

Approved

Enbridge Line 6B MP 608
Marshall, MI Pipeline Release
Case No.: 15-1411-CE
Report of Findings
Large Woody Debris Riffle Survey

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

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Approved: September 8, 2016

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ATTACHMENTS

Attachment A Standard Operating Procedures

Attachment B Photographic Log

LIST OF ACRONYMS

| | |
|---------------------|--|
| Ceresco Restoration | Ceresco Restoration Reach |
| Enbridge | Enbridge Energy, Limited Partnership |
| ft | feet |
| LWD | large woody debris |
| MDEQ | Michigan Department of Environmental Quality |
| MP | Mile Post |
| Yuma | Trimble® Yuma |

1.0 Introduction

Enbridge Energy, Limited Partnership (Enbridge) along with a contractor specializing in freshwater mussel surveys prepared an approach to conduct riffle surveys within large woody debris (LWD) work sites of the Kalamazoo River where heavy equipment may be used to install LWD. This approach, detailed in *Freshwater Mussel Evaluation & Management Plan Supplement to Large Woody Debris Installation Plan*, submitted to Michigan Department of Environmental Quality (MDEQ) on August 3, 2016 (Freshwater Mussel Plan) (Enbridge, 2016), included field verification of riffles. The engineered riffles constructed within the Ceresco Restoration Reach (Mile Post (MP) 3.50 – MP 5.25) have been previously identified and documented and therefore were not surveyed.

1.1 Objectives

The purpose of this survey was to identify and document riffles within potential travel routes of heavy equipment proposed to complete LWD installation on the Kalamazoo River. Data generated from this survey was used to re-assess potential travel routes for LWD installation activities to minimize impacts to riffle areas. Where impacts to these riffles are unavoidable, freshwater mussel surveys are proposed prior to navigating equipment through the impacted riffles.

The following sections outline riffle survey locations, methodology, and results; LWD riffle diversion routes for heavy equipment; and proposed mussel survey areas.

2.0 Riffle Surveys

2.1 Survey Locations

The riffle surveys occurred within areas scheduled for the placement or transporting of LWD with specific attention to areas where bottom substrates may be disturbed (also identified as survey areas). This included the following reaches of the Kalamazoo River:

- MP 2.25 downstream to MP 3.25 (Survey Area 1),
- MP 14.25 downstream to MP 15.00 (Survey Area 2),
- MP 19.25 downstream to MP 20.25 (Survey Area 3), and
- MP 32.25 downstream to MP 36.25 (Survey Area 4).

2.2 Methodology

Riffle surveys were conducted on August 1 and August 2, 2016, in accordance with the *Standard Operating Procedure for Identifying and Documenting Riffle Areas Within Work Segments of the Kalamazoo River*, included in *Attachment A*. In brief, this standard operating procedure includes locating pool to pool transition zones (probable areas for riffles to be present); identifying riffles through visual observations of flow lines, water depths, and presence and percent of various coarse bottom substrates; and recording the presence and relative abundance of macroinvertebrate and fish species to assist in identifying the value of the riffle to provide habitat for mussels.

On August 1, 2016, three technical staff representing Enbridge, inclusive of a senior aquatic biologist, a Certified Wildlife Biologist, and a stream morphologist, conducted riffle surveys and mapping of areas identified above as Survey Areas 1 and 2. Enbridge technical staff were accompanied by an Enbridge Environmental Inspector (EI) and a MDEQ representative. On August 2, 2016, this same field team, with the exception of the MDEQ representative, conducted riffle surveys and mapping of areas identified above as Survey Areas 3 and 4.

General field methods included launching from the boat launch site nearest the survey area and traveling by boat to the downstream edge of each survey area, and noting potential riffle areas during the trip downstream based on flow lines and locations between bends.

Commencing at the downstream end of the proposed LWD work area, the field team progressed upstream through the survey area, stopping at all potential riffle locations identified during the downstream trip as well as additional potential riffle areas identified during the

upstream survey. Water depths were measured at various points to assist with potential riffle identification, especially in transition areas between pools. The field team identified riffles in areas where water depths were relatively uniform across the river section, consistently shallow (less than 2.5 feet (ft) in depth) relative to upstream and downstream areas, and showed (in most cases) some evidence of turbulence on the water surface (commonly referred to as whitewater or rippling areas). These areas also had a mixture of coarser substrates containing at least three of the following particle sizes: boulder, cobble, gravel, and sand.

Shallow water areas between the pool to pool transition zones, which appeared to have substrates containing greater than 90% sand, lacked a mixture of coarser gravel and cobble substrates and also had relatively low to no macroinvertebrate or fish species. These areas consisted of unconsolidated and unstable sand and are not classified as riffles. The lack of riffles in combination with very low or no supporting biotic community of macroinvertebrate and fish species at these locations further supported unsuitable habitat for mussels. Field conditions in these areas, along with other potential riffle locations within each LWD work area, were recorded at survey points to document the absence of riffles in these survey areas. These survey points were recorded in a Trimble® Yuma (Yuma), including notes on water depth, river bottom substrate percentages, and any fish or aquatic macroinvertebrates observed. Photographs were taken of these features and representative photographs are provided in *Attachment B*.

In the areas where suitable riffle field indicators existed, the field team entered the river from the boat and mapped the riffle boundaries using a Yuma. The boundaries were entered as a polygon, while substrate and observations on fish and/or aquatic macroinvertebrates were entered as a survey point (identified on *Figure 1* as Riffle Survey Locations) near the polygon feature. Photographs were also taken of these features and representative photographs of several sites are provided in *Attachment B*.

3.0 Riffle Survey Results

Included as part of this report, *Figure 1* depicts the location of mapped riffles and additional survey points collected from August 1 and August 2, 2016 within the survey areas. In addition, *Table 1* summarizes the field data collected on these dates for all four survey areas, including both riffle and survey points. The following provides a summary of observations made in each survey area by the field team during completion of riffle surveys.

3.1 Survey Area 1

Survey Area 1 (MP 2.25 - MP 3.25) contained the highest riffle density of the four surveyed areas, including five locations exhibiting the field identification attributes for riffles (*Figure 1 – Sheet 1 and Sheet 2*). Riffles in this area were typically less than 1.5 ft in water depth with a mixture of cobble, gravel, and sand bottom substrates. Field observations included abundant fish and macroinvertebrates present within all of the mapped riffles. As previously noted, the lateral extents of the riffle across the river section were determined where a change in water depth (lack of consistent water depth near river banks) or bed sediment (change from cobble, gravel, sand mixture to sand/silt mixture) occurred. Therefore, riffle polygons in *Figure 1* do not extend laterally across the entire river channel from the left bank to right bank.

Geomorphic indications of transitions including sediment deposits forming islands within the river channel, affected the lateral and longitudinal extents of the identified riffles.

3.2 Survey Area 2

No riffles were identified in Survey Area 2 (MP 14.25 - MP 15.00), but survey points were documented (*Figure 1, Sheet 3*). The channel depths through surveyed areas varied from 0.7 ft to 2.6 ft, and the bed sediment was primarily fine sand and silt. No fish or macroinvertebrate sampling was conducted in this stretch, with few observed from the boat.

3.3 Survey Area 3

No riffles were identified in Survey Area 3 (Mile Post 19.25 - MP 20.25), but survey points were documented (*Figure 1, Sheet 4 and Sheet 5*). This reach of the Kalamazoo River exhibited several of the same features as Survey Area 2, with homogeneous bed substrate containing high fine sand content with trace gravel. Survey points were collected where riffles were most likely to exist, including cross-over areas between pools, and areas where water depth was less than 2.5 ft. Aquatic vegetation was present throughout the section, indicating slower water velocities and a lack of higher gradient bed slope.

3.4 Survey Area 4

Survey Area 4 (MP 32.25 – MP 36.25) contained six locations exhibiting the field identification attributes for riffles (*Figure 1, Sheet 6 through Sheet 11*). In contrast to the other three survey areas, a majority of the riffles contained boulders. Riffles also included a mixture of cobble, gravel, and sand with water depths ranging from 1.7 ft to 2.3 ft. Representative macroinvertebrate and fish taxa were observed, although the number and density were less than that observed in Survey Area 1.

4.0 Summary

Field teams surveyed areas of the river, within the proposed LWD work areas, for field attributes that would represent riffles in accordance with the *Standard Operating Procedures for Identifying and Documenting Riffle Areas Within Work Segments of the Kalamazoo River* included in *Attachment A*. Identified riffles were mapped and are depicted as polygons in *Figure 1*. Field teams also collected survey points in areas assessed that were not classified as riffles. Typically, these areas had water depths which exceeded 2.5 ft, unconsolidated and unstable bottom substrates dominated by sand with minimal gravel, and water velocities less than those identified in riffles, indicating low-quality macroinvertebrate, fish, and mussel habitat.

Enbridge has reviewed the riffle polygons generated from this riffle survey and the as-built riffle polygons located within the Ceresco Restoration Reach, in conjunction with LWD installation locations and travel routes for heavy equipment. Riffle polygons and LWD riffle diversion routes for heavy equipment are depicted on *Figure 2*. Enbridge will focus efforts on avoiding and minimizing impacts to these riffle locations wherever possible. Riffle boundaries will be marked with rope buoys prior to LWD installation activities to further define the travel routes around these riffles. If traversing riffle habitat is unavoidable, equipment will track along either the left or right edge of the riffle features. These areas alongside riffle habitat are typically lower velocity areas where finer sediment has accumulated to form banks or sediment bars. Refer to *Figure 2* for a depiction of proposed LWD diversion routes to limit impacts to riffles.

However, riffles located within the Ceresco Restoration Reach generally span the entire channel width; therefore Enbridge will not travel over these riffles with the tracked equipment, but attempt to traverse around these riffles with the excavator on the overbank. If traversing the overbank with an excavator is not feasible due to overbank impacts, Enbridge will propose an alternative overbank route to mobilize an excavator to the install locations to avoid these riffles. However, based on recent field experience utilizing the boat and barge timber delivery method in similar water depths, Enbridge will travel over these riffles using the boat/barge method, but not the tracked equipment.

Enbridge is prepared to survey and relocate freshwater mussels, if identified, in riffles that may not be able to be avoided from disturbance with heavy equipment, used to install LWD, at the following riffle locations:

- Polygon 34.50-R1,
- Polygon 34.50-R2, and
- Polygon 34.75-R1.

Mussel surveys, and relocation of mussels if identified, will be conducted in accordance with the *Standard Operating Procedure for Conducting Freshwater Mussel Surveys and Relocations Within Work Segments of the Kalamazoo River* included in *Attachment A*. Mussel surveys, and any required relocations, will be completed in advance of LWD installation activities that could potentially impact these riffles. Regardless of whether mussels are found within riffles, this habitat within LWD travel routes will be protected to the extent practicable during LWD installation activities.

5.0 References

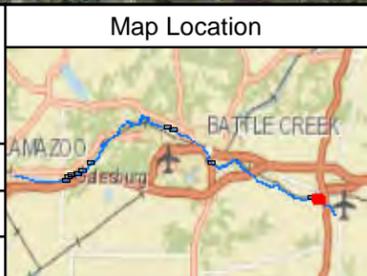
Enbridge, 2016. Enbridge Energy, Limited Partnership Line 6B MP 608 Pipeline Release, Marshall, Michigan; *Freshwater Mussel Evaluation & Management Plan Supplement to Large Woody Debris Installation Plan*, dated August 3, 2016.

Figures



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Legend

- Riffle Survey Location
- Approximate Riffle Boundary
- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

N

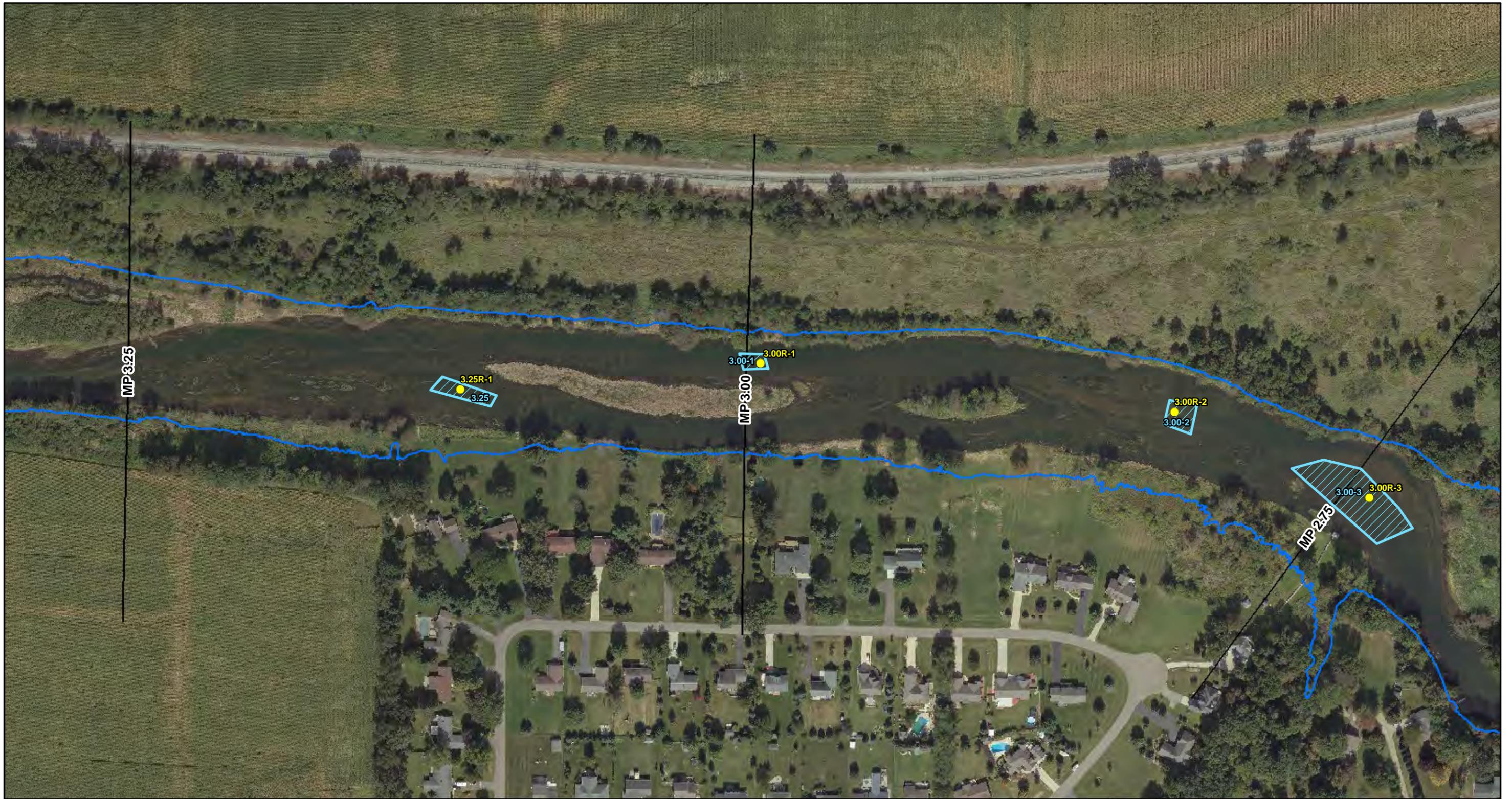
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Scale in Feet

