APPENDIX K-2

Ground-Truthing of Side Scan Sonar River Bed Substrate Classification Technical Report

Clarification Note for Central Alternative 1: Central Alternatives 1A and 1B as described in the DEIS/FEIS are physically the same alternative. The only difference between them is that Central Alternative 1A would include tolls on both the new I-69 bridge and on the US 41 bridge. Central Alternative 1B would only include tolls on the new I-69 bridge. Any reference in this document to Central Alternative 1 applies to both Central Alternative 1A and Central Alternative 1B.

This document was completed before the development of Central Alternative 1B Modified (Selected); therefore, the alternative is not included in the document. Applicable information regarding Central Alternative 1B Modified (Selected) is provided in the FEIS.

October 15, 2018

ORX 69

GROUND-TRUTHING OF SIDE SCAN SONAR RIVER BED SUBSTRATE CLASSIFICATION TECHNICAL REPORT

I-69 Ohio River Crossing Project

Evansville, IN and Henderson, KY

INDIANA DEPARTMENT OF TRANSPORTATION INDOT

KENTUCKY TRANSPORTATION CABINET

DEPARTMENT OF TRANSPORTATION UNITED STATES OF AMERICA

Ground-truthing of Side Scan Sonar River Bed Substrate Classification

I-69 Ohio River Crossing Project
Evansville, IN and Henderson, KY

Prepared by:
Stantec

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EXECUTIVE SUMMARY

This study was conducted to field verify substrate classification as determined by acoustic side scan sonar data in the Ohio River for the I-69 Ohio River Crossing (ORX) project in Evansville, IN and Henderson, KY. The study area was limited to proposed bridge crossings associated with the project alternatives.

Mainstream Commercial Divers, Inc. (MCDI) collected acoustic side scan sonar data in November 2017 for the purpose of:

- Mapping substrate types and evaluating the suitability of these substrates as mussel habitat within the West Alternatives 1 and 2, and Central Alternative 1 impact areas;
- Assessing the potential for impact of the project to threatened and endangered mussel species (INDOT and KYTC 2018); and
- Informing study plans for the formal mussel survey required for the Preferred Alternative.

The acoustic side scan sonar surveys were conducted between Ohio River miles 784.1 and 787.5 (~3.4 miles), extending from the mouth of the Green River to approximately 0.5 mile downstream of the existing US 41 bridges. In December 2017, ground-truthing of the collected acoustic data was performed to corroborate the substrate types related to each of the eight acoustic classes identified by MCDI. Both the acoustic data and the data gathered during ground-truthing can be used to assess the potential for suitable mussel habitat within the West and Central Alternatives' impact areas.

Ground-truthing of river substrate took place December 12–15, 2017 within the area 100 m (109 yd) upstream to 300 m (328 yd) downstream of the proposed bridge crossings. A chain-rigged Van Veen sediment sampler was used to collect river bed material. The Van Veen was deployed using a davit and motorized winch system mounted to a 24-ft V-hull Monarch boat. A total of 40 sampling locations were recorded across both the West Alternatives 1 and 2, and Central Alternative 1 study areas. The substrate sampling effort was weighted proportionally to the area of each acoustic class (i.e., stratified random sampling), such that more effort was placed on acoustic classes with larger areas. A minimum of two sample sites were assigned to each acoustic class. The field verification effort generally confirmed the desktop classifications proposed by MCDI, particularly the widespread presence of sand substrates within the acoustic survey area. Much of this substrate appears to be unstable shifting sand typical of dune waveforms. However, it impossible, at this time, to delineate the exact boundaries for stable versus unstable sand habitats. Freshwater mussels were only detected in acoustic class 7, which consists of cobble over an impermeable layer. Acoustic class 8 was initially classified by MCDI as bedrock, but could potentially be comprised of hardpan clay or boulder substrates. Acoustic class 2 was dominated by silt/clay substrates which sometimes support lentic mussel species, especially the endangered fat pocketbook (*Potamilus capax*). The remaining acoustic classes encompassed relatively small

discrete areas and were comprised of sand-dominant, but heterogeneous, substrates. Most of the classes within both corridor study areas appear capable of supporting freshwater mussels.

ABBREVIATIONS

Clean Water Act	CWA
Coarse Gravel	COGRV
Coarse Sand	COSND
Cobble	COB
Draft Environmental Impact Statement	DEIS
Endangered Species Act	ESA
Environmental Impact Statement	EIS
Environmental System Research Institute	ESRI
Federal Highway Administration	FHWA
Feet	ft
Fine Sand	FISND
Global Positioning System	GPS
Inch	in
Indiana Department of Natural Resources, Division of Nature Preserves	IDNR-NP
Indiana Department of Natural Resources, Division of Fish and Wildlife	IDNR-FW
Indiana Department of Transportation	INDOT
I-69 Ohio River Crossing	ORX
Kentucky Department of Fish and Wildlife Resources	KDFWR
Kentucky State Nature Preserves Commission	KSNPC
Kentucky Transportation Cabinet	KYTC
Mainstream Commercial Divers, Inc.	MCDI
Medium Gravel	MDGRV
Meters	m
Miles per Hour	mph
Millimeters	mm
National Oceanic and Atmospheric Administration	NOAA
National Environmental Policy Act	NEPA
Notice of Intent	NOI
Silt/Clay	SI/CL
U.S. Fish and Wildlife Service	USFWS
U.S. Geological Survey	USGS
Yard	yd

CHAPTER 1 – INTRODUCTION

1.1 PROPOSED PROJECT

The Federal Highway Administration (FHWA), Indiana Department of Transportation (INDOT), and Kentucky Transportation Cabinet (KYTC) issued a revised Notice of Intent (NOI) in the *Federal Register* on February 13, 2017 for the preparation of an Environmental Impact Statement (EIS) for the I-69 Ohio River Crossing (ORX) project in the Evansville, IN and Henderson, KY area, which is part of the National I-69 Corridor that extends between Mexico and Canada. An NOI was previously issued for the project on May 10, 2001. Under that NOI, a Draft Environmental Impact Statement (DEIS) was completed in 2004, but the project was subsequently suspended in 2005.

For the new DEIS that is being prepared for the I-69 ORX project, the project area extends from I-69 (formerly I-164) in Indiana on the south side of Evansville (i.e., northern terminus) across the Ohio River to I-69 (formerly Edward T. Breathitt Pennyrile Parkway) at the KY 425 interchange southeast of Henderson, KY (i.e., southern terminus) (Figure 1.1-1). The section of Edward T. Breathitt Pennyrile Parkway between KY 351 and KY 425 that was not re-designated as I-69, was recently re-designated as US 41. The western limit of the project area is parallel to and extends a maximum of about 2,000 feet west of US 41. The eastern limit of the project area extends about 1,500 feet to 3.4 miles east of US 41. Currently, I-69 does not cross the Ohio River and the only cross-river access between Evansville and Henderson is limited to US 41, which is classified as a principal arterial and does not meet interstate design standards.

One of the first steps in the EIS process for the I-69 ORX project was the scoping phase which included the analysis of the project's purpose and need. As a result of this analysis, the following project needs have been identified:

- Lack of National I-69 Corridor system linkage
- High cost of maintaining cross river mobility on existing facilities
- Unacceptable levels of service for cross-river traffic
- High-crash locations in the I-69/US 41 corridor

Based on these needs, the project's purpose includes the following:

- Provide cross-river system linkage and connectivity between I-69 in Indiana and I-69 in Kentucky that is compatible with the National I-69 Corridor
- Develop a solution to address long-term cross-river mobility
- Provide a cross-river connection that reduces traffic congestion and delay
- Improve safety for cross-river traffic

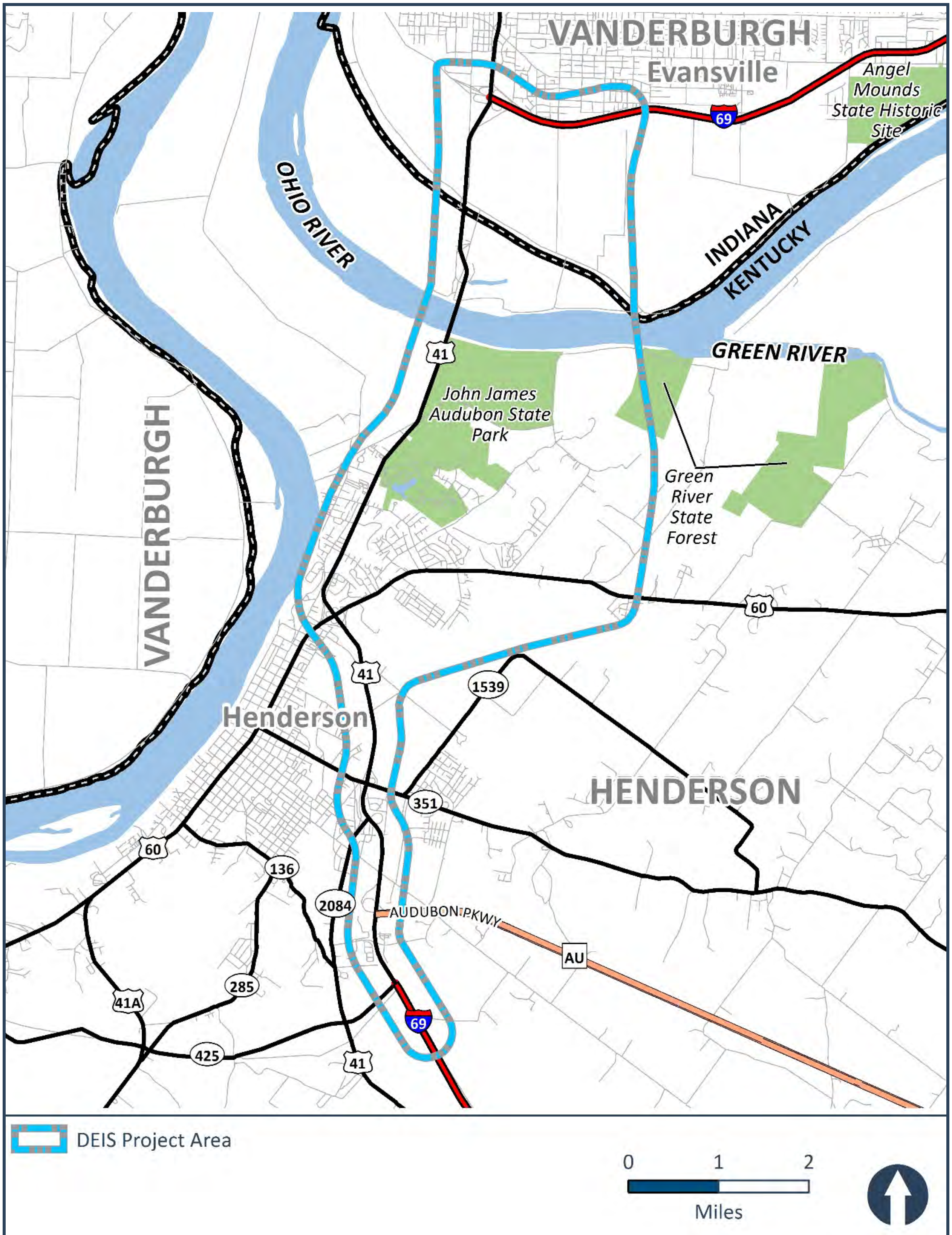

Figure 1.1-1. DEIS Project Area

Based on the project's purpose and need, a range of alternatives was developed and evaluated using secondary source and windshield survey data, and input from the public and federal, state, and local agencies. Because the range of alternatives was developed based on conceptual designs, they were referred to as corridors. Each corridor was evaluated on the degree to which it meets the purpose and need; its potential social, environmental, and economic impacts; and its conceptual cost. In addition to the No Build Alternative, the following five corridors were developed based on alternatives previously presented in the 2004 *Interstate 69 Henderson, Kentucky to Evansville, Indiana Draft Environmental Impact Statement* and the 2014 *I-69 Feasibility Study, Henderson, Kentucky, SIU #4, Final*.

- West Corridor 1 (Based on Alternative 7 from the 2014 Feasibility Study)
- West Corridor 2 (Based on Corridors F and G from the 2004 DEIS and Alternatives 5 and 6 from the 2014 Feasibility Study)
- Central Corridor 1 (Based on Alternative 1a from the 2014 Feasibility Study)
- Central Corridor 2 (Based on the Preferred Alternative 2 from the 2004 DEIS)
- East Corridor (Based on Alternative 3 from the 2004 DEIS)

The results of the evaluation of these corridors were presented in a *Screening Report* completed on July 28, 2017 that recommended three corridors — West Corridor 1, West Corridor 2, and Central Corridor 1 — be carried forward for more detailed evaluation in the DEIS, in addition to the No Build Alternative (INDOT and KYTC 2017). In the *Screening Report*, for West Corridors 1 and 2, it was assumed that both US 41 bridges would be taken out of service and the new I-69 bridge would have six lanes. For Central Corridor 1, it was assumed that both US 41 bridges would remain open and the new I-69 bridge would have four lanes. However, the report stated that the future use of the existing US 41 bridges and corresponding number of lanes on the new I-69 bridge for each corridor would be subject to further evaluation.

Following the *Screening Report*, preliminary designs were then developed within these corridors based on public and agency input, assessment of potential environmental and right-of-way impacts, and results of a traffic analysis. Follow-on studies were conducted regarding the location and configuration of interchanges, the disposition of and long-term maintenance costs for the existing US 41 bridges, and tolling scenarios with resulting traffic patterns. This included the development, evaluation, and screening of the following three different US 41 and I-69 bridge scenarios for each of the three corridors.

- Build a six-lane I-69 bridge for all cross-river traffic and remove both US 41 bridges from vehicular use.
- Build a four-lane I-69 bridge and retain one US 41 bridge for local traffic.
- Build a four-lane I-69 bridge and retain both US 41 bridges for local traffic

The results from this next level of evaluation of the project corridors were presented in a *Screening Report Supplement*, dated January 2018. The *Screening Report Supplement* identified the best bridge scenario for each corridor and the following alternatives to be carried forward for detailed evaluation in the DEIS and this Ground-truthing of Side Scan Sonar River Bed Substrate Classification report.

- No Build Alternative: required by NEPA to serve as a baseline for comparison
- West Alternative 1: four lanes on the new I-69 bridge and retain one of the existing US 41 bridges
- West Alternative 2: six lanes on the new I-69 bridge and take both existing US 41 bridges out of service
- Central Alternative 1: four lanes on the new I-69 bridge and retain one of the existing US 41 bridges

Following the *Screening Report Supplement*, it was determined that the northbound US 41 bridge would be retained and the southbound US 41 bridge would be removed for West Alternative 1 and Central Alternative 1 and both bridges would be removed for West Alternative 2. The three recommended DEIS build alternatives are shown in Figure 1.2-1 and described in greater detail in the following sections.

Consistent with the Evansville Metropolitan Planning Organization's fiscally-constrained Metropolitan Transportation Plan, tolling I-69 will be a key part of the financing for this project. The toll policy will define business rules and toll rates for different vehicle types and will be developed with the federally required financial plan prior to construction. The NEPA process will not determine the toll policy but will evaluate, and document in the DEIS, the environmental consequences associated with tolling being a part of the project.

The DEIS will evaluate potential impacts that would result from the placement of tolls on both the I-69 bridge and the remaining northbound US 41 bridge. This would provide a "reasonable worst case" in terms of potential impacts associated with increased traffic volumes on I-69. For purposes of evaluation, it was assumed that toll rates would be similar to the Louisville, KY metropolitan area bridges for the I-65 and KY 841/SR 265 Ohio River Crossings (i.e., $2.00 for cars, $5.00 for medium trucks, and $10 for large trucks). Both projects are located in metropolitan areas within the same geographical region and have comparable total costs.

1.2 ALTERNATIVES

1.2.1 WEST ALTERNATIVE 1

West Alternative 1 would include a new I-69 bridge approximately 5,400 feet long over the Ohio River and associated floodplain/floodway that would be located approximately 70 feet west of the existing southbound US 41 bridge. The new bridge would include four lanes, with the capacity to expand to six lanes in the future, if needed. The sections of the proposed new I-69 beyond the new bridge would also include four lanes. The northbound US 41 bridge would be retained and the southbound US 41 bridge would be removed. The northbound US 41 bridge that would be retained, which has two lanes, would be converted from a one-way bridge to a two-way bridge for local traffic. Most of West Alternative 1 would utilize rural design standards,

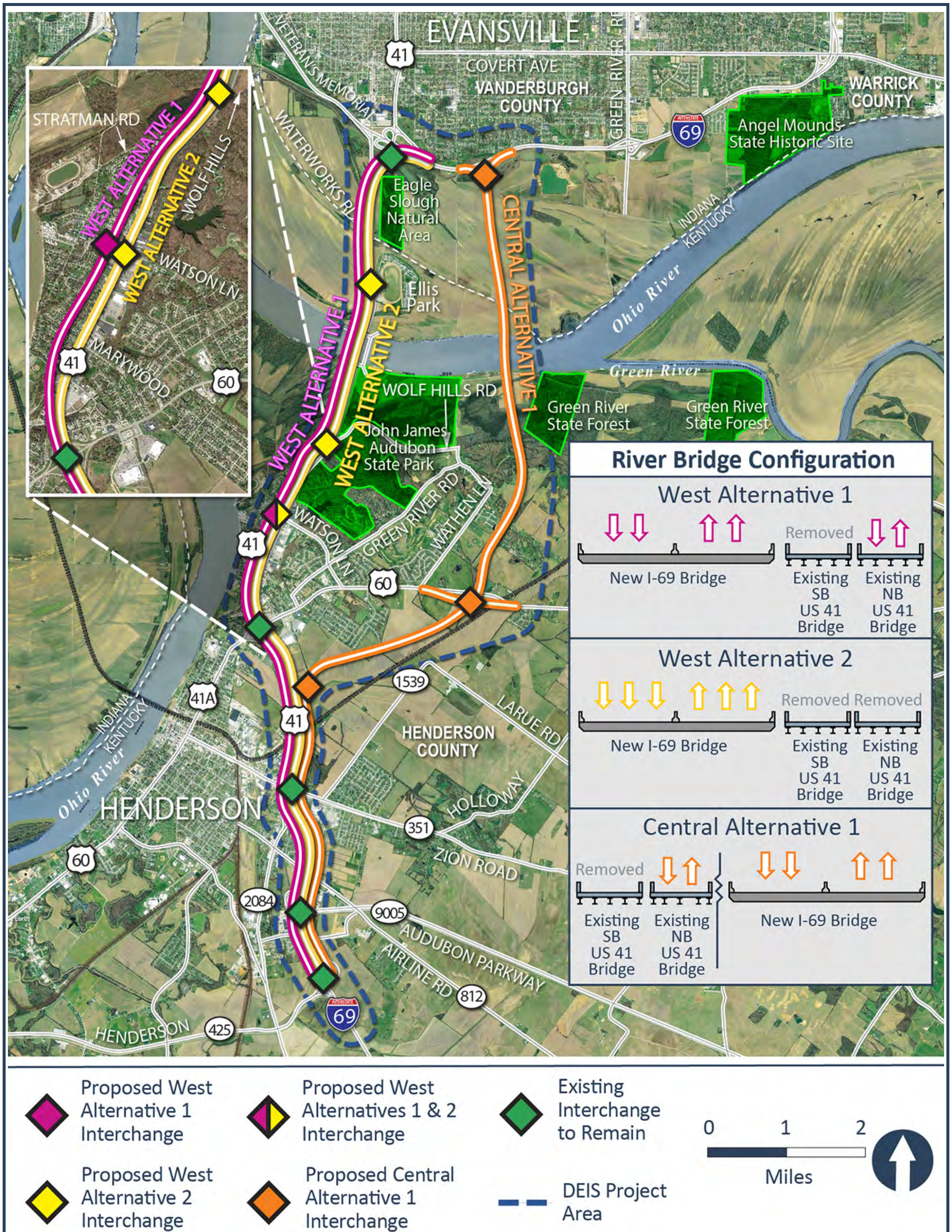

Figure 1.2-1. DEIS Alternatives

including a grass median; however, through Henderson, it would utilize urban design standards and include a narrower median with a concrete barrier. West Alternative 1 would begin on existing I-69 in Indiana just east of the US 41 interchange and become the through movement for I-69. Connections to US 41 to the north and Veterans Memorial Parkway to the west would be provided. The alternative would bridge over Waterworks Road and Nugent Drive while local access to Waterworks Road and Ellis Park would be maintained by US 41. In Kentucky, the alternative would bridge over Stratman Road, with local access to Stratman Road and Wolf Hills Road provided by US 41 and the local bridge. The alternative would continue south and run parallel to and approximately one block west of US 41 and the Henderson commercial strip. An interchange would be constructed at Watson Lane to provide highway access to the commercial strip and adjacent residential areas. An overpass (no interchange) would be provided at Barker Road to maintain connection to residential areas west of the alternative. A local access road with a sidewalk would be provided on the west side of the alternative between Barker Road and Atkinson Park. The alternative would then continue south and tie into the existing four-lane, fully-controlled access section of US 41 south of the US 60 interchange. The US 60 interchange would be modified to provide connections to and from existing US 41, US 60, and I-69. US 41 (formerly named the Edward T. Breathitt Pennyrile Parkway) south of US 60 to KY 425, where I-69 in Kentucky currently ends, would be modernized to meet interstate standards. The total length of West Alternative 1 is 11.1 miles, which includes 2.9 miles of existing US 41.

