MELVIN PRICE LOCKS AND DAM

UPPER MISSISSIPPI RIVER BASIN
MISSISSIPPI RIVER MISSOURI AND ILLINOIS

PROGRESS REPORT 2010-2011

DESIGN MEMORANDUM NO. 24
AVOID AND MINIMIZE MEASURES

US Army Corps of Engineers
St. Louis District®

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SEPTEMBER 2012

Cover photo

W Dike at River Mile 290.4. In 2010, a W-dike was constructed at river mile 290.4R, below Blackbird Island. The W dike design was developed in lieu of a traditional dike structure to create flow diversity and hence, habitat diversity, for fish and other biota while also providing the benefit of channel deepening and reduced dredging requirements.

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MELVIN PRICE LOCKS AND DAM
MISSISSIPPI RIVER - MISSOURI AND ILLINOIS

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Table of Contents

A&M 1. 2010-2011 Construction 1

W Dike construction and mussel sampling (Appendix A) 1

Chevron consruction and dike shortening 5

Chevron construction and mussel sampling (Appendix B) 6

A&M 2. Hydraulic Sediment Response (HSR) Model Studies 8

Establishment Chute, Upper Mississippi River miles 134.0-128.0 8

A&M 3. Analysis of the Effects of Bendway Weir Construction on Channel Cross-Sectional Geometry 10

St. Louis District Avoid and Minimize Program Dollars Expended, 1996 - 2011 11

List of Figures

Figure 1. W dike location, past dive and brail surveys, and general extent of the 2009 mussel survey. 3

Figure 2. Mussel survey area showing transect locations, Mississippi River Mile 291, July 2009. 4

Figure 3. Chevron construction and dike shortening along the Cliff Cave-Kimmswick Reach..... 5

Figure 4. Pool 24 chevrons constructed in 2011 7

Figure 5. Location of November 2010 mussel surveys. 7

Appendix A

Final Report: Assessment of Unionids and Habitat for Proposed Dike Construction near Mississippi River Mile 291

Appendix B

Final Report: Assessment of Unionids and Habitat for Proposed Dike Construction at the Gilbert Island Complex, Mississippi River Mile 298.6 to 298.

Avoid and Minimize Environmental Impacts Program
St. Louis District - Mississippi Valley Division
2007-2009 Progress Report

Executive Summary

The St. Louis District agreed to establish an Avoid and Minimize Program (A&M) in 1992 to reduce possible environmental impacts of increased navigation industry traffic due to construction of a second lock at Melvin Price Locks and Dam. Expenditures in the program average around $826,000 a year. Full-scale implementation of the program began in 1996. Direction of the program is coordinated through the River Resource Action Team, which consists of state, federal and private partners in both natural resources and industry.

Several construction efforts funded through the Avoid and Minimize Program were made between 2010 and 2011. In 2010, a "W" dike was constructed at river mile 290.4R, below Blackbird Island. A mussel survey for this area was conducted in July 2009 with a final report submitted in October 2009. In general, mussel habitat at the site was considered poor, being primarily composed of unstable, shifting sand, which did not support a significant mussel community.

Beginning in 2010 and completed in 2011, chevron construction (river miles 162.8, 162.6, 162.5, and 162.4L) and dike shortening construction (river miles 163.0, 162.6, and 162.3L) took place along the Cliff Cave-Kimmswick Reach of the Middle Mississippi River. These channel structures and modifications were the result of recommendations made from a hydraulic sediment response study (HSR) completed in September 2006. Additionally in 2011, two chevrons were constructed in Pool 24 at river miles 298.55L and 298.4L.

Between January 2010 and September 2011 an HSR model was evaluated on a stretch of the Mississippi River between river miles 134.0 and 128.0. The study area was at Establishment Chute which is roughly twenty miles downstream of the town of Herculaneum, Missouri. The objective of the study was to evaluate environmental design alternatives for the development of side channel and island habitat utilizing an existing dike field and island complex.

Recently, St. Louis's environmental partners have been concerned that the bendway weirs are having an undocumented effect on channel geometry. To investigate the effects of the bendway weirs on cross-sectional bed geometry, a study was undertaken in which area, width, wetted perimeter, and slope were compared pre- to post-weir installation. The post-weir periods (2007 and 2005) and pre-weir periods (1986, 1982, and 1976) were chosen because nearly every weir field had been surveyed in each period. These results indicate the bendway weirs are largely achieving their primary goal of widening the navigable portion of the channel without a serious detrimental effect on the inside bar slope.

Avoid and Minimize
Environmental Impacts Program
St. Louis District - Mississippi Valley Division
2010-2011 Progress Report

In October 1992, the St. Louis District issued Design Memorandum No. 24, "Avoid and Minimize Measures, Melvin Price Locks and Dam, Upper Mississippi River - Missouri and Illinois." The document was developed as a commitment made in the 1988 Record of Decision attached to the Melvin Price Locks and Dam Environmental Impact Statement for the Second Lock. St. Louis District set aside funds from 1989 to 1995 to implement eight measures recommended by the study team. Implementations of measures in that part of the program were detailed in the 1995 Progress Report. In fiscal year 1996, O&M funds were received to begin full-scale implementation of recommended measures. The planning and implementation team consists of staff from the US Army Corps of Engineers (Corps), U.S. Fish and Wildlife Service (FWS), Illinois Department of Natural Resources (IDNR), Missouri Department of Conservation (MDOC), River Industry Action Committee (RIAC), and the Long Term Resource Monitoring Field Station (LTRM/MDOC) at Jackson, Missouri. Each group contributes staff time to plan and attend meetings and may collect data as part of an ongoing monitoring program. This team meets at least once a year, recently as members of the River Resources Action Team (RRAT), to discuss ongoing work and planned future work. Outside of these meetings the St. Louis District routinely corresponds with the team to coordinate monitoring and solicit ideas and input.

2010-2011 A&M Program Activities

A&M 1. 2010-2011 Construction

Several construction projects funded through the Avoid and Minimize Program were completed during fiscal years 2010 and 2011.

W Dike construction and mussel sampling (Appendix A)

In 2010, a W-dike was constructed at river mile 290.4R, below Blackbird Island (see front cover). The W dike design was developed in lieu of a traditional dike structure to create flow diversity and hence, habitat diversity, for fish and other biota while also providing the benefit of channel deepening and reduced dredging requirements. The project was coordinated with the MDOC, IDNR, and the FWS. In early discussions, the agencies had concerns about potential impacts to mussels in the area. Just up-river, along the Missouri side of Blackbird Island, earlier surveys had identified established mussel beds (Figure 1). In addition, the Missouri state and federally endangered fat pocketbook (*Potamilus capax*) had been transplanted to an area behind the lower end of Blackbird Island (a short distance from the proposed work) in1989 in an attempt

to re-establish a historical population; however, recent surveys suggested that its success was questionable.

In light of the potential for existing mussel beds to be impacted as a result of the project, a mussel survey was conducted during July 2009 prior to construction of the W dike (Figure 2). Semi-quantitative, quantitative, and qualitative search methods were used to evaluate the mussel community and habitat potentially impacted by construction. Relatively few mussels [unionids] were collected in the area; search efforts yielded 117 live adult unionids representing 12 common species. The low number of unionids collected attributed to poor habitat quality within the site. Most unionids were collected within 50 meters from the bank where some gravel was present and therefore substrate was more stable. The majority of the study area was comprised of unstable, shifting sands where unionids populations are normally absent. Overall, the proposed construction area offered little suitable habitat for unionids and did not support a significant unionids community. It was held that construction of the W dike would have no effect on unionids and that mitigation actions were not necessary. At this time, no post-construction biological surveys have been conducted in this area.

Figure 1. W dike location, past dive and brail surveys, and general extent of the 2009 mussel survey.

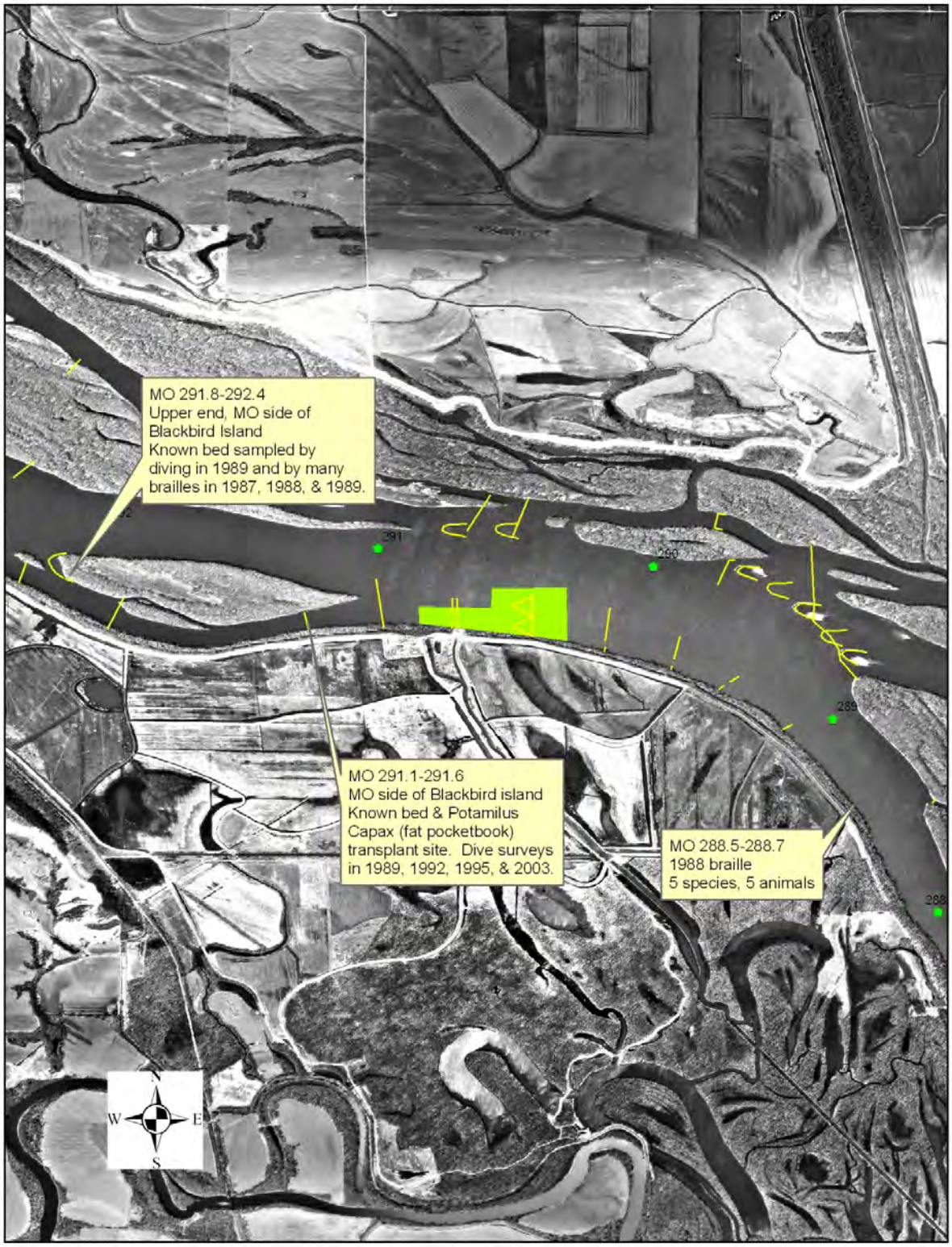
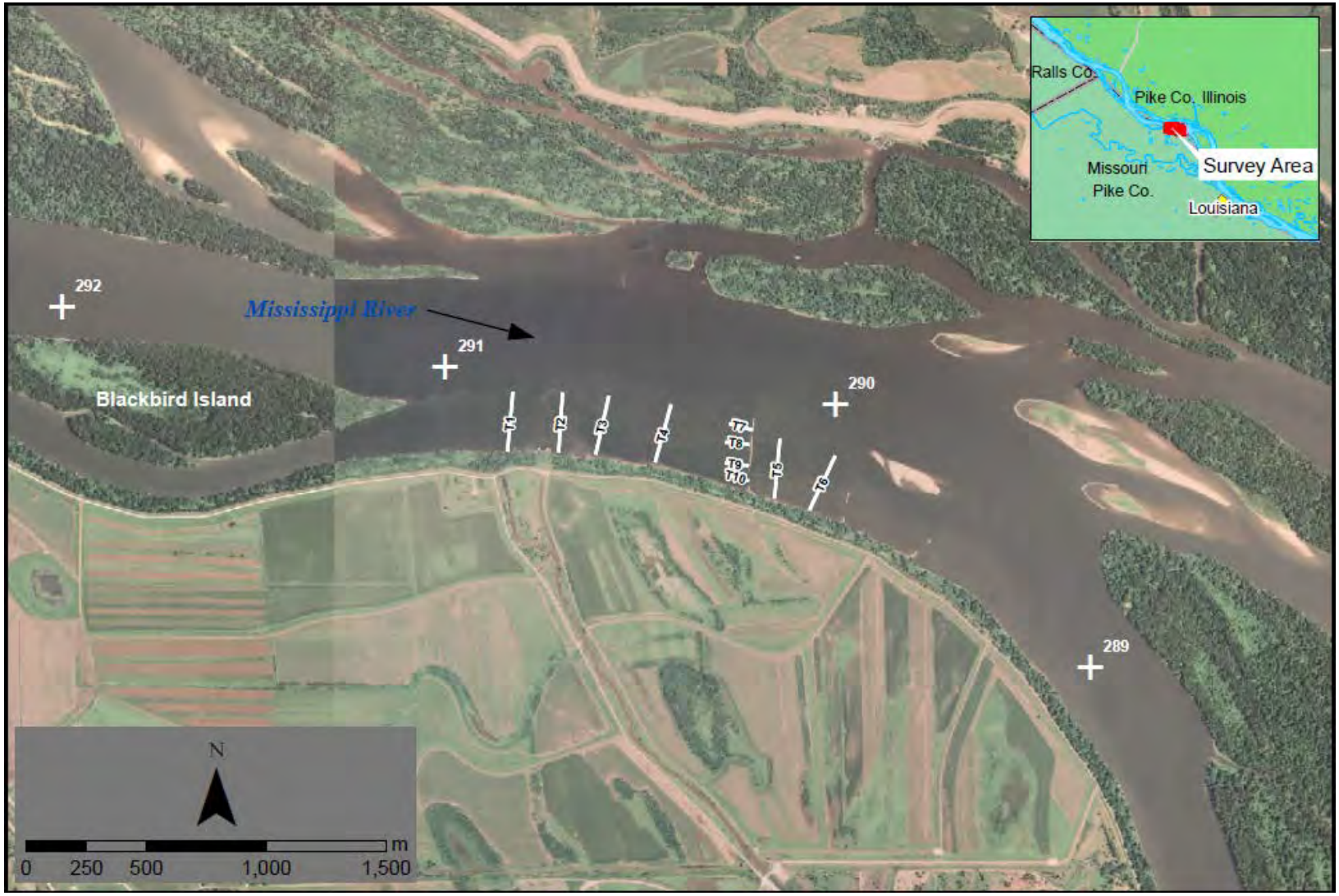


Figure 2. Mussel survey area showing transect locations, Mississippi River Mile 291, July 2009.



Chevron consruction and dike shortening

Beginning in 2010 and completed in 2011, chevron construction (river miles 162.8, 162.6, 162.5, and 162.4L) and dike shortening construction (river miles 163.0, 162.6, and 162.3L) was conducted along the Cliff Cave-Kimmswick Reach of the Middle Mississippi River (Figure 3). These channel structures and modifications were the result of recommendations made from the Cliff Cave-KImmswick HSR study conducted by the St. Louis District's Applied River Engineering Center and completed in September 2006 (http://mvs-wc.mvs.usace.army.mil/arec/Documents/HSR_Models/M41_Cliff_Cave_Kimmswick.pdf). The model was used to evaluate sediment transport conditions as well as the impact of various structural alternatives along this reach. The primary goal of the study was to diversify aquatic habitat by modifying present dike structures, developing new side channels and bar formations while maintaining the integrity of the navigation channel.

Figure 3. Chevron construction and dike shortening along the Cliff Cave-Kimmswick Reach.

Chevron construction and mussel sampling (Appendix B)

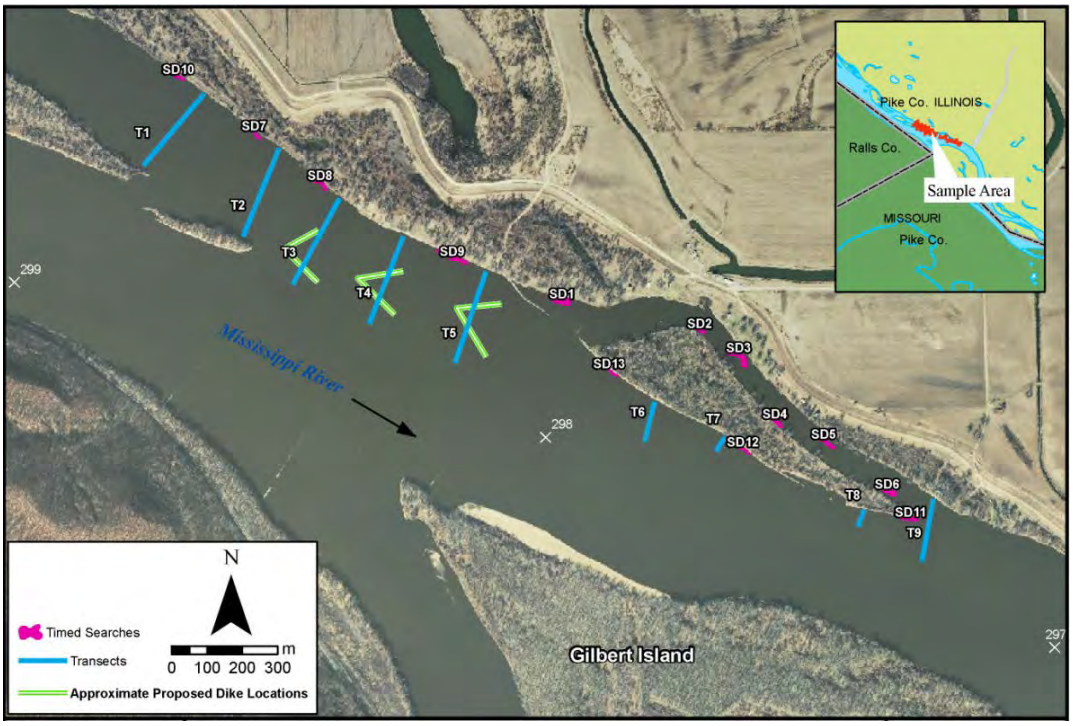
In 2011, two chevrons were constructed (of three proposed) in Pool 24 at river miles 298.55L and 298.4L (Figure 4) – the third is proposed at river mile 298.2L. However, IDNR records indicated that a mussel bed exists along the Illinois shoreline from approximate river mile 299.8 to 298.0 and there were concerns that these mussels could be directly or indirectly impacted from chevron placement. In addition, IDNR records showed the presence of a mussel bed at the lower end of the chute behind the small unnamed island just below the project area (Figure 4). Following further coordination with the FWS, MDOC and IDNR in January of 2010, it was concurred that mussel surveys be conducted prior to chevron construction. Particularly, the ILDNR was concerned the chevrons would reduce flow through the small side channel, altering substrates and negatively impact the mussel assemblage that might still occur there. As a result, the Corps conducted a mussel survey of the area from 1-3 November 2010 (Appendix B).

Results of the survey indicated that the mussel community within the project area was sparse and patchy with most mussels collected within 20 meters of the Illinois bank upstream and shoreward of the proposed chevron dikes (Figure 5). Substrates near the bank consisted of stable gravel, silt, and clay. Conversely, the substrate for the proposed chevron construction sites consisted primarily of unstable, shifting sands – a habitat that rarely supports mussel populations.

It should also be noted that the agencies concurred that the chevrons should be constructed using a phased approach. That is, in the phased approach the two upper chevrons would be constructed, the channel would be monitored, and a proposed third chevron would be added only if absolutely necessary. Also, it was agreed that no future dredge material would be placed within the chevron field.

Figure 4. Pool 24 chevrons constructed in 2011

Figure 5. Location of November 2010 mussel surveys.



A&M 2. Hydraulic Sediment Response (HSR) Model Studies

A full report of the following study can be found on the St. Louis District's Applied River Engineering Center website:

http://mvs-wc.mvs.usace.army.mil/arec/Documents/HSR_Models/Estblishment_Chute/M60_Establishment_Chute.pdf

Establishment Chute, Upper Mississippi River miles 134.0-128.0

This HSR study was conducted by the St. Louis District's Applied River Engineering Center between January 2010 and September 2011 on a stretch of the Mississippi River between river miles 134.0 and 128.0, located roughly twenty miles downstream of the town of Herculaneum, Missouri). The objective of the study was to evaluate environmental design alternatives for the development of side channel and island habitat, utilizing an existing dike field and island complex.

Over time, the Establishment Chute side channel of the Middle Mississippi River had silted in. Surveys of the side channel indicated that the bed of Establishment Chute was relatively high and homogenous. As a result of the shallow elevations, there was little aquatic diversity within the side channel. Typically, side channels, both continuous and detached, serve as important backwater habitats for a variety of fish species. Alternating bars, deep scour holes, and other forms of diversity are desired within side channels, but this habitat does not exist within Establishment Chute.

The purpose of this study was to produce a report that communicates the results of the HSR analysis of various river engineering measures used to develop diversity within Establishment Chute. The increased diversity within Establishment Chute would, in turn, create a more beneficial aquatic habitat.

The goals of this study were to:

1. Evaluate a variety of remedial measures utilizing an HSR model with the primary objective of identifying the most effective and economical plan to diversify aquatic habitat in Establishment Chute. The secondary objective was to create a secondary side channel between Establishment Island and the existing point bar. In order to determine the best alternative, three criteria were used to evaluate each alternative.

    a. The alternative should increase aquatic habitat within Establishment Chute by creating more bathymetric diversity.
    b. The alternative should maintain the navigation channel requirements of at least 9 ft of depth and 300 ft of width.
    c. The alternative should not negatively impact the bar located between Establishment Island / Schmidts Island and the main channel.

2. Communicate to other engineers, river industry personnel, and environmental agency personnel the results of the HSR model tests and the plans for improvements.

Designing Alternative Tests

The testing process consisted of modeling alternative measures in the HSR model followed by analyses of the bathymetry results. The goal was to alter the model bed response in a manner intended to create more diversity within Establishment Chute while maintaining the existing navigation channel. Evaluation of each alternative was accomplished through a qualitative comparison to the model replication test bathymetry. The environmental impacts of alternatives were analyzed by looking at bathymetry changes in specified environmental areas.

Recommendations

Alternative 16, Plate 35, was recommended as the most desirable alternative because of its observed ability to create depth diversity within Establishment Chute. The alternative showed a narrow navigation channel within the crossing between RM 132.0 and RM 131.5, but this area was also narrower in the replication test than in the prototype. The alternative requires little changes to be made to the existing structures at the entrance to Establishment Chute, so the navigation channel should be minimally affected.

The recommended design included the following:

- RM 132.4R: Construct a 1,400 ft upstream L-dike - structure top elevation = 372 ft (+18 ft LWRP)

- RM 132.5R: Remove approximately 200 ft of the existing dike. The dike should be removed starting from the RDB and continue until it meets the upstream L-dike.

- RM 131.0R: Remove approximately 325 ft of the existing closure structure within Establishment Chute. The portion of the dike to be removed is from the RDB of Establishment Chute to the tip of Establishment Island.

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.

