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Enbridge Line 5

Straits of Mackinac, MI

Coating Inspection in the Vicinity of Installed Pipeline Anchors Work Plan

Enbridge Energy, Limited Partnership

Submitted: September 15, 2017

ENBDNR0001472

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LIST OF ACRONYMS

CP	Cathodic Protection
CPDM	Cathodic Protection Data Management
CSE	Copper Sulphate Electrode
DFT	Dry Film Thickness
Enbridge	Enbridge Energy, Limited Partnership
mV	Millivolt
ROV	Remote Controlled Vehicle
USEPA	United States Environmental Protection Agency

DEFINTIONS

Area(s) of Interest

An Area of Interest is a part of the pipeline where, based on visual inspection, (i) the normal (local) Biota is unexpectedly absent or (ii) there is evidence of possible coating damage (e.g., Dislodged Coating and/or potential Holiday). Disturbed Areas (see definition below) are not Areas of Interest as the lack of Biota can be attributed to past maintenance and monitoring activities.

Biota

Animals and plants living around and on the pipelines through the Straits (e.g. mussels, periphyton, algae, microbes).

Dislodged Coating

An area on the pipeline where, based on visual inspection, the outer wrap of the coating appears to have been dislodged or removed without exposure of the pipe steel.

Disturbed Area

An area on the pipeline where past maintenance and monitoring activities resulted in the removal of Biota but does not represent damage to the pipe coating.

Holidays

An area on the pipeline where there is a discontinuity in the coating that exposes the pipe steel to the environment.

Undisturbed Area

An area on the pipeline where there is no evidence of any loss of Biota (or pipe coating).

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1.0 Introduction

Pursuant to the September 1, 2017 letter from the State of Michigan ("September 1 Letter"), Enbridge has prepared this "Coating Inspection in the Vicinity of Pipeline Anchors - Work Plan". Enbridge anticipates the information obtained from this investigation will complement the information gathered during integrity monitoring activities already being undertaken by Enbridge.

The federal consent decree (Case 1:16-cv-00914, ECF No. 14 entered May 23, 2017),) entered between Enbridge Energy, Limited Partnership (Enbridge) and the United States requires that Enbridge initiate a detailed investigation into the potential for marine organisms to impact the integrity of the two 20-inch diameter pipelines ("Dual Pipelines") that span the Straits of Mackinac ("Straits") and form part of Enbridge's' Lakehead System Line 5 pipeline ("Line 5"). That investigation is detailed in Enbridge's Biota Investigation Work Plan (BI Work Plan), which was prepared for and, in June 2017, approved by the United States Environmental Protection Agency ("USEPA").

The BI Work Plan identified eighteen (18) Areas of Interest for investigation, as well as three additional sites for coating damage investigation. As Enbridge previously advised the State, one of these additional sites (WAS-1 in Span W-68A) was coincident with an area of the west pipeline where a pipe support anchor was installed in 2014. Dive inspection at this site confirmed four small areas of coating loss (with a total area of 0.38 square feet). Electrical measurements indicated high levels of cathodic protection, and no external metal loss was observed.

In the September 1 Letter, the State makes note of the fact that at least one of the investigated sites with a coating gap was adjacent to an area where a screw anchor had been installed. The State expresses concern as to whether the methods used for installation of such anchors might have resulted in damage to the coating of the pipeline. The State has thus requested that Enbridge submit a plan, subject to approval by the State, for an investigation of anchor sites. This Work Plan is intended to fulfill that requirement.

2.0 Michigan AG Requested Actions

The September 1 Letter requests that Enbridge undertake the following Requested Actions:

1. Within 7 days from the date of this letter, provide the State with an interim report describing each location where damage to the external coating has been observed, the extent and nature of the damage, and any available documentation, including, without limitation, photographs and videos.

2. Within 14 days from the date of this letter, provide the State with a plan to inspect each area on the pipeline where a pipeline anchor was installed to determine whether and to what extent the external coating has been damaged. The plan should include an implementation schedule and is subject to approval by the State.

