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

20 April 2018

Reply to:
Regional Planning and Environmental Division North
Environmental Compliance Section (PD-C)

Dear Reviewer:

The St. Louis District of the U.S. Army Corps of Engineers has prepared a Draft Environmental Assessment (EA) with an unsigned Finding of No Significant Impact (FONSI) for proposed construction activities known as Red Rock Landing Phase 4, Middle Mississippi River (RM 104.0 – 101.5 L), Randolph County, Illinois. This document serves to notify the public of the Draft EA. You are receiving this letter because you may be interested in the assessment. The Draft EA with unsigned FONSI are available for public review. The electronic version of these documents is available through the link below, or you may request a copy of the Draft EA and FONSI be mailed to you.

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

We invite your comments related to the content of the attached document. Please note that the FONSI is unsigned. This document will be signed into effect only after having carefully considered comments received as a result of this 30-day public review. The 30-day public review period is open April 20, 2018 through May 20, 2018.

Please address your written comments to:
Shane Simmons
U.S. Army Corps of Engineers (CEMVP-PD-P)
1222 Spruce Street
St. Louis, MO 63103
Email: Shane.M.Simmons@usace.army.mil

Sincerely,

Brian Johnson
Chief, Environmental Compliance Branch

U.S. Army Corps
Of Engineers
St. Louis District

April 2018

DRAFT ENVIRONMENTAL ASSESSMENT
WITH UNSIGNED FINDING OF NO SIGNIFICANT IMPACT

Red Rock Landing Phase 4
Middle Mississippi River (RM 104.0 – 101.5 L)
Randolph County, Illinois

Regulating Works Project

U.S. Army Corps of Engineers, St. Louis District
Regional Planning & Environmental Division North (CEMVS-PD-P)

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Chapter 1. Introduction

1.1 Overview

The U.S. Army Corps of Engineers (Corps), Mississippi Valley Division (MVD), St. Louis District (District), proposes to undergo construction activities to reduce sediment deposition on a sandbar that is encroaching on the navigation channel leading to unsafe navigation due to insufficient navigation channel width adjacent to the left descending bank of the Mississippi River between river miles 101.5 - 104, in Randolph County, Illinois (Figure 1), referred to herein as the Red Rock Landing Phase 4 (Red Rock) work area under the Regulating Works Project (described below). It is approximately 1.5 miles west of Rockwood, Illinois and 5 miles southeast of Chester, Illinois.

This Draft Environmental Assessment (EA) and unsigned Finding of No Significant Impact (FONSI) have been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 and the Council on Environmental Quality's Regulations (40 Code of Federal Regulations §1500-1508), as reflected in the Corps Engineering Regulation 200-2-2.

1.2 Authorization, Prior Reports, and Incorporation by Reference

The St. Louis District of the U.S. Army Corps of Engineers is charged with obtaining and maintaining a navigation channel on the Middle Mississippi River (MMR) that is nine feet deep, 300 feet wide with additional width in bends as necessary. The MMR is defined as that portion of the Mississippi River that lies between its confluence with the Ohio and the Missouri Rivers (Figure 1). This ongoing Project is also commonly referred to as the Regulating Works Project (Project). As authorized by Congress, the Project utilizes bank stabilization, rock removal, and sediment management to maintain bank stability and ensure adequate navigation depth and width. Bank stabilization is achieved by revetment and river training structures, while sediment management is achieved by river training structures. The Project is maintained through dredging and any needed maintenance to already constructed features. The long-term goal of the Project, as authorized by Congress, is to obtain and maintain a navigation channel and reduce federal expenditures by alleviating the amount of annual maintenance dredging through the construction of regulating works.

This site-specific Environmental Assessment is tiered off of the 1976 Environmental Impact Statement (1976 EIS) covering the Project – *Mississippi River between the Ohio and Missouri Rivers (Regulating Works)*, (USACE 1976), and the supplement to that prepared in 2017: *Final Supplement I to the Final Environmental Statement, Mississippi River between the Ohio and Missouri Rivers (Regulating Works)* (USACE 2017) (2017 SEIS).

Further, the District recently completed a draft Supplemental EA (SEA) on five (5) tiered site-specific Environmental Assessments (SSEAs) that were completed for the Project during the

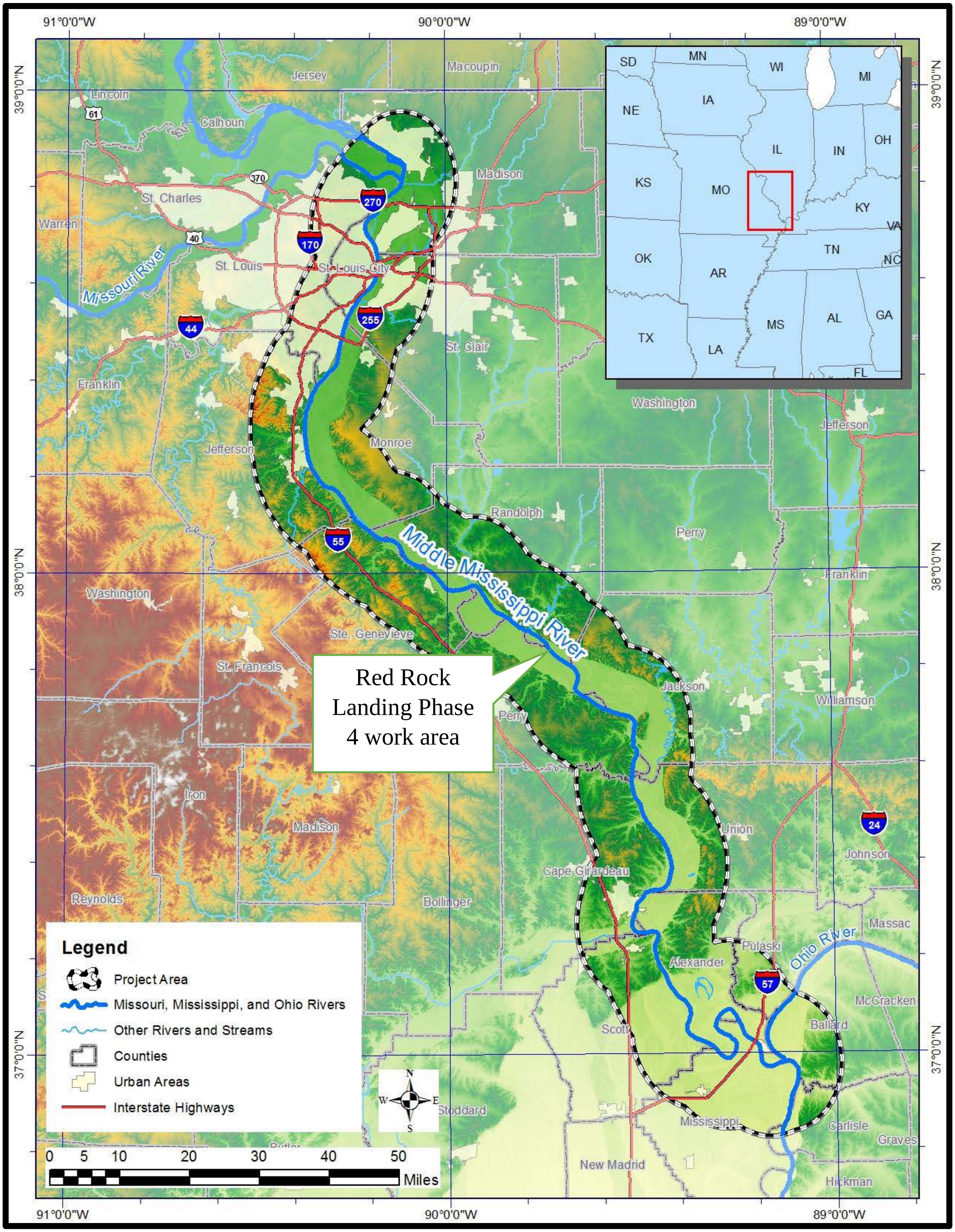

Figure 1. The proposed work area in relation to the Regulating Works Project Area.

preparation of the 2017 SEIS. In the draft SEA, the work done under those SSEAs was reevaluated for impacts to main channel border (MCB) habitat using a certified habitat model because the 2017 SEIS found a potentially programmatic significant impact to this particular habitat by continuing with new construction to reduce dredging under the Regulating Works Project. The draft SEA includes results and analysis of the initial assessment of the Project's impacts to MCB habitat, as well as an update to the Project's monitoring and adaptive management plan for any potential compensatory mitigation. The 1976 EIS, 2017 SEIS, SSEAs, draft SEA, and all other applicable background information and documentation can be found here and are hereby incorporated by reference into this draft EA:

http://www.mvs.usace.army.mil/Missions/Navigation/SEIS/Library.aspx

Regarding the Red Rock work area, this draft EA discusses the impacts of the particular action on the environment. Site-specific impacts to MCB habitat have been assessed at the Red Rock work area using the MMR Sturgeon Chub Model discussed in detail in the SEIS and the Draft SEA (Chub Model). The results of that assessment as to the Red Rock work area are included in this draft EA and are discussed in terms of the Project's programmatic impact on MCB habitat and its associated monitoring and adaptive management plan. Further, any applicable site-specific environmental impacts from this new work not fully covered in the 2017 SEIS are included herein.

1.4 Purpose of and Need for Action

Frequent dredging has been required in order to maintain a safe and efficient navigation channel within the proposed work area. From 2000 to 2015, approximately 5.8 million cubic yards of material has been dredged from the navigation channel in the vicinity (Figure 2), costing approximately $12.7 million. Sediment accumulation readily occurs along the right descending bank within the work area, allowing a sandbar to encroach on the navigation channel (Figure 3). Sediment also accumulates within the navigation channel itself, immediately downstream of the sandbar on the right descending bank (Figure 4).

Through analysis and modeling, the District has concluded that construction and/or modification of river training structures in the area is reasonable and necessary to address the repetitive channel maintenance dredging in order to provide a sustainable, less costly navigation channel in this area. Therefore, the overall purpose of the proposed federal action is to reduce the amount of costly channel maintenance dredging that has been required in the area and to ensure a safe and dependable navigation channel under the Regulating Works Project in the proposed work area by:

1) Reducing sediment deposition along the RDB within the work area; and
2) Stopping sandbar encroachment on the navigation channel.

Figure 2. Approximate location of the 17 channel maintenance dredging events (green) and dredge disposal locations (red) performed in the work area from 2000 to 2015.

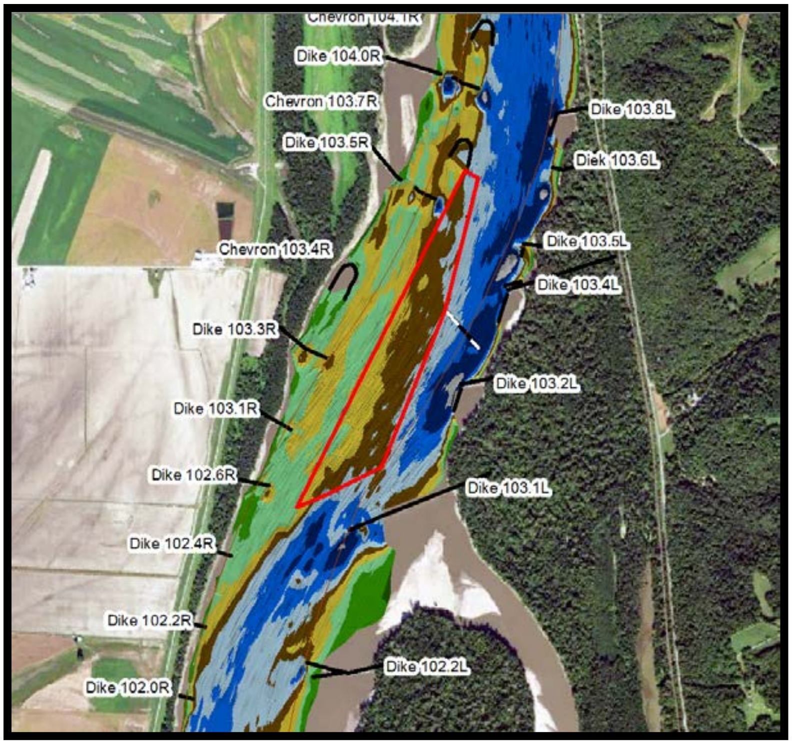

Figure 3. Bathymetric survey conducted in 2013 that reveals encroachment of the sandbar on the navigation channel (red box) within the work area.

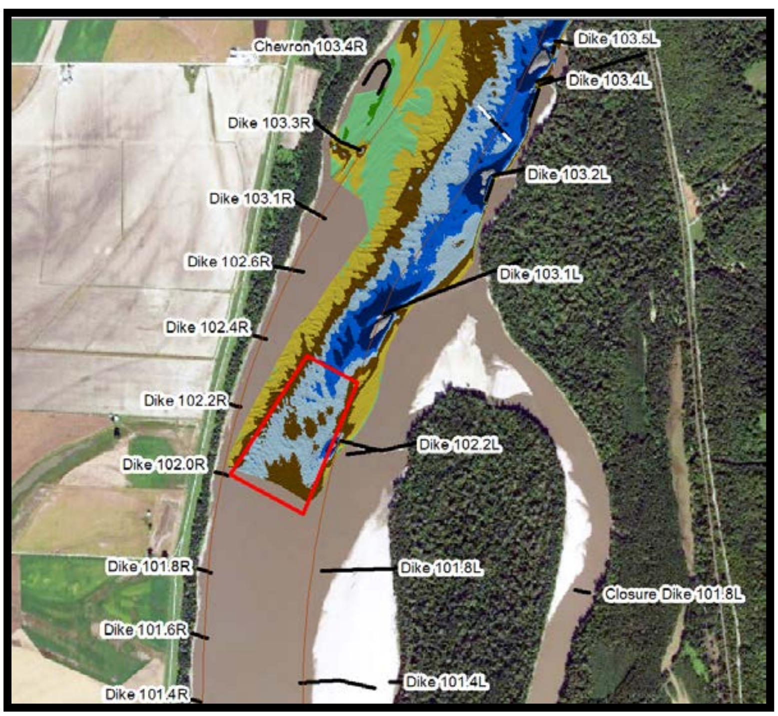

Figure 4. Bathymetric survey conducted in 2011 that reveals the sediment deposition in the navigation channel (red box) within the work area.

1.5 Scoping

Scoping is an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action. Scoping was conducted early in the planning process using a variety of communication methods with affected agencies, organizations, and tribes. The input received during scoping was incorporated in the process of decision making for this work; however, the District must ultimately make the decision what direction the Project will follow.

Tribal Scoping

The United States government has a unique legal relationship with federally recognized American Indian Tribes, based on the inherent powers of Tribal sovereignty and self-government. The District will uphold this special relationship and implement its activities in a manner consistent with it. Communication with 28 federally recognized tribes affiliated with the St. Louis District was initiated by the District's tribal liaison with a Corps letter dated 17 January, 2017 (Appendix C), and they will be notified of the 30-day public review period (see below). All responses to this coordination received by the District will be included in the final version of this report.

Public Scoping

Public scoping activities will be held prior to the development of the Final EA. This environmental assessment will be made available to the public for a 30-day public review period. The report will be made available on the District's website along with mailed letters to interested members of the public addressing where to find the report and how to provide comments.

Agencies and Organization Scoping

The planning of specific construction areas, including the Red Rock Landing Phase 4 work area, requires extensive coordination with resource agency partners and the navigation industry. The U.S. Fish and Wildlife Service (USFWS), Missouri Department of Conservation (MDC), Illinois Department of Natural Resources (IDNR), and multiple navigation industry groups were included in the planning of the Red Rock Landing Phase 4 work area and provided comments related to navigation industry concerns and environmental resources issues, as documented in technical report: UMR 104.0 – 101.5 Hydraulic Sediment Response (HSR) Model Study (Appendix B).

Chapter 2. Alternatives Including the Proposed Action

This section describes the alternatives or potential actions that were considered as ways to address the issues with maintaining the authorized depth, width, and alignment of the navigation channel within the work area vicinity for the purpose of reducing dredging within the work area. Alternatives will be described and their environmental impacts and usefulness in achieving the overall Project objectives are compared.

Alternative 1 - No Action. Under the No Action Alternative, the District would not construct any new river training structures within the work area, nor would it lengthen or reduce any of the existing river training structures in the area. Under this alternative, the District would continue to maintain the existing river training structures in the area to their design specifications and elevations, and continue channel maintenance dredging to ensure a safe and dependable navigation channel exists in the work area.

Alternative 2 - Proposed Action. The Proposed Action Alternative involves modifying the configuration of river training structures within the Red Rock Landing reach of the MMR, between river miles 104.0 – 101.5 (L). As summarized in Table 1, the specific details of the Proposed Action include constructing a new traditional rock dike at RM 103.9 (L), degrading the existing trail portion of dike 103.8 (L) and reusing the stone to rebuild the trail portion with a more bankward alignment, constructing a new trail dike at RM 103.6 (L), degrading the trail segment of dikes 103.5 (L), 103.4 (L) and 103.2 (l), and rebuilding them with a more riverward alignment, reducing the length of dike 103.1 (L), and constructing a multiple round-point structure (MRS) at 102.3 (L). In total, approximately 319,200 tons of new stone would be added to the work area vicinity, 40,000 tons would be recycled and reused, and 11,200 would be completely removed from the project area. This would result in a net increase of 308,000 tons of stone to the work area.

Table 1. Features associated with the Proposed Action Alternative. Lengths and stone quantities are approximate, and are subject to revision during structure design. Final elevation of all proposed construction/realignment would be 354 NGVD (+18 LWRP).

Location	Proposed Work	Purpose	New Stone	Recycled Stone
103.9 (L)	Construct dike 100 ft long	Establish scour along the LDB leading into the river bend.	7,100	0
103.8 (L)	Degrade existing 350 ft long trail dike and re-use stone to construct trail dike (same length) with new alignment	Maintain smooth flow alignment along the LDB structures.	6,100	36,100

Location	Proposed Work	Purpose	New Stone	Recycled Stone
103.6 (L)	Restore existing dike 210 ft long from bank, and add new trail segment 400 ft long	Maintain smooth flow alignment along the LDB structures.	93,400	0
103.5 (L)	Degrade existing 200 ft long trail dike and re-use stone to construct new trail dike (same length)	Maintain smooth flow alignment along the LDB structures.	16,300	1,800
103.4 (L)	Degrade existing 400 ft long trail dike and re-use stone to construct trail dike (same length) with new alignment	Maintain smooth flow alignment along the LDB structures.	74,400	1,700
103.2 (L)	Degrade existing trail dike 400 ft long and construct trail dike 865 ft long	Maintain smooth flow alignment along the LDB structures.	106,900	400
103.1 (L)	Remove riverward 500 ft of dike 1,560 ft long dike	Maintain smooth flow alignment along the LDB structures.	0	11,200*
102.3 (L)	Construct multiple round point structure 600 ft long	Prevent sediment deposition in the channel crossing at RM 102.3 (L).	15,000	0

*This amount would be completely removed from the work area, it would not be recycled and re-used for construction.

2.1 Development of Alternatives

Pursuant to the Project objectives and authority discussed in the 1976 EIS and the 2017 SEIS, the District’s alternative evaluation process for this work area considered only those alternatives that will obtain and maintain a safe and reliable 9-foot navigation channel in the work area through continued maintenance dredging or construction of regulating works to minimize the dredging required.

For the Red Rock work area, the District developed 28 different design configurations using widely recognized and accepted river engineering guidance and practice, and then screened and analyzed the different configurations with the assistance of a Hydraulic Sediment Response model (HSR model) (HSR models are discussed in detail in the 2017 SEIS). The 28 different configurations of river training structures were considered in the HSR model to determine the best combinations to reduce the need for dredging and improve the navigation channel alignment, while also minimizing environmental impacts. Throughout the HSR modeling process, four specific criteria were used to evaluate each of the alternatives:

- The alternative should reduce or eliminate the need for dredging along the RDB sandbar between RM 104.0 and RM 102.5;

- The alternative should reduce or eliminate the need for dredging in the channel crossing between RM 102.5 and RM 101.5;

- The alternative should have a minimal impact on the flows entering Liberty Chute; and

- The alternative should have a minimal impact on the sandbar along the riverward side of Rockwood Island.

Based on the results of the HSR model study, alternative 25 was recommended as the most desirable alternative because of its observed ability to reduce sandbar encroachment on the navigation channel, maintain sufficient navigation channel width between RM 104.0 - 102.5, and reduce sediment deposition within the navigation channel between RM 102.5 - 101.5, while simultaneously having minimal impact on the aquatic habitat in the work area (Figure 7). The design of alternative 25 is based largely on the realignment and modification of existing river training structures in the area, and involves the construction of fewer new structures than many of the other alternatives analyzed, meaning the construction footprint and overall environmental impact would be minimized within the work area. Flow visualization testing on alternative 25 revealed it would not reduce flow into Liberty Chute (referred to as *Rockwood Chute* in the HSR model study report), nor would it significantly impact the sandbar at the upper end of Rockwood Island. The HSR model study report provides more information on the 28 modeled alternatives, including their designs, performance (i.e., criteria met), and the justification for their elimination or selection (Appendix B).

Throughout the alternative evaluation process, the District worked closely with industry and natural resource agency partners to further evaluate potential alternatives in this reach of the river, including the 28 configurations analyzed in the HSR model. All partner concerns were satisfactorily resolved and a consensus was reached on an acceptable design. In particular, the original design configuration of alternative 25 included two rootless dikes at the downstream end of the work area (Figure 7). However, natural resource agency personnel expressed concern over these structures being placed on main channel border habitat. The District maintains that the entirety of alternative 25 is the best solution for the area, but agreed to take a phased approach to the work area, in which the furthest downstream dike would be omitted from the current Proposed Action Alternative, and would only be implemented after future monitoring, coordination, and NEPA documentation. Additionally, the District agreed to modify the proposed rootless dike at RM 102.3 (L) to be an MRS, thereby serving to enhance bathymetric diversity and aquatic habitat while still helping to prevent sediment deposition in the navigation channel.

This collaborative process resulted in the Proposed Action Alternative, which reasonably met the Project purpose while also avoiding/minimizing environmental impacts. Based on this extensive evaluation of design configurations, the District determined that the Proposed Action Alternative was the only reasonable alternative to minimize dredging from the current level and that more extensive analysis of any of the additional configurations of river training structures in the EA would be unnecessary for failure to meet the objectives described above.

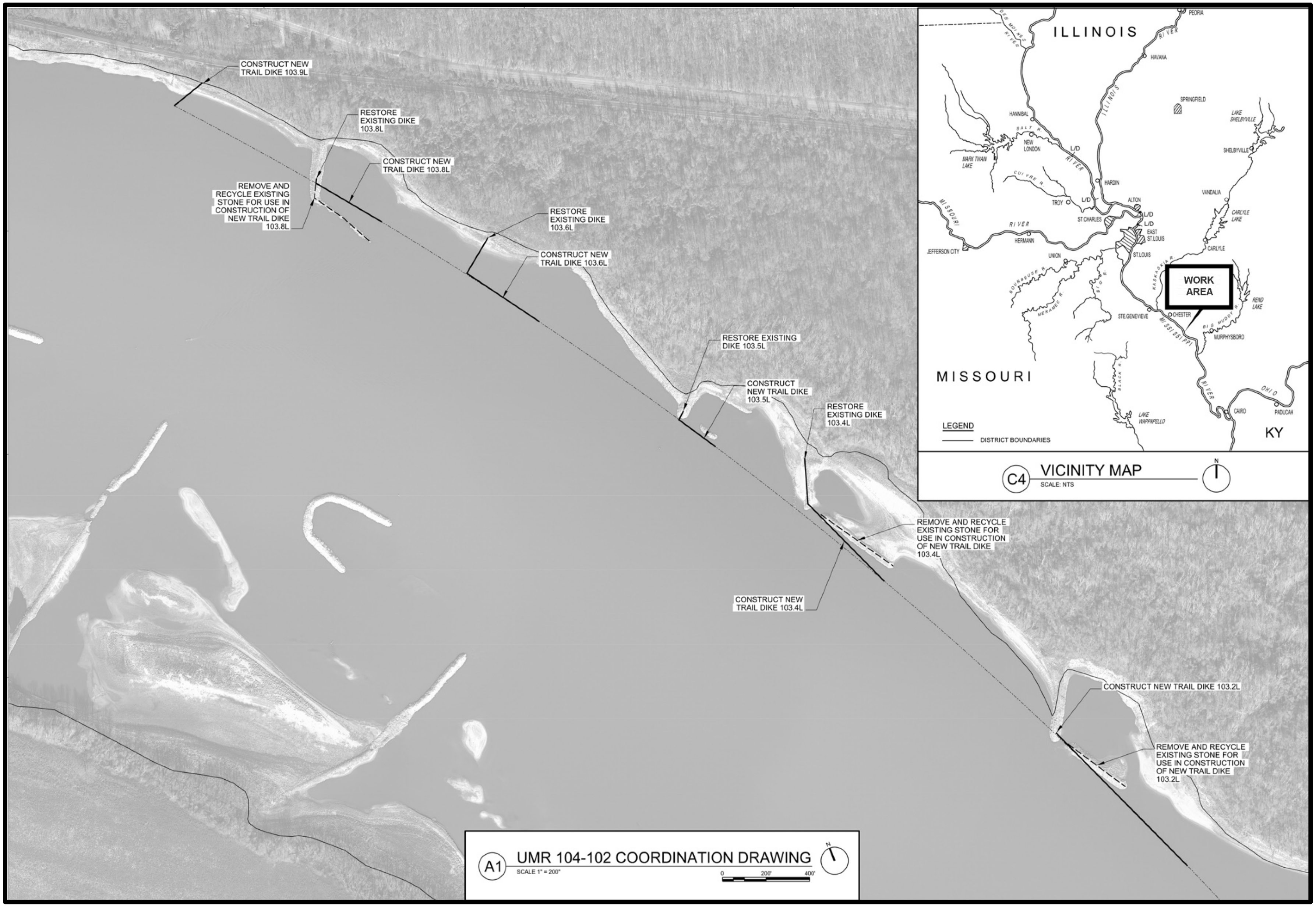

Figure 5. Proposed construction and modification of river training structures at the upstream portion of the work area.

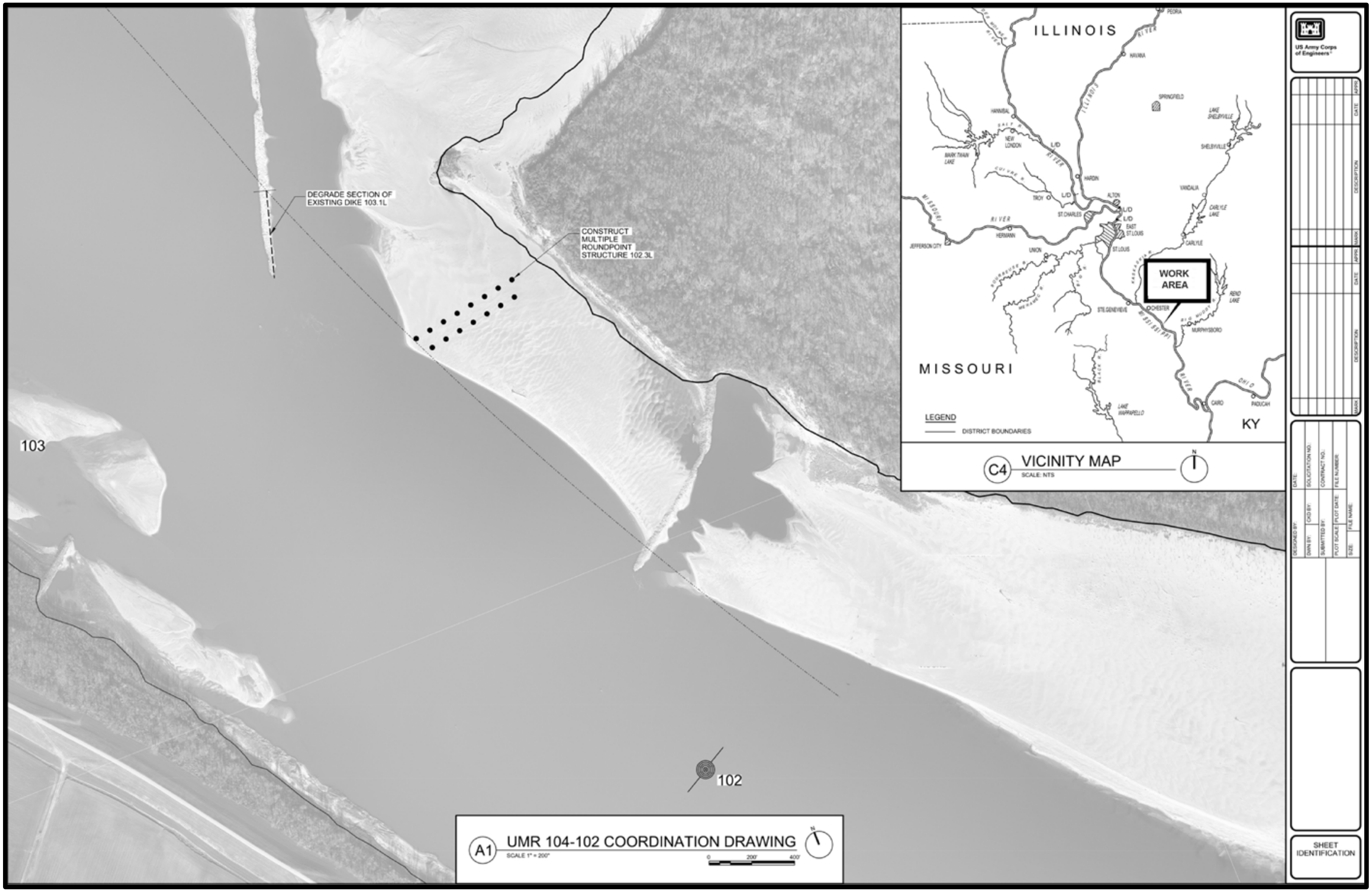

Figure 6. Proposed construction and modification of river training structures at the downstream portion of the work area.

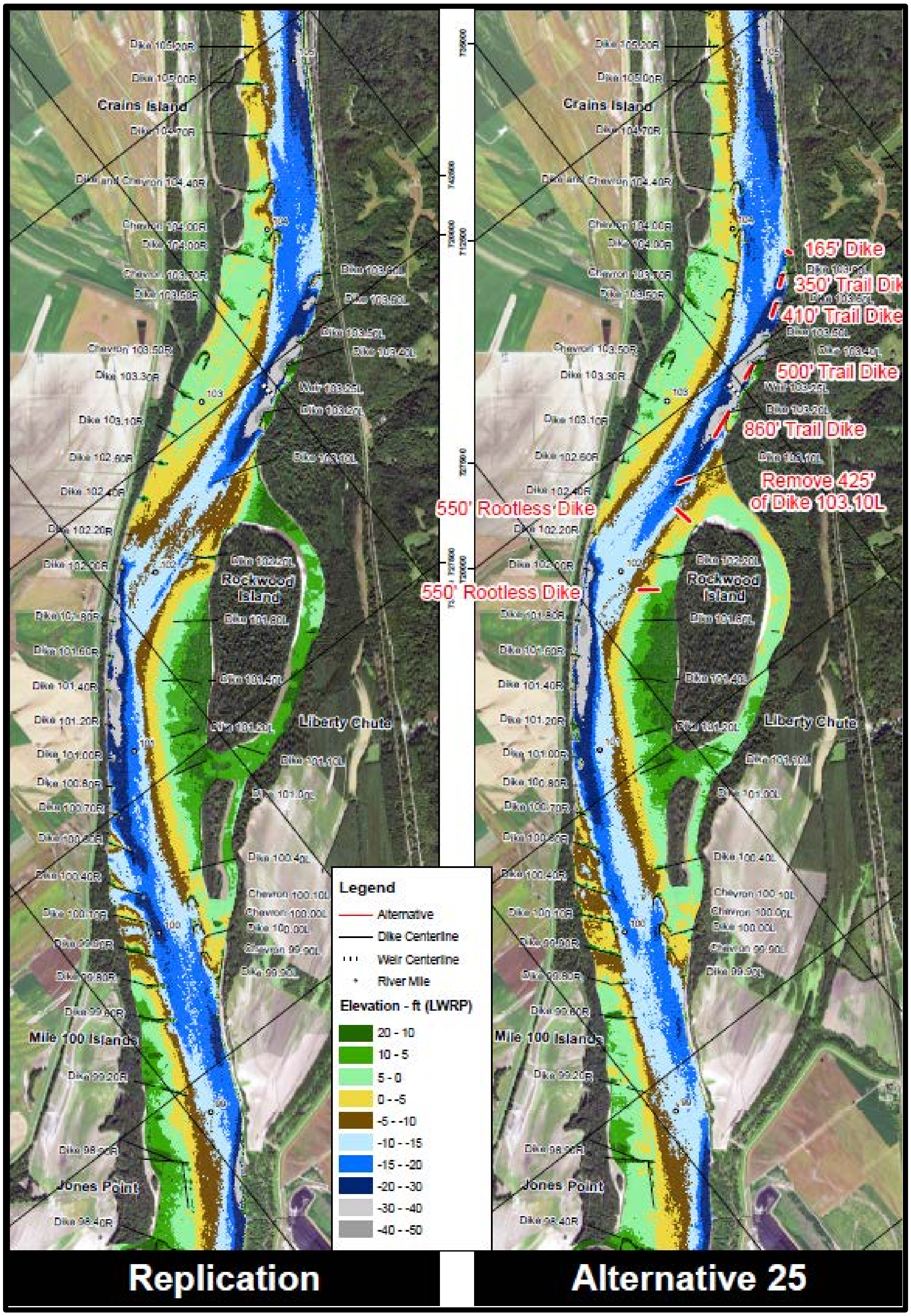

Figure 7. HSR model base test (left) compared to the results of Alternative 25 (right). NOTE: changes to Alternative 25 that result in the Proposed Action are not reflected in this image (i.e., one rootless dike removed, and one rootless dike changed to MRS).

Chapter 3. Affected Environment and Environmental Consequences

This section presents details on the historic and existing conditions of resources within the work area that would potentially be affected by the No Action alternative and the Proposed Action alternative, as well as a comparison of the effects that are likely to result from these alternatives.

3.1 Summary of Environmental Consequences

The existing resources in the work area and the anticipated impacts associated with the two Alternatives are both consistent with the information described in the 1976 EIS and 2017 SEIS. As such and pursuant to CEQ regulations and guidance to minimize the size of NEPA documents by not duplicating analyses or presenting redundant information, this section incorporates by reference the description of the affected environment and the environmental consequences included in the aforementioned documents with no need for additional details as to this specific work area. Therefore, many resource categories (e.g., stages, air quality, HTRW) will not be described any further in this document and the analyses and impacts described are incorporated by reference. Other resource categories (e.g., fishery resources, historic and cultural resources) as they relate specifically to this work will be described further with the appropriate amount of additional site-specific details regarding their existing conditions and the associated impacts of both Alternatives.

Further, an analysis of the Project's cumulative effects is presented in the 2017 SEIS, which accurately captures the affected environment and environmental consequences of the Proposed Action Alternative described herein. As such this is incorporated by reference, and an additional cumulative effects analysis has not been prepared for the Proposed Action.

3.2 Geomorphology

The physical layout of the Red Rock Landing Phase 4 work area consists primarily of main channel and structured main channel border on the left descending bank. A series of traditional rock dikes extend from the LDB toward the navigation channel within the area, four of which have trail dike segments. A single navigation weir in the work area helps steer the thalweg away from the LDB. A channel crossover exists in the work area - the thalweg meanders from the LDB near RM 103.5 to the RDB near RM 102. The entrance to Liberty Chute is found along the left bank within the work area vicinity. Liberty Chute is one of the better connected side channels in the MMR. Based on median monthly stages and recent bathymetric surveys, Liberty Chute has consistent flowing water and remains connected to the main channel for the majority of the year. As previously discussed, sediment accumulation has led to the sandbar on the right bank encroaching on the navigation channel and reduced navigation channel depths immediately downstream near RM 102.

Impacts of the No Action Alternative on Geomorphology - The physical layout of the work area is expected to remain similar to its current condition under the No Action Alternative. All existing river training structures in the area would remain in their current positions and would be maintained to their original design specifications. Sedimentation would likely continue along the right descending bank and within the navigation channel itself. This would cause the sandbar to extend further from the bank and encroach on the navigation channel and the average bed elevation to increase within the navigation channel. Therefore, under this alternative, channel maintenance dredging would continue to be necessary in the work area vicinity. Dredging and disposal areas would presumably be located near their previous locations, as illustrated in Figure 2. This would lead to periodic decreases in bed elevation within the navigation channel and periodic increases to elevation along the right bank, a direct result from dredging and dredge disposal. All other geomorphology characteristics would remain unchanged.

Impacts of the Proposed Action on Geomorphology - The Proposed Action Alternative would slightly alter the geomorphological characteristics of the work area. As described in Chapter 2, some river training structures would be realigned and extended, one would be shortened, and a rootless MRS would be constructed. The Proposed Action would result in a net increase to the volume of stone and collective length of river training structures in the area. Further, the Proposed Action would enhance the channel scour effect of the river within the work area, increasing sediment transport within the navigation channel in the area. The sandbar on the right bank would cease extending from the bank and encroaching on the navigation channel, and a lower bed elevation would be maintained within the navigation channel. This alternative would lessen the need for continued channel maintenance dredging within the work area, meaning the bed elevations of the navigation channel and sandbar would fluctuate less frequently as a result of sediment accretion and channel maintenance dredging.

The net increase in river training structures in the work area and their enhancement of the navigation channel would slightly modify the geomorphology in the area, by negatively impacting the shallow to moderate-depth, moderate to high-velocity MCB habitat identified in the 2017 SEIS as a programmatically significant negative impact. See Chapter 4 for more details on this impact for the work area.

3.3 Fishery Resources

The existing condition of fishery resources within the Red Rock work area vicinity is consistent with the description provided in the 2017 SEIS. Namely, the assemblage of aquatic organisms (i.e., fish and macroinvertebrates) that is likely to occur within the work area is presumably the same as what commonly occurs throughout the MMR. Fish macrohabitat features in the area are also similar to the descriptions provided in the 2017 SEIS. Habitat types in the area fall under common Mississippi River habitat classifications (see Barko et al. 2004, Phelps et al. 2010), including the main channel, unstructured main-channel border, structured main-channel border, and a side channel. Because of this, the work area likely fulfills the habitat requirements for the major habitat guilds of large river fishes: fluvial specialists, fluvial dependents, and macrohabitat generalists.

Impacts of the No Action Alternative on Fishery Resources - Under the No Action Alternative, fishery resources in the work area vicinity would likely remain unchanged from their current condition. However, given that the area has a continued need for channel maintenance dredging, and that the Proposed Action is specifically designed to alleviate this issue, a continued need for channel maintenance dredging would be expected with implementation of the No Action Alternative. A thorough description of the effects of channel maintenance dredging on aquatic organisms and aquatic habitat is provided in the 2017 SEIS. Those effects would be expected to be the same for the Red Rock work area, and while these effects are mostly temporary, the rate and frequency of these temporary effects would be increased under the No Action Alternative. Examples include entrainment of fish and macroinvertebrates, smothering of benthic macroinvertebrates, and temporary re-suspension of sediment.

Impacts of the Proposed Action on Fishery Resources - Multiple impacts to fishery resources are likely to occur with implementation of the Proposed Action Alternative. These impacts align with the described effects of river training structure construction outlined in the 2017 SEIS. The planned construction would alleviate the continued need for channel maintenance dredging, thereby reducing its associated impacts, i.e., less fish and macroinvertebrate entrainment, less disturbance of sediment, and less smothering of benthic organisms with dredge disposal material. Further, the extension of existing trail dikes and construction of new trail dikes would increase the amount of lentic (slackwater) habitat along the left bank within the work area. The pockets of lentic habitat found behind emergent river training structures are often used as flow refugia for different fish species, especially macrohabitat generalists and slackwater specialists.

While collaborating with natural resource agency partners, much consideration was given to aquatic habitat within the work area. This resulted in the MRS being proposed in lieu of a traditional rootless dike structure in order to enhance bathymetric diversity and split-flow conditions while also reducing or eliminating the need for dredging of the navigation channel. Similarly, the removal of 425 ft from dike 103.1L serves to enhance sediment transport within the navigation channel while also promoting more lateral flow along MCB habitat and increasing connectivity with Liberty Chute.

The aforementioned impacts on fishery resources that would likely result from the Proposed Action are primarily beneficial. However, using the Chub Model, the initial mitigation assessment of the Proposed Action revealed it would negatively affect shallow to moderate-depth, moderate-to high-velocity habitat within the vicinity of the work area. This specific habitat type is important for fluvial specialist and fluvial dependent fish species that occur in the MMR, which was found to likely be significantly impacted on a programmatic basis by the Continue Construction Alternative of the overall Project analyzed in the 2017 SEIS. The amount of this habitat anticipated to be lost at the Red Rock work area with implementation of the Proposed Action is not in itself a significant amount. The Red Rock work area would still provide abundant aquatic habitat to fluvial specialist/dependent species as well as generalist species. However, given that loss of this habitat type was deemed significant on a programmatic basis in the 2017 SEIS, the anticipated loss at the Red Rock work area must be discussed and assessed as such. More detail on this impact is provided in Chapter 4.

3.4 Threatened and Endangered Species

A programmatic (Tier I) consultation (USACE 1999), conducted under Section 7 of the Endangered Species Act, considered the systemic impacts of the operation and maintenance of the 9-Foot Channel Navigation Project on the Upper Mississippi River System (including the MMR) and addressed listed species as projected 50 years into the future (USFWS 2000). Since the aforementioned consultation process, additional species that could potentially occur within the Project Area have been listed threatened or endangered. These species were addressed in an additional programmatic (Tier I) consultation that accompanied the 2017 SEIS. These consultations did not include individual, site specific effects or new construction. It was agreed that site specific impacts and new construction impacts would be handled under separate Tier II consultations. Although channel structure impacts were covered under the Tier I consultations, other site and species specific impacts could occur. As such, the Red Rock Landing Phase 4 work requires Tier II consultation. Accordingly, this section of this report is being used to satisfy the requirements of completing a Tier II Biological Assessment for this work.

In compliance with Section 7(c) of the Endangered Species Act of 1973, as amended, the St. Louis District consulted with the U.S. Fish and Wildlife Service, Marion Ecological Services Sub-Office. Through the Service's Information, Planning, and Conservation (IPaC) System (accessed March 14, 2018) they provided a list of threatened and endangered species that could potentially occur within the vicinity of the work area. According to the Service, three federally endangered species and two federally threatened species may occur within the work area (Table 2). There is no federally designated critical habitat in the proposed work area.

This section will also serve as the effects determination portion of the Biological Assessment required by the Endangered Species Act. This satisfies the requirement for Section 7 Consultation under the Endangered Species Act. The Indiana bat, northern long-eared bat, least tern, pallid sturgeon, and small whorled pogonia are listed as federally threatened or endangered species that may occur within the vicinity of the work area.

Table 2. List of threatened and endangered species that may occur in the work area vicinity.

Species	Status	Habitat
Indiana bat (*Myotis sodalis)*	Endangered	Hibernates in caves and mines. Maternity and foraging habitat: small stream corridors with well-developed riparian woods; upland and bottomland forests

Northern long-eared bat (*Myotis septentrionalis)*	Threatened	Hibernates in caves and mines; swarming in surrounding wooded areas in autumn. Roosts and forages in upland forests during spring and summer.
Pallid sturgeon (*Scaphirhynchus albus*)	Endangered	Mississippi and Missouri Rivers
Least tern (*Sterna antillarum*)	Endangered	Large rivers - nest on bare alluvial and dredge disposal islands.
Small Whorled Pogonia (*Isotria medeoloides*)	Threatened	Dry woodlands

Indiana Bat - The range of the Indiana bat (*Myotis sodalis*) includes much of the eastern half of the United States, including southern Missouri. Indiana bats migrate seasonally between winter hibernacula and summer roosting habitats. Winter hibernacula include caves and abandoned mines. Females emerge from hibernation in late March or early April to migrate to summer roosts. During the summer, the Indiana bat frequents the corridors of small streams with well-developed riparian woods, as well as mature upland forests. It forages for insects along stream corridors, within the canopy of floodplain and upland forests, over clearings with early successional vegetation (old fields), along the borders of croplands, along wooded fencerows, and over farm ponds in pastures. Females form nursery colonies under the loose bark of trees (dead or alive) and/or cavities, where each female gives birth to a single young in June or early July. A maternity colony may include from one to 100 individuals. A single colony may utilize a number of roost trees during the summer, typically a primary roost tree and several alternates. Some males remain in the area near the winter hibernacula during summer months, but others disperse throughout the range of the species and roost individually or in small numbers in the same types of trees as females.

The leading causes of the Indiana bat population decline includes disturbance, vandalism, improper cave gates and structures, natural hazards such as flooding or freezing, microclimate changes, land use changes in maternity range, and chemical contamination (USFWS 2000, 2004). To avoid incidental take of this species, the Service recommends tree clearing activities should not occur during the period of 1 April to 30 September. In addition, trees suitable for bat roosts or maternity colonies should not be removed without first performing a bat survey.

The Proposed Action does not call for the removal of any trees; all construction would be completed by river-based equipment and will not result in the destruction of any forested riparian habitat. However, unforeseen effects from construction activities (e.g., noise), could potentially disturb Indiana bats roosting on the land adjacent to the work area. As such, the proposed action *may affect, but is not likely to adversely affect* the Indiana bat.

Northern Long-Eared Bat - The northern long-eared (*Myotis septentrionalis*) bat is a federally threatened bat species. The northern long-eared bat is sparsely found across much of the eastern and north central United States, and all Canadian provinces from the Atlantic Ocean west to the southern Yukon Territory and eastern British Columbia. Northern long-eared bats spend winter hibernating in large caves and mines. During summer, this species roosts singly or in colonies underneath bark, in cavities, in crevices of both live and dead trees. Foraging occurs in interior upland forests. Forest fragmentation, logging and forest conversion are major threats to the species. One of the primary threats to the northern long-eared bat is the fungal disease, white-nose syndrome, which has killed an estimated 5.5 million cave-hibernating bats in the Northeast, Southeast, Midwest and Canada. Suitable northern long-eared bat summer habitat may occur in the forested areas adjacent to the work area.

The Proposed Action does not call for the removal of any trees; all construction would be completed by river-based equipment and will not result in the destruction of any forested riparian habitat. However, unforeseen effects from construction activities (e.g., noise), could potentially disturb Indiana bats roosting on the land adjacent to the work area. As such, the Proposed Action *may affect, but is not likely to adversely affect* the Indiana bat.

Pallid Sturgeon - The pallid sturgeon is federally endangered big-river fish species. It is the position of the Service that over time, river training structures have adversely affected pallid sturgeon by impacting the quality and quantity of habitats in the MMR to which the species is adapted (e.g., braided channels, irregular flow patterns, flood cycles, extensive microhabitat diversity, and turbid waters). According to the Service, this loss of habitat has reduced pallid sturgeon reproduction, growth, and survival by (1) decreasing the availability of spawning habitat; (2) reducing larval and juvenile pallid sturgeon rearing habitat; (3) reducing the availability of seasonal refugia; and (4) reducing the availability of foraging habitat (USFWS 2000).

In addition to the habitat changes, reduction in the natural forage base for the pallid sturgeon is likely another factor contributing to the species decline (Mayden and Kuhajda 1997, USFWS 2000). The Service states that river training structures have also altered the natural hydrograph of the MMR by contributing to a downward trend in annual minimum stages (Simons et al. 1974, Wlosinski 1999, USFWS 2000). As a result, areas that were historically aquatic habitats are now dry at low discharges (Wlosinski 1999). This has potentially reduced the availability of pallid sturgeon spawning habitat through the loss of habitat heterogeneity (USFWS 2000).

Working in coordination with the USFWS, potential adverse impacts to the pallid sturgeon associated with the Proposed Action have been avoided and minimized to the greatest extent possible and design modifications have been incorporated to provide habitat benefits (i.e., dike removal, MRS design as opposed to a rootless or traditional dike). Further, as discussed in

Section 2.1 of this report, design criteria used to select the Proposed Action included not impacting the sandbar adjacent to Rockwood Island and not reducing flow into Liberty Chute. The Proposed Action met those criteria, and would therefore not negatively affect these important pallid sturgeon aquatic habitats. Additionally, given that one of the primary purposes of the Proposed Action is to reduce the need for channel maintenance dredging, implementation of the Proposed Action would reduce the likelihood of pallid sturgeon entrainment in the Red Rock work area.

Although adverse impacts to pallid sturgeon associated with this project have been avoided and minimized to the greatest extent possible and design modifications have been incorporated to provide habitat benefits, pallid sturgeon may still be adversely affected by the project. However, the adverse effects of the project on the pallid sturgeon are consistent with those anticipated in the programmatic Biological Opinion (USFWS 2000) and the District has implemented the Reasonable and Prudent Alternative, Reasonable and Prudent Measures, and Terms and Conditions prescribed therein as appropriate for the project.

Least Tern - The interior population of the least tern (*Sterna antillarum*) is characterized as a colonial, migratory waterbird, which resides and breeds along the Mississippi River during the spring and summer. Least tern arrive on the Mississippi River from late April to mid-May. Reproduction takes place from May through August, and the birds migrate to the wintering grounds in late August or early September (USACE 1999). Sparsely vegetated portions of sandbars and islands are typical breeding, nesting, rearing, loafing, and roosting sites for least tern along the MMR. Nests are often at higher elevations and well removed from the water's edge, a reflection of the fact that nesting starts when river stages are relatively high (USACE 1999).