1.2.2 West Alternative 2

As with West Alternative 1, West Alternative 2 would include a new I-69 bridge approximately 5,400 feet long over the Ohio River and associated floodplain/floodway that would be located approximately 70 feet west of the existing southbound US 41 bridge. The new I-69 bridge for West Alternative 2 would include six lanes and both existing US 41 bridges would be removed. The sections of the proposed new I-69 beyond the new bridge would also include six lanes. Most of West Alternative 2 would utilize rural design standards, including a grass median; however, through Henderson, it would utilize urban design standards and include a narrower median with a concrete barrier. Like West Alternative 1, West Alternative 2 would begin on existing I-69 in Indiana just east of the US 41 interchange and become the through movement for I-69. Connections to US 41 to the north and Veterans Memorial Parkway to the west would be provided. From the US 41/I-69 interchange to Ellis Park, the alternative would follow the existing US 41 alignment. Through this area, Waterworks Road would bridge over the alternative and an interchange would be provided at Ellis Park.

In Kentucky, the alternative would follow existing US 41 through the Henderson commercial strip, with local access provided via a reconstructed US 41, which would function as a frontage road, located adjacent to and east of the alternative. The reconstructed US 41 would include two lanes plus a center, two-way left turn lane. It would also include a sidewalk on the east side. An interchange would be provided at Stratman Road/Wolf Hills Road and at Watson Lane. At the Watson Lane interchange, US 41 would be relocated approximately 300 feet to the east to provide adequate spacing between the interchange and the US 41/Watson Lane intersection. An overpass (no interchange) would be provided at Rettig Road to maintain connection to residential areas west of the alternative. In addition, a shared-use path would be provided on the west side of the alternative. The alternative would continue south, within the US 41 corridor, to the existing US 60 interchange, which would be modified to provide connections to and from existing US 41, US 60, and I-69. The existing four-lane section of US 41 (formerly named the Edward T. Breathitt Pennyrile Parkway) south of US 60 to KY 425, where I-69 in Kentucky currently ends, would be modernized to meet interstate standards. The total length of West Alternative 2 is 11.0 miles, which includes 2.9 miles of existing US 41.

1.2.3 CENTRAL ALTERNATIVE 1

Central Alternative 1 would include a new I-69 bridge, approximately 7,600 feet long over the Ohio River and associated floodplain/floodway, located approximately 1.5 miles east of the existing US 41 bridges. The new I-69 bridge would include four lanes, with the capacity to expand to six lanes in the future, if needed. The sections of the proposed new I-69 beyond the new bridge would also include four lanes. The northbound US 41 bridge would be retained and the southbound US 41 bridge would be removed. The US 41 bridge that would be retained, which has two lanes, would be converted from a one-way bridge to a two-way bridge for local traffic. Central Alternative 1 would utilize rural design standards and include a depressed grass median outside of the bridge limits.

Central Alternative 1 begins at existing I-69 in Indiana, approximately 1 mile east of the US 41 interchange. The alternative would continue south across the Ohio River just west of a gas transmission line. It would remain just west of the gas transmission line near the Green River State Forest, then turn southwest where an access road for the gas transmission line would bridge over the alternative. The alternative would continue south to US 60 where an interchange would be provided. As part of the US 60 interchange, US 60 would be relocated approximately 400 feet south, which would require a new bridge over the CSX Railroad east of the interchange. The alternative would continue southwest and tie into to US 41 via an interchange approximately 1 mile south of the US 60 interchange. From the alternative's interchange with US 41 to KY 425, the existing four-lane US 41 would be modernized to meet interstate standards through improvements to ramps and merge areas. The total length of Central Alternative 1 is 11.2 miles, which includes 2.8 miles of existing US 41.

1.3 STUDY AREA SETTING

This study consisted of two study areas- one for Central Alternative 1 and the other for West Alternative 1 and 2, since the West Alternatives share the same alignment. At both corridors' crossings, the Ohio River channel wetted width is approximately 600 m (656 yd). The Newburgh Locks and Dam is approximately 15 miles upstream of Central Alternative 1. The project is located within the Wabash-Ohio Bottomlands and Southeastern Plains Physiographic Province.

1.4 REGULATORY ENVIRONMENT

The federal Endangered Species Act (ESA) [16 U.S.C.1531 et seq.] became law in 1973 and provides for the listing, conservation, and recovery of endangered and threatened species. The U.S. Fish and Wildlife Service (USFWS) is the agency responsible for protecting and monitoring populations of listed species. Section 7(a)(2) of the ESA states that each federal agency shall insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of listed species, or result in destruction or adverse modification of designated critical habitat. A federal action includes issuance of funds, permits, or licenses.

The Fish and Wildlife Coordination Act requires federal agencies that construct, license or permit water resource development projects to first consult with the USFWS and state fish and wildlife agencies regarding the impacts on fish and wildlife resources and measures to mitigate these impacts, as well as potential impacts to any watercourse within a wild, scenic, or recreational river area. In addition to the USFWS, State agencies like Kentucky State Nature Preserves Commission (KSNPC), Kentucky Department of Fish and Wildlife Resources (KDFWR), Indiana Department of Natural Resources, Division of Nature Preserves (IDNR-NP), and Indiana Department of Natural Resources Division of Fish and Wildlife (IDNR-FW) maintain state and federally-listed listed species databases.

1.5 SIDE SCAN SONAR SURVEY

On September 11, 2017, an informal Section 7 consultation meeting was held at KYTC with representatives from Parsons, USFWS, KYTC, FHWA, and Stantec to discuss the project's approach to assessing the potential for mussel habitat within the project area. Meeting minutes are presented in Appendix A. At that time, it was decided that it would be in the best interest of all parties to collect side scan sonar survey data which could be used to:

- Map substrate types and evaluate the suitability of these substrates as mussel habitat within the West and Central Alternatives impact areas;
- Assess the potential impacts of the project to threatened and endangered mussel species for each project alternative (INDOT and KYTC 2018); and
- Inform study plans for the formal mussel survey needed for the Preferred Alternative.

Mainstream Commercial Divers, Inc. (MCDI) conducted a side scan sonar and bathymetric survey November 19–22, 2017, for the survey reach in the Ohio River (MCDI 2017). Appendix B contains the entire MCDI report of the side scan and bathymetric data. Surveys were conducted between Ohio River miles 784.1 and 787.5 (approximately 3.4 miles), extending from the mouth of the Green River to approximately 0.5 miles downstream of the existing US 41 bridges. MCDI used a Klein 3900 side scan sonar unit (455kHz mode) for data collection. Hypack v2017 Hydrographic Software was used to process and analyze the side scan data. The acoustic imagery was mosaicked and georeferenced in KY State Plane Feet (South) NAD83 coordinates. The mosaic images are presented in Appendix C.

MCDI delineated eight discrete acoustic classes based off the reflectance signatures of the side scan data and hypothesized a river bed substrate type associated with each acoustic class. These substrate classes were subsequently incorporated into Environmental Systems Research Institute (ESRI) shape files. Table 1.5-1 shows MCDI's initial substrate classification of acoustic classes and the total area of each class within the surveyed reach. The specific locations of the proposed West and Central Alternatives are shown in Figure 1.6-1 overlain on the delineated side scan sonar classes.

Table 1.5-1. Total Area of Acoustic Classes and Related Substrate Classes as Hypothesized by MCDI Prior to Stantec Field Verification

ACOUSTIC CLASS	MCDI HYPOTHESIZED SUBSTRATE CLASS	TOTAL AREA (ACRES)
1	Sand	4,853.7
2	Sand/Silt shoreline	1,347.0
3	Woody Debris	50.3
4	Sparse Wood	543.5
5	Manmade Debris	11.5
6	Unknown	72.8
7	Cobble Over Bedrock	971.7
8	Bedrock	896.2

1.6 STUDY PURPOSE

The first purpose of this study was to ground-truth river bed substrate types related to each MCDI-delineated acoustic class in the Project Area by evaluating the relationship between collected substrates and registered acoustic classes. Using the river substrate classification, the secondary purpose of this study was to assess the potential for mussel habitat within the West and Central Alternatives' impact areas. Freshwater mussels, including State and Federally listed species, living in large riverine systems commonly use certain substrates as habitat over others. This study provided a preliminary evaluation of potential suitable habitat for freshwater mussel species within the alternatives. A more detailed assessment of habitats and their relationship to special status taxa was beyond the scope of this document and will be addressed in a separate report (INDOT and KYTC 2018). Results from this study will be used to assist in decision making regarding potential wildlife habitat and appropriate geospatial focus for future mussel investigations.

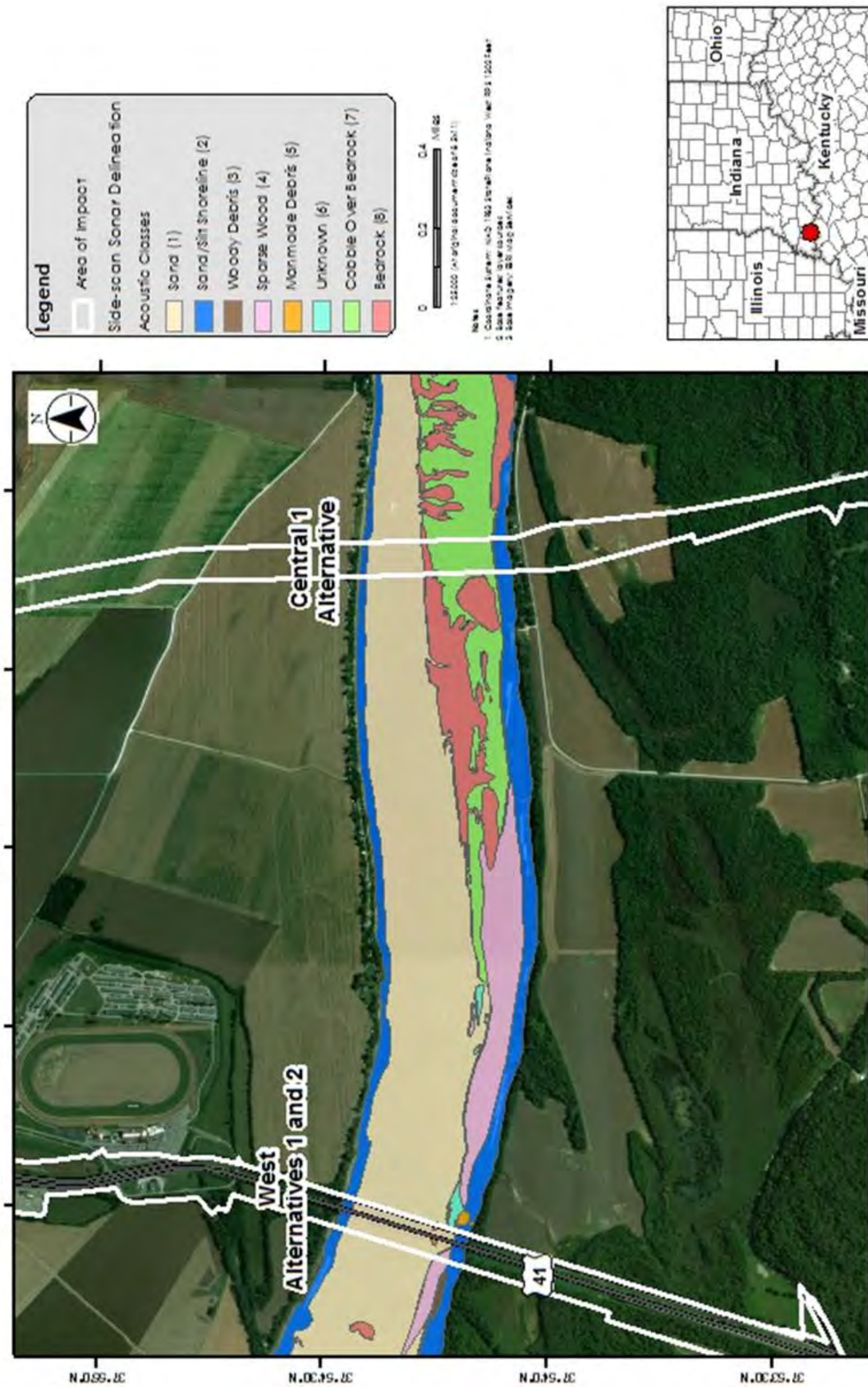

Figure 1.6-1. Acoustic Sonar Classes Overlain with West and Central Alternatives Impact Areas

CHAPTER 2 – METHODS

2.1 SEDIMENT SAMPLING METHODS

Ground-truthing of river substrate took place December 12 – 15, 2017, and occurred between 100 m (109 yd) upstream and 300 m (328 yd) downstream of the West and Central Alternative impact areas. A chain-rigged Van Veen sediment sampler was used to collect river bed material. The Van Veen was deployed using a davit and motorized winch system mounted to a 24-ft V-hull Monarch boat (Figure 2.1-1 a and b). It was originally anticipated that the field verification surveys would be conducted by divers. However, high river discharges and low temperatures made it necessary to undertake an alternative approach as described in the Methods section below.

Figure 2.1-1. (a) Davit and Winch System Used to Deploy Van Veen Sampler to River Bed From (b) Sampling Platform

A Trimble Geo7x handheld Global Positioning System (GPS) unit was used to navigate to the selected sample locations. Coordinates for each sample location were recorded while the grab sampler was deployed, and field personnel monitored that the boat location remained within the intended acoustic class during each grab attempt. Water depth was recorded once at each sampling location using a digital depth sounder.

2.1.1 SAMPLE SITE SELECTION

A total of 40 sampling locations were recorded within the combined study areas. Substrate sampling efforts were weighted proportionally to the area of each acoustic class (i.e., stratified random sampling), such that more effort was placed on acoustic classes with larger areas. A minimum of two survey sites were assigned to each acoustic class. Sampling site locations were randomly generated in ArcGIS with the National Oceanic and Atmospheric Administration's (NOAA) "Sampling Design Tool" using a stratified random sampling design (NOAA 2009). Table 2.1-1 summarizes the number of sample locations and total area per acoustic class within each corridor study area. Fine grain substrates (i.e., sand, silt, and clay) comprised the largest proportion of MCDI-delineated substrate classes by area (Table 2.1-1). Figure 2.1-2 and Figure 2.1-3 illustrate the sampling locations within the West and Central Alternative study areas. The presence of a gas pipeline area prevented the sampling of substrate from the most upstream, approximately 160 yd section, of the Central Alternative 1 study area. Alternate sampling locations were selected to replace those that fell within the pipeline area. CCB9 was an alternate sample location for class 1 that fell approximately 30 yards downstream of the boundary for the Central Alternative 1 study area (Figure 2.1-3). Data collected from this sample location was still included in the analysis of class 1 substrate data.