3. Within 21 days from the date of this letter, provide the State with a plan detailing the materials, methods and procedures Enbridge will used to repair all areas where damage to the external coating is identified. The plan should include an implementation schedule and is subject to approval by the state. We expect that the Schedule would provide for completion of repairs in the identified areas as soon as possible, and in any event within the same construction season during which they are identified."

Enbridge responded to Requested Action no. 1 in a letter to the State dated September 8, 2017. This Work Plan is submitted in response to Requested Action no. 2. Enbridge intends to separately respond to Requested Action no. 3.

3.0 Details of Inspection Plan

Since 2002, Enbridge has installed 128 pipe support anchors on the Dual Pipelines. Table 1 provides a listing, GPS coordinates, and the depth of all anchors that have been installed, which will be inspected as part of this Inspection Plan.

3.1 ROV Examination

A ROV will be deployed to record detailed video on both sides of each of the Dual Pipelines for a span of 20 feet on each side of the target anchor. The video log will be documented to show the direction of the ROV (North or South). The first pass will be conducted on the east or west side of each pipeline based on existing water currents at the time of the inspection – the first pass will be completed in a manner that minimizes interference by suspended sediment that may be stirred up by the ROV's propulsion systems.

A second pass with the ROV will be completed on the opposite side of each pipeline.

The swimming velocity of the ROV will be maintained at a sufficiently low rate to enable detailed inspection by the operator; and the visual image of the pipe should be maintained at approximately 30% of the video field of view unless close-up imaging is required.

In the event that areas of interest, holidays or deposits are found, the ROV and camera system will be carefully navigated to record the nature of the feature. The ROV operator will document these inspections on the ROV Inspection Form for L5 Straits of Mackinac ("ROV Inspection Form"), which is enclosed as Appendix A.

In the event that water currents or general turbidity in the water preclude good quality inspection, the same shall be noted on the ROV Inspection Form. In these cases, a more extensive dive examination will be conducted, in accordance with the diver examination measures described below in Section 3.2.

3.2 Diver Examination

Following the completion and analysis of the video inspections recorded by the ROV, a diver will be deployed to each anchor to conduct a detailed manual examination of the pipe support anchor and adjacent pipe coating. This inspection will span approximately six (6) feet axially

on both sides of the pipe support anchor, for a total inspection of approximately 12 feet. In cases where the previous ROV examination produced insufficiently good quality images for video analysis, the diver examination will include an additional 14 axial feet of inspection on each side of the anchor (extending the full 20 feet of the ROV inspection scope)[1].

The diver will first manually remove biota from the pipe (+/- 6 feet of the anchor location only) and will communicate observations to the dive-supervisor onboard the support boat/barge. The general and detailed observations will be recorded on the Diver Inspection Form for L5 Straits of Mackinac ("Diver Inspection Form", which is enclosed as Appendix B).

The Diver Inspection Form will include detailed documentation of locations that are found to be disturbed areas, dislodged areas, coating holidays, or contain deposits. Location data shall include the feature classification (e.g., dislodged coating, coating holiday, deposits, if any), the circumferential orientation of the feature (o'clock position), size of the feature, and approximate distance of the feature from the pipe support anchor. Feature classification and location data shall be recorded for all features observed within the span of the diver inspection.

3.2.1 Coating Thickness Measurements

In the absence of any features in the coating at a pipe support anchor location, the diver shall record at least two representative coating thickness readings within six (6) feet on each side of the anchor (a total of four (4) readings).

In the presence of: (i) disturbed areas, (ii) dislodged areas, (iii) coating holidays, and/or (iv) deposits, coating thickness measurements will be obtained from at least one (1) representative location within each feature area. Larger features may have two (2) to three (3) readings obtained depending on feature size. For comparison to intact coating, adjacent coating thickness measurements will also be obtained from four (4) locations surrounding the feature within two (2) inches of the feature, and a second set of adjacent four (4) coating thickness measurements will be obtained approximately 12 inches outside the feature of interest.

