MARIES RIVER REGION
MODOT STREAM MITIGATION BANK
FINAL BANKING INSTRUMENT

Environmental Unit
Design Division

TABLE OF CONTENTS

I. Introduction 3
A. Location 3
B. Establishment and Operation of the Bank 4
C. Ownership of the Low Water Crossing 4
D. Qualifications of Sponsor (MoDOT) 4
E. Responsibility Statement 5

II. Watershed approach to mitigation bank 5
A. Watershed Boundary and Watershed Approach 5
i. Historic Losses and Current Trends in the Watershed 5
ii. Water Quality Issues in the Watershed 6
iii. Needs of the Watershed 6
iv. State of the Bank site 7
v. Threats Within the Watershed 8

III. Service area of the bank 10
A. Define the Service Area 10
B. Map of Service Area 11

IV. Mitigation plan requirements 12
A. Objectives of the Bank 12
B. Site Selection 12
C. Site Protection Instrument 12
D. Baseline Information 13
E. Determination of Credits and structure length 13
F. Mitigation Work Plan 18
G. Operation and Maintenance Plan for the Bank 21
H. Ecological Performance Standards for the Bank 21
I. Monitoring Requirements 21
J. Long-term Management Plan 22
K. Adaptive Management Plan 22
L. Financial Assurances 22

V. Credit Release Schedule 22

VI. Accounting Procedures 23

VII. Reporting for the Mitigation Bank Site 25

VIII. Default and Closure Provisions 25
A. Force Majeure 25
B. Dispute Resolution 25
C. Validity, Modification, and Termination of the Banking Instrument 25

IX. Environmental documentation 26
A. NEPA 26
B. SHPO 26
C. FWS 26

X. Signatures 28

LIST OF TABLES AND FIGURES

FIGURE 1. MoDOT Maries River Region Mitigation Bank, Osage County, Missouri, location map 3

FIGURE 2. Human threats 9

FIGURE 3. Maries River Region Bank Service Area Boundary 11

FIGURE 4. Survey Methodology to Determine Length of Crossing Influence 14

FIGURE 5. Elevation Survey Method to Determine Length of Crossing Influence 15

FIGURE 6. MSMM worksheet 16

FIGURE 7. Survey Cross Sections to Determine Bank Full Width 17

FIGURE 8. Existing Crossing Elevations 20

TABLE 1. Ledger 24

LIST OF PHOTOGRAPHS

PHOTOGRAPH 1: Taken February 9, 2009. Looking west at upstream side of Sestak's Slab 46

PHOTOGRAPH 2: Taken July 16, 2009. Looking west at downstream side of Sestak's Slab 46

PHOTOGRAPH 3: Taken July 16, 2009. Looking downstream at Sestak's Slab 47

PHOTOGRAPH 4: Taken July 16, 2009. Looking upstream of Sestak's Slab 47

PHOTOGRAPH 5: Taken April 21, 2010. Looking upstream at Sestak's Slab 48

PHOTOGRAPH 6: Taken April 21, 2010. Marking field indicators of bankfull 48

APPENDICES

APPENDIX A: MOU with County 49

APPENDIX B: FWS Clearance Letter 57

APPENDIX C: Profile of Crossing 59

APPENDIX D: Determining Bankfull Width 63

I. INTRODUCTION

The Missouri Department of Transportation (MoDOT) is proposing to construct a low profile span bridge in place of a low water crossing as compensatory mitigation for MoDOT construction projects with unavoidable and adverse environmental impacts to aquatic resources of the United States and where legal requirements apply to other natural resources, as these impacts result from public transportation projects constructed, inspected, or cost-shared by MoDOT. The proposed site is locally called Sestak Slab crossing the Maries River on County Road 521.

A. LOCATION

The bank site is located on the Maries River in Osage County, Missouri. The site is located in Section 24, T42N, R10W, Freeburg Quadrangle.

Latitude: 38.3697088888889
Longitude: -91.9859513888889

Directions to the site: From Jefferson City, take Route 50 east to Route 63 south. Just past Westphalia, take County Road 521 to the low water crossing (***Figure 1***).

This particular low water crossing was chosen because of its location within the Maries River watershed. MoDOT is planning for future mitigation needs in this watershed resulting from two projects. These include the construction of Route 50 east to County Road 604, and the proposed Route 63 improvements from the Osage River to Rolla. There are no other known locations of publicly owned low water crossings on the Maries River.

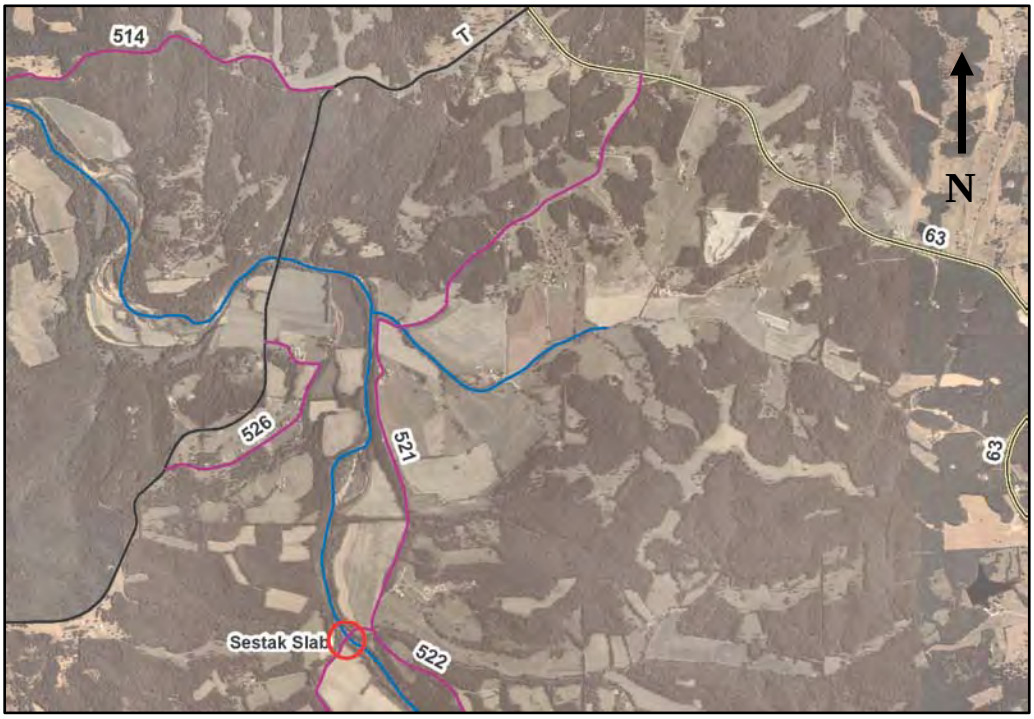


Figure 1: MoDOT Maries River Region Mitigation Bank, Osage County, Missouri, location map.

B. ESTABLISHMENT AND OPERATION OF THE BANK

MoDOT plans to establish and operate a stream mitigation bank by removing and replacing the existing low water crossing with a low profile span bridge on the Maries River.

The credits generated by the Bank shall be used as compensatory mitigation for unavoidable and adverse environmental impacts to aquatic resources of the United States and where legal requirements apply to other natural resources, as these impacts result from public transportation projects constructed, inspected, or cost-shared by MoDOT.

At the discretion of the US Army Corps of Engineers (USACE), all activities authorized by federal, state or local permits, including compensatory mitigation for unauthorized activities and non-compliance actions, will be eligible for the use of credits at the Bank. The number of credits required for such activities will be determined on a case-by-case basis.

C. OWNERSHIP OF THE LOW WATER CROSSING

MoDOT will enter into an agreement with the owner of the crossing, Osage County, which enables MoDOT to transfer the crossing into the State system for the period of construction, and then the structure is conveyed back to the County after construction. The County will agree to maintain the structure in its new state and must take into account aquatic organism passage and sediment transport in any modifications/maintenance of the structure.

D. QUALIFICATIONS OF SPONSOR (MODOT)

MoDOT has previously replaced four low water crossings on the Little Niangua River with pre-cast structures. The first three structures were finished in January 2009 and the fourth in September 2009. To date, these structures are in good condition and have been visually inspected annually and after major flow events.

Furthermore, the MoDOT Bridge Division is responsible for the structural design and detailed plans production for all state highway bridges, including cost estimates. Design includes preliminary investigation that begins with a detailed and complex study to determine the most suitable type of structure for a given location considering hydraulics, economy, site requirements and aesthetics. The finished product is a set of detailed design plans from which a contractor can construct the bridge. Inspection services are provided by the Bridge Division in fabrication shops around the nation to ensure steel and concrete girders and other materials meet specifications and that the bridges are safe for the motoring public. In addition, the Bridge Division analyzes bridges to determine their safe load-carrying capacities, and posts bridges with limited load capacity.

The division also reviews plans for the rehabilitation or replacement of locally owned bridges using federal bridge funds and administers a program for the inspection of locally owned bridges and a program to provide engineering assistance to counties and cities.

E. RESPONSIBILITY STATEMENT

Credits generated by the construction of this Bank are intended as compensation for MoDOT projects or MoDOT related projects with unavoidable stream impacts and are not likely to be sold to third parties. However, in the event that MoDOT should sell credit to a third party, MoDOT would assume legal responsibility for providing compensatory mitigation at the time the third party secures credits.

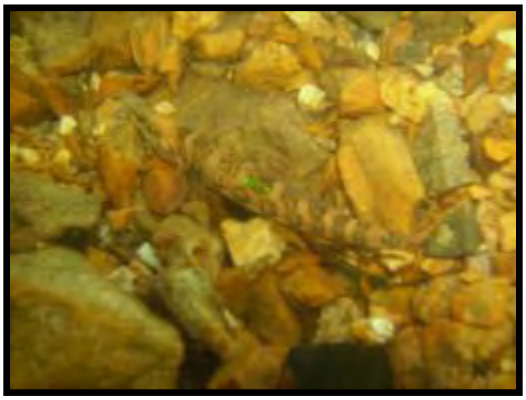
II. WATERSHED APPROACH TO MITIGATION BANK

A. WATERSHED BOUNDARY AND WATERSHED APPROACH

The Watershed Assessment and Inventory by the Missouri Department of Conservation (MDC), the 303d list, the Nonpoint Source Management Programs Annual Report to EPA, beneficial use data, stream team data and other information were used to assess losses, trends, water quality, needs and threats within the watershed.

i. Historic Losses and Current Trends in the Watershed

Niangua darter(Etheostoma nianguae)
There are 17 miles on the Maries River of stream known to be inhabited by the Niangua darter, *Etheostoma nianguae*, and Sestak Slab is located within this reach. Habitat requirements of the Niangua darter include streams characterized as medium sized, moderately clear upland creeks draining hilly topography, underlain by bedrock. Niangua darters are most often found in shallow pools or "runs" having slight to moderate current and clean, gravelly or rocky bottoms. Niangua darters are found in riffles when spawning occurs.



