MEMORANDUM

To: Michigan Pipeline Safety Board
From: Craig Hupp, General Public Representative
Jennifer McKay, Environmental Group Representative
Michael Shriberg, Statewide Conservation Group Representative
Subject: A Brief Overview of Maritime Conditions in and near The Straits of Mackinac that could impair or prevent oil spill response actions.

On November 27, 2017, the Governor for the State of Michigan entered into an Agreement Between the State of Michigan and Enbridge Energy, Limited Partnership and Enbridge Energy Company, Inc. ("the Agreement"). The Agreement is intended to improve the safety of Enbridge's pipelines within the State and requires improved practices for pipeline safety and emergency response at the Straits, the St. Clair River and throughout the State of Michigan.

Section I.C of the Agreement provides that Enbridge will temporarily shut-down the operation the Dual Pipelines while "Sustained Adverse Weather Conditions" remain in the effect in the Straits. Sustained Adverse Weather Conditions are defined in the Appendix to the Agreement as "conditions in which median wave heights in the Straits of Mackinac over a continuous 60-minute period are greater than 8 feet [that is, maritime conditions where half the waves are higher than 8 feet] based on 'Near-real Time Data' or in its absence 'Modeled Data.'"

Temporary shut down of Line 5 operations in the Straits during periods of sustained adverse weather conditions is required because those conditions do not allow watercraft and equipment to respond effectively to potential oil spills.

This memo makes several general points. First, the purpose of Section I.C can only be achieved by assessing the limits of effectiveness of the currently available response equipment under a variety of maritime conditions, not only waves but also wind, ice cover, currents and potentially other factors. Second, developing shutdown criteria based on maritime conditions requires an understanding of the frequency of adverse conditions in and near the Straits. Third, the present criterion permits pipeline operation well past the point at which oil spill response equipment will be deployable, much less effective. Finally, because the current criterion does not anticipate adverse conditions, in many cases it will be invoked hours after conditions already exist that prevent watercraft and equipment from responding effectively to oil spills.

<u>Recommendation</u>

Our conclusion based on the points below is that the current definition of "Sustained Adverse Weather Conditions" is inadequate to protect the public health, safety, and welfare and the unique ecological and natural resources of the Straits Crossing in the event of a release of petroleum from

Line 5 because it does not correlate with conditions in the Straits that would prevent or significantly impair containment and recovery of spilled oil using current emergency response capabilities in the Straits of Mackinac based upon available equipment and resources.

"Sustained Adverse Weather Conditions" should be replaced with the concept "Adverse Maritime Conditions" which are tailored to operational limitations of available emergency response equipment and to the maritime conditions observed in the Straits and the nearby open water in Lakes Michigan and Huron.

Known Limitations on the Deployment of Response Equipment

In 2016, Enbridge committed to acquiring 8 NOFI Current Buster 2 and Current Buster 4 oil containment systems for open water. The equipment brochure (Exhibit 1) states that this equipment can be deployed in open water in conditions up to Beaufort Wind Scale of 4 (Exhibit 2) – wind below 19 mph and wave height below 3.4 feet. Given this is currently the most sophisticated and effective system available for open water response, the known limits of the Current Busters set 18 mph winds and 3.3 foot waves as the limiting maritime conditions for oil response effectiveness.

Adverse Maritime Conditions

The purpose of this section is to give a sense of the scale and frequency of conditions adverse to oil spill response actions in and near the Straits – high waves, high winds, ice cover and strong currents.

Wave Height

There were almost no hours in the preceding 12 months when median wave heights in the Straits exceeded 8 feet for 60 minutes.

However, for the period December 9, 2016 to December 8, 2017, the NOAA Great Lakes Coastal Forecasting System (GLCFS) Nowcast wave model forecast Significant Wave Height exceeded 3.3 feet (the Current Buster's operational limit) for 359 hours in the vicinity of Line 5. In the Agreement, this model provides the wave data for the Straits when the wave buoy is not operational.

The oil transport models indicate released oil will quickly spread out of the Straits into more open water. Wave height generally increases in more open waters to the east and west of the Straits. This effect can be seen visually in the NOAA GLCFS Nowcast wave height forecast model for last week's gale. Exhibit 3, GLCFS Nowcast forecast for December 5, 2017.