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[1] This additional diver inspection does not require removal of biota unless missing coating is observed.

3.2.2 CP Potential Measurements

The Polatrak Cathodic Protection (CP) gun will be employed to record CP potentials. The resulting data will be used to establish the existence of bare metal on the pipelines. CP measurements will be obtained from areas of obvious bare metal, suspected holidays (with Dry Film Thickness (DFT) thickness less than the minimum resolvable measurement of the DFT gauge), as well as through any deposits that have formed on the pipe wall regardless of indicated DFT measurement. Because the CP gun's angled probe is designed to penetrate thin film coatings, firm continuous pressure is to be applied at bare metal, suspected holidays, and deposits by the diver. Sharp impact or excessive pressure shall not be applied by the diver, as this would damage intact pipe coating.

3.2.3 Deposit Removal

Where white calcareous deposits are encountered, the diver will use a non-metallic scraper to remove the deposit to expose the pipe surface underneath.

The surface of the pipe will be cleaned and any exposed steel shall be visually assessed to determine the amount of bare steel expressed as a percentage of the original white deposit covered area. In the divers/ROV operators opinion, the percentage of exposed area will be evaluated and recorded with maximum precision of 10% area (i.e., 0, 10, 20, ...90, 100).

If bare metal is visually confirmed, then the Polatrack CP gun shall be used to re-record cathodic protection measurements (per section 3.2.2) from the same approximate locations as originally recorded.

3.2.4 Criteria for Establishing Coating Defects

Enbridge's Dual Pipelines through the Straights were designed with: (i) a corrosion preventing enamel coating system, which is intended to isolate the pipeline from the lake water; and (ii) a fibre reinforced outer wrap, which is intended to prevent damage to the protective enamel coating during pipeline installation. Areas of damaged or missing outer wrap that have been confirmed by residual thickness measurements greater than 40 mils do not constitute a repairable coating defect.

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A coating holiday (area of exposed metal) can only be established by clear visual evidence of bare metal (alone), or coating thickness measurements less than 25 mils in conjunction with CP potentials that are more electronegative than -600mV CSE.

The divers that will be used on this project must be Operator Qualified (OQ) certified for CP readings. Data collected during this investigation will be evaluated by one of Enbridge's NACE Accredited CP Specialists prior to incorporation into Enbridge's Cathodic Protection Data Management (CPDM) system.

4.0 Quality Assurance/Quality Control

Quality assurance/quality control measures will be implemented to ensure the integrity of samples and measurements that are generated as a result of actions required under this Work Plan. Such measures shall include, but not be limited to:

- Project organization: the Project Manager, subcontractors, and all parties taking part in this effort will be identified and their roles will be articulated prior to commencing efforts. Planning and coordination calls and/or meetings will take place with divers, members of the integrity team, biologists, etc., to ensure the proper execution of sampling and data collection protocol.
- All instruments will be calibrated prior to and throughout their use according to manufacturer recommendations.
- Video photography and audio communication (between divers and personnel on boats) will be utilized to ensure proper documentation of conditions and sampling requirements.
- Documentation and records: field notes, laboratory reports, etc., will be compiled and saved at secure locations in hard copy and/or electronic format.
- Data validation: Data generated through the course of these efforts will be routinely evaluated for accuracy, precision, representativeness, and completeness.
- Reporting: Reports and project deliverables will be edited, reviewed, and finalized prior to submittal. A final report detailing the findings will be provided to the State after completion of the anchor coating inspections and assessment of the data.

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5.0 Implementation Schedule

Enbridge will implement this Work Plan in accordance with the schedule set forth below. This Plan is also highly dependent on weather conditions allowing safe access to perform the work. Logistical requirements and seasonal limitations may necessitate completing some of the anchor inspection efforts in 2018.

- September 14, 2017: Commence ROV inspections
- October 1, 2017: Commence Diver inspections
- November 30, 2017: Anticipated end of safe seasonal access
- May, 2018: Anticipated earliest seasonal access if dive inspections cannot be fully completed in 2017.

