge, and Operation of Pool Information. The nearest stream gage locations to the Project are Starved Rock Dam Pool located at RM 231.1 and Ottawa, IL at RM 239.8. The Starved Rock Pool gage was placed into operation in 1933 and the Ottawa gage in 2008. The Starved Rock flat pool elevation is 458.52 feet (tailwater flat pool of 440.3) and the dam is operated to maintain a pool elevation between 458.75 feet and 458.95 feet in order to provide a nine-foot navigation channel between RM 231 and 244.5. Figure H-2 shows that this elevation range is maintained the majority of the time. Note that record elevations may not be indicated in Figure H-2 since this data is based on daily 6 am readings.

Pool adjustments by the Peru Hydropower Plant are completed only in the range between 1,000 cubic feet per second (cfs) and 8,300 cfs (all four turbines in operation). Outside of these limits, the pool elevation is controlled by the Corps of Engineers. The Corps of Engineers has total control of the river whenever total river flows are less than 1,000 cfs or greater than 39,000 cfs. The pool is maintained between 458.75 and 458.95 the majority of the time (including when the Peru Hydropower Plant is in operation) using this operation schedule. The maximum pool elevation for navigation at Starved Rock is 461.5 feet. When the total river flow is higher, the dam goes out of operation when the tail reaches an elevation of 460 feet and the pool is at 461.5 feet (1.5' swell head). Experience has shown that there are navigation impacts when the pool level drops below elevation 458.5. Consequently, in recent years the pool elevation has not been allowed to drop much below this elevation.

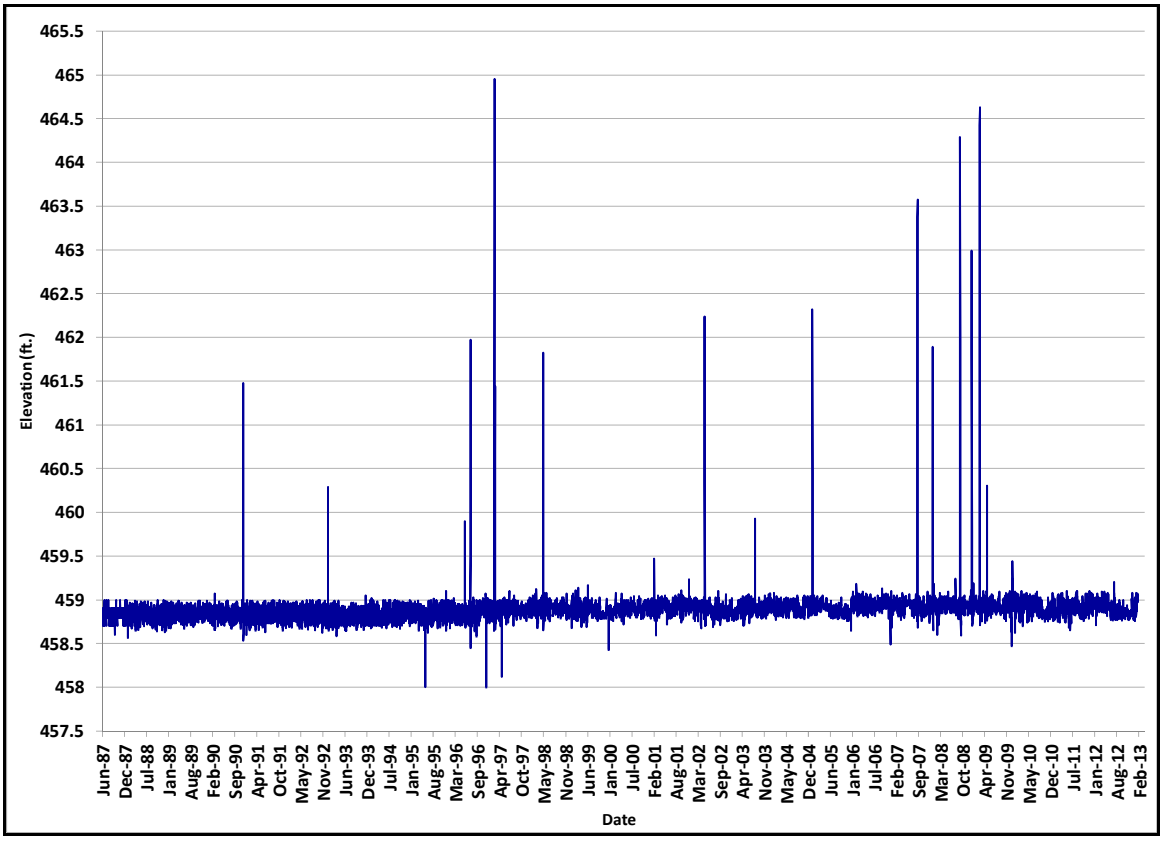

Figure H-2. Starved Rock Historical Daily (6 am) Water Surface Elevation for the Period 1987-201**3**

Flow data for the Illinois River at Starved Rock is summarized in Table H-3.

Table H-3. Starved Rock Pool Flow Data

Average Annual Flow	12,680 cfs
Minimum Daily Average Flow	1,380 cfs October 22, 2005
Minimum Monthly Average Flow	3,120 cfs November, 1999
Minimum Annual Average Flow	6,326 cfs 1964 Water Year
Maximum Annual Average Flow	21,790 cfs 1993 Water Year
Maximum Monthly Average Flow	52,600 cfs March, 1979
Maximum Daily Average Flow	127,000 cfs September 16, 2008
Maximum Instantaneous Flow	135,000 cfs September 16, 2008

Flows rarely fall below 3,000 cfs because of the diversion from the Lake Michigan Basin. Historical flow from June 1987-February 2013 is shown in Figure H-3.

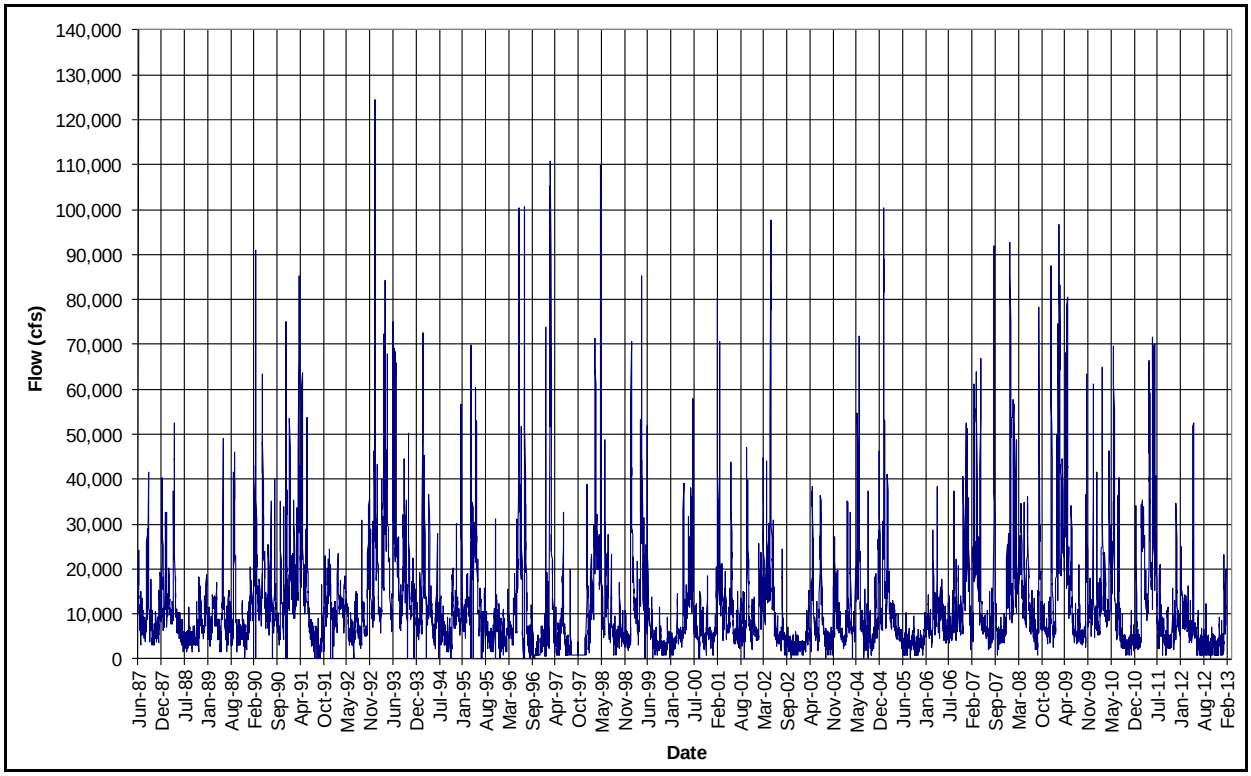

Figure H-3. Starved Rock Historical Daily (6 am) Flow for the Period 1987-2013

The Starved Rock Annual Stage-Duration curve for RM 231.1 is shown in Figure H-4. Stage-Duration is the percent chance that a specified water surface is equaled or exceeded at any given time. This is different from flood frequency curves, which are based on the percent chance that a specified flood has of being equaled or exceeded in any year. The water surface (Figure H-5) shows Elevation-Duration information from the Starved Rock Dam headwater to the Marseilles Dam tailwater. Table H-4 shows Figure H-5 in Table format and water surface slopes for various Elevation-Duration % Exceedances, specifically from the upstream to downstream end of the proposed project site. Table H-4 lists information at key locations associated with the proposed project.

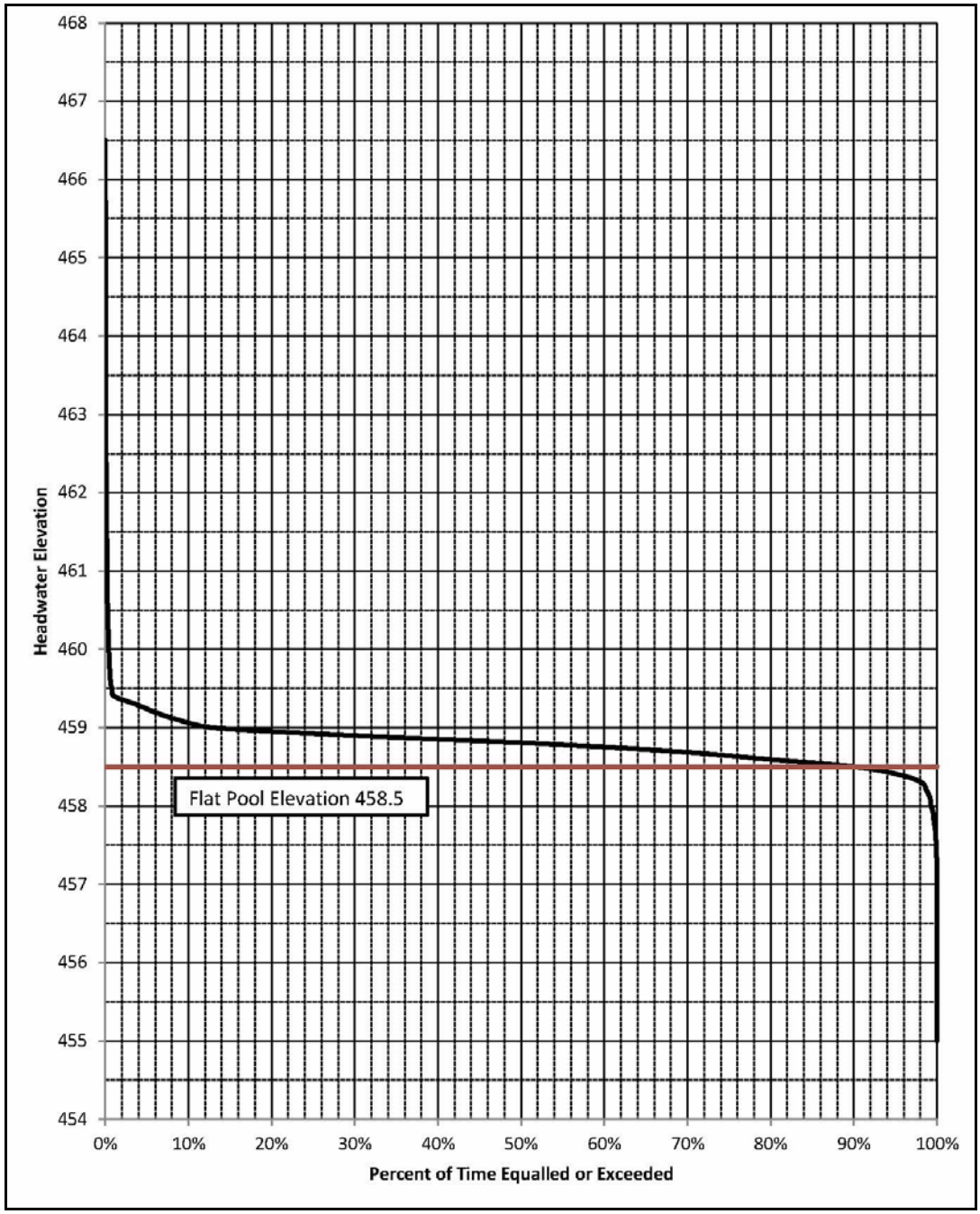

Figure H-4. Starved Rock Dam Headwater Annual Stage-Duration Curve for the Period 1935-2011

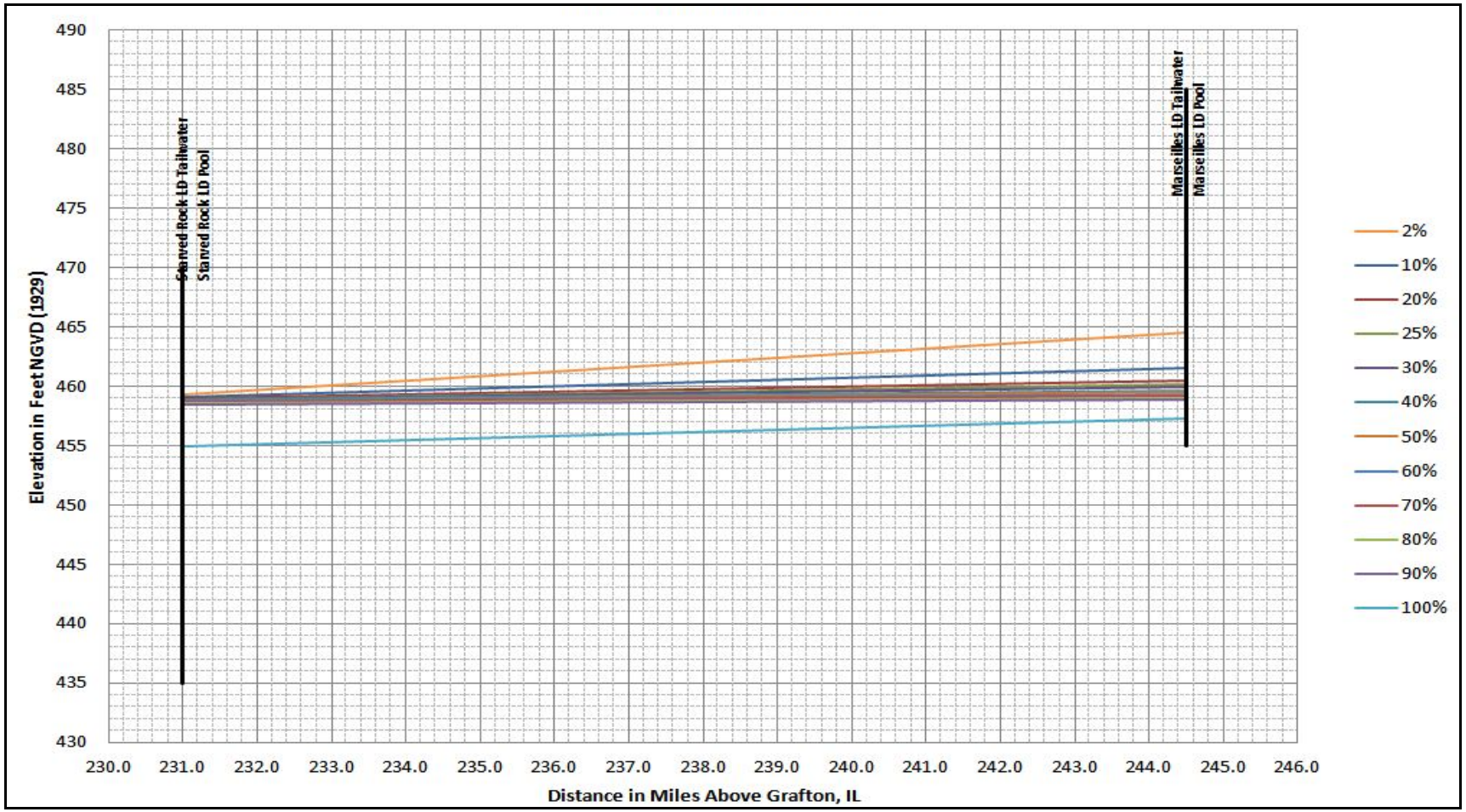

Figure H-5. Starved Rock Elevation-Duration - Starved Rock Pool-Marseilles Tailwater for the Period 1980-2011

Table H-4. Starved Rock Elevation-Duration - Starved Rock Dam Pool-Marseilles Tailwater

Percent of Time Exceeded

Elevation Duration Values	RM	Gage Zero	100%	90%	80%	70%	60%	50%	40%	30%	25%	20%	10%	5%	2%	0%
IL River LD 5 (Marseilles) TW	244.5		457.3	458.9	459.0	459.2	459.3	459.5	459.7	460.0	460.2	460.5	461.6	462.7	464.6	474.1
	235		455.7	458.6	458.7	458.8	458.9	459.0	459.1	459.2	459.3	459.4	459.8	460.3	460.9	468.8
	234.5		455.6	458.6	458.7	458.8	458.9	459.0	459.1	459.2	459.3	459.4	459.7	460.1	460.7	468.5
US end of project	234		455.5	458.6	458.7	458.8	458.9	459.0	459.0	459.1	459.2	459.3	459.6	460.0	460.5	468.2
middle of project	233.5		455.4	458.6	458.7	458.8	458.9	458.9	459.0	459.1	459.2	459.2	459.5	459.9	460.3	467.9
WQ site SR-1, DS end of project	233		455.3	458.6	458.7	458.8	458.8	458.9	459.0	459.1	459.1	459.2	459.4	459.8	460.1	467.6
WQ site SR-2	231.6		455.1	458.5	458.6	458.7	458.8	458.8	458.9	458.9	459.0	459.0	459.2	459.4	459.6	466.8
IL River LD 6 (Starved Rock) Pool	231.0		455.0	458.5	458.6	458.7	458.7	458.8	458.9	458.9	458.9	459.0	459.1	459.2	459.4	466.5
SLOPE (ft/mile)			0.170	0.028	0.032	0.036	0.041	0.050	0.061	0.081	0.094	0.115	0.184	0.260	0.386	0.563

Notes. 1. Values between Marseilles L&D and Starved rock L&D interpolated.
2. WQ sites SR-1 and SR-2 are Water Quality Monitoring Sites.

The annual elevation-duration information at the Starved Rock Pool gage indicates a median river elevation of 458.8 feet (period of record 1980-2011). This Table shows that the water surface elevations in the lower reach of the pool are very stable. Significant precipitation events in northeast Illinois cause short periods of high water (as shown in Figure H-2) to occur.

4.4. Flood Conditions. The 2004 Upper Mississippi River System Flow Frequency Study includes several cross sections through the Starved Rock Pool (USACE, 2004). Results from this flow frequency study that pertain to Starved Rock Pool (RM 231.1 to RM 236.9) are shown on Figure H-6. The 1 percent chance exceedance flood has a 1/100 chance of being equaled or exceeded in any year. The 1 percent chance exceedance flood elevation is 468.0 at Starved Rock Dam/RM 231.1 (137,000 cfs). There is no flood control storage in Starved Rock Pool.

The highest water levels at the Starved Rock Pool gage occurred in 2008, 1982, 1997, 2009, 1985, and 1979[(listed in order of decreasing magnitude (Table H-5). The highest flood on record at the Starved Rock Pool gage occurred on September 16, 2008 at a river elevation of 468.0 feet (from 2-hr. readings at Starved Rock Dam gage). This pool elevation was equivalent to a 0.01 annual exceedance probability (100-yr flood) stage. Several past flood event profiles from Starved Rock Dam to the Marseilles Lock gage are shown in Figure H-6. As mentioned in Section B., the maximum instantaneous flow at Starved Rock is estimated to have been 135,000 cfs on September 16, 2008 (slightly less than the 0.01 annual exceedance probability (100-yr flood) discharge).

Table H-5. Record High Stages at Starved Rock Pool Gage for the 1933-2013 Period of Record

	Stage	Date
1	468.0	9/16/2008
2	466.1	12/05/1982
3	464.95	02/22/1997
4	464.63	03/12/2009
5	464.4	03/05/1985
6	464.1	03/21/1979
7	463.9	05/16/1970
8	463.57	08/26/2007
9	462.99	12/29/2008
10	462.8	05/22/1943
11	462.6	11/21/1985
12	462.5	04/26/1950
13	462.32	01/15/2005
14	462.24	05/14/2002
15	461.97	07/20/1996

Note: Normal Operating Pool varies between 458.75 & 458.95

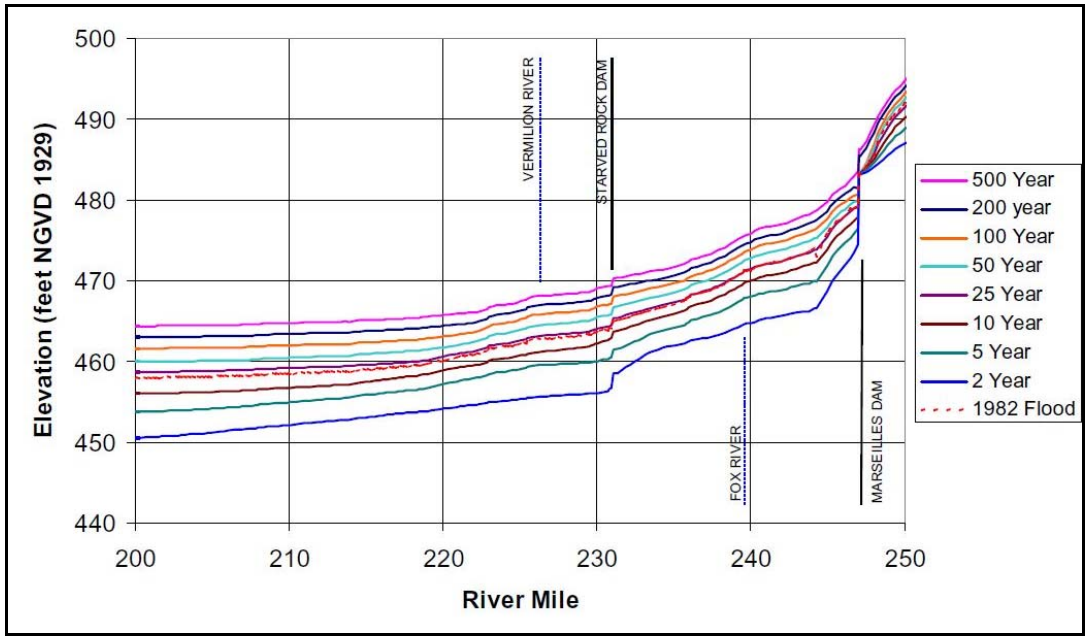

Figure H-6. 2003 Illinois River Stage-Frequency Profiles for Starved Rock Pool

4.5. Navigational Trends. Lockage data for Starved Rock Lock from 1992 to 2011 indicates an average of 5780 boats locking through per year. See Figure H-7.

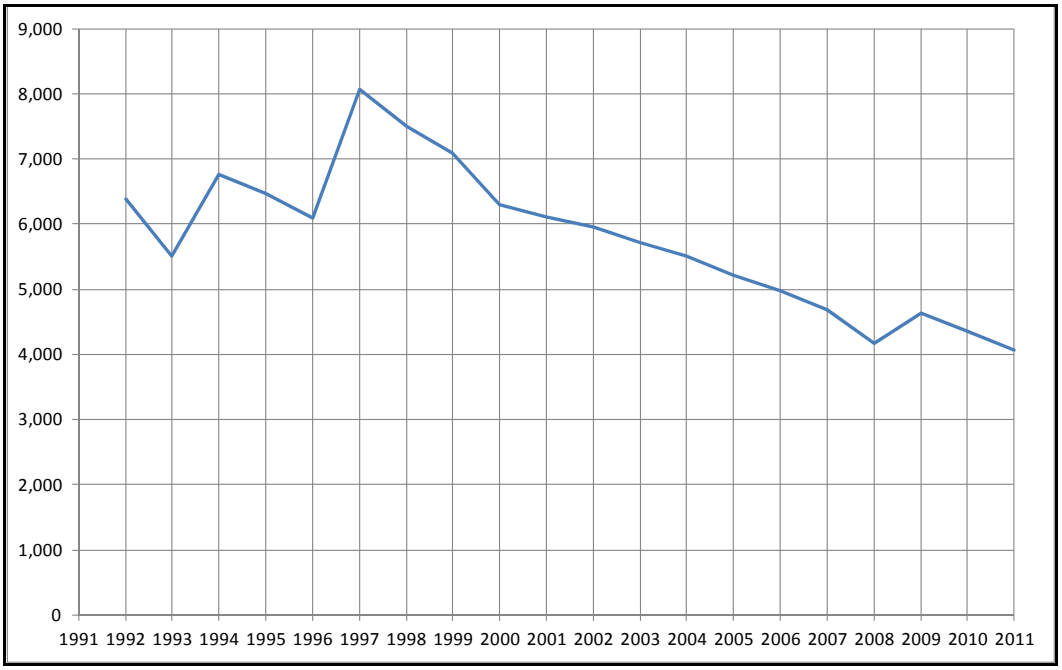

Figure H-7. Annual Starved Rock Lockages1992-2011)

4.6. Summary. Since Starved Rock Lock and Dam was placed into operation in 1933, other than large floods, such as the record 2008 event, there has been minimal fluctuation in the pool. Figure H-2 indicates minimal fluctuation. The operation limits for navigation purposes are between elevations 458.75 and 458.95. Maintaining a minimum water surface for navigation prevents the natural variation in river stage that much of the river habitat depends on. Another impact to river habitat is the large amount of boat traffic, which causes waves (for additional detail) and sediment to be re-distributed in the water column. See Section 6.2, *Vessel-Induced Waves* and Section 6.3, *Waves and Rock Size Design* In 1993, Starved Rock Lock was closed to boat traffic for a period of time.

5. HYDRAULIC MODELING

5.1. Two-Dimensional Hydraulic Modeling (AdH). Study needs and the physical characteristics of the project area drove the use of a 2-D hydraulic model. The project area is situated in a backwater area that is bordered by the navigation channel and a side channel, thereby requiring the use of a 2-D model to compute the velocity distribution within the two channels and throughout the project area. Velocity distribution within the project area is of interest to evaluate the effectiveness of reducing velocities for each of the proposed project alternatives. Velocities throughout the project area were also used for input to an SAV model. Evaluation of potential erosional impacts to existing archaeological sites, as well as velocity impacts to the navigation channel and side channel resulting from project alternatives also warrants the use of a 2-D hydraulic model. Velocity distribution output was also used to support a qualitative evaluation of sediment deposition within the project area.

Initial efforts to develop the 2-D hydraulic model began in 2007. The 2-D hydrodynamic code Adaptive Hydraulics (AdH) version 4.202 was chosen to simulate island inundation conditions due to its strength in modeling conditions where wetting and drying of nodes is occurring. AdH solves the 2-D vertically averaged form of the Navier-Stokes equation. The river reach modeled in AdH begins upstream of Sheehan Island at RM 236.9 and continues downstream to Starved Rock Dam at RM 231.1, i.e., 5.7 miles in length. Figure H-1 shows the island locations and Figure H-8 shows the extents of the model.

5.1.1. Mesh Development and Supporting Elevation Data. Using SMS, the approach to developing the AdH finite element mesh was to first interpolate scatter point bathymetric data obtained from the Rock Island District Operations Division (OD-T) in the form of XYZ coordinates into a mesh consisting of triangulated nodes. The model mesh is composed of three-sided elements. Each corner of an element is a node. The nodes were defined by an x and y location in the horizontal plane and the z location (or elevation) in the vertical plane. Bankline elevations were then added at the left and right edges of the mesh. Lastly, discharge and stage boundary conditions were defined in the boundary conditions (.bc) file and material types were defined using SMS. Material type parameterization is discussed in Section5.1.2, *Parameterization*. The mesh was constructed using the NGVD 1929 vertical datum and the NAD 83, IL State Plane West, FIPS 1202, Feet horizontal coordinate system. The density of mesh nodes varied only slightly within the model. The average node-spacing was approximately 150 feet. Node spacing was less at Sheehan Island.

As previously indicated, 2-D model development began in 2007. At that time current hydrographic surveys were assembled from existing navigation channel maintenance surveys from the Rock Island

District Operations Division. Pool bathymetry data used to develop the mesh was collected between 2005 and 2007. The 2005 periodic inspection survey was checked against the existing navigation channel maintenance survey data. Most of the survey data collected was in the navigation and left descending side channel, including each side of Sheehan Island. However, there was a lack of data in the backwater areas between the side channel and navigation channel, in the center part of the pool. In April of 2007 additional bathymetric survey was obtained by the Rock Island District Survey and Water Quality) Sections to obtain coverage of this area of the Starved Rock Pool. In areas where bathymetric surveys overlap, the most recent data was used in the numerical model.

Orthophotographic aerial survey data was also available for areas above approximately the average operating pool elevation.

The right and left edge strings in the 2-D model were assigned elevations based on the Starved Rock flat pool elevation of 458.5 in most areas. In areas of the mesh that are located at the top of bank, the edge string elevation was interpolated from aerial data. The downstream boundary mesh elevation at the tainter gates was set to 438.0 feet, which is the dam sill elevation. There was no bathymetric data available immediately upstream of the dam. The lack of bathymetric data extended further upstream on the left descending side channel than on the right descending channel (navigation channel). Therefore, the mesh elevations were set by interpolation between the downstream boundary and downstream extent of available bathymetric data. Interpolation in this area was performed by manually setting the elevation at each node individually. Upstream and downstream boundary conditions are explained in Section 5.1.3, *Hydrodynamic Simulation*.

In early 2013, the need for collection of additional bathymetric data in the central portion of the pool was identified in order to evaluate the significance of recent sedimentation in the study area and whether any updates to the model mesh would be necessary based on significant changes in the immediate project area. Bathymetric data was collected between RMs 232.75 and 234.75 by the Rock Island District Survey Section in February of 2013 (Figure H-31). The 2013 survey data was combined with the most current (primarily 2009 and more recent) bathymetric data maintained by OD-T and an updated surface for the entire model reach was created. Pool depths computed from this data are shown in Figure H-8. This more current surface was compared with the original surface used to generate the 2007 mesh and relatively minor differences were found along the model reach. The improved density of survey data in the project vicinity did result in some differences between the old and new surfaces in this specific area. To account for these changes, the mesh nodes within the project area where the February 2013 survey data was collected were updated with the current elevation information.

The 2-D model as developed is capable of being simulated up to approximately a 75 percent to 50 percent chance exceedance event since the edge strings only reached flat pool elevation at the dam and a few feet above in a few areas at the upstream end of the mesh as mentioned above. Once the 2-D model is calibrated (additional detail in Section 5.1.4, *Hydrodynamic Calibration*), the model is suited to simulate most any discharge less than and as high as approximately the 75 percent to 50 percent chance exceedance event.

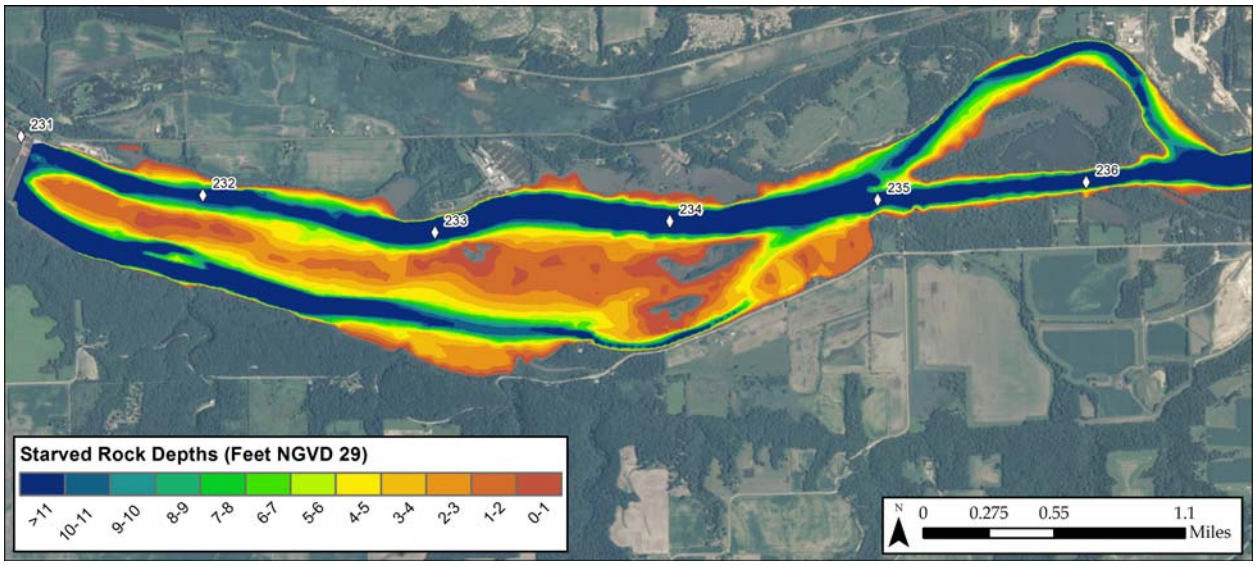

Figure H-8. Starved Rock Pool Depths

5.1.2. Selection of Roughness Values for Modeling. Manning's roughness was the method used to represent frictional losses throughout the model domain. Material types were defined at locations where a change in frictional parameters was anticipated based on channel morphology, bed material or vegetation density and type. For each element of the model, a Manning's roughness value was specified in SMS. Individual material types were defined as shown in Table H-6 and Figure H-9 below. Open Channel Hydraulics, (Chow, 1959), was used as a guide for n-value selection.

Table H-6. Existing and Proposed Conditions Material Roughness Summary

Material No.	Roughness Value (*n*)	Description
1	0.025	Main navigation channel and side channel
2	0.040	Submerged vegetation
3	0.070	Wet forest
4	0.050	Wet meadow
5	0.120	Developed areas
6	0.035	Deep marsh
7	0.027	Areas outside of main navigation channel
8	0.040	Shallow areas in central portion of pool
9	0.025	Area in front of dam gates
10	0.050	Shallow marsh (submergent and emergent vegetation)
11	0.045	Agriculture

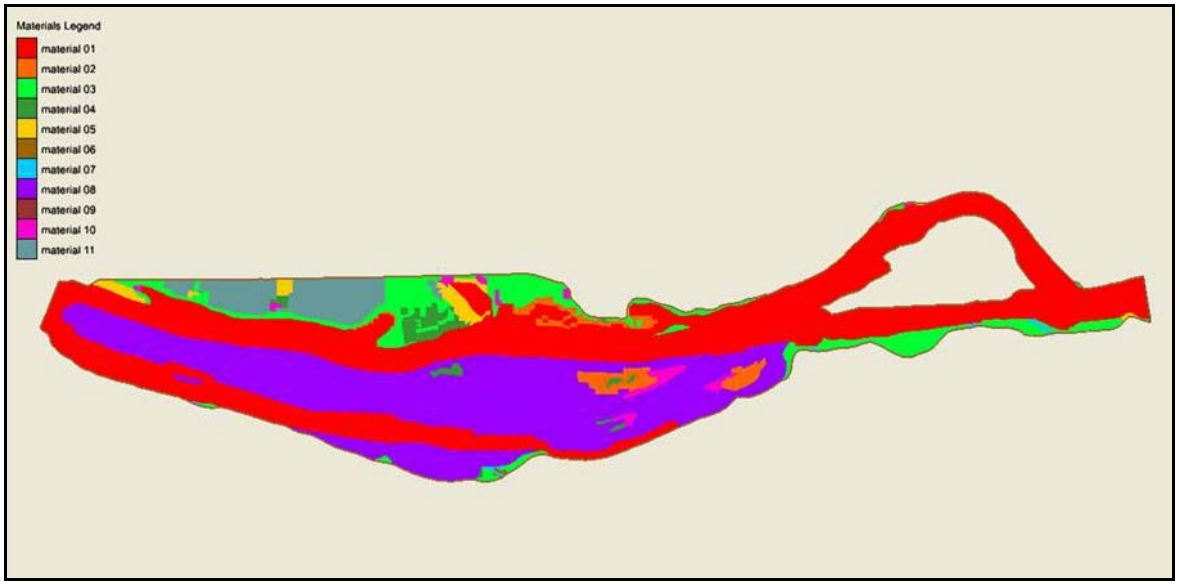

Figure H-9. AdH Material Type Map

5.1.3. Hydrodynamic Simulation. Two discharges were chosen for evaluation of the project's existing conditions and proposed alternatives. A medium-low discharge of 9,740 cfs (40 percent exceedance duration) was chosen to evaluate water depth and velocity conditions under typical conditions. A higher discharge of 33,555 cfs (10 percent exceedance duration) was chosen to examine existing depth and velocity conditions under a higher discharge and to test the performance of any proposed alternatives. These are also the two discharges under which ADCP data was collected for calibration.

For the 9,740 cfs simulation, the downstream boundary of the model was located at the upstream face of the gates of the dam and the powerhouse. The downstream boundary condition was set as the average water surface elevation at the time of the November ADCP survey (458.98 ft), as measured by the Starved Rock Pool gage. Discharge through the powerhouse is included in the total flow rate of 9,740 cfs. Discharge was allowed to pass through the powerhouse and gates 2 and 4 in the AdH model. The upstream boundary condition of the model was established as the 9,740 cfs incoming discharge.

The downstream boundary of the model for the 33,555 cfs simulation was located at the upstream face of the gates of the dam. Discharge was allowed to pass through gates 1, 2, and 3, which were open 12 ft, 12 ft, and 6 ft, respectively. The average Starved Rock Pool gage elevation at the time of the January ADCP survey was 458.95 ft. The powerhouse was not in operation during this ADCP survey. By trial and error the downstream boundary condition was set to a water surface elevation of 456.53 ft. This input downstream boundary condition resulted in a simulated water surface elevation of 458.95 at the downstream boundary. An inflowing discharge of 33,555 cfs was established as the upstream boundary condition for the model.

5.1.4. Hydrodynamic Calibration. This section focuses on the calibration of a numerical model to set up a reliable existing condition model from which various design alternatives were added.

Calibration of the model was accomplished by comparing model solutions to ADCP field data and modifying the model until the simulation results were reasonably close to what is observed in the field. This data was used to compute flow discharges, velocities (magnitude and direction), and flow distributions.

Calibration Method and Results. In addition to bathymetric information, data was collected by Acoustic Doppler Current Profiler (ADCP), an instrument that measures discharge, velocity, and flow direction. ADCP measurements in Starved Rock Pool were collected under two different flow conditions.

For each ADCP transect, the raw data collected contains velocity magnitude and direction for each 2 ft cell of depth in the water column across this transect. Each transect also has a single discharge calculated which was used for initial stages of the calibration process. The raw data set is very large and must be simplified to easily compare ADCP velocity measurements to velocities computed by the numerical model. Since the numerical model is a 2-dimensional depth averaged model, ADCP velocities at each transect were vertically averaged to better match the model output. The ADCP velocities were then averaged at each 20 ft distance across the ADCP transect. ADCP velocities were compared to model-computed results as part of the calibration process of the numerical model, and comparison data is provided herein.

An ADCP data set was taken on November 1 & 2, 2006 at an ADCP measured flow rate of approximately 9,740 cfs. After a forecast was issued for higher water surface elevations in Starved Rock Pool, another ADCP data set was taken on January 17, 2007 at an ADCP measured flow rate of approximately 33,555 cfs. A discharge of 33,555 cfs is representative of a flow rate in Starved Rock Pool that occurs more frequently than a 50 percent exceedance probability (two-year event) discharge of 58,000 cfs. Locations of the ADCP transects are shown in Figure H-10. Two transects were completed at each ADCP location.

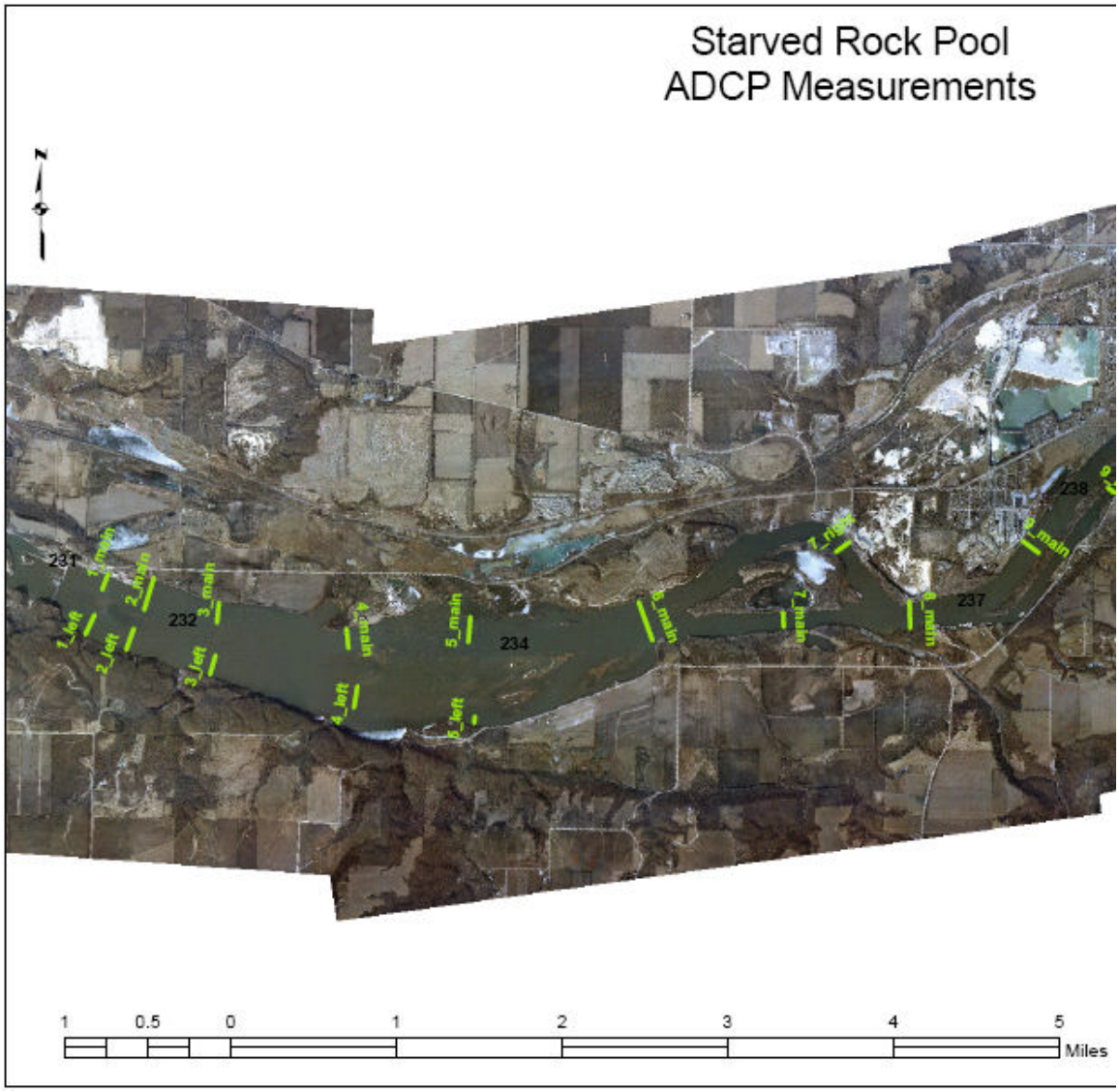

Figure H-10. ADCP Transects at Starved Rock Pool Obtained November, 2006 & January, 2007

9,740 cfs/November, 2006 ADCP Details. On the morning of November 1, 2006, gate 2 of Starved Rock Dam was open 0.6 feet and gate 4 was open 1 foot and then closed at 2:00 pm. On the morning of November 2, 2006, gate 2 of Starved Rock Dam was open 0.6 feet. The powerhouse was in operation both days with a discharge of approximately 6,200 cfs passing through it. On November 1, 2006, the gage- measured river discharge was 8,330 cfs at the start of ADCP measurements in the pool (11:55 am). By 3:00 pm, river discharges had dropped to 6,670 cfs. On November 2, 2006, the gage measured river discharge was 7,075 cfs at the start of ADCP measurements in the pool (9:15 am). By 10:15 am, the river discharge had dropped slightly to 7,050 cfs. The water surface elevation at the Starved Rock Pool gage on November 1, 2006 was 458.92 at the start of the ADCP

measurements. By 10:15 am, the water surface elevation had risen to 458.96. The water surface elevation on November 2, 2006 was 459.0.

33,555 cfs/January, 2007 ADCP Details. On the morning of January 17, 2007, gates 1 & 2 of Starved Rock Dam were open 12 feet and gate 3 was open 6 feet. The powerhouse was not in operation. The gage-measured river discharge was 32,050 cfs at the start of ADCP measurements in the pool (10:15 am). By the afternoon, the river discharge had risen to 32,640 cfs. The water surface elevation at the Starved Rock Pool gage was 458.89 at the start of ADCP measurements in the pool. By the afternoon, the water surface elevation had risen to 458.96.

Model calibration made use of ADCP measurements collected under both the 9,740 cfs and 33,555 cfs discharge conditions. Hydrodynamic model calibration begins with water surface slope across the model reach, followed by discharge and then velocity at each of ADCP transects. The reference used to measure the model's water slope fitness was based upon the historical fall record between the Ottawa gage (RM 239.8) and the Starved Rock gage (RM 231.1). Because the Ottawa gage is upstream of the model reach, the slope between the upstream model boundary (RM 236.9) and the downstream model boundary at Starved Rock gage (RM 231.1) was computed and used to extrapolate the water surface from the upstream model boundary to the Ottawa gage (RM 239.8). The AdH model captures the lower portion of the pool, which is largely influenced by the dam and therefore has a flatter slope than the upper reach of the pool. Therefore, when the slope that is computed using the upstream and downstream AdH model boundaries (i.e. the lower half of the pool) is assumed as the slope between the upstream model boundary and the Ottawa gage (i.e. the upper half of the pool), the stage computed at Ottawa is likely to be underestimated.

The calibration of water surface slope tends to be most sensitive to Manning's roughness values. Final Manning's roughness values that resulted in a calibrated water surface profile included roughness values shown in Table H-6. Computed and observed fall in water surface between Ottawa and Starved Rock for the final calibrated model under the two ADCP discharges is shown in Figure H-11. Under 9,740 cfs discharge, Figure H-11 illustrates that the computed difference in water surface elevation between the Ottawa gage location and the downstream model boundary is slightly less than the observed fall between the Ottawa gage and the Starved Rock pool gage. However, under 33,555 cfs discharge the computed fall is generally greater than the observed fall, but still within the bounds of observed data.

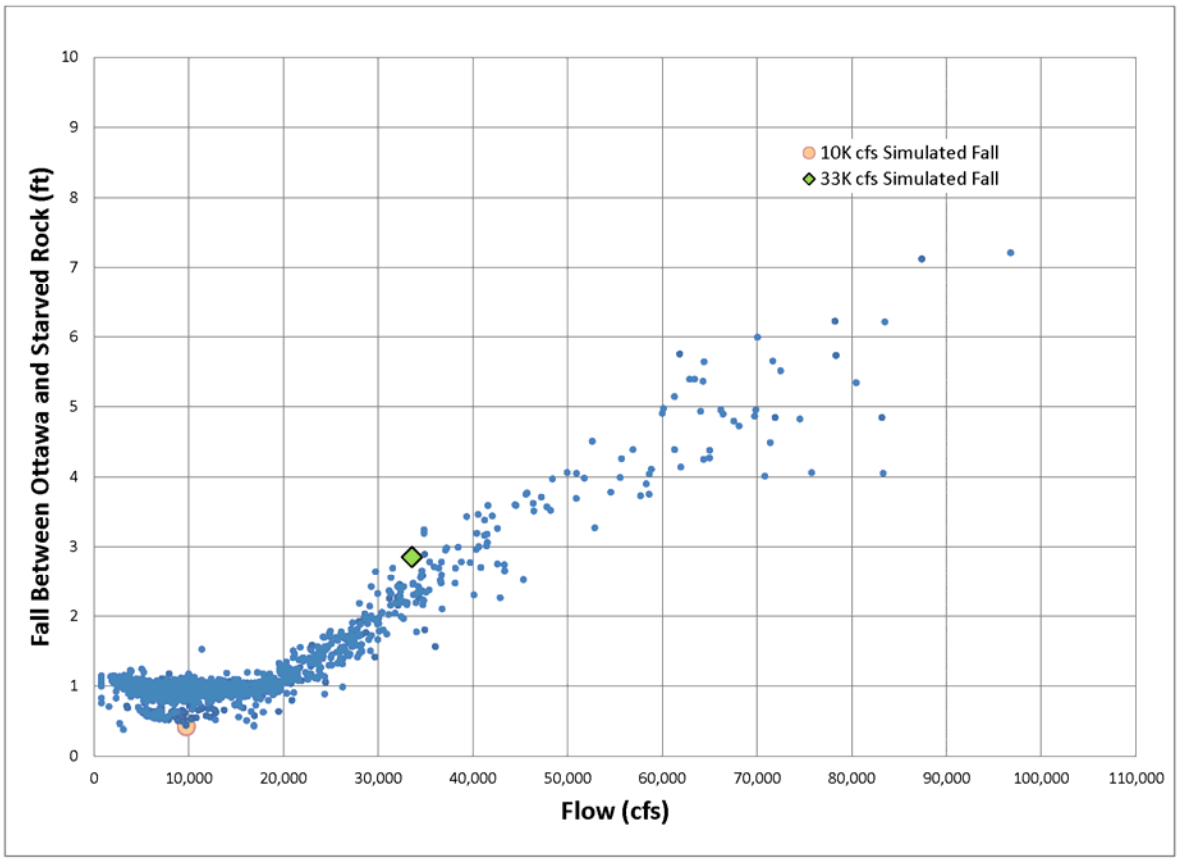

Figure H-11. AdH Water Surface Slope Calibration

Following calibration of water surface slope, the model was then calibrated to discharge distribution. Discharge distribution is most sensitive to mesh geometry changes. The calibrated flow results for the existing conditions model form the basis of comparison for proposed design alternative models.

The total discharge data was compared across each ADCP transect. These comparisons were less favorable than point velocity comparisons (see 4th and 5th paragraphs on page H-21). Several of the observation strings at the ADCP transect locations in the model were positioned better for the higher 33,555 cfs discharge. The difference between the AdH-computed flows and the ADCP-measured flows at the observation strings for the 33,555 cfs discharge ranged from 0 percent to 15.7 percent. The observation strings showing the greatest difference were areas in which there was a significant lateral flow component from the navigation channel across the middle portion of the pool and then converging with the side channel flow. This may be due to a lack of bathymetric data in the middle portion of the pool. See Attachment H-1 and Figure H-10. The most significant source of difference between the AdH model and ADCP data were flows moving from the main navigation channel through the center portion of the pool and into the side channel. Also, the transect areas at the downstream end of the model had the most difference between the two sources of data.

The difference in the AdH-computed discharge and the ADCP-measured flows at the observation strings for the 9,740 cfs discharge ranged from 0 percent to 25.3 percent. The observation strings showing the greatest difference were areas in which there was a significant lateral flow component from the navigation channel across the middle portion of the pool and then converging with the side channel flow. This may be due to a lack of bathymetric data in the middle portion of the pool. See Attachment H-1 and Figure H-10. As with the higher discharge, the most significant source of difference between the AdH model and ADCP data were flows moving from the main navigation channel through the center portion of the pool and into the side channel.

Calibration of velocity distribution is the final step in the calibration process. Velocity distribution along a channel cross-section is most sensitive to roughness values. A part of the calibration process included a comparison between velocities and depths simulated by AdH and data measured by the ADCP survey. ADCP data near the shoreline is generally less accurate than other areas.

To compare velocity data, the ADCP transects were loaded into SMS as scatter data. The locations of these transects are visible behind the AdH model results. Velocity data from the model was manually collected in SMS at each 20 ft increment along each transect. The comparisons at various locations show that flow velocities computed are reasonably close to those measured.

For the 33,555 cfs discharge, velocities between the AdH model and the ADCP data matched fairly well. See Attachment H-1 for examples of velocity comparisons between the AdH model and ADCP data. Velocities near the ADCP transect "2 main" (Figure H-10) indicate the greatest disparities between the ADCP data and the model. Point depths for the 33,555 cfs discharge between the AdH model and ADCP data matched fairly well within the tolerance of +/- 0.5 fps. The data points from the AdH model followed the trend of the ADCP data in most transect locations.

For the 9,740 cfs discharge, point velocities between the AdH model and ADCP data matched fairly well within the tolerance of +/- 0.5 fps. See Attachment H-1 for examples of velocity comparisons between the AdH model and ADCP data. The data points from the AdH model followed the trend of the ADCP data in most transect locations

5.1.5. Hydrodynamic Results

5.1.5.1. Existing Conditions. Existing conditions hydrodynamics are presented based on the two ADCP discharge conditions: 9,740 cfs (40 percent exceedance duration); and 33,555 cfs (~10 percent exceedance duration). These discharges were chosen for evaluation because they represent low flow and high flow conditions under which the project alternatives' performance can be evaluated. Velocities under each of these two discharge conditions in the project vicinity are shown in the figures below (figures H-12 and H-13). As shown there is a significant lateral flow component from the navigation channel across a portion of the project area. As this lateral flow crosses the project area it converges with the side channel flow and continues downstream. This lateral flow component was observed in the field during a site visit by boat in October 2011. Under existing conditions velocities in the thalweg of the downstream reach of the side channel do not drop below 0.4 ft/s under a discharge of 9,740 cfs and are no less than 1.5 ft/s under a discharge of 33,555 cfs.

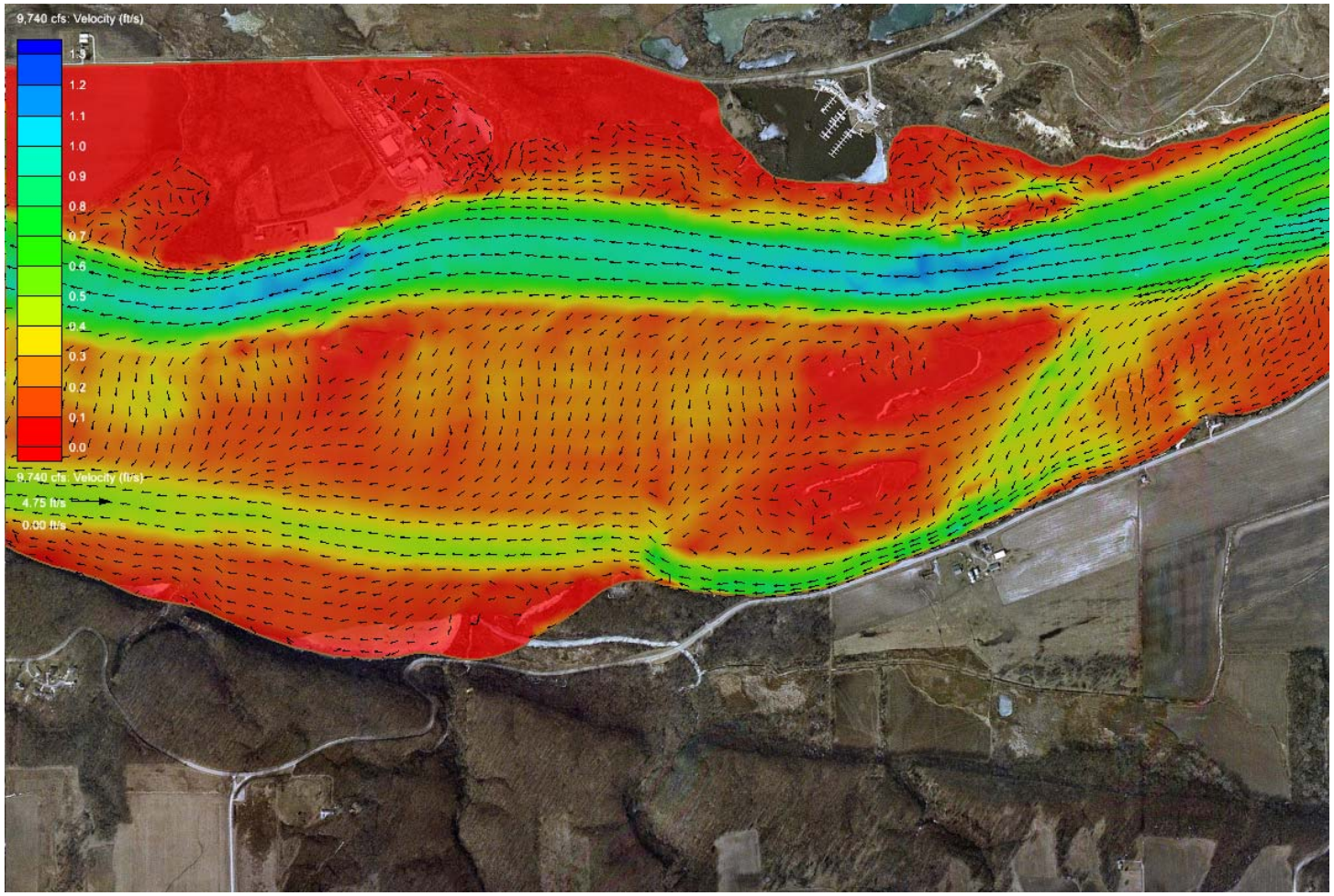

Figure H-12. Existing Condition Velocity Results for Starved Rock under Discharge Conditions of 9,740 cfs

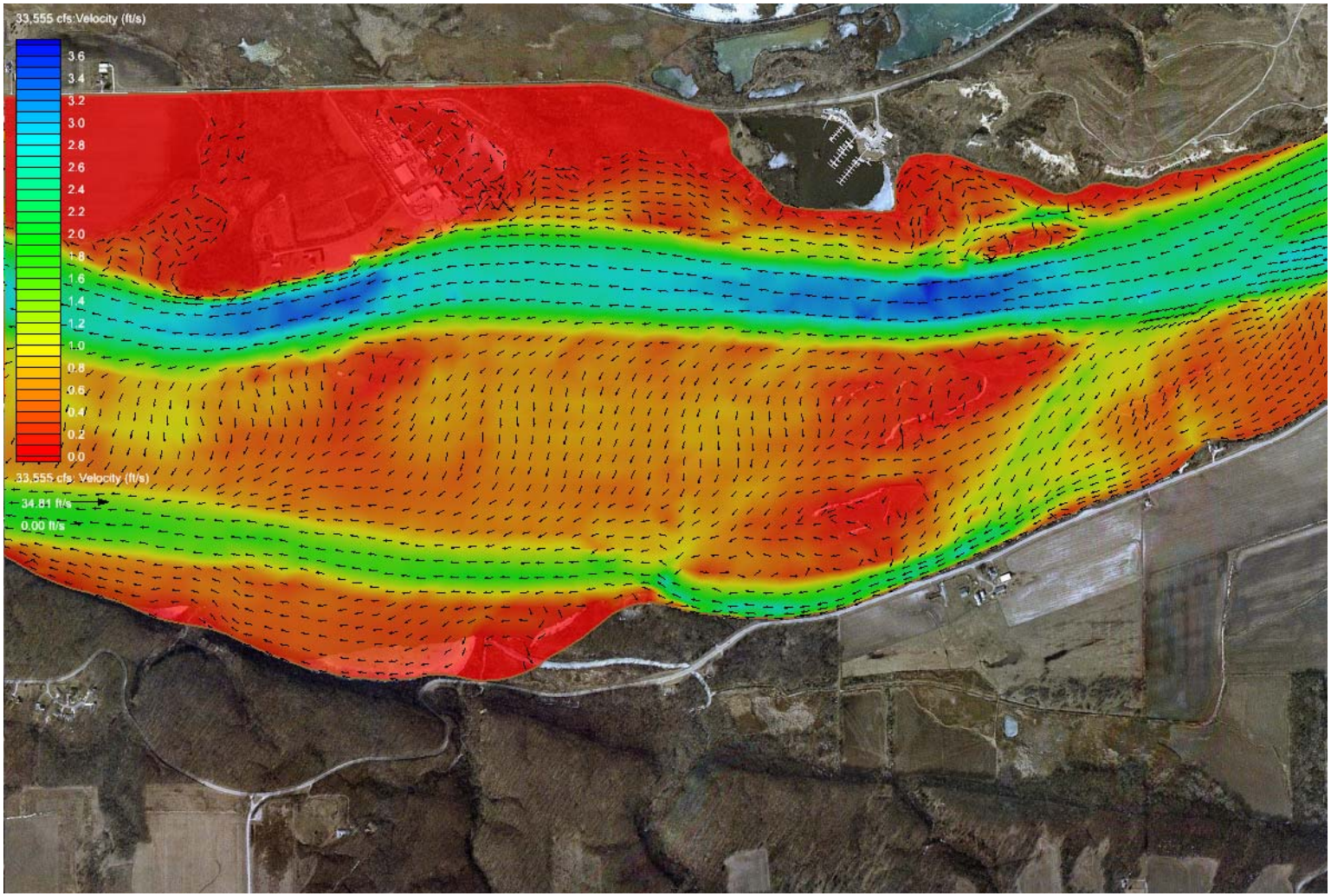

Figure H-13. Existing Condition Velocity Results for Starved Rock Under Discharge Conditions of 33,555 cfs

5.1.5.2. Evaluation of Alternatives. During the early phases of this study numerous project features had been identified that were subsequently ruled out for various reasons including exceeding floodplain permit standards and were therefore not modeled using AdH. These features are shown below in Figure H-14 and on Sheet C-102. Discussion of the floodplain impact analysis for these features is included in Section5.2, *Impacts to Water Levels*.

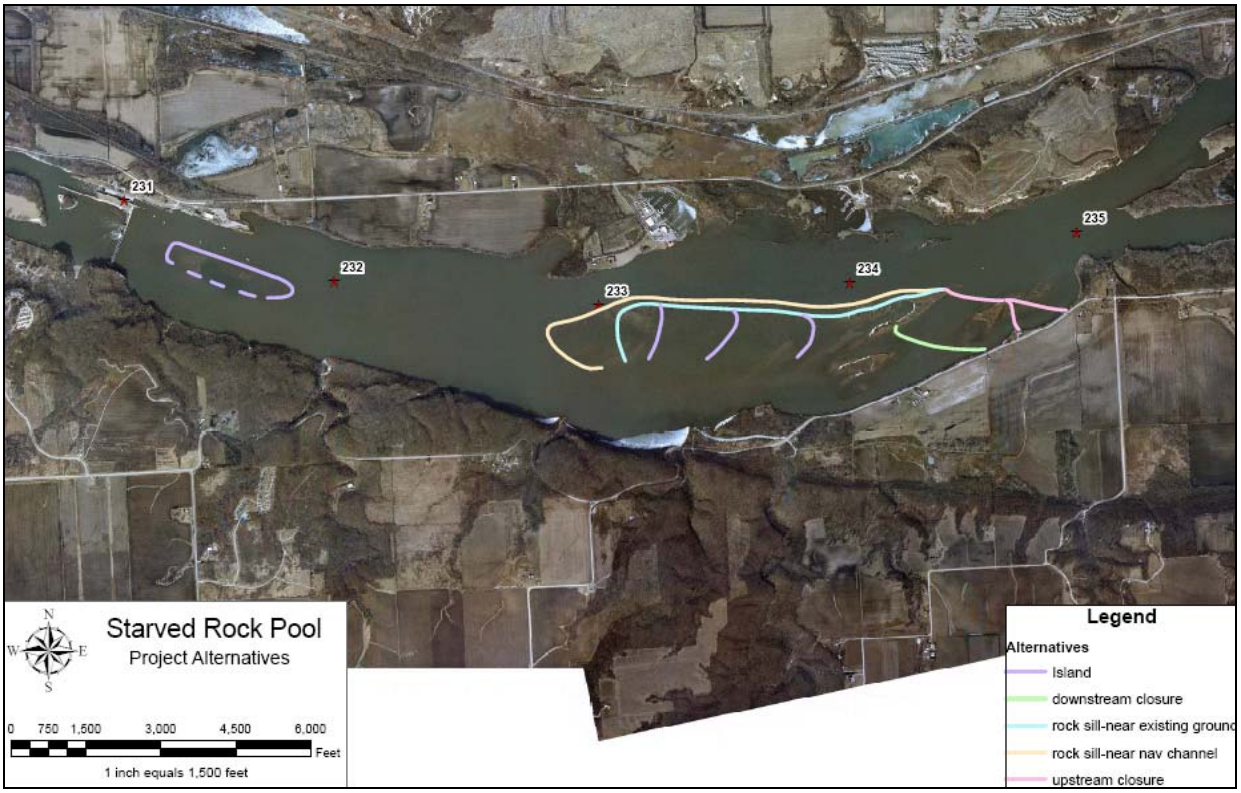

Figure H-14. Potential Alternatives

The final set of alternatives that remained under consideration by the PDT included two different riprap breakwater alignments (Alternative 1 and Alternative 2), the two riprap breakwater alignments in combination (Alternative 3), a floating island (Alternative 4), and a floating breakwater (Alternative 5) (see Sheet C-101). The purpose of these alternatives is to reduce wind- and navigation-induced waves thereby reducing velocities in the project area and providing conditions suitable for recruitment of SAV. Constraints of the project design include no induced erosional impacts to existing archeological sights, no induced impacts to navigation, no induced sedimentation in the project area and no induced sedimentation in the side channel as a result of the riprap breakwater. Evaluation of impacts to existing archeological sights and navigation are discussed later within this section, while impacts to sedimentation are discussed in the *Sedimentation Projections* section.