FIGURE 1
 LARGE WOODY DEBRIS - RIFFLE SURVEY
 SURVEY AREA 1
 SHEET 1 OF 11

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
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 Project #: 60481718



Legend

- Riffle Survey Location
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- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

N

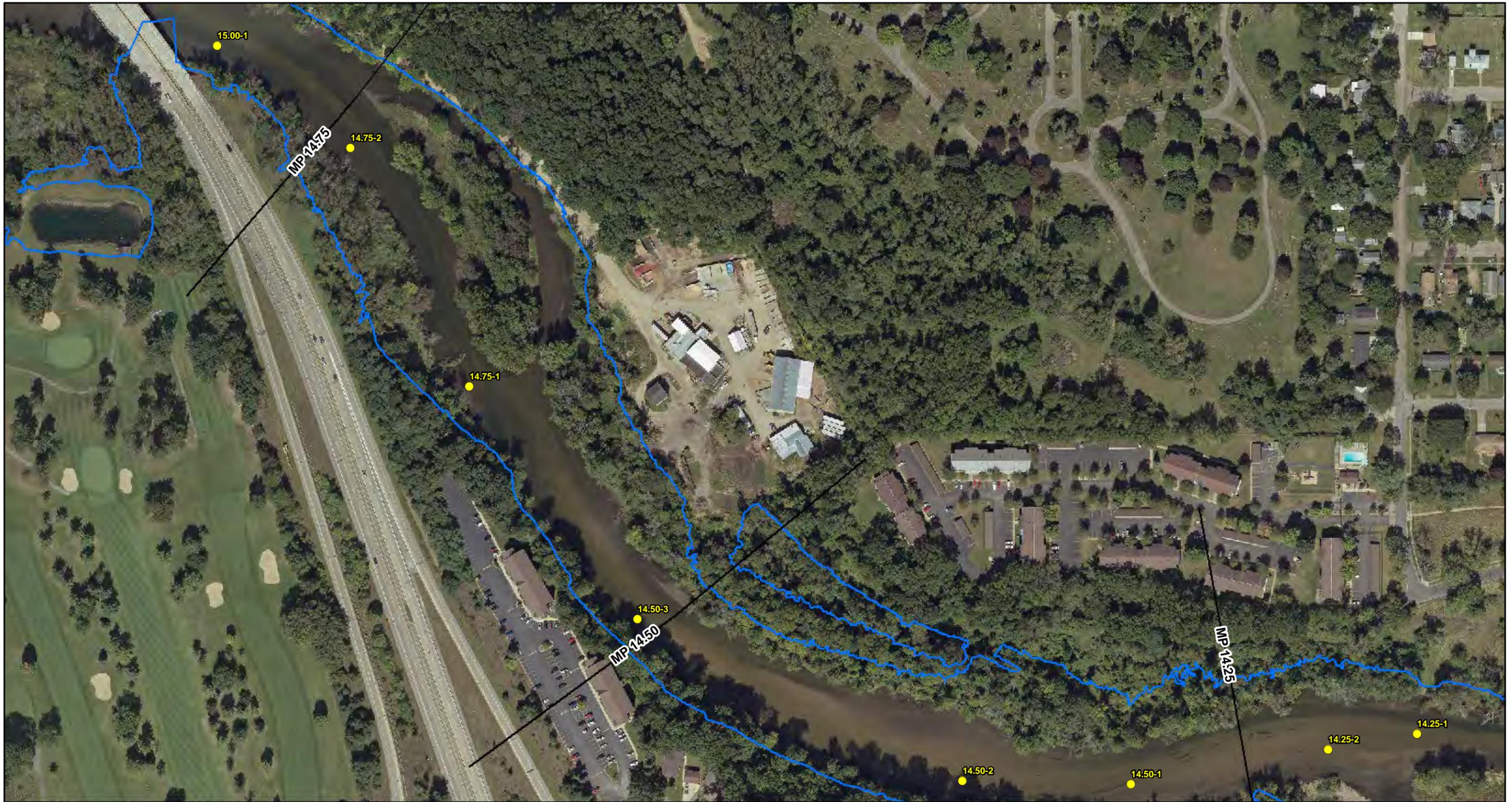
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Scale in Feet

FIGURE 1
 LARGE WOODY DEBRIS - RIFFLE SURVEY
 SURVEY AREA 1
 SHEET 2 OF 11

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 MARSHALL, MI PIPELINE RELEASE
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Legend

- Riffle Survey Location
- Approximate Riffle Boundary
- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

N

0 100 200 400

Scale in Feet

FIGURE 1
 LARGE WOODY DEBRIS - RIFFLE SURVEY
 SURVEY AREA 2
 SHEET 3 OF 11

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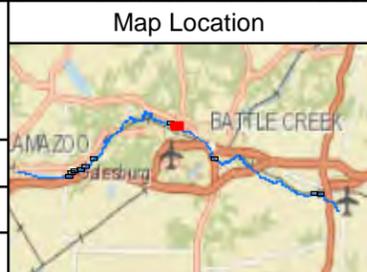


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Legend

- Riffle Survey Location
- Approximate Riffle Boundary
- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

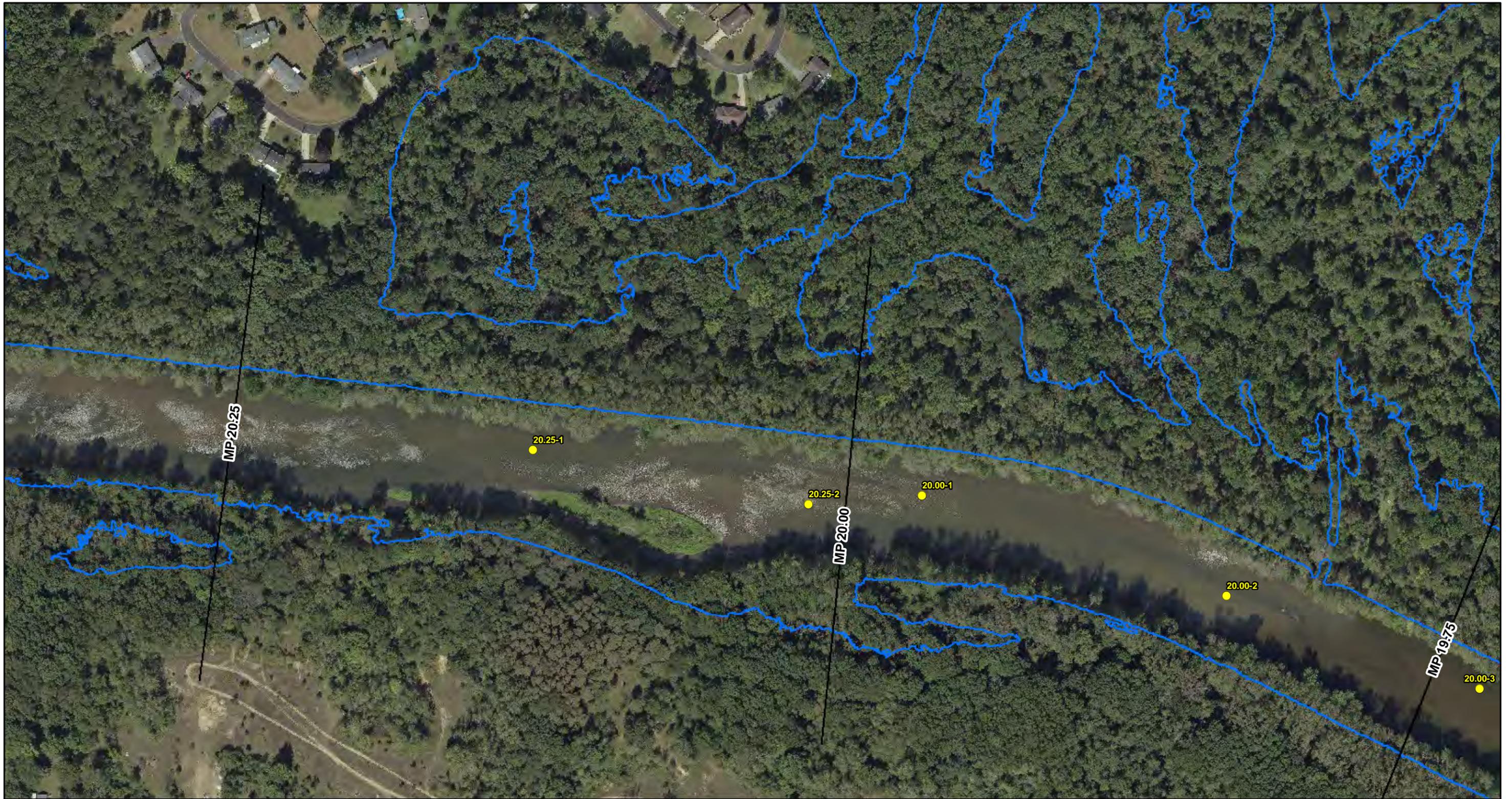
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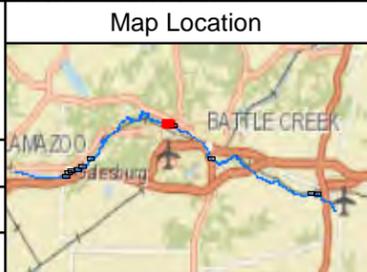
FIGURE 1
LARGE WOODY DEBRIS - RIFFLE SURVEY
SURVEY AREA 3
SHEET 4 OF 11

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Legend

- Riffle Survey Location
- Approximate Riffle Boundary
- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

N

0 100 200 400

Scale in Feet

FIGURE 1
 LARGE WOODY DEBRIS - RIFFLE SURVEY
 SURVEY AREA 3
 SHEET 5 OF 11

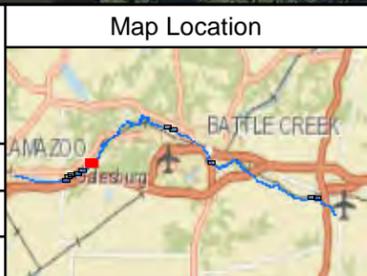
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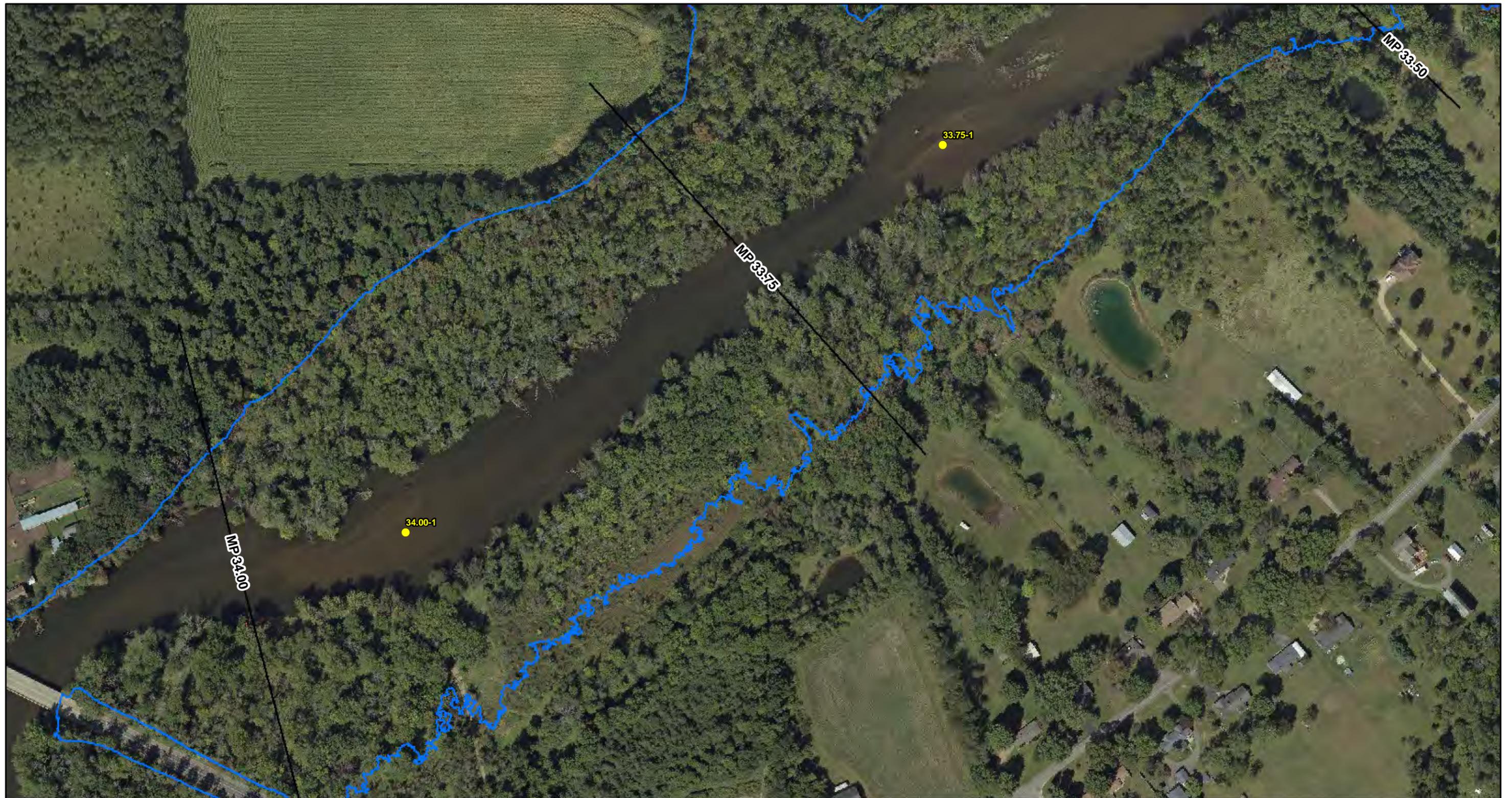
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 Project #: 60481718



| | | |
|---|----------------------------|-----------------------|
| Legend | | Scale in Feet |
| Riffle Survey Location | Parcel | |
| Approximate Riffle Boundary | Quarter Mile Grid Segments | |
| Kalamazoo River Flood Inundation Boundary | | |