Table 2.1-1. Stantec Sampling Locations and Total Area Per MCDI Acoustic Class

		WEST ALTERNATIVES 1 AND 2		CENTRAL ALTERNATIVE 1			
ACOUSTIC CLASS	MCDI HYPOTHESIZED SUBSTRATE CLASS	AREA (ACRES)	COUNT SAMPLING LOCATIONS	AREA (ACRES)	COUNT SAMPLING LOCATIONS	TOTAL COUNT	TOTAL AREA (ACRES)
1	Sand	52.2	12	31.2	7	19	83.4
2	Sand/Silt shoreline	12.8	3	12.0	2	5	24.8
3	Woody Debris	1.10	2	0.00	0	2	1.10
4	Sparse Wood	4.70	2	0.00	0	2	4.70
5	Manmade Debris	1.10	2	0.00	0	2	1.10
6	Unknown	1.00	2	0.00	0	2	1.00
7	Cobble Over Bedrock	0.00	0	23.8	5	5	23.8
8	Bedrock	0.00	0	17.2	3	3	17.2

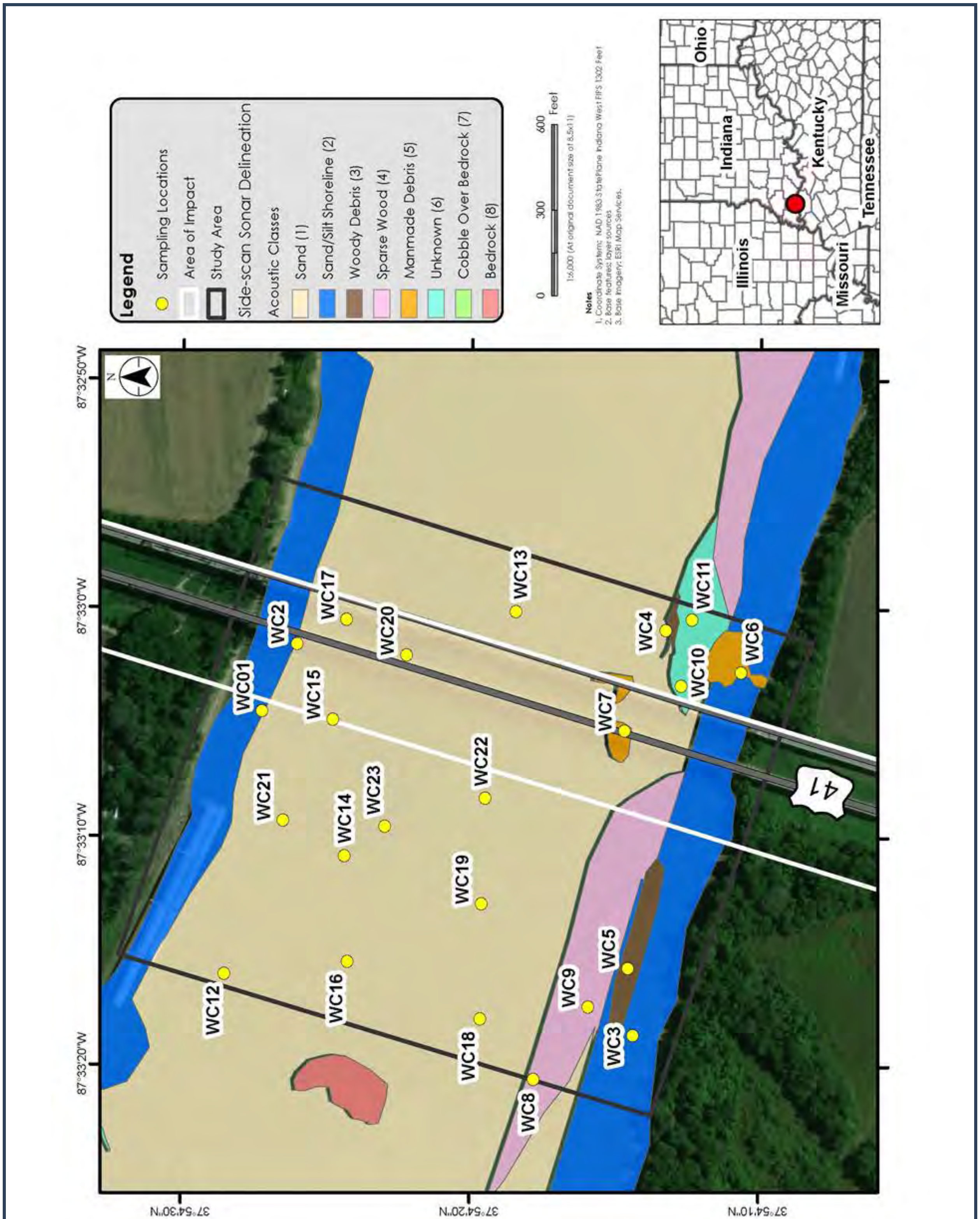

Figure 2.1-2. Substrate Sampling Locations for the West Alternatives Study Area

Figure 2.1-3. Substrate Sampling Locations for the Central Alternative 1 Study Area

2.1.2 Grab Performance Assessment

Upon grab retrieval, field personnel visually assessed the grab sample to determine whether it was fully closed, partially closed, or open. Partially closed grabs were defined when the grab sampler retained some bed material but the remainder of the material washed out due to incomplete closure of the grab. In these instances of partial disturbance, the coarser grained sizes were generally retained while the finer particles washed out. Open grabs occurred when the object (e.g., stick, cobble, debris, etc.) that prevented grab closure was the only material collected by the grab (Figure 2.1-4). In some instances, the sampler was fully closed but empty. The grab closure status and sediment disturbance level for each grab attempt was recorded. Samples were also photographed.

At each sample location, field personnel attempted to collect an acceptable sample, defined as an undisturbed, fully closed grab. The sampler was deployed a maximum of six times at each location, stopping when an acceptable sample was obtained. Total grab attempts only exceeded six in instances where the sampler flipped and failed during deployment, possibly due to impact with boulders, cobble, or other objects on the river bed.

The depth of grab penetration was noted for all undisturbed samples as an additional evaluation of grab performance. Field personnel measured the distance from the top of the sediment sample to the top of the grab sampler. This metric was termed "grab fullness". Grab penetration was later calculated by subtracting grab fullness from the total depth of the empty grab sampler.

Figure 2.1-4. Examples of Open Grabs Where a Rock or Stick Prevented the Closure of Van Veen Grab Sampler

2.1.3 Grain Size Analysis

For all acceptable samples, field personnel estimated the dominant and subdominant particle size through visual inspection using the particle size classes listed in Table 2.1-2. Particle sizes were not classified for open grabs and disturbed samples where most material washed out of the sampler. Examples of different grain sizes collected via grab sampler are shown in Figure 2.1-5. In cases where rocks or sticks prevented complete closure of the sampler, field personnel measured the intermediate or y-axis of coarser grains retained by the grab. This practice was intended to help provide at least some useful data at sites where washout occurred.

Table 2.1-2. Particle Size Categories Used to Visually Assess Substrate Size Classes in the Field

SUBSTRATE CLASS	SIZE RANGE
Boulder	> 256 mm (10.1 in)
Cobble	64 - 256 mm (2.5 – 10.1 in)
Coarse Gravel	16 - 64 mm (0.63 – 2.5 in)
Medium Gravel	8 - 16 mm (0.32 – 0.63 in)
Fine Gravel	2 - 8 mm (0.08 – 0.32 in)
Coarse Sand	1/2 - 1 mm (0.02 – 0.04 in)
Medium Sand	1/4 - 1/2 mm (0.01 – 0.02 in)
Fine Sane	62.5 - 250 µm (2460 – 9842 µin)
Silt/Clay	<1 - 62.5 µm (40 – 2460 µin)

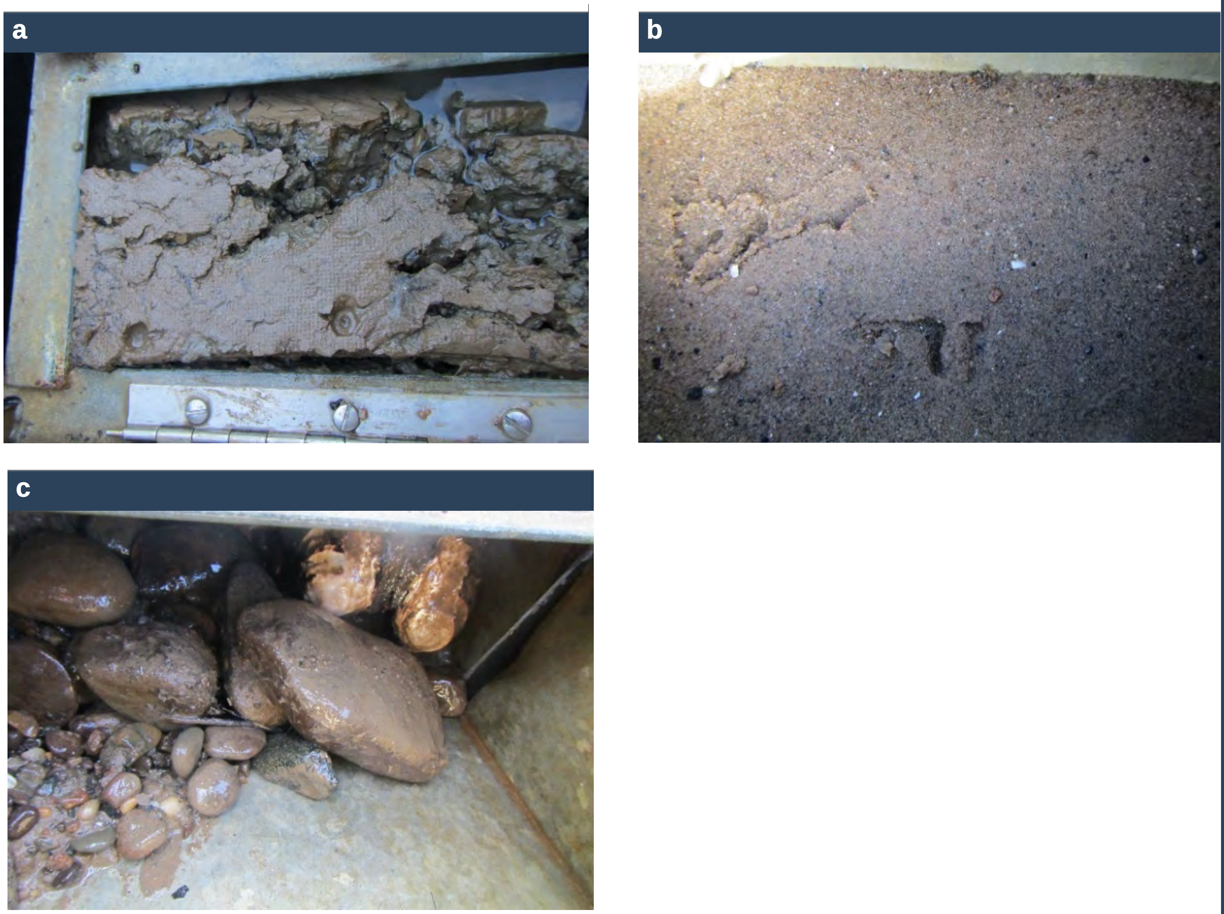

Figure 2.1-5. Substrates Obtained by Grab Sampler (a) Silt/Clay (b) Sand (c) Gravel and Cobble

2.1.4 Ancillary Observations

Field personnel recorded general notes pertaining to the biological characteristics of the sample, including the presence of sticks, woody debris, trash, shell fragments, and mussels. Collected freshwater mussels were photographed, measured, and returned to the water. Sediment was also inspected for particle size stratification, such as laminate or interbedded structure. In cases where particle size stratification was observed, dominant and subdominant particle size were assessed individually for the different stratums (i.e., surface and subsurface sediment layers).

2.2 UNDERWATER IMAGERY

Underwater video footage of the river bed was collected to obtain additional qualitative data on river substrate. Video of the river bed was recorded once at each sample location using a GoPro Hero+ mounted to an external housing (Figure 2.2-1). The camera and housing were deployed during the approximate time of grab sampling from the side of the boat opposite that of the sampler to insure neither instrument interfered with the other. The imagery was intended to verify the substrate findings collected via grab sampling and/or assess substrate characteristics in circumstances where the grab sampler failed to retrieve substrate. All footage was reviewed to assess its correlation with substrate classification via grab sampler.

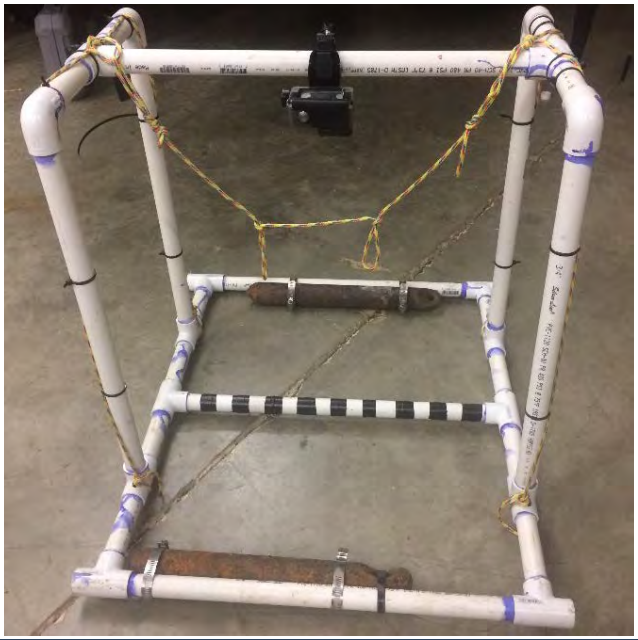

Figure 2.2-1. GoPro and Camera Housing Used to Collect Imagery of River Bed

2.3 ANALYTICAL APPROACH

The main purpose of this study was to ground-truth river bed substrate by evaluating the relationship between the collected field data on river substrate and acoustic classes. This analysis synthesizes multiple lines of evidence, including sediment grain size, depth, sample locations, frequency of empty and disturbed grabs, and grab sampler penetration, to draw conclusions about the defining substrate characteristics of each acoustic class. Grab penetration and frequency of disturbed/empty grabs are used as proxy for substrate hardness. This rationale is based on the general observation that the grab sampler typically more easily penetrates fine, soft substrates compared to coarse, hard substrates. The aforementioned parameters are summarized in tables and graphs to evaluate their correspondence with acoustic classes, and subsequently make distinctions between class properties. The observed characteristics of each class are then assessed for mussel habitat suitability.

2.4 SURVEY CONDITIONS

MCDI recorded the wind conditions during the bathymetric and sonar surveys conducted on November 19, 2017, to be approaching 20 mph. The wind conditions were lighter and more favorable for the second survey day on November 22 (MCDI 2017). Wind conditions during the substrate ground-truthing fieldwork were strong on December 13 but calmer on subsequent sampling days, December 14 and 15. Field work was concluded prematurely December 13 because 3-ft swells on the river made it difficult to sample effectively. The Ohio River stream gauge elevation was relatively stable throughout the substrate sampling fieldwork but was slightly higher during the sonar survey (USGS 2017) (Figure 2.4-1). River stage may be used as a proxy for assessing the energy available to do work on the river bed. River stage is also directly correlated with bed form types in mobile sand bed channels (Knighton 1998).

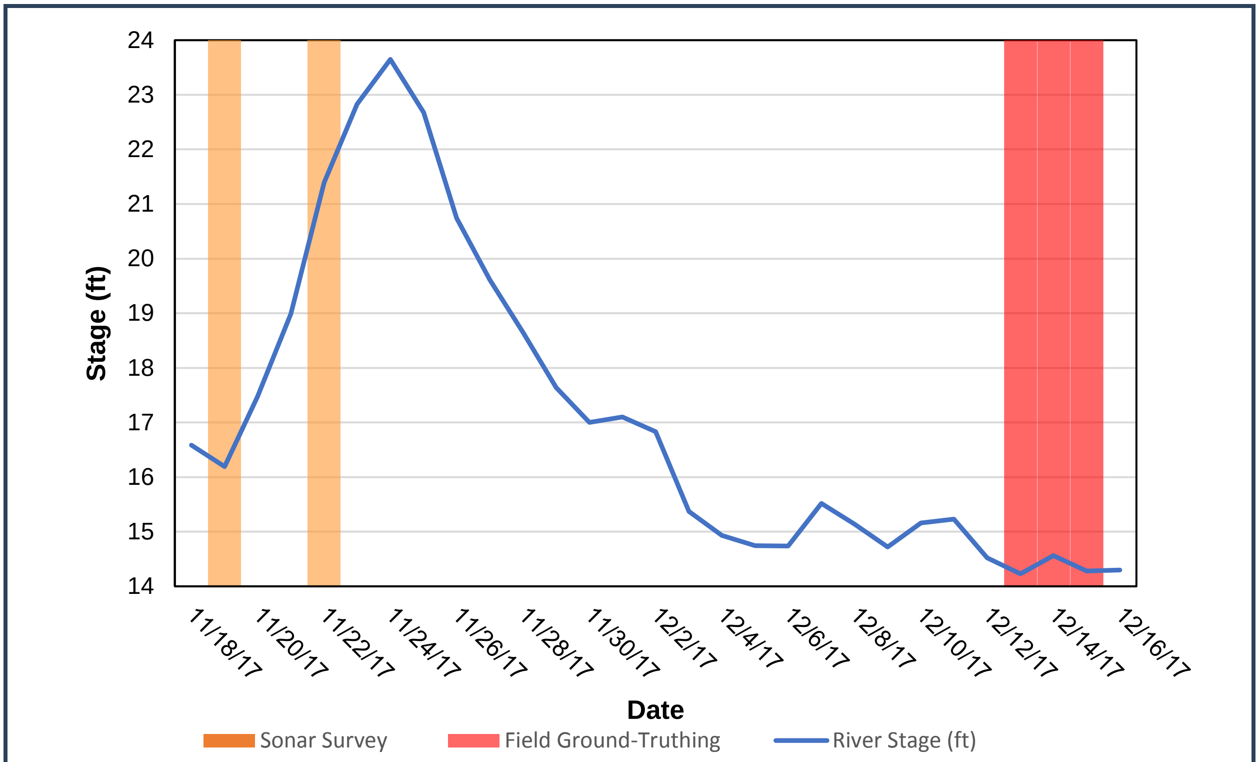

Figure 2.4-1. River Stage Height (ft) at U.S. Geological Survey (USGS) Stream Gauge 03322000 on the Ohio River at Evansville, IN During the Side-Scan Sonar and Substrate Sampling Surveys. Flood Stage is 42 ft

CHAPTER 3 – RESULTS

3.1 FIELD OBSERVATIONS

3.1.1 SAMPLING EFFORT

Field personnel surveyed 40 sample locations and deployed the grab sampler 97 times (Table 3.1-1). An undisturbed sample was obtained at 35 of the sample locations, with at least one undisturbed sample collected within each acoustic class. Disturbed or empty grabs accounted for 31% of all attempts, undisturbed for 36%, and partially disturbed for the remaining 33%. Class 8 had the highest proportion of empty or disturbed grabs (88%) and Class 2 had the lowest (0%). Overall, the frequency of undisturbed grabs was higher in classes 1–4 than in classes 5–8 (Table 3.1-1).

Table 3.1-1. Overview of Grab Sampling for all 40 Sample Locations

ACOUSTIC CLASS	SAMPLING LOCATIONS COUNT	GRAB ATTEMPTS*	UNDISTURBED GRABS	DISTURBED OR EMPTY GRABS	% UNDISTURBED	% EMPTY OR DISTURBED
1	19	28	20	2	71%	7%
2	5	5	5	0	100%	0%
3	5	8	2	1	25%	13%
4	3	4	2	0	50%	0%
5	2	9	1	5	11%	56%
6	2	7	1	3	14%	43%
7	2	20	3	5	15%	25%
8	2	16	1	14	6%	88%
Total	40	97	35	30	36%	31%

* Total grab attempts also include open and partially disturbed grabs which are not summarized in the table.

Table 3.1-2 illustrates the relative effort necessary to collect successful grab samples from each of the acoustic classes. Classes 1, 2, and 4 required comparatively fewer grab attempts to obtain acceptable samples than the rest of the classes. Classes 5, 6, 7, and 8 all required the maximum amount of grab attempts (six) for at least one sample location (Table 3.1-2). Classes 7 and 8 exceeded six attempts due to grab sampler failure during deployment. Among all classes, the average number of grab attempts per sample location was 3.1.