The design profile of Alternatives 1-3 was based on anticipated wave impacts resulting from vessels and wind as well as criteria for offshore rock mounds presented in the Upper Mississippi River System Environmental Management Program (UMRS-EMP) Environmental Design Handbook (USACE,

2013). Wind- and navigation-induced wave impacts are discussed in Section 6, *Wave Effects,* the design handbook criteria is summarized in Table H-7.

Table H-7. Typical Offshore Rock Mound Design Criteria from the Environmental Design Handbook

Top Width	Rock Slope	Height Above Average Water Surface Elevation
3 – 5 feet	1V:1.5H – 3H	1.5 – 2 feet

The crest elevation for Alternatives 1-3 was set to 461.85 ft. This elevation was chosen because it will not be overtopped by the maximum assumed wave (3.5 ft wave height as measured crest to trough) during the 5 percent exceedance duration stage (460.0 ft), it is slightly less than the 50 percent exceedance probability (2-yr event) elevation at the upstream end of the proposed alternatives and is 3 feet above the average of the pool operating limits (458.75-458.95 ft) (USACE, Rock Island District, 2004). A design elevation of 461.85 ft is slightly higher than the 1.5-2 ft above the average water surface recommended in Table H-7, but the PDT determined that this design was acceptable because it afforded protection under a wider range of conditions without exceeding the floodplain standards. This design will be overtopped at a discharge somewhere between the 50 percent chance exceedance discharge (58,000 cfs) and the 20 percent chance exceedance discharge (80,000 cfs). With a 3 ft top width, 1V:2.5H side slopes, and an average structure height of ~4-7 feet for Alternative 1, the resulting bottom width will be approximately 20-35 ft bottom width. The overall height (and bottom width) of the Alternative 2 riprap breakwater will be greater than that for Alternative 1 because the water depths are slightly deeper at the location of Alternative 2.

Alternative 4, the floating island, is approximately 1 ft thick and is designed to float on the water surface while anchored to the river bottom. Little slack is allowed for in the anchoring and the project biologist indicated the preferred anchored elevation would be such that the island is functioning as designed at the 50 percent annual exceedance duration water surface elevation (458.9 ft at RM 233.5). It is assumed that 0.5 ft will sit below the water surface and 0.5 ft will sit above the water surface. The dimensions of the floating island include a 25 ft width and an approximate length of 6,100 ft.

Alternative 5, the floating breakwater, is also tethered to the river bottom, however slack is provided to allow for the barrier to rise with increasing water levels. The floating breakwater is approximately 5 ft in diameter, with approximately 2.5 ft floating above the water surface and 2.5 ft submerged below the water surface. It was assumed that the system would be allowed to float to an elevation of 461.85 ft.

Of the five alternatives under consideration by the PDT, only Alternatives 1 & 3 were simulated in the AdH model. Alternative 1 was identified as the TSP and is therefore the alternative for which detailed results are presented herein. Although the design of the riprap breakwater in both of these alternatives is a trapezoid with a 3 ft top width and approximate 30 ft bottom width, due to the coarseness of the AdH mesh, the rip-rap alternative was modeled as a triangle with an approximate 300 ft bottom width. Velocity results for the TSP under the two different discharges are shown in the figures below (Figures H-15 and H-16). A velocity difference plot between the with-project and without-project velocities (for the TSP) is also shown in figures H-17 and H-18.

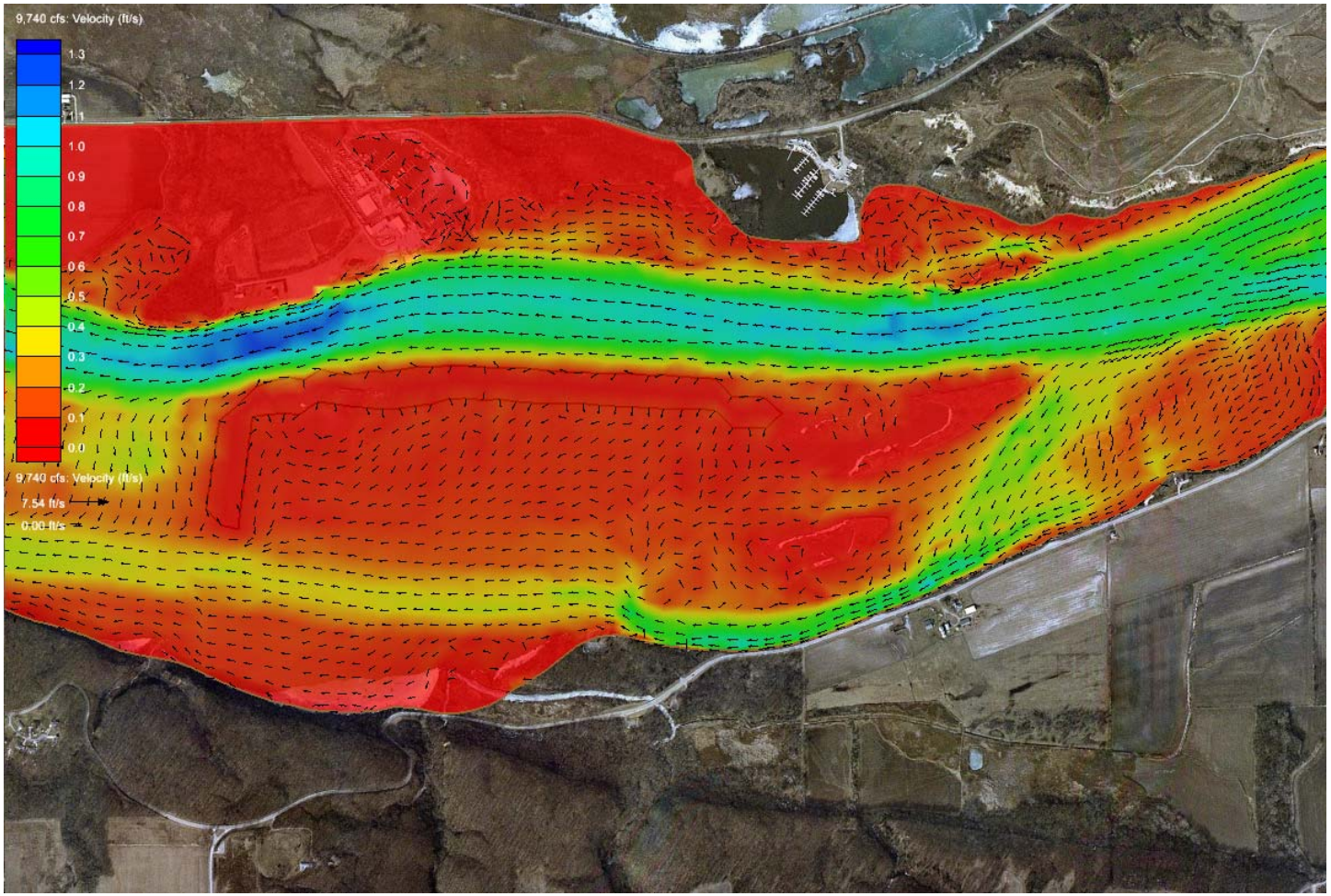

Figure H-15. Velocity Results for the Starved Rock TSP Under Discharge Conditions of 9,740 cfs

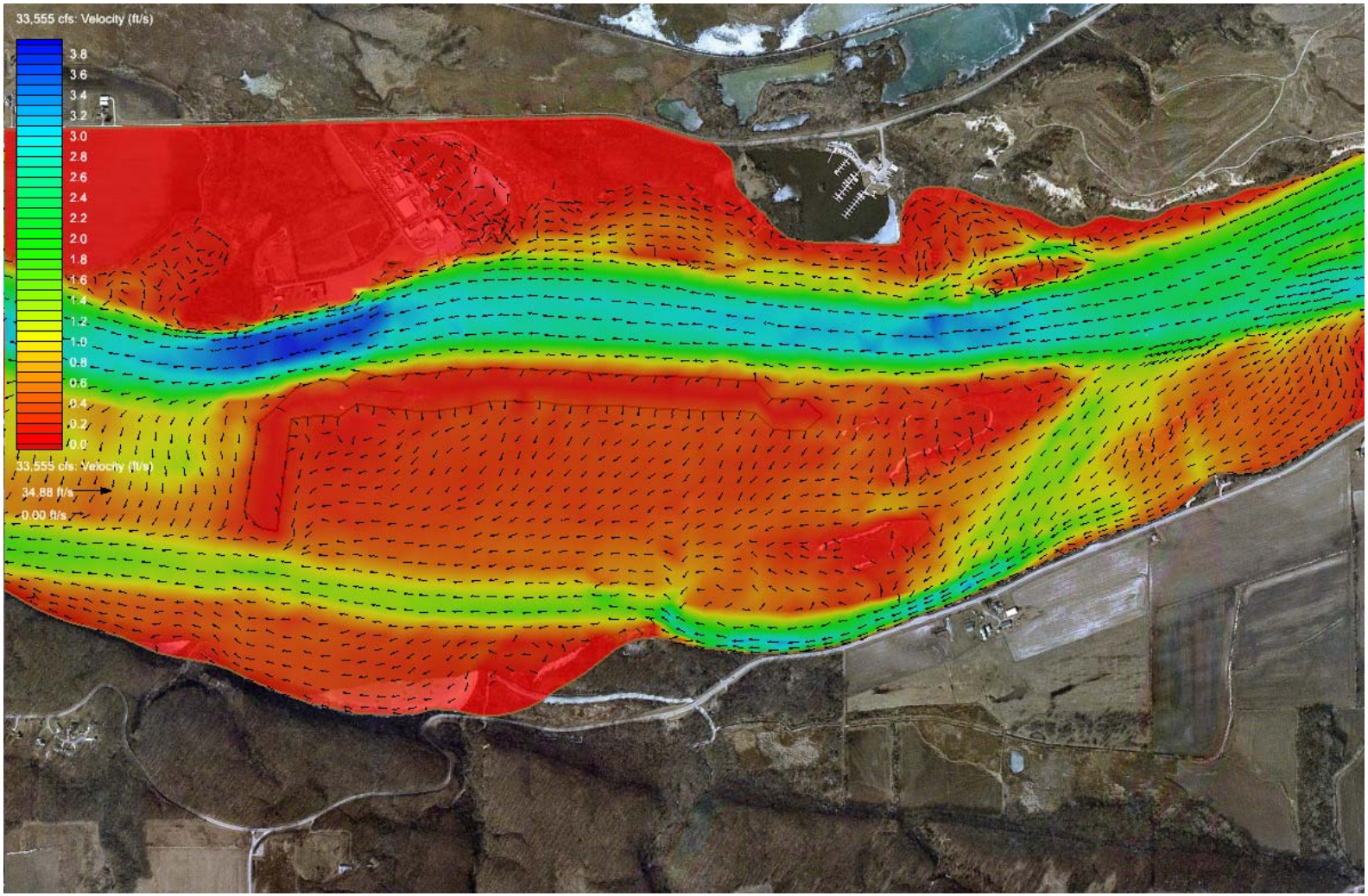

Figure H-16. Velocity Results for the Starved Rock TSP Under Discharge Conditions of 33,555 cfs

Figures H-15 and H-16 illustrate the effect of the riprap breakwater on velocities within the protected area, within the side channel and within the navigation channel. The velocity vectors under both discharge conditions illustrate how the lateral component of flow from the navigation channel across the project area that exists without-project is effectively eliminated along the alignment reach. A reduction in velocities behind the riprap breakwater is desired for recruitment of SAV. For successful SAV establishment velocities should be less than 1 ft/s and preferably less than 0.5 ft/s. As shown in Figures H-15 and H-16, velocities in the area behind the structure are less than 1 ft/s and much of the area is even less than 0.5 ft/s, even under higher discharge conditions (33,555 cfs; the 10 percent exceedance duration). Therefore, the TSP provides necessary wave protection and favorable velocity conditions for fish and plant habitat at least 90 percent of the time in any given year.

The AdH velocity results were provided to the PDT for input to an SAV model. The SAV model, developed for the Upper Mississippi River System Pool 8 and applied to Starved Rock Pool, utilizes distributed velocity input under ~5 percent exceedance duration discharge. Because model boundary conditions had already been established for the 33,555 cfs model, which is approximately the 10 percent exceedance duration discharge, the SAV modeler Jim Rogala at UMESC was consulted to verify applicability of these existing velocity results for the simulation. Jim Rogala confirmed the use of the 10 percent exceedance duration discharge results which were then provided for SAV modeling purposes.

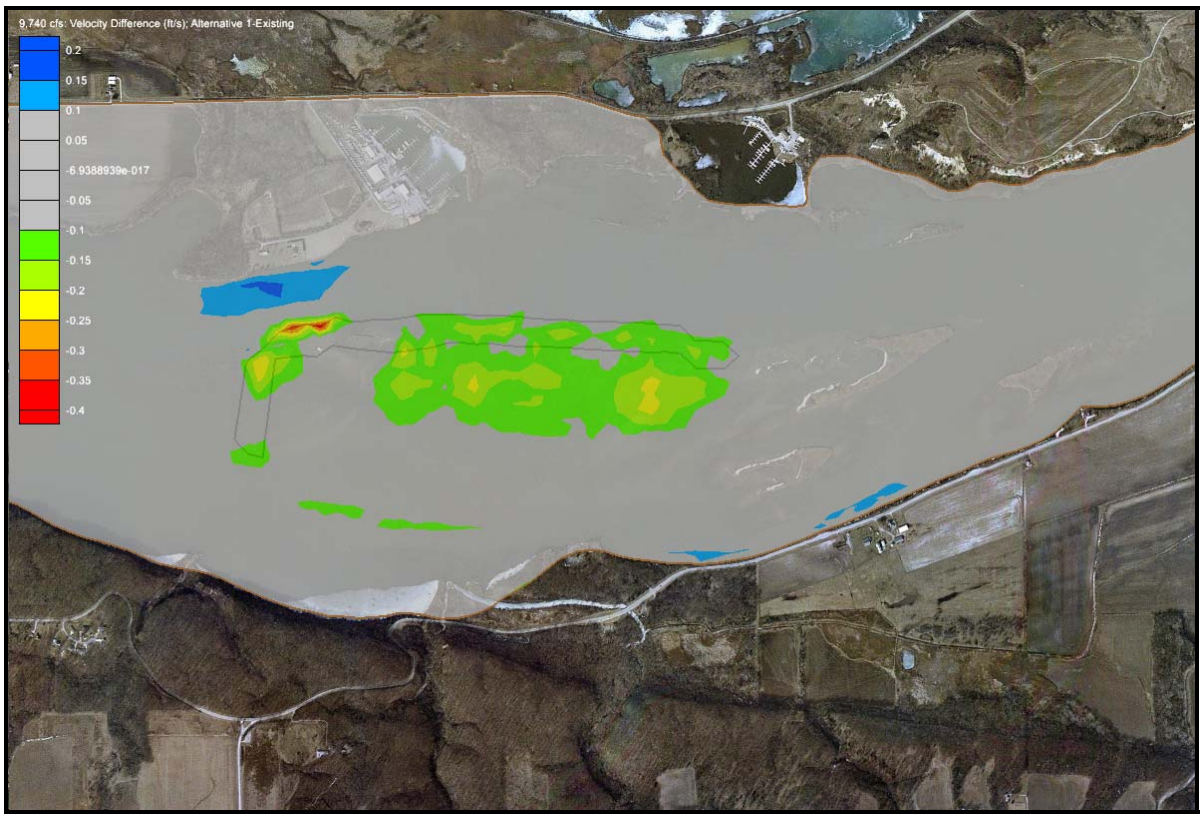

Figure H-17. Velocity Difference Results Comparing Without-Project to the TSP Under Discharge Conditions of 9,740 cfs

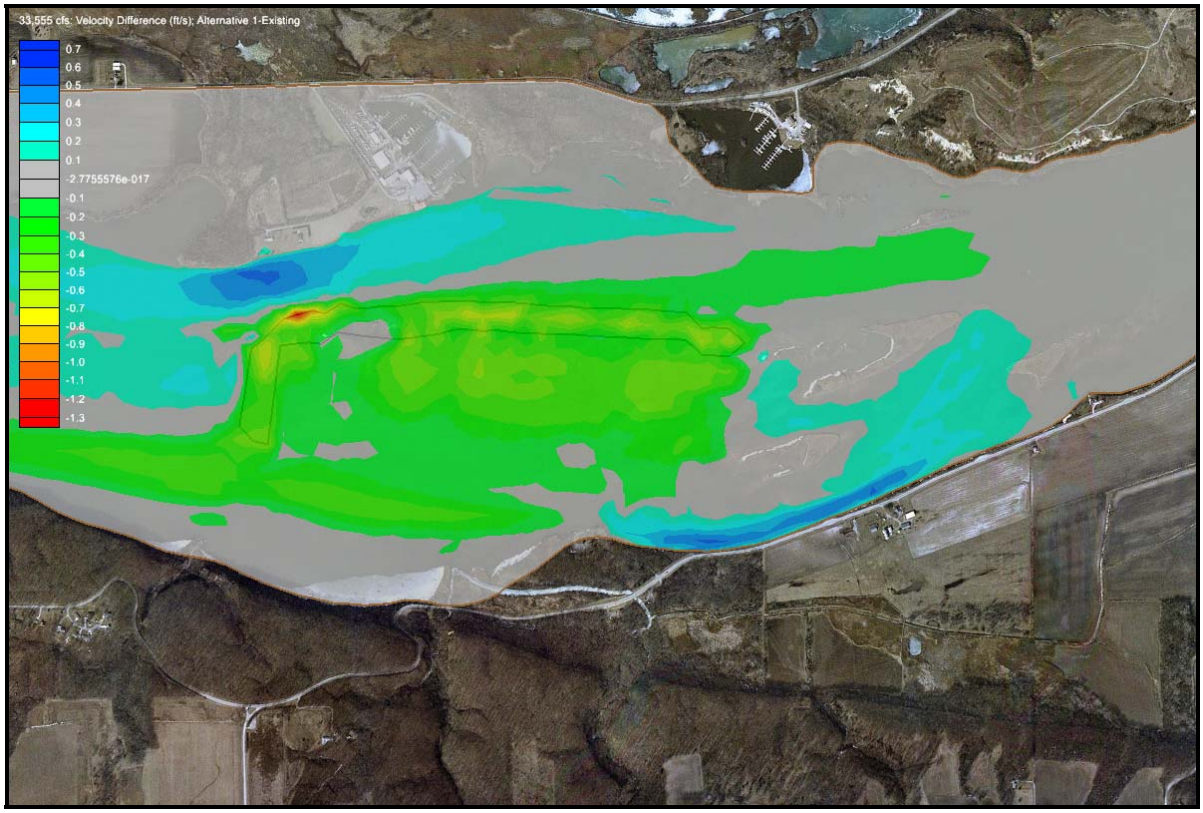

Figure H-18. Velocity Difference Results Comparing Without-Project to the TSP Under Discharge Conditions of 33,555 cfs.

As the lateral flow over the historic Delbridge Island area is reduced with-Project, flows in the main channel are slightly increased. As shown in figures H-17 and H-18 there is an increase in main channel velocities at the downstream edge of the riprap breakwater alignment. This increase in velocity is being coordinated with Operations Division to ensure that it is not significant enough to cause impacts to navigation. If impacts are identified, the alignment will be moved southward, away from the navigation channel during plans and specifications.

Velocity conditions with the TSP in place were also evaluated with respect to existing archeological sites. Locations of existing sites were provided by the PDT's archeologist and subsequently examined for resulting velocity changes and the potential for induced erosion. Results indicated additional erosion induced by the TSP was not of concern to existing archeological sites.

As previously mentioned, one of the design constraints was to prevent an increase in sedimentation in the side channel as a result of the riprap breakwater. The sponsor raised concern over the potential for Alternative 1 to result in increased sedimentation in the side channel. To address this concern, Alternatives 2 and 3 were developed (see Plate C-101). The Alternative 2 riprap breakwater is located along the side channel and the thought was that it would act to confine flow along that reach thereby increasing or maintaining velocities in that area. Alternative 3 is simply a combination including the Alternative 1 riprap breakwater alignment and the Alternative 2 riprap breakwater alignment. Figures

H-17 and H-18 illustrate that there is an increase in velocity in the upstream reach of the side channel and a slight decrease in velocity in the lower reach of the side channel with the TSP in place. The magnitude of velocity decrease in the side channel under discharge conditions of 33,555 cfs with the TSP in place is not significant enough to cause increased sedimentation. The with-Project velocity magnitude in the thalweg of the downstream side channel reach remains no less than 0.3 ft/s under a discharge of 9,740 cfs (a decrease of 0.1 ft/s) and no less than 1.2 ft/s under a discharge of 33,555 cfs (a decrease of 0.3 ft/s). Furthermore, analysis of Alternative 3 does not result in any significant changes in side channel velocity relative to the Alternative 1 velocities.

5.1.5.3. Risk and Uncertainty. There was some risk and uncertainty involved with the modeling. Much of it was mentioned elsewhere in this Section but is summarized here.

During the calibration process, the observation strings showing the greatest difference were areas in which there was a significant lateral flow component from the navigation channel across the middle portion of the pool and then converging with the side channel flow. This may be due to a lack of bathymetric data in the center portion of the pool between just upstream of the dam to the proposed project area. It is difficult for a boat to perform a bathymetric survey in this area since it is shallow. An attempt to address some of this uncertainty in the AdH model due to a lack of bathymetric data in the center portion of the pool between the navigation and side channels was made. In April of 2007 additional bathymetric survey was obtained by the Rock Island District to obtain coverage of this area of the Starved Rock Pool. To minimize risk further, additional bathymetric data was obtained in the proposed project area in February, 2013.

To minimize uncertainty with the overall bathymetric data, the 2013 survey data was combined with the most current (primarily 2009 and more recent) bathymetric data and an updated surface for the entire model reach was created. This more current surface was compared with the original surface used to generate the 2007 mesh and relatively minor differences were found along the model reach. The improved density of survey data in the project vicinity did result in some differences between the old and new surfaces in this specific area. To account for these changes, the mesh nodes within the project area where the February, 2013 survey data was collected were updated with the current elevation information.

There was no recent bathymetric data available immediately upstream of the dam, which results in some uncertainty in the AdH model. Therefore, the mesh elevations were set by interpolation between the downstream boundary and downstream extent of available bathymetric data.

Although the design of the riprap breakwater in both of these alternatives is a trapezoid with a 3 ft top width and approximate 30 ft bottom width, due to the coarseness of the AdH mesh, the rip-rap alternative was modeled as a triangle with an approximate 300 ft bottom width. However, this results in a conservative estimate of floodplain impacts.

In addition to velocity calculations performed by the AdH model, shear stress calculations were completed to better understand existing and proposed erosion and deposition areas. This results in less uncertainty.

Some possible risk factors related to the hydraulic modeling include unexpected scour after project completion, which would be addressed by repairing the rock breakwater structure. As mentioned in Section 8.3, the structure could overtop during a high discharge event; however, this would likely result in insignificant effects to the proposed project area. As mentioned in Section 8.3, changes in climate could result in higher or lower long-term rainfall and discharge amounts.

5.2. Floodplain Impact Modeling (UNET)

Impacts to Water Levels. The Starved Rock Project area is subject to State of Illinois floodplain impact requirements (IDNR, Floodplain Study Group, July, 2007). The State of Illinois requires that any action in the floodplain that increases flood heights is not allowable or must be accompanied by mitigation of adverse effects. Mitigation actions include purchase of easements, land acquisition, etc. Due to the potential high cost associated with mitigation actions, one of the project constraints is to avoid increasing flood heights. In other words, the Project is restricted to "no rise" (equal to or less than 0.04' of increase).

In 2007 some of the preliminary alternatives as mentioned previously in Section 2. *Evaluation of Alternatives* were evaluated for floodplain impacts using the one-dimensional hydraulic model HEC-RAS (Figure H-14). These features which included islands, rock vanes, closure structures and riprap breakwaters were found to exceed the water surface elevation impact limit of 0.04 ft under the 1 percent exceedance probability discharge. Two riprap breakwater alternatives, as shown in Figure H-14, the 'rock sill-near nav channel' and 'rock sill-near existing ground', did not result in floodplain impacts as long as the cross-section of the structures did not exceed a 3-foot top width and 1(V):2.5(H) side slopes. Alternatives 1, 4 and 5 maintain a 3 ft top width and 1(V):2.5(H) side slopes and have a slightly shorter alignment than the 'rock sill-near nav channel' and 'rock sill-near existing ground', thereby maximizing the extent of the sheltered area.

Alternative 1, the TSP, was then analyzed for floodplain impacts using the unsteady flow model, UNET (Plate C-103, Figure H-19, and Figure H-20). UNET is a one-dimensional unsteady flow model, capable of simulating flow through a network of connected channels and storage areas. The 2004 Upper Mississippi River Flow Frequency Study serves as the water surface profile basis or existing condition to which the TSP water surface profile is compared (USACE, 2004). As a result of updated bathymetric data in the vicinity of the Project, particularly in the side channel and backwater areas, the existing condition UNET model was updated to incorporate this data. Additional cross-sections were also added to the model in order to adequately define the extents of the TSP. The maximum computed water surface increase resulting from construction of the TSP is 0.04 feet. Placement of the TSP as designed would not cause an unacceptable increase in water surface for any of the modeled frequency floods. See Attachment H-2.



Blue lines indicate the authorized navigation channel location. The purple area is the footprint of the project feature in the 2D hydraulic model. The white line in the purple area is the centerline of the project feature.

Figure H-19. Tentatively Selected Plan Riprap Breakwater Alignment in Starved Rock Pool



Blue lines indicate the authorized navigation channel location. The purple area is the footprint of the project feature in the 2D hydraulic model. The white line in the purple area is the centerline of the project feature.

Figure H-20. Tentatively Selected Plan Riprap Breakwater Alignment

6. WAVE EFFECTS

In shallow water, wave action can result in physical disturbance of the substrate. Water quality monitoring results suggested that this stressor may play a role in limiting SAV survival in Starved Rock Pool. One of the project objectives is to reduce wind fetch lengths and provide areas that are sheltered from wind and wave action to reduce this stressor and promote growth of SAV. According to the Starved Rock Lockmaster, wave heights of up to 2 to 3 ft are experienced in the pool due to wind waves and vessel wakes (Witalka, personal communication, Jan 11, 2013). Anticipated wave heights in the project area were further researched in order to characterize the waves caused by wind, navigation traffic, and recreational boats and to ensure that the TSP riprap breakwater would not be overtopped by waves during normal flows.

6.1. Wind Waves and Fetch. Wind data collection efforts indicated that winds from the northwest and southeast are the most prevalent in the lower Starved Rock Pool. See Appendix F, *Water Quality*. In this reach, the river generally flows from east to west. The navigation channel flows along the northern edge of the pool, but the pool extends south of the main channel and encompasses an area generally about 0.5 to 0.75 miles wide and 3.5 to 4 miles long. Due to the large expanse of open water in this pool, fetch lengths in the project area, especially along lines from the east/west and east-southeast/west-northwest, can be as much as 2 to 3 miles. Because the prevailing winds occur from the northwest/southeast, layouts for the evaluated alternatives were designed such that the wind fetch would be broken up by the project, lessening the wind-wave action in the project area. With the TSP in place, wind fetch would decrease by about half in the protected area.

Figure H-21 depicts calculated wave heights for the 1 percent exceedance wind and varying average water depths and fetch lengths (Tom Gambucci, personal communication, December 3, 2012). The graph indicates that for fetch lengths of 3 miles, wave heights of 1 to 2 ft are produced depending on depth. It appears that wind waves would reach a height of 0.5 to 1 foot above pool elevation 458.85 ft (avg pool operating elevation) during normal flows at the west end of the rock structure alternative.

The CEDAS – ACES coastal engineering software to further examine wind wave growth in the project area, especially for sustained winds with longer duration than a 3-second gust. Observed wind data for November 2005 – March 2010 were obtained from the meteorological station located at the Starved Rock Lock and Dam and analyzed. Over the entire period of record, the highest observed wind speed occurred during a severe winter storm on December 22-23, 2008, when a 30-minute average wind speed of 84.5 mph was measured from a direction of 128 degrees. This event was very extreme, as wind speeds exceeded hurricane-force, and the data is not supported by data from other stations in the area obtained through the National Climatic Data Center. During the growing seasons (May 15 – September 15) of 2006 – 2009, the maximum daily 30-minute average wind speed ranged from 2.3 mph to 28.8 mph with an average of 13.0 mph. The maximum wind speed of 28.8 mph was measured on June 22, 2008 from a direction of 301 degrees.

Fetch lengths from a point near the middle of the project area were measured using GIS software. The point location is shown in Figure H-22. Fetch measurements were taken at every 10 degrees around the chosen point and ranged from 0.33 miles to 2.38 miles with an average of 0.66 miles. Figure H-23 illustrates the relative fetch lengths around the chosen point along with the direction of the maximum observed growing season wind speed.

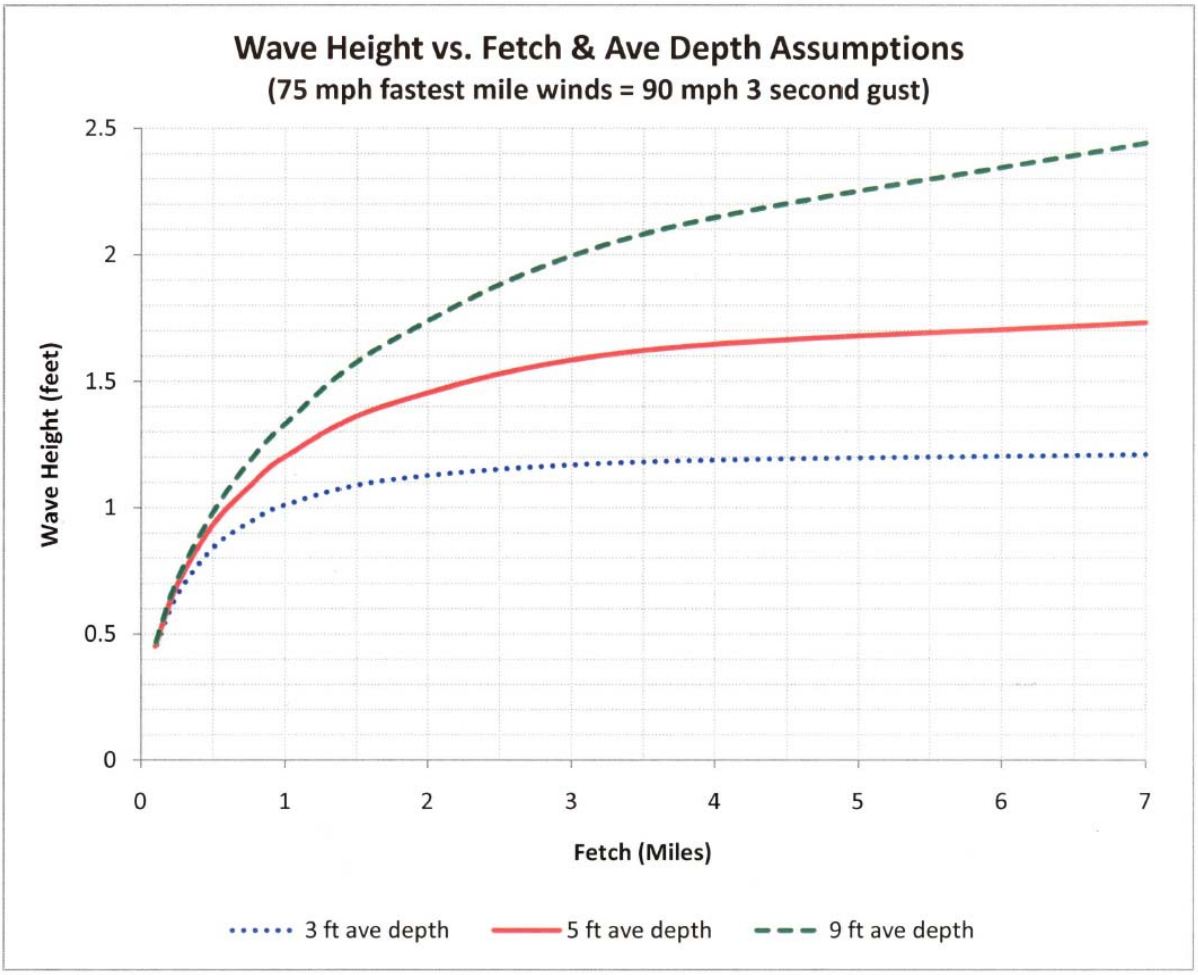

Figure H-21. 1% Exceedance Wind-Induced Wave Heights for Various Fetch Lengths and Average Depths



Figure H-22. Location of Fetch Measurement Point (Google Earth image)

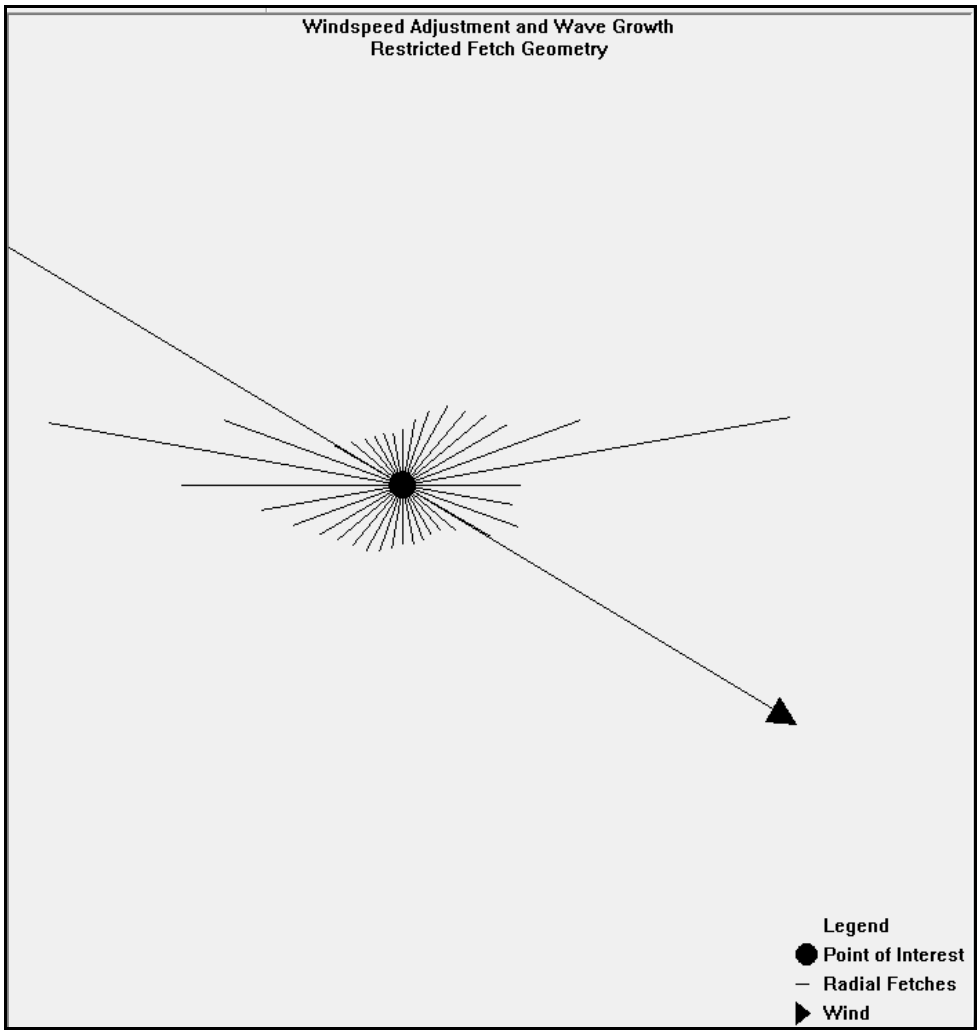

Figure H-23. Fetch Graphic Produced in ACES

The maximum observed growing season wind speed and measured wind fetch data were input into the Windspeed Adjustment and Wave Growth routine in the Wave Prediction functional area of ACES. The model converted the wind speed from a 30-minute duration to a 1-hour duration. The average water depth was estimated at 3 ft for the project area. The model predicted a wave height of 1.04 ft and wave period of 2.05 sec. These results are very similar to the wave height produced by the 1 percent exceedance wind discussed above. The model results are presented in Figure H-24. As a check, the maximum wind speed for the entire period of record was input into the model, and a wave height of 2.05 ft with a wave period of 3.13 sec was produced. This wave height is comparable to the anecdotal evidence provided by the Starved Rock Lockmaster; however, it is likely that the observed wave heights occurred at wind speeds much lower than the maximum observed.

Breaking criteria	0.780	
Item	Value	Units
El of Observed Wind (Zobs)	16.00	feet
Observed Wind Speed (Uobs)	28.80	mph
Air Sea Temp. Diff. (dT)	0.00	deg F
Dur of Observed Wind (DurO)	0.50	hours
Dur of Final Wind (DurF)	1.00	hours
Lat. of Observation (LAT)	41.33	deg
Results		
Wind Fetch Length (F)	1.82	MILES
Avg Fetch Depth (d)	3.00	feet
Wind Direction (WDIR)	301.00	deg
Eq Neutral Wind Speed (Ue)	33.39	mph
Adjusted Wind Speed (Ua)	44.17	mph
Mean Wave Direction (THETA)	281.00	deg
Wave Height (Hmo)	1.04	feet
Wave Period (Tp)	2.05	sec
Wave Growth:	Shallow	

Figure H-24. ACES Wind Wave Results

6.2. Vessel-Induced Waves. Vessel waves likely have a larger impact on the subject site than wind waves. In addition to producing higher wave heights, vessel waves can extend deeper into the water column and likely create greater than acceptable velocities and turbulence in the shallow project area. A riprap breakwater would block these deeper waves, but the floating breakwater and floating island alternatives may not be able to completely stop the velocity and turbulence effects in the project area (Tom Gambucci, personal communication, December 3, 2012). The impacts could be reduced if a no wake zone is enforced. However, according to Operations Division personnel, no wake limits are currently in place in the navigation channel within the project area. The U.S. Coast Guard would have to get involved, and it would be difficult to enforce a restriction.

As part of the Upper Mississippi River – Illinois Waterway System Navigation Study, waves induced by navigation traffic on the Mississippi and Illinois Rivers and their impacts on SAV were studied. According to Sorensen, wave height depends on the relative velocity of flow past the hull, the hull geometry, and the clearance between the hull and the channel side and bottom. Wave period and the direction of wave propagation depend only on the vessel speed and the water depth (USACE 1997).

The bow of a vessel moving in deep water generates a pattern of wave crests, as shown in Figure H-25, consisting of symmetrical sets of diverging waves that move out from the sailing line at an angle θ and a single set of transverse waves that move in the direction of the sailing line (Sorensen, 1997). When the two waves meet along the cusp locus line, the highest waves are formed, referred to as secondary waves (Stewart et. al., 1997). The vessel's stern will generate a similar pattern of waves with much lower amplitudes (Sorensen, 1997).

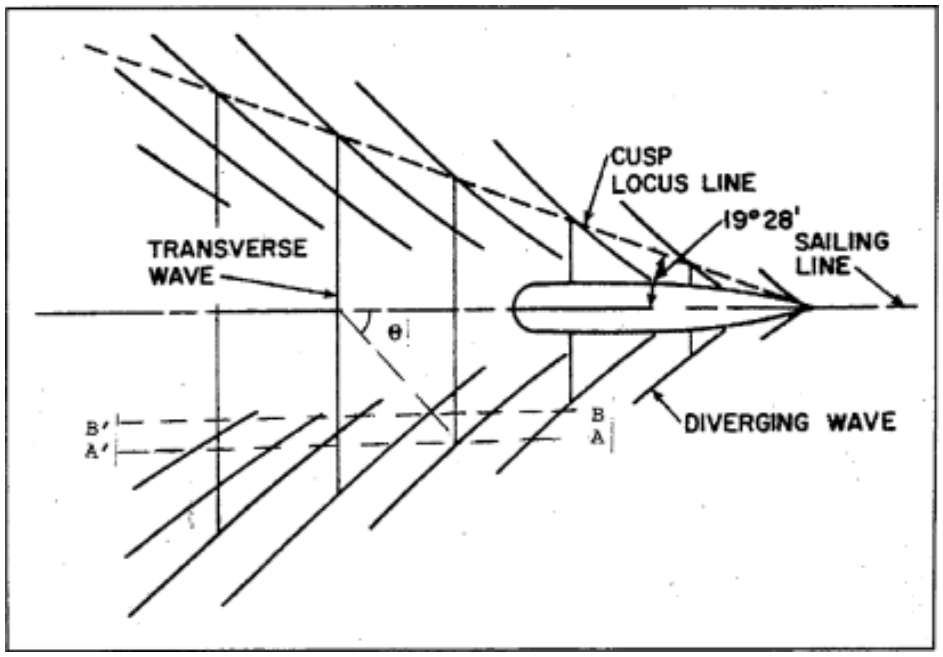

Figure H-25. Deep Water Wave Crest Pattern Generated by the Bow of a Moving Vessel (Sorensen, 1997)

When the depth is less than approximately half the wavelength, the wave characteristics are affected by the channel bottom because the wave-induced orbital water particle motion reaches the bottom. As depth decreases, wave heights increase, and the angle that the diverging wave forms with the sailing line increases. Generally this condition is referred to as shallow water and occurs when the Froude number is greater than 0.7 (Sorensen, 1997).

The Navigation Study found that navigation traffic generally produces wave heights of less than 1 ft with a wave period of 1 to 5 seconds on the Upper Mississippi and Illinois Rivers. However, due to the frequency of navigation traffic on the system, a location can experience daily cumulative exposures to waves of 30 to 75 minutes (Stewart et. al., 1997). Another study by Martin that developed wave height relationships with vessel speed and blockage ratio (defined as the cross-sectional area of the channel divided by the cross-sectional area of the submerged barge tow) found that wave height increases exponentially with vessel speed for different blockage ratios in confined channels (1992).

A check of the bathymetry in the narrowest cross-section near the alignment of the TSP showed that the blockage ratio with the riprap breakwater in place would be about 10.6 for tows pushing loaded barges. Figure H-26 below shows the wave height relationships developed for a blockage ratio of 10.5 (Martin, 1992). As shown in the Figure, for speeds of 7 to 9 miles per hour, wave heights ranged from 0.5 to 3.5 ft. For existing conditions, the blockage ratio for the same cross-section is about 11.9. The wave height relationship for a blockage ratio of 13.4 (the next highest given by the reference) looks similar to that of Figure H-26, except that higher speeds (9 to11 mph) are needed to produce the same range of wave heights (Martin, 1992). As wave height is measured from crest to trough, it appears that waves induced by navigation traffic would reach at most a height 1.75 ft above pool elevation 458.85 ft (average pool operating elevation) during normal flows.

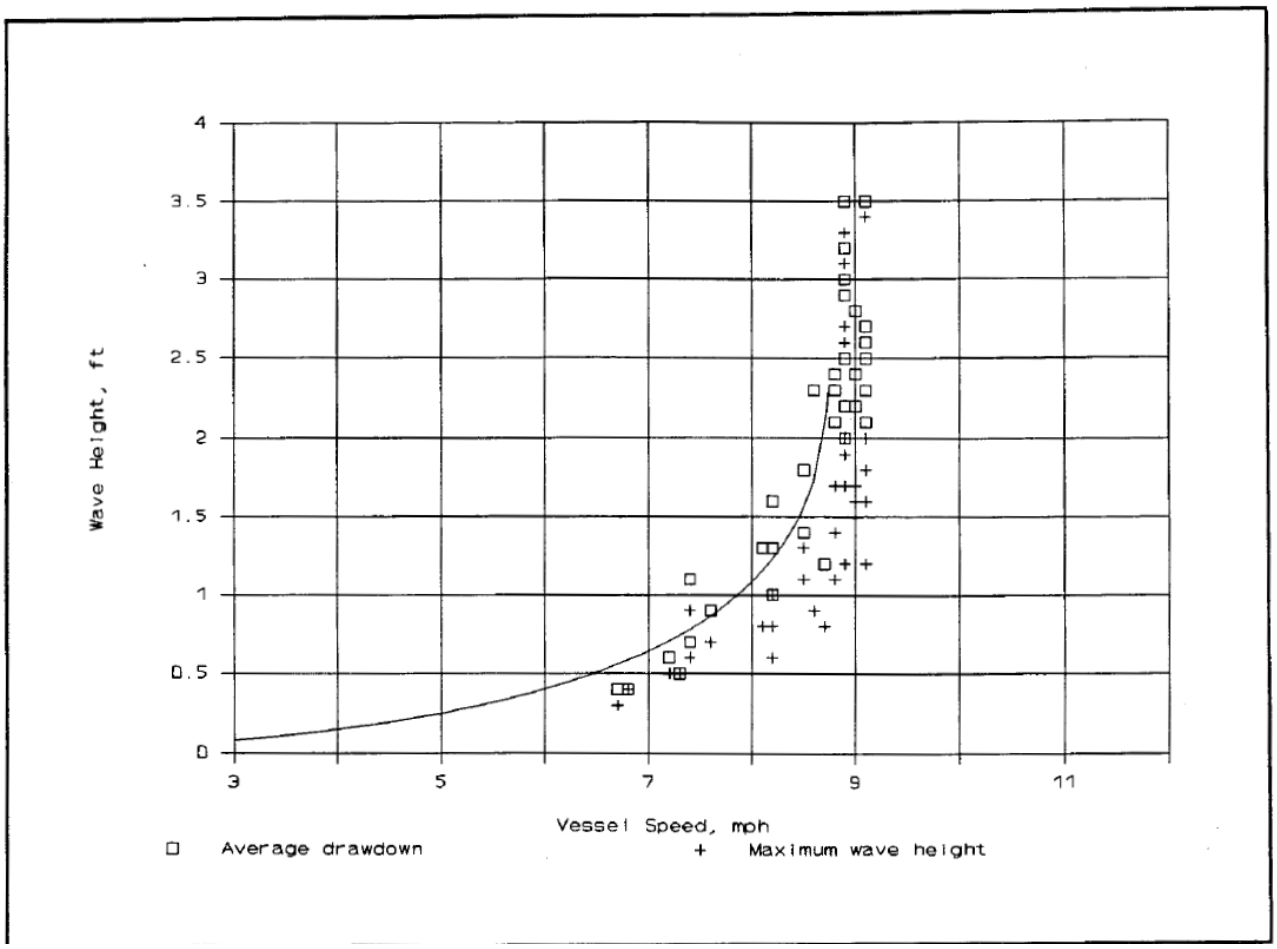

Figure H-26. Wave Height Relationships for a Blockage Ratio of 10.5 (Martin, 1992)

For high-speed crafts, secondary waves can have significant wave heights (Stewart et. al., 1997). A study of waves generated by recreational traffic on the Upper Mississippi and Illinois Rivers developed an equation to estimate maximum wave height based on speed, draft, and length of the boats, and their distance from the measuring point. Test runs at two sites, one on the Illinois River and one on the Mississippi River, indicated that recreational boats can generate from 4 to 40 waves per pass, with a mean of about 10 to 20 waves. The waves lasted from 6 to 40 seconds or more. The average wave heights varied from 0.01 to 0.25 meter (0.03 to 0.82 ft), with a median of about 0.06 to 0.12 meter (0.2 to 0.39 ft). The maximum wave height was 0.6 meter (1.97 ft) (Bhowmik, Soong, Reichelt, & Seddik, 1991). As wave height is measured from crest to trough, it appears that waves induced by recreational boat traffic would reach at most a height of 1 foot above pool elevation 458.85 ft (average pool operating elevation) during normal operating conditions.

The review of literature on waves in the Upper Mississippi and Illinois Rivers revealed that wave heights of up to about 2 to 3 ft are expected in the project area, confirming the anecdotal evidence provided by Corps employees familiar with the project area. The research also confirmed that the top elevation of the TSP riprap breakwater would be sufficient to avoid overtopping during normal flows.

Because much of the vessel traffic occurs in the main channel on the north side of the project area, layouts for the evaluated alternatives were designed such that the project area would be protected from this wave action during normal hydrologic conditions. Although the proposed alternatives will greatly reduce the effects in the protected area of waves induced by navigation vessels and recreational boats operating in the main channel, there is still a risk of waves induced by recreational boats utilizing the side channel negatively affecting the shallow protected area over the submerged Delbridge Island. The only portion of the protected area that will not be exposed to these effects is the area south of the shorter riprap breakwater in Alternatives 2 and 3. A boat ramp is located on the left descending bank of the pool near RM 233.6, and two marinas are located off the main channel on the right descending bank between RM 233-234, but the frequency, speed, and types of recreational boaters utilizing the side channel is unknown.

6.3. Waves and Rock Size Design. According to the Environmental Design Handbook, the Rock Island District often uses Illinois Department of Transportation (IL DOT) Gradation No. RR-5, a gradation with 400-lb top size rock [equivalent spherical diameter of 21 inches (Table H-8)]. A 24-inch layer of riprap is applied over a 12-inch bedding layer of CA6 gravel for stabilization (USACE, 2006). This size rock is also typically used for wing dams and closing dams on the Mississippi River (Marv Martens, personal communication, December 5, 2012). It is assumed that this gradation of limestone riprap (150 lb/ft^3) will be used for the TSP riprap breakwater. However, the handbook also recommends using the Hudson Equation to determine rock size if wave action is a concern (USACE, 2006).

Table H-8. Illinois Department of Transportation RR-5 Gradation

Percent Passing	Weight of Stone (lbs.)
100	400
50±20	90
8±8	3

The Breakwater Design Using Hudson and Related Equations routine in the Structural Design functional area of ACES was used to check the recommended rock size. Although Martin's research indicated that waves as high as 3.5 ft could be experienced in the project area, the model resulted in a median stone weight, or W_{50}, of over 400 lbs., which exceeds the typical gradation, and a minimum top width of over 4 feet, which exceeds the crest width design constraint that is based on floodplain impacts. According to Figure H-26, navigation traffic would need to be moving at a speed of nearly 9 mph to produce such large waves, but the average speed of navigation traffic in the project area is typically only about 4 mph. Above the average, downbound tows pushing empty barges could reach speeds up to about 7 mph, depending on flow. Tows moving in higher flows typically create larger propwash, especially if they are upbound and pushing against the current (Witalka, personal communication, Apr 12, 2013).

The above-average scenarios are not practical for design of this project, however. Empty barges have a smaller cross-sectional area; thus, a larger blockage ratio and even higher speeds (greater than 9 mph) would be needed to produce the same range of wave heights as those in Figure H-26. Also, this project is designed for normal flow conditions; it will likely be over-topped in high-flow conditions. Therefore, the average expected wave height of 2.5 ft was determined to be a more reasonable wave height to use in the model, and it is still a conservative estimate. It is higher than the maximum wave

produced by recreational boat traffic observed by Bhowmik et al, and, according to Figure H-26, vessel speeds required to produce this wave height are still nearly 9 mph. Using a wave height of 2.5 ft, the model produced a median stone weight, or W_{50}, of 170 lbs and a minimum crest width of approximately 3 ft, indicating that the typical gradation and selected riprap berm dimensions will be adequate to maintain stability for the TSP. The model results are presented in Figure H-27.

Armor unit weight (Wr):	150.000	lb/ft³
Wave height (Hi):	2.500	ft
Stability coefficient (KD):	2.000	
Layer coefficient (k delta):	1.000	
Average porosity (P):	37.000	%
Cotan of structure slope (cot theta):	2.500	
No. of units comprising thickness of layer (n):	2.000	
Single armor unit weight (w):	169.564	lb
Minimum crest width (B):	3.12513	ft
Average layer thickness (r):	2.08342	ft
No single armor units per unit surface area (Nr):	1161.120	per 1000 ft²

Figure H-27. ACES Breakwater Design Results

7. ICE CONSIDERATIONS

Starved Rock Pool typically experiences heavy ice buildup during the winter. Figure H-28 is an old photo of the area near the Starved Rock Dam with the pool covered in ice. Figure H-29 is a recent photo looking north near RM 233.5 that shows the extensive ice coverage over the pool just as it began to melt in late January 2013.

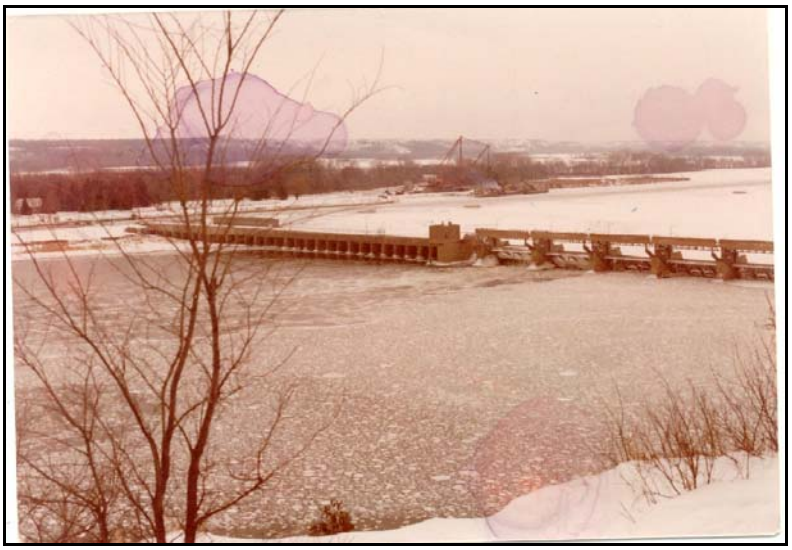

Figure H-28. Ice Coverage Near Starved Rock Dam, Date Unknown



Figure H-29. Ice Coverage In Starved Rock Pool Looking North Near RM 233.5, January 28, 2013

It is not uncommon for the ice coverage in Starved Rock Pool to extend all the way up to Marseilles Lock, a distance of approximately 13.5 miles, with 100 percent coverage (Witalka, personal communication, Jan 11, 2013). Past ice problems upstream of Delbridge Island and RM 235 resulted in a straight channel being cut through the meander, creating Sheehan Island. Ice formation in the pool depends on the winter. Ice can form in large sheets covering the pool. Because of a dam on the Fox River, typically broken ice enters from this tributary and can break up ice sheets in the pool (Kathy Higdon, personal communication, December 17, 2012). Ice thickness in the Starved Rock Pool can grow to 1 ft or more (Mark Witalka, personal communication, Jan 11, 2013). Normally in the U.S., ice thickness will not exceed 2 feet (USACE, 1987). Figure H-30 shows the thickness of a piece of ice in Starved Rock Pool.

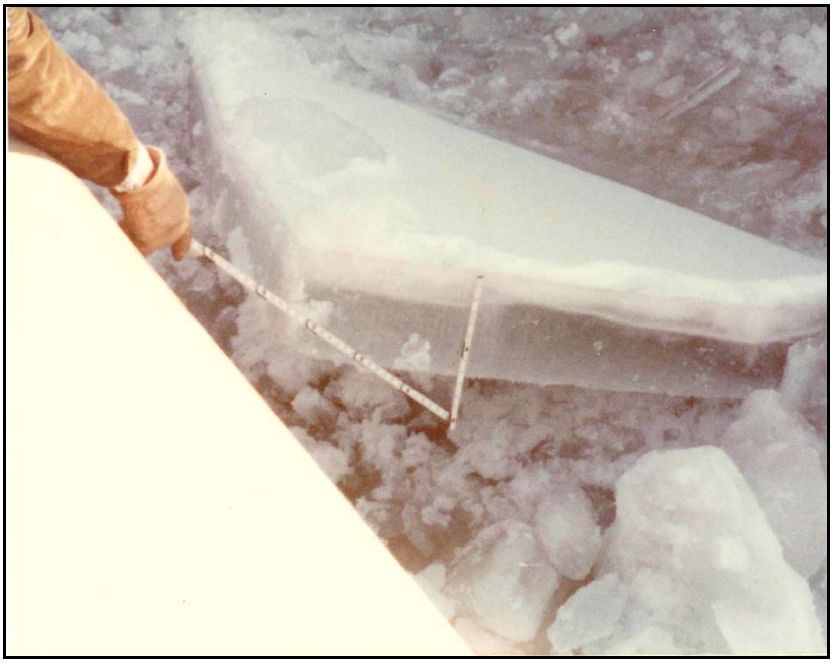

Figure H-30. Ice Thickness in Starved Rock Pool, Date Unknown

According to Part VI-3-5 of the Coastal Engineering Manual (CEM), rubble-mound structures, like the proposed TSP riprap breakwater, may experience several types of ice action, including: rideup of sheet ice on the structure slope, piling up of fractured ice fragments on the slope, ice sheets or fragments overriding the structure crest, dislocation of individual armor units by a moving ice sheet, damage to individual armor units by ice fragments, lateral forces on the entire structure by an ice sheet, and grounded ice rubble adjacent to the structure that could impede functionality (USACE, 2002). In order to maintain stability for structures that experience ice action, the Environmental Design Handbook recommends that rock slopes should be 1V:4H or flatter and/or the maximum rock size should be increased to twice the ice thickness (USACE, 2006). The CEM also notes that sizing the median diameter, or D_{50}, of the riprap greater than the expected maximum winter ice thickness could prevent individual stones from being dislodged due to adfreeze (USACE, 2002). IL DOT Gradation RR-5 has a D_{50} of 12 in. and a D_{max} of 19 in. (Natural Resources Conservation Service, 1994). This gradation approximately meets the recommended criteria for maintaining stability during ice action.

The alignment of the proposed TSP riprap breakwater is oriented parallel with the flow alongside the main channel, so ice would be expected to generally flow along the structure, generating a sliding or lateral force on the structure. The structure could perhaps experience more direct forces caused by thermal expansion of ice sheets, wind-driven ice sheets or tows pushing ice aside out of the navigation channel. Flow from the side channel could cause ice to accumulate in the west end of the protected area due to the "hook" in the alignment; however, the exact position of the hook could be adjusted during the design phase to mitigate this problem.

The CEM states that floating structures are particularly susceptible to ice impact, ice buoyancy lifting, and lateral ice loads. Also, ice loads may be transferred to the mooring system of a floating

breakwater, creating concerns of the possibility of mooring line breakage or anchor dragging (USACE, 2002). These concerns are especially significant for the proposed floating island and floating breakwater alternatives in the project area in lower Starved Rock Pool because of the proximity to the navigation channel and the Starved Rock Dam and hydropower plant. The CEM notes that floating structures are typically used seasonally and removed during winter months. However, the cost of deploying and retrieving the floating structure alternatives could be prohibitive, and the floating islands may not hold up to such handling.

8. SEDIMENTATION PROJECTIONS

8.1. Analysis Objectives. Expert elicitation was completed to estimate both existing sediment deposition conditions in the project areas as well as the effects of constructing the TSP riprap breakwater structure on sediment deposition in the project area. The approach taken was to engage two senior hydraulic engineers with sedimentation analysis experience to conduct independent qualitative analyses addressing sediment deposition trends and to identify projected areas of scour and deposition for both the future without- and with-Project conditions. As previously described, the TSP is a riprap breakwater structure which is intended to lower velocities to promote SAV growth and fish spawning areas. A concern of the PDT is that the with-Project conditions may increase current sediment deposition rates in the area protected by the structure or in the side channel. In order to address these concerns, background and anecdotal information related to sediment deposition in the Starved Rock Pool, as well as results from the independent analyses are presented herein.

8.2. Existing Conditions. Sedimentation rates within the Starved Rock Pool are a function of the discharge magnitude and the rainfall distribution in the contributing watershed, and are sensitive to the spatial and temporal variability in vegetation. Generally higher concentrations of suspended sediment occur early during a rainfall event as sediments suspended during overland flow are flushed into the stream, with decreasing concentrations as the rainfall declines. In agricultural watersheds, early spring rain that falls on fields without vegetative cover can result in significant sediment runoff.

Before impoundment of Starved Rock Pool in 1933 there were several additional islands in between the current navigation channel and left descending side channel, from RM 231.1 to RM 235 (Attachment H-3). Results from an aerial photo analysis illustrate some historic and more recent changes to island areas within the project area. Attachment H-4 shows the submergence of Delbridge Island after impoundment in 1933. From 1978 to 1983, there was a small amount of island re-growth. Over the past few decades, sediment has been aggrading in the project area within Starved Rock Pool. From 1983 to present there has been approximately 32.5 acres of additional island growth and this trend seems to be continuing. Most of the island growth has occurred at the upstream end of Delbridge Island. In 2012, the Starved Rock Lockmaster and a Park Ranger noted concerns with sediment accumulation in the pool, specifically the existence of a vegetated island just upstream of the dam that did not occur until about 5 years ago, after the 2007 and 2008 floods. They mention that it has not yet been destroyed or degraded by floods or ice. This island is also beginning to appear in recent aerial imagery.

The TSP riprap breakwater alignment is located near the edge of the Delbridge Island footprint (Plate C-103 in Appendix L). In October, 2011, core samples were taken by the Rock Island District

Geotechnical Branch along and just north of the proposed TSP riprap breakwater alignment as shown on Plate B-101. The particle type and size results from these core samples are shown on Plate B-301. These soil borings indicate that the near-surface material near the alignment ranges from slightly over 50 percent fines (passing the 200 sieve; silts and clays) to over 90 percent fines.

In February, 2013, numerous survey transects were collected by the Rock Island District Survey Branch and 13 additional soil samples were taken by the Rock Island District Geotechnical Branch at the locations shown on Figure H-31. Nine of the soil samples indicate that the near-surface material closer to the navigation channel contains a greater amount of sands/bedload-type material, with gradually increasing fines-content as you move toward the left descending side channel (Table H-9). It is believed that erosion, resulting from wind- and navigation-induced waves, as well as high water events are moving some of the bedload from the navigation channel into the middle portion of the pool. Sample HH 15-1 was taken behind the location of Alternative 2 near the left descending bank. It indicated material consisting mostly of clay and silt.

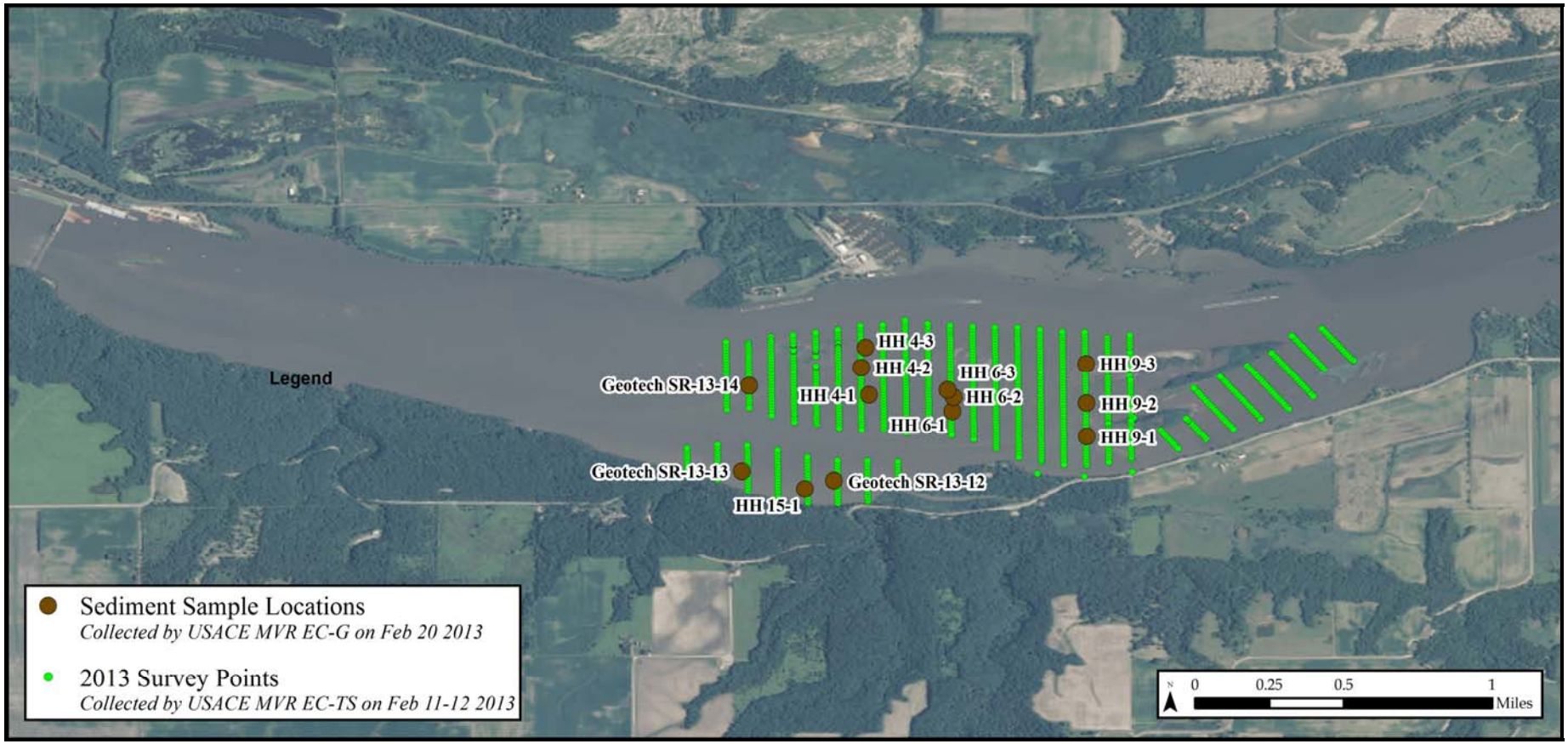

Figure H-31. Sediment Sample and Survey Transect Locations Obtained February, 2013

Table H-9. Sediment Sample Analysis Results obtained February, 2013

Boring ID	Depth From Top of Sediment (ft)	Water Depth (ft)	Moisture Content (% by wt.)	% Passing 200 Sieve (i.e. Fines)
HH-4-1	0-1	1.1	24.1	7.7
HH-4-1	2-3		36.0	27.1
HH-4-2	0-1	1.0	23.1	11.6
HH-4-2	2-3		69.0	82.5
HH-4-3	0-2	1.0	23.8	10.2
HH-6-1	0-2	2.3	61.4	62.9
HH-6-1	2-4		43.5	86.4
HH-6-2	0-3.5	1.7	35.6	23.3
HH-6-2	3.5-4.5		74.7	84.4
HH-6-3	0-1	0.5	23.9	8.3
HH-6-3	1-2		29.0	22.4
HH-6-3	2-3.5		59.5	90.8
HH-9-1	0-1	1.7	41.9	25.9
HH-9-1	1-1.5		37.6	68.3
HH-9-2	0-1	2.6	30.1	15.9
HH-9-2	1-2		41.9	91.7
HH-9-3	0-3.5	0.6	20.5	6.1
HH-15-1	0-2.5	2.5	76.2	99.8
HH-15-1	2.5-4.0		43.2	99.9

As illustrated above in Table H-9, the dominant particle size near the proposed TSP riprap breakwater alignment is fine sand, generally with increasing clay & silt moving toward the left descending side channel. The silt particles are presumably predominantly cohesive because non-colloidal particles would be washed downstream by larger duration and flood flows. There is likely a firm clay base that is unlikely to scour. Additionally, the two small island outcrops at the upstream portion of the TSP alignment are vegetated which improves resistance to scour. This logic is supported by the anecdotal information provided in Section 8.2 regarding the Lockmaster and Park Ranger's concerns with sediment accumulation in the pool, specifically the existence of a vegetated island just upstream of the dam. ILDNR staff also indicated that the Delbridge Island area has been filling in during recent years.