Given the highly dynamic nature of the historic MMR planform, the ability to return to previously used colony sites is not likely a critical life history requirement. The availability of sandbar habitat to least terns for breeding, nesting, and rearing of chicks from 15 May to 31 August is a key variable in the population ecology of this water bird. Only portions of sandbars that are not densely covered by woody vegetation and are emergent during the 15 May to 31 August period are potentially available to least terns (USACE 1999).

Least terns are almost exclusively piscivorous (Anderson 1983), preying on small fish, primarily minnows (Cyprinidae). Prey size appears to be a more important factor determining dietary composition than preference for a particular species or group of fishes (Moseley, 1976; Whitman, 1988, USACE 1999). Fishing occurs close to the nesting colonies and may occur in both shallow and deep water, in main channel and backwater habitats. Radiotelemetry studies have shown that least tern will travel up to 2.5 miles to fish (Sidle and Harrison, 1990, USACE 1999). Along the Mississippi River, individuals are commonly observed hovering and diving for fish over current divergences (boils) in the main channel, over eddies, and other areas with turbulent conditions (e.g., downstream of MRSs).

Potential adverse impacts to the least tern associated with the Proposed Action have been avoided and minimized to the greatest extent possible and design modifications have been incorporated to provide habitat benefits (i.e., dike removal, MRS construction). Additionally, as discussed in Section 2.1 of this report, not impacting the sandbar adjacent to Rockwood Island was one of the design criteria during the development phase. The Proposed Action met this criteria, and would therefore not negatively affect the sandbar, which could serve as least tern nesting and rearing habitat.

Although adverse impacts to the least tern associated with this project have been avoided and minimized to the greatest extent possible and design modifications have been incorporated to provide habitat benefits, the least tern may still be adversely affected by the project. However, the adverse effects of the project on the least tern are consistent with those anticipated in the programmatic Biological Opinion and the District has implemented the Reasonable and Prudent Measures and Terms and Conditions prescribed therein as appropriate for the project.

Small Whorled Pogonia - The small whorled pogonia (*Isotria medeoloides)* is a member of the orchid family. This orchid grows in older hardwood stands of beech, birch, maple, oak, and hickory that have an open understory. It prefers acidic soils with a thick layer of dead leaves, often on slopes near small streams

This species' preferred habitat (older hardwood stands of beech, birch, maple, oak, and hickory that have an open understory) does not exist within the Red Rock work area. The Proposed Action would occur entirely over open water habitat, no construction would occur on land, and no terrestrial habitat is expected to be impacted. Therefore, the Proposed Action would have *no effect* on the small whorled pogonia.

Bald Eagle - Although the bald eagle was removed from the federal list of threatened and endangered species in 2007, it continues to be protected under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act (BGEPA). The BGEPA prohibits unregulated take of bald eagles, including disturbance. The USFWS developed the National Bald Eagle Management Guidelines (USFWS 2007) to provide landowners, land managers, and others with information and recommendations regarding how to minimize potential impacts to bald eagles, particularly where such impacts may constitute disturbance. No bald eagle nest trees are known to occur in the immediate vicinity of the work area at this time. If any nest trees are identified in the work area, the National Bald Eagle Management Guidelines will be implemented to minimize potential impacts and appropriate coordination with the USFWS will be conducted.

Impacts of the No Action Alternative on Threatened and Endangered Species – Under the No Action Alternative, significant impacts to threatened and endangered species would not be expected. The Red Rock work area would remain in its current condition, and the temporary effects due to construction (e.g., noise, sediment disturbance) would not occur. However, continued channel maintenance dredging would be expected in the vicinity with implementation of the No Action Alternative. This would increase the risk of pallid sturgeon entrainment.

Therefore, the No Action Alternative may pose a greater threat to pallid sturgeon than the Proposed Action.

Impacts of the Proposed Action on Threatened and Endangered Species- As outlined above, the District has determined that the Proposed Action would have no effect on the small whorled pogonia, and is not likely to adversely affect the Indiana bat, northern long-eared bat, and that potential effects to least tern and pallid sturgeon are consistent those discussed in programmatic (Tier 1) consultations discussed above. Ultimately, the consideration of environmental resources (e.g., fish and wildlife habitat) during the design and modeling phase has largely resulted in avoidance and minimization of impacts to threatened and endangered species. Furthermore, the localized reduction in channel maintenance dredging that would result from the Proposed Action could ultimately benefit pallid sturgeon by reducing the likelihood of entrainment.

3.5 Socioeconomics

The Middle Mississippi River is a critically important navigation corridor that enables transportation of a wide variety of commodities of local, national, and international importance. Within the work area vicinity, repetitive channel maintenance dredging has been necessary in recent years. Figure 8 shows the annual amount of material removed from 2000 to 2017.

The annual amount of material dredged in the area fluctuates due to a myriad of reasons that are discussed in the 2017 SEIS (e.g., hydrograph and sedimentation variability). Sedimentation patterns in the area were also affected by the construction of chevrons along the right descending bank immediately upstream in 2012 under the Biological Opinion compliance. Figure 9 shows the associated cost for the same time period. Since the year 2000, approximately 6.6 million cubic yards of material has been removed between RM 104.0 – 101.5 at a cost of approximately $14 million. Annual dredging costs are also prone to fluctuation for a number or reasons, including fuel cost, labor cost, mobilization (i.e., distance traveled to reach site).

Impacts of the No Action Alternative on Socioeconomics - With the No Action Alternative, periodic maintenance dredging activities would be expected to continue at a rate similar to recent history. Dredging costs in the area since 2000 have averaged approximately $846,000 per year. These expenditures would be expected to continue in the future. Further, channel maintenance dredging has been adequately funded and thus far addressed the sedimentation and sandbar encroachment that result from the inefficiency of river training structures in the area, ensuring the navigation channel remains open. However, the No Action Alternative would result in an increased risk of potential groundings and/or channel closure. For example, just-in-time dredging could become necessary in the area, but a dredge might not be able to reach the site in a timely manner, resulting in groundings or channel closure.

Impacts of the Proposed Action on Socioeconomics - Implementation of the Proposed Action is expected to reduce the amount and frequency of repetitive maintenance dredging necessary in the area by approximately 85%. This reduction is a projected average based on previous work in chronic dredging locations on the MMR (See Table 1-1 in the 2017 SEIS). Actual reductions in

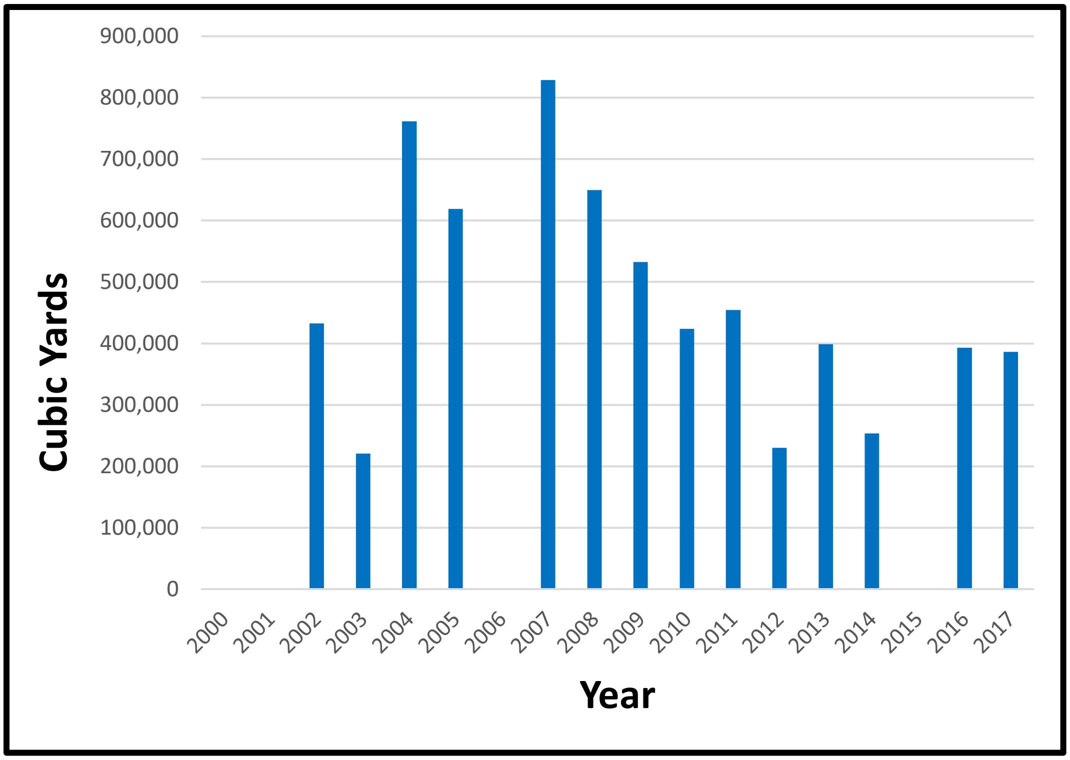

Figure 8. Annual volume of material dredged in work area from 2000 to 2017.

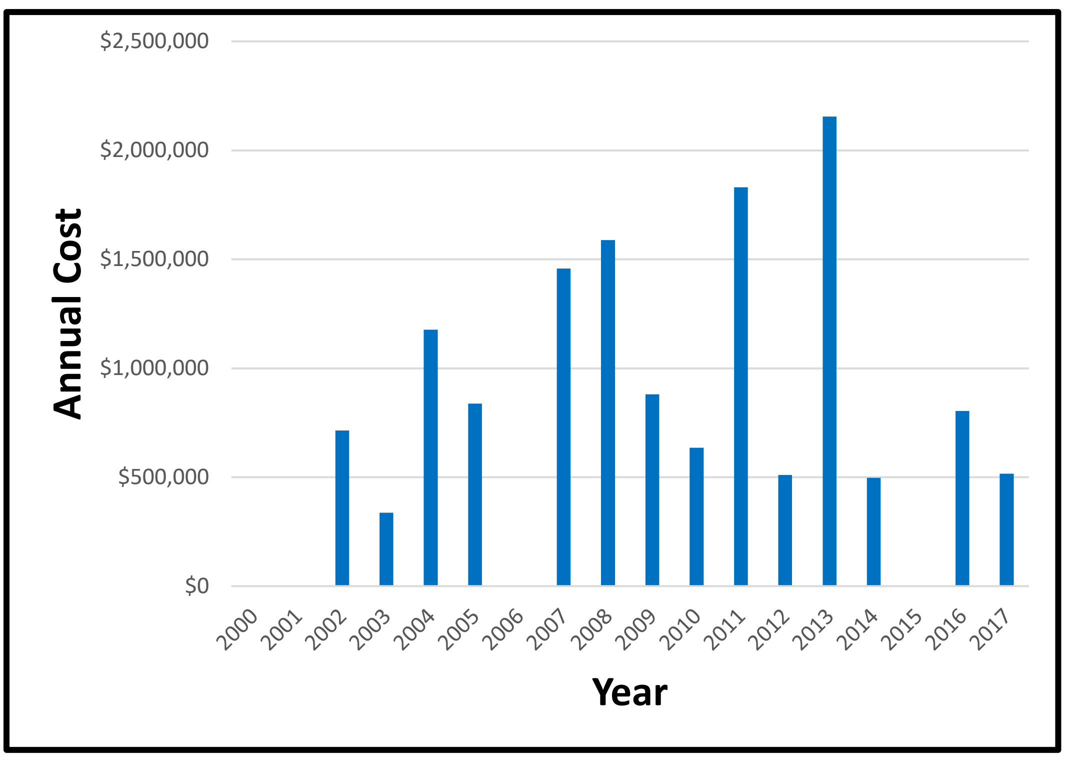

Figure 9. Annual cost of dredging in work area from 2000 to 2017.

the amount and frequency of dredging are dependent on a number of natural factors including the hydrograph and the amount of sediment entering the system. Navigation industry partners were included in the HSR modeling workshop (Appendix C) to ensure that unintended navigation impacts were avoided. The cost of the Proposed Action is not expected to exceed $5,800,000.

3.4 Historic and Cultural Resources

Landform History - The bankline of the Red Rock Landing Reach has not significantly changed in the past century and a half (Figure 10). It has, however, regressed moderately in places so that four of the structure locations were, in 1890, on land. The erosion causing the regression would have destroyed any cultural features existing on the landform prior to that time. No proposed feature contacts the existing bankline.

All the river training structures are constructed via barge, without recourse to land access; therefore, any effects are limited to submerged cultural resources. Primary among these are historic period shipwrecks. Given the continual river flow and associated sedimentary erosion, deposition, and reworking, it is highly unlikely that any more ephemeral cultural material remains on the river bed in this work area.

Potential Shipwrecks - During the summer of 1988 when the Mississippi River was at a particularly low level, the St. Louis District Corps of Engineers conducted an aerial survey of exposed wrecks between Saverton, Missouri, and the mouth of the Ohio River (Norris 2003). The nearest observed wreck to the work area was located approximately a mile downstream and in a side channel.

Five of the proposed structures are directly adjacent to the dredged channel, which probably resulted in channel slump and sediment reworking in the locations. The reach has been regularly dredged over the years, and it is likely that any unrecorded wreckage located in the path of those dredge events was destroyed and removed during the process. While exact location information is not available for dredging events prior to 1979, USACE has been conducting such activities to deepen the navigation channel of the MMR since 1896 (Manders and Rentfro 2011:61).

The District performs periodic bathymetric channel surveys to monitor the depths of the navigation channel, with the latest processed survey having been completed in 2015. The single-beam survey was conducted with range lines spacing of 200 feet. No topographic anomalies suggesting wrecks are visible on the resulting bathymetric map within this work area.

Impacts of the No Action Alternative on Historic and Cultural Resources - Continued dredging operations under the No Action Alternative are not anticipated to impact any known historic and cultural resources in the work area. Any undocumented historic and cultural resources that may have existed in the work area likely would have been destroyed by previous dredging activities. Future maintenance dredging under the No Action Alternative would likely occur in the same locations as previous dredging, and, therefore, would be unlikely to impact undocumented historic and cultural resources.

Impacts of the Proposed Action on Historic and Cultural Resources - All construction work on the dikes will be carried out via barge, without recourse to land access; therefore, any effects are limited to submerged cultural resources. Primary among these are historic period shipwrecks. The continual river flow and associated sedimentary erosion, deposition, and reworking make it highly unlikely that any more ephemeral cultural material remains on the river bed.

Given the features' construction method (with no land impact), the previous disturbance of the riverbed, and the lack of any survey evidence for extant wrecks, it is the District's opinion that the proposed undertaking will have no significant effect on cultural resources.

The Illinois State Historic Preservation Officer (SHPO) concurred that the Proposed Action would not affect listed or eligible historic properties. A copy of the correspondence is included in Appendix C. If, however, cultural resources were to be encountered during construction, all work would stop in the affected area and further consultation would take place.

Via a letter dated 17 January, 2017, consultation with twenty-eight federally recognized tribes affiliated with the St. Louis District was initiated and will continue as necessary during implementation. All corresponding documents associated with this consultation will be included in the Final Environmental Assessment. A copy of the consultation letter is included in Appendix C. If cultural resources were to be encountered during construction, all work would stop in the affected area and further consultation would take place.

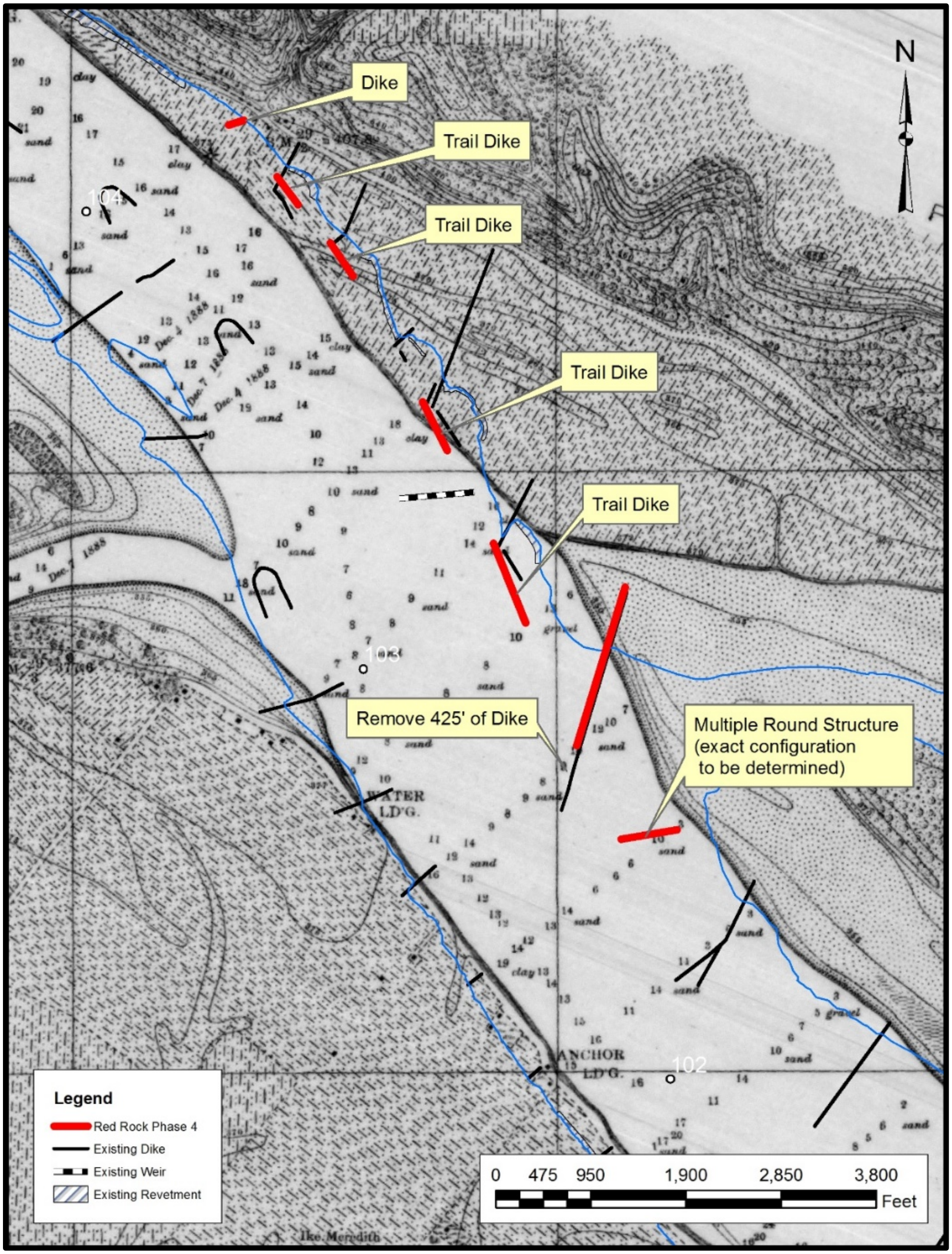

Figure 10. Work area features imposed on the 1890 MRC map.

Chapter 4. Mitigation

Mitigation measures are used to avoid, minimize, or compensate for adverse impacts to environmental resources. Throughout the alternative development process, potential adverse impacts associated with the Red Rock Landing Phase 4 work have been avoided and minimized to the extent possible. As demonstrated by the HSR model, the Proposed Action would not reduce flow to Liberty Chute or impact connectivity to the side channel in any other way. Further, the proposed work area includes the construction of an MRS in lieu of a traditional rock dike structure. This features will help meet the Project objective to reduce dredging of the navigation channel, while simultaneously creating diverse flow patterns and enhancing bathymetric diversity immediately downstream of the structures - adding to the overall habitat heterogeneity of the MMR.

However, as previously discussed, analyses completed as part of the 2017 SEIS process revealed that the Continue Construction Alternative would likely have a programmatic significant adverse effect on shallow to moderate-depth, moderate-to high-velocity habitat along the main channel border that warrants consideration of compensatory mitigation for the Project. As discussed in both the 2017 SEIS and the draft SEA, the Chub Model has been developed and certified to further evaluate the quantity and quality of this particular habitat impacted by new construction. The draft SEA includes results and discussion of the initial assessment of the Project’s new work area impacts to MCB habitat, as well as an update to the Project’s monitoring and adaptive management plan for any compensatory mitigation for this adverse impact.

The following sections provide the details on the site-specific mitigation assessment for the Proposed Action at the Red Rock work area, as well as an update to the overall Project’s programmatic impacts and the monitoring and adaptive management plan for the Regulating Works Project. Details of the Chub Model and a thorough explanation of how it is applied to construction activity completed under the Project are provided in the draft SEA. That document includes an explanation of Habitat Suitability Index (HSI) scores and Average Annual Habitat Units (AAHUs), the performance metric by which mitigation will be assessed. For complete details and background information on the Project’s monitoring and adaptive management plan, as well as its initial mitigation assessment, refer to those respective sections found within the 2017 SEIS and the Project’s draft SEA incorporated herein by reference.

4.1 Site Specific Assessment for Mitigation Considerations

In general, the Proposed Action at the Red Rock Phase 4 work area is not as intensive as other construction activities carried out under the Project. It relies heavily on the realignment of existing trail dikes in the work area, and the removal of a significant portion of a dike. The minimal amount of new structures included in the Proposed Action is ultimately reflected in the results of this mitigation assessment, which documents a minimal loss to shallow to moderate-depth, moderate- to high-velocity habitat.

Structure Parameter - River training structures already exist along the left bank of the work area, meaning this area is assigned the low-quality structure HSI score (0.3) for its pre-construction condition. The adjacent area riverward from the dike field is assigned the moderate structure HSI score (0.7), given that this area is highly influenced by the existing structures. The presence of existing structures within the majority of the work area results in a relatively low overall structure HSI score (0.41) for the pre-construction condition. The proposed removal of the riverward portion of dike 103.1L would result in a marked rise (0.3 to 1.0) in structure score for the area immediately downstream of that dike segment. The construction of the MRS structure would occur within an existing dike field (i.e., already low scoring), meaning it would have no influence on the overall structure HSI score. Furthermore, realignment and lengthening of the trail dikes would not significantly change the structure score either because the structure parameter is applied in a longitudinal manner, and this area is already considered heavily structured. The furthest upstream dike (103.9 L) would drop the structure HSI score (0.7 to 0.3) for the area immediately downstream to the next dike. The overall structure HSI score within the total area of influence would rise (0.41 to 0.45) as a result of the Proposed Action. This is primarily due to the proposed dike removal, as well as the fact that the Proposed Action does not include a significant amount of new structure.

Depth Parameter - The pre-construction depth HSI score (0.35) was based on bathymetric survey data collected during the District’s latest periodic channel survey from 2016. It is relatively low because much of the work area includes the navigation channel, which has the minimal depth HSI score (0.0). The HSR model results for the Proposed Action (Figure 7) were used to develop the post-construction depth HSI score (0.28). The results of the HSR model demonstrate that the Proposed Action would increase the average depth within the work area, reducing the sites overall depth HSI score to 0.28.

Velocity Parameter - Both pre- and post-construction velocity HSI scores (0.46 and 0.44 respectively) were derived from 2-D numerical modeling efforts used to estimate pre- and post-construction velocities. Differences between the pre- and post-construction modeling results suggest the Proposed Action would have little impact on the overall velocity score within the work area. This is due to the fact the Proposed Action would not increase or decrease flow velocity over a large area. Rather, it was designed to realign the flow of the navigation channel, allowing it to flow more smoothly along the left bank.

Substrate Parameter - Similar to the initial mitigation assessment documented in the draft SEA, the substrate parameter was not included in this assessment. Little predictive capability exists regarding local changes to substrate composition that result from construction activity carried out under the Project, and substrate data were not readily available. It was therefore assumed that the substrate in the work areas was mostly sand (HSI = 0.5) for both the pre- and post-construction conditions. However, new pre- and post-construction substrate data may become available as data are collected and visual observations are made at planned and completed work sites. Therefore, this assumption may be revisited during future planning and mitigation assessments, at which time the pre- and post-construction substrate category could be updated for the work site assessed herein, potentially altering the programmatic change in AAHUs.

Overall HSI Score - Due to the anticipated changes to structures, depth, and velocity within the Red Rock work area, this initial mitigation assessment suggests the Proposed Action would result in a slightly reduced overall HSI score (0.47 to 0.46). Coupled with the acreage of the total area of influence (239.5 acres), this results in a net loss of 2.89 programmatic AAHUs (Table 3).

4.2 Monitoring and Adaptive Management

Since the District's initial compensatory mitigation assessment, which is documented in the draft SEA, no additional construction activity or monitoring efforts have been completed. As such, the AAHUs of the previously completed Project work areas have not been updated. However, the initial pre-construction mitigation assessment for the Proposed Action described above results in a new amount of programmatic AAHUs for the Regulating Works Project (Table 3). The Proposed Action would reduce the overall Project's AAHUs from 8.77 to 5.87, due to anticipated impacts on shallow to moderate-depth, moderate- to high-velocity MCB habitat at the Red Rock work area.

As stated in the draft SEA, the District is committed to using the best available data for site-specific mitigation assessments related to the Project. At this time, the data produced by 2-D numerical modeling represents the best available data to assess the pre-construction velocity HSI score for the Proposed Action at the Red Rock work area. The District will continue to monitor Mississippi River stage and discharge data and attempt to collect pre-construction ADCP (velocity) field data from the work area if an adequate stage and discharge window is presented. If the District can successfully collect pre-construction field data prior to implementation of the Proposed Action Alternative, the mitigation assessment of the Red Rock work area would be reassessed and the programmatic AAHUs would be updated in subsequent NEPA documentation for the Project.

Presently, a net gain in AAHUs still results from programmatic implementation of the overall Project. Therefore, as discussed in the 2017 SEIS and the draft SEA, compensatory mitigation is not currently warranted for the Project. However, as discussed in the draft SEA, the District is proceeding with potential mitigation site planning and ranking through a collaborative effort with the Adaptive Management Team (AMT), in anticipation of the future need for compensatory mitigation. At this time, the District will proceed forward with the post-construction monitoring of the previously assessed work sites (Table 3), which will rely heavily on the periodic channel bathymetry surveys performed by the District. The next comprehensive channel survey is expected in 2018 or 2019, after which the depth parameter HSI scores and the dynamic equilibrium (DE) status of the work areas will be reassessed. Information from these surveys will be used to update the AAHUs in each work area as it becomes available for continued monitoring of the overall Project's impact to MCB habitat.

Table 3. Current results of the compensatory mitigation assessment for the Project, and the tentative monitoring plan for each of the Project's work areas post-2017 SEIS.

Project Work Area	FWOP HSI	FWP HSI	Net Change	Latest Assessment
Mosenthein-Ivory Landing Phase 4 (71 acres)				
Velocity	0.63	0.68	+0.05	Nov-17
Depth	0.57	0.53	-0.04	Nov-17
Substrate	0.50	0.50	0.00	Nov-17
Structured/Unstructured	1.00	0.63	-0.37	Nov-17
Overall HSI Score	0.67	0.58	-0.09	Nov-17
AAHUs	**47.5**	**41.32**	**-6.19**	Nov-17
Monitoring: Post-construction field data has already been collected and assessed once for the velocity and depth parameters. Progress to dynamic equilibrium (DE) will be determined upon collection of channel survey bathymetric data. Monitoring will end if the site has reached DE, and all HSI scores and AAHUs will be deemed final. If the site has not reached DE, it will continue to be monitored and will be reassessed after periodic channel surveys are performed and provide updated bathymetry. Once the site has reached DE, velocity field data will be recollected and reassessed.				
Eliza Point-Greenfield Bend Phase 3 (52 acres)				
Velocity	0.63	0.68	+0.05	Nov-17
Depth	0.72	0.34	-0.38	Nov-17
Substrate	0.50	0.50	0.00	Nov-17
Structured/Unstructured	1.00	0.61	-0.39	Nov-17
Overall HSI Score	0.71	0.53	-0.19	Nov-17
AAHUs	**37.25**	**28.09**	**-9.16**	Nov-17
Monitoring: Post-construction depth data has already been collected and assessed once. Progress to dynamic equilibrium (DE) will be determined upon collection of channel survey bathymetric data. If the site has reached DE, velocity field data will be collected and all HSI scores and AAHUs will be deemed final. If the site has not reached DE, it will continue to be monitored and will be reassessed after periodic channel surveys are performed and provide updated bathymetry. Once the site has reached DE, post-construction velocity field data will be collected and assessed.				
Dogtooth Bend Phase 5 (25 acres)				
Velocity	0.37	0.52	+0.14	Nov-17
Depth	0.31	0.25	-0.06	Nov-17
Substrate	0.50	0.50	0.00	Nov-17
Structured/Unstructured	0.70	0.60	-0.10	Nov-17
Overall HSI Score	0.45	0.46	+0.01	Nov-17
AAHUs	**11.21**	**11.45**	**+0.24**	Nov-17
Monitoring: Post-construction depth data has already been collected and assessed once. Progress to dynamic equilibrium (DE) will be determined upon collection of channel survey bathymetric data after the next periodic channel survey is performed. If the site has reached DE,				

velocity field data will be collected and all HSI scores and AAHUs will be deemed final. If the site has not reached DE, it will continue to be monitored and will be reassessed after periodic channel surveys are performed and provide updated bathymetry. Once the site has reached DE, post-construction velocity field data will be collected and assessed.				
Mosenthein-Ivory Landing Phase 5 (122 acres)				
Velocity	0.50	0.74	+0.24	Nov-17
Depth	0.46	0.55	+0.09	Nov-17
Substrate	0.50	0.50	0.00	Nov-17
Structured/Unstructured	0.60	0.47	-0.13	Nov-17
Overall HSI Score	0.52	0.56	+0.05	Nov-17
AAHUs	**63.38**	**68.11**	**+4.73**	Nov-17
Monitoring: Post-construction field data has already been collected and assessed once for the velocity and depth parameters. Progress to dynamic equilibrium (DE) will be determined upon collection of channel survey bathymetric data. If the site has reached DE, velocity field data will be collected and reassessed and all HSI scores and AAHUs will be deemed final. If the site has not reached DE, it will continue to be monitored and will be reassessed after periodic channel surveys are performed and provide updated bathymetry. Once the site has reached DE, velocity field data will be recollected and reassessed.				
Grand Tower Phase 5 - Crawford Chevrons (175 acres)				
Velocity	0.41	0.64	+0.23	Nov-17
Depth	0.54	0.46	-0.07	Nov-17
Substrate	0.50	0.50	0.00	Nov-17
Structured/Unstructured	0.54	0.44	-0.10	Nov-17
Overall HSI Score	0.50	0.51	+0.01	Nov-17
AAHUs	**87.49**	**89.18**	**+1.70**	Nov-17
Monitoring: Post-construction field data has not been collected for any of the parameters. This is a more recent construction activity, meaning it is unlikely the site has reached dynamic equilibrium (DE). Depth field data will be assessed after multiple periodic channel surveys have been performed, such that temporal changes to bathymetry can be observed. Once the site has reached DE, post-construction velocity field data will be collected and assessed.				
Grand Tower Phase 5 - Vancill Dikes (257 acres)				
Velocity	0.38	0.56	+0.18	Nov-17
Depth	0.51	0.57	+0.06	Nov-17
Substrate	0.50	0.50	0.00	Nov-17
Structured/Unstructured	0.51	0.54	+0.03	Nov-17
Overall HSI Score	0.48	0.55	+0.07	Nov-17
AAHUs	**123.36**	**140.81**	**+17.45**	Nov-17
Monitoring: Post-construction field data has not been collected for any of the parameters. This is a more recent construction activity, meaning it is unlikely the site has reached dynamic equilibrium (DE). Depth field data will be assessed after multiple periodic channel surveys				

have been performed, such that temporal changes to bathymetry can be observed. Once the site has reached DE, post-construction velocity field data will be collected and assessed.				
Red Rock Landing Phase 4 (239.5 acres)				
Velocity	0.46	0.44	-0.02	April-18
Depth	0.35	0.28	-0.07	April-18
Substrate	0.50	0.50	0.00	April-18
Structured/Unstructured	0.41	0.45	+0.04	April-18
Overall HSI Score	0.47	0.46	-0.01	April-18
AAHUs	**112.9**	**110**	**-2.89**	April-18
Monitoring: If the Proposed Action is implemented, depth field data will be assessed after multiple periodic channel surveys have been performed, such that temporal changes to bathymetry can be observed. Once the site has reached dynamic equilibrium (DE), post-construction velocity field data will be collected and assessed.				
Programmatic AAHUs			**+5.87**	April-18

Chapter 6. Relationship to other Environmental Laws and Regulations

Table 4. Federal policy and compliance status.

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

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

2 This list of Executive Orders is not exhaustive and other Executive Orders not listed may be applicable.

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

4 Required permits, coordination will be sought during public review.

Chapter 7. List of Preparers

Table 5. List or report preparers, including their role and level of experience.

Name	Role	Experience
Mike Rodgers, P.E.	Project Manager	16 years, hydraulic engineering
Shane Simmons	Environmental Lead	5 years, biology
Corey Tabbert	Hydraulic Engineering	5 years, hydraulic engineering
Edward Brauer, P.E.	Engineering Lead	14 years, hydraulic engineering, Regional Technical Specialist-River Engineering
Mark Smith, Ph.D.	Historical and Cultural Resources	24 years, archaeology
Keli Broadstock	Legal Review	12 years, legal
Danny McClendon	Regulatory	30 years, regulatory compliance and biology

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FINDING OF NO SIGNIFICANT IMPACT

Red Rock Landing Phase 4 – Regulating Works Project
Middle Mississippi River (RM 104.0 – 101.5 L)
Randolph County, Illinois

I. In accordance with the National Environmental Policy Act, I have reviewed and evaluated the documents concerning the Red Rock Landing Phase 4 – Regulating Works Project, Middle Mississippi River (RM 104.0 – 101.5 L) Randolph County, Illinois. As part of this evaluation, I have considered:

a. Existing resources and the No Action Alternative; and

b. Impacts to existing resources from the Proposed Action.

II. The possible consequences of these alternatives have been studied for physical, environmental, cultural, social and economic effects, and engineering feasibility. My evaluation of significant factors has contributed to my finding:

a. The work would address repetitive dredging in the area. This would be accomplished by the construction and modification of river training structures in the area;

b. No significant impacts to federally listed threatened or endangered species are anticipated;

c. No significant impacts are anticipated to natural resources, including fish and wildlife resources. The proposed work would have no effect upon significant historic properties or archaeological resources. There would be no appreciable degradation to the physical environment (e.g., stages, air quality, and water quality) due to the work;

d. The "no action" alternative was evaluated and determined to be unacceptable as repetitive dredging expenditures would continue; and

e. Minor impacts to shallow to moderate-depth, moderate- to high-velocity main channel border habitat are anticipated, but these impacts are not significant on a programmatic level.

III. Based on the evaluation and disclosure of impacts contained within the Environmental Assessment, I find no significant impacts to the human environment are likely to occur as a result of the proposed action. Therefore, an Environmental Impact Statement will not be prepared prior to proceeding with the proposed Red Rock Landing Phase 4 construction.

_________________________	_________________________
(Date)	BRYAN K. SIZEMORE COL, EN Commanding

Appendix A. Clean Water Act Section 404(b)(1) Evaluation

CLEAN WATER ACT
SECTION 404(b)(1) EVALUATION

Red Rock Landing Phase 4
Middle Mississippi River (RM 104.0 – 101.5 L)
Randolph County, Illinois

Regulating Works Project

April 2018

Contents

CLEAN WATER ACT
SECTION 404(b)(1) Evaluation

1. PROJECT DESCRIPTION

A. Location. The Red Rock Landing Phase 4 (Red Rock) work area is located along the left descending bank of the Middle Mississippi River (MMR) between river miles 104.0 – 101.5, approximately 101.5 miles upstream of the confluence with the Ohio River, in Randolph County, Illinois. The MMR is defined as the reach that lies between its confluences with the Ohio and Missouri Rivers.

B. General Description. The U.S. Army Corps of Engineers St. Louis District is proposing to construct the Red Rock Landing Phase 4 work as part of its Regulating Works Project (Project). The Regulating Works Project utilizes bank stabilization and sediment management to maintain bank stability and ensure adequate navigation depth and width. Bank stabilization is achieved by revetments, while sediment management is achieved by river training structures, i.e. dikes. The Proposed Action Alternative involves modifying the configuration of river training structures within the Red Rock Landing reach of the MMR, between river miles 104.0 – 101.5 (L). As summarized in Table 1, the specific details of the Proposed Action Alternative include constructing a new traditional rock dike at RM 103.9 (L), degrading the existing trail portion of dike 103.8 (L) and reusing the stone to rebuild the trail portion with a more bankward alignment, constructing a new trail dike at RM 103.6 (L), degrading the trail segment of dikes 103.5 (L), 103.4 (L) and 103.2 (l), and rebuilding them with a more riverward alignment, reducing the length of dike 103.1 (L), and constructing a multiple round-point structure (MRS) at 102.3 (L). In total, approximately 319,200 tons of new stone would be added to the work area vicinity, 40,000 tons would be recycled and reused, and 11,200 would be completely removed from the project area.

C. Authority and Purpose. The St. Louis District of the U.S. Army Corps of Engineers is charged with obtaining and maintaining a navigation channel on the MMR that is nine feet deep, 300 feet wide with additional width in bends as necessary. The MMR is defined as that portion of the Mississippi River that lies between its confluence with the Ohio and the Missouri Rivers. This ongoing Project is also commonly referred to as the Regulating Works Project. As authorized by Congress, the Project utilizes bank stabilization, rock removal, and sediment management to maintain bank stability and ensure adequate navigation depth and width. Bank stabilization is achieved by revetment and river training structures, while sediment management is achieved by river training structures. The Project is maintained through dredging and any needed maintenance to already constructed features. The long-term goal of the Project, as authorized by Congress, is to obtain and maintain a navigation channel and reduce federal expenditures by alleviating the amount of annual maintenance dredging through the construction of regulating works.

D. General Description of the Fill Material.

Fill material for dike construction would include quarry run limestone consisting of graded “A” stone. Size requirements for graded “A” stone are shown in Table 1 below. Some stone (51,200 tons) required for construction would be recycled stone from adjacent dike removal efforts. The source of new and recycled stone was commercial stone quarries in the vicinity of the Project area capable of producing stone which meets USACE specifications.

Table 1. Size requirements for graded “A” stone.

Stone Weight (LBS)	Cumulative % Finer by Weight
5000	100
2500	70-100
500	40-65
100	20-45
5	0-15
1	0-5

E. Description of the Proposed Action Alternative.

The proposed work would consist of the following (see Table 2):

Table 2. Description of the Proposed Action Alternative.

Location	Proposed Work	Purpose	New Stone	Recycled Stone
103.9 (L)	Construct dike 100 ft long	Establish scour along the LDB leading into the river bend.	7,100	0
103.8 (L)	Degrade existing 350 ft long trail dike and re-use stone to construct trail dike (same length) with new alignment	Maintain smooth flow alignment along the LDB structures.	6,100	36,100
103.6 (L)	Restore existing 210 ft long dike, and add new trail segment 400 ft long	Maintain smooth flow alignment along the LDB structures.	93,400	0
103.5 (L)	Degrade existing 200 ft long trail dike and re-use stone to construct new trail dike (same length)	Maintain smooth flow alignment along the LDB structures.	16,300	1,800

Location	Proposed Work	Purpose	New Stone	Recycled Stone
103.4 (L)	Degrade existing 400 ft long trail dike and re-use stone to construct trail dike (same length) with new alignment	Maintain smooth flow alignment along the LDB structures.	74,400	1,700
103.2 (L)	Degrade existing 400 ft long trail dike and construct trail dike 865 ft long	Maintain smooth flow alignment along the LDB structures.	106,900	400
103.1 (L)	Remove riverward 500 ft of dike 1,560 ft long dike	Maintain smooth flow alignment along the LDB structures.	0	11,200*
102.3 (L)	Construct multiple round point structure 600 ft long	Prevent sediment deposition in the channel crossing at RM 102.3 (L).	15,000	0

F. Description of the Placement and Removal Method.

Placement and removal of dike material would be accomplished by track hoe or dragline crane. Stone would be transported to placement sites by barges. All construction would be accomplished from the river and all work would be performed below the ordinary high water mark.

2. FACTUAL DETERMINATIONS

A. Physical Substrate Determinations

I. Elevation and Slope.

There would be an immediate change in substrate elevation and slope over the areal extent of dike construction and dike removal between RM 104.0 – 101.5L. The dikes consist of a rock mound of uniform shape, between 165 and 900 ft. long, placed off existing bankline and existing dikes, and detached from the bank placed in open water. The final elevation of newly constructed and realigned dikes would be 354 ft. (NGVD). The final elevation of dike removal would be 335 ft. (NGVD).

Side slopes would be approximately 1 vertical on 1.5 horizontal. After placement, sediment patterns in the immediate vicinity of the structures would change with scour occurring off both ends of the dikes. Areas immediately downstream of the dikes would experience some areas of accretion and some areas of scour. The structures consist of Graded A-Stone (Limestone), and would be placed and removed by floating plant (no bankline access needed). Much of the proposed work consists of simply realigning existing structures, meaning benthic habitat would be exposed and covered simultaneously. Overall, the proposed construction would increase the amount of benthic habitat permanently covered by approximately 1.15 acres.

II. Sediment Type.

The work area is located within the main stem of the MMR, which is composed mainly of sands with some gravels, silts, and clays. The stone used for construction would be Graded "A" limestone.

III. Fill Material Movement.

No bank grading or excavation would be required for placement of stone. Draglines and/or track hoes would pull rock from floating barges and place the material into the river and on the banks. Fill materials would be subject to periodic high flows which may cause some potential movement and dislodging of stone. This may result in the need for minor repairs; however, no major failures are likely to occur.

IV. Physical Effects on Benthos.

Rock placement and dredge disposal should not significantly affect benthic organisms. Shifting sediments at structure placement sites are likely harbor oligochaetes, chironomids, caddisflies, turbellaria, and other macroinvertebrates. High densities of hydropsychid caddisflies and other macroinvertebrates would be expected to colonize the large limestone rocks after construction. Fish are likely to avoid the work areas during dike construction and removal. Greater utilization of the location by fish is expected after construction due to the expected increase in densities of macroinvertebrates, enhanced access to the side channel, and flow/bathymetry diversity produced by the multiple roundpoint structure (MRS).

V. Actions Taken to Minimize Impacts.

Best Management Practices for construction would be followed.

B. Water Circulation, Fluctuation, and Salinity Determinations

I. Water.

Some sediments (mostly sands) would be disturbed when the rock is deposited onto the riverbed, and during dike removal. This increased sediment load would be local and minor compared to the natural sediment load of the river, especially during high river stages.

II. Current Patterns and Circulation.

The construction, realignment, and restoration of trail dikes along the LDB would help maintain flow energy within the navigation channel, and enhancing the local scouring effect of the channel. The removal of 425 ft. from dike 103.1 L would also help to maintain flow energy within the navigation channel, while simultaneously allowing more flow along the main channel border (MCB) near Rockwood Island, and increasing connectivity of the main channel with Liberty Chute. The MRS would also help maintain flow energy within the navigation channel, but would also create split-flow conditions and enhance bathymetry and flow diversity along the MCB adjacent to Rockwood Island.

III. Normal Water Level Fluctuations.
Stages at average and high flows both in the vicinity of the work area and on the MMR are expected to be similar to current conditions. Stages at low flows on the MMR show a decreasing trend over time and this trend is expected to continue with or without implementation of the Proposed Action Alternative.

IV. Actions Taken to Minimize Impacts. Best Management Practices for construction would be followed.

C. Suspended Particulate/Turbidity Determinations

I. Expected Changes in Suspended Particles and Turbidity Levels in Vicinity of Placement Site.
Increases in suspended particulates and turbidity due to construction are expected to be greatest within the immediate vicinity of the rock structures. The increased sediment load would be local and minor compared to the natural sediment load of the river. This would cease soon after construction completion.

II. Effects on Chemical and Physical Properties of the Water Column

a. Light Penetration. There would be a temporary reduction in light penetration until sediments suspended as part of construction activities settled out of the water column.
b. Dissolved Oxygen. No adverse effects expected.
c. Toxic Metals and Organics. No adverse effects expected.
d. Aesthetics. Aesthetics of work sites are likely to be adversely affected during construction, but are expected to return to normal after construction.

III. Effects on Biota.
The work would likely result in some short-term displacement of biota in the immediate vicinity of construction activities due to temporary decreases in water quality and disturbance by construction equipment.

IV. Actions Taken to Minimize Impacts. Impacts are anticipated to be minimized by the use of clean, physically stable, and chemically non-contaminating limestone rock for construction.

D. Contaminant Determinations.
It is not anticipated that any contaminants would be introduced or translocated as a result of the Proposed Action Alternative.

E. Aquatic Ecosystem and Organism Determinations

I. Effects on Plankton.
The work could have a temporary, minor effect on plankton communities in the immediate vicinity of the work area. This would cease after construction completion.

II. Effects on Benthos.

Sediments at structure placement sites likely harbor oligochaetes, chironomids, caddisflies, turbellaria, and other macroinvertebrates. Construction activities would eliminate some of these organisms. High densities of caddisflies and other macroinvertebrates would be expected to colonize the large limestone rocks after construction. Fish would be expected to temporarily avoid the area during construction. Greater utilization of the location by fish is expected after construction due to the expected increase in densities of macroinvertebrates, and enhanced access to the side channel.

III. Effects on Nekton.

Nekton would be temporarily displaced during construction activities, but would return shortly after completion. Greater utilization of the area by fish may occur after construction due to the enhanced connectivity with Liberty Chute.

IV. Effects on Aquatic Food Web.

Temporary reductions in macroinvertebrate and fish communities during construction in the relatively small work area should not significantly impact the aquatic food web in the MMR. Improvements in lower trophic levels (macroinvertebrates) subsequent to completion should benefit the aquatic food web.

V. Effects on Special Aquatic Sites.

There are no special aquatic sites within the work area.

VI. Threatened and Endangered Species.

Presence of, or use by, endangered and threatened species is discussed in the Environmental Assessment and Biological Assessment for the Proposed Action Alternative. The effects likely occur are consistent with the programmatic (Tier I) consultations that have been conducted for the Regulating Works Project, and the Tier 2 Biological Assessment that has been prepared for the Proposed Action Alternative.

VII. Other Wildlife.

The work would likely result in localized, short-term displacement of wildlife in the immediate vicinity of construction activities. Displacement would end immediately after construction completion.

VIII. Actions Taken to Minimize Impacts.

Best Management Practices for construction would be followed.

F. Proposed Placement Site Determinations

I. Mixing Zone Determinations.

The fill material is inert and would not mix with the water. The lack of fine particulate typically contained in rock fill and main channel sediments indicates negligible chemical or turbidity effects resulting from the Proposed Action Alternative.

II. Determination of Compliance with Applicable Water Quality Standards.
The application for Section 401 water quality certification has been submitted. All permits necessary for the completion of the work would be obtained prior to implementation.

III. Potential Effects on Human Use Characteristics.
The proposed work would have no adverse impact on municipal or private water supplies; water-related recreation; aesthetics; or parks, national and historic monuments, national seashores, wilderness areas, research sites or similar preserves. During construction the area would not be available for recreational and commercial fishing.

G. Determinations of Cumulative Effects on the Aquatic Ecosystem.

Dikes and weirs have been used extensively throughout the Lower, Middle, and Upper Mississippi River System to provide a safe and dependable navigation channel. Due to concerns from natural resource agency partners about the potential cumulative impacts of river training structures, and other actions within the watershed, on the aquatic ecosystem, the St. Louis District has been utilizing innovative river training structures such as side channel enhancement dikes and the MRS included in the Proposed Action to increase habitat diversity in the MMR while still maintaining the navigation channel. The District conducts extensive coordination with resource agency and navigation industry partners to ensure that implementation is accomplished effectively from an ecological and navigation viewpoint. Although minor short-term construction-related impacts to local fish and wildlife populations are likely to occur, only minimal cumulative impacts on the aquatic ecosystem are identified for the Proposed Action Alternative at the Red Rock Landing Phase 4 work area.

H. Determinations of Secondary Effects on the Aquatic Ecosystem.

No adverse secondary effects would be expected to result from the Proposed Action Alternative.

3. FINDINGS OF COMPLIANCE OR NON-COMPLIANCE WITH THE RESTRICTIONS ON PLACEMENT

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

B. Alternatives that were considered for the Proposed Action Alternative included:

1. No Action Alternative - Under the No Action Alternative, the District would not construct any new river training structures within the work area, nor would it lengthen or reduce any of the existing river training structures in the area. Under this alternative, the District would continue to maintain the existing river training structures in the area to their design specifications and elevations, and continue channel maintenance dredging to ensure a safe and dependable navigation channel exists in the work area.

2. Proposed Action Alternative - The Proposed Action Alternative involves modifying the configuration of river training structures within the Red Rock Landing reach of the MMR, between river miles 104.0 – 101.5 (L). As summarized in Table 1, the

specific details of the Proposed Action Alternative include constructing a new traditional rock dike at RM 103.9 (L), degrading the existing trail portion of dike 103.8 (L) and reusing the stone to rebuild the trail portion with a more bankward alignment, constructing a new trail dike at RM 103.6 (L), degrading the trail segment of dikes 103.5 (L), 103.4 (L) and 103.2 (l), and rebuilding them with a more riverward alignment, reducing the length of dike 103.1 (L), and constructing a multiple round-point structure (MRS) at 102.3 (L). In total, approximately 319,200 tons of new stone would be added to the work area vicinity, 40,000 tons would be recycled and reused, and 11,200 would be completely removed from the project area.