The Nowcast forecast for the past year for the open water about two miles west of Line 5 indicates significant wave height exceeded 3.3 feet for 521 hours, 44% more hours than in the Straits. Thus, wave heights outside the Straits are better criterion for pipeline shutdown than wave heights within the Straits.

With that as background, it is clear there are several shortcomings with the current definition of Sustained Adverse Weather Conditions.

- The current wave height criterion – median wave height of 8 feet in the Straits – is far above the 3.3 feet operational limits of the NOFI Current Buster oil containment equipment.
- The wave height criterion should not be expressed as the median wave height because that means that half of the waves will exceed the criterion. A median 8 feet height means half of the waves are taller than 8 feet!
- Adverse Marine Conditions criteria for shut down based on the operational limits of current emergency response equipment should include wave heights of 3.3 feet in the open water east and west of the Straits.
- The Adverse Marine Conditions criteria should use the Nowcast model's more conservative calculation of wave height, Significant Wave Height, which is the mean wave height of the highest third of all waves.

High Winds

High winds will hamper recovery efforts not only because of the high waves they create but also because they can make it difficult to maneuver and station maritime equipment being pushed around by the force of the wind. In addition, high wind can cause damage on shore that could interfere with response efforts, e.g., loss of power due to downed power lines and access blocked by fallen trees or structures.

Sustained winds above 20 mph occur frequently in the Straits. Wind data for Mackinac City indicates between November and April, sustained winds (3 hours of more) above 20 mph are experienced from 6% to 14% of the time. Exhibit 4, Sustained High Wind Data at Mackinac City. Data for wind monitoring points at Spectacle Reef Light in Lake Huron and West Shoal Light in Lake Michigan reveal stronger and longer sustained winds.

Imagine trying to maneuver the Current Buster containment equipment in high winds in the Straits. Exhibit 5, Photo of wind conditions in the Straits, December 5, 2017.

Ice Cover

Ice cover may impede or prevent oil containment and recovery depending on ice thickness and other conditions. The Straits were entirely or mostly covered by ice of varying thickness in CY 2014 – 121 days, CY 2015 – 107 days, and CY 2016– 59 days. Source: U.S. National Ice Center. On many of those days, ice conditions would have prevented or significantly impeded oil containment and recovery.

Surface and Underwater Currents

Surface and underwater currents in the Straits are complex and variable. Conditions of high currents can increase the spread of the oil and the difficulty of containing it.

Conditions Preceding or Following a Release

Some adverse conditions can lead or lag adverse weather events. For example, high west winds push water from Lake Michigan through the Straits into Lake Huron. After they abate, wave heights may fall but high currents of the water returning from the east for several days afterwards may exacerbate the spread of contamination.

Anticipatory Criteria

Shutdown criteria should also be anticipatory or forward looking. For example, suppose a release occurs today when wave height is 1 foot but the marine forecast is for 5 feet waves in 24 hours. Very little cleanup will occur before the adverse weather arrives and prevents or impairs response efforts.

Development of Criteria for Adverse Maritime Conditions

The State should work with federal, tribal, and local response agencies and Oil Spill Response Organizations currently contracted to respond to oil spills in the Straits to review operational limits on all equipment that will be used to respond to a spill. They should also review data available for maritime conditions in the Straits and in the waters east and west where contaminant plumes are expected to travel. With that information, they should craft multi-factor criteria intended to prompt the shutdown of Line 5 at the Straits when current or forecasted marine conditions are likely to prevent or substantially interfere with the effectiveness of emergency response actions.