3.1.2 GRAB SAMPLER PERFORMANCE

Table 3.1-2. Summary Statistics of Grab Attempts per Sample Location for Each Acoustic Class

CLASS	TOTAL ATTEMPTS[a]	MIN. ATTEMPTS[b]	MAX. ATTEMPTS[b]	AVERAGE ATTEMPTS[b]	MEDIAN ATTEMPTS	STD. DEV. ATTEMPTS[b]
1	28	1.0	4.0	1.5	1.0	0.8
2	5	1.0	1.0	1.0	1.0	0.0
3	8	2.0	6.0	4.0	4.0	2.0
4	4	1.0	3.0	2.0	2.0	1.0
5	9	3.0	6.0	4.5	4.5	1.5
6	7	1.0	6.0	3.5	3.5	2.5
7	20	2.0	7.0	4.0	3.0	2.1
8	16	1.0	8.0	4.0	3.5	3.1

a - total attempts per acoustic class

b - statistics calculated from attempts per sample location

The grab sampler performance was most successful in classes 1 and 2. All grab attempts were undisturbed in class 2, and 71% of grab attempts were undisturbed in class 1 (Table 3.1-1 and Figure 3.1-1). A substantial proportion of empty and disturbed grabs were observed in classes 5 - 8 (Figure 3.1-1). The frequency of closed but empty grabs is important to substrate characterization, because it is one indicator of the grab sampler’s ability to penetrate the substrate. Empty grabs were most frequent in class 8, accounting for 81% of grab attempts. Classes 3 and 6 had the highest proportion of open grabs (50% and 30% of attempts, respectively).

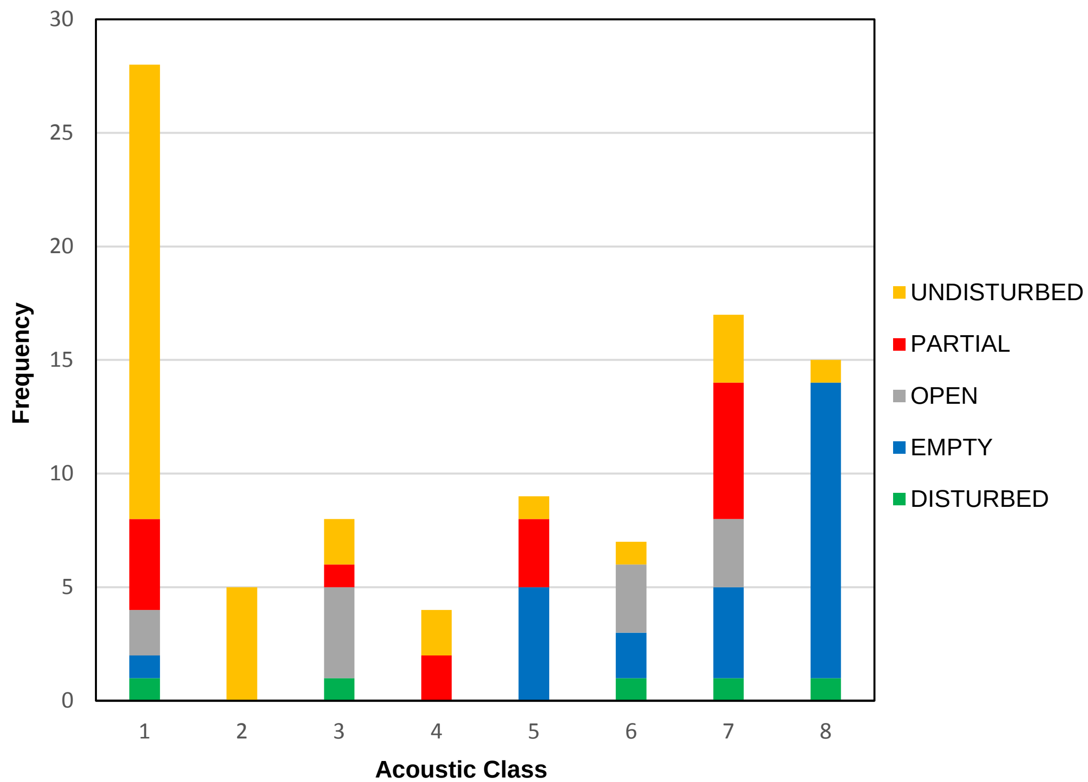

Figure 3.1-1. Distribution of Surface Disturbance Category by Acoustic Class

3.1.3 GRAB PENETRATION

Grab penetration was measured for all undisturbed samples and used as an additional indicator of substrate hardness. Grab penetration ranged between 26 and 146 mm (1.0 and 5.75 in) for all samples. Grab penetration was the shallowest in classes 3 and 7 (36 and 46 mm [1.4 and 1.8 in], respectively), suggesting harder sediment was likely present in these classes (Table 3.1-3). The clustering of similar average penetration values for classes 1, 2, and 6 suggests that substrate hardness may be similar for these classes. Grab penetration for the one undisturbed sample collected in class 8 was the deepest recorded grab penetration at 146 mm (5.75 in) (Table 3.1-3). This deep penetration indicates that MCDI's hypothesized of bedrock for class 8 is not an accurate classification at this particular sampling location.

Table 3.1-3. Summary Statistics for Grab Penetration by Acoustic Class, Corridor Study Areas Combined. Grab Penetration Was Only Measured for Undisturbed Samples

ACOUSTIC CLASS	COUNT	MIN. GRAB PENETRATION (MM)	MAX. GRAB PENETRATION (MM)	AVG. GRAB PENETRATION (MM)
1	20	26	106	81
2	5	26	101	71
3	2	26	46	36
4	2	51	81	66
5	1	96	96	96
6	1	81	81	81
7	1	46	46	46
8	1	146	146	146

3.1.4 Sample Depth

Water depth measured at sample locations ranged between < 2.0 and 38.7 ft. Average depth was lowest in class 2 (10.9 ft) which was located along the channel margins. Class 1 covered the greatest range of depths (Table 3.1-4) and largest area within the West and Central Alternative 1 study areas (Table 2.1-1). Class 4 was the deepest on average (36.1 ft). Classes 3, 5, and 6 all had similar average depths of approximately 30 ft (Table 3.1-4).

Table 3.1-4. Summary Statistics for Grab Depth by Acoustic Class, Corridor Study Areas Combined

ACOUSTIC CLASS	COUNT	MIN. DEPTH (FT)	MAX. DEPTH (FT)	AVG. DEPTH (FT)
1	19	8.4	34.1	22.7
2	4	< 2.0	18.6	10.9
3	1	30.2	30.2	30.2
4	2	35.4	36.7	36.1
5	2	20.3	38.7	29.5
6	2	20.3	38.1	29.2
7	5	21.8	26.5	24.7
8	4	20.3	26.6	22.9

3.1.5 Underwater Imagery

Underwater imagery was not the primary focus of this analysis, but was intended to provide additional data on the substrate, particularly at sample locations where grab sampling was unsuccessful. High turbidity in the river greatly decreased image clarity at many sample locations and rendered some images unusable. On December 14 and 15, 2017, lighting on the camera and camera height was adjusted to improve image quality. Of the six sample locations where no undisturbed grab was obtained, sample locations CCB8 and WC11 were the only sites where river bed substrate was captured via GoPro imagery. Imagery obtained from CCB8 (class 7) shows a coarse gravel and cobble mixture. WC11 (class 6) imagery shows a heterogeneous mixture of coarse grains overlain with fines.

3.2 GRAIN SIZE ANALYSIS

In the study areas, finer grained sediments were substantially more prevalent than coarser grained sediments. Coarse sand, fine sand, or silt/clay were the dominant substrate classes for 36 of all 51 undisturbed or partially disturbed samples. Coarse gravel was the dominant substrate for nine samples (Figure 3.2-1). A dominant substrate class was not documented for partially disturbed samples that retained an inadequate amount of sediment for classification, represented by the "N/A" category in Figure 3.2-1.

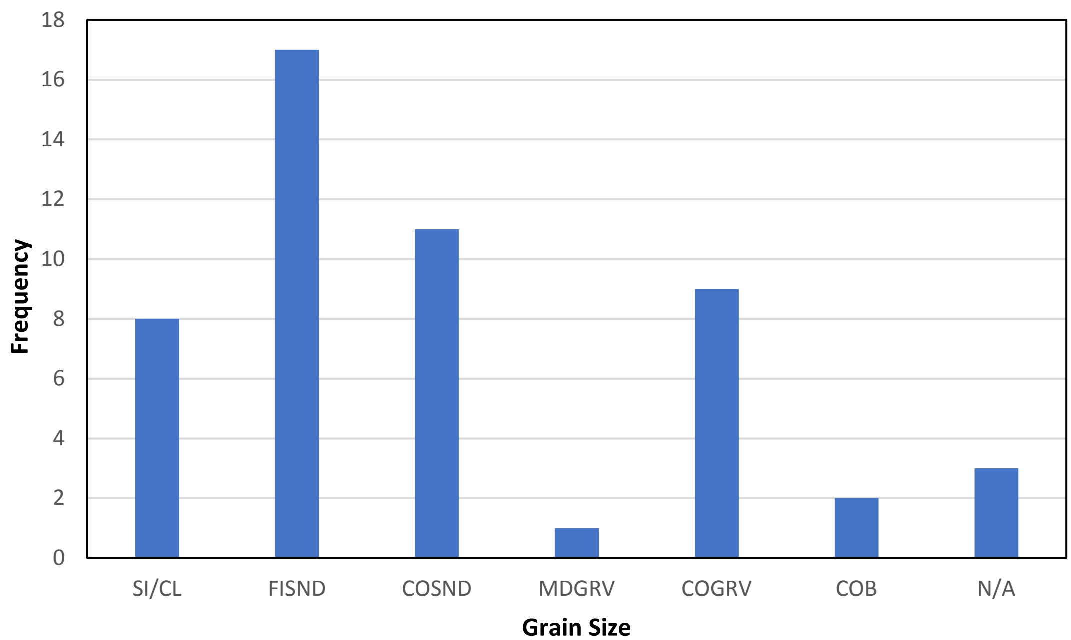

Figure 3.2-1. Frequency of Observed Grain Sizes for All Partially Disturbed and Undisturbed Samples

3.2.1 DOMINANT GRAIN SIZES FOR PARTIALLY DISTURBED AND UNDISTURBED SAMPLES

More than one particle size was dominant for most acoustic classes. Class 1 was dominated by a combination of fine and coarse sands. Class 2 was silt/clay-dominant with a few samples of fine sand. Cobble and coarse gravel was dominant in Class 7. Only one acceptable sample for grain size classification was collected from classes 6 and 8, each of which were silt/clay-dominant (Figure 3.2-2). When only undisturbed samples were considered, classes 3, 4, and 5 contained primarily finer particles (i.e., sand and silt/clay) (Figure 3.2-2 a). However, partially disturbed samples from these classes contained a mixture of coarser (i.e., gravel) and finer sediment (Figure 3.2-2 b).

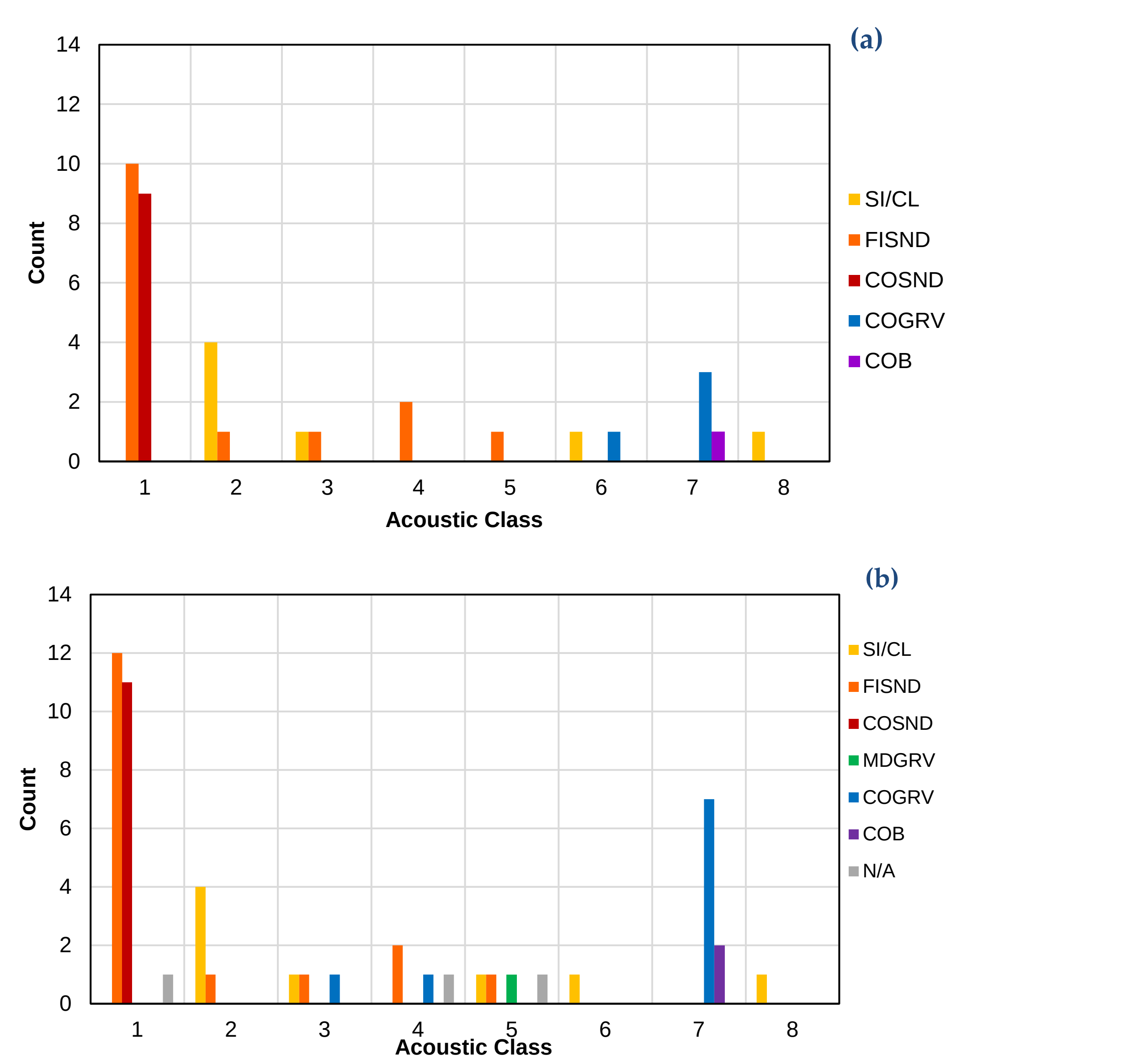

Figure 3.2-2. Dominant Grain Size For (a) Undisturbed Grab Samples and (b) Partially and Undisturbed Grab Samples by Acoustic Class

3.2.2 SUBDOMINANT GRAIN SIZES

Table 3.2-1 compares the dominant grain sizes of samples to that of their subdominant component(s). For samples predominantly composed of a singular class size, the subdominant grain size is given the same classification as the dominant. These homogenous samples all fall within the diagonal/shaded cells in Table 3.2-1. The most frequent combination of grain sizes was fine and coarse sand, with 22 samples containing this mixture of sediment. Cobble and coarse gravel were also frequently combined (n=5). Silt/clay samples generally had no subdominant component (Table 3.2-1). Heterogeneous mixes of fine and coarse grains is one important consideration for mussel habitat as this parameter can influence the stability of substrate.

Table 3.2-1. Grain Size Comparison of Dominant and Subdominant Components, Samples in the Diagonal/Shaded Cells Were Composed of One Primary Grain Size

		SUBDOMINANT GRAIN SIZE							
		SI/CL	FISND	MDSND	COSND	FIGRV	MDGRV	COGRV	COB
DOMINANT GRAIN SIZE	SI/CL	6	1			2	1		
	FISND	1	4		13	1			
	MDSND								
	COSND		9	1		2			
	FIGRV								
	MDGRV		1			1			
	COGRV					1	2	4	5
	COB							1	1

3.3 FRESHWATER MUSSELS

Two native freshwater mussels were incidentally collected in class 7 from the Central Alternative 1 study area: ebony shell (*Fusconaia ebena)* and long solid mussel (*Fusconaia subrotunda)*. The long solid is an Indiana state listed endangered species and Kentucky species of special concern (INDOT and KYTC 2018). Photos of these specimens are presented in Figure 3.3-1. The animal in Figure 3.3-1a was alive whereas the animal in Figure 3.3-1b was not. Details of the grab sample characteristics where these mussels (live and dead) were found are outlined in Table 3.3-1. Grain sizes for the sample locations of these mussels were primarily gravels. Alive and dead zebra mussels (*Dreissena polymorpha*) and Asiatic clams (*Corbicula fluminea)* were abundant throughout the study areas and found in all acoustic classes except 8. Actual counts of these species were not recorded, as collection and identification of mussels was not the purpose of this report and only occurred incidentally.