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TABLES

Table 1: Anchor Locations

Line 5 Straits Pipeline - East			
Anchor Indentification	Water Depth (ft)	Latitude	Longitude
E-1	73	REDACTED	
E-2	74		
E-3	73		
E-4	74		
E-5	75		
E-6	83		
E-7	88		
E-8	88		
E-9	87		
E-10	86		
E-11	86		
E-12	80		
E-13	78		
E-14	82		
E-15	81		
E-16	91		
E-17	95		
E-18	97		
E-19	99		
E-20	101		
E-21	107		
E-22	107		
E-23	107		
E-24	106		
E-25	103		
E-26	105		
E-27	104		
E-28	114		
E-29	116		
E-30	117		
E-31	124		
E-32	127		
E-33	131		
E-34	136		
E-35	139		
E-36	142		
E-37	143		
E-38	148		
E-39	148		
E-40	151		
E-41	150		
E-42	145		
E-43	133		
E-44	139		
E-45	143		
E-46	147		
E-47	195		
E-48	219		
E-49	227		
E-50	230		
E-51	233		
E-52	231		
E-53	229		
E-54	228		
E-55	224		
E-56	220		
E-57	221		
E-58	221		
E-59	220		
E-60	220		
E-61	215		
E-62	209		
E-63	188		
E-64	179		
E-65	169		
E-66	160		
E-67	69		

Line 5 Straits Pipeline - West			
Anchor Indentification	Water Depth (ft)	Latitude	Longitude
W-1	78	REDACTED	
W-2	78		
W-3	76		
W-4	75		
W-5	73		
W-6	91		
W-7	93		
W-8	109		
W-9	116		
W-10	120		
W-11	123		
W-12	126		
W-13	127		
W-14	136		
W-15	138		
W-16	137		
W-17	137		
W-18	138		
W-19	137		
W-20	136		
W-21	133		
W-22	130		
W-23	128		
W-24	124		
W-25	125		
W-26	141		
W-27	146		
W-28	165		
W-29	171		
W-30	173		
W-31	177		
W-32	180		
W-33	173		
W-34	173		
W-35	178		
W-36	183		
W-37	195		
W-38	194		
W-39	227		
W-40	235		
W-41	235		
W-42	241		
W-43	245		
W-44	249		
W-45	235		
W-46	233		
W-47	224		
W-48	224		
W-49	222		
W-50	222		
W-51	215		
W-52	210		
W-53	193		
W-54	163		
W-55	158		
W-56	135		
W-57	81		
W-58	77		
W-59	76		
W-60	76		
W-61	75		

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APPENDICES

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Appendix A – Video Inspection Report Form

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ENBRIDGE	ROV Inspection Form for L5 Straits of Mackinac

General Information			
Date:		Contractor:	
AFE / W.O.#:		ROV Operator:	
Pipe Support Anchor:		Water Depth (ft):	
Longitude:		Latitude:	

ROV Visual Inspection Log			
	ROV Transit Description (E/W of pipe, travelling N/S)	Video Log (start/end)	Video Reference (hh:mm:ss)