C. Certification under Section 401 of the Clean Water Act has been applied for.

D. The proposed fill activity is in compliance with Applicable Toxic Effluent Standards of Prohibition under Section 307 of the Clean Water Act.

E. No significant impact to threatened or endangered species is anticipated from this work. Prior to construction, full compliance with the Endangered Species Act would be documented.

F. No municipal or private water supplies would be affected by the Proposed Action Alternative, and no degradation of waters of the United States is anticipated.

G. The work area is situated along an inland freshwater river system. No marine sanctuaries are involved or would be affected by the Proposed Action Alternative.

H. The materials used for construction would be chemically and physically stable and non-contaminating

I. The proposed construction activity would not have a significant adverse effect on human health and welfare, recreation and commercial fisheries, plankton, fish, shellfish, wildlife, or special aquatic sites. No significant adverse effects on life stages of aquatic life and other wildlife dependent on aquatic ecosystems are expected to result. The proposed construction activity would have no significant adverse effects on aquatic ecosystem diversity, productivity, and stability. No significant adverse effects on recreational, aesthetic, and economic values would occur.

J. No other practical alternatives have been identified. The Proposed Action Alternative is in compliance with Section 404(b)(1) of the Clean water Act, as amended. The Proposed Action Alternative would not significantly impact water quality and would improve the integrity of an authorized navigation system.

____________________ (Date)

____

Bryan K. Sizemore
COL, EN
Commanding

Appendix B. UMR 104.0 – 101.5 Hydraulic Sediment Response (HSR) Model Study

US Army Corps of Engineers®
St. Louis District

UMR 104.0 – 101.5 Hydraulic Sediment Response (HSR) Model Study

Technical Report M73

January, 2017

Jasen Brown, P.E.
Robert Davinroy, P.E.
David Gordon, P.E.
Tim Lauth, P.E.
Cory Tabbert

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Executive Summary

The U.S. Army Corps of Engineers, St. Louis District, is responsible for providing a navigation channel on 195 miles of the Middle Mississippi River (MMR) between the confluences of the Missouri River near St. Louis, MO and the Ohio River near Cairo, IL. District personnel have relied upon the construction of river training structures to minimize the need for repetitive channel maintenance dredging in order to accomplish this task.

From 2000 to 2015, approximately 5.8 million cubic yards of material was dredged between UMR 104.0 and 101.5 at a cost of approximately $12.7M (see Figures 3 and 4, below). The dredging in this location is roughly 8% of the Middle Mississippi dredging material and expenditure over this timeframe.

In December, 2015, the U.S. Army Corps of Engineers, St. Louis District began conducting a physical hydraulic sediment response (HSR) model at the Applied River Engineering Center (AREC) in St. Louis, Missouri. Alternative testing involved testing 28 different potential solutions to the dredging issues in the UMR 104.0 – 101.5 reach. Of the 28 alternatives tested, it was determined that Alternative 25 was the most effective in reducing or eliminating the need for repetitive channel maintenance dredging in the future while avoiding and minimizing adverse effects to fish and wildlife. River training structure construction associated with Alternative 25 is shown on Plate 45 and also detailed in the table below.

Type of Structure	Location (River Mile)	LDB or RDB	Dimensions in Feet (Plan View)
Install Dike	103.90	LDB	165
Install Trail Dike	103.80	LDB	350
Install Trail Dike	103.60	LDB	410
Install Trail Dike	103.40	LDB	500
Install Trail Dike	103.20	LDB	860
Degrade Riverward Section of Existing Dike	103.10	LDB	425
Install Rootless Dike	102.30	LDB	550
Install Rootless Dike	102.00	LDB	550

Model bathymetry for Alternative 25 clearly demonstrated improved navigation channel depths and widths between UMR 102.5 and 101.5 when compared to the model base test. Model testing results for Alternative 25 demonstrated no significant negative environmental impacts.

1 Introduction

The U.S. Army Corps of Engineers, St. Louis District, conducted a study of the flow and sediment transport response conditions of the Upper Mississippi River (UMR) between River Miles (RM) 104.0 and 101.5 near Rockwood, Illinois. This study was funded by the U.S. Army Corps of Engineers, St. Louis District's Regulating Works Project. The objective of the model study was to provide a recommended course of action based upon an analysis of the effectiveness of various river engineering measures intended to reduce or eliminate the need for repetitive channel maintenance dredging. The recommended alternative should avoid and minimize negative environmental impacts whenever reasonably possible.

The study was conducted between December, 2015 and January, 2017 using a physical hydraulic sediment response (HSR) model at the St. Louis District Applied River Engineering Center in St. Louis, Missouri. The model study was conducted by Jasen Brown, P.E., Hydraulic Engineer, with model operation performed by Cory Tabbert, Engineering Co-Op student. Robert D. Davinroy, P.E., Chief, River Engineering (retired) and David Gordon, P.E. Chief, Hydraulic Design provided direct supervision of the effort. Other personnel involved in this study are shown in Table 1, below.

Table 1: Other Personnel Involved in the Study.

Name	Position	District / Company
Leonard Hopkins, P.E.	Chief of Hydrologic and Hydraulic Branch	St. Louis District
Brian Johnson	Chief of Environmental Compliance Section	St. Louis District
Tim Lauth, P.E.	Regulating Works Project Technical Lead	St. Louis District
Mike Rodgers, P.E.	Regulating Works Project Project Manager	St. Louis District
Lance Engle	Dredge Project Manager	St. Louis District
Butch Atwood	Mississippi River Fishery Biologist	Illinois Department of Natural Resource (IDNR)
Matthew Mangan	Biologist	U.S. Fish and Wildlife Service(FWS)
Bernie Heroff	Port Captain	ARTCO
Janet Sternburg	Fishery Biologist	Missouri Department of Conservation (MDC)

2 Background

2.1 Problem Description

The authorized minimum channel dimensions for ensuring the safe passage of commercial vessels on the UMR are 9 feet of depth and 300 feet of width with additional width in bends at low water. For practical considerations, the Corps has established a Low Water Reference Plane (LWRP) to use for measuring relative river depths.

River training structures and revetments have previously been utilized in the reach between UMR river miles 104.0 and 101.5 to reduce the need for repetitive channel maintenance dredging. The most recent Regulating Works Project construction in this reach was completed in 2000. However, the reach still requires a substantial amount of dredging to maintain a safe and dependable navigation channel. The reach between UMR river miles 104.0 and 102.5 is a river bend where the sediment deposition along the right descending bank (RDB) sandbar will, without dredging, encroach upon the navigation channel enough to make navigation through the bend unsafe due to insufficient navigation channel width. See Figure 1, below.

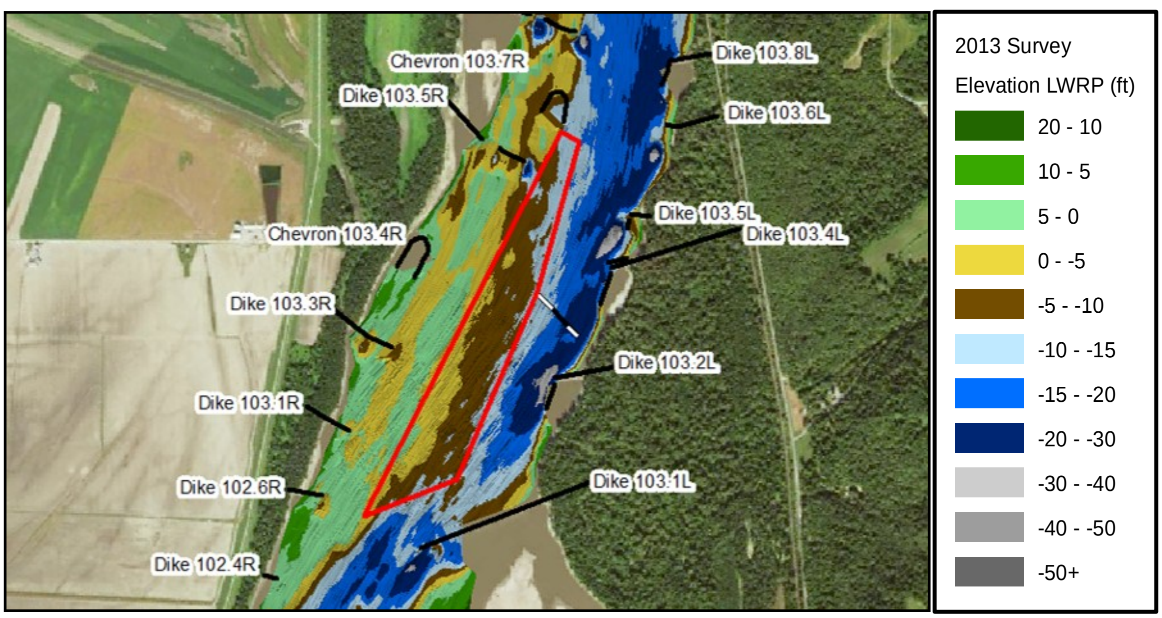

Figure 1: 2013 Bathymetry Survey. Representative dredge box outlined in red.

Additionally, the crossing from UMR 102.5 to 101.5 has required dredging to maintain sufficient navigation channel depth. See Figure 2, below.

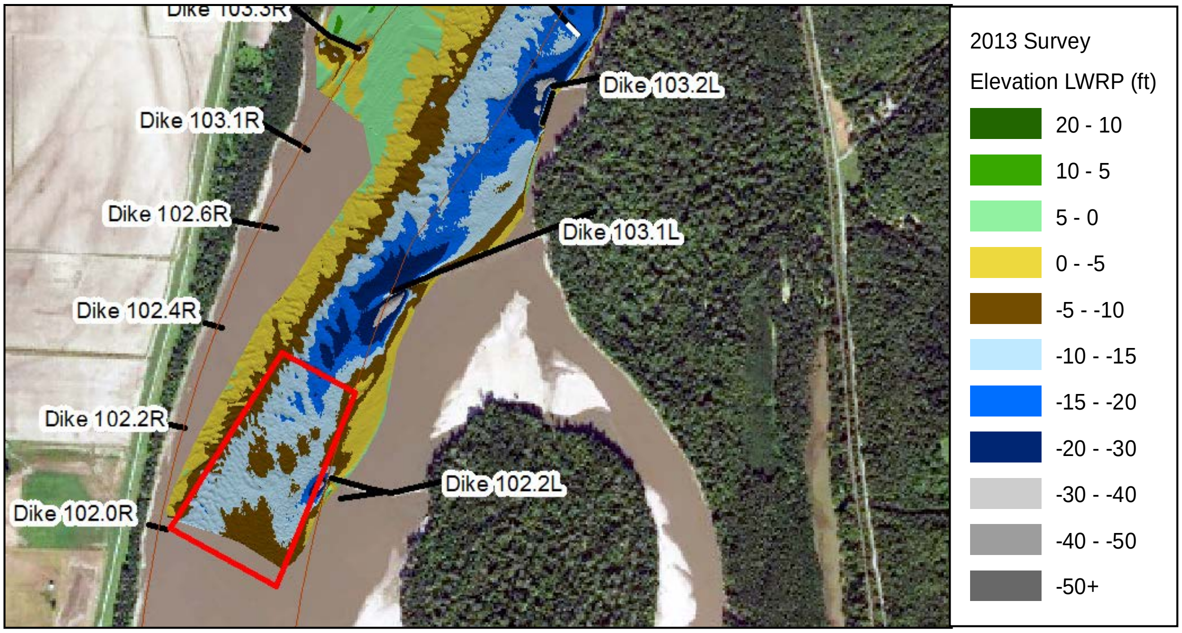

Figure 2: 2011 Bathymetry Survey. Representative dredge box outlined in red.

From 2000 to 2015, approximately 5.8 million cubic yards of material was dredged between UMR 104.0 and 101.5 at a cost of approximately $12.7M. See Figures 3 and 4, below. Also reference Plate 3.

2.2 Environmental Features

USACE biologists and partnering natural resource agency representatives pointed out that there are two important areas of habitat along the LDB between UMR 104.0 and 101.5. Alternatives in this model study were

a. Rockwood Chute – The entrance to Rockwood Chute is at UMR 102.7. Side channels are important for overwintering and low velocity habitats for various fish species prevalent on the MMR.

b. Rockwood Island Sandbar – The sandbar located at the upstream end and river side of Rockwood Island serves as important shallow water habitat for various fish species prevalent on the MMR. Sandbars on the MMR are also potential nesting areas for local birds (including the Least Tern).

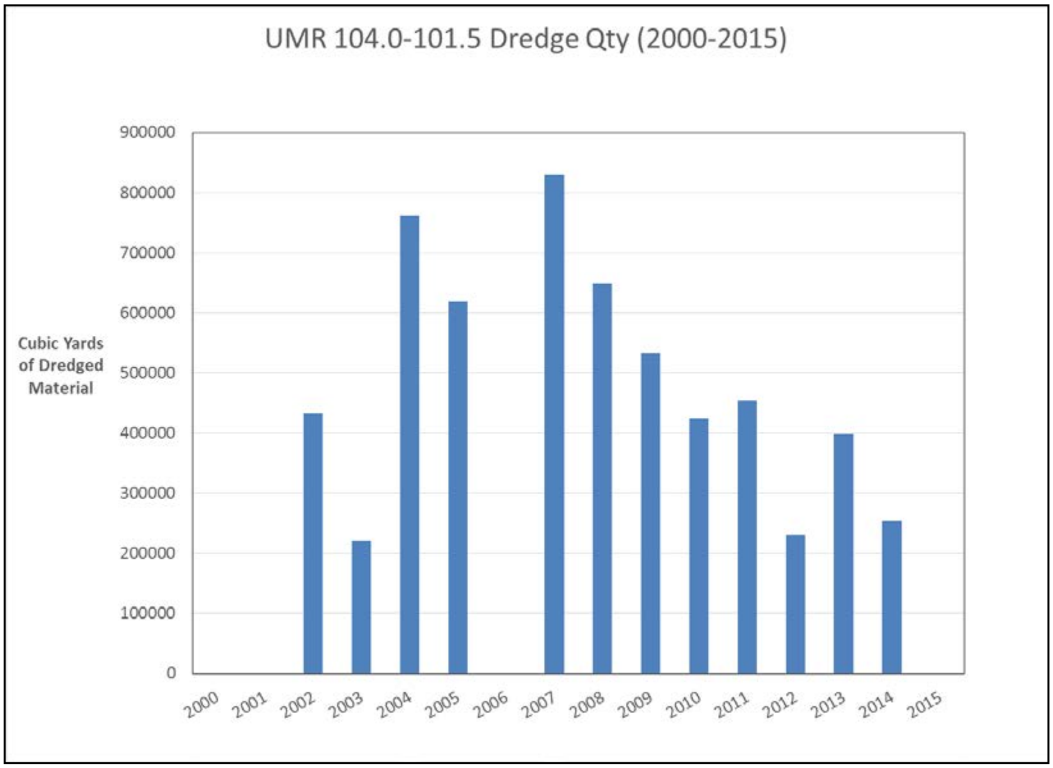

Figure 3: Dredge quantities over time for UMR 104.0-101.5.

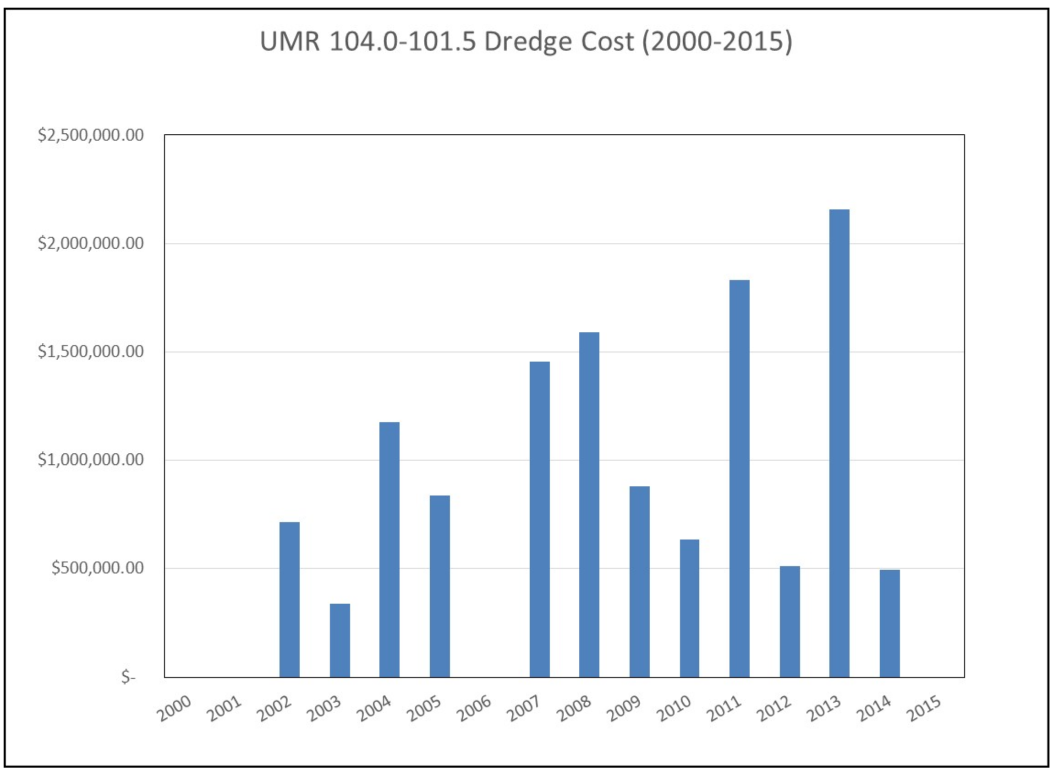

Figure 4: Dredge costs over time for UMR 104.0-101.5.

2.3 Study Purpose and Goals

The purpose of this study was to evaluate various design alternatives intended to reduce or eliminate repetitive dredging between UMR river miles 104.0 and 101.5. HSR modeling technology was used to test the changes in flow patterns and sediment transport.

The goals of this study were to:

i. Investigate and provide analysis on the existing flow mechanics.

ii. Evaluate a variety of remedial measures utilizing an HSR model with the objective of identifying the most effective and economical plan to reduce or eliminate the need for dredging between RM 104.0 to RM 101.5 while avoiding and minimizing adverse effects to fish and wildlife. In order to determine the best alternative, 4 criteria were used to evaluate each alternative.

   a. The alternative should reduce or eliminate the need for dredging along the RDB sandbar between RM 104.0 and RM 102.5.

   b. The alternative should reduce or eliminate the need for dredging in the channel crossing between RM 102.5 and RM 101.5.

   c. The alternative should have a minimal impact, if possible, on the flows entering Rockwood Chute.

   d. The alternative should have a minimal impact, if possible, on the sandbar along the river side of Rockwood Island.

2.4 Study Reach

The study comprises a 2.5 mile stretch of the UMR between RM 104.0 and RM 101.5 near Rockwood, Illinois. Additional river length both upstream and downstream of the study area was modeled to allow for adequate entrance and exit conditions. Plate 1 is a location and vicinity map of the study reach. Plate 2 is a planform and nomenclature map of the study reach. Plate 4 illustrates geomorphological changes to the river banklines in the study reach over the time period from 1968 to 2011. Counties located around the study reach are Randolph and Jackson in Illinois and Perry in Missouri.

Present and historic hydrographic surveys of the Mississippi River, in the HSR model study area, are shown on Plates 5-9. The plates show bathymetric surveys from 1986-1987, 2005, 2007, 2010, and 2013.

The following bathymetric trends have remained relatively constant after comparison of the above mentioned hydrographic surveys:

Table 2: Study Reach Characteristics

River Miles	Description
105.0 – 104.5	The thalweg was located along the LDB throughout this 0.5 mile reach. Depths along the LDB increased to up to 30' below LWRP from UMR 106.0 – 105.0 as the flow was concentrated along the LDB. Between RM 104.7 and 104.5, flows tended to spread out as the thalweg moved slightly away from the LDB. There was a dike field extending from the RDB with a spacing of 900' and an average effective length of 300'.
104.5 – 103.0	The thalweg at UMR 104.5 was located slightly off the LDB, as the river planform turned south between RM 104.0 and RM 103.0. Flows were concentrated along the LDB and scour down to depths approaching 40' below LWRP were observed. Between RM 103.7 and RM 103.0 there were structures located along both banklines. The RDB had a mix of chevrons and notched river training structures that were constructed on a large sandbar. The average spacing of these structures was approximately 800'. The LDB had a series of trail dikes with an effective length of approximately 250' on average with approximately 400' trail sections on average. There was also a single weir with a degraded cross section at RM 103.2 extending from the LDB approximately 400' and angled upstream at approximately 25 degrees.
103.0 – 102.0	The thalweg crossed from the LDB to the RDB in this reach. There were structures on both sides of the channel, but Dike 103.1L just upstream of the entrance to Rockwood Chute was shown to have a substantial impact on the bathymetry in the crossing. The structure is angled downstream at approximately 40 degrees downstream from the primary direction of flow and extends out from the bank approximately 1700'. The top of the dike was approximately 10' above LWRP. Just upstream of this structure, the sandbar along the RDB tended to encroach upon the navigation channel. However, there was

	significant scour off the end of this structure and as a result the RDB sandbar was cut back downstream of the structure. The average channel width from dike tip to dike tip through this reach was approximately 1600'.
102.0 – 100.4	The thalweg was concentrated along the RDB from RM 102.0 through RM 100.0. The planform bent toward the LDB in a gentle curve. There were structures on both sides of the river. The structures along the outside of the bend along the RDB that were spaced approximately 1100' apart. The average effective length of these structures was approximately 200'. The structures along the sandbar on the inside of the bend are spaced approximately 1700' apart. These structures had little to no effective length as they were completely covered in sand. Liberty Chute reconnects to the main channel at RM 100.7 and RM 100.0.
100.4 - 99.0	The thalweg crossed from the RDB to the LDB in this reach. There was a set of chevrons along the LDB at the downstream end of Liberty Chute near RM 100.0. Along the RDB, there was a series of notched dikes where the Mile 100 islands formed. These structures were spaced approximately 800' – 2000' apart with effective lengths of approximately 900' – 1300'. The average width from the dike tips to the LDB in this reach was approximately 1500'.

3 HSR Modeling

3.1 Model Calibration and Replication

The HSR model was calibrated to replicate the general conditions of the river at the time of the model study. This involved a 3 step process.

First, planform "fixed" boundary conditions of the study reach, i.e. banklines, islands, side channels, tributaries and other features were established according to recent available high resolution aerial photographs. Various other fixed boundaries were also introduced into the model including any channel improvement structures, underwater rock, clay and other non-mobile boundaries. These boundaries were based off of documentation (such as plans and specifications) as well as hydrographic surveys.

Second, "loose" boundary conditions of the model were replicated. Bed material was introduced into the channel throughout the model to an approximate level plane. The combination of the fixed and loose boundaries served as the starting condition of the model.

Third, model tests were run using steady state discharge. Adjustment of the discharge, sediment volume, model slope, fixed boundaries, and entrance conditions were refined during these tests as part of calibration. The bed progressed from a static, flat, arbitrary bed into a fully-formed, dynamic, and three dimensional (3D) mobile bed. Repeated tests were simulated for the assurance of model stability and repeatability. When the general trends of the model bathymetry were similar to observed recent river bathymetry and the tests were repeatable, the model was considered calibrated and alternative testing began.

An overhead view of the HSR model is shown in Plate 16.

See Appendix 2: HSR Modeling Theory for more details on the use of HSR Models.

3.2 Scales and Bed Materials

The model employed a horizontal scale of 1 inch = 500 feet, or 1:6000, and a vertical scale of 1 inch = 68 feet, or 1:816, for a 7.4 to 1 distortion ratio of linear scales. This distortion supplied the necessary forces required for the simulation of sediment transport conditions similar to those observed in the prototype. The bed material was granular plastic urea, Type II, with a specific gravity of 1.40. Some areas of the model bed were determined to consist of non-erodible materials. These areas were modeled using heavy steel pellets that would not translate downstream during model calibration and testing.

3.3 Appurtenances

The HSR model insert was constructed according to the 2012 high-resolution aerial photography of the study reach. The insert was then mounted in a hydraulic flume that recirculates water and sediment in a closed, steady state loop. The riverbanks of the model were constructed from dense polystyrene foam, and modified during calibration with clay (banklines). Steel pellets were utilized in the model as non-erodible material. River training structures in the model were made of galvanized steel mesh. Rotational jacks located within the hydraulic flume controlled the slope of the model. The measured slope of the insert and flume was approximately 0.01 inch/inch.

3.4 Flow Control

In all model tests, a steady state flow was simulated in the channel. This served as the average design energy response of the river. Because of the constant variation experienced in the prototype, this steady state flow was used to theoretically analyze the ultimate expected sediment response. The flow was held steady at a constant flow rate of 1.45 Gallons per Minute (GPM) during model calibration and for all design alternative tests.

3.5 Data Collection

The river bed in the model was surveyed with a high definition, 3D laser scanner that collects a dense cloud of xyz data points. These xyz data points were then geo-referenced to real world coordinates and triangulated to create a 3D surface. The surface was then color coded by elevation using standard color tables that were also used in color coding prototype surveys. This process allowed a direct visual comparison between HSR model bathymetry surveys and prototype bathymetry surveys.

Flow visualization was used for the recommended alternative to provide a better understanding of the changes to the flow distribution in the model as a result of the changes. The water surface was seeded with dry sediment and the area of interest was recorded with a high definition camera as the sediment passed by. The analysis allowed the observation of surface flow patterns in addition to qualitative information such as flow distribution and direction.

4 HSR model tests

4.1 Replication Test

Once the model adequately replicated general prototype trends, the resultant bathymetry served as a benchmark for the comparison of all future model alternative tests. In this manner, the actions of any alternative, such as new channel improvement structures, realignments, etc., were compared directly to the replicated condition. General trends were evaluated for any major differences positive or negative between the alternative test and the replication test by comparing the surveys of the two and also carefully observing the model while the actual testing was taking place. The resultant bathymetry of this bed response served as the base test of the HSR model. Plate 17 shows the bed configuration of the HSR Model Replication.

Results of the HSR model base test bathymetry and a qualitative comparison to the aforementioned prototype surveys between Mile 106.0 and Mile 99.0 indicated the following trends:

Table 3: Comparison of Model and Prototype bathymetric trends.

River Mile	Comparison
106.0 – 104.5	Both the model and the prototype surveys showed the thalweg located along the LDB. The prototype's thalweg was deeper. Along the RDB a large depositional bar was apparent in both the model and prototype.
104.5 – 102.0	The depositional bar grew from the RDB towards the LDB in both the prototype and model. The thalweg became shallower, but small scour holes appeared around the ends of the river training structures. The scour holes were slightly more defined in the model.
102.5 – 101.5	The transition of the thalweg from the LDB to the RDB was observed in both the model and the prototype. The crossing was moderately deeper in the prototype than in the model.
101.5 – 99.0	The thalweg was located along the RDB in both the model and in the prototype. Depths in the model were greater than those in the prototype surveys.

4.2 Design Alternative Tests

The testing process consisted of installing alternative structure configurations in the model in an attempt to alter the model bathymetry and velocity distribution in a manner intended to alleviate the repetitive dredging in the UMR 104.0 – 101.5 reach of the Mississippi River. Alternative designs began with an evaluation of concept level river engineering solutions based on the judgment of the design engineer and other engineers consulted. These concept level designs were generally evaluated in the model via high impact / high cost designs to progressively less impact / lower cost designs before reaching an optimized design for a given concept. Evaluation of each alternative was accomplished through a qualitative comparison to the model base test bathymetry.

Alternative 1: (Plate 18)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Trail Dike	103.50	RDB	1,140
Install Trail Dike	103.30	RDB	4,640

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
No	No

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	Yes

Additional Comments
Structures tested were designed to terminate at a point along a 1500’ navigation channel stabilization line. It was shown that there was likely insufficient energy along the RDB (inside of a bend) to deepen the channel and prevent the RDB sandbar from encroaching on the navigation channel.

Alternative 2: (Plate 19)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Trail Dike	104.3	LDB	8,810

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
Yes	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
No	No

Additional Comments
This alternative utilizes the energy along the LDB on the outside of the bend. However, because this alternative involves a structure that extends downstream of the opening to Rockwood Chute, this alternative would likely reduce the flows within Rockwood Chute.

Alternative 3: (Plate 20)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Trail Dike	103.40	LDB	4,290

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
Yes	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
No	No

Additional Comments
This alternative is similar to Alternative 2, but with less upstream construction. It utilizes the energy along the LDB on the outside of the bend. However, because this alternative involves a structure that extends downstream of the opening to Rockwood Chute, this alternative would likely reduce the flows within Rockwood Chute.

Alternative 4: (Plate 21)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Trail Dike	103.20	LDB	850
Repair Dike	103.10	LDB	600
Install Dike	102.30	LDB	680

Bathymetry

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
Yes	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
No	Yes

Additional Comments
This alternative had generally positive results, but raising the 600' section of Dike 103.1 could significantly impact the flows going into Rockwood Chute. Existing scour at the upstream end of Rockwood Island would likely be exacerbated by this alternative.

Alternative 5: (Plate 22)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Repair Dike	103.10	LDB	600

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
No	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
No	No

Additional Comments
This alternative could significantly impact the flows entering Rockwood Chute. It also would likely increase the scour at the upstream end of Rockwood Island.

Alternative 6: (Plate 23)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Remove Dike	102.20	LDB	1,475

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
No	No

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	No

Additional Comments
This alternative was done to investigate the effect of Dike 102.2L on the current bathymetry.

Alternative 7: (Plate 24)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Repair Dike	103.10	LDB	700
Remove Dike	102.20	LDB	1,475

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
No	No

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
No	No

Additional Comments
This alternative was done to investigate the possibility of establishing a secondary channel behind the sandbar along the LDB at RM 102.

Alternative 8: (Plate 25)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Weir	103.40	LDB	200
Install Weir	103.20	LDB	250

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
No	No

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	Yes

Additional Comments
This alternative was intended to begin understanding how additional bendway weirs would impact the bathymetry through the bend.

Alternative 9: (Plate 26)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Trail Dike	103.60	LDB	890
Install Trail Dike	103.40	LDB	1,470
Install Dike	102.30	LDB	1,140

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
Yes	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	No

Additional Comments
While this alternative showed some positive results, the thalweg alignment near RM 103.5 would likely be problematic for navigation. It's also likely that the sandbar along the RDB would still encroach on the navigation channel periodically.

Alternative 10: (Plate 27)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Trail Dike	103.60	LDB	890
Install Trail Dike	103.40	LDB	1,470
Install Dike	102.30	LDB	1,030

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
No	No

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	No

Additional Comments
This alternative was meant to build off of Alternative 9, evaluating what impact a shorter dike at RM 102.3L would have.

Alternative 11: (Plate 28)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Trail Dike	104.40	LDB	5,560

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
No	No

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	No

Additional Comments
This alternative was tested to evaluate the impact of working farther upstream with a trail dike with tiebacks along the LDB.

Alternative 12: (Plate 29)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Rootless Dike	103.50	RDB	470
Install Rootless Dike	103.30	RDB	365
Install Rootless Dike	103.10	RDB	215
Install Rootless Dike	102.60	RDB	110
Install Rootless Dike	103.50	RDB	140
Install Dike	104.10	LDB	265
Install Dike	103.90	LDB	370
Install Weir	103.40	LDB	310
Install Weir	103.20	LDB	510
Install Dike	102.30	LDB	850

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
No	No

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	No

Additional Comments
This alternative was an attempt to evaluate a 1200' channel constriction through the UMR 104.0 – 102.5 reach.

Alternative 12A: (Plate 30)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Rootless Dike	103.50	RDB	575
Install Rootless Dike	103.30	RDB	370
Install Rootless Dike	103.10	RDB	280
Install Rootless Dike	103.60	RDB	230
Install Rootless Dike	102.40	RDB	180
Install Rootless Dike	102.20	RDB	200
Install Rootless Dike	102.00	RDB	200
Install Dike	104.10	LDB	265
Install Dike	103.90	LDB	370
Install Weir	103.40	LDB	725
Install Weir	103.20	LDB	900
Install Trail Dike	103.15	LDB	1,020
Install Dike	102.30	LDB	850
Extend Dike	101.80	LDB	310

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
Yes	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
No	Yes

Additional Comments
This alternative was similar to Alternative 12, with the addition of more structures including two additional rootless dike extensions at the downstream end of the bend (Dike 102.0R and Dike 102.2R). Also, the addition of Trail Dike 103.15L provided additional navigation channel depth, but would likely impact flows in Rockwood Chute.

Alternative 12B: (Plate 31)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Rootless Dike	103.50	RDB	575
Install Rootless Dike	103.30	RDB	370
Install Rootless Dike	103.10	RDB	280
Install Rootless Dike	103.60	RDB	230
Install Rootless Dike	102.40	RDB	180
Install Rootless Dike	102.20	RDB	200
Install Rootless Dike	102.00	RDB	200
Install Dike	104.10	LDB	265
Install Dike	103.90	LDB	370
Install Weir	103.40	LDB	725
Install Weir	103.20	LDB	900
Install Trail Dike	103.15	LDB	1,020
Restore Dike	103.10	LDB	1,400
Install Dike	102.30	LDB	850
Extend Dike	102.20	LDB	165
Extend Dike	101.80	LDB	310

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
Yes	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
No	Yes

Additional Comments
This alternative was similar to Alternative 12A, with the addition of the restoration of Dike 103.1L, at the entrance to Rockwood Chute. This change is likely to negatively impact the flows entering Rockwood Chute.

Alternative 12C: (Plate 32)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Rootless Dike	103.50	RDB	575
Install Rootless Dike	103.30	RDB	370
Install Rootless Dike	103.10	RDB	280
Install Rootless Dike	103.60	RDB	230
Install Rootless Dike	102.40	RDB	180
Install Rootless Dike	102.20	RDB	200
Install Rootless Dike	102.00	RDB	200
Install Dike	104.10	LDB	265
Install Dike	103.90	LDB	370
Install Weir	103.40	LDB	725
Install Weir	103.20	LDB	900
Install Dike	102.30	LDB	850
Extend Dike	102.20	LDB	165
Extend Dike	101.80	LDB	310

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
No	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	Yes

Additional Comments
This alternative was similar to Alternative 12B, but without the trail dike structure at RM 103.15L, which would likely impact the flows entering Rockwood Chute. This was done to evaluate the need for this structure.

Alternative 13: (Plate 33)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install BEDS	103.40	LDB	1,350
Install BEDS	103.20	LDB	1,350
Install BEDS	103.10	LDB	2,300
Install BEDS	102.60	LDB	1,600
Install BEDS	102.30	LDB	2,400
Install BEDS	102.20	LDB	2,200
Install BEDS	102.00	LDB	2,250

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
No	No

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	No

Additional Comments
This alternative was done to evaluate the use of a new and innovative type of structure constructed below average bed elevations intended to utilize the energy associated with bedload transport to deepen the navigation channel. These structures are tentatively referred to as Bedload Energy Distribution Structures (BEDS).

Alternative 14: (Plate 34)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Rootless Dike	103.50	RDB	575
Install Rootless Dike	103.30	RDB	370
Install Rootless Dike	103.10	RDB	280
Install Rootless Dike	103.60	RDB	230
Install Rootless Dike	102.40	RDB	180
Install Dike	103.90	LDB	370
Install Weir	103.40	LDB	725
Install Weir	103.20	LDB	900
Install Trail Dike	103.15	LDB	1,020
Repair Dike	103.10	LDB	1,400
Install Dike	102.30	LDB	850

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
Yes	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
No	Yes

Additional Comments
This alternative was similar to Alternative 12B, but with one less structure along the LDB at the upstream end of the UMR 104.0 to 102.5 reach.

Alternative 15: (Plate 35)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Rootless Dike	103.50	RDB	345
Install Rootless Dike	103.30	RDB	250
Restore Existing Dike	103.10	RDB	210
Install Rootless Dike	103.60	RDB	120
Install Rootless Dike	102.40	RDB	175
Install Dike	103.90	LDB	165
Install Weir	103.40	LDB	725
Install Weir	103.20	LDB	900
Install Trail Dike	103.15	LDB	850
Repair Dike	103.10	LDB	1,400

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
Yes	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
No	Yes

Additional Comments
This alternative was similar to Alternative 13, but without a structure at RM 102.1L. This was done to evaluate the need for this structure in the design.

Alternative 16: (Plate 36)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Rootless Dike	103.50	RDB	345
Install Rootless Dike	103.30	RDB	250
Install Rootless Dike	103.10	RDB	210
Install Rootless Dike	103.60	RDB	120
Install Rootless Dike	102.40	RDB	175
Install Dike	103.90	LDB	165
Install Weir	103.40	LDB	725
Install Weir	103.20	LDB	900
Repair Dike	103.10	LDB	1,400
Install Dike	102.30	LDB	1,215

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
No	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
No	Yes

Additional Comments
This alternative was similar to Alternative 12C, but with less structure along the LDB at the downstream end of the UMR 102.5 – 101.5 reach.

Alternative 17: (Plate 37)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Rootless Dike	103.50	RDB	345
Install Rootless Dike	103.30	RDB	250
Install Rootless Dike	103.10	RDB	210
Install Rootless Dike	103.60	RDB	120
Install Rootless Dike	102.40	RDB	175
Install Dike	103.90	LDB	165
Install Weir	103.40	LDB	725
Install Weir	103.20	LDB	900
Install Dike	103.15	LDB	520
Repair Dike	103.10	LDB	1,400

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
No	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
No	Yes

Additional Comments
This alternative was very similar to Alternative 15, but without the trail on the end of Dike 103.15L. This was done to evaluate the need for the trail on this structure.

Alternative 18: (Plate 38)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Rootless Dike	103.50	RDB	345
Install Rootless Dike	103.30	RDB	250
Install Rootless Dike	103.10	RDB	210
Install Rootless Dike	103.60	RDB	120
Install Dike	103.90	LDB	165
Install Weir	103.40	LDB	725
Install Weir	103.20	LDB	900
Install Dike	103.15	LDB	520
Repair Dike	103.10	LDB	1,400

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
No	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
No	Yes

Additional Comments
This alternative was very similar to Alternative 17, but without the Rootless Dike Extension at RM 102.4R. This was done to evaluate the need for this structure.

Alternative 19: (Plate 39)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Rootless Dike	103.50	RDB	345
Install Rootless Dike	103.30	RDB	250
Install Rootless Dike	103.10	RDB	210
Install Rootless Dike	103.60	RDB	120
Install Dike	103.90	LDB	165
Install Weir	103.40	LDB	725
Install Weir	103.20	LDB	900
Install Dike	103.15	LDB	520

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
Yes	No

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	Yes

Additional Comments
This alternative was very similar to Alternative 18, but without the restoration of Dike 103.1L. This was done to evaluate the need for restoring this structure.

Alternative 20: (Plate 40)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Trail Dike	103.20	LDB	860

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
Yes	No

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	Yes

Additional Comments
This alternative was done to evaluate a minimalist approach to construction in this reach to reduce the need for dredging.

Alternative 21: (Plate 41)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Dike	103.90	LDB	165
Install Trail Dike	103.60	LDB	800
Install Trail Dike	103.40	LDB	700
Install Trail Dike	103.20	LDB	860
Install Dike	102.30	LDB	1,300

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
No	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	Yes

Additional Comments
This alternative was done to evaluate an approach involving aligning the structures along the outside of a bend to establish a more hydraulically efficient navigation channel through the UMR 104.0 to 101.5 reach.

Alternative 22: (Plate 42)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Dike	103.90	LDB	165
Install Trail Dike	103.60	LDB	410
Install Trail Dike	103.40	LDB	500
Install Trail Dike	103.20	LDB	860
Remove Partial Dike	103.10	LDB	425
Install Dike	102.30	LDB	1,300

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
Yes	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	Yes

Additional Comments
This alternative was similar to Alternative 21, but with a shortening of Dike 103.1L. This was done in recognition that Dike 103.1L extended further into the navigation channel than any other structure along the LDB.

Alternative 23: (Plate 43)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Dredge Disposal Island Capped With “A” Size Rock	103.50	RDB	2100 x 650

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
No	No

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	Yes

Additional Comments
This alternative was done to test out another innovative idea involving covering the area typically used for dredge disposal near RM 103.0 along the RDB sandbar with a layer of A-Stone.

Alternative 24: (Plate 44)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Dike	103.90	LDB	165
Install Trail Dike	103.60	LDB	410
Install Trail Dike	103.40	LDB	500
Install Trail Dike	103.20	LDB	860
Remove Partial Dike	103.10	LDB	425
Install Chevron	102.30	LDB	300 x 300
Install Dike	102.00	LDB	1,150

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
Yes	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	Yes

Additional Comments
After further review of the Alternative 22 test results, AREC engineers decided that additional testing of an alternative similar to Alternative 22 was warranted. Alternative 24 was similar to Alternative 22, but with a chevron at RM 102.3L (as opposed to the 1,300 ft dike at 102.3L) and a new dike at RM 102.0L. This change was made to evaluate the performance of the chevron and downstream dike in creating additional depth at the UMR 102.5 – 101.5 channel crossing. Alternative 24 was marginally more effective in creating depth through this crossing when compared to Alternative 22.

Alternative 25: (Plate 45)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Dike	103.90	LDB	165
Install Trail Dike	103.80	LDB	350
Install Trail Dike	103.60	LDB	410
Install Trail Dike	103.40	LDB	500
Install Trail Dike	103.20	LDB	860
Remove Partial Dike	103.10	LDB	425
Install Rootless Dike	102.30	LDB	550
Install Rootless Dike	102.00	LDB	550

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
Yes	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	Yes

Additional Comments
Alternative 25 was similar to Alternative 24, but with different structure configurations at the downstream end of UMR 104.0-101.5 along the LDB. Flow visualization testing on Alternative 25 was also performed to demonstrate how this alternative may affect the flows entering Rockwood Chute and / or the sandbar adjacent to Rockwood Island. The flow visualization test results confirmed the bathymetry analysis that no significant impact is expected. Flow visualization test results are shown on Plate 49.

Alternative 26: (Plate 46)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Dike	103.90	LDB	165
Install Trail Dike	103.60	LDB	410
Install Trail Dike	103.40	LDB	500
Install Trail Dike	103.20	LDB	450
Remove Partial Dike	103.10	LDB	425
Install Rootless Dike	102.30	LDB	550
Install Rootless Dike	102.00	LDB	550

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
Yes	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	Yes

Additional Comments
Alternative 26 was similar to Alternative 25, but without any changes to Dike 103.8L at the upstream end of the UMR 104.0 to 101.5 reach.

Alternative 27: (Plate 47)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Remove Partial Dike	103.10	LDB	425

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
No	Yes

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	Yes

Additional Comments
This alternative was done to evaluate the effectiveness of making changes only to Dike 103.1L.

Alternative 28: (Plate 48)

Type of Structure	Miles	LDB or RDB	Dimensions in Feet (Plan View)
Install Dike	103.90	LDB	165
Install Trail Dike	103.80	LDB	350
Install Trail Dike	103.60	LDB	410
Install Trail Dike	103.40	LDB	500
Install Trail Dike	103.20	LDB	860
Remove Partial Dike	103.10	LDB	425

Bathymetry Analysis

Likely to Reduce Dredging Along UMR 104.0-102.5 RDB Sandbar?	Likely to Reduce Dredging at UMR 102.5-101.5 Channel Crossing?
Yes	No

Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Yes	Yes

Additional Comments
This alternative was done to evaluate the necessity of the two rootless Dikes included in Alternative 25 at UMR 102.3L and 102.0L.

5 Conclusions

5.1 Evaluation and Summary of the Model Tests

Table 4: Summary of Model Test Results

Test	Reduce Dredging Along RDB Sandbar (UMR 104.0-102.5)	Reduce Dredging / Deepen the Channel Crossing (UMR 102.5-101.5)	Minimal Impact on Flow into Rockwood Chute?	Minimal Impact on LDB Sandbar adjacent to Rockwood Island?
Alternative 1	No	No	Yes	Yes
Alternative 2	Yes	Yes	No	No
Alternative 3	Yes	Yes	No	No
Alternative 4	Yes	Yes	No	Yes
Alternative 5	No	Yes	No	No
Alternative 6	No	No	Yes	No
Alternative 7	No	No	No	No
Alternative 8	No	No	Yes	Yes
Alternative 9	Yes	Yes	Yes	No
Alternative 10	No	No	Yes	No
Alternative 11	No	No	Yes	No
Alternative 12	No	No	Yes	No
Alternative 12A	Yes	Yes	No	Yes
Alternative 12B	Yes	Yes	No	Yes
Alternative 12C	No	Yes	Yes	Yes
Alternative 13	No	No	Yes	No
Alternative 14	Yes	Yes	No	Yes
Alternative 15	Yes	Yes	No	Yes
Alternative 16	No	Yes	No	Yes

Alternative 17	No	Yes	No	Yes
Alternative 18	No	Yes	No	Yes
Alternative 19	Yes	No	Yes	Yes
Alternative 20	Yes	No	Yes	Yes
Alternative 21	No	Yes	Yes	Yes
Alternative 22	Yes	Yes	Yes	Yes
Alternative 23	No	No	Yes	Yes
Alternative 24	Yes	Yes	Yes	Yes
Alternative 25	Yes	Yes	Yes	Yes
Alternative 26	Yes	Yes	Yes	Yes
Alternative 27	Yes	No	Yes	Yes
Alternative 28	Yes	No	Yes	Yes

Most alternatives were implemented in the model to encourage the navigation channel to follow a path closer to the Right Descending Bank (RDB) than the river has shown a tendency to take in recent years. This was done with the goal of utilizing the river's energy to prevent or reduce problem sandbar encroachment on the navigation channel from the RDB side of the river. Overall, this approach was shown to be less effective than an approach taken in the 4 most successful alternatives. These were Alternatives 22, 24, 25, and 26. These alternatives focused on working within the existing river trends in this reach and reworking existing structures to be more effective in establishing a dependable navigation channel. Of these alternatives, it was determined that Alternative 25 was the most effective in reducing or eliminating the need for repetitive channel maintenance dredging in the future. Alternative 25 was more effective than Alternative 22, 24, and 26 at reducing the need for dredging along the RDB sandbar between RM 104.0 and 102.5. Alternative 25 included an adjustment to the length and trail dike configuration of Dike 103.8L (which Alternatives 22, 24, and 26 did not) that allows a wider navigation channel through this reach. Additionally, comparison of the bathymetry results of these alternatives showed that the utilization of rootless Dikes at RM 102.3 and 102.0 along with an 860 ft trail dike off the end of Dike 103.2L (along with the removal of 425 ft of Dike 103.1L, which is included in Alternatives 22, 24, 25, and 26) was necessary to minimize the potential for future repetitive channel maintenance dredging in the channel crossing between RM 102.5 and RM 101.5. During the alternative development process, natural resource agency partners expressed concern about flow impacts into Rockwood Chute and along the sandbar adjacent to Rockwood Island. Therefore, alternatives were developed to avoid and/or minimize these impacts. Flow

Visualization test results on Alternative 25 (see Plate 49) indicated that there will be no significant impacts to the flows entering Rockwood Chute and the model bathymetry for Alternative 25 demonstrated no significant change to the sandbar along the river side of Rockwood Island, avoiding any impact to the sandbar habitat.

5.2 Recommendations

Based on the analysis discussed above, Alternative 25 is the recommended alternative.

Construction of Alternative 25 will involve reconfiguring the planform layout of Dike 103.8L, Dike 103.6L, Dike 103.4L, and Dike 103.2L. Each of these structures should be restored to a height equal to the height of the newly configured dike trail in order to prevent river flows from flanking the structure.

The elevation of the remaining section of Dike 103.1 (after degradation of the riverward 425') should remain unchanged. The elevation of this structure is likely an integral component in maintaining the flows entering Rockwood Chute.

Funding limitations could result in a need to construct Alternative 25 in phases. Based on modeling results, it is not anticipated that there would be a significant benefit to any particular order of construction (i.e., upstream to downstream or vice versa).

Table 5: Recommended Alternative.