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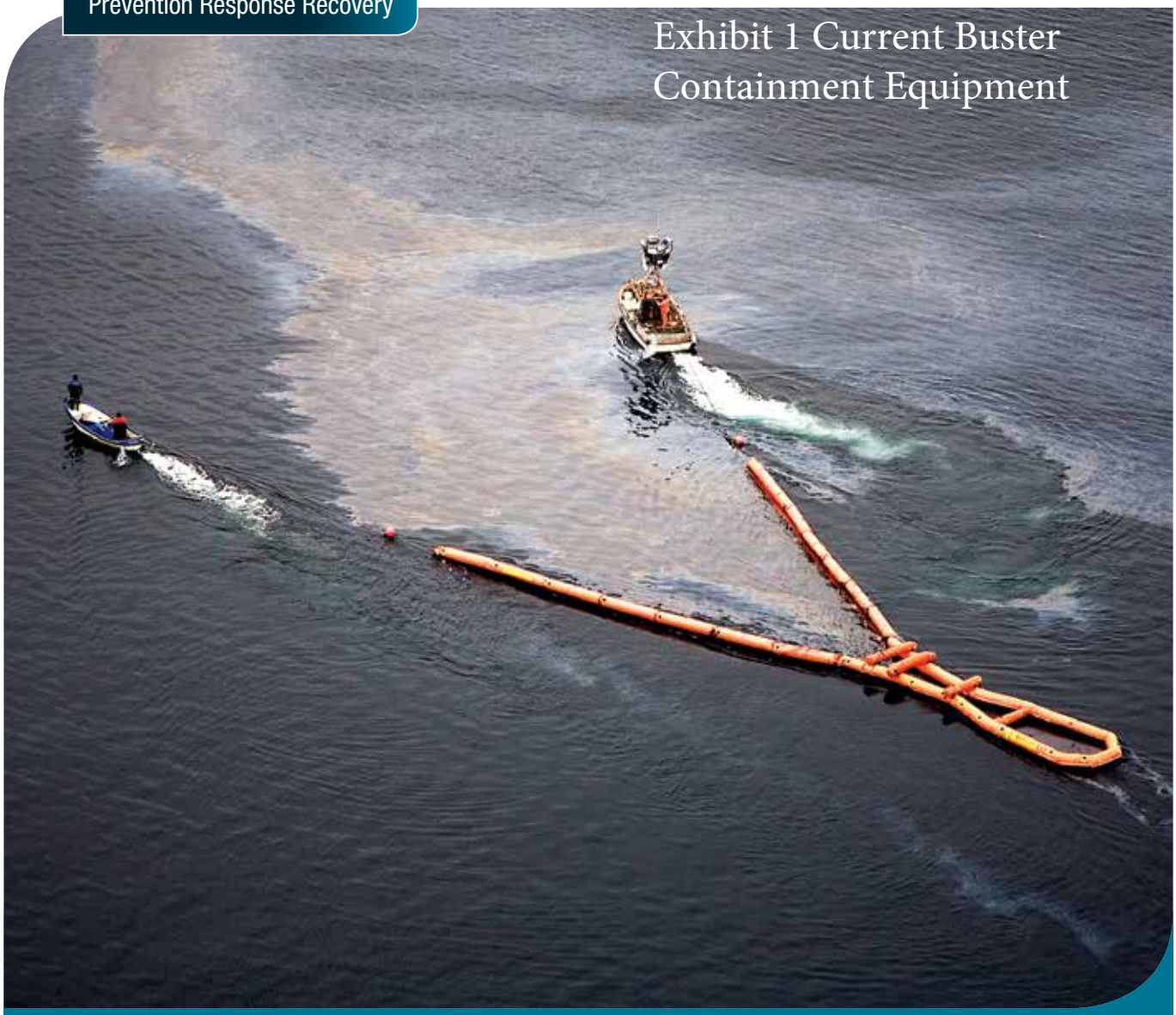
Prevention Response Recovery

Exhibit 1 Current Buster
Containment Equipment



Current Buster

Efficient, high speed oil containment

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RSP-ALM-C03

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Current Buster

Efficient, high speed oil containment

Product advantages

- Up to 5 knots without losses
- In built separation and temporary storage section
- Thick layer of oil produced for excellent recovery rates
- Single vessel tow when used with a vane system
- Suitable for most oils
- No adjustments required
- Four sizes available

The NOFI Current Buster is an internationally patented revolutionary oil spill contingency system regarded as the most efficient on the market. The system contains and controls oil spills at up to 5 knots towing speed with minimum losses, and is suitable for most types of oils.

Development of the Current Buster has been ongoing since 1995, and is used by a number of world leading oil spill contingency organisations. This proven system has undertaken extensive testing in controlled environments as well as real world oil and diesel spill incidents.

The Current Buster has the unique ability to collect and concentrate oil spills in current exposed waters and demanding conditions. The thick concentrated oil provides very efficient recovery rates, offering a great advantage when pumping into storage tanks.

