January 21, 2022

To: MPSC

Case: U-20763 Replace and Relocate Line 5 Segment Crossing the Straits of Mackinac

Subject: Comments on Enbridge Engineer Aaron Dennis January 14, 2022 Testimony to the Michigan Straits Corridor Authority (MSCA) as it doesn't reflect the explosion and fire risks during the proposed line 5 tunnel and pipeline construction or operation.

From: Brian O'Mara, Agate Harbor Advisors, LLC

To Whom it May Concern:

I have been providing technical review and comments on Enbridge's Proposed Line 5 Replacement Tunnel and Pipeline on behalf of Oil and Water Don't Mix and a paid technical expert and concerned native and citizen of Michigan to EGLE, USACE, MPSC and members of the news media I'm a 1987 graduate of Michigan Tech (B.S. Geological Engineering). I began working on similar scale tunnel projects in Milwaukee for the MMSD $2B Water Pollution Abatement Program four weeks after graduation. I have worked on dozens of tunnels from design, through construction, and decommissioning over the past 30 plus years.

I regularly encountered dissolved methane in groundwater and sediments and elevated methane levels in air when working underground constructing tunnels in Milwaukee, where a methane explosion on November 11, 1988 that killed three workers. An even worse methane tunnel disaster under Lake Huron near Port Huron on December 11, 1971 where 22 workers died of injuries. I have had extensive training from MSHA and others on methane safety and worked on numerous non-tunnel projects where methane gas was a hazard to workers and residents.

Methane has been reported in several or the pre-design, exploratory borings completed by Enbridge for this project, and I'm deeply concerned that Enbridge, their consultants, EGLE, USACE and MSCA have not taken the risk of methane explosions seriously and I hope the MPSC will do so.

I have prepared comments on several statements on the January 14, 2022 testimony that Enbridge Engineer Mr. Aaron Dennis has made to the MSCA. Mr. Dennis seems to be an experienced pipeline engineer, but it appears neither he nor Enbridge have deep tunnel construction experience and they don't understand the risk methane presents to the Line Replacement 5 Tunnel and Pipeline. Enbridge has hired WSP and Arup, both firms have deep tunnel experience, but they apparently have not reviewed the January 14, 2022 testimony. WSP acquired Parsons Brinckerhoff (PB), arguably America's oldest and most respected tunnel design firm and I'm presuming Enbridge wanted to hire a competent tunnel engineer. Thomas Pennington, PE of PB authored "*Tunneling Beneath Open Water – A Practical Guide for Risk Management and Site Investigation*" (TBOW) in April 2011. Neither WSP nor Arup have followed relevant best practices adopted by the tunnel industry over the past two hundred years and compiled in the TBOW. Enbridge has consistently ignored the hazards of methane during construction of the tunnel and pipeline and operation of the pipeline/tunnel system.

There has been a systematic failure of Enbridge and their engineers and consultants to complete a thorough and comprehensive inventory and assessment of all risks that could be encountered during construction and operation of the tunnel and pipeline. A comprehensive Failure Modes and Effects

Analysis (FEMA) should be required prior to proceeding with any regulatory approvals, permits, authorizations.

I have cited the Page and Line of Mr. Dennis' testimony and provided an excerpt of the text which I object to in ***bold italics*** and then followed with my comments in regular font. I have underlined select comments for emphasis.

Statement 1 - Page 2, Line 14: There is no credible scenario that would result in an explosion within the tunnel.

Comment 1: This statement is false and frankly it is uninformed and misleading. Dissolved methane has been detected in groundwater samples collected by Enbridge along the proposed tunnel alignment and they have not delineated the nature and extent of dissolved methane in the vicinity of the tunnel. Therefore, they have no idea how serious or extensive the methane risk is. Until the nature and extent of methane has been delineated a prudent engineer should assume an explosion from methane is not only possible, but it is probable, and that risk must be incorporated into the design and construction of both the tunnel and the pipeline.

<u>The only way to eliminate all credible scenarios that would result in an explosion within the tunnel would be if Enbridge adopted the original, highly conservative design proposed to the State of Michigan in the October 26, 2017 Alternatives Analysis for Straits Pipelines by Dynamic Risk Assessment Systems, Inc. Appendix E of the Dynamic Risk Report recommended that a "sealed annulus" configuration (i.e., the pipeline would be fully encapsulated inside the tunnel with concrete grout),</u> The Dynamic Risk report notes "T*he sealed annulus option is more in line with the objective of isolating the pipeline from the open waters of the Great Lakes, and so is the configuration of choice for this study*" <u>Unfortunately, Enbridge decided to cut corners and designed the tunnel to have an Open Annulus configuration, which provides ample opportunity for explosions during construction and operation of the pipeline.</u>

It is important to note that the "sealed annulus" design will not reduce or eliminate the risk of methane explosion during construction of the tunnel or the construction of the pipeline!

