APPENDICES TO FLOW PUBLIC COMMENTS ON THE JOINT APPLICATION OF ENBRIDGE ENERGY TO OCCUPY GREAT LAKES BOTTOMLANDS FOR ANCHORING SUPPORTS TO TRANSPORT CRUDE OIL IN LINE 5 PIPELINES IN THE STRAITS OF MACKINAC AND LAKE MICHIGAN [2RD-DFDK-Y35G]

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APPENDIX A

The Honorable Rick Snyder April 30, 2015
Office of the Governor
P.O. Box 30013
Lansing, Michigan 48909

Attorney General Bill Schuette
G. Mennen Williams Building, 7th Floor
525 West Ottawa Street
P.O. Box 30212
Lansing, Michigan 48909

Director Dan Wyant
Michigan Department of Environmental Quality
525 West Allegan Street
P.O. Box 30473
Lansing, Michigan 48909

Re: Based on Expert Review, Recommendation to the Michigan Petroleum Pipeline Task Force that Enbridge's Line 5 in the Straits Be Shut Down and/or Stringent Measures Be Imposed Pending a Comprehensive Review by the State under Public Trust Law to Assess Alternatives that Prevent Catastrophic Harm to Our Public Trust Waters of The Great Lakes

Dear Governor Snyder, Attorney General Schuette, and Director Wyant:

Your Administration and the citizens of Michigan share a common and grave concern involving Enbridge's 62-year-old twin oil pipelines in the Straits of Mackinac: the risk of a leak, rupture, or break in Line 5 and the resulting catastrophic oil spill into Lake Michigan and Lake Huron. The Michigan Petroleum Pipeline Task Force and all of us uniformly agree that such a globally significant calamity is unacceptable given the magnitude of harm and ramifications to our public waters, Great Lakes fisheries and ecosystem, and the public health, and economy – in short, an unacceptable risk to a *Pure Michigan* way of life.

During the last year, we at FLOW (For Love of Water) – in partnership with the Environmental Law & Policy Center, Michigan Environmental Council, Michigan Land Use Institute, Sierra Club, Tip of the Mitt Watershed Council, and many others – have submitted a number of letters and made formal and informal presentations to the Michigan Petroleum Pipeline Task Force with a clear and consistent request: for the State of Michigan to act immediately on Enbridge's Line 5 oil pipelines located in the Straits of Mackinac through a public process under the Great Lakes Submerged Lands Act (GLSLA) and its public trust authority under the 1953 easement and authorizing Act 10 of 1953.

This GLSLA process is the only way to assure that the unacceptable risk of devastating harm to the Great Lakes does not occur. Moreover, the GLSLA process is the only way to satisfy the State of Michigan's public trust duties as well as Enbridge's duties under the 1953 easement held in trust, because this public trust law sets forth clear legal principles, scope of review with alternative risk assessment and prevention, and subsequent decisions and actions required of Enbridge to ensure that there is no future risk of a release or leak from Enbridge Line 5 into the Great Lakes.

From September 2014 through February 2015, the Michigan Petroleum Pipeline Task Force conducted closed door stakeholder meetings with Enbridge, the U.S. Coast Guard, PHMSA, Great Lakes

Commission, National Wildlife Federation, FLOW and other members of the Oil & Water Don't Mix Campaign, Michigan's 12 federally recognized tribes, Marathon Petroleum Company, and Dr. James Hill and Ken Winters to consider "the status of existing pipelines, their safety, *how to mitigate risks* to the environment and natural resources, regulation, emergency planning and spill response, and providing information to the public." This method and scope of the Task Force's inquiry, however, *does not seek to prevent the risk* of such unacceptable devastating harm, and as result fails to comply with the State's fiduciary role as public trustee of the Great Lakes and their bottomlands for citizens and beneficiaries.

Before this Task Force issues its final recommendations, perhaps as early as May, FLOW is submitting this letter and accompanying composite summary report to further aid your review and decision, and to underscore and highlight the urgency for the State of Michigan to act under existing public trust law and to evaluate alternatives that place our Great Lakes at zero risk. FLOW convened a team of scientists and engineers – with extensive education and training and career-long experience in hazardous materials, environmental and process engineering, chemical and liquid processes, materials, design, construction, and security – to evaluate whether the information Enbridge provided and the scope of review undertaken by the Michigan Petroleum Pipeline Task Force follow standard principles for evaluation of risks and magnitude and probability of harm for pipelines carrying oil and related liquids, such as Enbridge's Line 5 under the Straits of Mackinac. This submission provides additional critical scientific and engineering information, and evaluation criteria regarding such review, decisions and actions. Specifically, this team evaluated:

- Whether the Task Force process and primary focus on Line 5 and its safety assures reasonable prevention and safety for the public, the Great Lakes and ecosystem, drinking water, and communities and citizens who live near the Straits of Mackinac or northern Lake Michigan and Lake Huron.
- Whether Enbridge's pipeline network logistics, strategies and alternative assessments have included abandoning Line 5 in favor of other options, including but not limited to alternative pipelines or routes, existing or feasible, that would prevent risk of devastating harm (achieve zero risk) entirely to the Straits and the Great Lakes.
- Whether Enbridge has submitted or the Task Force has sought and received sufficient information to address the prevention of risks and safety based on reliable and credible worst-case scenarios and alternatives, and overall age, end-of-life plan, anchoring structures, and integrity assessment of Line 5.
- Whether new circumstances exist that affect the pipeline's safety and reliability and that were not considered at the time of Line 5's design in 1952 and construction the following year.
- Whether the original design, welding techniques, and margin of safety are acceptable under modern practices and standards.
- Whether the risk and the impact of external corrosion on Line 5's coal tar enamel coating and external stresses of zebra and quagga mussels – which had not entered the Great Lakes when Line 5 was designed and began operating – on bare steel have been disclosed and reviewed.

It must be noted that there is a stunning lack of publicly available information about the integrity and end-of-life plans of this private aging infrastructure, even though an entire year has lapsed since the AG and DEQ made a formal request to Enbridge for critical information about operation, maintenance, and easement compliance of these Line 5 petroleum pipelines. Enbridge has controlled public access to some of this information through a password-protected portal that prevents the State to have documents in its possession as required under the state FOIA law. This situation puts the Great Lakes at an unacceptable risk to citizen beneficiaries of this public trust. Accordingly, based on the available public information, data, and other information, the summary report developed by a team of experts convened by FLOW concludes that:

- The charge or scope of review by Enbridge and the Task Force is unduly limited to "mitigation of risks" regarding the safety of Line 5, and improperly fails to evaluate logistics, strategies, and alternatives that would avoid or prevent the risk of devastating magnitudes of harm.
- Enbridge has controlled the nature and extent of available information, which has resulted in inadequate or insufficient information and review by the Task Force or state officials.
- The evaluation and review has ignored the reality that Line 5 is old, outdated, and that a break or leak in the line is inevitable without a broader, open and public review and decision-making process that seeks to both prevent and mitigate risks and ensure safety.
- The evaluation is not based on a reasonable and credible worst-case scenario assessment of alternatives, integrity, and safety issues.
- Between the period of 1952-1953, when Line 5 was designed and constructed, and 2015, materials, standards, and circumstances have changed significantly, such as corrosion and/or invasive populations of zebra and quagga mussels.
- There are a number of additional questions that must be asked, consistent with a necessarily broader scope of review and evaluation, and that must be answered by Enbridge and independent experts.
- Substantial risk of pipeline failure related to the potential impacts of new stresses and corrosion demand Line 5 be shut down and/or stringent measures be imposed pending a comprehensive review of alternative risk assessments, safety and integrity assessments, and response information has been made under the state's legal authority provided by the GLSLA.

We thank all of you and the Task Force for considering this new information, and we urge you to take meaningful and preventative action under the GLSLA that goes beyond mere mitigation and enhanced emergency response. The State and the Task Force must not continue to delay action because, as we know, eventually every pipeline breaks, if not removed or replaced in a timely manner. Anything less than the above puts the Great Lakes and the public health, safety, and public trust at risk, as if the Task Force and State are betting the Great Lakes, citizens' safety and health, and the public trust in order to allow Enbridge to continue using Line 5 indefinitely.

Sincerely,

James Olson, Founder and President, FLOW (For Love of Water)

Liz Kirkwood, Executive Director, FLOW (For Love of Water)

cc: Chief Deputy Attorney General Carol L. Isaacs

Division Chief S. Peter Manning

DNR Director Keith Creagh

Enclosures.

Before Governor Snyder's Michigan Petroleum Pipeline Task Force

Office of Attorney General William Schuette

Office of Director of Department of Environmental Quality Dan Wyant

Office of Director of Department of Natural Resources Keith Creagh

A COMPOSITE SUMMARY OF EXPERT COMMENT, FINDINGS, AND OPINIONS ON ENBRIDGE'S LINE 5 OIL PIPELINE IN THE STRAITS OF MACKINAC IN LAKE MICHIGAN

Compiled by James Olson, J.D., LL.M. and Liz Kirkwood, J.D.

on behalf of

FLOW's (For Love of Water) Great Lakes Water Policy Project

for submission to the

Michigan Petroleum Pipeline Task Force

April 30, 2015

1. OVERVIEW

This Composite Summary of several reports produced by qualified experts for FLOW (For Love of Water) – a Great Lakes water law and policy center located in Traverse City, Michigan – is intended to assist the Governor's Michigan Petroleum Pipeline Task Force and the above-named leaders and agencies charged by law with evaluating and protecting the Great Lakes, public health, and our water-dependent economy from the risk of devastating harm from the location and operation of the Enbridge Line 5 pipeline[1] in the Straits of Mackinac. The summary and underlying reports are also intended to help citizens better understand the nature of this 62-year-old pipeline, the scope of inquiry, information, and critical need for an alternative and course of action that prevents the risk of harm from an oil spill in the Straits.

Presently, federal and state officials have been focused on safety and emergency response measures, rather than considering and implementing alternatives or options that would prevent the risk of such devastating harm from an oil spill to the Great Lakes. This Composite Summary points to one inescapable overall conclusion: Even the best efforts by the Task Force and officials regarding Line 5 fail to encompass an outcome that would prevent entirely the risk of catastrophic harms to the public health and economy. Because the Task Force's review is limited to safety and mitigation, it has excluded review of alternatives or logistical options that would achieve zero risk of such unacceptable harm to the Great Lakes. The review has also been shrouded by non-disclosure and lack of complete information from Enbridge.

[1] For purposes of this summary, the words "pipeline" and "Line 5," although singular, refer to Enbridge's two (2) 20-inch diameter pipelines that rest on the state-owned bottomlands in Lake Michigan approximately two miles west of the Mackinac Bridge in the Straits of Mackinac.

It is submitted that the failure to consider and implement logistical, strategically available alternatives or options that achieve zero risk and the lack of an open, public proceeding under "rule of law" violate the state's and officials' fiduciary duty to citizens under the Great Lakes public trust doctrine and the Great Lakes Submerged Lands Act (GLSLA).[2]

FLOW – in partnership with the Environmental Law & Policy Center, Michigan Environmental Council, Michigan Land Use Institute, Sierra Club, Tip of the Mitt Watershed Council and others – has previously submitted letters to the Michigan Petroleum Pipeline Task Force, outlining the recommended legal framework and principles for the State regarding necessary process, scope of review, decisions, and actions required of Enbridge regarding Line 5. This submission provides additional critical scientific and engineering information and evaluation regarding such review, decisions, and actions.

FLOW convened a team of scientists and engineers – with extensive education and training and career-long experience in hazardous materials, environmental and process engineering, chemical and liquid processes, materials, design, construction, and security – to evaluate whether the information Enbridge provided and the scope of review undertaken by the Michigan Petroleum Pipeline Task Force follow standard principles for evaluation of risks and magnitude and probability of harm for a pipeline carrying oil and related liquids, such as Enbridge Line 5 under the Straits of Mackinac. Specifically, this team evaluated:

- Whether the Task Force process and primary focus on Line 5 and its safety assures reasonable prevention and safety for the public, the Great Lakes and ecosystem, drinking water, and communities and citizens who live near the Straits of Mackinac or northern Lake Michigan and Lake Huron.
- Whether Enbridge's pipeline network logistics, strategies, and alternative assessments have included abandoning Line 5 in favor of other options, including but not limited to alternative pipelines or routes, existing or feasible, that would prevent risk of devastating harm (achieve zero risk) entirely to the Straits and the Great Lakes.
- Whether Enbridge has submitted and the Task Force sought and received sufficient information to address the prevention of risks and safety based on reliable and credible worst-case scenarios and alternatives, and overall age, end-of-life plan, anchoring structures, and integrity assessment of Line 5.
- Whether new circumstances exist that affect the pipeline's safety and reliability and that were not considered at the time of Line 5's design in 1952 and construction the following year.
- Whether the original design, welding techniques, and margin of safety are acceptable under by modern practices and standards.
- Whether the risk and the impact of external corrosion on Line 5's coal tar enamel coating and external stresses of zebra and quagga mussels – which had not entered the Great Lakes when Line 5 was designed and began operating – on bare steel have been disclosed and reviewed.

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[2] MCL 324.32501 et seq. (here after "GLSLA").

Based on the available public information, data, and other information and the analysis and findings of the team of scientists and engineers,[3] this Summary Composite report concludes that:

- The charge or scope of review by Enbridge and the Task Force is unduly limited to "mitigation of risks" regarding the safety of Line 5, and improperly fails to evaluate logistics, strategies, and alternatives that would avoid or prevent the risk of devastating magnitudes of harm.
- Enbridge has controlled the nature and extent of available information, which has resulted in inadequate or insufficient information and review by the Task Force or state officials.
- The evaluation and review has ignored the reality that Line 5 is old, outdated, and that a break or leak in the line is inevitable without a broader, open and public review and decision-making process that seeks to both prevent and mitigate risks and ensure safety.
- The evaluation is not based on a reasonable and credible worst-case scenario assessment of alternatives, integrity, and safety issues.
- Materials, standards, and circumstances have significantly changed between the period of 1952-1953, when Line 5 was designed and constructed and 2015, such as corrosion and/or invasive populations of zebra and quagga mussels.
- There are a number of additional questions that must be asked, consistent with a necessarily broader scope of review and evaluation, and that must be answered by Enbridge and independent experts.
- Substantial risk of pipeline failure related to the potential impacts of new stresses and corrosion demand Line 5 be shut down and/or stringent measures be imposed pending a comprehensive review of alternative risk assessments, safety and integrity assessments, and response information has been made under the state's legal authority of provided by the GLSLA.

The Task Force and all stakeholders have repeatedly acknowledged that "No one wants an accident, release or leak in the Straits of Mackinac." However, Enbridge and the Task Force are, in effect, kicking the can down the road by limiting the Task Force review just to the safety issues surrounding the 62-year-old pipeline, thus avoiding other options and alternatives for Line 5.[4] It is precisely these types of strategic and alternative assessment decisions that prevent risk, not just mitigate it. By not demanding such information from Enbridge, the Task Force is literally betting the Great Lakes, public health and safety, environment, and the economy of Michigan.

[3] On request, FLOW will make its team of experts and their analyses and findings available to the Task Force and its officials, or their technical advisors, in a meeting called to discuss these conclusions, findings, and recommendations.

[4] By contrast, Enbridge has announced its plans and filed for a Certificate of Need and Route Permit with the Minnesota Public Utilities Commission for its $7.5 billion Line 3 Replacement Project. Press Release, Enbridge, MN, EnbridgeMN@enbridge.com, April 24, 2015.

2. QUALIFICATIONS OF SCIENTIFIC AND ENGINEERING TEAM[5]

Richard J. Kane, QEP, CHMM, CPP, was formerly the Director of Security, Environment, Transportation Safety & Emergency Services for Rhodia, North America. He is past Chairman of the Chemical Sector Coordinating Council, Chairman, Security Committee, the American Chemistry Council (ACC), and former member of The Society of Chemical Manufacturers & Affiliates (SOCMA) Environmental, Safety & Security Committees. He is a Certified Protection Professional (CPP), Certified Hazardous Materials Manager (CHMM), and Qualified Environmental Professional (QEP).

Gary L. Street, PE, was formerly Director of Engineering, Dow Environmental – AWD Technologies; Technology Director, Film Tec Corporation, subsidiary of Dow Chemical; Section Manager, Process Engineering, Dow Chemical; Board Chair and Vice President, Midland Engineering, Ltd.; and Engineering Consultant, Freshwater Future. He is currently an Engineering Consultant for FLOW. Mr. Street's 30-year career has covered an extensive range of experience in environmental engineering, chemical process design, ethanol production processes, minimization of waste materials, and project management. He is the co-author of the text, Applied Chemical Process Design.