The system has excellent maneuverability and can be towed conventionally between two vessels, or by only one vessel when used with a single vessel vane system. A high capacity separation and temporary storage section is incorporated in the Current Buster, which is available in four different sizes depending on application.

The Current Buster 2 and Current Buster 4 are designed for operations in areas from protected inlets and harbours, and can also be used in coastal areas and ocean currents.

The Current Buster 6 and Current Buster 8 are the heavier duty Current Buster products, designed for operations in open water, with strong currents, or in extreme weather up to Beaufort 7.

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TECHNICAL SPECIFICATIONS

Current Buster

Efficient, high speed oil containment

Product compliance

- US Coast Guard OHMSETT tested (1999)
- Canadian Coast Guard tested (2000)
- US NAVY tested with diesel oil (2001)

Model	Current Buster 2	Current Buster 4	Current Buster 6	Current Buster 8
Application	Protected waters (Beaufort 4-6), offshore and coastal (Beaufort 4)	Protected waters (Beaufort 4-6), offshore and coastal (Beaufort 4)	Offshore (Beaufort 5), protected waters (Beaufort 7)	Offshore (Beaufort 5), protected waters (Beaufort 7)
Front opening	15 m	22 m	34 m	50 m
Total length	27 m	35 m	63 m	65 m
Temp. storage volume	15 m^3	32 m^3	70 m^3	70 m^3
Max towing speed	3 knots	4 knots	5 knots	5 knots
Buoyancy chamber material	1100 g/m^2 PU/PVC coated polyester	1100 g/m^2 PU/PVC coated polyester	1150 g/m^2 heavy duty PU/PVC coated polyester	1150 g/m^2 airtight PU/PVC Coated Polyester
External fabric	Heavy Duty PU/PVC coated polyester	Heavy Duty PU/PVC coated polyester	Heavy Duty PU/PVC coated polyester	Heavy Duty PU/PVC coated polyester
External fabric tensile and tear strength	7400 N/50 mm, 1900 N	7400 N/50 mm, 1900 N	7400 N/50 mm, 1900 N	7400 N/50 mm, 1900 N
Storage	Optional (reel, pallet, net)	Boom reel 500 mm min shaft dia.	Boom reel 500 mm min shaft dia.	Boom reel 500 mm min shaft dia.
Storage temp	-30 to 70°C	-30 to 70°C	-30 to 70°C	-25 to 70°C
Recomended deck space	3.2 x 5 m	5 x 5 m	5 x 5 m	5 x 5 m
Connectors	N/A (stand-alone operation)	NOFI DRC, (Dynamic Response Connector)	NOFI DRC (Dynamic Response Connector)	NOFI DRC (Dynamic Response Connector)
Inflation	By backpack blower or electric fan	By backpack blower or electric fan	By backpack blower or electric/ hydraulic fan	By backpack blower or electric/ hydraulic fan
Oil types	All types of diesel to high viscosity oil	All types of diesel to high viscosity oil	All types of diesel to high viscosity oil	All types of diesel to high viscosity oil
Reflectors	50 × 200 mm pads	50 × 200 mm pads	50 × 200 mm pads	50 × 200 mm pads
Product options	Boom reel, power pack, pump (skimmer), vane system	Boom reel, power pack, pump (skimmer), vane system	Boom reel, power pack, pump (skimmer), vane system	Boom reel, power pack, pump (skimmer), vane system

For further technical assistance, please contact us.