Supplemental Note: In a November 2, 2021 virtual public webinar, Enbridge stated ***No hazardous gasses were identified along the tunnel path, like elsewhere in Michigan***. This is also false. Enbridge Subsurface Design Lead, Jon Hurt also said ***"While they do not expect to encounter any hazardous gasses, the boring machine and equipment will have a gas monitoring system and 'robust gasketing system' which will stop water infiltration and any gas infiltration, too'".*** While Mr. Hurt has acknowledged encountering hazard gas (e.g. methane) is possible and noted they will have a gas monitoring system and gaskets to prevent water and gas infiltration, it will not be feasible to stop all groundwater infiltration into this tunnel. If there is dissolved methane in the groundwater, it will enter the tunnel and be a potential source of an explosion. Mr. Hurt didn't acknowledge that methane can be introduced into the tunnel during construction as saturated sediments and bedrock tunnel spoils are removed through the face of the tunnel boring machine which is when the risk of explosion from environmental methane is greatest.

Statement 2 - Page 2, Line 15: To have an explosion three events must occur: 1) there must be a release; 2) the release must be sufficient to create an explosive atmosphere; and 3) there must be an ignition source.

Comment 2: This is a true statement. However, Mr. Dennis fails to recognize that all three events are or could be present during the tunnel construction, pipeline construction and the pipeline/tunnel operations as explained further below:

Statement 3 - Page 2, Line 15: There must be a release.

Comment 3: Below are known sources of releases of methane and flammable gasses that will or may be encountered during construction and/or operation of the tunnel/pipeline:

1) Dissolved methane has been reported in groundwater samples collected by Enbridge and the methane can be entrained in the saturated sediments and bedrock spoils produced by the tunnel boring machine
2) Dissolved methane and/or H2S will almost certainly enter the tunnel through groundwater seeps through construction joints in the pre-cast concrete tunnel liner segments, the portal and/or the retrieval shafts
3) Methane and other flammable gasses will be released from leaks of NGL in the operational pressurized pipeline. These releases could be small and relatively slow or large, rapid and catastrophic. These releases can occur at construction joints (i.e., the full girth welds) and weak portions of the pipeline walls and from accidents, fires, freezing, floods within the tunnel that damage the pipeline. Mr. Dennis acknowledges this fact when he states " *In the extremely unlikely event of a release*…" which completely undermines his assertion that there is no credible scenario that would result in an explosion.

Statement 4 - Page 2, Line 15: Sources must be sufficient to create an explosive atmosphere.

Comment 4:

During Construction -

1) The tunnel is a confined space where methane and other gasses can quickly enter and increase in concentration to levels that exceed the lower explosive limit. Methane is lighter than air and will accumulate in the uppermost portions of the TBM and tunnel. The LEL for methane is 5% in air so it doesn't take much methane seeping in to create an explosive atmosphere.
2) The situation will most likely happen when the TBM is being "driven" upwards from the lowest point (the middle of the Straits), which will occur in the second half of construction. While the tunnel is being constructed in an "uphill" run from the low point, methane will accumulate in or near the TBM and will concentrate there and very little will migrate or dissipate further back into the tunnel because it is lighter than air.
3) When the TBM is being driven "downhill" from the Portal there will also be increased risk because of groundwater infiltration (from the TBM face and any other leak from the tunnel or portal will flow downhill toward the TBM due to gravity). The water will tend to accumulate at the TBM, and methane dissolved in the water will de-gas and can accumulate in pockets where it can exceed the LEL.