Edward E. Timm, PhD., PE, was formerly a Senior Scientist and Consultant to Dow Chemical's Environmental Operations Business (EOB), subject matter expert on Dioxin Formation and Transport in Chemical Process Systems, and leader in the company's voluntary efforts to reduce dioxin emissions. He was also Senior Scientist for Liquid Separations Business (LSB), including Ion Exchange and Film Tec Products for water purification. As Senior Scientist in EOB, he served as technical professional in developing a process for gasification of chlorinated wastes as alternative to incineration, and as Senior Scientist for LSB, he developed reverse osmosis membranes to concentrate dissolved solids and purify water. He also served as an expert on development and evaluation of new chemical processes, invention and patents, process development, plant design and construction, and process optimization.

3. COMPOSITE SUMMARY OF COMMENTS, FINDINGS, AND OPINIONS ON LINE 5

a. The Available or Disclosed Information Is Inadequate and Insufficient to Comply with Standards Required for Assessing Oil Transport Strategies, Alternative Assessment, Risk Assessment, and Emergency Response Resources and Processes.

The existing available or disclosed information is inadequate for the Task Force or any agency or official to render a decision that the continued or future transport of oil or other petroleum products through Line 5 in or near the Straits of Mackinac would protect the public health and safety, private or public riparian property, the bottomlands and waters of the Straits and affected areas of Lake Michigan and Lake Huron, the ecosystem, and the public trust in or public trust uses thereof, including water for drinking, fishing and the preservation of fishing rights, boating, navigation, swimming, and other recreation. At a minimum, to be adequate for

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[5] Complete Curriculum Vitae are available upon request by the Task Force. As noted above, FLOW's technical consultants or science and engineering team offers to meet with the Task Force and its officials or their technical consultants to exchange and/or review their findings and comments.

reaching such a decision, the following information and conclusions[6] would have to be made publicly available, disclosed, reviewed, and considered:

i. Existing and Forecasted Evolution and Strategy for the Petroleum or Oil Distribution System and Role that Line 5 Serves for Both Normal Operations and in the Event of Disruptions Elsewhere in the System.

The scope of the system for such purposes is at least the pipeline and other petroleum transportation networks from the Western United States and Canada to the East, which potentially impact or affect the Michigan pipeline network and Line 5 in particular. The information is also fragmented, and a consolidated forecast is not available. An easily understood view on the current and forecasted distribution system evolution and strategy is basic and necessary for the Task Force, officials, and/or public review. This would also include Enbridge's disclosure of its existing and future back-up or alternative plan for oil pipeline transport if Line 5 is temporarily shut down due to a rupture, accident, or power outage, and it includes plans or contingent plans for discontinuing Line 5 for oil transport, future oil transport, or abandonment of Line 5 completely.

This is normal business and industry practice, and such information should exist or be prepared and should be submitted, made publicly available, and considered to comply with industry standards and the public trust and GLSLA.

ii. A Comprehensive Alternatives Assessment.

The alternatives assessment would identify all feasible alternatives to the existing Line 5, ranging from simply not using Line 5 to replacement through use of other pipeline options or alternative routes, and would provide a comparison of risk and harm with respect to opportunities for other alternatives.

A decision concerning safety or prevention or minimization of risk and harm at least should include a full and comprehensive assessment of alternatives, including capacity, location, routes, contingencies, disruptions, none-use or abandonment, and their comparative risk and harm. Understanding the forecasted evolution and strategy and the comparative risk and harm is the

[6] The conclusions that follow are based on the information available on the Michigan Department of Environmental Quality (DEQ)'s Michigan Petroleum Pipeline Task Force website: http://www.michigan.gov/deq/0,4561,7-135-3306_69266---,00.html, as well as Enbridge's website, and the websites of the U.S. DOT/PHMSA, several non-governmental organizations (NGOs), and several pipeline oil and gas trade associations.

only way to remove alternatives, if an accident or release of oil occurs, with the highest magnitude of harm based on a valid and credible "worst-case" scenario.

iii. **Even if Line 5 is within the Range of Acceptable Alternatives after Review and Decisions Regarding Subparagraphs i. and ii., above, a Technical, Engineering, and Risk Analysis of Line 5 Compared to a Model, State-of-the-Art Pipeline is Essential for Evaluation.**

The technical, engineering, and integrity safety risk assessment or analysis would provide a detailed comparison between the existing Line 5 and a model, state-of-the-art pipeline, covering engineering practices, installation, operation, and mechanical integrity management criteria. Protection of safety, health, environment, and the public trust must include a comparative technical, operational reliability, and risk assessment on Line 5.

iv. **A Detailed Consequence Assessment of a Straits of Mackinac Oil Release is Necessary Based on Both a "Credible Worst-Case Scenario" and the Release Scenario that Can Be Reasonably Mitigated Given Current Emergency Response Resources and Seasonal Conditions.**

A "credible worst-case scenario" would be the largest potential oil release or harm that could occur in the Straits based on assumptions that have been agreed upon by independent experts and the Task Force or officials. A key assumption in calculating a credible worst-case scenario is that active protective measures (i.e., those requiring automated, electronic, or mechanical activation) are *not* used in determining the size of the release. Based on available information, Enbridge has failed to present an acceptable credible worst-case scenario, which has resulted in a calculated release or spill and consequences that are less than what may occur under a credible worst-case scenario.[7] Moreover, a credible worst-case scenario is essential for any alternative assessment, risk assessment, and response assessment. To date, it appears that information does not exist or is unavailable, or that the scenario that has been provided is understated.

While the information on the DEQ website is a good starting point, it is inadequate for the purpose of rendering a decision as charged to the Task Force or as required by industry, alternative, system

[7] For example, a proper "worst-case" scenario would include a leak or release in the winter under several feet of ice in the Straits and/or winds in the range of 75-100 mph (hurricane force). Moreover, a shut down of valves would leave a million gallons of oil in the line, another aspect of "worst-case" scenario. Think Fukushima Daiichi nuclear disaster.

logistics, safety, and response standards. Moreover, the Great Lakes Commission submitted excellent draft studies on the overall petroleum distribution system, incidents, and regulatory trends, which support the above conclusions. Information and statements from Enbridge primarily defended the continued use of Line 5, particularly the segment near or in the Straits, without providing or assessing a standard base of information for such a decision by the company or the Task Force. Enbridge and the Task Force have not conducted or considered a state-of-the-art or standard feasible alternative harm and risk assessment. Information and reports submitted by NGOs focused mostly on potential consequences of an accident, release or spill, or matters regarding removal or discontinuance of Line 5 in or near the Straits or other water bodies, critical population or public facilities, or sensitive environmental features or areas. The information listed above should be submitted and available as key elements of industry or business continuity, risk management, and insurance coverage planning process, and assembled and submitted to the Task Force, officials, and the public. The public health, safety, public trust, and environment have not and cannot be adequately protected without the evolution strategy, alternative assessment, or other items listed in the subparagraphs i. through iv.

b. Basic Information Should Be Required, Obtained, or Prepared to Conduct an Adequate and Sufficient Review and Render a Decision on Alternatives, Comparative Harms and Risks, Safety and Integrity Assessment of Line 5, and Emergency Response Planning.

To assist the Task Force, decision-makers, officials, other agencies, and the public, the Task Force should submit additional questions to Enbridge and others in making a proper determination regarding Line 5, the Straits and near-shore areas, the ecosystem, safety and health, and the public trust or protection of public and private property. A set of proposed sample questions to address missing or inadequate information has been prepared, as draft only, and attached to this composite summary.[8] These questions and the information propounded are fundamental to the Task Force and state officials' responsibility under the public trust doctrine and the GLSLA. Moreover, Enbridge should submit evidence and assurances at its cost that emergency resources and equipment are immediately and locally available.

c. Although Available or Disclosed Public Information Is Inadequate or Imprecise, Additional Conclusions Can be Drawn Based on Expertise and Experience Regarding the Lack of Integrity or Safety of Line 5 in the Straits.

[8] See attached Exhibit 1.

The aquatic ecosystem of the Straits of Mackinac is very different from the conditions at the time of Line 5's design. The construction of the St. Lawrence Seaway, which opened to navigation in 1959, resulted in the proliferation of hundreds of new invasive species. Sea lampreys, zebra mussels, and quagga mussels are examples of populations that overwhelmed the ecosystem and human facilities. The designers of Line 5 could not, and had no reason to, have considered the impact or effects of these invasive species. While the design calculations and methods used in the early 1950s for the pipeline are not publicly available, the margin of safety must be reanalyzed and recalculated in light of the existence of invasive species and as a condition of the easement itself. The margin for safety considered to good engineering practice in 1953 necessarily needs to be reassessed for Line 5. The 1953 easement from the State of Michigan to the company demanded structural supports every 75 feet; that is, unsupported spans of the underwater pipeline must not exceed 75 feet, except where buried or approaching shore. Maximum working pressure must not exceed 600 pounds per square inch gauge (psig). Other requirements or techniques, such as structural screws, welding, and coating are outdated or deficient.

i. Line 5 Has Been and Continues to Be Subjected to Stresses that Were Not Contemplated in its Original Design and the Margin of Safety Considered to be Good Engineering Practice by Both Its Original Designers and the State of Michigan in 1953 No Longer Exists.

The underwater sections of Line 5 are made of low carbon, low strength, and high ductility grade steel. The two Schedule-60 20-inch pipelines that constitute Line 5 in the Straits are free of longitudinal seams and resistant to stress cracking. This material works well for welding. It appears the design for the underwater segment of Line 5 sought flexibility due to unanticipated conditions. However, the type of pipe is not dispositive. Based on the 75-foot easement limit on unsupported span for the pipeline, 211 structural supports would be required; however, according to Enbridge's records, a total of only 16 grout bags, 8 grout bags and mechanical supports, and 122 mechanical screw anchors have been installed to date. A portion of the pipeline was placed on a gravel bed, which is susceptible to erosion. Use of gravel bed in lieu of structural supports does not satisfy good engineering practice today. Enbridge has reported erosion of this gravel bed.

Further, based on calculated design stress per the easement and specifications for 75-foot spans in 1953, compared to calculated stresses in the changing aquatic environment and use since that time for transport of natural gas (NG) liquids (unfouled), light crude (2-inch fouling), heavy oil such as dilbit[9] (4-inch fouling), it can be concluded that: the margin of safety in 1953 for NG liquid through Line 5 would have a factor of 3.9; the margin of safety for light crude would have a factor of 3.4, and heavy oil or dilbit a factor of 2.75.[10] The safety factor required for the pipeline under ASME B31.8 (2003) is 2.5. At a safety factor of 1.0, there would be certain failure.

The only public information on the design in 1953 of Line 5 is summarized in "Enbridge Energy Limited Partners, Operational Reliability Plan, Line 5 and Mackinac Straits Crossing." This is not an engineering report, but appears to be a set of talking points to justify the safety of Line 5 to the Task Force and public. The document states that stress corrosion cracking "requires both a corrosive environment and high stress." "However, neither element is present in the pipelines through the Straits, which have excellent coating at less than 25% of their design capacity." This can be interpreted to mean that when operated at 600 psig and no more than 75-foot spans, the combined stress on Line 5 is less than 25% of the yield stress of the pipeline assuming adequate weld efficiency. This equates to the listed safety factor of 3.9 for NG liquid listed above.[11]

As noted above, the easement required maximum 75-foot spans. A disclosed in recent years, the maximum length of the actual spans for the pipeline under the Straits is 90 feet, which is significantly less than the specified margin of safety – only 64 percent of the required span length in the easement. More recently, Enbridge has applied for permits to install additional supports. Permits were obtained in 2014 for installation of supports every 50 feet under the GLSLA, but the DEQ did not request information related to the overall future plans, alternatives, or logistical options regarding Line 5. This should have been done so other alternatives to the old pipeline that would prevent risk to the Straits altogether.[12]

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[9] Dilbit and heavy oil are included in the event Enbridge in the future proposes or tries to use Line 5 for Tar Sands or other heavy oils. It should be noted that synthetic, diluted heavy oils and heavy oils would have similar characteristics.

[10] See Figure 2, Ed Timm, March 14, 2015, "Safety Factor Based on Yield Strength with Weld Efficiency Factor of 1.0 as Function of Support Spacing at 600 psig Maximum Allowed Pressure at 290 Feet Underwater," attached as Exhibit 2.

[11] *Id.*

[12] Looking at the Enbridge "Operational Reliability Plan" document, above, if a 90-foot span is equal to only a 64 percent safety span distance, then the original design called for 140.6 feet, with a safety factor of only 2.0. Using this as a baseline for calculating different scenarios and circumstances and respective margins of safety, and considering reported washouts of the gravel bed, a range of unsupported spans of 90 to 120 feet may not comply with ASME B31.8. Enbridge operated the pipeline in violation of the easement, under conditions that have been unsafe. The addition of some 50-foot spans demonstrates

Again, ASME requires at least a 2.5 safety factor. Based on observed changes in conditions, such as the encrustation of the pipeline with invasive mussels, the following conclusions can be made for a:

Span of 75 feet, NG liquid, 2" encrustation, and safety factor 3.5.
Span of 100 feet, NG liquid, 2" encrustation, and safety factor 3.0.
Span of 150 feet, NG liquid, 2" encrustation, and safety factor 1.8.
Span of 75 feet, light crude, 2" encrustation, and safety factor 3.5.
Span 100 feet, light crude, 2" encrustation, and safety factor 2.5.
Span 150 feet, light crude, 2" encrustation, and safety factor 1.4.
Span 75 feet, dilbit, 4" encrustation, and safety factor 3.1.
Span 100 feet, dilbit, 4" encrustation, and safety factor 2.2.
Span 150 feet, dilbit, 4" encrustation, and safety factor 1.1.

The above conclusions are summarized in Table 2 to this composite summary.[13] As can be seen, there are instances both above and below the safety factor and acceptable risk of failure of Line 5. Structural supports were added in 2005, then more permitted in 2014. The safety factor has been compromised, and attempts, including fabric bags, were used to address washouts and the lack of safe support. Based on calculations and the conditions of the 1953 easement, 211 structural supports are required according to Enbridge's records submitted to the state, only 16 grout bags, 8 grout bags and mechanical supports, and 122 mechanical screw anchors have been installed to date. Enbridge has added more supports, but more are required to achieve a "margin of safety" for supports. As noted previously, the supports, age of pipeline, and conditions in the Straits require a much broader logistical and alternative analysis on the pipeline under the Straits.[14]

ii. The Welding Techniques Used for Line 5 in 1953 Have Proven to Be Less Robust than Contemplated.

Welding techniques for underwater pipelines is a complex subject, and research is ongoing. Historically, the welding techniques used at the time of design and construction of Line 5 have been found

this. But the reason for these spans at 50 feet and the alternatives available to protect the Great Lakes and Straits were excluded from the GLSLA proceeding.

[13] See Table 2. Timm, 3/14/2015, p. 9, attached as Exhibit 3.

[14] The type of original support structures was designed for sandy soil. It is not clear how the new supports will perform under rocky, glacial till, subject to washouts and scouring, as evidenced from reports. Improper selection or installation of the screw anchor supports could result in failures of the supports and compromise of pipeline safety factors, as wells as greater risk of harm to the waters, bottomlands, and ecosystem, and the public trust and public uses.

deficient. Enbridge has recognized the problem as evidenced by its "X-ray" inspections of joints.[15] Until more is known about these welded joints or their deficiency corrected, a higher frequency of failure or risk factor should be assigned to the line.

iii. The Coating that Protects the Line 5 Pipeline Exterior from Corrosion Is an Obsolete Technology and May Have Failed Locally, Resulting in Corrosion that Has Reduced the Strength of the Assembled Pipeline.

The paint coating that was used may be deficient as well. Paragraph (9) of the 1953 easement requires protection by "asphalt primer coat, by inner wrap and outer wrap composed of glass fiber fabric material and one inch by four inch (1" x 4") slats, prior to installation."[16] The Enbridge "Operations Reliability Report" mentions tar, but no wood slats.

iv. Line 5, including in the Straits, Should Be De-Rated, Safely Downgraded,[17] and Stringently Controlled until a Full and Comprehensive Assessment of Forecasted Strategies, Alternative Risk Assessment, Safety and Integrity Assessments, and Response Information Has Been Made Available, Disclosed, or Prepared and Submitted to the Task Force, Officials and the Public.[18]

Given the above-identified deficiencies, there is a substantial and serious risk of a high magnitude of harm to public health, safety, communities, environment, and the public trust in the waters and bottomlands of the Straits of Mackinac for fishing, boating, navigation, drinking water, and swimming and other recreation. Because of this serious risk of grave harm, immediate interim action is required. Interim actions should be coupled with a full and comprehensive review of the major changes in circumstances, including the recently started and ongoing overhaul of the pipeline related to the inadequacies of the supports and stresses on the pipeline in the Straits. Such interim

[15] Note that the easement at p. 4 required at construction that "All welded joints shall be tested by X-Ray."