Shear stress under existing conditions was calculated in SMS using AdH hydrodynamic results. Wave-induced shear was not included in the shear computation. The water surface slope of the side channel was used in the equation tau = gamma * depth * slope. Figure H-32 illustrates the distribution of shear stress under existing conditions (i.e. without project). Based on the computed shear stress values, without the project in place there is a tendency for deposition within the Delbridge Island area. Areas subject to deposition and scour under existing conditions are illustrated on Figure H-32.

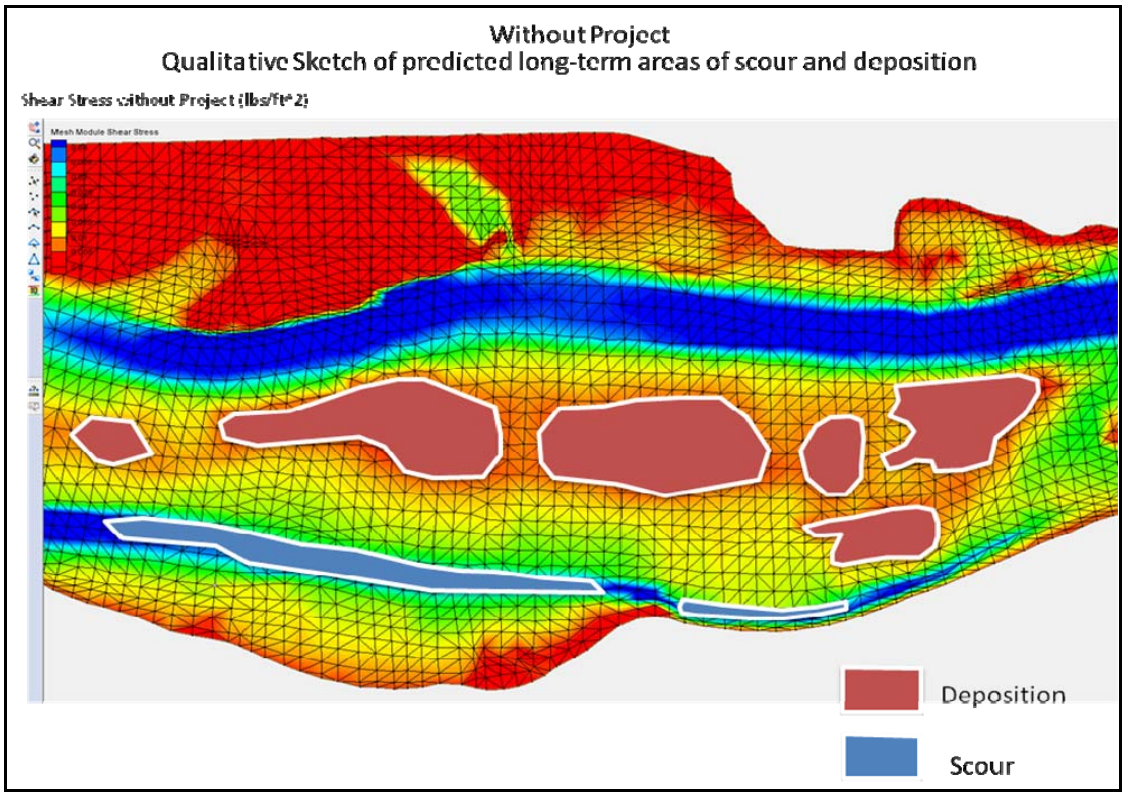

Figure H-32. Possible Without Project Scour and Deposition

ERDC reference TN-EMRRP-SR-29 was used to examine stability thresholds for critical shear stress. Colloidal silts and clays have a permissible shear stress of 0.26 lbs/sq ft. Existing condition shear stress values, as calculated in SMS, yielded 0.04 as the highest value under a discharge of 33,555 cfs; therefore the colloidal silts and clays are not expected to scour, especially if vegetated. Non-colloidal silt and clay materials have critical shear stresses of 0.045 to 0.05 lb/sq. ft. (Figure H-33), so these materials are not expected to be scouring except in the main and side-channels under existing conditions, based on the SMS shear stress calculations. Fine sand has a critical shear stress of approximately 0.03 lb/sq-ft and is also not expected to be scouring within the project area under existing conditions.

Boundary Category	Boundary Type	Permissible Shear Stress (lb/sq ft)	Permissible Velocity (ft/sec)	Citation(s)
Soils	Fine colloidal sand	0.02 - 0.03	1.5	A
	Sandy loam (noncolloidal)	0.03 - 0.04	1.75	A
	Alluvial silt (noncolloidal)	0.045 - 0.05	2	A
	Silty loam (noncolloidal)	0.045 - 0.05	1.75 – 2.25	A
	Firm loam	0.075	2.5	A
	Fine gravels	0.075	2.5	A
	Stiff clay	0.26	3 – 4.5	A, F
	Alluvial silt (colloidal)	0.26	3.75	A
	Graded loam to cobbles	0.35	3.75	A
	Graded silts to cobbles	0.43	4	A
	Shales and hardpan	0.67	6	A
Gravel/Cobble	1-in.	0.33	2.5 – 5	A
	2-in.	0.67	3 – 6	A
	6-in.	2.0	4 – 7.5	A
	12-in.	4.0	5.5 – 12	A
Vegetation	Class A turf	3.7	6 – 8	E, N
	Class B turf	2.1	4 - 7	E, N
	Class C turf	1.0	3.5	E, N
	Long native grasses	1.2 – 1.7	4 – 6	G, H, L, N
	Short native and bunch grass	0.7 - 0.95	3 – 4	G, H, L, N
	Reed plantings	0.1-0.6	N/A	E, N
	Hardwood tree plantings	0.41-2.5	N/A	E, N

Figure H-33. Permissible Shear and Velocity for Selected Lining Materials (ERDC TN-EMRRP-SR-29, Stability Thresholds for Stream Restoration Materials, May 2001)

Another possibility for sedimentation trends in the Project area under existing conditions is that the system is continuing to shift toward a more uniform depth through sediment focusing (scouring of higher elevations and deposition of lower elevations; (Bhowmik 1993). When Delbridge Island was inundated in 1933 there were high ridges and low swales providing depth diversity and new aquatic habitat. Since impoundment, lower elevations within Delbridge Island have seen deposition and higher elevations have changed locations in response to altered hydrodynamics. The February, 2013 survey data and sediment samples support this trend.

Island growth is expected to continue immediately upstream of the project area. Island growth is thought to be occurring in this area due to recent flood events. These islands are accreting up to elevation 460; therefore, this island growth must have occurred at stages above 460. As shown in Figure H-34, there have been six high water events averaging about 30 days in length that have reached elevation 460 from 2007 through 2009. There is enough energy carrying sand and approaching these islands, with the sand depositing as the flow expands in this area. This is likely the cause of island growth and some filling occurring at the upstream entrance to the left descending side channel. The sand deposition is forming a fluvial delta at the upstream end of the former island. The deltaic arms descend downstream as sediment drops out under lower velocities created by the island.

Below water a natural levee is forming along the right-descending bank of the former Delbridge Island, adjacent to the main channel. As indicated earlier, sands are dropping out of suspension at the channel margin and finer sediments are transported laterally across Delbridge Island. Qualitative sedimentation analysis indicates an equilibrium condition or slight sedimentation in the region which may be balanced by scouring flows during floods or more frequent vessel-induced currents.

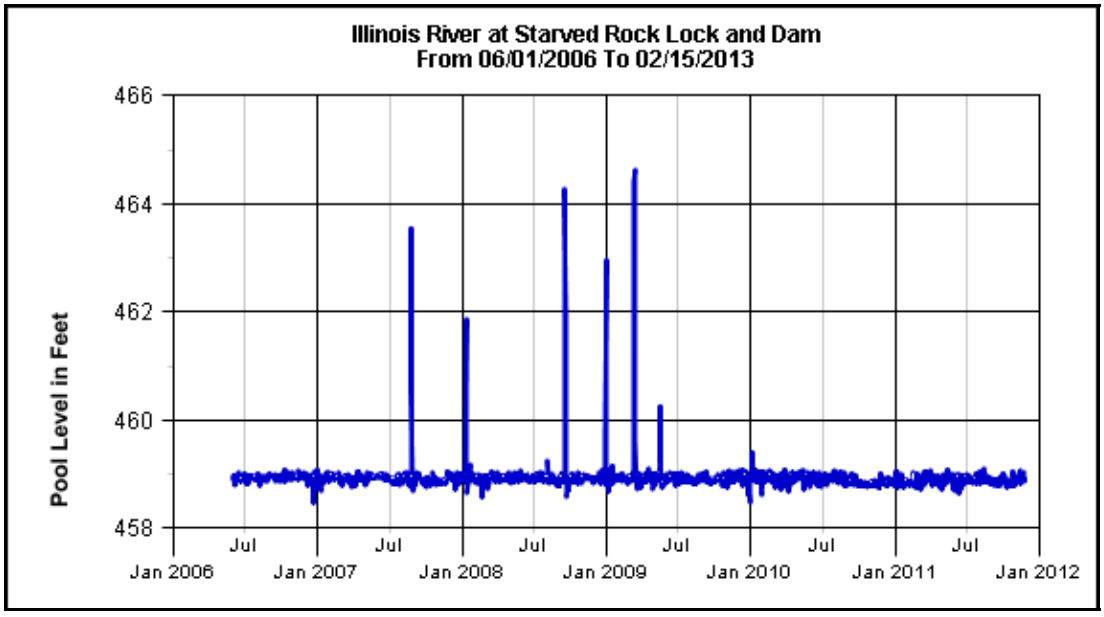

Figure H-34. Recent High Water Events in Starved Rock Pool

8.3. Evaluation of the Tentatively Selected Plan (TSP). Shear stress computed with the TSP in place is shown in Figure H-35. Similar to the existing conditions results, there is a tendency for deposition within the Project area with the Project in place. There is a slight increase in shear stress with the Project in place (less than 0.01 lb/sq ft), however this increase should not result in a significant increase in overall scour/deposition.

Shear stress values under with Project conditions do not exceed 0.04 under discharge values of 33,555 cfs; therefore the colloidal silts and clays are not expected to scour, especially if vegetated. Sediment deposition could occur with Project, but the TSP breakwater cuts off most of the lateral sediment flux source, so less deposition is expected in the project area with the TSP breakwater than under existing conditions (Figure H-35). Constructing the TSP essentially accelerates the natural levee-building process, thereby largely eliminating lateral flow over Delbridge Island and cutting off the sediment source. Non-colloidal silt and clay materials are also not expected to scour except in the main and side-channels and fine sand is not expected to scour based on with-Project shear stress. Potential areas of deposition and scour within the project area are shown in Figure H-35.

It is also possible that current without-project depositional trends within the project area remain the same under the with-Project condition. Island growth immediately upstream of the TSP alignment is expected to continue since velocities in this area are approximately the same with and without the Project. The velocity vector at the downstream end of the project area has a southerly component, similar to the velocity vectors under the existing condition, however the velocity magnitude is reduced with the Project in place. For both the 9,740 and 33,555 cfs discharge conditions, the flow across the project area from the navigation channel to the side channel is expected to be reduced by approximately 90 percent for the without- to with-project condition. Since construction of the breakwater project will greatly reduce cross-channel (lateral) flow from the navigation channel, conditions are anticipated to remain the same in terms of scour/deposition within the project area.

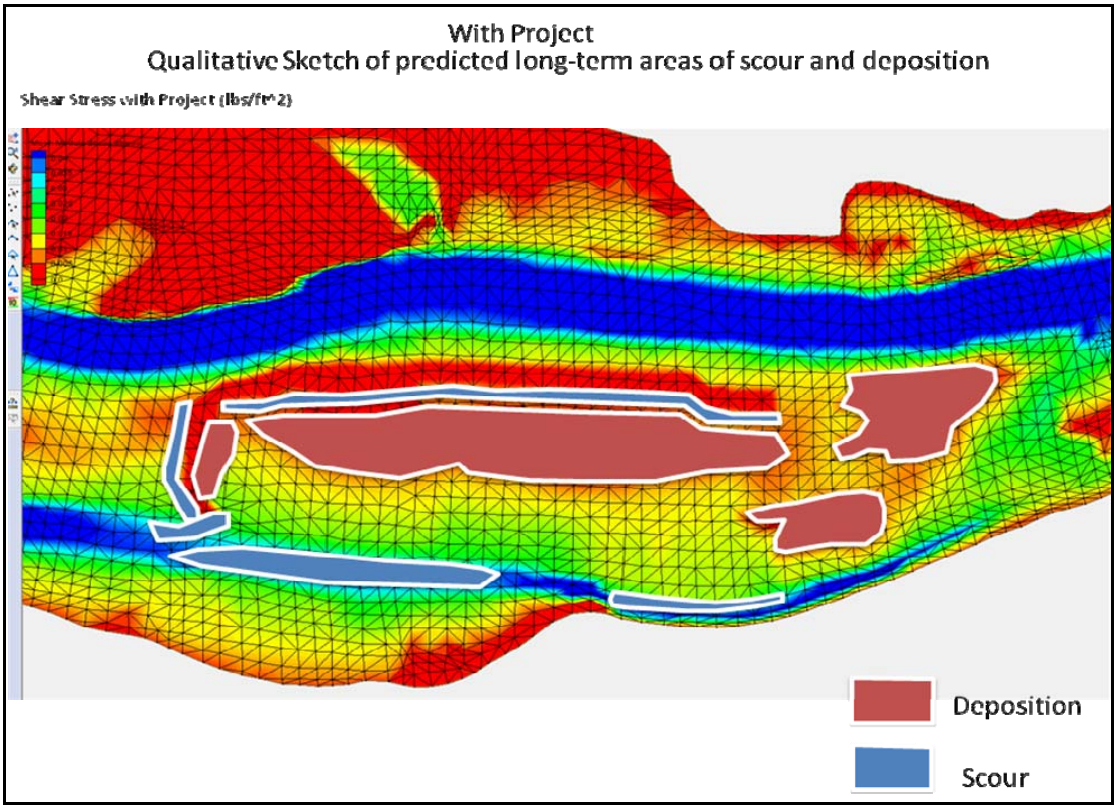

Figure H-35. Possible With Project Scour and Deposition

During flood events larger than those modeled, the breakwater will likely overtop and the downstream portion of the TSP alignment, assumed to be oriented perpendicular to main channel flow, would act like a wingdam. Scour is expected to occur immediately downstream of the "wingdam" and off the tip, and some deposition will likely occur immediately upstream of the "wingdam." Along the middle portion of the TSP breakwater alignment, flood water overtopping the breakwater will likely cause some scour on the backside in a localized area of the breakwater that runs parallel to main channel flow.

As previously mentioned, the TSP breakwater will reduce lateral flow across the project area from the main channel to the side channel. This change in flow distribution indicates a tendency for less deposition in the project area and more scour in the main channel with the Project in place. The main channel scour will tend to increase deposition downstream, likely in the same location that is currently dredged (RMs 232.2 and 232.7). However, the shear stress increase is not large (less than 0.01 lb/sq ft) so there should not be a significant increase in overall scour/deposition in the project area due to the breakwater.

During flood flows, discharge in the left descending side channel may increase due to the project. However, the shear stress increase is not large (less than 0.01 lb/sq ft) so there should not be a significant increase in overall scour/deposition due to the Project. The primary location for scour will

be off the downstream tip of the TSP alignment near the side channel, and at a hard point on the left descending bankline at approximately the midpoint of the breakwater.

Current Corps guidance on climate change states there may be an increase in frequency of flood events (and a greater amount of flow per frequency event), which would re-suspend sediment. However, it is not expected that increased flood events due to climate change would cause heavier bedload material from the navigation channel to overtop the TSP breakwater structure. There also may be an increase in intensity and frequency of drought conditions, which would cause sediments to compact. It is unknown if any climate change effects will occur within the design life of the project.

Several potential alignment modifications or improvements to the TSP alignment were considered as part of the sedimentation expert elicitation. These modifications included an upstream oriented U-shaped alignment; an adjustment to the orientation of the downstream portion of the TSP alignment; extending the upstream end of the TSP alignment further upstream; notching the TSP alignment; and staggering the TSP alignment. The results of these evaluations and there impacts on sediment deposition are discussed in the following.

There was concern from the ILDNR that there would be sediment deposition in the left descending side channel. It was suggested that if the downstream end of the proposed TSP breakwater structure is extended into a U-shaped alignment (opened up on the upstream, east side only), velocities would increase in the left descending side channel. However, it is assumed that this U-shaped alignment will collect sediment and likely result in island formation; therefore this alignment modification is not recommended. As discussed in Section 5.1.5.2, *Evaluation of Alternatives*, there is an increase in velocity in the upstream reach of the side channel and a slight decrease in velocity in the lower reach of the side channel with the TSP in place. The velocity magnitude in the side channel downstream reach with the TSP in place is great enough (no less than 1.2 ft/s) under discharge conditions of 33,555 cfs that the reduction in velocity as a result of the TSP (0.3 ft/s) is not significant enough to cause increased sedimentation. Therefore, the left descending side channel should maintain itself as the shear stress increases slightly due to the Project.

As previously discussed, under the assumed breakwater overtopping conditions, the downstream portion of the TSP alignment is assumed to be oriented perpendicular to flow. If so, it will act like a wingdam, thereby causing scour on the downstream side and off the tip of the structure and deposition immediately upstream. Changing the orientation of the downstream portion of the TSP breakwater may help reduce sediment deposition within the project area. Rather than perpendicular to flow, if this portion of the breakwater is directed at a downstream angle (30 or 45 degrees), low flows would tend not to have a clockwise eddy behind the breakwater that can accumulate sediments from side channel flow (Figure H-36). However, if the downstream breakwater is angled, flood flows that overtop this portion of the breakwater would be directed towards the main channel and may increase sedimentation in this area. This alignment modification will be further evaluated during Plans and Specifications.

One improvement to the TSP alignment that would potentially help to reduce sedimentation includes extending the upstream edge of the breakwater to tie into the island upstream.

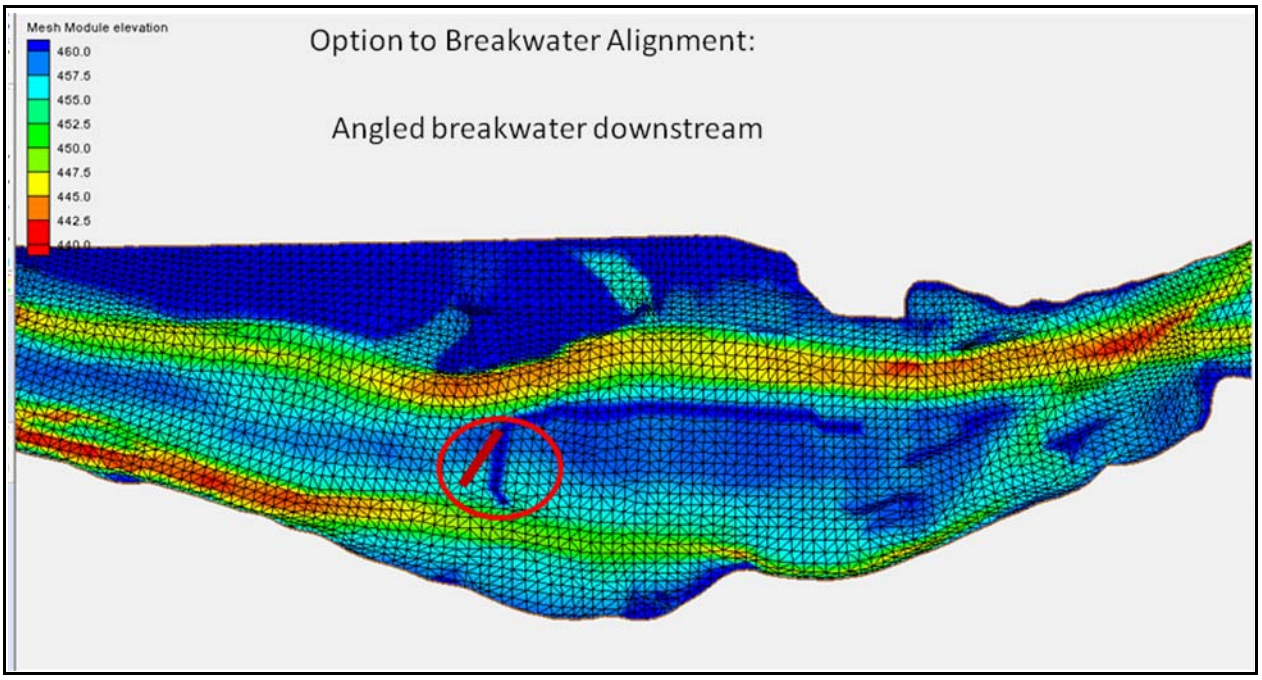

Figure H-36. Possible Modification to the TSP Riprap Breakwater at the Downstream End

Although not included in the AdH model due to time constraints, the independent qualitative analyses concluded that adding notches to the TSP breakwater alignment would allow flow through the project area. This flow carries fine particles that will encounter an area of low velocity (or zero velocity) water, and subsequently settle out (deposit). This conclusion is based on the shear stress calculations of the without project case; a notch or series of notches will not have shear stresses that exceed this case. Flood flows will periodically flush fine sediments from the area unless they are well vegetated. To maintain separation and wave protection, notches in the breakwater are not recommended.

Similar to a notched breakwater structure, the independent qualitative analyses concluded that staggering the rock breakwater alignment will allow more flow and turbulence through the alignment. Fine materials will be transported away from the backside of the breakwater, but will encounter low velocity water and likely settle out before reaching the side channel. A staggered rock breakwater alignment is also not recommended as it would lead to a higher degree of deposition in the project area.

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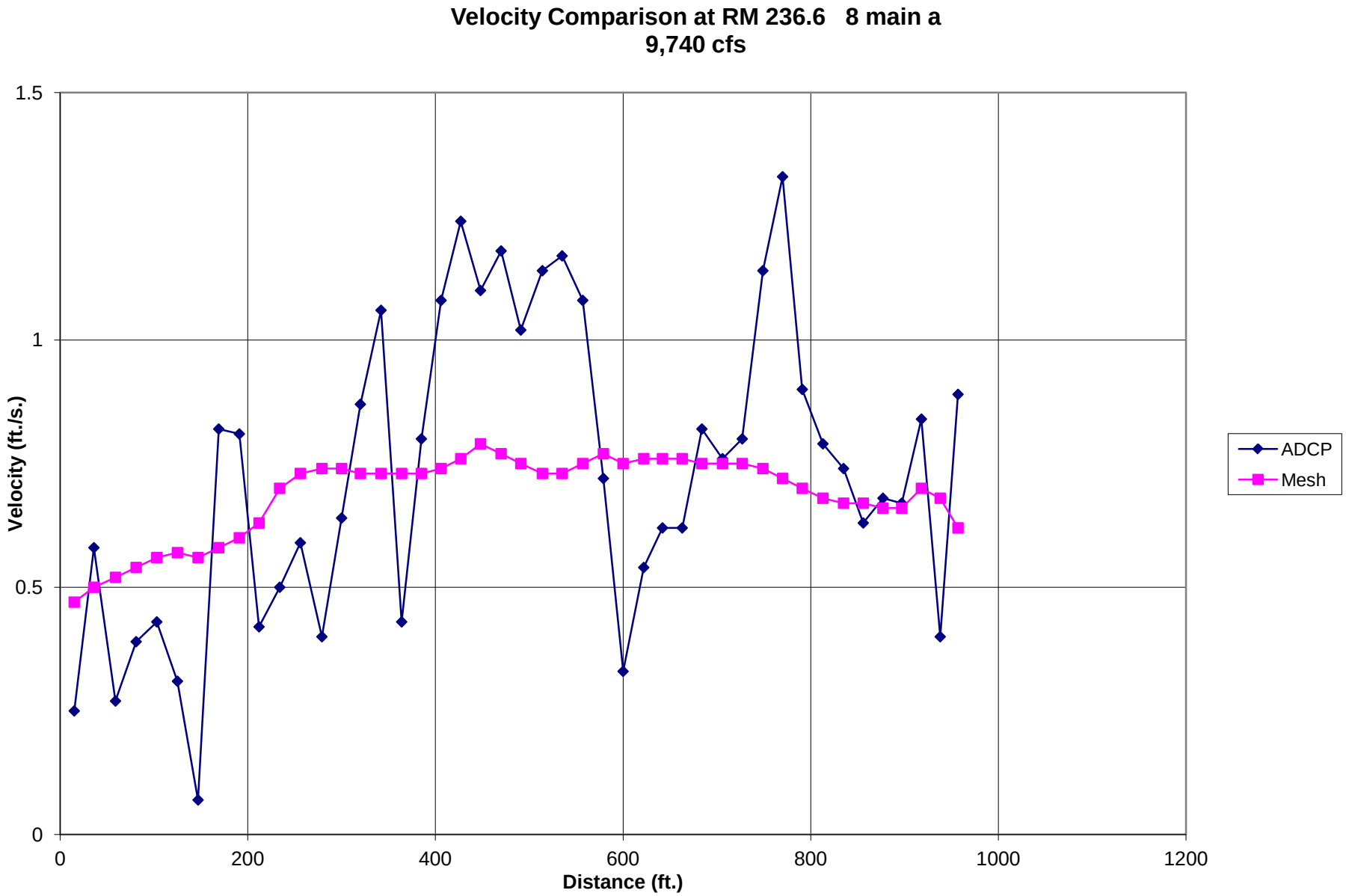
ATTACHMENT H-1

ADCP VS. 2-D MODEL POINT VELOCITY GRAPHS AND DISCHARGE CALIBRATION CHARTS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Distance (ft.)
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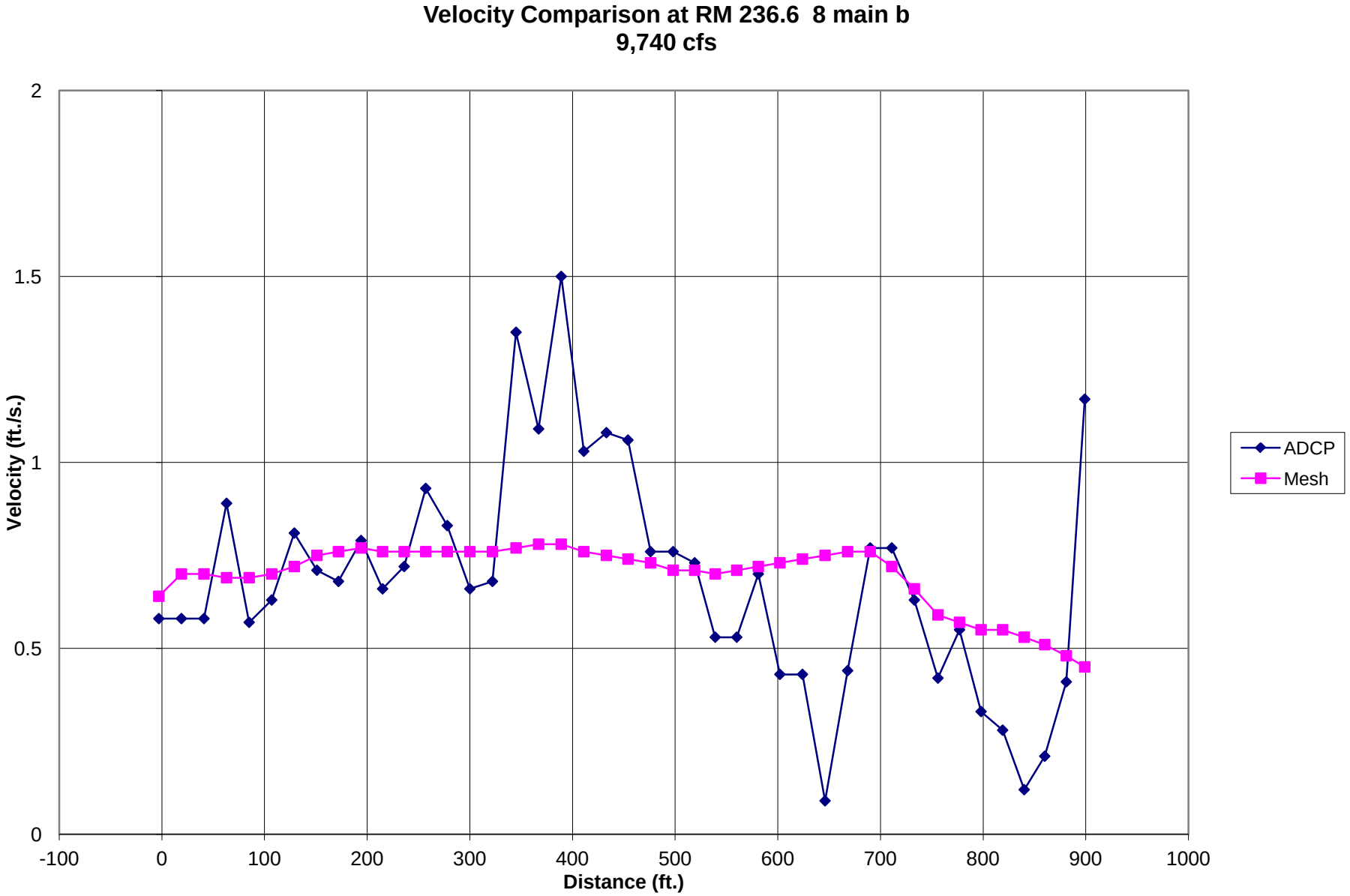
Mesh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ADCP
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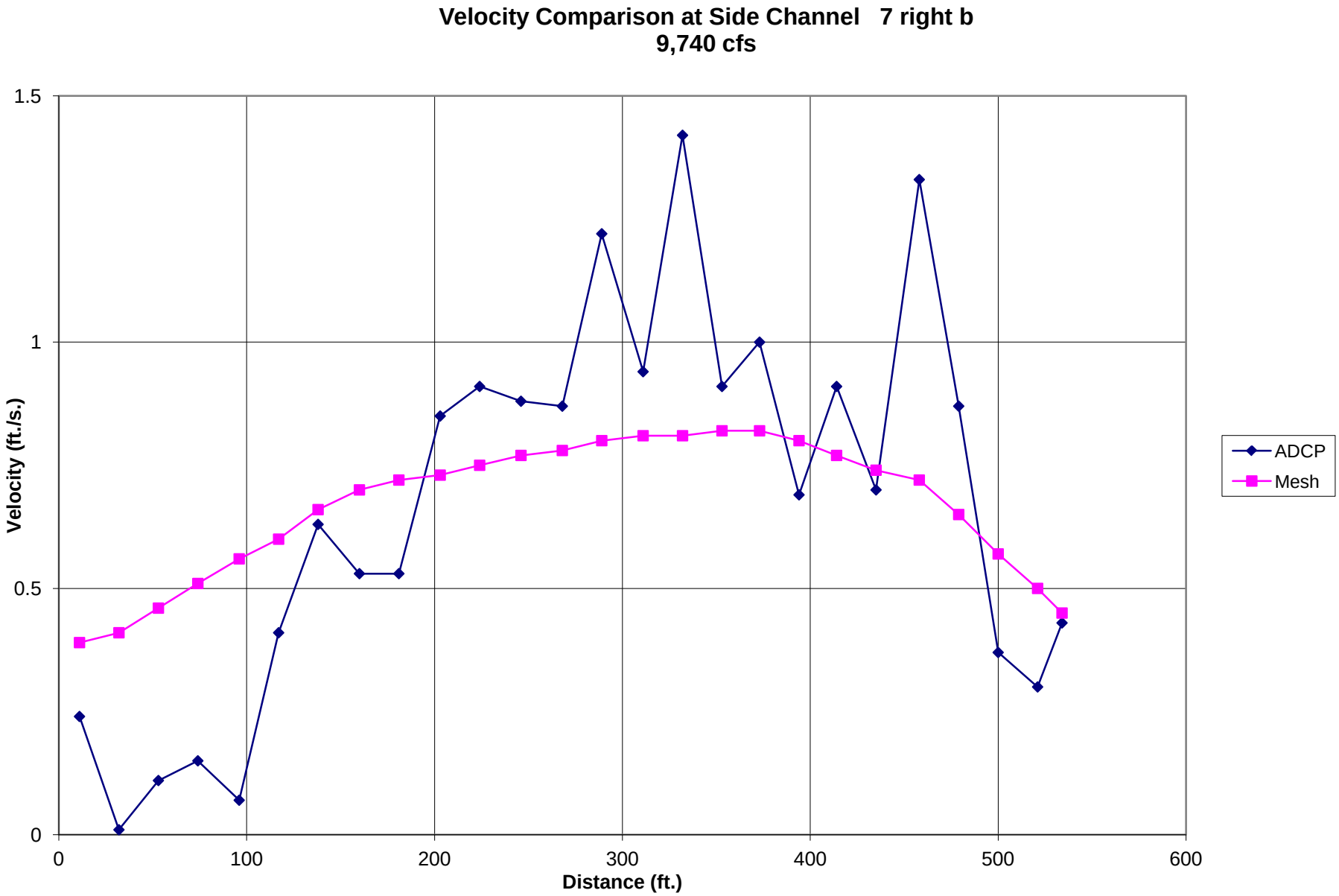
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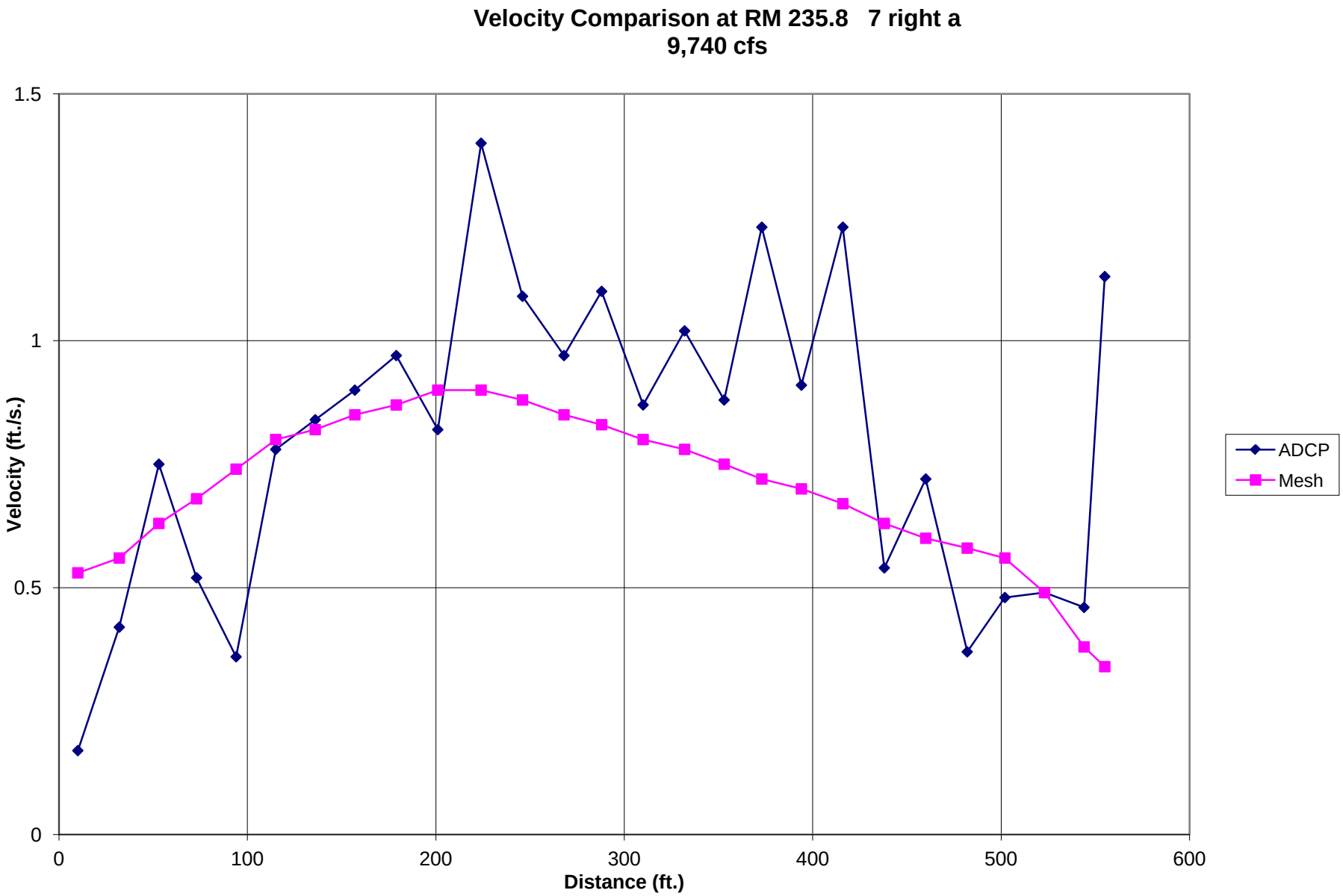
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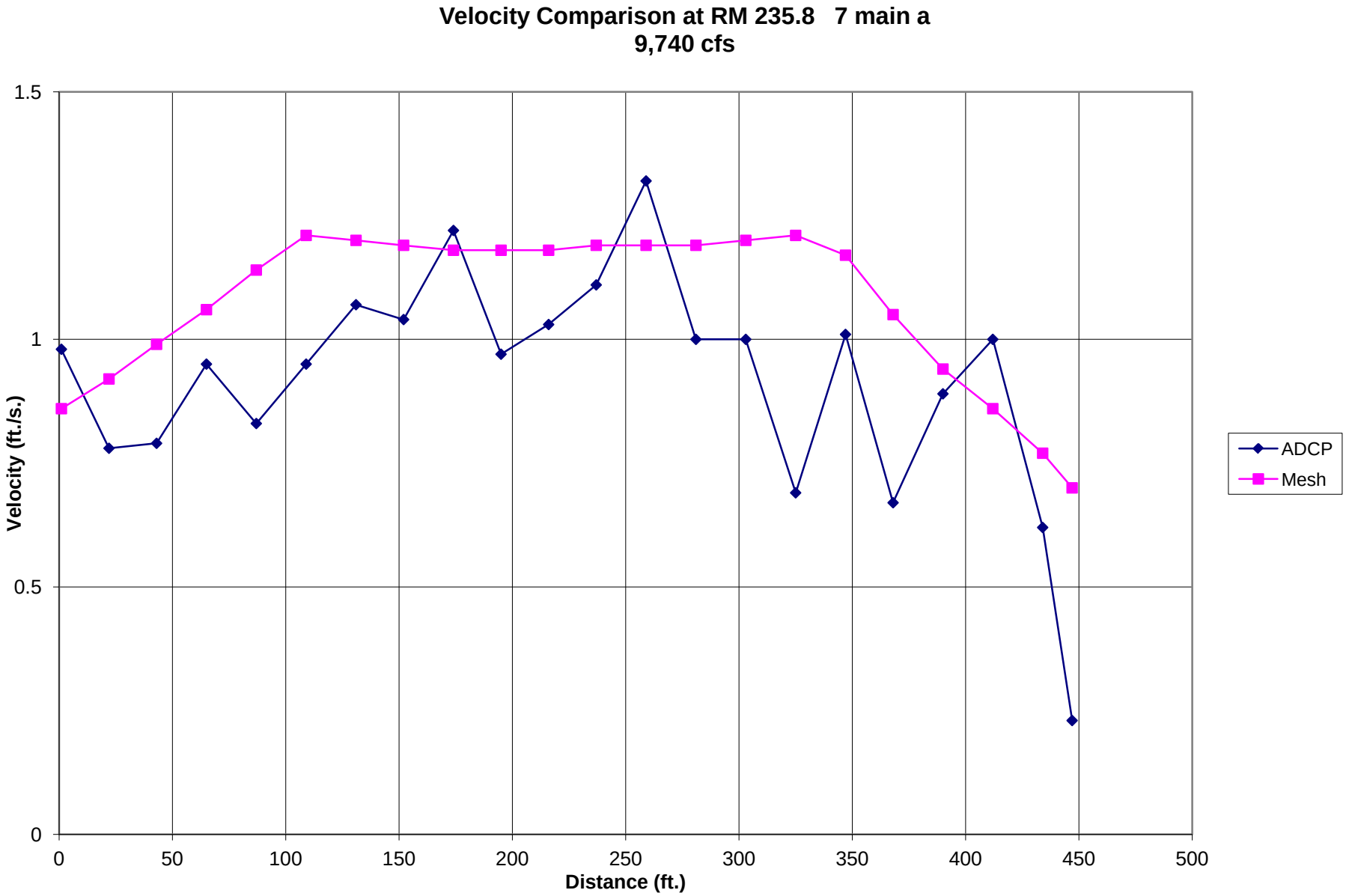
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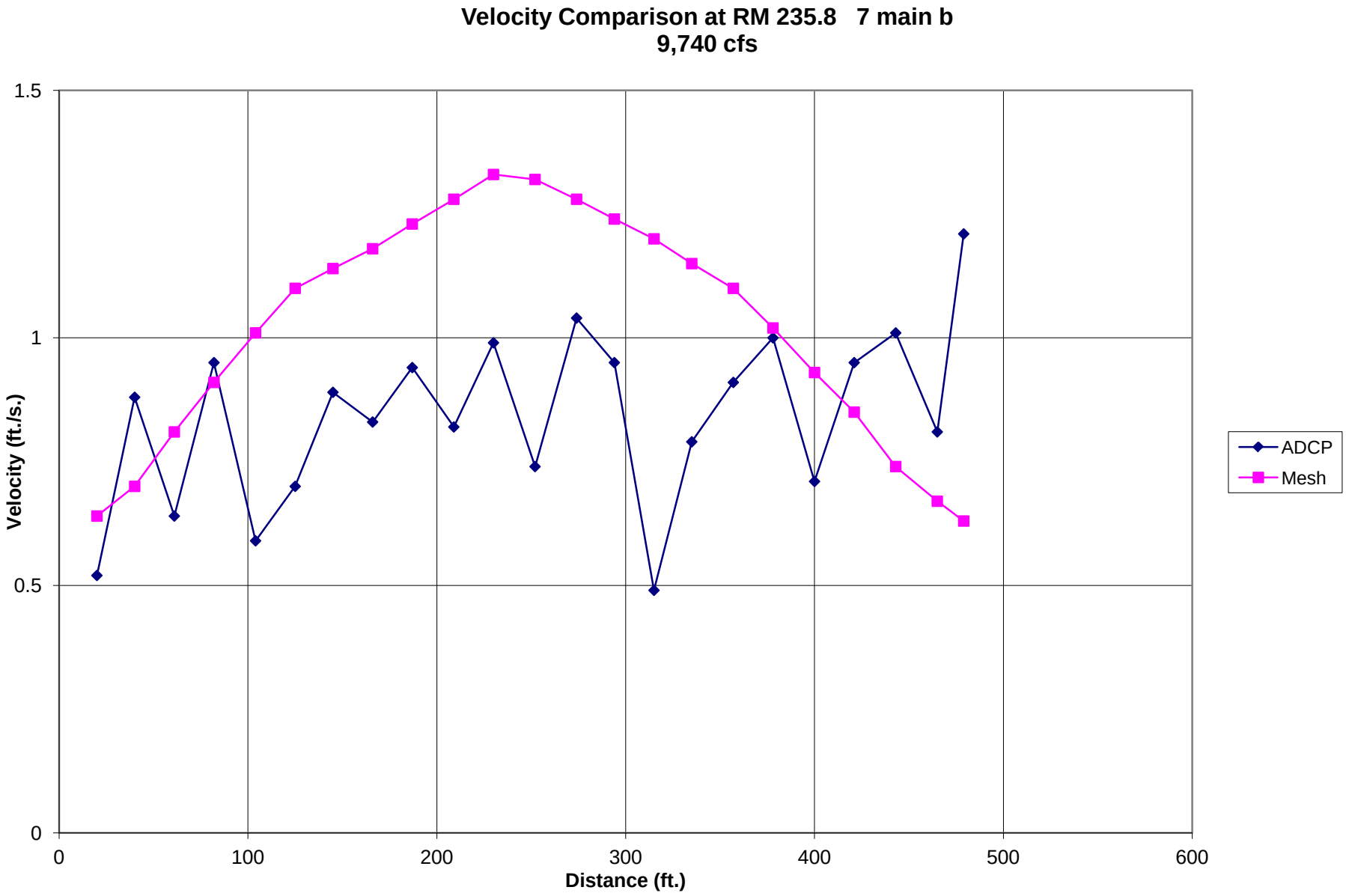
Distance (ft.)
ADCP
Mesh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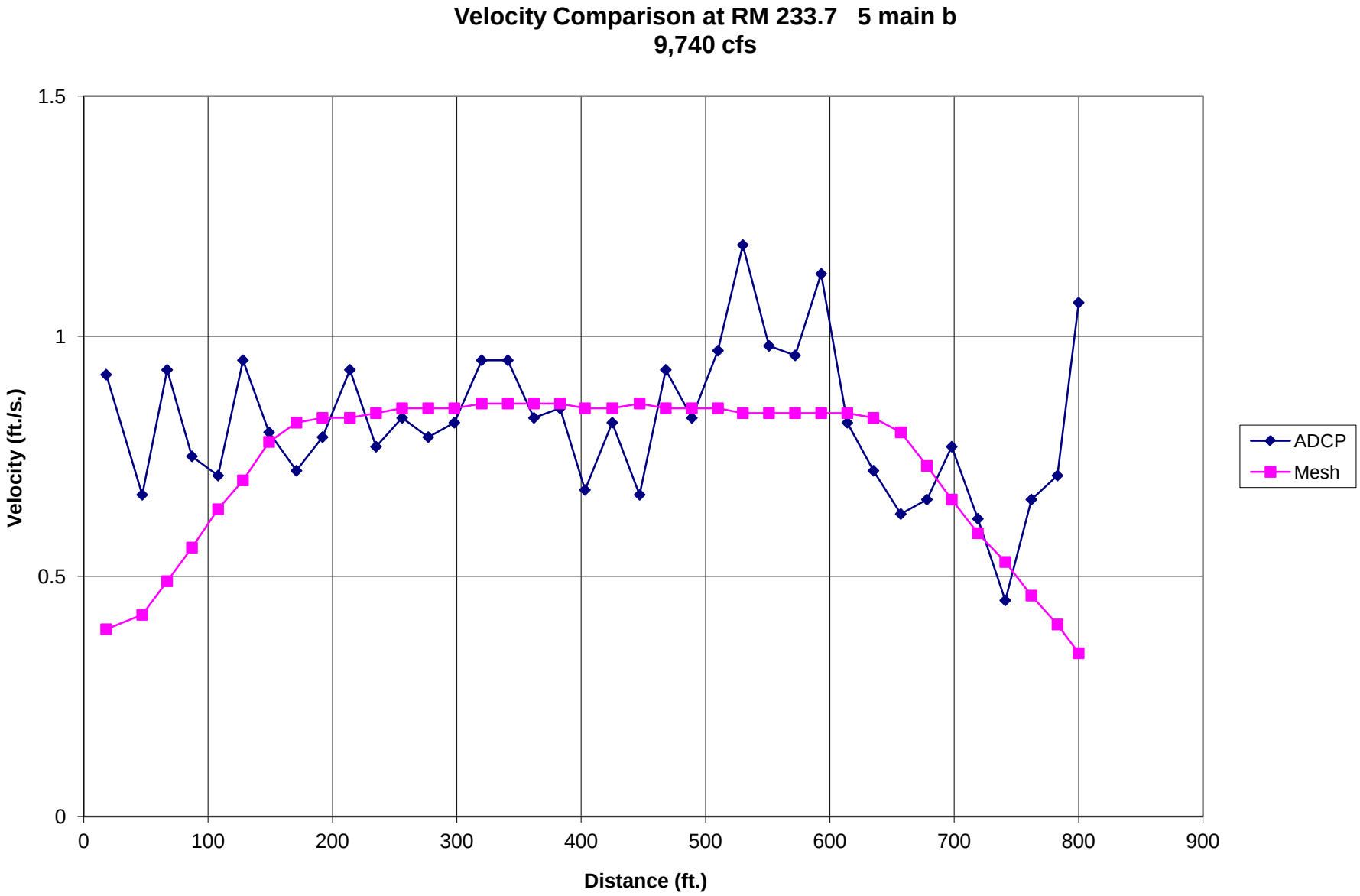
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Distance (ft.)
ADCP
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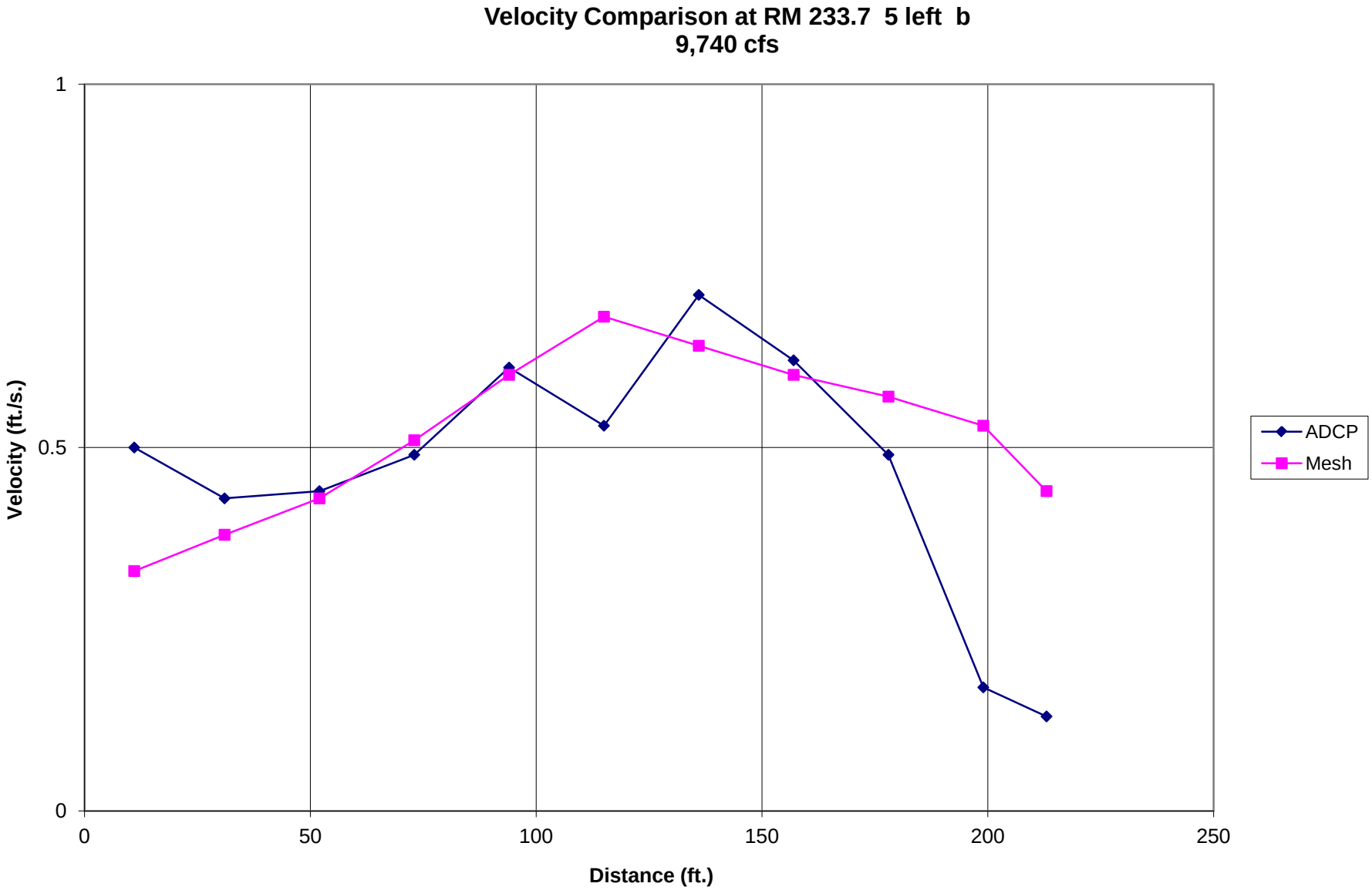
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Distance (ft.)
ADCP
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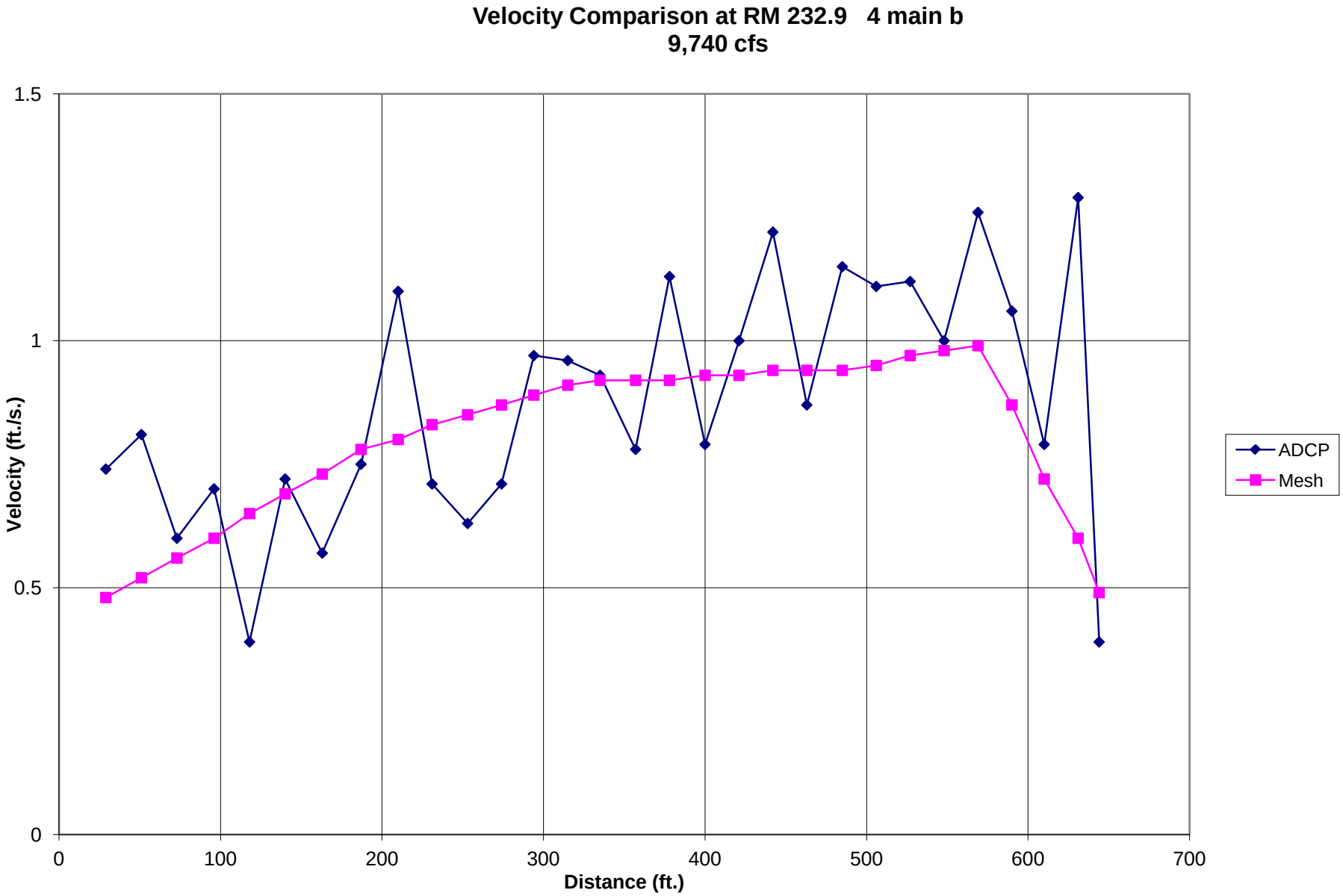
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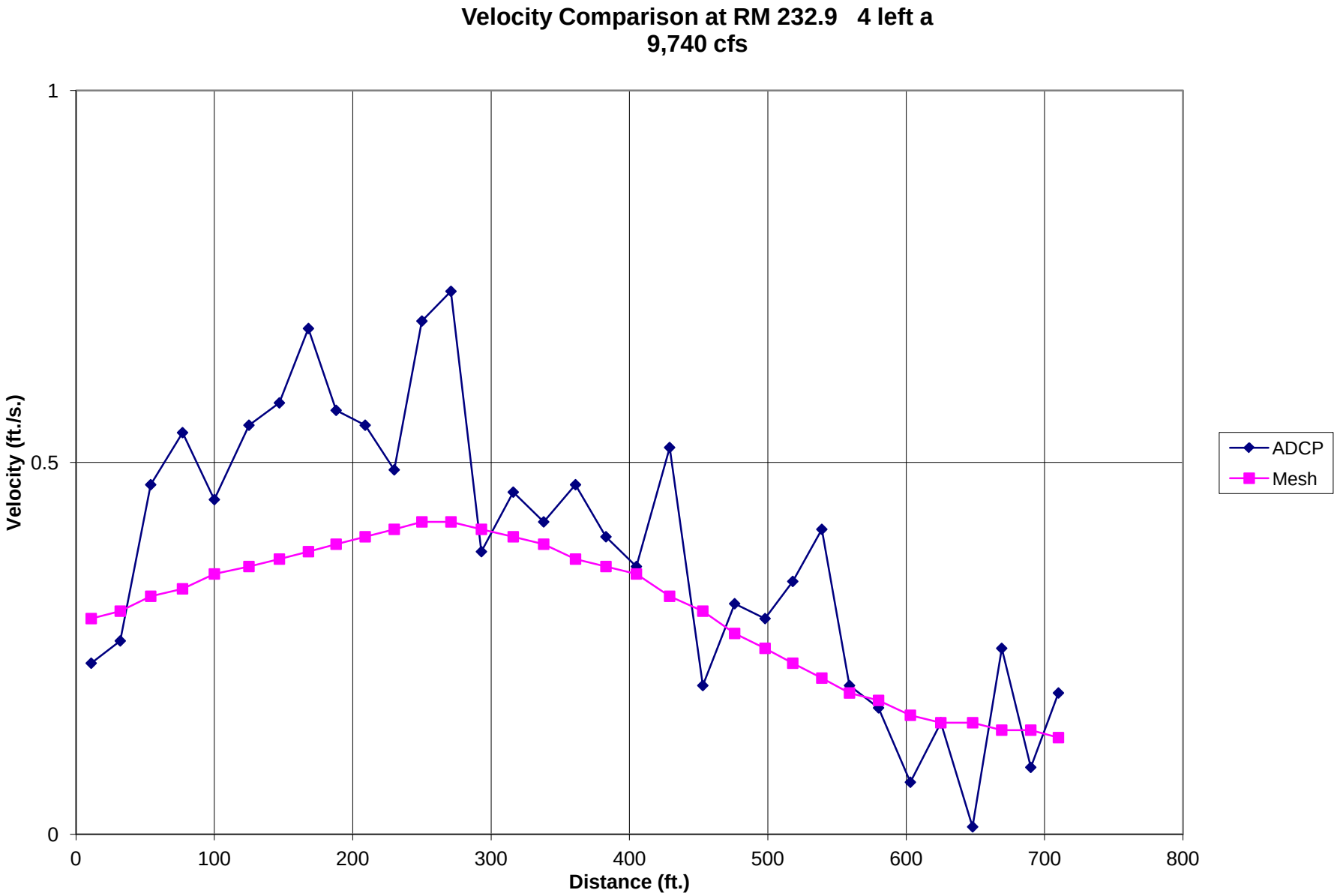
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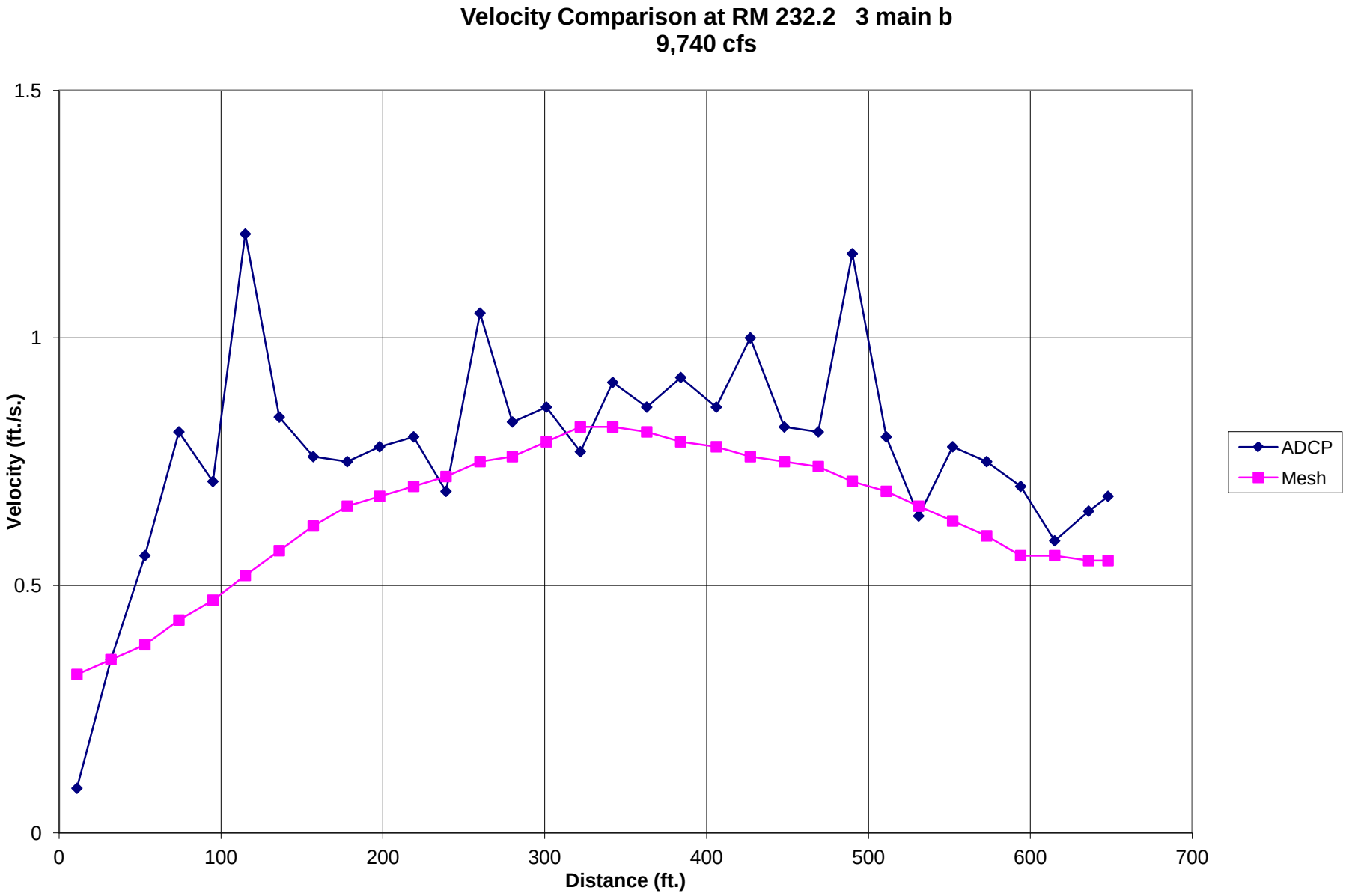
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Velocity (ft./s.)
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100
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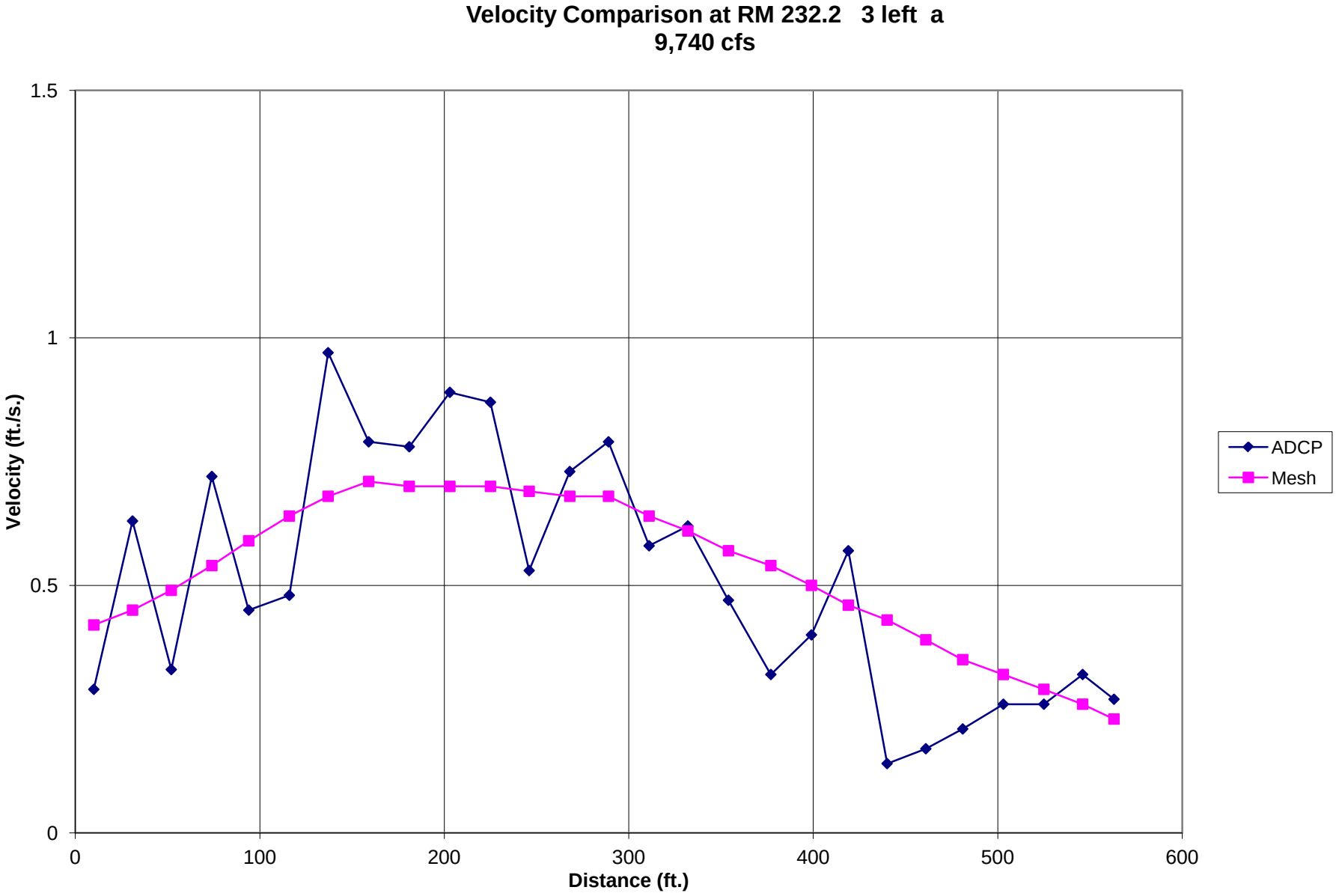
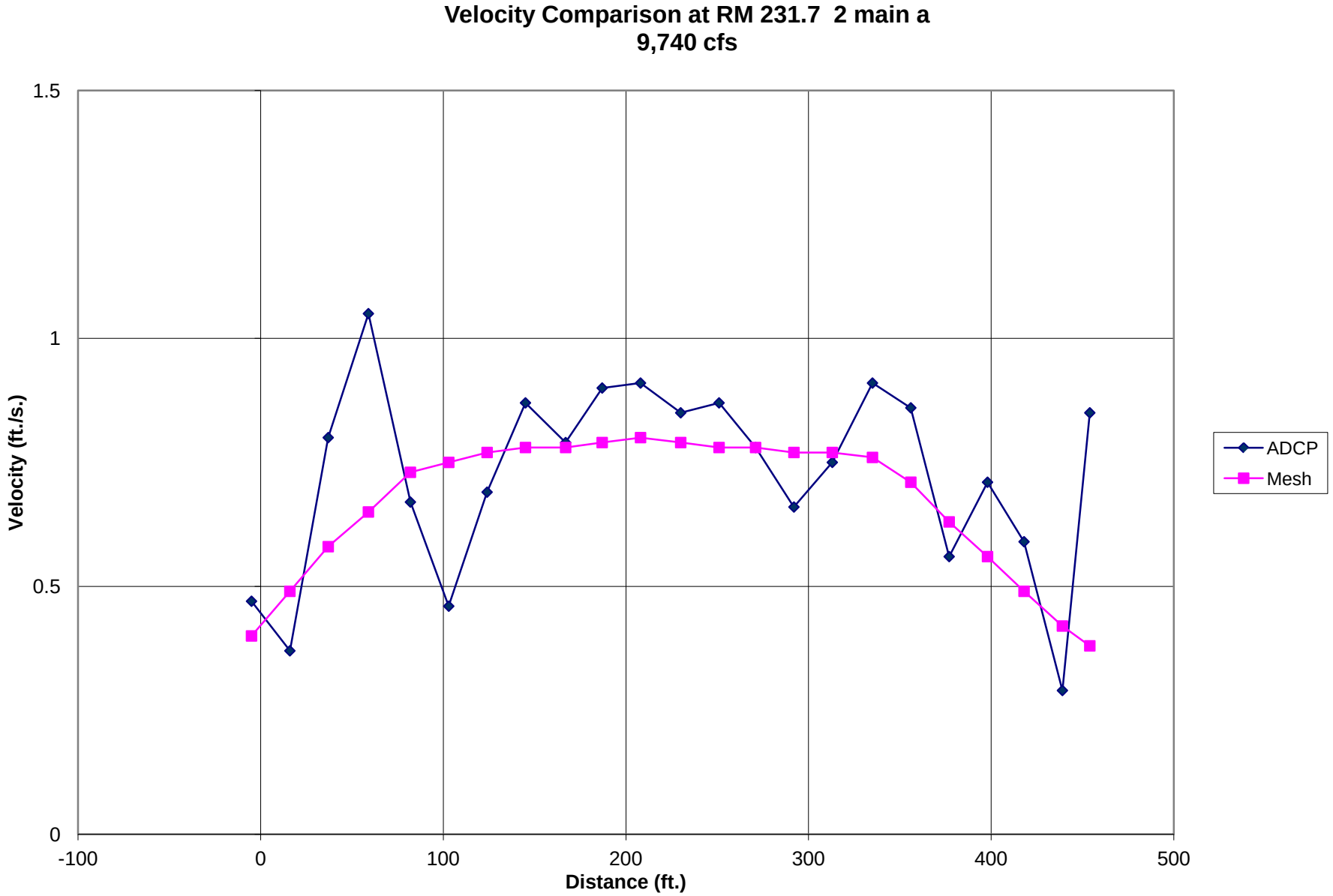
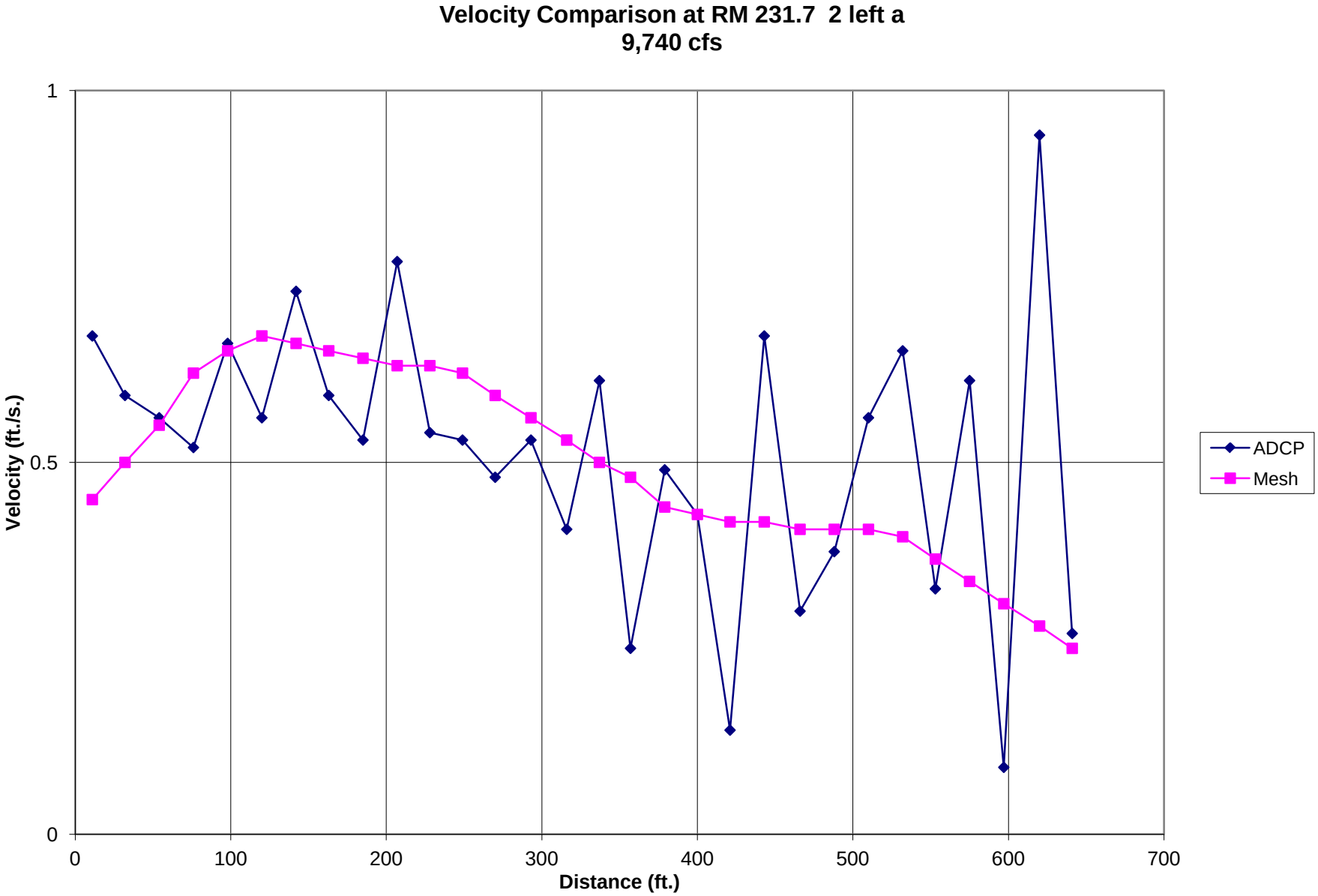
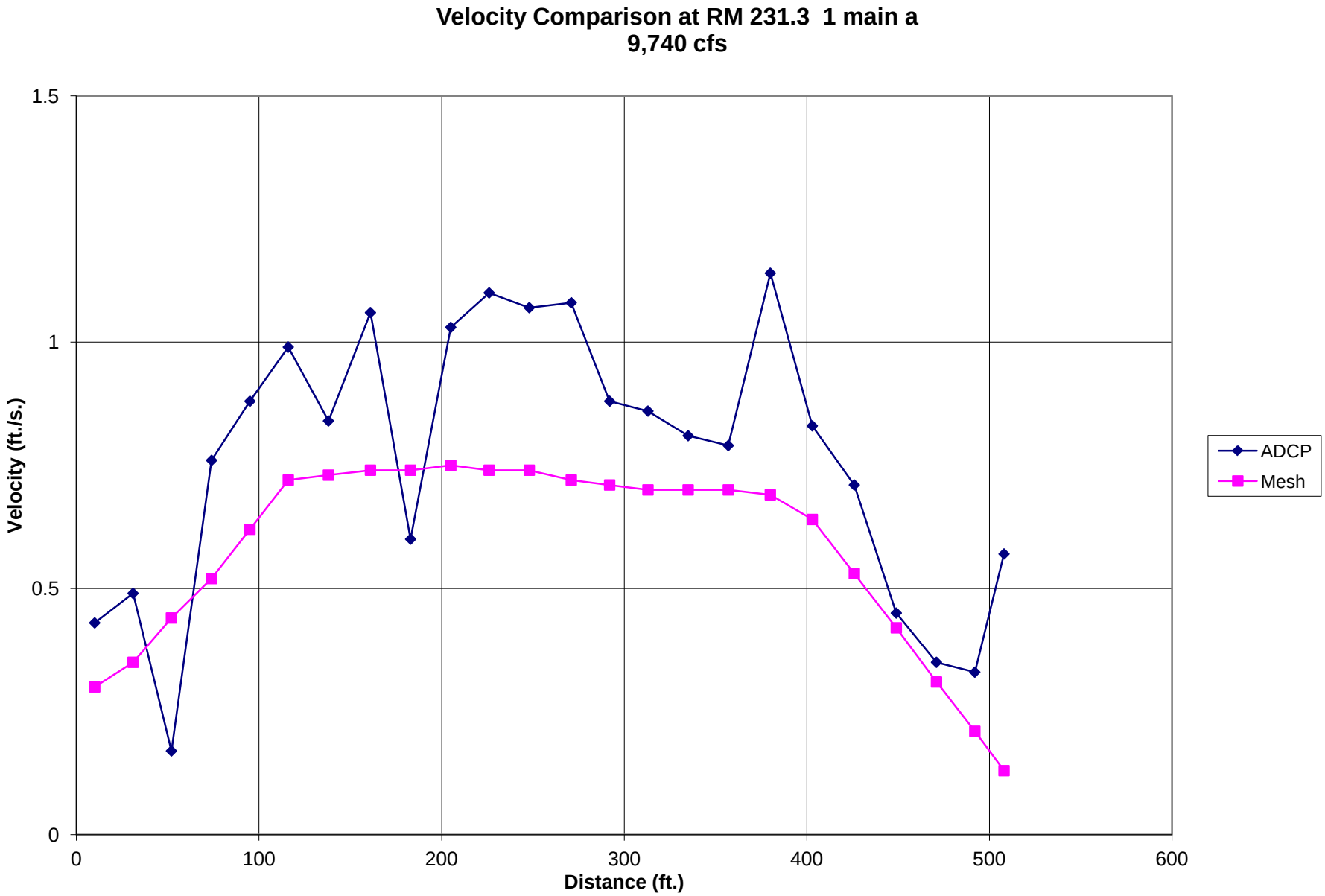
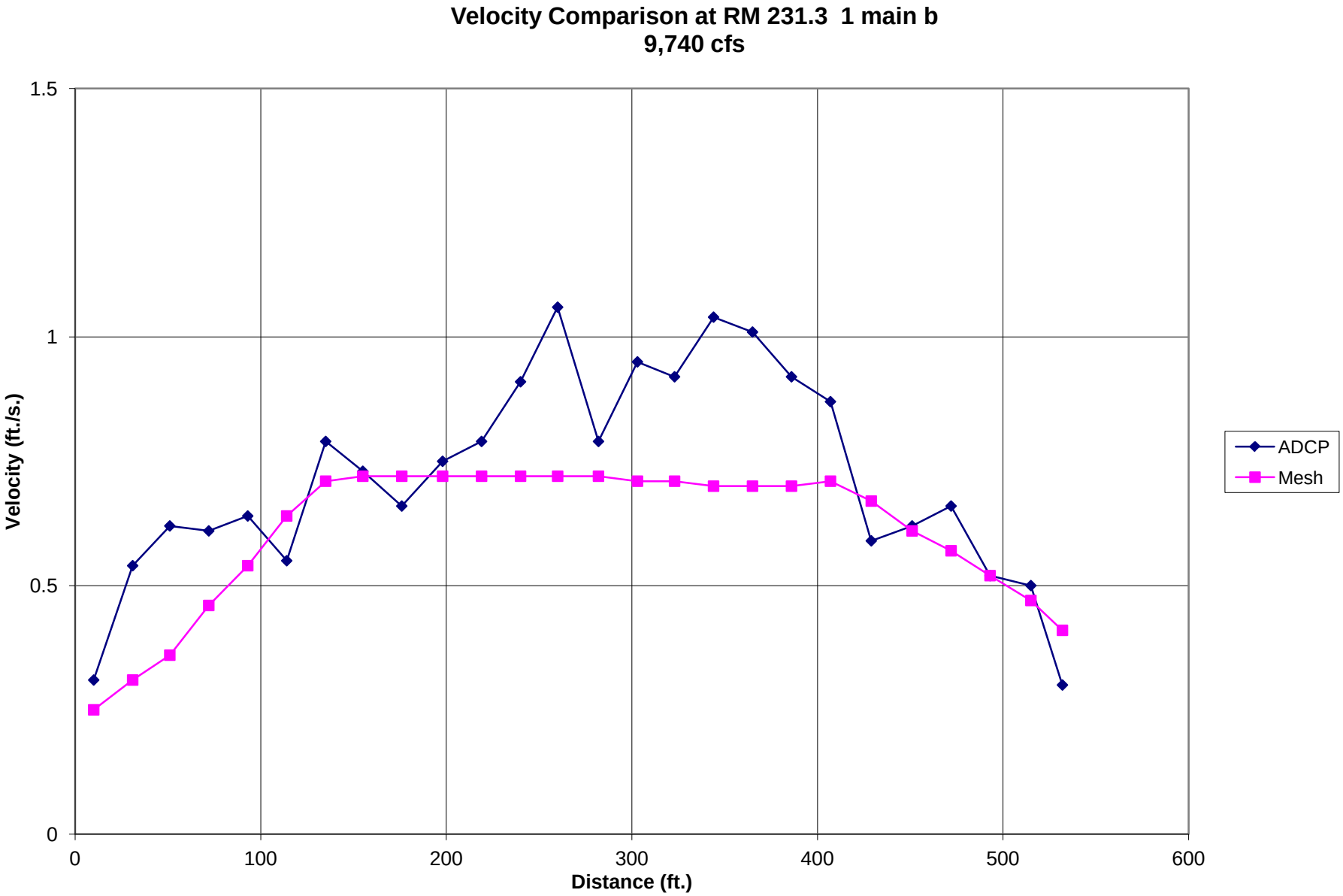
600
700
Distance (ft.)
ADCP
Mesh