During Operation -

4) Groundwater seeps will continue to infiltrate the tunnel and can introduce dissolved methane into the tunnel and depending on the geometry of the tunnel and location within the tunnel, methane can accumulate to concentrations that exceed the LEL.
5) Releases of pressured oil and gas from the pipeline within the tunnel can quickly exceed LEL criteria and would pose a near instantaneous threat of explosion inside the tunnel

Statement 5 - Page 2, Line 16: There must be an ignition source

Comment 5: Mr. Dennis has stated the tunnel has been designed to exclude all ignition sources. This may be the goal for the final pipeline operation, but it is infeasible to exclude or eliminate all ignition sources especially during construction and is not possible to eliminate all sources during operation. Below are a few known or likely ignition sources:

1) Tunneling with a TBM requires the use of electric motors to generate hydraulic cutting and push systems and gear to lift pre-cast concrete segmented liner panels. Electric motors are also used to power hand tools, compressors, grout mixers, pumps, lighting, communication cables and radios, ventilation systems. Enbridge says they will drive an electric vehicle in the tunnel to do inspections and conduct maintenance. While it is possible to specify use of Class 1 Division 2 or even Class 1 Division 1 explosion proof equipment or intrinsically safe equipment this must be specified and is not typical for tunnel construction.

   The 1988 Milwaukee Tunnel methane explosion occurred after the tunnel was evacuated because of high methane levels encountered and one of the three people sent back into the tunnel to confirm it was safe to return turned on an electric grout pump because to empty it and prevent it from being ruined. Flipping the switch created an arc flash that ignited the methane in the tunnel.

2) Sparks can be generated by steel striking hard surfaces in the tunnel and other mechanical actions. It's possible or likely the use of steel drills will be required and other large, heavy steel tools. While it's possible use some non-sparking tools. Sparks can be generated if tools and equipment fail or are misused or involved in an accident or a novel situation, probably a repair or some emergency and someone uses equipment not designed for explosive atmospheres.

   The Lake Huron Water Tunnel Methane Explosion was created by a large diameter drill sparking in the presence of a methane pocket. The explosion occurred when the tunnel was nearly completed.

3) Enbridge notes that the pipeline pieces will be installed and joined with full penetration girth welds. Welding creates sparks, and hot dross or slag waste that are possible ignition sources.

4) Enbridge will have to fasten or connect the pipeline to the tunnel interior wall by some mechanical means, probably by drilling into the concrete and installing steel support anchors. They will likely have to drill thousands of holes into the concrete. Once the pipeline is fabricated it will be subject to thermal expansion and contraction. It is certainly possible the pipeline support system could fail due to defective materials and/or thermal

expansion/contraction. Therefore, the installation process and potential failures could lead to sparks and are ignition sources.

5) Lastly, Enbridge in the November 2, 2021 virtual public webinar noted that "***the top of the tunnel is set aside for third-party utility companies to run electrical cable, fiber optic cables, or other equipment across the Straits of Mackinac***". Methane is lighter than air and will accumulate in the "top of the tunnel" which is where these other utilities will be installed, and the installation of third-party utilities represents opportunities for ignition sources!

Statement 6 - Page 2, Line 22: "Further, in the extremely unlikely event of a release there are leak detection systems which will detect a release and allow the shutdown of the pipeline. Finally, even assuming that a release was to theoretically occur and create an explosive atmosphere, the tunnel is close and confined space that has been designed to exclude all ignition sources".

Comment 6: These statements are problematic, misleading and again uninformed.

1) First of all these statements don't address the tunnel or pipeline construction activities where having methane detection systems should also be required. However, detection systems alone do NOT prevent explosions! You need proper detection systems, ventilations, explosion proof or intrinsic equipment, non-sparking tools, working wet when drilling, etc.
2) While Enbridge can seal both ends of the tunnel if a release from the pipeline is detected, the tunnel will have a tremendous amount of oxygen inside it which will allow a release of petroleum product or gas to burn for a long time. A fire in the tunnel with a large release of petroleum will cause the concrete liner to spall and fail. This will expose the reinforcing steel in the tunnel liner to melting temperatures and the tunnel structure will collapse. This will in turn allow the petroleum products from the pipeline to escape into the sediments, rock and water column above the pipeline – causing a worst-case scenario and catastrophic release of petroleum product to the Straits!

Statement 7 - Page 3 Line 8: The first safeguard against an explosion is the prevention of a release.

Comment 7: This statement is True; however the subsequent discussion applies only to the design of the pipeline itself and not the tunnel construction process, the tunnel liner/structural design or the pipeline construction process. It also ignores that groundwater with dissolved methane is likely to enter the tunnel throughout the life of the tunnel and represents a continuous source of a release of methane to the tunnel/pipeline system.

Statement 8 – Page 4, Line 12: As a result, the entire length of the replacement pipe segment within the tunnel will only have full penetration girth welds.