[16] Enbridge has encountered known failures in fossil fuel-based protective coatings, e.g., Line 2, Saskatchewan, 2009, also constructed in 1953.

[17] The word "safely" is used because reducing the volume or capacity would have to be evaluated if temperature and pressures remained the same; strict interim controls and monitoring are required. See subparagraph d, infra.

[18] Undoubtedly, Enbridge (as with any energy pipeline company) would or should have a logistical contingency plan in place for oil pipeline transport to locations served by Line 5 in Michigan in the event of Line 5 failure or outage. This plan should be disclosed if Enbridge has not done so to date, and such plan should be the starting point or baseline to determine what can be done with Line 5 or what alternatives may exist or be implemented in the future in the absence of an emergency; i.e., to achieve the goal of zero risk to the Great Lakes and its ecosystem.

action should be ordered along with an order that Enbridge immediately apply for proper authorizations, occupancy agreements, and permits under the easement and GLSLA.

d. The Substantial Risk of Failure from Lack of Adequate Consideration of Impacts of Stresses and Corrosion on Line 5 Should Be Made Subject to Stringent Conditions Pending a Thorough Review Under Public Trust Law.[19]

i. Protective Coating Covering Similar to that Specified for and Applied on Line 5 Has Failed in Michigan and Elsewhere and Resulted in Major Spills or Releases of Crude Oil or Heavy Crude Oil.[20]

Enbridge Line 5 was covered with a coating and wrapped, but without wooden slats, as described in subparagraph c.iii, above, to guard against corrosion when it was constructed in 1953. The Line 5 coating is rugged, but does not last forever. The integrity of the coating depends on whether it suffers other degradation or damage, which would weaken the coating or expose the steel surface of the pipeline.[21] The extent of damage or degradation to the protective coating on Line 5 is not fully known, because the pipeline is encrusted with invasive mussels, and the measured deflection standard for dents or gouging is not always sufficient.[22] Enbridge reported dents, each less than 2%, on Line 5 in September 2012. The outcome, including exposure of bare steel, of the investigation has not been disclosed. Bare steel corrodes. Because this can result in breaks and spills, it must be reported or assumed to be exposed steel. Dents or gouges set up stress points in the coating that can also lead to failure. One risk of stress points on the coating is the fact that Line 5 was simply laid on the bottom and not anchored in 1953, resulting in movement from erosion, washing away of the gravel, and direct contact of the coating with rocks or stones. Small amounts of corrosion can reduce the Maximum Allowable

[19] Those measures would include, at Enbridge's expense: (a) continuous monitoring at lowest possible thresholds for adverse conditions and leaks; (b) emergency and recovery response resources, including equipment and personnel, in place and/or immediately and locally available; (c) time-deadlines for (i) determination and (ii) implementation of alternatives and accompanying interim measures; (d) credible insurance liability and bonding requirements.

[20] While constructed along seams and then covered with protective coating and wrap, the Enbridge Line 6b failed in July 2010, caused by corrosion (and *not* a failure at the seam), resulting in a documented oil-spill disaster in Marshall, Michigan.

[21] From 2002 to 2010, there were 17 spills or releases involving coal tar enamel Enbridge pipelines. For reportable Enbridge spills or releases in these nine years, see attached Exhibit 4.

[22] E.g., Transportation Safety Board of Canada, Report P09H0084, Crude Oil Leak, Line 2, Mile Post 474.7335, Sept. 29, 2009 at www.tsb.gc.ca/eng/rapports-reports/pipeline/2009/p09h0084/p09h0084.asp.

Working Pressure (MAWP) of a pipeline. For example, as little 1 mm of corrosion will reduce MAWP from 1421 to 1345, or 5.4%, and 2 mm of corrosion would reduce the MAWP by 15.2%.[23] Very small stresses can have a devastating impact on MAWP.

ii. The Presence of Invasive Mussels that Encrust Line 5 Exacerbates the Corrosion of Line 5.

The documented presence of mussels in the Great Lakes and encrusting portions of Line 5 poses a substantial risk of corrosion or stress. Mussels exacerbate the corrosion of steel.[24] The accumulation of pseudo feces decomposes and removes large amounts of oxygen (very high BOD), and the pH becomes very acidic. Mussels encrusted on Line 5 will exacerbate corrosion of any steel surface, further stressing the line and decreasing the allowable MAWP. Moreover, unless removed, a process itself that could compromise the line, the encrusted layer of mussels makes inspection virtually impossible.

iii. Unless Enbridge Submits a Credible Worst-Case Scenario and Its Logistical, Strategic, and Alternative and Contingent Planning Information,[25] and the Task Force and State Officials Expand Their Review and Decision to Achieve "Zero Risk" Through An Alternative Assessment, Line 5 Should Be Shut Down.

Enbridge has not disclosed and the Task Force has not made information available to the public regarding the coating, inspection, and dents or gouges of the pipeline, or the layer of invasive mussels that completely encrust the pipelines. The 1953 easement, public trust duty under it, and the GLSA demand immediate interim action to reduce stress and risk until there has been a full and comprehensive review and properly authorized occupancy and/or permits for Line 5. The lack of "credible worst-case scenarios," logistical, strategic and alternative assessment to prevent any devastating harm to the Straits and Great Lakes requires a shut-down of Line 5. However, if Enbridge submits this information and applies as it should under the GLSLA to achieve prevention of such harm, i.e. "zero risk," then the Task Force and/or State officials should place stringent measures on Enbridge and the pipeline use and operation pending completion of review under the GLSLA.

[23] See Figure 1, attached as Exhibit 5.

[24] See e.g. http://www.lakehuron.ca/index.php?page=zebra-mussels.

[25] Contingent planning information includes Enbridge logistics and strategy for moving oil in event of disruption, rupture, or temporary shut-down of Line 5. Such information is the starting point for review and evaluation of the risks, safety, and alternatives for any decision or recommendation on Line 5.

iv. Pending a Submission and Review of Enbridge's Submission and Application under the GLSA and Public Trust or Other Related Standards, Enbridge's Use of Line 5 Must Be Subjected to Strict Measures and Controls.

Strict measures imposed on Enbridge's interim or temporary use, at Enbridge's cost, would include continuous monitoring, locally available emergency response and recovery resources and personnel, time deadline for the GLSLA determination as provided by law and the actions that eliminate or achieve zero risk (i.e., prevention, with one deadline for determination and a second deadline for elimination), credible insurance and bonding requirements under the easement, and daily disclosure of petroleum products.

4. CONCLUSION

There is a substantial and real risk and threat posed by Enbridge's Line 5 in and near the Straits of Mackinac to the waters, bottomlands, ecosystem, and the public trust in these Great Lakes waters and ecosystem and uses protected by the public trust. Based on available information, Enbridge has not submitted future and existing logistical information regarding present and alternative or future plans and alternative routes and alternative risk assessments. As a result, the scope of the Task Force review has been limited to safety and response activities because of the risk of accident, release, or leak. This is unacceptable.

The Task Force, officials, and all stakeholders agree that a release or leak of any oil from Line 5 in the Straits is unacceptable. This means that the baseline risk of the high magnitude of harm to the Straits and public health and safety is zero – 0. In turn, this means that the evaluation and decisions by the Task Force and/or state officials must include all logistical, strategical, and alternatives assessments and plans of Enbridge for volumes, pipelines, and existing and planned routes. Failure to conduct such an evaluation and decision to achieve zero risk would violate the public trust and the Great Lakes Submerged Lands Act.

This can and should be accomplished by a thorough analysis and public review of all relevant and required information identified in this composite summary – coupled with a review under the 1953 easement, associated public trust duties in and related to the easement, and the GLSLA to protect the public health, safety of citizens and communities, and public trust in the Straits, Lake Michigan, and Lake Huron. Immediate action should be taken to shut down and/or impose stringent measures for Line 5 for oil or similar petroleum products, pending a full and complete public review, consideration, and determination to implement an alternative assessment and decision.[26] This action is compelled by the easement and the fiduciary public trust responsibility that applies to it, as well as the necessary proceedings for Line 5 under the GLSLA. Anything less than the above puts the Great Lakes and the public health, safety, and public trust at risk; in effect, the Task Force and State officials would be betting the Great Lakes,

[26] See subparagraph d. iv, above.

citizens' safety and health, and the public trust in order to allow Enbridge to continue using Line 5 indefinitely.

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EXHIBIT 1

Questions for Michigan Pipeline Task Force

Introduction

This document provides questions for use by the Task Force to obtain additional information and fill critical gaps on Line 5. This is not comprehensive list but an initial "brain-storming" list. A recommended next step would be to expand and refine the list using a team approach including subject-matter-experts (SME's).

A. Petroleum Distribution System Overview and Strategy

Objectives:

- *Understand the commercial, operating and regulatory environments for petroleum distribution affecting the State of Michigan and specifically Line 5.*
- *Understand the short-term plans and capabilities of the existing network and potential impact of regulations and emergency incidents.*
- *Understand the key drivers and potential strategic changes in the distribution system, including: changes in petroleum supply-side, end-user demands, regulations, alternative transportation modes and the long-range plans for the pipeline network.*

Are *systems analyses* and *strategic plans* available for the North American (NA) petroleum distribution system that include Michigan?

Do the analyses cover all modes (pipeline, rail, truck, ship/barge) and a range of potential scenarios including normal and emergency operations?

Are the facts, assumptions, design bases and scenarios available for the strategic plans?

If system strategic plans are not available, can a study team be convened to develop system scenarios and analyze them with industry support? The team would include participants from the public sector, SME's, industry, NGO's and government?

The Great Lakes Commission issued several excellent draft reports on NA petroleum distribution. Is this organization appropriate and positioned to coordinate development of systems and ***alternatives assessment*** on behalf of the PTF?

What are the primary distribution scenarios (high, most-likely, low and "emergency") for all transport modes (pipeline, rail, truck, ship/barge) and evolution planned for petroleum production from the Alberta Tar Sands and Bakken Fields?

What is the contingency plan for disruptions in the different transportation modes?

What petroleum materials are allowed by regulation to be transported in Line 5? Are there regulatory requirements that must be met before additional materials can be transported and what are they?

What petroleum materials does Enbridge believe could be transported in Line 5 under the regulations? What petroleum materials is Line 5 able to transport in Enbridge's view based on the existing technical capabilities without regard to regulatory restrictions?

Is Line 5 technically capable of handling heavy crude oil and Dilbit (diluted bitumen) based on current engineering and risk assessments? Have any tests or pilot trials been run with these materials and Line 5?

Are there contingency plans or potential scenarios where an incident elsewhere in the pipeline or rail distribution system would drive Enbridge or government action to transport greater volumes or heavier crude oil or Dilbit through Line 5? If there are no plans in place, does Enbridge believe that Line 5 is capable of carrying these materials?

How will the proposed Sandpiper Pipeline Project affect the petroleum materials mix and volumes that are planned for Line 5? Will an additional feed point to the Superior Wisconsin terminal drive changes in Line 5 operation? If there is an incident on other pipelines originating from this terminal, could the incident drive volume or mix changes in Line 5?

How will Line 5 operations be affected if or when the rail tank car shortage becomes acute (retrofitting or replacement of DOT-111 specification tank cars)?

Has a "credible worst case" scenario been developed and analyzed? What are the assumptions and results?

Has a "Black Swan" event been considered of multimode system failure and the impact on Michigan pipeline operation such as a major rail tank car shortage and pipeline incident outside of the State of Michigan and the impact on Line 5 operation?

What are Enbridge's system operations and business continuity plans in the event of leak on Line 5?

What is the impact on suppliers, customers, regional and national economy if a leak on Line 5 causes extended or permanent shutdown due to clean-up, regulatory and public pressure?

Does the PTF and Great Lakes Commission have direct access to DNV - Det Norske Veritas to obtain information on their assessments and recommendations on Line 5 risk.

B. Alternatives Assessment

Objectives:

- *Launch an Alternatives Assessment, which includes key stakeholders.*
- *Develop a range of alternatives, such as modifications to Line 5, new pipelines, different petroleum materials transported, different routing, changes in modes and destinations.*
- *In simple terms, are there alternatives that reduce or eliminate risks in the Straits? Or is a greater risk transferred to other areas and modes; and what are the implications?*
- *Are there* ***inherently safer approaches****?*

Have alternatives and scenarios been developed for petroleum transportation if the Straits of Mackinac route is not an option? What are they and what are the facts, assumptions and risk assessment results?

What are the scenarios, timing and risks for a new trans-Canada pipeline above Lake Superior?

What are the alternatives, timing and risks for additional pipeline capacity through Wisconsin, Illinois, Indiana and southern Michigan and to the east?

What is the feasibility of eventually eliminating the Line 5 Straits Crossing by expanding transportation by pipelines in other areas and expansion of rail shipments?

Would a new pipeline reduce the risk for a Straits crossing by having state-of-the-art design, installation, operation and monitoring capabilities?

Is there a lower risk, more visible, above water, under-the-bridge option?

Are there viable alternatives for transporting only the lowest environmental risk materials (natural gas, NGL's) in Line 5 and no emergency provisions for higher risk materials such as heavy crude and Dilbit?

Are there feasibility studies and risk assessments for Great Lakes petroleum transportation by ship and barge? Are there plans for additional studies especially on comparative risk to other modes?

C. Evaluate the Current Line 5 Risk Assessment

Objectives:

- *Understand how risk assessments were conducted including the input facts, assumptions, technical and engineering design bases and especially the risk tolerance criteria.*

- *Understand any scenarios, assumptions in the scenarios and output consequences if assessed. Did the assessment and scenarios include events with failures triggered by common causes; multiple system failures of equipment, procedures and human elements?*

- *Was an analysis done on a "credible worst case scenario"? A credible worst-case scenario is a scenario that can technically occur and would include "common-cause" and multiple failures of layers of detection and mitigation. What are the triggering events? What were the conclusions for an "undefined triggering event", a "black swan event?" where the spill was limited to only passive protective measures that are inherently safe and reliable?*

Has a complete Line 5 segment risk assessment been conducted and routinely updated? Does one segment specifically cover the Straits Crossing? Are copies available for Task Force and public review?

Who conducted the original Straits risk assessment? What methodology, assumptions and scenarios were used?

In 1953 when Line 5 pipelines were laid by "pulling" it across the Lake, when it the edge of the gorge, did it sink to the Lake bottom and follow the gorge topography or did it totally, or at least partially, "bridge" the gorge?

If pipe did not sink completely to the Lake bottom, how is it supported? How is the additional strain on the lines managed due to currents, corrosion, storms, ship traffic, seches and etc.?

If the pipe did reach the Lake bottom and is supported, did it undergo significant "bending" to conform to the Lake bottom?

Did the bends set up strain on the outside of the curvature, and compression on the inside?

Did the pipelines undergo "thinning" as it was stretched to conform to the contours? Does this thinning reduce the MAWP?

Does the stress/strain on the pipeline enhance corrosion as well as lead to failure of the coating?

During operation when separation or gaps in the material being transported occur have changes in line buoyancy been analyzed to determine if "pipeline flexing" could occur causing metal and coating fatigue leading to failure?

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What would the economic and energy supply impact be for an extended Line 5 outage (any point, any cause) for Michigan residents, regionally and nationally?

Are there gaps in environmental impact studies? What areas and scenarios need additional study and what are the confidence levels? When was the last study completed and what was the scope of coverage?

Was a "credible worst-case scenario" scenario developed including assumptions on common-cause, multi-mode, human and management system failures? What resources are in-place and tested to respond to and mitigate this incident?

Did regulatory authorities evaluate a "credible worst-case scenario"? Independent experts?

What "design basis events" were considered in the original Line 5 design and assessment?

Does the assessment include “common-cause” and “multiple system failures” that could lead to a serious incident?

What recommendations were made from risk assessments? Were all recommendations implemented? What recommendations were modified? Are still open? Discarded and reasons for not implementing?

Have the consequences from a “black swan” event been determined and reviewed? This would be an “unconstrained release” with only inherently safety measures credited for risk reduction.

Has a risk assessment been conducted on start-up, shutdown and maintenance (SSM) operations covering differences between normal operating conditions and SSM transition periods? Are potential excursions investigated during testing and transitions?

Has a 3rd party review been conducted on Line 5 such as the study conducted by Dr. T. Gunton and S. Broadbent at Simon Frasier University titled, “A Spill Risk Assessment of the Enbridge Northern Gateway Project?”

Were risk and design assessments conducted on the design and placement criteria for the new underwater supports being installed to fill voids defined in the original design? Why is a new design being used? Why are additional supports being installed? Is the installation of new supports being driven in part by engineering modeling (line movement and vibration suppression) and / or actual incidents and fatigue measurements? Provide a detailed explanation.

Does the new support installation project initiate the regulatory requirement to conduct a new environmental impact assessment?