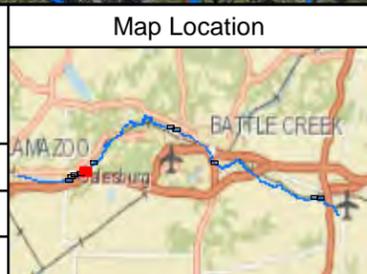
FIGURE 1
 LARGE WOODY DEBRIS - RIFFLE SURVEY
 SURVEY AREA 4
 SHEET 6 OF 11

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 MARSHALL, MI PIPELINE RELEASE
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Legend

- Riffle Survey Location
- Approximate Riffle Boundary
- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

N

0 100 200 400

Scale in Feet

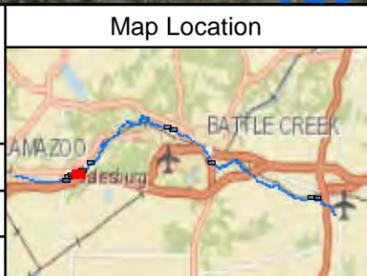
FIGURE 1
 LARGE WOODY DEBRIS - RIFFLE SURVEY
 SURVEY AREA 4
 SHEET 7 OF 11

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Legend

- Riffle Survey Location
- Approximate Riffle Boundary
- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

N

0 100 200 400

Scale in Feet

FIGURE 1
 LARGE WOODY DEBRIS - RIFFLE SURVEY
 SURVEY AREA 4
 SHEET 8 OF 11

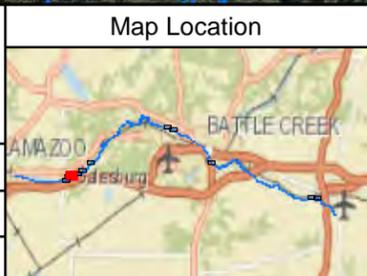
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Legend

- Riffle Survey Location
- Approximate Riffle Boundary
- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

N

0 100 200 400

Scale in Feet

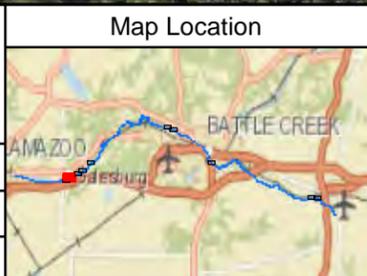
FIGURE 1
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 SURVEY AREA 4
 SHEET 9 OF 11

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Legend

- Riffle Survey Location
- Approximate Riffle Boundary
- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

N

0 100 200 400

Scale in Feet

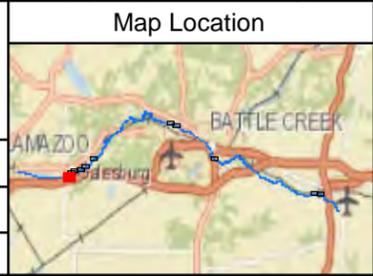
FIGURE 1
 LARGE WOODY DEBRIS - RIFFLE SURVEY
 SURVEY AREA 4
 SHEET 10 OF 11

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Legend

- Riffle Survey Location
- Parcel
- ▭ Approximate Riffle Boundary
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

N

0 100 200 400

Scale in Feet

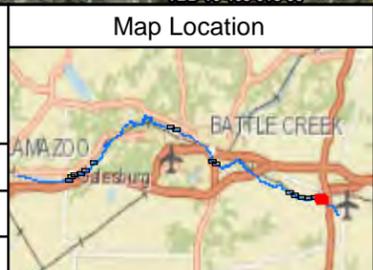
FIGURE 1
 LARGE WOODY DEBRIS - RIFFLE SURVEY
 SURVEY AREA 4
 SHEET 11 OF 11

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- Legend
- Large Woody Debris Typical Structures**
- Type 1A
 - Type 1B
 - Type 2
 - Type 3
 - Toe Wood
- Riffle Survey Location
 - Approximate Riffle Boundary (2016 Survey)
 - Ceresco As-Built Riffle Boundary (2014)
 - Riffle Diversion Route for Heavy Equipment

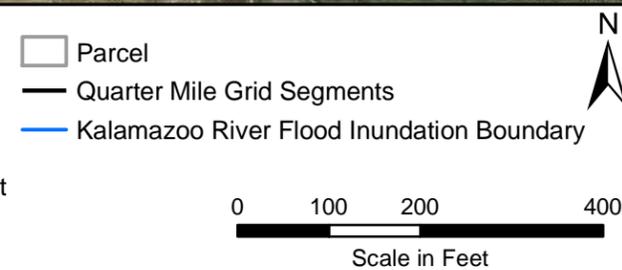


FIGURE 2
 LARGE WOODY DEBRIS RIFFLE
 DIVERSION ROUTES
 SHEET 1 OF 16

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 MARSHALL, MI PIPELINE RELEASE
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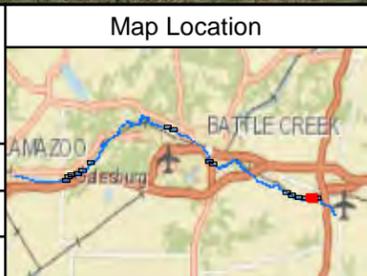


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Legend

Large Woody Debris Typical Structures

- Type 1A
- Type 1B
- Type 2
- Type 3
- Toe Wood

- Riffle Survey Location
- ▨ Approximate Riffle Boundary (2016 Survey)
- ▨ Ceresco As-Built Riffle Boundary (2014)
- ↔ Riffle Diversion Route for Heavy Equipment

- ▭ Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

0 100 200 400

Scale in Feet

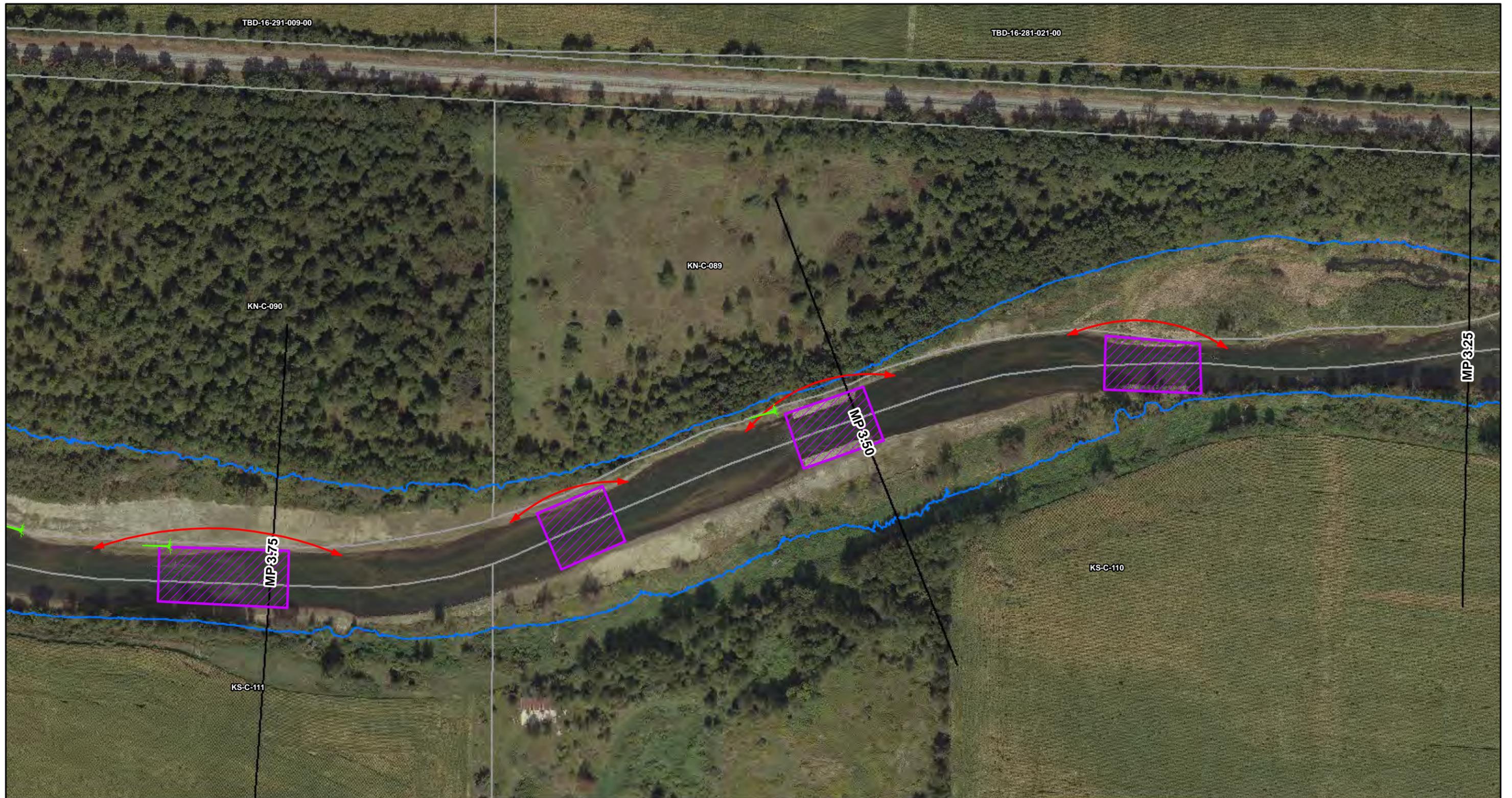
FIGURE 2

LARGE WOODY DEBRIS RIFFLE DIVERSION ROUTES

SHEET 2 OF 16

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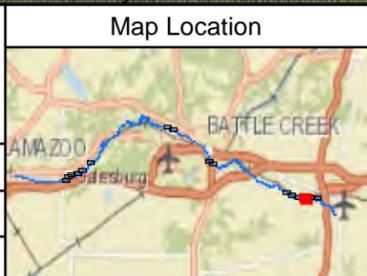


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Legend

Large Woody Debris Typical Structures

- Type 1A
- Type 1B
- Type 2
- Type 3
- Toe Wood

- Riffle Survey Location
- Approximate Riffle Boundary (2016 Survey)
- Ceresco As-Built Riffle Boundary (2014)
- Riffle Diversion Route for Heavy Equipment

- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

0 100 200 400

Scale in Feet

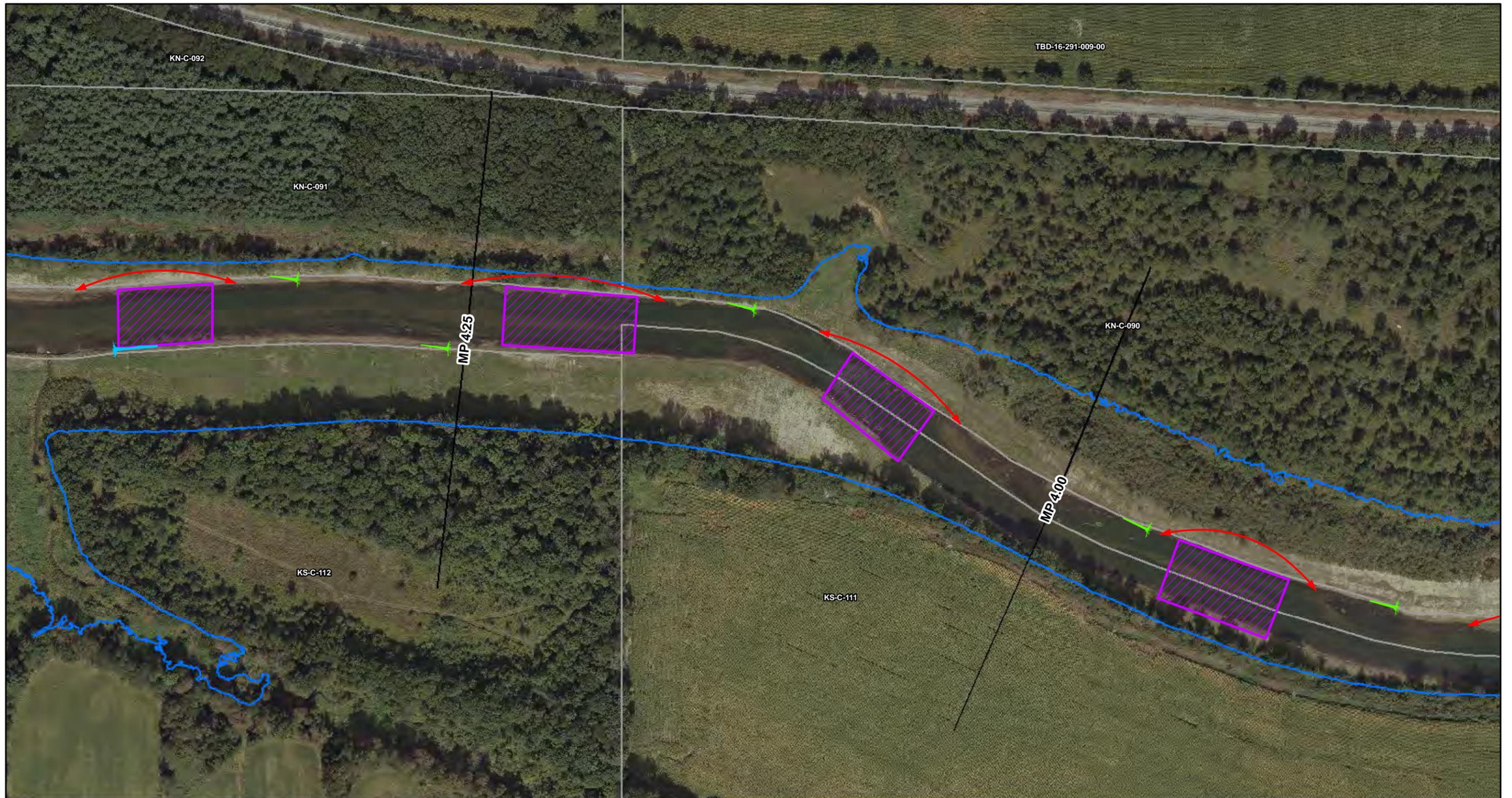
FIGURE 2

LARGE WOODY DEBRIS RIFFLE DIVERSION ROUTES

SHEET 3 OF 16

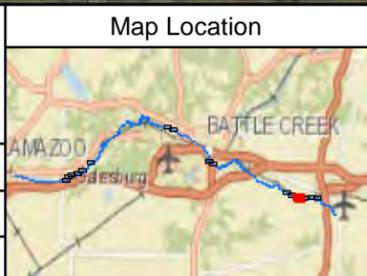
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Legend
Large Woody Debris Typical Structures
 Type 1A
 Type 1B
 Type 2
 Type 3
 Toe Wood