Deterioration of stream habitat by factors including reservoir construction, conversion of woodlands to pasture, increased sedimentation and nutrient enrichment have negatively influenced this species.

The design of Sestak Slab promotes impoundment upstream of the structure in addition to providing velocity barriers that inhibit the upstream migration of species. The flow velocity through the culverts and their elevation relative to the stream bed, prevents the Niangua darter, as well as other species of darters, from navigating through the pipes.

Improving this crossing should increase the quality of the habitat upstream and afford a viable pathway to the Niangua darter downstream that may currently be blocked from use. One of the most important anticipated long-term benefits includes reducing population and habitat fragmentation by removing the barrier. Currently, the distribution of the Niangua darter population in the Maries River is evenly split between the upstream

and downstream sides of the crossing.

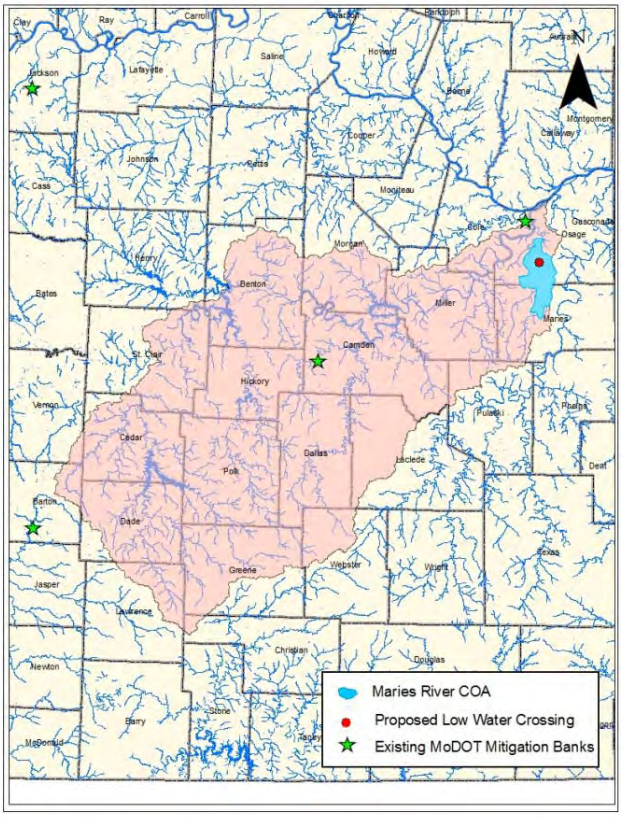
ii. Water Quality Issues in the Watershed

Water quality concerns within the Maries River watershed stem primarily from sediment and nutrient overload. One particular improvement when replacing low water crossings with open bottom spans is the ability of the system to "flush" itself during high water events, whereas with a typical low water crossing, the stream is less efficient at moving sediment/silt downstream.

The East Osage River Watershed Inventory and Assessment, compiled by MDC, lists sources of impairment include damming, riparian degradation, channel alteration, urbanization, flow alteration, sedimentation, low dissolved oxygen, point source pollution, and nonpoint source pollution.

iii. Needs of the Watershed

Currently, there is an ongoing AgNPS SALT project in the Lower Big Maries River administered by Missouri Department of Natural Resources (MDNR). The focus of the project incluedes establishing buffers, preventing soil erosion, and protecting stream banks. The project expires in 2011.



The Maries River watershed is a priority Conservation Opportunity Area (COA) watershed as designated by the MDC. This particular watershed is of increased concern due to the presence of the Niangua darter, which is recognized as both a federally listed threatened species, and state listed endangered species.

The Maries River has several stream use designations as classified by MDNR. Those designated beneficial uses include livestock and wildlife watering, protection of aquatic life and human health protection-fish consumption, whole body category A, cool water fishery, and secondary contact recreation. All classified waters have a rebuttable presumption of 'fishable and swimmable' according to the Clean Water Act, meaning the Missouri Department of Natural Resources protects these waters with the

use designation of at least livestock and wildlife watering, protection of aquatic life and human health protection-fish consumption, and whole body contact category B." In addition there are 298.5 miles of streams in the basin classified as supporting whole body contact. The Maries River (41.5 miles) is one of them. Sections 303(d) and 305(b) of the Clean Water Act (CWA) are a means for determining if beneficial uses are being attained. The Maries River is not listed in these sections of the CWA as impaired.

According to the East Osage River Watershed Inventory and Assessment, goals of the watershed include protecting and improving aquatic habitat conditions to meet the needs of native aquatic species. One of the problems and opportunities identified under this goal was habitat degradation affecting the Niangua darter. One way to counteract this habitat degradation is to identify, protect, and enhance Niangua darter habitat through purchases, easements, or other agreements. Another goal was to maintain the diversity and abundance of aquatic communities and improve the quality of the sport fishery. In the 2008 Niangua darter Monitoring Report by Doug Novinger (MDC), Jamie Decoske (MDC), John Calfee (MDC), it was stated that sites inhabited by Niangua darters have consistently had species richness values that were higher than sites where Niangua darters were absent. The disparity was greatest between occupied and unoccupied sites in Little Niangua and Maries rivers.

Therefore, it is expected that when the crossing is replaced, some aspects of those solutions may be achieved. If the reach upstream of the crossing improves as habitat for the Niangua darter, it is likely that the species richness will also increase.

iv. State of the Bank site

Sestak Slab is a low water crossing with an older second crossing paralleling the newer crossing. Sestak Slab and its adjacent crossing are good replacement candidates because there are strong numbers of Niangua darters downstream of the crossing, but none found in the stream segment directly upstream of the crossing.

The Maries River supports known populations of Niangua darter, a federally listed threatened species. The Niangua darter was assigned federal protection in 1985 under the Endangered Species Act (ESA) and the recovery plan was approved in July 1989. Recovery goals include reducing existing and potential threats to existing populations, documenting that population size is stable or increasing for an area, and establishing new populations in additional drainages.

The Missouri Department of Conservation annually monitors for the Niangua darter. A monitoring site has persisted on the Maries River (MAR050) and includes the 500 m reach downstream from Sestak. In 2009, the 300-500 m upstream reach upstream of Sestak was also surveyed in preparation for possible replacement of this crossing. Niangua darters were not found in the surveyed reach upstream of the crossing.

Sestak slab is a hinderance to fish movement because it is a jump, velocity and behavioral barrier segregating the upstream and downstream Niangua darter populations. Removal of this structure should enable darter populations to reconnect, thus increasing opportunity for genetic diversity and boosting population growth. Removal and replacement of the structure should also improve channel stability and sediment transport.

v. Threats Within the Watershed

The Maries River basin is primarily rural with animal agriculture as the primary land use. Nonpoint source pollution in the watershed comes from improper sand and gravel mining, animal agriculture, and construction.

Sediment and nutrients are repeatedly reported as the primary pollutants in the watershed. These come from overgrazed pastures and woodlands. Eroding stream banks are caused by accelerated runoff, lack of adequate vegetated riparian zones and livestock access to streams. Riparian corridors are often overgrazed and have little understory vegetation. Increased water velocities and volume result in bank erosion and instability into the uppermost reaches of the watershed.

In general, cattle numbers in this watershed are increasing and woodlands are being cleared and converted to pasture to support this. Crop ground is being converted to grass because pasture and hay requires less inputs and management time. New construction continues to grow, mostly along highways and roads.

The COA was assessed using information obtained from MoRAP's Human Threat Data Suite, based on a review of the relationship between reach specific watershed data and nonpoint pollution sources. There were three hazardous waste generators, one confined animal feeding operation (CAFO), and ten National Pollutant Discharge Elimination System **(**NPDES**)** permit sites within the designated COA. The majority of these are on the periphery of the watershed and the receiving streams are tributaries to the Maries River (***Figure 2***).

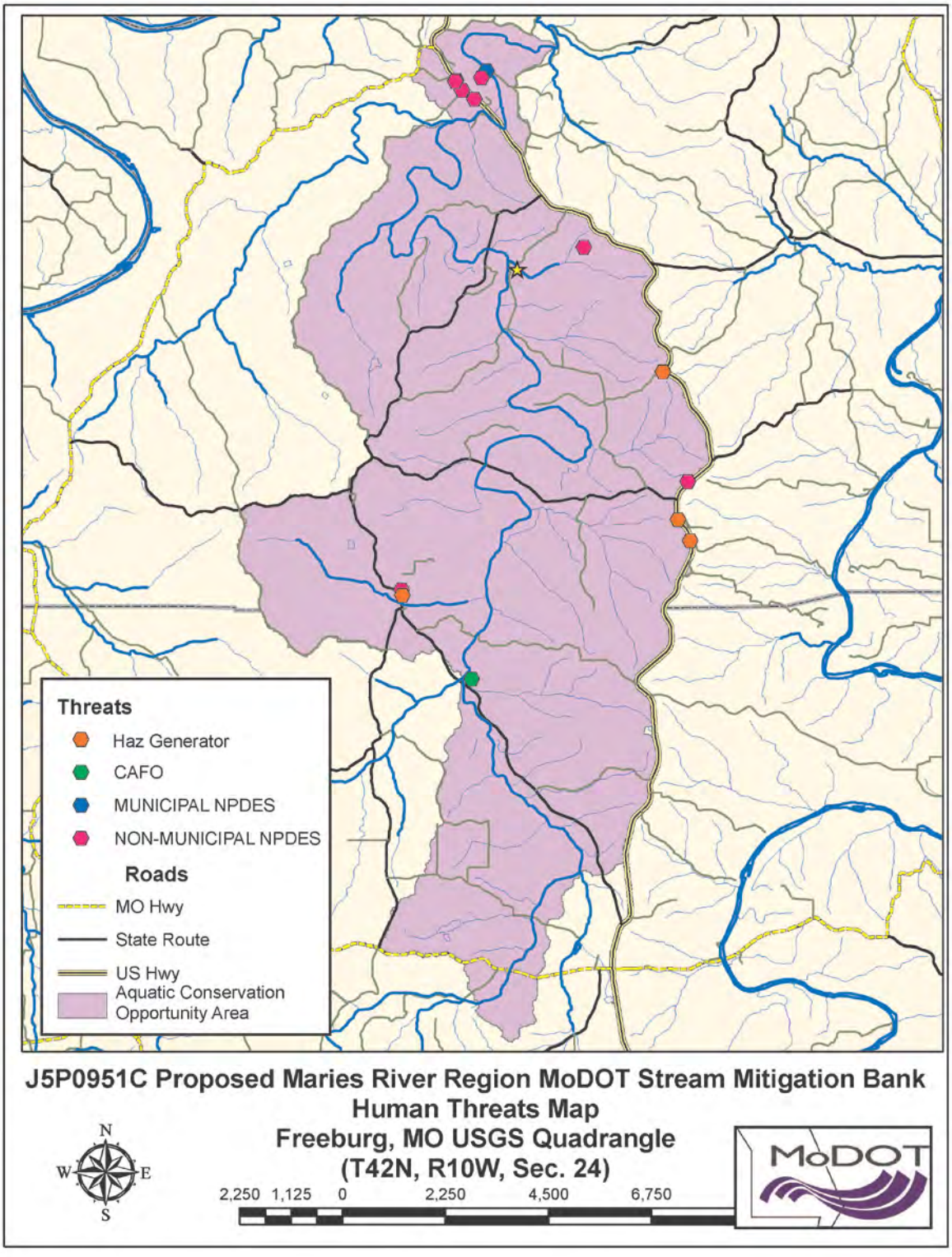


Figure 2: Human Threats within the Maries River watershed.