Provide a list of risk reduction assumptions and engineering measures for the existing line. What recommendations were developed and implemented or not implemented because or low cost-benefit such as incidents involving underwater land shifts, earthquakes, anchor drops and drags, potential installation issues from underwater slopes and bends and vibration causing pipeline fatigue that factor into risk assessments after 50+ years of operation?

What are Enbridge’s “risk tolerance” or “acceptable risk criteria” used in the risk assessment modeling? What are the bases for current risk transfer scenarios justifying the purchase of catastrophic incident insurance coverage?

What metrics are used for evaluating acceptable risk (spills / leaks per mile per year, size and cost of spill cleanup, reputation damage, environmental impact damage, public sector economic impact)?

Was an environmental impact assessment (ERA) required by and submitted to the EPA for the new support installation project?

Has DNV assessed Line 5 risk? References indicate that DNV was involved in modeling Line 5? What aspects were modeled and what were the results and recommendations? Can the assessments be made available for PTF review?

Are there plans and assessments to address a scenario where a large spill may generate enough public concern and pressure resulting in an extended or permanent shutdown of the Straits Crossing?

Crude oil transported in the pipeline is a complex mixture with some of the components being polyaromatic hydrocarbons (PAHs) which are listed CMR (carcinogenic, mutagenic , reprotoxic) materials. Has the human health and environmental impacts been assessed on the potential release of these materials into the Straits and Great Lakes?

Are toxicology reports available on risk to municipal and private water systems and human health impacts? Are there estimates on the time required to return to safe water consumption?

D. Comparative Design – a 1953 Vintage Pipeline Compared to State-of-the-Art 2015

<u>*Objective*</u>:

- *Conduct a comparison of risk for the existing Line 5 and a "2015 model" using state-of-the-art design, fabrication and installation and operation criteria.*

Have studies, preliminary designs and cost estimates for a new Straits Crossing pipeline been developed?

Has an assessment been conducted on "inherently safer design" (ISD) approaches that could be used on the existing or a new line and the benefits obtained?

Has comparative and/or gap analysis been conducted on the design and installation of the current line versus a new design?

What are the differences, advantages and disadvantages the Line 5 design compared to today's standards and normal industry practices? Enbridge - " The Straits pipelines are well designed and constructed to design standards that far exceed normal industry practice". What are the details behind "normal industry practice", especially for normal terrains versus environmentally sensitive, high consequence geography?

What are the state-of-the-art design and installation practices for pipelines crossing major waterways?

What are the differences between the Line 5 quality control and commissioning activities and todays best practices? Has a gap analysis been conducted? Enbridge - "Quality control and commissioning activities were robust to ensure safety and reliability"

Are there differences between pipelines crossing inland rivers and lakes compared to deep-water maritime environments? Are there practices used for maritime pipelines that would reduce risk for Line 5 or a new pipeline?

Have modeling studies been conducted to determine the possible effects of water currents land shifts and vibration on Line 5? Is there evidence of issues or concerns about pipeline vibration, stress and fatigue? What would be done differently for a new line design?

What were the design and installation consideration specifically for the deep lakebed channel, through the Straits connecting Lakes Michigan and Lake Huron? The channel has steep walls and can reach 300 ft deep in some areas. The pipeline suspends over this channel about quarter-mile-wide? The tension on that section of the line is likely to be severe?

Why were 2 - 20" lines installed instead of 1 - 30" line across the Straits, reliability, fabrication considerations, design limitations, maintenance, back-up in case one branch fails?

Are there scenarios where Line 5 could be impacted by ice packs? Does actual ice flow data exist or only assumptions? Discussions were conducted on possibly installing a new line underground through the Straits? Enbridge, "the lines are buried at depths that protect it from moving ice packs."

What is the risk for ship anchor drops and drags in the area? The area is marked and managed for routine shipping but what about emergency scenarios (human error, mechanical or navigation failures, accidents, severe weather, common-cause, multiple system failures)? Enbridge Line 5 - Location is not conducive to anchoring - deep water, strong currents, shipping corridor." How does this relate to the discussions on a buried pipeline that may be safer from anchor damage but more difficult to inspect?

How do the planned Keystone practices compare to the current Line 5 installation such as inspections, non-destructive testing (NDT), coatings, welding technology and testing cathodic and other protection? What best practices would be used for a new line compared to Line 5. Has a gap analysis been conducted?

E. Evaluate Current Approaches for Line 5 Integrity and Leak Detection

Objectives:

- *Obtain an understanding of the limitations in the Line 5 integrity management process. What potential line failure issues could be underestimated or not detected due to limitations in the technology and/or management system? What are the gaps that Enbridge reference studies are trying to address, timing and action plan related to improved pipeline integrity measurement and management? What is the "layered protection approach" being used to cover gaps?*

- *Obtain and understanding on reliability accuracy and precision for detecting leaks and the limitations of the detection process relative to leak size, quantity, leak rate and identification of location.*

- *Has an assessment been done on the management system and could it meet standards an OSHA PSM / NEP level audit? Are the gaps and areas for improvement, especially related to external communications?*

Have there been any underwater repairs made to Line 5 since installation? What were the reason for repairs and findings?

Technical studies have concluded that zebra mussel excrement has a corrosive impact on exposed steel. Has an assessment been made on the likelihood that at least some of the original coal tar sealant has deteriorated or been scraped off and the steel exposed to corrosion induced by zebra mussels?

As relative small levels or corrosion can result in a significant deterioration in MAWP has the impact of zebra mussels or other acidic materials been assessed on potential line failure?

Have zebra mussels impacted the ability to conduct pipeline exterior and surface inspections for integrity issues?

Has PHMSA or other regulatory agencies conducted detailed compliance audits on the pipeline system and management practices? Have regulatory agency audits similar to the OSHA / EPA National Emphasis Program (NEP) conducted on oil refineries and chemical operations been conducted? Any specific audits conducted as a result of lessons learned from the Marshal MI spill?

Specific regulatory compliance audits conducted - agencies, focus of audits, dates and deficiencies found. Open deficiencies under review and remaining to be completed?

Explain in detail - Enbridge has started to lay the groundwork to expand Line 5 by 50,000 barrels of oil per day— or 1.8 million gallons. As part of that effort, Enbridge has conducted hydro testing to evaluate the condition of the pipeline, which has turned up recent failures on the line near Bay City, Michigan

Enbridge personnel have stated that block valves on both sides of the Straits would shut immediately if a leak is detected. During activation for testing or in the event of an actual leak can severe pipeline damage occur and/or potential failure due to the "water hammer effect?" Are controls and surge dampeners in place to reduce hammer?

Has a 3rd party evaluation been conducted on pipeline integrity inspections and the minimum detection thresholds for issues such as defective welds, dents, cracks, areas of fatigue, stress, corrosion, stress corrosion cracking and wear both internal and external?

Have assessments or forecasts been conducted on pipeline end-of-life? Have cost estimates and/or preliminary designs been developed for line replacement in the event of it being taken out of service for any reason? Enbridge - " Prioritized repair timing, re-inspection interval setting, additional assessments in top consequence areas" - Are these areas in the Straits sections?

Has a comparison of the 1953 enamel coating reliability been made to state-of-the-art technology that would be used today? Would the 1953 coating be used today, if not why not? Does the original coating age and what are the "end-of-life" issues and criteria for replacement? How is the underwater coating inspected and repaired?

Is there a different coating used on Line 5 outside of the Straits area and what is the reliability and end-of-life issues with this coating?

Can the entire Line 5, especially sensitive areas be effectively checked by "high-technology pigs?" Are there areas of concern or gaps where pigs may not be reliable? The 1953 pipeline was not originally designed for pig inspections?

Where is cathodic protection used? How effective is the cathodic protection in corrosion protection? What areas are not effectively covered and how these areas inspected?

Integrity of records - a pipeline seam failure occurred on another pipeline where records incorrectly listed the segment as seamless. Have all Line 5 records been verified with what is actually in place?

Has the Task Force interviewed the Enbridge 3rd party service providers for findings, recommendations and pending safety and integrity issues yet to be addressed? Enbridge - "3rd party damage management."

Did the insurance company covering Line 5 make recommendations? What recommendations are open action items and are there recommendations that were rejected from resolution?

Provide information on: process safety studies conducted and findings, layer of protection assessments (LOPA), instrumentation reliability, calibration and testing programs? What is the history of instrument reliability in different seasons, weather conditions, electrical power and communication system disruptions?

How effective are the back flow check valves? Are they considered to be a credited protection layer? Is there an additional double block and bleed system that act as the primary isolation?

Explain inline inspections for cracks and metal loss - the “features” that were found, were they individual isolated features or were some concentrated in an area that could result in a large or catastrophic failure?

Explain comments by Enbridge that Line 5 corrosion rates are lower than typical? What is the “typical” comparison used? What are the differences between overland and underwater corrosion rates?

Pressure cycling and fatigue crack growth, how accurate and precise are inspections at detecting fatigue cracks? What are the crack initiation times and growth rates to possible failure compared to detection capabilities and inspection intervals? How good is the “best available crack inspection technology?

For geotechnical hazard management, have there been any incidents of line shifting? Steep slope changes, landslides, support of pipeline movement in the Straits? Are the new supports being installed to improve the stability in response to concerns about actual incidents or near misses? Has the ROV inspections detected any areas of actual movement and risk?

Explain - “no pipeline repairs have been required at the Straits” - how would underwater repairs be performed? What is the decision process, approvals required and how long would a repair take? Are there current defect areas where risk assessments list these as below the threshold criteria that would require repair?

What incidents could have happened during original installation or since installation that have reduced line integrity and are not adequately detected today, such as stress, bends and shifts?

What technical and scenario assumptions on line integrity have or are being challenged by any party and their views?

What studies have been conducted, conclusions and recommendations on additional leak detection? How reliable and sensitive is the technology, i.e. the lower level leak detection limits? Enbridge - “commissioning an engineering assessment to explore the feasibility of applying additional external leak detection and real-time damage-detection technology on the Straits crossing.”

What is the limit of detection for leaks using the Enbridge "material balance system?" For example, typical flow meters read +/- 0.5%, a leak of this magnitude could spill nearly 80,000 gallons of oil within 3 hours (for each line) and still be below the limit of detection.

ROV inspections, what are the real capabilities and observation limits for issues? What are the objectives for ROV inspections (leaks, line damage, line shifts, other)?

What is the possibility of long-term small leaks underwater not large enough to be detected by any of the existing measures? Have performance tests been conducted on the systems and what are the results?

Provide more details on new leak detection technologies understudy. Are any 3rd party studies being conducted and have advances in offshore systems been studied? (fiber-optic cable, rarefaction wave leak detection, acoustic strike detectors, etc)

Explain the approach, accuracy and precision of Enbridge’s “computational pipeline monitoring” and “scheduled line-balance calculations”. How large could a continuous leak or small intermittent leak be and miss detection by this system?

F. Emergency Response

Objectives:

- *Understand the baseline assumptions and scenarios (materials, leak size, weather conditions, time of day and length of time and etc.) that the emergency response plan is designed to address. What gaps or potential scenarios would the plan not be able to address or have short-comings?*

- *Given given a large scale incident, what additional resources and timing could be called on outside of the plan in a reasonable amount of time, such as other federal, states or communities?*

- *What are the assumptions on recovery and remediation issues and actions required for the baseline response scenario? Who takes responsibility, manages and pays?*

- *For emergency response, what resources are firmly committed (contracted) such as responders (government and 3rd party), equipment and funding? Extent of contractual agreements including retainers to insure that response personnel and equipment are guaranteed to be available.*

- *What agreements are in place with Canadian government for support and the type available?*

What scenarios have been developed and analyzed for emergency response?

What are the details for the base case scenario that the emergency response plans are represented as able to address?

What is the credible worst-case scenario? What are the response and mitigation capabilities for this worst-case scenario?

Has the Enbridge worst-case scenario been reviewed by SME's? Published articles state that according to the Enbridge emergency response plan, it takes the company a minimum of eight minutes to shut down a ruptured pipeline and isolate the flow of oil from the leaking pipe. Enbridge has estimated that a "worst-case" discharge for line 5, with the eight-minute shut off, would be up to 1.5 million gallons of oil released. This scenario does not appear to cover common-cause, cascading and multiple system failures.

What is the size of a release for a line failure at the worst point underwater with no "active" emergency shutdown communications and isolation systems in operation? In other words, only passive and inherently safe layers of protection would be credited for stopping the spill.

Are any actions being taken to prepare for possible new communications and response capabilities to address Executive Order 13650?

Has the University of Michigan release analysis been incorporated into emergency response planning?

Have experimental data and spill spreading scenarios been developed for the different petroleum materials transported in Line 5? For example, are the actual paths taken by light crude versus NGL's actually known and accounted for in planning? How does material evaporate or sink or move during different seasons and weather conditions?

How will a spill be located and tracked during each season especially under ice cover?

Is there any history or examples of a large oil spill in the Great Lakes? What were issues in cleanup and ecological recovery times (biodegradability compared to maritime, e.g. Gulf Coast spills)

Has an “all threat” integrated contingency analysis been conducted based on DHS protocols or NFPA 1600?

Do contingency plans have detailed procedures for working with the USCG, LEPC, EPA, SERC and Fusion Center? Do the plans cover mitigation, planning, response and recovery operations?

For the past three winters, the U.S. Coast Guard Sector Sault Ste. Marie has been running “oil and ice” exercises in the Straits of Mackinac. What spill scenarios and mitigations capabilities were used? What were the conclusions, gaps and recommendations?

For a response to worst-case scenario - what were the assumptions for the scenario and who participated in the exercises with the USCG? LEPC?

Has an independent group of SME’s review the Integrated Contingency Plan (not available to the public) and findings from the peer review? Who were the peers that reviewed the report? ref 8

What are the estimated times for emergency response crew to arrive? Set-up and commence spill stoppage? What is the time required to start cleanup operations and what would the equipment and scale of cleanup in the 1st day, 1st week? Enbridge’s emergency response plans show it would take company crews around three hours to respond to a spill in the Straits of Mackinac. Note this appears to be arrival time not set-up and cleanup and assumes required equipment is available where?

Describe the equipment and capabilities at the Straits or that will be sent to the Straits for cleanup that are on-site, will be brought in and timing. Are there guarantees that the equipment will be available on retainer or “expected to be available?”

Do villages and cities in the potential spill impact zone have contingency and communications plans in place to monitor and respond to a release that may impact there water intake systems and other critical infrastructure?

What organizations are directly involved in emergency response planning and recovery? Where is the incident command center and who are the designated incident commanders?

Have “after-action” and “hot-wash” analyses been conducted on line incidents, near-miss, false alarms and drills and exercises? What conclusions and recommendations were developed and are there any open actions?

In practical terms, how effective would a 2-man submarine from a Detroit company be in vacuuming oil from bottom of the lake?

Has the USCG Captain of the Port responsible for ship traffic in the Straits met with the PTF and explained actions that may be taken to shutdown ship traffic to reduce spill dispersion, potential outage times and conditions that allow reopening. Potential economic impact on Lake Huron and Lake Michigan sides of shipping lanes.

What is the status of studies on equipment that can be used to remove oil during ice cover?

Are there plans to use dispersants and surfactants on oil spills? What materials are in place, available for for use? Have the materials been assessed for human health and environmental impact?

The USCG objective is to prevent oil from a spill reaching the shoreline and environmentally sensitive areas. What equipment is readily available to meet this objective (skimmers, booms, boats, workers, designated areas and plans, and etc.)?

What are the economic and environmental costs calculated for the: 1) Enbridge worst case scenario release, 2) credible worst case scenario release and 3) a “black swan” release maximum release with only passive layers of protection credited?

What new regulations need to be addressed covering onshore oil pipeline facility response plans (FRPs) by PHMSA and coordinated with U.S. Coast Guard (USCG) oil spill response regulations?

What specific petroleum materials does the current emergency response plans cover? If there is a transportation shutdown elsewhere in the network and there are actions to transport materials in Line 5 that are not currently transported, what are the communication and response procedures to address this possible change?

What are possible events that could impact the system that would drive implementation of emergency plans or orders to change this position? In what areas can the federal government through interstate commerce authority override state law?