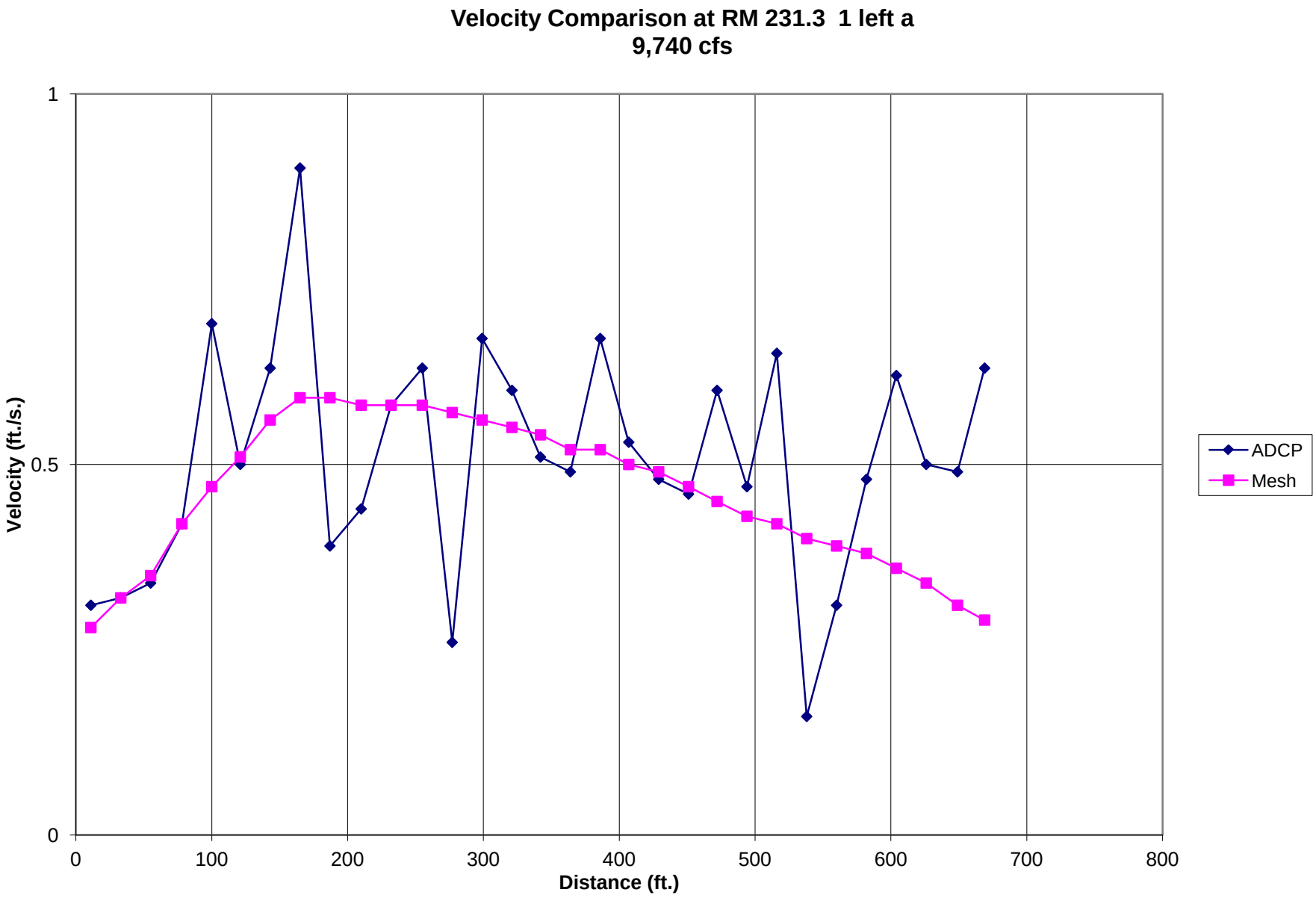

Velocity Comparison at RM 232.2 3 left a
9,740 cfs
1.5
1
0.5
0
Velocity (ft./s.)
0
100
200
300
400
500
600
Distance (ft.)
ADCP
Mesh

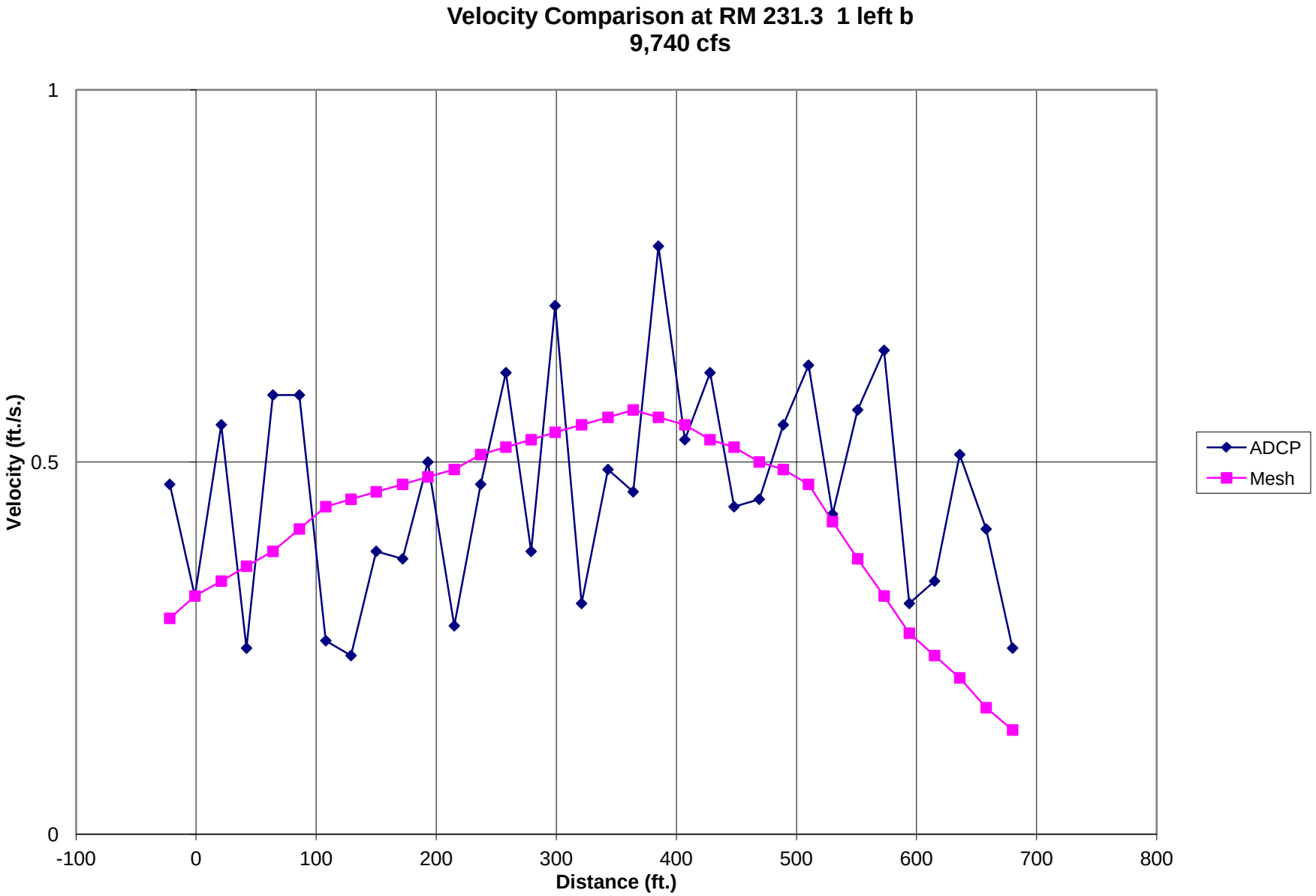

Velocity Comparison at RM 231.7 2 main a
9,740 cfs
1.5
1
0.5
0
Velocity (ft./s.)
-100
0
100
200
300
400
500
Distance (ft.)
ADCP
Mesh

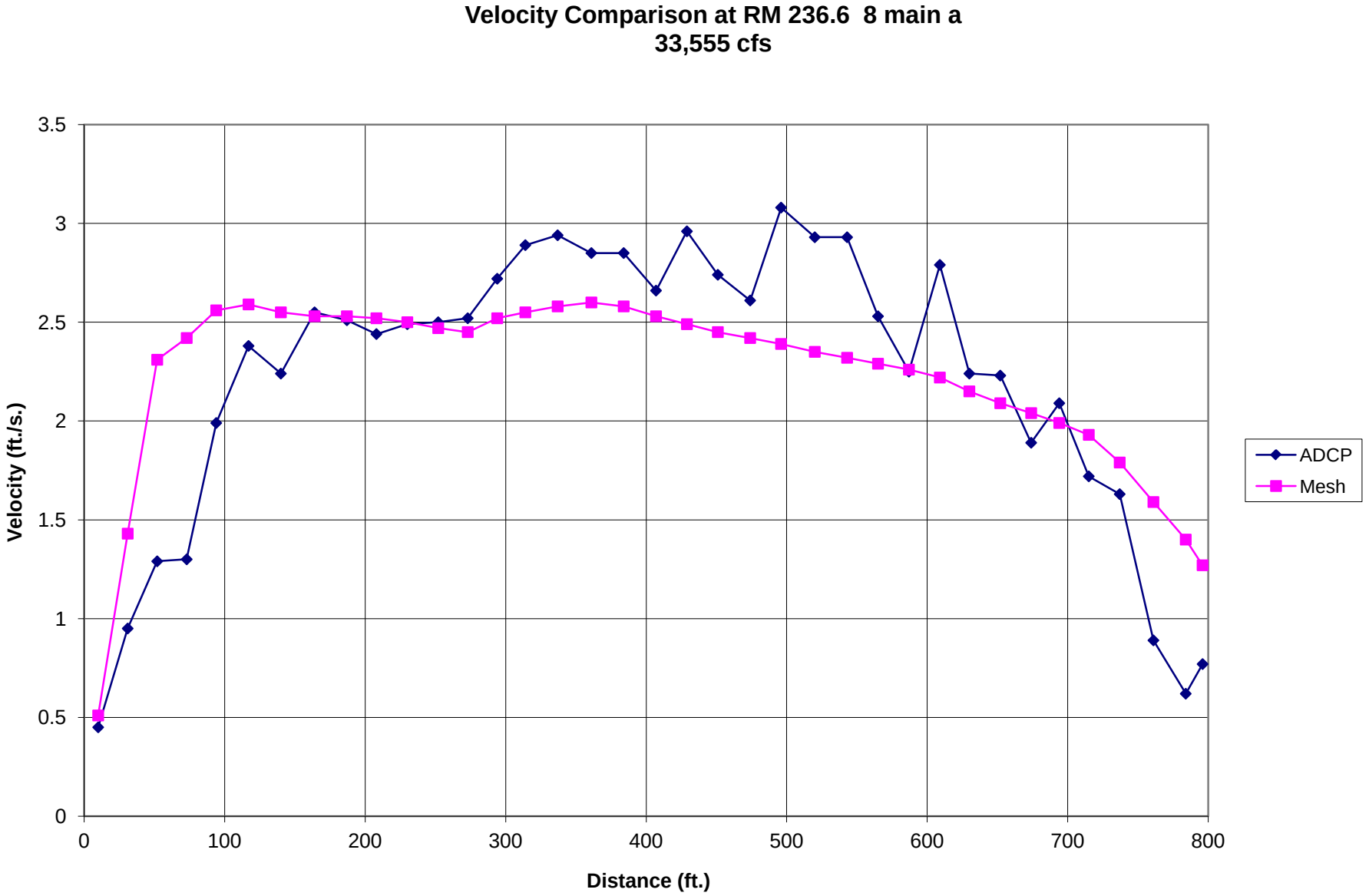

Velocity Comparison at RM 231.7 2 left a
9,740 cfs
Velocity (ft./s.)
1
0.5
0
0
100
200
300
400
500
600
700
Distance (ft.)
ADCP
Mesh

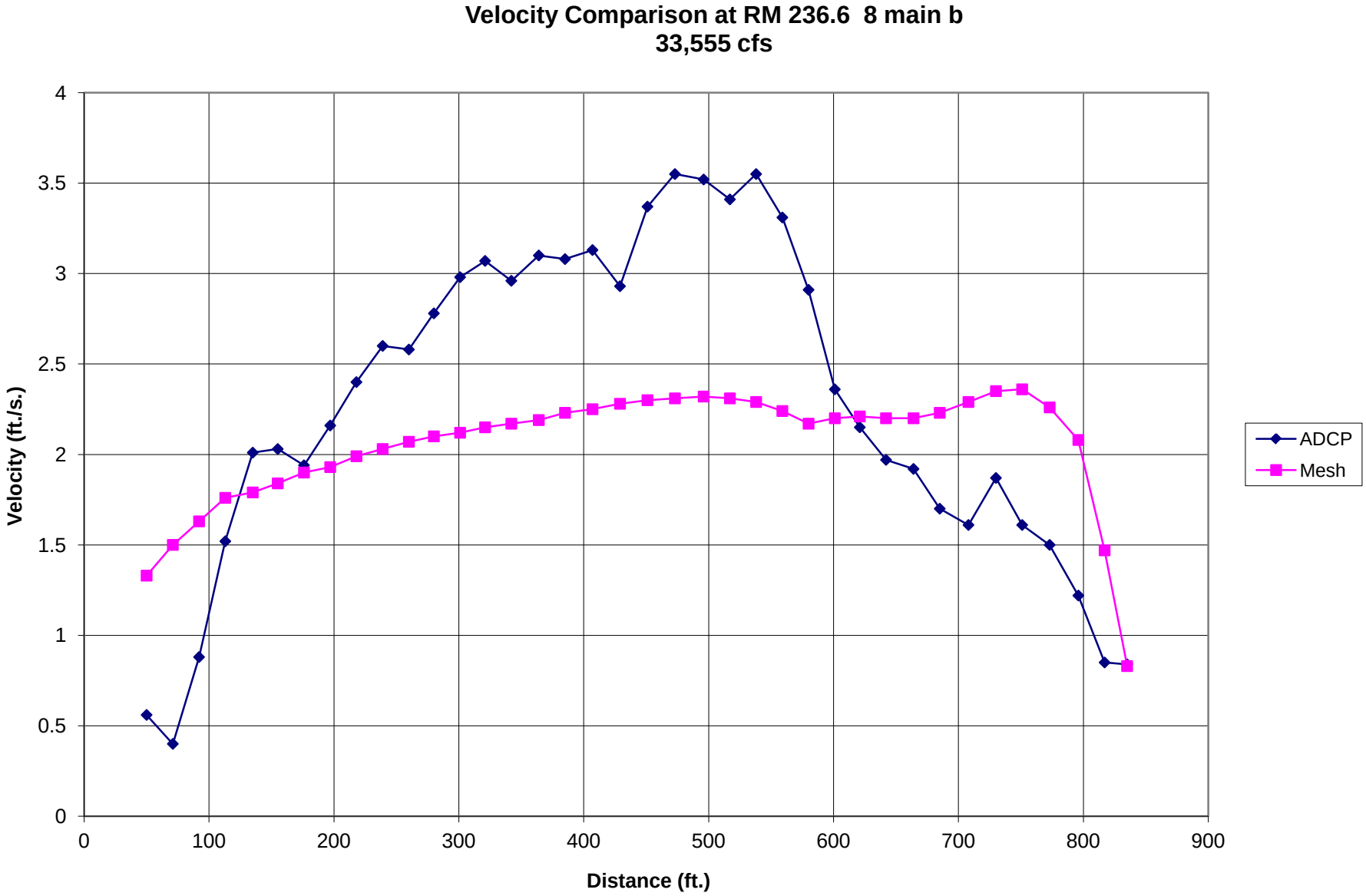

Velocity Comparison at RM 231.3 1 main a
9,740 cfs
1.5
1
0.5
0
Velocity (ft./s.)
0
100
200
300
400
500
600
Distance (ft.)
ADCP
Mesh

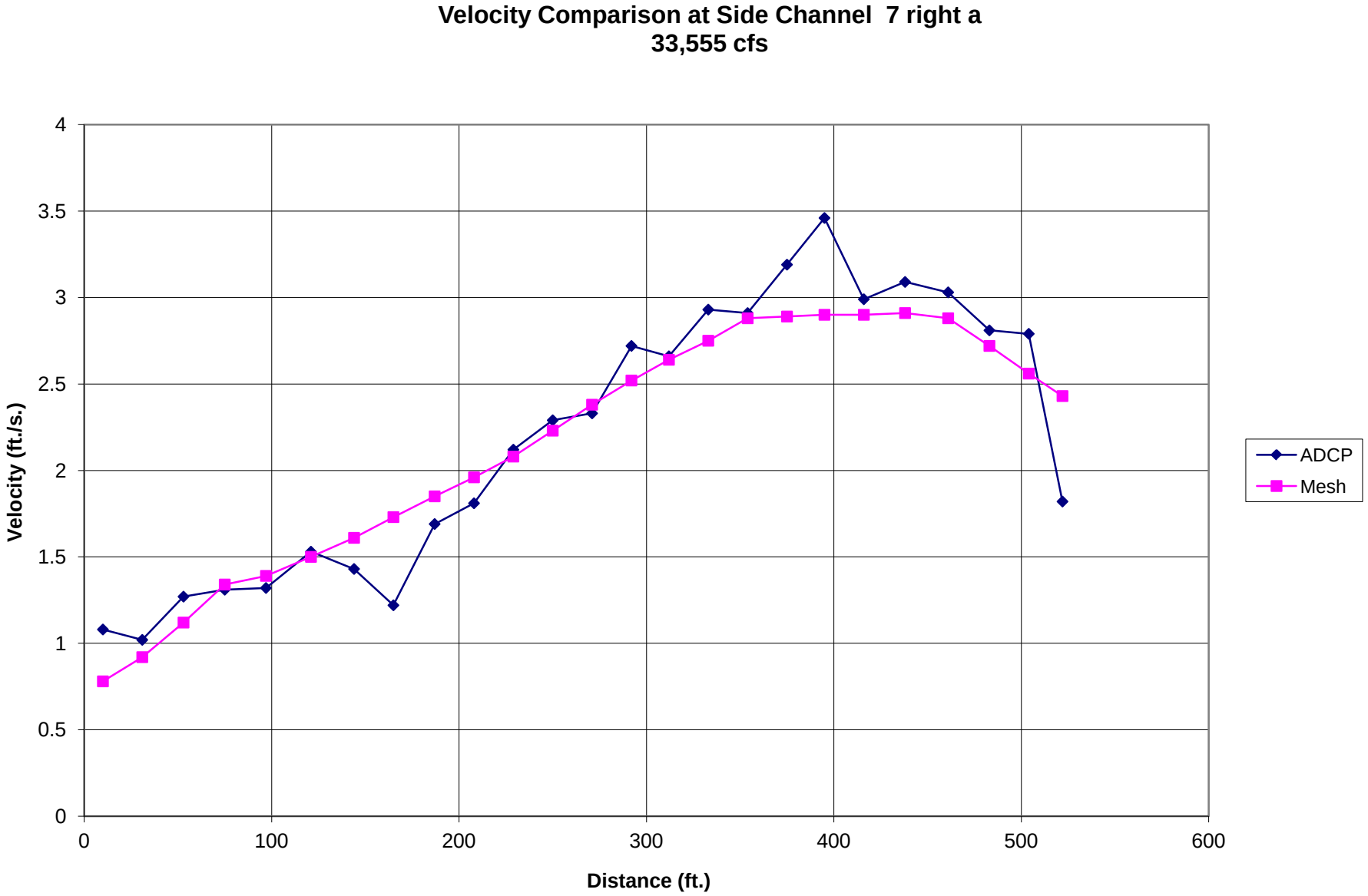

Velocity Comparison at RM 231.3 1 main b
9,740 cfs
1.5
1
0.5
0
Velocity (ft./s.)
0
100
200
300
400
500
600
Distance (ft.)
ADCP
Mesh

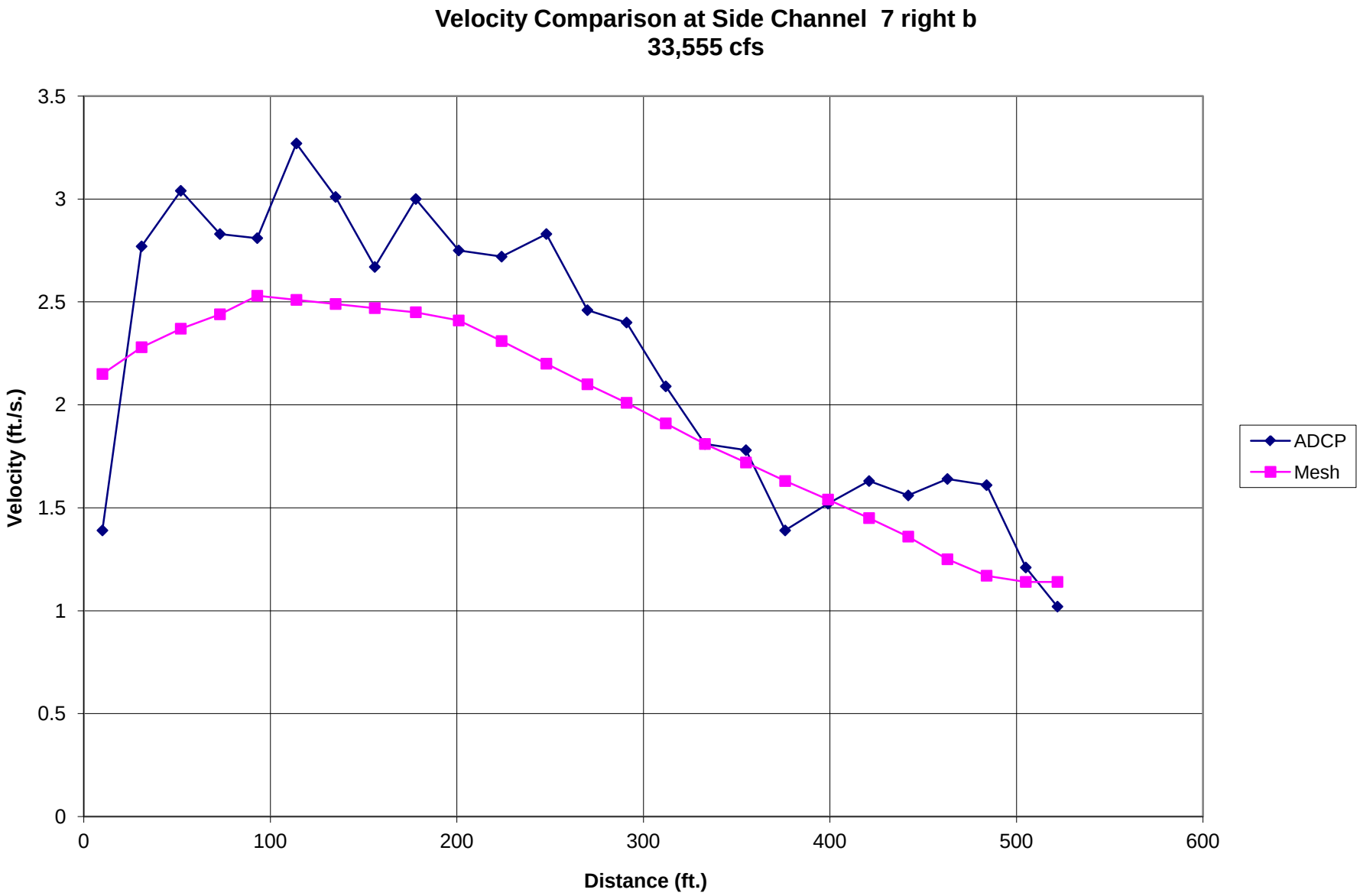

Velocity Comparison at RM 231.3 1 left a
9,740 cfs
Velocity (ft./s.)
1
0.5
0
0
100
200
300
400
500
600
700
800
Distance (ft.)
ADCP
Mesh

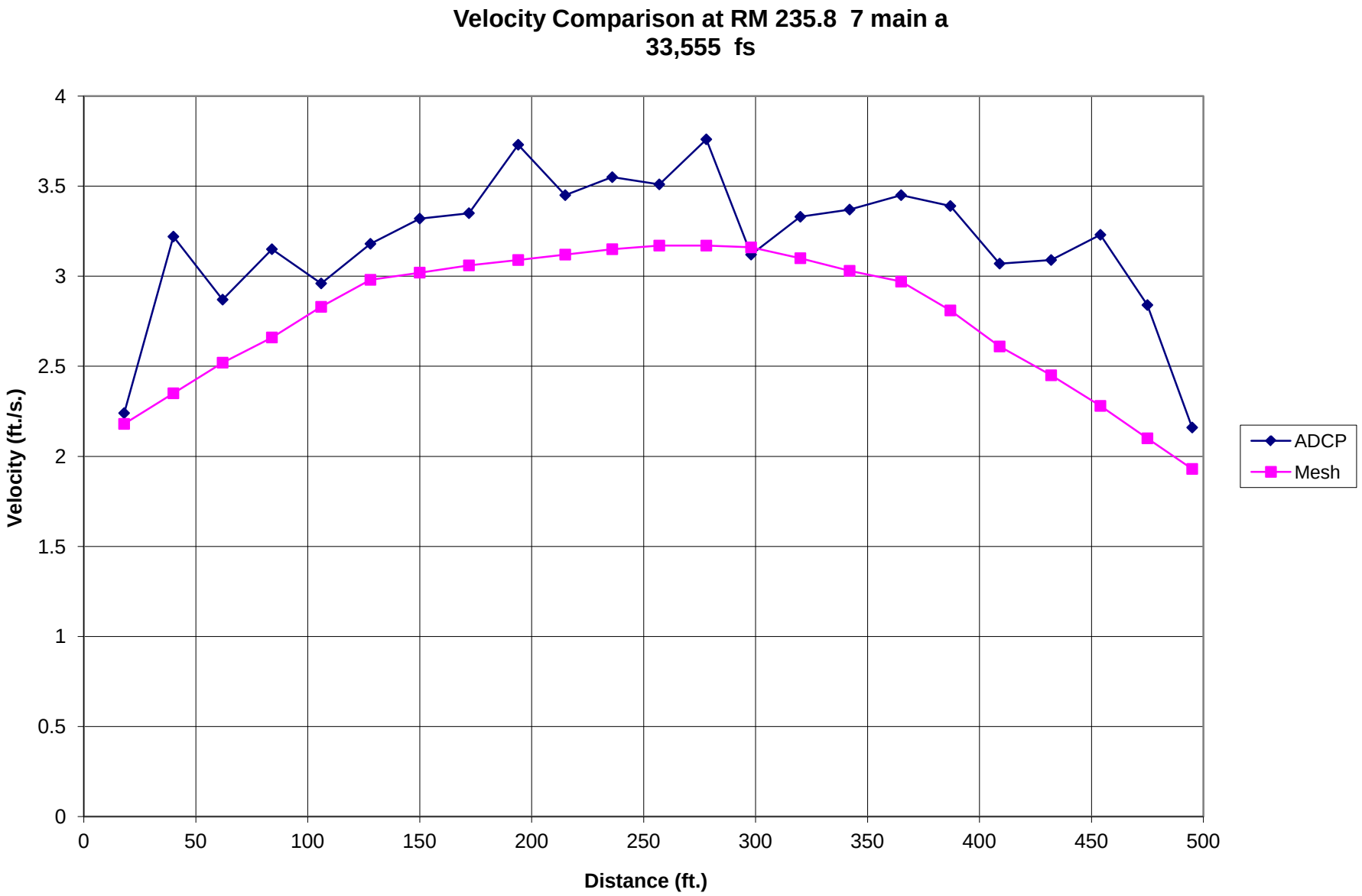

Velocity Comparison at RM 231.3 1 left b
9,740 cfs
Velocity (ft./s.)
1
0.5
0
-100
0
100
200
300
400
500
600
700
800
Distance (ft.)
ADCP
Mesh

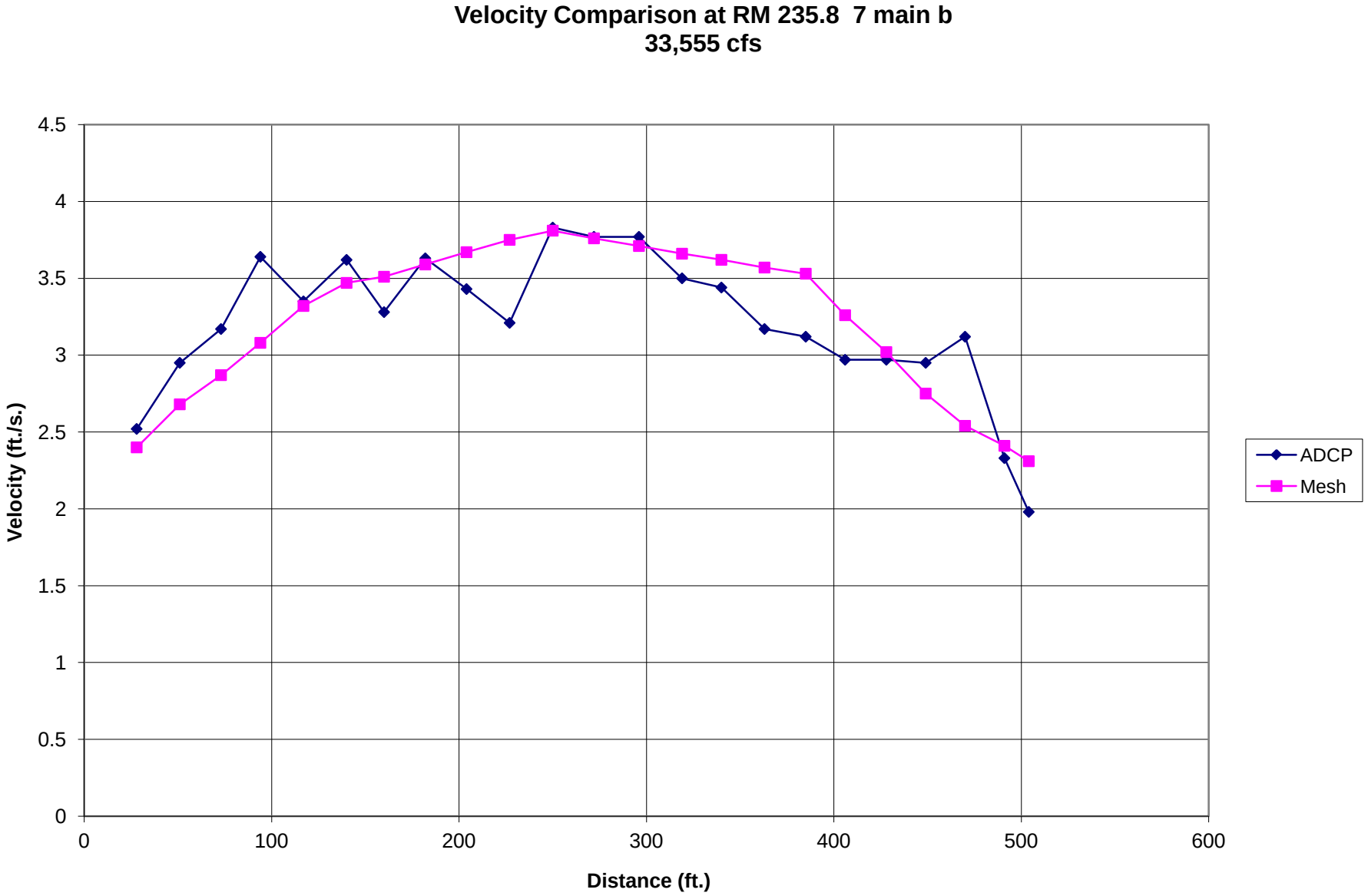

Velocity Comparison at RM 236.6 8 main a
33,555 cfs
Velocity (ft./s.)
Distance (ft.)
0
0.5
1
1.5
2
2.5
3
3.5
0
100
200
300
400
500
600
700
800
ADCP
Mesh

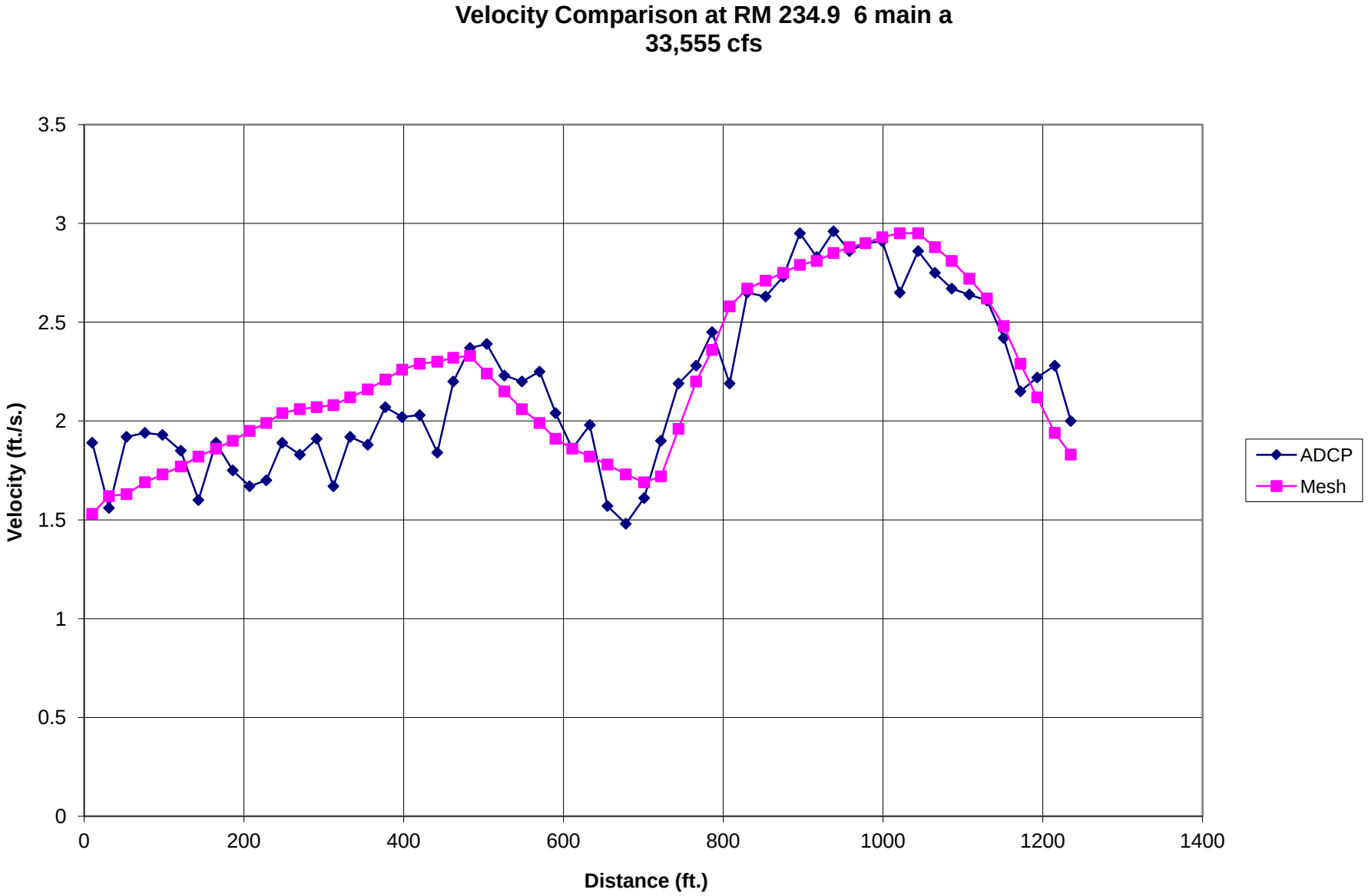

Velocity Comparison at RM 236.6 8 main b
33,555 cfs
Velocity (ft./s.)
Distance (ft.)
0
0.5
1
1.5
2
2.5
3
3.5
4
0
100
200
300
400
500
600
700
800
900
ADCP
Mesh

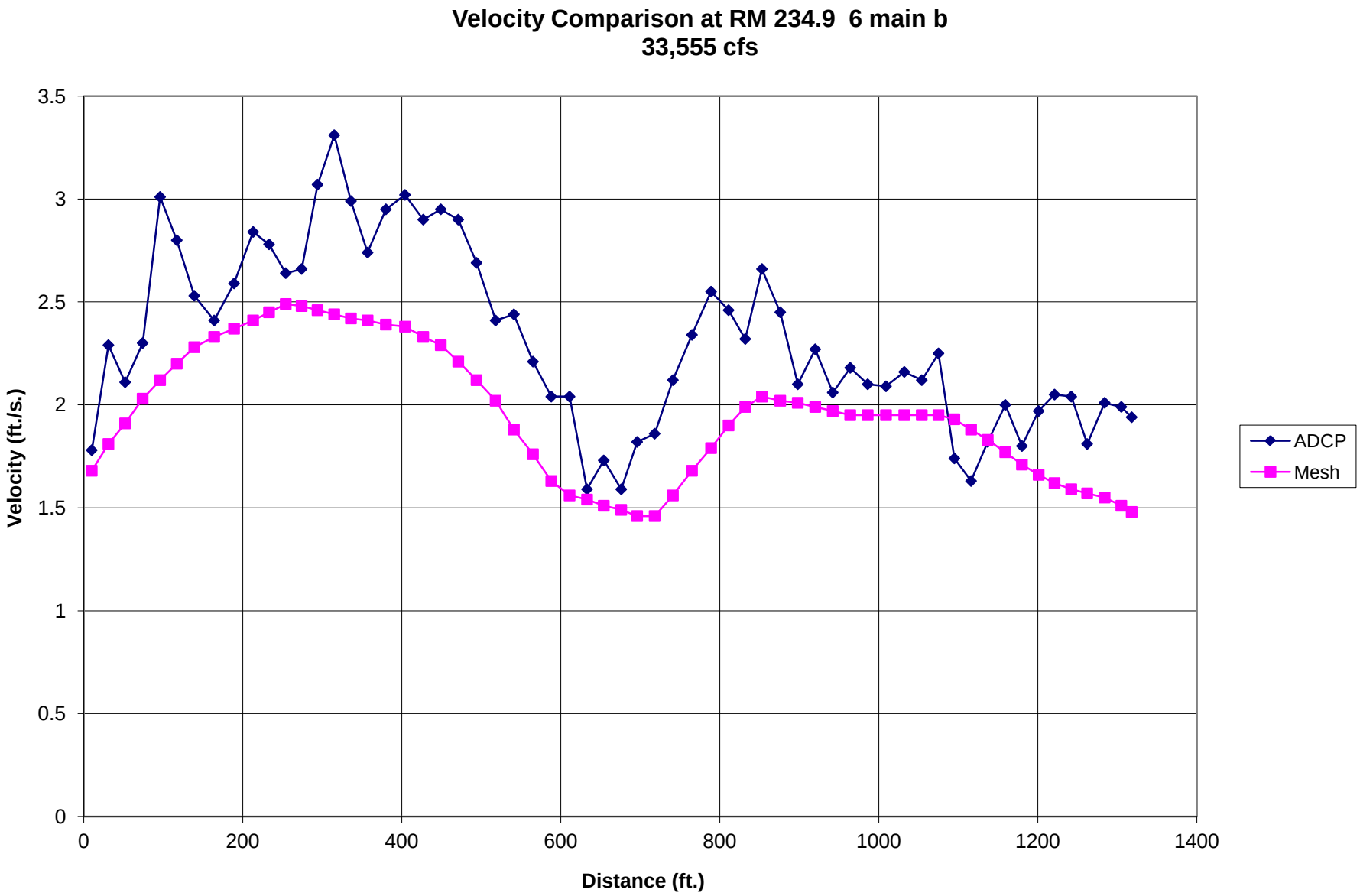

Velocity Comparison at Side Channel 7 right a
33,555 cfs
Velocity (ft./s.)
Distance (ft.)
0
0.5
1
1.5
2
2.5
3
3.5
4
0
100
200
300
400
500
600
ADCP
Mesh

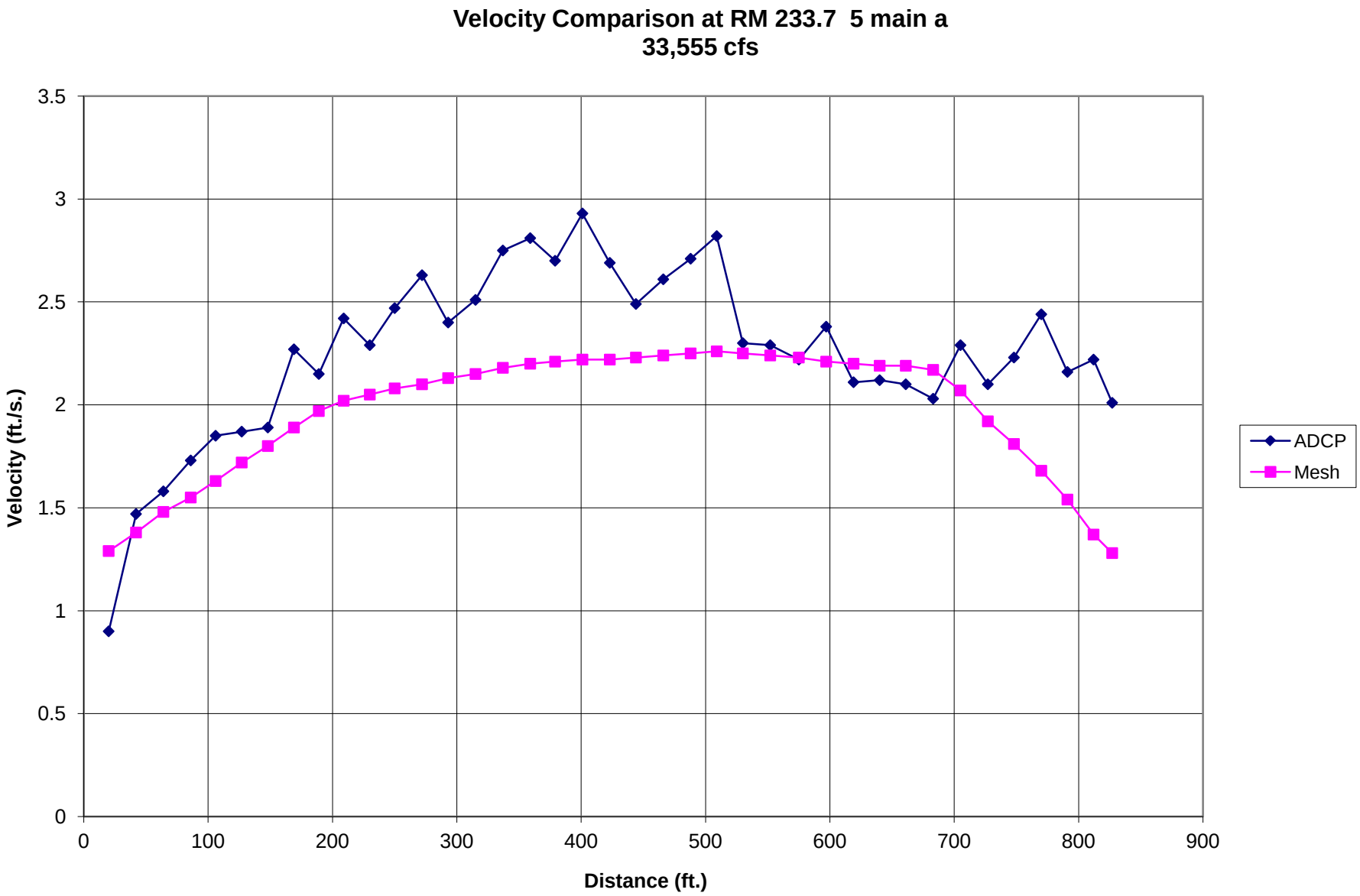

Velocity Comparison at Side Channel 7 right b
33,555 cfs
Velocity (ft./s.)
Distance (ft.)
0
0.5
1
1.5
2
2.5
3
3.5
0
100
200
300
400
500
600
ADCP
Mesh

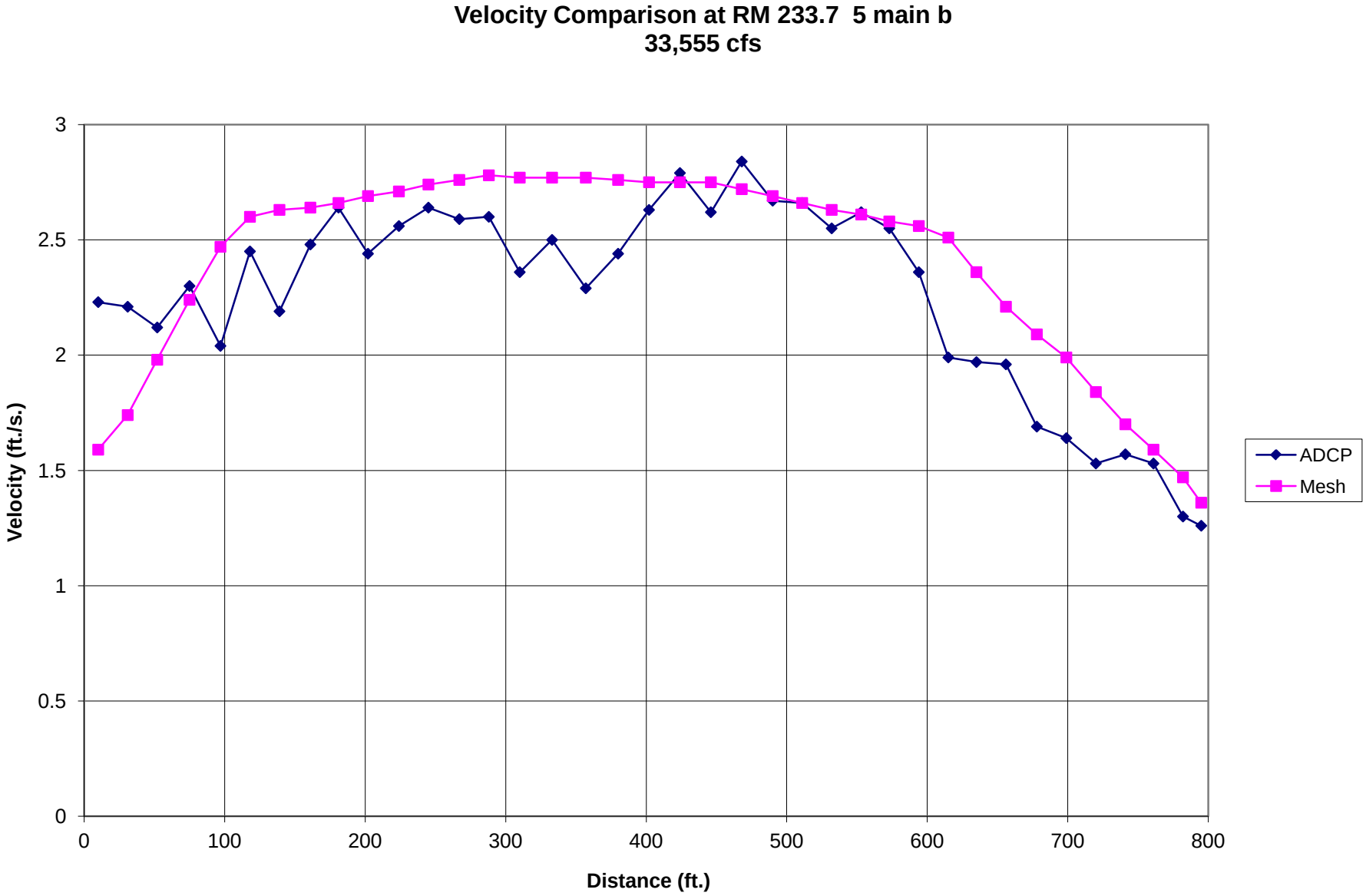

Velocity Comparison at RM 235.8 7 main a
33,555 fs
Velocity (ft./s.)
Distance (ft.)
0
0.5
1
1.5
2
2.5
3
3.5
4
0
50
100
150
200
250
300
350
400
450
500
ADCP
Mesh