III. SERVICE AREA OF THE BANK

A. DEFINE THE SERVICE AREA

According to 33 CFR Part 332.8(d)(6)(ii)(A) and the Mitigation Banking Instrument Outline For Proposed Mitigation Banks Within the State of Missouri, the service area for a bank "should be appropriately sized to ensure that the aquatic resources provided will effectively compensate for adverse environmental impacts across the entire service area". Furthermore, the Corps District and the Interagency Review Team (IRT) have agreed that the Ecological Drainage Unit (EDU), as defined by the Missouri Resource Assessment Partnership (MoRAP), is the largest service area unit that will be considered for mitigation banks. MoDOT linear transportation projects typically involve numerous small impacts within several watersheds; therefore, the EDU will be the basis for MoDOT Bank service areas.

The goal of this Bank consists of providing compensatory mitigation for unavoidable impacts to streams within the Banks service area, Ozark/Osage EDU. The service area of the Bank consists of that portion of the Osage River Basin designated as Ozark/Osage EDU (Maries River, Tavern Creek, Saline Creek, Lake Ozark, Niangua River, Grand Auglaize Creek, Gravois Creek, Pomme de Terre River, Osage River, Sac River, Cedar Creek, Turnback Creek). These sub-basins were defined in MDC's Aquatic Gap Analysis Pilot Project. Bank credits will generally be authorized for use within the Osage/Ozark EDU, but may be authorized within the same Aquatic Subregion, on a case-by-case basis, as accepted by the USACE project manager. Also, increased mitigation ratios may result when the impact location is located outside the Bank's EDU or Aquatic Subregion.

B. MAP OF SERVICE AREA

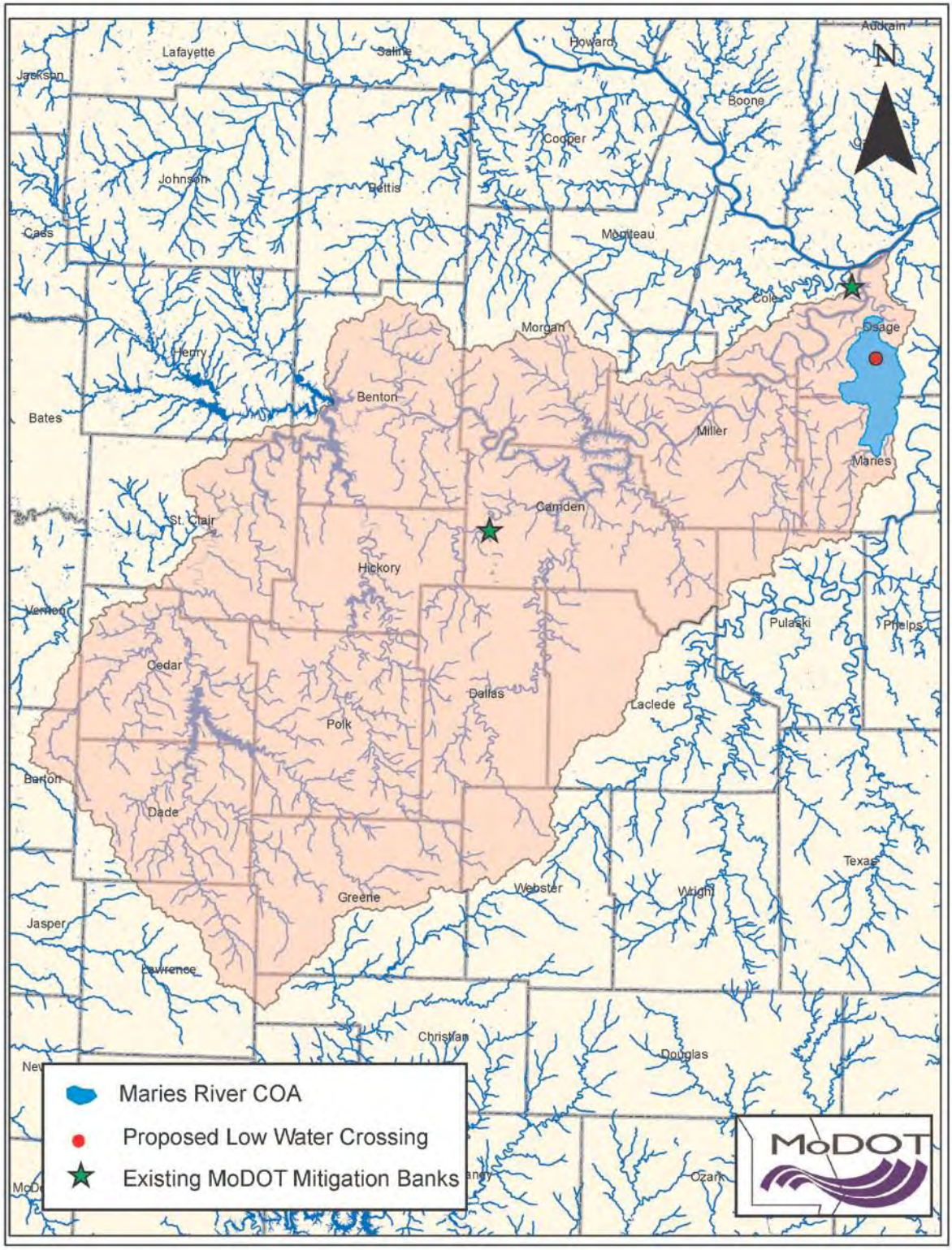


Figure 3. Maries River Region Service Area Boundary (Ozark/Osage EDU).

IV. MITIGATION PLAN REQUIREMENTS

A. OBJECTIVES OF THE BANK

The goal of this Bank is to restore stream function and habitat within the Maries River, where a low water crossing has impacted aquatic organism passage and sediment transport. The primary objective of this proposal is to mitigate for stream impacts resulting from MoDOT highway construction projects that are located within or near the proposed geographic service area boundary (Ozark/Osage EDU).

MoDOT plans to replace one low water crossing, Sestak's Slab (CR 521), on the Maries River in Osage County, Missouri. Improvements will involve removal of the entire crossing as well as the older upstream crossing, and installation of a multiple span structure similar to other structure improvements completed by MoDOT on the Little Niangua River.

Aquatic organism passage at this site will be significantly improved, with the expectation that habitat improvement will promote Niangua darter re-colonization directly upstream of the crossing.

B. SITE SELECTION

The site was selected for multiple reasons. Most importantly, the majority of future road construction projects for Route 50 east and Route 63 are located within the same watershed as the proposed bank site. The bank site is within a designated priority watershed, a subset of the conservation opportunity areas (as designated by MDC). The crossing is also in Niangua darter habitat, a federally threatened species. MoDOT has another stream mitigation bank, Little Niangua River Region Bank, within the same EDU, however, it is nearing closure and would not have enough credit balance available to cover future stream mitigation needs.

The existing crossing is 240-feet long and 20-feet wide. It has six 6-foot diameter metal pipes (2 of which are plugged by gravel). The adjacent structure upstream is a concrete slab with a section removed to allow for culvert flow (see ***Photograph 1***).

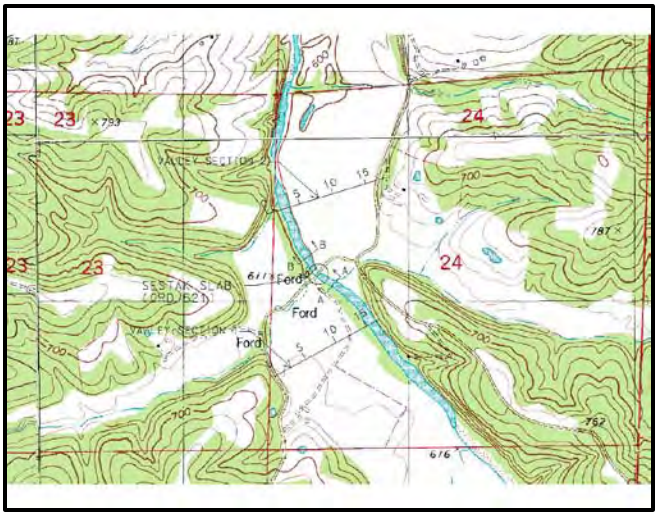
There are existing, privately owned, streambank stabilization project (with riparian buffer) located downstream and upstream of the crossing. The area downstream is enrolled in the Conservation Reserve Program (CRP) which is administered by the USDA Farm Service Agency (FSA).

C. SITE PROTECTION INSTRUMENT

Sestak Slab is owned and maintained by Osage County. MoDOT has coordinated with Osage County, and they are in agreement for MoDOT to replace this crossing. MoDOT and Osage County have developed an agreement similar to previous agreements that were executed with Camden County. The agreement covers maintenance of the structure and future modifications to the structure (***APPENDIX A***) The crossing will be transferred into the State road system for

replacement, bid through the normal MoDOT bidding process, constructed and inspected by MoDOT, then conveyed back to the County under terms of the agreement.

D. BASELINE INFORMATION



A survey has been completed for the existing crossing, consisting of upstream and downstream cross-sections and a streambed profile. A hydraulics study was also done at the site. Various other analyses have been done in an effort to determine what type of structure to build, including geotechnical work, borings, etc.

This reach is surveyed annually by MDC for Niangua darter populations, both upstream and downstream of the crossing. There are also Stream Team survey locations upstream and downstream of the crossing.

E. DETERMINATION OF CREDITS AND STRUCTURE LENGTH

Stream mitigation credit was calculated based on the site location meeting the parameters of a perennial stream greater than 50-feet in width, and due to the fact that it is located within a primary priority area (Missouri Stream Mitigation Method, MSMM) due to the presence of the Niangua darter. Additionally, it is located within an MDC priority COA.

To determine the number of credits generated from the proposed project, a survey elevation method was completed to find the length of stream "dammed" by the pooled effect of the crossing. This method was previously used on the Little Niangua River Region MoDOT Stream Mitigation Bank. This length was used as a value in the MSMM to determine the amount of credits that the project will generate.

MoDOT also surveyed downstream of the crossing at 3 separate cross sections to derive the proper "bankfull width" of the stream. This determined what width the stream channel opening should be; MoDOT is proposing to open up the channel to achieve a 100% opening, based on that bankfull width. This qualifies the project for the "excellent" restoration category within the MSMM.