Type of Structure	Location (River Mile)	LDB or RDB	Dimensions in Feet (Plan View)
Install Dike	103.90	LDB	165
Install Trail Dike	103.80	LDB	350
Install Trail Dike	103.60	LDB	410
Install Trail Dike	103.40	LDB	500
Install Trail Dike	103.20	LDB	860
Degrade Riverward Section of Existing Dike	103.10	LDB	425
Install Rootless Dike	102.30	LDB	550
Install Rootless Dike	102.00	LDB	550

5.3 Interpretation of Model Test Results

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

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

6 For more information

For more information about micro modeling or the Applied River Engineering Center, please contact Jasen Brown or David Gordon at:

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7 APPENDIX 1: REPORT PLATES INDEX

30. Alternative 12A – 1:40,000
31. Alternative 12B – 1:40,000
32. Alternative 12C – 1:40,000
33. Alternative 13 – 1:40,000
34. Alternative 14 – 1:40,000
35. Alternative 15 – 1:40,000
36. Alternative 16 – 1:40,000
37. Alternative 17 – 1:40,000
38. Alternative 18 – 1:40,000
39. Alternative 19 – 1:40,000
40. Alternative 20 – 1:40,000
41. Alternative 21 – 1:40,000
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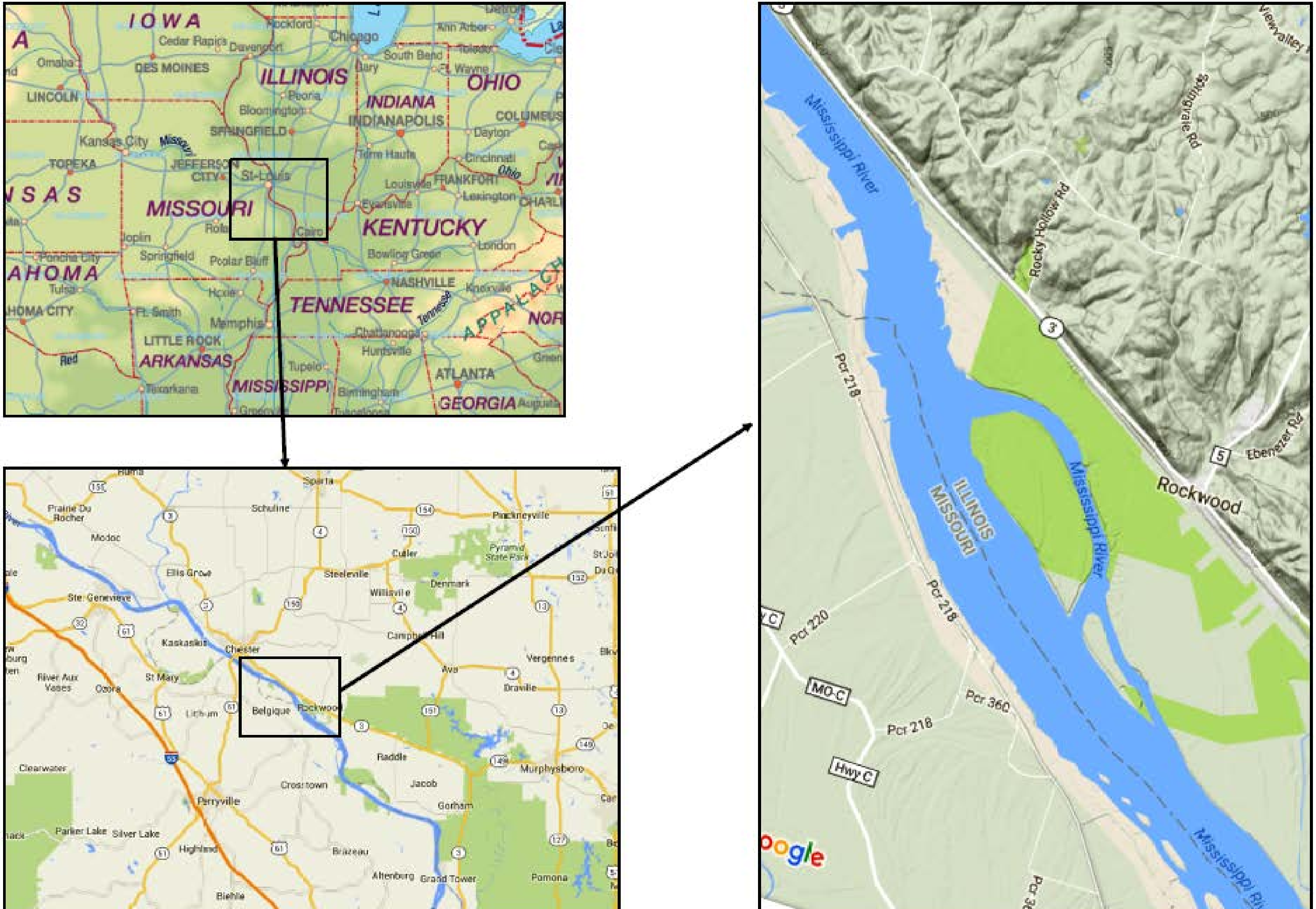
45. Alternative 25 – 1:40,000
46. Alternative 26 – 1:40,000
47. Alternative 27 – 1:40,000
48. Alternative 28 – 1:40,000
49. Alternative 25 – Flow Visualization



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	L:/HSR Modeling/ HSR Model Studies/UMR 120-90

UMR 104 - 101.5
Location and Vicinity Map

PLATE NUMBER
1

PLATE NUMBER 2	0 1,000 2,000 4,000 Feet
	Planform & Nomenclature 2015 AERIAL PHOTOGRAGHY

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PLATE NUMBER

3

0 1,000 2,000 4,000

Feet

Dredge & Disposal Locations
2010 - Present

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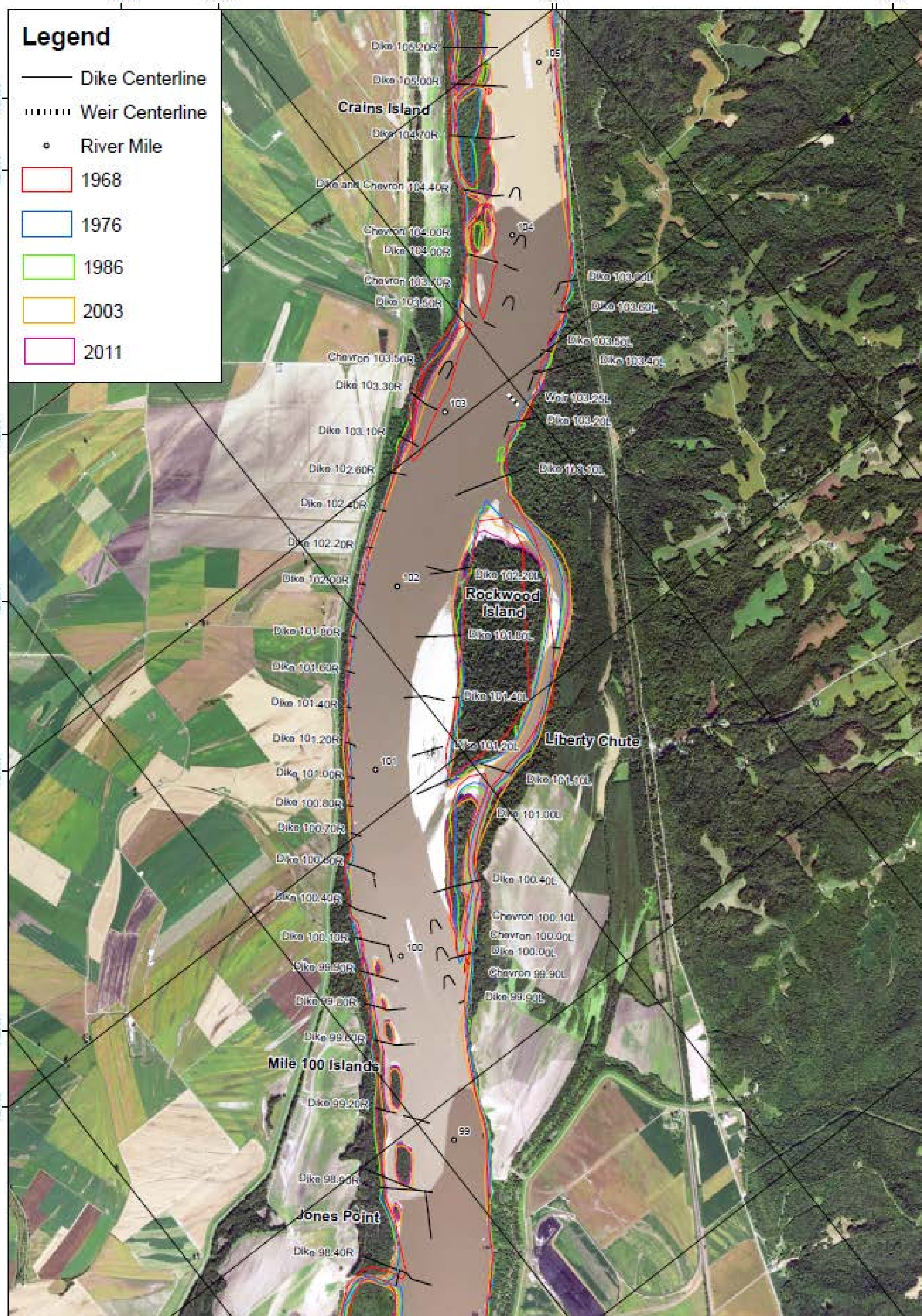

PLATE NUMBER 4

0 1,000 2,000 4,000
Feet

Geomorphology
1968 - Present

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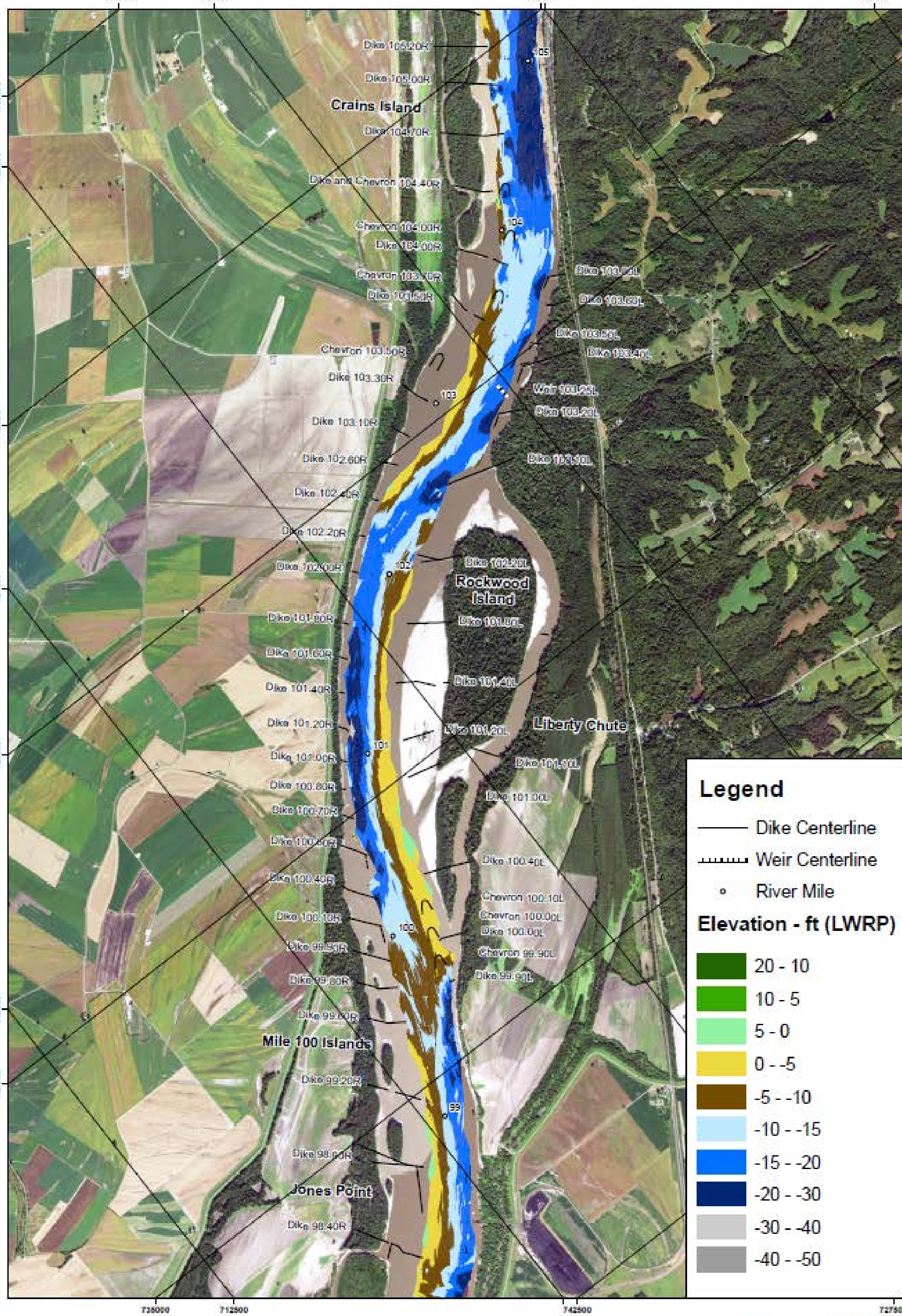

PLATE NUMBER 5

0 1,000 2,000 4,000
Feet

2005 Main Channel Hydrographic Survey

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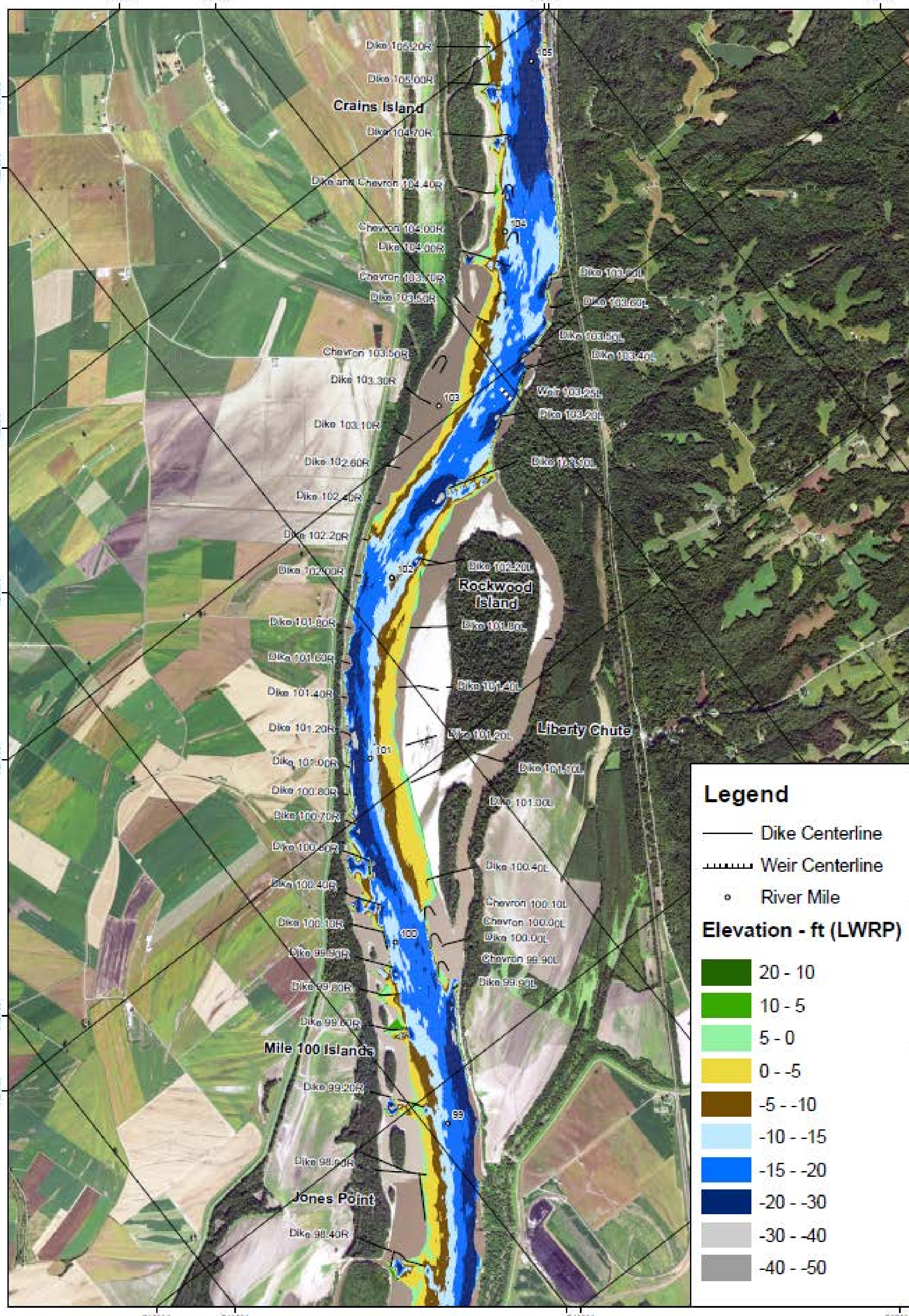

PLATE NUMBER 6

0 1,000 2,000 4,000
Feet

2007 Main Channel Hydrographic Survey

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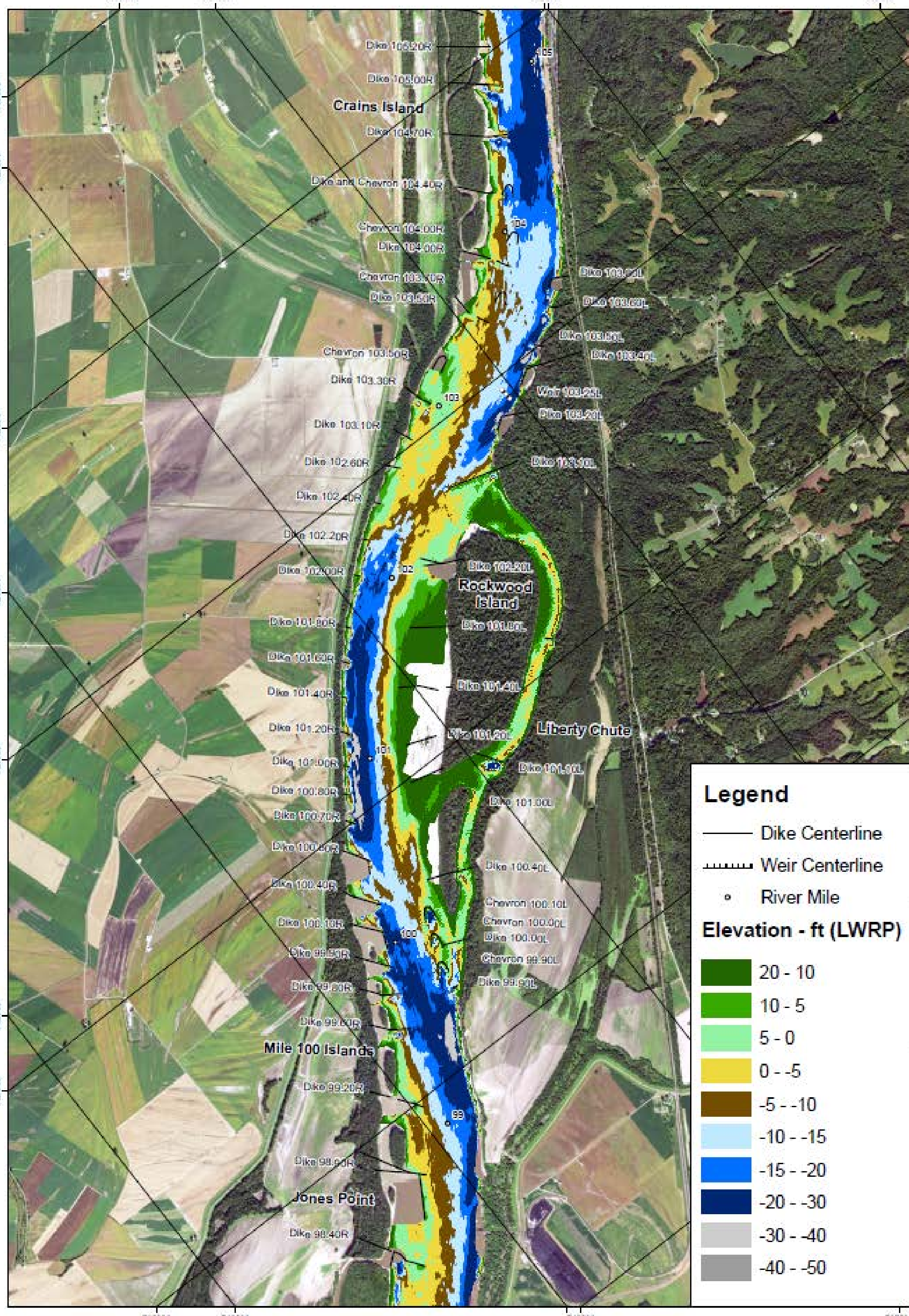

PLATE NUMBER 7

0 1,000 2,000 4,000
Feet

2010 Main Channel
2011 Side Channel
Hydrographic Survey

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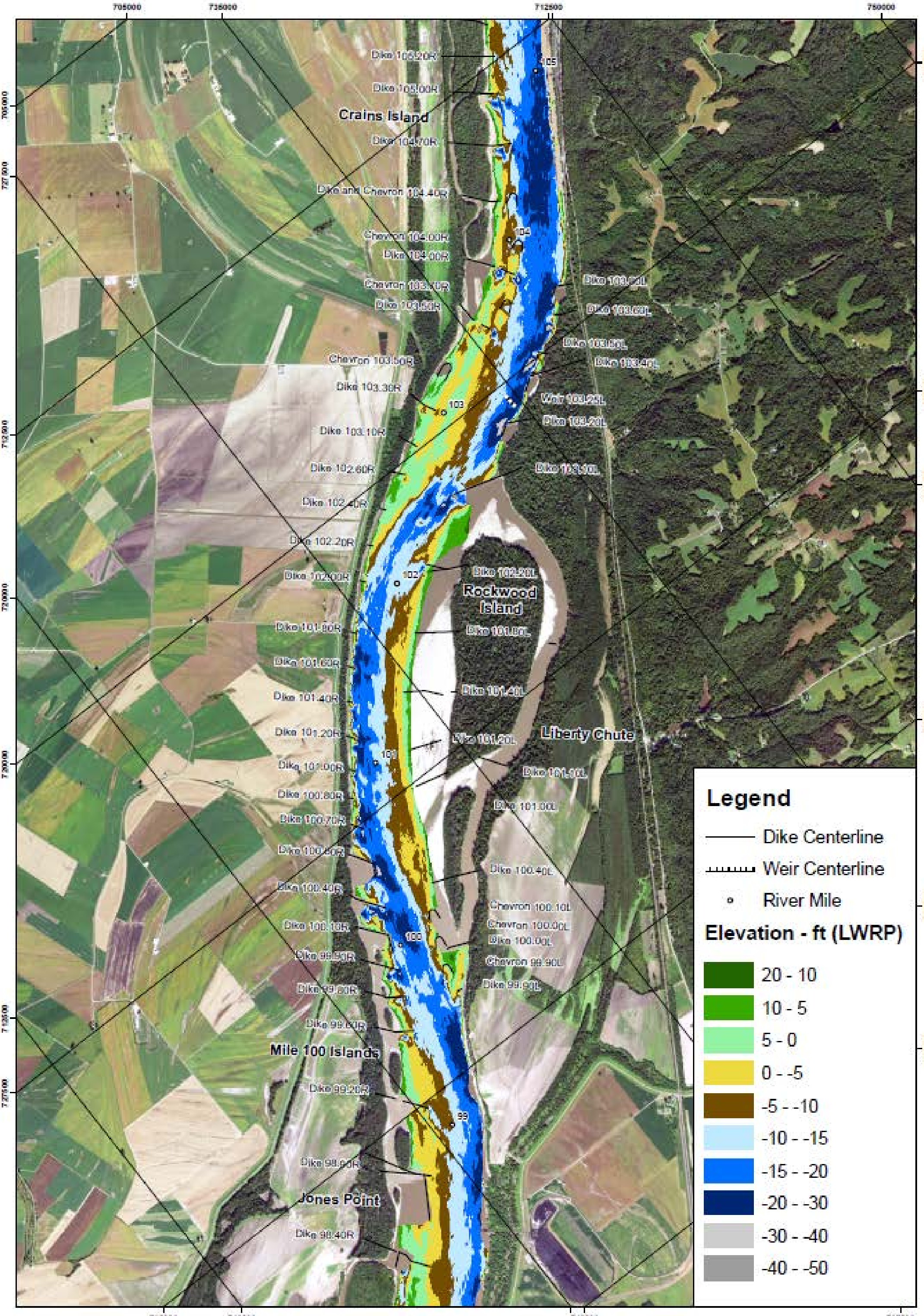

PLATE NUMBER 8

0 1,000 2,000 4,000
Feet

2013 Main Channel Hydrographic Survey

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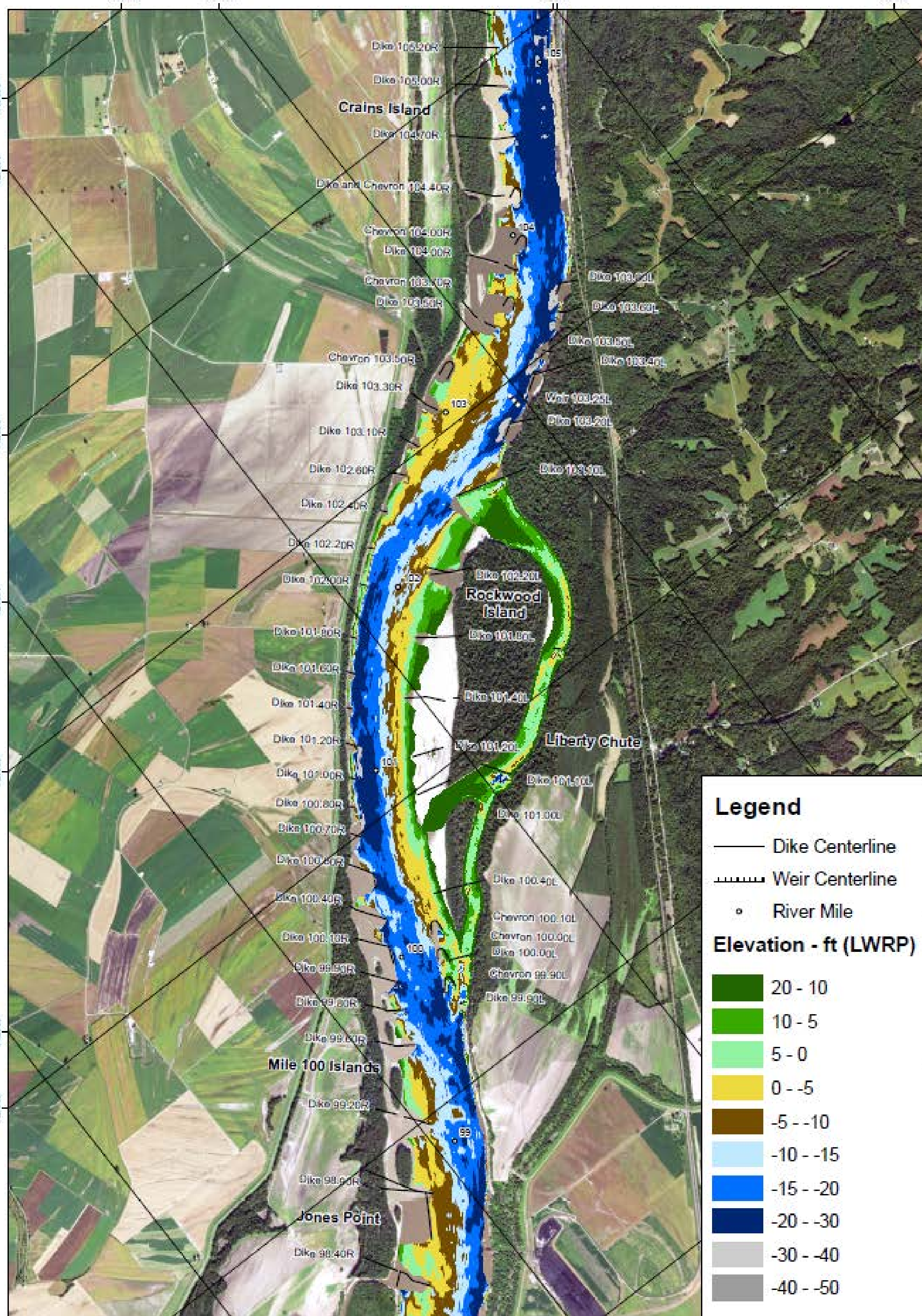

PLATE NUMBER 9

0 1,000 2,000 4,000 Feet

2015 Main Channel
2014 Side Channel
Hydrographic Survey

2015 AERIAL PHOTOGRAGHY

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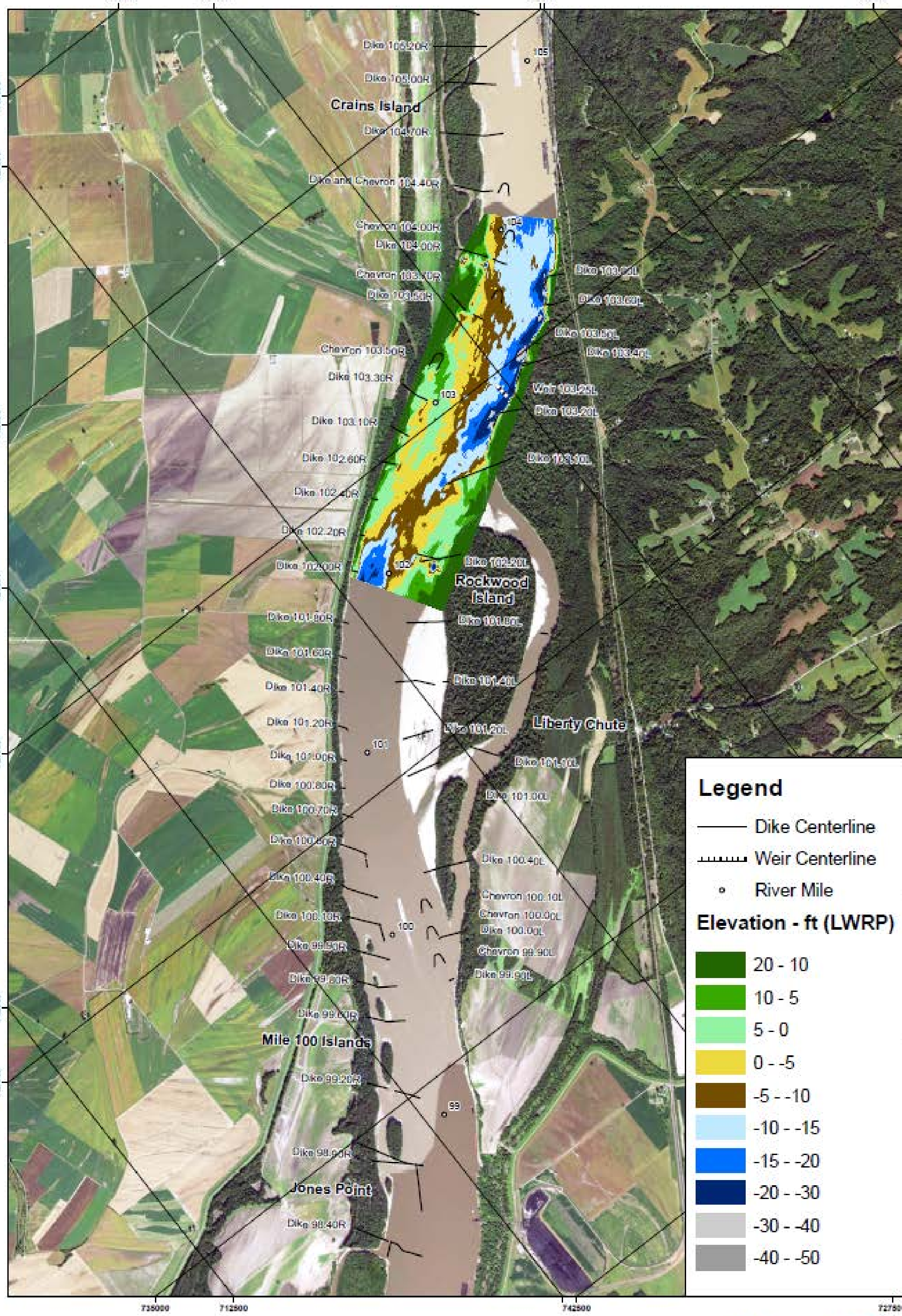

PLATE NUMBER 10

0 1,000 2,000 4,000
Feet

2010 Pre-Dredge Survey
2015 AERIAL PHOTOGRAPHY

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ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

J. Brown, P.E.
C. Tabbert
R. Kreichel, P.E.
D. Gordon, P.E.
C. Tabbert
Dave Gordon, P.E.
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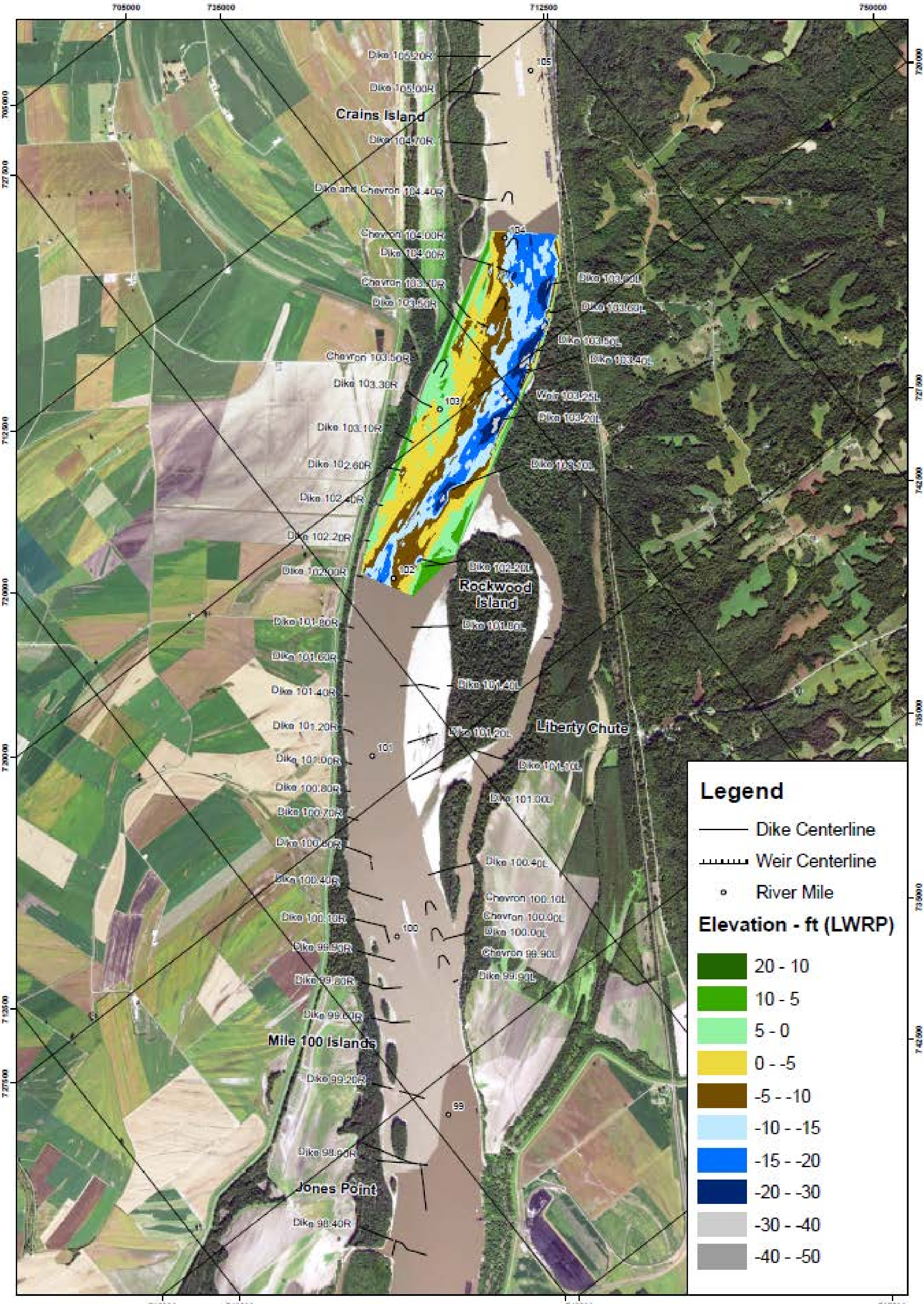

PLATE NUMBER	11

0 1,000 2,000 4,000
Feet

2011 Pre-Dredge Survey

2015 AERIAL PHOTOGRAGHY

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Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

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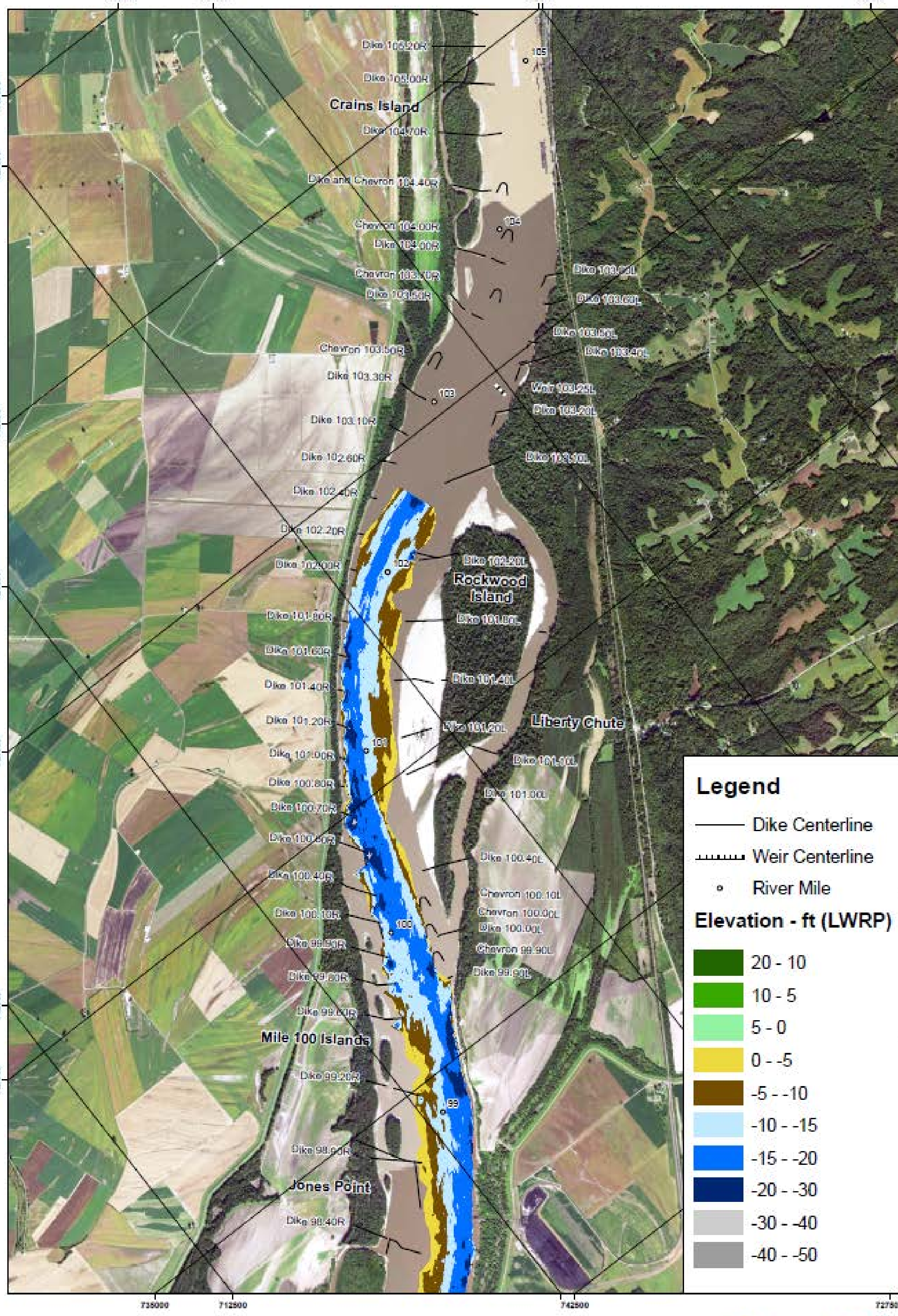

PLATE NUMBER 12

0 1,000 2,000 4,000
Feet

2012 Pre-Dredge Survey
2015 AERIAL PHOTOGRAGHY

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St. Louis District
UMR 104 - 101.5
HSR Model

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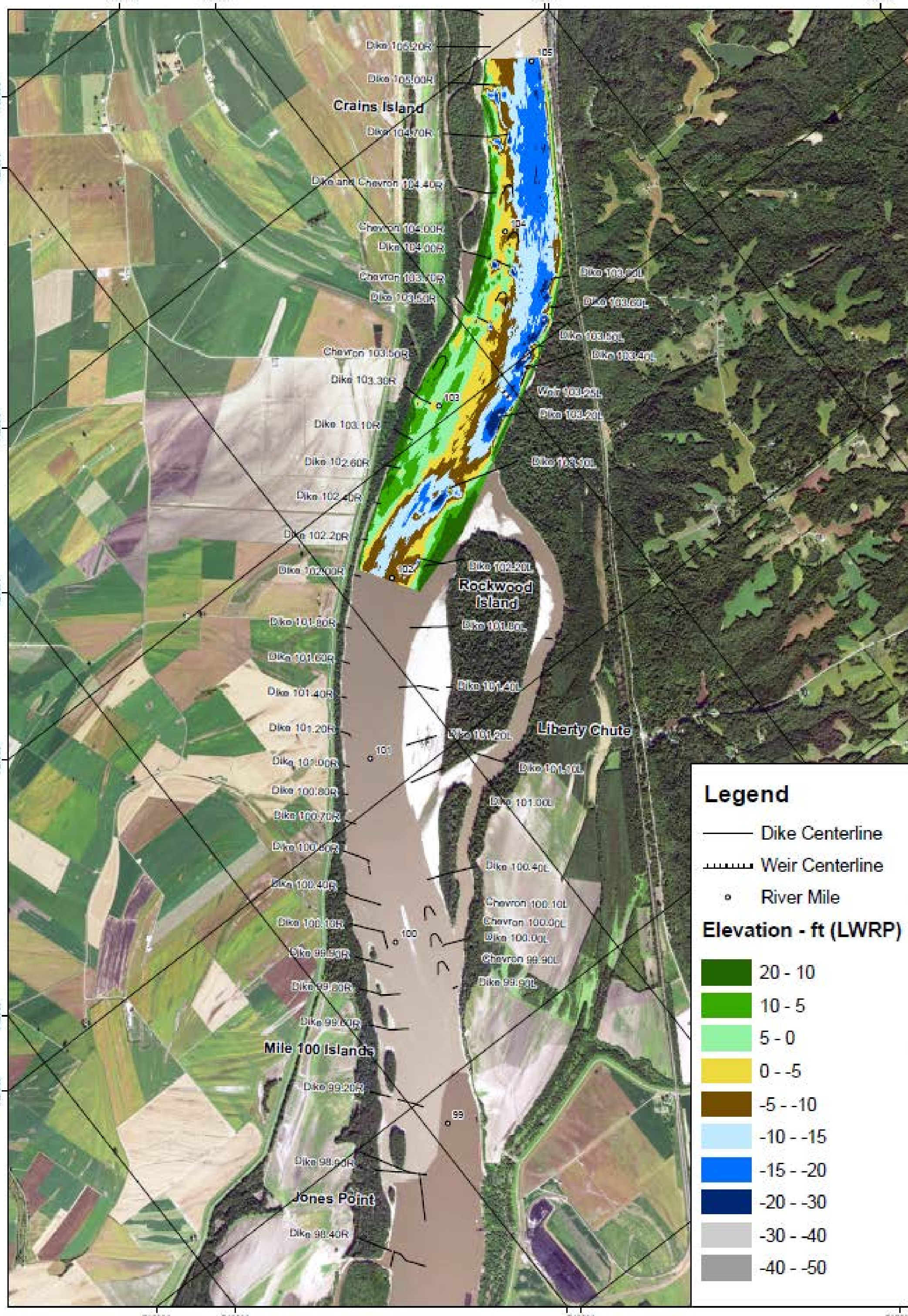

PLATE NUMBER 13

0 1,000 2,000 4,000
Feet

2013 Pre-Dredge Survey

2015 AERIAL PHOTOGRAGHY

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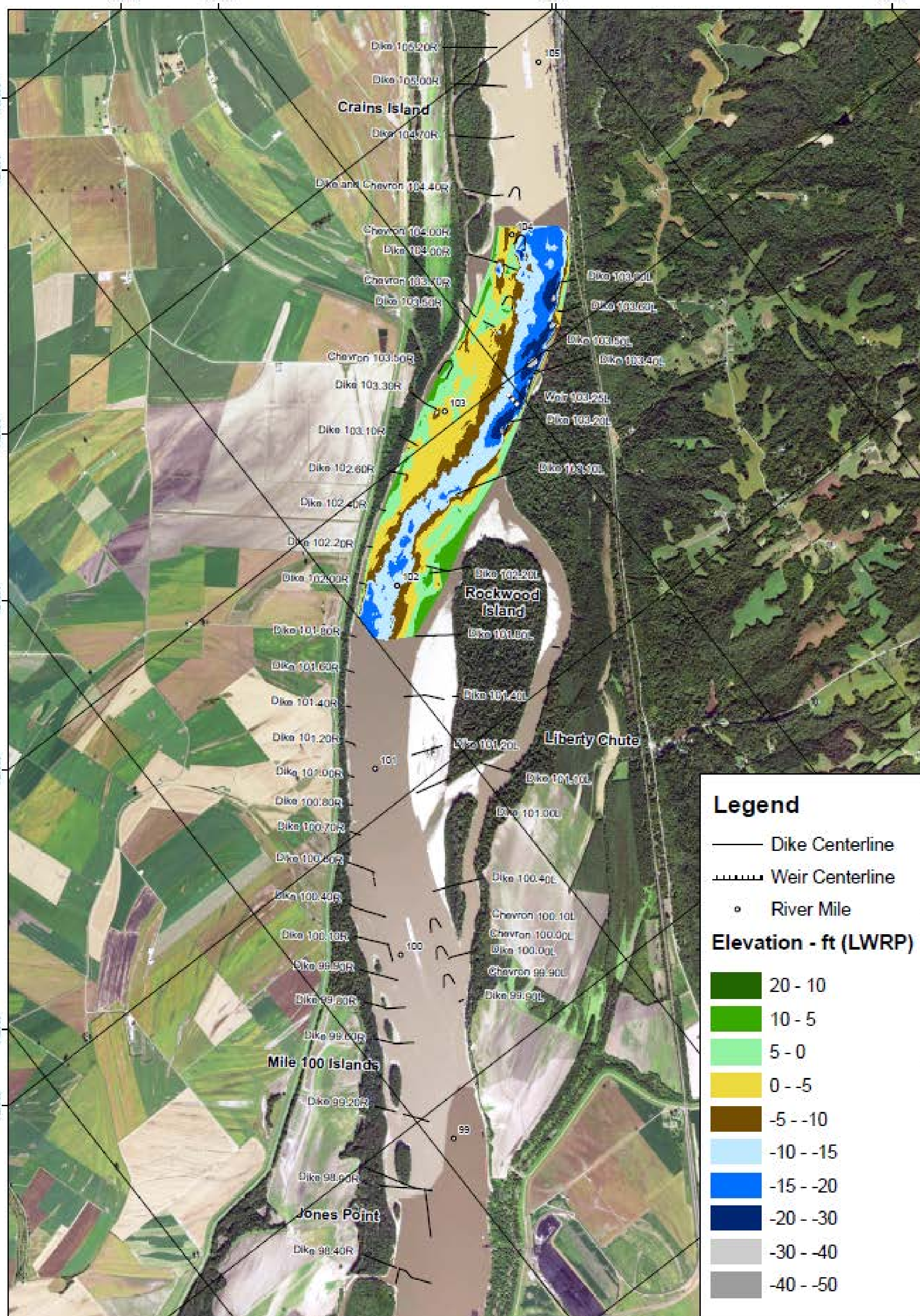

PLATE NUMBER 14

0 1,000 2,000 4,000
Feet

2014 Pre-Dredge Survey
2015 AERIAL PHOTOGRAGHY

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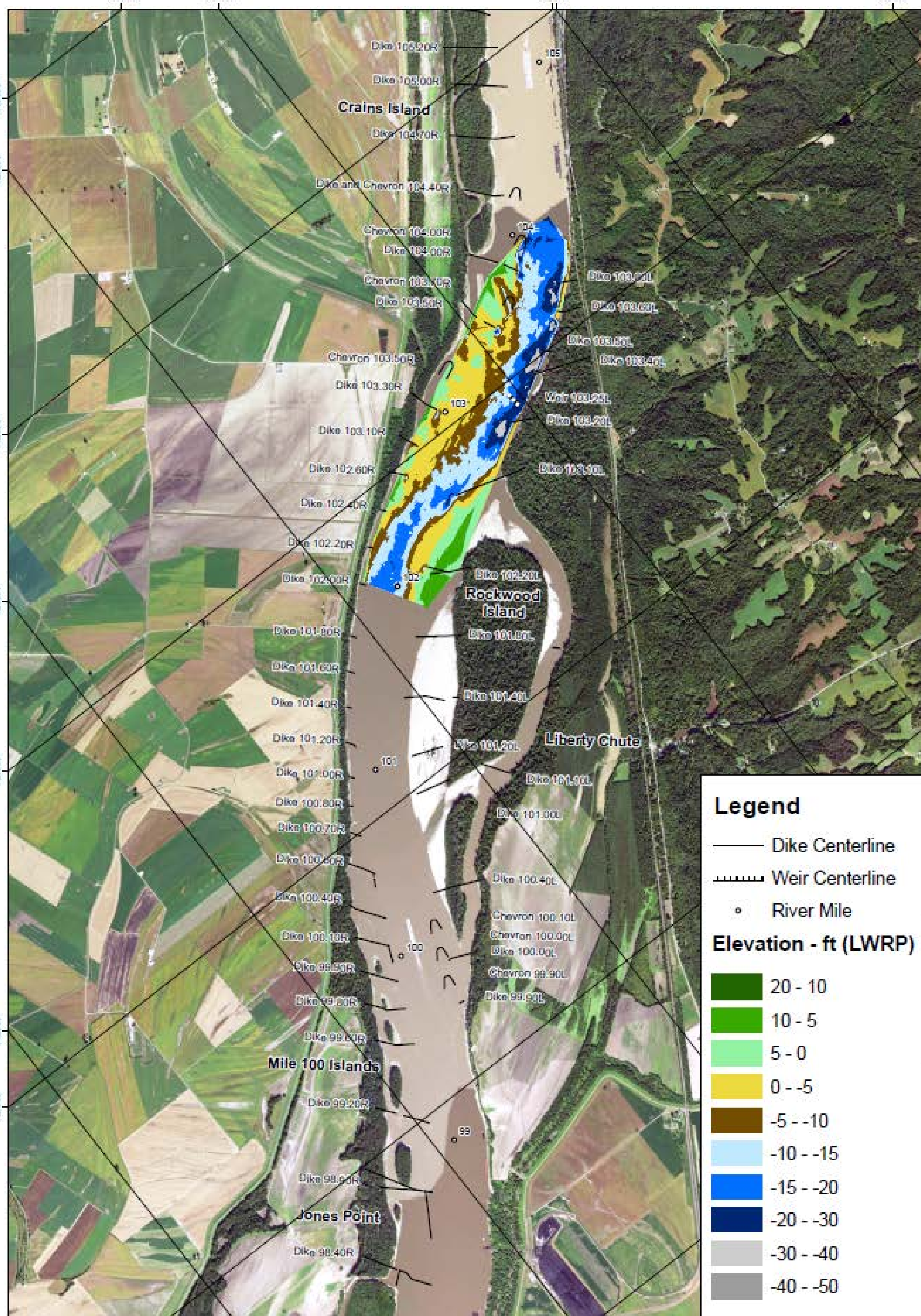