EXHIBIT 2

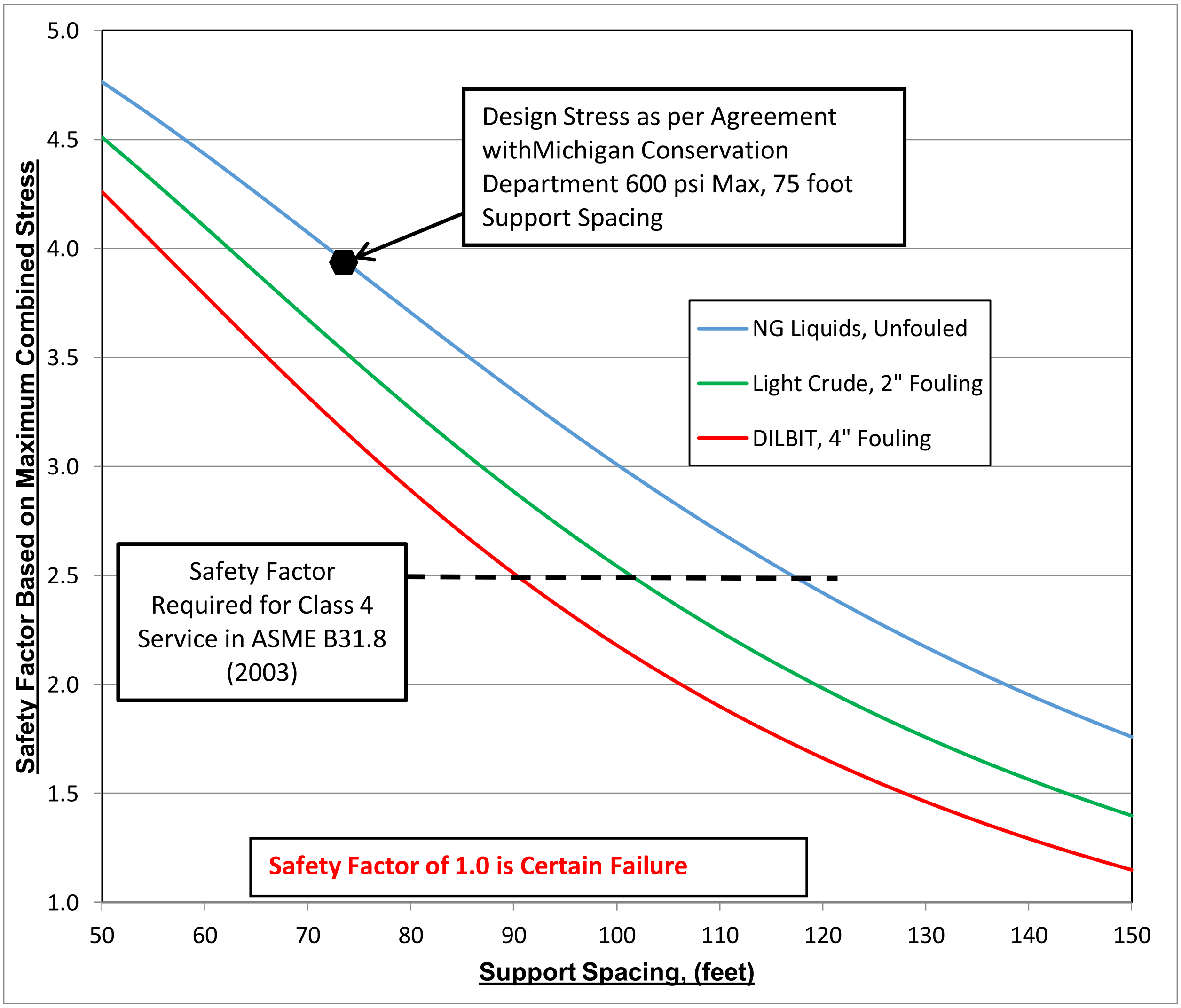

Figure 2. Safety Factor Based on Yield Strength with a Weld Efficiency Factor of 1.0 as a Function of Support Spacing at 600 psig Maximum Allowed Pressure at 290 Feet Underwater.

EXHIBIT 3

Table 2. Pipeline 5 Safety Factor Based on Yield Strength with a Weld Efficiency Factor of 1.0 as a Function of Support Spacing at 600 psig Maximum Allowed Pressure at 290 Feet Underwater.

Unsupported Span in Feet	Natural Gas Liquids, No Encrustation	Light Crude, 2" Encrustation	DILBIT, 4" Encrustation
75	3.9	3.5	3.1
100	3.0	2.5	2.2
150	1.8	1.4	1.1

Little is known from the publically available literature about the existing support of line 5. That the original gravel bed support structure is problematic is attested to by the many efforts over the years to repair this structure and add additional hard supports of the type that are considered current good practice. Exactly when this repair effort began is not known from the publically available literature. What is known is that for a number of years grout filled fabric bags were placed under the line to repair washouts. Starting in about 2005, modern screw type anchors were added in many places.

Exactly why, how many and where these discrete supports were added cannot be determined from the publically available record. If all the exposed underwater sections of line 5 were supported this way, approximately 211 would be required. From the publically available record it appears that at least 27 have been added since 2005. Improper selection or installation of discrete screw anchor support of the type detailed in Figure 3 as used by Enbridge can cause as many problems as they solve. Misalignment can actually add stress to the pipeline and if the saddles are not very carefully designed they can also add stress and cause coating failure.

1	Year	Month	State/Province	Location	Estimated Amount Spilled (m^3)	Cause	Caused by Corrosion?	Construction Date	Pipeline Material - Pipe	Pipeline Material Coating	Pipeline Material - Long Seam Weld	Material Transported	Amount recovered[1] (m^3)
2	2010	April	Minnesota	Pipeline	0.79	Corrosion	Yes	1957	Steel	Coal Tar Enamel	FW	Crude Oil	0.63
3	2010	January	North Dakota	Pipeline	477.0	Weld Failure	No	1956	Steel	Coal Tar Enamel	FW	Crude Oil	246.04
	2009	September	Saskatchewan	Pipeline	175.0	Excavation or physical damage to facility or pipeline by operator or operator's contractor	No	1953	Steel	Coal Tar Enamel	FW	Crude Oil	175.0
5	2009	July	Manitoba	Pipeline	0.02	Weld Failure	No	1953	Steel	Coal Tar Enamel	FW	Crude Oil	0.02
6	2009	June	Minnesota	Pipeline	0.79	Weld Failure	No	1954	Steel	Coal Tar Enamel	FW	Crude Oil	0
7	2008	April	Minnesota	Facility	0.95	Pump - Seal or Packing Failure	No	1950	Steel	Coal Tar Enamel	FW	Crude Oil	0.65
8	2007	July	Alberta	Pipeline	0.48	Corrosion	Yes	1954	Steel	Coal Tar Enamel	FW	Crude Oil	0.48
9	2007	March	Minnesota	Facility	0.79	Equipment Failure, stripped	No	1954	Steel	Coal Tar Enamel	FW	Crude Oil	0.79
10	2006	August	Alberta	Pipeline	30.0	Weld Failure	No	1954	Steel	Coal Tar Enamel	FW	Crude Oil	30.0
11	2006	May	Michigan	Facility	3.18	Pump - Seal or Packing Failure	No	1953	Steel	Coal Tar Enamel	SAW	Crude Oil & NGL	3.18
12	2005	August	Illinois	Pipeline	17.01	Hydrotest failure	No	1952	Steel	Coal Tar Enamel	DSAW/Flash Welded	Crude Oil	11.29
13	2005	April	Illinois	Pipeline	0.79	Dent	No	1968	Steel	Coal Tar Enamel	FW	Crude Oil	0.79
14	2004	December	Michigan	Facility	0.16	Equipment failure, cracked threads	No	1953	Steel	Coal Tar Enamel	SAW	Crude Oil & NGL	0.16
15	2004	February	Minnesota	Pipeline	1.59	Dent with cracking	No	1957	Steel	Coal Tar Enamel	FW	Crude Oil	1.43
16	2002	July	Saskatchewan	Pipeline	3.00	Natural Forces - Lightning	No	1954	Steel	Coal Tar Enamel	SAW	Crude Oil	3
17	2002	May	Manitoba	Facility	60.00	Weld Failure	No	1950	Steel	Coal Tar Enamel	ERW	Crude Oil	10

EXHIBIT 4 – Reportable Enbridge Liquids Pipeline Spills for Past 9 Years

EXHIBIT 5

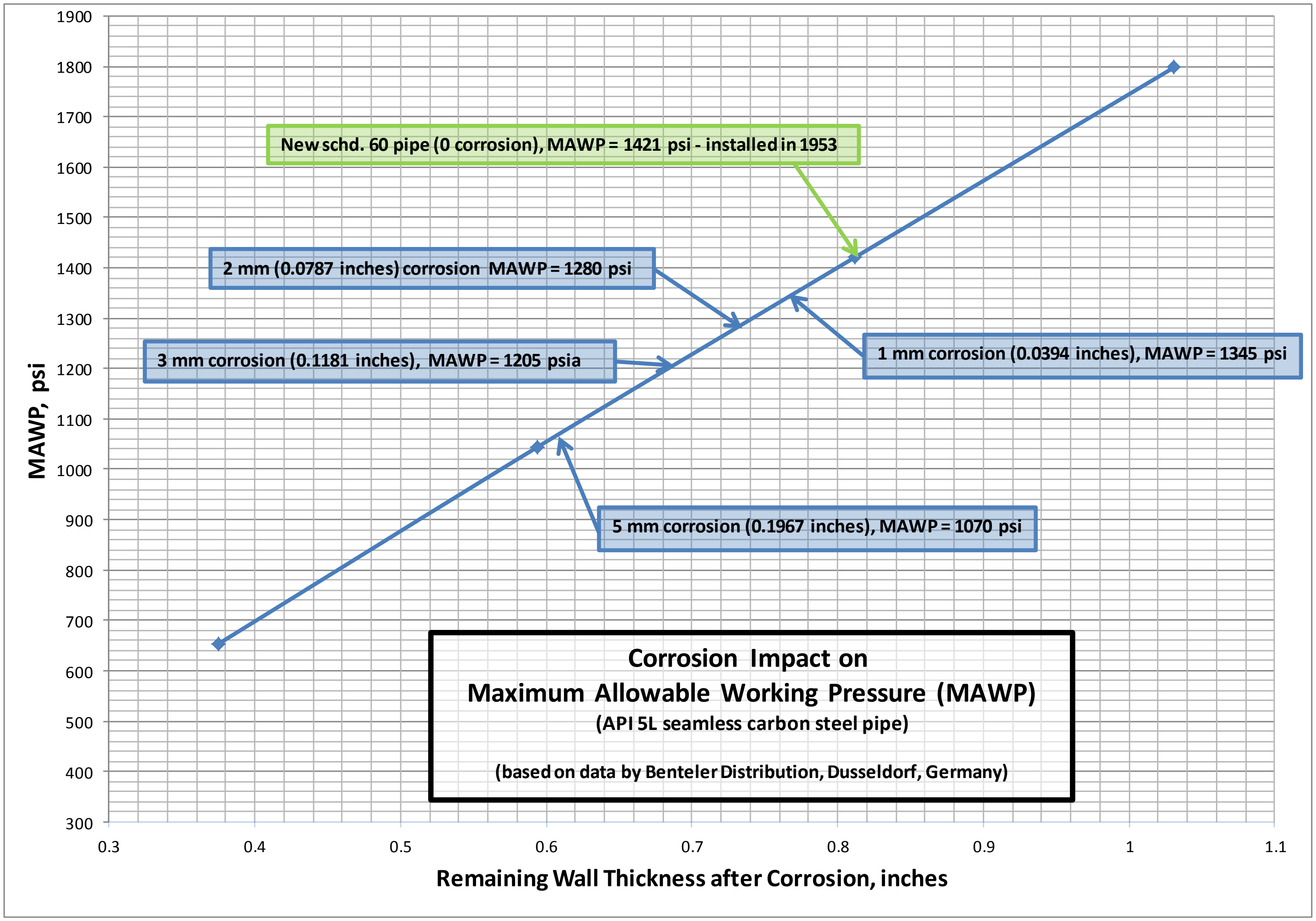

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EXHIBIT 6

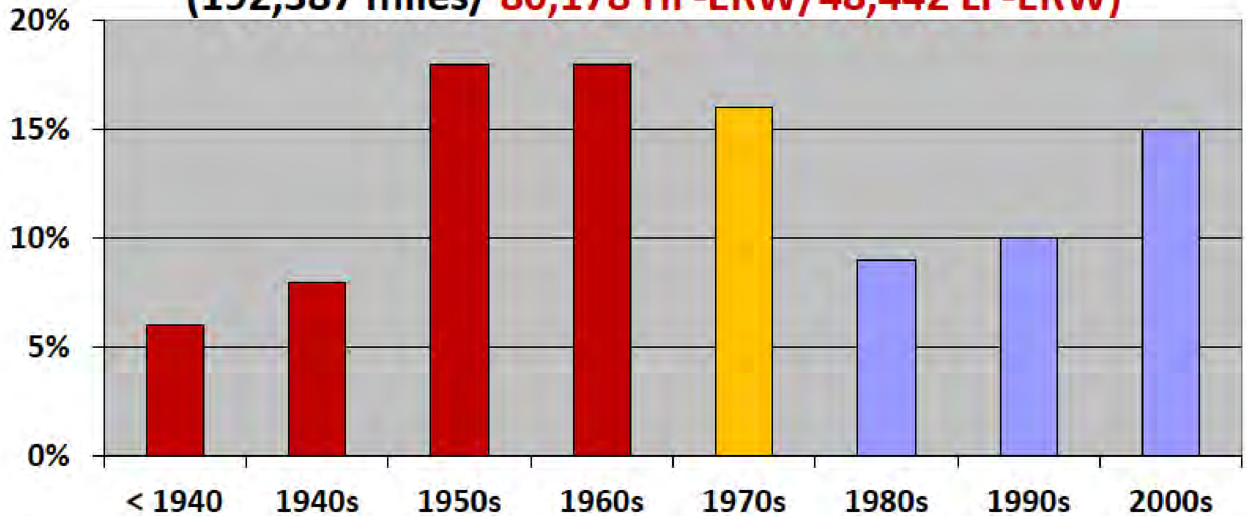
Pipeline and Hazardous Materials Safety Administration

U.S. Pipeline Infrastructure

Hazardous Liquid Pipeline Vintage

50% installed prior to 1970

(192,387 miles/ 80,178 HF-ERW/48,442 LF-ERW)



PHMSA Pipeline Annual Report Data – October 31, 2014

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FLOW
FOR LOVE OF WATER

Protecting the Common Waters of the Great Lakes Basin
Through Public Trust Solutions

A SCIENTIFIC AND LEGAL POLICY REPORT ON THE TRANSPORT OF OIL IN THE GREAT LAKES:

(1) RECOMMENDED IMMEDIATE ACTIONS ON THE TRANSPORT OF OIL THROUGH LINE 5 UNDER THE STRAITS OF MACKINAC; AND

(2) SUPPLEMENTAL COMMENTS ON THE MICHIGAN PETROLEUM PIPELINE TASK FORCE REPORT

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September 21, 2015

OVERVIEW

The Michigan Petroleum Pipeline Task Force, co-chaired by Attorney General William Schuette and Michigan Department of Environmental Quality Director Dan Wyant, issued its Michigan Petroleum Pipeline Task Force Report on July 14, 2015. The Task Force Report sets forth a summary of findings, specific recommendations to address the transport of oil in Enbridge Line 5 under the Straits of Mackinac, and general recommendations to address petroleum pipeline siting, environmental, health, and safety issues in Michigan. The Task Force Report advances a number of significant recommended actions that, if implemented properly, could address a number of short-term imminent harm or substantial endangerment to air, water, natural resources, and the public trust in these paramount resources, public and private property, and the public health and safety of Michigan.

For Love of Water ("FLOW") reconvened its scientific and technical advisory team and legal policy team to evaluate the Task Force Report and the available public record underlying the Task Force's review, and to provide additional scientific, engineering, policy and legal research and recommendations.[1]

Based on a careful review of the Task Force Report, FLOW submits this follow up report for the following purposes:

(1) FLOW concludes that the current use of Line 5 for the transport of crude oil poses a high level of risk and imminent high magnitude of harm, and proposes a specific action plan with prudent interim measures to immediately lower the risk and eliminate this imminent harm.

(2) FLOW provides supplemental comments on certain findings in the Task Force Report and offers a number of additional recommendations.

The Task Force and its leaders should be commended for the level of their review, evaluation, and recommendations. However, the Task Force did not recommend any action plan or specific interim measures, or establish implementation of studies for additional findings, with the exception of the establishment of the Pipeline Safety Advisory Board through the Governor's Executive Order, 2015-12.[2] While the Executive Order establishes a board of advisors with a charge to review and advise state agencies regarding the recommendations of the Task Force, it does not specify, authorize, or implement any action plan to address the high level of risk and magnitude of harm threatened by the continued transport of crude oil through Line 5 in the Straits of Mackinac.

[1] FLOW's scientific and technical advisors to this report are Richard J. Kane, QEP, CHMM, CPP; Gary L. Street, P.E., formerly Director of Engineering, Dow Environmental (Eastern Operations); and Edward E. Timm, P.E., Ph.D., Technology Director, Film Tec Corporation, subsidiary of Dow Chemical, (for a more complete description of qualifications; see paragraph 2., p. 7, Olson, J., and Kirkwood, E., FLOW *Composite Summary of Expert Comments, Findings and Opinions on Enbridge Line 5*, submitted to Michigan Petroleum Pipeline Task Force, on April 30, 2015 Hereinafter "FLOW Composite Report").
[2] Michigan Petroleum Pipeline Task Force Report (hereinafter "Task Force Report"), pp. 43-47.