A&M 3. Analysis of the Effects of Bendway Weir Construction on Channel Cross-Sectional Geometry

A full report of the following study can be found on the St. Louis District's Applied River Engineering Center website:

http://mvs-wc.mvs.usace.army.mil/arec/Reports_Bendway_Weirs.html

Bendway weirs are submerged rock river training structures pioneered by the St. Louis District reduce the scouring of exterior bend slopes while simultaneously widening the navigable channel. Since their development, bendway weirs have been installed throughout Corps waterways. Recently, St. Louis's environmental partners have been concerned that the bendway weirs are having an undocumented effect on channel geometry. To investigate the effects of the bendway weirs on cross-sectional bed geometry, a study was undertaken in which area, width, wetted perimeter, and slope were compared pre- to post-weir installation. The inner bend longitudinal slope was of particular interest, as there were concerns that the slopes were increasing, threatening shallow water habitat. Because of this, inner slope was calculated both for the entire cross section and using 10 ft vertical segments. For the study, 22 weir fields were examined over 5 time periods using 197 cross sections. Cross sections were established before the first weir, between each weir, and after the last weir in each weir field. The post-weir periods (2007 and 2005) and pre-weir periods (1986, 1982, and 1976) were chosen because nearly every weir field had been surveyed in each period.

When complete, the study revealed that the width at LWRP increased for 77% of the cross sections with an average increase of ~330 ft. The average slope decreased for 59% of all cross sections, with an average decrease of 1.27 ft. per 100 ft. The 10 ft vertical segment slopes were roughly even between decreases and increases, with ~70% of the slope changes falling with natural variation as defined by the study methodology. These results indicate the bendway weirs are largely achieving their primary goal of widening the navigable portion of the channel without a serious detrimental effect on the inside bar slope.

St. Louis District Avoid and Minimize Program Dollars Expended, 1996 - 2011

Fiscal Year	Total Expended
FY 1996	1,054,000
FY 1997	1,489,000
FY 1998	1,060,000
FY 1999	1,040,000
FY 2000	421,000
FY 2001	684,439
FY 2002	148,221
FY 2003	684,823
FY 2004	568,717
FY 2005	939,568
FY 2006	526,671
FY 2007	865,053
FY 2008	1,108,024
FY 2009	977,021
FY 2010	994,000
FY 2011	877,000
TOTAL	**13,437,537**

Appendix A

Final Report: Assessment of Unionids and Habitat for Proposed Dike Construction near Mississippi River Mile 291 (Blackbird Island)

Final Report: Assessment of Unionids and Habitat for Proposed Dike Construction near Mississippi River Mile 291

Prepared for:

Southern University and A&M College
Baton Rouge, LA

Under Contract to:
U.S. Army Corps of Engineers – St. Louis District
St. Louis, MO

Prepared by:

Ecological Specialists, Inc.
O'Fallon, Missouri

October 2009

(ESI Project No. 09-013)

Acknowledgements

St. Louis District Army Corps of Engineers (USACE) funded this project. Mr. Francis Walton was the St. Louis District's project biologist. Ecological Specialists, Inc. (ESI) was contracted through Southern University and A&M College – Baton Rouge (SUBR). Ms. Deanna Smith managed the project for SUBR. Mr. Eric Belt was the project manager for ESI. Ms. Heidi Dunn was the field team leader, and Mr. Nathan Badgett, Mr. Kendall Cranney, and Mr. Nathan Wurmb were the project divers for ESI. Mr. Eric Belt and Mr. Badgett co-authored the report, and Ms. Dunn assisted with report preparation.

Abstract

The St. Louis District of the US. Army Corps of Engineers has proposed dike construction near Mississippi River Mile 291. Semi-quantitative, quantitative, and qualitative search methods were used to evaluate the mussel community and habitat potentially impacted by construction. Relatively few unionids were collected in the area; search efforts yielded 117 live adult unionids representing 12 common species. The low number of unionids collected is likely due to poor habitat quality within the site. Most unionids were collected within 50m from the bank where some gravel is present and therefore substrate is more stable. The majority of the study area is comprised of unstable, shifting sand. The proposed construction area offers little suitable habitat for unionids and does not support a significant unionid community. Construction of the rock dikes should have no effect on unionids, and mitigation actions are likely unnecessary.

Table of Contents

1.0 Introduction 1
2.0 Methods 2
3.0 Results 4
3.1 Habitat 4
3.2 Unionid Community 4
4.0 Discussion 5
5.0 Literature Cited 6

List of Figures

Figure 1-1. Unionid survey area showing transect locations, Mississippi River Mile 291, July 2009 8
Figure 3-1. Substrate and depth (m) along transects, Mississippi River Mile 291, July 2009. 9
Figure 3-2. Unionid distribution for all sample methods, Mississippi River Mile 291, July 2009. 10

List of Tables

Table 1-1. Unionid species historically collected in Pool 24 of the Mississippi River. 11
Table 3-1. Depth (m) along transects, Mississippi River Mile 291, July 2009. 12
Table 3-2. Substrate along transects, Mississippi River Mile 291, July 2009. 13
Table 3-3. Unionids collected by sampling method, Mississippi River Mile 291, July 2009. 14
Table 3-4. Live unionids collected along transects, Mississippi River Mile 291, July 2009. 15
Table 3-5. Unionids collected in qualitative searches, Mississippi River Mile 291, July 2009. 16

Appendices

Appendix A. Scope of Work (SOW)
Appendix B. Water quality

1.0 Introduction

The St. Louis District Army Corps of Engineers (USACE) has proposed rock dike construction near Mississippi River Mile 291 (Figure 1-1). In-stream construction activity associated with dike construction has the potential to disrupt the substrate and the animals therein. Unionids (freshwater mussels) living within the area directly affected by construction could be crushed by equipment or permanently buried under excavation spoil. Disruption of the substrate could result in displacement of unionids to unsuitable habitat, which could lead to reduced fitness or death. Construction activities may also lead to altered flow patterns that may increase sedimentation, a major cause of unionid declines throughout North America (Fuller, 1974; Aldridge *et al*., 1987; Williams *et al*., 1993; Box and Mossa, 1999).

The Mississippi River harbors a diverse unionid mussel community, consisting of approximately 53 species. The proposed rock dike construction occurs in Pool 24 of the Mississippi River. A total of 30 unionid species have been found in Pool 24, including the federally endangered *Potamilus capax*, and two species listed as endangered in Missouri (Table 1-1). *Potamilus capax* individuals were previously transplanted into the slough behind Blackbird Island upstream of the project area.

USACE contracted Ecological Specialists, Inc. (ESI) to conduct a unionid survey in the vicinity of the proposed dike construction area to characterize habitat and unionid communities with respect to density, distribution, and species composition (Appendix A). Fieldwork for this survey was completed July 22 and 23, 2009.

2.0 Methods

Water quality parameters were recorded at the beginning of each sampling day. Temperature (°C), conductivity (microsiemens, µS), dissolved oxygen (DO, mg/L), and pH were measured using a Hydrolab Quanta water quality monitoring system. Water clarity (Secchi depth, m) was also recorded, and a Marsh-McBirney digital flow meter was used to measure flow velocities.

A combination of semi-quantitative, quantitative, and qualitative methods was used to survey the study area. Semi-quantitative sampling along transects was used to estimate unionid distribution and abundance (Dunn, 2000). Ten semi-quantitative transects were established within the study area. Six of the ten transects (T1 through T6) originated on the Missouri bank and extended riverward perpendicular to flow; these transects were 250m long and spaced 100m apart. An additional four transects (T7 through T10), 100m in length, were established parallel with the bank near dike 290.4. Sampling along all transects involved a diver searching the substrate for unionids within a 1m wide path. Each 10m section of transect was treated as a separate sample; the catch from each segment was individually recorded in order to track where species occurred along transects. Depth (m) and substrate composition (Wentworth scale, Wentworth 1922) were recorded at the end of each 10m segment, and GPS coordinates were recorded at the riverward and shoreward ends of each transect.

Quantitative sampling is necessary to accurately estimate density, age structure, and relative abundance (Miller and Payne, 1988; Cawley, 1993; Payne *et al.*, 1997). Quantitative sampling entailed a diver excavating all substrate within a $0.25m^2$ quadrat to a depth of 15cm. Excavated material was retrieved at the surface and processed through a series of nested sieves. Ten quadrats were excavated within the study area. Quantitative samples were collected in areas directly affected by dike construction and in areas likely to harbor mussels (based on results of semi-quantitative samples).

The effort required to find protected species is often considerable and they are rarely collected in quantitative samples (Kovalak *et al.*, 1986). Therefore, qualitative sampling was used to estimate the species composition of the community and the probability of finding endangered species. Qualitative samples entailed a diver searching the substrate for unionids, collecting all encountered shells within a specified time period. Ten 10-minute qualitative searches were conducted within the study area. Qualitative samples were collected in conjunction with quantitative samples such that the location of each quadrat sample served as the starting point for a timed search.

Unionids were identified to species, and shell condition (live; fresh dead = lustrous nacre, periostracum intact and dead <1yr; weathered dead = weathered or chalky nacre, worn periostracum, dead several months to many years; subfossil = severely worn and fragmented shell, often void of periostracum, dead many years to many decades) was recorded. Live individuals were aged (external annuli count) and measured (length in mm), and zebra mussel infestation was recorded. All live mussels were returned to the water following processing.

Metrics used to characterize unionid communities included:

- unionid abundance (no. of unionids collected)
- relative abundance of each species (% of total)
- catch per unit effort (CPUE, number of unionids per 5min of search time; qualitative searches only)
- rarefaction richness (richness based on equal number of unionids based on a regression of cumulative species vs. log of cumulative no. of individuals collected during sampling with samples randomized and the intercept set to 0, as no species occur if no individuals are collected)
- Simpson's diversity (D); expressed as 1-D; less diversity as value approaches zero
- evenness (based on the slope of an exponential equation- $y = ae^{bx}$ where y = relative abundance of species x, a = the intercept, e = constant 2.17828, b = slope of the line, and x = species rank: a steeper slope indicates species are less evenly distributed in the community, with a vertical line representing a situation where one species comprises more than 95% of the total number collected, and a horizontal line represents all species being equally represented in a community- maximum evenness)

3.0 Results

3.1 Habitat

The riverbank along the study site was gently sloped, depths along Transects 1 through 6 generally increased with distance from the bank. The area along Transects 7 through 10 was fairly uniform in depth; depths ranged from 2.1m to 3.0m and averaged 2.5m (Figure 3-1, Table 3-1). Substrate was primarily sand or a mixture of sand and silt. Patches of clay mixed in with sand and silt were observed along transects, and some gravel occurred near the bank (see Figure 3-1, Table 3-2).

3.2 Unionid Community

A total of 117 unionids representing 12 species were collected within the study site. *Amblema plicata* (n=36) was the most abundant species followed by *Obliquaria reflexa* (n=17) and *Quadrula quadrula* (n=16) (Table 3-3). Theoretical species richness was 10 species per 100 individuals, and the rarefaction slope was 5.22 ± 0.09 95%CI. Based on individuals collected, evenness was -0.391 and the diversity index (Simpson's 1- D) was 0.837.

Sixty-three (63) live unionids were collected along semi-quantitative transects (Table 3-4). Transects 1 and 4 were the most productive, each with ten live individuals. Unionids were collected throughout the site but appear to be more abundant within 100m of the bank; out of the 46 unionids were collected in Transects 1-6, 34 occurred within 100m of the bank. Location of semi-quantitative transects and number of unionids collected can be seen in Figure 3-2.

A total of 24-0.25m^2 quantitative samples were excavated within the study area. Two quantitative samples yielded live individuals, each with one live *P. ohiensis*. Locations of quantitative samples and number of unionids collected can be seen in Figure 3-2.

Twenty-four (24) 5-minute qualitative samples were collected within study area. Fifty-two (52) live unionids were collected during qualitative samples; the average catch per unit effort (CPUE, expressed as number of unionids per 5 minutes of search time) was 2.2 (Table 3-5). Location of qualitative searches and number of unionids collected can be seen in Figure 3-2.

4.0 Discussion

The unionid community within the study area is sparse and patchy with most unionids collected within 50m of the bank. The low abundance of freshwater mussels throughout the majority of the study area is likely due to poor habitat. Unionids are rarely found in unstable substrate (Cvancara, 1970; Strayer and Ralley, 1991) because they are unable to maintain their natural position, and they may be buried or displaced during fluvial events. Presence of gravel in the substrate near the bank may explain the occurrence of more unionids near the bank since the gravel can increase substrate stability. The substrate riverward, and throughout the majority of the survey area, is mostly sand and silt and is therefore less stable.

Construction of the proposed rock dikes is unlikely to require mitigation measures. The study area contains generally poor habitat throughout and does not support a significant unionid community. No state or federally listed species were collected, and no juveniles were collected suggesting that there is little to no recruitment in this area. Unionids currently inhabiting the area are likely transitional and may have been deposited by high water events. Construction activities should have no effect on unionids or unionid habitat in the vicinity of the proposed mooring cell.

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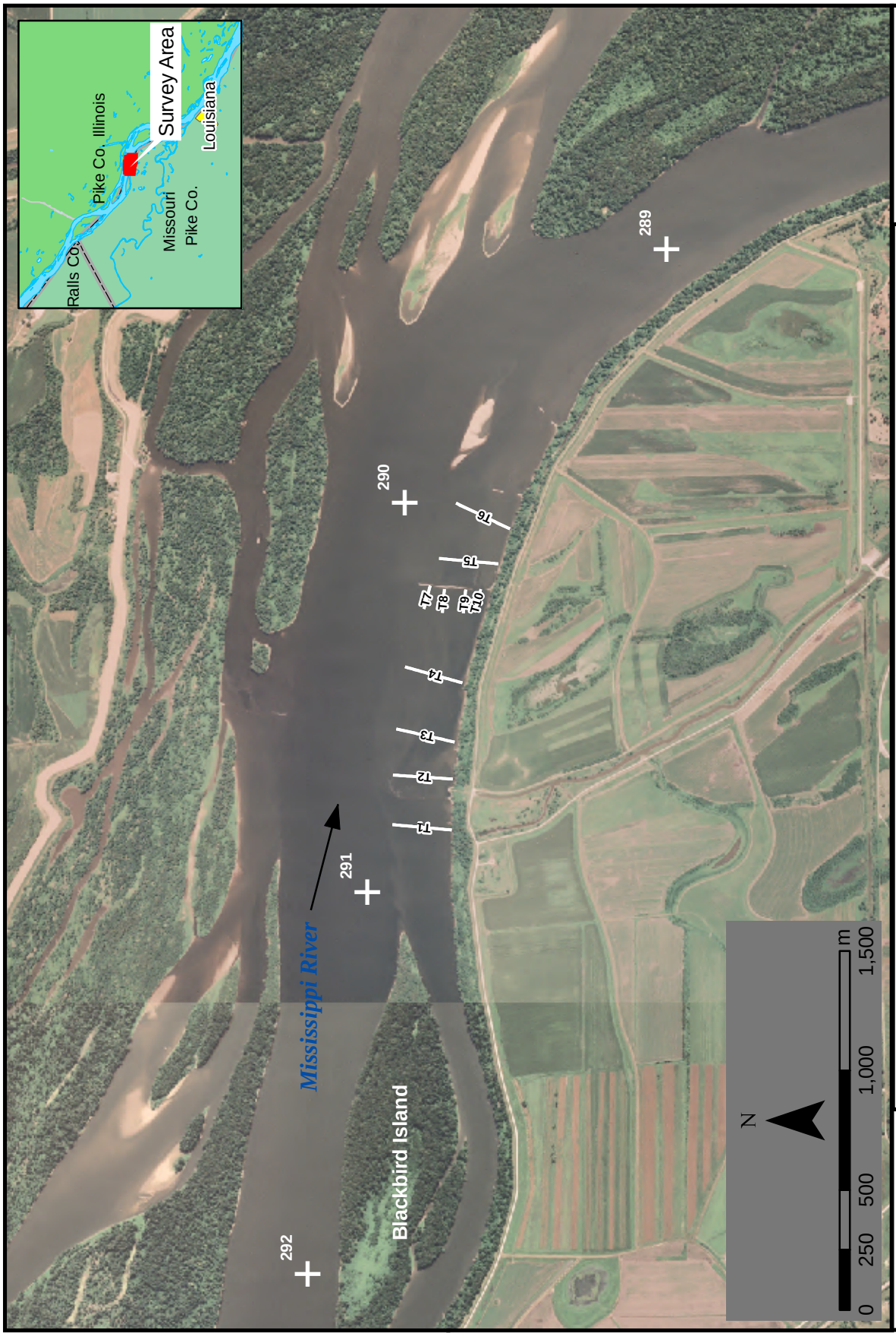

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Figure 1-1. Unionid survey area showing transect locations, Mississippi River Mile 291, July 2009.

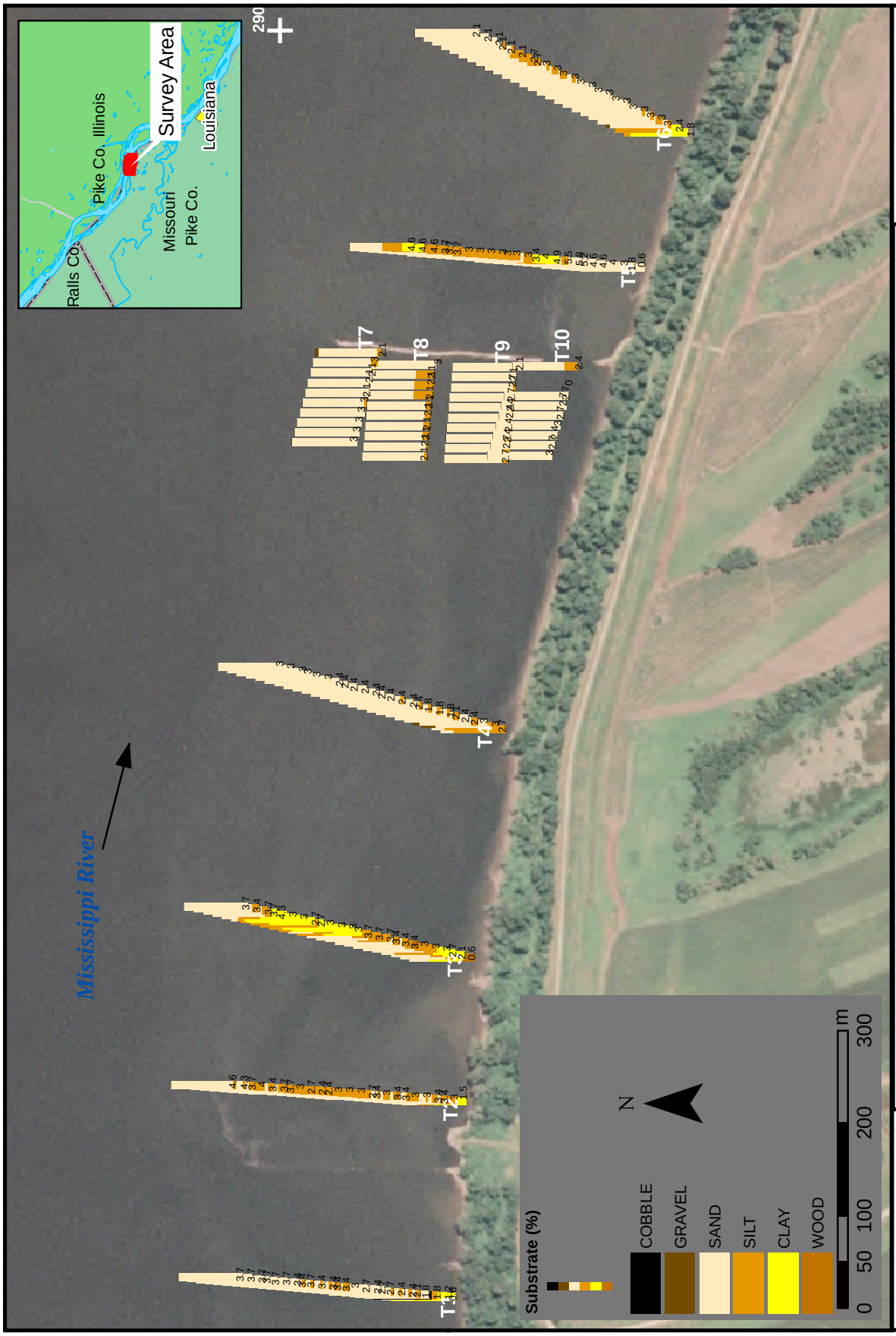

Figure 3-1. Substrate and depth (m) along transects, Mississippi River Mile 291, July 2009.

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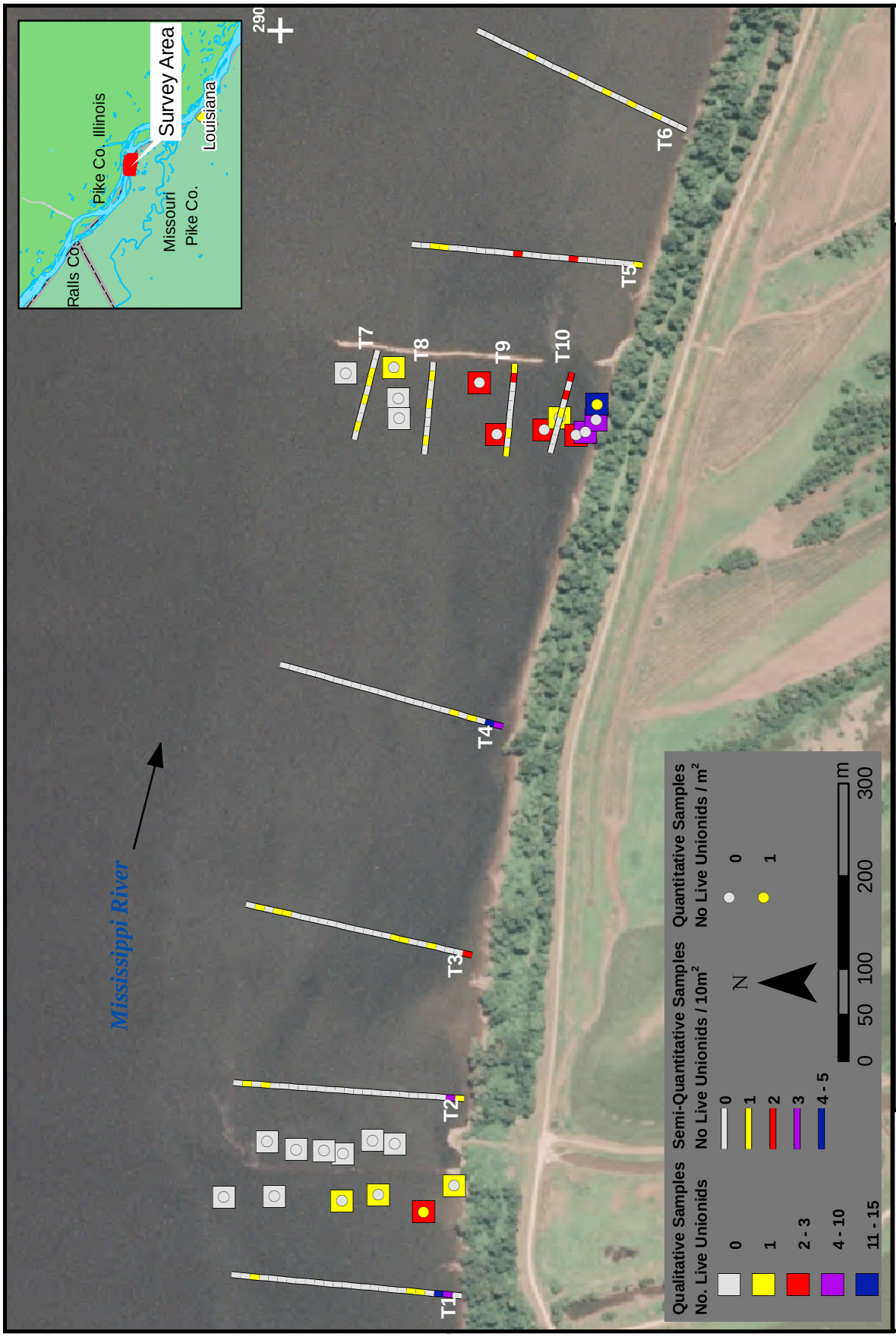

Figure 3-2. Unionid distribution for all sample methods, Mississippi River Mile 291, July 2009.