<u>Survey Elevation Method:</u>
The MSMM was used to calculate the number of credits generated for replacement of the low water crossing on the Maries River. MoDOT conducted a survey of the river bottom both upstream and downstream of the structure, in order to estimate the stream length influenced by the low water crossing (***Figure 4***). Initial credit establishment was based on the previously approved protocol. It is as follows: An elevation was shot at the top deck of the low water crossing. A second elevation was shot on the upstream side of the crossing in the thalweg of the streambed. In-stream survey shots were then taken progressing upstream to determine the

elevation equivalent to the deck crossing. This determines the height of the upstream aggradation. The distance between these survey points was calculated as the length of upstream influence. The downstream credit was calculated by determining the distance to the downstream edge of the scour hole below the structure, and subsequently multiplying this distance by two. This sum of the upstream and downstream distances equals the length of influence, which is defined in the box labeled *Stream Length in Reach* in the Stream Mitigation Bank Credit Assessment Worksheet of the MSMM (***Figure 6***). The Net Benefit value in the worksheet was determined based on two factors, sediment transport and benefits to a federally threatened species (Niangua darter).

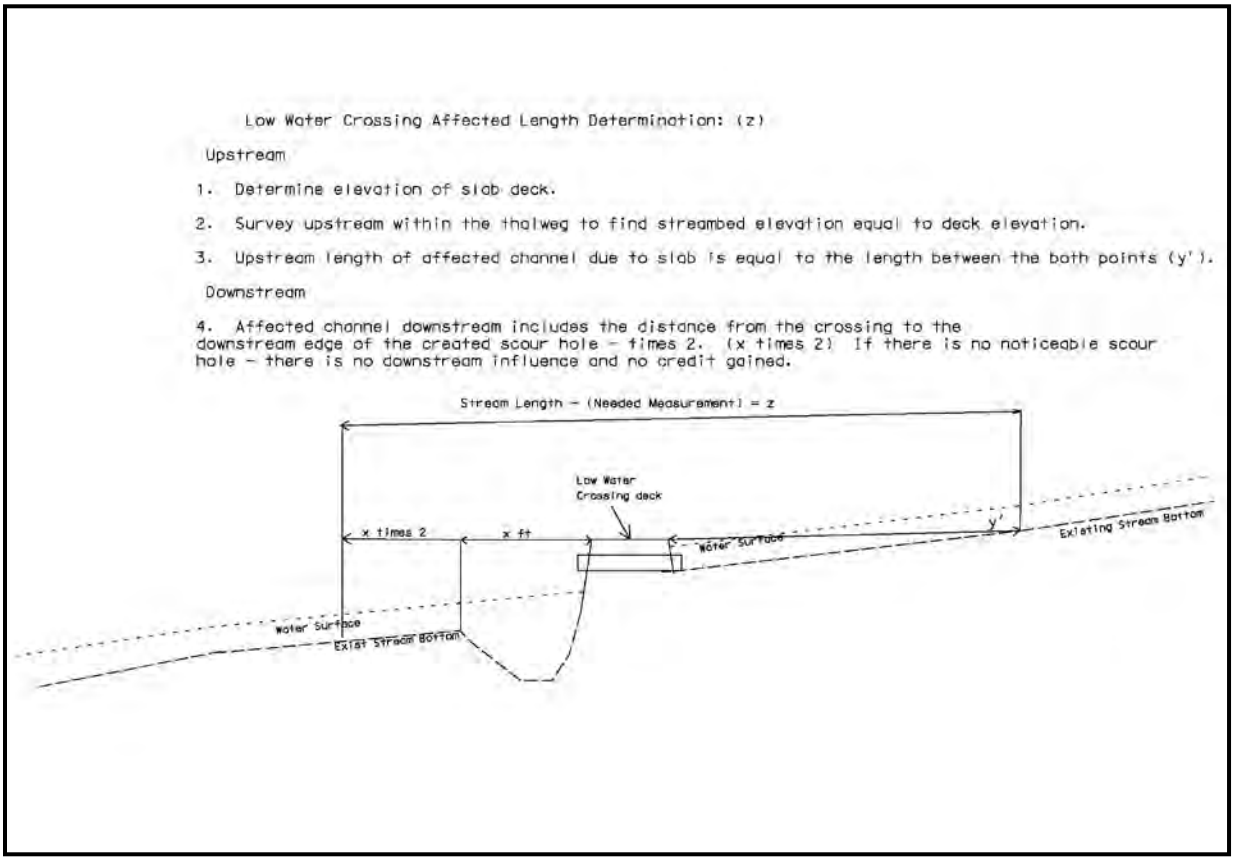


Figure 4: Survey Methodology to Determine Length of Crossing Influence.

A reach of approximately 7,000 linear feet upstream was recorded before meeting the target elevation at the top of the crossing, and 125 feet downstream was calculated for the downstream influence based on the size of the scour hole times two (***Figure 5***). The upstream elevation was achieved at a riffle, where an old ford once crossed the stream.

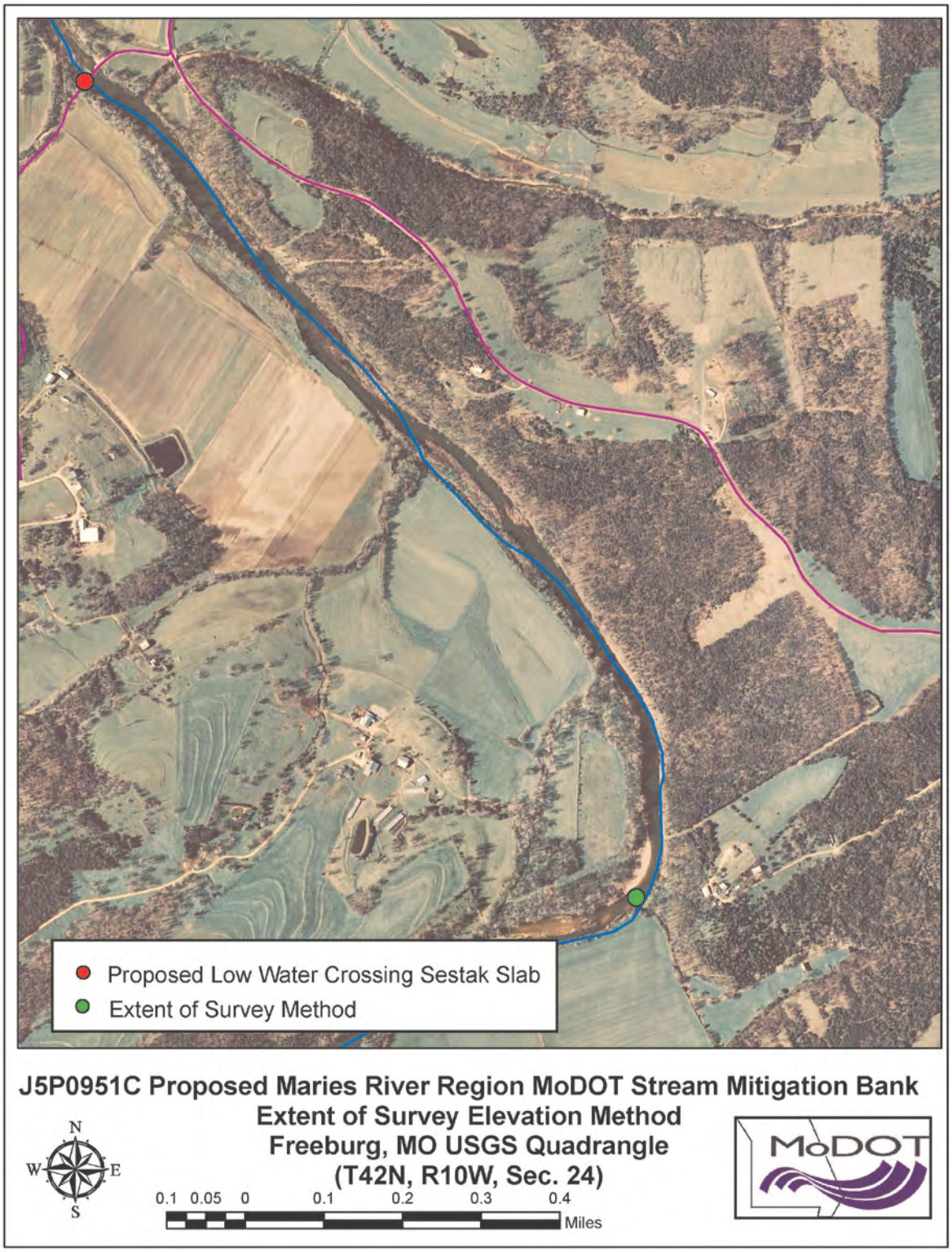


Figure 5: Elevation Survey Method to Determine Length of Crossing Influence (related to Figure 4).

Stream Mitigation Bank Credit Assessment Worksheet						
Stream Type	Ephemeral 0.01	Intermittent 0.6	Perennial			
			<15' 0.8	15'-30' 1.0	30'-50' 1.2	>50' 1.4
Priority Area	Tertiary 0.1	Secondary 0.4	Primary 0.8			
Net Benefit [Riparian (for each side of stream)]	Additional Improvements (select values from Table 1 times 1.2 multiplier)	Riparian Creation, Enhancement, Restoration, and Preservation Factors (slect values from Table 1) (MBW = Minimum Buffer Width = 25' + 2' / 1% slope)				
System Protection Credit	Condition: MBW restored or protected on both streambanks To calculate: (Net Benefit Stream Side A + Net Benefit Stream Side B) / 2					
Net Benefit (Stream)	Moderate 1.0	Good 2.0	Excellent 3.5			
Monitoring/Contingency (for each side of stream)	Level I 0.075	Level II 0.3	Level III 0.5			
Control/Site Protection	Corps approved site protection without third party grantee 0.075		Corps approved site protection with third party grantee, or transfer of title to a conservancy 0.3			

Factors		**Sestex-survey method**
Stream Type		1.4
Priority Area		0.8
Net Benefit	**Stream Side A**	0
	Stream Side B	0
System Protection Credit Condition Met (Buffer on both sides)		0
Net Benefit (Stream)		3.5
Monitoring/Contingency	**upstream**	0.3
	downstream	0.3
Control/Site Protection	**Stream Side A**	0
	Stream Side B	0
Sum Factors (M) =		6.3
Stream length in Reach (do not count each bank separately) (LF) =		7250
Credits (C) = M X LF		45,675
Total Credits Generated C X Mitigation Factor (MF) =		45,675

Total Riparian Restoration Credits Generated =	**45,675**	**credits**

Figure 6: MSMM Mitigation Credit Worksheet.