● Riffle Survey Location
 Approximate Riffle Boundary (2016 Survey)
 Ceresco As-Built Riffle Boundary (2014)
 Riffle Diversion Route for Heavy Equipment

Parcel
 Quarter Mile Grid Segments
 Kalamazoo River Flood Inundation Boundary

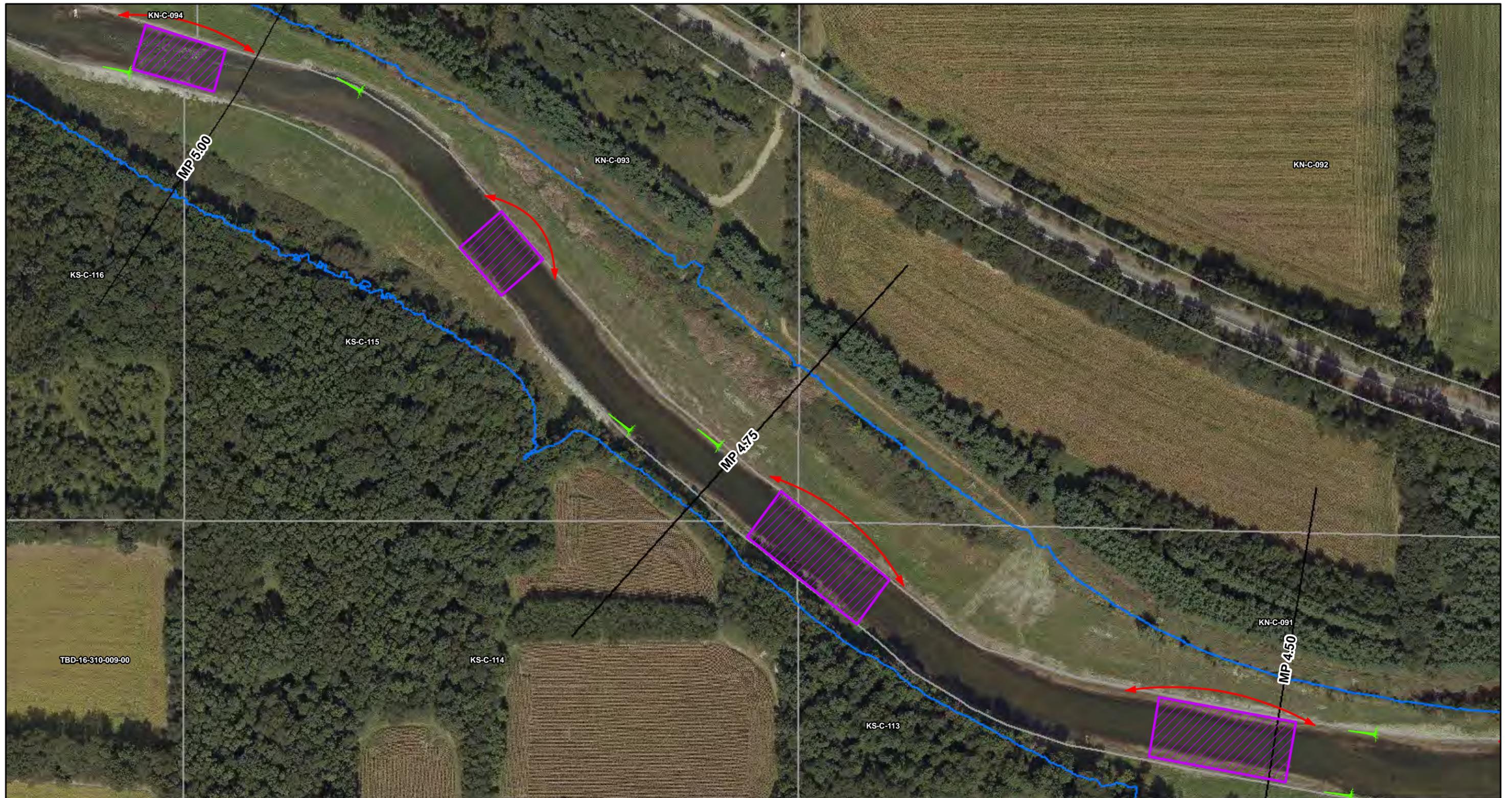
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 Scale in Feet



FIGURE 2
LARGE WOODY DEBRIS RIFFLE
DIVERSION ROUTES
SHEET 4 OF 16

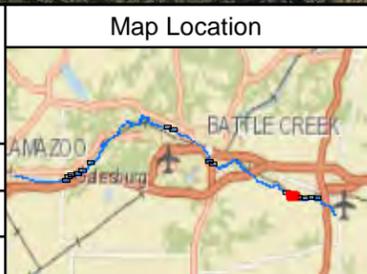
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- Legend
- Large Woody Debris Typical Structures**
- Type 1A
 - Type 1B
 - Type 2
 - Type 3
 - Toe Wood

- Riffle Survey Location
- Approximate Riffle Boundary (2016 Survey)
- Ceresco As-Built Riffle Boundary (2014)
- Riffle Diversion Route for Heavy Equipment

- Parcel
 - Quarter Mile Grid Segments
 - Kalamazoo River Flood Inundation Boundary
- Scale in Feet
- 0 100 200 400

FIGURE 2
 LARGE WOODY DEBRIS RIFFLE
 DIVERSION ROUTES
 SHEET 5 OF 16

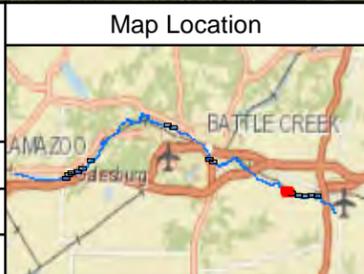
ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015



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 Project #: 60481718



Legend
Large Woody Debris Typical Structures

- Type 1A
- Type 1B
- Type 2
- Type 3
- Toe Wood

- Riffle Survey Location
- Approximate Riffle Boundary (2016 Survey)
- Ceresco As-Built Riffle Boundary (2014)
- Riffle Diversion Route for Heavy Equipment

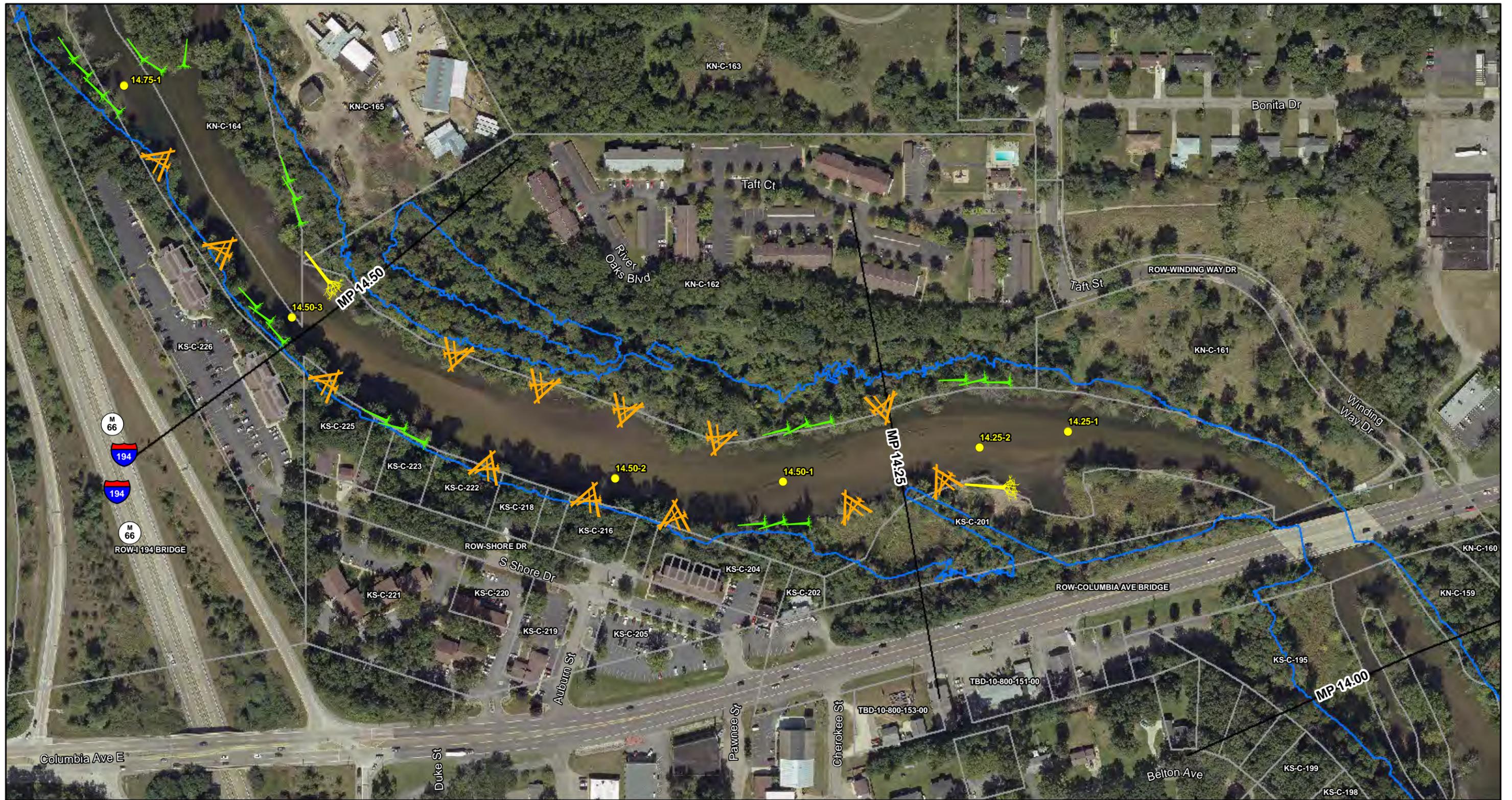
- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

0 100 200 400
 Scale in Feet

FIGURE 2
LARGE WOODY DEBRIS RIFFLE
DIVERSION ROUTES
SHEET 6 OF 16

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Legend

Large Woody Debris Typical Structures

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- Toe Wood

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- Ceresco As-Built Riffle Boundary (2014)
- Riffle Diversion Route for Heavy Equipment
- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

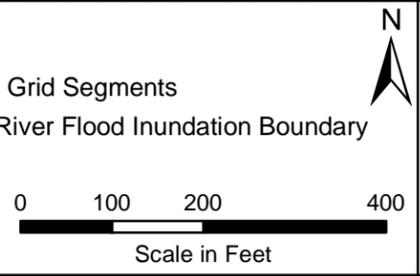
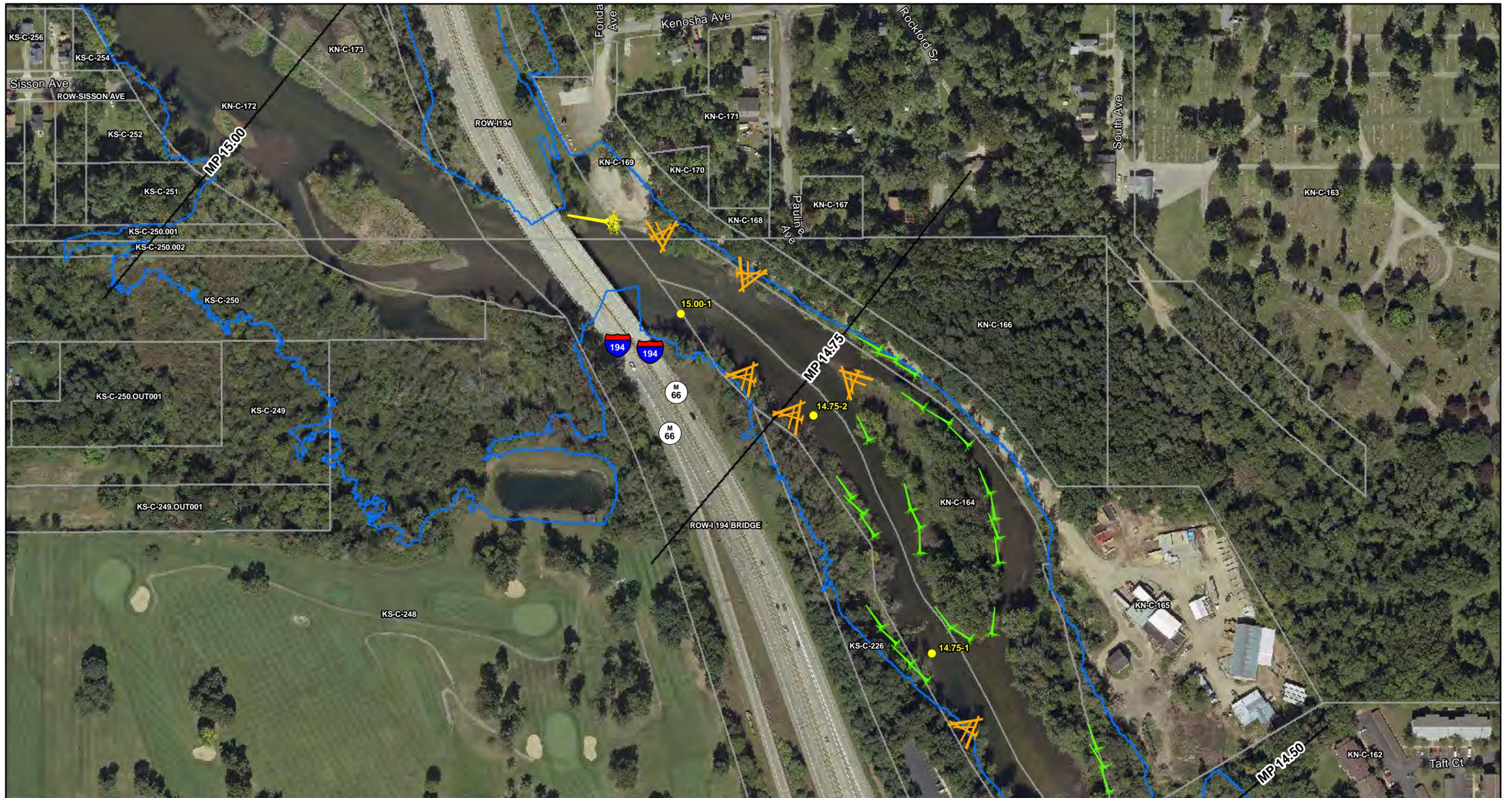