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Table 1-1. Unionid species historically collected in Pool 24 of the Upper Mississippi River.[1]

Scientific name	Common name	Status[2]	Pool 24[3]
Subfamily Cumberlandinae			
Cumberlandia monodonta	spectaclecase	FC	R
Subfamily Ambleminae			
Amblema plicata	threeridge		A
Cyclonaias tuberculata	purple wartyback		H
Elliptio crassidens	elephant ear		H
Elliptio dilatata	spike		H
Fusconaia ebena	ebonyshell	MOE	R
Fusconaia flava	Wabash pigtoe		R
Megalonaias nervosa	washboard		A
Plethobasus cyphyus	sheepnose	FC/MOE	R
Pleurobema sintoxia	round pigtoe		R
Quadrula metanevra	monkeyface		R
Quadrula nodulata	wartyback		C
Quadrula pustulosa	pimpleback		C
Quadrula quadrula	mapleleaf		C
Tritogonia verrucosa	pistolgrip		R
Subfamily Anodontinae			
Anodonta suborbiculata	flat floater		H
Arcidens confragosus	rock pocketbook		R
Lasmigona complanata	white heelsplitter		R
Pyganodon grandis	giant floater		R
Strophitus undulatus	strange floater		R
Utterbackia imbecillis	paper pondshell		R
Subfamily Lampsilinae			
Actinonaias ligamentina	mucket		R
Ellipsaria lineolata	butterfly		A
Lampsilis cardium	plain pocketbook		C
Lampsilis higginsii	Higgins eye		H
Lampsilis teres	yellow sandshell		R
Leptodea fragilis	fragile papershell		C
Ligumia recta	black sandshell		R
Obliquaria reflexa	threehorn wartyback		A
Obovaria olivaria	hickorynut		C
Potamilus alatus	pink heelsplitter		R
Potamilus capax	fat pocketbook	FE/MOE	R
Potamilus ohiensis	pink papershell		R
Truncilla donaciformis	fawnsfoot		C
Truncilla truncata	deertoe		A
Live species			30
Historic			5
Total species			35

[1]Kelner (2007)

[2]FE = Federally listed endangered species, FC=Candidate for federal endangered status (USFWS, 2009)
MOE=Missouri Endangered species (MDC, 2009)

[3]H = Records of occurrence but no live collections have been documented in the past ~25 years.
R = Rare, does not usually appear in sample collections, populations are small either naturally or have declined and may or may not be near extirpation.
C = Commonly taken in most samples; can make up a large portion of some samples.
A = Abundantly taken in most samples.

Table 3-1. Depth (m) along transects, Mississippi River Mile 291, July 2009.

Distance from shoreward end of transect (m)	Transect T 1	T 2	T 3	T 4	T 5	T 6	T 7[1]	T 8[1]	T 9[1]	T 10[1]
0										
10	0.6	1.5	0.6	2.7	0.6	1.8	2.1	2.1	2.1	
20	1.2	3.0	2.1	3.0	1.8	2.4	2.1	2.1	2.7	2.7
30	1.8	3.4	2.7	3.0	3.0	3.0	2.1	2.1	2.7	2.7
40	1.8	3.4	3.0	2.4	4.0	3.0	2.1	2.1	2.4	2.7
50	2.1	3.0	3.0	2.4	4.6	3.0	3.0	2.1	2.4	3.0
60	2.4	3.0	3.0	2.1	4.6	3.0	3.0	2.1	2.4	2.4
70	2.4	3.4	3.4	1.8	5.2	3.0	3.0	2.1	2.4	2.7
80	2.7	3.4	3.4	1.8	5.8	3.0	3.0	2.1	2.7	3.0
90	2.7	3.0	3.4	1.8	5.5	3.0	3.0	2.1	2.7	3.0
100	2.4	3.4	3.7	2.4	4.9	3.0	3.0	2.1	2.4	3.0
110	2.7	2.7	3.7	2.4	4.0	3.0				
120	3.0	3.0	3.7	2.4	3.4	3.0				
130	3.4	3.0	3.0	2.4	3.0	3.0				
140	3.4	3.0	3.0	2.4	3.0	3.0				
150	3.4	2.4	3.0	2.4	3.0	3.0				
160	3.4	2.4	3.0	2.4	3.0	3.0				
170	3.7	2.7	2.7	2.4	3.0	3.0				
180	3.4	3.0	2.7	2.4	3.0	2.7				
190	3.4	3.7	3.0	2.4	3.0	2.7				
200	3.7	3.7	3.0	3.0	3.7	2.1				
210	3.7	3.4	4.3	3.0	3.7	2.1				
220	3.7	4.0	3.7	3.0	3.7	2.1				
230	3.7	3.7	3.7	3.0	4.6	2.1				
240	3.7	4.3	3.4	3.0	4.6	2.1				
250	3.7	4.6	3.7	3.0	4.6	2.1				

[1]Transect ran parallel to flow and did not originate on bank

Table 3-2. Substrate along transects, Mississippi River Mile 291, July 2009.

Distance from shoreward end of transect (m)	Transect[1]									
	T 1	T 2	T 3	T 4	T 5	T 6	T 7[2]	T 8[2]	T 9[2]	T 10[2]
0										
10	CL	SD/ST/CL	SD/CL/WD	SD/ST	SD	ST/CL	GR/SD/ST	SD/ST	SD	SD
20	SD/ST/CL	SD/ST	SD/ST/CL	SD/ST	SD	ST/CL	SD/ST	SD/ST	SD/ST	SD
30	CB/ST	SD/ST	SD/ST/CL	GR/SD	SD	GR/SD/ST	SD	SD/ST	SD/ST	SD
40	SD	SD/ST	SD/ST/CL	GR/SD/ST	SD	SD/ST	SD	SD/ST	SD/ST	SD
50	SD/ST	SD/ST	SD/ST	SD	SD	SD/ST	SD/ST	SD/ST	SD/ST	SD
60	GR/SD/ST	SD/ST	SD/ST	SD/ST	SD	SD/ST	SD	SD/ST	SD/ST	SD
70	GR/SD/ST	SD/ST	SD/ST	SD/ST	SD	SD	SD	SD/ST	SD/ST	SD
80	SD/ST	SD/ST	SD/ST	SD/ST	SD	SD	SD	SD/ST	SD/ST	SD
90	SD	SD/ST	SD/ST	SD/ST	SD/ST	SD	SD	SD/ST	SD/ST	SD/ST
100	SD	SD/ST	SD/ST	SD/ST	SD/ST/CL	SD	SD	SD/ST	SD/ST	SD
110	SD	SD/ST	SD/ST	SD	SD/ST/CL	SD				
120	SD	SD/ST	SD/ST	SD/ST	SD/ST/CL	SD				
130	SD/ST	SD/ST	ST/CL	SD	SD/ST	SD				
140	SD/ST	SD/ST	SD/ST/CL	SD	SD/ST	SD/ST				
150	SD/ST	SD/ST	ST/CL	SD	SD/ST	SD/ST				
160	SD/ST	SD/ST	ST/CL	SD	SD/ST	SD/ST				
170	SD/ST	SD/ST	ST/CL	SD	SD/ST	SD/ST				
180	SD	SD/ST	ST/CL	SD	SD/ST	SD/ST				
190	SD	SD/ST	ST/CL	SD	SD/ST	SD/ST				
200	SD	SD/ST	SD/ST/CL	SD	SD/ST	SD/ST				
210	SD	SD/ST	SD/ST/CL	SD	SD/ST	SD/ST				
220	SD	SD/ST	SD/ST/CL	SD	SD/ST	SD/ST				
230	SD	SD/ST	SD/ST	SD	SD/ST	SD				
240	SD	SD/ST	SD/ST	SD	SD/ST/CL	SD				
250	SD	SD/ST	SD	SD	SD/ST/CL	SD				

[1]CB = Cobble, GR = Gravel, SD = Sand, ST = Silt, CL = Clay, WD = Woody Debris

[2]Transect ran parallel to flow and did not originate on bank

Table 3-3. Unionids collected by sampling method, Mississippi River Mile 291, July 2009.

	Sampling method[1]				
Species	Qualitative	Quantitiative	Semi-Quantitative	Total	% rel abund
Amblema plicata	24		12	36	30.8
Arcidens confragosus	1			1	0.9
Fusconaia flava	2		1	3	2.6
Lampsilis cardium	1			1	0.9
Lampsilis teres	WD		1	1	0.9
Obliquaria reflexa	4		13	17	14.5
Obovaria olivaria	1		12	13	11.1
Potamilus alatus	WD				0.0
Potamilus ohiensis	1	2	WD	3	2.6
Pyganodon grandis	1		1	2	1.7
Quadrula nodulata	2		8	10	8.5
Quadrula p. pustulosa	8		6	14	12.0
Quadrula quadrula	7		9	16	13.7
Total no. live	52	2	63	117	
Total live species	11	1	9	12	
Rarefaction slope (ave.)				5.222	
cum. Ind = 100				10	
cum. Ind = 500				14	
Evenness				-0.3906	
Simpson's Diversity Index (1-d)				0.814	
CPUE[2]	2.17				
Density[3]		0.33			

[1]FD=freshly dead shell, WD=weathered shell

[2]CPUE=Catch per unit effort, live unionids collected per 5min search time, averaged for qualitative searches

[3]Density is live unionids per $1m^2$, averaged for quantitative searches

Table 3-4. Live unionids collected along transects, Mississippi River Mile 291, July 2009.

Distance from shoreward end of transect (m)	Transect									
	T 1	T 2	T 3	T 4	T 5	T 6	T 7[1]	T 8[1]	T 9[1]	T 10[1]
0-10	-	1	2	3	1	-	-	-	1	-
10-20	3	3	-	5	-	-	-	1	2	2
20-30	4	-	-	-	-	-	1	-	-	-
30-40	-	-	-	1	-	1	1	-	-	2
40-50	1	-	1	-	-	-	-	1	-	-
50-60	1	-	-	1	-	-	1	-	-	1
60-70	-	-	-	-	-	1	-	-	-	-
70-80	-	-	1	-	2	-	-	-	1	-
80-90	-	-	1	-	-	-	1	1	-	-
90-100	-	-	-	-	-	1	-	-	1	-
100-110	-	-	-	-	-	-				
110-120	-	-	-	-	-	-				
120-130	-	-	-	-	-	-				
130-140	-	-	-	-	2	1				
140-150	-	-	-	-	-	-				
150-160	-	-	-	-	-	-				
160-170	-	-	-	-	-	-				
170-180	-	-	-	-	-	-				
180-190	-	-	-	-	-	1				
190-200	-	-	-	-	-	-				
200-210	-	-	1	-	-	-				
210-220	-	1	1	-	1	-				
220-230	1	-	-	-	1	-				
230-240	-	1	1	-	-	-				
240-250	-	-	-	-	-	-				

[1]Transect ran parallel to flow and did not originate on bank

Table 3-5. Unionids collected in qualitative searches, Mississippi River Mile 291, July 2009.

	Qualitative Search[1]																								
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Amblema plicata					1					3	8	12													24
Arcidens confragosus											1														1
Fusconaia flava											1	1													2
Lampsilis cardium		1																							1
Lampsilis teres											WD														0
Megalonaias nervosa																									0
Obliquaria reflexa									1	1			1	1											4
Obovaria olivaria							1																		1
Potamilus alatus															WD										0
Potamilus ohiensis										1															1
Pyganodon grandis												1													1
Quadrula nodulata						1									1										2
Quadrula p. pustulosa					1	2	1			1				2		1									8
Quadrula quadrula								1	2	3		1													7
																									0
Total no. live	0	1	0	0	2	3	2	1	3	9	10	15	1	3	1	1	0	0	0	0	0	0	0	0	52
CPUE[2]	0	1	0	0	2	3	2	1	3	9	10	15	1	3	1	1	0	0	0	0	0	0	0	0	2.17

[1]FD=freshly dead shell, WD=weathered shell

[2]Catch per unit effort = live individuals collected per 5 minutes of search time

Appendix A.

Scope of Work
Pre-Project Assessment of Mussels
MRM 289.89 – 291.1
D&R Rock Work

The U.S. Army Corps of Engineers (USACE) is proposing to construct two rock dikes. As part of this process, rock would be permanently placed in the river. A potential exists for mussels to be impacted by the proposed actions. Figure 1 displays the project area between MRM 289.9 and 291.1 outlined with a dashed blue line.

The purpose of this survey will be to thoroughly investigate the project area for the potential presence of mussels and their habitat. It will investigate the footprint of the project where direct impacts could occur as well as secondary areas where indirect impacts are possible. This mussel survey will serve as the primary source of data for decision-making concerning potential impacts in the project area. Fat pocketbook mussels, *Potamilus capax*, were transplanted into the slough behind Blackbird Island upstream of the project area. There is some speculation mussels may have drifted down to the project area, but surveys in the slough did not reveal them.

The extent of the requested surveys will encompass areas that could be adversely impacted by the proposed dikes (Figure 2). The Contractor will identify mussel beds and/or habitats that occur within these areas. Efforts will encompass semi-quantitative, quantitative, and qualitative methods. These will be broken into 3 separate tasks. Transects will be established to characterize the mussel communities in terms of species distribution, abundance, and habitat (substrate). Quantitative methods will entail collecting $0.25m^2$ quadrat samples to determine approximate mussel densities in areas of high abundance. Qualitative timed searches (approximately one hour) will be employed to further determine distribution and species richness. All survey efforts will begin in direct impact areas, then move to indirect impact areas, and finish with areas thought to be outside of the project impact. Particular attention will be given to any habitat suitable for fat pocketbook mussels, *Potamilus capax*, which could be impacted by the project area.

If any area exceeds established safety standards, it will not be sampled by divers. The Contractor will yield right-of-way to barges and tows at all times during the survey.

<u>Task 1 - Semi-quantitative Sampling</u>

1. Divers will collect unionids from 10 transects in the study area (Figure 1).
2. Sampling will begin upstream and downstream of the proposed work.
3. For transects, in areas where transect line placement will be in the navigation path, lines will not be set, rather the diver will navigate along the path that the line would have been placed (theoretical line).
4. One (1), 7, and 2 theoretical transects will be up-river, between dikes, and down-river of the dikes, respectively.
5. Six (6) theoretical transects will begin at the bank and a diver will collect along a path approximately 1m wide for approximately 250m towards the channel. Each of these transects will be approximately 100m apart. Four theoretical transects will be placed parallel with the bank in-line with proposed Dike 290.7, equidistance from the bank and the riverward-most limit of dike construction.
6. Each transect will be broken into 10m segments. The catch from each segment will be individually recorded. The purpose of this is to track where species occurred along the transects.
7. A minimum or 30-45 minutes will be spent collecting along the theoretical transects.
8. Divers will collect all unionids and shell encountered along the transect using visual and tactile searching within a 1m wide swath.
9. Unionids will be identified, classified as adult (A) or juvenile (J), and evaluated for zebra mussel infestation (I = infested; C = clear) and coverage (% of shell), if infested.
10. Substrate and depth will be recorded a minimum of 10 times while the diver is searching and/or when a

change in substrate is evident. The distance from the bank of each habitat record will be noted using a rangefinder. Substrate will be characterized using the Wentworth scale.

11. The beginning and end of each transect will be recorded with a Global Positioning System (GPS).

Task 2 - Quantitative Sampling

1. The project malacologist and accompanying USACE representative will use professional judgment in the field to determine where and how many quantitative samples should be collected.
2. Placement will be based on distribution and abundance of unionids collected during semi-quantitative sampling, proximity to areas of impact, and habitats suitable to unionid colonization, particularly for rare species.
3. At a minimum, if deemed necessary, ten (10) quadrats will be collected in the project area (see Figure 1): the construction zone.
4. Divers will excavate the substrate from $0.25m^2$ quadrats to a depth of 15cm. Excavated material will be retrieved at the surface and processed through a series of nested sieves (minimum size sieve = 3cm).
5. Unionids collected from quadrats will be identified, aged, measured (length in mm), and evaluated for zebra mussel infestation (as described above).
6. Substrate composition and depth will be recorded for each sample.
7. Quadrat sample locations will be recorded with a GPS.
8. All other locations will be completed prior to starting sampling above the L-dike.

Task 3- Qualitative Sampling

1. In areas where unionid abundance is high (as determined by the malacologist in the field) and in areas where direct impact for construction could occur, a series of 10 minute spot dives will be administered. Priority will be given to areas where direct impacts could occur.
2. At a minimum, 30 minutes will be spent in each of the areas described above (see Figure 1).
3. A diver will collect all unionids and shells encountered for the duration of the sample.
4. Unionids collected will be placed in a mesh-collecting bag and retrieved to the surface.
5. Unionids will be identified, classified as adult (A) or juvenile (J) and evaluated for zebra mussel infestation as described above.
6. Locations of qualitative samples will be recorded with a GPS.

Water quality will be recorded each day of sampling. Parameters will include:

1. Temperature (surface and bottom)
2. Dissolved oxygen (surface and bottom)
3. Current velocity (surface and bottom)
4. Transparency (Secchi disk at surface only)
5. Feet NGVD/pool height (daily)

Unionid parameters collected during semi-quantitative and qualitative samples will include:

1. Identification to species
2. Age classification of adult (A) or juvenile (J) based on external annuli. Juveniles are classified as ≤ 3 external annuli for anodontines and lampsilines, and ≤ 5 external annuli for amblemines.
3. Zebra mussel infestation noted as “I” for infested or “C” for clear and if infested the extent (%) of the unionid covered by zebra mussels.
4. Unionids collected from quantitative samples will be further classified as to external annuli count and measured for shell length to the nearest millimeter (mm).

Data Analysis

1. Abundance
    a. *Relative species abundance* – total number of individuals of a species expressed as a percentage of the total number of individuals of all species.

   b. *Index of species density* – Catch-per-unit-effort (CPUE) expressed as the number of individuals of each species collected during timed search.
   c. *Density* – average number of individual unionids per meter square from transect (semi-quantitative) and quadrat (quantitative) sampling.
2. Composition
   a. Family groups - i.e. Ambleminae, Anodontinae, Lampsilinae, etc.
   b. Size frequency distributions – percentage of population within 5-mm shell length intervals.
   c. Age class frequency distributions – percentage of population within each age class

Threatened/Endangered Species

1. Should individuals of any federally threatened or endangered species be captured at any time during fieldwork, the contractor shall, as soon as it is convenient, but not to exceed the following workday, notify the USACE Project Biologist.
2. Any federally protected mussels shall be sexed, aged, measured, photographed, and hand-placed back into the river at their recovery point.
3. Measurements of federally protected mussels shall include shell length, width, and height.

Diving

All diving activities will adhere to EM 385-1-1 (2008). The Contractor shall submit a dive plan within 15 days of contract award. All dive activities and plans will need to be approved by the Districts' point of contact for dive operations before fieldwork can begin.

Reporting

The Contractor will prepare, in draft and final forms, a technical report for this effort. The report will consist of the following sections: Abstract (designed for insertion into NEPA document), Introduction, Methods, Results, Discussion (including professional recommendations), Summary, and Mitigation (Avoid, Minimize, Mitigate). The report should include a characterization of mussel communities and habitat found within the project site. This should include density, recruitment, distribution, and species composition at each sampled location. Mussel presence and absence should be correlated with respect to substrate composition, water depth, water velocity, and water quality. Maps reflective of actual sampling locations, abundance data, observed substrate types, velocities, and depths will be included with the technical report. The Contractor shall assess potential project related direct and indirect impacts to mussel beds and provide suggestions for avoidance, minimization, and mitigation wherever impacts could occur.

Shapefiles will be created and each will have an accurately populated attribute table representing substrate, density, and species composition at each sampling location. The shapefiles will utilize Projected Coordinate System WGS_1984_UTM_Zone_15N. Each shapefile will be complete with metadata adhering to the federal spatial data standards.

This scope of work should be included as an appendix to the report.

The Technical Contracting Officer's Representative (TCOR) will be notified when the Draft Report is complete and three copies of the report and one CD of GIS data will be provided. The Contractor will be responsible for any revisions reported by the TCOR. The TCOR will be notified when the Final Report and associated materials are delivered. The final deliverable product shall consist of six copies of the final report along with 2 compact discs (each containing a copy of the final and all pertaining material). One copy of original field collection data/notes, GIS data, photo logs, photographs, and negatives shall be provided with the final report. These materials will be delivered to the TCOR.

Work on this survey should begin at the earliest suitable date in Fiscal Year 2009. The Contractor shall submit the Draft within 45 days of completing the fieldwork and the Final within 30 days of receipt of USACE comments.

The payment schedule will be as follows:

Tasks/Milestone	Percent of Contract Amount
100 Percent Field Work Completion**	64%
Submittal of Draft Report	26%
USACE Acceptance of Final Report	10%

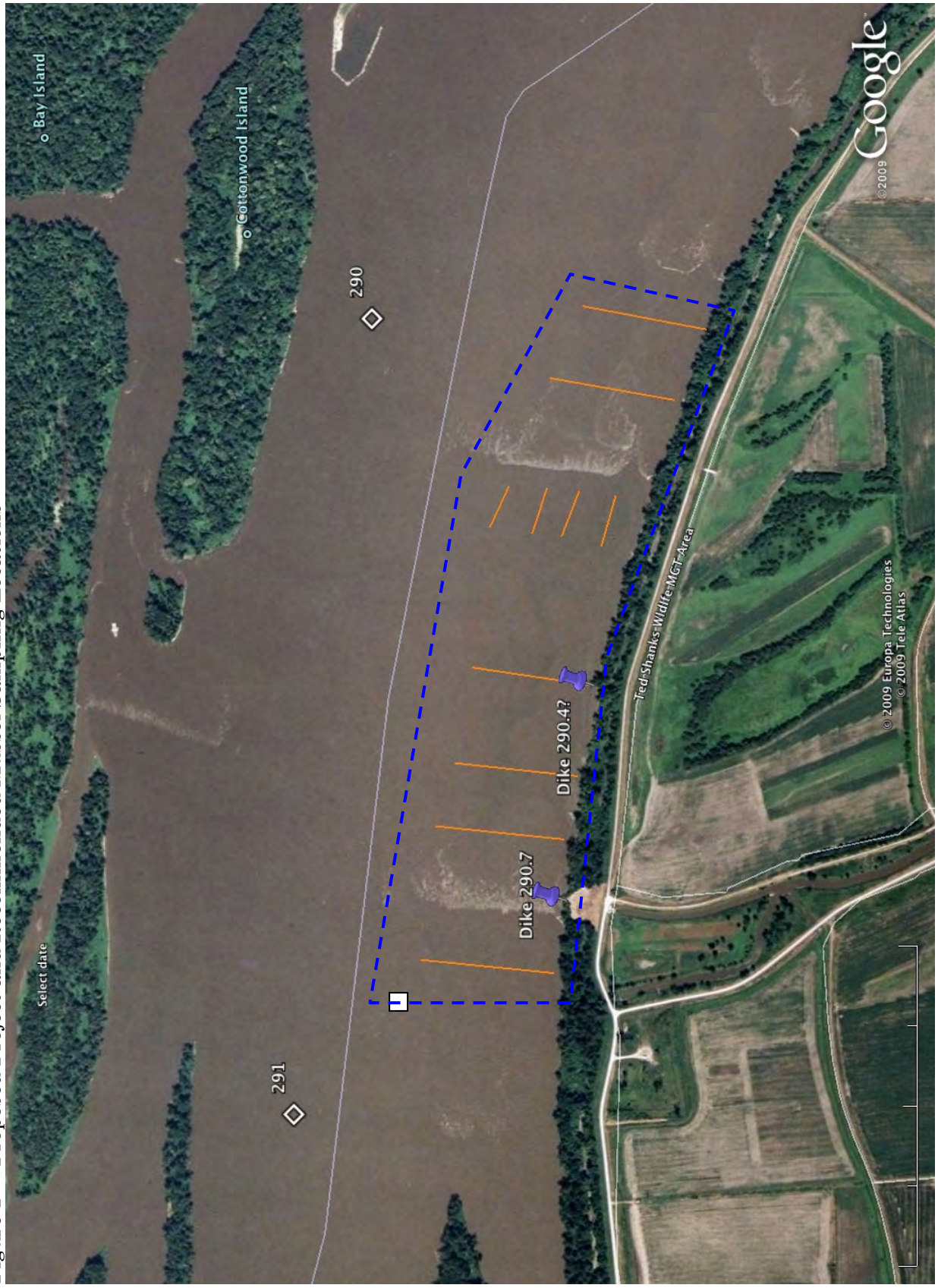
**Completion of fieldwork shall be documented by letter submitted by the Contractor to the USACE Technical Contracting Officer's Representative.