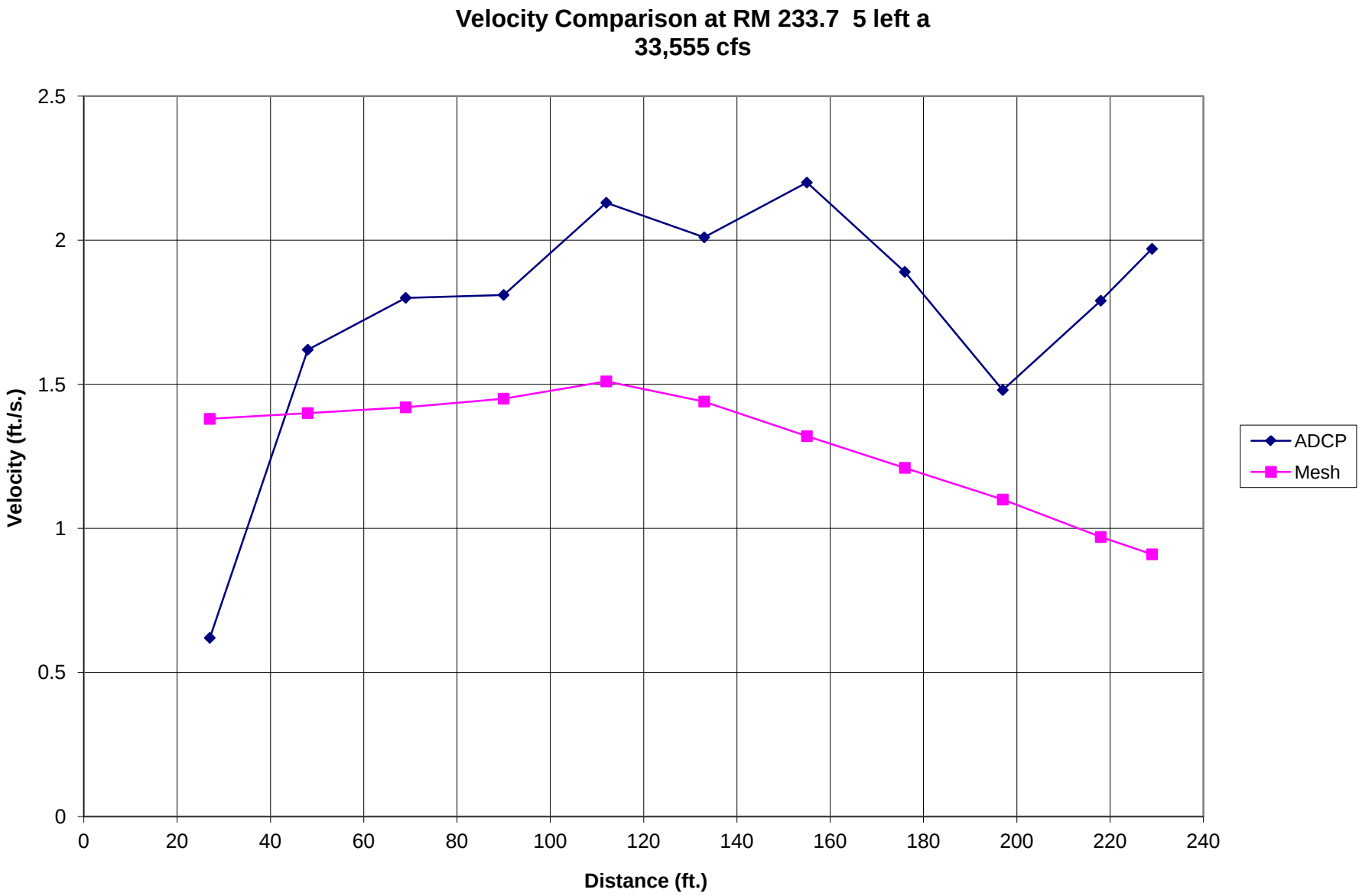

Velocity Comparison at RM 235.8 7 main b
33,555 cfs
Velocity (ft./s.)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
500
600
Distance (ft.)
ADCP
Mesh

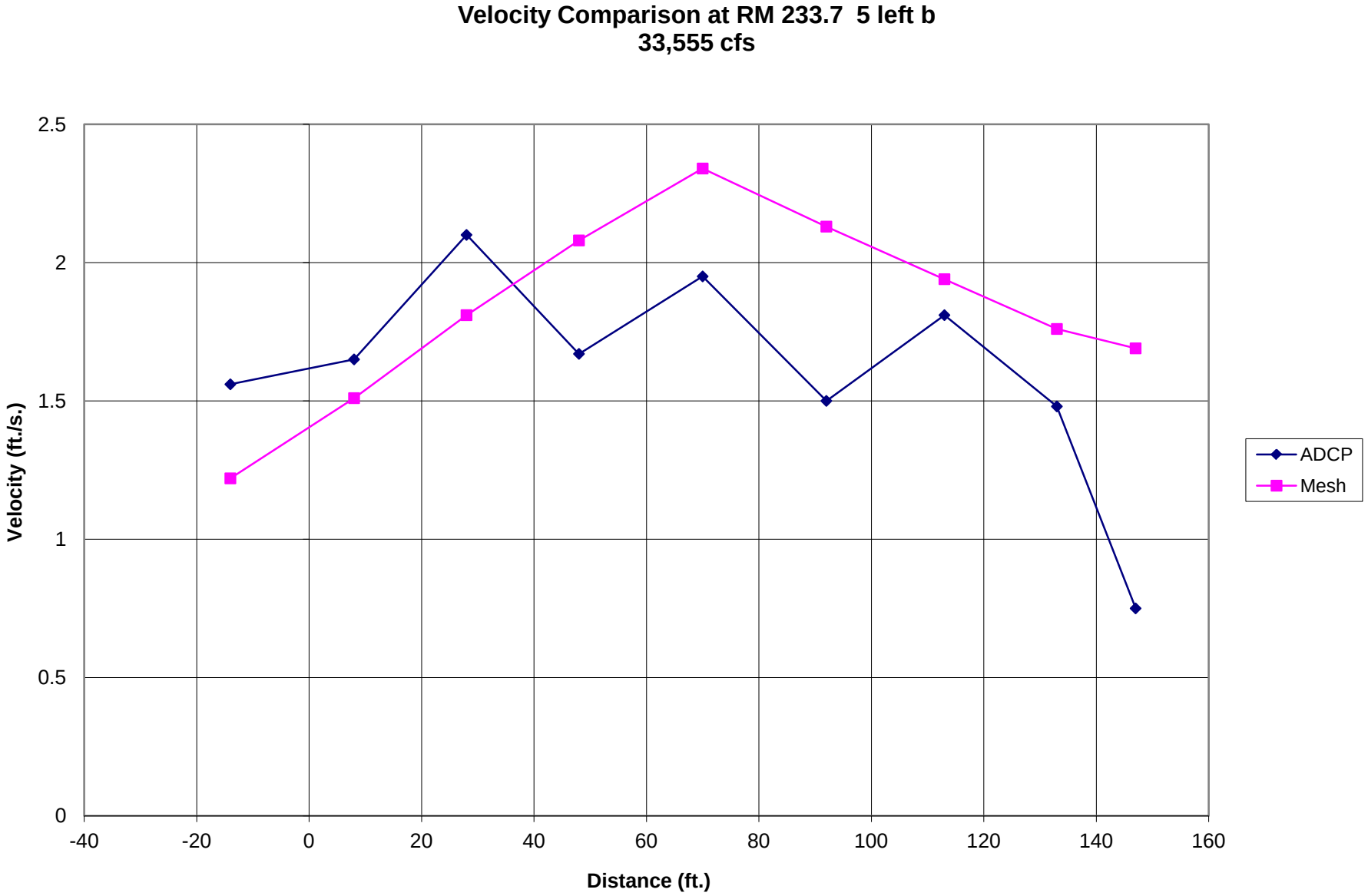

Velocity Comparison at RM 234.9 6 main a
33,555 cfs
Velocity (ft./s.)
3.5
3
2.5
2
1.5
1
0.5
0
0
200
400
600
800
1000
1200
1400
Distance (ft.)
ADCP
Mesh

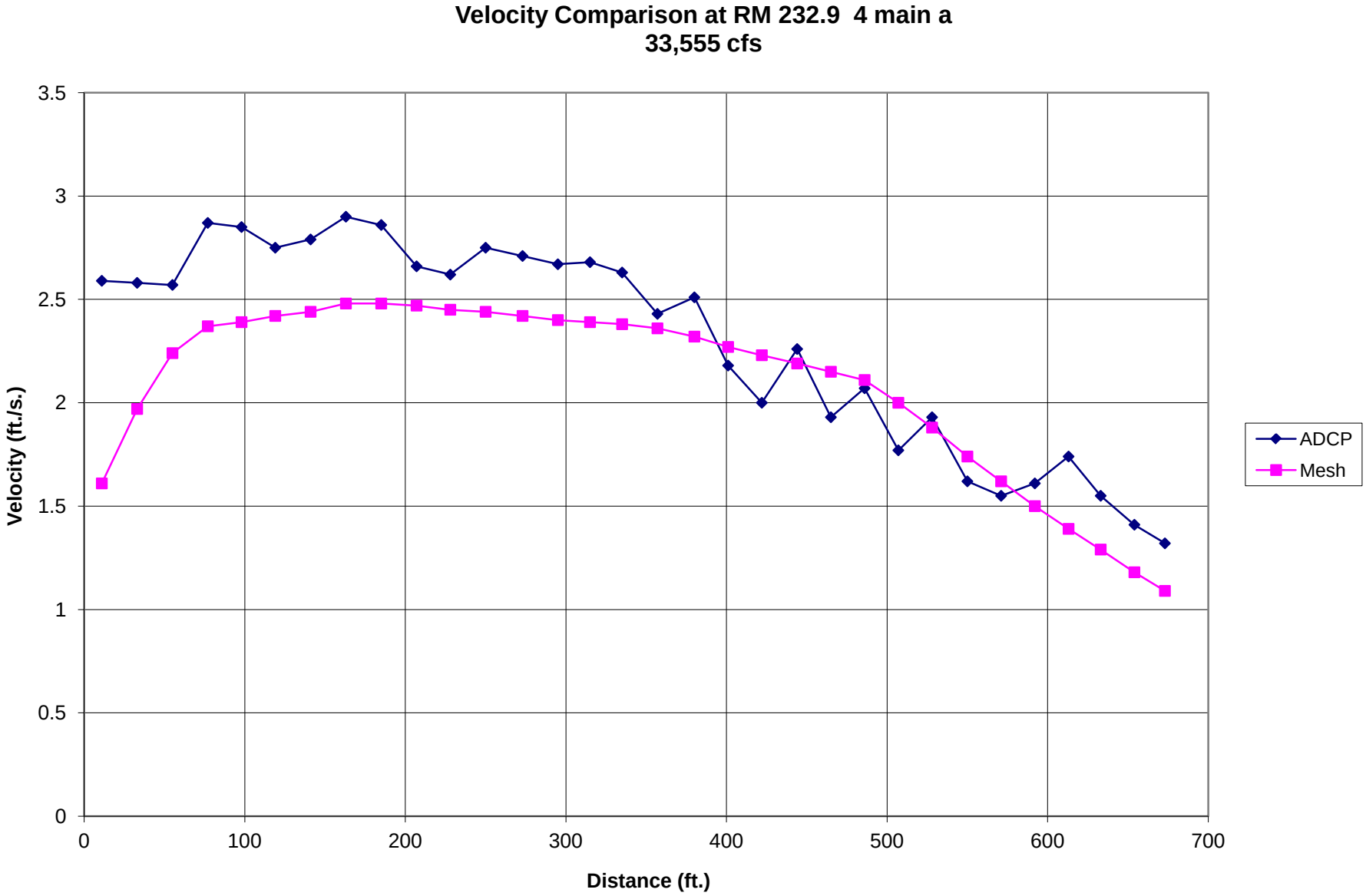

Velocity Comparison at RM 234.9 6 main b
33,555 cfs
Velocity (ft./s.)
3.5
3
2.5
2
1.5
1
0.5
0
0
200
400
600
800
1000
1200
1400
Distance (ft.)
ADCP
Mesh

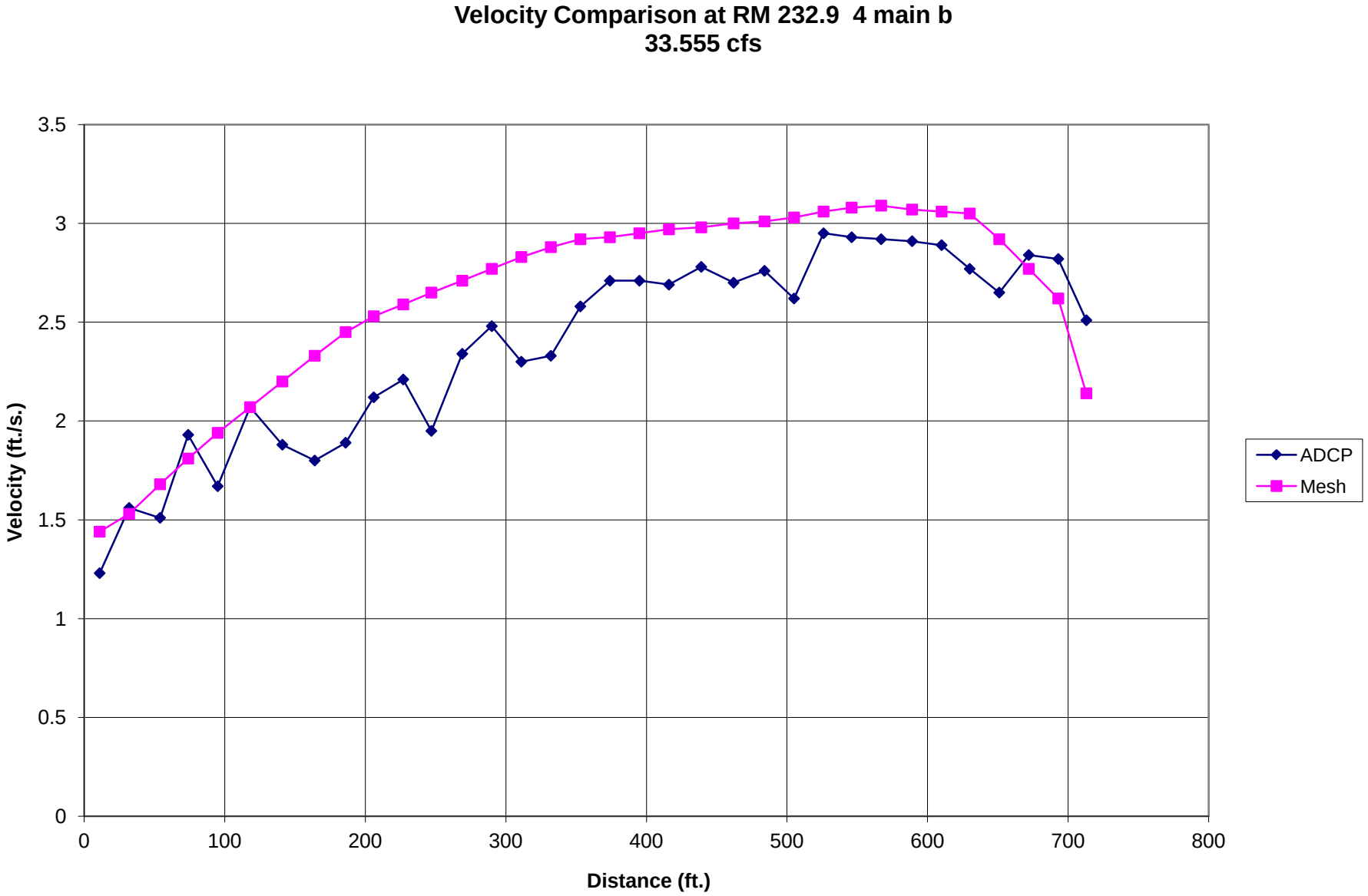

Velocity Comparison at RM 233.7 5 main a
33,555 cfs
Velocity (ft./s.)
Distance (ft.)
0
0.5
1
1.5
2
2.5
3
3.5
0
100
200
300
400
500
600
700
800
900
ADCP
Mesh

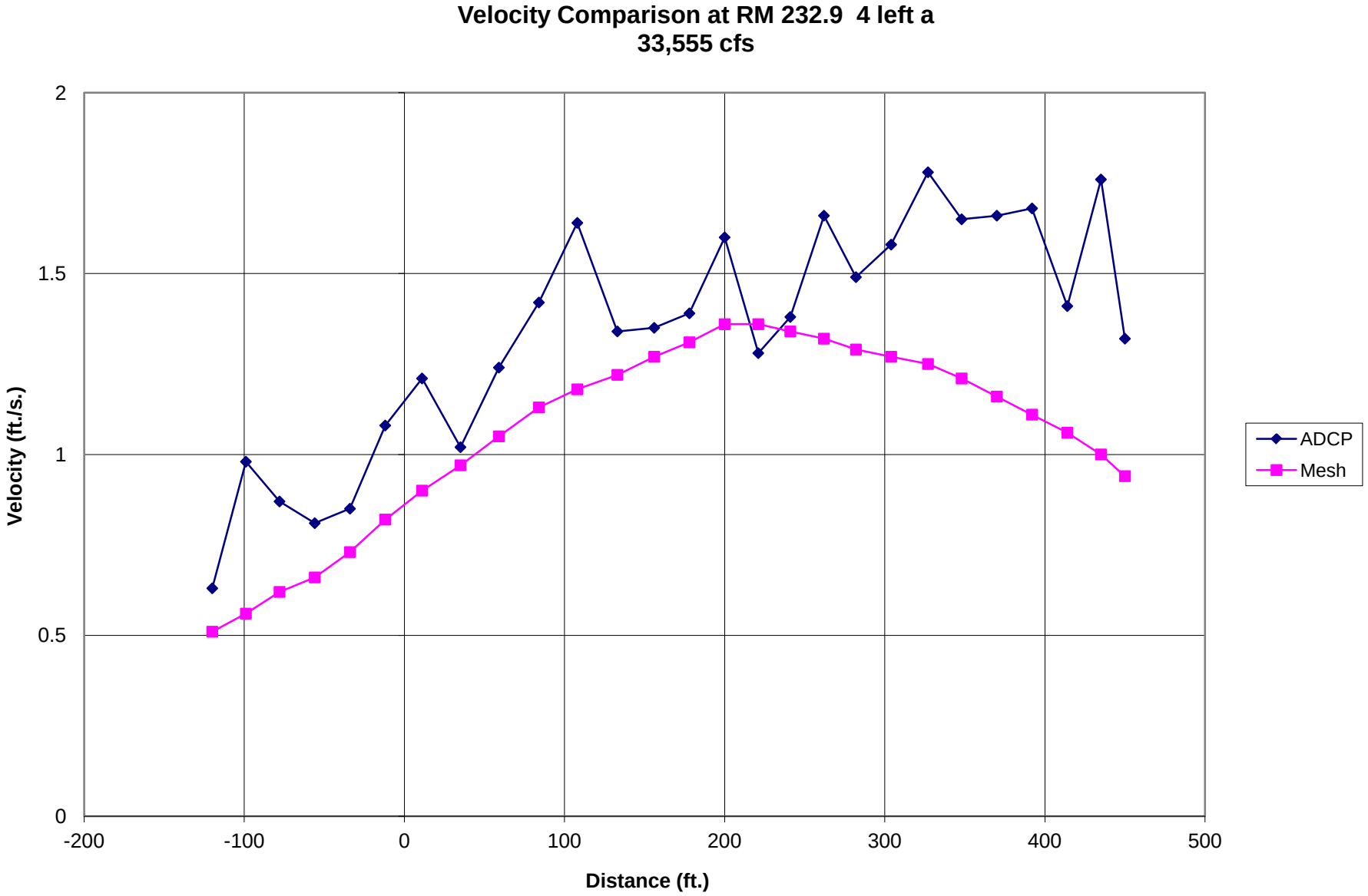

Velocity Comparison at RM 233.7 5 main b
33,555 cfs
Velocity (ft./s.)
Distance (ft.)
0
0.5
1
1.5
2
2.5
3
0
100
200
300
400
500
600
700
800
ADCP
Mesh

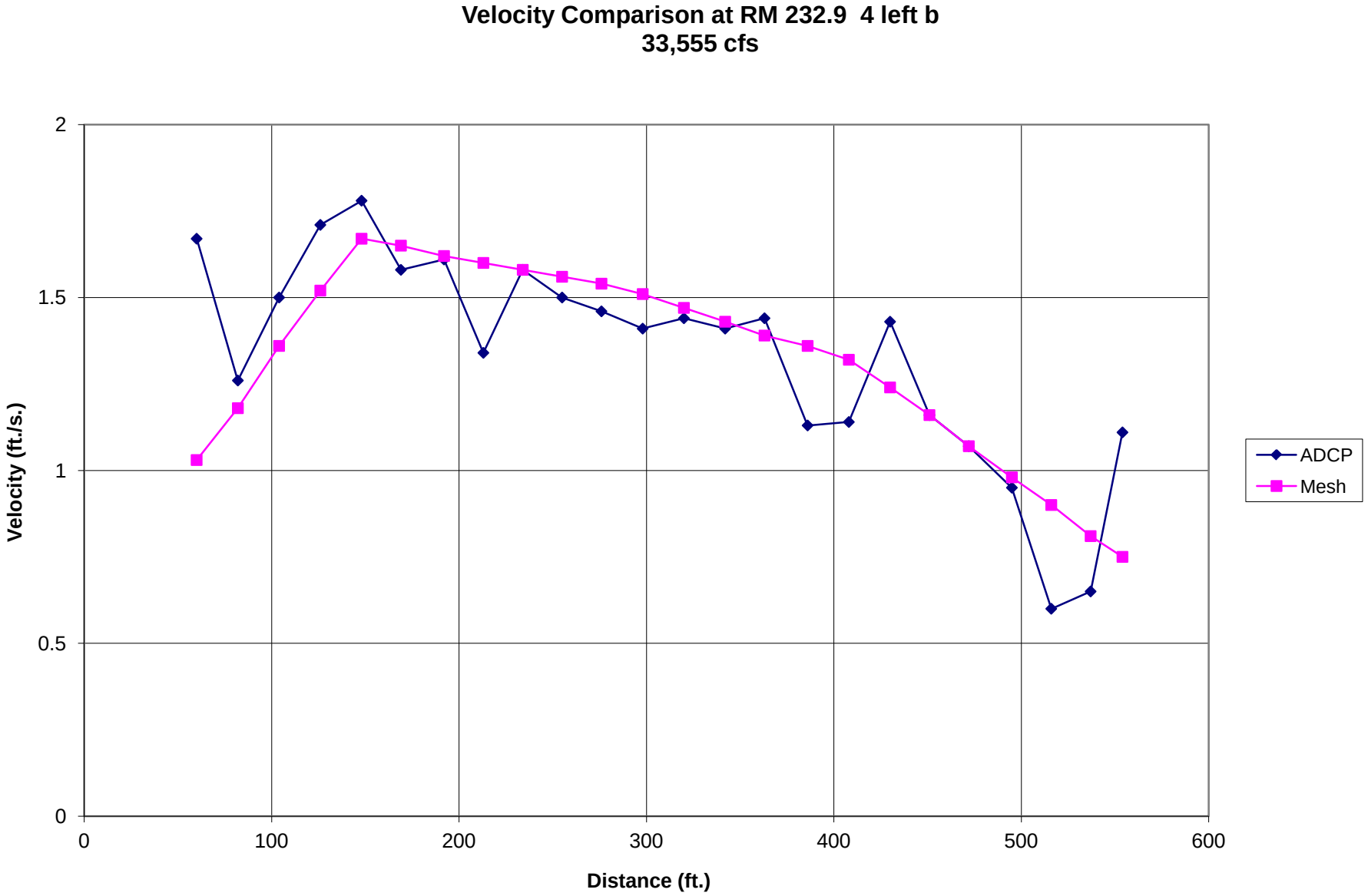

Velocity Comparison at RM 233.7 5 left a
33,555 cfs
Velocity (ft./s.)
2.5
2
1.5
1
0.5
0
0
20
40
60
80
100
120
140
160
180
200
220
240
Distance (ft.)
ADCP
Mesh

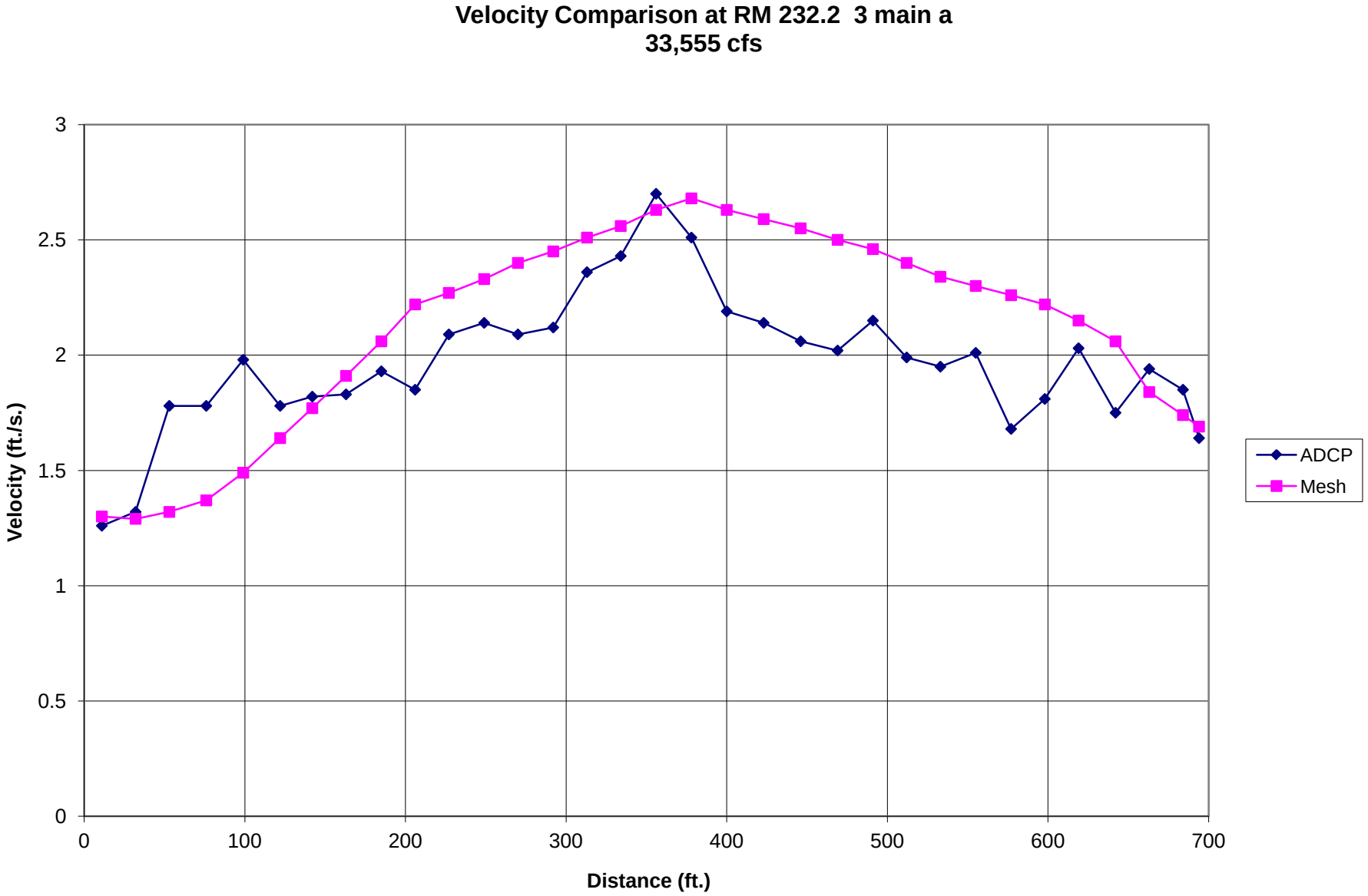

Velocity Comparison at RM 233.7 5 left b
33,555 cfs
Velocity (ft./s.)
2.5
2
1.5
1
0.5
0
-40
-20
0
20
40
60
80
100
120
140
160
Distance (ft.)
ADCP
Mesh

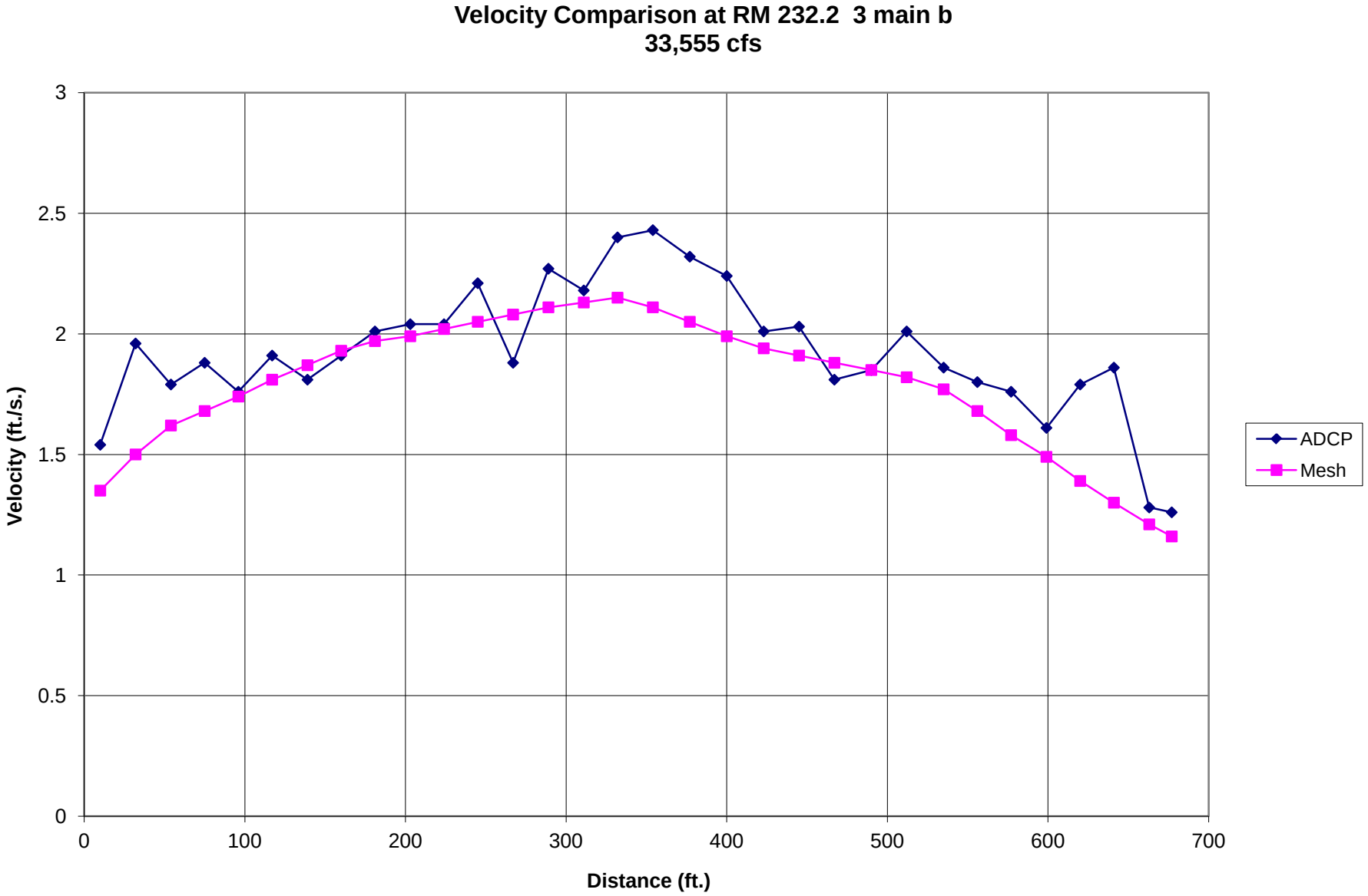

Velocity Comparison at RM 232.9 4 main a
33,555 cfs
Velocity (ft./s.)
3.5
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
500
600
700
Distance (ft.)
ADCP
Mesh

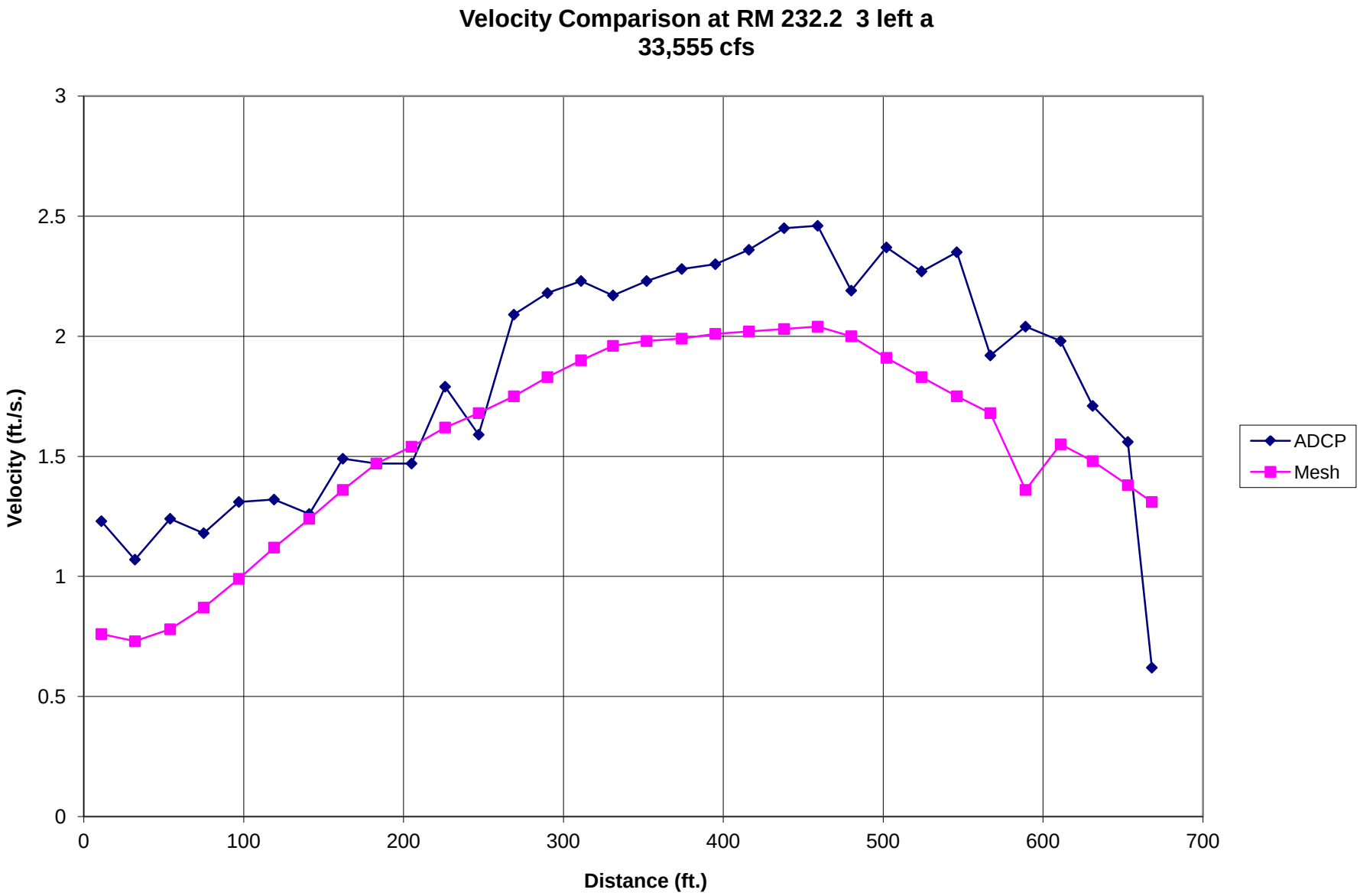

Velocity Comparison at RM 232.9 4 main b
33.555 cfs
Velocity (ft./s.)
Distance (ft.)
0
0.5
1
1.5
2
2.5
3
3.5
0
100
200
300
400
500
600
700
800
ADCP
Mesh

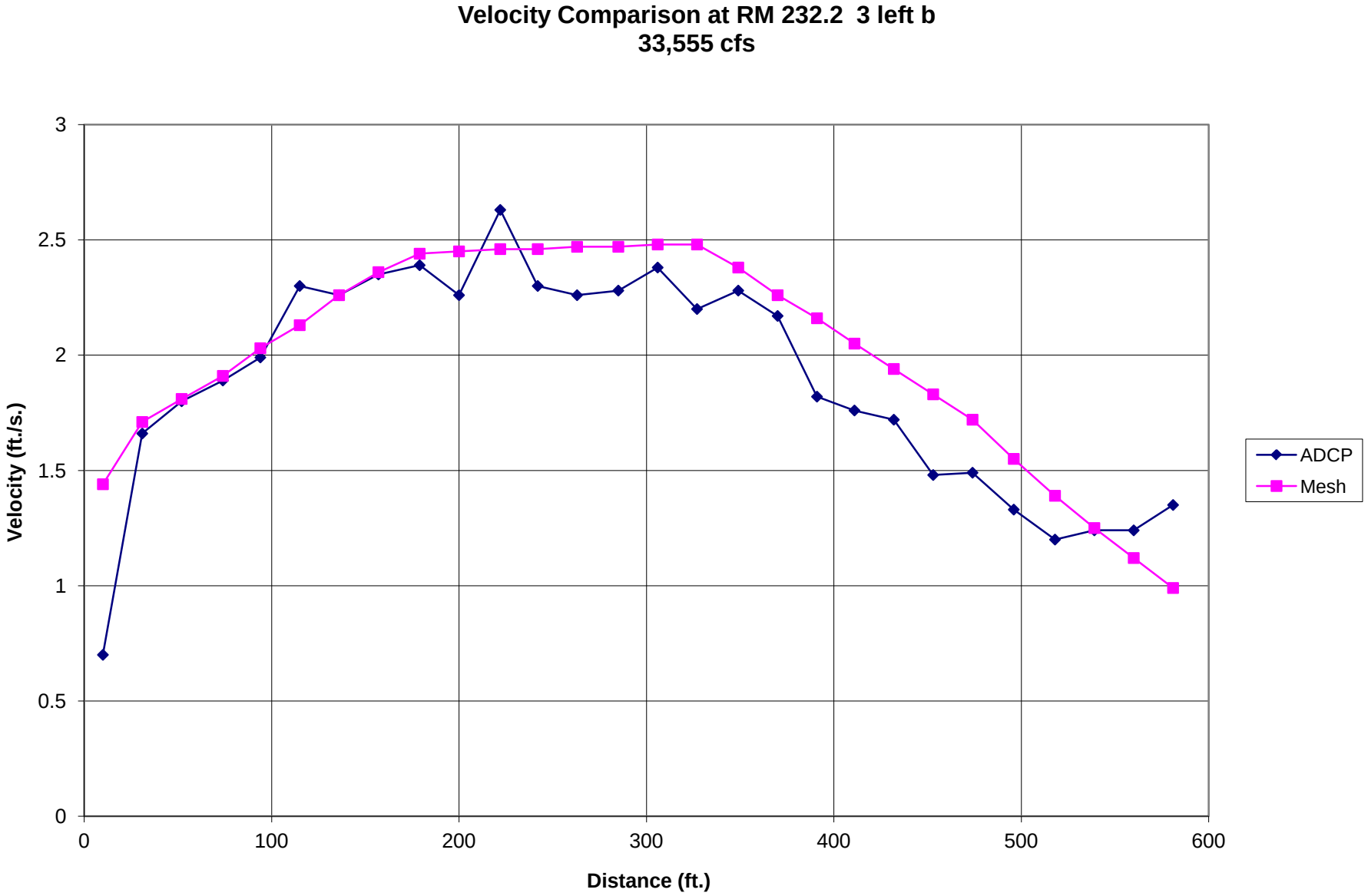

Velocity Comparison at RM 232.9 4 left a
33,555 cfs
Velocity (ft./s.)
2
1.5
1
0.5
0
-200
-100
0
100
200
300
400
500
Distance (ft.)
ADCP
Mesh

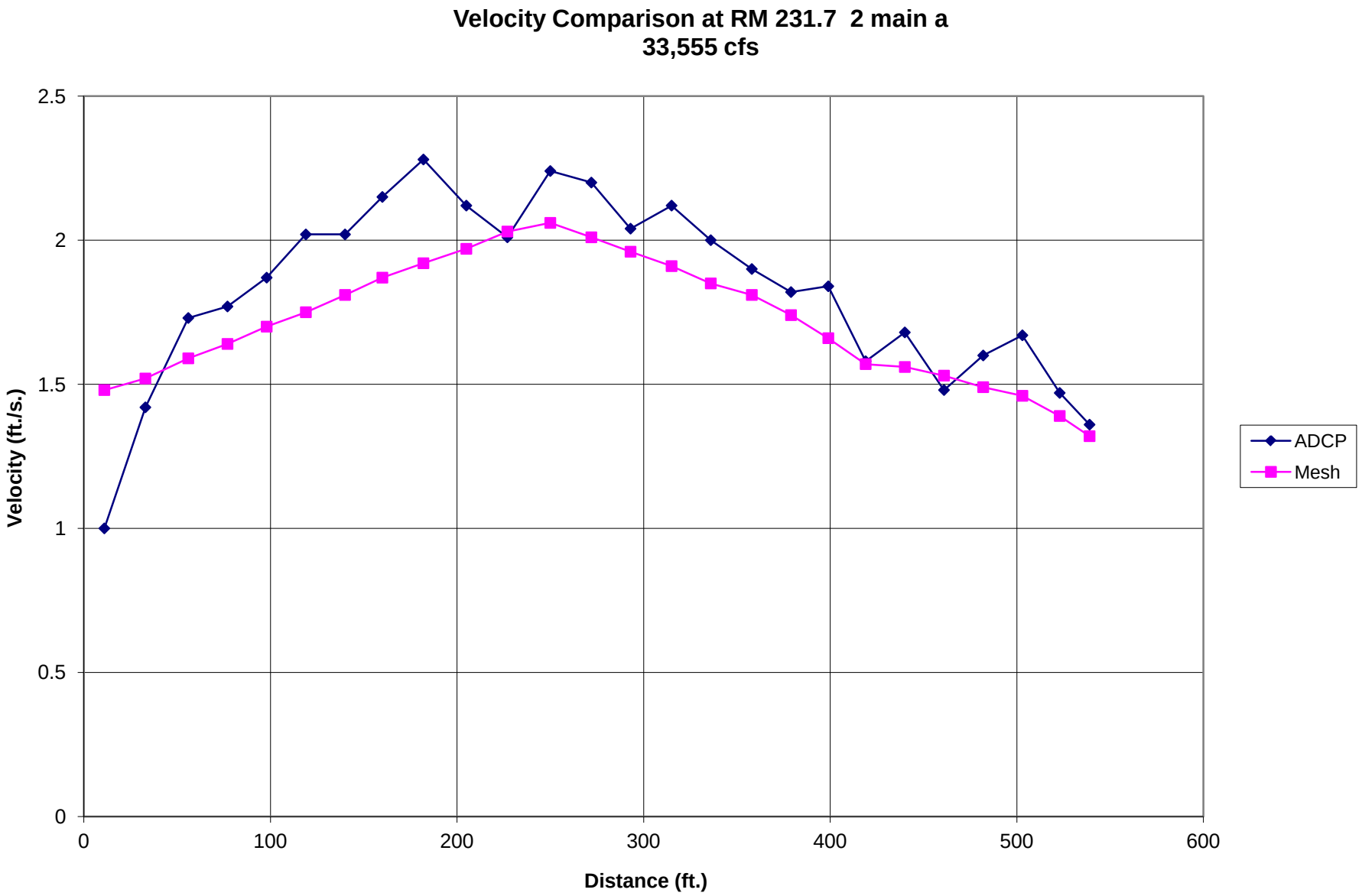

Velocity Comparison at RM 232.9 4 left b
33,555 cfs
Velocity (ft./s.)
Distance (ft.)
0
0.5
1
1.5
2
0
100
200
300
400
500
600
ADCP
Mesh

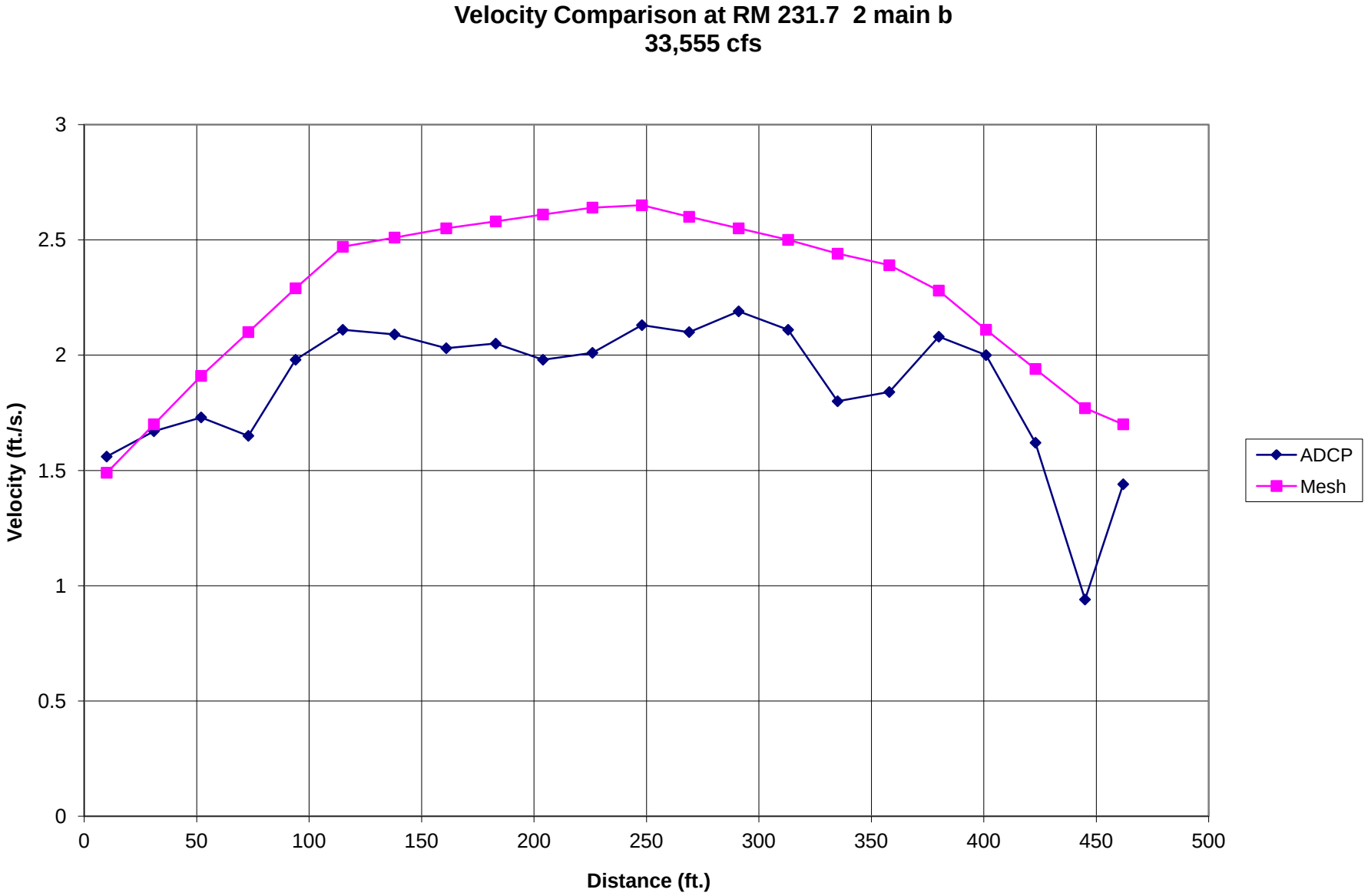

Velocity Comparison at RM 232.2 3 main a
33,555 cfs
Velocity (ft./s.)
Distance (ft.)
0
0.5
1
1.5
2
2.5
3
0
100
200
300
400
500
600
700
ADCP
Mesh

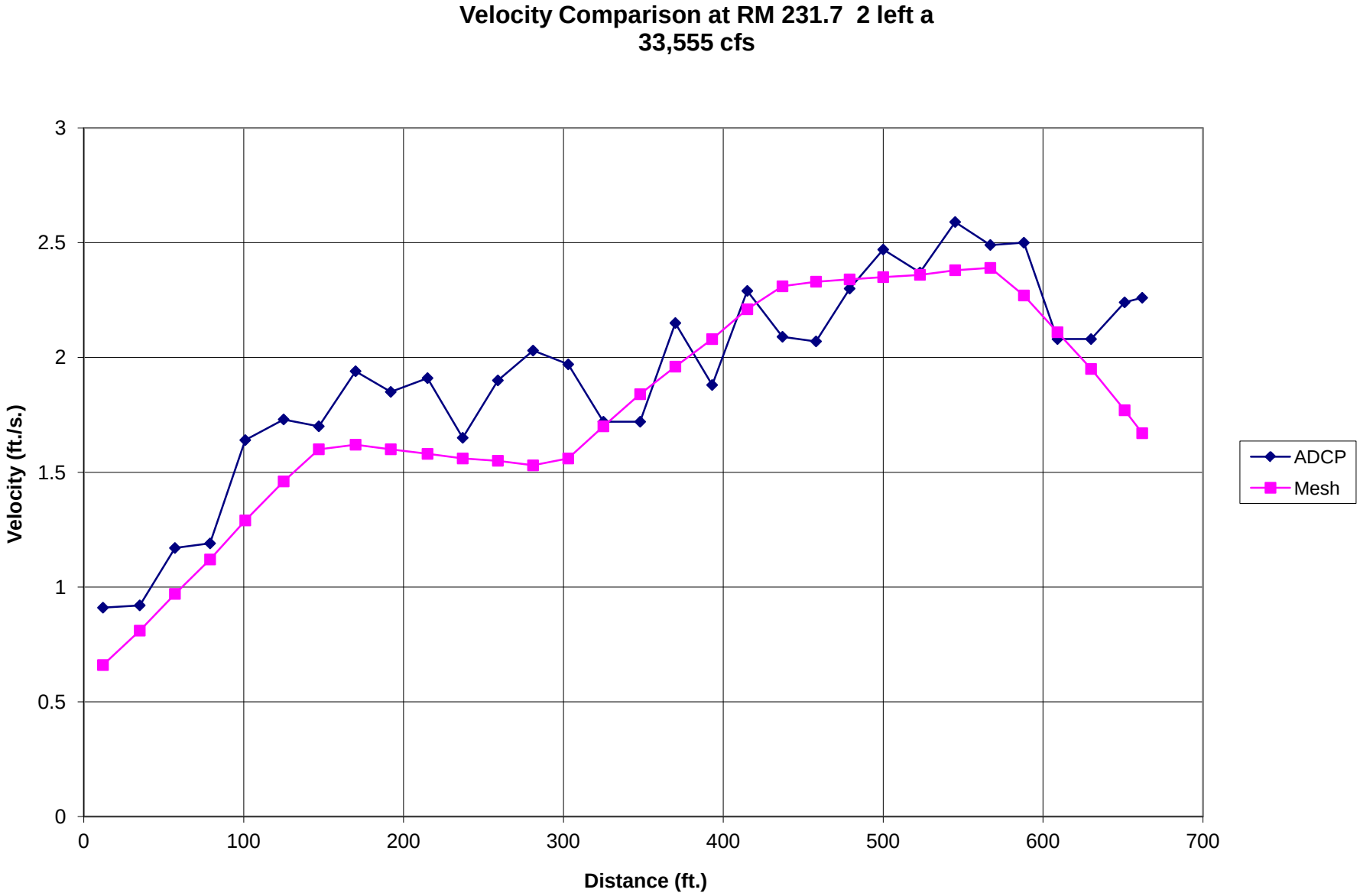

Velocity Comparison at RM 232.2 3 main b
33,555 cfs
Velocity (ft./s.)
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
500
600
700
Distance (ft.)
ADCP
Mesh

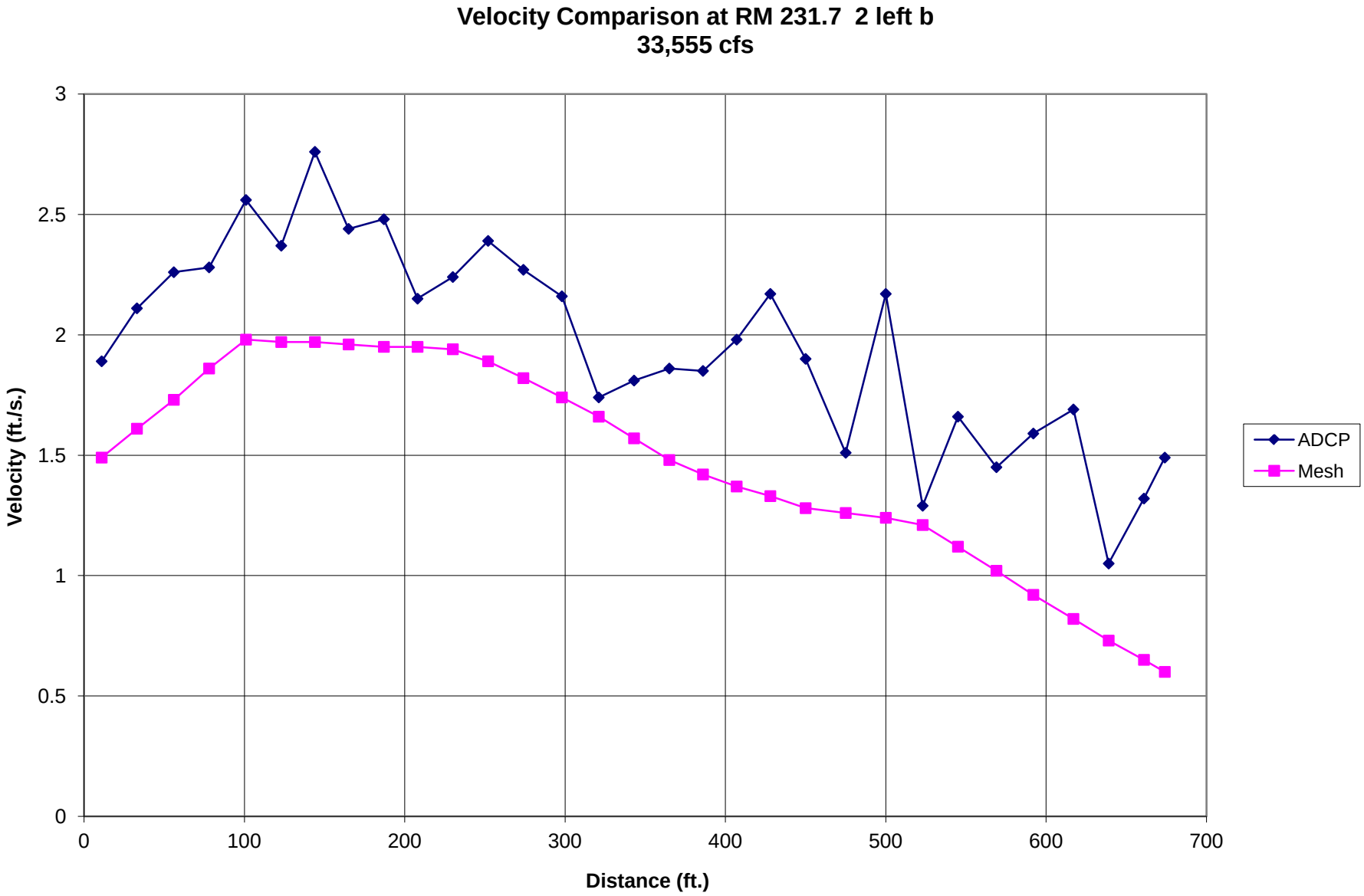

Velocity Comparison at RM 232.2 3 left a
33,555 cfs
Velocity (ft./s.)
Distance (ft.)
0
0.5
1
1.5
2
2.5
3
0
100
200
300
400
500
600
700
ADCP
Mesh

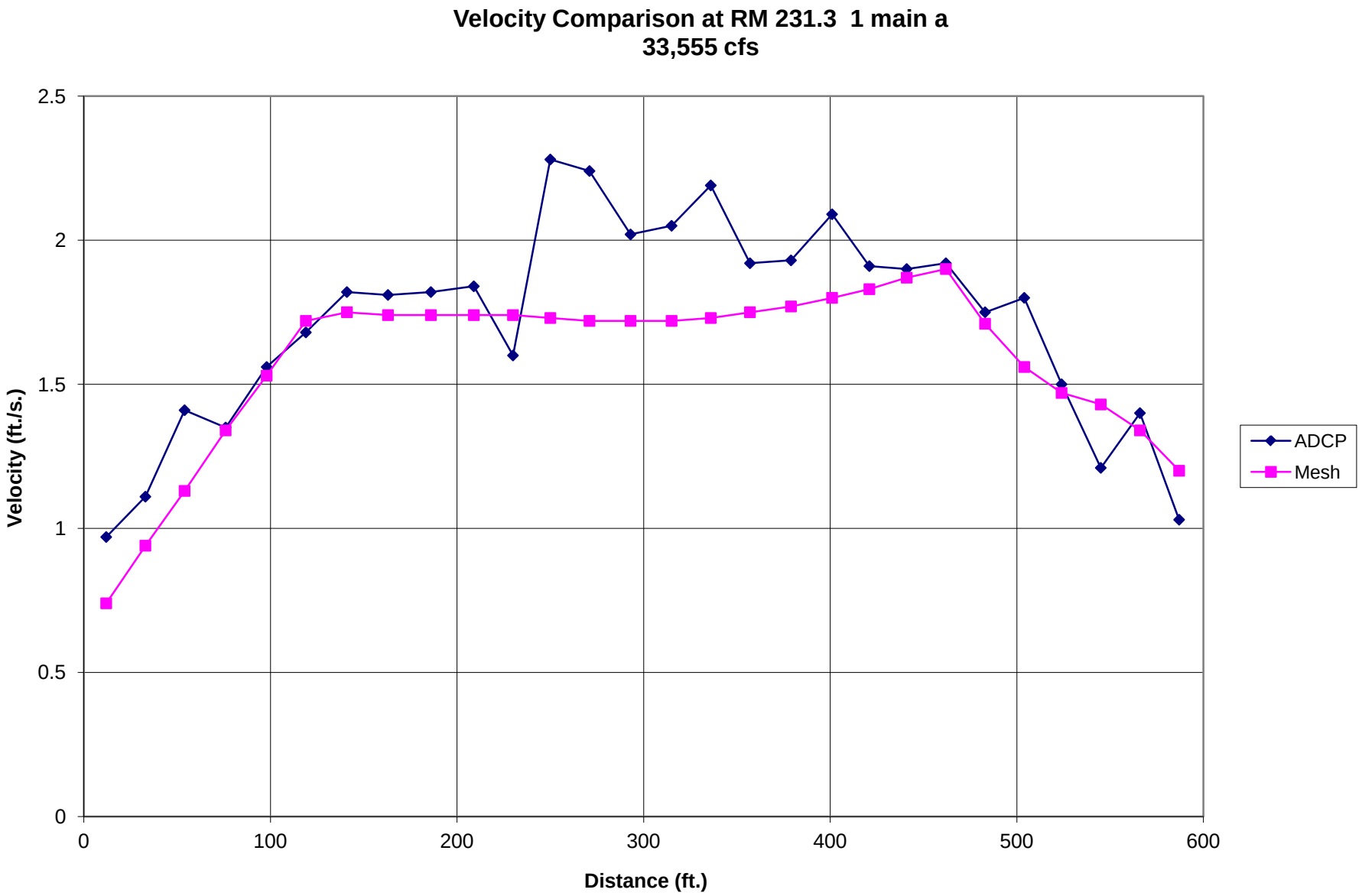

Velocity Comparison at RM 232.2 3 left b
33,555 cfs
Velocity (ft./s.)
Distance (ft.)
0
0.5
1
1.5
2
2.5
3
0
100
200
300
400
500
600
ADCP
Mesh

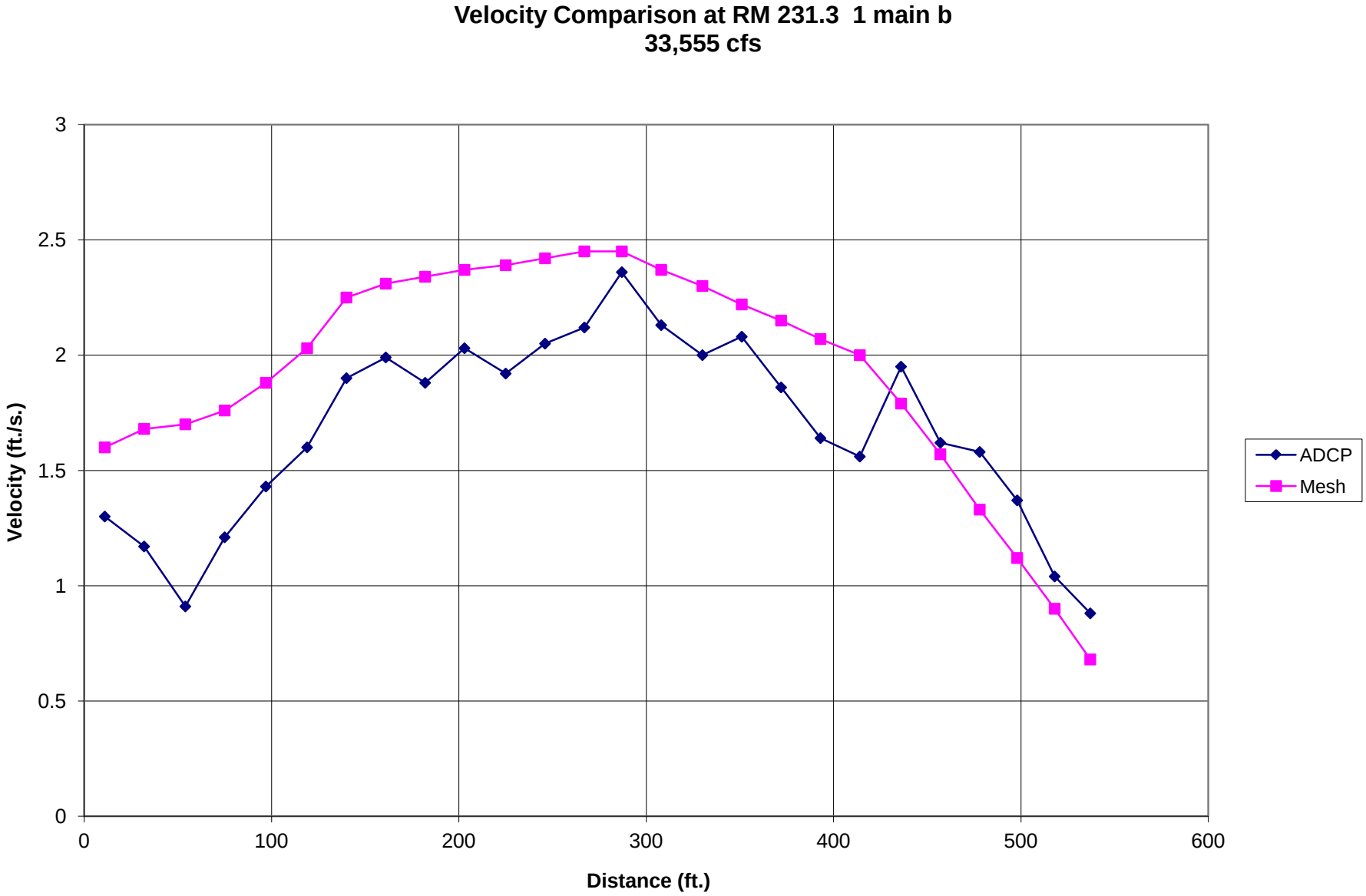

Velocity Comparison at RM 231.7 2 main a
33,555 cfs
2.5
2
1.5
1
0.5
0
Velocity (ft./s.)
0
100
200
300
400
500
600
Distance (ft.)
ADCP
Mesh

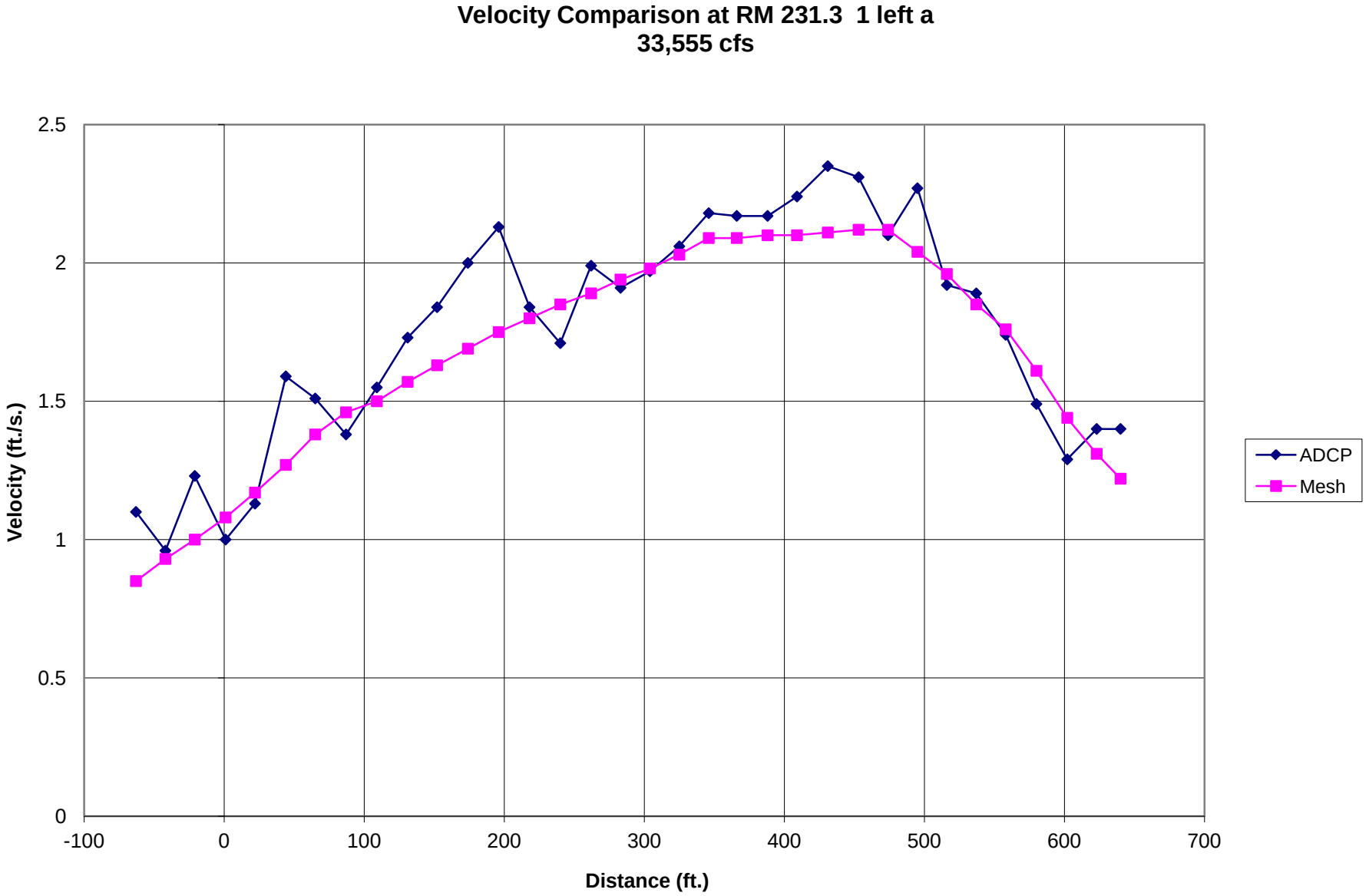

Velocity Comparison at RM 231.7 2 main b
33,555 cfs
Velocity (ft./s.)
Distance (ft.)
0
0.5
1
1.5
2
2.5
3
0
50
100
150
200
250
300
350
400
450
500
ADCP
Mesh

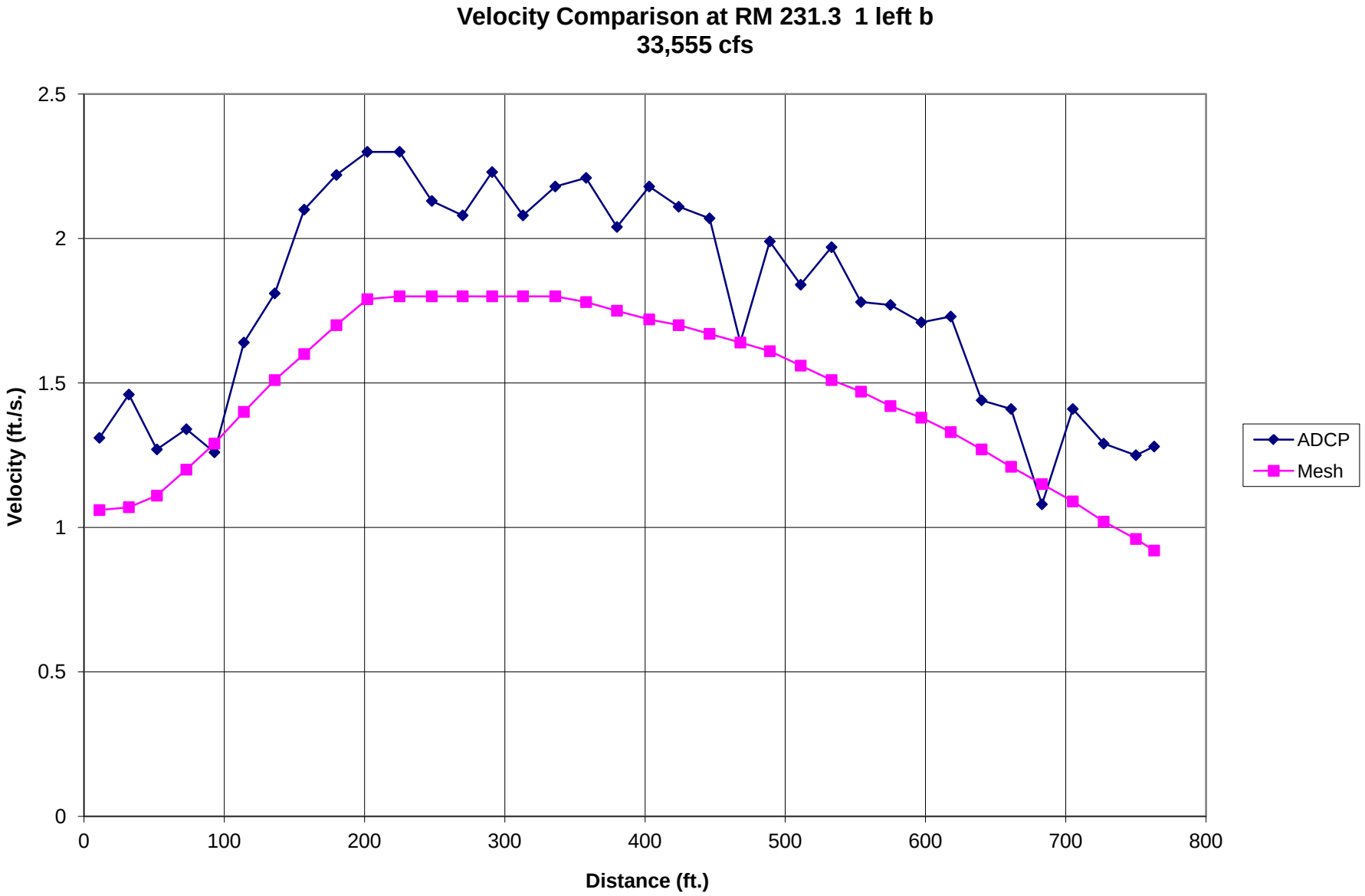

Velocity Comparison at RM 231.7 2 left a
33,555 cfs
Velocity (ft./s.)
Distance (ft.)
0
0.5
1
1.5
2
2.5
3
0
100
200
300
400
500
600
700
ADCP
Mesh


Velocity Comparison at RM 231.7 2 left b
33,555 cfs
Velocity (ft./s.)
3
2.5
2
1.5
1
0.5
0
0
100
200
300
400
500
600
700
Distance (ft.)
ADCP
Mesh


Velocity Comparison at RM 231.3 1 main a
33,555 cfs
Velocity (ft./s.)
2.5
2
1.5
1
0.5
0
0
100
200
300
400
500
600
Distance (ft.)
ADCP
Mesh


Velocity Comparison at RM 231.3 1 main b
33,555 cfs
Velocity (ft./s.)
Distance (ft.)
0
0.5
1
1.5
2
2.5
3
0
100
200
300
400
500
600
ADCP
Mesh


Velocity Comparison at RM 231.3 1 left a
33,555 cfs
Velocity (ft./s.)
2.5
2
1.5
1
0.5
0
-100
0
100
200
300
400
500
600
700
Distance (ft.)
ADCP
Mesh


Velocity Comparison at RM 231.3 1 left b
33,555 cfs
Velocity (ft./s.)
2.5
2
1.5
1
0.5
0
0
100
200
300
400
500
600
700
800
Distance (ft.)
ADCP
Mesh

Discharge Calibration						Discharge Calibration				
9,740 cfs						33,555 cfs				
	ADCP	Model	Model - ADCP				ADCP	Model	Model - ADCP	
	Calc. Flow	Flow	Flow				Calc. Flow	Flow	Flow	
Transect	cfs	cfs	cfs diff.	% diff.		Transect	cfs	cfs	cfs diff.	% diff.
8_main	9741	9740	-1	0		8_main	33555	33635	80	0
7_right	4286	4226	-60	-1		7_right	15803	14905	-898	-6
7_main	5228	5513	285	5		7_main	19714	18624	-1090	-6
6_main	9741	9741	0	0		6_main	34168	33540	-627	-2
5_main	8099	7623	-476	-6		5_main	24926	25368	441	2
5_left	1006	1128	122	12		5_left	3792	4008	216	6
4_main	7832	7129	-703	-9		4_main	22318	23691	1373	6
4_left	1622	1983	361	22		4_left	7839	7295	-545	-7
3_main	5528	4669	-859	-16		3_main	14746	15435	689	5
3_left	3654	4580	926	25		3_left	16226	16409	183	1
2_main	4986	4301	-685	-14		2_main	12134	14045	1911	16
2_left	4596	5232	636	14		2_left	20749	18659	-2090	-10
1_main	5329	4193	-1136	-21		1_main	12593	13646	1053	8
1_left	4388	5322	934	21		1_left	21200	19249	-1951	-9

ATTACHMENT H-2

WATER SURFACE IMPACT ANALYSIS

Water Surface Impact Analysis of Proposed Starved Rock Restoration Project (Section 519)
DRAFT
3-6-2013

I. PURPOSE

The US Army Corps of Engineers, Rock Island District, proposes to construct a riprap breakwater in the Starved Rock Navigation Pool of the Illinois River to promote ecosystem restoration. The proposed breakwater is located left descending bank of the navigation channel between River Miles 233 and 234. The proposed structure and hydraulic model features are shown on Figure 1. Figure 2 shows the existing flood profiles for the Starved Rock Pool based on the 2004 Upper Mississippi River System Flow Frequency Study (FFS).