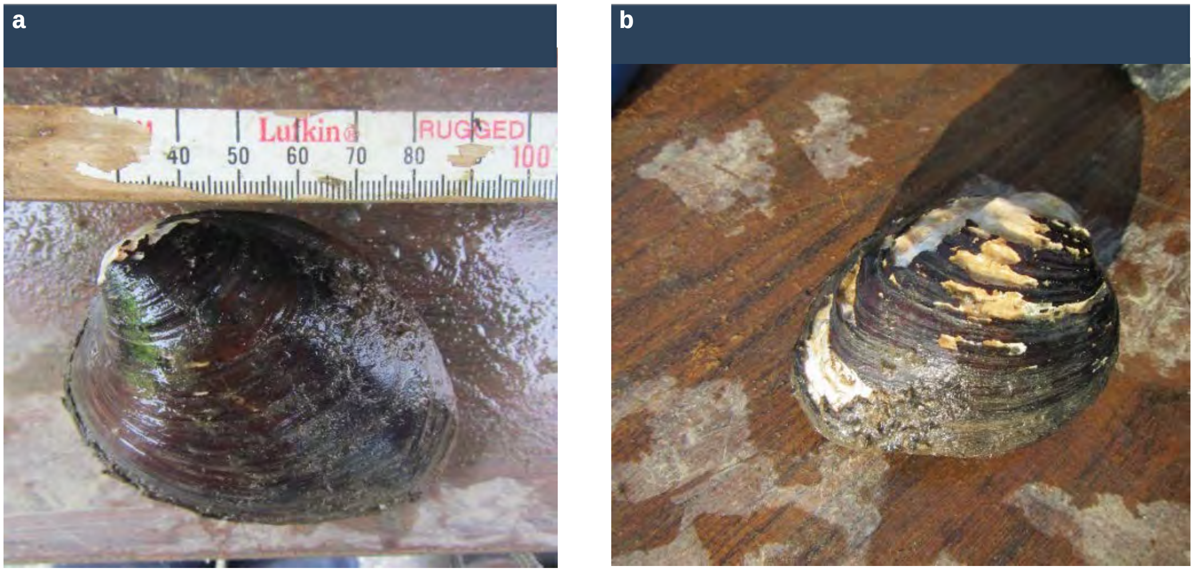

Figure 3.3-1. Representative Photos of Freshwater Mussels (a) Fusconaia ebena From Sample Location CCB8 (b) Fusconaia subrotunda From Sample Location CC14

Table 3.3-1. Summary of Sample Location Conditions Where Freshwater Mussels Found

SPECIES	CONDITION	SITE ID	DEPTH (FT)	CLASS	GRAB CLOSURE	SURFACE CONDITION	DOMINANT SUBSTRATE	SUBDOM. SUBSTRATE
Fusconaia ebena	Alive	CCB8	24.1	7	Partial	Disturbed	N/A	N/A
Fusconaia subrotunda	Dead	CC14	21.8	7	Full	Undisturbed	COGRV	FIGRV

CHAPTER 4 – DISCUSSION

4.1 SUMMARY CHARACTERISTICS OF ACOUSTIC CLASSES

This study documented the widespread prevalence of sand substrates in the study areas. Most samples were composed predominantly of fines (Table 4.1-1). Samples dominated by coarser materials often also contained fines. As MCDI identified within their hypothesized substrate class delineations (Table 1.5-1), woody debris was frequently encountered in sampling locations within classes 3 and 4. By examining the grain size data in relation to the MCDI delineated substrate classes, acoustic classes can be divided into three distinct groups:

- Acoustic classes 1, and 2 have fine-grained sediments and primarily lack coarser grained particles
- Acoustic classes 7 and 8 have primarily coarse-grained sediments, minimal finer particles, and likely contain exposed bedrock or hardpan
- Acoustic classes 3, 4, 5, and 6 are more heterogeneous than the above classes and contain both fine and coarse particles

Examination of other sample properties, such as depth and grab penetration, enables further distinctions between acoustic classes. Table 4.1-1 summarizes the key sample characteristics that informed this analysis. The following are distinguishing characteristics of each acoustic class:

- Acoustic class 1 is fine-grained with all samples comprised of a combination of coarse and fine-grained sand. Seven percent of samples had laminate stratification and this class covers the largest area within the study areas. The depth of grab penetration suggests substrates in this class were loosely packed or unconsolidated.
- Acoustic class 2 is the finest grained class. All samples were silt/clay and generally lacked any subdominant component. This class is located along the channel shoreline in the shallowest water.
- Acoustic class 3 is fine-grained but includes coarser grains such as coarse gravel and cobble in some samples. The class had the highest frequency of open grab attempts mainly due to the large presence of woody debris. The shallow overall grab penetration depth also suggests the presence of densely compacted sediment.
- Acoustic class 4 is primarily fine-grained with some samples comprised of fine sand and others containing coarse gravel. The highest frequency of laminate structure was observed in this class. Similar in composition to class 3, except the deeper grab penetration and lower frequency of failed grabs suggests the presence of less compacted sediment and less woody debris.
- Acoustic class 5 is a mixture of fine grains and medium gravel and exists primarily adjacent to the bridge for the West Alternatives. The deeper depth of grab penetration suggests an overall “soft” substrate type. However, empty grabs were also frequent (n=5) and may be indicative of boulder rip rap substrates typically used to armor bridge piers.

It is also interesting to note that MCDI did not classify sediments around the second set of bridge piers.

- Acoustic class 6 is probably coarse-grained but may be a matrix of fine and coarse-grained substrate. One undisturbed silt/clay sample was retrieved from within this class. The frequency of open, empty, and disturbed grabs was high in this class and suggests the presence of coarser substrates. The presence of coarse substrates was confirmed in the underwater imagery.
- Acoustic class 7 is coarse-grained with most samples comprised of coarse gravel and/or cobble and a few samples containing a small amount of fines. The shallow depth of penetration and substantial frequency of disturbed samples suggest that coarse material is overlain on clay hardpan, boulder or bedrock in this class.
- Acoustic class 8 is comprised of substrates that are difficult to sample even with a large and heavy sampler like the one used in the study. Possible substrate types include hardpan clay, boulder, or bedrock. MCDI classified this area as bedrock but an exposed hardpan clay outcrop on the margin of the channel (Figure 4.1-1) was observed during a low flow period. The proximity of this feature to acoustic class 8, plus the fact that an undisturbed silt/clay sample was retrieved from this class, raises the possibility that the bedrock classification is incorrect.

Table 4.1-1. Summary of Stantec's Ground Truthing Characteristics of MCDI's Acoustic Classes

	ACOUSTIC CLASS							
	1	2	3	4	5	6	7	8
DOMINANT GRAIN SIZE	Fine Sand	Si/Cl	Fines, Coarse Gravel	Fine Sand, Coarse Gravel	Medium Gravel, Fines	Si/Cl	Coarse Gravel	Bedrock
SUBDOMINANT GRAIN SIZE	Coarse Sand	N/A	Fines, Cobble	Coarse Sand	Medium Gravel, Fines	N/A	Cobble	Si/Cl
% OF TOTAL GRAB ATTEMPTS EMPTY OR DISTURBED	7.14%	0.00%	12.5%	0.00%	55.6%	42.9%	25.0%	87.5%
% OF TOTAL GRAB ATTEMPTS OPEN	7.14%	0.00%	50.0%	0.00%	0.00%	42.9%	15.0%	0.00%
% OF SAMPLES WITH LAMINATION	10.0%	40.0%	0.0%	50.0%	0.00%	0.00%	0.00%	0.00%
MEDIAN GRAB PENETRATION (MM)	86.0	76.0	36.0	66.0	96.0	81.0	46.0	146

Figure 4.1-1. Photo Evidence of Clay Hardpan in Acoustic Class 8

4.2 COMPARISON TO MCDI SUBSTRATE CLASSES

Direct comparison of our ground-truth survey findings to the substrate classes estimated by MCDI's side scan sonar and bathymetric survey was difficult since MCDI did not use dominant grain sizes to classify the substrate of every acoustic class. For instance, MCDI used the prevalence of "woody debris", instead of a dominant grain size, to represent acoustic classes 3 and 4. While our grab sampling did verify the presence of woody debris in these classes, sediment sampled from these classes was a heterogeneous mixture of fine and coarse grains. The difference between sand and sand-gravel mixtures is largely indiscernible from evaluation of side scan reflectance signatures, making distinction of these classes using the side scan sonar data alone difficult (MCDI 2018). MCDI classifications for classes 1 and 2 (sand and silt/sand, respectively) were confirmed by field sampling efforts. Class 8 was classified by MCDI as bedrock, but field sampling suggests that this class is potentially a clay hardpan layer.

We recommend that the classifications provided by MCDI be revised as suggested in Table 4.2-1. These revisions are recommended for the entire acoustic sonar data set because 1) the data processing algorithms MCDI used for the original classifications did not differ between impact areas and non-impact areas; and 2) the field verification samples were randomly selected and are therefore representative of all substrates, not just those within the impact areas.

Table 4.2-1. Suggested Revised Acoustic Classification Based on Ground-truthing

ACOUSTIC CLASS	MCDI HYPOTHESIZED SUBSTRATE CLASS	FIELD-INFERRED SUBSTRATE CLASS	TOTAL AREA (ACRES)
1	Sand	Sand	4,853.7
2	Sand/Silt shoreline	Silt/Clay	1,347.0
3	Woody Debris	Silt/Clay – Fine Sand - Gravel	50.3
4	Sparse Wood	Fine Sand – Coarse Gravel	543.5
5	Manmade Debris	Heterogeneous Mixture	11.5
6	Unknown	Cobble – Silt/Clay	72.8
7	Cobble Over Bedrock	Coarse Gravel – Cobble – Hardpan/Bedrock	971.7
8	Bedrock	Hardpan/Bedrock	896.2

4.3 IMPLICATIONS FOR MUSSEL HABITAT

The purpose of this study was to ground-truth the substrate data collected during the side scan sonar survey. A surficial review of the "recommended" substrate classes, as inferred from field data (Table 4.2-1) and the implications for mussel habitat are presented in this section. A more detailed analysis of the relationship between substrates within West and Central Alternative 1 impact areas and the distribution and abundance of freshwater mussels is presented in INDOT and KYTC (2018).

Acoustic class 1 was the dominant substrate in the study area, in both the West and Central Alternatives impact areas. However, it encompassed more area in the West Alternatives (52.2 acres) than in Central Alternative 1 (31.2 acres). Review of the imagery suggests that much of the Ohio River bed within this acoustic class was comprised of dune waveforms. Such substrates are typically mobile (saltation) and are too unstable to support freshwater mussels. The depth of grab penetration in this acoustic class corroborates observations regarding the unconsolidated nature of much of the sand in this acoustic class. It was impossible, within the scope of this study, to differentiate between class 1 sand substrates that could be capable of supporting mussels and those that could not. Nonetheless, for future mussel surveys, we recommend only limited sampling in this area, perhaps focused on the margins of the class boundaries.

Evidence of freshwater mussels was only detected in acoustic class 7 which apparently consists of cobble over some kind of impermeable layer. This type of habitat was not documented in the West Alternative but was the second largest substrate class in Central Alternative 1. If Central Alternative 1 is selected as the Preferred Alternative, this acoustic class should be the focus of surveys to detect special status freshwater mussels. We suspect that class 8 will provide poor habitat for freshwater mussels and recommend only limited survey effort in this area. Acoustic class 2 was dominated by silt/clay substrates which sometimes support lentic species, such as the endangered fat pocketbook (*Potamilus capax*). The remaining acoustic classes encompassed relatively small discrete areas and were comprised of sand dominant but heterogeneous substrates. Most of these classes appear capable of supporting freshwater mussels.

CHAPTER 5 – CONCLUSIONS

The side scan sonar survey by MCDI produced broad acoustic classes in the West and Central Alternative study areas that were related to substrate classes. Ground-truthing of river bed sediment evaluated the extent to which acoustic classes correspond to substrate types. Based upon the collected field data, different grain size classes were associated with each class. The majority of sediment samples were fine grains, comprised of either sand or silt/clay. Classes 1 and 2 combined to cover the largest area in both West and Central Alternatives and represent sand and silt/clay respectively. Coarse grained sediment dominated class 7 and little fine-grained sediment was collected. The field sampling confirmed that substrates in this acoustic class are capable of supporting freshwater mussels. Class 8 was identified as a bedrock/clay hardpan layer. For the remainder of the classes (3, 4, 5, and 6), no singular grain size class was dominant for all sediment samples. This suggests a mixture of fine and coarser material is present in these classes. The presence of woody debris caused frequent grab failure in classes 3 and 4, limiting the effectiveness of grab sampling. Although field verification of classes 3, 4, 5, and 6 found no evidence of freshwater mussel presence, these heterogeneous substrates likely provide suitable habitat for many mussel species.

CHAPTER 6 – LITERATURE CITED

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2017 *Screening Report t: I-69 Ohio River Crossing Project Evansville, IN and Henderson, KY.*

2018 *Rare Species Habitat Assessment and Wildlife Technical Report*.

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2017 "USGS 03322000 Ohio River at Evansville, IN". accessed January 8, 2017, https://waterdata.usgs.gov/nwis/uv?site_no=03322000

APPENDIX A

I-69 ORX Section 7 Meeting Minutes

MEETING SUMMARY

Date: September 11, 2017

Time: 10:00 AM ET

Meeting: I-69 ORX Section 7 Meeting; Mussel Survey Approach

Location: Kentucky Transportation Cabinet; 200 Mero Street, Frankfort, KY 40622

List of Attendees:

Name	Organization	Email
Dan Miller	Parsons	Daniel.J.Miller@parsons.com
Nancy Allen	Stantec	nancy.allen@stantec.com
Lee Andrews	U.S. Fish and Wildlife Service	Lee_Andrews@fws.gov
James Kiser	Stantec	James.Kiser@stantec.com
Leroy Koch	U.S. Fish and Wildlife Service	Leroy_Koch@fws.gov
Dave Harmon	KYTC/DEA	Dave.Harmon@ky.gov
Phil Degarmo	U.S. Fish and Wildlife Service	Phil_DeGarmo@fws.gov
Tim Foreman	KYTC	Tim.Foreman@ky.gov
Nathan Click	KYTC	nathan.click@ky.gov
Dan Prevost	Parsons	Daniel.Prevost@parsons.com
Eric Rothermal	FHWA	Eric.Rothermel@dot.gov
David Waldner	KYTC	David.Waldner@ky.gov

SUMMARY

1) Dave Waldner discussed the purpose of the meeting: To determine whether the benefits of getting mussel/habitat work done this fall outweigh the benefits of waiting and doing all of the work next year.

2) Dan Prevost, Parsons' Environmental Lead for the I-69 Ohio River Crossing (ORX) Project, gave an overview of the project:
   - The project started with five corridors (alternatives), and has been narrowed down to three (both eastern corridors have been eliminated).
   - Regarding the crossing of the Ohio, both west corridors are identical; immediately adjacent to the current US 41 bridges.

- Central Corridor 1 is approximately 1.5 miles upstream, and must occur in-between two existing interchanges, limiting the potential study area. Utilities, a state forest, TV tower, and an Imperiled Bat Conservation Fund (IBCF) property also limit where the bridge can potentially be placed.

3) Phil DeGarmo, U.S. Fish and Wildlife Service (USFWS) asked what was currently proposed for the existing bridges. Dan Prevost stated:
    - The bridges are approximately 80 and 50 years old, and are currently not in great condition.
    - All options are currently on the table and will be evaluated as part of the environmental process.
        - If the west corridor is built, both existing bridges may potentially be eliminated.
        - If the central corridor is built, options for keeping both, one, or none of the existing bridges will be evaluated.
    - The new bridge will potentially be tolled. This may affect the existing bridges.
        - Traffic access may potentially be limited.
        - The existing bridges may potentially be tolled.

    Phil DeGarmo, USFWS, stated that for the purpose of this meeting, the "worst-case" scenario (removing both bridges) would be assumed. Therefore, mussel surveys will be conducted at two locations; Central Corridor 1 and at the crossing for both West Corridors (at the existing bridges and potential new crossing).

4) Dan Prevost gave an overview of the project schedule.
    - The draft environmental impact statement (DEIS) is scheduled to be completed in the fall of 2018. The DEIS will identify the Preferred Alternative.
    - A combined final environmental impact statement (FEIS)/record of decision (ROD) is scheduled to be completed in the fall of 2019.

5) Phil DeGarmo stated that, until the results of the FEIS are finalized, USFWS will assume an impact on the West Corridors. Nathan Click, KYTC, clarified that it will be an assumed habitat impact, due to the known presence of mussels in the Green River and within this stretch of the Ohio, and the likelihood that suitable habitat is present. James Kiser, Stantec, noted that habitat around the existing piers has likely been reduced due to scour.

6) Lee Andrews, USFWS, noted that:
    - The survey area is relatively small.

- Data collected won't change whether it is collected this year or next.
- Collecting data this year provides the benefit of additional time to react to what is found and figuring out solutions.

7) Phil DeGarmo discussed the side-scan sonar, and asked if it could be done within the same season as the official survey. He also asked if there were benefits to doing only the side-scan survey this season (without field verification), and doing all of field work next year.
    - James Kiser replied that, yes, it could be done in the same season. However, doing the side-scan sonar without field verification limits the accuracy and value of the sonar data.
    - Leroy Koch, USFWS, stated that doing the side-scan sonar without field verification would provide information on scour and stability. He noted that, whenever it is done, the data would be valid for a few years, and advised that it be done when it best fit into the project needs.

8) Dan Prevost asked if the side-scan sonar survey and field follow-up could eliminate the need for a formal survey.
    - Leroy Koch stated that it would not likely eliminate the need for the formal survey, but could significantly reduce the area of investigation. He also clarified that the side-scan sonar would require field verification, whether it is done this year or the following.

9) James Kiser noted that there is only likely 1.5 months remaining of safe dive time this year, if it is decided to do the side-scan sonar and field follow-up this year. He also noted that if Hurricane Irma brings a substantial amount of rain, the remaining field season could be affected/eliminated.

10) The project team and USFWS further discussed the different benefits between the side-scan sonar and field follow-up being conducted this year and the next.
    - Leroy Koch reiterated that there is likely habitat present where sensitive species could occur. Particularly the Fat Pocketbook, (*Potamilus capax*), which prefers soft sediment/sand that is relatively stable. His opinion was that doing the side-scan survey this year would benefit next year's survey. He also noted that a quick "drop down" follow-up by divers would help provide a lot of useful information.
    - Phil DeGarmo stated that the benefit would be saving time and reducing the level of effort on the following year's investigation. He reiterated that both surveys could be done back to back next year.

- Tim Foreman, KYTC, stated that it comes down to risk/reward. He noted that the data must be collected at some point, and that doing it this year will have time savings and not force the project team to schedule two dive surveys within one season.
- James Kiser stated that collecting the data this year also helps with the DEIS being prepared for the project by allowing the project team to better compare both alternatives and their potential impacts to endangered or threatened mussel species.

11) Nathan Click asked, if the side-scan sonar was done this year for both alternatives, and the preferred alternative is chosen before the formal survey, could the formal survey be done for just the preferred alternative?
    - Dan Prevost noted that by the time the preferred alternative is chosen, the project team will know:
        - What will happen with the existing bridges.
        - What type of new bridges will be built.
        - The location of the piers (the number of piers on the Central Corridor will depend on the # of spans used).
    - Leroy Koch noted that it would be very beneficial to have the follow-up surveys done with the side-scan sonar. Divers could take buckets of existing sediment and get photos (the project team was referred to a recent study done in Ohio).

12) David Waldner asked for clarification on if there was value to doing the side-scan sonar without verification now, and whether the side-scan survey alone could help reduce the area of investigations required for the formal survey.
    - Leroy Koch noted that by doing a side-scan survey without field testing, potential errors (or wrong assumptions) or difficult sediments, such as mixtures of sand and gravel, etc., could not be corrected or verified.
    - Lee Andrews noted that it could still be clarified at a later date, as the data from the side-scan sonar would still be valid.
    - Dave Waldner noted that by waiting, the project team would know the location of the piers and the decision on what is to happen to the existing bridges.

13) Dave Waldner asked, if the project team did the side-scan sonar and follow-up field work now, would it definitely eliminate transects?
    - Leroy Koch and Lee Andrews both noted that they could not definitely

promise less transects before the data is known.

14) James Kiser asked whether or not dredging would definitely be required for the removal of the existing bridges.
    - Lee Andrews noted that side-scan sonar would let you know how deep you are, and help plan out what methods may be required.
    - Phil DeGarmo stated that not everything can be foreseen, such as barge staging requirements, etc.
    - Dave Harmon, KYTC/DEA, noted that the side-scan survey would provide information on habitat needed for permitting.

15) After these discussions, Phil DeGarmo suggested that side-scan sonar and field verification be conducted this year, due to the benefits and the likelihood that it could help direct and refine recommendations throughout the process.