The Contractor shall make provisions to allow USACE personnel to accompany them during fieldwork. It is the Contractor's responsibility to contact the Project Biologist or other USACE personnel to determine current field conditions regarding water levels and other conditions that might affect initiation or completion of the survey.

Francis Walton is the TCOR/Project Biologist for this work. He will be notified by the Contractor at least 1 week prior to the commencement of fieldwork. He may be reached by phone: 314.331.8487, FAX 314.331.8806, or E-mail: Francis.J.Walton@usace.army.mil and by mail at: Attn: Francis Walton, PM-E; Corps of Engineers; 1222 Spruce St.; St. Louis, Missouri 63103-2833.

Todd Werdebaugh is the St. Louis District Corps' Point of Contact (POC) for Contract Diving Operations. He may be reached by phone: 314.331-8570, E-mail: todd.m.werdebaugh@usace.army.mil. He shall be contacted to arrange for the USACE Dive Inspector's presence at all dive operations. Dive and dive safety related questions should be addressed to him.

Figure 1 – Proposed Project and Recommended Mussel Sampling Locations



Appendix B. Water quality data recorded at Mississippi River Mile 291, August 2009.

Date		Water quality parameter		
		Temperature ºC	Dissolved oxygen mg/L	Flow ft/second
7/22/09	Surface	23.5	7.65	0.20
	Bottom	23.5	7.51	0.60
7/23/09	Surface	23.26	7.42	0.40
	Bottom	23.27	7.25	0.15

Appendix B

Final Report: Assessment of Unionids and Habitat for Proposed Dike Construction at the Gilbert Island Complex, Mississippi River Mile 298.6 to 298.

Final Report: Assessment of Unionids and Habitat for Proposed Dike Construction at the Gilbert Island Complex, Mississippi River Mile 298.6 to 298.2

Prepared for:
URS Corporation
St. Louis, MO

Under Contract to:
U.S. Army Corps of Engineers – St. Louis District
St. Louis, MO
(W912EK-05-D-0005, DO#DJ02)

Prepared by:

Ecological Specialists, Inc.
O'Fallon, Missouri

December 2010
(ESI Project No. 10-023)

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6. AUTHOR(S) Eric J. Belt, Heidi Dunn			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Ecological Specialists, Inc. 1417 Hoff Industrial Drive O'Fallon, MO 63366			8. PERFORMING ORGANIZATION REPORT NUMBER ESI: 10-023; URS:15801312
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11. SUPPLEMENTARY NOTES Contract funding through URS Corporation.			
13. ABSTRACT *(Maximum 200 words)* The St. Louis District of the U.S. Army Corps of Engineers has proposed construction of three chevron dikes downstream of Lock and Dam 22 between Mississippi River Miles 298.6 to 298.2. Semi-quantitative and qualitative search methods were used to evaluate the mussel community and habitat potentially impacted by construction. Relatively few unionids were collected in the area; search efforts yielded 68 live adult unionids representing 8 common species. The low number of unionids collected is likely due to poor habitat quality within the site. Most unionids were collected within 20m from the bank where some gravel is present creating more stable substrate. The majority of the study area is indicative of habitat within the navigation channel: moderately consolidated sand. Neither suitable habitat nor live unionids were observed within the direct construction area. However, unionids are present within 20m of the Illinois bank shoreward and to at least 400m upstream of the proposed construction area. If hydraulic changes cause alteration of habitat within this area, unionids may be impacted by dike construction. Little to no impact to unionids is anticipated if habitat within 20m of the Illinois bank adjacent to the proposed construction area will not be changed.			
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Table of Contents

1.0 Introduction 1
2.0 Methods 2
3.0 Results 3
3.1 Habitat 3
3.2 Unionid Community 3
4.0 Discussion 4
5.0 Literature Cited 5

List of Figures

Figure 1-1. Unionid survey area showing transect locations and timed searches, Mississippi River Miles 297.2 to 298.8, November 2010. 6
Figure 3-1. Substrate and representative depth (m) along transects, Mississippi River Miles 297.2 to 298.8, November 2010. 7
Figure 3-2. Unionid distribution along transects and at spot dives, Mississippi River Miles 297.2 to 298.8, November 2010. 8

List of Tables

Table 1-1. Unionid species historically collected in Pool 24 of the Upper Mississippi River. 9
Table 3-1. Depth (m) along transects, Mississippi River Miles 297.2 to 298.8, November 2010. 10
Table 3-2. Substrate along transects, Mississippi River Miles 297.2 to 298.8, November 2010. 11
Table 3-3. Average substrate and depth (m) at spot dives, Mississippi River Miles 297.2 to 298.8, November 2010. 12
Table 3-4. Unionids collected by sampling method, Mississippi River Miles 297.2 to 298.8, November 2010. 13
Table 3-5. Live unionids collected along transects, Mississippi River Miles 297.2 to 298.8, November 2010. 14
Table 3-6. Unionids collected in qualitative searches, Mississippi River Miles 297.2 to 298.8, November 2010. 15

Appendices

Appendix A. Scope of Work (SOW)
Appendix B. GPS Coordinates
Appendix C. Field Data Sheets

1.0 Introduction

The St. Louis District Army Corps of Engineers (USACE) has proposed chevron dike construction at the Gilbert Island Complex, Mississippi River Miles 297.7 to 298.6 (Figure 1-1). In-stream construction activity associated with dike construction has the potential to disrupt the substrate and the animals therein. Unionids (freshwater mussels) living within the area directly affected by construction could be crushed by equipment or permanently buried under excavation spoil. Disruption of the substrate could result in displacement of unionids to unsuitable habitat, which could lead to reduced fitness or death. Construction activities may also lead to altered flow patterns that may increase sedimentation, a major cause of unionid declines throughout North America (Fuller, 1974; Aldridge *et al*., 1987; Williams *et al*., 1993; Box and Mossa, 1999). Placement of Chevron Dikes should divert flow into the thalweg, decreasing the need for dredging. Unionid distribution is closely related to local hydraulic patterns (Morales *et al*., 2006; Zigler *et al*., 2008). Changing local hydraulic patterns could affect unionid distribution in the study area.

The Mississippi River harbors a diverse unionid mussel community, consisting of approximately 53 species. The proposed rock dike construction occurs in Pool 24 of the Mississippi River. A total of 30 unionid species have been found in Pool 24, including the federally endangered *Potamilus capax*, and two species listed as endangered in Missouri (Table 1-1).

USACE (through URS Corporation) contracted Ecological Specialists, Inc. (ESI) to conduct a unionid survey in the vicinity of the proposed dike construction area to characterize habitat and unionid communities with respect to density, distribution, and species composition (Appendix A). Fieldwork for this survey was conducted November 1-3, 2010.

2.0 Methods

Semi-quantitative and qualitative methods were used to survey the study area. Semi-quantitative sampling along transects was used to estimate unionid distribution and abundance (Dunn, 2000). Nine (9) semi-quantitative transects were established within the study area. Five (5) of the nine transects (T1 through T5) originated on the Illinois bank and extended 300m riverward perpendicular to flow (Figure 1-1). An additional four transects were established downstream extending from the island shore (T6 to T8) and the Illinois bank (T9) downstream of the island to the navigation channel (see Figure 1-1). Transect lengths for T6, T7, T8, and T9 were 150m, 50m, 50m, and 200m, respectively. Sampling along all transects involved a diver searching the substrate for unionids within a 1m wide path. Each 10m section of transect was treated as a separate sample; the catch from each segment was individually recorded in order to track where species occurred along transects. Depth (m) and substrate composition (Wentworth scale, Wentworth 1922) were recorded at the end of each 10m segment, and GPS coordinates were recorded at the riverward and shoreward ends of each transect (Appendix B).

The effort required to find protected species is often considerable and they are rarely collected in quantitative samples (Kovalak *et al.*, 1986). Therefore, qualitative sampling was used to estimate the species composition of the community and the probability of finding endangered species. Qualitative samples entailed a diver searching the substrate for unionids, collecting all encountered shells within a specified time period. Thirteen (13) 10-minute qualitative searches were conducted within the study area. Four (4) were adjacent and upstream of the proposed construction, six were within the side channel (since transect sampling was not feasible within this area), and three were along the island shore (see Figure 1-1).

Unionids were identified to species, and shell condition (live; fresh dead = lustrous nacre, periostracum intact and dead <1yr; weathered dead = weathered or chalky nacre, worn periostracum, dead several months to many years; subfossil = severely worn and fragmented shell, often void of periostracum, dead many years to many decades) was recorded. Live individuals were characterized as adult or juvenile (≤5 external annuli for Ambleminae and ≤3 external annuli for Anodontinae and Lampsilinae) and zebra mussel infestation was recorded. All live mussels were returned to the water following processing. Copies of field data sheets are in Appendix C.

3.0 Results

3.1 Habitat

The Illinois bank and island bank within the study area was greatly sloped within 10m of the bank, then depths typically gradually increased with distance from the bank. Depths along Transects 1 through 5 ranged from 0.6m to 4.6m and increased upstream to downstream (Figure 3-1, Table 3-1). The riverward ends of transects 6 through 9 were within the navigation channel and were deeper than the upstream transects (≥5.8m). Substrate was primarily sand with some cobble, gravel, silt, and clay encountered near the bank and at the tail of the island (see Figure 3-1, Table 3-2, Table 3-3).

Habitat in the side channel differs from other areas in this study, likely due to the presence of a dike at the entrance, which restricts flow into the area. Depth ranged from 1.2 to 4.3m and substrate varied but was generally silt with various proportions of gravel, sand, and clay (see Table 3-3). The presence of silt in most of the samples is likely the result of restricted flow.

3.2 Unionid Community

A total of 68 adult unionids representing 8 species were collected within the study site. *Amblema plicata* (n=47) was the most abundant species (Table 3-4). Of the other live species (*Fusconaia flava*, *Quadrula p. pustulosa*, *Quadrula nodulata*, *Quadrula quadrula*, *Lasmigona c. complanata*, *Lampsilis cardium*, *Obliquaria reflexa*), five or fewer were collected. Weathered dead shells of *Pyganodon grandis*, *Leptodea fragilis*, and *Potamilus alatus* were also collected. No juvenile unionids, state or federally listed unionid species, or zebra mussels were observed.

Four (4) live unionids were collected along semi-quantitative transects (Table 3-5). Only Transects 1 and 2 produced live unionids, which were collected within 20m of the bank. Location of semi-quantitative transects and number of unionids collected can be seen in Figure 3-2.

Thirteen (13) 10-minute qualitative samples were collected within study area. The majority (64) of live unionids were collected during qualitative samples; the average catch per unit effort (CPUE, expressed as number of unionids per 10 minutes of search time) was 4.9 (see Table 3-4). Of the 64 live individuals, 58 were collected during spot dives 7 to 10 (Table 3-6), which were along the Illinois bank shoreward and upstream of the proposed construction area (see Figure 3-2). Location of qualitative searches and number of unionids collected can be seen in Figure 3-2.

4.0 Discussion

The unionid community within the study area is sparse and patchy with most unionids collected within 20m of the Illinois bank upstream and shoreward of the proposed chevron dikes. The low abundance of freshwater mussels throughout the study area is likely due to poor habitat. Unionids are rarely found in unstable substrate (Cvancara, 1970; Strayer and Ralley, 1991) because they are unable to maintain their natural position, and they may be buried or displaced during fluvial events. Presence of gravel, silt, and clay in the substrate near the bank may explain the occurrence of more unionids near the bank since the gravel can increase substrate stability. The substrate riverward, and throughout the survey area, is mostly sand and is therefore less stable.

If habitat within approximately 20m of the Illinois bank adjacent to the proposed construction area will not be changed by altered hydraulics from the proposed dike design and locations, construction is unlikely to require mitigation measures. The majority of the study area contains poor habitat throughout and does not support a significant unionid community. No state or federally listed species were collected, and no juveniles were collected suggesting that there is little to no recruitment in this area.

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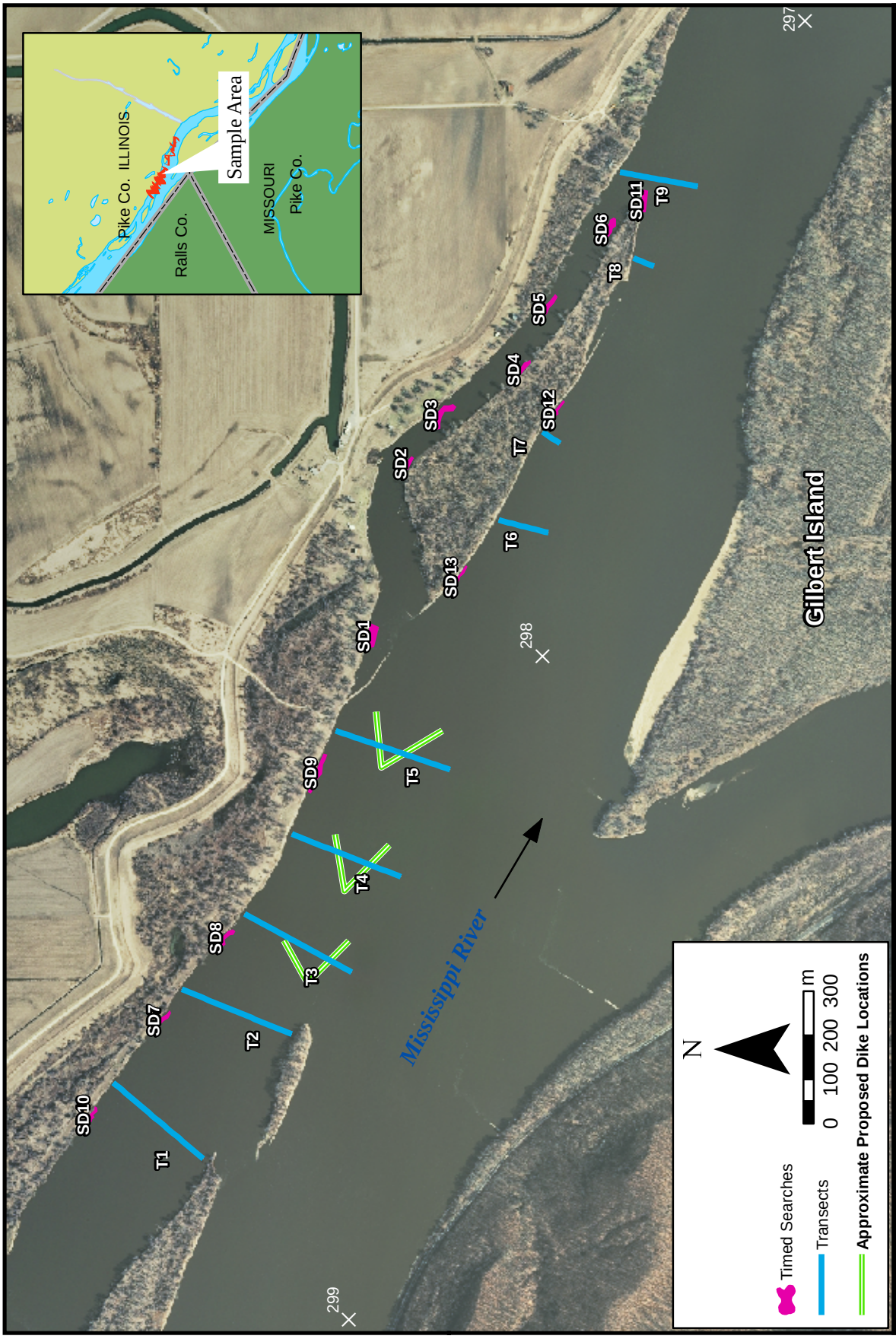

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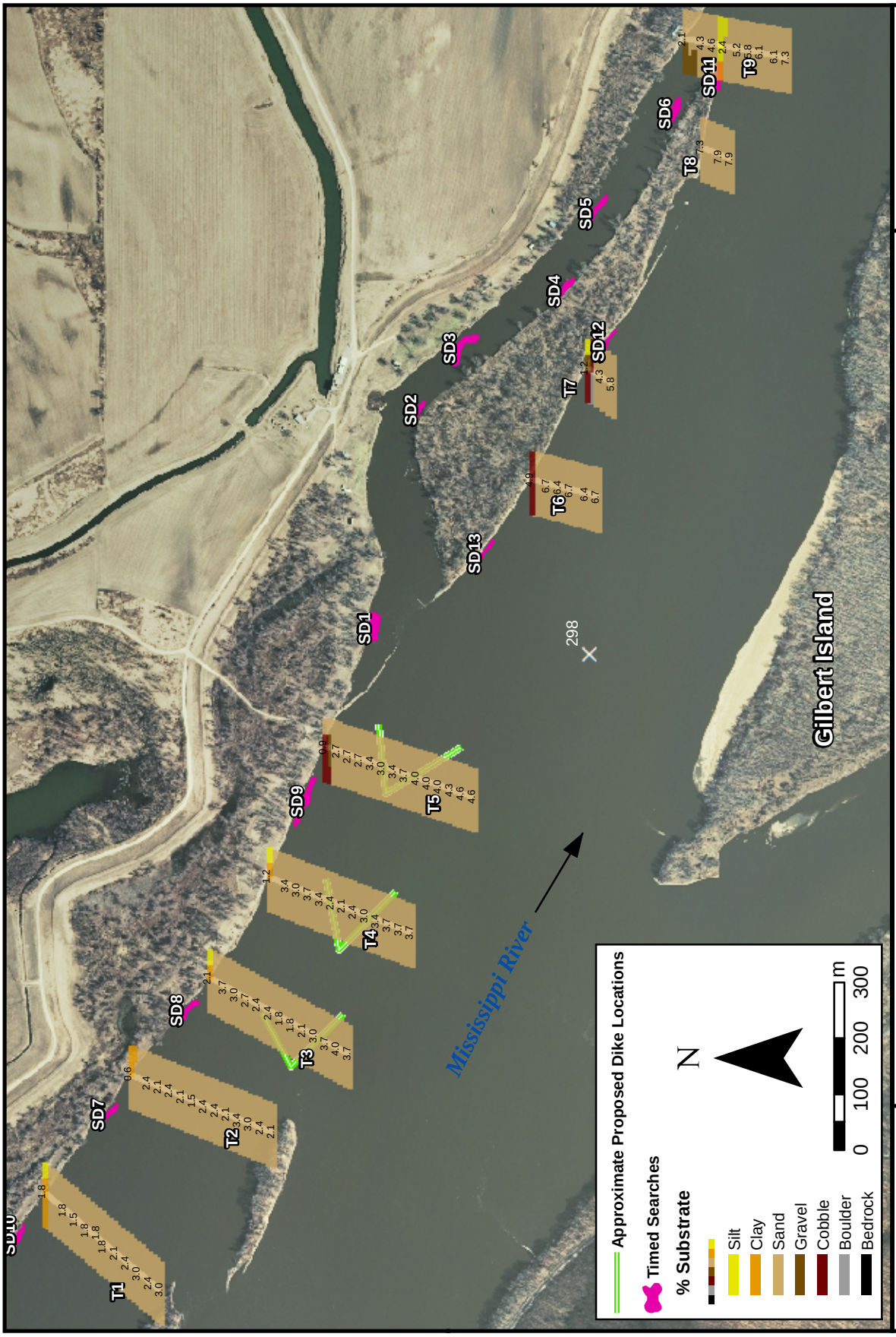
Figure 1-1. Unionid survey area showing transect locations and timed searches, Mississippi River Miles 297.2 to 298.8, November 2010.

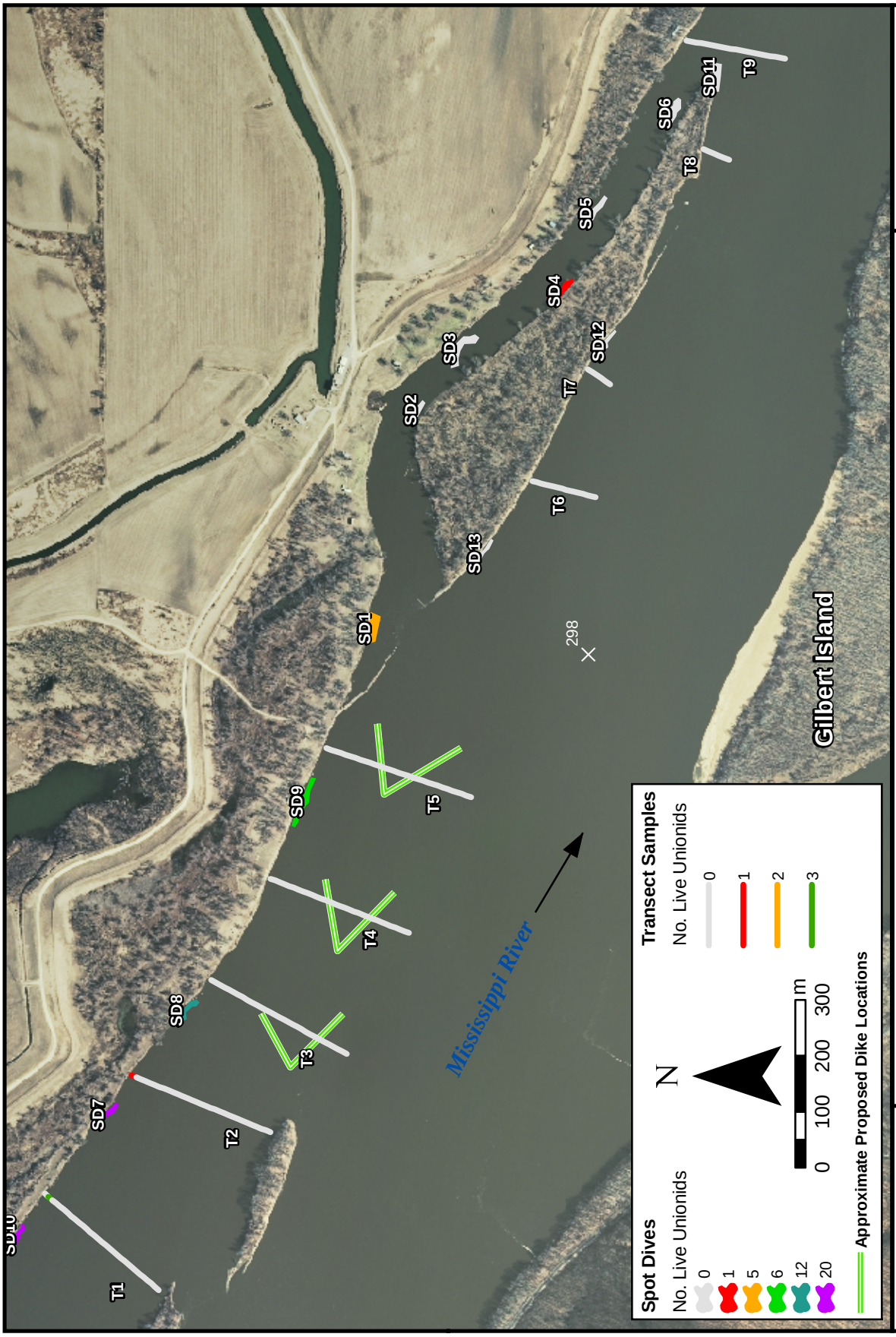
ESI



ECOLOGICAL SPECIALISTS, INC.