FIGURE 2
 LARGE WOODY DEBRIS RIFFLE
 DIVERSION ROUTES
 SHEET 7 OF 16

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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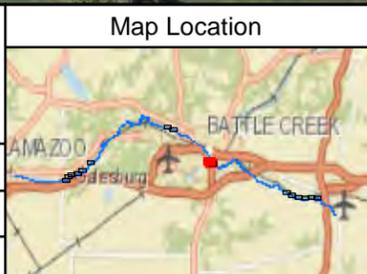


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Legend

Large Woody Debris Typical Structures

- Type 1A
- Type 1B
- Type 2
- Type 3
- Toe Wood

- Riffle Survey Location
- Approximate Riffle Boundary (2016 Survey)
- Ceresco As-Built Riffle Boundary (2014)
- Riffle Diversion Route for Heavy Equipment

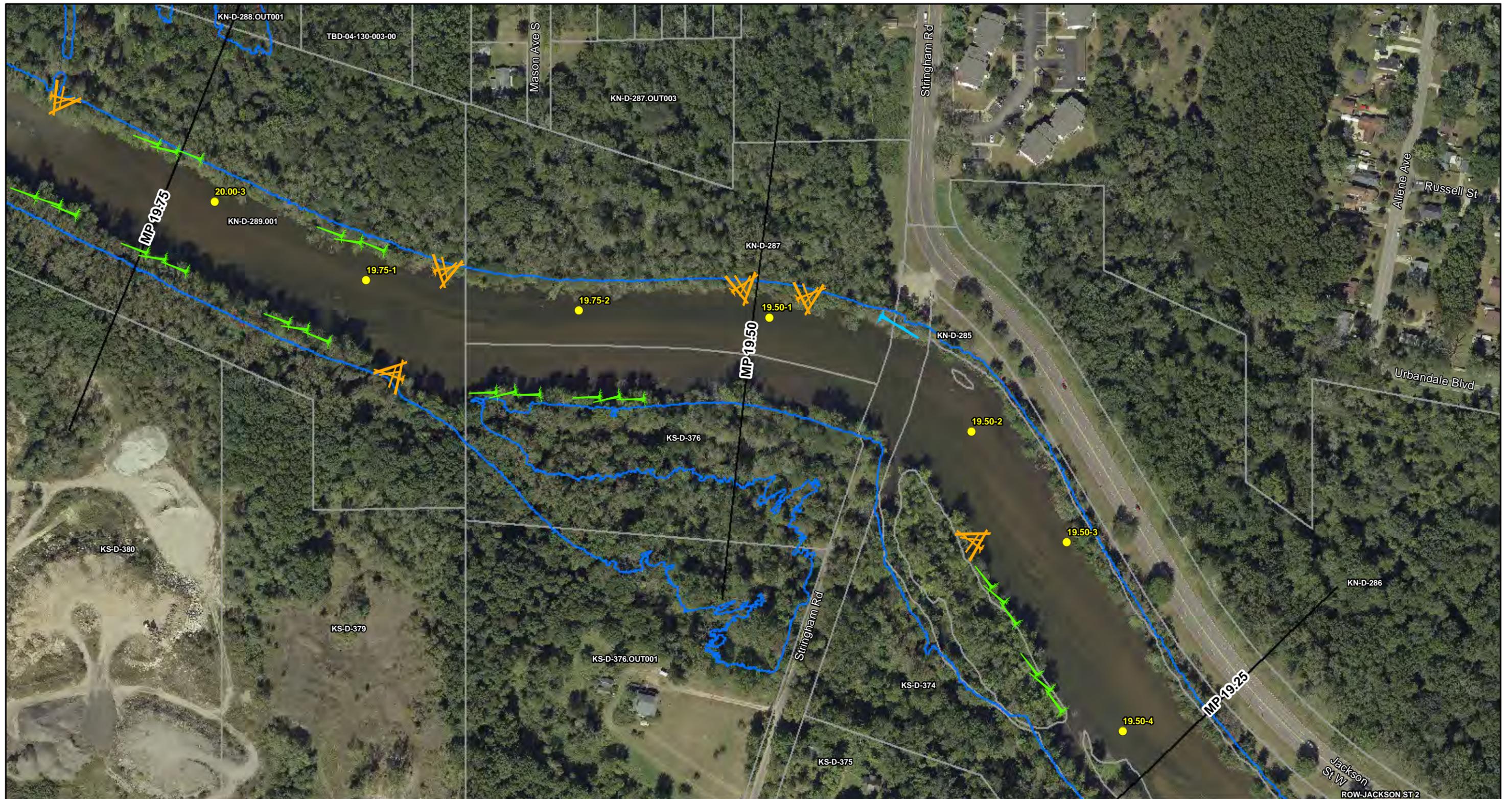
- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

0 100 200 400
Scale in Feet

FIGURE 2
LARGE WOODY DEBRIS RIFFLE
DIVERSION ROUTES
SHEET 8 OF 16

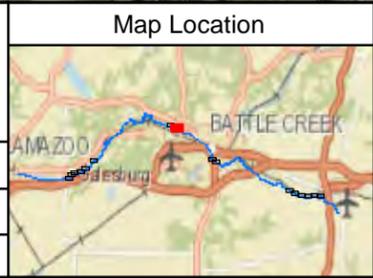
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 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015



ENBRIDGE

Drawn: EN 8/8/2016
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 Project #: 60481718



- Legend
- Large Woody Debris Typical Structures**
- Type 1A
 - Type 1B
 - Type 2
 - Type 3
 - Toe Wood
- Riffle Survey Location
 - Approximate Riffle Boundary (2016 Survey)
 - Ceresco As-Built Riffle Boundary (2014)
 - Riffle Diversion Route for Heavy Equipment

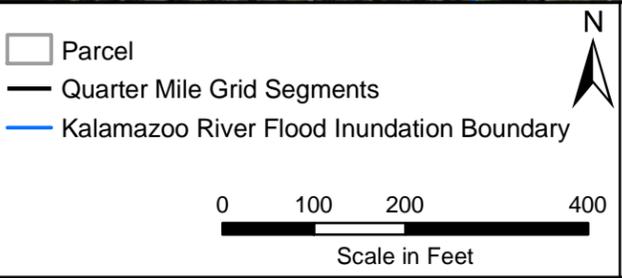
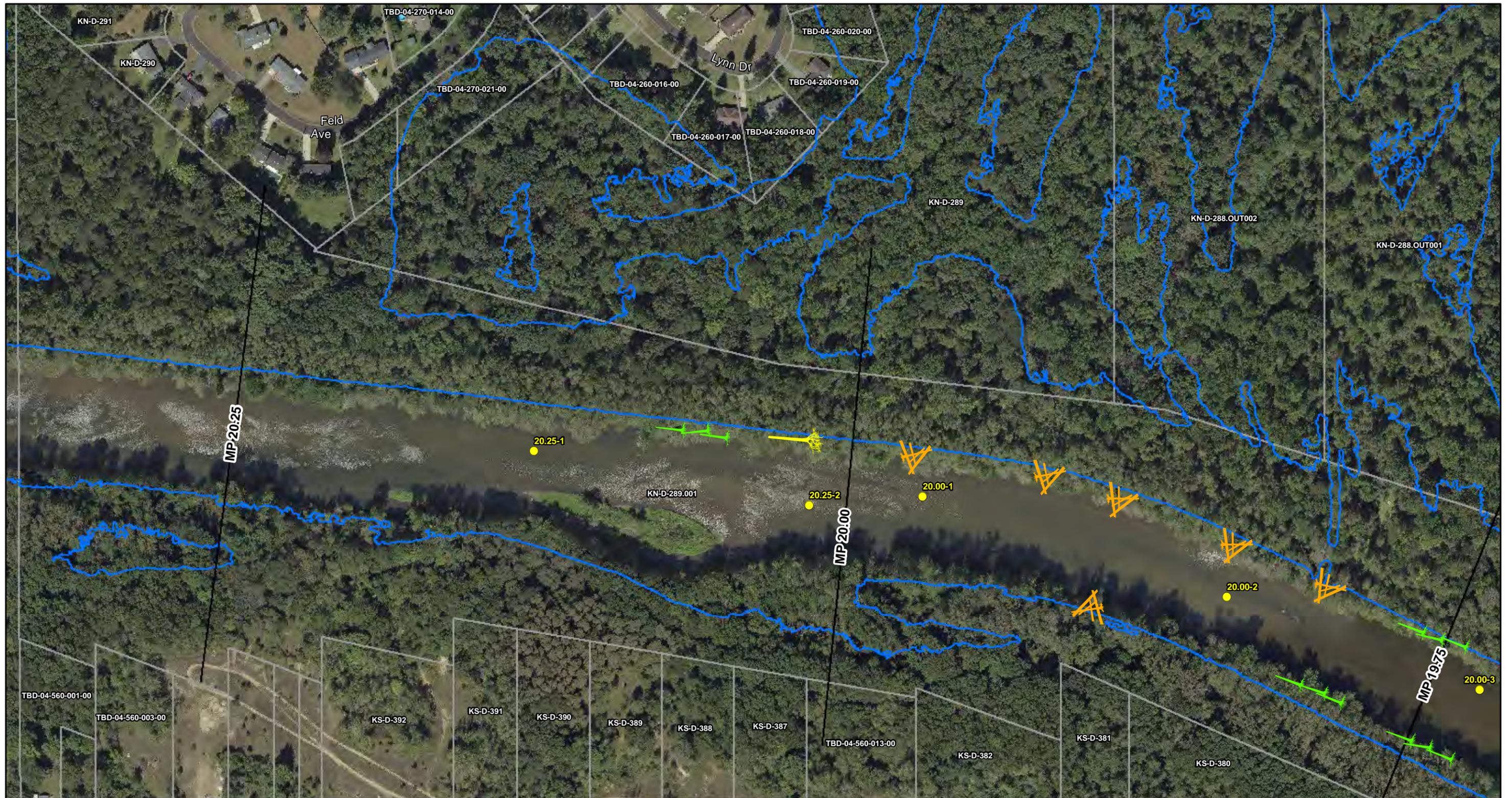


FIGURE 2
 LARGE WOODY DEBRIS RIFFLE
 DIVERSION ROUTES
 SHEET 9 OF 16

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015

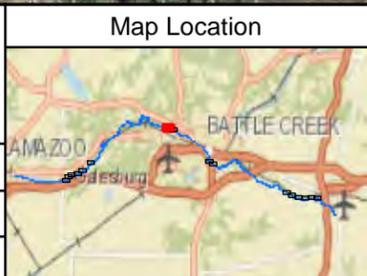


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Drawn: EN 8/8/2016

Approved: LN 8/8/2016

Project #: 60481718



Legend

Large Woody Debris Typical Structures

- Type 1A
- Type 1B
- Type 2
- Type 3
- Toe Wood

- Riffle Survey Location
- Approximate Riffle Boundary (2016 Survey)
- Ceresco As-Built Riffle Boundary (2014)
- Riffle Diversion Route for Heavy Equipment

- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

Scale in Feet

0 100 200 400

FIGURE 2
LARGE WOODY DEBRIS RIFFLE
DIVERSION ROUTES
SHEET 10 OF 16

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015



ENBRIDGE

Drawn: EN 8/8/2016

Approved: LN 8/8/2016

Project #: 60481718



- Legend
- Large Woody Debris Typical Structures**
- Type 1A
 - Type 1B
 - Type 2
 - Type 3
 - Toe Wood

- Riffle Survey Location
- Approximate Riffle Boundary (2016 Survey)
- Ceresco As-Built Riffle Boundary (2014)
- Riffle Diversion Route for Heavy Equipment

- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

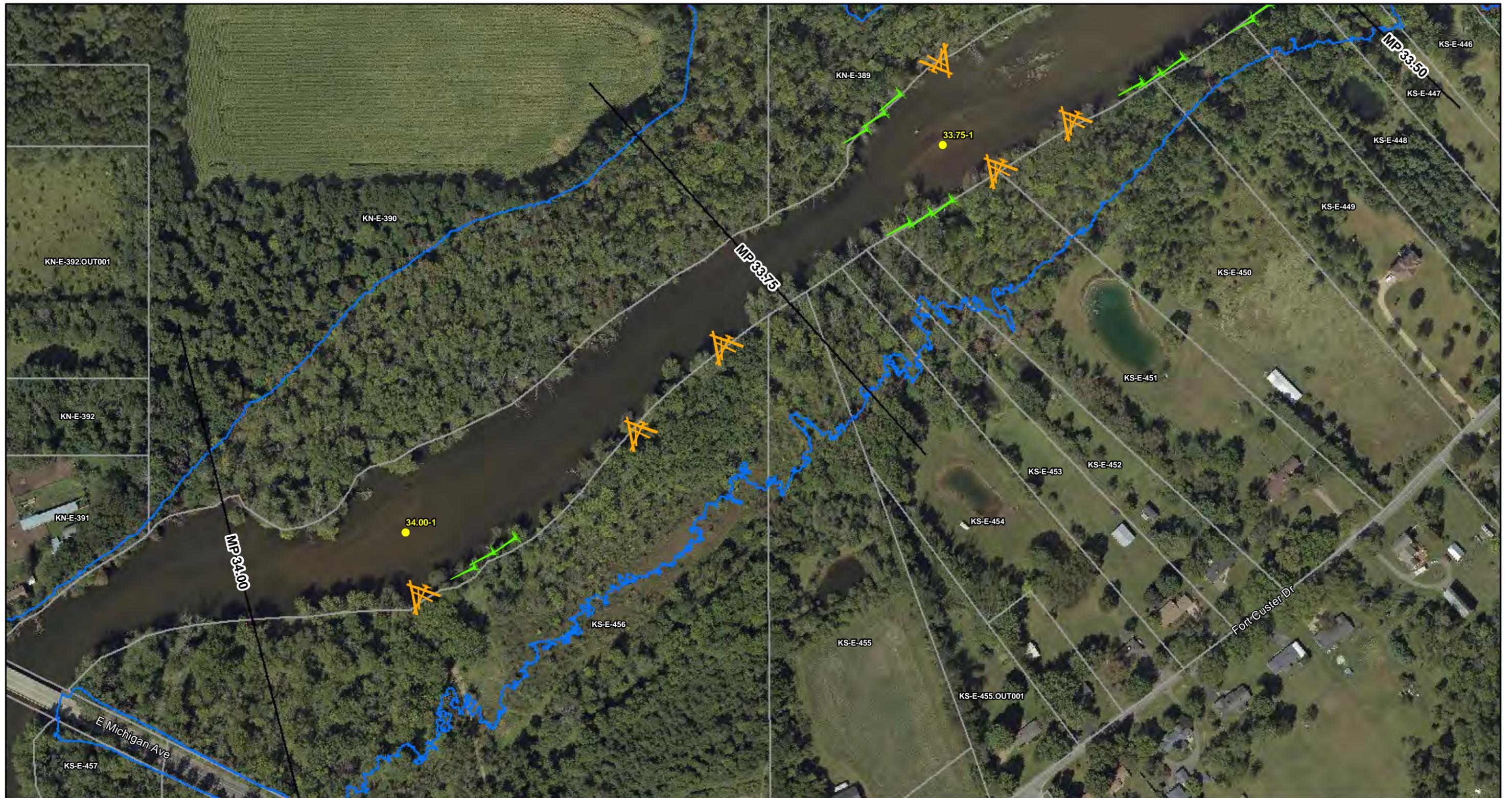
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Scale in Feet