Bankfull (bkf) Width Survey Method

In order to qualify as an "excellent" project in the net benefit category of the MSMM, a 100% opening was to be achieved. Based on MDC guidance, 100% opening was determined to be equivalent to the true bankfull width of the stream. In order to determine the bankfull width, MDC's survey method was used ***(Appendix E)***. In summary, three stream cross-sections and multiple field indicators of bankfull were surveyed. These three widths were then averaged to determine the final bankfull width value. This width was also used to determine the actual bridge length designed. The average bankfull width was determined to be 169.4 feet (min 151.7 and max 187.0). The new crossing will consist of four 45-foot precast spans totaling 180 feet.

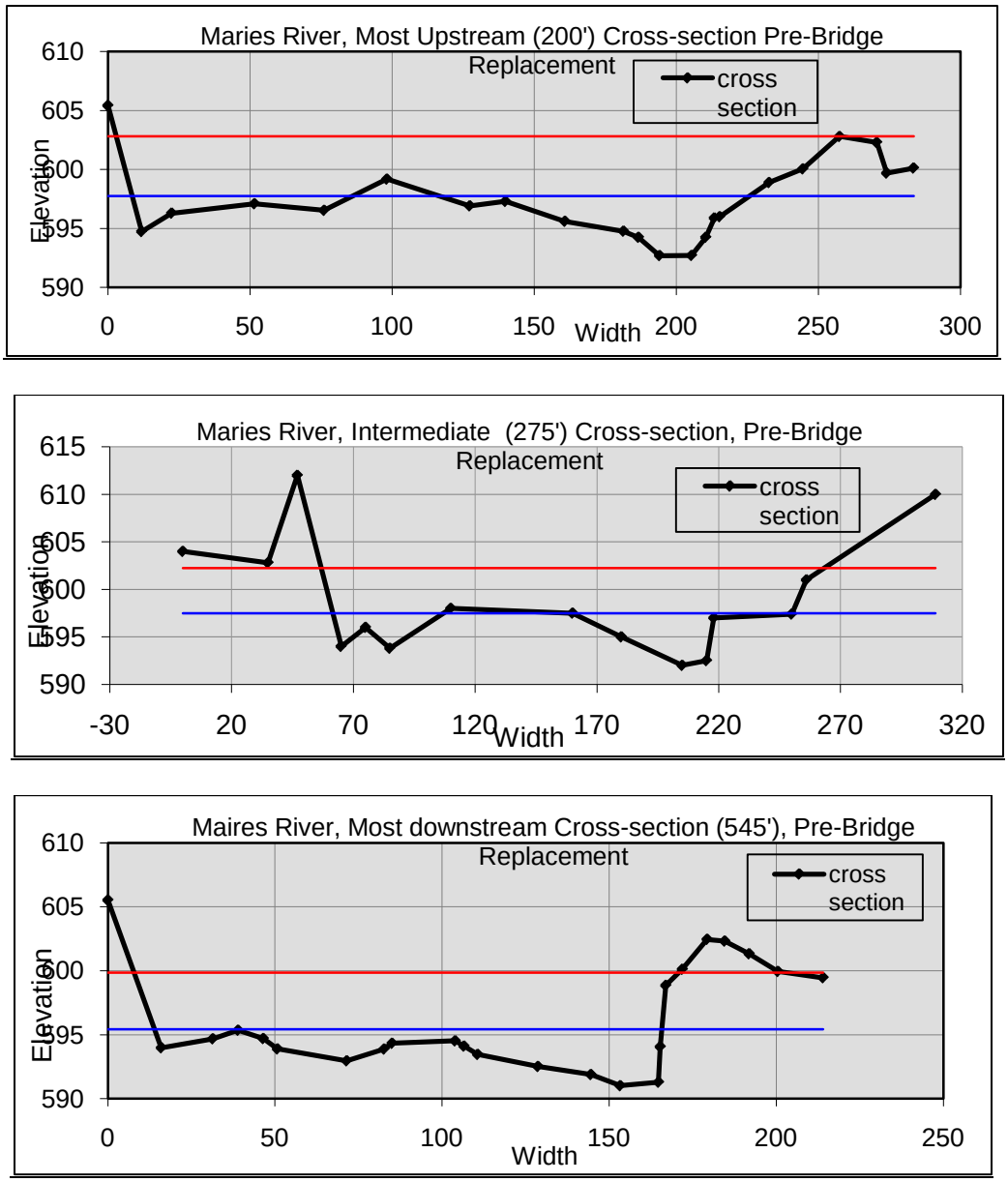


Figure 7: Survey Cross Sections to Determine Bank Full Width.

F. MITIGATION WORK PLAN

The geographic boundaries of the project encompass the crossing and approximately 30 feet of roadway on either side of the crossing. The staging area will be in one of the four quadrants adjacent to the corners of the structure. The staging area will likely be located where the parking area is (NE quadrant), but may also include the roadway on either side of the crossing, since the road will be closed to traffic. In-stream construction methods include using a cofferdam to de-water the area where the bents will be poured. The stream is typically routed through half the channel while the cofferdam occupies the other half.

A temporary crossing will be required for crane access, however it will not impound water and will allow the passage of normal flows. It is possible that a full crossing will not be constructed, but rather a work pad, depending on the crane reach or the need to access both sides. The temporary crossing/workpads will consist of clean rock fill with no more than 15% fines. All material will be removed when complete. The existing "ford" upstream of the crossing will likely be used as part of the temporary crossing and additional clean fill and pipes to maintain flows will be used on top of the "ford" to raise the equipment out of the stream flow. This temporary crossing, including the "ford" will be removed in their entirety.

A crane will be used to place the slabs/beams. It is anticipated that four 45-foot precast spans will be used to achieve 180-foot of opening. Clean rock will be placed around the wingwalls of the structure to protect from erosion. The aggregate material from the temporary crossing or workpads may be reused for this purpose. Also, the concrete/grouted rock from the existing structure may be applied as rock blanket protection as needed. All rebar will be cut flush, and concrete pieces will be broken up into smaller pieces. ***Figure 8*** (page 20) shows the pre-construction crossing elevations at the structure, and the 40-ft survey interval upstream and downstream of the structure. Below is a pictorial depiction of construction events involved in the proposed replacement activity.

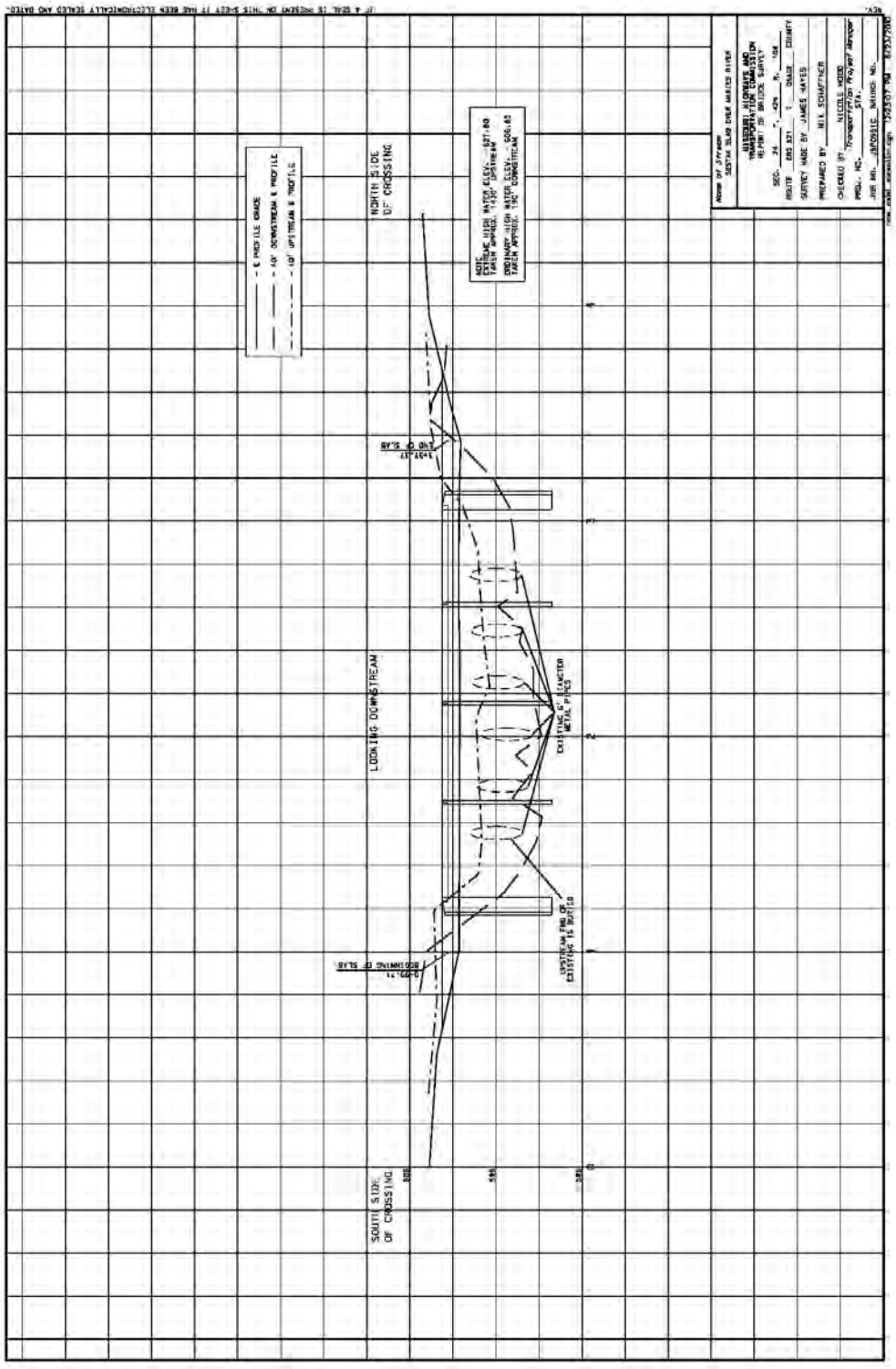


Figure 8: Existing crossing elevations; upstream and downstream.

G. OPERATION AND MAINTENANCE PLAN FOR THE BANK

Following construction Osage County shall continue with maintenance activities through and beyond closure of the Bank. MoDOT and the Osage County Commission have entered into an agreement (30 year) that releases MoDOT from all liability in regard to the crossing, as well as relinquishing responsibility to the county to conduct all future maintenance on the structure. A stipulation of the agreement requires the county to incorporate aquatic organism and sediment transport considerations into any subsequent design and construction whenever crossing repair or replacement is undertaken. An additional stipulation of the agreement is that the county shall, after flood events, visually inspect the improved crossing for scour and structure undermining. Additionally, they shall remove debris that may accumulate on the crossing center bents and abutments following these events.

MoDOT will monitor the structure and stream channel for any notable changes on a yearly basis for five years, and will include this information in the annual Bank Report.

H. ECOLOGICAL PERFORMANCE STANDARDS FOR THE BANK

Success will be measured by replacement of the crossing with a low profile span bridge crossing.