Figure 3-1. Substrate and representative depth (m) along transects, Mississippi River Miles 297.2 to 298.8, November 2010.

ESI



ECOLOGICAL SPECIALISTS, INC.

Figure 3-2. Unionid distribution along transects and at spot dives, Mississippi River Miles 297.2 to 298.8, November 2010.

ESI

Table 1-1. Unionid species historically collected in Pool 24 of the Upper Mississippi River.[1]

Scientific name	Common name	Status[2]	Pool 24[3]
Subfamily Cumberlandinae			
Cumberlandia monodonta	spectaclecase	FC	R
Subfamily Ambleminae			
Amblema plicata	threeridge		A
Cyclonaias tuberculata	purple wartyback	4.0	H
Elliptio crassidens	elephant ear		H
Elliptio dilatata	spike		H
Fusconaia ebena	ebonyshell	MOE	R
Fusconaia flava	Wabash pigtoe		R
Megalonaias nervosa	washboard		A
Plethobasus cyphyus	sheepnose	FC/MOE	R
Pleurobema sintoxia	round pigtoe		R
Quadrula metanevra	monkeyface		R
Quadrula nodulata	wartyback		C
Quadrula p. pustulosa	pimpleback		C
Quadrula quadrula	mapleleaf		C
Tritogonia verrucosa	pistolgrip		R
Subfamily Anodontinae			
Anodonta suborbiculata	flat floater		H
Arcidens confragosus	rock pocketbook		R
Lasmigona c. complanata	white heelsplitter		R
Pyganodon grandis	giant floater		R
Strophitus undulatus	strange floater		R
Utterbackia imbecillis	paper pondshell		R
Subfamily Lampsilinae			
Actinonaias ligamentina	mucket		R
Ellipsaria lineolata	butterfly		A
Lampsilis cardium	plain pocketbook		C
Lampsilis higginsii	Higgins eye		H
Lampsilis teres	yellow sandshell		R
Leptodea fragilis	fragile papershell		C
Ligumia recta	black sandshell		R
Obliquaria reflexa	threehorn wartyback		A
Obovaria olivaria	hickorynut		C
Potamilus alatus	pink heelsplitter		R
Potamilus capax	fat pocketbook	FE/MOE	R
Potamilus ohiensis	pink papershell		R
Truncilla donaciformis	fawnsfoot		C
Truncilla truncata	deertoe		A
Live species			30
Historic			5
Total species			35

[1]Kelner (2007)

[2]FE = Federally listed endangered species, FC=Candidate for federal endangered status (USFWS, 2010)
MOE=Missouri Endangered species (MDC, 2010)

[3]H = Records of occurrence but no live collections have been documented in the past ~25 years.
R = Rare, does not usually appear in sample collections, populations are small either naturally or have declined and may or may not be near extirpation.
C = Commonly taken in most samples; can make up a large portion of some samples.
A = Abundantly taken in most samples.

Table 3-1. Depth (m) along transects, Mississippi River Miles 297.2 to 298.8, November 2010.

Distance from shoreward end of transect (m)	Transect								
	T 1	T 2	T 3	T 4	T 5	T 6	T 7	T 8	T 9
0	1.8	0.6	2.1	1.2	0.9	4.9	1.2	7.3	2.1
10	1.8	1.5	2.7	3.0	2.4	4.6	2.4	7.6	3.0
20	2.1	1.8	3.4	2.7	2.4	5.2	3.7	7.3	4.0
30	1.8	1.8	3.4	2.7	2.7	5.5	4.3	7.3	4.0
40	1.8	2.1	3.7	3.0	3.0	6.7	5.2	7.9	4.3
50	1.8	2.4	3.7	3.4	3.0	6.7	5.8	7.9	4.6
60	1.8	1.8	3.4	3.4	2.7	6.7			4.6
70	1.8	2.1	3.0	3.0	3.0	6.4			1.2
80	1.8	1.8	2.4	3.0	2.7	6.7			2.4
90	1.5	2.4	2.7	3.7	2.7	6.7			4.6
100	1.8	2.4	2.7	4.3	3.4	6.4			5.2
110	1.8	2.4	2.4	3.7	3.4	6.7			5.2
120	1.8	2.1	2.7	3.4	3.0	6.7			5.8
130	1.8	1.8	2.7	2.1	3.0	6.4			5.8
140	1.8	1.5	2.4	2.4	3.4	6.4			6.1
150	1.8	2.1	2.4	2.7	3.4	6.7			6.1
160	1.8	2.7	1.8	2.1	3.7				6.1
170	1.8	2.4	1.5	2.7	3.7				6.1
180	2.4	3.0	1.8	2.7	3.7				6.1
190	2.1	2.4	1.8	2.4	4.0				6.7
200	2.1	2.4	2.1	3.4	4.3				7.3
210	2.1	2.1	2.1	3.0	4.0				
220	2.4	3.0	3.0	3.4	4.0				
230	2.4	3.0	3.0	3.4	4.0				
240	2.7	3.4	3.0	3.4	4.0				
250	3.0	3.4	3.0	4.0	4.3				
260	2.1	3.0	3.7	3.7	4.3				
270	2.7	3.0	3.4	3.7	4.6				
280	2.4	2.4	4.0	3.7	4.6				
290	3.0	2.7	3.7	3.7	4.6				
300	3.0	2.1	3.7	3.7	4.6				

Table 3-2. Substrate along transects, Mississippi River Miles 297.2 to 298.8, November 2010.

Distance from shoreward end of transect (m)	Transect[1]								
	T 1	T 2	T 3	T 4	T 5	T 6	T 7	T 8	T 9
0	ST/CL	SD/CL	SD/ST/CL	SD/ST/CL	CB/SD	CB	CB/GR/ST	SD	GR/SD
10	SD	SD/CL	SD	SD	CB/GR/SD	SD	BD/CB	SD	GR/SD
20	SD	SD	SD	SD	SD	SD	SD	SD	GR/SD
30	SD	SD	SD	SD	SD	SD	SD	SD	SD
40	4.0	SD	SD	SD	SD	SD	SD	SD	SD
50	SD	SD	SD	SD	SD	SD	SD	SD	SD
60	SD	SD	SD	SD	SD	SD			SD
70	SD	SD	SD	SD	SD	SD			ST/CL
80	SD	SD	SD	SD	SD	SD			SD/ST
90	SD	SD	SD	SD	SD	SD			SD
100	SD	SD	SD	SD	SD	SD			SD
110	SD	SD	SD	SD	SD	SD			SD
120	SD	SD	SD	SD	SD	SD			SD
130	SD	SD	SD	SD	SD	SD			SD
140	SD	SD	SD	SD	SD	SD			SD
150	SD	SD	SD	SD	SD	SD			SD
160	SD	SD	SD	SD	SD				SD
170	SD	SD	SD	SD	SD				SD
180	SD	SD	SD	SD	SD				SD
190	SD	SD	SD	SD	SD				SD
200	SD	SD	SD	SD	SD				SD
210	SD	SD	SD	SD	SD				
220	SD	SD	SD	SD	SD				
230	SD	SD	SD	SD	SD				
240	SD	SD	SD	SD	SD				
250	SD	SD	SD	SD	SD				
260	SD	SD	SD	SD	SD				
270	SD	SD	SD	SD	SD				
280	SD	SD	SD	SD	SD				
290	SD	SD	SD	SD	SD				
300	SD	SD	SD	SD	SD				

[1]BD = Boulder, CB = Cobble, GR = Gravel, SD = Sand, ST = Silt, CL = Clay, WD = Woody Debris

Table 3-3. Average substrate and depth (m) at spot dives, Mississippi River Miles 297.2 to 298.8, November 2010.

Spot Dive	Average Observed	
	Depth (m)	Substrate[1]
SD1	1.2	GR/SD/ST
SD2	1.5	SD/ST
SD3	4.0	GR/ST
SD4	3.7	ST/CL
SD5	3.1	SD
SD6	4.3	SD/CL
SD7	1.8	SD/ST
SD8	2.1	SD/ST/CL
SD9	2.1	SD/ST/CL
SD10	2.1	SD/ST/CL
SD11	1.8	SD/ST/CL
SD12	1.2	CB/CL
SD13	1.5	CB/SD

[1]BD = Boulder, CB = Cobble, GR = Gravel, SD = Sand, ST = Silt, CL = Clay, WD = Woody Debris

Table 3-4. Unionids collected by sampling method, Mississippi River Miles 297.2 to 298.8, November 2010.

Species[1]	Sampling method: Qualitative	Sampling method: Semi-Quantitative	Total	% Relative Abundance
Ambleminae				
Amblema plicata	44	3	47	69.1
Fusconaia flava	3	-	3	4.4
Quadrula nodulata	2	-	2	2.9
Quadrula p. pustulosa	3	1	4	5.9
Quadrula quadrula	5	-	5	7.4
Total	**57**	**4**	**61**	**89.7**
Anodontinae				
Lasmigona c. complanata	2	-	2	2.9
Pyganodon grandis	WD[2]	-	WD	
Total	**2**	**-**	**2**	**2.9**
Lampsilinae				
Lampsilis cardium	1	-	1	1.5
Leptodea fragilis	WD	-	WD	0.0
Quadrula p. pustulosa	4	-	4	5.9
Potamilus alatus	WD	-	WD	0.0
Total	**5**	**0**	**5**	**7.4**
Total no. live	64	4	68	100.0
Total live species	8	2	8	
CPUE[3]	4.9	-		
Density[4]	-	0.03		
Juveniles[5]	-	-	0	0.0
Mortality[6]	-	-	0	0.0

[1]Turgeon *et al.* (1998)

[2]WD=weathered shell

[3]CPUE=Catch per unit effort, live unionids collected per 10min search time, averaged for qualitative searches

[4]Density=number live unionids per $10m^2$ transect sample

[5]Juvenile=≤5 external annuli for Ambleminae and ≤3 external annuli for Anodontinae and Lampsilinae)

[6]Mortality=no. fresh dead unionids/no. fresh dead + no. live

Table 3-5. Live unionids collected along transects, Mississippi River Miles 297.2 to 298.8, November 2010.

Distance from shoreward end of transect (m)	Transect								
	T 1	T 2	T 3	T 4	T 5	T 6	T 7	T 8	T 9
0-10	-	1	-	-	-	-	-	-	-
10-20	3	-	-	-	-	-	-	-	-
20-30	-	-	-	-	-	-	-	-	-
30-40	-	-	-	-	-	-	-	-	-
40-50	-	-	-	-	-	-	-	-	-
50-60	-	-	-	-	-	-			
60-70	-	-	-	-	-	-			
70-80	-	-	-	-	-	-			
80-90	-	-	-	-	-	-			
90-100	-	-	-	-	-	-			
100-110	-	-	-	-	-	-			
110-120	-	-	-	-	-	-			
120-130	-	-	-	-	-	-			
130-140	-	-	-	-	-	-			
140-150	-	-	-	-	-	-			
150-160	-	-	-	-	-				
160-170	-	-	-	-	-				
170-180	-	-	-	-	-				
180-190	-	-	-	-	-				
190-200	-	-	-	-	-				
200-210	-	-	-	-	-				
210-220	-	-	-	-	-				
220-230	-	-	-	-	-				
230-240	-	-	-	-	-				
240-250	-	-	-	-	-				
250-260	-	-	-	-	-				
260-270	-	-	-	-	-				
270-280	-	-	-	-	-				
280-290	-	-	-	-	-				
290-300	-	-	-	-	-				

Table 3-6. Unionids collected in qualitative searches, Mississippi River Miles 297.2 to 298.8, November 2010.

	Qualitative Search[1]													
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Ambleminae														
Amblema plicata	3	-	-	-	-	-	19	7	2	13	-	-	-	44
Fusconaia flava	-	-	-	-	-	-	-	3	-	-	-	-	-	3
Quadrula nodulata	-	-	-	-	-	-	-	-	-	2	-	-	-	2
Quadrula p. pustulosa	1	-	-	-	-	-	-	-	-	2	-	-	-	3
Quadrula quadrula	-	-	-	-	-	-	-	1	2	2	-	-	-	5
Anodontinae														
Lasmigona c. complanata	1	-	-	-	-	-	-	-	-	1	-	-	-	2
Pyganodon grandis	-	-	-	-	-	WD	-	-	-	-	-	-	-	0
Lampsilinae														
Lampsilis cardium	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Leptodea fragilis	-	-	-	-	-	WD	-	-	-	-	-	-	-	0
Quadrula p. pustulosa	-	-	-	1	-	-	1	1	1	-	-	-	-	4
Potamilus alatus	-	-	WD	-	-	-	-	-	-	-	-	-	-	0
Total no. live	5	0	0	1	0	0	20	12	6	20	0	0	0	64
CPUE[2]	5	0	0	1	0	0	20	12	6	20	0	0	0	4.9

[1]WD=weathered shell
[2]CPUE=Catch per unit effort, live unionids collected per 10min search time

Appendix A. Scope of Work (SOW)

SCOPE-OF-WORK
Assessment of Unionid Mussels and Habitat for Pre-construction O & M Navigation Features near the Gilbert Island Complex, MRM 297 - 299
U. S. Army Corps of Engineers, St. Louis District
through Contract No. W912EK-05-D-0005
20 August 2010

1 CONTRACT PROVISIONS IN FORCE

1.1 Provisions of the main contract Scope-Of-Work (main-SOW) shall apply to this Work Order to fulfill the requirements of the main contract and to accomplish the work set out in the Specifications below, and are not repeated here.

2 PURPOSE AND LOCATION

2.1 The U.S. Army Corps of Engineers (USACE) is proposing to construct 3 chevrons and 2 weirs just downstream of Lock and Dam 22 between Mississippi River Miles 297.7 and 298.6, near the head of Gilbert Island. The purpose of the proposed structures is to reduce dredging and create a more self-sustaining navigation channel in this reach. To construct these river training structures, rock would be permanently placed in the river. In addition, the 5 structures would alter the pattern of scour and deposition within the reach. Therefore, a potential exists for mussels to be impacted by the proposed actions. The purpose of this mussel study is to identify, quantify and characterize the distribution of unionid mussels throughout the impacted area of the USACE, St. Louis District's (District) Operations and Maintenance Program. This mussel survey will serve as the primary source of data for decision-making concerning potential impacts to the mussel fauna in the project area. The purpose of this mussel survey is to determine the species composition and relative abundance of freshwater mussels in the project reach. The proposed project reach, and survey site, is located on the Mississippi River in Pool 24 just below the Lock and Dam 22 approximately MRM 297.7 – 298.6 (Exhibit 1).

3 AUTHORITY AND NEED

3.1 This study is being conducted to fulfill regulatory requirements stipulated under the provisions of the federal Endangered Species Act of 1973 (ESA) and associated regulations. Section 7(a)(2) of the Endangered Species Act requires Federal agencies to insure actions authorized, funded, or carried out by them are not likely to jeopardize the continued existence of endangered or threatened species. In addition, the Endangered Species Act of 1973 establishes as Federal policy that "all Federal departments and agencies shall seek to conserve endangered species and threatened species."

3.2 The proposed action is authorized under the 9-Foot Channel Navigation Project of the Rivers and Harbors Act of July 3, 1930, as amended, Senate Document 126/71/2. In accordance with the National Environmental Policy Act of 1969, this mussel survey will be undertaken to address impacts associated with construction and project conditions affected by placing river training structures in Pool 24 of the Mississippi River. The authority to plan, evaluate and design this project is the same authority for the System Study [Section 216 of the Flood Control Act of 1970 (Public Law 91-611)].

3.3 The purpose of this project is to provide for the construction and maintenance of a navigation channel 9 feet deep and 300 feet wide.

4 BACKGROUND

4.2 The St. Louis District of the U.S. Army Corps of Engineers (Corps), in cooperation with the U.S. Fish and Wildlife Service (USFWS), the navigation industry, the U.S. Coast Guard, and the Rock Island and St. Paul Districts of the Corps, developed and revised a list of avoid/minimize (A&M) measures. Those measures dealt with methods to minimize impacts of increased navigation traffic on aquatic organisms due to completion of the second lock at Melvin Price Locks and Dam. The St. Louis

District strives to promote projects with A&M measures to minimize impacts resulting from the operation and maintenance of the 9-Foot Navigation Channel whenever and wherever practicable.

4.2 The St. Louis District River Engineers recommended construction of 3 chevrons and 2 dikes from RM 297.7 and 298.6 (Exhibits 2-6). These structures would be arranged in two groups, with the three chevrons on the left descending bank just downstream of the unnamed island at river mile 298.7, (RM 298.5, 298.4, 298.2) and the two dikes on the right descending bank at 297.9 and 297.7 (Exhibits 2-6). This combination of chevrons and dikes will significantly improved the navigation channel and could reduce repetitive maintenance dredging.

4.3 The proposed features will alter the pattern of scour and deposition throughout the reach. In addition physical construction of the features could bury unknown unionid populations. The Illinois Department of Natural Resources indicated that there is a mussel bed along the Illinois shoreline from approximate river mile 299.8 to 298.0 which may or may not be directly or indirectly impacted from chevron placement. In addition to the mussels adjacent to the project site their records show a mussel bed is present at the lower end of the chute behind the small unnamed island just below the project area. For these reasons IDNR, MDC, and the US Fish and Wildlife Service requested the District conduct a mussel survey to determine species composition, distribution, and relative abundance of mussels in the project area.

5 OBJECTIVES

5.1 The purpose of this study is to identify and characterize unionid communities in the project area with respect to density, distribution, and species composition. The extent of the requested survey will encompass the areas that could be adversely impacted by the proposed river training structures. The Subcontractor will identify mussel beds and their habitats that occur within these areas. Efforts will encompass semi-quantitative and qualitative methods. These will be broken into 2 separate tasks. Transects will be established to characterize the mussel communities in terms of species richness, distribution, abundance, and habitat (substrate). Qualitative timed spot dives will be employed to further determine distribution and species richness. Survey efforts will begin by conducting transect searches. Once all transect searches are complete additional spot dives will be conducted to first: delineate boundaries of mussel beds and second: search suitable areas not covered by transects or already delineated beds.

6 STATEMENT OF WORK/SPECIFICATIONS

6.1 The Subcontractor shall perform semi-quantitative and qualitative surveys within the project area to well define density, age, distribution, and species composition of any mussel bed(s) within RM 298.8 and 297.2. All work and receipt of the final report must be completed prior to January, 2011. The Subcontractor shall be responsible for securing all applicable sampling permits from state and federal governments.

6.2 Study Site

6.2.1 The Subcontractor shall perform diver searches following techniques outlined below at the Gilbert Island project area. The project area includes the stretch of river on the Illinois side of the Mississippi River in Pool 24 just below the Lock and Dam 22 approximately MRM 297.7 – 298.6. The two dikes on the Missouri shore at RM 297.9 and 297.7 will not be sampled as this area is a long time dredge disposal area that has been previously coordinated. The area to be sampled will start at no less than 400 meter upstream of chevron 298.5 and continue downstream no less than 1600 meters below chevron 298.2, and will span up to 300 meters from the Illinois shore to the thalweg. In addition, the sample area will include the small side channel behind the unnamed island below chevron 298.2 (total length approximately 2,600 m).

6.3 Semi-quantitative Sampling Method (hand collection along transects)

6.3.1 The goal of sampling along transects is to identify areas of greatest mussel abundance in the project area. The resultant semi-quantitative data will be used to describe spatial variability in abundance and assemblage composition of native mussels.

6.3.2 The area to be sampled is approximately 2,600 m long and 300 m wide. Semi-quantitative (hand collection) sampling will be conducted along a minimum of 9 transects established perpendicular to the bank and spaced approximately 200 m apart. Transects will extend from the shoreline (below the ordinary high water mark) to 300 meters, or approximately the edge of the navigation channel. Sampling will begin at approximately RM 298.75 (400 meters upstream of chevron 298.5) and conclude at approximately 1600 meters below chevron 298.2 (RM 297.2). The number, placement, distance between transects, and the transect lengths may vary depending on proposed transect locations, actual navigation channel boundary, and/or physical conditions (shifting sand substrate). If a transect must be repositioned, lengthened, or shortened, the Subcontractor should do so based on the Subcontractor's professional judgment, surrounding physical conditions, and/or results of previous transect surveys.

6.3.3 Transects should be subdivided in 10 m intervals and treated as separate samples (i.e. 010 m, 10-20 m, 20-30 m, 30-40 m, etc.). Each 10 m sampling interval will be sampled for 3 minutes, plus or minus 30 seconds. GPS coordinates shall be recorded for the beginning/end of each 10 m increment. The coordinate system used shall be the Geographic (latitude and longitude) coordinate system using NAD83 ft.

6.3.4 Divers shall travel along each transect, disturb the substrate by sweeping arms and hands back and forth, and collect as many live and dead unionids as possible within an arms reach of the line (~2 meters) for the 3 minutes/10 m sample. Any unionid encountered shall be placed in a mesh collection bag and brought to the surface for identification.

6.3.5 For each 10 m sample, the following data will be collected and entered into the Grouped Data Excel spreadsheet template (Exhibit 7):

- All live native mussels shall be identified to species and counted,
- Unionids will be classified as adult (A) or juvenile (J) based on external annuli. Juveniles are classified as ≤ 3 external annuli for anodontines and lampsilines, and ≤ 5 external annuli for amblemines.
- If zebra mussels are found attached to native mussels enter "Yes" under the "Zebras Attached" column
- Native mussel species represented only with empty shells shall be recorded as weathered dead, fresh dead, or sub-fossil. The Subcontractor shall state in the Methods of the report the rational for classification of the shells,

6.3.6 The Subcontractor shall record the substrate type encountered at the beginning/end of each 10 meter sample into the Habitat Data Excel spreadsheet template (Exhibit 8). Substrate types shall be qualitatively characterized by dominant and sub-dominant substrate types using the Wentworth (Cummins 1962) scale. Minimum and maximum depth along each transect will be recorded to the nearest 10th of a meter.

6.4 Qualitative Sampling

6.4.1 In areas where unionid abundance is high (as determined by the malacologist in the field) and in areas not covered by transects where suitable habitat exists, a series of 10 minute spot dives will be administered. At a minimum, one half day will be spent conducting spot dives at suitable locations throughout the project area, including the small side channel behind the unnamed island below chevron 298.2. Priority will be given to delineating the boundary of mussel beds. Each spot dive sample location will be recorded with a GPS. The coordinate system used shall be the Geographic (latitude and longitude) coordinate system using NAD83 ft.