FIGURE 2
 LARGE WOODY DEBRIS RIFFLE
 DIVERSION ROUTES
 SHEET 11 OF 16

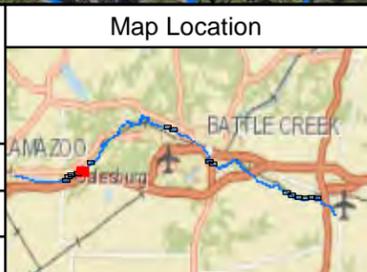
ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015



ENBRIDGE

Drawn: EN 8/8/2016
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Legend

Large Woody Debris Typical Structures

- Type 1A
- Type 1B
- Type 2
- Type 3
- Toe Wood

- Riffle Survey Location
- Approximate Riffle Boundary (2016 Survey)
- Ceresco As-Built Riffle Boundary (2014)
- Riffle Diversion Route for Heavy Equipment

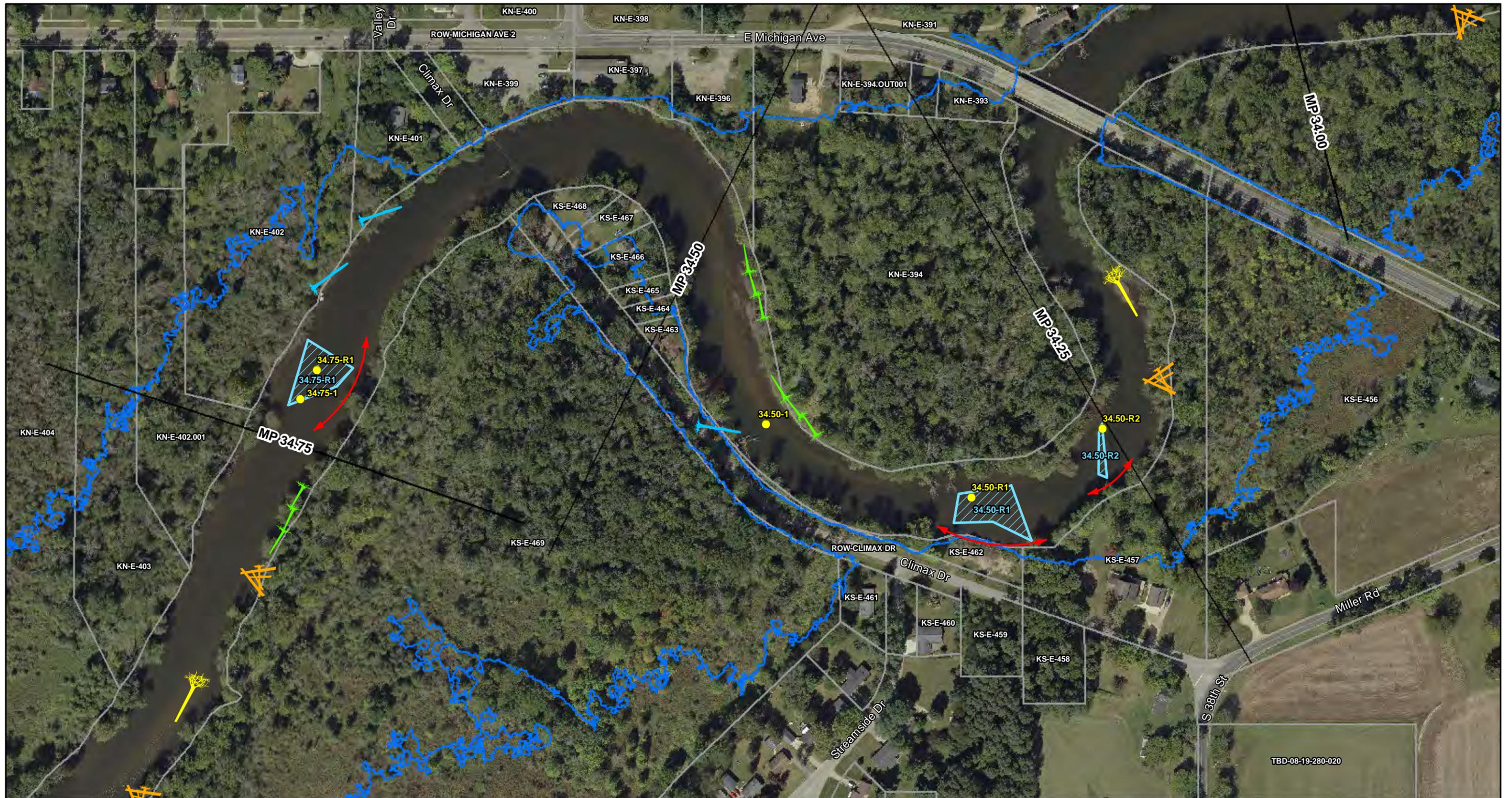
- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

0 100 200 400
 Scale in Feet

FIGURE 2
 LARGE WOODY DEBRIS RIFFLE
 DIVERSION ROUTES
 SHEET 12 OF 16

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015

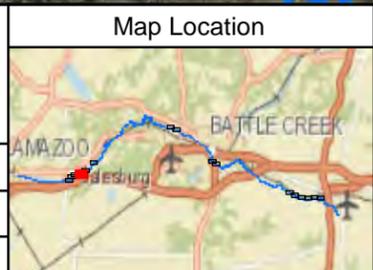


ENBRIDGE

Drawn: EN 8/8/2016

Approved: LN 8/8/2016

Project #: 60481718



Legend

Large Woody Debris Typical Structures

- Type 1A
- Type 1B
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- Riffle Survey Location
- Approximate Riffle Boundary (2016 Survey)
- Ceresco As-Built Riffle Boundary (2014)
- Riffle Diversion Route for Heavy Equipment
- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

FIGURE 2
LARGE WOODY DEBRIS RIFFLE
DIVERSION ROUTES
SHEET 13 OF 16

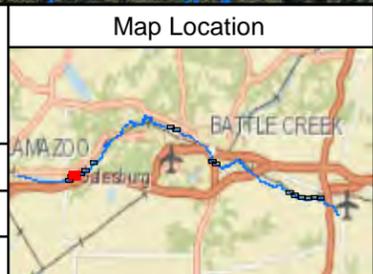
ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015



ENBRIDGE

Drawn: EN 8/8/2016
 Approved: LN 8/8/2016
 Project #: 60481718



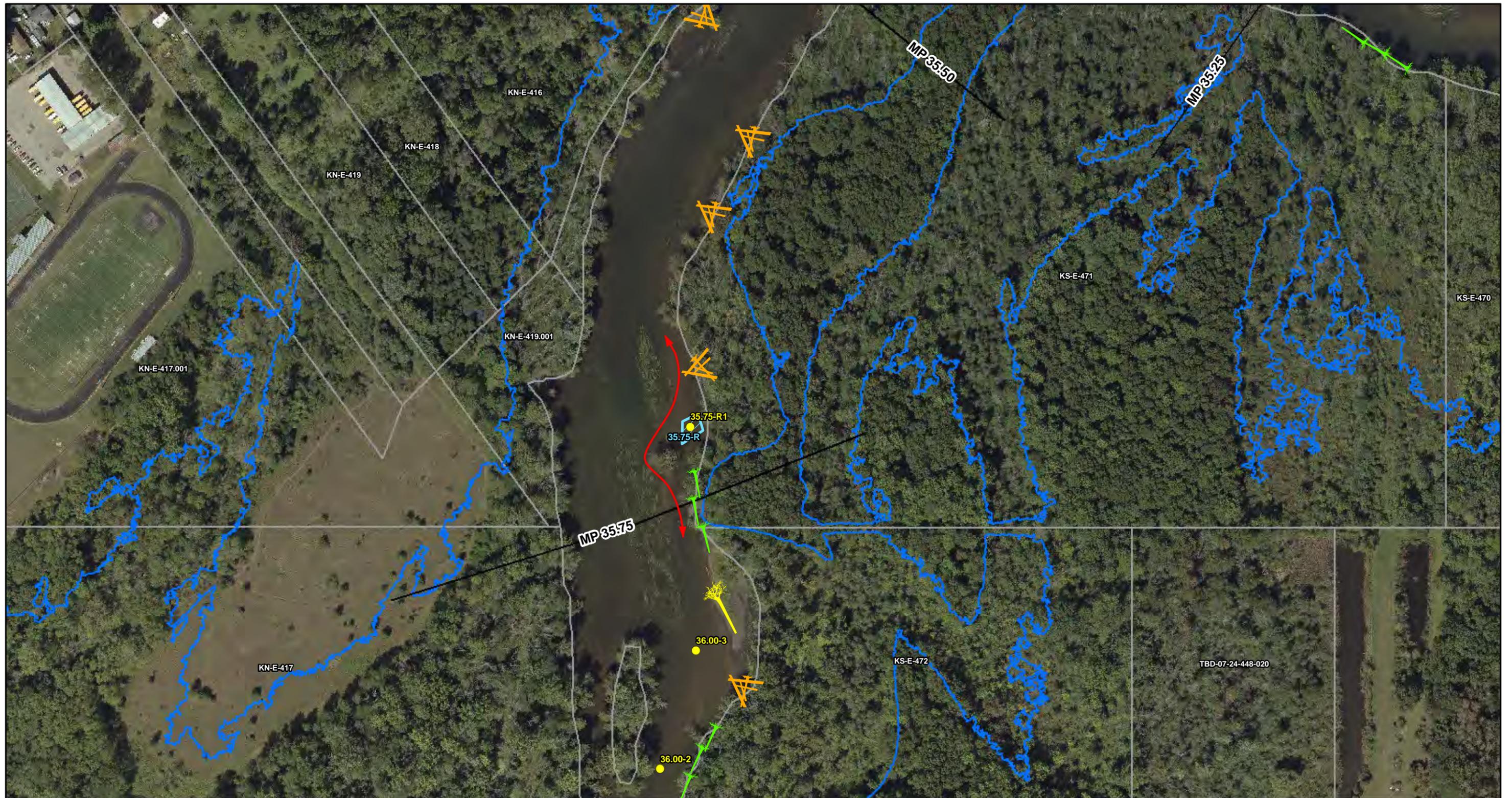
- Legend
- Large Woody Debris Typical Structures**
- Type 1A
 - Type 1B
 - Type 2
 - Type 3
 - Toe Wood
- Riffle Survey Location
 - Approximate Riffle Boundary (2016 Survey)
 - Ceresco As-Built Riffle Boundary (2014)
 - Riffle Diversion Route for Heavy Equipment

- Parcel
 - Quarter Mile Grid Segments
 - Kalamazoo River Flood Inundation Boundary
- 0 100 200 400
 Scale in Feet

FIGURE 2
 LARGE WOODY DEBRIS RIFFLE
 DIVERSION ROUTES
 SHEET 14 OF 16

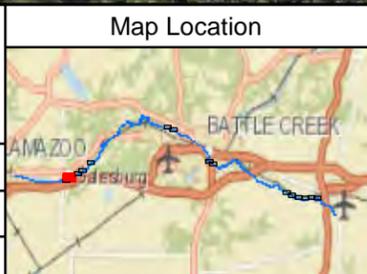
ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015



ENBRIDGE

Drawn: EN 8/8/2016
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Legend
Large Woody Debris Typical Structures

- Type 1A
- Type 1B
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- Toe Wood

- Riffle Survey Location
- Approximate Riffle Boundary (2016 Survey)
- Ceresco As-Built Riffle Boundary (2014)
- Riffle Diversion Route for Heavy Equipment