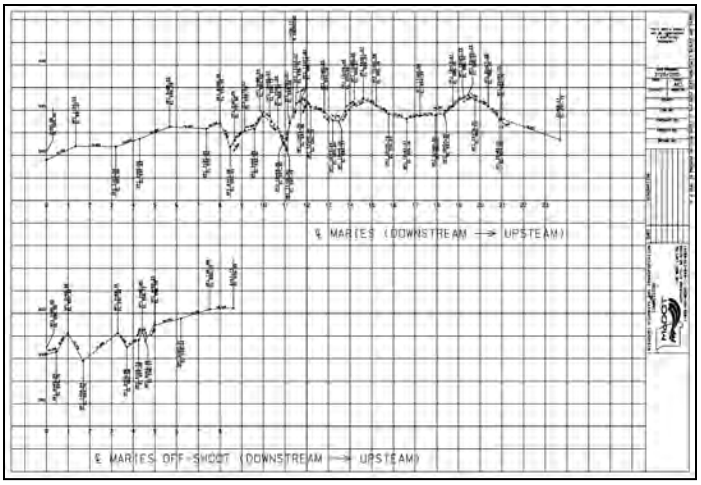
The following general criteria will be used to assess basic project success:

Initial Success: MoDOT will demonstrate that it has an agreement with Osage County to modify the low water crossing with a span structure. The agreement will allow Osage County to regularly perform maintenance activities on this structure, but will not allow them to modify the structure without integrating measures to accommodate for sediment transport and aquatic organism passage.

Final Success: Final success will be demonstrated once the structure replacement is completed. Corps approval of the as-built report will serve as the formal acknowledgement of final success.

I. MONITORING REQUIREMENTS

MoDOT will visually monitor the structural crossing and stream channel for any notable changes on a yearly basis for five years, and will include this information in the annual Bank Report. Physical monitoring will entail a survey of the streambed profile, as well as survey data for previously identified cross-sections of the stream, to determine sediment movement and streambed gradient changes. A summary of MDC's survey results for the Niangua darter will also be provided in the annual monitoring report. MDC has



surveyed the crossing upstream and downstream for darters in anticipation of the removal starting in 2009.

J. LONG-TERM MANAGEMENT PLAN

Long-term management will be provided by Osage County. The agreement contains language that requires Osage County to account for aquatic organism passage and sediment transport when modifying or replacing this structure in the future.

K. ADAPTIVE MANAGEMENT PLAN

Should the Chair USACE District, in consultation with the IRT, determine that remedial action is necessary because a Bank has failed to achieve the success criteria, MoDOT shall develop and implement remedial action plans in coordination with the Chair USACE District and the IRT. In the event MoDOT fails to implement necessary remedial actions at the Bank site within 90 calendar days or other time period determined by the Chair USACE District in consultation with the IRT, the Chair USACE District will notify MoDOT that debiting from the bank is suspended.

If the Chair USACE District determines that the Bank is operating at a deficit, MoDOT will be notified that debiting of credits from that Bank should immediately cease. The Chair USACE District, in consultation with the IRT and MoDOT, will determine what remedial actions are necessary to correct the situation.

L. FINANCIAL ASSURANCES

MoDOT will provide documentation that the project is on the State Transportation Improvement Plan (STIP), which is a 5-year list of project commitments. Once the project is advertised and awarded, MoDOT will provide documentation of the contract award information of the project to the USACE.

V. CREDIT RELEASE SCHEDULE

Upon submittal of all appropriate documentation by MoDOT and subsequent approval by the Chair USACE District, in consultation with the other members of the IRT, it is agreed that credits will become available for use by MoDOT in accordance with the following schedule:

1. Initially, 15 percent of total anticipated credits shall be available for debiting immediately after the IRT's approval of the Final Instrument, and, following MoDOT's proof that an executed MOU with Osage County has been completed. (**6,851 credits**)

2. An additional 25 percent of total anticipated credits shall be available for debiting immediately following removal of the low water crossing. (**11,418 credits**)

3. The remaining credits (60 percent) shall be made available for debiting after the low water crossing replacement is complete and the as-built report sent to the USACE. (**27,406 credits**)

VI. ACCOUNTING PROCEDURES

At the discretion of the USACE, all activities authorized by federal, state or local permits, including compensatory mitigation for unauthorized activities and non-compliance actions will be eligible for the use of credits at the Bank. The number of credits required for such activities will be determined on a case-by-case basis.

MoDOT will maintain a ledger for credit availability and debits for the Bank. The ledger will maintain a current credit balance for the Bank and will record the date and number of credits released, when the credit availability criteria are met, and also the date and number of credits debited when compensatory mitigation is required (***Table 1***). MoDOT shall submit an annual ledger showing all transactions for the Bank to the Chair USACE District for distribution to the IRT members.

Table 1. MoDOT Maries River Region Mitigation Bank Site Account Ledger.

MoDOT Mitigation Banking Ledger										
		Maries River Region								
Service Area		Ozark/Osage River EDU						45,675		
Chair Corps District		Kansas City District						Approved Stream Credits		
Mitigated Impact Information								Stream Mitigation		
Date of Permit	Permitting Corps District	CE Permit Number	Project or Action Description (Route and MoDOT project number for projects, Success criteria for credit release)	EDU	Aquatic Resource Type	Impact Size	Credits Needed	Credits Deposited	Credits Debited	Credits Remaining
* Credits Meeting Use Criteria									Date Approved	
1) 15 percent upon approval of the BDP (6,851)										
2) 25 percent upon removal of the structure (11,418)										
3) remaining credits release upon completion (27,406)										

Table 1: Sample Accounting Ledger.

VII. REPORTING FOR THE MITIGATION BANK SITE

MoDOT shall annually submit to the Chair USACE District a monitoring report describing the debits and credits for the Bank. Monitoring reports will be submitted each calendar year by December 31 for Bank, and will contain the following:

1. A US Geological Survey (USGS) map showing the location of the Bank;
2. A narrative summarizing the condition of the Bank and all regular maintenance activities;
3. Appropriate topographic maps (e.g., 1-2-foot contour intervals) showing location of cross section surveys, permanent photo points;
4. Results of qualitative fish, shellfish, and wildlife observations, as well as a summary from MDC annual Niangua darter monitoring report;
5. Ledger showing stream impacts debited from the Bank and the Bank's stream credit balances.
6. List of deficiencies identified for the Bank.

VIII. DEFAULT AND CLOSURE PROVISIONS

A. FORCE MAJEURE

MoDOT will not be responsible for complete or partial Bank failure that is attributed to natural catastrophes, such as flood, fire, wind, drought, disease, regional pest infestation, etc., which the USACE, in consultation with the IRT, determines is beyond the control of MoDOT to prevent or mitigate. However, if the bridge structure fails, as a result of a catastrophic natural event, the bridge must be replaced as outlined in the MODOT and Osage County Bridge Maintenance Agreement.

B. DISPUTE RESOLUTION

Resolution of disputes about the application of this Banking Instrument shall be in accordance with those stated in 33 CFR Part 332.8(e). The USACE has the responsibility of making final decisions regarding the Bank when consensus cannot be reached between IRT members and/or MoDOT.

C. VALIDITY, MODIFICATION, AND TERMINATION OF THE BANKING INSTRUMENT

This Banking Instrument will become valid on the date of the last signatory's signature. This Banking Instrument may be amended or modified with the written approval of all signatory parties as outlined in 33 CFR Part 332.8(g).

If the Corps determines that the mitigation bank is not meeting performance standards or complying with the terms of the instrument, appropriate action will be taken. Such actions may include, but are not limited to, suspending credit sales, adaptive management, decreasing available credits, utilizing financial assurances, and/or terminating the instrument.

Bank closure will occur when the terms and conditions of the Instrument have been determined by the Chair USACE District, in consultation with the IRT, to be fully satisfied or until all credits

have been debited, whichever is later.

IX. ENVIRONMENTAL DOCUMENTATION

A. NEPA

This project falls under a programmatic CE #17 (bridge rehabilitation, reconstruction or replacement. Must be on essentially the same alignment with no more than three acres of additional right-of-way acquired) and was approved 6/22/2010.

B. SHPO

This project qualified under MoDOT's Missouri Programmatic Agreement for Minor Highway Projects and the clearance date for SHPO was dated June 4, 2010. Minor highway projects are defined as activities funded by the Federal Aid Highway Program (FAHP), that qualify as Categorical Exclusions under the NEPA, as defined in 23 CFR 771, that do not individually or cumulatively have a significant impact on the environment, and therefore do not require the preparation of an environmental document. Since the existing slab would not be considered an eligible resource and there will be no impacts outside of the existing row, there was virtually no potential for adverse effects to significant cultural resources.

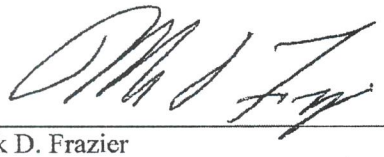
C. FWS

MoDOT received clearance from FWS by email on June 24, 2010. See **Appendix B**.

X. SIGNATURES

Banking Development Plan Lead USACE District

IRT Chair



Mark D. Frazier
Chief, Regulatory Branch
U.S. Army Corps of Engineers, Kansas City District

April 25, 2011
Date

IRT Concurrence

G. Ward Lenz

Ward Lenz
State Program Manager
U.S. Army Corps of Engineers, Kansas City District

18/Apr/2011
Date

IRT Concurrence

Karen A. Flournoy
Acting Director, Water, Wetlands, and Pesticides Division
U.S. Environmental Protection Agency, Region VII

3-28-11
Date

IRT Concurrence

Charles M. Scott

04/04/2011

Charles Scott
Field Supervisor
U.S. Fish and Wildlife Service

Date

IRT Concurrence

Kevin W. Ward

Kevin Ward
Division Administrator, Missouri Division
Federal Highway Administration

3/15/11
Date

IRT Concurrence

Steven Jurden

for Leanne Tippett-Mosby
Director, Division of Environmental Quality
Missouri Department of Natural Resources

3/17/2011
Date

IRT Concurrence

Tim Ripperger
Deputy Director
Missouri Department of Conservation

3/23/11
Date

FOR MISSOURI DEPARTMENT OF TRANSPORTATION

MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION

By Roberta Broeker 3-29-11

Title Chief Financial Officer

ATTEST:

Secretary to the Commission

Approved as to Form:

Commission Counsel

Site Photos

Photograph 1: Taken 2/9/09. Looking west at upstream side of Sestak's Slab.

Photograph 2: Taken 7/16/09. Looking west at downstream side of Sestak's Slab.

Photograph 3: Taken 7/16/09. Looking downstream of Sestak's Slab.

Photograph 4: Taken 7/16/09. Looking upstream of Sestak's Slab.

Photograph 5: Taken April 21, 2010 looking upstream at the crossing.

Photograph 6: Taken April 21, 2010 at field indicator of bankfull width.