Because of the high level of risk and serious harm associated with the transport of oil in Line 5 under the Straits of Mackinac, [3] there are several interim measures that should be taken as expeditiously as possible to lower the risk of unacceptable harm. In addition, we urge the Attorney General, Department of Environmental Quality ("DEQ"), and Department of Natural Resources ("DNR") to take a number of steps to implement these actions and enforce legal obligations concerning Line 5 that can assist in reducing and eventually removing the risk of unacceptable harms, which all interests appear to acknowledge, associated with crude oil transport in Line 5 under the Straits of Mackinac.

There are alternative pipeline routes and capacities to transport crude oil to Sarnia or other points in Canada and the U.S. Line 5, for example, primarily transports crude oil to Canada, and is not essential for Michigan refineries, which are served by pipelines across southern Michigan and elsewhere.[4] Natural gas liquids for propane, which are also transported in Line 5, would continue to be transported through Line 5 to its transfer point in the Upper Peninsula or locations in the Lower Peninsula.[5]

Finally, there are a number of supplemental findings and recommendations that may be helpful, if not essential, to the State's officials and departments, as trustees of the Great Lakes, to protect the Straits and other navigable waters of Michigan, including related aquatic resources and ecosystems, and the public and private uses that depend on them.

FLOW EXECUTIVE SUMMARY

PART 1: PROPOSED ACTION PLAN, INTERIM MEASURES, AND ENFORCEMENT FOR LINE 5, AND SUPPLEMENTAL FINDINGS AND COMMENTS TO THE TASK FORCE REPORT

a. Straits pipelines are an imminent hazard and substantial endangerment given the consequences and magnitude of harm, not probability.

An "imminent hazard" or "substantial endangerment" of high magnitude of harm for transporting hazardous materials, like crude oil, is defined by statute "as the existence of a condition relating of hazardous material that presents a substantial likelihood that death, serious illness, severe personal injury, or a substantial endangerment to health, property, or the environment may occur before the reasonably foreseeable completion date of a formal proceeding begun to risk of that death, illness, injury, or endangerment."[6] Notably, this definition of "imminent" emphasizes the

[3] Id; FLOW Composite Report, April 30, 2015; and see selected pages from the attached Appendix 4, Presentation August 4, 2015, Charlevoix Public Library, by Ed E. Timm, Ph.D. FLOW's science and technical advisors' new or additional findings are set forth below in Part I, 1. subparagraphs a. through o., and attached Appendices 1, 2A, 2B, 2C, 2D, 3, selected pages, Appendices 4 and 5.
[4] Attached Appendix 1, Gary Street, pp. 3-4, Street Appendices 1-6.
[5] See Part II 1, A, *infra.*
[6] 49 USC § 5102 (Title 49, Transportation, Subtitle III, Chpt. 51).

seriousness or magnitude of the harm, injury, or endangerment from a hazard, *not* the probability of the occurrence. In the leading court decision on "imminent" hazard risk of harm or "endangerment," the court ruled that the central question for government to evaluate when evaluating "imminent" injury and facing uncertainty of devastating harm was the magnitude of harm, not the probability of occurrence. In other words, government does not have to wait for a catastrophe or harm to occur, but can act to prevent it.[7]

b. Coupled with the Task Force Report findings, new additional risks and concerns establish imminent harm, unacceptable high-level risk, and catastrophic damage to the Great Lakes.

FLOW's science and technical advisors have identified several additional risks and concerns that are not covered by the Task Force Report, but which must be considered along with the findings of the Task Force Report. These additional findings and concerns, coupled with the findings of the Task Force Report, demonstrate a very high level of risk sufficient to establish imminent harm or substantial endangerment of the Straits waters and related natural resources, public and private property, and public health and safety. These additional findings include recognition by Enbridge's own mass balancing measuring system that as much as 3,350 barrels of crude oil per day are not accounted for or considered detectable. Enbridge unilaterally decided, without independent state agency review as to purpose and integrity, to reduce the number of required structural supports or anchors of the pipeline. Enbridge reported there have been no dents in Line 5 under the Straits, when the public record discloses "two minor dents." Once tar or other pipeline coating is compromised or dented, mussels can attack the steel pipeline more readily. It also appears that the pipeline in some instances is operating under over-pressurized conditions for its design and use for transporting crude oil.

c. Impose immediate interim measures to reduce the high-level risk from "Tier 1" to a lower risk tier pending implementation of the actions required from the Task Force Report.

Pending completion of a specific action plan, interim measures must be imposed as soon as possible to lower this high-level risk and eliminate the high unacceptable magnitude of harm to the Great Lakes and the Straits of Mackinac. These interim measures include additional and more frequent monitoring and inspections, an emergency response plan with effective local capacity, and the temporary cessation of transporting crude oil

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[7] Ethyl v. EPA, 541 Fed 2d 1 (D.C. 1976); See also Reserve Mining v. EPA, 514 Fed 2d 492, 519-520 (8th Cir. 1975).

through Line 5 under the Straits.[8] Based on current servicing of demand, these interim measures would not adversely impact the transport of natural gas liquids ("NGLs") to supply propane to the Upper Peninsula or other Michigan businesses and residents.

d. Implement the following specific actions to reduce the level of risk, mitigate harm, and finally address the fate and removal of transporting crude oil in Line 5 under the Straits.

(1) Convene and immediately complete the Task Force Report specific recommendation for an independent expert alternatives assessment regarding transport of crude oil in Line 5 through the Straits segment;

(2) Convene and immediately complete the Task Force Report specific recommendation for an independent risk analysis and credible release and worst-case scenarios;[9]

(3) Implement immediate adequate financial assurances and an approved emergency response plan by independent qualified experts that conform to the level of risk and credible release and worst-case scenarios;

(4) Require immediate submission of additional verifiable information from Enbridge and other qualified and independent sources to assure that information is full and complete for rendering evaluations, making final decisions, and taking actions regarding transport of oil in Line 5.

(5) Take immediate enforcement actions against Enbridge to address any material violations of the 1953 Easement.

(6) Exercise the full authority under our constitution and laws, including common law, that eliminate or prevent the high risk and magnitude of harm from a rupture, leak, or other failure of Line 5 under the Straits.

PART II: SUPPLEMENTAL FINDINGS AND COMMENTS ON THE TASK FORCE REPORT THAT ADDRESS THE HIGH-LEVEL RISK OF LINE 5 UNDER THE STRAITS AND GREAT LAKES, AND THE PUBLIC TRUST IN THESE TREASURED WATER RESOURCES OF THE STATE.

a. The proper context for evaluating petroleum pipelines is Michigan's constitutionally required paramount concern for the protection of health and safety and the air, water, natural resources, and public trust Great Lakes waters and the State's lakes and streams.

[8] Attached Appendix 3, Rick. Kane, Technical Advisory Team Immediate Implementation and Action Plan for Enbridge Line 5, pp. 3-4, Appendix. 3-B.
[9] Id.

While crude and refined oil are important to the overall economy in the United States, the fundamental background or "setting" for addressing pipelines in Michigan is the State's highly valued Straits, Great Lakes, lakes and streams, and environment.[10] The unacceptable harms to Michigan's economy from the impact of an oil spill in the Great Lakes on public drinking water supplies, business viability, fishing, shipping, boating, tourism, and recreation far outweigh the significantly smaller impact, if any, on the oil industry if oil is not transported in pipelines under or in these highly valued waters. There are alternative pipeline routes and capacities to transport crude oil to Sarnia or other points in Canada and the U.S. Line 5, for example, primarily transports crude oil to Canada, and is not essential for Michigan refineries, which are served by pipelines across southern Michigan and elsewhere.[11] Natural gas liquids for propane, which is also transported in Line 5, would continue to be transported through Line 5 to its transfer point in the Upper Peninsula or locations in the Lower Peninsula.[12]

b. New, additional findings and concerns from available public information establish that transport of crude oil in, under, or on the Great Lakes presents a serious high-level risk that should be eliminated.[13]

The lack of sufficient structural supports and wooden slat covers to protect Line 5 under the Straits exposes the pipeline to currents, abrasion, and other failures. Moreover, Enbridge has never been required to do, and has never done, a competent emergency response plan based on a full and worst-case scenario of a rupture or release of crude oil in the Straits. In the event of a catastrophic spill in the open waters of the Great Lakes, there is insufficient capacity in place at the local level, and winter conditions would challenge any adequate cleanup response. Further, inherent detection limits are not designed to detect a leak from one of the lines of up to 70,000 gallons of oil per day (140,000 gallons per day, if both lines leak). Standard corrosive data in the industry shows significant thinning of aging pipelines like Line 5, which coupled with the weight of mussels and increased volume capacity from 300,000 to 500,000 gallons per day create a substantial risk of failure.

c. Michigan's legal and regulatory framework has not been fully identified or utilized by state agencies or officials.[14]

Regulatory tools of the Michigan Public Service Commission ("MPSC"), the DEQ, and DNR include environmental impact statements and alternative analyses, along with water and public trust protections on routing, siting, or

[10] Part II, *supra*, p 19.
[11] Attached Appendix 1, Gary Street, pp. 3-4, Street Appendices 1-6.
[12] Id. Because of its volatile explosive nature, NGL pipeline releases pose primarily an endangerment to public health and safety. While serious in nature, NGL ruptures present a different harm analysis than the high level risk and magnitude of harm associated with release of oil from Line 5 in the Straits.
[13] See the additional risks described in Part I, supra, 1. a. through o.
[14] See Part II, 2,b.

additions and expansion of existing or future pipelines. These legal requirements have either been largely ignored or limited in scope to segments, rather than the entire pipeline and impacts and alternatives as a whole. As a result, opportunity for public review of existing lines and their locational risks, such as in the Great Lakes or near increasingly-populated areas, has been lost. For example, substantial changes and additions were made to Line 5 with little or no MPSC oversight and no environmental impact or alternatives analysis; if the Michigan Environmental Protection Act ("MEPA") had been fully utilized, the MPSC could have reevaluated Line 5 on various occasions. Likewise, since the catastrophic Kalamazoo River spill from Enbridge's Line 6B, the MPSC had several opportunities to address impacts or alternatives from the significant changes or additions to the pipeline, as well as related issues like future capacity and crude oil transport purposes in Michigan to Canada or elsewhere. However, the MPSC waived or did not assert the authority to do so.

d. Michigan Inland Lakes and Streams ("ILSA"), Part 301, NREPA, and Great Lakes Submerged Lands Act ("GLSLA"), Part 325, were not identified as part of the legal and regulatory framework.

The GLSLA and ILSA protect the water resources and public trust in Michigan and Great Lakes waters.[15] These laws specifically require environmental assessments and alternative studies before authorization or permits are approved for crossing or using Michigan water bodies. These laws were not identified by the Task Force as part of the framework to address pipeline siting, routing, impacts, and alternatives in Michigan. These laws and their regulations offer significant opportunities for review of existing oil pipelines that cross or run under our public waters.

e. The Michigan Environmental Protection Act ("MEPA"), Part 17, NREPA, offers an important overarching framework and body of environmental common law that supplements agency laws and regulations.

The MEPA or Part 17 imposes a duty and grants authority to state agencies to consider and determine likely environmental effects and alternatives, either in review of existing or new pipelines. Part 17 also provides a basis for taking affirmative action to prohibit likely unacceptable harms or imminent risks to our air, water, natural resources, or recognized public trust in water or natural resources. Part 17 should be added as a regulatory principle and tool to the Task Force Report.

[15] Id.

FLOW REPORT

PART I

SPECIFIC COMMENTS AND IMMEDIATE ACTIONS TO ADDRESS SERIOUSLY HIGH AND UNACCEPTABLE RISKS AND IMMINENT HARMS OR SUBSTANTIAL ENDANGERMENT TO THE STRAITS FROM THE TRANSPORT OF CRUDE OIL IN LINE 5

In addition to specific covenants and conditions, Enbridge has a legal and covenantal duty under the 1953 Easement "at all times…to exercise the due care of a *reasonably prudent person* for the safety and welfare of all persons and of all public and private property." The unreasonable risk and high or catastrophic level of imminent harm violate this "reasonably prudent person" standard under the terms of the Easement. The high risk and imminent harm from shipping oil through Line 5 under the Straits also violate the continuing and supervisory duty imposed by the public trust doctrine and environmental laws that apply to the Great Lakes. The public trust in these waters and environmental standards require the State of Michigan and Enbridge to take immediate action to prevent and minimize harm to the air, water, natural resources, and public trust in those resources.[16] The State has both the legal authority and affirmative duty to protect these waters and uses. In short, the transport of oil through Line 5 presents an imminent risk or endangerment of an unacceptable level of harm and destruction that is irreparable – that is, the harm if a release occurs will be pervasive, in large degree irreparable or irreversible, and persistent.

1. **Additional Concerns and Risks Compound the Immanency and High, Unreasonable, and Unacceptable Risk of Harm of Transporting Oil through Line 5.**

The transport of oil in Line 5 under the Straits of Mackinac and in the Great Lakes presents an imminent unacceptable risk of harm and endangerment, and is categorized as a "Tier 1" risk[17] to public and private property, water, water resources, the public trust, and the public health and safety, and welfare of persons, businesses, and communities.

a. **The spill, release, accident, and harm history of Enbridge oil pipelines has increased from 40 per year in 2001 to 115 per year in 2015**.

[16] Ray v. Mason County Drain Comm'r., 393 Mich 294, 224 NW2d 883 (1975). The protected public uses, such as navigation, drinking water, fishing, boating, swimming, water-dependent recreation and businesses, are by law paramount and cannot be subordinated. Obrecht v. National Gypsum Co., 361 Mich 399, 412, 415-416, 105 NW2d 143, 149-151 (1960); Illinois Central R. R. v. Illinois, 146 US 387, 436, 437, 453-459 (1892).

[17] Line 5 is categorized as a high level "Tier 1" risk and constitutes a substantial and imminent harm or endangerment. Appendix 3, R. Kane, supra, pp. 2-3. As noted above, the definition of "imminent" risk of harm for transporting hazardous materials, like crude oil, is defined as "the existence of a condition relating to t hazardous material that presents a substantial likelihood that death, serious illness, seer personal injury, or a substantial endangerment to health, property, or the environment…" 49 USC § 5102 (Title 49, Transportation, Subtitle III, Chpt. 51).