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EXHIBIT 2 BEAUFORT SCALE

BEAUFORT WIND FORCE SCALE:
Specifications and equivalent speeds for use at sea

FORCE	Equivalent miles/hr	Speed knots	Wave m	Height ft	Description	Map Symbols	U.S. Advisory Flags	SPECIFICATIONS FOR USE AT SEA
0	0-1	0-1	0	0	Calm			Sea like a mirror
1	1-3	1-3	.1	.33	Light Air			Ripples with the appearance of scales are formed, but without foam crests.
2	4-7	4-6	.2	.66	Light Breeze			Small wavelets, still short, but more pronounced. Crests have a glassy appearance and do not break.
3	8-12	7-10	.6	2	Gentle Breeze			Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered white horses.
4	13-18	11-16	1	3.3	Moderate Breeze			Small waves, becoming larger; fairly frequent white horses.
5	19-24	17-21	2	6.6	Fresh Breeze			Moderate waves, taking a more pronounced long form; many white horses are formed. Chance of some spray.
6	25-31	22-27	3	9.9	Strong Breeze		Small Craft Advisory 	Large waves begin to form; the white foam crests are more extensive everywhere. Probably some spray.
7	32-38	28-33	4	13	Near Gale			Sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind.
8	39-46	34-40	5.5	18	Gale		Gale Warning 	Moderately high waves of greater length; edges of crests begin to breakinto spindrift. The foam is blown in well-marked streaks slong the direction of the wind.
9	47-54	41-47	7	23	Severe Gale			High waves. Dense streaks of foam along the direction of the wind. Crests of waves begin to topple, tumble and roll over. Spray may affect visibility.
10	55-63	48-55	9	30	Storm		Storm Warning 	Very high waves with long over-hanging crests. The resulting foam, in great patches, is blown in dense white streaks along the direction of the wind. On the whole the surface of the sea takes on a white appearance. The 'tumbling' of the sea becomes heavy and shock-like. Visibility affected.
11	64-72	56-63	11.5	38	Violent Storm			Exceptionally high waves (small and medium-size ships might be for a time lost to view behind the waves). The sea is completely covered with long white patches of foam lying along the direction of the wind. Everywhere the edges of the wave crests are blown into froth. Visibility affected.
12	73-83	64-71	14+	46+	Hurricane		Hurricane Warning 	The air is filled with foam and spray. Sea completely white with driving spray; visibility very seriously affected.

"The scale was created in 1806 by Sir Francis Beaufort, a British naval officer. The initial scale did not have wind speeds, but listed a set of qualitative conditions from 0 to 12 by how a naval vessel would act under them - from 'just sufficient to give steerage' to 'that which no canvas could withstand'. The scale was made a standard part of log entries for Royal Navy vessels in the late 1830s." From Wikepedia

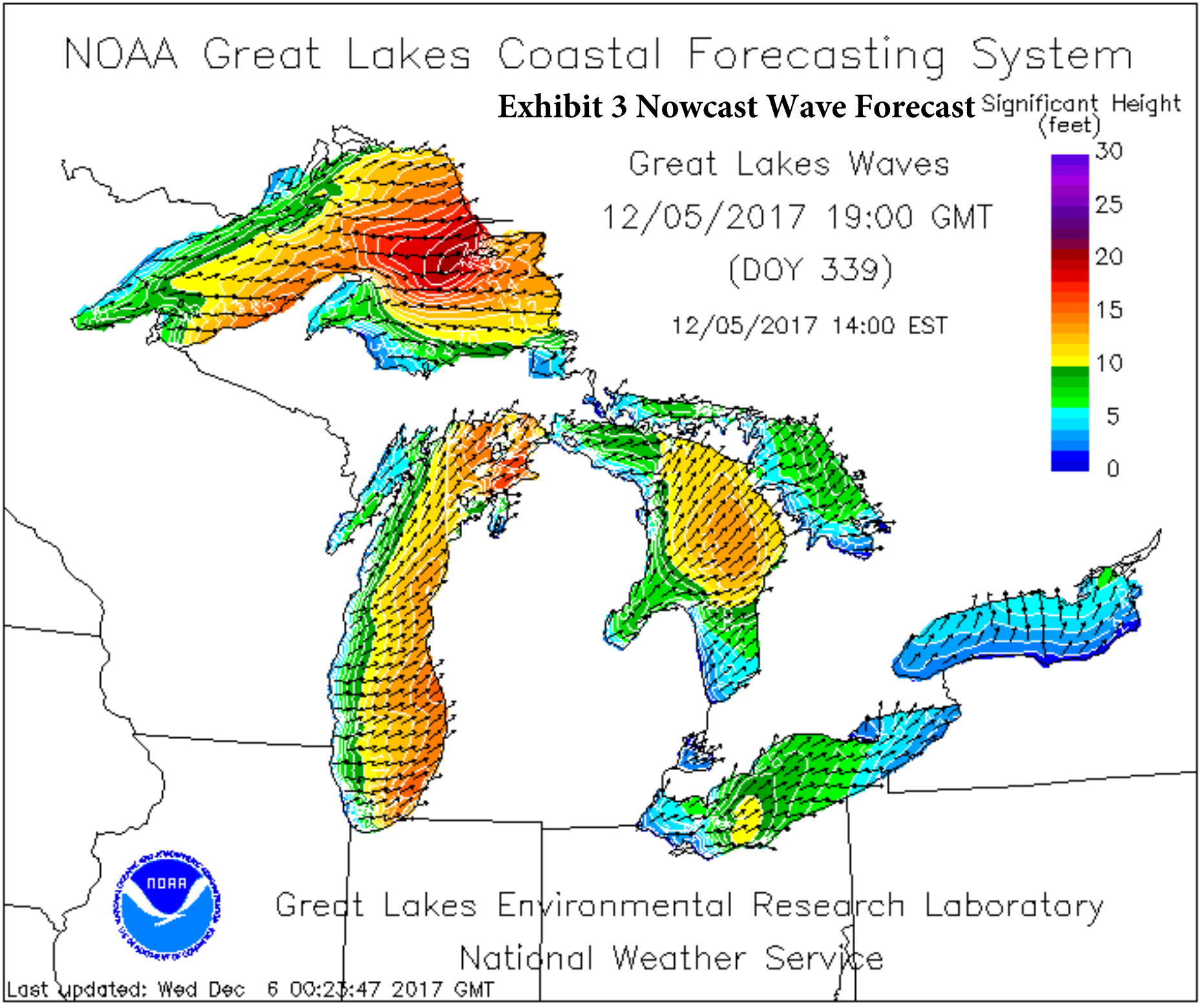
NOAA Great Lakes Coastal Forecasting System
Exhibit 3 Nowcast Wave Forecast
Significant Height (feet)
30
25
20
15
10
5
0
Great Lakes Waves
12/05/2017 19:00 GMT
(DOY 339)
12/05/2017 14:00 EST
NOAA
Great Lakes Environmental Research Laboratory
National Weather Service
Last updated: Wed Dec 6 00:25:47 2017 GMT