6.4.2 A diver will collect all unionids and shells encountered for the duration of each spot dive. Unionids collected will be placed in a mesh-collecting bag and retrieved to the surface. Unionids will be identified, classified as adult (A) or juvenile (J), evaluated for zebra mussel infestation and empty shells classified as described above (Section 6.2).

6.5 Data analysis

6.5.1 Data analysis shall include measures of native mussel species abundance and

composition using the following format or methodologies:

6.5.2 Abundance *Relative species abundance* – total number of individuals of a species expressed as a percentage of the total number of individuals of all species for the project area and each transect where mussels are found. *Density* – average number of individual mussels per meter for each transect.

6.5.3 Composition *Family groups* - i.e. Ambleminae, Anodontinae, Lampsilinae, etc. *Age class frequency distributions* – percentage of assemblage within each age class

6.6 USACE Freshwater Mussel Database Requirements

6.6.1 It is not required that the Subcontractor upload the data to the USACE Freshwater Mussel Database. Instead, the Subcontractor will complete all necessary shapefiles and tabular data sheets (i.e., habitat, individual, grouped, project report Excel spreadsheets), and include in the Draft Report and Final Report packages.

6.6.2 Exhibit 9 contains the Standard Operating Procedure for the USACE Freshwater Database. It explains the structure and function of the database. Exhibit 10 provides the data dictionary which will help explain the structure of each data template.

6.6.3 Geospatial Survey Data will be collected and stored in GIS format using a standardized ESRI Shapefile. These templates are provided in Exhibit 12. The spatial geodatabase file shall contain all geospatial information and some attribute information for each sample (timed searches). Note: many of the fields are restricted by the use of domain values (Exhibit 10).

6.6.4 Tabular Data –Note: many of the fields are restricted by the use of domain values.

- Habitat table (Exhibit 8) shall contain records to describe the habitat for each sample (transects).
- Sample Grouped table (Exhibit 7) shall contain records for each species where individual mussels were not recorded (semi-qualitative timed searches/hand collection).
- Sample Individual table (Exhibit 13) shall contain records for each individual native mussel that is described (federal/state endangered/threatened species encountered). Project Report table shall contain information on the principle investigator, title and the location of the report.

6.6.5 SAMPLE_IDs - The field titled "SAMPLE_ID" is primary key used in the GIS files and all spreadsheets, and shall be assigned using the following method:

- The first part of all SAMPLE_ID's shall be the sample date YYYYMMDD (20070312).
- The second part of all SAMPLE_ID's shall be the Org_Code, Subcontractor's Org Code will be 14.
- The third part of all SAMPLE_ID's shall be the sample number, using two digits (01).
- For example, the first sample taken on March 12, 2007, by the Subcontractor would be
- (200703121401).

Exhibits 12, 13, and 14 contain descriptions of the spreadsheets and domain values in the shapefile. It contains descriptions of each table and each field and domain value.

6.7 Federal and/or State Threatened/Endangered

6.7.1 For any state or federally threatened/endangered mussel collected, shell length, width, and height, age, sex, GPS coordinates of approximate location and state of gravidity shall be determined. This information shall be recorded on the Individual Data spreadsheet template field sheet (Exhibit 13). Individuals will be photographed and photographs will be submitted as figures in the report. These individuals shall be hand placed back into the river at their recovery point.

7 SPECIAL CONDITIONS

7.1 Radio.

The Subcontractor shall carry a marine band radio and cell phone while conducting field work, to facilitate communication with the Lockmasters and approaching towboats. The marine band radio shall, at a minimum, be equipped with "safety and calling" channel 16 (frequency 156.8 mhz), operating channel 14 (frequency 156.7 mhz) and bridge to bridge" channel 13 (frequency 156.65

mhz). When not being used to receive or transmit a message, the radio shall simultaneously monitor channels 13 and 16.

7.2 Diving

7.2.1 Diving operations will be overseen by a District representative who is qualified as a Corps of Engineer's Dive Inspector. The Corps Dive Inspector is required to be present during all dive operations, unless otherwise notified by the COR. The Subcontractor shall make provisions to allow the Dive Inspector to accompany them during all diving activities.

7.2.2 Diving operations are to be conducted to fully satisfy the requirements specified in the US Army Corps of Engineers EM 385-1-1, Section 30, dated 15 September 2008 – SAFETY AND HEALTH REQUIREMENTS MANUAL. No contract dive operations will be permitted until all requirements specified in the EM 385-1-1, and the appropriate appendices and references are satisfied. **The Subcontractor shall develop, submit and maintain a Safe Practices Manual (SPM), a Dive Plan (to include an emergency management plan), Activity Hazard Analysis, and required certification for all divers and equipment. These documents must be submitted (hard copy or electronic copy) to the District Diving Coordinator (DDC) (Katharine Meadows, 314-331-8307) for review and approval prior to the commencement of dive operations. No dive operations are to be performed until approval is received from the DDC.**

7.2.3 In addition, the following apply:

- If dive operations will be conducted with surface-supplied air (SSA), SSA helmets must be of the demand valve type.
- Each diver must have a reserve breathing supply ("bail-out bottle") that can be turned on immediately by the diver and shall contain no less than 30 cubic feet of air.
- All members of the team must have at least 1 year of commercial experience in the applicable position.

8 PRESENTATION OF FINDINGS--DRAFT AND FINAL REPORTS AND OTHER SUBMITTALS.

8.1 Draft and Final Reports

8.1.1 General Format for Report. The Subcontractor shall prepare, in draft and final forms, a technical report for this effort. The report shall include introduction, study area location and site descriptions, methods, results, discussion, conclusions, references, and a minimum of the following Appendices, all GPS coordinates labeled by transect interval, spot dive or endangered species and the raw data sheets.

The main report shall include a characterization of unionid communities within the proposed project area including a discussion of relative abundance, density, distribution and species composition throughout the project area and within each mussel bed located in the project area. Additionally, unionid distribution in relation to substrate composition, water depth, and water velocity and any correlations shall be discussed. Finally, potential impacts of the proposed project on unionids documented as part of this SOW should be discussed. Maps reflective of actual sampling locations, abundance data, observed substrate types and depths should also be included in the main report.

8.1.2 Review of Draft and Final Reports and Other Submittals. Reports and submittals shall be reviewed by the Corps and any other individuals and/or entities as selected by the Corps. Once comments are received by the Subcontractor, the Contractor will address comments and re-submit an electronic version of the revised report to the URS Project Manager. The Project Manager will notify the Subcontractor of acceptance of the report as final or of additional comments. Once the Subcontractor is notified that the report is accepted as final the Subcontractor shall prepared and submit the final report to the Corps.

8.1.3 Report Copies. The draft report should be emailed to the Technical Manager and COR for review as a digital Microsoft Word document. The final report will be in .pdf format and include four bound hard copies and two CDs mailed to the Technical Manager.

8.2 Other Submittals

8.2.1 Hard copies or emailed copies (submitted to the Technical Manager) of the required state and federal permits obtained for capturing, handling, and/or collecting data from any threatened or endangered species prior to initiation of field work.

8.2.2 Hard copies or emailed copies of all field notes and data sheets shall accompany the first payment submittal. This will indicate the Subcontractor has completed all field work.

9 SCHEDULE

9.1 Project Schedule:

Tasks	Calendar Day or Date
Date of Award (DOA)	0*
Field Work Initiation	+ 15 days from DOA*
Field Work Completed	+ 45 days from DOA
Draft report Submittal on or Before	+ 55 days from DOA
Final Report Submittal on or Before	+ 85 days from DOA

*Calendar Day 0 is the Date in Block 3 of DD Form 1155.

*Initiation of field work can begin as soon as notice to proceed is received, DDC has given necessary approvals, and river levels are at safe water surface elevation.

Invoices shall be submitted on a monthly basis. Gross amount billed shall not exceed the percent of contract amounts designated below until the task/milestone is complete. Payment Schedule shall be as follows:

Task/Milestone*	Percent of Contract Amount
100% Fieldwork Completion*	60
Draft Report Acceptance by Corps	20
Final Report Acceptance by Corps	20
Total	100%

*Completion of field work shall be documented by letter or email submitted by the Principal Investigator and addressed to the Corps Contracting Officer's Representative (COR) and the Technical Manager.

10 COORDINATION

10.1 Mark Felton is the URS Project Manager for this work. He may be reached by phone at (314) 429-0100, email at **Mark_Felton@urscorp.com**, or by cell phone (314) 504-7555

10.2 Donovan Henry is the Corps biologist and Corps Technical Manager for this work. He may be reached by phone at (314) 331-8497 or by email at **Donovan.B.Henry@usace.army.mil**. The Technical Manager shall be notified of the date(s) field work is to begin and end. Reports may be mailed to:

U.S. Army Corps of Engineers Environmental Branch PD-E Attn: Donovan Henry 1222 Spruce St. St. Louis MO 63103-2833

10.3 Contracting Officer's Representative (COR) for this work will be appointed upon award of the contract. All post-award contractual questions should initially be directed to the COR.

10.4 Katharine Meadows is the St. Louis District Corps' District Diving Coordinator. She may be reached by phone at 314.331.8307 e-mail: katharine.h.meadows@usace.army.mil. She shall be contacted to arrange for the presence of the Corps Dive Inspector at all dive operations. As stated in Section 7.2.2, the Subcontractor shall submit a dive plan to the DDC. All dive activities and plans will need to be approved by the DDC before fieldwork can begin. Dive and Dive safety related questions should be addressed to the DDC.

10.5 Lockmaster Stephen McCann or Assistant Lockmaster Thomas Pickett at Lock and Dam 22 will be notified by the Subcontractor at least 1 week prior to the commencement of field work. The Lockmaster shall be contacted again 24 hours prior to initiation of fieldwork to confirm that there are no abnormal conflicts with lock and dam activities. Each day of the survey, the Subcontractor will coordinate with the lockmaster to assure that he knows the location of the survey team. The dive team shall remain available for constant communication with the Lock and Dam staff. The phone number for the Lock and Dam 22 is 573-221-0294.

11 UNAUTHORIZED DIRECTION, TIME EXTENSIONS, AND MONTHLY REPORTS

11.1 Unauthorized Direction: Only the Contracting Officer has authority to change the contract or issue a task order. No price or completion date changes can be made without approval from the Contracting Officer in advance of commencing work. The A-E shall not accept directions from any Government employee or otherwise, other than the Contracting Officer, that would involve a change to the contract cost or final completion date.

11.2 Time Extensions: If the schedules indicated above are exceeded due to causes beyond the control and without the fault or negligence of the A-E, as determined by the Contracting Officer, this task order will be modified in writing and the completion date will be extended one calendar day for each calendar day of delay. The A-E shall notify the Government of such delays.

11.3 Monthly Reports: The A-E shall submit monthly reports to the Technical Manager and COR delineating project current status, unresolved issues, resolved issues, percent complete earned, percent complete planned, and dollars earned. Within seven days of Notice to Proceed, the A-E shall submit a completion schedule for approval.

12 EXHIBITS

1. The proposed channel improvement structures at the Gilbert Island Complex, MRM
2. 298.6 to 297.7.Illinois Waterway Dike and Revetment project area and proposed project features.
3. Location, description, and layout of Chevron 298.5.
4. Location, description, and layout of Chevron 298.4.
5. Location, description, and layout of Chevron 298.2.
6. Location, description, and layout of Dike 297.9.
7. Location, description, and layout of Dike 297.7.
8. USACE - Freshwater Mussel Database Templates (**ON CD**)

13 REFERENCES

Cummins, K. W - 1962 - An evaluation of some techniques for the collection and analysis of benthic samples with a special emphasis on lotic waters. *Amer. Midl. Nat.*, 67: 477–504.

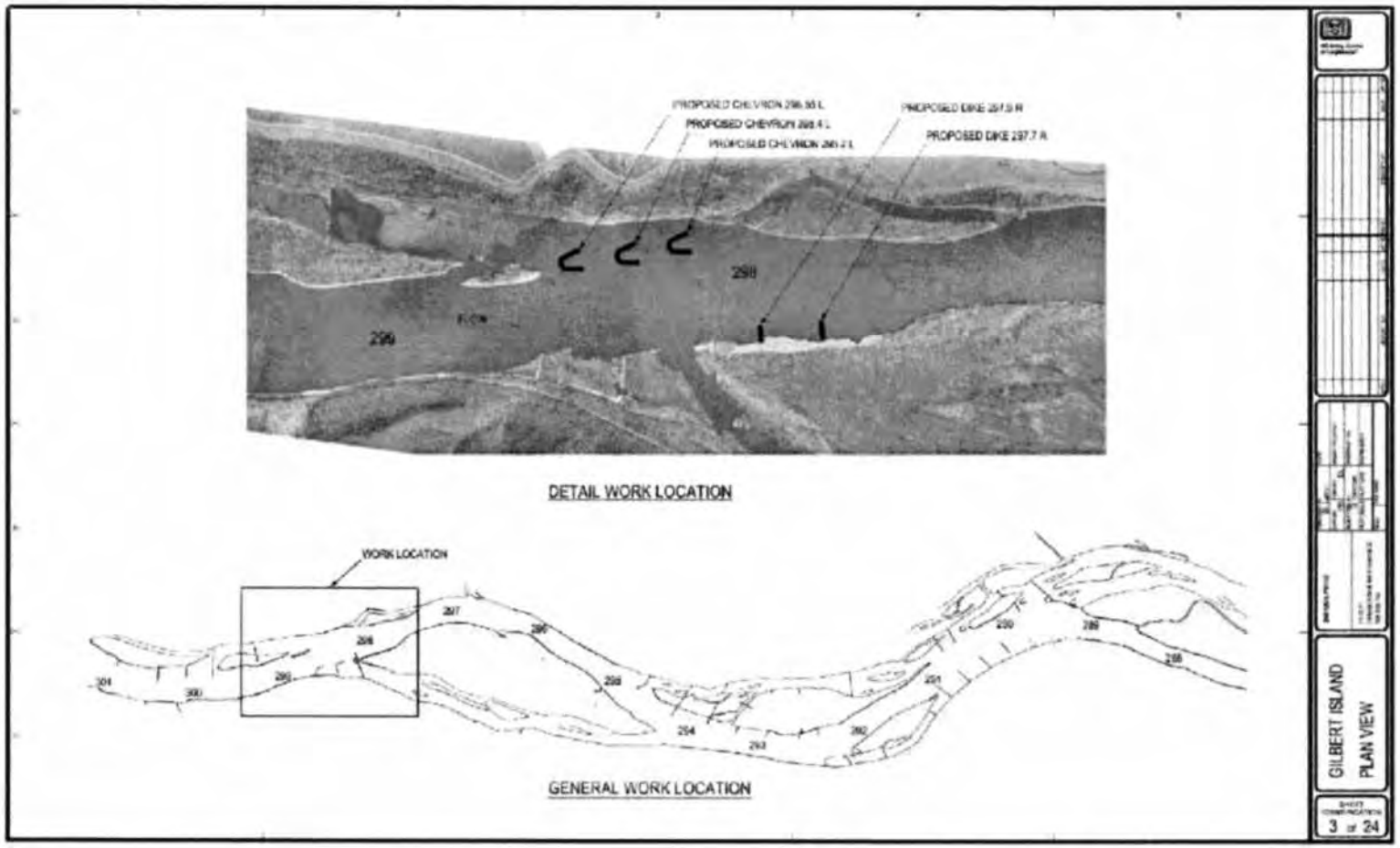
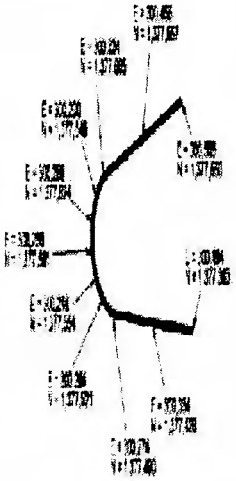
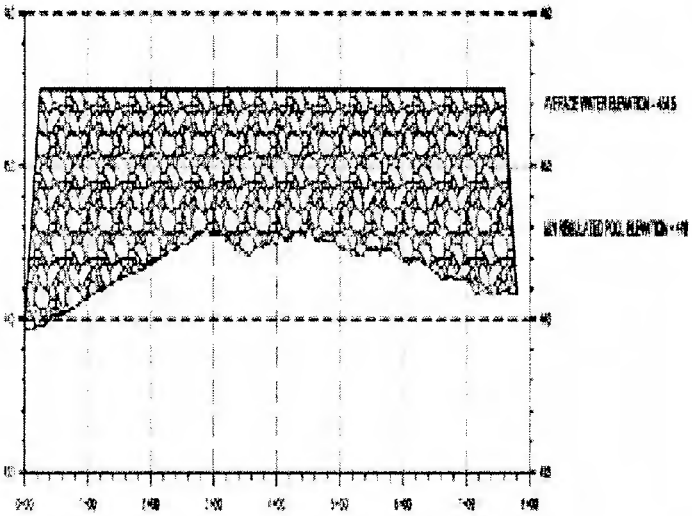


Exhibit 1. The proposed channel improvement structures at the Gilbert Island Complex, MRM 298.6 to 297.7.

CHEVRON 208.5L - GRADING PLAN



CHEVRON 208.5L - COORDINATE LAYOUT



CHEVRON 208.5L - PROFILE

CHEVRON 208.5 L
GRADING PLAN

4 of 21

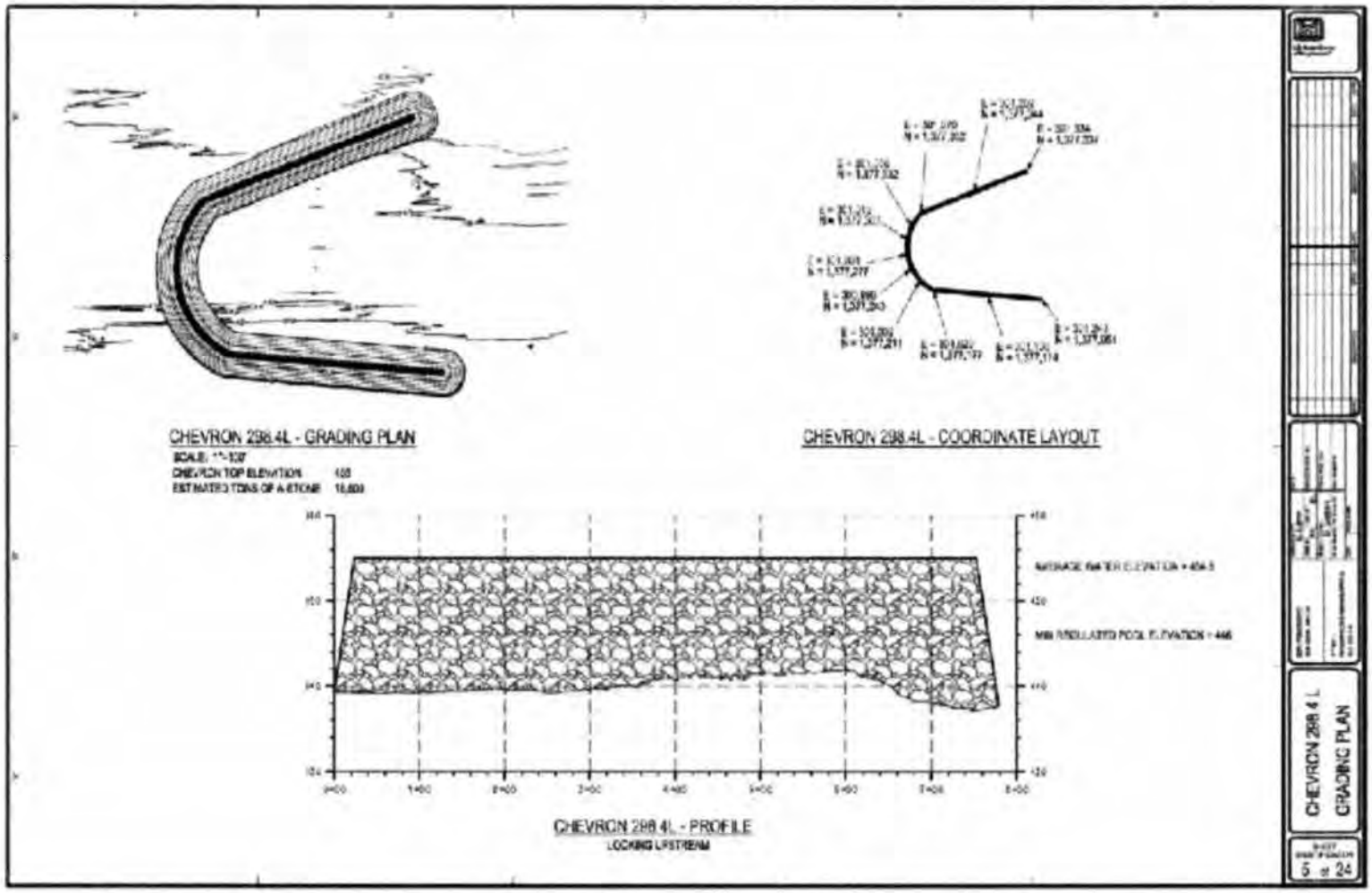
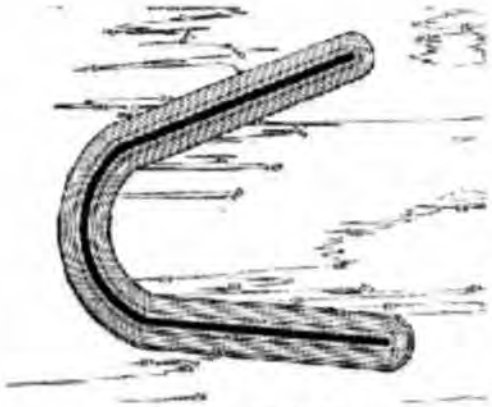


Exhibit 3. Location, description, and layout of Chevron 298.4. Exhibit 4. Location, description, and layout of Chevron 298.2. Exhibit 5. Location, description, and layout of Dike 297.9. Exhibit 6. Location, description, and layout of Dike 297.7.