APPENDIX A

CCO Form:	DE10	Route 50
Approved:	01/99 (BDG)	Job No. J5P0951C
Revised:	10/06 (MRA)	Osage County
Modified:		County Agreement

MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION

COUNTY AGREEMENT

THIS AGREEMENT is entered into by the Missouri Highways and Transportation Commission (hereinafter, "Commission") and the County of Osage, Missouri (hereinafter, "County").

WITNESSETH:

WHEREAS, the Commission is required to mitigate the stream impacts from the Route 50 transportation project under Job No. J5P0951; and

WHEREAS, the County maintains a low water stream crossing (hereinafter, “crossings”) on County Road 521 over the Maries River; and

WHEREAS, the Commission will mitigate the stream impacts from the Route 50 transportation project by structurally modifying this crossing thus enhancing the Niangua Darter habitat; and

WHEREAS, the Commission and County realize the importance and need for this crossing to be structurally modified to facilitate fish passage and sediment transport.

NOW, THEREFORE, in consideration of the mutual covenants, promises and representations contained herein, the parties agree as follows:

(1) DESIGNATION OF IMPROVEMENT: The public improvement designated as Job No. J5P0951, in Osage County, shall consist of modifying the crossings over the Maries River to enhance the Niangua darter habitat.

(2) IMPROVEMENTS WITHIN COUNTY: The improvements within the County are located as follows:

The crossing is located over the Maries River at the Sestak Slab on County Road 521.

(3) LOCATION: The general location of the public improvement is shown on an attached sketch marked "Exhibit A" and made a part of this Agreement.

(4) PURPOSE: It is the intent of this Agreement that the Commission shall provide without cost to the County the design and construction of modifications to the crossing to facilitate fish passage and sediment transport while still allowing for the safe passage of vehicular traffic over the crossing.

(5) RIGHT-OF-WAY USE: The County grants the right to use the right-of-way of public roads at the crossing as necessary for construction of said public improvement.

(6) CLOSE AND VACATE: The County shall temporarily close and vacate all public roads and crossings, or parts thereof, which may be necessary to permit the construction of the project in

accordance with the detailed plans. When the Commission deems it necessary to close County Roads 521 permanently during construction, the County shall be advised in advance of the road closure.

(7) RIGHT-OF-WAY ACQUISITION: No acquisition of additional right-of-way is anticipated in connection with Job No. J5P0951C or contemplated by this Agreement.

(8) UTILITY RELOCATION: It is understood and agreed by the parties to this Agreement that no county-owned utility facilities will require relocation or adjustment in connection with these improvements; however, should utility facilities be discovered at any time during development or construction of this improvement, relocation or adjustment of the same will be done and performed under a supplemental agreement covering the subject, and in accordance with Commission policy then in effect on division of costs for adjustment of utility facilities.

(9) DRAINAGE: The Commission may use any existing storm and surface water drainage facilities now in existence in the area. The County shall be responsible for receiving and disposing of storm and surface water discharged from those drainage facilities which the Commission constructs within the limits of highway right-of-way to the extent of the County's authority and control of the storm sewer facilities or natural drainage involved.

(10) PERMITS: The Commission shall secure any necessary approvals or permits from the Surface Transportation Board, the Public Service Commission of Missouri, or any other state or federal regulating authority required to permit the construction and maintenance of the crossing.

(11) COMMENCEMENT OF WORK: The Commission shall perform the work in accordance with final detailed plans approved by the FHWA (or as they may be changed from time to time by the Commission with the approval of the FHWA) at such time as federal and state funds are allocated to the public improvement in an amount sufficient to pay for the federal and state government's proportionate share of construction costs. The obligation of the Commission toward the actual construction of the public improvement shall be contingent upon the timely completion of plans to allow for the obligation of federal funds for such construction, upon approval of the plans by the FHWA, upon the award by the Commission of the contract for the construction, and upon the approval of the award by the FHWA.

(12) MAINTENANCE: Effective upon completion of construction, the Commission shall transfer ownership to the County, and the County will accept the portion of the existing public road and crossing that was affected by this improvement.

(13) ACCEPTED WITHIN HIGHWAY SYSTEM: Effective upon initializing construction of this improvement, the Commission accepts the portion of the County road system at the crossing described in this Agreement as part of the State Highway System for the purposes of this project. However, during the construction period contemplated in this Agreement:

(A) The Commission will assume no police or traffic control functions not obligatory upon Commission immediately prior to the execution of this Agreement**;** and

(B) The County shall perform or cause to be performed emergency maintenance on the project site.

(14) COUNTY TO MAINTAIN: Upon completion of construction of this improvement, the County shall accept control and maintenance of the improved crossing and shall thereafter keep, control, and maintain the same as, and for all purposes, a part of the County system at its own cost and expense

and at no cost and expense whatsoever to the Commission. All obligations of the Commission under this Agreement shall cease upon completion of this improvement. After the modifications to the crossing are constructed pursuant to this Agreement:

(A) The County shall incorporate aquatic organism and sediment transport considerations into subsequent design and construction whenever the crossing is to be repaired or replaced**;** and

(B) The County shall allow the Missouri Department of Conservation to conduct stream morphology and fish surveys to document the effects of the crossing modifications.

(C) The County shall, after flood events, visually inspect the improved crossing for scour and structure undermining and remove debris that may accumulate on the crossing center bents and abutments.

(D) The County shall only use appropriate size shot rock (and not concrete or grouted rock) on the improved crossing to fill scour voids and/or areas needing additional protection from erosion.

(15) POLICE POWERS: It is the intent of the parties to this Agreement that the County shall retain its police powers with respect to the regulation of traffic upon the improvement contemplated. However, the County will enact, keep in force, and enforce only such regulations relating to traffic movement and parking restrictions as may be approved by the Commission and as are not in conflict with any regulations for federal aid. The Commission shall not arbitrarily withhold approval of reasonable traffic regulations, signs, and markings which will permit the movement of traffic in accordance with accepted traffic regulation practices.

(16) WITHHOLDING OF FUNDS: In the event that the County fails, neglects, or refuses to enact, keep in force or enforce regulations specified or enacts regulations contrary to the provisions in this Agreement, or in any other manner fails, neglects or refuses to perform any of the obligations assumed by it under this Agreement, the Commission may, after serving written request upon the County for compliance and the County's failure to comply, withhold the expenditure of further funds for improvement and construction of the crossing in the County.

(17) FEDERAL HIGHWAY ADMINISTRATION: This Agreement is entered into subject to approval by the Federal Highway Administration, and is further subject to the availability of federal and state funds for this construction.

(18) INDEMNIFICATION: To the extent allowed by law, the County shall defend, indemnify and hold harmless the Commission, including its members and department employees, from any claim or liability whether based on a claim for damages to real or personal property or to a person for any matter relating to or arising out of the County's performance of its obligations under this Agreement.

(19) AMENDMENTS: Any change in this Agreement, whether by modification or supplementation, must be accomplished by a formal contract amendment signed and approved on or between the duly authorized representatives of the County and Commission.

(20) COMMISSION REPRESENTATIVE: The Commission's District Engineer is designated as the Commission's representative for the purpose of administering the provisions of this Agreement. The Commission's representative may designate by written notice other persons having the

authority to act on behalf of the Commission in furtherance of the performance of this Agreement.

(21) COUNTY REPRESENTATIVE: The County's Presiding Commissioner is designated as the County's representative for the purpose of administering the provisions of this Agreement. The County's representative may designate by written notice other persons having the authority to act on behalf of the County in furtherance of the performance of this Agreement.

(22) NOTICES: Any notice or other communication required or permitted to be given hereunder shall be in writing and shall be deemed given three (3) days after delivery by United States mail, regular mail postage prepaid, or upon receipt by personal or facsimile delivery, addressed as follows:

(A) To the County:

The Honorable Russell Scheulen
Presiding Commissioner
Osage County Courthouse
P.O. Box 826
Linn, Missouri 65051
Facsimile No.: (573) 897-4741

(B) To the Commission:

Mr. Roger Schwartze, P.E.
District Engineer
Missouri Department of Transportation
1511 Missouri Boulevard, P.O. Box 718
Jefferson City, Missouri 65102
Facsimile No.: (573) 751-8267

or to such other place as the parties may designate in accordance with this Agreement. To be valid, facsimile delivery shall be followed by delivery of the original document, or a clear and legible copy thereof, within three (3) business days of the date of facsimile transmission of that document.

(23) ASSIGNMENT: The County shall not assign, transfer or delegate any interest in this Agreement without the prior written consent of the Commission.

(24) VENUE: It is agreed by the parties that any action at law, suit in equity, or other judicial proceeding to enforce or construe this Agreement, or regarding its alleged breach, shall be instituted only in the Circuit Court of Cole County, Missouri.

(25) LAW OF MISSOURI TO GOVERN: This Agreement shall be construed according to the laws of the State of Missouri. The County shall comply with all local, state and federal laws and regulations relating to the performance of the contract.

(26) SOLE BENEFICIARY: This Agreement is made for the sole benefit of the parties hereto and nothing in this Agreement shall be construed to give any rights or benefits to anyone other than the Commission and the County.

(27) AUTHORITY TO EXECUTE: The signers of this Agreement warrant that they are acting officially and properly on behalf of their respective institutions and have been duly authorized, directed and empowered to execute this Agreement.

(28) SECTION HEADINGS: All section headings contained in this Agreement are for the convenience of reference only and are not intended to define or limit the scope of any provision of this Agreement.

IN WITNESS WHEREOF, the parties have entered into this Agreement on the date last written below.

Executed by the County this 22nd day of June, 2010.

Executed by the Commission this 25th day of June, 2010.

MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION

By _____

Title Chief Financial Officer

ATTEST:

_____
Secretary to the Commission

APPROVED AS TO FORM:

_____
Commission Counsel

OSAGE COUNTY, MISSOURI

By _____

Title: Presiding Commissioner

By _____

Title: First District Commissioner

By _____

Title: Second District Commissioner

ATTEST:

By _____

Title _____

APPROVED AS TO FORM:

By _____

Title _____

APPENDIX B

Section 7 for Sestak Slab

Rick_Hansen to alan.leary 06/23/2010 12:40 PM

Cc: craig.fuller, doyle.brown, Charlie_Scott, melissa.scheperle

Alan:

This is in reference to your letter dated June 18, 2010, concerning the replacement of Sestak Slab and replacing it with a precast span bridge across the Maries RIver in Section 24, T42N, R10W, Osage County, Missouri. I have been involved in the planning process as a member of the Interagency Review Team. The proposed project is within the range of the federally threatened Niangua darter (Etheostoma nianguae)

The proposal will remove the existing low water crossing and 30-foot of roadway approach. The concrete ford upstream of the crossing will also be removed but used as a temporay crossing during construction.The low water crossing will be replaced with precast spans. It is anticipated ta four 45-foot spans will be used to achieve a 180-foot opening. Temporary impacts to the Niangua darter will be limited to a temporary equipment corssing or workpad at the site. Culverts will be put in under the temporary crossing to maintain flow and allow for aquatic organism passage. The temporary crossing will be removed and streams banks restored to previous condition when the project is completed. Construction will take place outside of the Niangua darter's spawning season (March 15-June 15).