16) Dave Waldner asked for clarification on the proposal for the work to be done.
    - Dan Prevost stated that cost proposals have already been received for the side-scan sonar work.
    - James Kiser noted that the level of effort needed to be clarified to be able to put together the proposal for the follow-up field work.
        - Leroy Koch stated that the follow-up is not a full mussel survey, but just a quick check identifying substrate with minimal work done if any mussels are found. He noted that the survey would provide a quick quality assurance to the side-scan sonar. He reiterated that the follow-up checks are necessary to get more useful information such as percent substrate, and again noted the example from another location on the Ohio River as a template.
    - Tim Foreman stated that the work done this year needs to cover demolition impacts and the farthest reach of construction impacts.
    - Dave Waldner concurred, and asked for clarifications on a conservative survey area to ensure additional work would not be required later in the process.
    - Phil DeGarmo stated that side-scan sonar will help USFWS define the reach of construction impacts. He noted that if there is a minor change in limits, it should not have a substantial effect as the information collected will also provide information on what should be further upstream.
    - Leroy Koch and Phil DeGarmo determined that the project team should survey 300 meters downstream and 100 meters upstream of the areas of impact for the side-scan sonar. hey noted that this has been used on other large bridge surveys.

17) Dan Prevost asked whether the side-scan survey results may help determine/affect the demolition options on the existing bridges, and whether there could potentially be information collected this year that would drive the project team to a certain alternative.

- Phil DeGarmo stated that the level of impacts can be substantially different depending on how a bridge is dismantled, etc. He noted that knowing the substrate type could help determine recommendations for how the work will be done. The level of impacts would be defined by what is found in the surveys.

18) James Kiser noted that, historically, if a project finds a decent concentration of mussels, USFWS typically assumes that endangered species known within the area will be present and considered impacted.

- Leroy Koch confirmed that USFWS would assume listed species are present if such populations were found. He stated that if mussel populations are present, USFWS would want to see assemblages. From current known information, this is not likely. USFWS would want to know the number of Fat Pocketbook identified. Also, if the project team found more riverine assemblages, more work may be required.
- Phil DeGarmo stated that, although the listed species were assumed, the impact would be more defined (much smaller than the entire reach).

19) Lee Andrews stated that due to the presence of the Green River, the sediment that it brings into the area, and the known species within the area, there is likely habitat present within the project area.

20) Nathan Click asked for a consensus that the side-scan survey and field follow-up will be conducted this year, and a full survey will occur next year within defined areas within the preferred alternative. This was agreed upon by everyone present.

CONCLUSIONS

1) A side-scan survey and field follow-up will be conducted this year, and a full survey will occur next year within defined areas within the preferred alternative.

2) The project team will survey 300 meters downstream and 100 meters upstream of the areas of impact for the side-scan sonar.

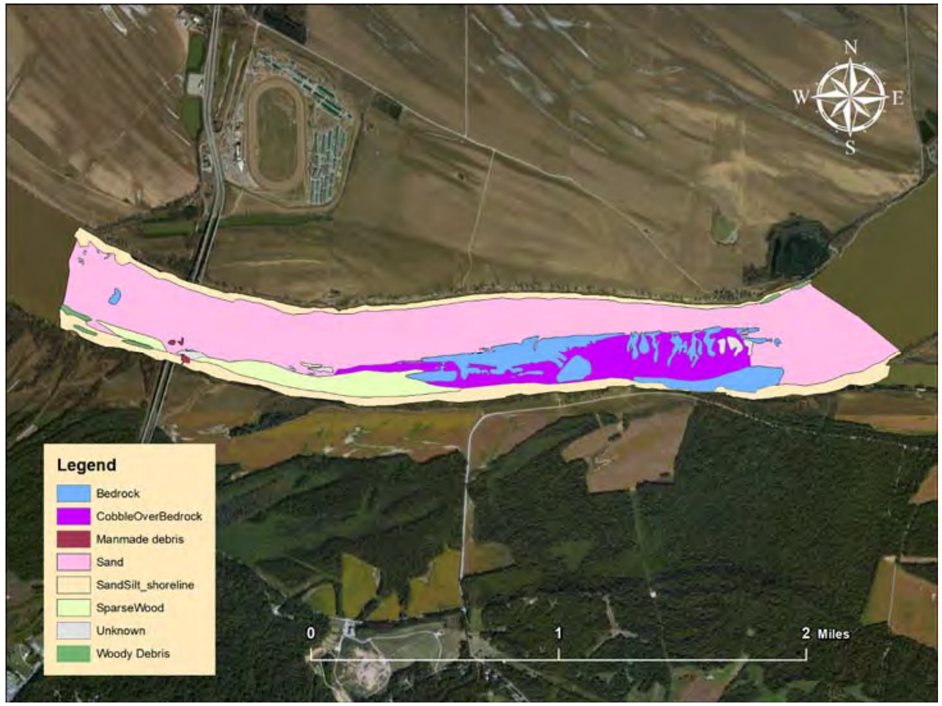
3) A report will be prepared detailing the information found.

APPENDIX B

MCDI Report

Side Scan and Bathymetric Soundings

Potential I-69 Bridge Site
Near Henderson, KY



Prepared By:

Mainstream Commercial Divers, Inc.
a MER company

322 C.C. Lowry Dr.
Murray, KY 42071

Prepared for:
Stantec
11687 Lebanon Road
Cincinnati, OH 45241

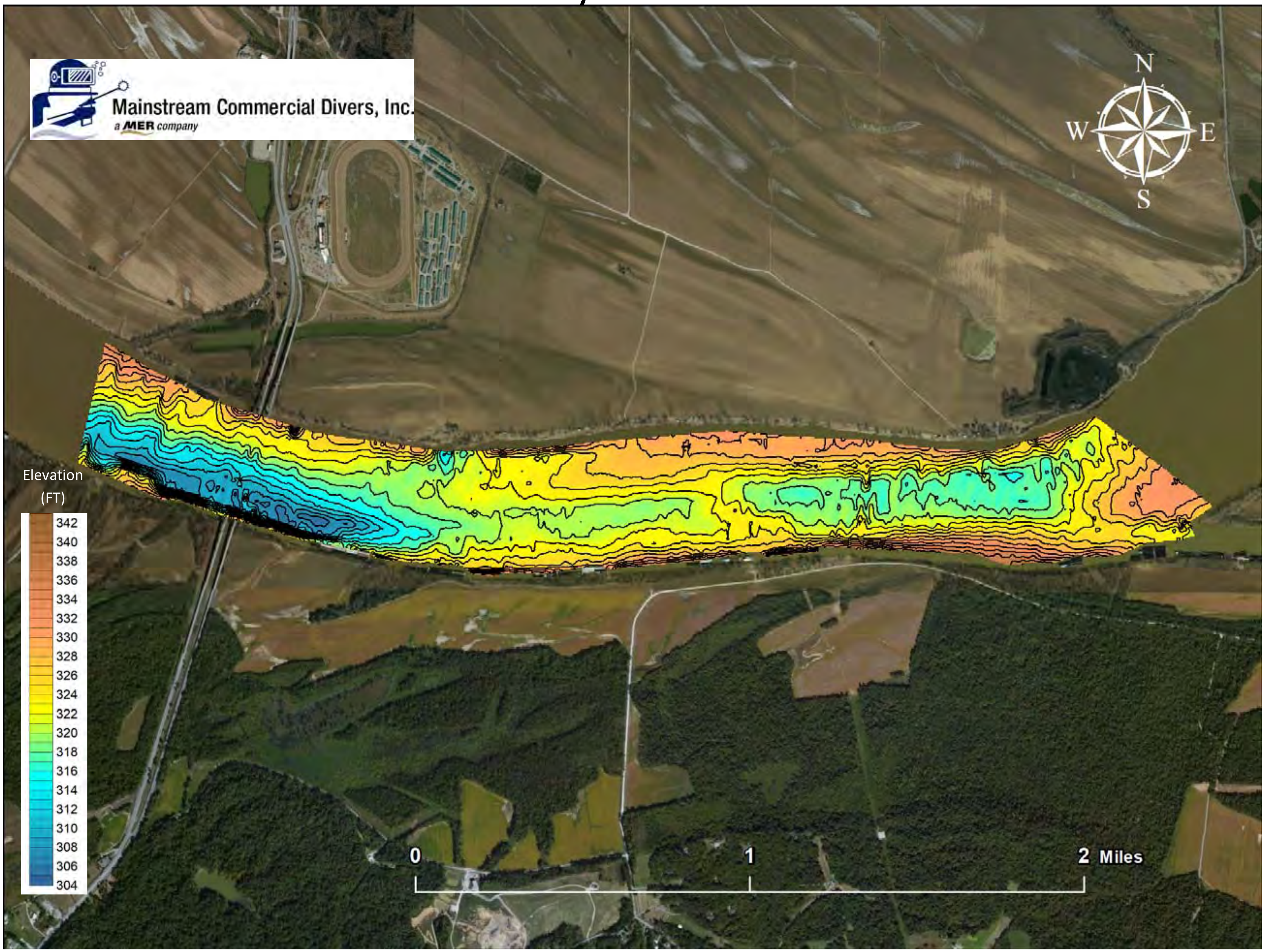
Stantec

Inspection Dates:
November 19 and 22, 2017

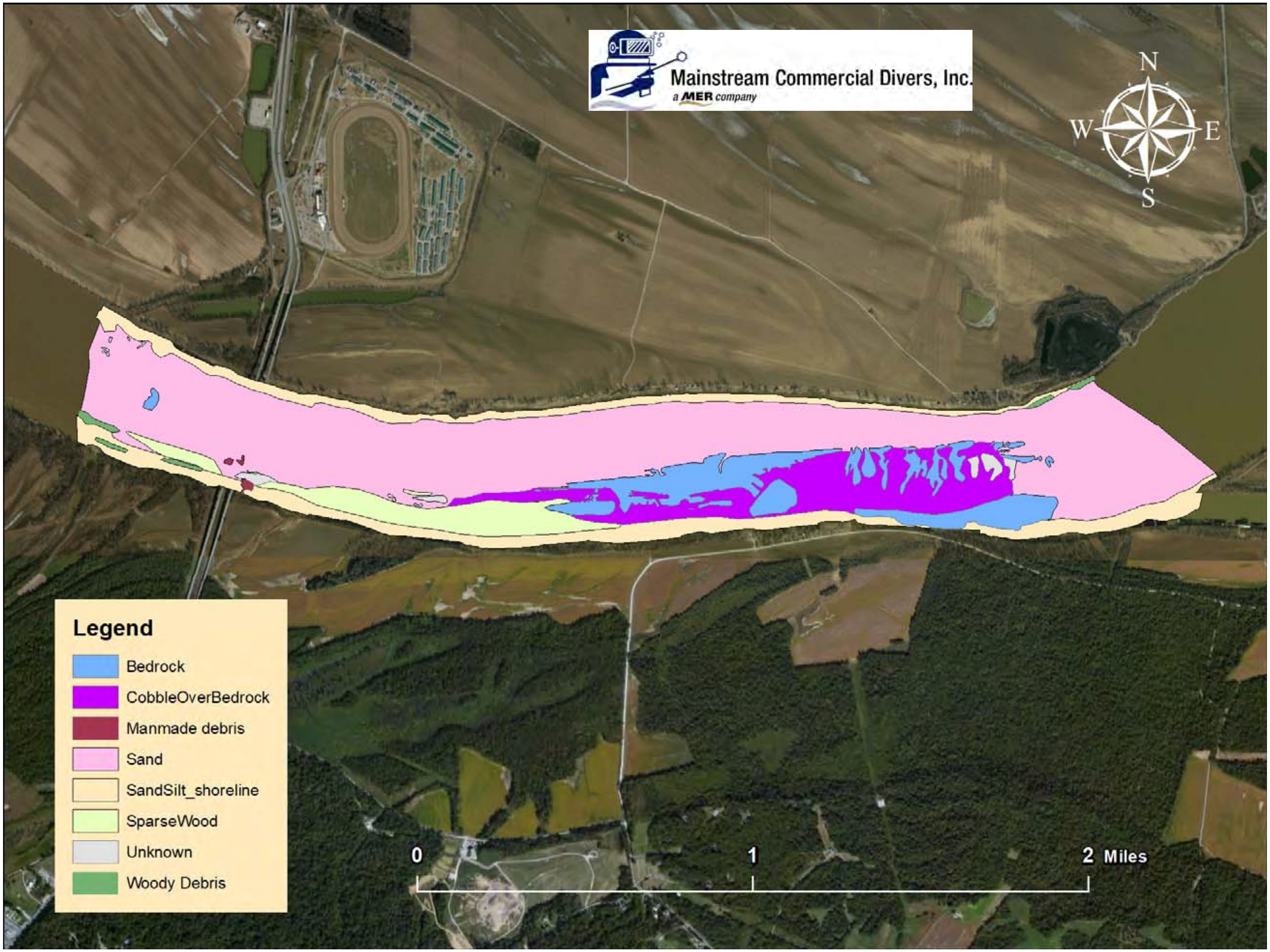
Bathymetric / Side Scan Survey Notes
Mainstream Commercial Divers, Inc.

Date of Survey	November 19 & 22, 2017
Customer Name	Stantec
Site Location	Ohio River – ORM 784.1 – 787.5 (~ 3.5 miles)
Purpose of Survey	Side scan imagery, bathymetric data collection, and river substrate delineation for potential I-69 bridge site
Elevation Reference Info	Evansville gauge – Rivergauges.com
Water Elevation at Data Collection	345.4 (ORD) – 11/19/2017 350.2 (ORD) – 11/22/2017
River Conditions	Conditions on 19 November were very rough with surface winds approaching 20mph. Conditions on 22 November were favorable. Winds were light and variable. A few commercial vessels moved through at the time of data collection.
Horizontal Coordinates	Indiana State Plane West – feet (NAD83)
Equipment Used	Oquawka survey boat Trimble MS750 GPS Hypack v2017 Hydrographic Software Klein 3900 side scan sonar (455 kHz mode) Odom CV100 grade echosounder w/ 8 degree transducer
Additional Notes	Delineation of substrate is our best guess based on the side scan image data collected. Ground truthing should be performed to confirm our hypothesis. Additional CAD and shapefiles provided to Stantec via dropbox.