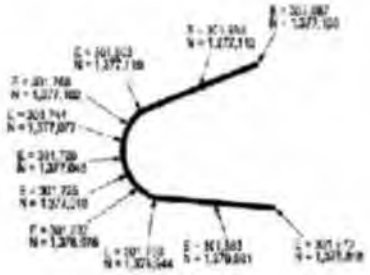


CHEVRON 298.2 L - GRADING PLAN

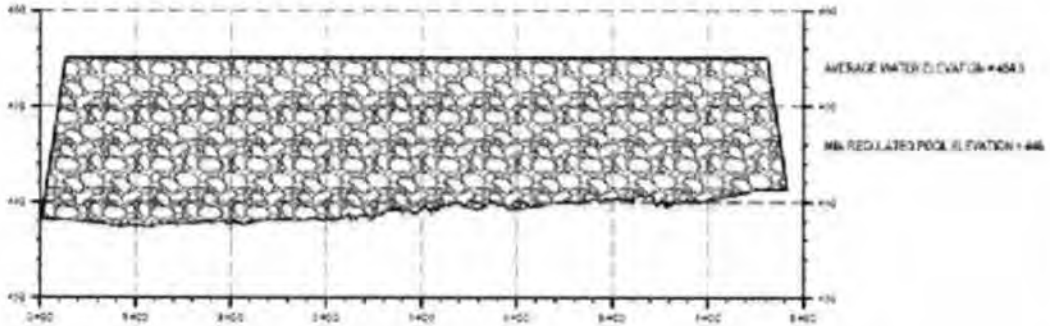
SCALE: 1" = 10'

CHEVRON TOP ELEVATION - 460

ESTIMATED TONS OF ROCK = 11,200 TONS



CHEVRON 298.2 L - COORDINATE LAYOUT

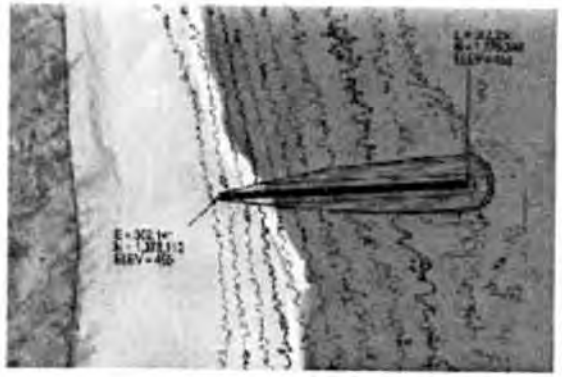


CHEVRON 298.2 L - PROFILE

LOOKING UPSTREAM

CHEVRON 298.2 L
GRADING PLAN

SHEET
9 of 24

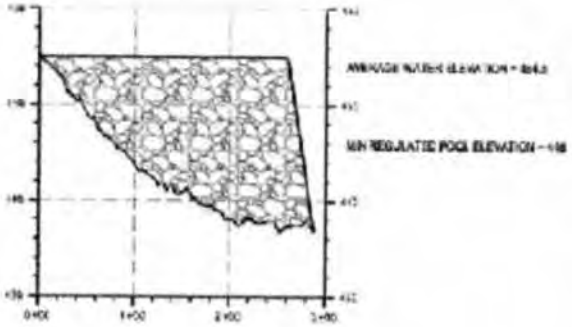


DIKE 297.9R - GRADING PLAN

SCALE 1" = 100'

DIKE TOP ELEVATION = 458

ESTIMATED TONS OF A-STONE = 5,200 TONS

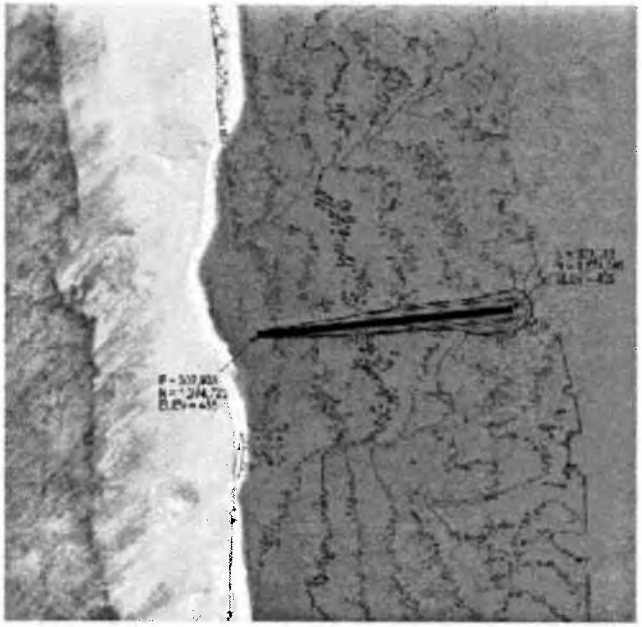


DIKE 297.9R - PROFILE

LOOKING UPSTREAM

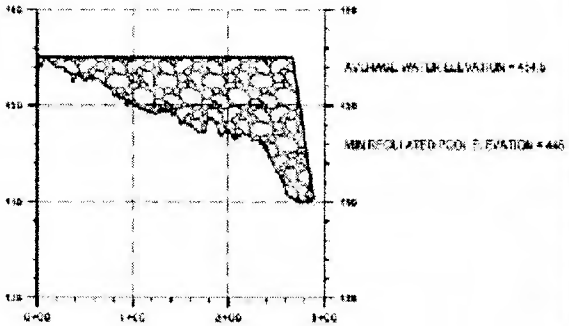
DIKE 297.9R
GRADING PLAN

SHEET
7 of 34



DIKE 297.7 R - GRADING PLAN

SCALE: 1" = 100'
DIKE TOP ELEVATION = 455
ESTIMATED TONS OF A-STONE = 1,300 TONS



DIKE 297.7 R - PROFILE

LOOKING UPSTREAM

DIKE 297.7 R
GRADING PLAN

SHEET
8 of 24

Appendix B. GPS Coordinates

Sample ID	Transect	Distance (m)	Easting	Northing
201011011401	1	10	653480.3910	4386969.6594
201011011402	1	20	653474.4450	4386962.6294
201011011403	1	30	653468.4990	4386955.5993
201011011404	1	40	653462.5530	4386948.5693
201011011405	1	50	653456.6070	4386941.5392
201011011406	1	60	653450.6611	4386934.5092
201011011407	1	70	653444.7151	4386927.4791
201011011408	1	80	653438.7691	4386920.4491
201011011409	1	90	653432.8231	4386913.4190
201011011410	1	100	653426.8771	4386906.3890
201011011411	1	110	653420.9312	4386899.3589
201011011412	1	120	653414.9852	4386892.3289
201011011413	1	130	653409.0392	4386885.2988
201011011414	1	140	653403.0932	4386878.2688
201011011415	1	150	653397.1472	4386871.2387
201011011416	1	160	653391.2013	4386864.2087
201011011417	1	170	653385.2553	4386857.1786
201011011418	1	180	653379.3093	4386850.1485
201011011419	1	190	653373.3633	4386843.1185
201011011420	1	200	653367.4173	4386836.0884
201011011421	1	210	653361.4714	4386829.0584
201011011424	1	220	653355.5254	4386822.0283
201011011425	1	230	653349.5794	4386814.9983
201011011426	1	240	653343.6334	4386807.9682
201011011429	1	250	653337.6875	4386800.9382
201011011422	1	260	653331.7415	4386793.9081
201011011423	1	270	653325.7955	4386786.8781
201011011427	1	280	653319.8495	4386779.8480
201011011428	1	290	653313.9035	4386772.8180
201011011430	1	300	653307.9576	4386765.7879
201011011431	2	10	653691.8839	4386814.3741
201011011432	2	20	653688.3688	4386805.8001
201011011433	2	30	653684.8538	4386797.2260
201011011434	2	40	653681.3388	4386788.6520
201011011435	2	50	653677.8238	4386780.0780
201011011436	2	60	653674.3087	4386771.5039
201011011437	2	70	653670.7937	4386762.9299
201011011438	2	80	653667.2787	4386754.3559
201011011439	2	90	653663.7637	4386745.7818
201011011440	2	100	653660.2486	4386737.2078
201011011441	2	110	653656.7336	4386728.6338
201011011442	2	120	653653.2186	4386720.0597
201011011443	2	130	653649.7035	4386711.4857
201011011444	2	140	653646.1885	4386702.9116
201011011445	2	150	653642.6735	4386694.3376
201011011446	2	160	653639.1585	4386685.7636
201011011447	2	170	653635.6434	4386677.1895
201011011448	2	180	653632.1284	4386668.6155
201011011449	2	190	653628.6134	4386660.0415
201011011450	2	200	653625.0984	4386651.4674
201011011451	2	210	653621.5833	4386642.8934
201011011452	2	220	653618.0683	4386634.3193
201011011453	2	230	653614.5533	4386625.7453
201011011454	2	240	653611.0383	4386617.1713
201011011455	2	250	653607.5232	4386608.5972
201011011456	2	260	653604.0082	4386600.0232
201011011457	2	270	653600.4932	4386591.4492
201011011458	2	280	653596.9781	4386582.8751
201011011459	2	290	653593.4631	4386574.3011
201011011460	2	300	653589.9481	4386565.7271
201011021401	3	10	653862.4119	4386672.4262
201011021402	3	20	653857.8457	4386664.0492
201011021403	3	30	653853.2794	4386655.6723
201011021404	3	40	653848.7132	4386647.2954
201011021405	3	50	653844.1469	4386638.9184
201011021406	3	60	653839.5807	4386630.5415
201011021407	3	70	653835.0144	4386622.1646
201011021408	3	80	653830.4482	4386613.7877
201011021409	3	90	653825.8819	4386605.4107
201011021410	3	100	653821.3157	4386597.0338
201011021411	3	110	653816.7494	4386588.6569
201011021412	3	120	653812.1832	4386580.2799

Sample ID	Transect	Distance (m)	Easting	Northing
201011021413	3	130	653807.6169	4386571.9030
201011021414	3	140	653803.0507	4386563.5261
201011021415	3	150	653798.4844	4386555.1491
201011021416	3	160	653793.9182	4386546.7722
201011021417	3	170	653789.3519	4386538.3953
201011021418	3	180	653784.7857	4386530.0183
201011021419	3	190	653780.2194	4386521.6414
201011021420	3	200	653775.6532	4386513.2645
201011021421	3	210	653771.0869	4386504.8875
201011021422	3	220	653766.5207	4386496.5106
201011021423	3	230	653761.9544	4386488.1337
201011021424	3	240	653757.3882	4386479.7567
201011021425	3	250	653752.8219	4386471.3798
201011021426	3	260	653748.2557	4386463.0029
201011021427	3	270	653743.6894	4386454.6259
201011021428	3	280	653739.1232	4386446.2490
201011021429	3	290	653734.5569	4386437.8721
201011021430	3	300	653729.9907	4386429.4951
201011021431	4	10	654043.4194	4386565.7271
201011021432	4	20	654040.0686	4386557.1859
201011021433	4	30	654036.7178	4386548.6447
201011021434	4	40	654033.3670	4386540.1035
201011021435	4	50	654030.0163	4386531.5624
201011021436	4	60	654026.6655	4386523.0212
201011021437	4	70	654023.3147	4386514.4800
201011021438	4	80	654019.9639	4386505.9388
201011021439	4	90	654016.6132	4386497.3977
201011021440	4	100	654013.2624	4386488.8565
201011021441	4	110	654009.9116	4386480.3153
201011021442	4	120	654006.5608	4386471.7741
201011021443	4	130	654003.2101	4386463.2330
201011021444	4	140	653999.8593	4386454.6918
201011021445	4	150	653996.5085	4386446.1506
201011021446	4	160	653993.1577	4386437.6094
201011021447	4	170	653989.8070	4386429.0683
201011021448	4	180	653986.4562	4386420.5271
201011021449	4	190	653983.1054	4386411.9859
201011021450	4	200	653979.7546	4386403.4447
201011021451	4	210	653976.4039	4386394.9036
201011021452	4	220	653973.0531	4386386.3624
201011021453	4	230	653969.7023	4386377.8212
201011021454	4	240	653966.3515	4386369.2800
201011021455	4	250	653963.0008	4386360.7389
201011021456	4	260	653959.6500	4386352.1977
201011021457	4	270	653956.2992	4386343.6565
201011021458	4	280	653952.9484	4386335.1153
201011021459	4	290	653949.5977	4386326.5742
201011021460	4	300	653946.2469	4386318.0330
201011021461	5	10	654276.8237	4386465.6966
201011021462	5	20	654273.8014	4386456.7612
201011021463	5	30	654270.7792	4386447.8258
201011021464	5	40	654267.7569	4386438.8904
201011021465	5	50	654264.7346	4386429.9550
201011021466	5	60	654261.7124	4386421.0197
201011021467	5	70	654258.6901	4386412.0843
201011021468	5	80	654255.6678	4386403.1489
201011021469	5	90	654252.6456	4386394.2135
201011021470	5	100	654249.6233	4386385.2781
201011021471	5	110	654246.6010	4386376.3427
201011021472	5	120	654243.5788	4386367.4073
201011021473	5	130	654240.5565	4386358.4719
201011021474	5	140	654237.5342	4386349.5365
201011021475	5	150	654234.5120	4386340.6011
201011021476	5	160	654231.4897	4386331.6657
201011021477	5	170	654228.4674	4386322.7303
201011021478	5	180	654225.4452	4386313.7949
201011021479	5	190	654222.4229	4386304.8595
201011021480	5	200	654219.4007	4386295.9241
201011021481	5	210	654216.3784	4386286.9887
201011021482	5	220	654213.3561	4386278.0533
201011021483	5	230	654210.3339	4386269.1179
201011021484	5	240	654207.3116	4386260.1826

Sample ID	Transect	Distance (m)	Easting	Northing
201011021485	5	250	654204.2893	4386251.2472
201011021486	5	260	654201.2671	4386242.3118
201011021487	5	270	654198.2448	4386233.3764
201011021488	5	280	654195.2225	4386224.4410
201011021489	5	290	654192.2003	4386215.5056
201011021490	5	300	654189.1780	4386206.5702
201011021491	9	10	655541.9704	4385821.6912
201011021492	9	20	655540.2657	4385812.4152
201011021493	9	30	655538.5609	4385803.1392
201011021494	9	40	655536.8561	4385793.8632
201011021495	9	50	655535.1513	4385784.5872
201011021496	9	60	655533.4466	4385775.3112
201011021497	9	70	655531.7418	4385766.0352
201011021498	9	80	655530.0370	4385756.7592
201011021499	9	90	655528.3322	4385747.4832
201011031401	9	100	655526.6274	4385738.2072
201011031402	9	110	655524.9227	4385728.9312
201011031403	9	120	655523.2179	4385719.6552
201011031404	9	130	655521.5131	4385710.3791
201011031405	9	140	655519.8083	4385701.1031
201011031406	9	150	655518.1035	4385691.8271
201011031407	9	160	655516.3988	4385682.5511
201011031408	9	170	655514.6940	4385673.2751
201011031409	9	180	655512.9892	4385663.9991
201011031410	9	190	655511.2844	4385654.7231
201011031411	9	200	655509.5796	4385645.4471
201011031422	6	10	654754.1117	4386097.0130
201011031423	6	20	654752.0703	4386088.9834
201011031424	6	30	654750.0289	4386080.9537
201011031425	6	40	654747.9874	4386072.9241
201011031426	6	50	654745.9460	4386064.8944
201011031427	6	60	654743.9046	4386056.8648
201011031428	6	70	654741.8631	4386048.8351
201011031429	6	80	654739.8217	4386040.8055
201011031430	6	90	654737.7802	4386032.7758
201011031431	6	100	654735.7388	4386024.7462
201011031432	6	110	654733.6974	4386016.7165
201011031433	6	120	654731.6559	4386008.6869
201011031434	6	130	654729.6145	4386000.6572
201011031435	6	140	654727.5731	4385992.6276
201011031436	6	150	654725.5316	4385984.5979
201011031437	7	10	654954.1726	4385997.9353
201011031438	7	20	654947.5039	4385987.9322
201011031439	7	30	654940.8352	4385977.9292
201011031440	7	40	654934.1665	4385967.9262
201011031441	7	50	654927.4978	4385957.9231
201011031442	8	10	655347.6256	4385791.2057
201011031443	8	20	655342.8623	4385779.7737
201011031444	8	30	655338.0989	4385768.3416
201011031445	8	40	655333.3356	4385756.9096
201011031446	8	50	655328.5722	4385745.4775

Appendix C. Field Data Sheets

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Ecological Specialists, Inc. 2010

Project no. 102023 Date 11/3/10 Collectors: ER [illegible] (circle lder and square diver)
Site M.A.M Subsite T6, 7, 8

Collection Type: Dive / Bank Search / Wade / Snorkel
Collection Method: Qual. / Quan. / Semi-Quan/Recon
Sub-Method: Timed Search / Quadrat / Transect / Relocation
Effort 10 min / m2 / m

State IL County Pike River MS Habitat Channel – T7-T8
Bank LDB Pool 24 RM UP ____ DN ____
T6 297.9 T7 297.7 T8 297.5
Comments Chanel Border/Chanel T6

	Subsite	Rep.	Dist. from bank (min/max)	Depth min/max Ft or M	Substrate (one per sample) Be	Bo	Cb	Gr	Sd	St	Cl			Species	# Indiv. (L/FD, WD, SF)	Age (annuli count or A/J)	Length (mm or ≤30mm)	Reprod. Condition 1	Zebras/ unio 2	Zebras/ 1/4m2 3	% Inf. 4	Notes/GPS/ Depthfinder/Pic Info./if marked, mussel ID
1	T6	0	0 0											—								
2		1	0 10											Ø								
3		2												Ø								
4		1												Ø								
5														Ø								
6		20	190 200											Ø								
7																						
8																						
9	T7	0	0 0											—								
10		1	0 10											Ø								
11		2	10 20											Ø								
12		3	20 30											Ø								
13		4	30 40											Ø								
14		5	40 50											Ø								
15																						
16	T8	0	0 0											—								
17		1	0 10											Ø								
18		2	10 20											Ø								
19		3	20 30											Ø								
20		4	30 40											Ø								
21		5	40 50											Ø								
22																						
23																						
24																						
25																						
26																						
27																						
28																						
29																						
30																						

1= reprod cond-M=male, FC=F charging, FG=F gravid, FNG=F not gravid
1=actual no. of zebras or 0, 1-10, 11-50, >50
2=total zebras per 0.25m2 quadrat=loose zebras+ all zebras on unionids
3=% of shell covered; 0, 1-10%, 1-50%, 51-100%

Environmental conditions
Gage used: ____
River stage (ft): ____
River discharge (cfs): ____
Weather: ____
Air temp: ____ C F
Secchi disk depth (cm): ____

Current velocity (surface) ____ Ft/sec m/sec
Current velocity (bottom) ____
Water temp (surface) 50 C F
Water temp (bottom) ____ C F
DO (surface) ____
DO (Bottom) ____

pH (surface) ____
pH (bottom) ____
Cond (surface) ____
Cond (bottom) ____
Redox (surface) ____
Redox (bottom) ____

Data summary
No. species: ____
No. unionids: ____
CPUE: ____
Density: ____
T&Es: ____

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Ecological Specialists, Inc. 2010

Project no. 10-023 Date 11/3/10 Collectors: EB JG NW KC
Site Subsite SD11 - 13 (circle Ider and square diver)

Collection Type: Dive / Bank Search / Wade / Snorkel
Collection Method: ~~Qual / Quan.~~ / Semi-Quan/Recon
Sub-Method: ~~Timed Search~~ / Quadrat / Transect / Relocation
Effort 10 min m2 m

State IL County Pike River MS Habitat Channel / Channel Border
Bank LDB Pool 24 RM UP DN
Comments

	Subsite	Rep.	Dist. from bank (min/max)	Depth min/max Ft or M	Substrate (one per sample) Be	Bo	Cb	Gr	Sd	St	Cl			Species	# Indiv. (L/FD, WD, SF)	Age (annuli count or A/J)	Length (mm or ≤30mm)	Reprod. Condition 1	Zebras/ unio 2	Zebras/ 1/4m2 3	% Inf. 4	Notes/GPS/ Depthfinder/Pic Info./if marked, mussel ID
1	SD11													Ø								MRM 297.4
2																						
3	SD12													Ø								MRM 297.7
4																						
5	SD13													Ø								MRM 298.1
6																						
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
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22																						
23																						
24																						
25																						
26																						
27																						
28																						
29																						
30																						

1= reprod cond-M=male, FC=F charging, FG=F gravid, FNG=F not gravid
1=actual no. of zebras or 0, 1-10, 11-50, >50
2=total zebras per 0.25m2 quadrat=loose zebras+ all zebras on unionids
3=% of shell covered; 0, 1-10%, 1-50%, 51-100%

Environmental conditions
Gage used:
River stage (ft):
River discharge (cfs):
Weather:
Air temp: C F
Secchi disk depth (cm):

Current velocity (surface) Ft/sec m/sec
Current velocity (bottom)
Water temp (surface) C F
Water temp (bottom) C F
DO (surface)
DO (Bottom)

pH (surface)
pH (bottom)
Cond (surface)
Cond (bottom)
Redox (surface)
Redox (bottom)

Data summary
No. species:
No. unionids:
CPUE:
Density:
T&Es:

fill in blocked info on all pages

Ecological Specialists, Inc. 2010

Project no. 10-023 Date 11/2/10 Collectors: (FB) NW NB JG KC
Site Subsite T3 (0 - Dike 1 (circle lder and square diver)

Collection Type: (Dive) / Bank Search / Wade / Snorkel
Collection Method: Qual. / Quan. / (Semi-Quan) / Recon
Sub-Method: Timed Search / Quadrat / (Transect) / Relocation
Effort 10 min (m2) m

State IL County Pike River MS Habitat Channel Border
Bank LDB Pool 24 RM UP 298.6 DN 298.6
Comments

	Subsite	Rep.	Dist. from bank (min/max)	Depth min/max Ft or M	Substrate (one per sample) Be	Bo	Cb	Gr	Sd	St	Cl			Species	# Indiv. (L/FD, WD, SF)	Age (annuli count or A/J)	Length (mm or ≤30mm)	Reprod. Condition 1	Zebras/ unio 2	Zebras/ 1/4m2 3	% Inf. 4	Notes/GPS/ Depthfinder/Pic info./if marked, mussel ID
1	T3	0	0 0						100													
2		1	0 10						↓					Lost	L?							
3		2	10 20						100					Ø								
4																						
5																						
6									100													
7																						
8		30	250 300						100					Ø								
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
25																						
26																						
27																						
28																						
29																						
30																						

1= reprod cond-M=male, FC=F charging, FG=F gravid, FNG=F not gravid
1=actual no. of zebras or 0, 1-10, 11-50, >50
2=total zebras per 0.25m2 quadrat=loose zebras+ all zebras on unionids
3=% of shell covered; 0, 1-10%, 1-50%, 51-100%

Environmental conditions
Gage used:
River stage (ft):
River discharge (cfs):
Weather: P. cloudy
Air temp: C F
Secchi disk depth (cm):

Current velocity (surface) Ft/sec m/sec
Current velocity (bottom)
Water temp (surface) 50.0 C (F)
Water temp (bottom) C F
DO (surface)
DO (Bottom)

pH (surface)
pH (bottom)
Cond (surface)
Cond (bottom)
Redox (surface)
Redox (bottom)

Data summary
No. species: 1 ?
No. unionids: 1 ?
CPUE:
Density:
T&Es: Ø

fill in blocked info on all pages

Ecological Specialists, Inc. 2010

Project no. 10-033 Date 11/2/10 Collectors: FK NW UB JG KC (circle Ider and square diver)
Site — Subsite T4

Collection Type: Dive / Bank Search / Wade / Snorkel
Collection Method: Qual. / Quan. / Semi-Quan / Recon
Sub-Method: Timed Search / Quadrat / Transect / Relocation
Effort 10 min m2 m

State MO County Pike River MS Habitat Channel Border
Bank LDB Pool 24 RM UP 298.5 DN 298.5
Comments

	Subsite	Rep.	Dist. from bank (min/max)	Depth min/max Ft or M	Substrate (one per sample) Be	Bo	Cb	Gr	Sd	St	Cl			Species	# Indiv. (L/FD, WD, SF)	Age (annuli count or A/J)	Length (mm or ≤30mm)	Reprod. Condition 1	Zebras/ unio 2	Zebras/ 1/4m2 3	% Inf. 4	Notes/GPS/ Depthfinder/Pic Info./if marked, mussel ID
1	T4	0	0 0	4					50	25	25			—								
2		1	0 10	10					100					∅								
3		2	10 20	9																		
4		1												∅								
5		1																				
6		1																				
7		30	290 320						100					∅								
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
25																						
26																						
27																						
28																						
29																						
30																						

1= reprod cond-M=male, FC=F charging, FG=F gravid, FNG=F not gravid
1=actual no. of zebras or 0, 1-10, 11-50, >50
2=total zebras per 0.25m2 quadrat=loose zebras+ all zebras on unionids
3=% of shell covered; 0, 1-10%, 1-50%, 51-100%