PLATE NUMBER 15

0 1,000 2,000 4,000
Feet

2015 Pre-Dredge Survey

2015 AERIAL PHOTOGRAGHY

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CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

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PLATE NUMBER 16

0 1,400 2,800 5,600
Feet

HSR Model
UMR 104 - 101.5

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Mississippi River Basin
St. Louis District
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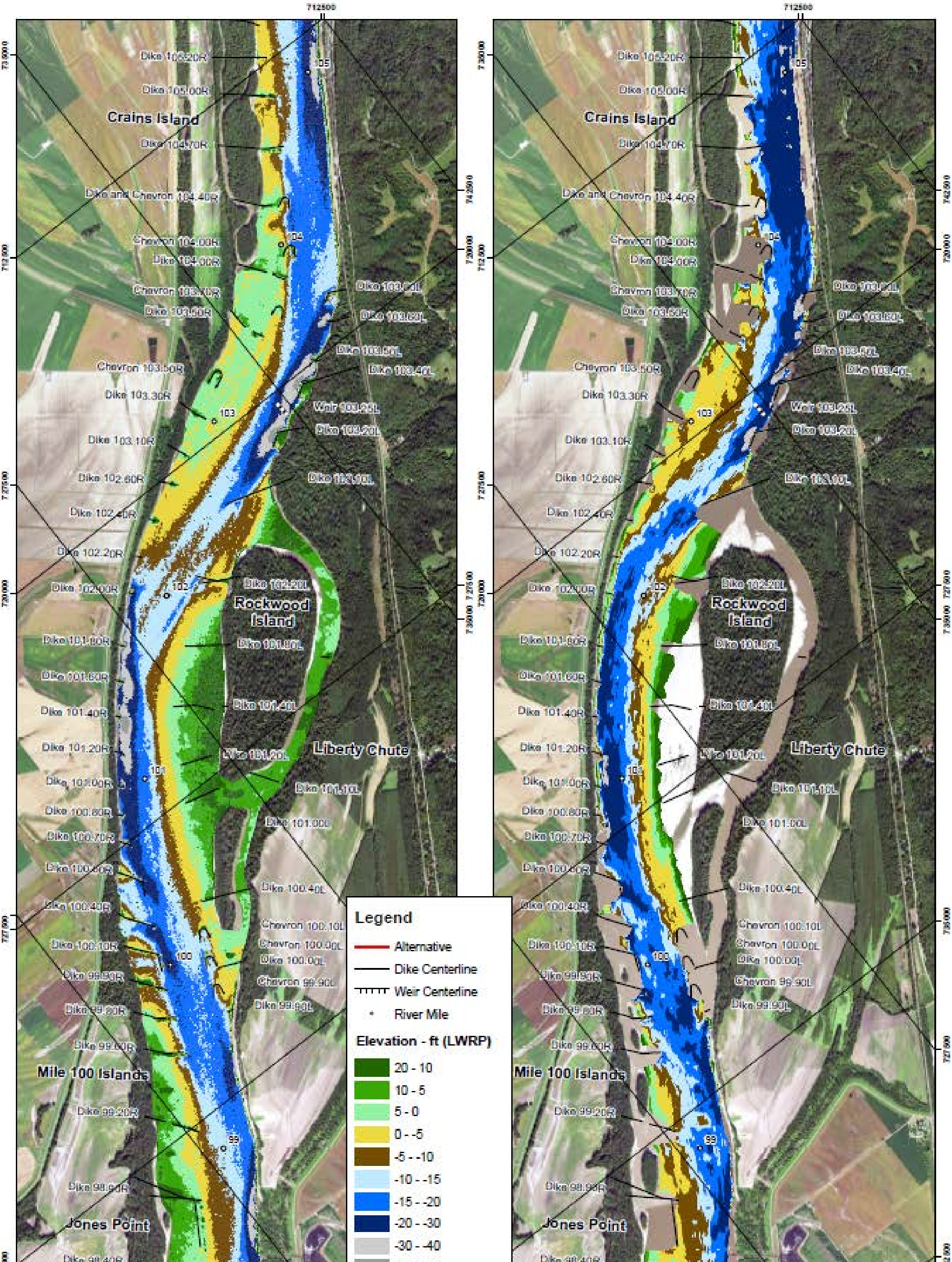

Replication

2015 Hydrographic Survey

PLATE NUMBER
17

0 1,000 2,000 4,000
Feet

Model Replication
2015 AERIAL PHOTOGRAGHY

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Mississippi River Basin
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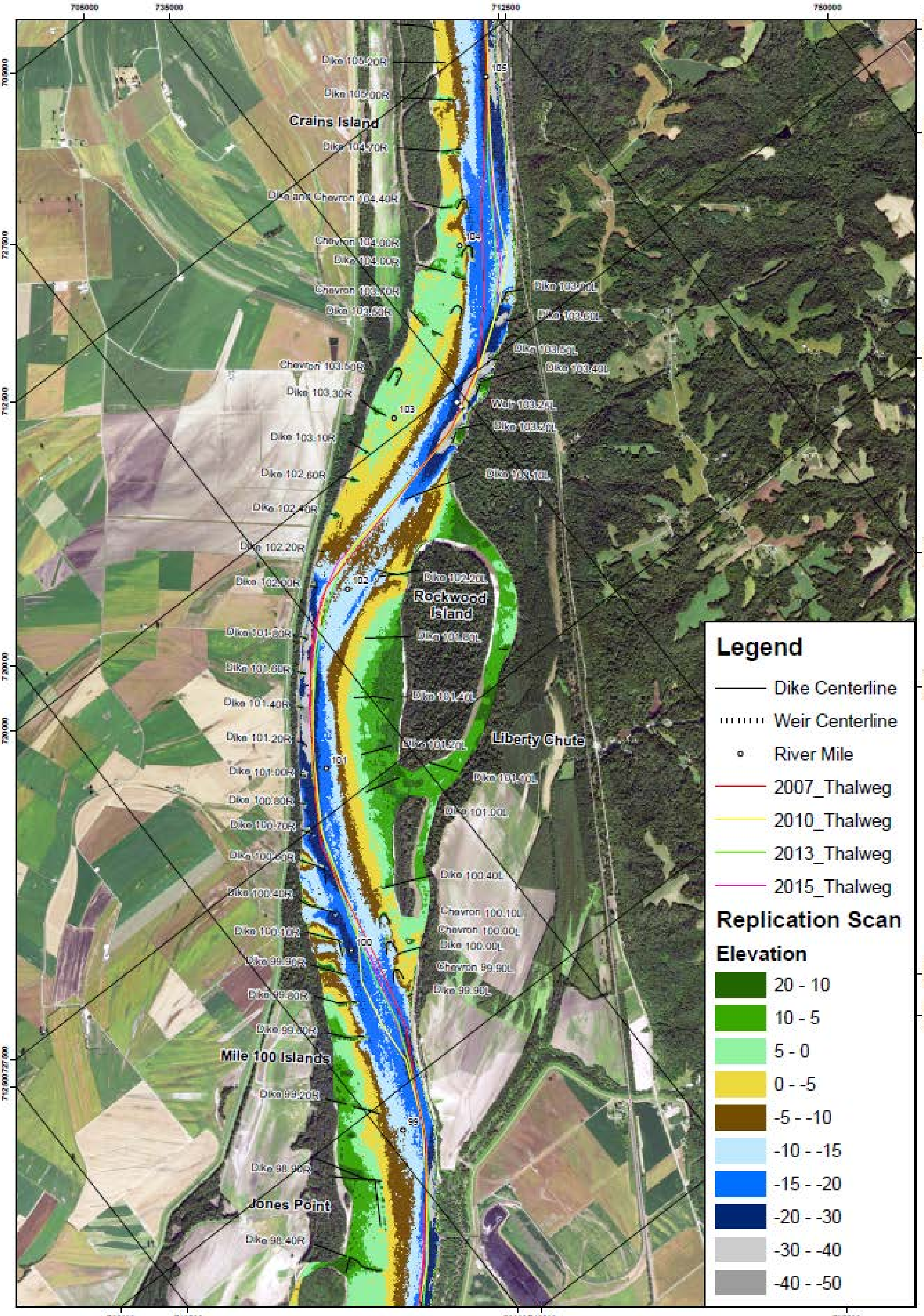

PLATE NUMBER

17A

Model vs. Prototype
Thalweg Analysis

2015 AERIAL PHOTOGRAGHY

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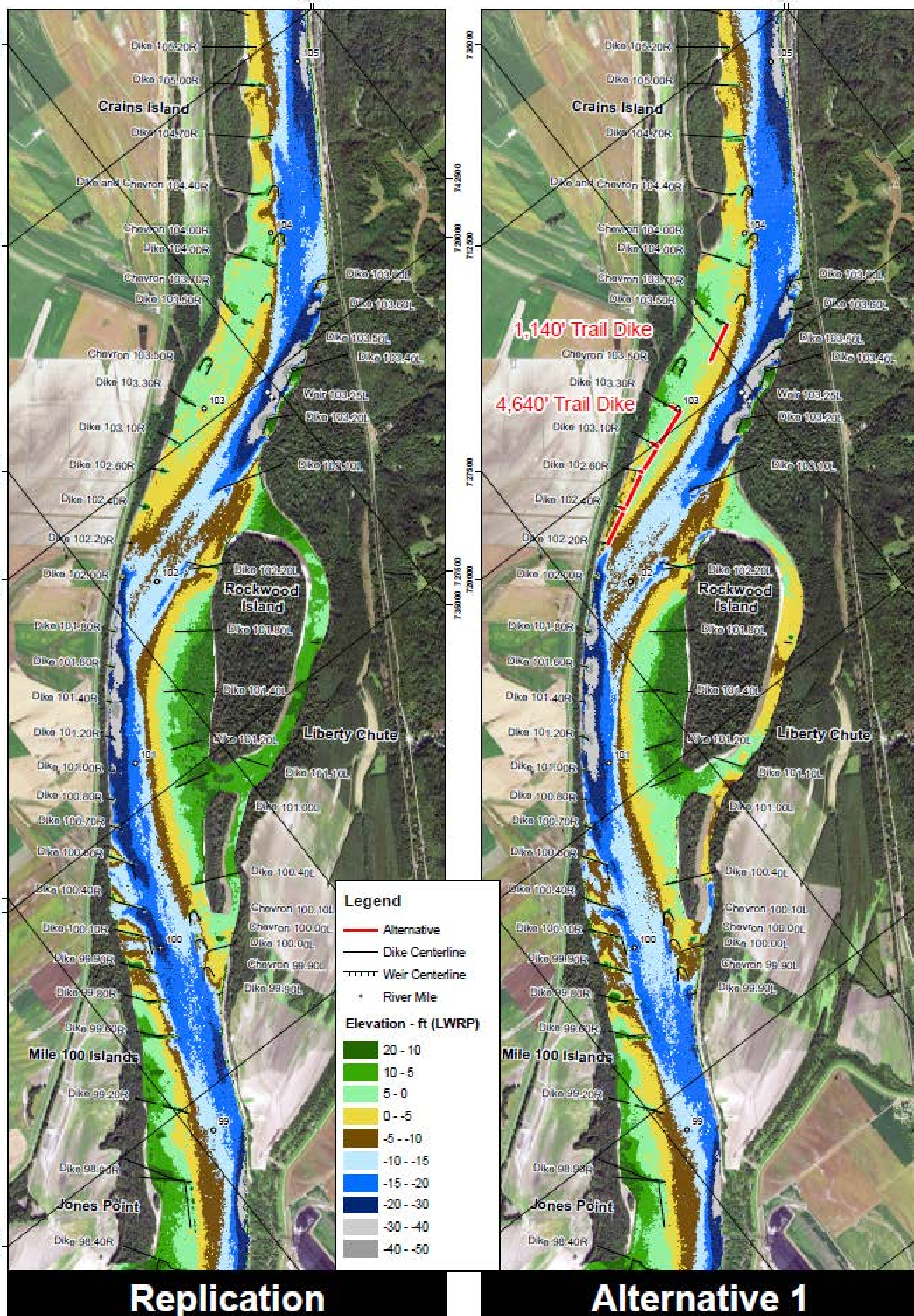

PLATE NUMBER 18	0 1,000 2,000 4,000 Feet Alternative 1 2015 AERIAL PHOTOGRAGHY	U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI Mississippi River Basin St. Louis District UMR 104 - 101.5 HSR Model	J. Brown, P.E. C. Tabbert · B. Krischel, P.E. · D. Gordon, P.E. C. Tabbert · Dave Gordon, P.E. L:/HSR Modeling/HSR Model Studies/UMR 110-99

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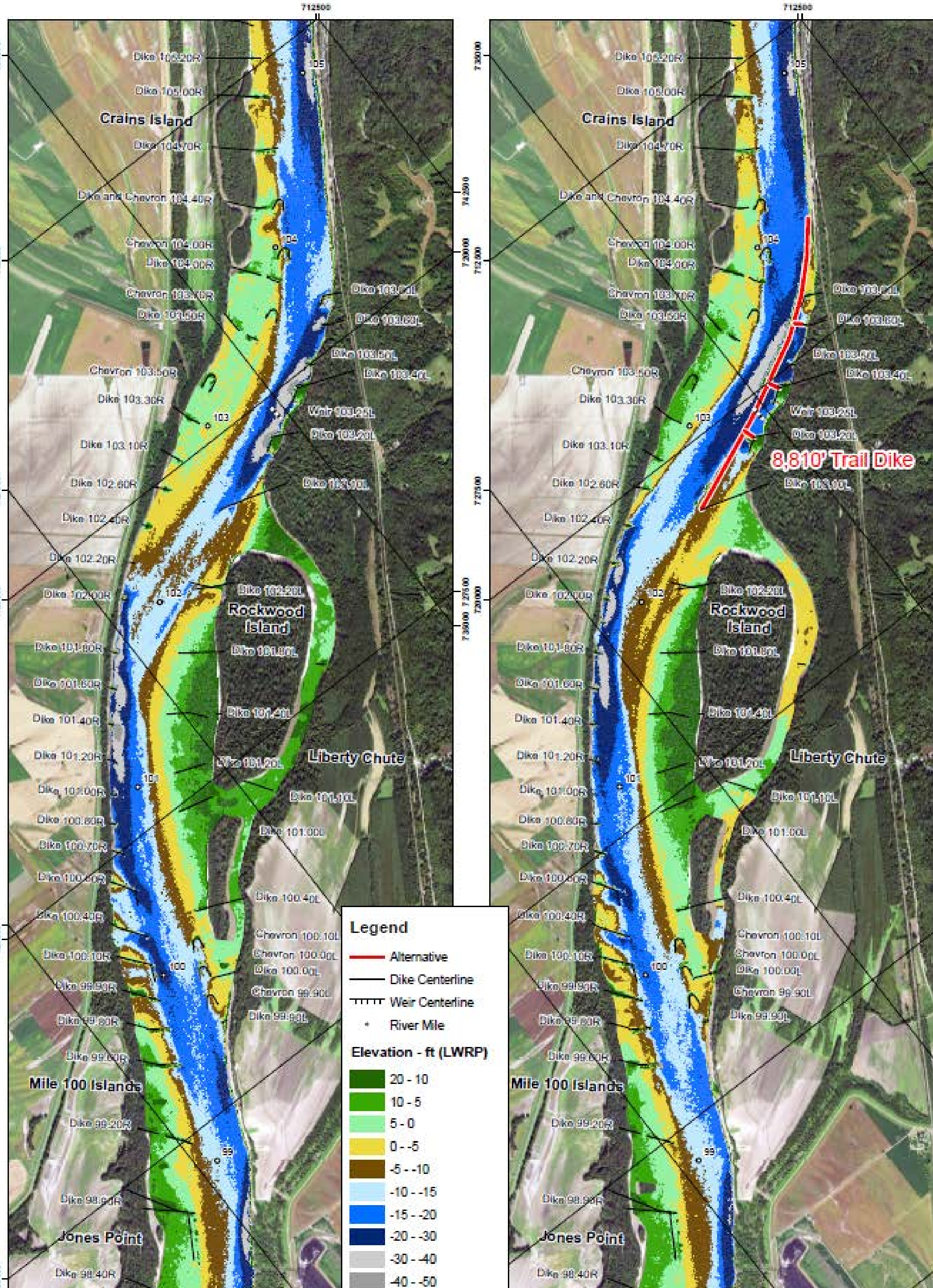

Replication | **Alternative 2**

PLATE NUMBER 19	0 1,000 2,000 4,000 Feet Alternative 2 2015 AERIAL PHOTOGRAGHY	U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI Mississippi River Basin St. Louis District UMR 104 - 101.5 HSR Model

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C. Tabbert	B. Krischel, P.E.	D. Gordon, P.E.
C. Tabbert	Dave Gordon, P.E.	
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US Army Corps of Engineers St. Louis District

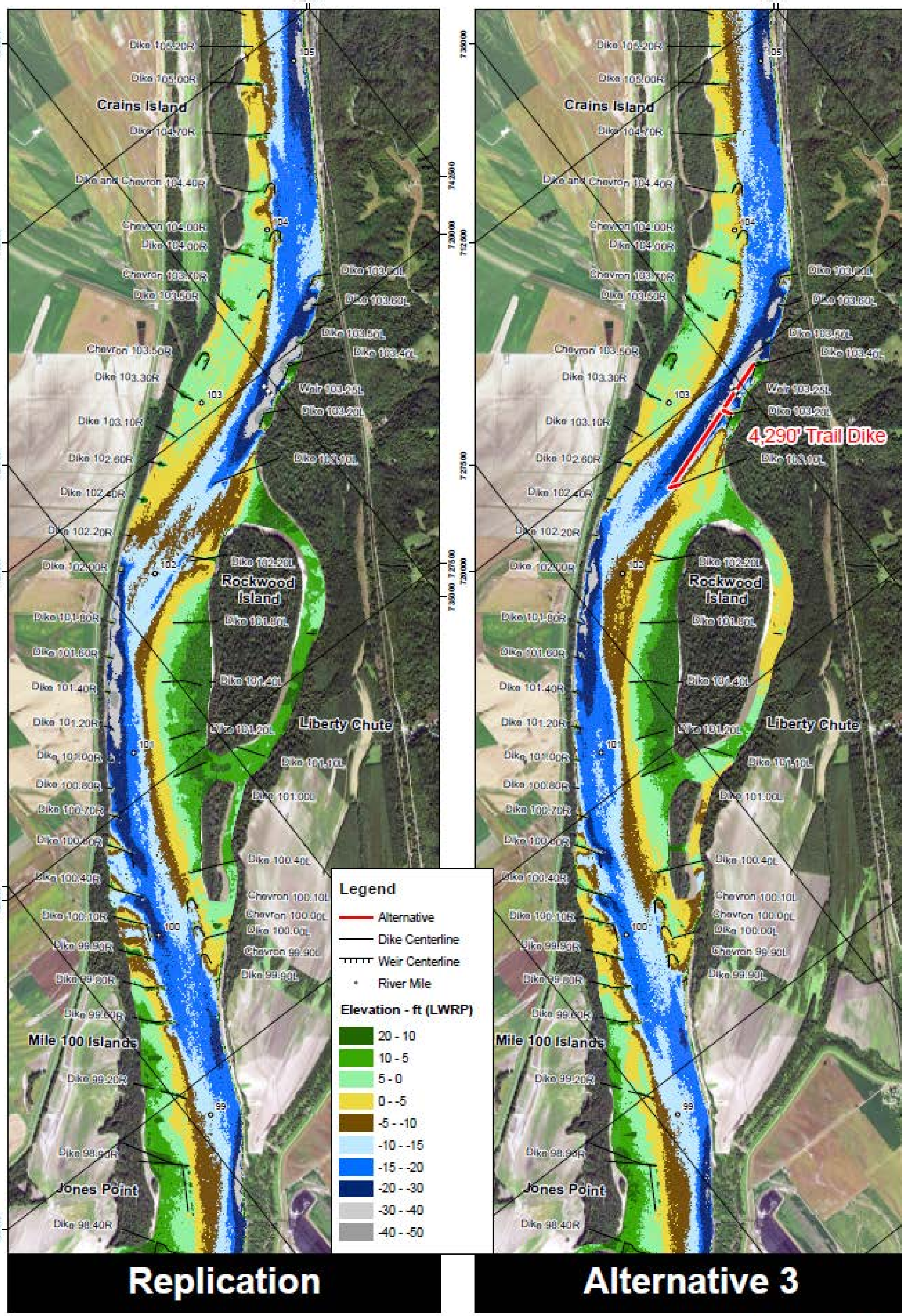

PLATE NUMBER 20

0 1,000 2,000 4,000
Feet

Alternative 3
2018 AERIAL PHOTOGRAGHY

U.S. ARMY ENGINEER DIVISION
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Mississippi River Basin
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UMR 104 - 101.5
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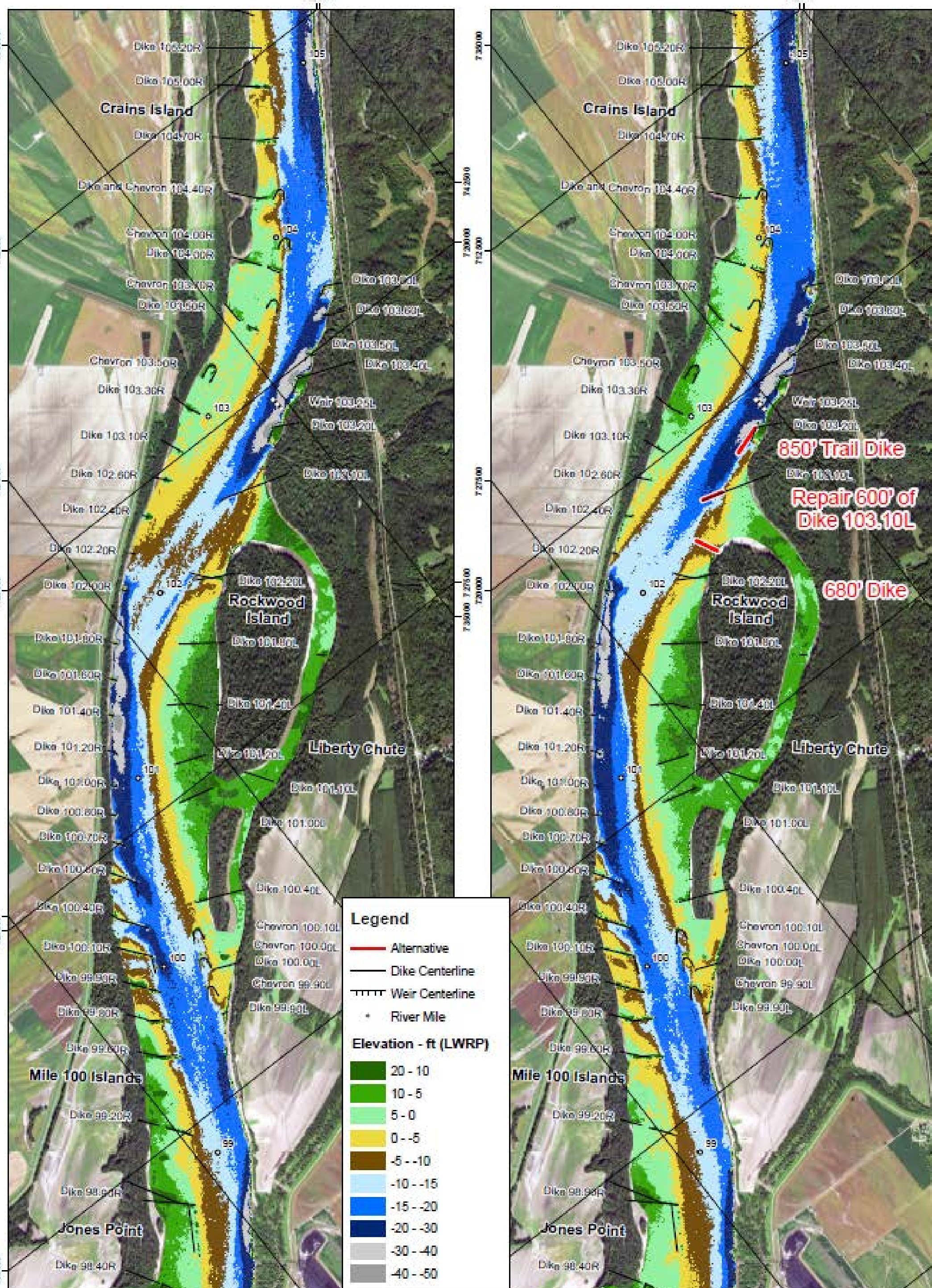
St. Louis District



Replication | **Alternative 4**

PLATE NUMBER 21

0 1,000 2,000 4,000
Feet

Alternative 4
2015 AERIAL PHOTOGRAGHY

U.S. ARMY ENGINEER DIVISION
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Mississippi River Basin
St. Louis District
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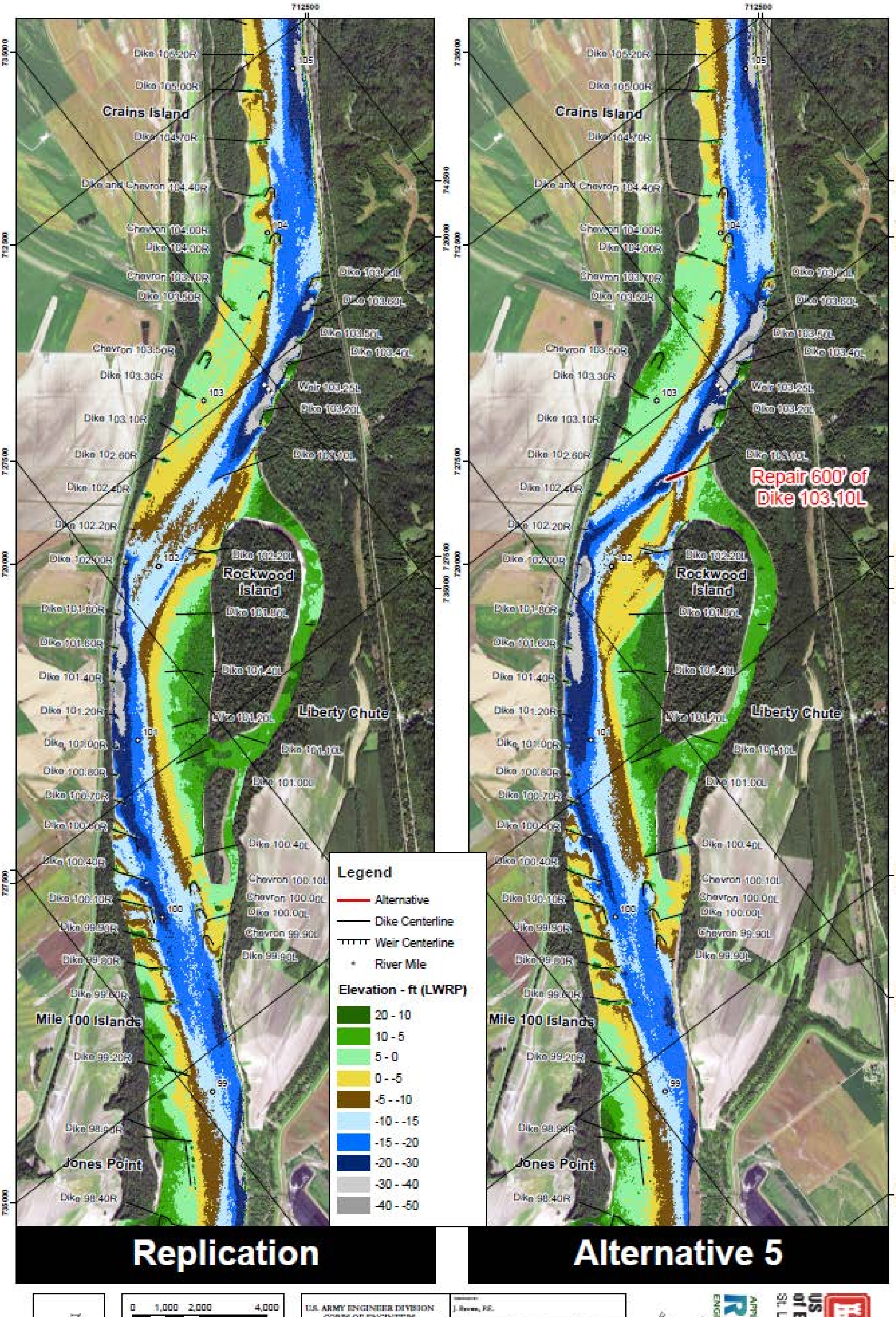

PLATE NUMBER 22

0 1,000 2,000 4,000
Feet

Alternative 5

2015 AERIAL PHOTOGRAGHY

U.S. ARMY ENGINEER DIVISION
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ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
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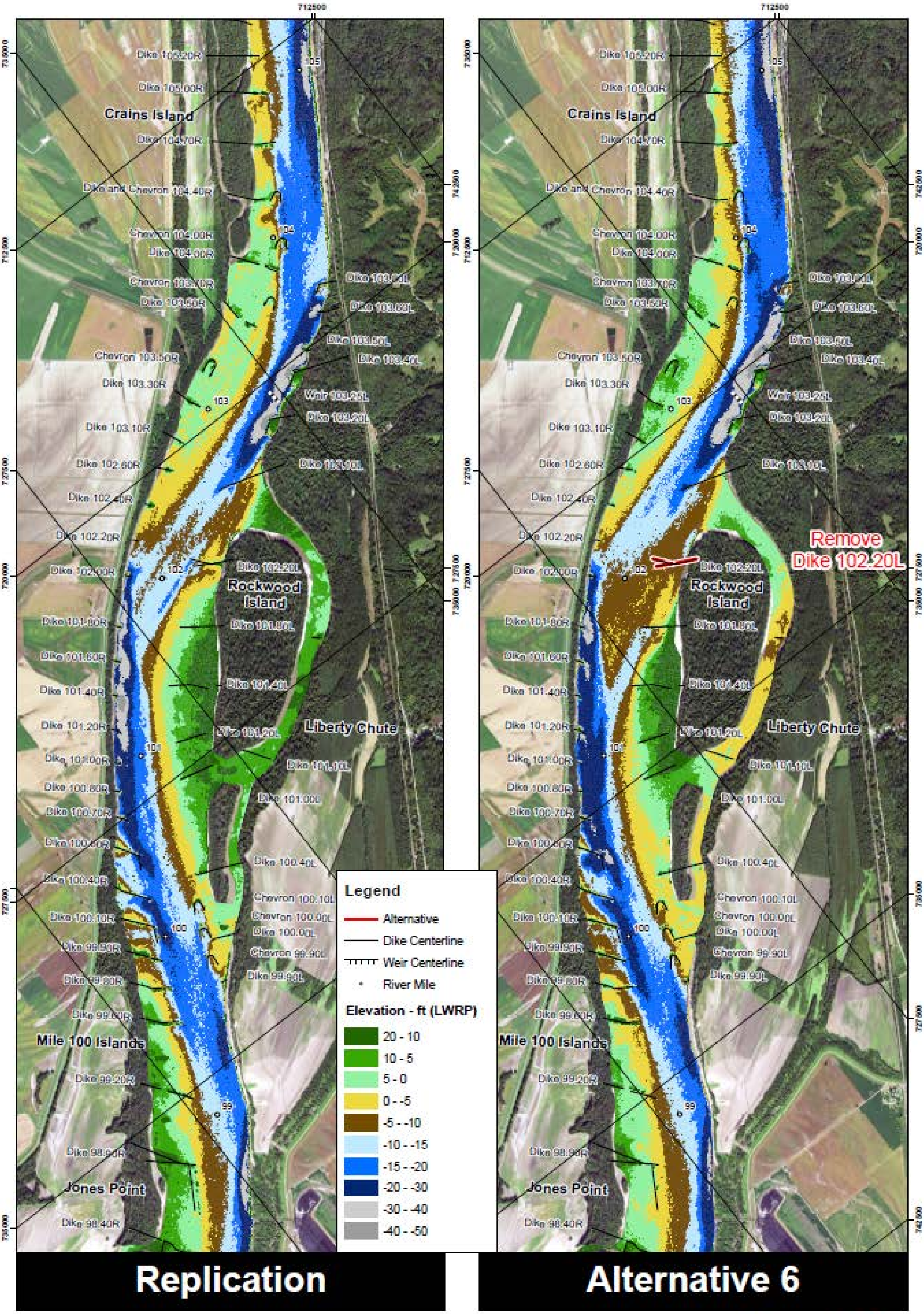

PLATE NUMBER 23

0 1,000 2,000 4,000
Feet

Alternative 6
2015 AERIAL PHOTOGRAGHY

U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

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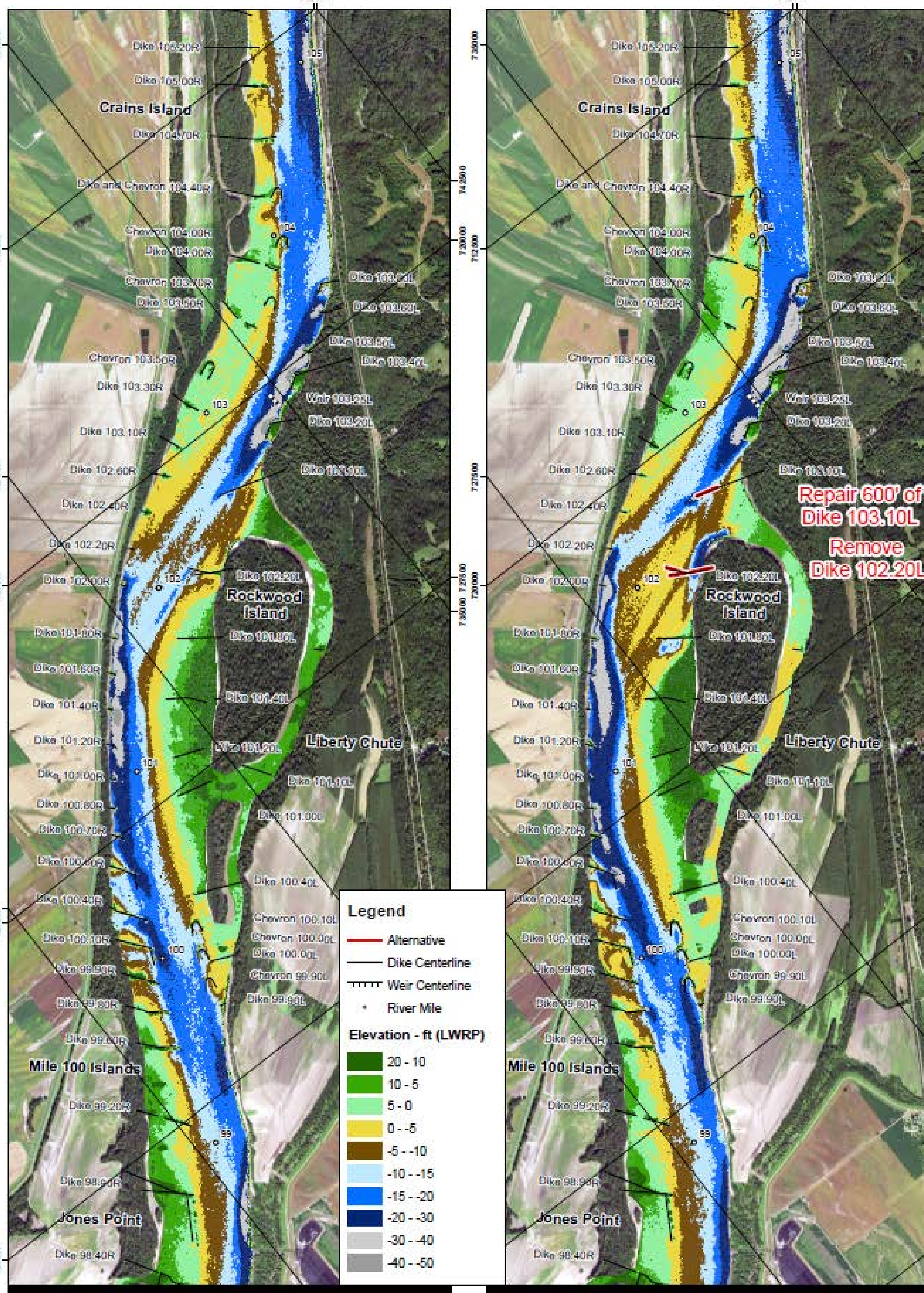

Replication

Alternative 7

PLATE NUMBER

24

0 1,000 2,000 4,000

Feet

Alternative 7

2015 AERIAL PHOTOGRAGHY

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CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

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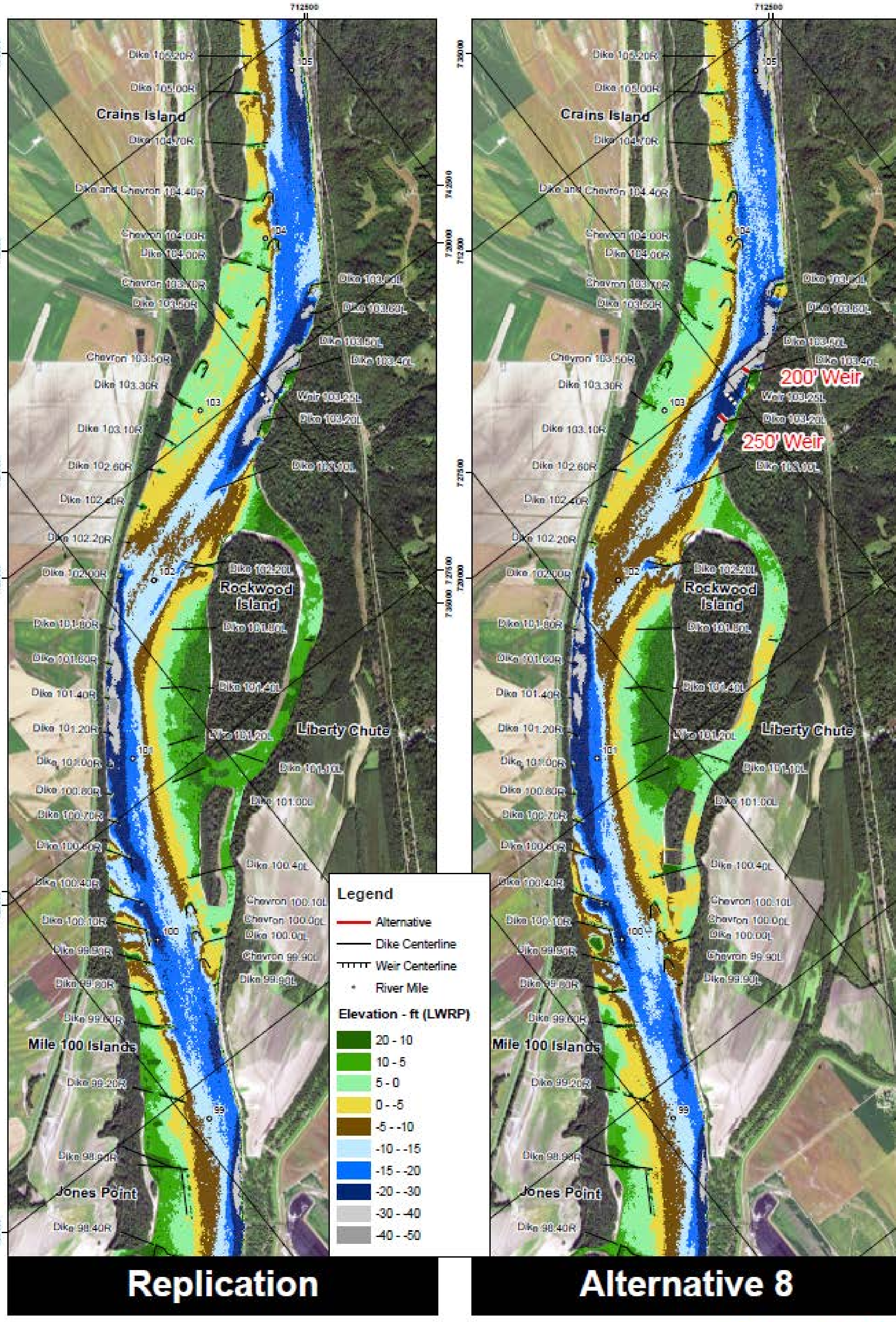

PLATE NUMBER 25

0 1,000 2,000 4,000
Feet

Alternative 8

2015 AERIAL PHOTOGRAGHY

U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

J. Brown, P.E.
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Dave Gordon, P.E.
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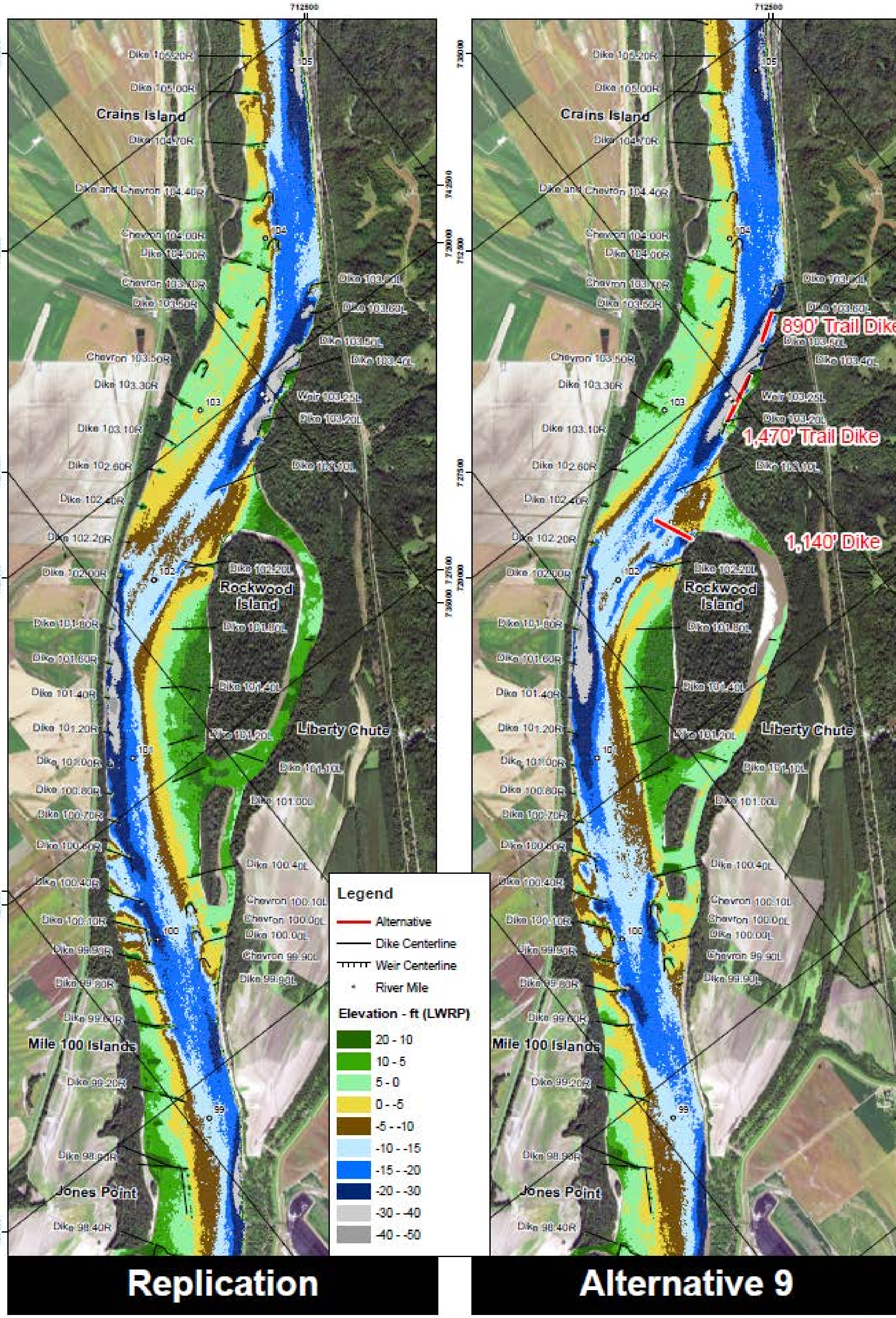

PLATE NUMBER 26	0 1,000 2,000 4,000 Feet Alternative 9 2018 AERIAL PHOTOGRAGHY	U.S. ARMY ENGINEER DIVISION CORPS OF ENGINEERS ST. LOUIS, MISSOURI Mississippi River Basin St. Louis District UMR 104 - 101.5 HSR Model	J. Brown, P.E.; C. Tabbert; B. Krischel, P.E.; D. Gordon, P.E.; C. Tabbert; Dave Gordon, P.E.; L:/HSR Modeling/HSR Model Studies/UMR 110-99

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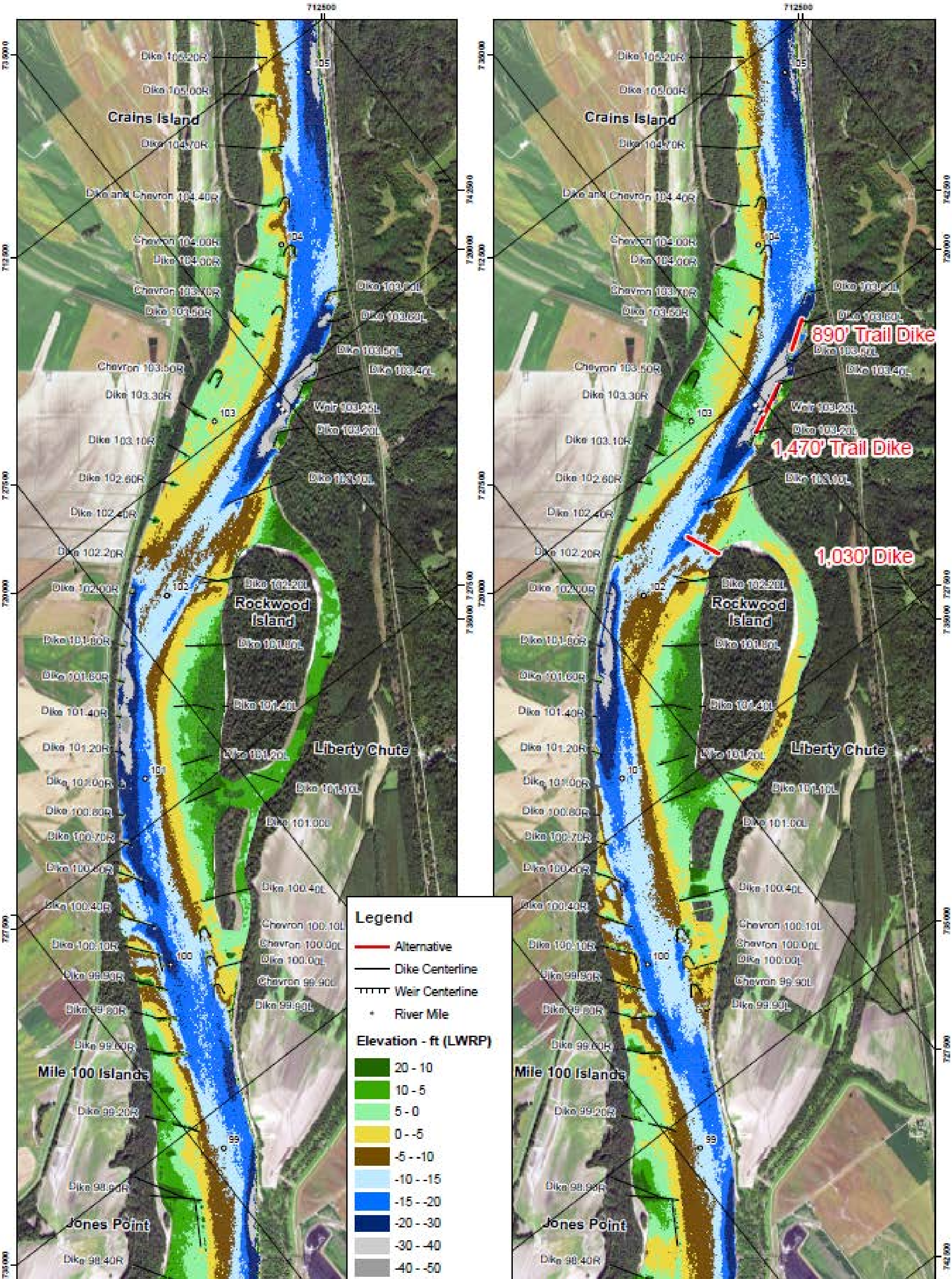