Comment 8: I like that the Enbridge design for the pipeline includes removing all appurtenances (from within inside the tunnel. This eliminated flanges, threaded, filet welded or branch connections within the tunnel which will limit potential leak points. However, it is still possible for a full penetration girth weld to fail and if there is a defective portion of even a small portion of the pipe wall there could be a catastrophic failure. While the proposed pipeline construction minimizes the potential for leaks it does not and cannot eliminate the potential for all leaks unless they adopt the Sealed Annulus design.

Statement 9 – Page 5, Line 13: Given all of the above factors a release in the replacement pipe segment is extremely unlikely with the risk of release being 0.000001 or less for any type of release.

Comment 9 - This is a very specific statement that suggests the risk has been evaluated in a highly quantitative manner, to six significant digits. What is the basis for the 0.000001 value? It simply is not credible on any level that there is only a 0.000001 chance for any type of release given the numerous examples of releases, ignition sources and scenarios where releases can result in explosive atmospheres that I have identified. According to Mr. Dennis' statements it seems the risk would be zero as he stated there are no sources of releases, no ignition sources and no scenarios where an explosive atmosphere can exist. <u>The 0.00001 value is not credible or supported by the facts.</u>

Statement 10 – Page 5, Line 20: These valves are mechanical and will automatically close within three minute if the pressure exceeds or drops below prescribed standards.

Comment 10: Approximately 150,000 gallons of petroleum product would be released inside the tunnel over the three minutes it may take to shut down the pipeline. As I discussed in Comment 6, the product will be contained in the tunnel but if there is any ignition source there will be a fire, or an explosion given the vast quantity of product released and if there is a fire it could result in failure of the tunnel liner and result in a catastrophic release to the Straits.

Statement 11 – Page 6, Line 2. These tools are able to detect a release of 2% or more of the shipped volume.

Comment 11: If this statement is meant to instill confidence in Enbridge's system it does NOT! The statement implies that a release of less than 2% cannot be detected by these tools. A release of 1.5% of the shipped volume of the Line 5 pipeline is an enormous amount of petroleum product.

Statement 12 – Page 6, Line 4. Enbridge will have monitors at the ends of and middle of the tunnel to detect NGL vapors and oil vapors. These monitors will detect a concentration of less than 20% of the lower explosive limit (LEL).

Comment 12. These statements are also troubling. Having LEL detectors at the ends and middle of the tunnel only is problematic given the length and proposed tunnel alignment as most of the tunnel will not have LEL detectors and this can allow the accumulation of a large quantity of NGL or oil vapors to go undetected. Enbridge should greatly increase the number of LEL detectors. Also note that while setting the LEL detectors to 20% of the LEL is a good practice, the concentration of flammable or explosive gasses can quickly exceed the LEL and an explosion or fire can occur before Enbridge has detected there has been an exceedance of the LEL.

Statement 13 – Page 6, Line 11. All equipment and instrumentation will be Class 1, Division 2.

Comment 13 – Enbridge must determine the nature and extent of dissolved methane in groundwater and complete a FEMA to determine if more protective Class 1 Division 1 equipment is required.

Statement 14 – Page 6, Line 18. Thus, even in the unlikely scenario of a release which then went undetected long enough to create an explosive atmosphere, there is still not an ignition source within the tunnel.

Comment 14: This is another problematic statement. As indicated in previous comments there are ignition sources in the tunnel during construction and operation. Whenever Mr. Dennis acknowledges there is a possibility that one of the three events needed for an explosion are present, he ends his argument with a statement that one or two of the events is not present. These statements are incorrect and misleading.

Statement 15 – Page 7, Line 7. Before entering the tunnel, the ventilation system will be turned on and air recirculated within the tunnel. As air leaves the tunnel through the ventilation system it will be tested for NGL vapor and oil vapor.

Comment 15. These are also problematic statements. If there is a release of NGL or oil vapor it may be best to keep the ventilation system working and thus keep the accumulation of gas diluted to the point it does not exceed the LEL. If there is fire or explosion in the tunnel, any ventilation piping could be damaged or destroyed and rendered inoperable. It is never a good idea to send humans into a gassy tunnel to determine if it is safe to re-enter (This is how three workers including the Safety Officer were killed in the Milwaukee tunnel methane explosion). It is much better to have a sufficient amount of LEL and Oxygen detectors that can be read remotely (i.e., from the surface) prior to any personnel re-entering the tunnel.