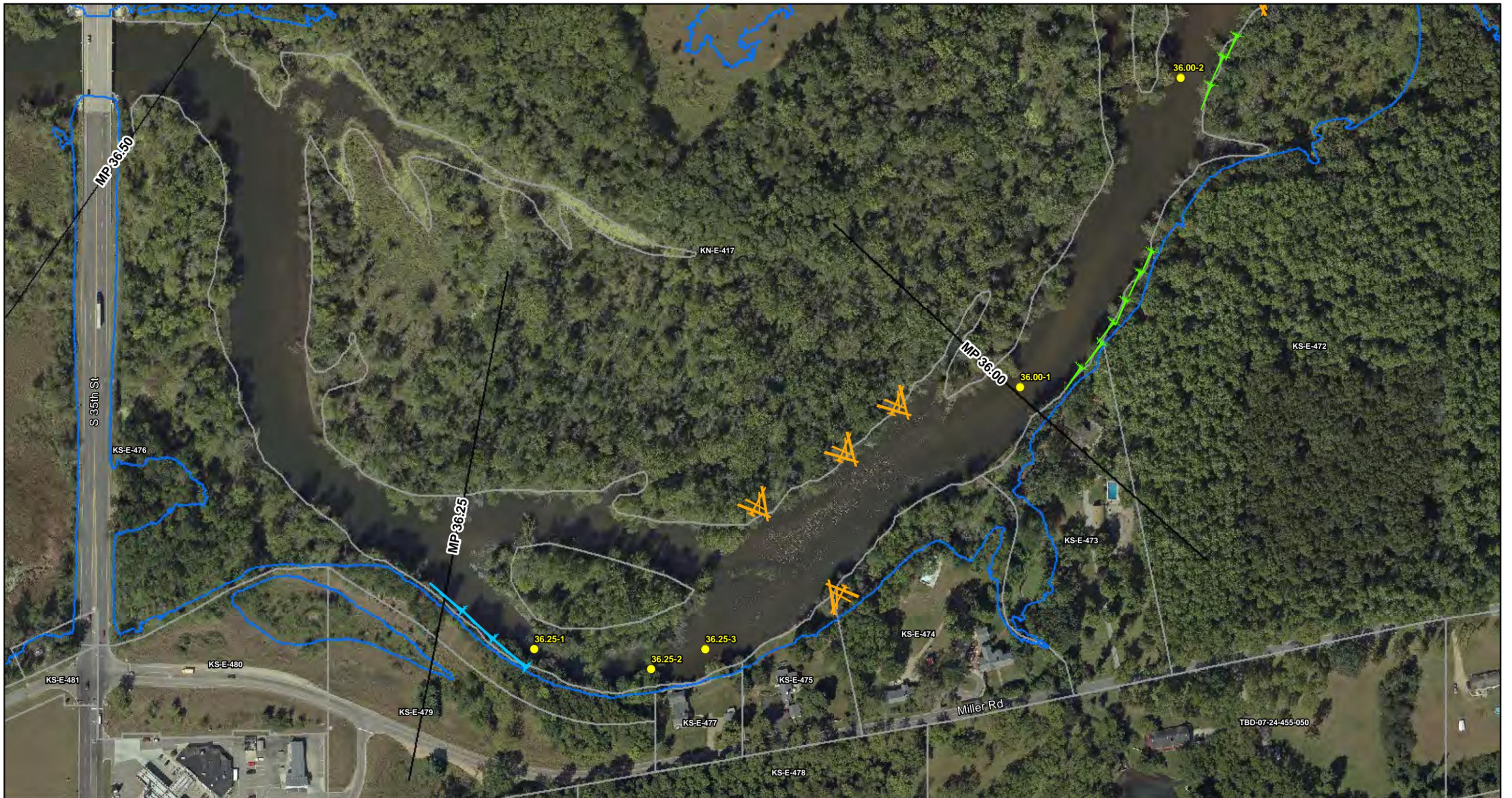
- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

0 100 200 400
 Scale in Feet

FIGURE 2
LARGE WOODY DEBRIS RIFFLE
DIVERSION ROUTES
SHEET 15 OF 16

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015

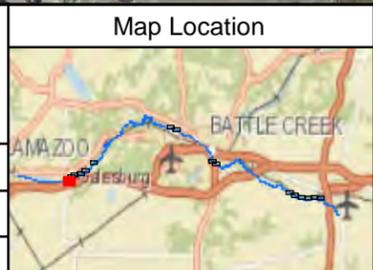


ENBRIDGE

Drawn: EN 8/8/2016

Approved: LN 8/8/2016

Project #: 60481718



Legend

Large Woody Debris Typical Structures

- Type 1A
- Type 1B
- Type 2
- Type 3
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- Approximate Riffle Boundary (2016 Survey)
- Ceresco As-Built Riffle Boundary (2014)
- Riffle Diversion Route for Heavy Equipment
- Parcel
- Quarter Mile Grid Segments
- Kalamazoo River Flood Inundation Boundary

FIGURE 2
LARGE WOODY DEBRIS RIFFLE
DIVERSION ROUTES
SHEET 16 OF 16

ENBRIDGE LINE 6B MP 608
 MARSHALL, MI PIPELINE RELEASE
 ENBRIDGE ENERGY, LIMITED PARTNERSHIP

Aerial Photography Date: September 2015

Table

Table 1. Large Woody Debris - Riffle Survey Field Data
 Enbridge Line 6B MP 608, Marshall, MI Pipeline Release
 Enbridge Energy, Limited Partnership

| Description | Feature Type | Range of Water Depths (feet) | Average Water Depth (feet) | Boulder (%) | Cobble (%) | Gravel (%) | Sand (%) | Silt (%) | Biological Field Notes |
|-------------|--------------|------------------------------|----------------------------|-------------|------------|------------|----------|----------|--|
| 2.50R-1 | Riffle | 1.0 - 1.2 | 1.1 | | 50 | 45 | 5 | | Abundant macroinvertebrates and sparse fish. Taxa present includes: caddisflies (Glossosomatidae and Hydropsychidae), mayflies (Heptageniidae), water scud (Amphipoda), dragonflies (Aeschnidae and Gomphidae), dobsonflies (Corydalus sp.), asian clams (Corbicula fluminea), and warmouth (Lepomis gulosus) |
| 3.00R-3 | Riffle | 0.7 - 0.9 | 0.8 | | 70 | 20 | 10 | | Abundant fish and macroinvertebrates. Taxa present includes: caddisflies (Glossosomatidae and Hydropsychidae), mayflies (Heptageniidae, Siphonuridae, and Hexagenia sp.), stoneflies (Pteronarcidae), water scud (Amphipoda), black flies (Simuliidae), crayfish (Decapoda), asian clams (Corbicula fluminea), johnny darter (Etheostoma nigrum), rainbow darter (E. caeruleum), and black bullhead (Ameiurus melas) |
| 3.00R-2 | Riffle | 0.9 - 1.1 | 1.0 | | 20 | 60 | 20 | | Abundant fish and macroinvertebrates. Taxa present includes: caddisflies (Glossosomatidae and Hydropsychidae), mayflies (Baetidae and Heptageniidae), asian clams (Corbicula fluminea), snail (Physidae), and johnny darter (Etheostoma nigrum) |
| 3.00R-1 | Riffle | 1.3 - 1.5 | 1.4 | | 20 | 60 | 20 | | Abundant fish and macroinvertebrates. Taxa present includes: caddisflies (Glossosomatidae, Hydropsychidae and Heliopsychidae), mayflies (Heptageniidae and Siphonuridae), crayfish (Decapoda), and johnny darter (Etheostoma nigrum) |
| 3.25R-1 | Riffle | 0.3 - 0.5 | 0.4 | | 30 | 50 | 20 | | Abundant fish and macroinvertebrates. Taxa present includes: caddisflies (Glossosomatidae and Hydropsychidae), mayflies (Baetidae, Heptageniidae and Siphonuridae), stoneflies (Pteronarcidae), diving beetle (Dystiscidae), water scud (Amphipoda), crayfish (Decapoda), asian clams (Corbicula fluminea), johnny darter (Etheostoma nigrum), rainbow darter (E. caeruleum), and creek chubs (Semotilus atromaculatus) |
| 14.25-1 | Survey Point | NR | 2.0 | | | | 100 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 14.25-2 | Survey Point | NR | 1.4 | | | | 95 | 5 | No macroinvertebrates or fish visually observed (no sampling conducted) |

Table 1. Large Woody Debris - Riffle Survey Field Data
 Enbridge Line 6B MP 608, Marshall, MI Pipeline Release
 Enbridge Energy, Limited Partnership

| Description | Feature Type | Range of Water Depths (feet) | Average Water Depth (feet) | Boulder (%) | Cobble (%) | Gravel (%) | Sand (%) | Silt (%) | Biological Field Notes |
|-------------|--------------|------------------------------|----------------------------|-------------|------------|------------|----------|----------|---|
| 14.50-1 | Survey Point | NR | 0.7 | | | | 100 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 14.50-2 | Survey Point | NR | 2.2 | | | | 100 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 14.50-3 | Survey Point | NR | 1.9 | | | | 100 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 14.75-1 | Survey Point | NR | 1.1 | | | | | 100 | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 14.75-2 | Survey Point | NR | 2.0 | | | | 20 | 80 | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 15.00-1 | Survey Point | NR | 2.6 | | | | 100 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 19.50-4 | Survey Point | 2.8 - 2.9 | 2.9 | | | 5 | 95 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 19.50-3 | Survey Point | NR | 1.2 | | | 5 | 95 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 19.50-2 | Survey Point | 1.2 - 1.3 | 1.3 | | | 5 | 95 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 19.50-1 | Survey Point | NR | 3.5 | | | 10 | 90 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 19.75-2 | Survey Point | NR | 3.2 | | | 10 | 90 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 19.75-1 | Survey Point | NR | 3.5 | | | 5 | 95 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 20.00-3 | Survey Point | 1.5 - 2.0 | 1.8 | | | 5 | 95 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 20.00-2 | Survey Point | NR | 2.5 | | | 10 | 90 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 20.00-1 | Survey Point | NR | 2.3 | | | 5 | 95 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 20.25-2 | Survey Point | NR | 3.0 | | | 5 | 95 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 20.25-1 | Survey Point | NR | 3.2 | | | 5 | 95 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 32.25-1 | Survey Point | 3.1 - 3.3 | 3.2 | | | 10 | 90 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 32.50-1 | Survey Point | 3.0 - 3.0 | 3.0 | | | 10 | 90 | | No macroinvertebrates or fish visually observed (no sampling conducted) |

Table 1. Large Woody Debris - Riffle Survey Field Data
 Enbridge Line 6B MP 608, Marshall, MI Pipeline Release
 Enbridge Energy, Limited Partnership

| Description | Feature Type | Range of Water Depths (feet) | Average Water Depth (feet) | Boulder (%) | Cobble (%) | Gravel (%) | Sand (%) | Silt (%) | Biological Field Notes |
|-------------|--------------|------------------------------|----------------------------|-------------|------------|------------|----------|----------|--|
| 32.75-1 | Survey Point | 1.7 - 2.1 | 1.9 | | | 10 | 90 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 33.00R-1 | Riffle | 1.6 - 2.0 | 1.8 | | 10 | 45 | 45 | | Sparse macroinvertebrates and no fish observed. Taxa present includes: caddisflies (Hydropsychidae) and mayflies (Heptageniidae) |
| 33.75-1 | Survey Point | 1.0 - 1.2 | 1.1 | | | 10 | 90 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 34.00-1 | Survey Point | 1.9 - 2.1 | 2.0 | | | 10 | 90 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 34.50R-2 | Riffle | 1.4 - 2.0 | 1.7 | 40 | 30 | 15 | 15 | | Moderate fish and macroinvertebrates observed. Taxa present includes: caddisflies (Hydropsychidae), mayflies (Heptageniidae), dobsonflies (Corydalus sp.); darters (Etheostoma sp.), and creek chubs (Semotilus atromaculatus) |
| 34.50R-1 | Riffle | 1.5 - 2.0 | 1.8 | 10 | 30 | 30 | 30 | | Moderate fish and macroinvertebrates observed. Taxa present includes: caddisflies (Hydropsychidae and Limnephilidae), mayflies (Siphonuridae), asian clams (Corbicula fluminea), and darters (Etheostoma sp.) |
| 34.50-1 | Survey Point | 3.2 - 4.5 | 3.9 | | 10 | 40 | 50 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 34.75R-1 | Riffle | 1.5 - 2.5 | 2.0 | 10 | 30 | 40 | 20 | | Sparse macroinvertebrates and one fish observed. Yellow bullhead (Ameiurus natalis); taxa present includes: caddisflies (Glossomatidae and Hydropsychidae), mayflies (Heptageniidae and Siphonuridae), dragonflies (Aeschnidae and Gomphidae), and worms (Oligochaete) |
| 34.75-1 | Survey Point | 2.1 - 2.2 | 2.2 | | 10 | 30 | 60 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 35.50R-1 | Riffle | 1.5 - 2.7 | 2.3 | 10 | 10 | 30 | 50 | | Sparse macroinvertebrates and no fish observed. Taxa present includes: caddisflies (Hydropsychidae) and mayflies (Heptageniidae and Siphonuridae) |
| 35.75-1 | Survey Point | 3.5 - 3.7 | 3.6 | | | 10 | 90 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 35.75R-1 | Riffle | 1.8 - 2.4 | 2.2 | 10 | 10 | 30 | 50 | | Sparse macroinvertebrates, no fish observed. Taxa present includes: caddisflies (Hydropsychidae) and mayflies (Heptageniidae) |
| 36.00-3 | Survey Point | 2.5 - 2.6 | 2.6 | | | 10 | 90 | | No macroinvertebrates or fish visually observed (no sampling conducted) |

Table 1. Large Woody Debris - Riffle Survey Field Data
 Enbridge Line 6B MP 608, Marshall, MI Pipeline Release
 Enbridge Energy, Limited Partnership

| Description | Feature Type | Range of Water Depths (feet) | Average Water Depth (feet) | Boulder (%) | Cobble (%) | Gravel (%) | Sand (%) | Silt (%) | Biological Field Notes |
|-------------|--------------|------------------------------|----------------------------|-------------|------------|------------|----------|----------|---|
| 36.00-2 | Survey Point | 3.0 - 3.6 | 3.3 | | | 5 | 95 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 36.00-1 | Survey Point | 4.5 - 4.5 | 4.5 | | | 5 | 95 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 36.25-3 | Survey Point | 2.5 - 2.6 | 2.6 | | | 5 | 95 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 36.25-2 | Survey Point | 3.5 - 4.0 | 3.7 | | | 10 | 90 | | No macroinvertebrates or fish visually observed (no sampling conducted) |
| 36.25-1 | Survey Point | 4.3 - 4.3 | 4.3 | | | | 95 | 5 | No macroinvertebrates or fish visually observed (no sampling conducted) |

NR = Not recorded

Attachment A
Standard Operating Procedures

**Enbridge Line 6B MP 608
Marshall, MI Pipeline Release**

Case No.: 15-1411-CE

**Standard Operating Procedure for Identifying and
Documenting Riffle Areas Within
Work Segments of the Kalamazoo River**

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: August 3, 2016

Approved: September 8, 2016

(MDEQ Approval: August 23, 2016)

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| 4.0 | LITERATURE CITED..... | 5 |

1.0 BACKGROUND

This protocol has been developed for alluvial channels (channels that carry the same sediment that compose their bed and banks) that are primarily composed of riffle-pool sequences such as the Kalamazoo River which flows through Calhoun and Kalamazoo County, Michigan. It is not to be used for step-pool or bedrock confined channels such as those often found in the Upper Peninsula of Michigan.

River and stream shape is driven by the balance between transporting incoming water and sediment and moderating the energy that drives this transport. Fluvial geomorphology theory holds that the shape of flowing water systems is driven by minimizing the total work (energy expenditure) and the variance of energy loss along the channel (uniform distribution of energy utilization) as the channel accommodates changes in both flow and sediment load (Leopold, 1994). Both the channel cross-section and the meandering plan form of channels exhibit the results of these tendencies (*Figure 1*).