Based on the above information, I concur with your may affect but is not likely to adversely affect the Niangua darter.

If you have any questions, please call me at the address below.

Rick L. Hansen
U.S. Fish and Wildlife Service
Ecological Services
101 Park DeVille Drive, Suite A
Columbia, Missouri 65203
573-234-2132, ext. 106
fax 573-234-2181
rick_hansen@fws.gov

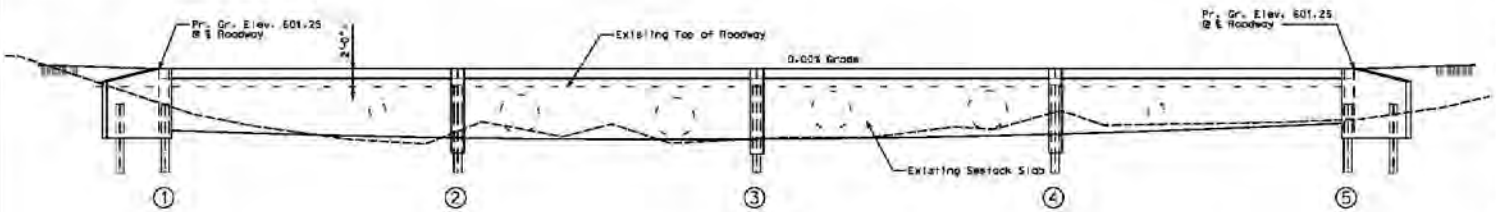
APPENDIX C

SEC/SUR 24 TWP 42N RGE 10W

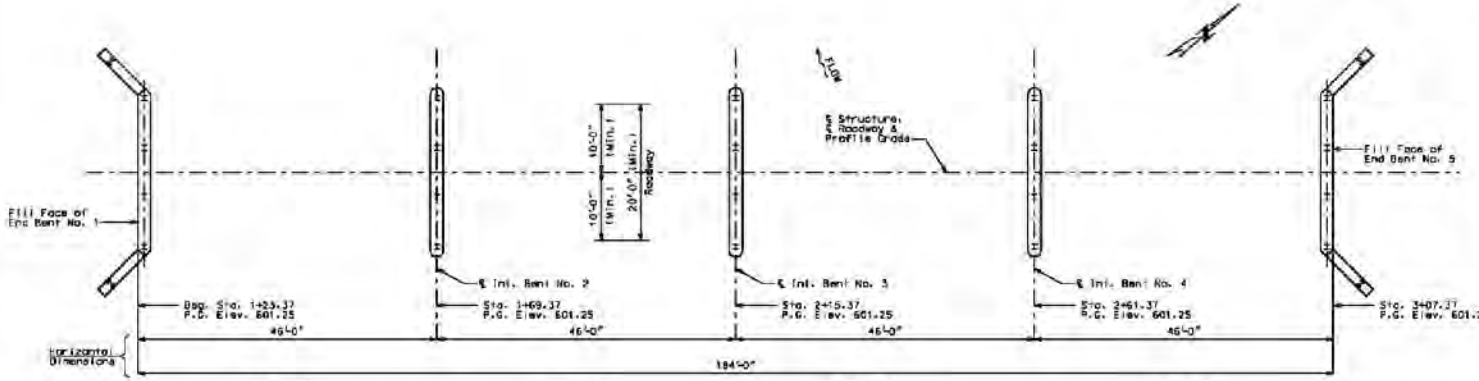
MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION

(4 @ 46') Simple Reinforced Concrete Slab Beam Spans

PRELIMINARY 05/11/10
FOR INFORMATION ONLY
NOT FOR CONSTRUCTION



ELEVATION



PLAN

S.M. M-09 ELEV. 903.18. - BENT SPIKE IN SOUTH ROOT OF 24" TRIPLE SYCAMORE, 13' EAST OF EAST END OF SLAB, 52' NORTH OF E COUNTY RD 521

BRIDGE OVER MARIES RIVER

COUNTY ROAD 521

ABOUT

STA.

Designed 2010
Detailed 2010
Checked 2010

Note: This drawing is not to scale. Follow dimensions.

Sheet No. 1 of XX

STD. 708-35

B_A7889_001_JSP095°C_FrontLdgn 12/23/24 PW 5/13/2010

"THIS MEDIA SHOULD NOT BE CONSIDERED A CERTIFIED DOCUMENT."

DATE PREPARED 5/13/2010
DIST 50 STATE MO
DISTRICT BR SHEET NO. 1
COUNTY OSAGE
JOB NO. JSP095°C
CONTRACT NO.
PROJECT NO.
BRIDGE NO. A7889

DESCRIPTION | DATE

MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION
105 WEST CAPITOL
JEFFERSON CITY, MO 65102
1-888-ASK-MODOT (1-888-275-6636)

IF A SEAL IS PRESENT ON THIS SHEET IT WAS DIGITALLY SEALED AND DATED.

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APPENDIX D

Determining Bankfull Width for Use in the Missouri Stream Mitigation Method for Crossing Replacements

Prepared by the Missouri Department of Conservation Stream Unit

The Missouri Stream Mitigation Method requires stream crossing replacements to have bankfull (bkf) width openings in order to restore more natural channel dimensions and to receive a Net Benefit of Excellent for mitigation credit. Many existing stream crossings have insufficiently sized or blocked culverts/boxes. This reduces or eliminates longitudinal connectivity of the stream system both geomorphically and ecologically.

These structures can impact stream channels both up and downstream of the crossing by inhibiting the channels natural ability to transport sediment. Channel widening and bank erosion can be caused by aggradation upstream of the structure. Downstream of the structure, water can drop from the ford deck or elevated culverts to the channel bed below, which can cause channel bed scour immediately downstream of the structure. Insufficient channel openings through these structures also hinder aquatic organism passage because they can pose jump, velocity, exhaustion, depth and behavioral barriers.

Because field identification of bkf elevations are difficult to correctly and consistently identify in Missouri, multiple approaches are necessary to determine appropriate bkf widths for replacement crossing openings. The following techniques yield a narrow range of bkf elevations from which a width can be identified in vertically stable streams. Streams that are not vertically stable may require alternate methods.

Field measurements for this procedure need to be taken downstream of the existing crossing, starting at a distance of at least twice the length of the crossing's downstream scour hole and upstream of any significant tributaries. This assures that reference channel dimensions are more natural because they are not being influenced by potential impounding effects occurring upstream of the crossing, or scour effects immediately downstream; yet are still representative of discharge potentials for that site. It is also important to attempt to locate the field measurements areas away from human disturbance as much as possible (i.e., levees, gravel mining areas, bank stabilization areas, trampled or modified channel or banks).

1. Survey Cross Transects:

Select three downstream cross section sites that appear to have variable channel widths, attempt to avoid cross sections that have secondary channels. At least one of the cross sections should be across a riffle. All cross sections should extend over the high bank areas on both sides of the river and need to include enough data points on the streambanks and point bars to allow detection of subtle slope breaks when graphing the data. A water surface elevation point (or water's edge) should be included as well.

2. Flag Bankfull Field Indicators:

Field indications of bkf include: presence of a floodplain at the elevation of incipient flooding; elevation associated with the top of the highest active depositional features (e.g. point bars and central bars); a break in slope and/or change in the depositional particle size distribution on the bank (finer material is associated with deposition by overland flow rather than deposition of

coarser material within the active channel); defined benches inside of incised rivers; exposed root hairs below an intact soil layer (indicating exposure to frequent erosive flow) (Rosgen 2006). For further training see Guide to Identification of Bankfull Stage in the Northeastern United States (USDA 2005). After locating the cross section transects, flag bkf field indicators along the streambanks downstream of the crossing and extending to the most downstream cross transect. Be sure to identify bkf field indicator points along the cross transects. A minimum of 6 bkf field indicators should be identified.

3. Survey Longitudinal Profile:
Traverse downstream from the bridge and collect bkf field indicator flag elevations, adjacent water surface elevations, and horizontal station distances. Capture and note data points where this profile intersects the cross section survey lines.

4. Analyze the Data:
Data from the survey can be entered into Reference Reach Survey spreadsheets produced by Dan Mecklenburg at Ohio DNR (http://ohiodnr.com/?TabId=9188) or any software that can yield the following analysis. Once survey data have been entered to spreadsheets, generate cross section and longitudinal profile graphs.

Once the water surface points have been plotted on the longitudinal profile graph, fit a linear trend line to these points to calculate a slope for the stream reach. (Most spreadsheets can automatically calculate this.) To find the slope, calculate the equation of the line; the formula is $y = m(x) + b$, where m is the slope of the line and b is the y-intercept. The water surface points on the longitudinal profile graph provide a frame of reference when comparing the bkf field indicator points with the bkf estimated points (which will be added later); it also provides an indicator of vertical streambed instability if the lines slope towards or away from each other considerably. The same process used for water surface points can now be done with the bkf field indicator points.

The final longitudinal profile will contain 3 plots: water surface points, bkf field indicator points, and bkf estimated points. The water surface points and bkf field indicator points were collected during the field survey. In contrast, the bkf estimated points will be determined from the plotted cross section transects. The process for determining the bkf estimated points is detailed in the following paragraph.

Examine the cross section graphs for distinct breaks in slope that precede flatter floodplain or depositional areas within a range of plausible bkf elevations (i.e. between the lowest point bar and the top of the streambank). Typically, bkf clues will be much more distinct on one transect than the others, but elevations should be within a reasonable range of each other. Locate the elevation of the bkf line for that transect and determine what the bkf discharge would be at that elevation ($Q = VxA$) by assuming a Manning's N value (i.e., .041) and computing a slope from the water surface elevations of the longitudinal profile.

After the discharge has been determined, enter that for the other two cross transects. The estimated bkf lines will now be computed at that discharge and plotted on the cross transect graphs. These lines will be called the estimated bkf elevations. Plot these elevations on the

longitudinal profile, fit a linear trend line, and compare the difference in elevation and slopes between this estimated bkf line and the bkf field indicator line. Although these lines will not always match, this gives a good indication of the potential range of bkf elevations (in vertically stable channels).

If there is more than three feet of elevation difference anywhere between the bkf field indicator line and the bkf estimated line, or if the slopes of these two lines are not going in the same direction (positive vs. negative), data will need to be re-examined. Delete the most variable outliers of the bkf field indicator points and compare the slope lines again. If there is still more than three feet of difference between the bkf field line and the estimated line, return to the cross section transect graphs and look for another bkf elevation slope break that will make the elevation difference between the two lines closer. Repeat the previously mentioned steps to determine discharge. Make all three cross transects reflect the new discharge and re-plot the new estimated bkf line on the longitudinal profile graph. If the two lines are now less than 3ft of elevation apart, determine the width of the cross transect bkf lines computed from that bkf discharge and average them to determine an appropriate estimate of the minimum bkf width.

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