The proposed breakwater is within the effective regulatory floodway of the Illinois River, and therefore, requires a worst-case cumulative effects analysis as specified in the State of Illinois floodway constructions rules. A hydraulic analysis was performed to quantify the change in water surface elevation due to placement of the proposed breakwater.

II. METHOD

This hydraulic analysis utilizes the UNET numerical hydraulic model, originally used to compute the stage frequency profiles of the IWW in the 2004 UMRS-FFS. The UNET model is a one-dimensional unsteady flow model, capable of simulating flow through a network of connected channels and storage areas. Changes to conveyance and storage are computed simultaneously in UNET. This hydraulic analysis computes the water surface changes caused by project conditions for the eight frequency flow events used to compute the stage frequency profiles in the FFS. These flow events range from the 50 percent annual exceedance probability flow (2-year) to the 0.2 percent annual exceedance probability flow (500-year). The upstream boundary of the IWW UNET model is at Lockport, IL (RM 291) and the downstream boundary is at Grafton, IL (RM 0).

The 2004 FFS UNET model was constructed using the best available data of the time, with most data sets dating between 1997 and 2001. Since the FFS, new bathymetry has been collected that better represents the non-navigable portions of the Illinois River within the Starved Rock Pool. Newer bathymetry collected both for the navigation channel and side channels between River Mile 236 and 231.1 (Starved Rock Dam), were incorporated into the UNET model to create an updated existing condition UNET model. The same cross section locations of the FFS UNET model were used in the updated UNET model. Model roughness values and ineffective flow areas are consistent with the FFS UNET model, but slightly modified to better reflect the added detail of the updated cross sections.

The 2004 FFS UNET model did not contain a sufficient number of cross sections to adequately define the limits of this proposed project; therefore, additional cross sections were added to the model. These added cross sections were generated using the same datasets and processes that were used to create the cross sections in the updated, existing condition UNET model. The

process of updating or adding geometry starts with HEC-GeoRAS in GIS, using geospatial terrain and bathymetry to cut cross sections and define project features. Cross sections are exported from GIS and imported to RAS for further refinement. The refined RAS geometry is converted to UNET format to incorporate any revised cross sections into the existing FFS UNET geometry. The roughness values, ineffective flow areas, and reach lengths of the added cross sections are added, consistent with the surrounding cross sections of the existing condition model. This creates a Base condition UNET model for direct comparison to the Project condition.

The necessary alteration for each cross section to represent Project condition was developed in GIS using site maps and 3D project features. The portions of each cross section determined to be obstructed by the proposed project embankment and those areas estimated to be ineffective to flow by the proposed project are represented in the UNET model as a modification to the cross section. Figures 3 and 4 present two of the Project condition UNET cross sections. Water surface elevations for a few select frequency events are also included on the plots for reference. Unlike the HEC-RAS modeling system, UNET does not provide cross sectional features to define "blocked" obstructions or "blocked" ineffective flow areas, which defined by user-specified start and end points. The cross section modification done for the UNET computations eliminates both conveyance and storage for that portion of each cross section either directly obstructed by the breakwater's embankment or estimated to become ineffective to flow by the breakwater placement.

III. RESULTS

Table 1 presents the maximum water surface increase in feet caused by the placement of the proposed breakwater. Water surface increases are shown for the full extent of the Starved Rock Dam navigation pool. The water surface increases outside of the pool are equal to, or less than, the values shown. Rows with bold formatting represent locations modified in the model by the breakwater placement.

Table 1. Computed Water Surface Increases (in feet)

River Mile	2-Year (50%)	5-Year (20%)	10-Year (10%)	25-Year (4%)	50-Year (2%)	100-Year (1%)	200-Year (0.5%)	500-Year (0.2%)
246.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
246.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
246.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
246.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
245.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
245.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
245.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
245.17	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
244.95	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
244.25	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
244.15	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
243.79	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
243.44	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
242.96	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
242.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
242.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

River Mile	2-Year (50%)	5-Year (20%)	10-Year (10%)	25-Year (4%)	50-Year (2%)	100-Year (1%)	200-Year (0.5%)	500-Year (0.2%)
242	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
241.65	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
241.3	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
241.05	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
240.8	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
240.55	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
240.27	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01
240	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01
239.7	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01
239.6	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01
239.4	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01
239.17	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.01
238.95	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.01
238.63	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.01
238.3	0.01	0.03	0.02	0.02	0.02	0.01	0.01	0.01
237.9	0.01	0.03	0.02	0.02	0.02	0.01	0.01	0.01
237.65	0.01	0.03	0.03	0.02	0.02	0.02	0.01	0.01
237.4	0.01	0.03	0.03	0.02	0.02	0.02	0.01	0.01
237.15	0.01	0.03	0.03	0.02	0.02	0.02	0.01	0.01
236.9	0.01	0.03	0.03	0.02	0.02	0.02	0.02	0.01
236.52	0.01	0.03	0.03	0.02	0.02	0.02	0.02	0.01
236.15	0.01	0.03	0.03	0.02	0.02	0.02	0.02	0.01
236	0.01	0.03	0.03	0.02	0.02	0.02	0.02	0.02
235.85	0.01	0.04	0.03	0.03	0.02	0.02	0.02	0.02
235.7	0.01	0.04	0.03	0.03	0.02	0.02	0.02	0.02
235.1	0.01	0.04	0.03	0.03	0.03	0.02	0.02	0.02
234.5	0.02	0.04	0.04	0.03	0.03	0.02	0.02	0.02
234.25	0.02	0.04	0.04	0.03	0.03	0.02	0.02	0.02
234	0.02	0.04	0.04	0.03	0.03	0.02	0.02	0.02
233.95	**0.02**	**0.04**	**0.04**	**0.03**	**0.03**	**0.02**	**0.02**	**0.02**
233.85	**0.01**	**0.04**	**0.04**	**0.03**	**0.03**	**0.02**	**0.02**	**0.02**
233.5	**0.01**	**0.03**	**0.03**	**0.02**	**0.02**	**0.02**	**0.01**	**0.01**
233.4	**0.01**	**0.02**	**0.02**	**0.02**	**0.02**	**0.01**	**0.01**	**0.01**
233.3	**0.01**	**0.02**	**0.02**	**0.02**	**0.01**	**0.01**	**0.01**	**0.01**
233.2	**0.00**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.00**	**0.00**
233.05	**-0.03**	**-0.04**	**-0.03**	**-0.02**	**-0.02**	**-0.01**	**-0.01**	**-0.01**
233	**-0.03**	**-0.03**	**-0.02**	**-0.01**	**-0.01**	**-0.01**	**-0.01**	**-0.01**
232.9	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
232.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
232.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
231.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
231.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
231.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

IV. CONCLUSION

The maximum computed water surface increase caused by the proposed breakwater placement in the Starved Rock Pool is 0.04 feet. The placement of breakwater as designed would not cause an unacceptable increase in water surface for any of the modeled frequency floods.

V. REFERENCES

Barkau, Robert L., 1992. UNET, *One-Dimensional Unsteady Flow Through a Full Network of Open Channels*, Computer Program, St. Louis, MO.

Hydrologic Engineering Center, (November 2006) *HEC-RAS River Analysis System*, User's Manual, U.S. Army Corps of Engineers, Davis, CA.

Starved Rock Pool Section 519 Restoration Project



Figure 1

CORPS OF ENGINEERS

U.S. ARMY

Q 500=137,000 CFS
Q 200=124,500 CFS
Q 100=114,500 CFS
Q 50=104,500 CFS
Q 25=91,000 CFS
Q 10=79,000 CFS
Q 5=66,500 CFS
Q 2=48,000 CFS

Q 500=164,000 CFS
Q 200=149,500 CFS
Q 100=137,500 CFS
Q 50=125,000 CFS
Q 25=109,500 CFS
Q 10=94,000 CFS
Q 5=79,000 CFS
Q 2=57,500 CFS

Q 500=196,000 CFS
Q 200=181,000 CFS
Q 100=166,500 CFS
Q 50=150,500 CFS
Q 25=134,000 CFS
Q 10=113,000 CFS
Q 5=93,500 CFS
Q 2=66,500 CFS

FOX RIVER - R
DRAINAGE AREA
2,640 SQ. MI.

VERMILLION RIVER - L
DRAINAGE AREA
1250 SQ. MI.

BIG BUREAU CREEK - R
DRAINAGE AREA
200 SQ. MI.

ELEVATION ABOVE MEAN SEA LEVEL (N.G.V.D. 1929)

484 482 480 478 476 474 472 470 468 466 464 462 460 458 456 454 452 450 448

500 YEAR
200 YEAR
100 YEAR
50 YEAR
25 YEAR
10 YEAR
5 YEAR
2 YEAR

DECEMBER 1982

MARCH 1979

STARVED ROCK POOL 458.52

PEORIA POOL 440.0

STARVED ROCK DAM
M. 231.1

LASALLE, ILL.
M. 224.7

SPRING VALLEY, ILL.
M. 218.4
(DISCONTINUED)

HENNEPIN, ILL.
M. 207.6
(DISCONTINUED)

HENRY, ILL.
M. 196.0 GAGE O=425.88

CHILLICOTHE, ILL.
M. 180.3
(DISCONTINUED)

MARSEILLES DAM
M. 247.0

MARSEILLES, ILL.
M. 246.5

MARSEILLES LOCK, ILL.
M. 244.6

MARSEILLES U.S.G.S. GAGE M. 246.6

OTTAWA, ILL. M. 239.7
FOX RIVER M. 239.7

UTICA, ILL. M. 229.6

VERMILLION RIVER M. 226.5

PRIVATE RR BRIDGE M. 225.5

PERU, ILL. M. 223.0

I-180 HWY. BRIDGE M. 207.8

BIG BUREAU CREEK M. 199.2

250 248 246 244 242 240 238 236 234 232 230 228 226 224 222 220 218 216 214 212 210 208 206 204 202 200 198 196 194 192 190 188 186 184 182 180

MILES ABOVE MISSISSIPPI RIVER

1. FLOW VALUES ARE AVERAGED FOR THE REACH
2. THE HISTORIC FLOOD PROFILE IS PLOTTED AS A STRAIGHT LINE BETWEEN THE GAGES

U.S. ARMY CORPS OF ENGINEERS

2004 FLOW FREQUENCY STUDY

APPENDIX C

ILLINOIS RIVER

FLOOD PROFILES- N.G.V.D. 1929

ROCK ISLAND DISTRICT

2, 5, 10, 25, 50, 100, 200, & 500 YEAR FLOOD
&
1982 HISTORIC FLOOD

RIVER MILES 247.0 TO 180.3

PLATE # 2

Figure 2

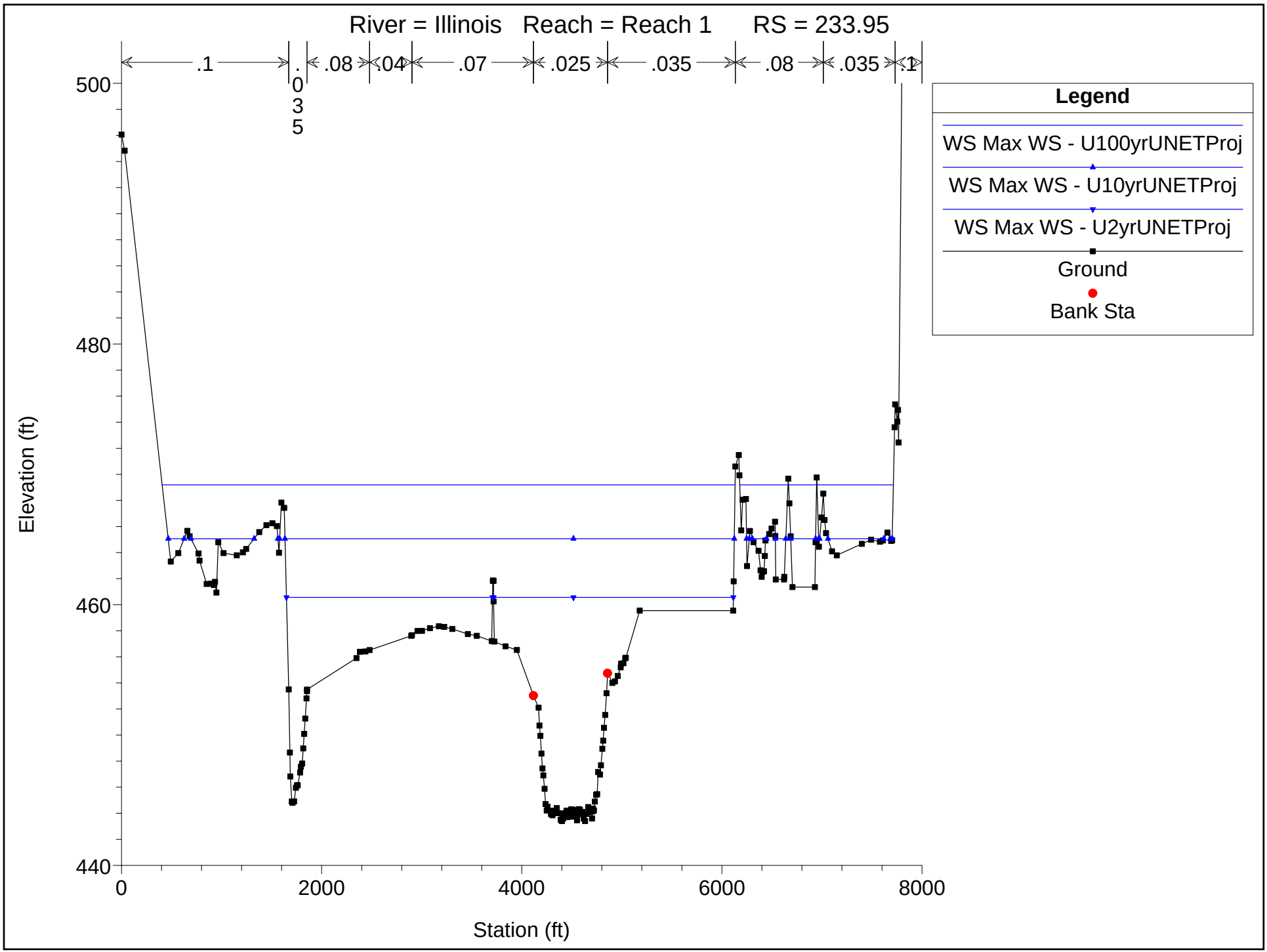

River = Illinois Reach = Reach 1 RS = 233.95
.1
.035
.08
.04
.07
.025
.035
.08
.035
.1
500
480
460
440
Elevation (ft)
0
2000
4000
6000
8000
Station (ft)
Legend
WS Max WS - U100yrUNETProj
WS Max WS - U10yrUNETProj
WS Max WS - U2yrUNETProj
Ground
Bank Sta

Figure 3

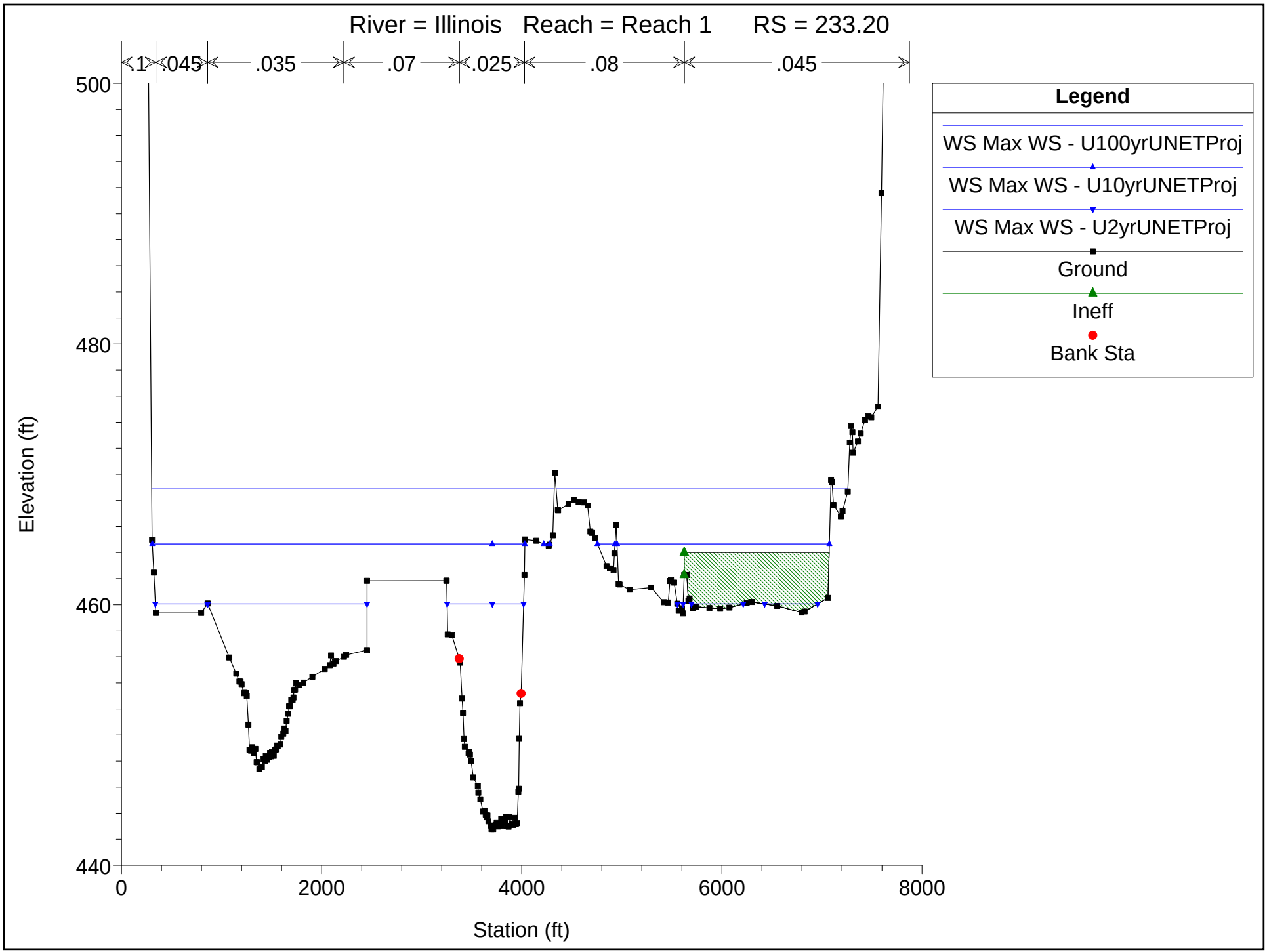
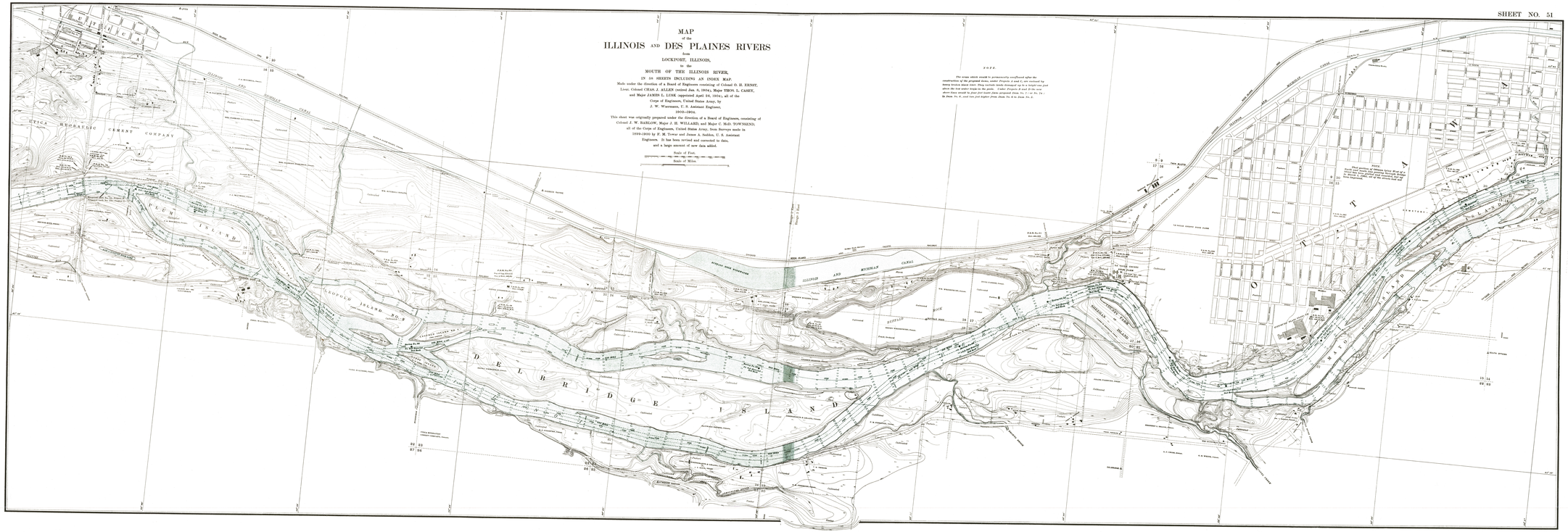

River = Illinois Reach = Reach 1 RS = 233.20
.1
.045
.035
.07
.025
.08
.045
500
480
460
440
Elevation (ft)
0
2000
4000
6000
8000
Station (ft)
Legend
WS Max WS - U100yrUNETProj
WS Max WS - U10yrUNETProj
WS Max WS - U2yrUNETProj
Ground
Ineff
Bank Sta

Figure 4

ATTACHMENT H-3

WOERMANN MAPS


MAP
of the
ILLINOIS AND DES PLAINES RIVERS
from
LOCKPORT, ILLINOIS,
to the
MOUTH OF THE ILLINOIS RIVER,
IN 58 SHEETS INCLUDING AN INDEX MAP.
Made under the direction of a Board of Engineers consisting of Colonel O. H. ERNST, Lieut. Colonel CHAS. J. ALLEN (retired Jan. 8, 1904), Major THOS. L. CASEY, and Major JAMES L. LUSK (appointed April 26, 1904), all of the Corps of Engineers, United States Army, by J. W. Watermann, U. S. Assistant Engineer, 1902–1904.
This sheet was originally prepared under the direction of a Board of Engineers, consisting of Colonel J. W. BARLOW, Major J. H. WILLARD, and Major C. McD. TOWNSEND, all of the Corps of Engineers, United States Army, from Surveys made in 1899-1900 by F. M. Towne and James A. Seddon, U. S. Assistant Engineers. It has been revised and corrected to date, and a large amount of new data added.
Scale of Feet.
Scale of Miles.
NOTE.
The areas which would be permanently overflowed after the construction of the proposed dams, under Projects A and C, are enclosed by heavy lines. The areas which would be temporarily overflowed by a height two feet above the low water levels in the pools. Under Project A, the 10 ft. contour line shown thus would be four feet lower than proposed from No. 7 to No. 24; 20 ft. from No. 8, and two feet higher from Nos. 25 to Nos. 31.
UTICA HYDRAULIC CEMENT COMPANY
PLUM ISLAND
GEORGE ISLAND NO. 2
DELBRIDGE ISLAND
ILLINOIS AND MICHIGAN CANAL
BUFFALO ROCK
SHERIDAN ISLAND
OTTAWA
OTTAWA ISLAND
NOTE.
This sheet is one of 58 sheets which form the set of maps of the Illinois and Des Plaines Rivers, and is a part of the Index Map of the Illinois and Des Plaines Rivers.

SHEET NO. 51

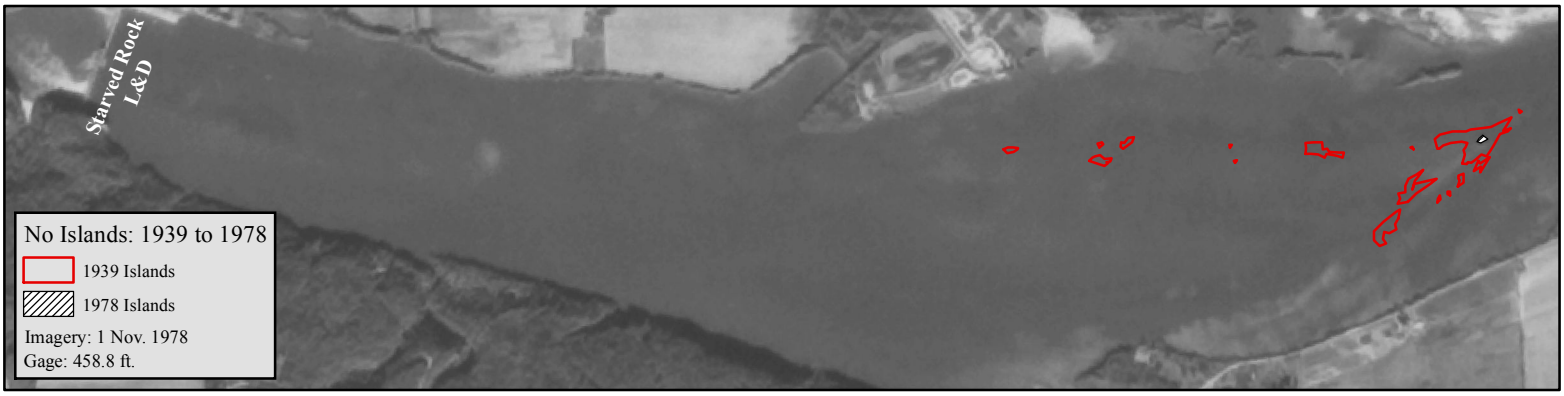
ATTACHMENT H-4

ISLAND CHANGE TRACKING
PRE-LOCK AND DAM TO PRESENT

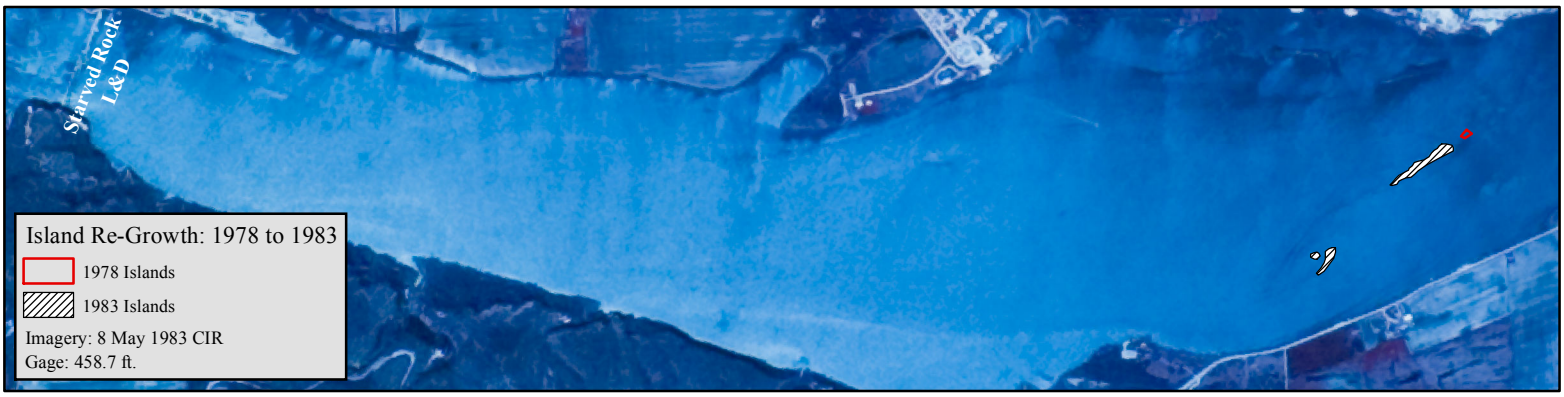
Starved Rock Island Change: Pre-Lock & Dam to Present



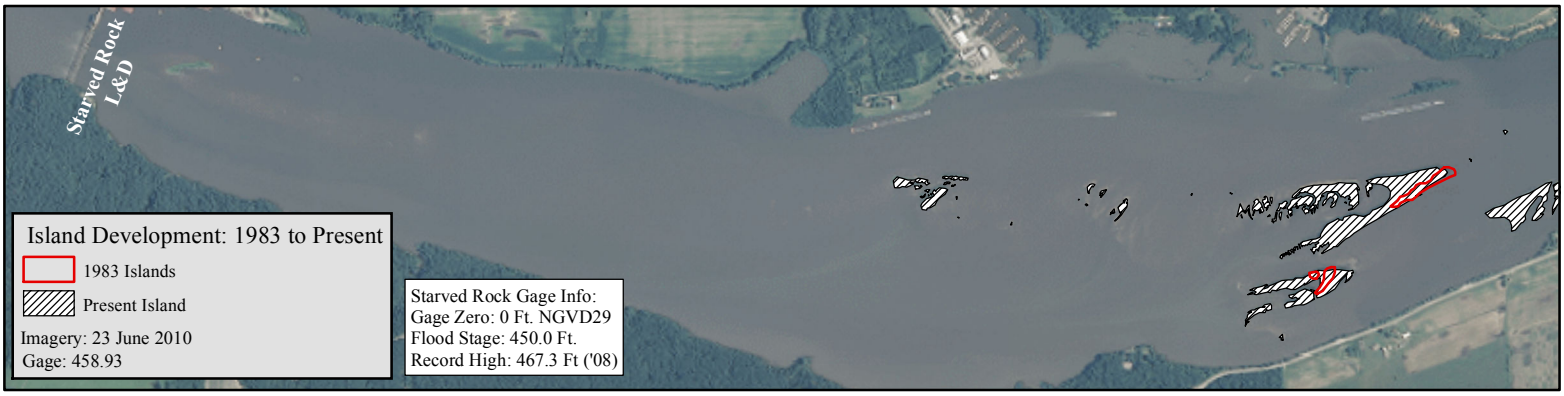
Starved Rock L&D was constructed from 1926-1933, post construction pool development inundated Delbridge Island (Approx. 467 Ac.). By 1939 only a small portion of the original island was left above the surface (Approx 9.5 Ac.)



From 1939 to 1978 Island loss continued with the portion above the surface ranging between 0.2 and 0.1 Ac. depending on water levels. High water events (>10 ft. above Flood Stage) occurred in '42, '43, '50, '54, '70.



Between 1978 and 1983 islands in the area began to re-emerge. By May of 1983 approx. 2.5 Ac. had been permanently reestablished. High water events (>10 ft. above Flood Stage) occurred in '79, '81, '82.



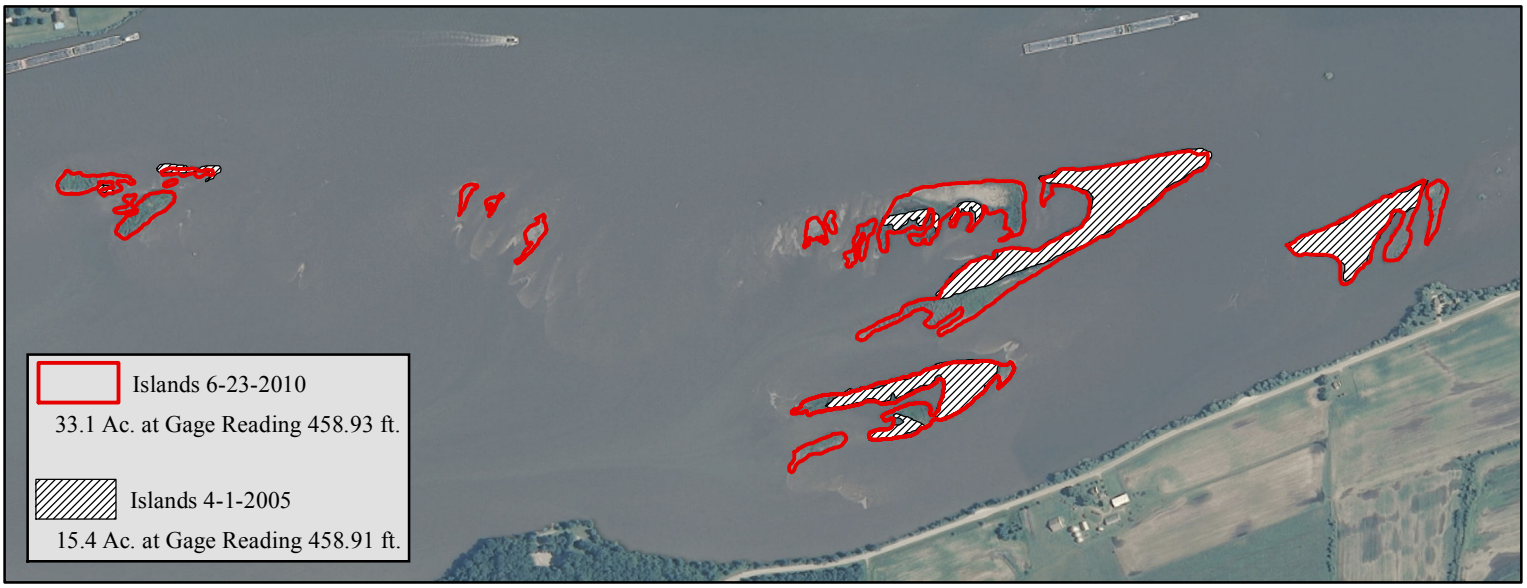
1983 to the Present has shown a continued growth of islands. Acreage has increased from approx. 2.5 ac. in 1983 to approx. 35.1 ac. of island in 2011. Island growth should be considered permanent as high flows (>10ft. above Flood Stage) that occurred in '85, '90, '96, '97, '98, '02, '05, '06, '07, '08 & '09 failed to remove the islands through scour and other hydraulic processes.

1:28,000 0 0.25 0.5 1 Miles

Starved Rock Island Change: A Detailed Look from 1998 to 2011



Note: All Imagery is from 2010 as imagery from other years is unavailable for GIS
Imagery for the years shown is available in Google Earth.



All gage readings reference the Starved Rock Gage

1:13,500 0 550 1,100 2,200 Feet

N



ILLINOIS RIVER BASIN RESTORATION
SECTION 519
DEFINITE PROJECT IMPLEMENTATION REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STARVED ROCK
CRITICAL RESTORATION PROJECT

APPENDIX I

COST ESTIMATE

ILLINOIS RIVER BASIN RESTORATION
SECTION 519
DEFINITE PROJECT IMPLEMENTATION REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STARVED ROCK
CRITICAL RESTORATION PROJECT

APPENDIX I

COST ESTIMATE

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2.2. Adaptive Management I-1

3. COST METHODOLOGY I-2
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3.2. Direct Cost I-2
3.3. Indirect Costs I-3
3.4. Escalation I-3
3.5. Contingency I-4
3.6. Other Assumptions I-4

4. PROJECT FEATURE ACCOUNTS I-4
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4.2. (10) Breakwaters and Seawalls I-4
4.3. (30) Planning, Engineering, and Design I-4
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I-B Contingency Determination
I-C Project Schedule
I-D Total Project Cost Summary

ILLINOIS RIVER BASIN RESTORATION
SECTION 519
DEFINITE PROJECT IMPLEMENTATION REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STARVED ROCK
CRITICAL RESTORATION PROJECT

APPENDIX I

COST ESTIMATE

1. INTRODUCTION

This appendix describes the creation of the detailed Project cost estimate prepared for the Starved Rock Critical Restoration Project (Project). The Project area is located in the Starved Rock Pool, between river miles (RM) 233 and 234, approximately two miles upstream of Starved Rock Lock, Utica, IL. This area of lower Starved Rock pool includes Delbridge Island, Leopold Islands, and Gypsy Island, which are all currently submerged, and some small unnamed islands near RM 234 that are above the normal pool elevation.

2. PROJECT DESCRIPTION

The goals of the proposed Project are to restore submerged aquatic vegetation in lower Starved Rock pool, increase the area and quality of resting and feeding habitat for migratory water birds, and improve spawning and nursery habitat for native fish. The Tentatively Selected Plan would accomplish the Project goals by construction a rock breakwater along the northern edge of former Delbridge Island adjacent to the navigation channel between RMs 233 and 234 in Starved Rock Pool.

2.1. Rock Breakwater. The breakwater will be approximately 6,100 feet long and constructed to a design elevation 461.85 feet with a 3-foot top width and 2.5H:1V side slopes. Riprap will conform to the requirements of Gradation RR-5 of the Illinois Department of Transportation). Rock would presumably be loaded onto barges at LaFarge North America's Utica Stone Quarry at Utica, IL and moved to the Project location where it would be placed by a clamshell bucket and crane on a floating plant. The riprap breakwater will be constructed in close proximity to the navigation channel so that the riprap may be easily placed. The riprap breakwater is positioned to protect the area behind it from wind and wave action to support submergent aquatic vegetation.

2.2. Adaptive Management. Baseline adaptive management measures to determine if naturally-occurring vegetation is taking hold include topographic surveys, SAV evaluations, water quality monitoring, and annual reports. Adaptive Management measures if natural vegetation fails to take hold include yearly plantings.

3. COST METHODOLOGY

3.1. General. This Fully Funded Estimate has been prepared to FY15 1st Quarter(the presumed midpoint of construction) 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 1110-1-1300, *Cost Engineering Policy and General Requirements*, (26 Mar 1993) and Engineering Regulation 1110-2-1302, *Civil Works Cost Engineering*, (15 Sept 2008). The Fully Funded Estimate was completed in accordance with Engineering Manual 1110-2-1304, *Civil Works Construction Cost Index System* (revised 31 Mar 2013).

The estimate was developed using Micro Computer Aided Cost Estimate System MII v4.1 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 for the overall Project is anticipated to be the 1st quarter of FY15, and was used to determine the Fully Funded Estimate. The MII reports of the Work Breakdown Structure may be found in Appendix I-A.

This Project is slated to be advertised as an open bid solicitation and the estimate is constructed accordingly. The possibility of this becoming an 8A contract was discussed and properly evaluated in the determination of what contingency value to apply to the Project.

3.2. 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 quote were obtained for the rock. 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 a general construction prime contractor, with the survey work completed by a subcontractor. It is assumed that if this becomes an 8A contract, the prime contractor will be the 8A contractor who will perform the Project coordination and oversight with little or no construction work. The current general contractor would then become a subcontractor under the 8A prime.

3.2.1. Labor-Rate Determination. Labor Rates are based on 2013 Davis-Bacon Wage Rates general decision number IL130013, 05/13/2013.

3.2.2. Equipment Rates. All equipment costs are from MII Equipment Region 02 2011 and MII English Cost Book 2010.

3.2.3. Fuel Rates. Rates have been updated as of May 22, 2013. Current fuel prices are based on Midwest averages from http://www.eia.doe.gov/. This includes gasoline, on-road diesel, and off-road diesel, which was calculated by subtracting Illinois state taxes from the diesel cost per gallon.

3.2.4. Overtime Consideration. Overtime was considered and it was determined that overtime was not required for the work to be completed within the construction season.

3.2.5. Sales Tax. The Rock Island District does not use sales tax in the creation of estimates as contractors are issued tax exemption numbers to use when purchasing materials.

3.2.6. Productivity. Production rates were created based on historical rates used in the Cost Engineering Section in Rock Island and also based on what was determined reasonable by the cost estimator. In addition, user crews were created using the estimator's judgment.

3.3. Indirect Costs

3.3.1. Prime Contractor

Job Office Overhead (JOOH). Overhead rate for JOOH was applied as a running percentage. In this case a value of 15 percent was applied for the prime contractor.

Home Office Overhead (HOOH). Overhead rate for HOOH was applied as a running percentage. In this case, the value of six percent was applied for the prime contractor. HOOH 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.

Profit. Profit has been included and was calculated using the profit weighted guidelines. For the prime contractor a value of 8.3 percent was calculated based on the level difficulty for the type of work involved on this Project.

Bond. Bond was included and applied as a running percentage. In this case, a value of 1 percent was used assuming an experienced contractor is awarded the work.

Insurance. Insurance has been included and was applied as a running percentage. In this case, a value of two percent was applied.

3.3.2. Subcontractors

JOOH. Overhead rates for JOOH were applied as a running percentage. In this case, a value of 10 percent was applied to the survey subcontractor.

HOOH. Overhead rates for HOOH were applied as a running percentage. In this case, a value of six percent was applied to the survey subcontractor.

Profit. Profit has been included and was applied as a running percentage. In this case, a value of nine percent was assumed for the survey subcontractor.

Insurance. Insurance has been included and was applied as a running percentage. In this case, a value of two percent was applied for the subcontractor.

3.4. Escalation. The Project costs have been escalated to the midpoint of construction, assumed to be the 1st quarter of FY15 for the overall Project.

3.5. Contingency. After review of Project documents and discussion with members of the Project development team (PDT) involved in the design, a risk register was conducted resulting in the development of contingencies for each construction type. The contingencies were developed to reflect the uncertainty associated with the features of work. The contingency matrix is shown in Appendix I-B. This includes the development of the contingencies applied to the construction features of work as well as PED and Construction Management costs.

3.6. Other Assumptions

3.6.1. Mobilization. Equipment needs were identified from work items in the MII estimate. Equipment was assumed to be mobilized within 50 miles for land-based equipment. Because the marine equipment didn't include any specialized plant, such as a dredge, it was assumed to be mobilized from within one day's travel to the Project location.

3.6.2. Government Furnished Materials. The estimate is based on no government furnished materials.

3.6.3. Site Access. It is assumed that the site can be accessed from May 15 through November 15 of each year, except in the event of a flood.

4. PROJECT FEATURE ACCOUNTS

4.1. (01) Lands and Damages. This account contains no values as no real estate will need to be acquired for this Project.

4.2. (10) Breakwaters and Seawalls. This account contains all construction, survey, and adaptive management tasks, as applicable.

4.3. (30) Planning, Engineering, and Design. The work covered under this account includes the Project management, engineering, and design costs spent to date as well as the remaining estimated costs that will be associated with the engineering and design for this Project. The percentages for PED were determined by the Project Engineer and the Project Manager.

4.4. (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 percentages for Construction Management were determined by the Project Engineer and the Project Manager.

5. PROJECT SCHEDULE

The schedule includes assumed periods of design with durations provided by the Project engineer. The construction portion of the schedule was created using the durations for crews and equipment in the MII estimate and estimator judgment when needed. A working period of approximately 15 May – 15 December was followed in creating the schedule. The schedule includes all construction features

except for Adaptive Management, as it is unknown when this work will occur if it does. It is assumed in the schedule that surveys for verification of cross sections and payment will take place at the midpoint and end of construction. The schedule may be found in Appendix I-C.

6. TOTAL PROJECT COST SUMMARY

The total Project cost prior to being fully funded is $4,186.00 (First Costs). The total fully funded Project cost is $5,172,000. The cost share for this Project is estimated to be 65 percent federally funded and 35 percent non-federally funded. The midpoint of construction is currently assumed to be 1st quarter FY15.

ILLINOIS RIVER BASIN RESTORATION
SECTION 519
DEFINITE PROJECT IMPLEMENTATION REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STARVED ROCK
CRITICAL RESTORATION PROJECT

APPENDIX I-A

MII COST ESTIMATE

IW124 Starved Rock 519 Critical Restoration Project

The goals of the proposed project are to restore submerged aquatic vegetation in lower Starved Rock pool, increase the area and quality of resting and feeding habitat for migratory water birds, and improve spawning and nursery habitat for native fish. The Tentatively Selected Plan (TSP) would accomplish the project goals by construction a rock breakwater along the northern edge of former Delbridge Island adjacent to the navigation channel between River Miles 233 and 234 in Starved Rock Pool. Riprap breakwater will be approximately 6,100 feet long and constructed to a design elevation 461.85 feet with a 3-foot top width and 2.5H:1V side slopes. Riprap will conform to the requirements of Gradation RR-5 of the Illinois Department of Transportation (ILDOT). Rock would presumably be loaded onto barges at LaFarge North America's Utica Stone Quarry at Utica, IL and moved to the project location where it would be placed by a clamshell bucket and crane on a floating plant. The riprap breakwater will be constructed in close proximity to the navigation channel so that the riprap may be easily placed. The riprap breakwater is positioned to protect the area behind it from wind and wave action to support submergent aquatic vegetation.

Estimated by	CEMVR-EC-TE
Designed by	CEMVR-EC-D
Prepared by	Ben Ferrell
Preparation Date	5/22/2013
Effective Date of Pricing	5/22/2013
Estimated Construction Time	108 Days

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Description	UOM	Quantity	ContractCost	ProjectCost
Project Owner Summary			2,830,732	2,830,732
Rock Breakwater	LS	1	2,830,732	2,830,732
10 Breakwaters and Seawalls	LS	1	2,830,732	2,830,732
Mobilization and Demobilization	LS	1	65,192	65,192
Riprap	LS	1	2,282,891	2,282,891
Adaptive Management and Monitoring	LS	1	482,649	482,649

ILLINOIS RIVER BASIN RESTORATION
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DEFINITE PROJECT IMPLEMENTATION REPORT
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STARVED ROCK
CRITICAL RESTORATION PROJECT

APPENDIX I-B

CONTINGENCY DETERMINATION

Abbreviated Risk Analysis

Project (less than $40M): **Starved Rock 519 Critical Restoration Project**
Project Development Stage: **Feasibility (Alternatives)**
Risk Category: **Moderate: Typical-Possible Life Safety**

Total Construction Contract Cost = **$ 2,830,732**

	WBS	Potential Risk Areas	Contract Cost	% Contingency	$ Contingency	Total
1	10 BREAKWATERS AND SEAWALLS	**Rock Breakwater**	$ **2,348,083**	27.31%	$ 641,290	$ 2,989,373.58
2			$ -	5.00%	$ -	$ -
3			$ -	5.00%	$ -	$ -
4			$ -	5.00%	$ -	$ -
5			$ -	5.00%	$ -	$ -
6			$ -	5.00%	$ -	$ -
7			$ -	5.00%	$ -	$ -
8			$ -	5.00%	$ -	$ -
9			$ -	5.00%	$ -	$ -
10			$ -	5.00%	$ -	$ -
11			$ -	5.00%	$ -	$ -
12		**Remaining Construction Items**	$ **482,649**	6.82%	$ 32,919	$ 515,568.47
13	30 PLANNING, ENGINEERING, AND DESIGN	**Planning, Engineering, & Design**	$ **283,000**	5.00%	$ 14,150	$ 297,150.00
14	31 CONSTRUCTION MANAGEMENT	**Construction Management**	$ **283,000**	5.00%	$ 14,150	$ 297,150.00

Totals					
Total Construction Estimate	$	2,830,732	23.82%	$	674,210	$	3,504,942
Total Planning, Engineering & Design	$	283,000	5.00%	$	14,150	$	297,150
Total Construction Management	$	283,000	5.00%	$	14,150	$	297,150
Total	$	3,396,732		$	702,510	$	4,099,242

Starved Rock 519 Critical Restoration Project
Feasibility (Alternatives)
Abbreviated Risk Analysis

Meeting Date: 7-Nov-12

Risk Level

	Negligible	Marginal	Significant	Critical	Crisis
Very Likely	2	3	4	5	5
Likely	1	2	3	4	5
Possible	0	1	2	3	4
Unlikely	0	0	1	2	3

Risk Element	Potential Risk Areas	Concerns Pull Down Tab (ENABLE MACROS THRU TRUST CENTER) (Choose ALL that apply)	Concerns	PDT Discussions & Conclusions (Include logic & justification for choice of Likelihood & Impact)	Likelihood	Impact	Risk Level
Project Scope Growth							
						Max Potential Cost Growth	**75%**
PS-1	Rock Breakwater	• Potential for scope growth, added features and quantities?	• Potential for scope growth, added features and quantities?	Adequate survey exists for quantites. Rock is a common construction method for the District. Potential for further geotech investigations.	Possible	Marginal	**1**
PS-13	Planning, Engineering, & Design	• Potential for scope growth, added features and quantities?	• Design confidence?	There is potential for design changes to impact cost growth, such as the need for new hydraulic modeling or updated quantities.	Likely	Negligible	**1**
PS-14	Construction Management	• Project accomplish intent?	• Project accomplish intent?	The difficulties of managing a construction in a river contributes to this concern.	Possible	Marginal	**1**
Acquisition Strategy							
						Max Potential Cost Growth	**30%**
AS-1	Rock Breakwater	• 8a or small business likely?	• 8a or small business likely?	The project isn't currently scheduled to be solicited as an 8a contract, but if it becomes an 8a contract that will increase the cost.	Likely	Significant	**3**
AS-12	Remaining Construction Items	• Contracting plan firmly established?	No concerns.	No impacts identified.	Unlikely	Negligible	**0**
AS-13	Planning, Engineering, & Design	• Contracting plan firmly established?	No concerns.	No impacts identified.	Unlikely	Negligible	**0**
AS-14	Construction Management	• Contracting plan firmly established?	No concerns.	No impacts indentified.	Unlikely	Negligible	**0**
Construction Elements							
						Max Potential Cost Growth	**25%**
CE-1	Rock Breakwater	• High risk or complex construction elements, site access, in-water?	• Accelerated schedule or harsh weather schedule? • High risk or complex construction elements, site access, in-water?	Working in the river presents construction challenges. Usage of riprap, however, is a common constuction method for the District. Weather could affect the construction schedule.	Likely	Negligible	**1**
CE-12	Remaining Construction Items	• Accelerated schedule or harsh weather schedule?	No concerns.	No further issues.	Unlikely	Negligible	**0**
CE-13	Planning, Engineering, & Design	• Accelerated schedule or harsh weather schedule?	No concerns.	No further issues.	Unlikely	Negligible	**0**
CE-14	Construction Management	• Accelerated schedule or harsh weather schedule?	No concerns.	No further issues.	Unlikely	Negligible	**0**

Quantities for Current Scope

					Max Potential Cost Growth		20%
Q-1	Rock Breakwater	• Possibility for increased quantities due to loss, waste, or subsidence?	• Possibility for increased quantities due to loss, waste, or subsidence?	The nature of the material throughout the channel bottom isn't completely known at the time of this register and could cause an increase in quantities, but the Geotech survey should help avoid this. Quantites shouldn't change much unless the design alignment changes.	Possible	Marginal	1
Q-12	Remaining Construction Items	• Level of confidence based on design and assumptions?	• Level of confidence based on design and assumptions?	There is the possibility for the alignment to change during design, requiring a change in quantities and affecting the mob/demob.	Possible	Marginal	1
Q-13	Planning, Engineering, & Design	• Level of confidence based on design and assumptions?	No concerns.	No impacts identified.	Unlikely	Negligible	0
Q-14	Construction Management	• Level of confidence based on design and assumptions?	No concerns.	No impacts identified.	Unlikely	Negligible	0

Specialty Fabrication or Equipment

					Max Potential Cost Growth		75%
FE-1	Rock Breakwater	• Unusual parts, material or equipment manufactured or installed?	No concerns.	No impacts identified. Common construction.	Unlikely	Negligible	0
FE-12	Remaining Construction Items	• Unusual parts, material or equipment manufactured or installed?	No concerns.	No impacts identified.	Unlikely	Negligible	0
FE-13	Planning, Engineering, & Design	• Unusual parts, material or equipment manufactured or installed?	No concerns.	No impacts identifed.	Unlikely	Negligible	0
FE-14	Construction Management	• Unusual parts, material or equipment manufactured or installed?	No concerns.	No impacts identified.	Unlikely	Negligible	0

Cost Estimate Assumptions

					Max Potential Cost Growth		35%
CT-1	Rock Breakwater	• Reliability and number of key quotes?	• Reliability and number of key quotes?	The quotes are reliable, but prices will likely climb between this register and construction.	Likely	Marginal	2
CT-12	Remaining Construction Items	• Reliability and number of key quotes?	No concerns.	No impacts identified.	Unlikely	Negligible	0
CT-13	Planning, Engineering, & Design	• Reliability and number of key quotes?	No concerns.	No impacts identified.	Unlikely	Negligible	0
CT-14	Construction Management	• Reliability and number of key quotes?	No concerns.	No impacts identified.	Unlikely	Negligible	0

External Project Risks

					Max Potential Cost Growth		40%
EX-1	Rock Breakwater	• Political influences, lack of support, obstacles?	• Political influences, lack of support, obstacles? • Potential for severe adverse weather? • Unanticipated inflations in fuel, key materials?	There is a possibility for Native American cultural issues to arise. Yearly flooding on project is likely. Stone will probably be delivered by barge, and the quarry will likely have at least one lock between it and the project site. This could lead to delays if navigation becomes an issue.	Possible	Significant	2
EX-12	Remaining Construction Items	• Potential for severe adverse weather?	No concerns.	No impacts identified.	Unlikely	Negligible	0
EX-13	Planning, Engineering, & Design	• Potential for severe adverse weather?	No concerns.	No impacts identified.	Unlikely	Negligible	0
EX-14	Construction Management	• Potential for severe adverse weather?	No concerns.	No impacts identified.	Unlikely	Negligible	0

Abbreviated Risk Analysis

Starved Rock 519 Critical Restoration Project
Feasibility (Alternatives)

Meeting Date: 7-Nov-12

PDT Members
Note: PDT involvement is commensurate with project size and involvement.