Replication | **Alternative 10**

PLATE NUMBER 27

0 1,000 2,000 4,000 Feet

Alternative 10

2015 AERIAL PHOTOGRAGHY

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Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

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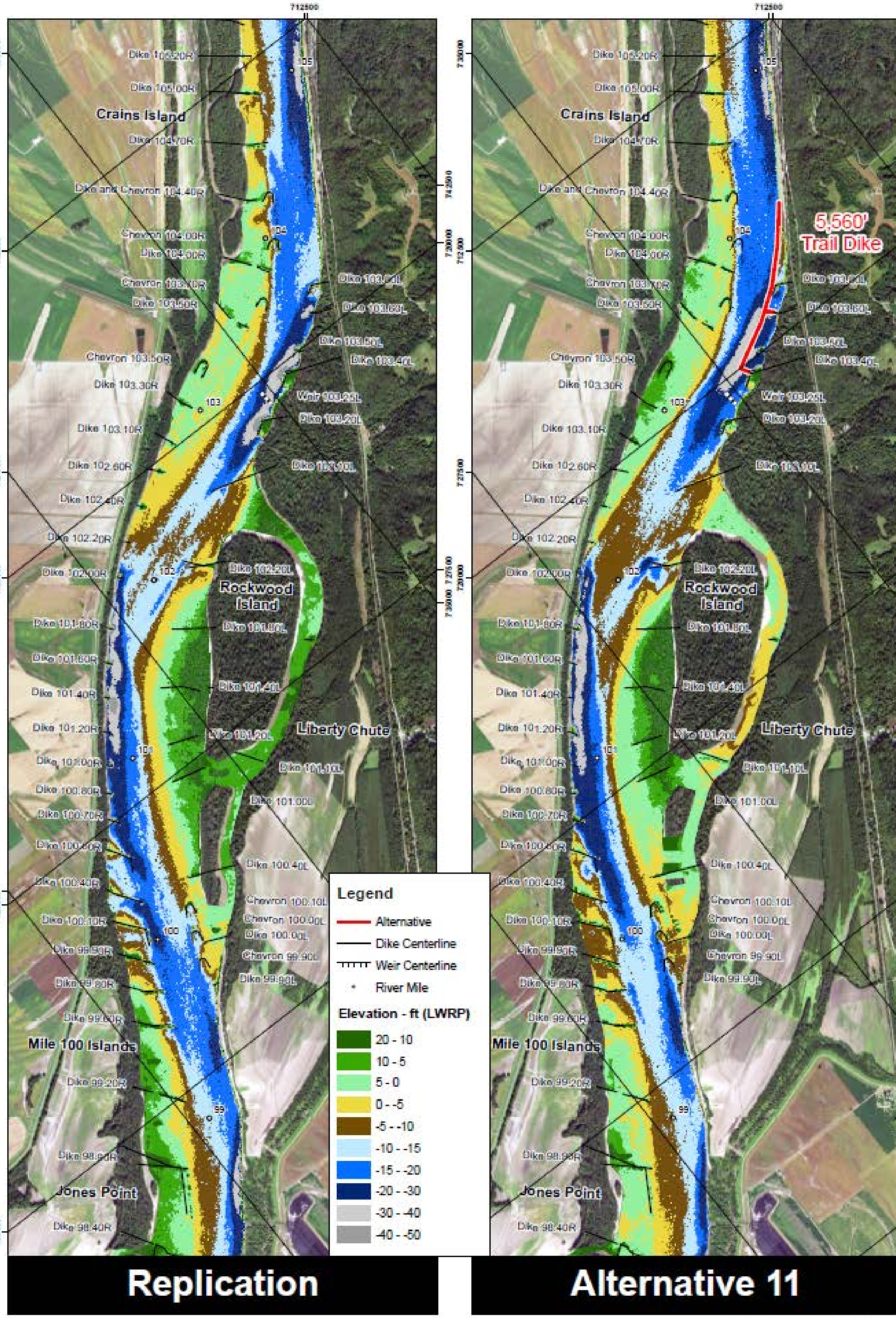

PLATE NUMBER 28

0 1,000 2,000 4,000
Feet

Alternative 11

2015 AERIAL PHOTOGRAPHY

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ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

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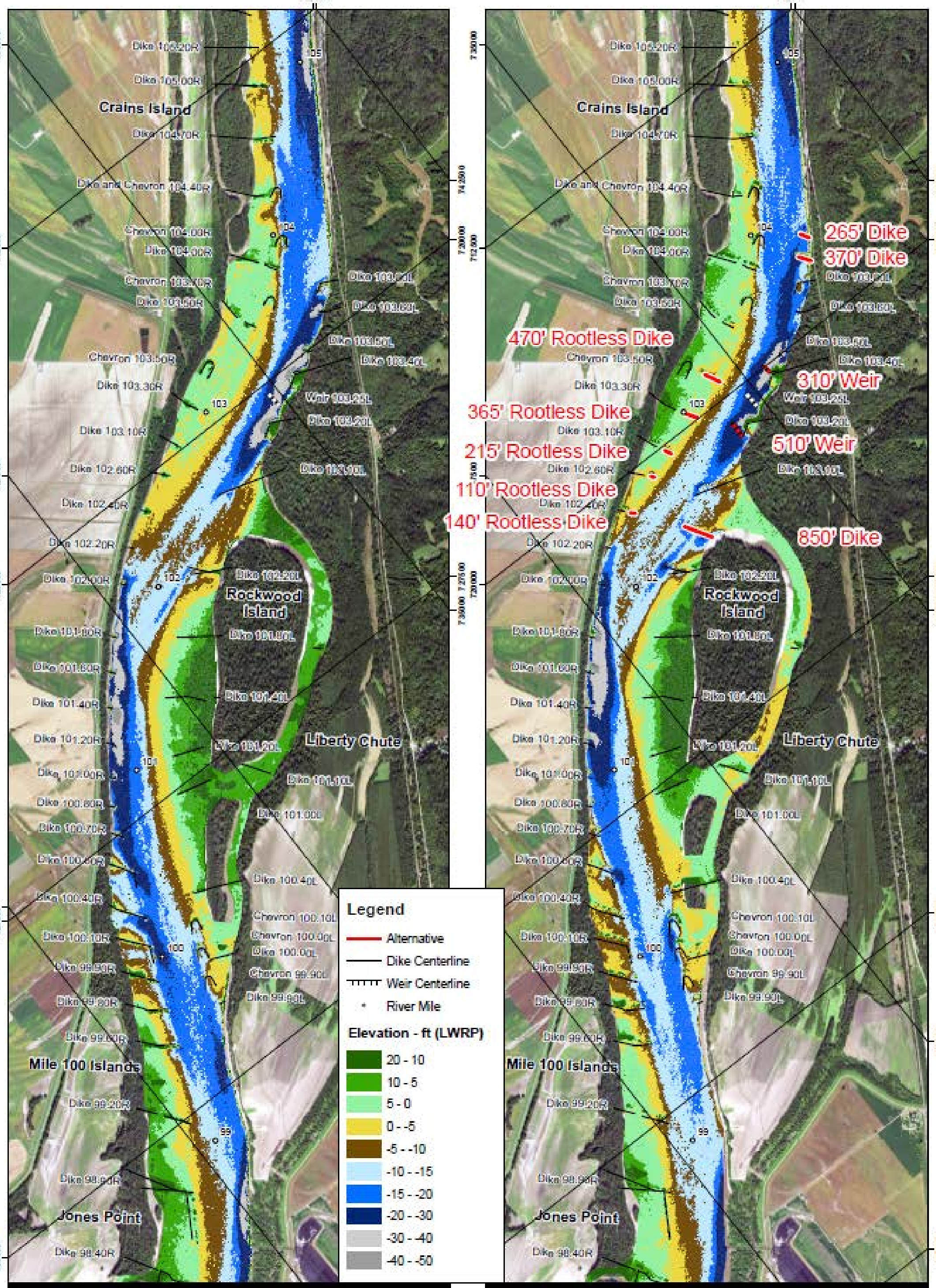

Replication | **Alternative 12**

PLATE NUMBER 29

0 1,000 2,000 4,000
Feet

Alternative 12
2015 AERIAL PHOTOGRAPHY

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ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

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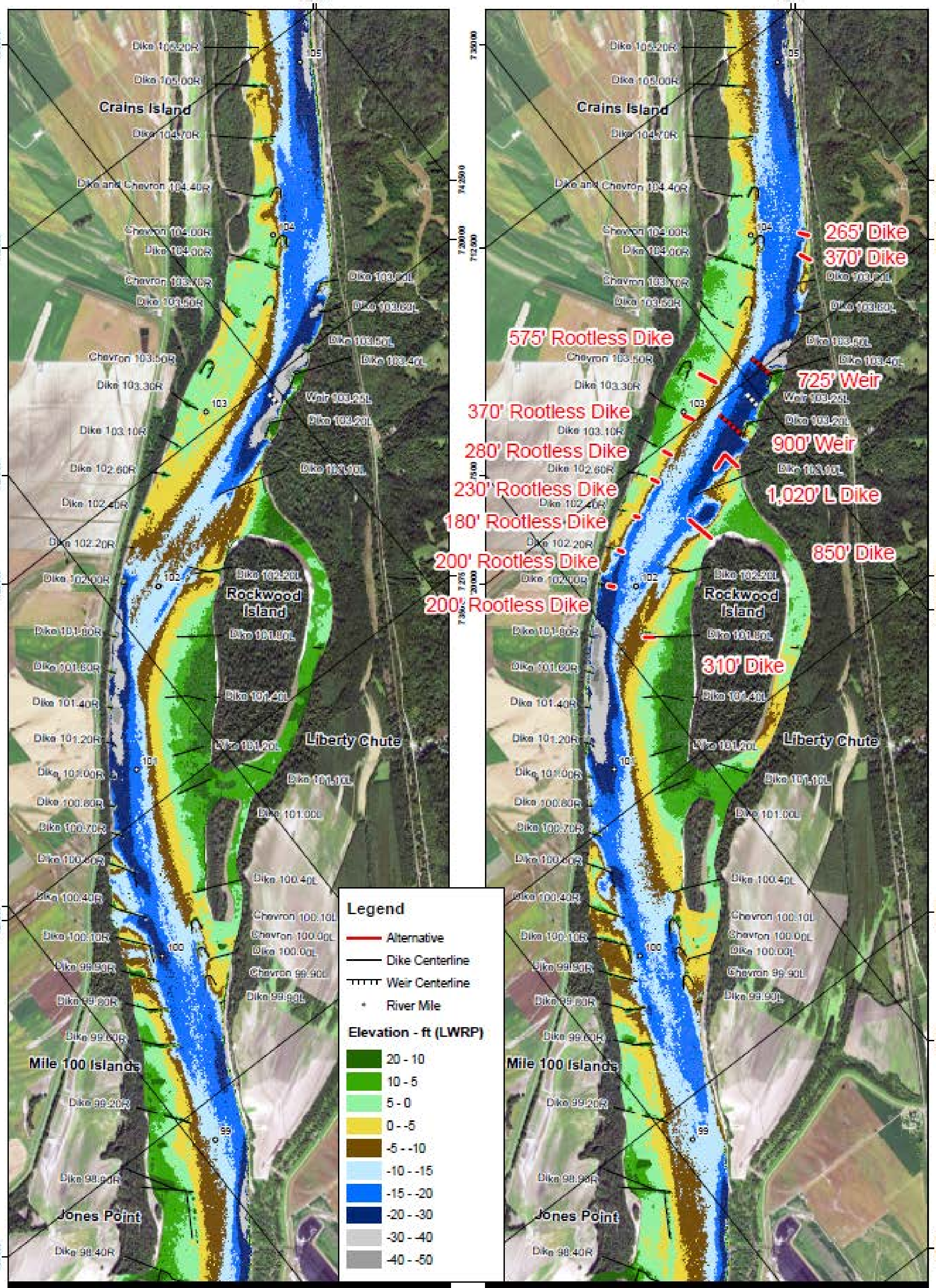

Replication | **Alternative 12A**

PLATE NUMBER 30

0 1,000 2,000 4,000
Feet

Alternative 12A
2015 AERIAL PHOTOGRAPHY

U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

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St. Louis District

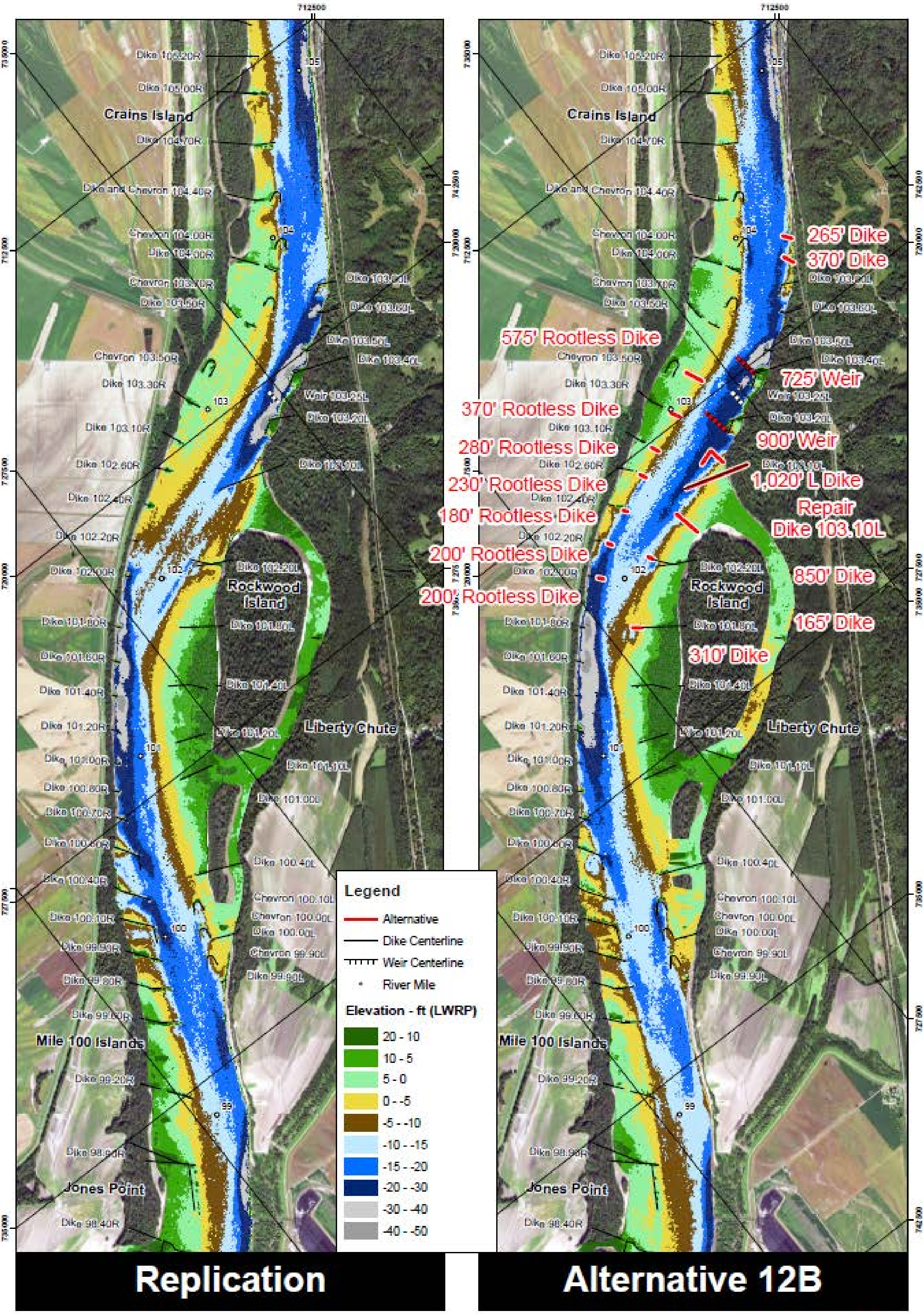

PLATE NUMBER 31

0 1,000 2,000 4,000
Feet

Alternative 12B
2015 AERIAL PHOTOGRAGHY

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ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

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C. Tabbert
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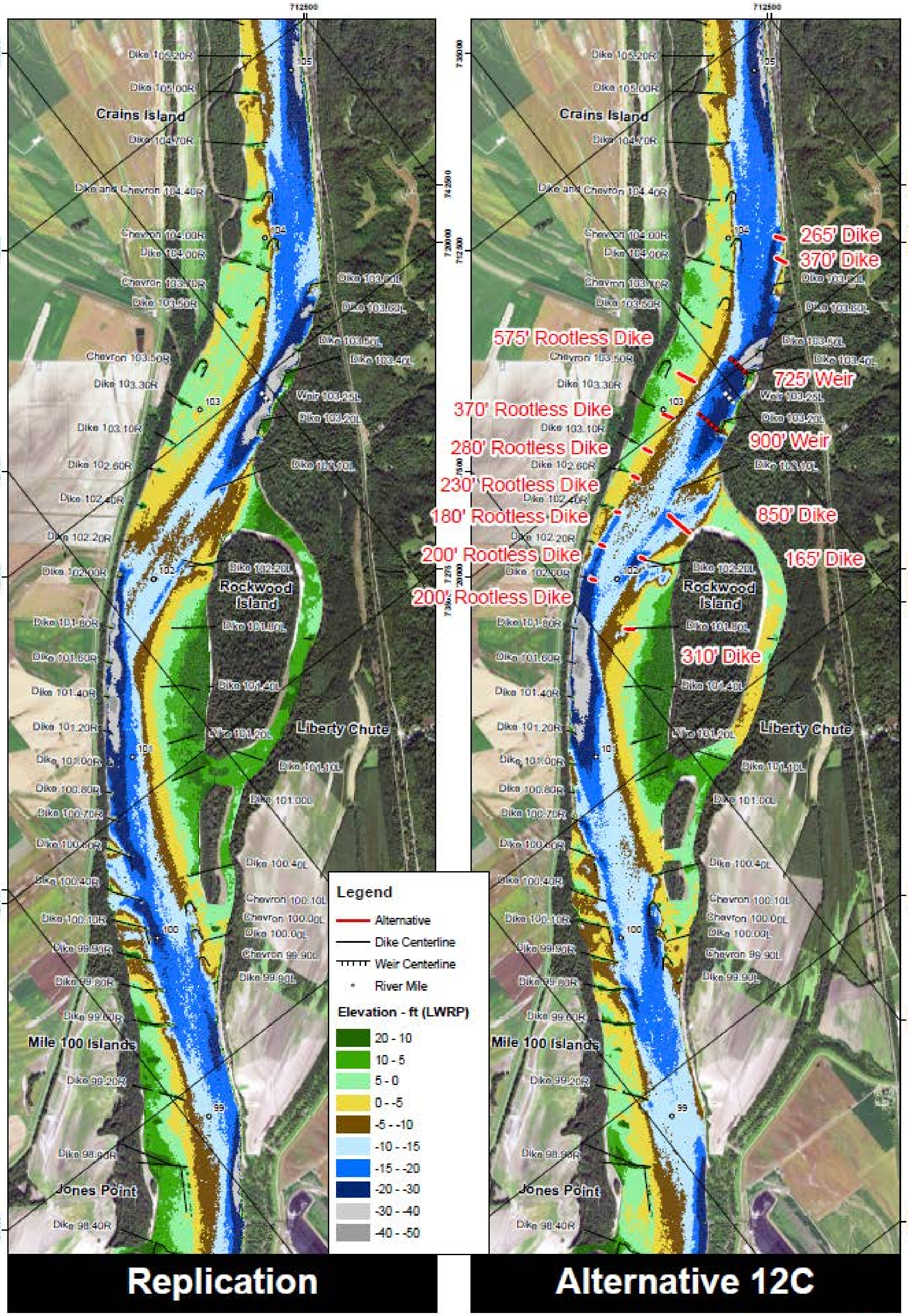

PLATE NUMBER 32

0 1,000 2,000 4,000
Feet

Alternative 12C

2015 AERIAL PHOTOGRAGHY

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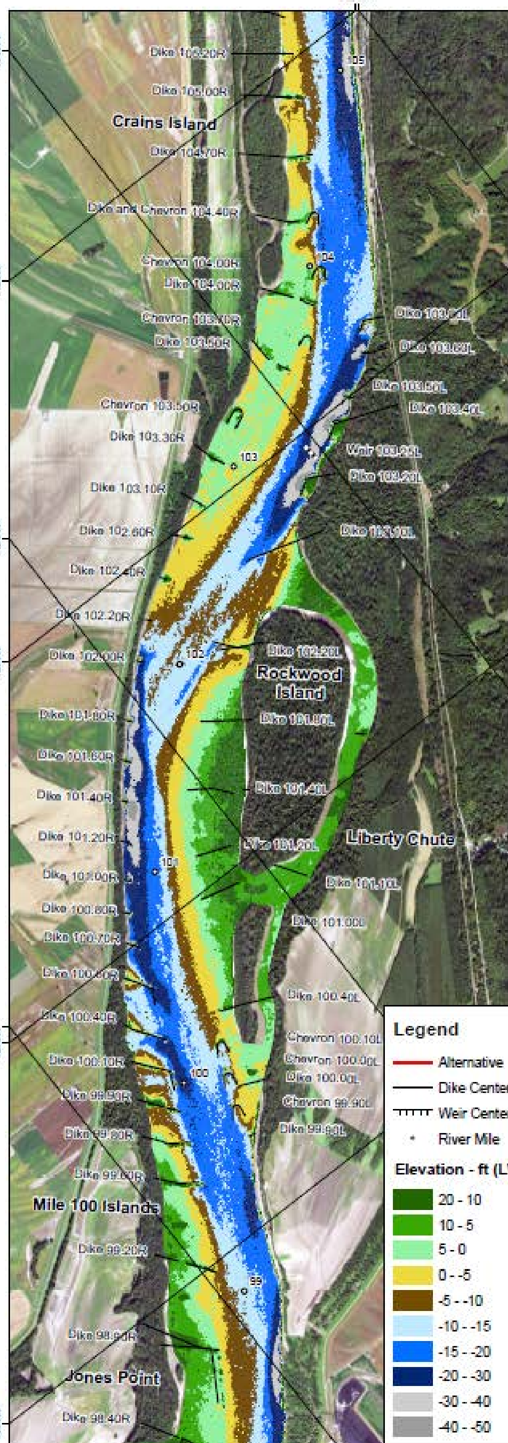
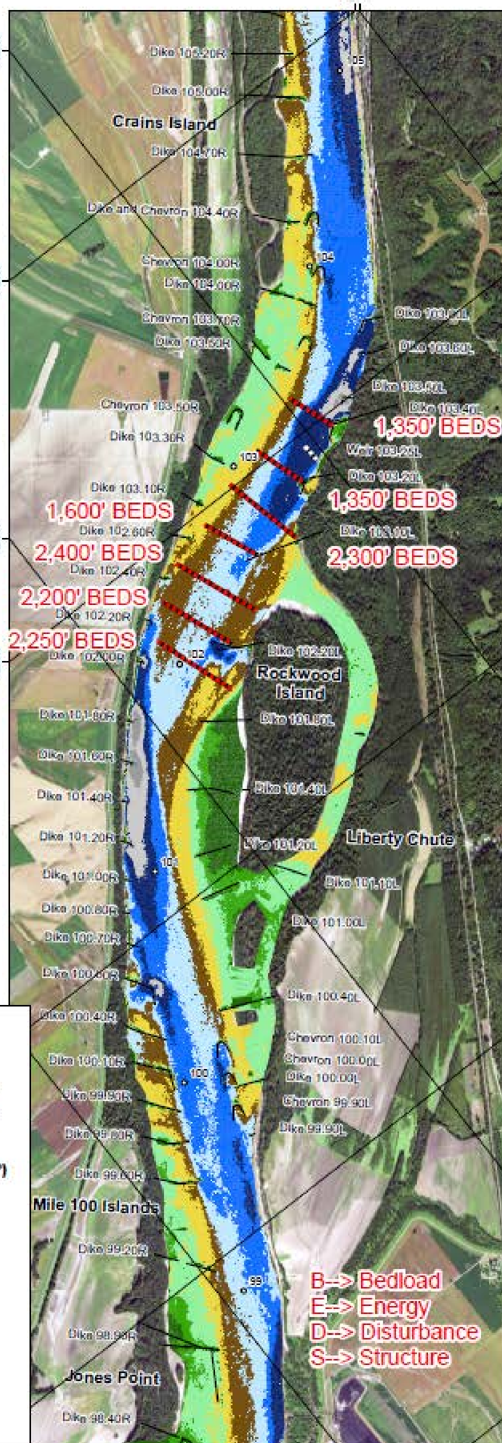


Replication



Alternative 13

Legend

- Alternative
- Dike Centerline
- Weir Centerline
- River Mile

Elevation - ft (LWRP)

- 20 - 10
- 10 - 5
- 5 - 0
- 0 - -5
- -5 - -10
- -10 - -15
- -15 - -20
- -20 - -30
- -30 - -40
- -40 - -50

PLATE NUMBER 33

0 1,000 2,000 4,000
Feet

Alternative 13
2018 AERIAL PHOTOGRAGHY

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ST. LOUIS, MISSOURI

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Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

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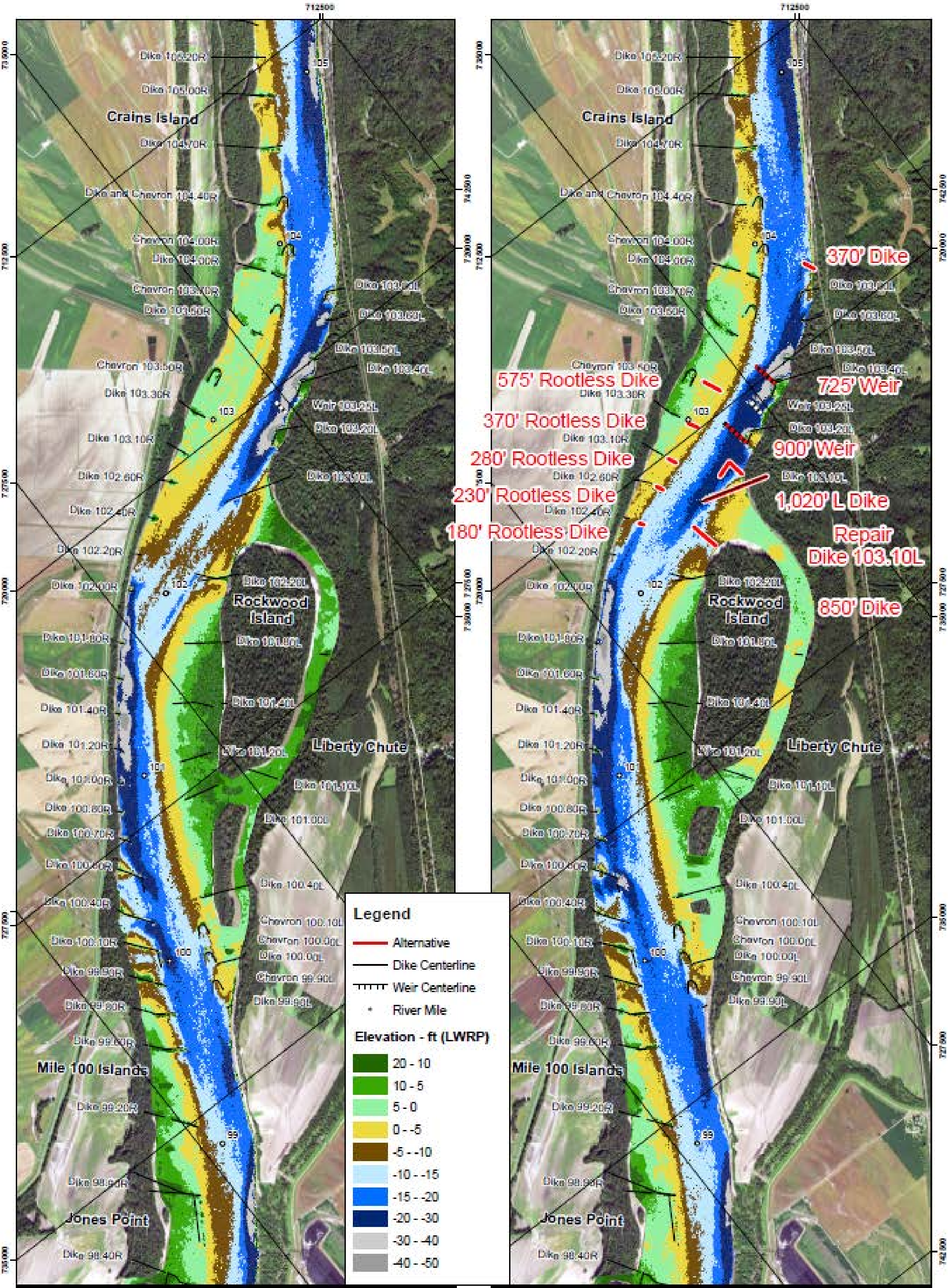

Replication | **Alternative 14**

PLATE NUMBER 34

0 1,000 2,000 4,000
Feet

Alternative 14

2015 AERIAL PHOTOGRAPHY

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Mississippi River Basin
St. Louis District
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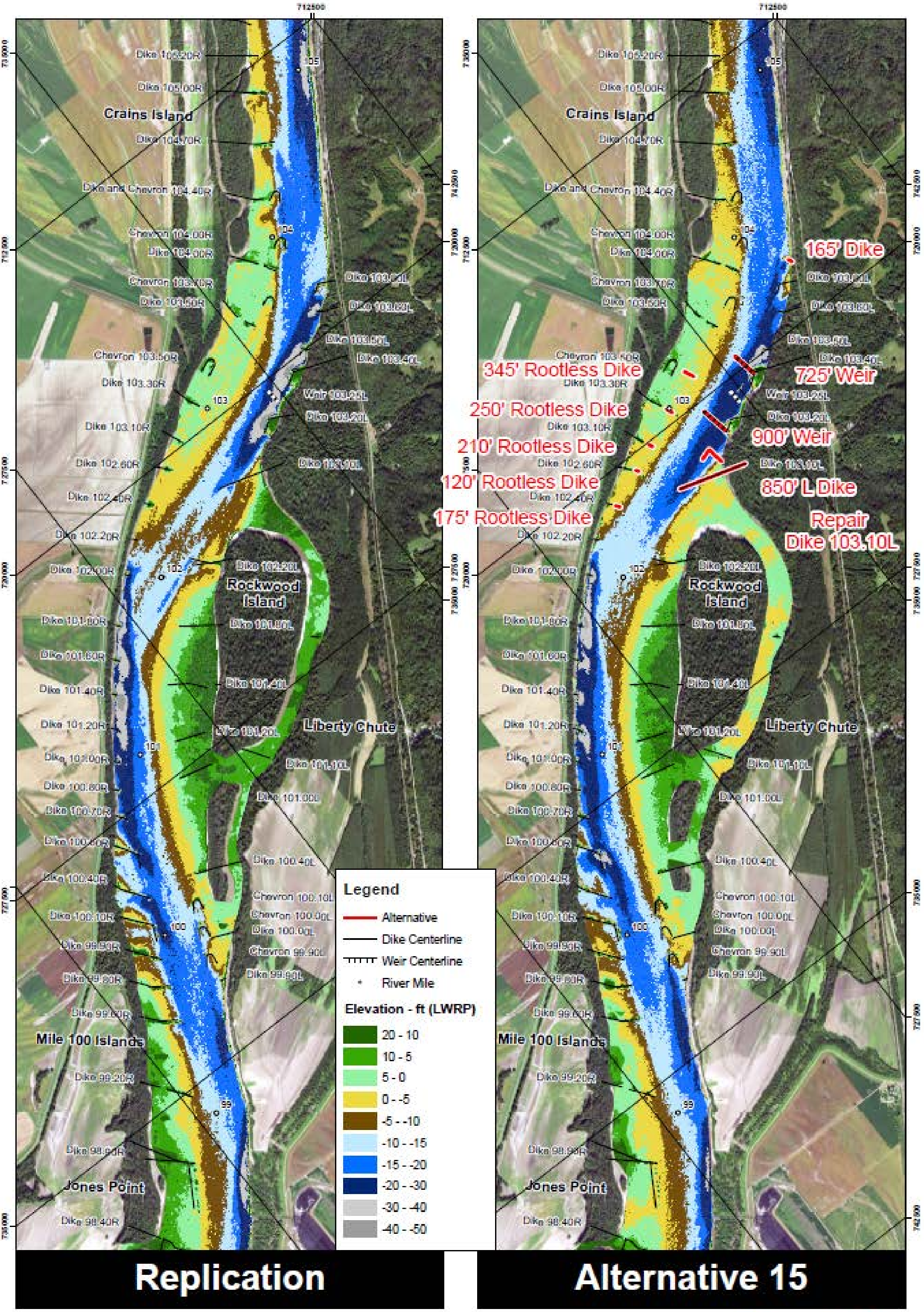

PLATE NUMBER 35

0 1,000 2,000 4,000
Feet

Alternative 15
2015 AERIAL PHOTOGRAGHY

U.S. ARMY ENGINEER DIVISION
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ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
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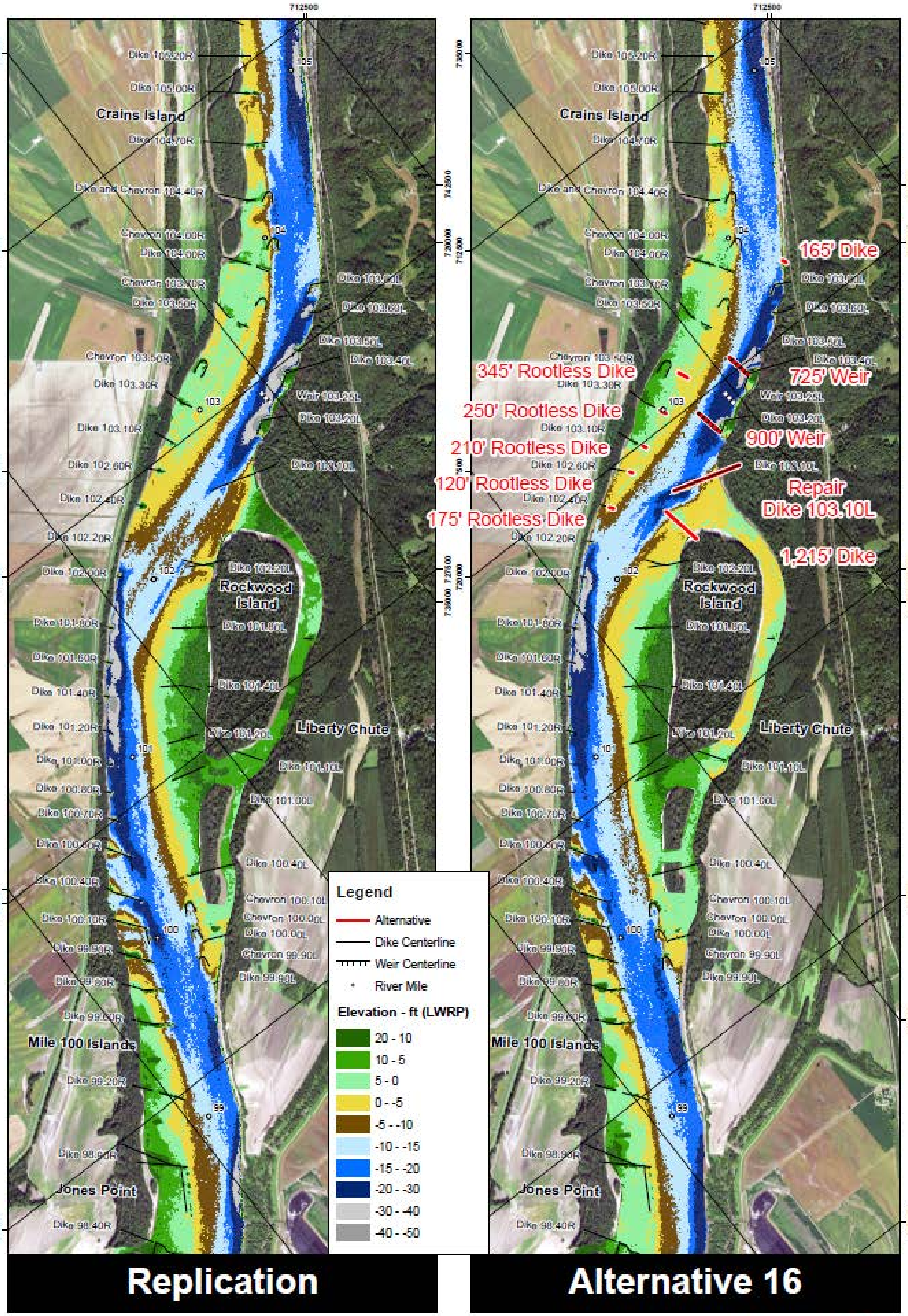

PLATE NUMBER 36

0 1,000 2,000 4,000
Feet

Alternative 16
2015 AERIAL PHOTOGRAGHY

U.S. ARMY ENGINEER DIVISION
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Mississippi River Basin
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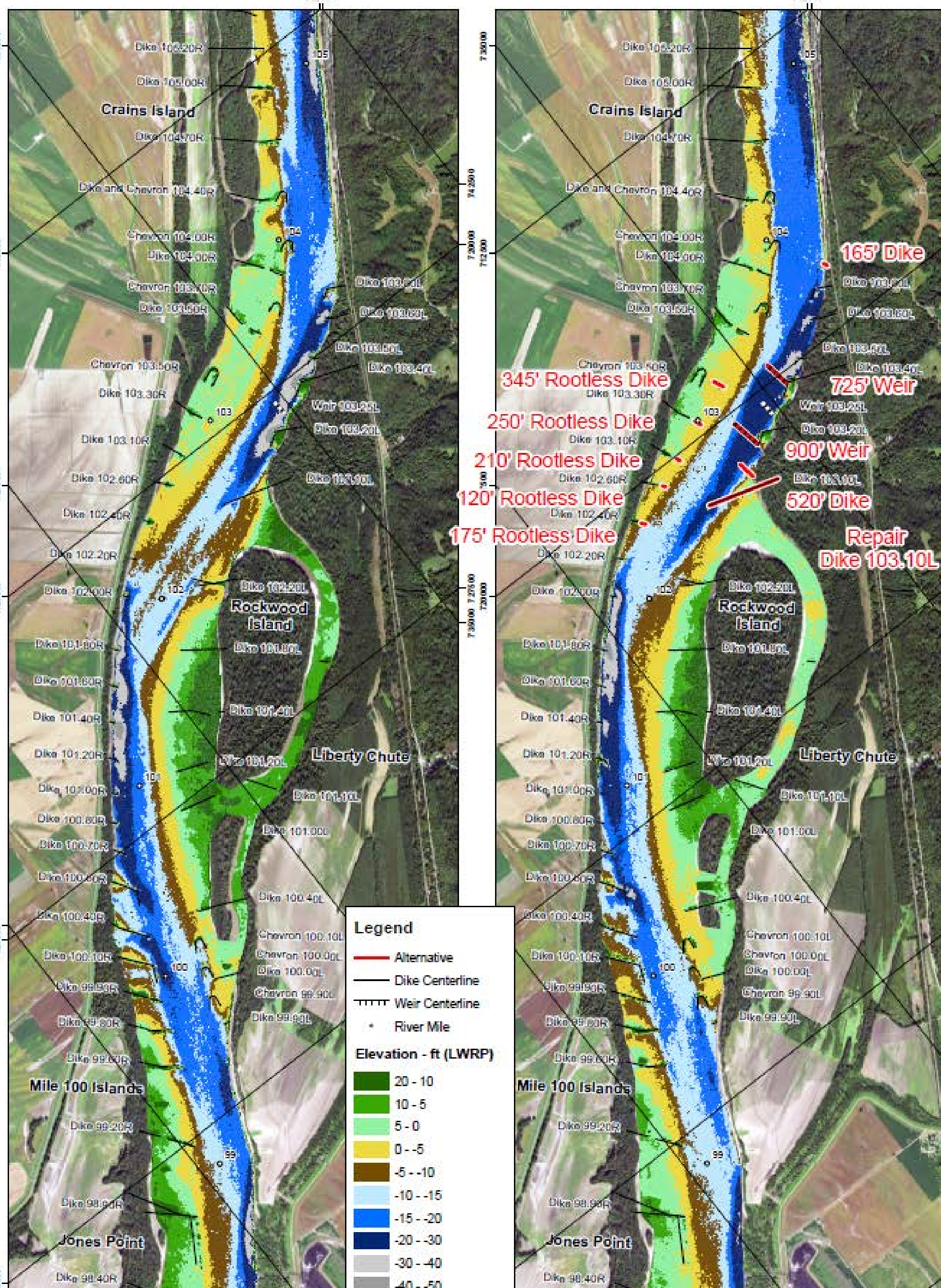
C. Tabbert
B. Krischel, P.E.
D. Gordon, P.E.
C. Tabbert
Dave Gordon, P.E.
L:/HSR Modeling/HSR Model Studies/UMR 110-99

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District



Replication | **Alternative 17**

PLATE NUMBER 37

0 1,000 2,000 4,000
Feet

Alternative 17
2015 AERIAL PHOTOGRAGHY

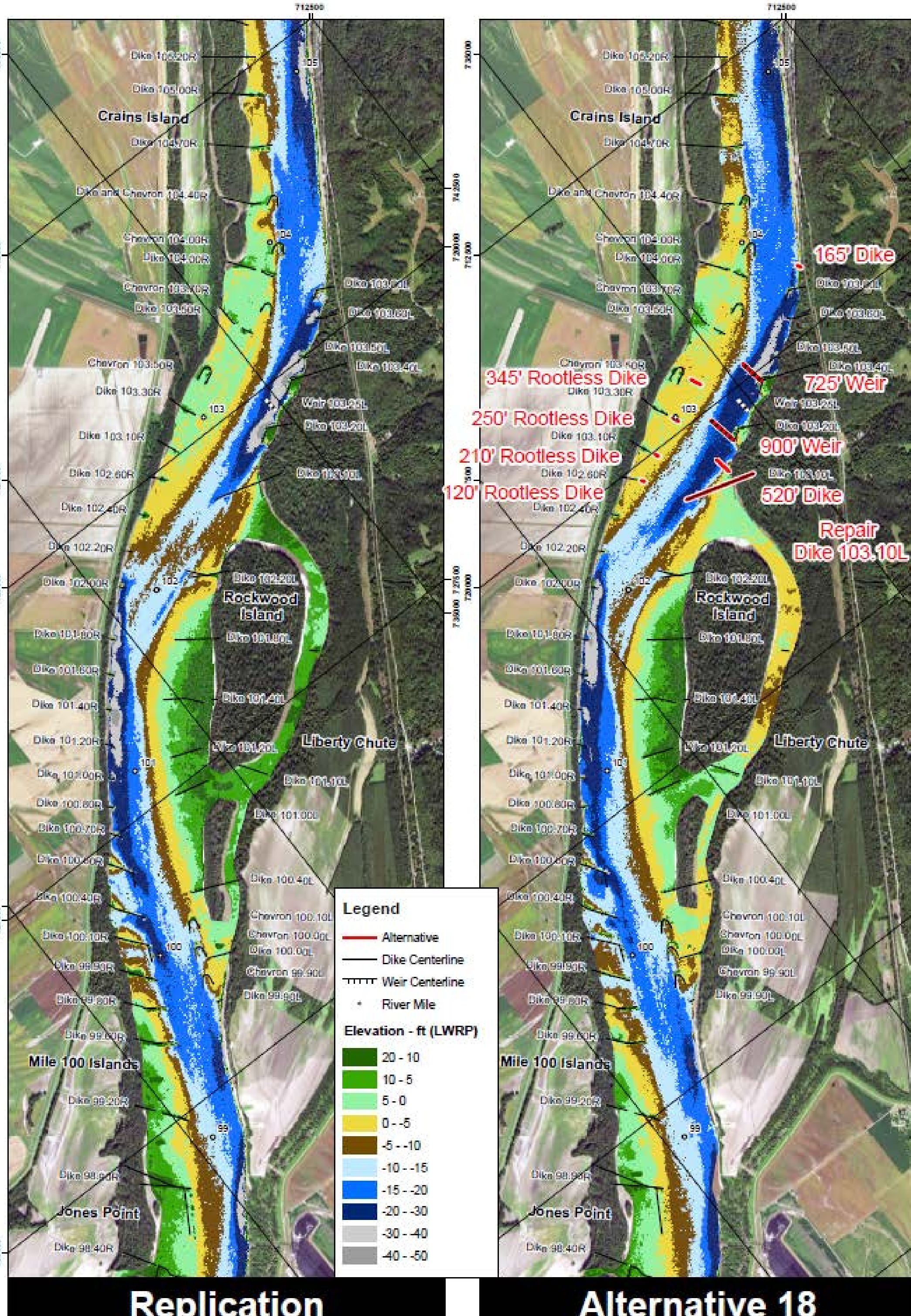
U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

J. Brown, P.E.
C. Tabbert
R. Kreichel, P.E.
D. Gordon, P.E.
C. Tabbert
Dave Gordon, P.E.

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District



Replication | **Alternative 18**

PLATE NUMBER 38

0 1,000 2,000 4,000
Feet

Alternative 18

2015 AERIAL PHOTOGRAGHY

U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

J. Brown, P.E.

C. Tahbeni | B. Kreinhel, P.E. | D. Gordon, P.E.

C. Tahbeni | Dave Gordon, P.E.

L:/HSR Modeling/HSR Model Studies/UMR 110-90

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

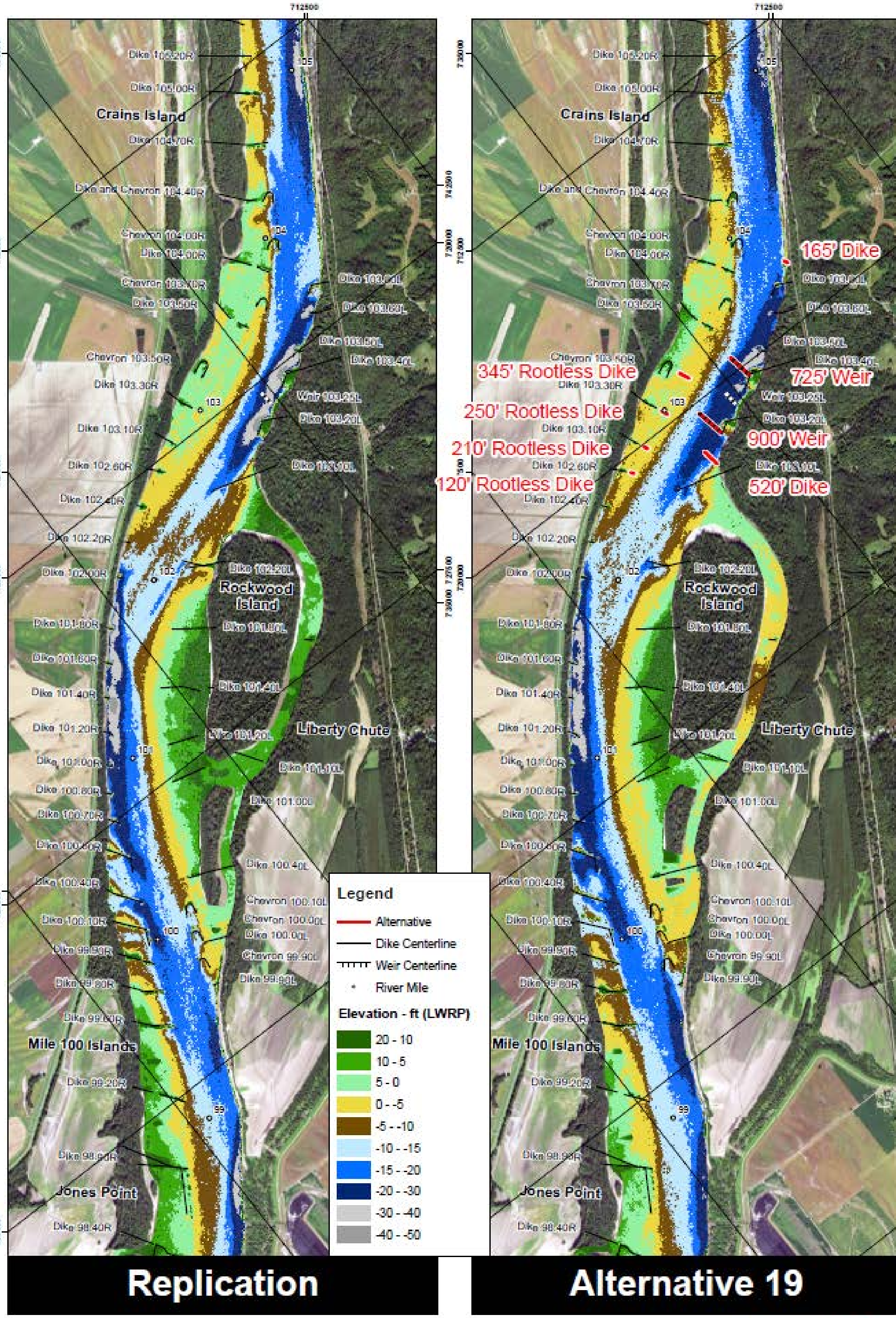


PLATE NUMBER 39

0 1,000 2,000 4,000
Feet

Alternative 19
2018 AERIAL PHOTOGRAGHY

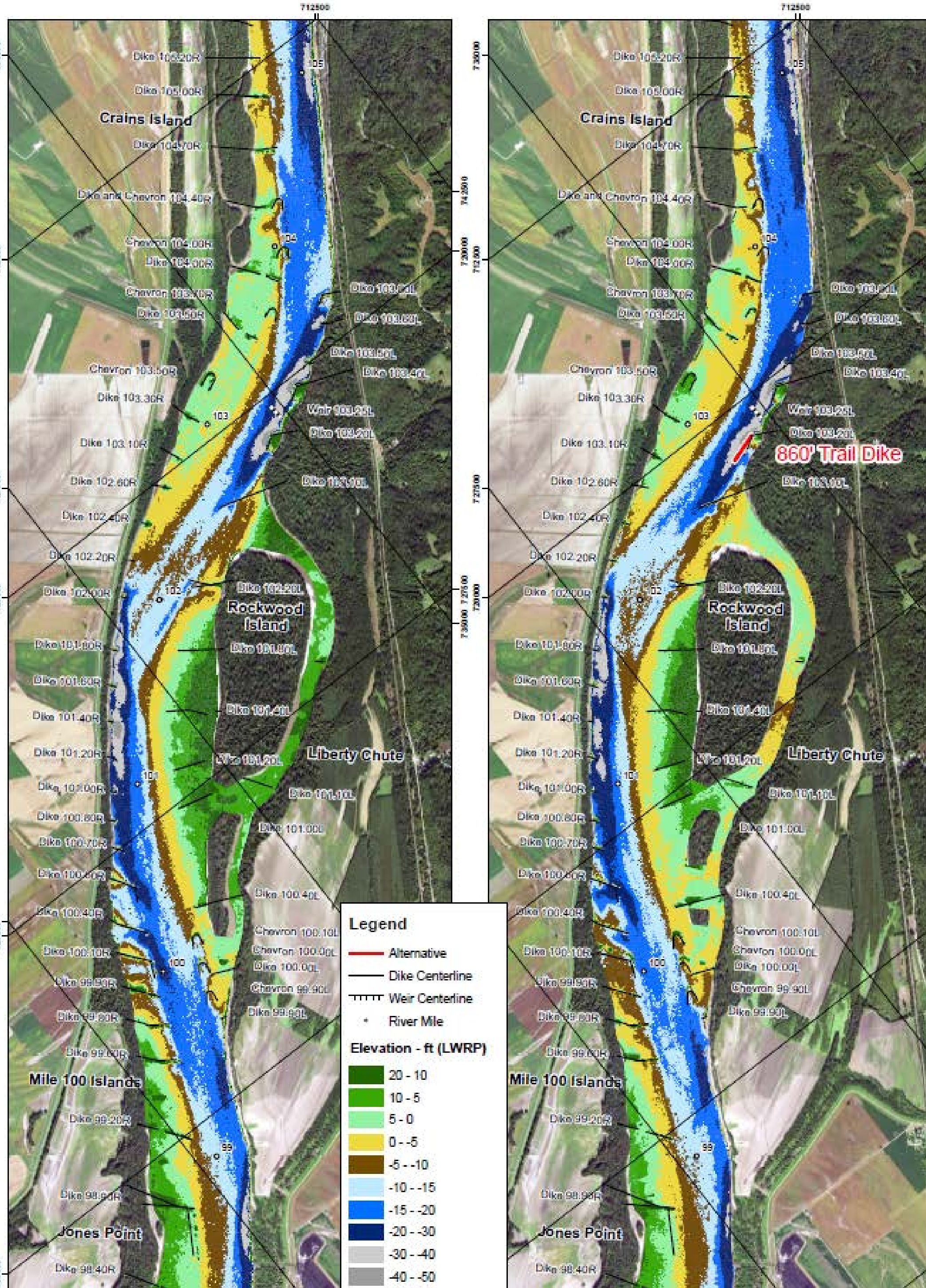
U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

J. Brown, P.E.
C. Tabbert
B. Krischel, P.E.
D. Gordon, P.E.
C. Tabbert
Dave Gordon, P.E.

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District



Replication | **Alternative 20**

PLATE NUMBER 40

0 1,000 2,000 4,000
Feet

Alternative 20

2015 AERIAL PHOTOGRAGHY

U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

J. Brown, P.E.

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Dave Gordon, P.E.