Environmental conditions
Gage used:
River stage (ft):
River discharge (cfs):
Weather:
Air temp: C F
Secchi disk depth (cm):

Current velocity (surface) Ft/sec m/sec
Current velocity (bottom)
Water temp (surface) C F
Water temp (bottom) C F
DO (surface)
DO (Bottom)

pH (surface)
pH (bottom)
Cond (surface)
Cond (bottom)
Redox (surface)
Redox (bottom)

Data summary
No. species:
No. unionids:
CPUE:
Density:
T&Es:

fill in blocked info on all pages

Ecological Specialists, Inc. 2010

Project no. 10-023 Date 11/2/10 Collectors: (EW) NW KRNB, JG (circle Ider and square diver)
Site Subsite TS

Collection Type: (Dive) / Bank Search / Wade / Snorkel
Collection Method: Qual. / Quan. / Semi-Quan/Recon
Sub-Method: Timed Search / Quadrat / (Transect) Relocation
Effort 10 min (m2) m

State IL County Pike River MS Habitat Channel Border
Bank LDB Pool 24 RM UP 298.3 DN 298.3
Comments

	Subsite	Rep.	Dist. from bank (min/max)	Depth min/max Ft or M	Substrate (one per sample) Be	Bo	Cb	Gr	Sd	St	Cl			Species	# Indiv. (L/FD, WD, SF)	Age (annuli count or A/J)	Length (mm or ≤30mm)	1 Reprod. Condition	2 Zebras/ unio	3 Zebras/ 1/4m2	4 % Inf.	Notes/GPS/ Depthfinder/Pic Info./if marked, mussel ID
1	TS	0	0 0																			
2		1	0 10											Ø								
3		2	10 20																			
4		↓												Ø								
5																						
6		30	250 300											Ø								
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
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19																						
20																						
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23																						
24																						
25																						
26																						
27																						
28																						
29																						
30																						

1= reprod cond-M=male, FC=F charging, FG=F gravid, FNG=F not gravid
1=actual no. of zebras or 0, 1-10, 11-50, >50
2=total zebras per 0.25m2 quadrat=loose zebras+ all zebras on unionids
3=% of shell covered; 0, 1-10%, 1-50%, 51-100%

Environmental conditions
Gage used:
River stage (ft):
River discharge (cfs):
Weather:
Air temp: C F
Secchi disk depth (cm):

Current velocity (surface) Ft/sec m/sec
Current velocity (bottom)
Water temp (surface) C F
Water temp (bottom) C F
DO (surface)
DO (Bottom)

pH (surface)
pH (bottom)
Cond (surface)
Cond (bottom)
Redox (surface)
Redox (bottom)

Data summary
No. species: Ø
No. unionids: Ø
CPUE:
Density:
T&Es: Ø

fill in blocked info on all pages

Ecological Specialists, Inc. 2010

Project no. 10-023 Date 11/2/10 Collectors: EB DS JG MW KC (circle Ider and square diver)
Site Transects Subsite T9

Collection Type: Dive / Bank Search / Wade / Snorkel
Collection Method: Qual. / Quan. / Semi-Quan/Recon
Sub-Method: Timed Search / Quadrat / Transect / Relocation
Effort 10 min m2 m

State IL County Pike River MS Habitat Ch. Bider
Bank LDB Pool 24 RM UP 297.3 DN 297.3
Comments

	Subsite	Rep.	Dist. from bank (min/max)	Depth min/max Ft or M	Substrate (one per sample) Be	Bo	Cb	Gr	Sd	St	Cl			Species	# Indiv. (L/FD, WD, SF)	Age (annuli count or A/J)	Length (mm or ≤30mm)	Reprod. Condition 1	Zebras/ unio 2	Zebras/ 1/4m2 3	% Inf. 4	Notes/GPS/ Depthfinder/Pic Info./if marked, mussel ID
1	T9	0	0-0											Ø								
2		1	0-10																			
3		2	10-20											Ø								
4		T																				
5		V																				
6		20	190-200											Ø								
7																						
8																						
9																						
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
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19																						
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24																						
25																						
26																						
27																						
28																						
29																						
30																						

1= reprod cond-M=male, FC=F charging, FG=F gravid, FNG=F not gravid
1=actual no. of zebras or 0, 1-10, 11-50, >50
2=total zebras per 0.25m2 quadrat=loose zebras+ all zebras on unionids
3=% of shell covered; 0, 1-10%, 1-50%, 51-100%

Environmental conditions
Gage used:
River stage (ft):
River discharge (cfs):
Weather:
Air temp: C F
Secchi disk depth (cm):

Current velocity (surface) Ft/sec m/sec
Current velocity (bottom)
Water temp (surface) C F
Water temp (bottom) C F
DO (surface)
DO (Bottom)

pH (surface)
pH (bottom)
Cond (surface)
Cond (bottom)
Redox (surface)
Redox (bottom)

Data summary
No. species: Ø
No. unionids: Ø
CPUE:
Density: Ø
T&Es:

fill in blocked info on all pages

Ecological Specialists, Inc. 2010

Project no. 10-023 Date 11/2/10 Collectors: (EK) (NR) KC NW JG
Site Subsite Side channel (circle Ider and square diver)

Collection Type: (Dive) / Bank Search / Wade / Snorkel
Collection Method: (Qual.) / Quan. / Semi-Quan/Recon
Sub-Method: Timed Search / Quadrat / Transect / Relocation
Effort 10 (min / m2 m)

State IL County Pike River MS Habitat Scouring riffle
Bank LDB Pool 24 RM UP 298.0 DN 297.4
Comments

	Subsite	Rep.	Dist. from bank (min/max)	Depth min/max Ft or M	Substrate (one per sample) Be	Bo	Cb	Gr	Sd	St	Cl			Species	# Indiv. (L/FD, WD, SF)	Age (annuli count or A/J)	Length (mm or ≤30mm)	1 Reprod. Condition	2 Zebras/ unio	3 Zebras/ 1/4m2	4 % Inf.	Notes/GPS/ Depthfinder/Pic Info./if marked, mussel ID
1	Side ch.	SD1												Aplic	3L	A		O				258 unit
2														Qquad	1L	A		O				
3														L.comp.	1L	A		O				
4		SD2												Ø								
5		SD3												Dala	WD	A						
6		SD4												Oret	1L	A						
7		SD5												Ø								
8		SD6												L.fragi	WD							
9														P.grand	WD							
10																						
11																						
12																						
13																						
14																						
15																						
16																						
17																						
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22																						
23																						
24																						
25																						
26																						
27																						
28																						
29																						
30																						

1= reprod cond-M=male, FC=F charging, FG=F gravid, FNG=F not gravid
1=actual no. of zebras or 0, 1-10, 11-50, >50
2=total zebras per 0.25m2 quadrat=loose zebras+ all zebras on unionids
3=% of shell covered; 0, 1-10%, 1-50%, 51-100%

Environmental conditions
Gage used:
River stage (ft):
River discharge (cfs):
Weather:
Air temp: C F
Secchi disk depth (cm):

Current velocity (surface) Ft/sec m/sec
Current velocity (bottom)
Water temp (surface) C F
Water temp (bottom) C F
DO (surface)
DO (Bottom)

pH (surface)
pH (bottom)
Cond (surface)
Cond (bottom)
Redox (surface)
Redox (bottom)

Data summary
No. species: 4
No. unionids: 6
CPUE:
Density:
T&Es: 0

fill in blocked info on all pages

Ecological Specialists, Inc. 2010

Project no. 10-023 Date 11/2/10 Collectors: (circle Ider and square diver)
Site Min Subsite SD

Collection Type: Dive / Bank Search / Wade / Snorkel
Collection Method: Qual. / Quan. / Semi-Quan/Recon
Sub-Method: Timed Search / Quadrat / Transect / Relocation
Effort 10 (min) m2 m

State IL County Pike River MS Habitat 2nd Ch.
Bank RDB Pool 24 RM UP 298.9 DN 299.3
Comments Sd/St/Cl then drops off to Sd 5-10 m from the bank, some wdy debris

	Subsite	Rep.	Dist. from bank (min/max)	Depth min/max Ft or M	Substrate (one per sample) Be	Bo	Cb	Gr	Sd	St	Cl			Species	# Indiv. (L/FD, WD, SF)	Age (annuli count or A/J)	Length (mm or ≤30mm)	Reprod. Condition (1)	Zebras/ unio (2)	Zebras/ 1/4m2 (3)	% Inf. (4)	Notes/GPS/ Depthfinder/Pic Info./if marked, mussel ID
1	Min	SD7												A plic	19L	A						
2														O rel	1 L	A						
3		SD8												A plic	7L	A						
4														O rel	1L	A						
5														F. flava	3L	A						
6														Quad.	1L	A						
7		SD9												A plic	2L	A						
8														L cord	1L	A		M				
9														Quad	2L	A						
10														O rel	1L	A						
11		SD10												A plic	13L	A						
12														L c'cong	1L	A						
13														Quad	2L	A						
14														Quad	2L	A						
15														Quad	2L	A						
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
25																						
26																						
27																						
28																						
29																						
30																						

1= reprod cond-M=male, FC=F charging, FG=F gravid, FNG=F not gravid
1=actual no. of zebras or 0, 1-10, 11-50, >50
2=total zebras per 0.25m2 quadrat=loose zebras+ all zebras on unionids
3=% of shell covered; 0, 1-10%, 1-50%, 51-100%

Environmental conditions
Gage used:
River stage (ft):
River discharge (cfs):
Weather:
Air temp: C F
Secchi disk depth (cm):

Current velocity (surface) Ft/sec m/sec
Current velocity (bottom)
Water temp (surface) C F
Water temp (bottom) C F
DO (surface)
DO (Bottom)

pH (surface)
pH (bottom)
Cond (surface)
Cond (bottom)
Redox (surface)
Redox (bottom)

Data summary
No. species:
No. unionids:
CPUE:
Density:
T&Es:

fill in blocked info on all pages

Ecological Specialists, Inc. 2010

Project no. 10-023 Date 11/1/10 Collectors: (EB) KC NLS AW JTG (circle Ider and square diver)
Site Subsite T1

Collection Type: Dive / Bank Search / Wade / Snorkel
Collection Method: Qual. / Quan. / Semi-Quan/Recon
Sub-Method: Timed Search / Quadrat / Transect / Relocation
Effort 10 min m2 m

State IL County Pike River MS Habitat Secondary Channel
Bank LDB Pool 24 RM UP 299 DN 299
Comments 2:07 PM

	Subsite	Rep.	Dist. from bank (min/max)	Depth min/max Ft or M	Substrate (one per sample) Be	Bo	Cb	Gr	Sd	St	Cl			Species	# Indiv. (L/FD, WD, SF)	Age (annuli count or A/J)	Length (mm or ≤30mm)	1 Reprod. Condition	2 Zebras/ unio	3 Zebras/ 1/4m2	4 % Inf.	Notes/GPS/ Depthfinder/Pic Info./if marked, mussel ID
1	T1	0	0 0											—								
2		1	0 10											Ø								
3		2	10 20											A. plic	2L	A			0	0	0	
4														Q. quad	1L	A			0	0	0	
5		3	20 30											Ø								
6		4	30 40											Ø								
7		5	40 50											Ø								
8		6	50 60											Ø								
9		7	60 70											Ø								
10		8	70 80											Ø								
11		9	80 90																			
12		10	90 100																			
13		11	100 110																			
14		12	110 120																			
15		13	120 130																			
16		14	130 140																			
17		15	140 150																			
18		16	150 160																			
19		17	160 170																			
20		18	170 180																			
21		19	180 190																			
22		20	190 200																			
23		21	200 210																			
24		22	210 220																			
25																						
26																						
27																						
28																						
29		✓																				
30		30																				

SAME

1=reprod cond-M=male, FC=F charging, FG=F gravid, FNG=F not gravid
1=actual no. of zebras or 0, 1-10, 11-50, >50
2=total zebras per 0.25m2 quadrat=loose zebras+ all zebras on unionids
3=% of shell covered; 0, 1-10%, 1-50%, 51-100%

Environmental conditions
Gage used:
River stage (ft):
River discharge (cfs):
Weather: M Cloudy
Air temp: 54 C (F)
Secchi disk depth (cm):

Current velocity (surface) Ft/sec m/sec
Current velocity (bottom)
Water temp (surface) 51 C (F)
Water temp (bottom) C F
DO (surface)
DO (Bottom)

pH (surface)
pH (bottom)
Cond (surface)
Cond (bottom)
Redox (surface)
Redox (bottom)

Data summary
No. species: 2
No. unionids: 3
CPUE:
Density:
T&Es: Ø

fill in blocked info on all pages

Ecological Specialists, Inc. 2010

Project no. 10-023 Date 11/01/10 Collectors: (EB) [illegible] KC NR NW
Site Subsite (circle Ider and square diver)

Collection Type: (Dive) / Bank Search / Wade / Snorkel
Collection Method: Qual. / Quan. / (Semi-Quan) / Recon
Sub-Method: Timed Search / Quadrat / (Transect) / Relocation
Effort 10 min (m2) m

State IL County Pike River MS Habitat Secondary Channel
Bank LDB Pool 24 RM UP ~~299.7~~ DN 299.7
Comments

	Subsite	Rep.	Dist. from bank (min/max)	Depth min/max Ft or M	Substrate (one per sample) Be	Bo	Cb	Gr	Sd	St	Cl			Species	# Indiv. (L/FD, WD, SF)	Age (annuli count or A/J)	Length (mm or ≤30mm)	Reprod. Condition 1	Zebras/ unio 2	Zebras/ 1/4m2 3	% Inf. 4	Notes/GPS/ Depthfinder/Pic Info./if marked, mussel ID
1	T2	0	0-5											—					0	0	0	
2		1	0-10											Aplic	L	A				-		
3		2	10-20											Ø								
4		3	20-30											Ø								
5		4	30-40											Ø								
6		5	40-50											Ø								
7		6	50-60											Ø								
8		7	60-70											Ø								
9		8	70-80											Ø								
10		↑	↑																			
11		↑	↑																			
12		↑	↑																			
13		↑																				
14		↑	↑																			
15		30	260-270											Ø								
16																						
17																						
18																						
19																						
20																						
21																						
22																						
23																						
24																						
25																						
26																						
27																						
28																						
29																						
30																						

1= reprod cond-M=male, FC=F charging, FG=F gravid, FNG=F not gravid
1=actual no. of zebras or 0, 1-10, 11-50, >50
2=total zebras per 0.25m2 quadrat=loose zebras+ all zebras on unionids
3=% of shell covered; 0, 1-10%, 1-50%, 51-100%

Environmental conditions
Gage used:
River stage (ft):
River discharge (cfs):
Weather:
Air temp: C F
Secchi disk depth (cm):

Current velocity (surface) Ft/sec m/sec
Current velocity (bottom)
Water temp (surface) C F
Water temp (bottom) C F
DO (surface)
DO (Bottom)

pH (surface)
pH (bottom)
Cond (surface)
Cond (bottom)
Redox (surface)
Redox (bottom)

Data summary
No. species: 1
No. unionids: 1
CPUE:
Density:
T&Es: Ø

T-1 10-023 p1 of 4

11-01-10

ocation		Substrate								
	Depth	Be	Bo	Cb	Gr	Sd	St	Cl	Other	Comments
0 1	6						25	75		
1 2	6					100				
2 3	7					100				
3 4	6					100				
4 5	6					100				
5 6	6					100				
6 7	6					100				
7 8	10					100				
8 9	6					100				
9 10	5					100				
10 11	6					100				
11 12	6					100				
12 13	6					100				
13 14	6					100				
14 15	6					100				
15 16	6					100				
16 17	6					100				
17 18	6					100				
18 19	8					100				
19 20	7					100				

e Ti	Who	In	Out	Depth		Press.
	SG	2:05				

p2 of 4

T-1 10-023

11-01-10

ocation		Substrate								
	Depth	Be	Bo	Cb	Gr	Sd	St	Cl	Other	Comments
20 1	7					100				
21 2	7					100				
22 3	7					100				
23 4	9					100				
24 5	8					100				
25 6	8					100				
26 7	9					100				
27 8	8					100				
28 9	10					100				
29 10	10					100				
30 11	10					100				
12										
13										
14										
15										
16										
17										
18										
19										
20										

e Ti	Who	In	Out	Depth		Press.

[redacted]

p 3 of 4

T-2

10-023

11-01-10

ocation		Substrate								
	Depth	Be	Bo	Cb	Gr	Sd	St	Cl	Other	Comments
0	2					50		50		
1	5					75		25		
2	6					100				
3	6					100				
4	7					100				
5	8					100				
6	6					100				
7	7					100				
8	6					100				
9	8					100				
10	8					100				
11	8					100				
12	7					100				
13	6					100				
14	5					100				
15	7					100				
16	9					100				
17	8					100				
18	10					100				
19	8					100				

e Ti	Who	In	Out	Depth		Press.

p 4 of 4

T-2

10-023

11-01-10

ocation		Substrate								
	Depth	Be	Bo	Cb	Gr	Sd	St	Cl	Other	Comments
20	8					100				
21	7					100				
22	10					100				
23	10					100				
24	11					100				
25	11					100				
26	10					100				
27	10					100				
28	8					100				
29	9					100				
30	7					100				
12										
13										
14										
15										
16										
17										
18										
19										
20										

e Ti	Who	In	Out	Depth		Press.

[redacted]

T-3 10-023 p1 of 9

11-02-10

ocation	Depth	Be	Bo	Cb	Gr	Substrate Sd	St	Cl	Other	Comments
0	1 7					50	25	25		
1	2 9					100				
2	3 11					100				
3	4 11					100				
4	5 12					100				
5	6 12					100				
6	7 11					100				
7	8 10					100				
8	9 8					100				
9	10 9					100				
10	11 9					100				
11	12 8					100				
12	13 9					100				
13	14 9					100				
14	15 8					100				
15	16 8					100				
16	17 6					100				
17	18 5					100				
18	19 6					100				
19	20 6					100				

e Ti	Who	In	Out	Depth		Press.
	NW	8:45	10:00			
		10:30	11:30			

T-3 10-023 p2 of 9

11-2-10

ocation	Depth	Be	Bo	Cb	Gr	Substrate Sd	St	Cl	Other	Comments
20	1 7					100				
21	2 7					100				
22	3 10					100				
23	4 10					100				
24	5 10					100				
25	6 10					100				
26	7 12					100				
27	8 11					100				
28	9 13					100				
29	10 12					100				
30	11 12					100				
	12									
	13									
	14									
	15									
	16									
	17									
	18									
	19									
	20									

e Ti	Who	In	Out	Depth		Press.

T-4

11-2-10 10-023 p 3 of 9

ocation	Depth	Be	Bo	Cb	Gr	Substrate Sd	St	Cl	Other	Comments
0	4					50	25	25		
1	10					100				
2	9					100				
3	9					100				
4	10					100				
5	11					100				
6	11					100				
7	10					100				
8	10					100				
9	12					100				
10	14					100				
11	12					100				
12	11					100				
13	7					100				
14	8					100				
15	9					100				
16	7					100				
17	9					100				
18	9					100				
19	8					100				
20										

e Ti	Who	In	Out	Depth	Press.

T-4

11-2-10 10-023 p 4 of 9

ocation	Depth	Be	Bo	Cb	Gr	Substrate Sd	St	Cl	Other	Comments
20	11					100				
21	10					100				
22	11					100				
23	11					100				
24	11					100				
25	13					100				
26	12					100				
27	12					100				
28	12					100				
29	12					100				
30	12									
12										
13										
14										
15										
16										
17										
18										
19										
20										

e Ti	Who	In	Out	Depth	Press.

T-5

11-2-10 10-023 5 of 9

ocation	Depth	Be	Bo	Cb	Gr	Sd	St	Cl	Other	Comments
				Substrate						
0	3			75		25				
1	8			25	50	25				
2	8					100				
3	9					100				
4	10					100				
5	10					100				
6	9					100				
7	10					100				
8	9					100				
9	9					100				
10	11					100				
11	11					100				
12	10					100				
13	10					100				
14	11					100				
15	11					100				
16	12					100				
17	12					100				
18	12					100				
19	13					100				

e Ti	Who	In	Out	Depth		Press.

T-5

10-02-10 10-023 6 of 9

ocation	Depth	Be	Bo	Cb	Gr	Sd	St	Cl	Other	Comments
				Substrate						
20	14					100				
21	13					100				
22	13					100				
23	13					100				
24	13					100				
25	14					100				
26	14					100				
27	15					100				
28	15					100				
29	15					100				
30	15					100				
12										
13										
14										
15										
16										
17										
18										
19										
20										

e Ti	Who	In	Out	Depth		Press.

T-9

10-02-10 10-023 7 of 9

	Depth	Be	Bo	Cb	Gr	Sd	St	Cl	Other	Comments
0	7				50	50				
1	10				30	70				
2	13				40	60				
3	13					100				
4	14					100				
5	15					100				
6	15					100				
7	4						70	30		
8	8					70	30			
9	15					100				
10	17					100				
11	17					100				
12	19					100				
13	19					100				
14	20					100				
15	20					100				
16	20					100				
17	20					100				
18	20					100				
19	22					100				
20	24					100				

Who	In	Out	Depth		Press.

Spot Dives

11-2-10 10-023 8 of 9

Location	Depth	Be	Bo	Cb	Gr	Sd	St	Cl	Other	Comments
SD-1	10				30	40	30			
	4					100				
SD-2	5					100				
	6					90	10			
SD-3	13					100				
	25				80	20				
SD-4	12						20	80		
SD-5	10					100				
	14					100				
SD-6	15					100				
	14							90		
18										
19										
20										

Time	Who	In	Out	Depth		Press.
	NP	12:30	1:20			
		1:40	2:15			

Spot Dives

11-2-10 10-023 9 of 9

ocation	Depth	Be	Bo	Cb	Gr	Sd	St	Cl	Other	Comments
SD 7	6					80	20			
SD-8	10					100				
	7						25	75		
SD-9	10		10			10	10	70		
	7		100							
SD-10	7					100				
	7						30	70		
14										
15										
16										
17										
18										
19										
20										

e Ti	Who	In	Out	Depth		Press.

T-6

11-3-10 10-023 1 of 3

ocation	Depth	Be	Bo	Cb	Gr	Sd	St	Cl	Other	Comments
0 1	16			100						
1 2	15					100				
2 3	17					100				
3 4	18					100				
4 5	22					100				
5 6	22					100				
6 7	22					100				
7 8	21					100				
8 9	22					100				
9 10	22					100				
10 11	21					100				
11 12	22					100				
12 13	22					100				
13 14	21					100				
14 15	21					100				
15 16	22					100				
16 17										
17 18										
18 19										
19 20										

e Ti	Who	In	Out	Depth		Press.
	SG	8:40				

T-7 10-023 2 of 3

11-3-10

ocation	Depth	Be	Bo	Cb	Gr	Sd	St	Cl	Other	Comments
0	4			50	25		25			
1	8		50	50						
2	12					100				
3	14					100				
4	17					100				
5	19					100				
7										
8										
9										
T-8 0	24					100				
1	25					100				
2	24					100				
3	24					100				
4	26					100				
5	26					100				
16										
17										
18										
19										
20										

e Ti	Who	In	Out	Depth	Press.

[redacted]

Spot Dive

10-023 3 of 3

11-3-10

ocation	Depth	Be	Bo	Cb	Gr	Sd	St	Cl	Other	Comments
SD-11	6						50	50		
	12					75	25			
SD-12	4								100	Rip Rap
	6							50	50	Rip Rap
SD-13	5					50			50	Rip Rap
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

e Ti	Who	In	Out	Depth	Press.