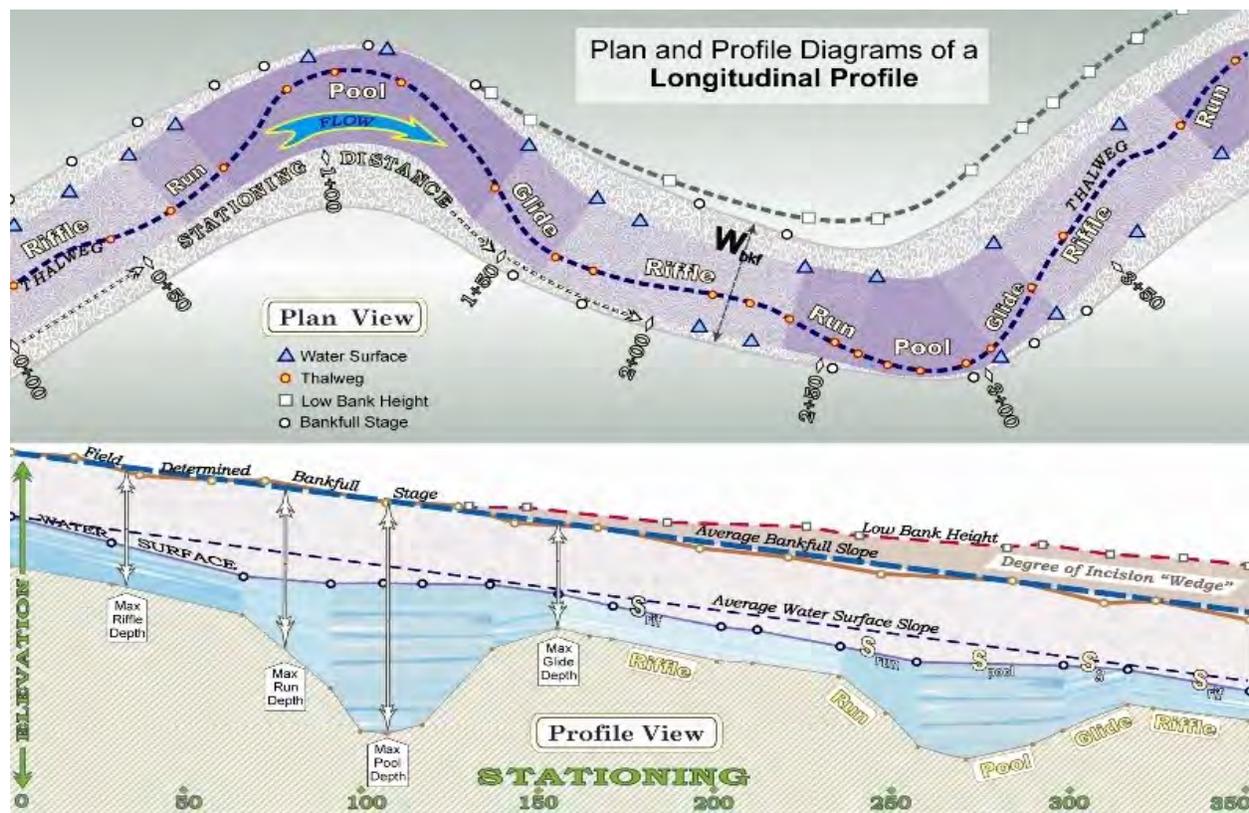


Figure 1. Idealized stream channel plan and profile with facet features identified (Rosgen, 2006).

Riffles are normally the sections of stream where the channel transitions from pool to pool. These areas typically possess uniform water depths across the channel and consist of coarse substrates containing a mixture primarily of gravel and cobble. Riffles will have the shallowest flow depths, highest flow velocities, the greatest likelihood for turbulent water, and the coarsest bed material within continuously inundated areas.

If considered in cross-section, the majority of flow will be along the thalweg (the deepest point of each cross-section). In unobstructed flow through bends, the thalweg will hug the outer bank. As flow exits the bend/pool feature, it will “cross-over” as it transitions to the outerbank of the next pool. Because of the channel's need to balance flow, sediment and energy dissipation, all alluvial channels will exhibit some degree of meandering. The degree of sinuosity that streams exhibit will vary, but this characteristic meandering pattern, however subtle will persist.

The riffle crest will be located at the high point of the transition/cross-over in each section and will transition to the shallowest flows between pools. This is also typically where the coarsest, consistently inundated bed material will be found. For instance, point bars, located on the opposite bank from meander bends can accumulate material coarser or similarly sized to riffle bed material, but point bars tend to be out of water for low to moderate flows that are below bankfull flows.

2.0 FIELD PROTOCOL

To assist with riffle identification and a general qualitative assessment within proposed work segments, the following actions shall be conducted:

1. Locate pool to pool transition zones (or point bar to point bar as indicators of relative pool locations) in the longitudinal direction.
2. Identify riffles. They will typically be located in the transition zone from pool to pool. Flow lines, or concentrated flow patterns, can sometimes be discerned on the water surface. The riffle can usually be found where the flow lines are approximately in the middle of the channel between successive pools.
3. At each riffle:
 - a. Record riffle boundaries using a global positioning system unit capable of sub-meter accuracy.

- b. Record current water depths or water depth ranges within each riffle. Water depths will assist in establishing the Area of Direct Impact as discussed in the *Standard Operating Procedure for Conducting Freshwater Mussel Surveys and Relocations Within Work Segments of the Kalamazoo River*.
- c. Assess the bottom substrate within the riffle with respect to percent cover by boulder, cobble, gravel, sand and other finer material. Those riffles exhibiting coarse substrates such as cobble, sand and gravel will be considered potential mussel habitat for future mussel survey if impacts cannot be avoided. Those riffles dominated by fine substrates such as muck, silt, clay, or detritus will be considered low-quality or less than optimal mussel habitat and will not require a mussel survey.
- d. Note the presence or absence of macroinvertebrate and fish species, with specific attention to those fish species often associated as hosts for transporting young mussels (glochidia). For example, these species include, but are not limited to, various dace and darter species. Utilize visual observations, viewing buckets, and/or kick nets to conduct a 10 minute timed search of the riffle. Record aquatic biota observed to the lowest possible taxonomy (typically family level).

3.0 EXAMPLE RIFFLES



Photograph of a riffle on an un-named river in the State of Vermont. Note cobble-sized riffle substrate, shallow flows, and froth of water over the riffle. Note the point bar in the background.



Photograph of a riffle on the Shiawassee River. Note the rippling of the water in the foreground as it goes over the riffle. Note meander bend and point bar in the background.

4.0 LITERATURE CITED

Leopold, 1994. Leopold, L.B. A View of the River, Harvard University Press, Boston, MA.
1994

Rosgen, 1996. Rosgen, D. Applied River Morphology. Wildland Hydrology, Pagosa
Springs, CO. 1996

Approved

**Enbridge Line 6B MP 608
Marshall, MI Pipeline Release**

Case No.: 15-1411-CE

**Standard Operating Procedure for Conducting
Freshwater Mussel Surveys and Relocations Within
Work Segments of the Kalamazoo River**

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

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Approved: September 8, 2016

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LIST OF ACRONYMS

| | |
|-------|---|
| ADI | Area of Direct Impact (ADI) |
| LWD | large woody debris |
| MDNR | Michigan Department of Natural Resources |
| ODNR | Ohio Department of Natural Resources |
| T&E | Threatened and Endangered Species |
| WVDNR | West Virginia Department of Natural Resources |

1.0 BACKGROUND

Prior to conducting freshwater mussel surveys or relocations, a Scientific Collectors Permit is required and will be secured from the Michigan Department of Natural Resources (MDNR) for the handling or relocation of any non-listed mussel species (neither listed as endangered, threatened, nor of special concern). Proposed mussel surveys for work segments of the Kalamazoo River will encounter non-listed species based upon an October 2010 Mussel Shell Survey Report (Badra, 2011) which documented the presence of live mussels (non-listed) in various reaches of the Kalamazoo River.

In the unlikely event state-listed species are encountered (i.e. species listed as endangered, threatened, or of special concern), a MDNR Threatened and Endangered Species (T&E) Permit will be secured as a precaution.

To date, the MDNR has yet to establish their own freshwater mussel protocols for the survey and relocation of mussels within Michigan's streams or rivers. The MDNR has been utilizing protocols established by the West Virginia Department of Natural Resources (WVDNR) and more recently, the Ohio Department of Natural Resources (ODNR). The ODNR has adapted their protocols from the WVDNR protocols to account for more northern climates and conditions more indicative of the Great Lakes (ODNR, 2016). In light of the fact that future MDNR mussel survey and relocation methodologies will apparently be aligned closely with ODNR protocols, proposed Standard Operating Protocols for conducting the large woody debris (LWD) installation freshwater mussel survey and relocation will utilize the ODNR protocols unless otherwise provided in the field protocols below to account for the type of activities being proposed throughout the work segments.

2.0 FIELD PROTOCOL

Areas documented as riffles along LWD installation heavy equipment access routes that cannot be avoided will be surveyed, and any mussels that are found will be relocated in accordance with the ODNR protocols (ODNR, 2016). In addition to the defined Area of Direct Impact (ADI), 10-meter upstream and downstream buffers will also be surveyed and mussels relocated as listed in Appendix G of the *Ohio Mussel Survey Protocol* (ODNR, 2016). Using Appendix G, the proposed placement of LWD best fits the category of "shoreline protection" in that table, which recommends buffer distances of 10 meters

upstream and 10 meters downstream of the ADI. Based upon the relatively narrow width of the ADI, the lateral buffer of 10 meters recommended for mussel survey and relocation will be reduced to 2 meters given the precision to which equipment is expected to navigate through these proposed impact areas. The lateral buffer shall be on both sides of the ADI and may only be on one side if the ADI abuts the river bank.

Transects will not be used; instead the entire ADI, upstream, downstream, and lateral buffer areas will be surveyed, and all mussels encountered will be identified to the species level and relocated outside of the ADI and its associated buffer areas.

The following briefly summarizes portions of the Ohio Mussel Survey Protocol (ODNR, 2016) and past approved MDNR mussel protocols that will be utilized:

1. Visual or surface searches of the bottom substrates for mussels will be conducted of the entire ADI, including buffer areas. Each of these areas shall be subdivided into smaller areas or cells, not exceeding 100 square meters (m^2) in size, to assist in conducting systematic searches of each area or cell, to ensure that all areas are surveyed. This includes moving cobble and woody debris; hand sweeping away silt, sand, and/or small detritus; and disturbing/probing the upper 5 centimeter (2 inches) of substrate in order to better view or feel the mussels which may be present. A minimum rate of 20 minutes per 100 m^2 of visual searching shall be expended in each segment of heterogeneous substrate within each cell.
2. If any state-listed mussels are found, an additional 30 minutes of visual searching shall be expended within that existing 100 m^2 area along with any adjoining upstream, downstream and laterally abutting 100 m^2 areas or cells.
3. Visual searches will commence at the downstream end and work upstream.
4. All mussels encountered will be identified to species, enumerated, photographed (at least once per species), temporarily stored in submerged mesh bags, and then moved to a predetermined Relocation Area. The Relocation Areas consist of undisturbed riffle habitat outside of the ADI and 2-meter lateral buffer area within the same riffle complex containing the same or similar suitable habitat. Mussels will therefore be relocated a short distance and remain within their same riffle complex, where other mussels are also presumably present.. Mussels shall be inserted posterior end up and their location, either individually or in groups, will be mapped using a global positioning system unit capable of sub-meter accuracy.

5. Once the ADI and lateral buffer have been surveyed and mussels have been relocated, physical markers will be installed within the Kalamazoo River that clearly demarcate where mussel relocations have been conducted and the area in which LWD installation equipment can travel.
6. A mussel survey and relocation summary report will be prepared upon completion of the relocation effort. Information on the species and number of mussels encountered and relocated from the ADI and buffer zones shall be provided to the MDNR and/or other regulatory agencies requesting said survey/relocation work.

3.0 LITERATURE CITED

Badra, 2011. Badra, Peter. *Mussel Shell Survey Report: Kalamazoo River Unionid Mussel Shell Survey in the Marshall and Battle Creek Area*, October 2010. Prepared for Stephanie Milsap, U.S. Fish and Wildlife Service and Kalamazoo River Enbridge Line 6B Oil Spill Trustee Council. July 20, 2011.

ODNR. 2016. Ohio Department of Natural Resources, Division of Wildlife and U.S. Fish and Wildlife Service, Ohio Ecological Services Field Office; *Ohio Mussel Survey Protocol*. April 2016.

Attachment B
Photographic Log



Photo 1. Field crew mapping a riffle in Survey Area 1: MP 2.25-3.25 (August, 2016).



Photo 2. Fish and macroinvertebrate sampling within riffle habitat (August, 2016).



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Photo 3. Stonefly (*Pteronarcidae* family) identified in Survey Area 1 (August, 2016).



Photo 4. Rainbow Darter (*Etheostoma caeruleum*) identified in Survey Area 1 (August, 2016).



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Photo 5. Shell of the invasive Asian clam (*Corbicula fluminea*) identified in Survey Area 1 (August, 2016).



Photo 6. Riffle identified in Survey Area 1. Uniform shallow water depth and mixture of coarse substrate (August, 2016).



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Photo 7. Typical riffle substrate consisting of cobble, gravel, and sand identified in Survey Area 1 (August, 2016).



Photo 8. Typical habitat identified in Survey Area 2: MP 14.25-15.00 (August, 2016).



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Photo 9. Typical habitat identified in Survey Area 2 consisting of homogeneous sand bed with aquatic vegetation (August, 2016).



Photo 10. Collecting water depth in Survey Area 3: MP 19.25-20.25 (August, 2016).



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Photo 11. Survey point collected in Survey Area 3. Water is slow moving with homogeneous bed and dense aquatic vegetation (August, 2016).



Photo 12. Survey point collected in Survey Area 3. Water is slow moving with homogeneous sand bed (August, 2016)



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Photo 13. Survey point collected near large woody debris installation location. Water depth exceeds typical riffle depth (greater than 2.5 feet) (August, 2016).



Photo 14. Mapping riffle boundaries in Survey Area 4: MP 32.25-36.25 (August, 2016).



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Photo 15. Looking downstream at an identified riffle area. Water depth is shallow (less than 2.5 feet) and uniform in cross-section (August, 2016).



Photo 16. Riffle identified in Survey Area 4. High boulder content (40%) with mixture of gravel, cobble, and sand. Whitewater exists at upstream edge of riffle feature (August, 2016).



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Photo 17. Survey point collected in Survey Area 4. Bed substrate is homogenous and primarily comprised of sand with little gravel. Water is slow moving (August, 2016).



Photo 18. Close up view of bed substrate primarily comprised of sand with little gravel (August, 2016).



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