L:/HSR Modeling/HSR Model Studies/UMR 110-99

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

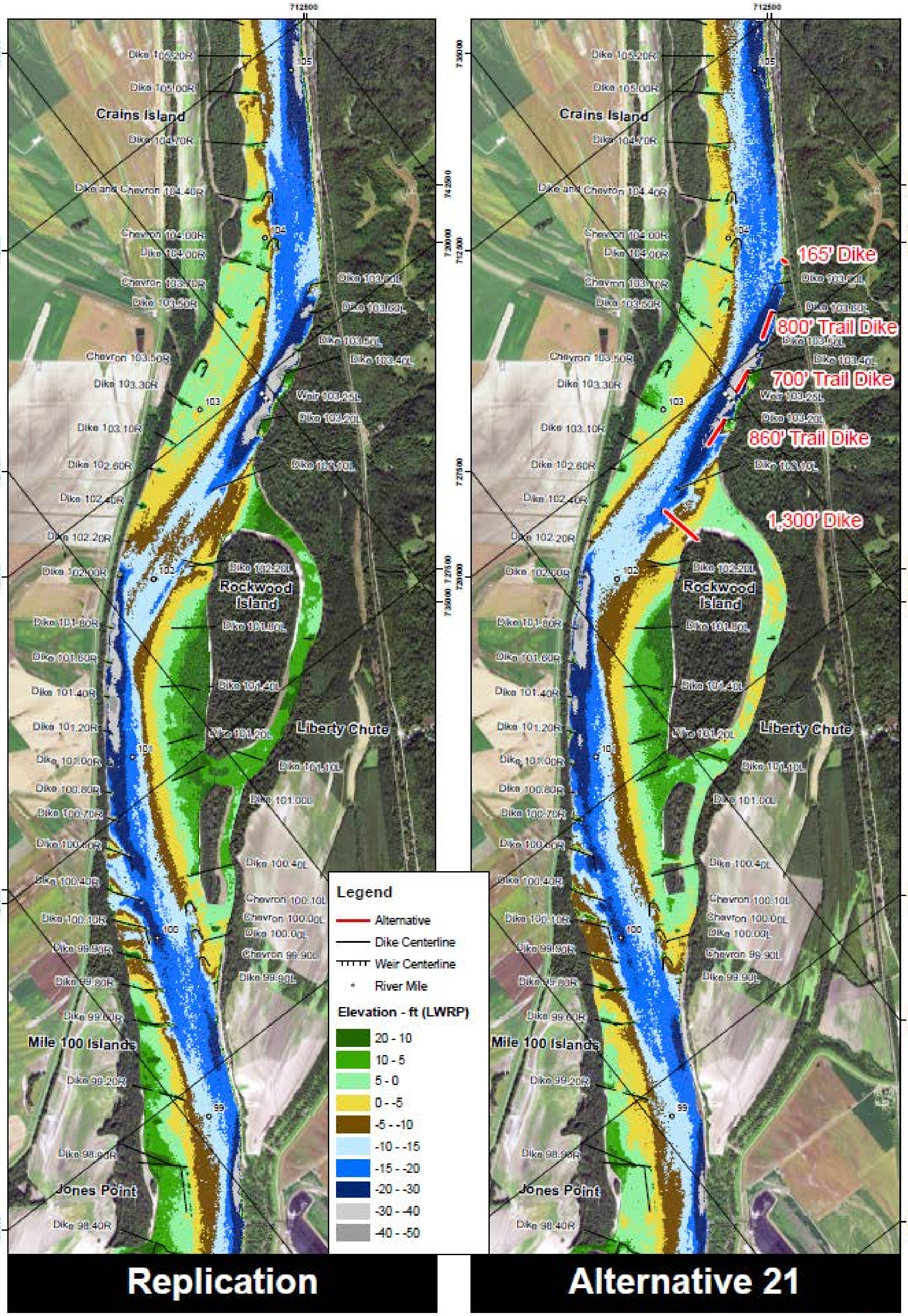

PLATE NUMBER 41

0 1,000 2,000 4,000
Feet

Alternative 21

2015 AERIAL PHOTOGRAGHY

U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

J. Brown, P.E.

C. Tabbert | B. Krischel, P.E. | D. Gordon, P.E.

C. Tabbert | Dave Gordon, P.E.

L:/HSR Modeling/HSR Model Studies/UMR 110-90

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

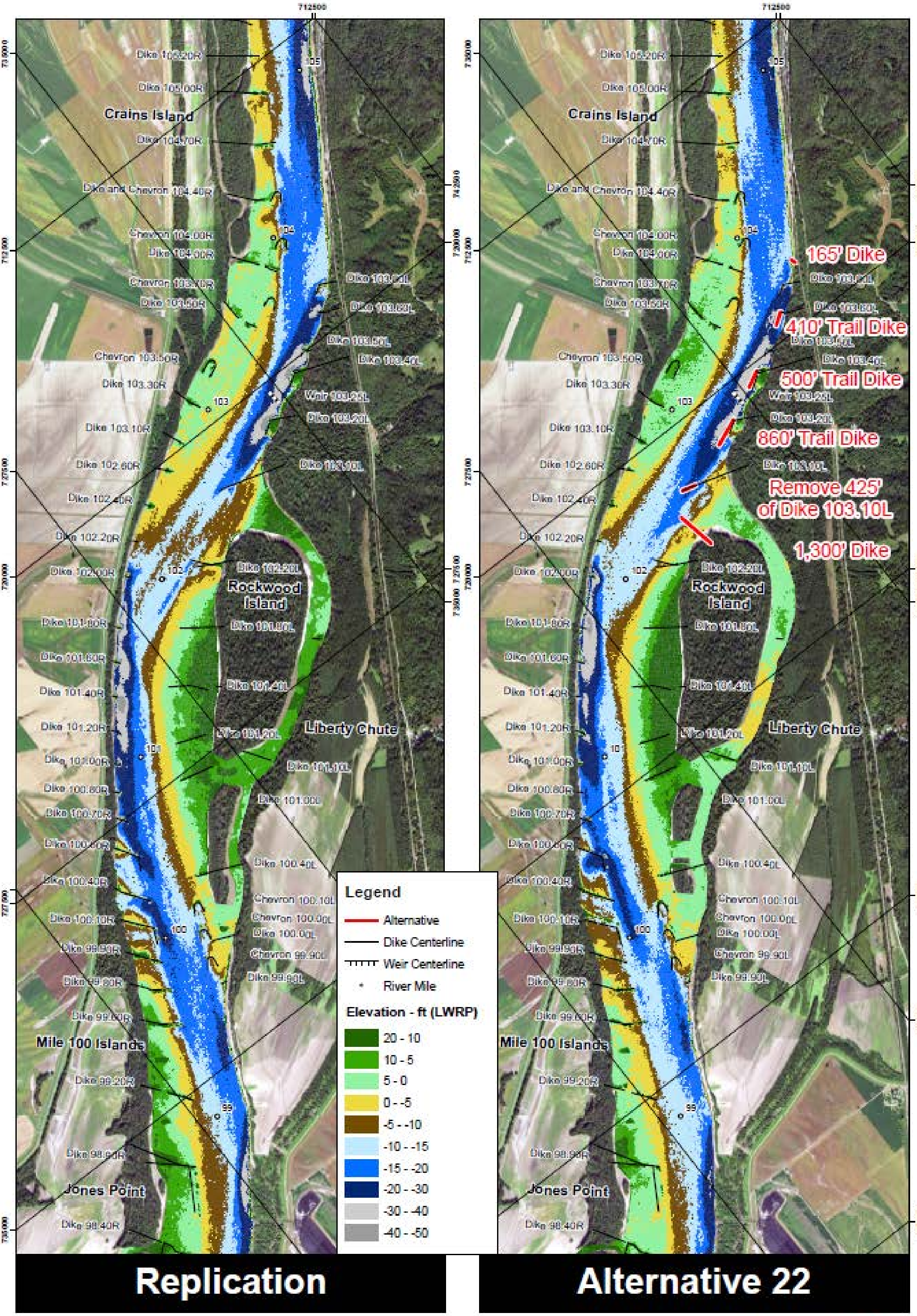

PLATE NUMBER 42

0 1,000 2,000 4,000 Feet

Alternative 22

2015 AERIAL PHOTOGRAGHY

U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

J. Brown, P.E.

C. Tabbert | R. Kreichel, P.E. | D. Gordon, P.E.

C. Tabbert | Dave Gordon, P.E.

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APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District

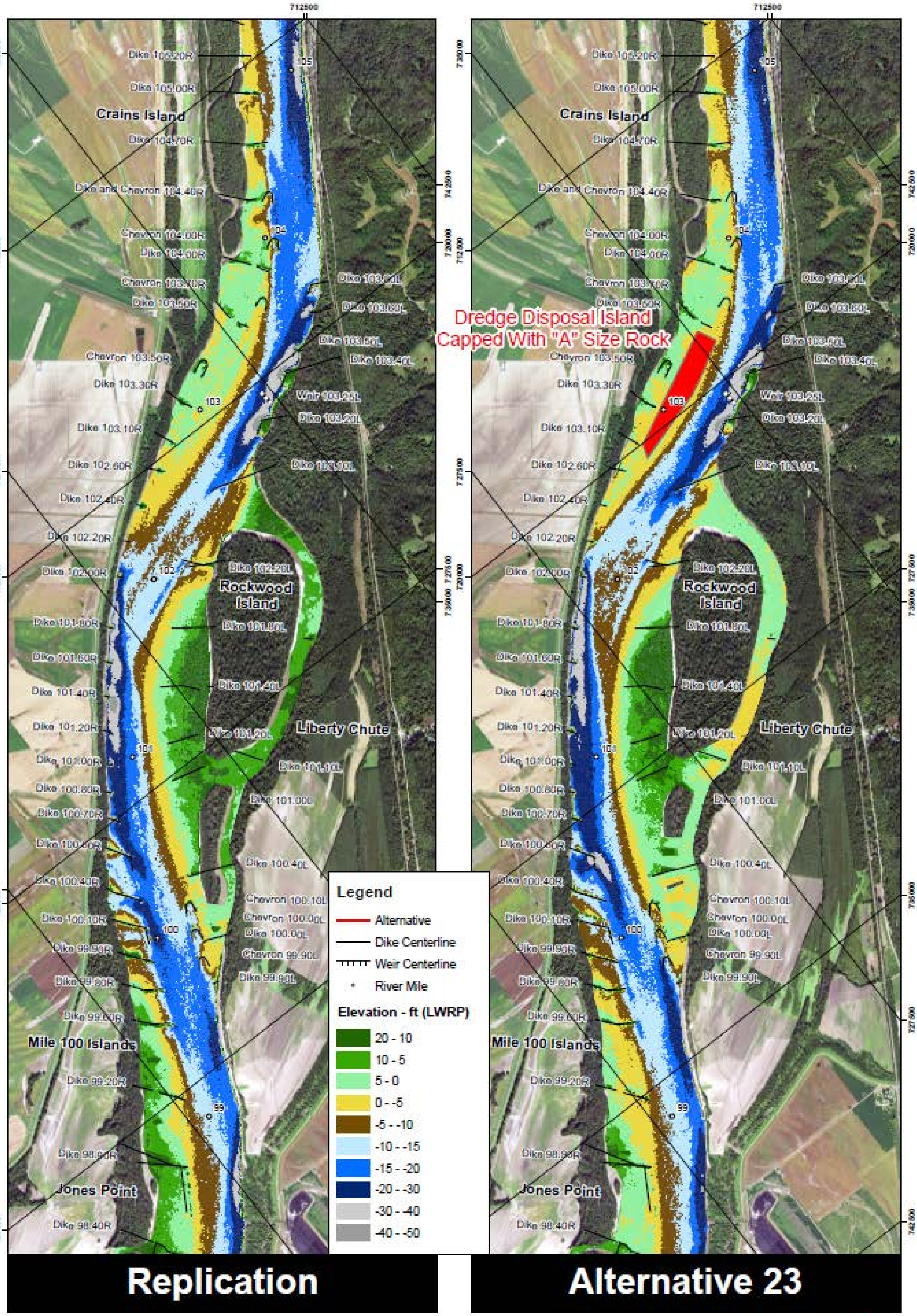

PLATE NUMBER 43

0 1,000 2,000 4,000
Feet

Alternative 23

2015 AERIAL PHOTOGRAGHY

U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

J. Brown, P.E.

C. Tabbert | R. Kreichel, P.E. | D. Gordon, P.E.

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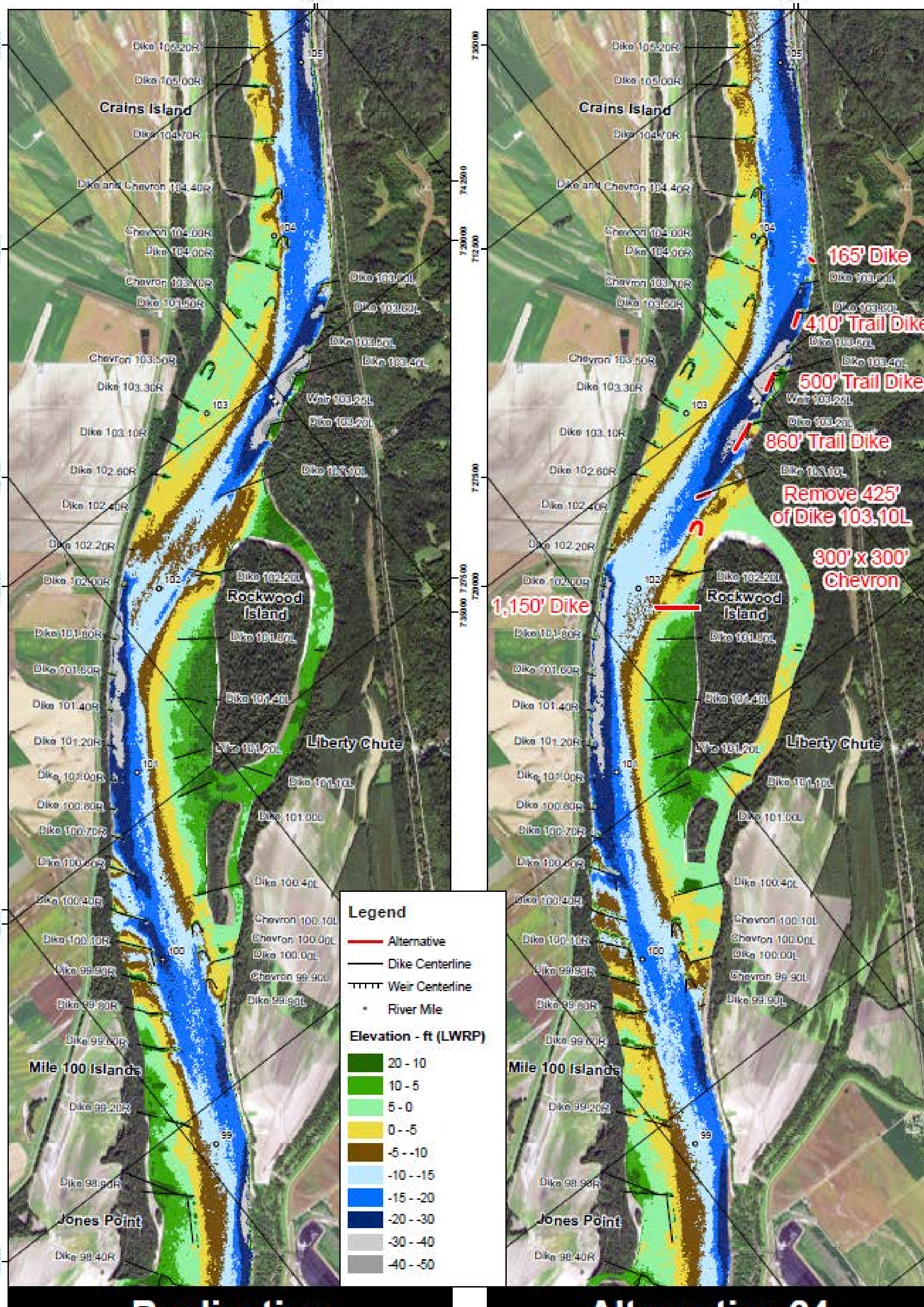
L:/HSR Modeling/HSR Model Studies/UMR 110-99

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District



Replication

Alternative 24

PLATE NUMBER 44

0 1,000 2,000 4,000
Feet

Alternative 24
2015 AERIAL PHOTOGRAGHY

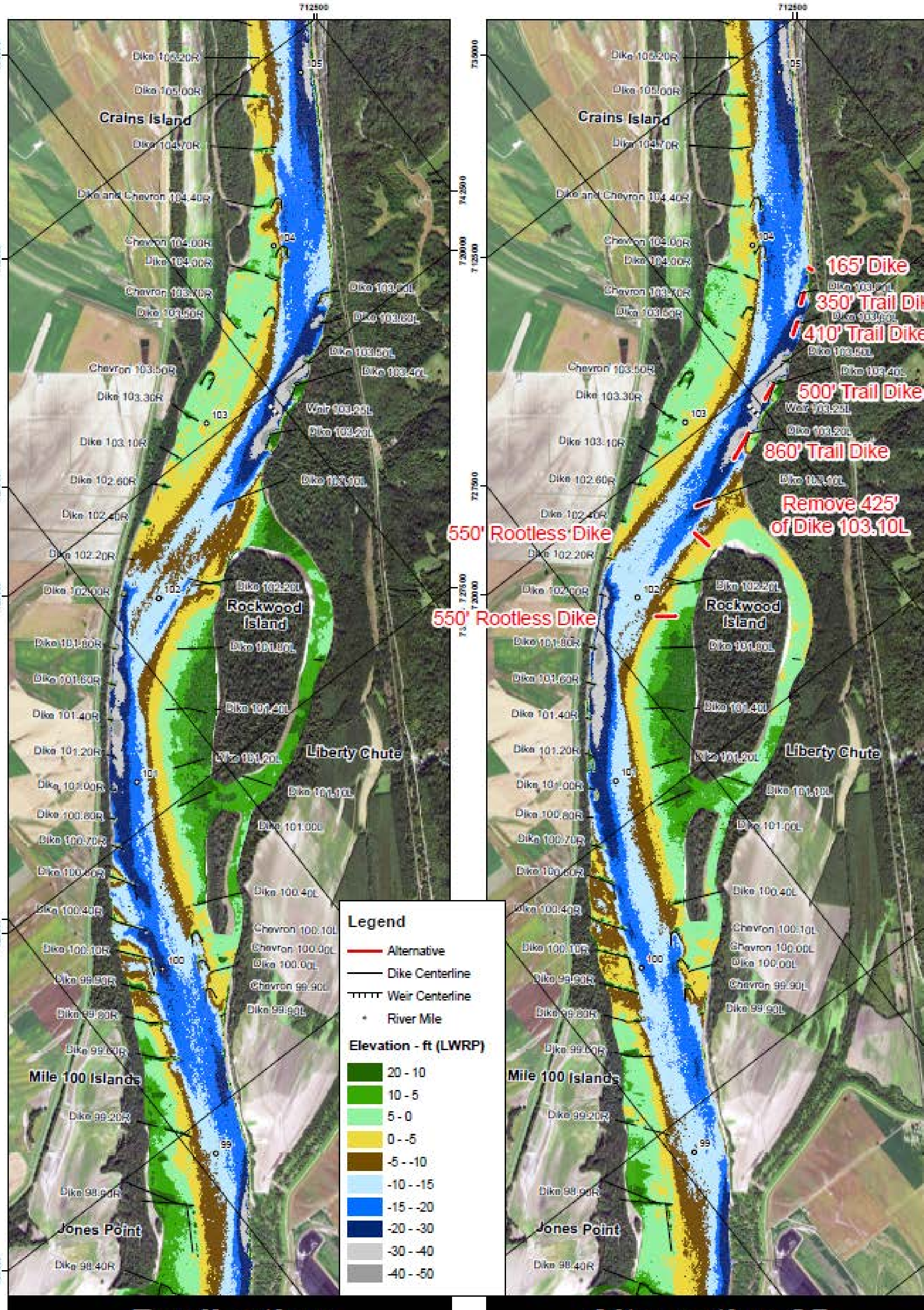
U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

J. Brown, P.E.
C. Tabbert
D. Gordon, P.E.
C. Tabbert
Dave Gordon, P.E.

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District



Replication | **Alternative 25**

PLATE NUMBER 45

0 1,000 2,000 4,000
Feet

Alternative 25

2015 AERIAL PHOTOGRAGHY

U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

J. Brown, P.E.
C. Tabbert
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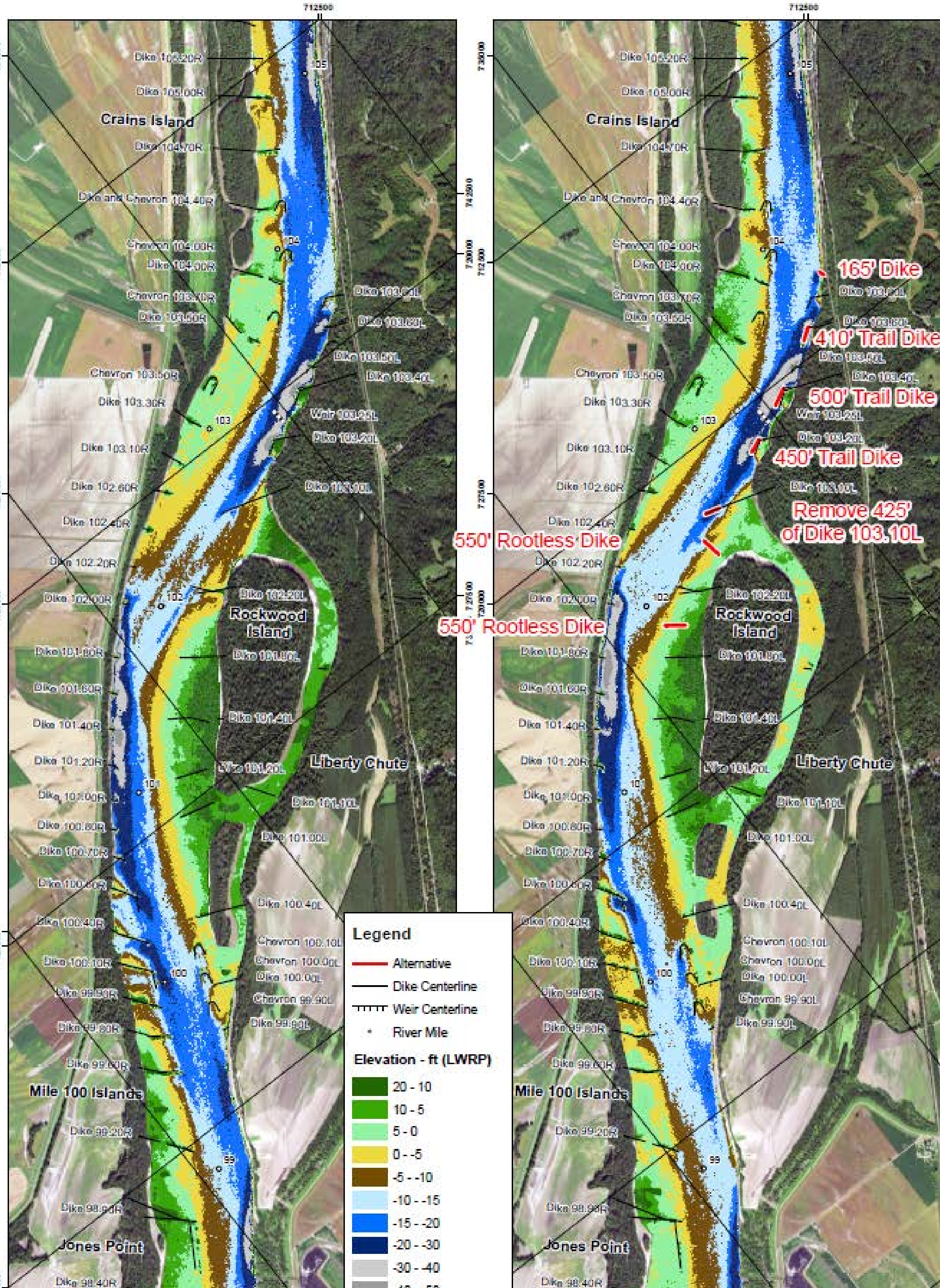
C. Tabbert
Dave Gordon, P.E.
L:/HSR Modeling/HSR Model Studies/UMR 110-99

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District



Replication | **Alternative 26**

PLATE NUMBER 46

0 1,000 2,000 4,000 Feet

Alternative 26

2015 AERIAL PHOTOGRAGHY

U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

J. Brown, P.E.

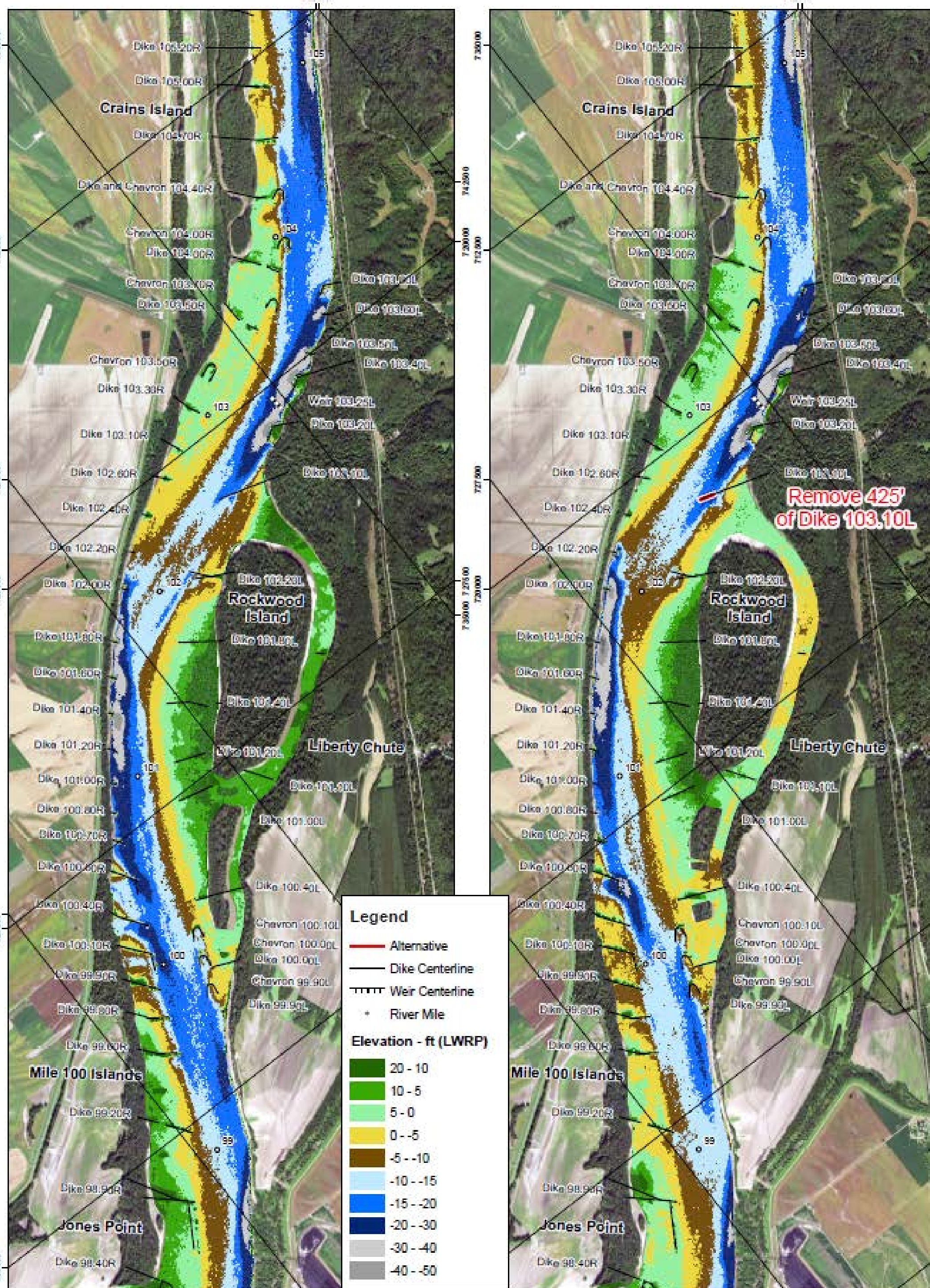
C. Tabbert | R. Kinchel, P.E. | D. Gordon, P.E.

C. Tabbert | Dave Gordon, P.E.

L:/HSR Modeling/HSR Model Studies/UMR 110-99

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District



Replication | **Alternative 27**

PLATE NUMBER 47

0 1,000 2,000 4,000
Feet

Alternative 27

2015 AERIAL PHOTOGRAGHY

U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

J. Brown, P.E.

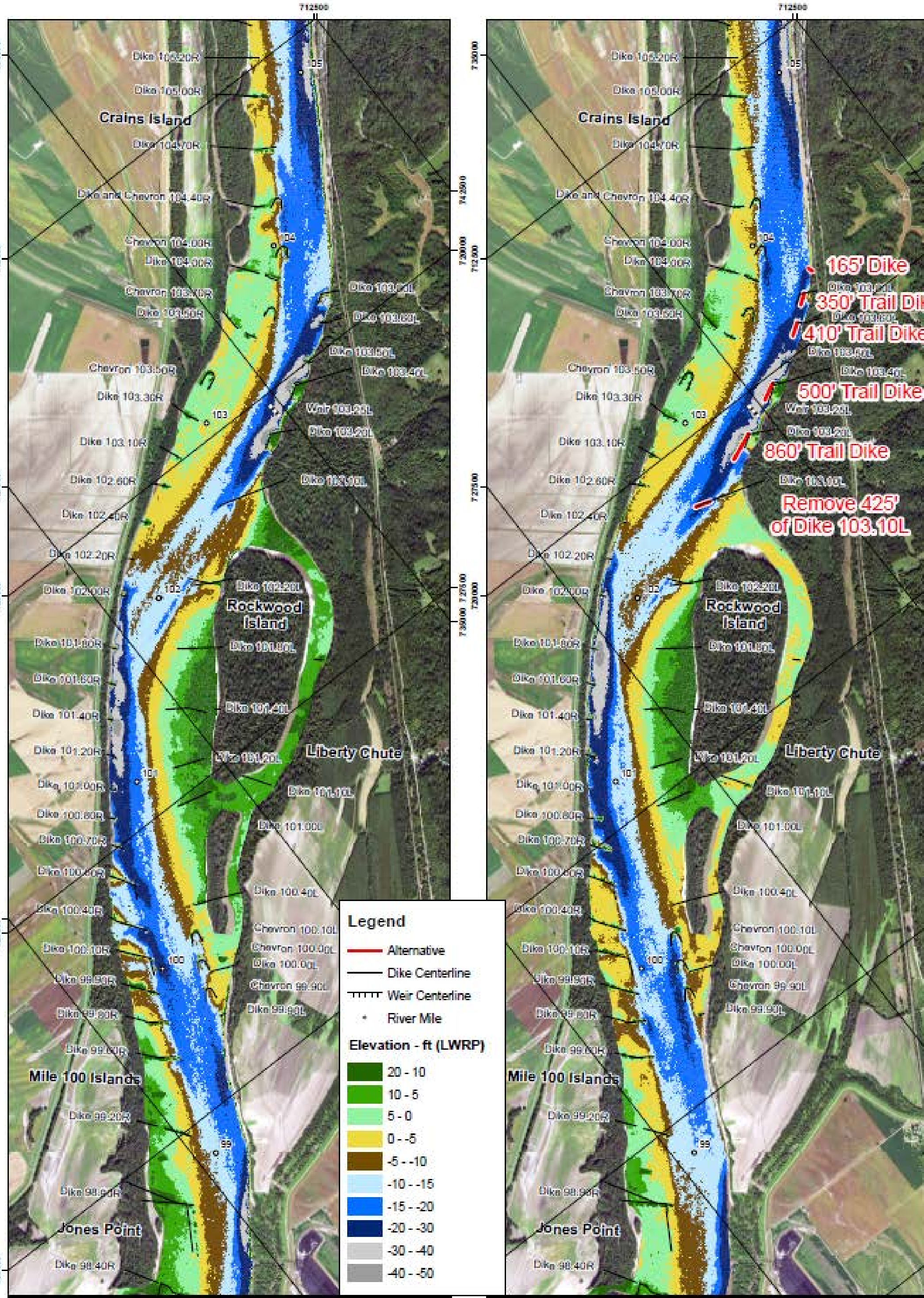
C. Tabbert | B. Kreichel, P.E. | D. Gordon, P.E.

C. Tabbert | Dave Gordon, P.E.

L:/HSR Modeling/HSR Model Studies/UMR 110-90

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District



Replication | **Alternative 28**

PLATE NUMBER 48

0 1,000 2,000 4,000
Feet

Alternative 28
2015 AERIAL PHOTOGRAGHY

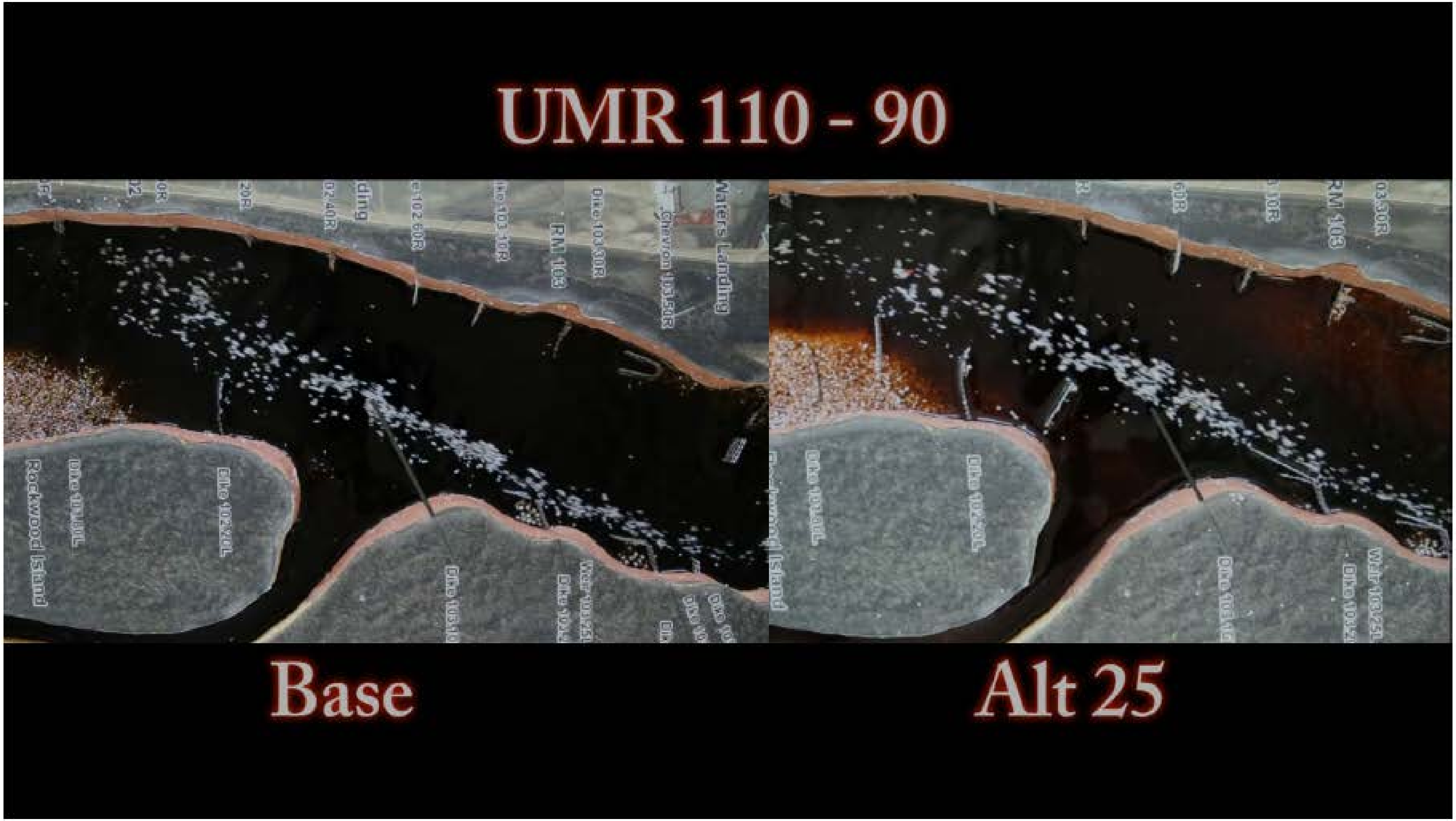
U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

J. Brown, P.E.
C. Tabbert
B. Krischel, P.E.
D. Gordon, P.E.
C. Tabbert
Dave Gordon, P.E.

APPLIED RIVER ENGINEERING CENTER

US Army Corps of Engineers
St. Louis District



0 1,400 2,800 5,600
Feet

Flow Visualization

U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Mississippi River Basin
St. Louis District
UMR 104 - 101.5
HSR Model

J. Brown, P.E.
C. Tabbert
D. Gordon, P.E.
C. Tabbert
Dave Gordon, P.E.

US Army Corps of Engineers
St. Louis District

APPLIED RIVER ENGINEERING CENTER

PLATE NUMBER
49

8 APPENDIX 2: HSR MODELING THEORY

The principle behind the use of a hydraulic sediment response model is similitude, the linking of parameters between a model and prototype so that behavior in one can predict behavior in the other.

There are two different types of similitude; mathematical similitude and empirical similitude. Mathematical similitude is founded on the scale relationship between all linear dimensions (geometric similarity), a scale relationship between all components of velocity (kinematic), or both geometric and kinematic similarity with the ratio of all common point forces equal (dynamic similarity).

In contrast to mathematical similitude, empirical similitude is based on the belief that the laws of mathematical similitude can be relaxed as long as other more fundamental relationships are preserved between the model and the prototype. All physical models used in the past by USACE employed, to some degree, empirical similitude. Numerous definitions of what relationships must be preserved have been put forward concerning physical sediment models. These relationships often deal with the scalability of elements of sediment transport processes or surface or structure roughness. Hydraulic sediment response models depend on similitude in the morphologic response, i.e. the ability of the model to replicate known prototype parameters associated with the bed response in the river under study. Bed response includes thalweg location, scour and deposition within the channel and at various river structures, and the overall resultant bed configuration. These parameters are directly compared to what is observed from prototype surveys.

Detailed cross-sectional analysis of prototype and model surveys defining bed response and bed configuration have shown that HSR model variation from the prototype is often approximately that of the natural variation observed in the prototype. This correspondence allows hydraulic engineers to use the HSR model with confidence and introduce alternatives in the model to approximate the bed response that can be expected to occur in the prototype.

HSR models were developed from empirical large scale coal bed models utilized by the USACE Waterways Experiment Station (now named the Environmental Research and Development Center, or ERDC). These models were used by MVS from 1940 to the mid-1990s. For a more thorough explanation of the early ERDC model development, please refer to the following link:

http://www.erdc.usace.army.mil/

Appendix C. Agency and Tribal Government Coordination

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

REPLY TO
ATTENTION OF:

October 21, 2016

Engineering and Construction Division
Curation and Archives Analysis Branch (EC-Z)

Ms. Rachel Leibowitz
Deputy State Historic Preservation Officer
Illinois Historic Preservation Agency
1 Old State Capitol Plaza
Springfield, Illinois 62701-1507

Subject: Red Rock Landing Phase 4: River Training Structures

Dear Ms. Leibowitz:

The United States Army Corps of Engineers (USACE) is presently planning the construction, or modification, of eight (8) river training structures in the Red Rock Landing Reach of the Mississippi River between river miles 101 and 105 (Figure 1). The structures comprise the Red Rock Landing Phase 4 Project. We are contacting your office to initiate consultation under Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), and its implementing regulation 36 CFR 800.

Background

Beginning in 1824, the Congress of the United States authorized the Secretary of the Army, by and through the USACE, to make improvements to the Mississippi River, and some of its major tributaries, for the purpose of obtaining and maintaining an inland navigation channel for waterway commercial transportation throughout the United States. Ultimately for the Mississippi River, Congress authorized obtaining and maintaining at least a nine foot deep navigation channel from the Gulf of Mexico to Minneapolis, Minnesota, through multiple projects by various methods and management.

Congress authorized the ultimate plan for how the navigation channel should be obtained and maintained for a majority of the Middle Mississippi River (from the confluence of the Ohio River to the confluence of the Missouri River) in the Rivers and Harbors Act of 1910 and eventually established the current navigation channel dimensions of 9 feet deep and not less than 300 feet wide, with additional width in the bends as required, in the Rivers and Harbors Act of 1927.

There are a number of types of river training structures including dikes, revetments, bendway weirs, and chevrons. Dikes redirect the river's own energy to manage sediment distribution within the river channel to provide adequate depth for navigation. While the original dikes of the nineteenth century were largely pile structures, by the middle of the twentieth century most had been converted to stone-fill types. Revetments are structures placed along the river bank to stabilize or protect the bank from erosion. They are usually constructed out of stone, but a variety of other materials have historically been used including concrete-mat, willow mattresses, and gabions. First constructed in 1989, submerged bendway weirs widen the navigation channel in rivers bends by creating a favorable redistribution of current velocities and sediments. A more-recent development is chevrons built in the river itself. Chevrons create and promote split flows rather than unidirectional deflections and provide more diverse aquatic habitats.

River training structures continue to be constructed, as they provide a more cost-effective and environmentally friendly solution for moving sediment through the river system than dredging alone.

Project

It is proposed to modify four existing river training structures in the Red Rock Landing Reach of the Mississippi River and construct an additional four (Figure 1). All the structures would be located in Randolph County, Illinois (Table 1).

Table 1. Proposed Features

River Mile	Structure	Action	County	State
104.0L	Dike	New construction	Randolph	Illinois
103.8L	Trail Dike	Move/extend	Randolph	Illinois
103.6L	Trail Dike	New construction	Randolph	Illinois
103.4L	Trail Dike	Move/extend	Randolph	Illinois
103.2L	Trail Dike	Move/extend	Randolph	Illinois
103.1L	Dike	Remove 425 feet	Randolph	Illinois
102.4L	Multiple Rock Structure	New construction	Randolph	Illinois
101.9L	Multiple Rock Structure	New construction	Randolph	Illinois

Potential Effects on Cultural Resources

The bankline of the Red Rock Landing Reach has not significantly changed in the past century and a half (Figure 2). It has, however, regressed moderately in places so that four of the structure locations were, in 1890, on land. The erosion causing the regression would have destroyed any cultural features existing on the landform prior to that time. No proposed feature contacts the existing bankline.

All the river training structures are constructed via barge, without recourse to land access; therefore, any effects are limited to submerged cultural resources. Primary among these are historic period shipwrecks. Given the continual river flow and associated sedimentary erosion, deposition, and reworking, it is highly unlikely that any more ephemeral cultural material remains on the river bed.

Possible Shipwrecks

During the summer of 1988 when the Mississippi River was at a particularly low level, the St. Louis District Corps of Engineers conducted an aerial survey of exposed wrecks between Saverton, Missouri, and the mouth of the Ohio River (Norris 2003). The nearest observed wreck to the project features was located approximately a mile downstream and in a side channel.

Five of the proposed structures are directly adjacent to the dredged channel, which probably resulted in channel slump and sediment reworking in the locations. The reach has been regularly dredged over the years, and it is likely that any unrecorded wreckage located in the path of those dredge events was destroyed and removed during the process. While exact location information is not available for dredging events prior to 1979, USACE has been conducting such activities to deepen the navigation channel of the Middle Mississippi since 1896 (Manders and Rentfro 2011:61).

The river bed in the project area is surveyed every year or two, with the latest processed survey having been completed in 2015. The single-beam survey was conducted with range lines spacing of 200 feet. No topographic anomalies suggesting wrecks are visible on the resulting bathymetric map (Figure 3). Additional multi-beam surveys will be conducted prior to construction and will also be examined for anomalies.

The location of two of the new structures is visible at times of low flood stage. Visual examination of imagery taken at that time show no indications of wrecks at or near those locations (Figure 1). As outlined above, the locations of four of the other structures were on land until the early 20th century which precludes the possibility of any wrecks existing there before that time.

Summation

Given the features' construction method (with no land impact), the previous disturbance of the riverbed, the channel history recorded for the location in the nineteenth century, and the lack of any survey evidence for extant wrecks, it is our opinion that the proposed undertaking will have no significant effect on cultural resources.

If you have any questions or comments, please feel free to contact me at (314) 331-8466 or Dr. Mark Smith at (314) 331-8831 (e-mail: mark.a.smith4@usace.army.mil).

