

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

**Case No.: 15-1411-CE**

**Supplement to Report of Findings  
Large Woody Debris Riffle Survey**

**Prepared for Michigan Department of Environmental Quality**

**Enbridge Energy, Limited Partnership**

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## Table of Contents

<b>1.0 Introduction</b> .....	<b>1</b>
1.1 Objectives .....	1
<b>2.0 Riffle Surveys</b> .....	<b>2</b>
2.1 Survey Locations .....	2
2.2 Methodology .....	2
<b>3.0 Riffle Survey Results</b> .....	<b>4</b>
3.1 Survey Area 5 .....	4
3.2 Survey Area 6 .....	4
<b>4.0 Summary</b> .....	<b>5</b>
<b>5.0 References</b> .....	<b>6</b>

### FIGURES

- Figure 1**      **Large Woody Debris – Riffle Survey**
- Figure 2**      **Large Woody Debris – Riffle Diversion Route**

### TABLE

- Table 1**      **Large Woody Debris – Riffle Survey Field Data**

### ATTACHMENTS

- Attachment A**      **Standard Operating Procedure**
- Attachment B**      **Photographic Log**

**LIST OF ACRONYMS**

Enbridge	Enbridge Energy, Limited Partnership
ft	feet
LWD	large woody debris
MDEQ	Michigan Department of Environmental Quality
MP	Mile Post
Riffle SOP	<i>Standard Operating Procedure for Identifying and Documenting Riffle Areas Within Work Segments of the Kalamazoo River</i> , submitted to the MDEQ on September 8, 2016.
Yuma	Trimble® Yuma

## 1.0 Introduction

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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 the approved *Freshwater Mussel Evaluation & Management Plan Supplement to Large Woody Debris Installation Plan*, submitted to Michigan Department of Environmental Quality (MDEQ) on September 8, 2016 (Enbridge, 2016a), included field verification of riffles. Due to alternate LWD installation locations as detailed in *Addendum to the Large Woody Debris Replacement Work Plan and Large Woody Debris Installation Plan Supplement to Large Woody Debris Replacement Work Plan*, submitted to MDEQ on September 8, 2016 (Enbridge, 2016b), additional riffle surveys were necessary. Data collected during these additional riffle surveys is presented as a supplement to the approved *Report of Findings: Large Woody Debris Riffle Survey*, submitted to MDEQ on September 8, 2016 (Enbridge, 2016c).

### 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; and LWD riffle diversion routes for heavy equipment.

## 2.0 Riffle Surveys

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### 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:

- Mile Post (MP) 31.75 downstream to MP 32.00 (Survey Area 5), and
- MP 26.50 downstream to MP 27.25 (Survey Area 6).

### 2.2 Methodology

Riffle surveys were conducted on September 9, 2016, in accordance with the approved *Standard Operating Procedure for Identifying and Documenting Riffle Areas Within Work Segments of the Kalamazoo River*, submitted to the MDEQ on September 8, 2016 (Riffle SOP) (Enbridge, 2016d), 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 September 9, 2016, four technical staff representing Enbridge, inclusive of two aquatic biologists, a wetland scientist, and a stream morphologist, conducted riffle surveys and mapping of areas identified above as Survey Areas 5 and 6. Enbridge technical staff were accompanied by an Enbridge Environmental Inspector.

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 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

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Included as part of this report, *Figure 1* depicts the location of mapped riffles and additional survey points collected on September 9, 2016 within the survey areas. In addition, *Table 1* summarizes the field data collected on these dates for the two 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 5

Survey Area 5 (MP 31.75 – MP 32.00) contained one location with field attributes indicative of a riffle (*Figure 1, Sheet 1*). At the time of the field survey, water depths in this riffle area ranged from 1.6 ft to 2.3 ft, and riffle area bottom substrates consisted of a mixture of cobble, gravel, and sand. The riffle does not extend laterally across the entire channel from the left bank to right bank, as depicted by the riffle polygon in *Figure 1*. Field observations included sparse macroinvertebrates and a lack of fish present.

### 3.2 Survey Area 6

No riffles were identified in Survey Area 6 (MP 26.50 – MP 27.25), but survey points were documented (*Figure 1, Sheet 2*). The channel depths through surveyed areas exceeded 2.5 ft, with the exception of one surveyed area, and the bed sediment was primarily sand and gravel. No fish or macroinvertebrates were observed in this survey area.

## 4.0 Summary

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Field teams surveyed areas of the river, within the proposed LWD work areas, for field attributes that would represent riffles in accordance with the Riffle SOP included in *Attachment A*. The one identified riffle was mapped and is depicted as a polygon 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 polygon generated from this riffle survey in conjunction with LWD installation locations and travel routes for heavy equipment. The one identified riffle polygon and LWD riffle diversion route for heavy equipment is depicted on *Figure 2*. Enbridge will focus efforts on avoiding and minimizing impacts to the riffle location by diverting heavy equipment travel around the riffle. Riffle boundaries will be marked with rope buoys prior to LWD installation activities to further define the travel route around this riffle.

## 5.0 References

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Enbridge, 2016a. 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 September 8, 2016.

Enbridge, 2016b. Enbridge Energy, Limited Partnership Line 6B MP 608 Pipeline Release, Marshall, Michigan; *Addendum to Large Woody Debris Replacement Work Plan and Large Woody Debris Installation Plan*, dated September 8, 2016.

Enbridge, 2016c. Enbridge Energy, Limited Partnership Line 6B MP 608 Pipeline Release, Marshall, Michigan; *Report of Findings: Large Woody Debris Riffle Survey*, dated September 8, 2016.