Overview of Bathymetric Data Collection

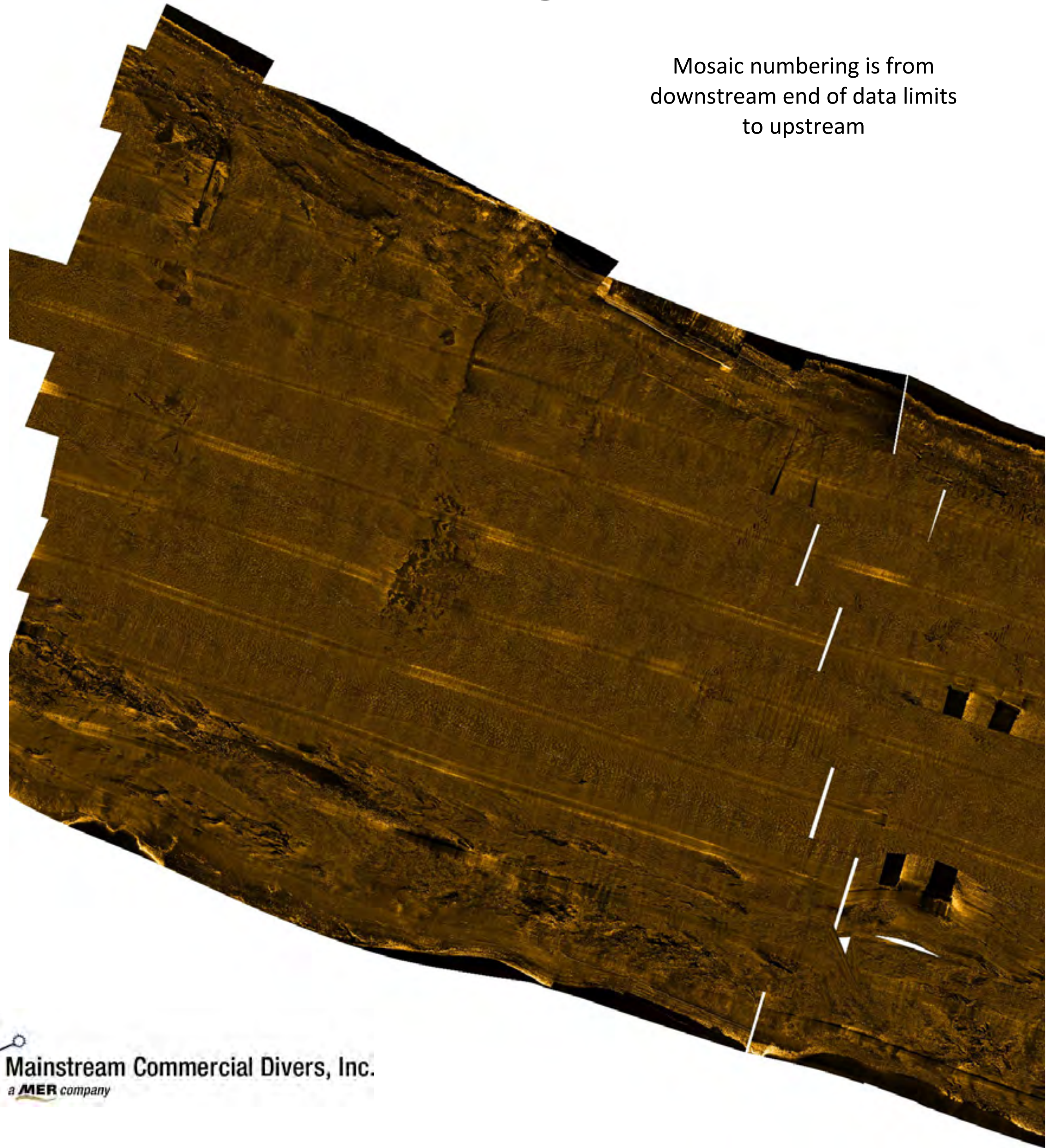


Delineation Overview



Side Scan Image Mosaic #1

Mosaic numbering is from
downstream end of data limits
to upstream



Mainstream Commercial Divers, Inc.
a MER company

Side Scan Image Mosaic #2

Mosaic numbering is from downstream end of data limits to upstream

Mainstream Commercial Divers, Inc.
a MER company

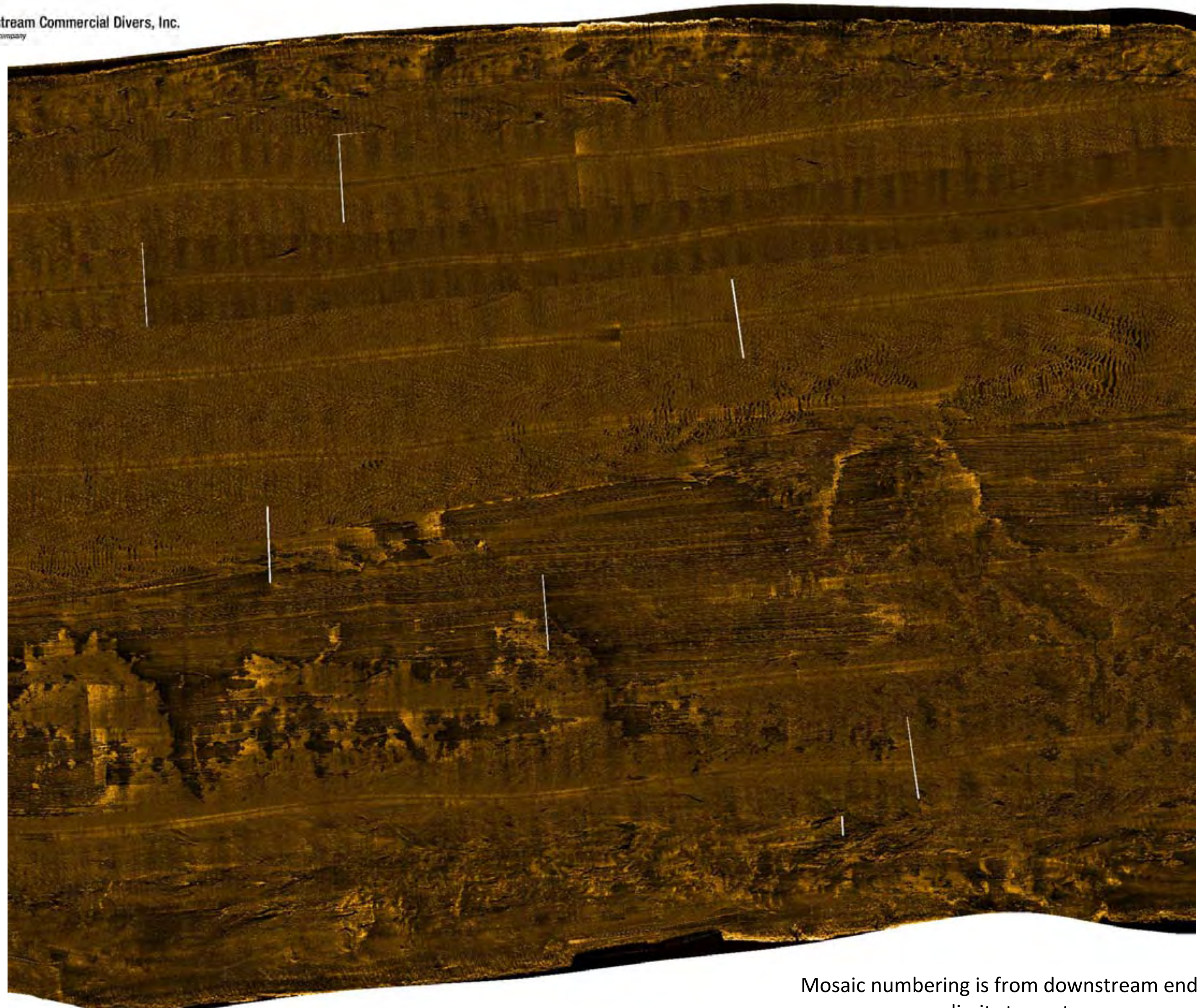
Side Scan Image Mosaic #3

Mosaic numbering is from downstream end of data limits to upstream

Mainstream Commercial Divers, Inc. a MER company

Mainstream Commercial Divers, Inc.
a MER company

Side Scan Image Mosaic #4



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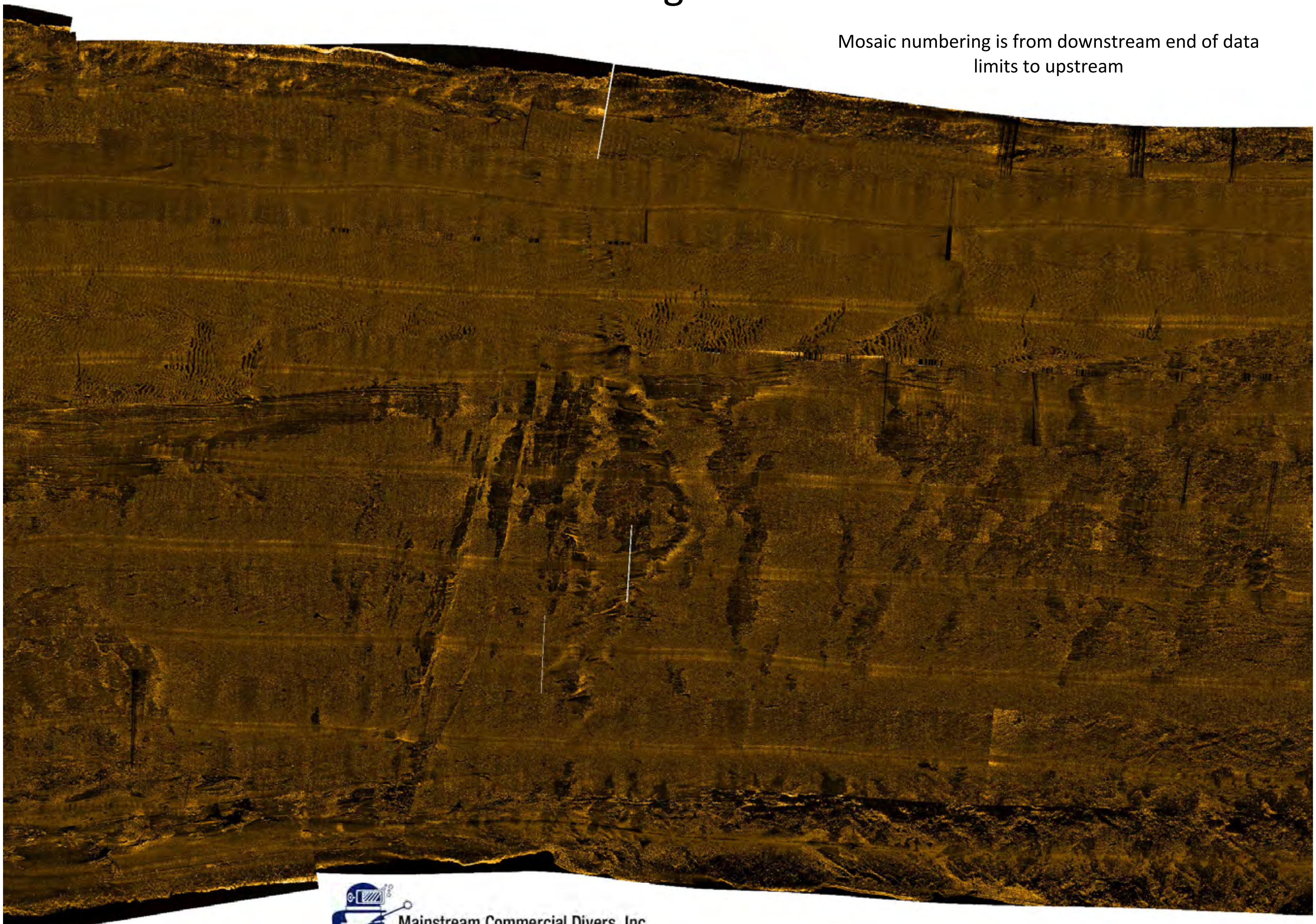
Side Scan Image Mosaic #5



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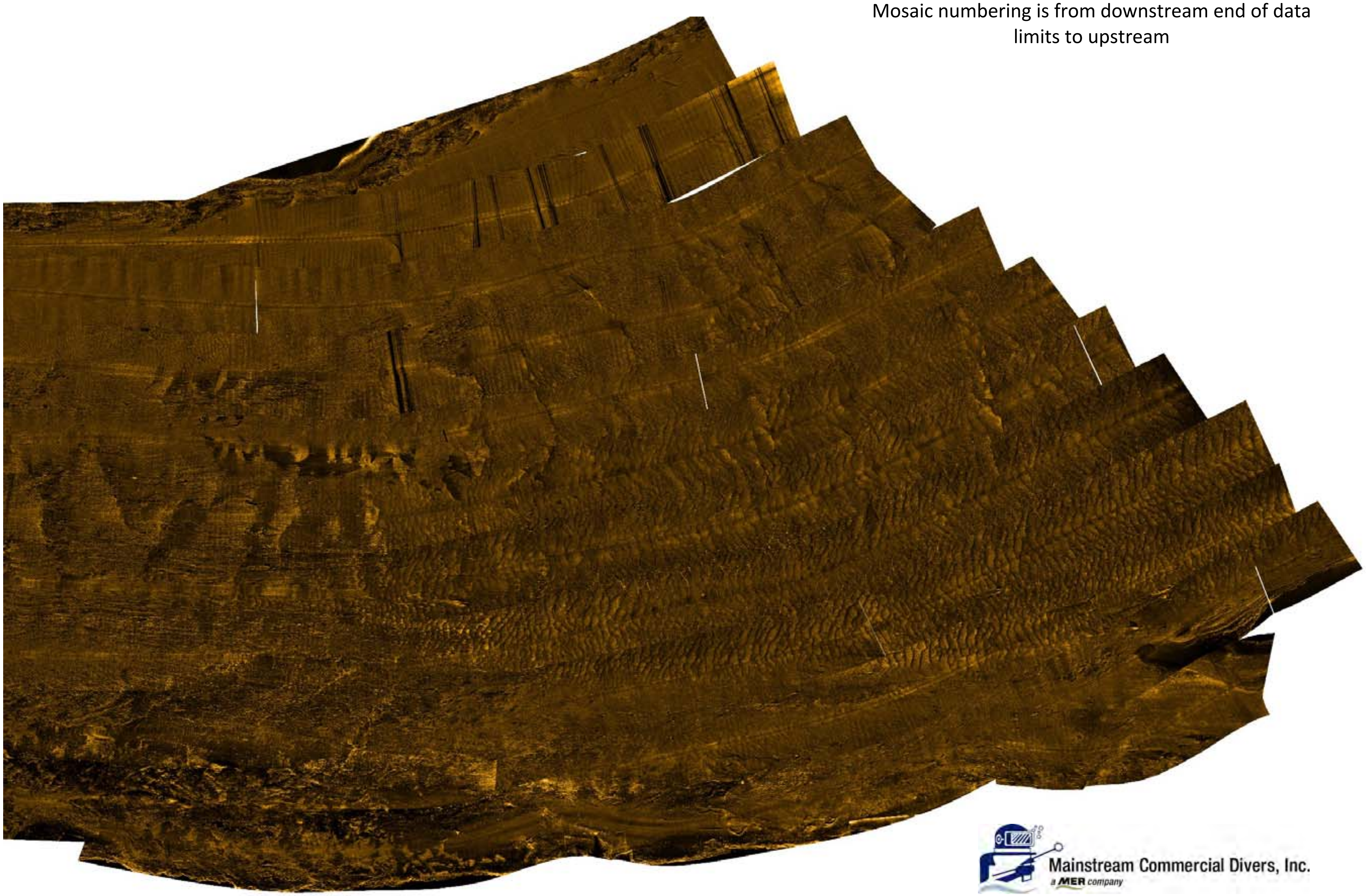
Side Scan Image Mosaic #6

Mosaic numbering is from downstream end of data limits to upstream



Mainstream Commercial Divers, Inc.
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APPENDIX C

Side Scan Sonar Mosaic Imagery

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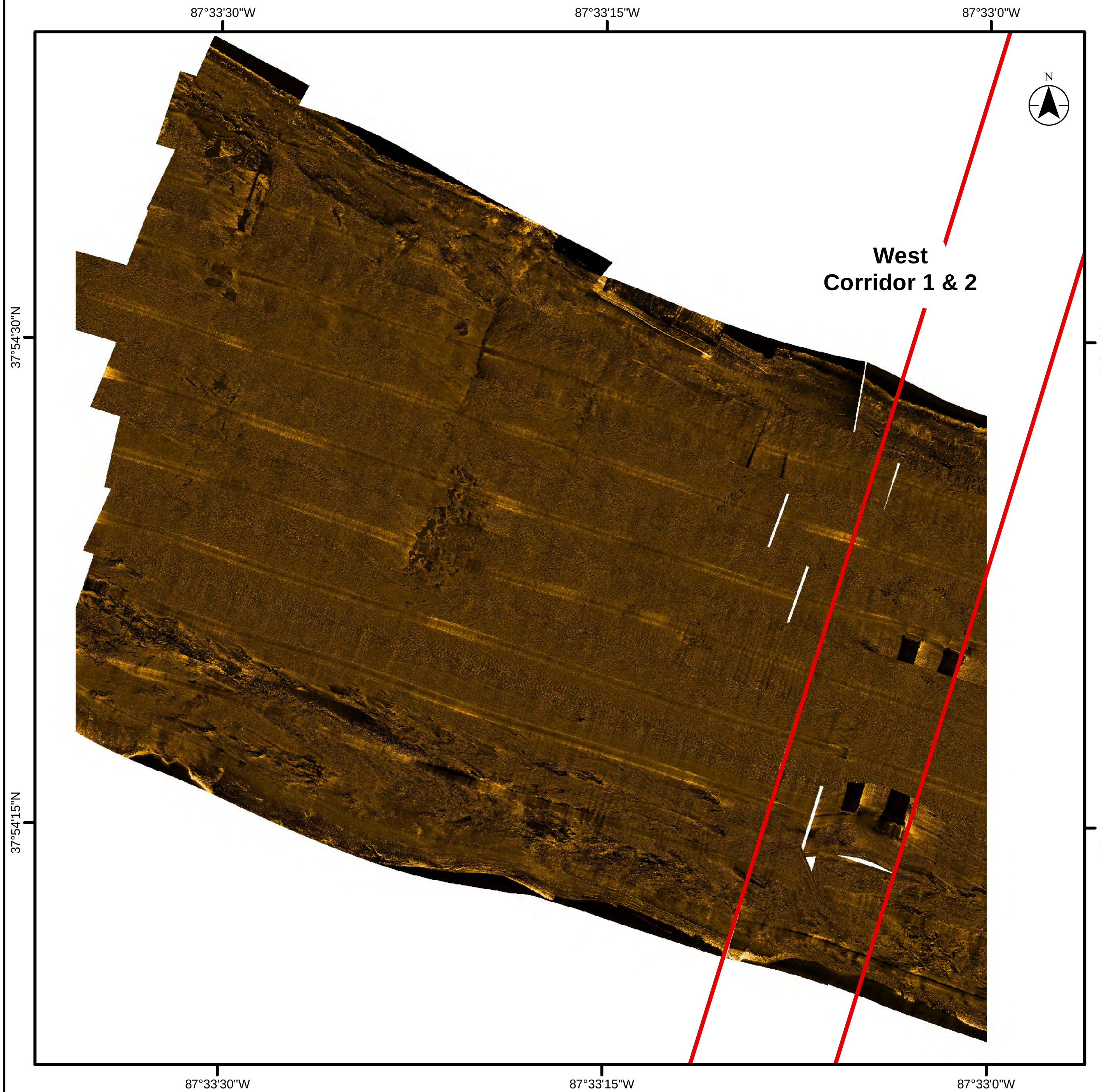


Mosaic numbering is from downstream limits of survey reach to upstream

Legend

Area of Impact

0 300 600 Feet

1:5,594 (At original document size of 8.5x11)

Notes

1. Coordinate System: NAD 1983 StatePlane Indiana West FIPS 1302 Feet
2. Base features: layer sources
3. Base Imagery: ESRI Map Services.

Project Location
Ohio River
Evansville, IN

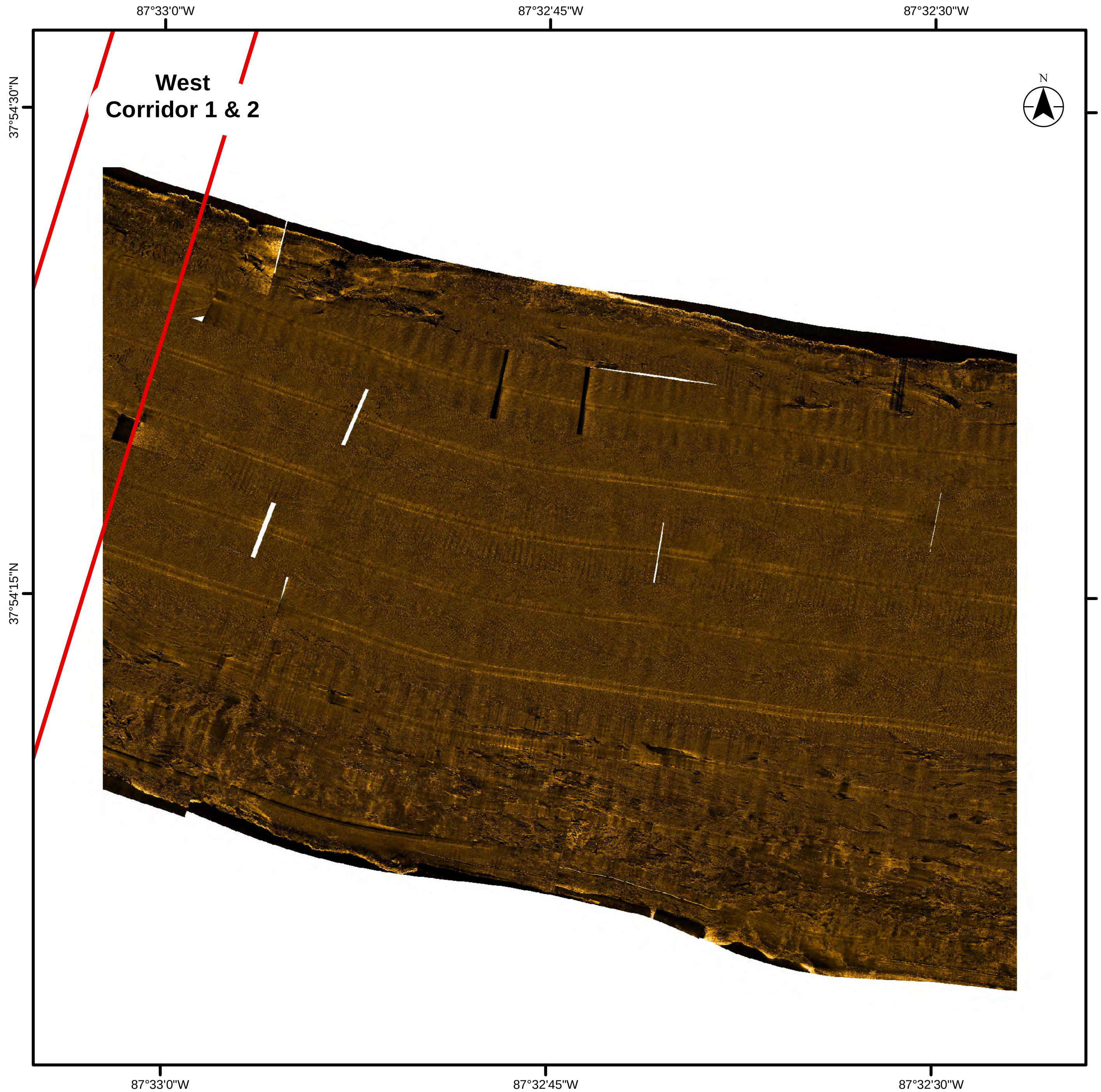
178567016
Prepared by EKD on 2018-01-04
Reviewed by WCF on 2018-01-19