Project Management:	
Planner:	Monique Savage
Study Manager:	
Contracting:	
Real Estate:	
Relocations:	
OTHER:	Environmental Chuck Theiling / Brent Ackerman
Engineering & Design:	
Technical Lead:	
Geotech:	
Hydrology:	John Lacy
Civil:	Rachel Fellman
Structural:	
Mechanical:	
Electrical:	
Cost Engineering:	Ben Ferrell
Construction:	
Operations:	

ILLINOIS RIVER BASIN RESTORATION
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DEFINITE PROJECT IMPLEMENTATION REPORT
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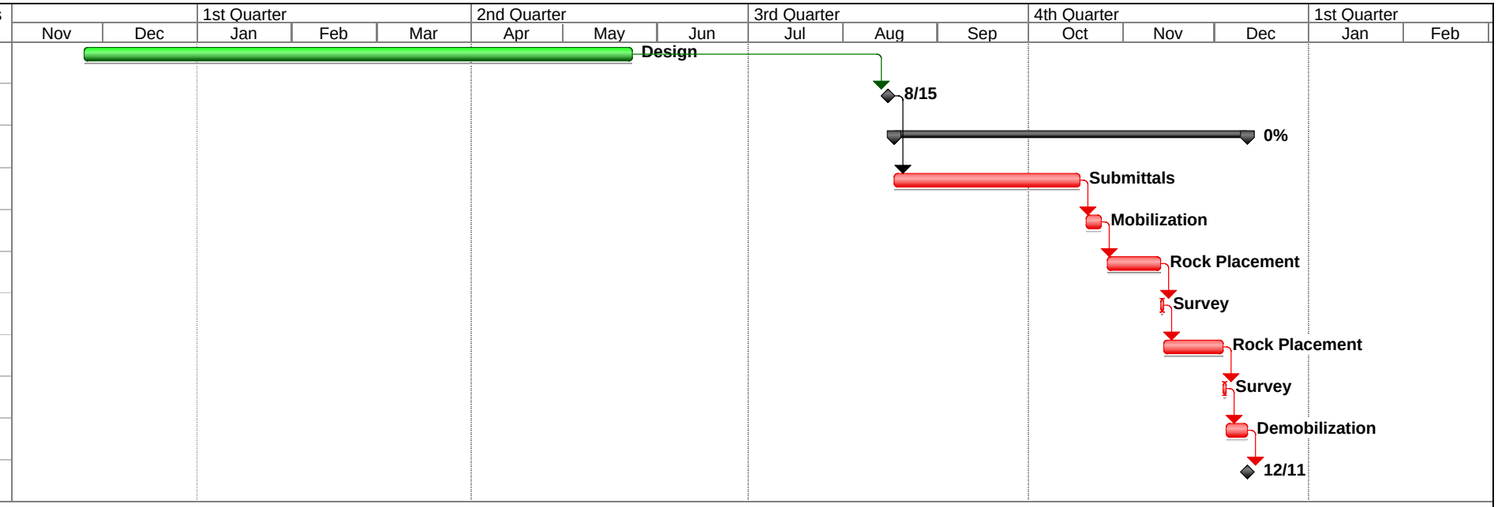
STARVED ROCK
CRITICAL RESTORATION PROJECT

APPENDIX I-C

PROJECT SCHEDULE

ID	Task Name	Duration	Start	Finish	Predecessors
1	Design	130 days	Mon 11/25/13	Fri 5/23/14	
2	Notice to Proceed	0 days	Fri 8/15/14	Fri 8/15/14	1FS+60 days
3	**Construction**	**84 days**	**Mon 8/18/14**	**Thu 12/11/14**	
4	Submittals	45 days	Mon 8/18/14	Fri 10/17/14	2
5	Mobilization	5 days	Mon 10/20/14	Fri 10/24/14	4
6	Rock Placement	13.5 days	Mon 10/27/14	Thu 11/13/14	5
7	Survey	1 day	Thu 11/13/14	Fri 11/14/14	6
8	Rock Placement	13.5 days	Fri 11/14/14	Wed 12/3/14	7
9	Survey	1 day	Thu 12/4/14	Thu 12/4/14	8
10	Demobilization	5 days	Fri 12/5/14	Thu 12/11/14	9
11	Substantial Completion	0 days	Thu 12/11/14	Thu 12/11/14	10



Project: IW124ATRSchedule
Date: Fri 5/24/13

Critical	Task	Baseline	Milestone	Project Summary	Deadline
Critical Split	Split	Baseline Split	Summary Progress	External Tasks	
Critical Progress	Task Progress	Baseline Milestone	Summary	External Milestone	

ILLINOIS RIVER BASIN RESTORATION
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STARVED ROCK
CRITICAL RESTORATION PROJECT

APPENDIX I-D

TOTAL PROJECT COST SUMMARY

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: **PN 135153 Starved Rock Section 519 TSP**
LOCATION: Utica, IL

DISTRICT: MVR Rock Island PREPARED: 5/22/2013
POC: CHIEF, COST ENGINEERING, Charles R. Van Laarhoven

This Estimate reflects the scope and schedule in report; CAP STUDY - STARVED ROCK SECTION 519

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
						Program Year (Budget EC): 2013								
						Effective Price Level Date: 1 OCT 12								
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	**TOTAL ($K)**	Spent Thru: 1-Oct-12 ($K)		COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*	*L*	*M*	*N*	*O*
10	BREAKWATER & SEAWALLS	$2,348	$562	24%	$2,910	2.1%	$2,396	$574	$2,970			$2,440	$584	$3,025
10	ADAPTIVE MANAGEMENT	$483	$116	24%	$598	2.1%	$493	$118	$611			$556	$133	$690
	CONSTRUCTION ESTIMATE TOTALS:	$2,831	$678		$3,509	2.1%	$2,889	$692	$3,581			$2,997	$718	$3,714
01	LANDS AND DAMAGES	$0	$0	30%	$0	2.1%	$0	$0	$0			$0	$0	$0
22	FEASIBILITY STUDY (CAP studies)									$840				$840
30	PLANNING, ENGINEERING & DESIGN	$283	$14	5%	$297	1.8%	$288	$14	$302			$289	$14	$304
31	CONSTRUCTION MANAGEMENT	$283	$14	5%	$297	1.8%	$288	$14	$302			$298	$15	$313
	PROJECT COST TOTALS:	$3,397	$706	21%	$4,103		$3,465	$721	**$4,186**	$840		$3,585	$747	$5,172

CHIEF, COST ENGINEERING, Charles R. Van Laarhoven

PROJECT MANAGER, Henry DeHaan

CHIEF, REAL ESTATE, Stuart P. Jackson

CHIEF, PLANNING, xxx

CHIEF, ENGINEERING, xxx

CHIEF, OPERATIONS, xxx

CHIEF, CONSTRUCTION, xxx

CHIEF, CONTRACTING, xxx

CHIEF, PM-PB, xxxx

CHIEF, DPM, xxx

ESTIMATED FEDERAL COST:	65%	**$2,816**
ESTIMATED NON-FEDERAL COST:	35%	**$1,516**
FEDERAL FEASIBILITY CAP COSTS ($100K + 65%):		**$581**
NON-FEDERAL FEASIBILITY COSTS:		**$259**
ESTIMATED TOTAL PROJECT COST:		**$5,172**

****** TOTAL PROJECT COST SUMMARY ******

****** CONTRACT COST SUMMARY ******

PROJECT: PN 135153 Starved Rock Section 519 TSP
LOCATION: Utica, IL
This Estimate reflects the scope and schedule in report; CAP STUDY - STARVED ROCK SECTION 519

DISTRICT: MVR Rock Island PREPARED: 5/22/2013
POC: CHIEF, COST ENGINEERING, Charles R. Van Laarhoven

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared: 22-May-13 Effective Price Level: 1-Oct-12				Program Year (Budget EC): 2013 Effective Price Level Date: 1 OCT 12								
				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	INFLATED (%)	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													
10	BREAKWATER & SEAWALLS	$2,348	$562	24%	$2,910	2.1%	$2,396	$574	$2,970	2015Q1	1.8%	$2,440	$584	$3,025
10	ADAPTIVE MANAGEMENT	$483	$116	24%	$598	2.1%	$493	$118	$611	2020Q3	13.0%	$556	$133	$690
	CONSTRUCTION ESTIMATE TOTALS:	$2,831	$678	24%	**$3,509**		$2,889	$692	$3,581			$2,997	$718	$3,714
01	LANDS AND DAMAGES	$0	$0	30%	$0	2.1%	$0	$0	$0	2014Q2	0.4%	$0	$0	$0
30	PLANNING, ENGINEERING & DESIGN													
	Project Management			5%										
	Planning & Environmental Compliance			5%										
10.0%	Engineering & Design	$283	$14	5%	$297	1.8%	$288	$14	$302	2014Q2	0.5%	$289	$14	$304
	Engineering Tech Review ITR & VE			5%										
	Contracting & Reprographics			5%										
	Engineering During Construction			5%										
	Planning During Construction			5%										
	Project Operations			5%										
31	CONSTRUCTION MANAGEMENT													
10.0%	Construction Management	$283	$14	5%	$297	1.8%	$288	$14	$302	2015Q1	3.7%	$298	$15	$313
	Project Operation:			5%										
	Project Management			5%										
	CONTRACT COST TOTALS:	$3,397	$706		**$4,103**		$3,465	$721	$4,186			$3,585	$747	**$4,332**

ILLINOIS RIVER BASIN RESTORATION
SECTION 519
PROJECT IMPLEMENTATION REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STARVED ROCK CRITICAL RESTORATION PROJECT
LASALLE COUNTY, ILLINOIS

APPENDIX J

REAL ESTATE PLAN

ILLINOIS RIVER BASIN RESTORATION
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STARVED ROCK
CRITICAL RESTORATION PROJECT

APPENDIX J

REAL ESTATE PLAN

1. PURPOSE J-1

2. DESCRIPTION OF THE LANDS, EASEMENTS, AND RIGHTS-OF-WAY J-1
REQUIRED FOR CONSTRUCTION, OPERATION, & MAINTENANCE OF THE PROJECT

3. SPONSOR-OWNED LANDS J-2

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ILLINOIS RIVER BASIN RESTORATION
SECTION 519
DEFINITE PROJECT IMPLEMENTATION REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STARVED ROCK
CRITICAL RESTORATION PROJECT

APPENDIX J

REAL ESTATE PLAN

1. PURPOSE

This Real Estate Plan (REP) is developed in support of the Illinois River Basin Restoration of the Illinois River Watershed, Illinois. The Project is authorized under Section 519 of the Water Resources Development Act of 2000. The Project area is located upstream of Starved Rock Lock and Dam along the Illinois River in LaSalle County, Illinois. The Illinois Department of Natural Resources (ILDNR) is the non-Federal Sponsor for this Project. There are no other Real Estate Plans that support this Project.

The Project was proposed as a Critical Restoration Project during the development of the Illinois River Basin Restoration Comprehensive Plan. The proposed Project was intended to address the perceived problem of a loss of side channel and island habitat in Starved Rock Pool. The primary ecological limiting factor was identified as a lack of submerged aquatic vegetation (SAV). The proposed Project would involve constructing a riprap breakwater to improve SAV. The lack of SAV in Starved Rock Pool is considered to be limiting both waterfowl and fisheries.

2. DESCRIPTION OF THE LANDS, EASEMENTS, AND RIGHTS-OF-WAY (LER) REQUIRED FOR CONSTRUCTION, OPERATION, AND MAINTENANCE OF THE PROJECT

Starved Rock Pool is a 16-mile section of the Illinois River located 65 miles southwest of Chicago. It extends from Starved Rock Lock and Dam (River Mile 231) eastward to the base of Marseilles Dam (River Mile 247). The pool is located in La Salle County and has the communities of Ottawa, South Ottawa and Marseilles located along its length. Starved Rock State Park lies along a portion of its left descending bank, and the Fox River (the pool's primary tributary) enters midway down its right descending bank. Several major islands (totaling approximately five miles in length) remain in the Starved Rock Pool including Sheehan, Mayo, Hitt, Scherer, Bulls, and Bell's Island.

The recommended plan includes placement of a riprap breakwater along the northern edge of former Delbridge Island adjacent to the navigation channel between River Miles 233 and 234 in Starved Rock Pool (Enclosure 1). The breakwater will be approximately 6,100 feet long and constructed to a design elevation 461.85 feet with a 3-foot top width and 2.5H:1V side slopes. Riprap shall conform to the requirements of Gradation RR-5 of the Illinois Department of Transportation.

Rock placement would be accomplished by floating plant. It is anticipated that rock will be transported from a quarry by barge to the Project area. The riprap breakwater will be placed in close proximity to the navigation channel so that the riprap can be easily placed. The riprap breakwater is positioned to protect the area behind it from wind and wave action to support submergent aquatic vegetation.

Access to the site will be by water. A public boat ramp is located at Starved Rock State Park. The staging area for temporary construction offices will be located at the Starved Rock Lock and Dam and will need to be coordinated with lock and dam personnel. No material storage will be allowed at the staging area. The boat ramp and staging area are identified on Enclosure 1. Access to the site for OMRR&R will also be by water. No additional access is required. There are no borrow or disposal sites required for the Project.

Project coordinates are Sections nineteen (19) and twenty-four (24), Township thirty-three (33) North, Range two (2) and three (3) East of the Third Principal Meridian (LaSalle County, Illinois). The Project area is shown as Enclosure 1.

Type of Estate	**Type of Owner**	**Size in Square Feet**
Fee	Sponsor owned	approximately 18,300
Temporary Work Area Easement	Sponsor owned	approximately 610,000

3. SPONSOR-OWNED LANDS

From a real estate perspective, the intent of this Project is to remain entirely within lands owned by the Sponsor, the State of Illinois. With that said, extensive research has been conducted to best determine what interests are owned and by who and where those specific real estate boundaries are located within the Project area. In the lower Starved Rock Pool, as it is known today and prior to the construction of the series of locks and dams along the Illinois River, this area had numerous naturally occurring islands within the River. The largest of those islands was called Delbridge Island and was approximately 440 acres in size. In the late 1920s and early 1930's land interests were acquired within and surrounding the River by the State and Federal Government for the improvement of the Illinois Waterway through the construction of the nearby lock and dam. Today, depending on the water elevation at time of observation, there is only about 10 acres of exposed land on the upstream end of the former Delbridge Island. After a thorough review of current and historical maps, examining all available conveyance documents, and speaking to the surrounding landowners, it is the opinion of this author that the State of Illinois holds fee simple title to the upstream 317 acres of the former Delbridge Island within which the entire Project is expected to take place. This portion of the Island is identified as tracts P-5 and P-15 on the Corps of Engineers Composite Map from 1932 and attached as Enclosure 2. As stated above, most of this acreage is permanently inundated and now lies below the normal high water mark.

Research has also revealed that there is one additional landowner near the Project area. Over many years of ever changing river hydrology and the absence of an accurate survey, the landowner does not have a definitive way of identifying the limits of his property. The legal description describes the ownership as being, "three small islands located at the Northeasterly end of Delbridge Island; said

islands being formed by the backwater of pool level to be created by the Starved Rock Lock and dam and all of which is less than 2 feet above pool level." In this case, the proposed Project alignment has been designed in a fashion as to avoid potentially impacting the landowner. The "three small islands" are best identified on a map supplied by the State and outlined in dark green on Enclosure 3. The existing state-owned estates would be sufficient and available for the Project, but navigational servitude will be exercised as further described in Section 7, *Navigational Servitude*, of this report.

4. NON-STANDARD ESTATES

The Project does not require the use of any non-standard estate.

5. EXISTING FEDERAL PROJECT WITHIN THE LER REQUIRED FOR THE PROJECT

There is no evidence and it does not appear that the LER required for this Project was previously provided as an item of local cooperation.

6. EXISTING FEDERALLY-OWNED LAND

There is no known federally-owned land required for the Project; however, it should be noted that the downstream end of the proposed Project alignment borders land interests held by the Federal Government. In 1933 the Government acquired a permanent Flowage Easement lying in Section twenty-three (23), Township thirty-three (33) North, Range two (2) East of the Third Principal Meridian of Delbridge Island, containing one hundred twenty-three (123) acres, more or less and identified on Illinois Waterway Land Acquisition Map as Tract D. This map is attached as Enclosure 4.

7. NAVIGATIONAL SERVITUDE

ER 405-1-12 Section II, 12-7 defines navigation servitude as, "the dominant right of the Government under the Commerce Clause of the U.S. Constitution (U.S. CONST. art.I, S8, cl.3) to use, control and regulate the navigable waters of the United States and the submerged lands thereunder for various commerce-related purposes including navigation and flood control." Waters determined to be "navigable waters of the United States" in the Rock Island District include the Illinois River as it exists within District boundaries. The proposed Project site falls within those parameters. MVR-Office of Counsel has reviewed the Project and previous legal opinions on the subject as applicable, and concurs with MVR-RE that the conditions the project addresses were ultimately caused by navigation, thus supporting the assertion of navigation servitude. Paragraph 12-7 also states, "Generally, it is the policy of the U.S. Army Corps of Engineers (USACE) to utilize the navigation servitude in all situations where available, whether or not the Project is cost shared or full Federal." It should also be noted that in no event shall credit be afforded for lands that are available to the Project through the exercise of the navigation servitude.

8. MAP DEPICTING THE AREA

The real estate Project Area Map is attached as Enclosure 1.

9. INDUCED FLOODING

There will be no induced flooding by the construction or the operation and maintenance of the Project.

10. BASELINE COST ESTIMATE

A Baseline Cost Estimate for Real Estate was not developed because there are no anticipated lands to be acquired and navigation servitude will be exercised for the Project. Table J-1 was included for the purposes of identifying an estimate of Government costs for staff monitoring and review.

Table J-1

	NON-FEDERAL	FEDERAL
Lands and Damages	$ 0	$0
Relocation Assistance (91-646)	$ 0	$0
Incidental Acquisition Costs		
a. Monitoring non-Federal Sponsor's Acquisition		$
b. Survey	$ 0	$
c. Title Evidence	$ 0	$
d. Negotiation/Closing	$ 0	$
e. Appraisal	$ 0	$
f. Administrative	$ 0	$4,000
GRAND TOTAL	**$ 0**	**$4,000**

11. PUBLIC LAW (PL) 91-646 RESIDENCE/BUSINESS RELOCATION ASSISTANCE BENEFITS

The Project does not require any relocation of persons, farms, or businesses; therefore, there are no anticipated Public Law 91-646 Relocation Assistance Benefit payments.

12. MINERAL ACTIVITY IN THE PROJECT AREA

There is no current or anticipated mineral or timber harvest activity within the Project boundary; however mining operations are planned to occur near the Project area. According to a press release, dated December 12, 2012, the Sierra Club, Prairie Rivers Network, and Openlands filed a complaint in Circuit Court in Springfield, Illinois demanding judicial review of a massive open pit silica sand mining permit granted to Mississippi Sand, LLC by the Illinois Department of Natural Resources Office of Mines and Minerals. The report states the ILDNR approved an 80 acre open pit mine to harvest and process silica sand for use in the hydraulic fracturing (or "fracking") natural gas extraction

process. The mine is also said to potentially pump up to five million gallons a day of water from its operation and storm water into Horseshoe Creek, which runs through Starved Rock State Park. A concern is that introducing that much water will likely cause damage to Horseshoe Creek and the creek mouth empties into the Starved Rock Pool near the downstream end of the Project area.

13. NON-FEDERAL SPONSOR'S LEGAL AND PROFESSIONAL ACQUISITION CAPABILITY TO ACQUIRE LER

As further described in Section 7, *Navigational Servitude*, of this report, navigation servitude is available and will be exercised for the proposed Project. The non-Federal Sponsor's Acquisition Capability Checklist is attached as Enclosure 5.

14. ZONING ORDINANCES

No known zoning ordinances are proposed.

15. SCHEDULE OF LAND ACQUISITION

There are no anticipated lands to be acquired for the Project. As mentioned in Section 7, *Navigational Servitude*, of this report, navigation servitude will be exercised.

16. FACILITY/UTILITY RELOCATIONS

There is no known facility or utility relocations associated with this Project.

17. IMPACTS OF SUSPECTED OR KNOWN CONTAMINANTS

A Phase I Hazardous, Toxic, and Radioactive Waste (HTRW) Environmental Site Assessment (ESA) was completed in October 2011 for the proposed restoration activities located in the Starved Rock Pool of the Illinois Waterway, La Salle County, Illinois in accordance with Engineering Regulation (ER) 1165-2-132, HTRW Guidance for Civil Works Projects, and ER 405-1-12, Real Estate Handbook. The report revealed evidence of two Recognized Environmental Conditions (REC) that could potentially affect the study area. The first REC is the potential of contaminated sediments in the Starved Rock Pool. The other REC is the potential for herbicide contamination from overspray on county roads adjacent to the study area. No additional assessment or investigation of the study area is recommended based on the fact that no river sediments are planned to be manipulated or moved.

18. LANDOWNERS SUPPORT OR OPPOSITION TO THE PROJECT

At this time, the support or opposition of adjoining or nearby landowners is unknown. Adjoining and nearby landowner concerns are not anticipated.

19. RISKS OF ACQUIRING LANDS BEFORE EXECUTION OF THE PPA

Notice to the sponsor regarding risks of acquisition prior to the signing of the PPA is not necessary since no acquisitions are expected.

20. OTHER REAL ESTATE ISSUES RELEVANT TO THE PROJECT

There are no other known real estate issues at this time.

Date: 27-JUNE-2013

Jason Appel
Realty Specialist
Planning & Acquisition Branch
Regional Real Estate Division North

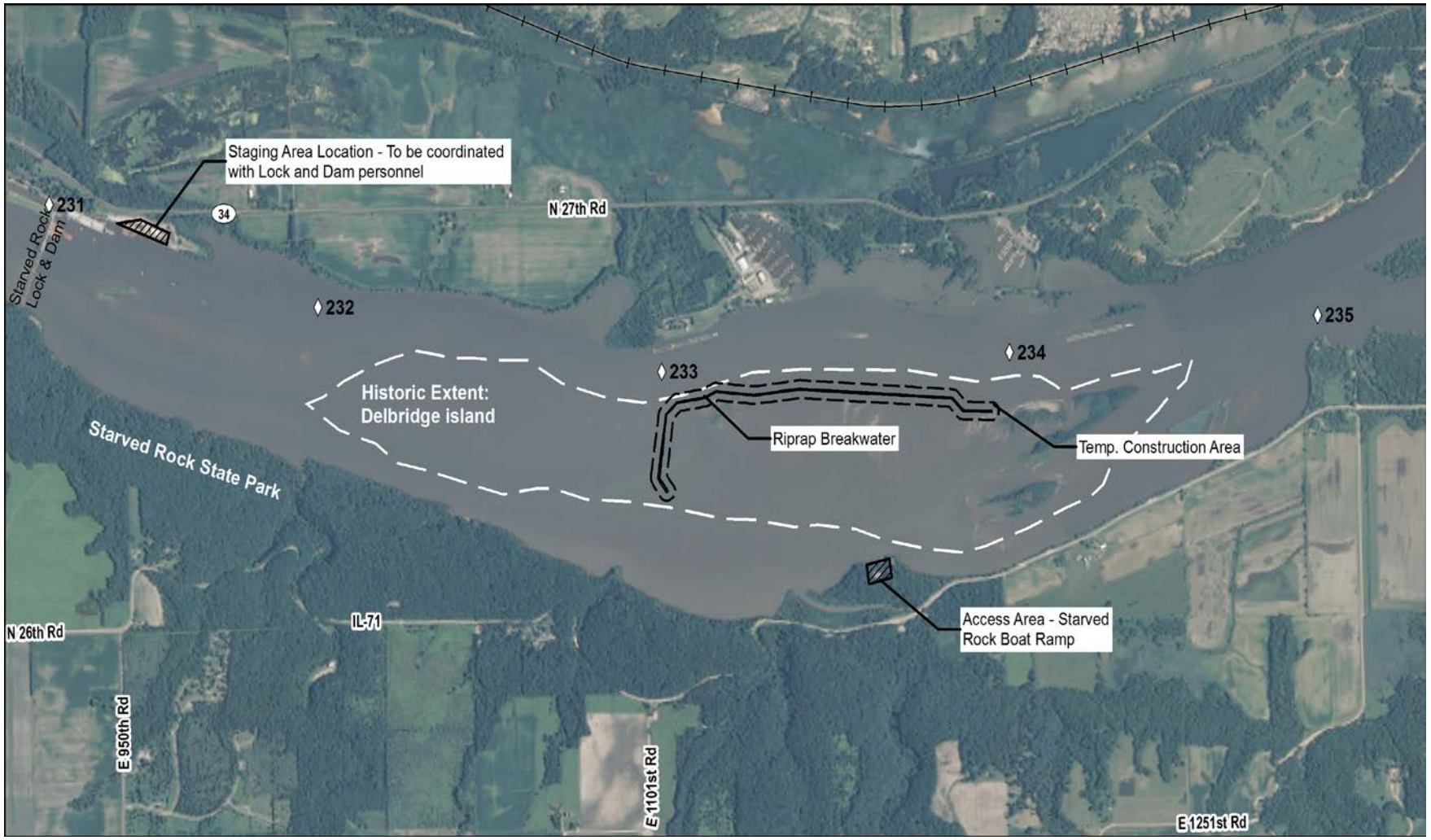
Date: 27 JUNE 2013

Ron Williams
Chief, North Region Appraisal & Realty Services
MVD RE North Region
Rock Island District

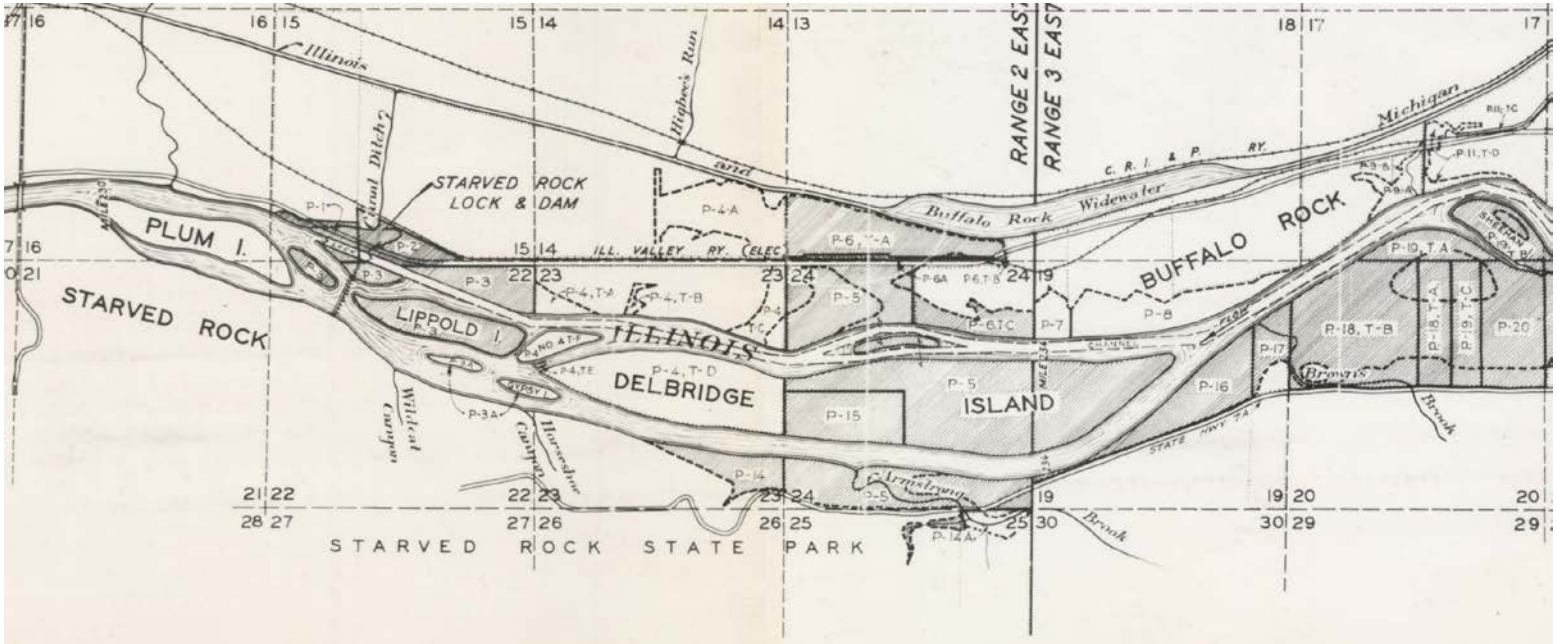
Date: 12 July 2013

Stuart P. Jackson
Chief, Real Estate Division North Region
U.S. Army Corps of Engineers
Rock Island District

ENCLOSURE 1
PROJECT AREA MAP



ENCLOSURE 2 – CORPS OF ENGINEERS COMPOSITE MAP - 1932



LEGEND

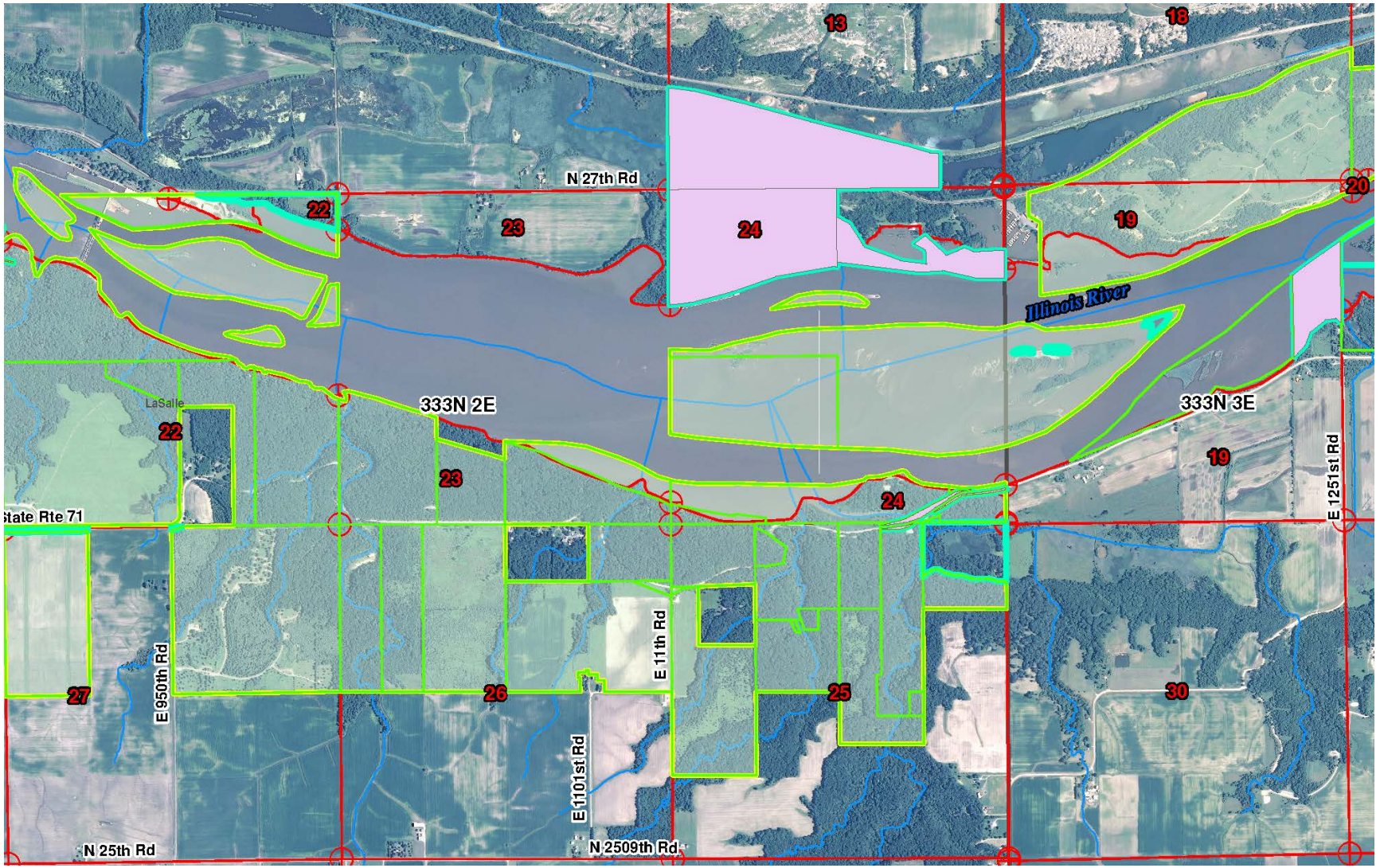
- Easement to be acquired by United States
- Fee simple title acquired by State of Illinois.
- Easement acquired by United States.
- Contour line 2 feet above Pool.
- Plat Line
- (X) Easements not required. Lands below Ordinary High Water Mark.
- Ownership Boundary
- Channel Line

NOTE :- Distances are given in miles from U.S. Tailage at Grafton, Illinois.

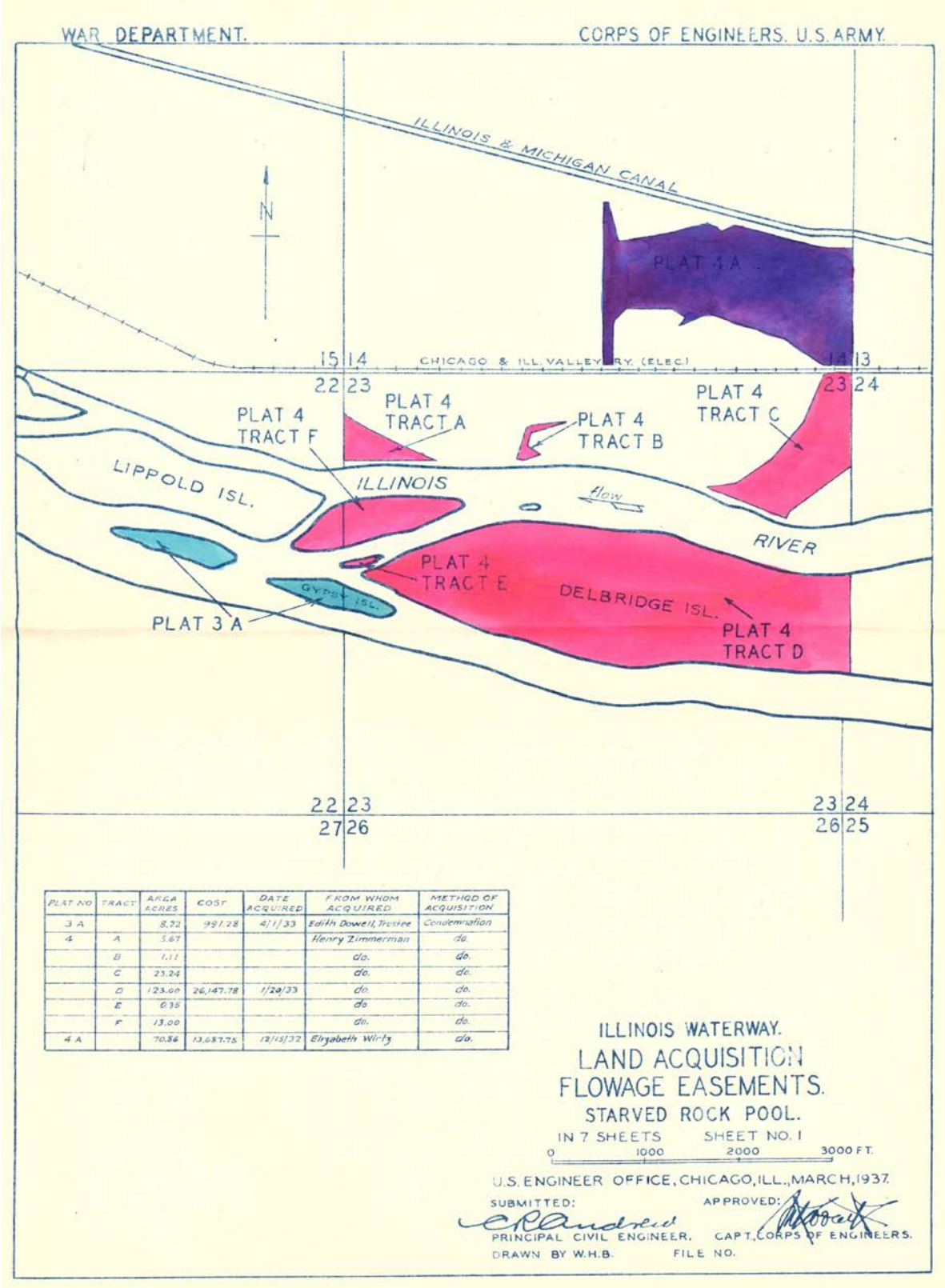
PLAT NO.	TRACT	OWNER	AREA (ACRES)
1		STATE OF ILLINOIS	13.95
2		" " "	36.58
3		" " "	123.88
3A		W. S. BALLARD	8.24
4	A	HENRY ZIMMERMAN	5.67
"	B	" "	1.11
"	C	" "	23.24
"	D	" "	123.00
"	E	" "	0.35
"	F	" "	13.00
4A		ELIZABETH WIRTZ	70.86
5		STATE OF ILLINOIS	399.82
6	A	" " "	109.33
	B	" " "	
	C	" " "	
7		MOLINE CONSUMERS CO.	13.93
8		AMERICAN SILICA SAND CO.	49.69
9-A		ROBERT A. O'MEARA	19.70
9-B		JAMES O'MEARA	Non Damage
10		FOLLETT & CEBULSKE	3.46
11	A	LA SALLE COUNTY FARM	9.10
"	B	" " "	4.69
"	C	" " "	2.27
"	D	" " "	18.55
12		OTTAWA SILICA CO.	0.88
14		STATE OF ILLINOIS	21.00
14A		EDGAR A. FISHBURN et ux	13.87
15		STATE OF ILLINOIS	46.26
16		" "	58.42

PLAT NO.	TRACT	OWNER	AREA (ACRES)
17		STATE OF ILLINOIS	22.74
18	A	" " "	40.00
"	B	" " "	147.60
19	A	" " "	21.00
"	B	" " "	39.00
"	C	" " "	40.00
20		" " "	79.00
21		" " "	63.00
23		" " "	63.81
24		DANIEL F. MITT EST.	29.00
26	A.B.C.	DANIEL F. MITT EST.	12.58
26A		ISAAC DEGEN	0.64
0-12		CHRISTINE K. BOOTH	1.24
0-13		GUSTAV KNEUSSL	0.55
0-14		FRED C. BEEM	0.15
0-15		NETTIE S. HAVNAAD	0.24
0-16		MINNIE M. HARTSHORN EST.	0.19
0-17		GEORGE J. GLEIM	0.21
0-22		JOHN H. GRAY et al	7.06
0-28		P.B.SCHOCH & L. EWING PORTER	0.86
0-30		OWEN J. FOX	9.30
0-36	B	THOMAS R. GODFREY	1.90
0-37	A	ISAAC DEGEN	1.33
0-37	B	" "	2.11
6A		CHICAGO & ILL. VALLEY R.R.CO.	3.73

ENCLOSURE 3 – STATE SUPPLIED OWNERSHIP MAP
STATE OWNERSHIP OUTLINED IN LIGHT (LIME) GREEN



ENCLOSURE 4
FLOWAGE EASEMENT



PLAT NO	TRACT	AREA ACRES	COST	DATE ACQUIRED	FROM WHOM ACQUIRED	METHOD OF ACQUISITION
3 A		8.72	991.28	4/1/33	Edith Dowell, Trustee	Condemnation
4	A	5.67			Henry Zimmerman	do.
	B	1.11			do.	do.
	C	23.24			do.	do.
	D	123.00	26,147.78	1/20/33	do.	do.
	E	0.35			do	do.
	F	13.00			do.	do.
4 A		70.86	13,687.75	12/15/32	Elizabeth Wirtz	do.

ILLINOIS WATERWAY.
LAND ACQUISITION
FLOWAGE EASEMENTS.
STARVED ROCK POOL.
IN 7 SHEETS SHEET NO. 1
0 1000 2000 3000 FT.
U.S. ENGINEER OFFICE, CHICAGO, ILL., MARCH, 1937.
SUBMITTED: APPROVED:
PRINCIPAL CIVIL ENGINEER. CAPT., CORPS OF ENGINEERS.
DRAWN BY W.H.B. FILE NO.

ENCLOSURE 5

ASSESSMENT OF NON-FEDERAL SPONSOR'S REAL ESTATE ACQUISITION CAPABILITY

I. Legal Authority

A. Does the sponsor have legal authority to acquire and hold title to real property for project purposes? **Yes**

B. Does the sponsor have the power of eminent domain for this project? **Yes, the State does have eminent domain authority; however it requires the Governor's approval. The sponsor has used eminent domain sparingly, only in extraordinary circumstances.**

C. Does sponsor have "quick take" authority for this project? **No**

D. Are any of the land/interests in land required for the project located outside the sponsor's political boundary? **No**

E. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? **Not Applicable**

II. Human Resource Requirements

A. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including P.L. 91-646, as amended? **No**

B. If the answer to II.A is "yes", has a reasonable plan been developed to provide such training?

C. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? **Yes**

D. Is the sponsor's projected in-house staffing level sufficient considering its other work load, if any, and the project schedule? **Yes**

E. Can the sponsor obtain contractor support, if required in a timely fashion? **Yes**

F. Will the sponsor likely request USACE assistance in acquiring real estate? (If "yes", provide description). **No**

III. Other Project Variables

A. Will the sponsor's staff be located within reasonable proximity to the project site? **Yes**

B. Has the sponsor approved the project/real estate schedule/milestones? **No**

IV. Overall Assessment

A. Has the sponsor performed satisfactory on other USACE projects? **Yes**

B. With regard to this project, the sponsor is anticipated to be: **Fully Capable**

V. Coordination

A. Has this assessment been coordinated with the sponsor? **No**

B. Does the sponsor concur with this assessment? (If "no", provide explanation). **The sponsor has worked closely with the Corps on similar projects in the recent past. It is reasonable to assume that the sponsor would concur with the generalities of this assessment.**

Date: 27-JUNE-2013

Jason Appel
Realty Specialist
Planning & Acquisition Branch
Regional Real Estate Division North

Date: 27 June 2013

Ron Williams
Chief, North Region Appraisal & Realty Services
MVD RE North Region
Rock Island District

Approved by:
Date: 12 July 2013

Stuart P. Jackson
Chief, Real Estate Division North Region
U.S. Army Corps of Engineers
Rock Island District

Quality Control Plan Checklist

Real Estate Plans

And other similar Feasibility-Level Real Estate Planning Documents

ER 405-1-12, Section 12-16, Real Estate Handbook, 1 May 1998

A Real Estate Plan (REP) is prepared in support of a decision document for full-Federal or cost shared specifically authorized or continuing authority projects. It identifies and describes lands, easements and rights-of-way (LER) required for the construction, operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) of a proposed project including requirements for mitigation, relocations, borrow material, and dredged or excavated material disposal. It also identifies and describes facility/utility relocations, LER value, and the acquisition process. The REP does not just cover LER to be acquired by the non-Federal sponsor (NFS) or Government. The report covers all LER needed for the project, including LER already owned by the NFS, Federal Government, other public entities, or subject to the navigation servitude.

The REP must contain a detailed discussion of the following 20 topics, as set out in Section 12-16 of the ER, including sufficient description of the rationale supporting each conclusion presented. If a topic is not applicable to the project, this should be stated in the REP. The pages of a REP should be numbered.

PROJECT - Section 519 Starved Rock Critical Restoration Project

REPORT TITLE – Illinois River Basin Restoration, Section 519, Definite Project Implementation Report with Integrated Environmental Assessment, Starved Rock Critical Restoration Project

Date of Report – June 2013 **Date of REP –** June 2013

1. **Purpose of the REP**. _X_
   a. Describe the purpose of the REP in relation to the project document that it supports.
   b. Describe the project for the Real Estate reviewer.
   c. Describe any previous REPs for the project.

2. **Describe LER**. _X__
   a. Account for all lands, easements, and rights-of-way underlying and required for the construction, OMRR&R of the project, including mitigation, relocations, borrow material and dredged or excavated material disposal, whether or not it will need to be acquired or will be credited to the NFS.
   b. Provide description of total LER required for each project purpose and feature.
   c. Include LER already owned by the Government, the NFS and within the navigation servitude.
   d. Show acreage, estates, number of tracts and ownerships, and estimated value.
   e. Break down total acreage into fee and the various types and durations of easements.

f. Break down acreage by Government, NFS, other public entity, and private ownership, and lands within the navigation servitude.

3. **NFS-Owned LER**._X__

a. Describe NFS-owned acreage and interest and whether or not it is sufficient and available for project requirements.

b. Discuss any crediting issues and describe NFS views on such issues.

4. Include any proposed **Non-Standard Estates**. _X__

a. Use Standard Estates where possible.

b. Non-standard estates must be approved by HQ to assure they meet DOJ standards for use in condemnations.

c. Provide justification for use of the proposed non-standard estates.

d. Request approval of the non-standard estates as part of document approval.

e. If the document is to be approved at MSC level, the District must seek approval of the non-standard estate by separate request to HQ. This should be stated in the REP.

f. Exception to HQ approval is District Chiefs of RE approval of non-standard estate if it serves intended project purposed, substantially conforms with and does not materially deviate from the standard estates found in the RE Handbook, and does not increase cost or potential liability to the Government. A copy of this approval should be included in the REP. (See Section 12-10c. of RE 405-1-12)

g. Although estates are discussed generally in topic 2, it is a good idea to also state in this section which standard estates are to be acquired and attach a copy as an appendix. The duration of any temporary estates should be stated.

5. **Existing Federal Projects**. _X__

a. Discuss whether there is any existing Federal project that lies fully of partially within LER required for the project.

b. Describe the existing project, all previously-provided interests that are to be included in the current project, and identify the sponsor.

c. Interest in land provided as an item of local cooperation for a previous Federal project is not eligible for credit.

d. Additional interest in the same land is eligible for credit.

6. **Federally-Owned Lands** _X__

a. Discuss whether there is any Federally owned land included within the LER required for the project.

b. Describe the acreage and interest owned by the Government.

c. Provide description of the views of the local agency representatives toward use of the land for the project and issues raised by the requirement for this land.

7. **Navigation Servitude**. _X__

a. Identify LER required for the project that lies below the Ordinary High Water Mark, or Mean High Water Mark, as the case may be, of a navigable watercourse.

b. Discuss whether navigation servitude is available

c. Will it be exercised for project purposes? Discuss why or why not.

d. Lands over which the navigation servitude is exercised are not to be acquired nor eligible for credit for a Federal navigation or flood control project or other project to which a navigation nexus can be shown.

e. See paragraph 12-7 of ER 405-1-12.

8. **Map** _X__

a. An aid to understanding

b. Clearly depicting project area and tracts required, including existing LER, LER to be acquired, and lands within the navigation servitude.

c. Depicts significant utilities and facilities to be relocated, any known or potential HTRW lands.

9. **Induced Flooding** can create a requirement for real estate acquisition. __X__

a. Discuss whether there will be flooding induced by the construction and OMRR&R of the project.

b. If reasonably anticipated, describe nature, extent and whether additional acquisition of LER must or should occur.

c. Physical Takings Analysis (separate from the REP) must be done if significant induced flooding anticipated considering depth, frequency, duration, and extent of induced flooding.

. d. Summarize findings of Takings Analysis in REP. Does it rise to the level of a taking for which just compensation is owed?

10. **Baseline Cost Estimate** as described in paragraph 12-18. _X__

a. Provides information for the project cost estimates.

b. Gross Appraisal includes the fair market value of all lands required for project construction and OMRR&R.

c. PL 91-646 costs

d. Incidental acquisition costs

e. Incremental real estate costs discussed/supported.

f. Is Gross Appraisal current? Does Gross Appraisal need to be updated due to changes in project LER requirements or time since report was prepared?

11. **Relocation Assistance Benefits** Anticipated. _X__

a. Number of persons, farms, and businesses to be displaced and estimated cost of moving and reestablishment.

b. Availability of replacement housing for owners/tenants

c. Need for Last Resort Housing benefits

d. Real Estate closing costs

e. See current 49 CFR Part 24

12. **Mineral Activity**. _X__

a. Description of present or anticipated mineral activity in vicinity that may affect construction, OMRR&R of project.

b. Recommendation, including rationale, regarding acquisition of mineral rights or interest, including oil or gas.

c. Discuss other surface or subsurface interests/timber harvesting activity

d. Discuss effect of outstanding 3rd party mineral interests.

e. Does estate properly address mineral rights in relation to the project?

13**. NFS Assessment** _X__

a. Assessment of legal and professional capability and experience to acquire and provide LER for construction, OMRR&R of the Project.

b. Condemnation authority

c. Quick-take capability

d. NFS advised of URA requirements

e. NFS advised of requirements for documenting expenses for credit.

f. If proposed that Government will acquire project LER on behalf of NFS, fully explain the reasons for the Government performing work.

g. A copy of the signed and dated Assessment of Non-Federal Sponsor's Real Estate Acquisition Capability (Appendix 12-E) is attached to the REP.

14. **Zoning** in Lieu of Acquisition _X__

a. Discuss type and intended purpose

b. Determine whether the proposed zoning proposal would amount to a taking for which compensation will be due.

15**. Schedule** _X__

a. Reasonable and detailed Schedule of land acquisition milestones, including LER certification.

b. Dates mutually agreed upon by Real Estate, PM, and NFS.

16. **Facility or Utility Relocations** _X__

a. Describe the relocations, identity of owners, purpose of facilities/utilities, whether owners have compensable real property interest.

b. A synopsis of the findings of the Preliminary Attorney's Investigation and Report of Compensable Interest is included in the REP as well as statements required by Sections 12-17c.(5) and (6).

c. Erroneous determinations can affect the accuracy of the project cost estimate and can confuse Congressional authorization.

d. Eligibility for substitute facility

1. Project impact
2. Compensable interest
3. Public utility or facility
4. Duty to replace
5. Fair market value too difficult to determine or its application would result in an injustice to the landowner or the public.

e. See Sections 12-8, 12-17, and 12-22 of ER 405-1-12.

17. **HTRW** and Other Environmental Considerations _X___

a. Discussion the impacts on the Real Estate acquisition process and LER value estimate due to known or suspected presence of contaminants.

b. Status of District's investigation of contaminants.
c. Are contaminants regulated under CERCLA, other statues, or State law?
d. Is clean-up or other response required of non-CERCLA regulated material?
e. If cost share, who is responsible for performing and paying cost of work?
f. Status of NEPA and NHPA compliances
g. See ER 1165-2-132, Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects.

18. **Landowner Attitude.** _X__
a. Is there support, apathy, or opposition toward the project?
b. Discuss any landowner concerns on issues such as condemnation, willing seller provisions, estates, acreages, etc.?

19. A statement that the **NFS has been notified in writing about the risks of acquiring LER before the execution of the PPA.** Notice to the sponsor regarding risks of acquisition prior to the signing of the PPA is not necessary since no acquisitions are expected.

20. **Other Relevant Real Estate Issues.** Anything material to the understanding of the RE aspects of the project. __X___

A copy of the completed Checklist is attached to the REP. _X__
(Draft REPs must contain a draft checklist and draft Technical Review Guide)

I have prepared and thoroughly reviewed the REP and all information, as required by Section 12-16 of ER 405-1-12, is contained in the Plan.

Preparer — Date: 27-JUNE-2013

A copy of the Real Estate Internal Technical Review Guide for Civil Works Decision Documents is attached and signed by me as the Reviewer

RE Internal Technical Reviewer — Date: 27 JUNE 2013

The REP has been signed and dated by the Preparer and the District Chief of Real Estate.
___X____

REAL ESTATE INTERNAL TECHNICAL REVIEW GUIDE FOR CIVIL WORKS DECISION DOCUMENTS

Real Estate Guide for Review of Civil Works Decision Documents

1. Initially, read the entire Real Estate Plan (REP). After reading the REP:

   a. Do you have a good idea of the scope of the project?

   b. Did you note any omissions?

   c. What questions do you have regarding the project?

   d. Were all the elements of an REP as listed in Chapter 12 covered?

   e. Do you have a completed Quality Control Plan for the REP?

2. Next, read the main body of the decision document (including the chapter on the recommended plan), paying particular attention to the overall scope of the project, proposed facility relocations, environmental investigations, mitigation requirements, navigational servitude, and possibility of induced flooding.

3. Then, read the REP again, noting any discrepancies between the REP and the main report. Pay particular attention not only to what the report says, but also to what the report does not say. Many review comments are due to items being omitted or not discussed in enough detail in the REP.

4. Finally, ask yourself specific questions about the project such as the following. You should be able to answer them by reading the REP.

   a. What is the project's purpose and have there been prior real estate planning documents for this project?

   b. Is the purpose of the report to gain Congressional authorization (e.g., a Feasibility Report)? If not, what is the real estate acquisition authority for the project and is the proper authority cited in the report?

   c. Who is the sponsor that will execute the PPA? Has an assessment of the sponsor's capability been completed and included in the report? Does the sponsor have eminent domain and quick take authority? If not, does the report address how acquisition will be accomplished if condemnation is required? Does the sponsor currently own any lands required for the project? If

so, were any of these lands obtained as part of another Federal project or funded with Federal funds in whole or in part?

d. Are there any lands currently owned by the Federal government involved in this project? If so, has it been coordinated with the

e. Does the project involve a navigable waterway and could the navigational servitude be utilized for purposes of the project? If the project is not a navigation project and asserting navigational servitude is proposed, does the report state the legal basis for asserting navigational servitude?

f. Is there a possibility of induced flooding, and has a taking analysis been completed? What was the outcome of that analysis? Are flowage easements required because the anticipated flooding will rise to the level of a taking?

g. Are the interests and estates sufficient to provide for construction, operation, maintenance, repair, replacement and rehabilitation (OMRR&R) of the project? Do the estates not only grant the interest needed for construction and maintenance, but do they prohibit practices that might interfere with the project in the future? Is the term for any temporary easements defined and are they for an appropriate duration?

h. How do we physically access the project site? Is an additional real estate interest required for construction access and/or OMRR&R access?

i. Is there a need to dispose of borrow material? If so, are these areas included in the report as LERRD items or, if proven cost efficient, contractor provided items? Are the environmental issues associated with borrow/disposal effectively addressed?

j. Will a contractor's staging area be required?

k. Are any persons being displaced from their homes as a result of the project? If so, how many? Is replacement housing available? Will standard PL 91-646 benefits be provided? Will any businesses require relocation assistance? Has a replacement housing survey been accomplished?

l. Are there any public facilities to be altered or relocated? Do the below relocations meet all of the following five tests?

(1) The project design requires the facility to be moved in whole or in part (temporarily or permanently), or the project will negatively impact the ongoing function or operation of the facility.

(2) The owner of the facility has a compensable real property interest in the land on which the impacted portion of the facility is located.

(3) The facility serves a public purpose.

(4) The owner of the facility has a duty to replace the facility as a result of legal or factual necessity (continuing need).

(5) The fair market value of the interest that must be acquired due to project impact is too difficult to ascertain, or payment of fair market value instead of providing a substitute facility would result in manifest injustice to the owner or the public. Have preliminary opinions of compensability be completed for each facility? If the REP is part of a decision document that will serve as the basis for Congressional authorization, does it contain the disclaimer language required by ER 405-1-12, para. 12-17c(6)?

m. Are any cemeteries in the project area? If so, how will they be impacted? If they are allowed to remain in place, how will permanent access be provided? If they are to be relocated, the report should address the preparation of a cemetery relocation plan.

n. Does the report address the types of ownership, number of tracts and acres, and estates to be acquired? Does the report address mineral activity and whether the minerals will be acquired, subordinated, or left outstanding?

o. Does the report state if any nonstandard interest or estate will be utilized? If so, is a copy of the estate in the report?

p. Do the acres, values, and estates contained in the baseline cost estimate agree with those contained in an approved gross appraisal for the project? If not, any discrepancy should be discussed with the Appraisal Branch and reconciled. Does the acreage and cost presented in the REP agree with real estate acreage and costs shown elsewhere in the main report or MCACES estimate? Does the cost estimate show the estimated cost by estate, contingency, administrative cost, and relocation assistance? The cost should be shown for both Federal and non-Federal, where appropriate.

q. Does the report address the status of all environmental considerations and approvals, HTRW assessments, NEPA compliance, and NHPA compliance? If any land required for the project is contaminated, is it CERCLA or non-CERCLA regulated material?

r. Does the report contain a reasonable schedule for acquisition, and has the schedule been coordinated with the sponsor? Is the project to be accomplished in more than one phase?

s. Does the report contain a map depicting all of the tracts and estates to be acquired? Does it show any known or potential HTRW lands?

t. Obviously, all of the above items will not apply to every project; however, if the REP fails to address an item, the reviewer does not know if it is considered. If the individual preparing the document is aware that an item is not applicable, but fails to include that information in the REP, the report should contain a statement that this item is not applicable.

u. The Reviewer should verify that the real estate requirements shown in the REP are in consort with the latest design drawings.

v. The Reviewer should consult with the other team members and Real Estate employees, as necessary, to resolve questions or misunderstandings prior to preparing comments to the Report Preparer.

I have reviewed the Starved Rock Real Estate Plan and have considered all of the above.

Real Estate Internal Technical Reviewer

27 June 2015
Date

ILLINOIS RIVER BASIN RESTORATION
SECTION 519
PROJECT IMPLEMENTATION REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STARVED ROCK POOL CRITICAL RESTORATION PROJECT
LASALLE COUNTY, ILLINOIS

APPENDIX K

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DAILY TIMES
110 W JEFFERSON
OTTAWA IL 61350

ILLINOIS VALLEY WEEKLY
426 2ND ST
LA SALLE IL 61301

NEWS TRIBUNE
426 2ND ST
LA SALLE IL 61301

NEWS TRIBUNE
426 2ND ST
LA SALLE IL 61301

THE NEWS
242 A LA SALLE ST
TONICA IL 61370

THE REPORTER
703 IL AVE
MENDOTA IL 61342

THE TIMES
110 W JEFFERSON
OTTAWA IL 61350

THE TIMES-PRESS
122 S BLOOMINGTON ST
STREATOR IL 61364

JOANN HUSTIS
FARM WORLD
PO BOX 65
KNIGHTSTOWN IN 46148

JAMES MALLEY
THE DAILY TIMES
110 W JEFFERSON ST
OTTAWA IL 61350

WARREN PUFAHL
EDITOR
ILLINOIS AGRI-NEWS
420 2ND ST
LA SALLE IL 61301

NEWS ROOM
WCMY RADIO
216 W LAFAYETTE
OTTAWA IL 61350

NEWS ROOM
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3905 PROGRESS BLVD
PERU IL 61465-1121

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WIZZ RADIO
PO BOX 377
STREATOR IL 61364

NEWS ROOM
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3905 PROGRESS BLVD
PERU IL 61354

RICK KOSHKO
WCMY/WRKX RADIO STATIONS
216 W LAFAYETTE ST
OTTAWA IL 61350

RON EINHAUS
MANILUS CONCERNED CITIZEN
PO BOX 108
SENECA IL 61360

DR JOHN ARMSTRONG
412 CONGRESS ST
OTTAWA IL 61350

ANN BEALS
BFA
217 11TH ST
LA SALLE IL 61301

JOHN BENJA
RR 1
OTTAWA IL 61350

MARK - JOAN BERNABE
1289 N 2803 RD
OTTAWA IL 61350

DR RICHARD BJORKLUND
26034 HARRIS LANE
TOPEKA IL 61567

LELAND & ELAINE BOTTOMLEY
348 LINCOLN ST
UTICA IL 61373

E E BREIPOHL
PO BOX 1039
OTTAWA IL 61350-6039

FORREST BUCK
200 E ALLEN ST
OTTAWA IL 61350

DONALD BYCZYNSKI
1211 HOWARD ST
OTTAWA IL 61350

KIM CAIRNS
1457 E STATE RT 71
OTTAWA IL 61350

ROBERT COKLEY
206 E WASHINGTON ST
OTTAWA IL 61350-2266

JAMES DESPER
PO BOX 45
TONICA IL 61370

JAMES DESPER
387 N 2629TH RD
OGLESBY IL 61348

STEVE DOUGHERTY
2755 E 1835TH RD
OTTAWA IL 61350

DAVID EGAN
23368 MALLARD LN
TOPEKA IL 61567

WILLIAM EICHELKRAUT
1432 OTTAWA AVE
OTTAWA IL 61350

ALETA ERNAT
JOSEPH ERNAT ESTATE
627 30TH ST
PERU IL 61354

WILLIAM EVANS
117 CARRIAGE LANE EST
STREATOR IL 61364-3969

PETER FERRACUTI
110 E MAIN ST
OTTAWA IL 61350

BILL FRAUSE
1425 DAIRY LANE
OTTAWA IL 61350

WILLIAM GALLUP
457 LINCOLN ST PO BOX 306
UTICA IL 61373

TERRY G. GATHMAN
PO BOX 41
TOPEKA IL 61567-0041

WALTER GATZA
106 MAIN ST
OGLESBY IL 61348

PAUL GERDING
725 CONGRESS ST
OTTAWA IL 61350

EARL GERDING
101 W ALLEN ST
OTTAWA IL 61350

IRA GILLMAN
210 S ILLINOIS ST
STREATOR IL 61364

JAMES HART
660 OVERTON ST
MARSEILLES IL 61341

TONY HUMMEL
22610 N CR 2800 E
TOPEKA IL 61567

ARTHUR HUSTIS
RR 1 BOAT HARBOR RD
MARSEILLES IL 61341

KAY JEVITZ
2 VALLEY VIEW LANE
OTTAWA IL 61350

GARY KIRKPATRICK
621 SHABBONA ST
OTTAWA IL 61350

DONALD KRANOV DDS
150 FOREST PARK RD
OTTAWA IL 61350

W KRAUSE
1425 DAIRY LN
OTTAWA IL 61350

WESLEY LARSEN
PO BOX 375
SENECA IL 61360-0375

THOMAS MALPASS
630 E VAN BUREN ST
OTTAWA IL 61350

DENNIS MANN
PO BOX 154
STREATOR IL 61364-0154

DR RONALD MARINO
542 CHAPEL ST
OTTAWA IL 61350

GREG MASLOWSKI
622 YORK ST
OTTAWA IL 61350

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1460 N 2401 RD
OTTAWA IL 61350

BENNIE MILITELLO
460 MAIN ST
MARSEILLES IL 61341

STANLEY NEWELL
1714 27TH ST PO BOX 194
PERU IL 61354

ROBERT NEWKIRK
521 BROADWAY ST
MARSEILLES IL 61341

JACK OLLER
404 MEADOW LANE
OTTAWA IL 61350

PAUL PERONA JR
2580 E 259 RD
PERU IL 61354-1179

DAVID RALKES
PO BOX 114
MARSEILLES IL 61341

WILLIAM J REAGAN
546 E MAIN ST
OTTAWA IL 61350

ROSE MARIE REPKA
2066 N 25TH RD
MARSEILLES IL 61341-9734

ADAM RUE
12121 N ST PAUL
GRANVILLE IL 61326

GENE SARVER
ENGINEERING CONSULTANT
218 W LAFAYETTE
OTTAWA IL 61350

DARRELL SEIGLER
434 PEARL ST
OTTAWA IL 61350

BERNARD SMITH
736 COMMERCIAL ST
MARSEILLES IL 61341

SIGNEY STIEFEL
808 PEARL ST
OTTAWA IL 61350

DONALD STUEDEMANN
590 LOGUE CIRCLE
SENECA IL 61360-9671

JOHN THOMAS
1848 N 24
GRAND RIDGE IL 61325

S TOMMINELLO
1320 CROSS ST
PERU IL 61354

RAYMOND ULM
2719 W 98TH PLACE
EVERGREEN PARK IL 60642

RICHARD ULM
10 LALINCH
LEMONT IL 60439

RONALD & JOANN WALLING
1263 E STATE RT 71
OTTAWA IL 61350

RONALD & JOANN WALLING
102 N STAUFFER
NAPERVILLE IL 60540

TOM WALLS
BFA
BOX 212
PERU IL 61350

WILLIAM WALSH
1839 COLUMBUS ST
OTTAWA IL 61350

MARK WALTER
RR 1
GRAND RIDGE IL 61325-9801

VERONA WHITMORE
1416 LAKEWOOD
MENDOTA IL 61342-1020

ROBERT BO WINDY
135 JUNEWAY DR
UTICA IL 61373

RALPH WLATER
RR 1
GRAND RIDGE IL 61325

ILLINOIS RIVER BASIN RESTORATION
SECTION 519
PROJECT IMPLEMENTATION REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STARVED ROCK POOL CRITICAL RESTORATION PROJECT
LASALLE COUNTY, ILLINOIS

APPENDIX L

LITERATURE CITED

Appendix L
Literature Cited

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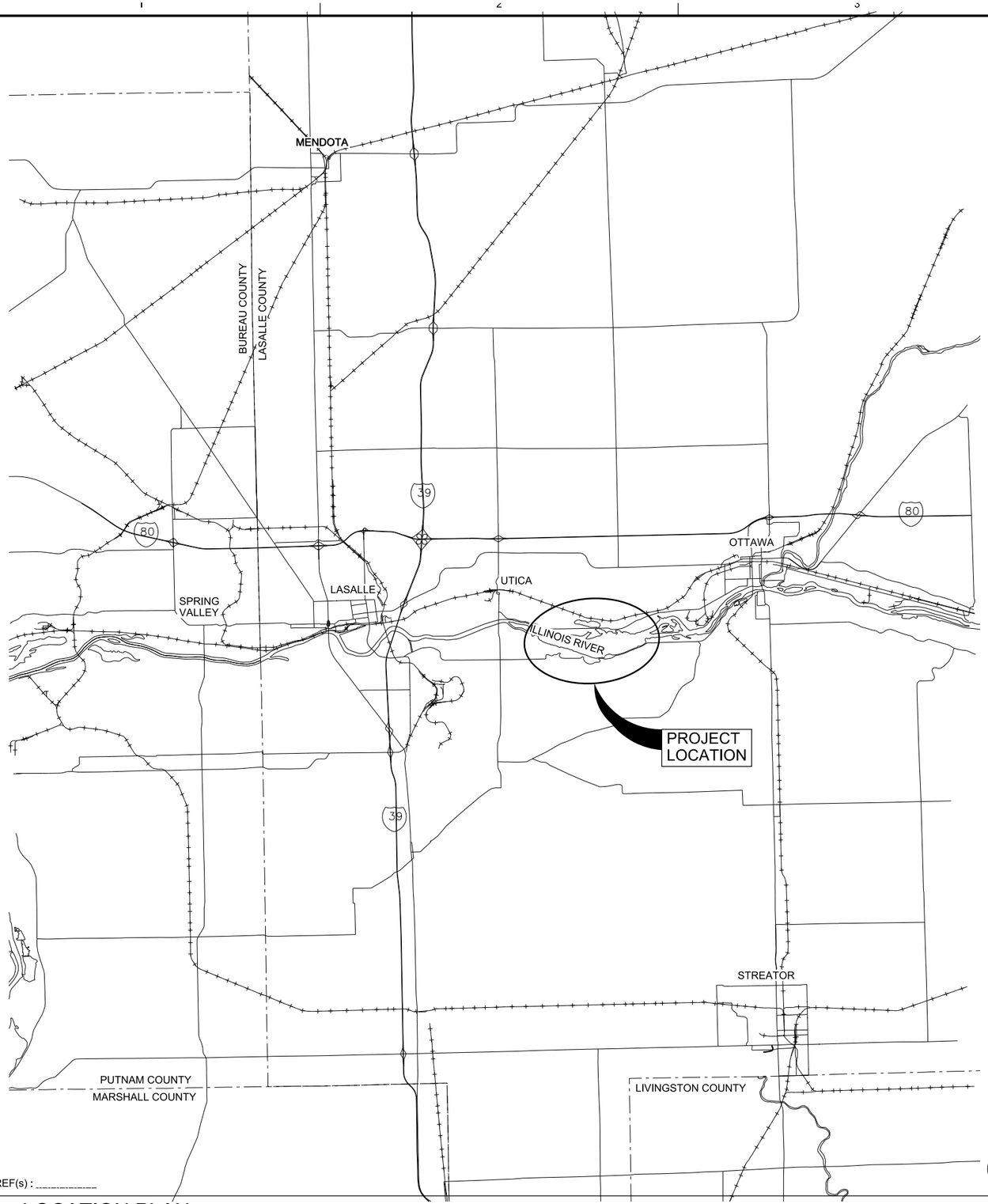
ILLINOIS RIVER BASIN RESTORATION
SECTION 519
PROJECT IMPLEMENTATION REPORT
WITH INTEGRATED ENVIRONMENTAL ASSESSMENT

STARVED ROCK POOL CRITICAL RESTORATION PROJECT
LASALLE COUNTY, ILLINOIS

APPENDIX M

PLATES



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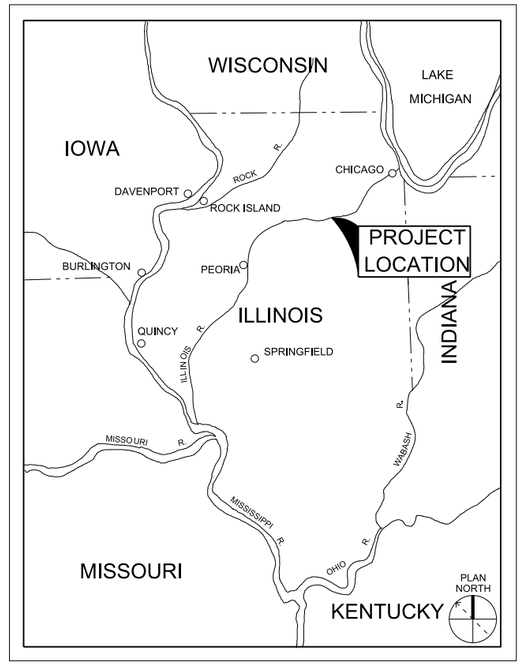

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A4 VICINITY MAP

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
MVR
ROCK ISLAND, ILLINOIS

DESIGNED BY: RCF
DWN BY: LUH
SUBMITTED BY: HLA
CKD BY:
PLOT SCALE: N.T.S.
SIZE: ANSI D
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PROJECT CODE: IW124
PLOT DATE:
FILE NAME: IW124G-002xxx.dgn

ILLINOIS RIVER BASIN
STARVED ROCK POOL
LASALLE COUNTY, IL
STARVED ROCK RESTORATION PROJECT
SECTION 519

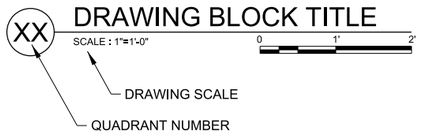
LOCATION PLAN AND VICINITY MAP

PLATE 1

Sheet ID
G-002

DRAWING ANNOTATIONS

DWG REF(s) :



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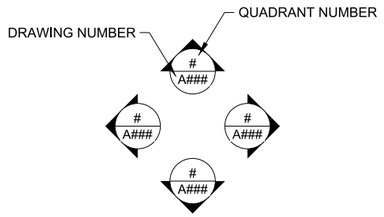

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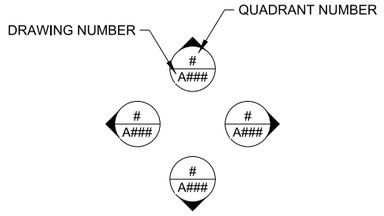

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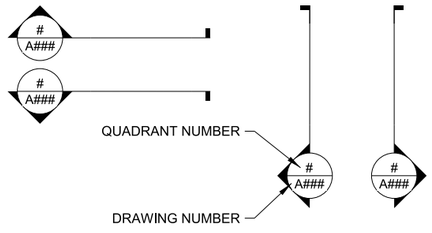

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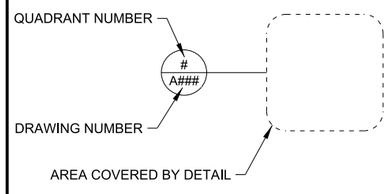
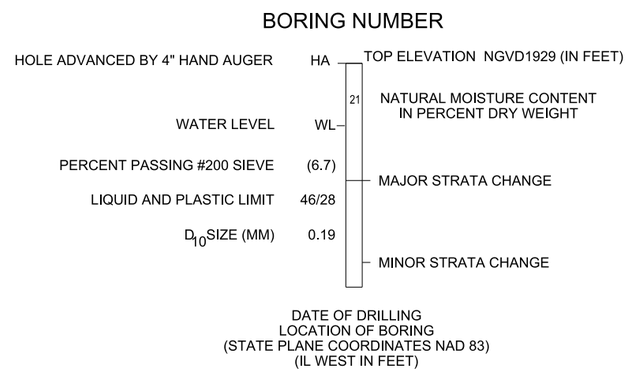


DETAIL CALLOUT

LEGEND

- EXISTING GROUND
- CENTERLINE
- RIGHT-OF-WAY
- ENVIRONMENTALLY SENSITIVE ZONE
- RIPRAP
- RIVERMILE
- WATER QUALITY MONITORING STATION
- BORING LOCATION
- BENCHMARK



BORING LEGEND

ABBREVIATIONS

A	
AC	ACRE
APPROX.	APPROXIMATE
AVE	AVENUE
B	
BM	BENCHMARK
E	
EL.	ELEVATION
F	
FT	FEET
H	
H	HORIZONTAL
M	
MAX	MAXIMUM
MSL	MEAN SEA LEVEL
MIN	MINIMUM
R	
RD	ROAD
RM	RIVERMILE
RR	RAILROAD
S	
ST	STREET
STA.	STATION
T	
TYP.	TYPICAL
V	
V	VERTICAL

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
MVR
ROCK ISLAND, ILLINOIS

DESIGNED BY: RCF
DWN BY: LLH
CKD BY:
SUBMITTED BY: HLA
PLOT SCALE: AS SHOWN
PLOT DATE:
SIZE: ANSI D
FILE NAME: IW124G-003xxx.dgn
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PROJECT CODE: IW124

ILLINOIS RIVER BASIN
STARVED ROCK POOL
LASALLE COUNTY, IL
STARVED ROCK RESTORATION PROJECT
SECTION 519
LEGEND AND ABBREVIATIONS
PLATE 2

Sheet ID
G-003

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Plate Number	**Sheet Id**	**Sheet Title**
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PLATE 2	G-003	LEGEND AND ABBREVIATIONS
PLATE 3	G-004	INDEX AND GENERAL NOTES
SURVEY		
PLATE 4	V-101	SURVEY CONTROL DIAGRAM
GEOTECHNICAL		
PLATE 5	B-101	BORING PLAN
PLATE 6	B-301	BORING LOGS
CIVIL		
PLATE 7	C-101	FEATURES EVALUATED
PLATE 8	C-102	FEATURES NOT EVALUATED
PLATE 9	C-103	TENTATIVELY SELECTED PLAN
PLATE 10	C-104	RIPRAP PLAN AND PROFILE STA. 0+00 TO STA. 30+00
PLATE 11	C-105	RIPRAP PLAN AND PROFILE STA. 30+00 TO STA. 60+91
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PLATE 14	C-303	CROSS SECTION
OTHER DISCIPLINES		
PLATE 15	O-101	PRE-CONSTRUCTION MONITORING
PLATE 16	O-102	POST-CONSTRUCTION MONITORING

GENERAL NOTES

1. THE STARVED ROCK RESTORATION PROJECT IS LOCATED IN STARVED ROCK POOL ALONG THE LEFT DESCENDING BANK OF THE ILLINOIS RIVER (RM 233 TO 234) IN LASALLE COUNTY, IL.
2. THE PROJECT LANDS ARE STATE OWNED BY THE ILLINOIS DEPARTMENT OF NATURAL RESOURCES.
3. WAVE AND WIND ACTION IN THE AREA HAS NEGATIVELY IMPACTED THE GROWTH OF SUBMERGENT AQUATIC VEGETATION.
4. HORIZONTAL DATUM IS STATE PLANE COORDINATE SYSTEM, IL WEST, NAD 83, US SURVEY FOOT. VERTICAL DATUM IS NGVD 1929.
5. ORTHO PHOTOGRAPHY FROM 2010.
6. FLAT POOL IS AT EL. 458.52.
7. THE ENTIRE PROJECT SITE IS WITHIN THE RIVER AND IS THEREFORE HIGHLY SUSCEPTIBLE TO WATER FLUCTUATION THAT MAY IMPACT CONTRACTOR WORK PROGRESS. HYDRAULIC DATA WILL BE PROVIDED IN THE SPECIFICATIONS.
8. COORDINATION WITH THE ILLINOIS DEPARTMENT OF NATURAL RESOURCES PERSONNEL IS REQUIRED PRIOR TO WORKING DURING THE WATERFOWL HUNTING SEASONS. DURING PEAK HUNTING WEEKENDS OR DATES, ALL CONSTRUCTION ACTIVITIES MAY BE REQUIRED TO CEASE FOR A SHORT PERIOD OF TIME.
9. CONSTRUCTION SCHEDULE IS SHOWN IN SECTION 3 OF THE MAIN REPORT.