The increased number of reported accidents and releases elevates the Enbridge Line 5 pipeline, including the Straits segment, toward the top of the "environmental disaster" pyramid.[18]

b. **The "worst-case" scenario of Enbridge is understated, unrealistic, and inconsistent.**

Enbridge has made inconsistent statements over its representation of a "worst-case" scenario. In one statement Enbridge reported that a release from two lines would release 8,583 barrels; in another statement Enbridge reported the "worst-case" for a single pipeline release would be 4,950, and from two lines 9,900 barrels. In any event, Enbridge's representation of its "worst-case" is not credible; a worst-case scenario involves full loss of hazardous substance or liquid, failed detection and/or shut-in technology, or in lack of emergency response capacity.[19] Full disclosure and analysis of a catastrophic/low probability event is required for considering impacts, alternatives, and critical to establishing valid emergency response plans.[20] Enbridge has either not completed this or has not disclosed its internal worst-case scenario. Moreover, its emergency response plan is flawed because it did not apply a valid or credible worst-case analysis and disclosure.[21]

c. **Line 5 under the Straits was not designed or intended for additional weight from mussels.**

Mussels, pipeline changes, increases in volume, and other factors were not accounted for in its original design standards. This new factor has compromised the safety and stability of the pipeline.[22] These pipelines were not designed for the added weight or acidity of invasive species currently present on the pipelines or prevalent in the Great Lakes. If coupled with increased volume of oil by as much as 80%, safety factors are compromised.[23]

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[18] Appendix 1, Appendices 1-1 and 1- 2, pp. 6-7.
[19] Id., p. 3. Actually, Enbridge's "worst-case" scenarios are not credible and not based on standard "worst-case" principles. Moreover, this is not a credible worst case, but rather closer to a "best case" scenario. A worst-case scenario would involve long slower release with a failure of detection and total loss of product with a long response time. Another would involve a major rupture with failed "shut-in" valve and long response time or lack of response capacity. For a definition and application of "worst case," see CEQ guidelines, 40 C.F.R. §1502.022, and Sierra Club v. Sigler, 695 F.2d.957, 969-975 (5th Cir. 1983); CWA "Worst-case discharge." 33 U.S.C. § 1321(a)(24)) for offshore facilities including pipelines.
[20] Sierra Club v. Sigler at 972.
[21] See "30-Day Notice of Intent to Sue," Letter from Attorney Neil Kagan, National Wildlife Federation, to Secretary, U.S. Department of Transportation, July 28, 2015, pp. 9-11. It should be noted that Enbridge intends to test its emergency response readiness via its Emergency Response Team (E3RT) on September 24, 2015. This is an exercise in response to a Best-Case Scenario, not a worst case response plan exercise as demanded by industry standards.
[22] Appendix 1, Appendices 1-1 and 1-2, p.3.
[23] Id.

d. **Enbridge mass balance inaccuracy could lead to an undetected release of as much as 140,700 gallons of oil per day.**

Enbridge uses mass balance measuring to make sure the amount of crude arriving at Mackinaw City is the same amount that went into the pipeline at St. Ignace. However they state that due to the inherent inaccuracy of the measurement, 3,350 barrels per day (140,700 gallons per day) could be "unaccounted for." Thus, the "unaccounted for" quantity may have leaked into the Straits and not detected by the mass balance.

e. **Federal and State agencies cannot adequately respond to a spill, especially in the winter.**

US Coast Guard commandant Admiral Paul Zukunft is "not comfortable" with contingency plans for a worst-case scenario in the Great Lakes,[24] and DEQ oil spill chief Robert Wagner has stated that "if the Straits are frozen over, cleanup would be far more challenging."[25] Dr. Amy McFadden, NOAA, pointed out that responders can recover oil for a few days, but parts that sink into the water column are "practically impossible" to recover.[26] In addition, Steven Keck of the U.S. Coast Guard said that they "wouldn't put people on the water at night or in waves over three feet" in either a training or an actual spill scenario regardless of the season.[27]

f. **The number of supports/anchors for Line 5 required by the Easement has been violated, the current number is insufficient, and authorization has not involved complete review or the proper amendment of the Easement.**

Enbridge has admitted that it has not installed calculated support for the original 300,000 barrels per day ("bbls/day") construction design, and did little to comply with the Easement. Enbridge unilaterally increased oil flow to 540,000 bbls/day. The1953 Easement requires support every 75 feet for 300,000 bbls/day, but Enbridge has installed only 140 supports today, with most installed between 2014 and 2015.[28] To comply with the Easement, many additional supports are needed. There has been no reported calculation for the effects of the possible 27% added weight from mussel biomass and/or the increased flow of 200,000 bbls/day. These changes have not been fully approved through proper amendment to the Easement or by state agencies; rather these changes appear to have been determined unilaterally by Enbridge. Moreover, the State DEQ has not yet fully evaluated the risks to the public

[24] Id., p. 4, Appendix 1-9.
[25] Id., p. 4, Appendix 1-8.
[26] Dr. Amy McFadden, NOAA, http://response.resoration.noaa.gov/about/media/five-key-questiions-noa-scientists-ask-during-oil-spils.html
[27] Tip of the Mitt Pipeline Workshop, Petoskey, Michigan, August 27, 2015.
[28] Id., p. 4; emails on file in FLOW offices (available on request).

trust, water, uses, or the alternatives to Line 5 regarding these significant changes, violations of the Easement, and increases in volume of oil.

g. **Based on available data from Enbridge and other public sources, the pump station discharge pressure limits set by MPSC orders for the existing 12 pump stations exceed values compliant with ASME standards.**

These MPSC orders document the evolution of Line 5 from an initial design capacity of 120,000 bbls/d with no pump stations in Michigan, to a capacity of 300,000 bbls/d with four pump stations in Michigan, to a capacity of 565,000 bbls/d[29] with 19 pump stations in Michigan, and currently to a capacity of 540,000 bbls/d with 12 pump stations in Michigan. As these changes were implemented over a 60-year period, the MPSC set discharge pressure limits based on the varying wall thickness of the pipe downstream of each pump station. By agreement with Enbridge, these pressure limits were set at 65% of system yield pressure as calculated according to the American Society of Mechanical Engineers ("ASME") B31.4, using the as-new wall thickness of each pipe section as an input.[30] ASME B31.4 allows operation at 72% of system yield pressure so it can be said that Enbridge has chosen a lower value (by seven %) as a safety allowance for corrosion and other unforeseen factors. Based on available data for the rates of wall thinning by both internal and external corrosion and erosion, it is probable that the seven % safety allowance accepted by the MPSC in the past without considering age-related wall thinning is no longer adequate to assure compliance with ASME B31.4 or to assure safety.[31] Additionally, the encroachment of development on the Line 5 right-of-way over the past 60 years raises questions about whether more stringent safety factors then previously used by Enbridge and the MPSC in determining safe operating pressures for the 12 segments of Line 5 should be applied.[32]

h. **There have been significant changes in the number and locations of pump stations, volumes of oil and pressure, and/or crude oil product that create substantial risks of non-compliance with pressure limits or other standards.**

A review of available public records of the Michigan Public Service Commission ("MPSC") show a range of four to 19 pump stations for handling oil and other products in Line 5. Currently 12 pump stations serve Line 5; in addition, a number of anti-friction agents and stations have been changed in an effort to reduce pressure or erosion.[33] On the other hand, it appears some of these changes were made without public review or consideration of

[29] Appendix 2A, p. 1-2.
[30] Id., p. 2.
[31] Id., p. 4.
[32] Id., pp. 4-6.
[33] See Timm, E., Appendix 2A, pp. 1-2, Appendix. 2C, pp. 2-3; see paragraph I.(1)(i), infra.

intended purpose, risks, effects, or alternatives on the part of the MPSC. In one instance, the MPSC limited its review by not requiring an environmental impact assessment or statement on the cumulative impacts or alternatives from a change in the number and location of pump stations and other measures.[34]

i. **Enbridge may well be operating beyond the original design calculations which increase the risk of failure.**

The original design for Line 5 was for 120,000 bbls/day but increased to 300,000 bbl./day when four pump stations were added later in 1953. Between 1953 and 1993, up to 19 pump stations existed or were noted. In 1987, MPSC issued order for up to 19 pump stations and discharge pressures.[35] Between 1953 and 1987, there does not appear to be a public record of the purpose, risks, or other considerations regarding these changes. In 2012, Enbridge disclosed to MPSC that it has 12 existing pump stations. During an undisclosed period, Enbridge added or moved injection equipment on its own, in order to inject friction-reduction agents. In June 2012, Enbridge notified MPSC of changes in injection facilities, and in 2014 notified MPSC that these changes had been completed.[36] No information is available on the impact to Line 5 pressure profiles or compliance with ASME piping codes, which creates uncertainty and further risk concerning Line 5. Use of drag or friction agents has been introduced without public record, except in 2012-2014, and without engineering calculations or compliance considerations. As a result, the operating condition of Line 5 cannot be determined, and it appears the MPSC allows Enbridge to operate significantly beyond the original design and calculations for siting Line 5 in Michigan; this, in turn, presents a greater risk of rupture or failure of Line 5, including the Straits segment, than considered when originally designed and constructed in 1952-1953.[37]

j. **In addition to violation of its Easement conditions regarding support/anchors, Enbridge is in violation of the additional requirement for installation of wooden slats to protect the coating and increase support for Line 5 under the Straits**.

Paragraphs (8), (9), and (10) of the 1953 Easement require cathodic protection of the pipeline from deterioration, specific pipeline coating materials, and interval supports for the pipeline resting on the gravel bed. Specifically, "(9) all pipe shall be protected by … one inch by four inch (1"x4") slats prior to installation."[38] Slats covering and protection were necessary because large sections of Line 5 rest on gravel beds on the floor of the Straits. The layer of

[34] Id., p. 4.
[35] Appendix. 2A, pp. 1-2; Appendix 2C, pp. 1-2.
[36] Appendix 2C, pp. 2-3.
[37] The potential greater risk of exceeding ASME operating pressure increases the probability pipeline failure or rupture; Appendix 2C, p. 4.
[38] Appendix 2B, p. 1.

slats surrounding the entire submerged pipeline was needed to protect the bottom of the pipeline and to prevent abrasion of the coating material. Otherwise motions from temperature gradients, currents, and internal pressure changes would cause coating failure from mechanical abrasion.[39] Moreover, while Enbridge has been adding support structures, it has not used grout bags very often to stabilize the pipeline, and the number of structures remains in violation of the 75-foot spacing numbers required by the Easement.[40] Based on the record submitted by Enbridge to the Task Force, over 50 percent of unburied sections of the Straits pipelines rest directly on what remains of the bed prepared in 1953, and these sections lack the required corrosion and abrasion protection from the slats required by the Easement.[41] As a result, there is a greater risk of pipeline failure from dents, abrasion, coating loss, or corrosion under the Straits.

k. **Enbridge inspection technology and response methodology is inadequate.**

All aging pipelines are structurally degraded as a result of fluid-friction, erosion, corrosion, cracking, or mechanical damage and operation. Industry addresses this degradation through a combination of inspection technologies and modeling. Since most pipelines are buried and/or coated with protective or other substances, external inspection is often impractical. The data is often plotted on "unity charts" to determine if there are undesirable readings or measurements.[42] Under-measured points show a risk of degraded conditions that could result in pipeline rupture. Critical flaws or problems must be identified and lines promptly repaired, replaced, or shut down to avoid undetected failures or ruptures.[43] It appears that Enbridge set measurement or threshold levels to trigger repairs or other prompt action on its Line 6B too high;[44] the practice in connection with Line 5 has not been documented.

l. **While Enbridge stated there has never been any damage to Line, in fact Enbridge has reported dents in Line 5.**

Enbridge reported two dents noted by its contractor who inspected the pipelines under the Straits.[45]

m. **Evacuation of oil from the line will be difficult and take a very long time.**

Enbridge states it can easily evacuate the oil in the pipeline if necessary. In fact, this is very difficult, if even possible, would take a long time, and would

39 Id., p. 1.
40 Appendix 2B, Table 2, p. 4 (document Appendix_B4_493991_7.pdf, MPP Task Force Record).
41 Id., p. 3-4.
42 Appendix 2D, Fig. C.1, pp. 1-3.
43 Id., p. 3.
44 Id., p. 3.
45 See Appendix 2B, 1, pp. 1 and 4.

be incomplete. Moreover, even if hydrostatic pressure prevented immediate release, a release could likely occur from other factors.[46]

n. **Myopic review and behavioral bias in reviewing data and assuring pipeline safety are endemic to the industry.**

It has been reported from the BP Gulf oil spill and other catastrophes that risk and consequences are underestimated. Ambiguity in interpretation of rules and standard methodology tend to cause personnel to discount risks. As a result, protective measures are inadequate, and that interdependent risks, such as the location of the nuclear power plant in Fukishima, Japan, are ignored.[47]

o. "**Failsafe" detection system failed in an oil pipeline in Canada last month**.

In addition to the examples listed in the report, pipeline failures, leaks, and ruptures continue to mount,[48] last month, a "failsafe" pipeline detection system failed in Canada, resulting in harm to a river larger than the Kalamazoo River rupture in 2010.[49]

2. Proper Legal and Scientific Standard for Imminent Risk or Endangerment of Serious Harm

In determining the imminent threat and endangerment of Line 5, it must be kept in mind that the higher degree of magnitude of harm based on credible release scenarios, especially where the harm is very high and risks extremely challenging such as in the Straits, the lower the degree of probability required for imminent harm or endangerment. An "imminent hazard" for transporting hazardous substances or materials, like crude oil, is defined as "the existence of a condition relating to hazardous material that presents a substantial likelihood that death, serious illness, severe personal injury, or a substantial endangerment to health, property, or the environment may occur before the reasonably foreseeable completion date of a formal proceeding begun to risk of that death, illness, injury, or endangerment."[50]

It is again important to note that the central focus of the definition of "imminent" is on the seriousness or magnitude of the harm, injury, or endangerment, not the probability of the occurrence. In the leading court decision on "imminent" risk or "endangerment" in environmental law, the D.C. Circuit ruled that the government, when faced with uncertainty of devastating or serious harm does not have to wait for a catastrophe or harm

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[46] Id., at p. 5.
[47] H. Kunreuther, and E. Michel-Kerjan, Overcoming Myopia (Milken Institute Review, 4th Quarter, 2010), pp. 52-53.
[48] Jordan, Lubetkin, Contact Person, National Wildlife Federation, "NWF to Sue Department of Transportation over Oil Pipeline Oversight Failures," July 28, 2015, pp. 3-4.
[49] Schlanger, Newsweek, July 20, 2015. "Offshore" facilities like Line 5 pose substantial and unique harms that are not easily detected or cleaned up, and which are either difficult to oversee or lack oversight and response plans. See "30-Day Notice of Intent to Sue," *supra*, note 19.
[50] 49 USC § 5102 (Title 49, Transportation, Subtitle III, Chpt. 51).

to occur, but can act to prevent it.[51] In support of its ruling, the court reasoned that, "The public health [in this case, public trust and waters of the Straits of Mackinac] can be endangered both by a lesser risk of greater harm or higher risk of lesser harm. Danger depends upon the relation between risk and harm presented in each case, and cannot be legitimately pegged to "probable" harm."[52] The court further observed that law and common sense "demand regulatory action to prevent harm, even if the regulator is less than certain that harm is otherwise inevitable."[53]

Given the high or catastrophic degree of harm from a release of oil, a hazardous substance, the transport of any crude oil, whether light crude, synthetic, or heavy crude, through Line 5 under the Straits is a "Tier 1" or unacceptable risk and should be eliminated.[54] The Task Force concluded that the transport of heavy crude oil is an unreasonable risk and should be prohibited.[55] Light or synthetic crude oil transported in Line 5 would also have devastating and catastrophic consequences to the Straits. Response capability at best will clean up only a portion of oil but not fully remediate the irreparable harm. As a public trustee of our waters, the State has the authority and duty to enforce the Easement and to ensure Enbridge complies with its duty to exercise the due care of a reasonably prudent person. Accordingly, Enbridge cannot reasonably ignore or refuse to respond to the State's necessary demands to prevent unacceptable risk and harm to public health and safety and public and private property in the Straits and Great Lakes.

3. Interim Stringent Measures to Reduce Imminent or High Risk of Unacceptable Harm to Lower Category of Risk Pending Implementation and Completion of Actions

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[51] Ethyl v. EPA, 541 Fed 2d 1 (D.C. 1976); See also Reserve Mining v. EPA, 514 Fed 2d 492, 519-520 (8th Cir. 1975). For example, see the circuit court decision and order in Filer Charter Twp. v. Aztec Production Co., Manistee County, Michigan Circ. Ct. Case No. 97-8384-CE, Decision on Motion for Summary Disposition, April 28, 1997 (The Court issued injunction that shut down oil well because concentrations of hydrogen sulfide were so high that the threat to public health and safety outweighed other factors and constituted a nuisance. The Court noted that, "[a] nuisance may exist as a dangerous, offensive, or hazardous condition even with the best of care [where the threat of harm is very serious, the threshold of proof is diminished." (Id., pp. 62-63). Similarly, it is proper to issue a preliminary injunction to protect the status quo of an unpolluted environment, or in this case waters and public trust of the Straits of Mackinac; Ray v. Mason County Comm'r,, 393 Mich 294, 224 NW2d 883 (1975) (establishing that "likely pollution, impairment, or destruction of air, water, or natural resources or public trust" are a function of magnitude of harm and risk or probability; unacceptable harm to Michigan's elk herd and Pigeon River wild area from accidental release and/or oil development.); Attorney General v. Thomas Solvent, (status quo is an ante unpolluted environment).

[52] Id., Ethyl Corp, at 18-20.

[53] Id.

[54] Rick J. Kane, Appendix 3.

[55] Task Force Report, p. 45. While the agreement between the State of Michigan and Enbridge does prohibit the transport of heavy tar sands oil, this ban is not permanent and can be challenged by Enbridge either in court or by legislation. *See* Agreement between the State of Michigan and Enbridge Energy, Limited Partnership regarding the Transportation of Heavy Crude Oil Through the Straits of Mackinac Pipelines, Section 5, (Sept. 3, 2015). http://www.michigan.gov/documents/snyder/Final_Agreement_Line_5_Heavy_Crude_Transport_FINAL_complete_090315_499169_7.pdf

Because Line 5 is a “Tier 1” high-level risk and presents an imminent risk of unacceptable harm or endangerment of public trust, environment, and injury to public trust, and other public and private property, immediate interim measures are required to eliminate the “Tier 1” risk pending final actions, such as the appended alternatives assessment, worst-case and independent risk studies, and receipt and investigation concerning additional information.[56]

Industry standard and custom requires one of two options to address and mitigate high-level risks: Option 1, immediately remove oil from transport through Line 5 under the Straits; Option 2, implement interim measures (e.g., temporarily halting transport of crude oil through Line 5 in the Straits segment) while finding a permanent alternative solution.[57]

To reduce the high level of risk and magnitude of unacceptable harm, FLOW’s Technical Advisory Team recommends Option 2, which requires the following concurrent actions:

> (1) *Interim Measures:* immediately impose and implement interim stringent measures to reduce the high-level risk to a temporary lower risk pending completion of the alternatives assessment or study; and
> (2) *Immediate Actions*: convene, conduct, and complete an independent, competent alternatives assessment, together with an independent risk assessment and any other required study needed to make a final decision consistent with Michigan laws and constitution.