Client/Project
Palmer Engineering
I-69 Habitat Assessment
Ground truthing of side scan sonar survey

Figure No.
A-1

Title
Side Scan Image
Mosaic #1

Page 01 of 01



Stantec

Mosaic numbering is from downstream limits of survey reach to upstream

Legend

Area of Impact

0 300 600 Feet

1:5,594 (At original document size of 8.5x11)

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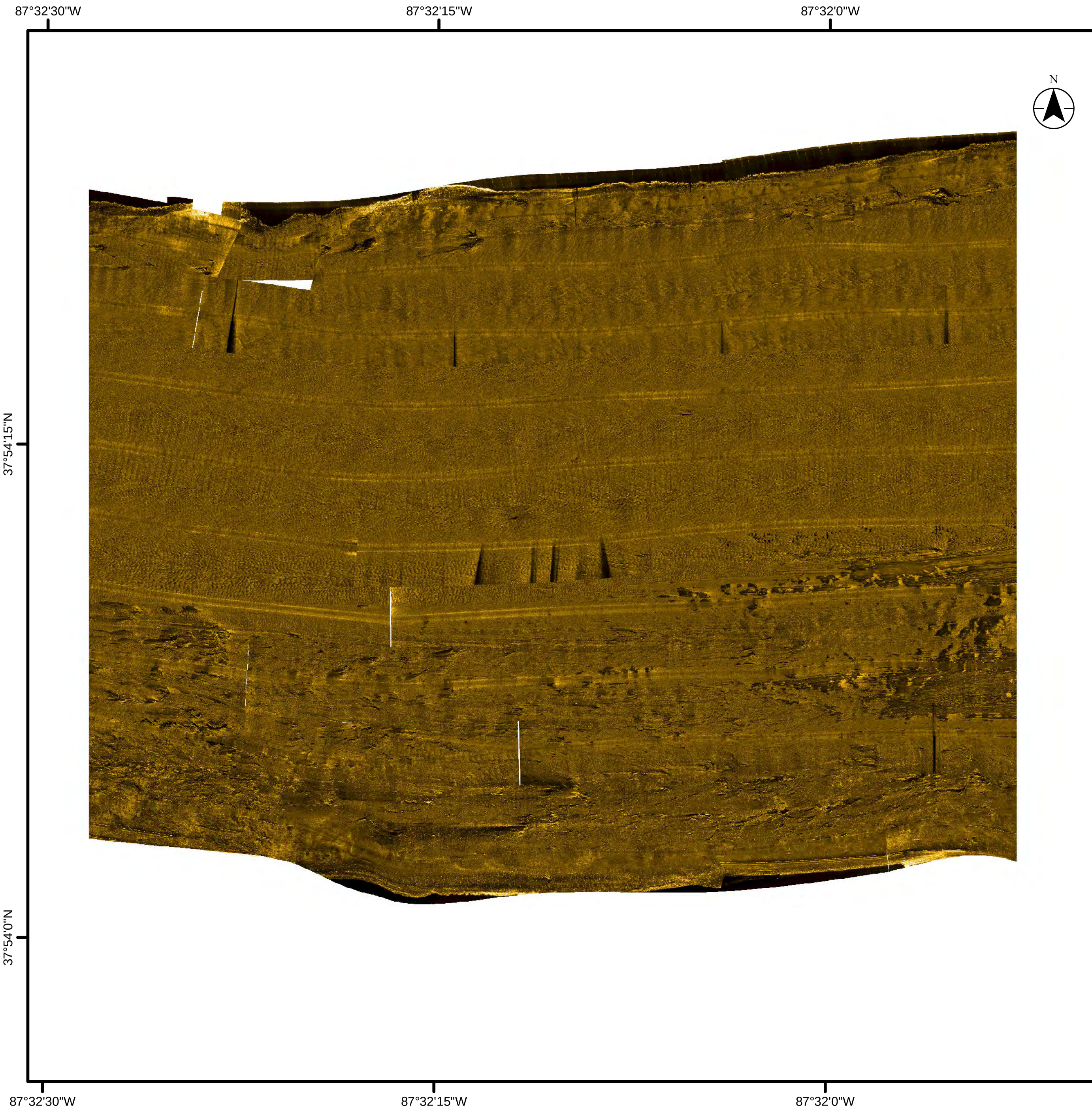
I-69 Habitat Assessment
Ground truthing of side scan sonar survey

Figure No.
A-2

Title
Side Scan Image
Mosaic #2

Page 01 of 01



Stantec

Mosaic numbering is from downstream limits of survey reach to upstream

0 300 600 Feet

1:5,594 (At original document size of 8.5x11)

Notes
1. Coordinate System: NAD 1983 StatePlane Indiana West FIPS 1302 Feet
2. Base features: layer sources

3. Base Imagery: ESRI Map Services.

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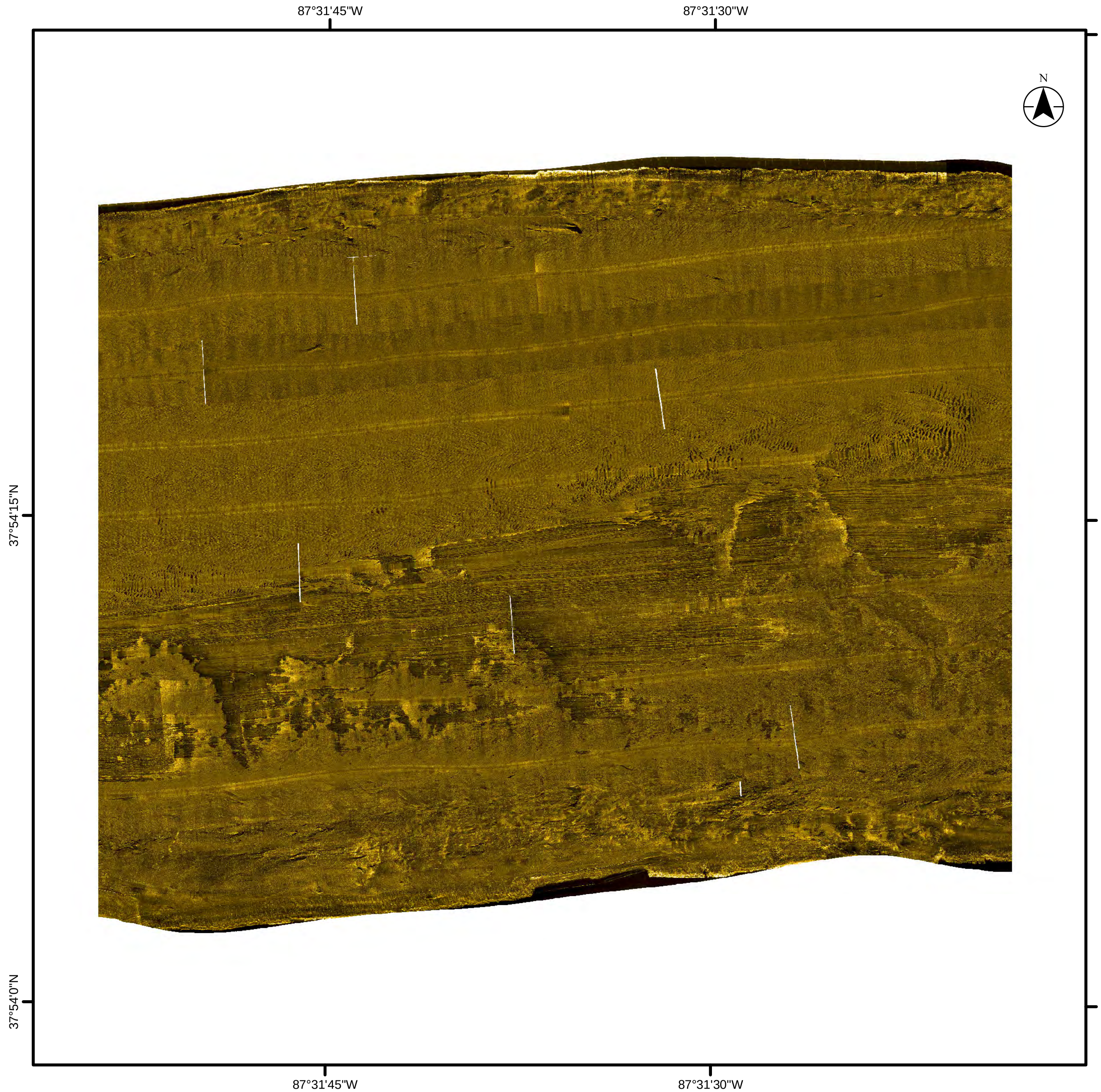
Client/Project
Palmer Engineering
I-69 Habitat Assessment
Ground truthing of side scan sonar survey

Figure No.
A-3

Title
Side Scan Image
Mosaic #3

Page 01 of 01

U:\1743\178566013\I_69_Bridge\05_report_Deliv\draft\Appendix\Mosaic4.mxd Revised: 2018-01-19 By: edilbone



Mosaic numbering is from downstream limits of survey reach to upstream

0 300 600 Feet
1:5,594 (At original document size of 8.5x11)

Notes
1. Coordinate System: NAD 1983 StatePlane Indiana West FIPS 1302 Feet
2. Base features: layer sources
3. Base Imagery: ESRI Map Services.

Project Location
Ohio River
Evansville, IN

178567016
Prepared by EKD on 2018-01-04
Reviewed by WCF on 2018-01-19

Client/Project
Palmer Engineering
I-69 Habitat Assessment
Ground truthing of side scan sonar survey

Figure No.
A-4

Title
Side Scan Image
Mosaic #4

Page 01 of 01

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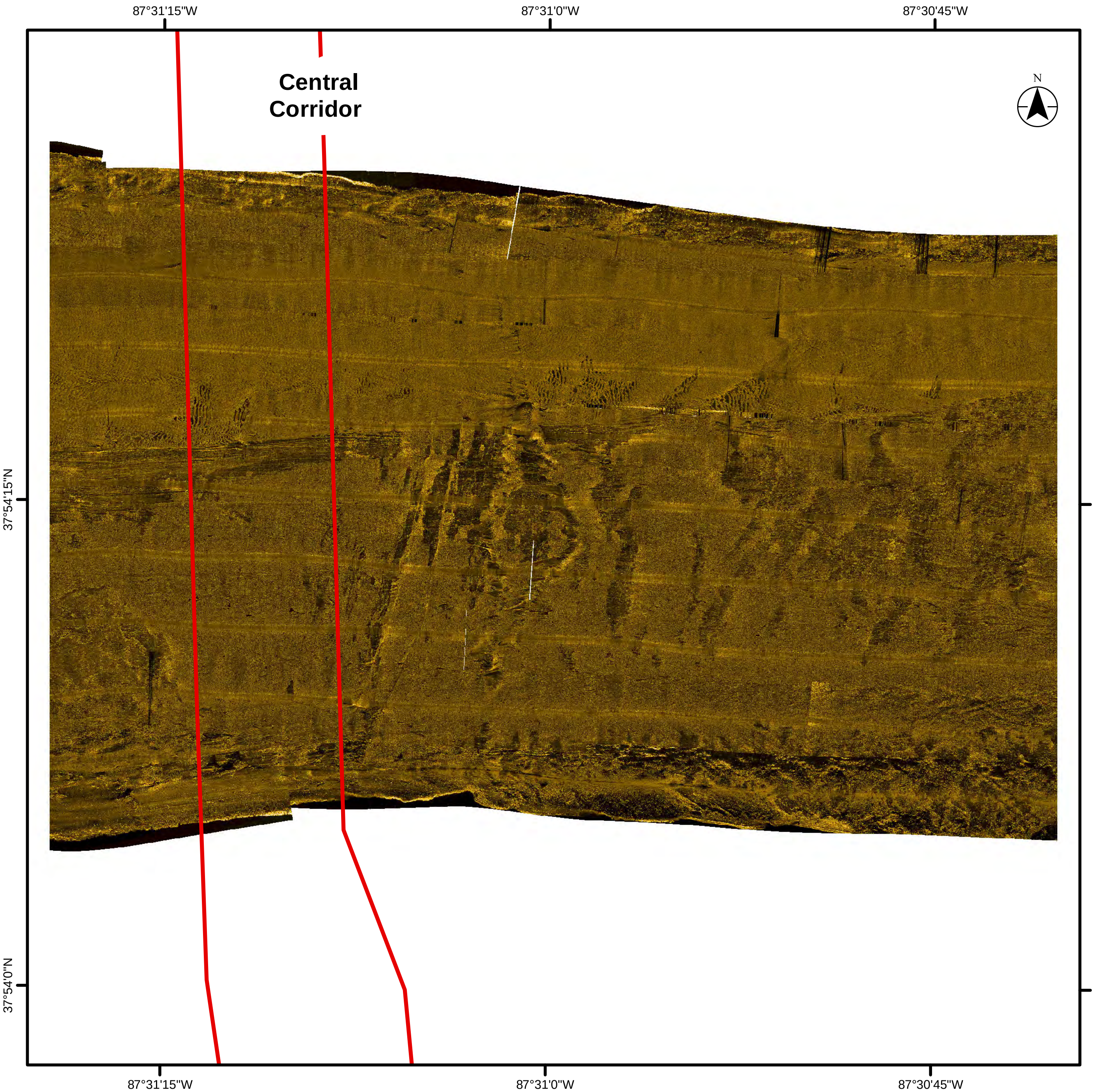


Mosaic numbering is from downstream limits of survey reach to upstream

Legend

Area of Impact

0 300 600 Feet

1:5,594 (At original document size of 8.5x11)

Notes
1. Coordinate System: NAD 1983 StatePlane Indiana West FIPS 1302 Feet
2. Base features: layer sources
3. Base Imagery: ESRI Map Services.

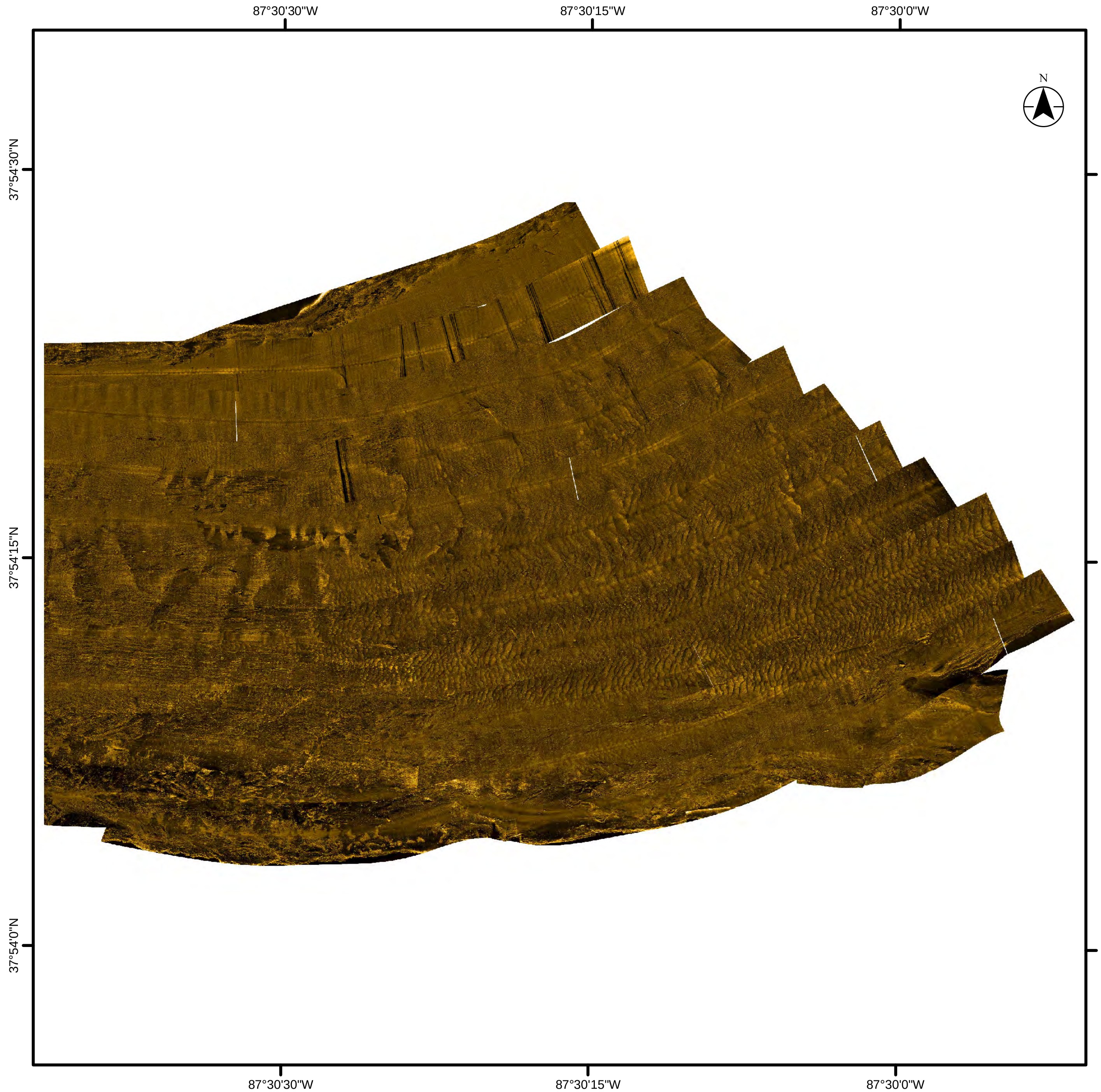
Project Location 178567016
Ohio River
Evansville, IN
Prepared by EKD on 2018-01-04
Reviewed by WCF on 2018-01-19

Client/Project
Palmer Engineering
I-69 Habitat Assessment
Ground truthing of side scan sonar survey

Figure No.
A-5

Title
Side Scan Image
Mosaic #5

Page 01 of 01



Stantec

Mosaic numbering is from downstream limits of survey reach to upstream

0 300 600 Feet

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Notes
1. Coordinate System: NAD 1983 StatePlane Indiana West FIPS 1302 Feet
2. Base features: layer sources
3. Base Imagery: ESRI Map Services.

Project Location
Ohio River
Evansville, IN

178567016
Prepared by EKD on 2018-01-04
Reviewed by WCF on 2018-01-19

Client/Project
Palmer Engineering
I-69 Habitat Assessment
Ground truthing of side scan sonar survey

Figure No.
A-6

Title
Side Scan Image
Mosaic #6

Page 01 of 01