ROV Visual Inspection Results			
Feature Number	Location of Feature (w.r.t. pipe support)	Visual Classification of Feature	Video Reference (hh:mm:ss)
		☐ Area of Interest ☐Holiday (bare metal) ☐ Deposit ☐Other	
		☐ Area of Interest ☐Holiday (bare metal) ☐ Deposit ☐Other	
		☐ Area of Interest ☐Holiday (bare metal) ☐ Deposit ☐Other	
		☐ Area of Interest ☐Holiday (bare metal) ☐ Deposit ☐Other	
		☐ Area of Interest ☐Holiday (bare metal) ☐ Deposit ☐Other	
		☐ Area of Interest ☐Holiday (bare metal) ☐ Deposit ☐Other	
		☐ Area of Interest ☐Holiday (bare metal) ☐ Deposit ☐Other	
		☐ Area of Interest ☐Holiday (bare metal) ☐ Deposit ☐Other	
		☐ Area of Interest ☐Holiday (bare metal) ☐ Deposit ☐Other	
		☐ Area of Interest ☐Holiday (bare metal) ☐ Deposit ☐Other	
		☐ Area of Interest ☐Holiday (bare metal) ☐ Deposit ☐Other	
		☐ Area of Interest ☐Holiday (bare metal) ☐ Deposit ☐Other	
		☐ Area of Interest ☐Holiday (bare metal) ☐ Deposit ☐Other	
		☐ Area of Interest ☐Holiday (bare metal) ☐ Deposit ☐Other	
Dislodged coating observed on the lake floor: ☐YES ☐NO		Pipe Location w.r.t. Lake Floor: (ie. partially buried, fully suspended)	

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ENBRIDGE	ROV Inspection Form for L5 Straits of Mackinac

Comments/Issues/Discussion

Contractor Signature	Date

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South End of Affected and Non-Affected Area							
For all sections of dislodged coating or holidays, provide pictures below. Included the date and time stamps associated with video surveillance.							
Date:		Frame(HH:MM:SS)		Date:		Frame(HH:MM:SS)	
Comments:							

Overall South Affected Area							
For all sections of dislodged coating or holidays, provide pictures below. Included the date and time stamps associated with video surveillance.							
Date:		Frame(HH:MM:SS)		Date:		Frame(HH:MM:SS)	
Comments:							

Anchor

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For all sections of dislodged coating or holidays, provide pictures below.
Included the date and time stamps associated with video surveillance.

Date:		Frame(HH:MM:SS)		Date:		Frame(HH:MM:SS)	

Comments:

Anchor

For all sections of dislodged coating or holidays, provide pictures below.
Included the date and time stamps associated with video surveillance.

Date:		Frame(HH:MM:SS)		Date:		Frame(HH:MM:SS)	

Comments:

Overall North Affected Area

For all sections of dislodged coating or holidays, provide pictures below.
Included the date and time stamps associated with video surveillance.

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Date:		Frame(HH:MM:SS)		Date:		Frame(HH:MM:SS)	
Comments:							

North End of Affected and Non-Affected Area

For all sections of dislodged coating or holidays, provide pictures below.
Included the date and time stamps associated with video surveillance.

Date:		Frame(HH:MM:SS)		Date:		Frame(HH:MM:SS)	
Comments:							

Feature #1

For all sections of dislodged coating or holidays, provide pictures below.
Included the date and time stamps associated with video surveillance.

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Date:		Frame(HH:MM:SS)		Date:		Frame(HH:MM:SS)	

Feature #2							
For all sections of dislodged coating or holidays, provide pictures below. Included the date and time stamps associated with video surveillance.							
Date:		Frame(HH:MM:SS)		Date:		Frame(HH:MM:SS)	

Feature #3
For all sections of dislodged coating or holidays, provide pictures below. Included the date and time stamps associated with video surveillance.

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ENBRIDGE	ROV Inspection Form for L5 Straits of Mackinac

Date:		Frame(HH:MM:SS)		Date:		Frame(HH:MM:SS)	

Feature #4							
For all sections of dislodged coating or holidays, provide pictures below. Included the date and time stamps associated with video surveillance.							
Date:		Frame(HH:MM:SS)		Date:		Frame(HH:MM:SS)	

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Appendix B – Diver Coating Inspection Report Form

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ENBRIDGE	Diver Inspection Form for L5 Straits of Mackinac

General Information			
Date:		Diver:	
AFE / W.O.#:		Company Rep / Inspector:	
Pipe Support Anchor:		Water Depth (ft):	
Longitude:		Latitude:	