Exhibit 4
NOAA High Wind Data At Mackinac City

A Sustained Wind Event is a consecutive 3-hour period with winds above 20 mph

MACM4 Mackinac City

2016

Total Sustained Wind Events = 23 **Duration** (hrs) **Min:** 4 **Max:** 14 **Avg:** 7

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
3-Hr. Periods exceed 20 mph	416	572	576	534	38	68	54	99	54	262	606	1060	4339
% 0f 3-Hr. Periods exceed 20 mph	6%	8%	8%	8%	1%	1%	1%	1%	1%	4%	9%	14%	5%

2015

Total Sustained Wind Events = 23 **Duration** (hrs) **Min:** 4 **Max:** 22 **Avg:** 8

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
3-Hr. Periods exceed 20 mph	737	290	338	699	171	20	20	46	25	938	620	1026	4930
% 0f 3-Hr. Periods exceed 20 mph	10%	4%	5%	10%	2%	0%	0%	1%	0%	13%	9%	14%	6%

2014

Total Sustained Wind Events = 16 **Duration** (hrs) **Min:** 4 **Max:** 13 **Avg:** 7

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
3-Hr. Periods exceed 20 mph	557	498	204	867	195	68	128	19	104	443	852	408	4343
% 0f 3-Hr. Periods exceed 20 mph	8%	7%	3%	12%	3%	1%	2%	0%	1%	6%	12%	6%	5%

2013

Total Sustained Wind Events = 18 Duration (hrs) Min: 4 Max: 27 Avg: 9

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
3-Hr. Periods exceed 20 mph	620	592	249	842	290	14	63	89	47	458	949	1021	5234
% 0f 3-Hr. Periods exceed 20 mph	8%	9%	3%	12%	4%	0%	1%	1%	1%	6%	13%	14%	6%

2012

Total Sustained Wind Events = 19 Duration (hrs) Min: 4 Max: 22 Avg: 8

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
3-Hr. Periods exceed 20 mph	654	424	698	310	133	160	57	312	233	606	612	769	4968
% 0f 3-Hr. Periods exceed 20 mph	9%	6%	9%	4%	2%	2%	1%	4%	3%	8%	9%	10%	6

Data from NOAA site **http://www.ndbc.noaa.gov/station_history.php?station=macm4**

Exhibit 5 Wind Conditions in the Straits 12/5/17