Enbridge, 2016d. Enbridge Energy, Limited Partnership Line 6B MP 608 Pipeline Release, Marshall, Michigan; *Standard Operating Procedure for Identifying and Documenting Riffle Areas Within Work Segments of the Kalamazoo River*, dated September 8, 2016

## Figures

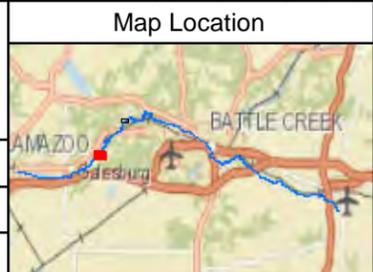


**ENBRIDGE**

Drawn: EN 9/14/2016

Approved: LN 9/14/2016

Project #: 60481718



**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

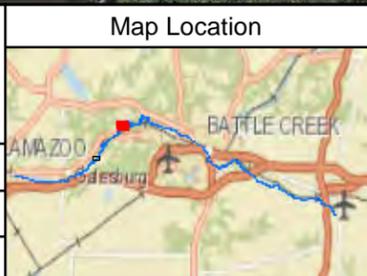
**FIGURE 1**  
**LARGE WOODY DEBRIS - RIFFLE SURVEY**  
**SURVEY AREA 5**  
**SHEET 1 OF 2**

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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

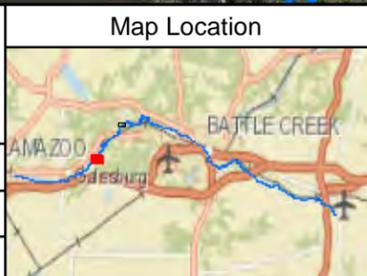
**FIGURE 1**  
 LARGE WOODY DEBRIS - RIFFLE SURVEY  
 SURVEY AREA 6  
 SHEET 2 OF 2

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<b>Legend</b>		  Scale in Feet
	Riffle Survey Location	
	Approximate Riffle Boundary (2016 Survey)	
	Riffle Diversion Route for Heavy Equipment	
	Parcel	
	Quarter Mile Grid Segments	
	Kalamazoo River Flood Inundation Boundary	

**FIGURE 2**  
 LARGE WOODY DEBRIS - RIFFLE DIVERSION ROUTE  
 SHEET 1 OF 1

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**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
26.75-2	Survey Point	4.0 - 4.3	4.2		5	55	40		No macroinvertebrates or fish visually observed (no sampling conducted)
26.75-1	Survey Point	4.1 - 4.3	4.2			40	60		No macroinvertebrates or fish visually observed (no sampling conducted)
27.00-4	Survey Point	3.0 - 3.5	3.3			40	60		No macroinvertebrates or fish visually observed (no sampling conducted)
27.00-3	Survey Point	1.4 - 1.7	1.6			50	50		No macroinvertebrates or fish visually observed (no sampling conducted)
27.00-2	Survey Point	4.8 - 5.0	4.9				90	10	No macroinvertebrates or fish visually observed (no sampling conducted)
27.00-1	Survey Point	3.9 - 4.0	4.0			10	90		No macroinvertebrates or fish visually observed (no sampling conducted)
27.25-3	Survey Point	4.9 - 5.4	5.2			10	90		No macroinvertebrates or fish visually observed (no sampling conducted)
27.25-2	Survey Point	5.6 - 5.6	5.6			10	90		No macroinvertebrates or fish visually observed (no sampling conducted)
27.25-1	Survey Point	4.7 - 4.9	4.8			10	90		No macroinvertebrates or fish visually observed (no sampling conducted)
32.00-3	Survey Point	4.1 - 4.1	4.1			20	80		No macroinvertebrates or fish visually observed (no sampling conducted)
32.00-2	Survey Point	2.9 - 3.1	3			40	60		No macroinvertebrates or fish visually observed (no sampling conducted)
32.00-R1	Riffle	1.6 - 2.3	2.2		5	45	50		Sparse macroinvertebrates. Taxa present includes: caddisflies (Hydropsychidae), and mayflies (Heptageniidae and Siphonuridae)
32.00-1	Survey Point	2.5 - 2.5	2.5			20	80		No macroinvertebrates or fish visually observed (no sampling conducted)
32.25-1	Survey Point	3.7 - 4.4	4.1			20	80		No macroinvertebrates or fish visually observed (no sampling conducted)

**Attachment A**  
**Standard Operating Procedure**

**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**

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## Table of Contents

1.0	BACKGROUND.....	1
2.0	FIELD PROTOCOL .....	2
3.0	EXAMPLE RIFFLES.....	4
4.0	LITERATURE CITED.....	5



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

**Attachment B**  
**Photographic Log**



Photo 1. Collecting water depth in Survey Area 5: MP 31.75 - MP 32.00 (September, 2016).



Photo 2. Collecting water depth near proposed structures in Survey Area 5: MP 31.75 - MP 32.00 (September, 2016).



LARGE WOODY DEBRIS RIFFLE SURVEY  
ENBRIDGE LINE 6B MP 608  
MARSHALL, MI PIPELINE RELEASE  
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Photo 3. Looking downstream along riffle boundary in Survey Area 5: MP 31.75 - MP 32.00 (September, 2016).



Photo 4. Collecting water depth in Survey Area 5: MP 31.75 - MP 32.00 (September, 2016).



LARGE WOODY DEBRIS RIFFLE SURVEY  
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Photo 5. Collecting water depth in Survey Area 6: MP 26.50 - MP 27.25 (September, 2016).



Photo 6. Collecting water depth in Survey Area 6: MP 26.50 - MP 27.25 (September, 2016).



LARGE WOODY DEBRIS RIFFLE SURVEY  
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Photo 7. Collecting water depth in Survey Area 6: MP 26.50 - MP 27.25 (September, 2016).



Photo 8. Collecting water depth in Survey Area 6: MP 26.50 - MP 27.25 (September, 2016).



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