Diver Inspection Record

Feature Number	Location of Feature (w.r.t. pipe support)	Circumferential Position of the Feature (o'clock position)	Measured Feature size (ft^2)	Visual Classification of Feature	
				☐ Dislodged Area ☐ Deposit	☐Holiday (bare metal) ☐Disturbed Area
				☐ Dislodged Area ☐ Deposit	☐Holiday (bare metal) ☐Disturbed Area
				☐ Dislodged Area ☐ Deposit	☐Holiday (bare metal) ☐Disturbed Area
				☐ Dislodged Area ☐ Deposit	☐Holiday (bare metal) ☐Disturbed Area
				☐ Dislodged Area ☐ Deposit	☐Holiday (bare metal) ☐Disturbed Area
				☐ Dislodged Area ☐ Deposit	☐Holiday (bare metal) ☐Disturbed Area
				☐ Dislodged Area ☐ Deposit	☐Holiday (bare metal) ☐Disturbed Area
				☐ Dislodged Area ☐ Deposit	☐Holiday (bare metal) ☐Disturbed Area
				☐ Dislodged Area ☐ Deposit	☐Holiday (bare metal) ☐Disturbed Area
				☐ Dislodged Area ☐ Deposit	☐Holiday (bare metal) ☐Disturbed Area
				☐ Dislodged Area ☐ Deposit	☐Holiday (bare metal) ☐Disturbed Area
				☐ Dislodged Area ☐ Deposit	☐Holiday (bare metal) ☐Disturbed Area
				☐ Dislodged Area ☐ Deposit	☐Holiday (bare metal) ☐Disturbed Area
				☐ Dislodged Area ☐ Deposit	☐Holiday (bare metal) ☐Disturbed Area
				☐ Dislodged Area ☐ Deposit	☐Holiday (bare metal) ☐Disturbed Area
				☐ Dislodged Area ☐ Deposit	☐Holiday (bare metal) ☐Disturbed Area
				☐ Dislodged Area ☐ Deposit	☐Holiday (bare metal) ☐Disturbed Area
NB: insert table rows as necessary to identify all features observed. Feature numbering starts at top row (for detailed video images)			Biota present:	☐YES ☐ NO	

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Dislodged coating observed on the lake floor: ☐YES ☐NO	Lake floor location wrt pipe:	

Comments/Issues/Discussion		
	Contractor Signature	Enbridge Representative/ Inspector Signature

Coating Gauge Information			
Manufacturer:	Elcometer Inspection Equip	Product:	211 Coating Thickness Gauge
Last Calibrated:	08/09/2017	Next Calibration Due:	08/09/2018
Gauge verified prior to use:	☒YES ☐ NO		

Coating Thickness Inspection Data (complete this table in the absence of any Features)			
Location	Coating Thickness (mil)	Distance from Anchor (ft)	Location on Pipe (o'clock)
North of Anchor #1			
North of Anchor #2			
South of Anchor #1			
South of Anchor #2			
Average Thickness			

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ENBRIDGE	Diver Inspection Form for L5 Straits of Mackinac

Cathodic Protection and Coating Measurements (for Feature # __)[1]					
CP Reading #1 (mV) (north end of feature)	**N/R**	**CP Reading #2 (mV)** (center of feature)	**N/R**	**CP Reading #3 (mV)** (south end of feature)	**N/R**
DFT #1 (mil) (north end of feature)	**N/R**	**DFT #2 (mil)** (center of feature)	**N/R**	**DFT #3 (mil)** (south end of feature)	**N/R**
(record #2 for features < 2" long; record #1 and #3 for features 2"-8" long; record #1, #2 and #3 for features >8" long)					
Temperature (°F)		**DFT Adjacent to Feature (mil)** (~2" away from edge)		**DFT Adjacent to Feature (mil)** (~8"-12" away from edge)	
Provide 1 to 2 photos of feature, below: *Included the date and time stamps associated with video surveillance.*					
Date:		Frame(HH:MM:SS)		Date:	Frame(HH:MM:SS)

Note: CP readings will not be taken at features classified as disturbed areas or dislodged areas.

[1] Copy this page for each feature identified in the preceding page table.