Sincerely yours,

mK Trimble

Michael K. Trimble, Ph.D.
Chief, Curation and Archives Analysis Branch

Enclosure

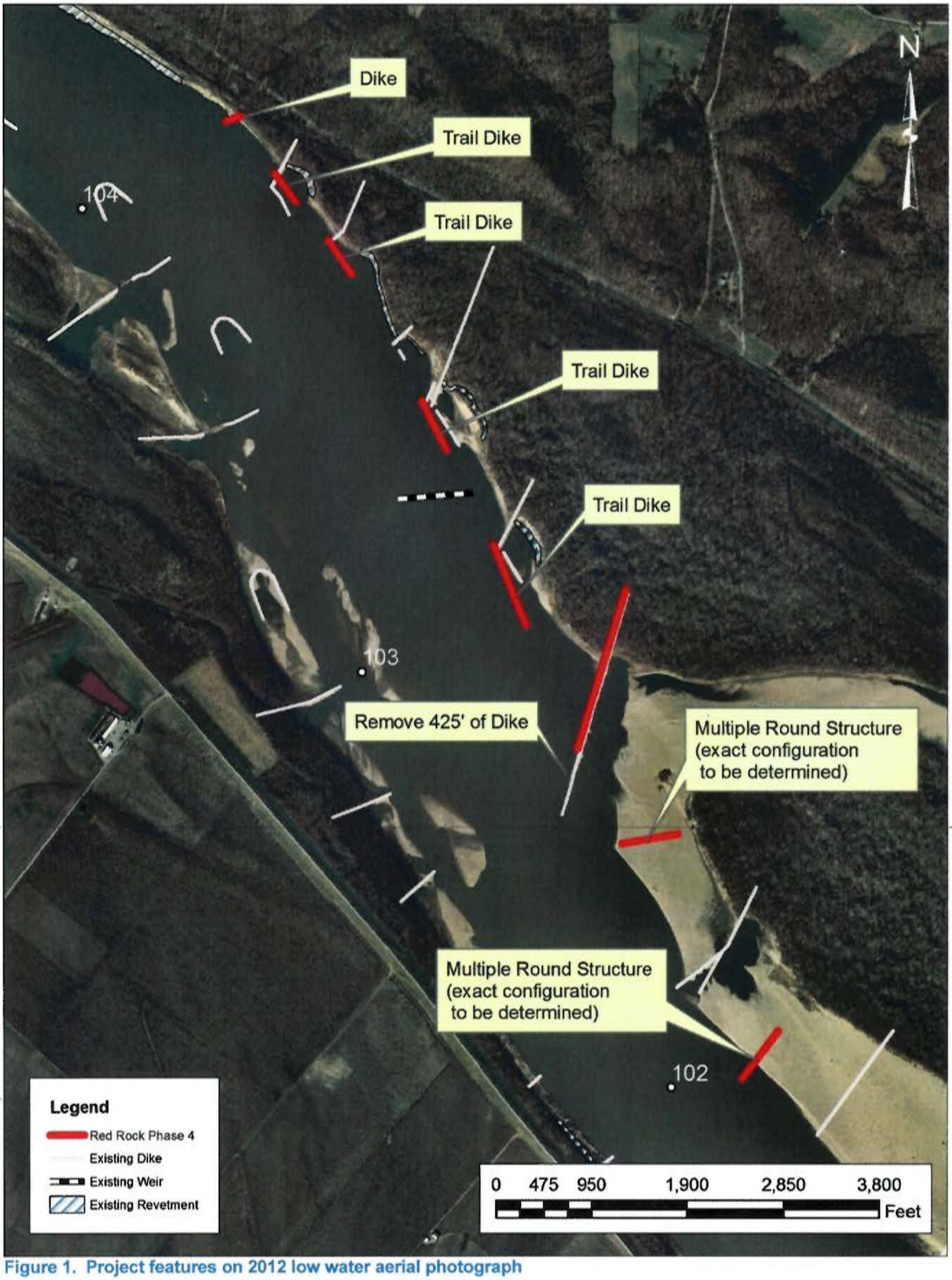


Figure 1. Project features on 2012 low water aerial photograph

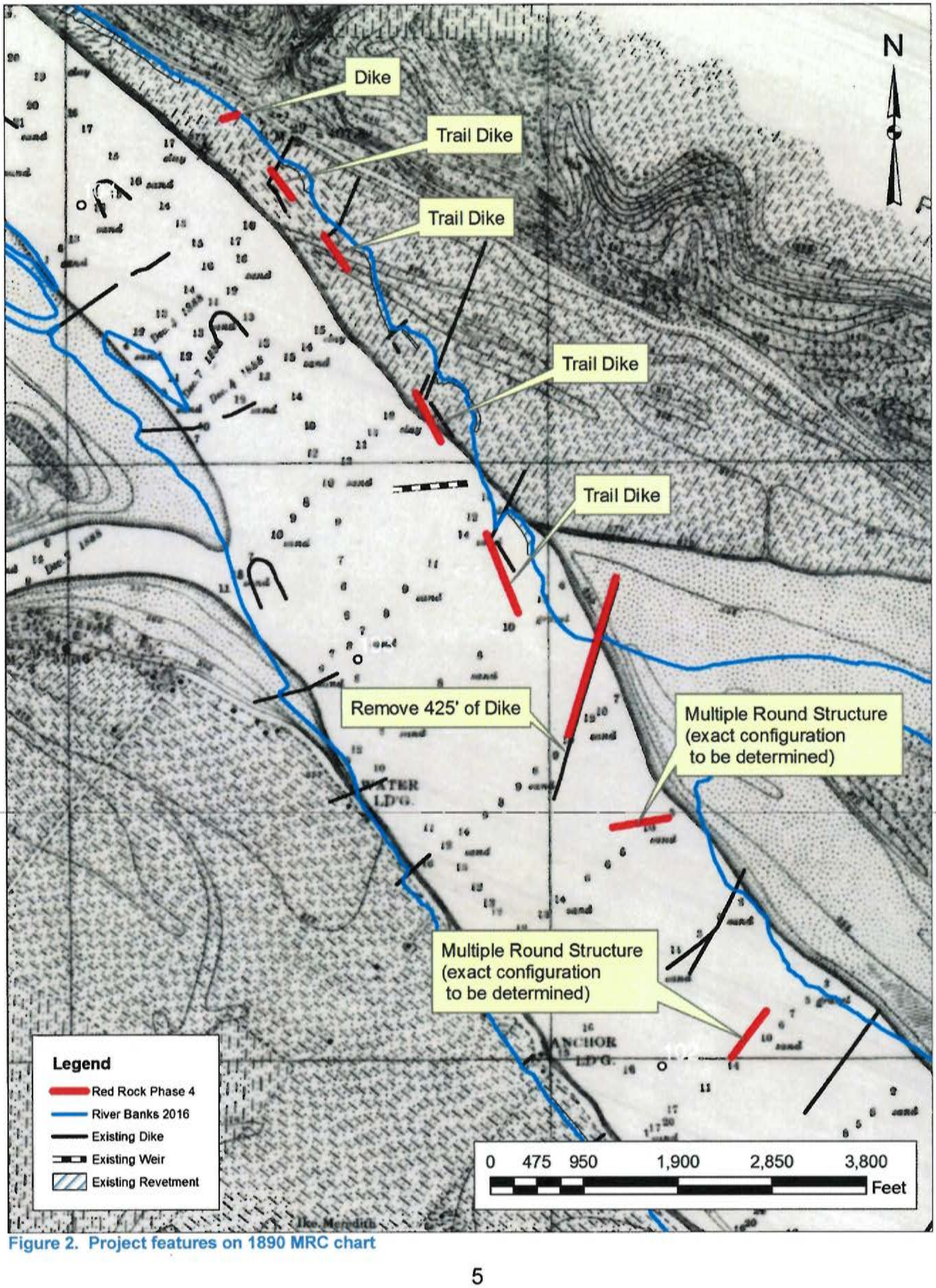


Figure 2. Project features on 1890 MRC chart

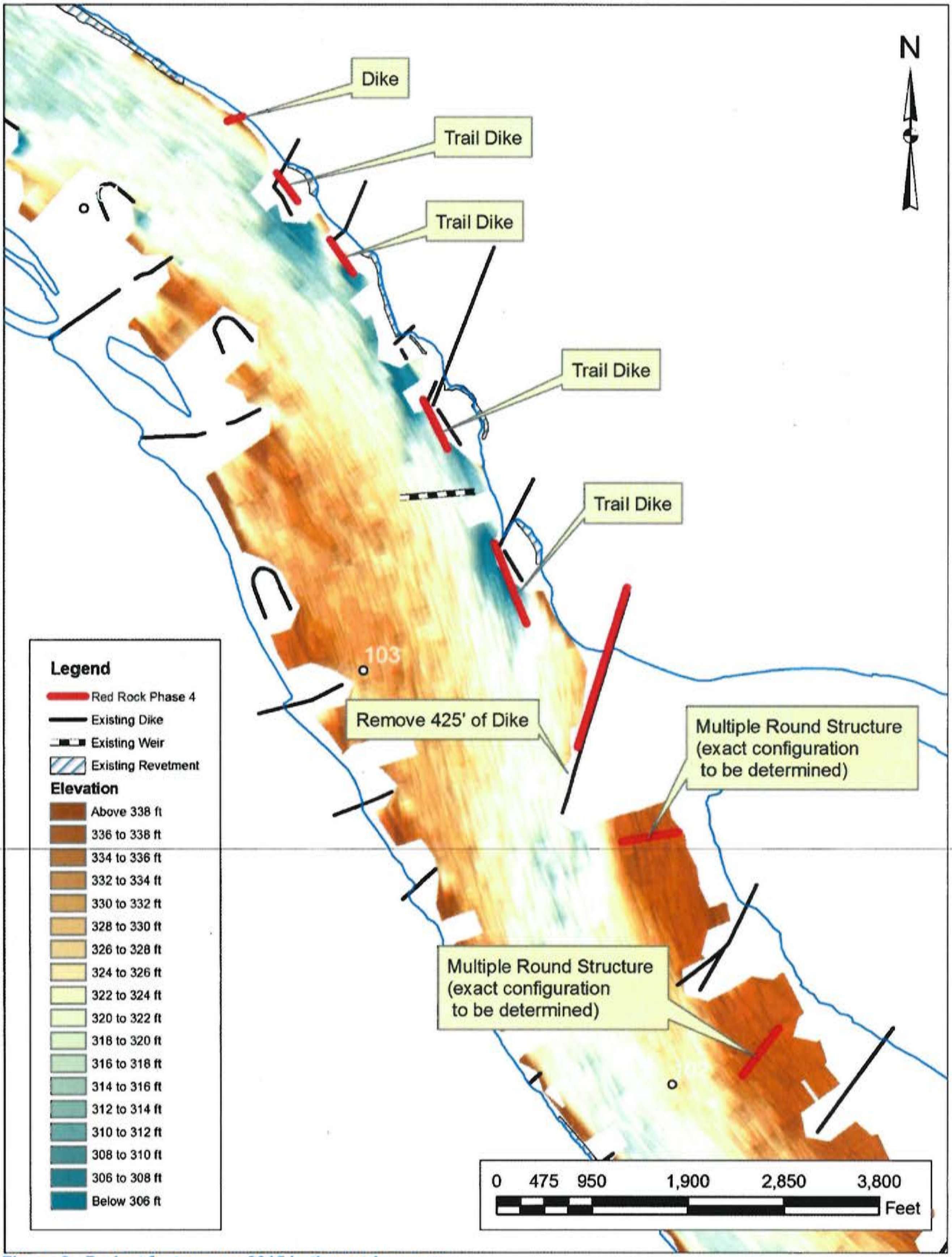


Figure 3. Project features on 2015 bathymetric survey

References Cited

Manders, D., & B. Rentrfro
2011 Engineers *Far From Ordinary*. St. Louis District USACE, St Louis, MO.

Mississippi River Commission (MRC)
1881 Chart No 109. Survey of the Mississippi River.

Norris, F. T.
2003 Historical Shipwrecks on the Middle Mississippi and Lower Illinois Rivers. Curation and Archives Analysis Branch, U. S. Army Corps of Engineers, St. Louis District.

Illinois Historic
Preservation Agency

1 Old State Capitol Plaza, Springfield, IL 62701-1512

FAX 217/524-7525
www.illinoishistory.gov

Randolph County
Rockwood
Between Mississippi River miles 101 & 105
COESTL
River training structures - Red Rock Landing

PLEASE REFER TO: IHPA LOG #007102416

November 7, 2016

Michael K. Trimble, Ph.D., Chief
Department of the Army
St. Louis District, Corps of Engineers
Curation and Archives Analysis Branch (EC-Z)
1222 Spruce St.
St. Louis, MO 63103-2833

Dear Chief Trimble:

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,

Rachel Leibowitz, Ph.D.
Deputy State Historic
Preservation Officer

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

REPLY TO
ATTENTION OF:

March 27, 2018

Engineering and Construction Division
Curation and Archives Analysis Branch (EC-Z)

Ms. Rachel Leibowitz
Illinois State Historic Preservation Office
Illinois Dept. of Natural Resources
Attn: Review & Compliance/Old State Capital
One Natural Resources Way
Springfield, Illinois 62702

Subject: Red Rock Landing Phase 4: River Training Structures (**IHPA LOG #007102416**)

Dear Ms. Leibowitz:

The United States Army Corps of Engineers (USACE) is presently planning the construction, or modification, of eight (8) river training structures in the Red Rock Landing Reach of the Mississippi River between river miles 101 and 105 in Randolph County, Illinois (Figure 1). The structures comprise the Red Rock Landing Phase 4 Project. We are contacting your office to continue consultation under Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), and its implementing regulation 36 CFR 800.

USACE previously contacted your office regarding the project in a letter dated October 21, 2016. Your office concurred with the USACE's determination of no adverse effect in a letter dated November 7, 2016. The project was assigned the IHPA LOG #007102416. We are writing to inform you that the project was delayed and construction may extend beyond the two years clearance outlined in your letter.

We continue to believe that given the features' construction method (with no land impact), the previous disturbance of the riverbed, the channel history recorded for the location in the nineteenth century, and the lack of any survey evidence for extant wrecks, that the proposed undertaking will have no significant effect on cultural resources and would like to extend your clearance for two additional years.

If you have any questions or comments, please feel free to contact me at (314) 331-8466 or Dr. Mark Smith at (314) 331-8831 (e-mail: mark.a.smith4@usace.army.mil).

Sincerely yours,

Michael K. Trimble, Ph.D.
Chief, Curation and Archives
Analysis Branch

Enclosure

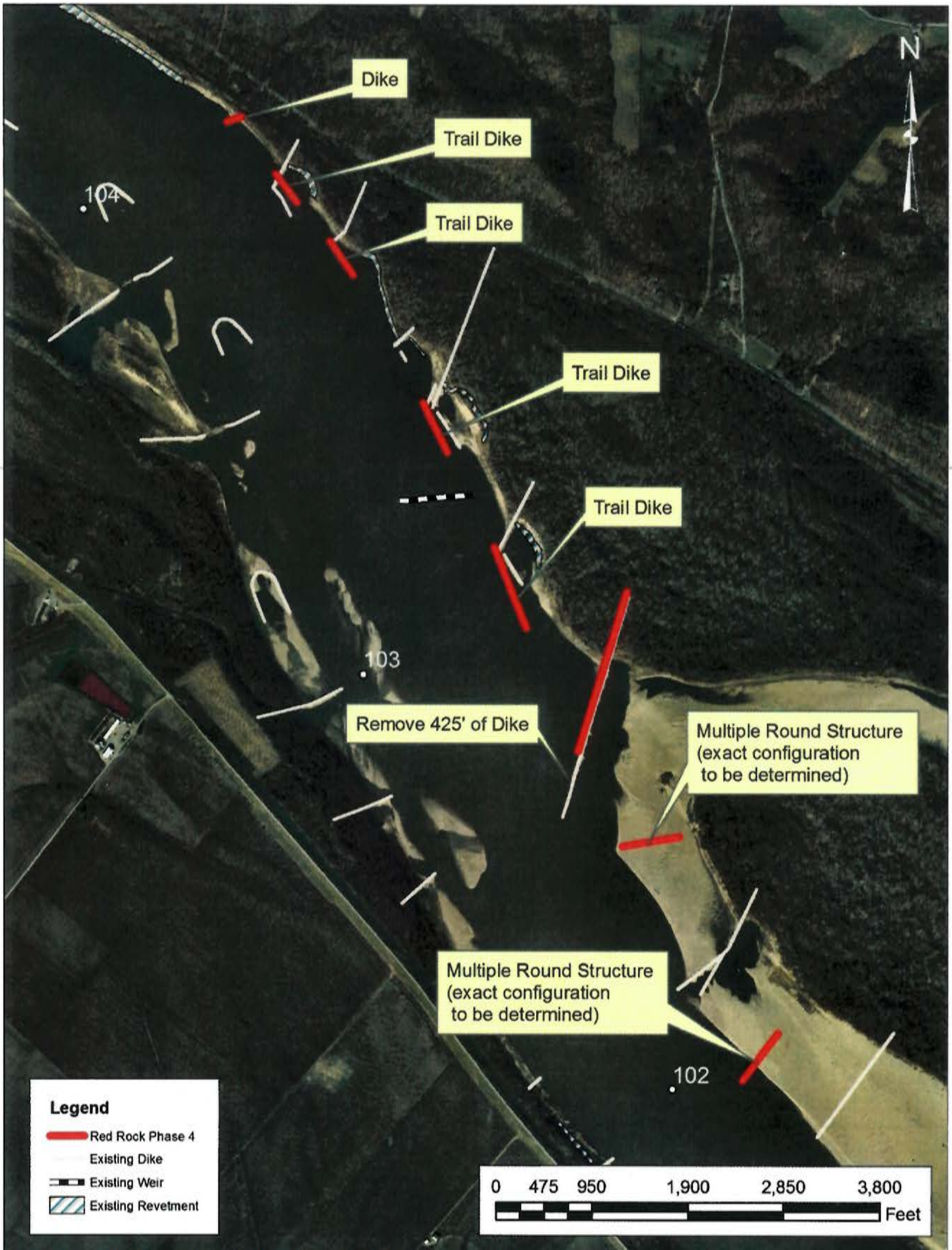


Figure 1. Project features on 2012 low water aerial photograph.

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

REPLY TO
ATTENTION OF:

January 17, 2017

Engineering and Construction Division
Curation and Archives Analysis Branch

Governor Edwina Butler-Wolfe
Absentee-Shawnee Tribe of Indians of Oklahoma
2025 South Gordon Cooper Drive
Shawnee, Oklahoma 74810-9381

Dear Governor Butler-Wolfe:

The United States Army Corps of Engineers (USACE), St. Louis District, is providing information in this letter that addresses the planning, construction, or modification, of eight (8) river training structures in the Red Rock Landing Reach of the Mississippi River between river miles 101 and 105 (Figure 2). The structures comprise the Red Rock Landing Phase 4 Project. We are contacting your tribe to initiate consultation regarding this project.

Beginning in 1824, the Congress of the United States authorized the Secretary of the Army, by and through the USACE, to make improvements to the Mississippi River, and some of its major tributaries, for the purpose of obtaining and maintaining an inland navigation channel for waterway commercial transportation throughout the United States. Ultimately for the Mississippi River, Congress authorized obtaining and maintaining at least a nine foot deep navigation channel from the Gulf of Mexico to Minneapolis, Minnesota, through multiple projects by various methods and management.

Congress authorized the ultimate plan for how the navigation channel should be obtained and maintained for a majority of the Middle Mississippi River (from the confluence of the Ohio River to the confluence of the Missouri River) in the Rivers and Harbors Act of 1910. Eventually the Rivers and Harbors Act of 1927 established the current navigation channel dimensions of 9 feet deep and not less than 300 feet wide, with additional width in the bends as required.

There are a number of types of river training structures including dikes, revetments, bendway weirs, and chevrons. Dikes redirect the river's own energy to manage sediment distribution within the river channel to provide adequate depth for navigation. While the original dikes of the nineteenth century were largely pile structures, by the middle of the twentieth century most had been converted to stone-fill types. Revetments are structures placed along the river bank to stabilize or protect the bank from erosion. They are usually constructed out of stone, but a variety of other materials have historically been used including concrete-mat, willow mattresses, and gabions. First constructed in 1989, submerged bendway weirs widen the navigation channel in rivers bends by creating a favorable redistribution of current velocities and sediments. A more-recent development is chevrons built in the river itself. Chevrons create and promote split flows rather than unidirectional deflections and provide more diverse aquatic habitats.

River training structures continue to be constructed, as they provide a more cost-effective and environmentally friendly solution for moving sediment through the river system than dredging alone.

It is proposed to modify four existing river training structures in the Red Rock Landing Reach of the Mississippi River and construct an additional four (Figure 2). All the structures would be located in Randolph County, Illinois (Table 1).

Table 1. Proposed Features

River Mile	Structure	Action	County	State
104.0L	Dike	New construction	Randolph	Illinois
103.8L	Trail Dike	Move/extend	Randolph	Illinois
103.6L	Trail Dike	New construction	Randolph	Illinois
103.4L	Trail Dike	Move/extend	Randolph	Illinois
103.2L	Trail Dike	Move/extend	Randolph	Illinois
103.1L	Dike	Remove 425 feet	Randolph	Illinois
102.4L	Multiple Rock Structure	New construction	Randolph	Illinois
101.9L	Multiple Rock Structure	New construction	Randolph	Illinois

The bankline of the Red Rock Landing Reach has not significantly changed in the past century and a half (Figure 3). It has, however, regressed moderately in places so that four of the structure locations were, in 1890, on land. The erosion causing the regression would have destroyed any cultural features existing on the landform prior to that time. No proposed feature contacts the existing bankline.

All the river training structures are constructed via barge, without recourse to land access; therefore, any effects are limited to submerged cultural resources. Primary among these are historic period shipwrecks. Given the continual river flow and associated sedimentary erosion, deposition, and reworking, it is highly unlikely that any more ephemeral cultural material remains on the river bed.

During the summer of 1988 when the Mississippi River was at a particularly low level, the St. Louis District Corps of Engineers conducted an aerial survey of exposed wrecks between Saverton, Missouri, and the mouth of the Ohio River (Norris 2003). The nearest observed wreck to the project features was located approximately a mile downstream and in a side channel.

Five of the proposed structures are directly adjacent to the dredged channel, which probably resulted in channel slump and sediment reworking in the locations. The reach has been regularly dredged over the years, and it is likely that any unrecorded wreckage located in the path of those dredge events was destroyed and removed during the process. While exact location information is not available for dredging events prior to 1979, USACE has been conducting such activities to deepen the navigation channel of the Middle Mississippi since 1896 (Manders and Rentfro 2011:61).

The river bed in the project area is surveyed every year or two, with the latest processed survey having been completed in 2015. The single-beam survey was conducted with range lines spacing of 200 feet. No topographic anomalies suggesting wrecks are visible on the resulting bathymetric map. Additional multi-beam surveys will be conducted prior to construction and will also be examined for anomalies.

The location of two of the new structures is visible at times of low flood stage. Visual examination of imagery taken at that time show no indications of wrecks at or near those locations. As outlined above, the locations of four of the other structures were on land until the early 20th century which precludes the possibility of any wrecks existing there before that time.

Given the features' construction method (with no land impact), the previous disturbance of the riverbed, the channel history recorded for the location in the nineteenth century, and the lack of any survey evidence for extant wrecks, it is our opinion that the proposed undertaking will have no significant effect on cultural resources. Further, the Illinois Historic Preservation Agency has concurred with our opinion that the proposed undertaking will have no significant effect on cultural resources in a letter dated November 7, 2016.

Please notify our office no later than March 1, 2017, if you have any areas of concern. If you have any questions or comments, please feel free to contact me at (314) 331-8466 or Chris Koenig, Archaeologist and Tribal Liaison, at (314) 331-8151 (e-mail: chris.j.koenig@usace.army.mil). Thank you in advance for your timely review of this request. A copy of this letter has been furnished to Mr. Leonard Longhorn.

Sincerely,

Michael K. Trimble, Ph.D.
Chief, Curation and Archives
Analysis Branch

Enclosures

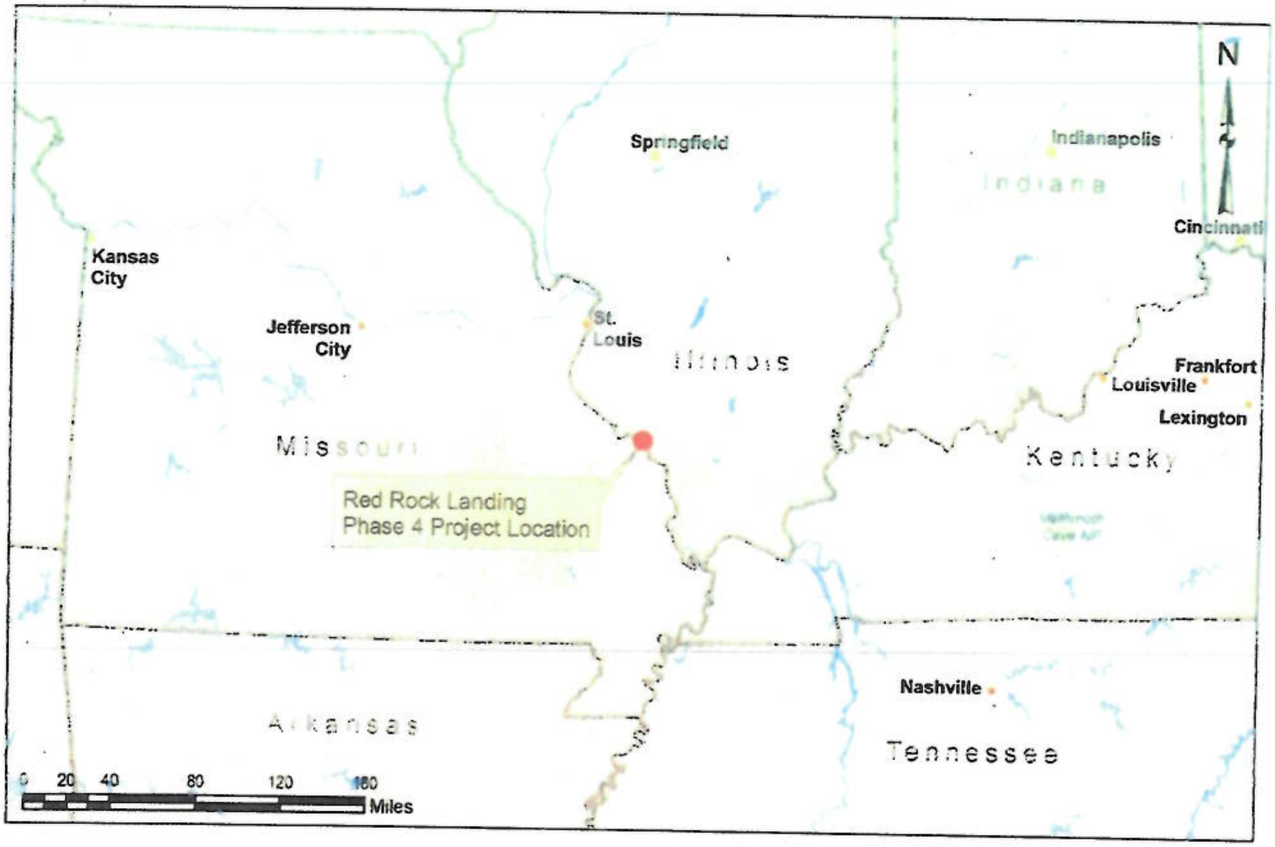


Figure 1. Red Rock Landing location on state map.

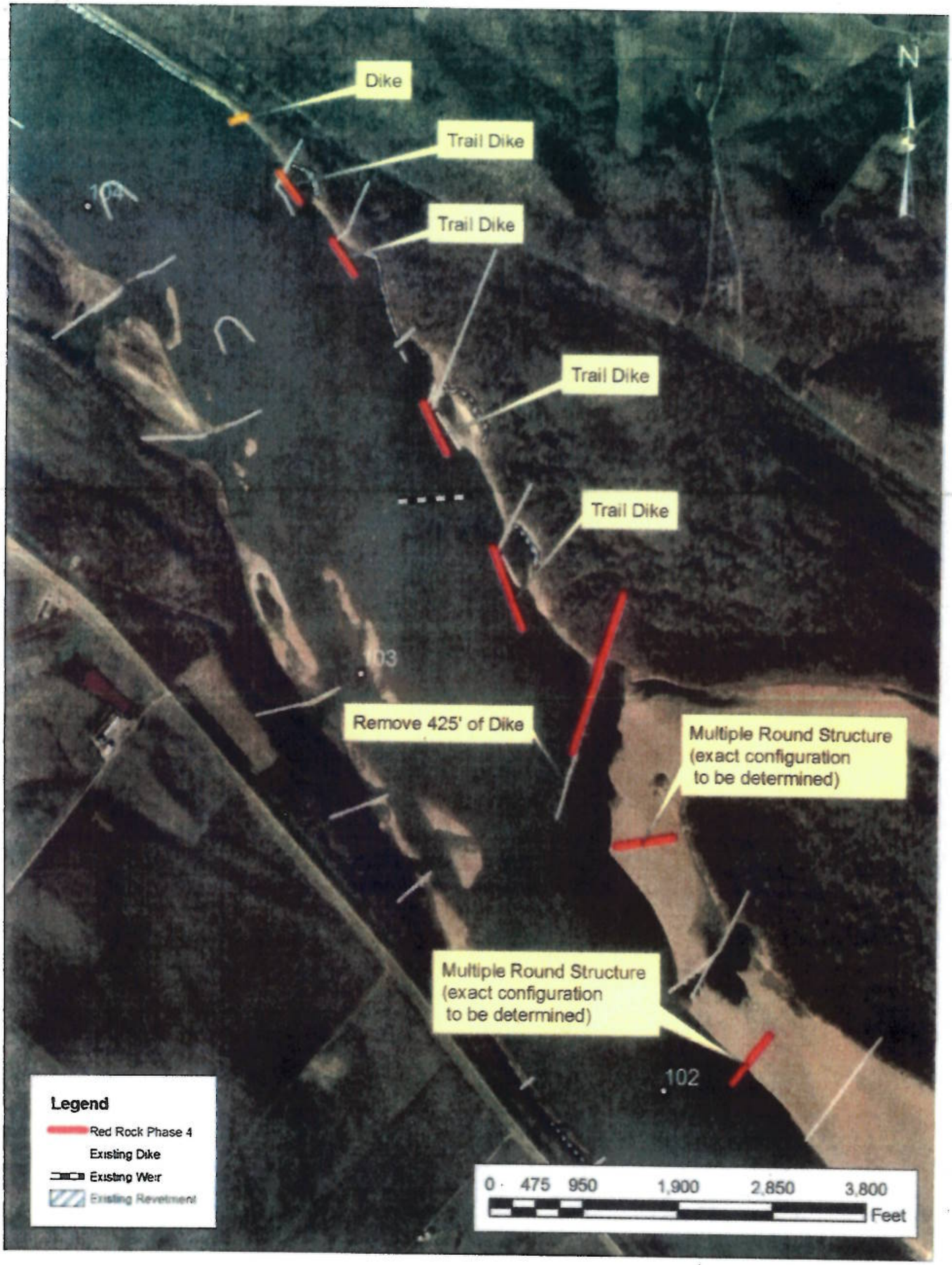


Figure 2. Project features on 2012 low water aerial photograph.

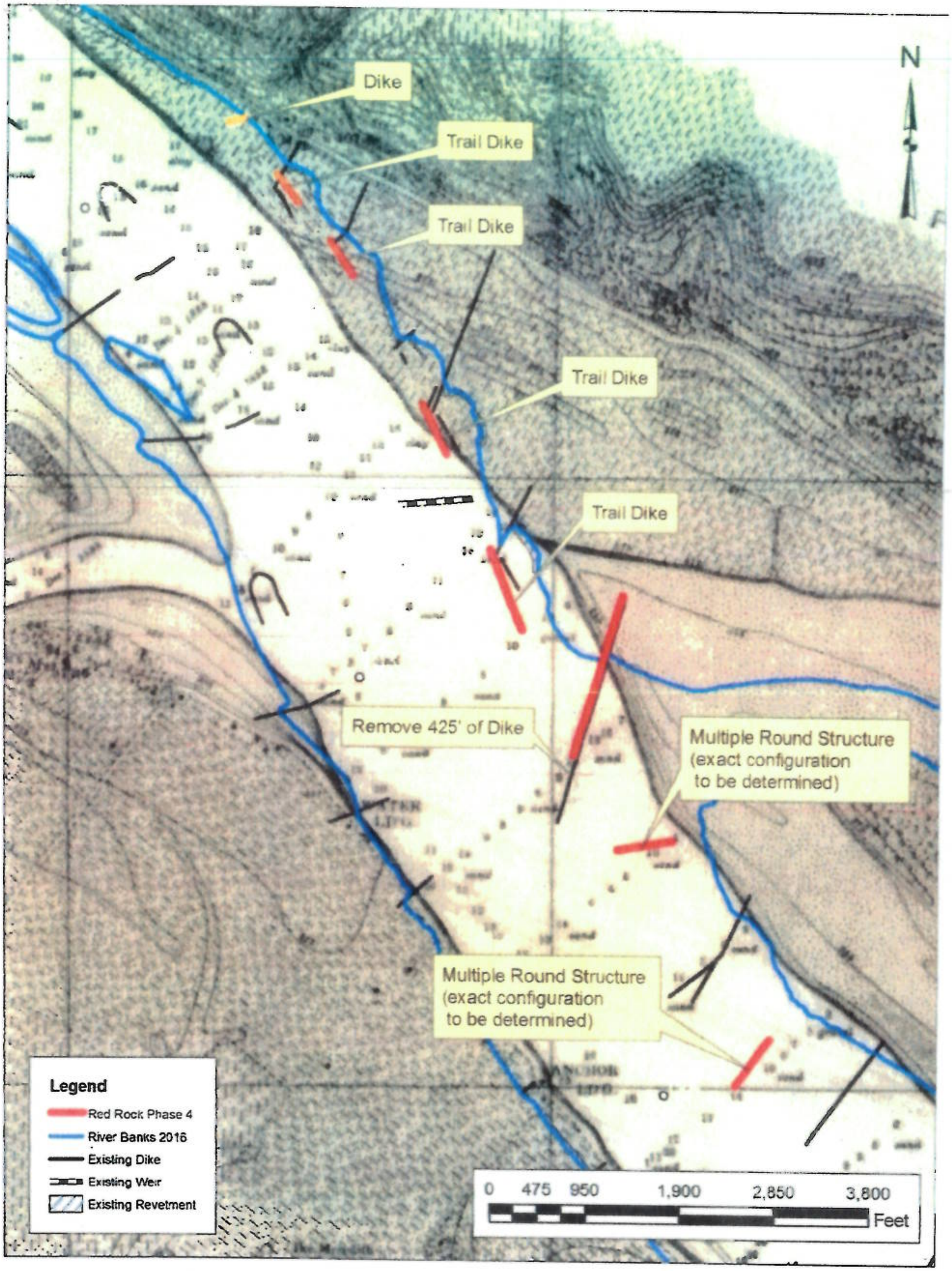


Figure 3. Project features on 1890 MRC chart.

References Cited

Manders, D., & B. Rentrfro
2011 Engineers *Far From Ordinary*. St. Louis District USACE, St Louis, MO.

Mississippi River Commission (MRC)
1881 Chart No 109. Survey of the Mississippi River.

Norris, F. T.
2003 Historical Shipwrecks on the Middle Mississippi and Lower Illinois Rivers. Curation and Archives Analysis Branch, U. S. Army Corps of Engineers, St. Louis District.

Eco CAT
Ecological Compliance Assessment Tool

Applicant:	U.S. Army Corps of Engineers, St. Louis District	*IDNR Project Number:*	1808774
Contact:	Shane Simmons	*Date:*	03/14/2018
Address:	1222 Spruce St. St. Louis , MO 63103	*Alternate Number:*	1705966

Project: Regulating Works - Red Rock Landing Phase 4
Address: Randolph County, Rockwood

Description: The proposed work area is adjacent to the left descending bank of the Mississippi River between river miles 102.5 - 104, in Randolph County, Illinois. It is approximately 1.5 miles west of Rockwood, Illinois and 5 miles southeast of Chester, Illinois. Frequent dredging has been required in order to maintain a safe and sufficient navigation channel within the proposed work area. The U.S. Army Corps of Engineers, St. Louis District, has concluded that construction of the Red Rock Landing Phase 4 project is reasonable and necessary to address the repetitive channel maintenance dredging in order to provide a sustainable, less costly navigation channel in this area. The District has concluded through analysis and modeling that construction of river training structures would provide a sustainable alternative to repetitive maintenance dredging. Specifically, the project involves degrading existing trail dikes and rebuilding them at different angles, removing a segment of an existing dike, construction of new trail dikes, construction of a new traditional dike, and construction of a new multiple round-point structure (MRS). The project is expected to begin in 2018 or 2019.

Natural Resource Review Results

The Illinois Natural Heritage Database contains no record of State-listed threatened or endangered species, Illinois Natural Area Inventory sites, dedicated Illinois Nature Preserves, or registered Land and Water Reserves in the vicinity of the project location.

Consultation is terminated. This consultation is valid for two years unless new information becomes available that was not previously considered; the proposed action is modified; or additional species, essential habitat, or Natural Areas are identified in the vicinity. If the project has not been implemented within two years of the date of this letter, or any of the above listed conditions develop, a new consultation is necessary. Termination does not imply IDNR's authorization or endorsement.

Location

The applicant is responsible for the accuracy of the location submitted for the project.

County: Randolph

Township, Range, Section:
8S, 6W, 2
8S, 6W, 3
8S, 6W, 11
8S, 6W, 13
8S, 6W, 14

IL Department of Natural Resources Contact
Adam Rawe
217-785-5500
Division of Ecosystems & Environment

Government Jurisdiction
U.S. Army Corps of Engineers

Disclaimer

The Illinois Natural Heritage Database cannot provide a conclusive statement on the presence, absence, or condition of natural resources in Illinois. This review reflects the information existing in the Database at the time of this inquiry, and should not be regarded as a final statement on the site being considered, nor should it be a substitute for detailed site surveys or field surveys required for environmental assessments. If additional protected resources are encountered during the project's implementation, compliance with applicable statutes and regulations is required.

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1. The IDNR EcoCAT website was developed so that units of local government, state agencies and the public could request information or begin natural resource consultations on-line for the Illinois Endangered Species Protection Act, Illinois Natural Areas Preservation Act, and Illinois Interagency Wetland Policy Act. EcoCAT uses databases, Geographic Information System mapping, and a set of programmed decision rules to determine if proposed actions are in the vicinity of protected natural resources. By indicating your agreement to the Terms of Use for this application, you warrant that you will not use this web site for any other purpose.

2. Unauthorized attempts to upload, download, or change information on this website are strictly prohibited and may be punishable under the Computer Fraud and Abuse Act of 1986 and/or the National Information Infrastructure Protection Act.

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Unauthorized use, tampering with or modification of this system, including supporting hardware or software, may subject the violator to criminal and civil penalties. In the event of unauthorized intrusion, all relevant information regarding possible violation of law may be provided to law enforcement officials.

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Marion Ecological Services Sub-Office
Marion Illinois Sub-office
8588 Route 148
Marion, IL 62959-5822
Phone: (618) 997-3344 Fax: (618) 997-8961
http://www.fws.gov/midwest/Endangered/section7/s7process/step1.html

In Reply Refer To: March 14, 2018
Consultation Code: 03E18100-2017-SLI-0157
Event Code: 03E18100-2018-E-00666
Project Name: Red Rock Landing Phase 4

Subject: Updated list of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The attached species list identifies any federally threatened, endangered, proposed and candidate species that may occur within the boundary of your proposed project or may be affected by your proposed project. The list also includes designated critical habitat if present within your proposed project area or affected by your project. This list is provided to you as the initial step of the consultation process required under section 7(c) of the Endangered Species Act, also referred to as Section 7 Consultation.

Section 7 of the Endangered Species Act of 1973 requires that actions authorized, funded, or carried out by Federal agencies not jeopardize federally threatened or endangered species or adversely modify designated critical habitat. To fulfill this mandate, Federal agencies (or their designated non-federal representative) must consult with the Service if they determine their project “may affect” listed species or critical habitat. Under the ESA, it is the responsibility of the Federal action agency or its designated respresentative to determine if a proposed action "may affect" endangered, threatened, or proposed species, or designated critical habitat, and if so, to consult with the Service further. Similarly, it is the responsibility of the Federal action agency or project proponent, not the Service to make "no effect" determinations. If you determine that your proposed action will have "no effect" on threatened or endangered species or their respective critical habitat, you do not need to seek concurrence with the Service. Nevertheless, it is a violation of Federal law to harm or harass any federally-listed threatened or endangered fish or wildlife species without the appropriate permit.

Under 50 CFR 402.12(e) (the regulations that implement Section 7 of the Endangered Species Act) the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally. You may verify the list by visiting the ECOS-IPaC website http://ecos.fws.gov/ipac/ at regular intervals during project planning and implementation and completing the same process you used to receive the attached list. As an alternative, you may contact this Ecological Services Field Office for updates.

Please use the species list provided and visit the U.S. Fish and Wildlife Service's Region 3 Section 7 Technical Assistance website http://www.fws.gov/midwest/endangered/section7/s7process/index.html. This website contains step-by-step instructions which will help you determine if your project will have an adverse effect on listed species and will help lead you through the Section 7 process.

For all wind energy projects and projects that include installing towers that use guy wires or are over 200 feet in height, please contact this field office directly for assistance, even if no federally listed plants, animals or critical habitat are present within your proposed project or may be affected by your proposed project.

Although no longer protected under the Endangered Species Act, be aware that bald eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*) and Migratory Bird Treaty Act *(*16 U.S.C. 703 *et seq*), as are golden eagles. Projects affecting these species may require measures to avoid harming eagles or may require a permit. If your project is near an eagle nest or winter roost area, see our Eagle Permits website http://www.fws.gov/midwest/midwestbird/EaglePermits/index.html to help you determine if you can avoid impacting eagles or if a permit may be necessary.

We appreciate your concern for threatened and endangered species. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List
- USFWS National Wildlife Refuges and Fish Hatcheries

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Marion Ecological Services Sub-Office
Marion Illinois Sub-office
8588 Route 148
Marion, IL 62959-5822
(618) 997-3344

Project Summary

Consultation Code: 03E18100-2017-SLI-0157

Event Code: 03E18100-2018-E-00666

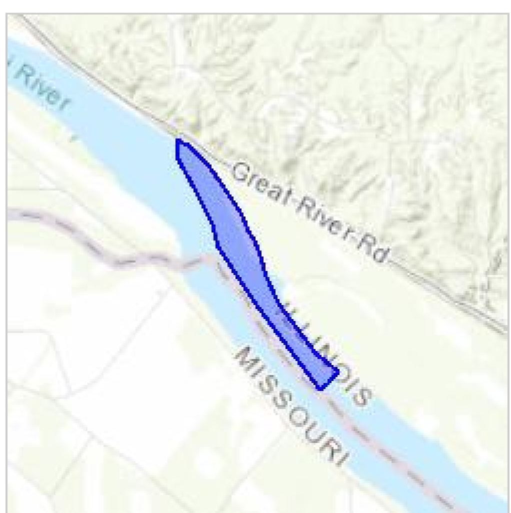
Project Name: Red Rock Landing Phase 4

Project Type: STREAM / WATERBODY / CANALS / LEVEES / DIKES

Project Description: The proposed work area is adjacent to the left descending bank of the Mississippi River between river miles 102.5 - 104, in Randolph County, Illinois. It is approximately 1.5 miles west of Rockwood, Illinois and 5 miles southeast of Chester, Illinois. Frequent dredging has been required in order to maintain a safe and sufficient navigation channel within the proposed work area. The U.S. Army Corps of Engineers, St. Louis District, has concluded that construction of the Red Rock Landing Phase 4 project is reasonable and necessary to address the repetitive channel maintenance dredging in order to provide a sustainable, less costly navigation channel in this area. The District has concluded through analysis and modeling that construction of river training structures would provide a sustainable alternative to repetitive maintenance dredging. Specifically, the project involves degrading existing trail dikes and rebuilding them at different angles, removing a segment of an existing dike, construction of new trail dikes, construction of a new traditional dike, and construction of new multiple round-stone (MRS) structure. The project is expected to begin in 2018 or 2019.

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/37.846052258801805N89.73544685327388W



Counties: Randolph, IL

Endangered Species Act Species

There is a total of 5 threatened, endangered, or candidate species on this species list. Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

Mammals

NAME	STATUS
Indiana Bat *Myotis sodalis* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/5949	Endangered
Northern Long-eared Bat *Myotis septentrionalis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9045	Threatened

Birds

NAME	STATUS
Least Tern *Sterna antillarum* Population: interior pop. No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/8505	Endangered

Fishes

NAME	STATUS
Pallid Sturgeon *Scaphirhynchus albus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/7162	Endangered

Flowering Plants

NAME	STATUS
Small Whorled Pogonia *Isotria medeoloides* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/1890	Threatened

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

USFWS National Wildlife Refuge Lands And Fish Hatcheries

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

REFUGE INFORMATION WAS NOT AVAILABLE WHEN THIS SPECIES LIST WAS GENERATED. PLEASE CONTACT THE FIELD OFFICE FOR FURTHER INFORMATION.

Appendix D. Distribution List

The following individuals and organizations received e-mail notification of the Public Notice:

Adrian, D
Alexander County Highway Department
Amato, Joel
Andria, Kathy
Atwood, Butch
Baldera, Patrick
Banner Press
Barnes, Robert
Bax, Stacia
Beardslee, Thomas
Bellville, Colette
Beres, Audrey
Berland, Paul
Boaz, Tracy
Boehm, Gerry
Brescia, Chris
Brinkman, Elliot
Brown, Doyle
Buan, Steve
Buffalo, Jonathan
Burlingame, Chuck
Caito, J
Campbell-Allison, Jennifer
Carney, Doug
Ceorst MVS External Stakeholder
Chicago Commodities
Chief John Red
City of Portage des Sioux
Clements, Mark
Clover-Hill, Shelly
Coder, Justin
Congressman Clay
Congressman Graves
Corker, Ashley
Crowley, S
Cruse, Lester
Curran, Michael
Davis, Dave
Deel, Judith
Dewey, Dave
Diedrichsen, Mike
Senator Blunt
Dodd, Harold
Dorothy, Olivia
Dotts, Glenn
Dougherty, Mark
Duncan, Cecil
Ebey, Mike
Elmestad, Gary
Escudero, Marisa
Fabrizio, Christi
Favilla, Christine
Foster, Bill
Fretz, Eileen
Fung, Jenny
Genz, Greg
Glenn, S
Goode, Peter
Great Lakes Dredge & Dock
Grider, Nathan
Hall, Mike
Hammond, Cheryl
Hanke Terminals
Hanneman, M
Hansens Harbor
Harding, Scott
Held, Eric
Henleben, Ed
Henry, Donovan
Heroff, Bernard
Herschler, Mike
Herzog, Dave
HMT Bell South
Hoppies Marine
Howard, Chuck
Hubertz, Elizabeth
Hughes, Shannon
Hunt, Henry
Hussell, B
IL SHPO
Jamison, Larry
JBS Chief

Jefferson Port Authority
Johnson, Frank
Knowles, Kim
Knuth, Dave
Kowal, Kathy
Kovarovics, Scott
Kristen, John
Lange, James
Larson, Robert
Lavalle, Tricia; Senator Blunt
Leary, Alan
Lipeles, Maxie
Logicplus
Lorberg, Jerry
Louis Marine
Malone, Pat
Manders, Jon
Mangan, Matthew
Mannion, Clare
Marrs, T. Bruce
Mauer, Paul
McGinnis, Kelly
McPeek, Kraig
MDNR
Medina, Santita
Melgin, Wendy
Menees, Bob
Middleton, Joeana; Senator McCaskill
Miller, Jeff
Miller, Kenneth
Missouri Corn Growers Association
Morgan, Justin
Morrison, Bruce
Muench, Lynn
Muir, T
Nash-Mayberry, Jamie
Nelson, Lee
Niquette, Charles
Novak, Ron
O'Carroll, J
Peper, Sarah
Pinter, Nicholas
Popplewell, Mickey
Porter, Jason
Randolph, Anita
Reitz, Paul
Roark, Bev
Samet, Melissa
Sauer, Randy
Schranz, Joseph Standing Bear
Schulte, Rose
SEMO Port
Senator Blunt's Office
Shepard, Larry
Shoulberg, J
Skrukrud, Cindy
Slay, Glen
Smith, David
Southern Illinois Transfer
Spoth, Robert
Stahlman, Bill
Staten, Shane
Sternburg, Janet
SUMR Waterways
Taylor, Susan
Teah, Philip
Todd, Brian
Tow Inc
Tyson, J
Urban, David
U.S. Salt
USEPA Region 5
USEPA Region 7
Walker, Brad
Welge, Owen
Werner, Paul
Westlake, Ken
Wilmsmeyer, Dennis
Winship, Jaci
York Bridge Co.
Zupan, T

The following individuals received a hard copy mailing of the Public Notice:

Blankenship, Tina
Campbell, Leon
Congressman Bost
Congressman Luetkemeyer
Congressman Smith
Congresswoman Wagner
Damptz, Amanda
Governor Greitens
Governor Rauner
Knupp, Virgil
Korando, David
Houghton, Fay
Houston, Elena
Mezo, Braden
Randall, Lester
Salazar, Tony
Schranz, Joseph Standing Bear
Senator Durbin
Senator Duckworth
Shepard, Ron
Spurlock, Jessica
Standing Bear, Geoffrey
Taflinger, Jim
Verble, Kenneth
Verble-Whitaker, LaRae