DWG REF(s) :

A1 INDEX

US Army Corps of Engineers®

MARK | DESCRIPTION | DATE | APPR.

U.S. ARMY CORPS OF ENGINEERS
MVR
ROCK ISLAND, ILLINOIS

DESIGNED BY: RCF | DRAWN BY: LUH | SUBMITTED BY: HLA | PLOT SCALE: AS SHOWN | SIZE: ANSI D
DATE: | CKD BY: | PLOT DATE: | FILE NAME: MVR24S-004xxx.dgn
SOLICITATION NO.: | CONTRACT NO.: | PROJECT CODE: HY124

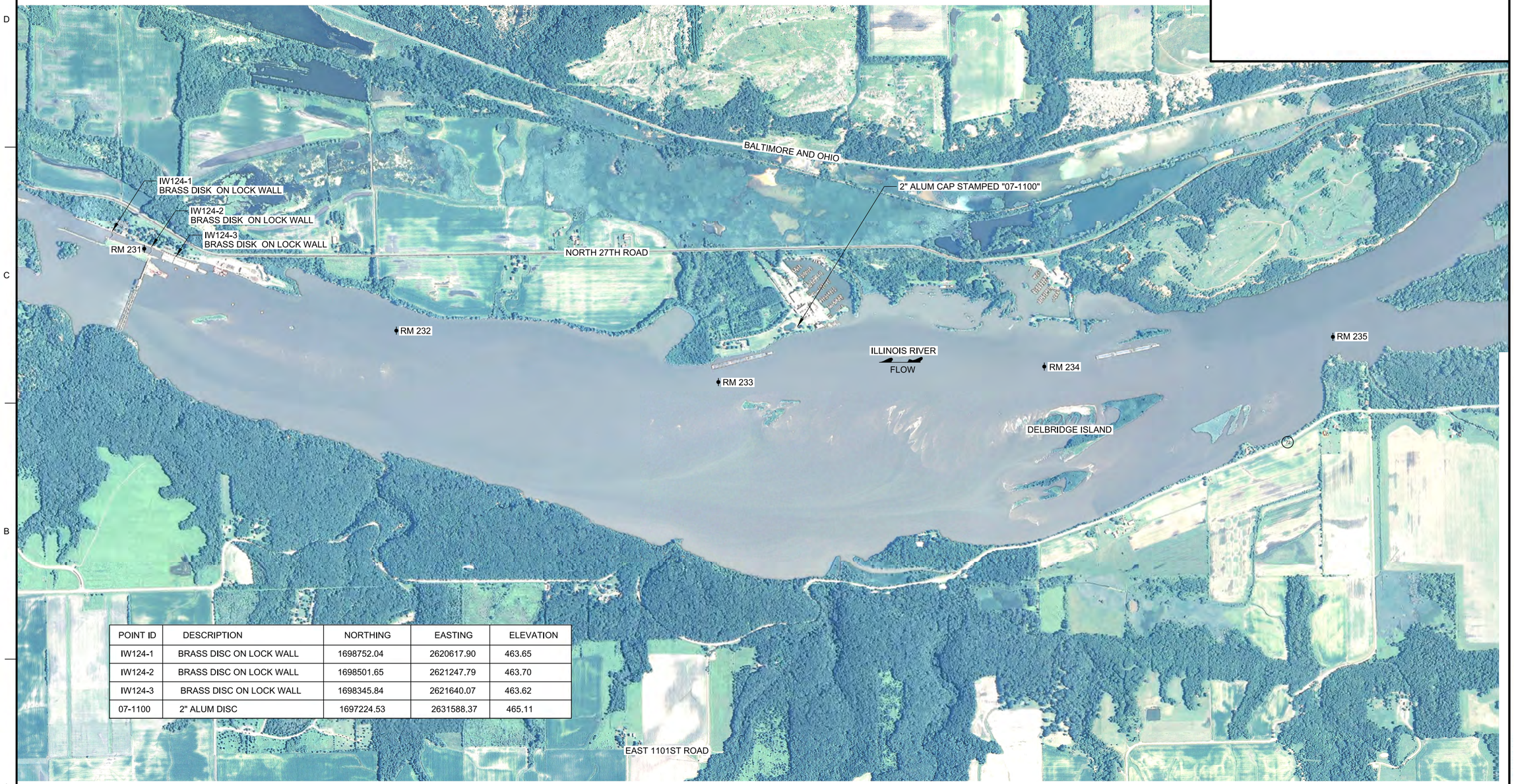
ILLINOIS RIVER BASIN
STARVED ROCK POOL
LASALLE COUNTY, IL
STARVED ROCK RESTORATION PROJECT
SECTION 519
INDEX AND
GENERAL NOTES
PLATE 3

Sheet ID
G-004

SHEET NOTES

1. PROJECT HORIZONTAL DATUM IS STATE PLANE NAD88, ILLINOIS WEST - 1202 SURVEY FEET
   PROJECT VERTICAL DATUM IS NGVD 29 GEOID 09 CONUS.

2. TO CONVERT NGVD 29 TO NAVD88 SUBTRACT 0.18 FEET



POINT ID	DESCRIPTION	NORTHING	EASTING	ELEVATION
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IW124-2	BRASS DISC ON LOCK WALL	1698501.65	2621247.79	463.70
IW124-3	BRASS DISC ON LOCK WALL	1698345.84	2621640.07	463.62
07-1100	2" ALUM DISC	1697224.53	2631588.37	465.11

N

DWG REF(s) : _____

A1 SURVEY CONTROL DIAGRAM

SCALE : 1"=800'-0" 0 800' 1600'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
MVR
ROCK ISLAND, ILLINOIS

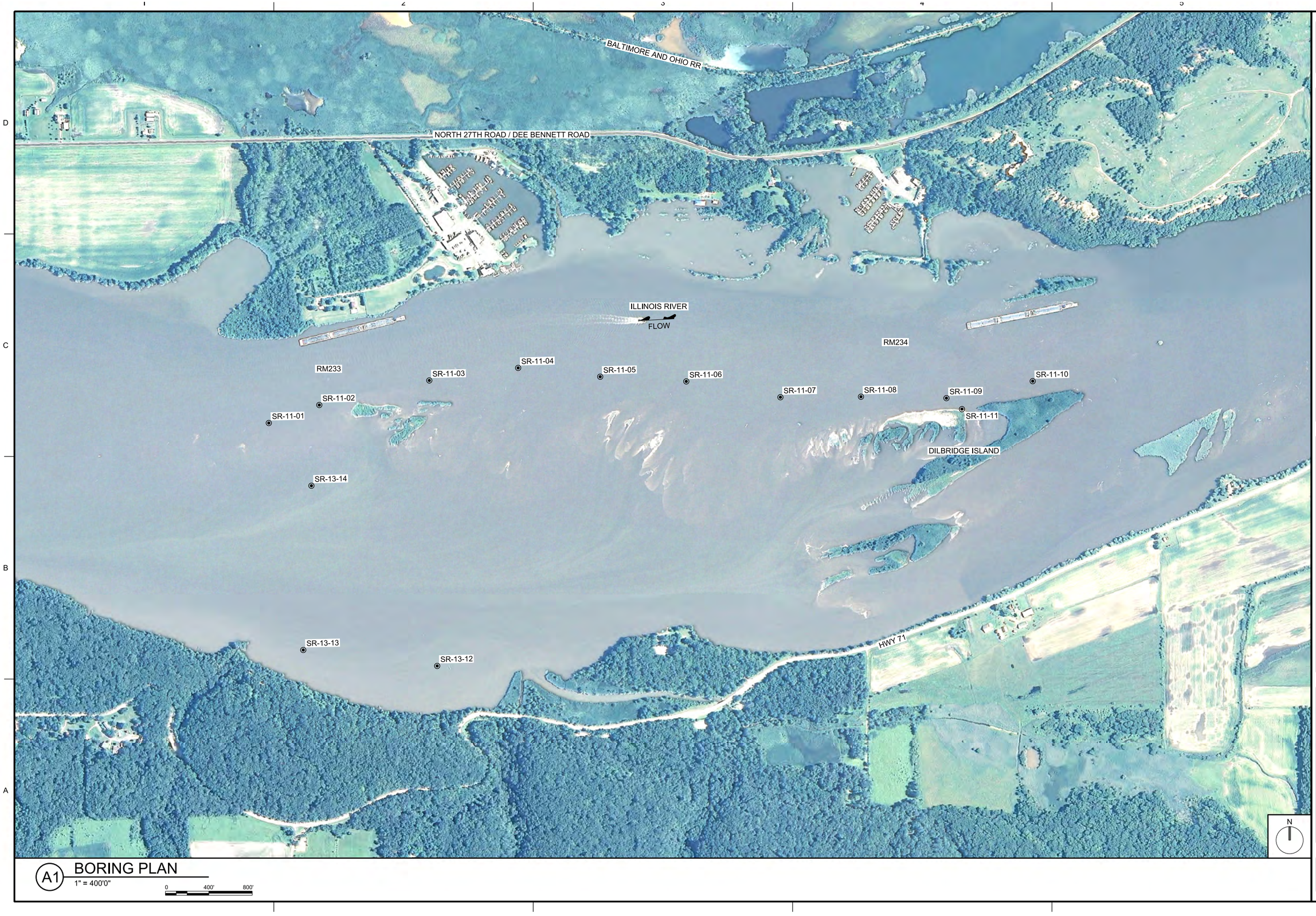
DESIGNED BY: | DATE:
DWN BY: | CKD BY: | SOLICITATION NO.:
SUBMITTED BY: | CONTRACT NO.:
PLOT SCALE: AS SHOWN | PLOT DATE: | PROJECT CODE: IW124
SIZE: ANSI D | FILE NAME: IW124V*10?xx.dgn

ILLINOIS RIVER BASIN
STARVED ROCK POOL
LASALLE COUNTY, IL
STARVED ROCK RESTORATION PROJECT
SECTION 519

SURVEY CONTROL DIAGRAM

PLATE 4

Sheet ID
V-101



A1 BORING PLAN

1" = 400'0"

0 400' 800'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

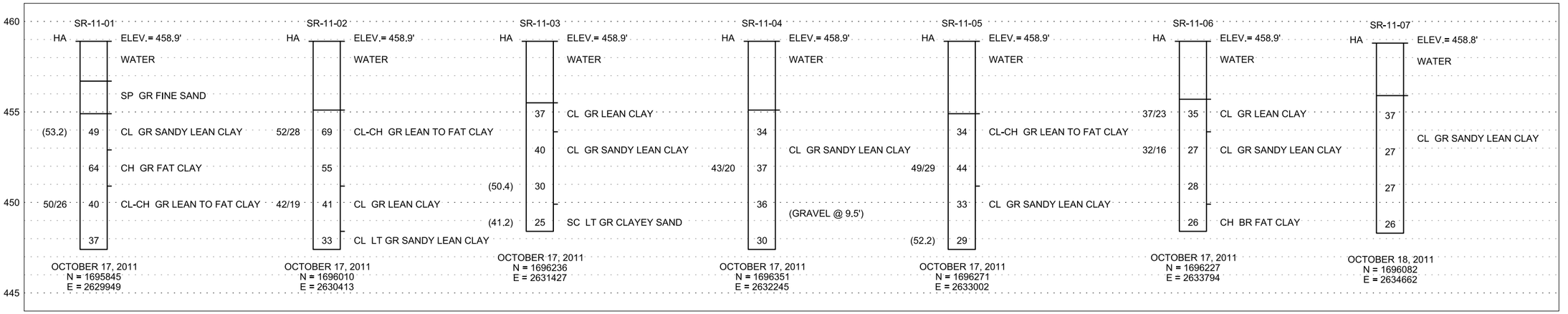
U.S. ARMY CORPS OF ENGINEERS
MVR
ROCK ISLAND, ILLINOIS

DESIGNED BY: JKP
DWN BY: WTT
CKD BY:
SUBMITTED BY:
PLOT SCALE: AS SHOWN
PLOT DATE:
SIZE: ANSI D
FILE NAME: IW124B-101xxx.dgn
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PROJECT CODE: IW124

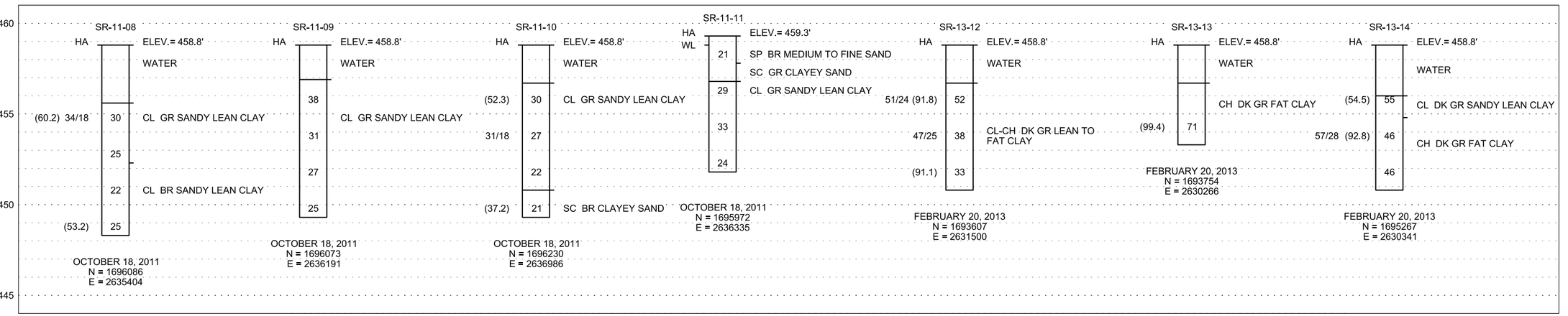
ILLINOIS RIVER BASIN
STARVED ROCK POOL
LASALLE COUNTY, IL
STARVED ROCK RESTORATION PROJECT
SECTION 519
BORING PLAN

PLATE 5

Sheet ID
B-101



STATE PLANE COORDINATES NAD 83 IL WEST U.S. SURVEY FEET



A1 BORING LOGS

1" = 3'0"

0 3' 6'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: JAP
DWN BY: WTT
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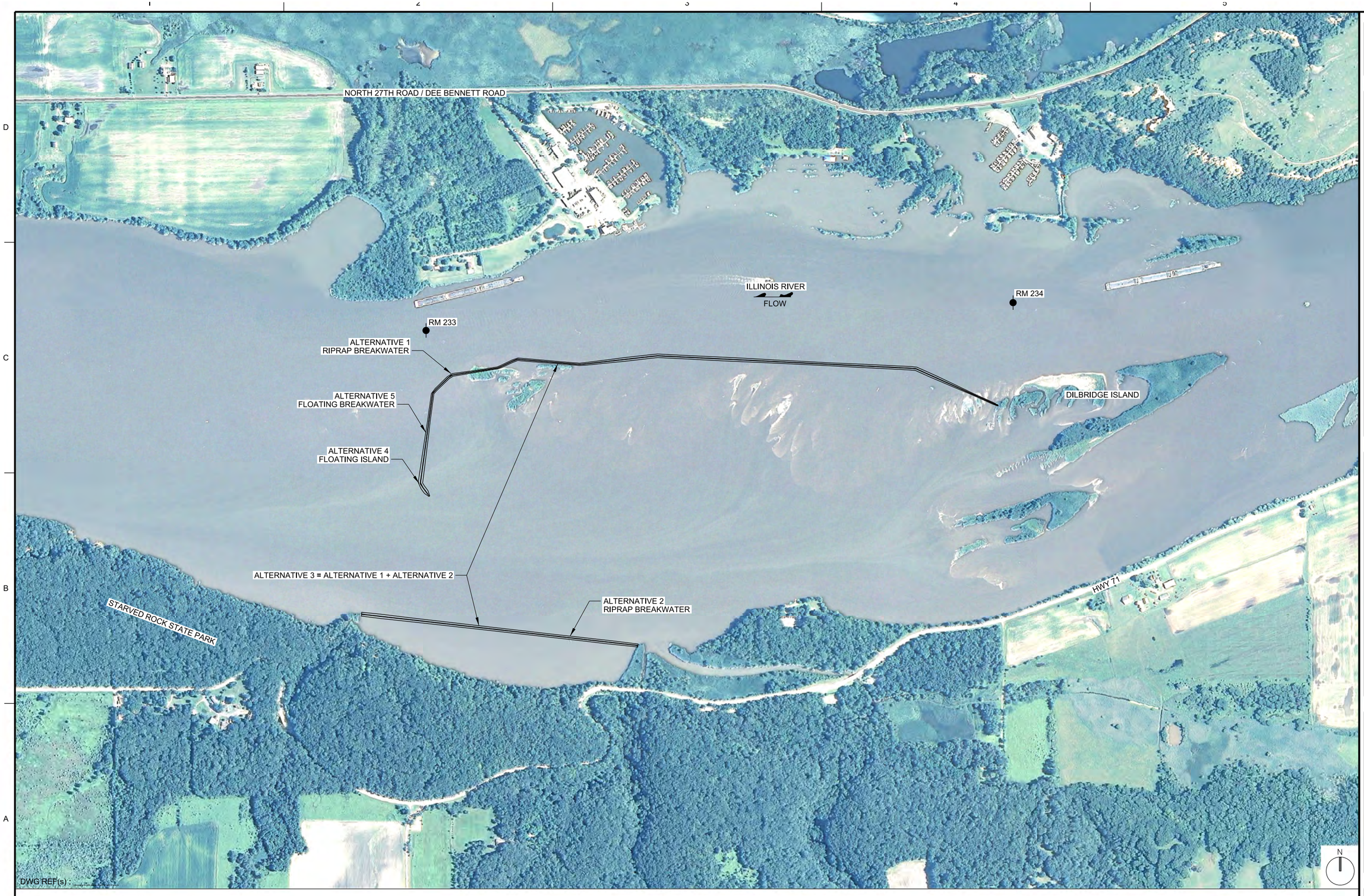
SUBMITTED BY:
PLOT SCALE:
PLOT DATE:
SIZE: ANSI D
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PROJECT CODE: IW124
FILE NAME: IW124B-301xxx.dgn

U.S. ARMY CORPS OF ENGINEERS
MVR
ROCK ISLAND, ILLINOIS

ILLINOIS RIVER BASIN
STARVED ROCK POOL
LASALLE COUNTY, IL
STARVED ROCK RESTORATION PROJECT
SECTION 519
BORING LOGS

PLATE 6

Sheet ID
B-301



A1 FEATURES EVALUATED

SCALE : 1"=400'-0" 0 400' 800'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
MVR
ROCK ISLAND, ILLINOIS

DESIGNED BY:	DATE:
RCF	
DWN BY:	CKD BY:
LLH	
SUBMITTED BY:	
HLA	
PLOT SCALE:	PLOT DATE:
AS SHOWN	
SIZE:	FILE NAME:
ANSI D	IW124C-101xxx.dgn

SOLICITATION NO.:

CONTRACT NO.:

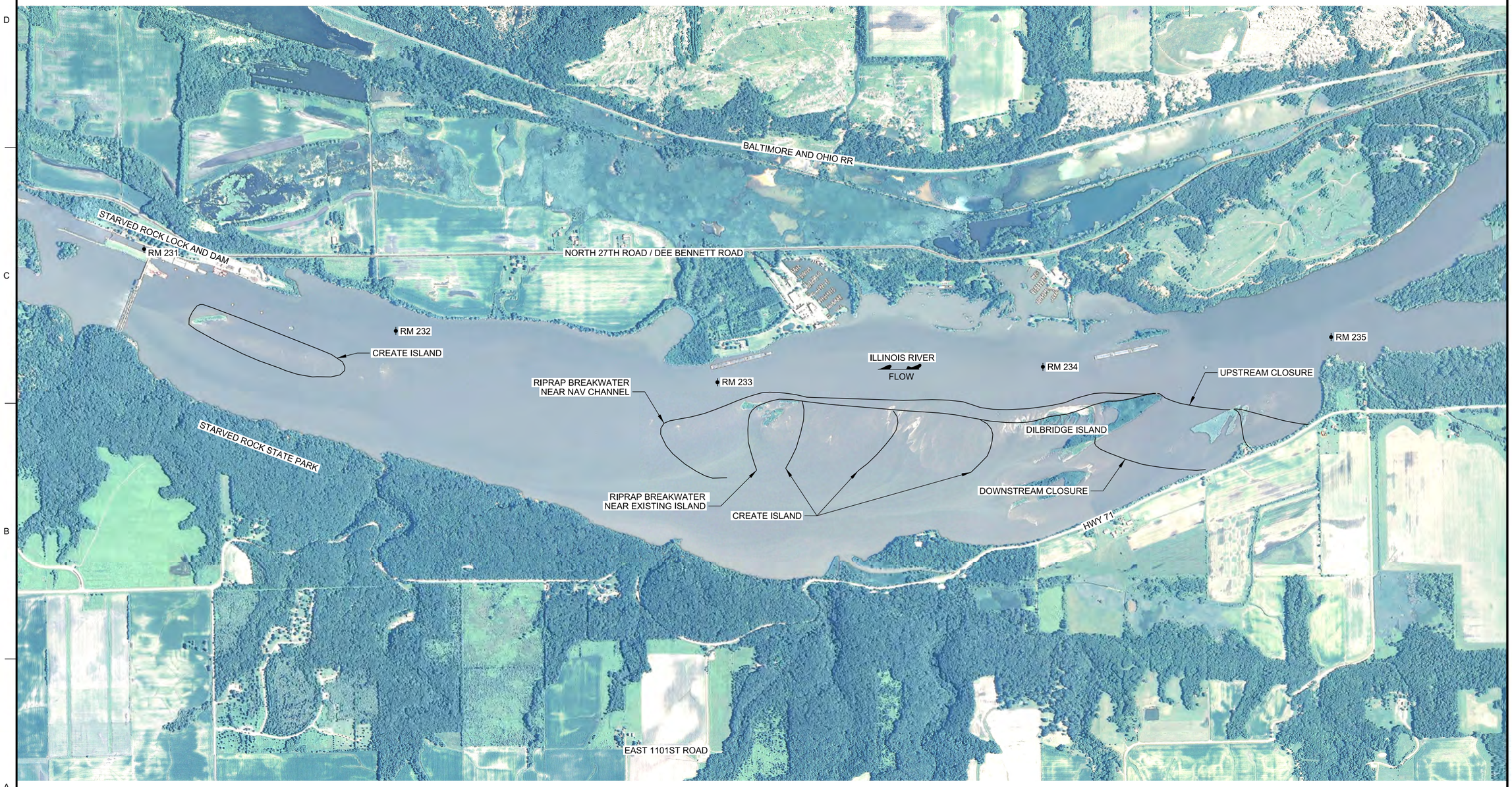
PROJECT CODE:
IW124

ILLINOIS RIVER BASIN
STARVED ROCK POOL
LASALLE COUNTY, IL
STARVED ROCK RESTORATION PROJECT
SECTION 519

FEATURES EVALUATED

PLATE 7

Sheet ID
C-101



DWG REF(s) : _____

A1 FEATURES NOT EVALUATED

SCALE : 1"=800'-0" 0 800' 1600'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
MVR
ROCK ISLAND, ILLINOIS

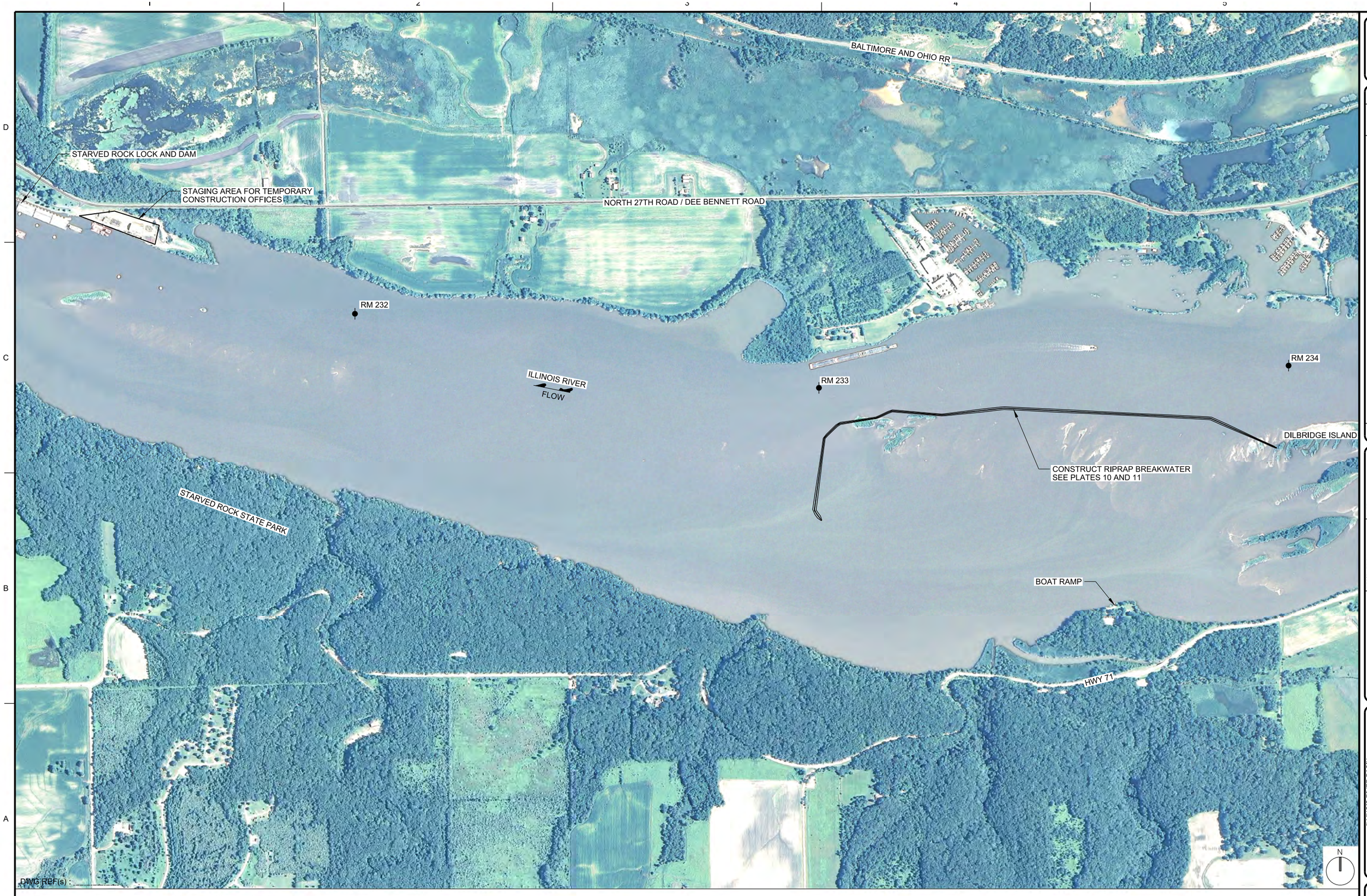
DESIGNED BY: RCF
DWN BY: LLH
SUBMITTED BY: HLA
PLOT SCALE: AS SHOWN
QC BY: ANSI D
DATE:
CKD BY:
SOLICITATION NO.:
CONTRACT NO.:
PLOT DATE:
FILE NAME: MV124C-102xxx.dgn
PROJECT CODE: MV124

ILLINOIS RIVER BASIN
STARVED ROCK POOL
LASALLE COUNTY, IL
STARVED ROCK RESTORATION PROJECT
SECTION 519

FEATURES
NOT EVALUATED

PLATE 8

Sheet ID
C-102



DWG REF(s) :

A1 TENTATIVELY SELECTED PLAN

SCALE : 1"=500'-0" 0 500' 1000'

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MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
MVR
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CKD BY:
SUBMITTED BY: HLA
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PLOT DATE:
SIZE: ANSI D
FILE NAME: MVR24C-103xxx.dgn

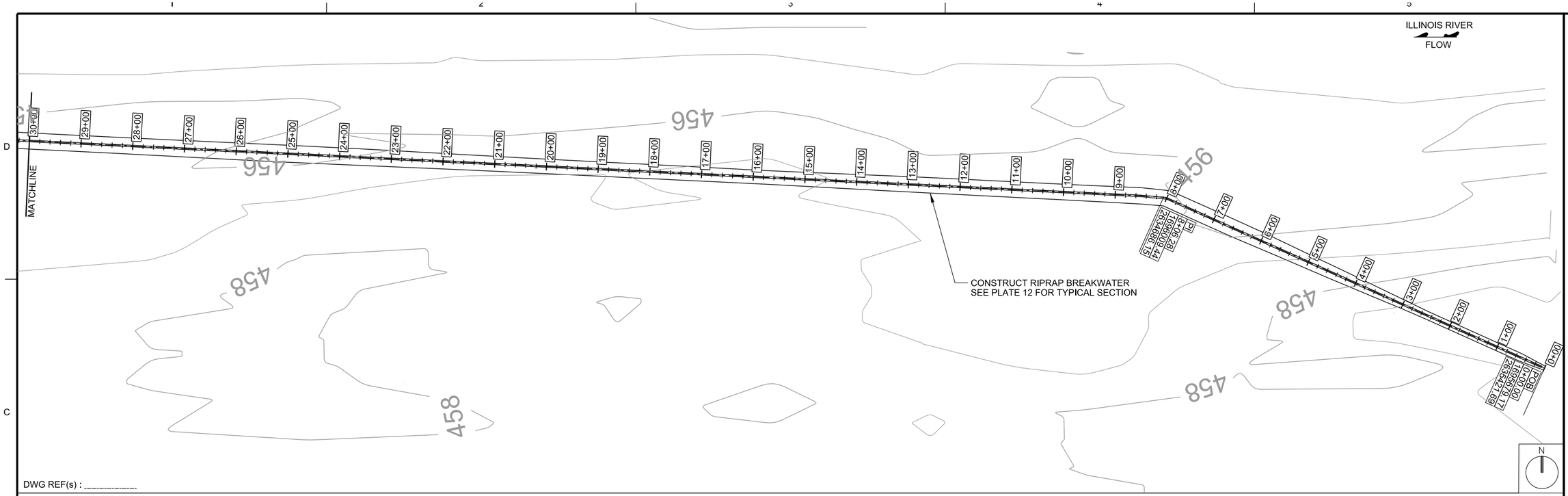
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PROJECT CODE: MY24

ILLINOIS RIVER BASIN
STARVED ROCK POOL
LASALLE COUNTY, IL
STARVED ROCK RESTORATION PROJECT
SECTION 519

TENTATIVELY SELECTED PLAN

PLATE 9

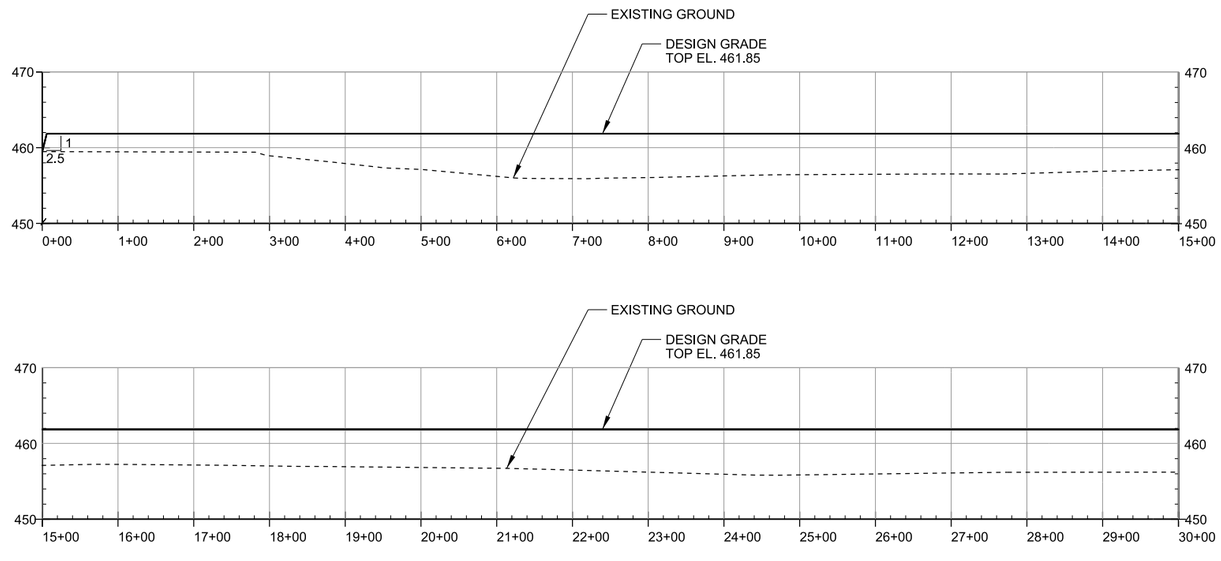
Sheet ID
C-103



DWG REF(s) : _____

C1 RIPRAP BREAKWATER PLAN

SCALE : 1"=100'-0" 0 100' 200'



DWG REF(s) : _____

A1 RIPRAP BREAKWATER PROFILE

SCALE : 1"=100'-0" 0 100' 200'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
MVR
ROCK ISLAND, ILLINOIS

DESIGNED BY: RCF
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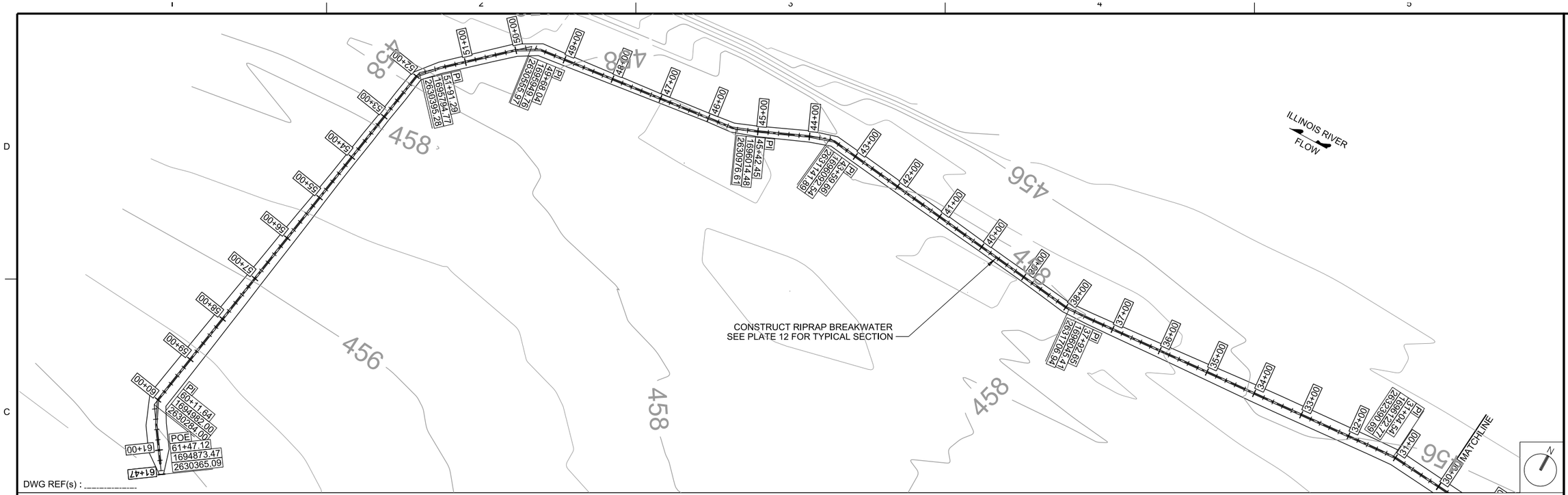
SUBMITTED BY: HLA
PLOT SCALE: AS SHOWN
SIZE: ANSI D
DATE:
CKD BY:
PLOT DATE:
FILE NAME: IW124C-104xxx.dgn
SOLICITATION NO.:
CONTRACT NO.:
PROJECT CODE: IW124

ILLINOIS RIVER BASIN
STARVED ROCK POOL
LASALLE COUNTY, IL
STARVED ROCK RESTORATION PROJECT
SECTION 519

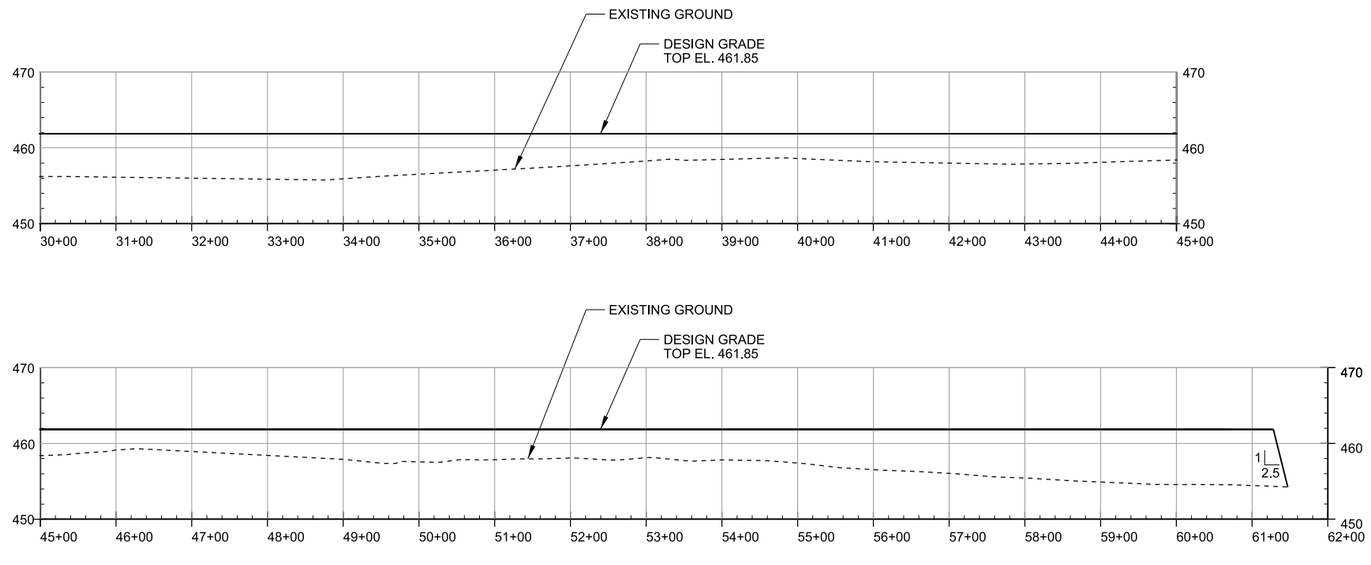
RIPRAP BREAKWATER
PLAN AND PROFILE
STA. 0+00 TO STA. 30+00
PLATE 10

Sheet ID
C-104



C1 RIPRAP BREAKWATER PLAN

SCALE : 1"=100'-0" 0 100' 200'



DWG REF(s) : _____

A1 RIPRAP BREAKWATER PROFILE

SCALE : 1"=100'-0" 0 100' 200'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

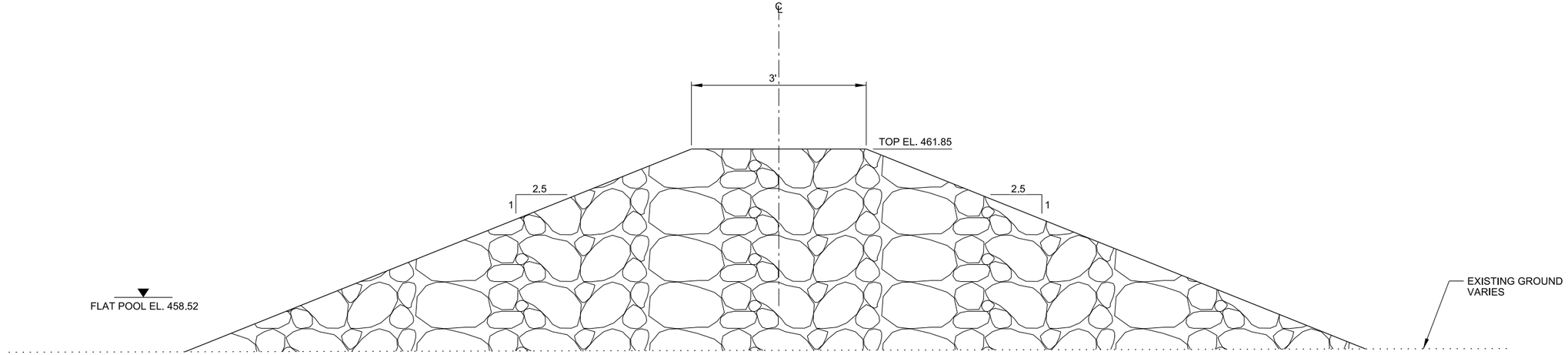
U.S. ARMY CORPS OF ENGINEERS
MVR
ROCK ISLAND, ILLINOIS

DESIGNED BY: RCF
DWN BY: LLH
CKD BY:
SUBMITTED BY: HLA
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PLOT SCALE: As shown
PLOT DATE:
PROJECT CODE: IW124
SIZE: ANSI D
FILE NAME: IW124C-105xxx.dgn

ILLINOIS RIVER BASIN
STARVED ROCK POOL
LASALLE COUNTY, IL
STARVED ROCK RESTORATION PROJECT
SECTION 519

RIPRAP BREAKWATER
PLAN AND PROFILE
STA. 30+00 TO STA. 60+91
PLATE 11

Sheet ID
C-105



DWG REF(s) : _____

A1 TYPICAL SECTION

SCALE : 1"=1'-0" 0 1' 2'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
MVR
ROCK ISLAND, ILLINOIS

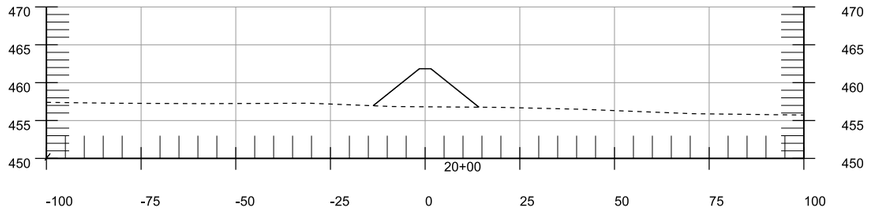
DESIGNED BY: RCF
DWN BY: EJJ
CKD BY:
SUBMITTED BY: HLA
PLOT SCALE: AS SHOWN
PLOT DATE:
SIZE: ANSI D
FILE NAME: MV24C-301xxx.dgn
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PROJECT CODE: HY124

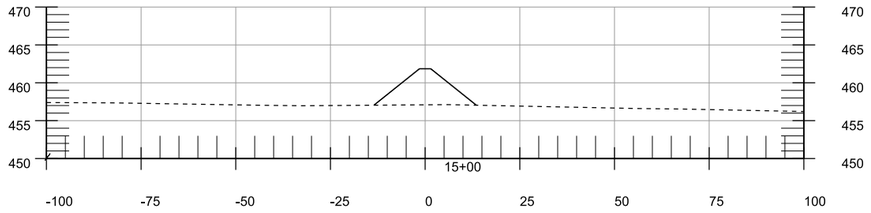
ILLINOIS RIVER BASIN
STARVED ROCK POOL
LASALLE COUNTY, IL
STARVED ROCK RESTORATION PROJECT
SECTION 519

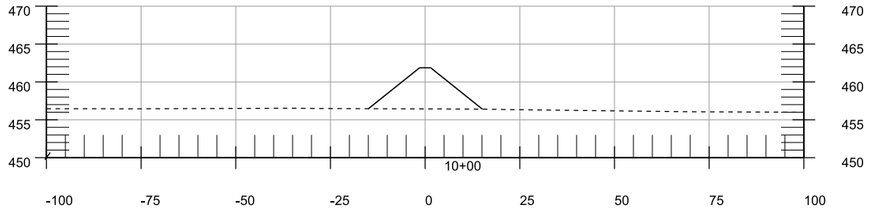
TYPICAL SECTION

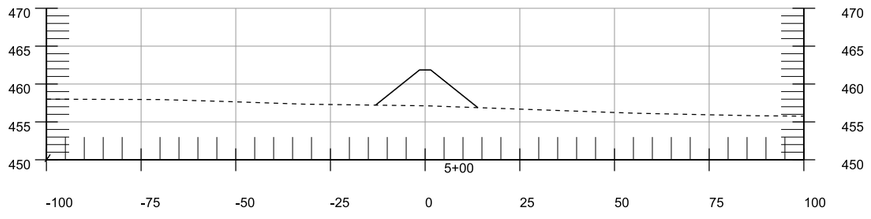
PLATE 12

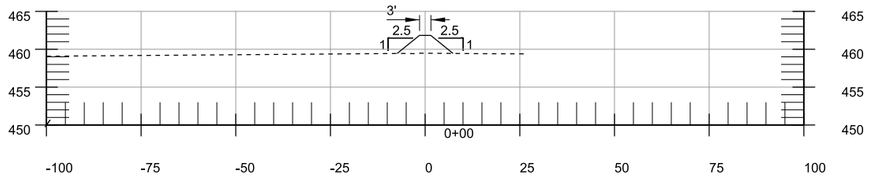
Sheet ID
C-301

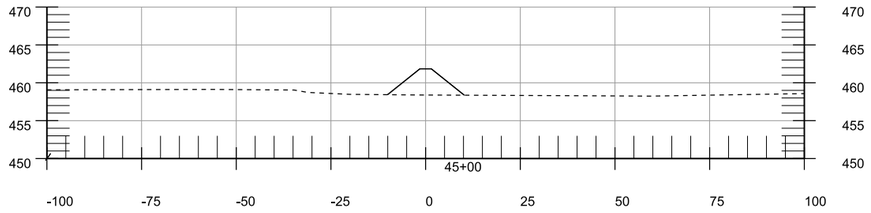


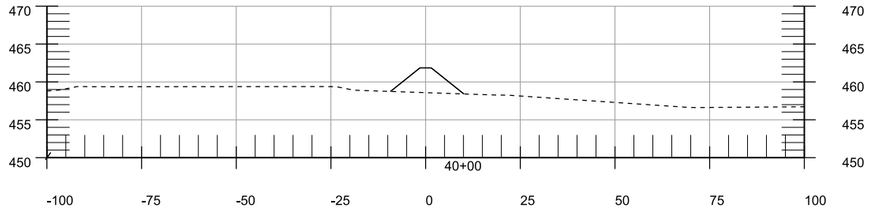


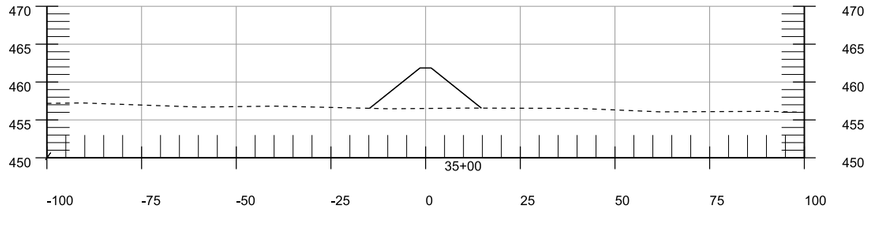


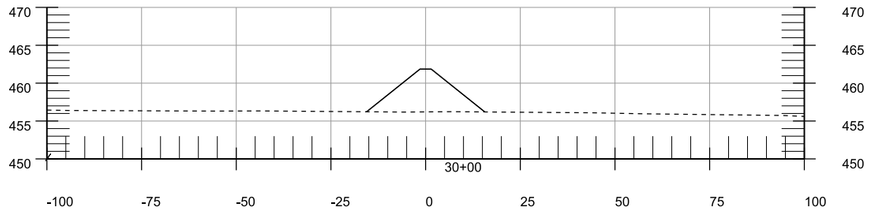


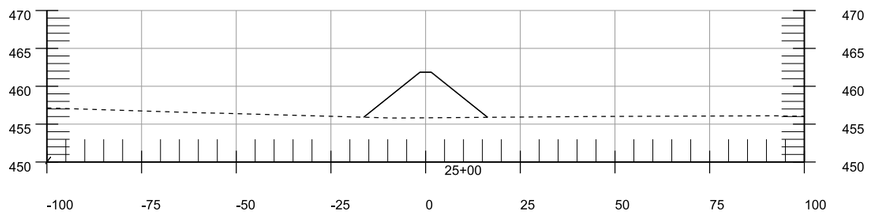












DWG REF(s) : _____

A1 CROSS SECTIONS

SCALE : 1"=20'-0" 0 20' 40'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
MVR
ROCK ISLAND, ILLINOIS

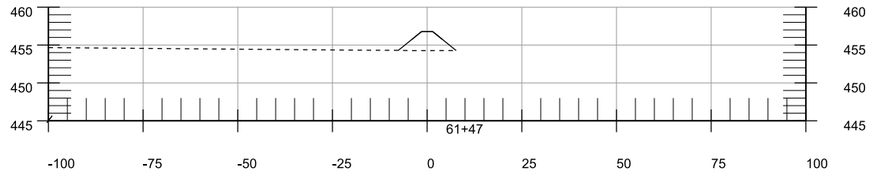
DESIGNED BY: RCF
DWN BY: LLH
CKD BY:
SUBMITTED BY: HLA
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PLOT SCALE: As shown
PLOT DATE:
SIZE: ANSI D
PROJECT CODE: 111124
FILE NAME: MV124C-302xxx.dgn

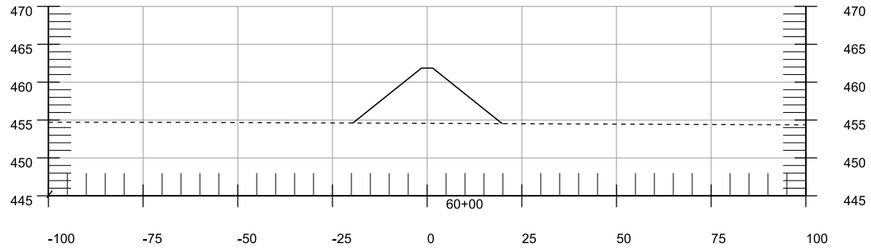
ILLINOIS RIVER BASIN
STARVED ROCK POOL
LASALLE COUNTY, IL
STARVED ROCK RESTORATION PROJECT
SECTION 519

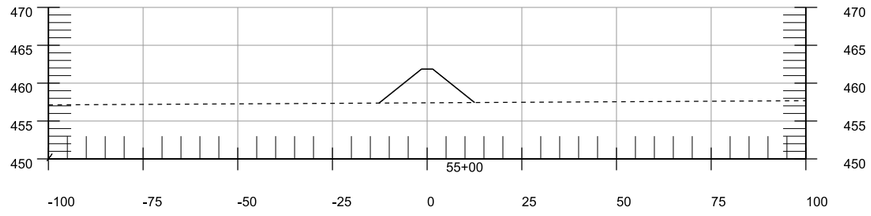
CROSS SECTIONS

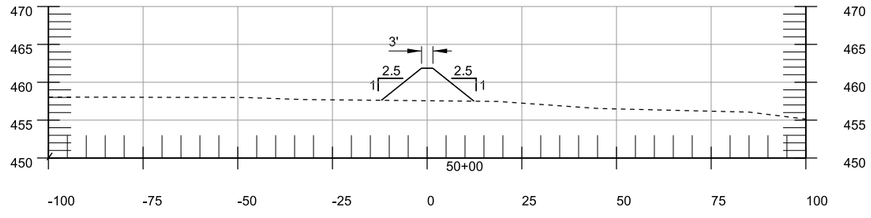
PLATE 13

Sheet ID
C-302









DWG REF(s) : _____

A1 CROSS SECTIONS

SCALE : 1"=20'-0" 0 20' 40'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
MVR
ROCK ISLAND, ILLINOIS

DESIGNED BY: RGF
DWN BY: LLH
CKD BY:
SUBMITTED BY: HLA
PLOT SCALE: AS SHOWN
SIZE: ANSI D
DATE:
SOLICITATION NO.:
CONTRACT NO.:
PLOT DATE:
PROJECT CODE: tw124
FILE NAME: tw124c-303xxx.dgn

ILLINOIS RIVER BASIN
STARVED ROCK POOL
LASALLE COUNTY, IL
STARVED ROCK RESTORATION PROJECT
SECTION 519

CROSS SECTIONS

PLATE 14

Sheet ID
C-303

SHEET NOTES

PRE-CONSTRUCTION MONITORING INCLUDES:

1. WATER QUALITY



DWG REF(s) : _____

A1 PRE-CONSTRUCTION MONITORING PLAN

SCALE : 1"=800'-0" 0 800' 1600'

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE	APPR.

U.S. ARMY CORPS OF ENGINEERS
MVR
ROCK ISLAND, ILLINOIS

DESIGNED BY: RCF		DATE:	
DWN BY: EJJ	CKD BY:	SOLICITATION NO.:	
SUBMITTED BY: HLA		CONTRACT NO.:	
PLOT SCALE: AS SHOWN	PLOT DATE:	PROJECT CODE: IW124	
SIZE: ANSI D	FILE NAME:	IW124D-101xxx.dgn	

ILLINOIS RIVER BASIN
STARVED ROCK POOL
LASALLE COUNTY, IL
STARVED ROCK RESTORATION PROJECT
SECTION 519

PRE-CONSTRUCTION MONITORING PLAN

PLATE 15

Sheet ID
O-101

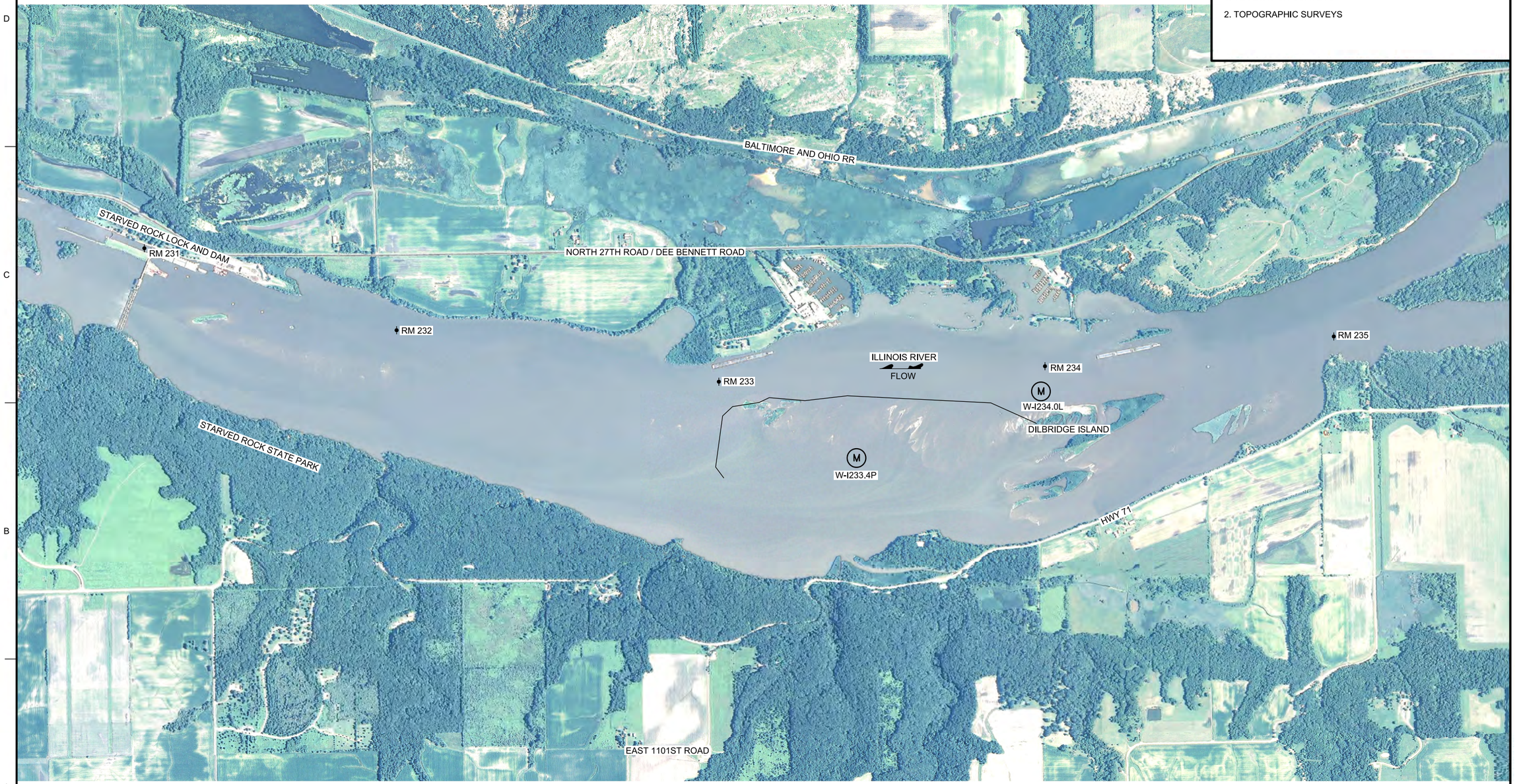
SHEET NOTES

POST- CONSTRUCTION MONITORING INCLUDES:

1. WATER QUALITY

POST CONSTRUCTION MONITORING NOT SHOWN:

1. VEGETATION SURVEYS
2. TOPOGRAPHIC SURVEYS



DWG REF(s) : _____

A1 POST-CONSTRUCTION MONITORING PLAN

SCALE : 1"=800'-0" 0 800' 1600'

US Army Corps of Engineers®

MARK	DATE	APPR.	DESCRIPTION

U.S. ARMY CORPS OF ENGINEERS
MVR
ROCK ISLAND, ILLINOIS

DESIGNED BY: RCF		DATE:	
DWN BY: EJJ	CKD BY:	SOLICITATION NO.:	
SUBMITTED BY: HLA		CONTRACT NO.:	
PLOT SCALE: AS SHOWN	PLOT DATE:	PROJECT CODE: IW124	
SIZE: ANSI D	FILE NAME: W124O-102xx.dgn		

ILLINOIS RIVER BASIN
STARVED ROCK POOL
LASALLE COUNTY, IL
STARVED ROCK RESTORATION PROJECT
SECTION 519

POST-CONSTRUCTION MONITORING PLAN

PLATE 16

Sheet ID
O-102