The following interim measures should be immediately requested and implemented within 30 days and completed within 90 days, or as soon as possible.

a. Halting the flow of oil under the Straits segment;

b. Implementing and completing obtaining verifiable information from Enbridge or other sources in accordance with Specific Task Force Recommendation No. 4;

c. Conducting additional and more frequent monitoring by Enbridge and federal and state agencies;

d. Approving a worst-case scenario emergency response plan and staging of adequate emergency response resources at the Straits capable of responding to an approved credible scenario for a major release, based on credible information;

e. Implementing subject expert panel to evaluate and determine credible worst-case scenario for the Straits segment;

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[56] Appendix 3, Rick Kane, Flow Technical Advisory Team Immediate Implementation and Action Plan for Enbridge Line 5, August 31, 2015, pp. 1-3.
[57] Id., p. 3.

f. Reviewing and implementing binding and adequate financial insurance based on independent risks assessment, including credible worst-case scenario; and

g. Providing that interim measures are established within an immediate time frame pending the final implementation and completion of the alternatives assessment called for by the Task Force Recommendation and described in this FLOW Report.

4. **Immediate Actions and Timetables**

   a. **Alternatives Assessment.** This requires convening qualified independent subject matter experts, with participation and input from stakeholder groups, to obtain information, investigate, evaluate, and recommend the best alternative to eliminate the risk of a crude oil spill, leak, or release in the Straits Line 5 segment. A timetable should be established, so it is started and completed as soon as practicable. Convene within 60 days, draft report and recommendation of best alternative without high unacceptable risks or harms. Complete final report and recommended action in 180 days.

   b. **Immediate Implementation and Completion of Independent Credible or Worst-Case Scenario Study**. Convene immediately a qualified independent team or panel of subject matter experts, parallel to and/or same as panel that conducts alternatives assessment, to conduct and complete an independent risk analysis, credible worst case scenario, and establishment of adequate financial assurances, or advise and/or and recommend other interim measures. Convene with 60 days and complete within 120 days.

   c. **Immediate Implementation and Completion of General Recommendations Related to Line 5 Alternatives Assessment.** Effectively completing the alternatives assessment will require the partial implementation of some of the Task Force Report's general recommendations that are necessary to evaluate alternatives to oil in Line 5 in the Straits of Mackinac.[58] This includes mapping of pipelines, emergency response plans and coordinated training for Straits, consultation with PHMSA on oil in the Line 5 segment, and implementation of the independent expert study to establish the worst-case scenario, independent risk assessment, and financial insurance obligations. Complete within 120 days.

[58] Id., p. 4, and Appendix 3-B.

d. **Immediate Enforcement of Easement and Other Actions.** The Attorney General and/or the DEQ and/or the DNR should take the following actions to address violations or enforce the terms and conditions of the 1953 Easement:

(1) Insurance Requirement (Section J): Section J of the Easement provides: "all damage or losses caused to property (including property belonging to or held in trust by the State of Michigan)…" According to the Task Force Report on page 46, "[t]o date, Enbridge has not documented that it is in compliance with this requirement."

(2) Support Requirement (Section A (10)): Section A (10) of the Easement states: "The maximum span or length of pipe unsupported shall not exceed seventy-five (75) feet." The Task Force Report found that Enbridge had failed to install the required structural supports for Line 5, and that there is a risk of failure as a result of the lack of analysis and unknown integrity of the lines.[59] Because unanticipated currents have caused the gravel bed that originally provided continuous support for the unburied portions of the Line 5 Straits sections to wash out leaving the pipe unsupported, continuous efforts by Enbridge have been required since at least 1975 to add supports to Line 5 and maintain compliance with the requirements of the Easement. Documentation supplied to the MPSC by Enbridge[60] does not support the assertion that the unburied portions of the Straits sections of Line 5 have been and are in compliance with the Easement. Specifically, Enbridge has installed discrete supports on 1.03 out of 2.1 miles on the east section and 1.02 out of 2.3 miles on the west section, leaving over 50% of the total unburied sections of Line 5 with uncertain support, thus requiring action.

(3) Pipeline Coating Requirement (Section A (9)): Section A (9) of the Easement states: "All pipe shall be protected by asphalt primer coat, by inner wrap and outer wrap composed of glass fiber fabric material, and one inch by four inch (1" x 4") slats, prior to installation." Recent underwater photographic surveys have shown that the circumferential bands used the whole mandated wooden slats around the circumference of the pipeline have rusted away with the result that the wooden slats are missing. These slats, or "circumferential lagging" as they are called in the industry, provide protection against abrasion where the pipe rests on the gravel support bed. Without this protection, it is doubtful that the water barrier coating that protects the steel pipe from external corrosion still fulfills its function, resulting in the risk of excessive corrosion on the bottom of the pipe, with subsequent rupture hazard. The failure to maintain this wooden

[59] Task Force Report, p. 44; Appendix 2A, Operating Pressure Limits.
[60] Enbridge Appendix_B.4_493991_7 (2).pdf

protective layer is a clear violation of the conditions of the Easement, and requires action.

(4) Curvature Requirement (Section A (4)): Section A (4) of the Easement states: "The minimum curvature of any section of pipe shall be no less than two thousand and fifty (2,050) feet radius." Line 5 is subject to potentially dangerous stress due to unanticipated conditions and circumstances at the time the Easement was granted. The introduction of zebra and quagga mussels into the Great Lakes with the construction of the St. Lawrence Seaway in 1959 has resulted in an accumulation of mussels growing on the unburied portions of the Straits sections of Line 5. This accumulation adds weight to the pipe, resulting in new and increased support requirements beyond the original 75-foot Easement terms. The accumulation also creates an acidic environment under the mussel colony, resulting in corrosion conditions unanticipated by the Easement. Action is required to assess this new risk of harm caused by mussel encrustation, particularly because Enbridge's 2014 assessment of attached aquatic organizations[61] is incomplete.

(5) Reasonably Prudent Person and Public Trust Standards. The State should immediately enforce the obligations and liability of Enbridge under the Easement and public trust in the waters, bottomlands, fish and aquatic habitat, ecosystem, and public trust uses as follows:

(i) This "due care" obligation under the Easement extends to "public property," which includes public trust bottomlands, waters of Lake Michigan and Lake Huron, fish and ecosystem resources. The acts or omissions described in paragraphs (1) through (4) above constitute a failure to act as a reasonably prudent person to prevent unacceptable harm to public property, private property, and the health and safety of persons who are at risk;

(ii) Under the public trust doctrine and the Easement, the State, as trustee, has an affirmative "high, solemn and perpetual" duty to protect these waters, bottomlands, and public trust resources and public uses from unacceptable harm and endangerment. The findings of the Task Force Report, FLOW's two reports, National Wildlife Federation's Sunken Hazard Report and others all underscore the imminent and high-level risk of catastrophic harm Line 5 poses to the public trust and protected public trust waters. Failure on the part of Enbridge to implement interim measures or take immediate actions,

[61] GEI Consultants, Enbridge Line 5 – Straits of Mackinaw – Assessment of Attached Aquatic Organisms, Stu Kogge, PWS, Sr. Wetland/Aquatic Biologist, GEI Consultants of Michigan, P.C., and Grant De Jong, Aquatic Biologist, GEI Consultants, Inc., (November 12, 2014).

including those identified by the Task Force Report, constitutes a violation of its Easement obligation to exercise the care of a reasonably prudent person and the public trust. Failure of the State, as trustee, to take immediate action to enforce this obligation and/or the protection of the public trust constitutes a violation of its high, solemn, perpetual, and affirmative duty under the Easement and common law.

Accordingly, the Attorney General, DEQ, DNR, and other state agencies or officials, as trustees, should take immediate action, including directing interim measures, to enforce the Easement and public trust to protect the waters, bottomlands, ecosystem, public uses, private property and businesses, and communities and persons in the Straits and northern Lake Michigan and Lake Huron area.

NOTE: While the Governor's recent Executive Order 2015-12, Section II, 1 establishes the newly appointed Pipeline Safety Advisory Board, the Executive Order does not provide for any action plan or timeline to address Line 5 under the Straits and through the Great Lakes. Moreover, the role of the Advisory Board is advisory only, and it remains to be seen whether its role is limited to "pipeline safety" or includes the protection of the Great Lakes and public trust duties and paramount protections required for these and other navigable waters.[62] However, the Executive Order does not interfere with the existing authority of the DEQ, DNR, MPSC, or Attorney General to take whatever actions are necessary to eliminate or prevent the imminent unacceptable harms or endangerment of the Great Lakes from the transport of crude oil in Line 5 under the Straits. Clearly, the Attorney General and Directors of the DEQ and/or DNR can take whatever actions by their duty of office they should or are compelled to take. Accordingly, the enforcement and other actions described above remain urgent and critical. The actions listed in the above paragraphs (a.) through (d.) should be implemented promptly, including strict interim measures to immediately lower the existing high level of risk.

[62] Mich. Const. 1963, Art 4, § 52 (paramount public concern for air, water, and natural resources"); Great Lakes Submerged Lands Act, MCL 32501 et seq.; Obrecht v National Gypsum, *supra*.

PART II

SPECIFIC SUPPLEMENTAL COMMENTS TO MICHIGAN TASK FORCE REPORT

A MORE BALANCED BACKGROUND FOR "SETTING THE STAGE": THE TASK FORCE REPORT REQUIRES CONSIDERATION OF THE PARAMOUNT PUBLIC INTEREST IN THE WATERS OF THE GREAT LAKES AND THE STRAITS OF MACKINAC.

The background/setting identified by the Task Force Report focuses only on petroleum and the economy in Michigan and the United States. Oddly, the fundamental background or setting is not mentioned: the Great Lakes ecosystem and the outstanding quality of life, jobs, and economy that depend on these waters. Moreover, the report nearly ignores the Straits and Great Lakes' heritage, culture, and expansive public and private uses and the venerable public trust principles that protect these waters, their ecosystem, and the paramount public uses that depend on them.[63]

The Great Lakes make up one-fifth of the surface freshwater in the world and provide unparalleled opportunities for 10 million citizens and millions more tourists. Our lakes benefit the sustainability and prosperity of homes, jobs, the economy, and the way of life of 40 million people. These waters provide Michigan with 823,000 jobs that make up 25 percent of the payrolls in the state.[64]

The Straits of Mackinac have played a primary role in the State's history, civilization, economy and environment. Historically, the Straits were the center of the fur trade, fishing, and Odawa and Chippewa culture. Since the appearance of Europeans, Mackinac Island and the Straits have been and continue to be the center of fishing, culture, shipping, tourism, recreation, and a high quality of life and environment. Mackinac Island was the United States' second national park, and Michigan's first state park. St. Ignace, Mackinac City, Cheboygan, Beaver Island, Drummond Island, and other islands remain at the center of shipping, boating, fishing, tourism, and hospitality in the region.

While oil and fossil fuels remain important to the current U.S. economy, the significance of Line 5 to Michigan and the U.S. oil and gas industry or economy is small compared to the unacceptable risks of devastating and serious harm to the Straits, Michigan's ecosystem and economy, and protected public trust resources and uses. Further, the value of oil and gas to Michigan's economy is small compared to the value of the Great Lakes to our jobs, economy, and way of life. In fact, most if not all of the crude oil shipped

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[63] The U.S. Supreme Court and those of all eight Great Lakes states have recognized that the bottomlands and waters of the Great Lakes are held by the states and managed in public trust for the benefit of citizens for sustenance, fishing, fowling, boating, swimming, drinking water, navigation; public trust interests of the State and citizens are legally paramount to any private purposes or uses. Frey, Bertram and Mutz, The Public Trust in the Surface Waters and Submerged Lands of the Great Lakes, 4 U. Mich J. Reform 907-993 (2007); Olson, James, All Aboard: Navigating the Course for Universal Adoption of the Public Trust Doctrine, 15 Vt. ENV'T'L. L. J. 135 (2014).

[64] Michigan Great Lakes Plan: Our Path to Protect, Restore, and Sustain Michigan's Natural Treasures, MDEQ, Jan. 2009.

through Line 5 starts in Canada and ends in Canada.[65] There is no appreciable benefit to Michigan refineries by the transport of crude oil through Lake Michigan. Further, the removal of the transport of oil through Line 5 would not affect the transport of natural gas liquid products to the Upper Peninsula or elsewhere.[66] Enbridge and other oil pipeline companies have a vast network and capacity to move oil, including the recently doubled Line 6B across the Lower Peninsula that transports crude oil to Sarnia, Canada, with spurs to refineries in Detroit and Toledo.[67]

1. **A supplementation of the Task Force Report to assist the State in implementing proper measures and actions to address the high risks and unacceptable harm from the transport of oil through Line 5.**

    a. **Existing pipeline maps and other information demonstrates that transporting oil under the Straits in Line 5 is not essential to refineries in Michigan or the US economy**.

The MPSC Pipelines Map at page 28 of the Task Force Report identifies the pipelines and the products transported in and through Michigan. Line 6B and Line 5 can transport multiple products at different times. Line 6B transports crude oil to refineries in Detroit and Toledo, as well as Sarnia. Line 5 transports light crude oil and natural gas liquids. No information is presented on Enbridge or other pipeline company's future pipeline routes, capacity, or other plans. The existing and future pipeline routing and capacity and related market for transport or export/import of crude oil is not shown or evaluated. The lines that are shown, principally Line 6B, transport oil to Sarnia with spurs to Detroit and Toledo; most, if not all, crude oil in Line 5 goes to Canada.[68]

Moreover, the continued transport of crude oil or petroleum throughout the U.S. or the Great Lakes region is not dependent on the Straits. In 1952, the State of Michigan allowed Enbridge to choose and then build Line 5 the next year to transport crude oil from Alberta, Canada, to Canadian refineries in Sarnia, Ontario over a route that traveled through Minnesota Wisconsin, Illinois, and up through Indiana and across southern Michigan. At the time, it was expressly built as a short cut for the convenience of Enbridge to transport Canadian oil back to Canada. Interestingly, in 1969, Enbridge located and constructed a route similar to the one it originally rejected in 1952. By contrast, this pipeline does not cross or touch any of the Great Lakes (except near the terminus at Sarnia), although it crosses many vulnerable streams and rivers. Since the disastrous Kalamazoo River spill in 2010, Enbridge has replaced and doubled the capacity of this

[65] Enbridge's own "Systems Map," 1Q-2015, shows no crude oil going through Line 5 to a Michigan refinery.
[66] See Appendix. 1, pp. 3-4, Appendix. 1-6; See also attached Appendix 5, North American Pipeline Expansion Plans, Pipeline and Gas Journal, June 2015, p. 46.
[67] Appendix. 5. These maps illustrate that Michigan and the Great Lakes are merely the conduit for Canada's crude oil, and that there are other pipelines, increased pipeline capacity, and new pipelines or events that demonstrate the likelihood of other feasible and prudent or suitable alternatives.
[68] Id.; Appendix 1, pp. 3-4, Sub-Appendix.

pipeline in Michigan, known as Line 6B. This and pipelines other than Line 5 transport or have the capacity to transport heavy crude oil to Sarnia, Detroit, and Toledo.

Crude oil ranges from 50% to 80% of the petroleum products transported through Line 5 every year; a significant portion of the capacity is used to transport natural gas liquids ("NGLs").[69] It is important to point out that NGLs or propane transport through Line 5 would not be affected, if Line 5 no longer transported light crude oil. While NGLs always present a public health and safety threat because of their volatile nature, the extent and magnitude of harm to the water, ecosystem, and communities would be much less to the Great Lakes themselves. Further, while the Task Force Report identifies risks and examples associated with the transport by pipelines, railroads, tanker ships, and trucks, all modes of crude oil transport carry significant risks of spills, breaks, leaks, failures, and harm. However, only shipping and Line 5 under the Straits present a catastrophic risk with a high magnitude of harm to the Great Lakes and the Straits. Currently, there are no tanker shipments of crude oil over the Great Lakes. A Superior, Wisconsin refinery recently announced it would abandon plans to ship crude oil over the Great Lakes because it is not economical.[70]

b. The Michigan regulatory and legal framework is broader and potentially more effective than represented by the Task Force Report.

The legal and regulatory framework remains a very critical part of not only the report, but more importantly the implementation of the recommendations and other actions required to prevent the serious and unacceptable harm from a pipeline leak or rupture. Both the legal and regulatory framework and authority must be fully understood and exercised where necessary to prevent such unacceptable harm, including immediate, interim measures, short-term actions, and long-term actions. Based on a review of statutes and court decisions, the following legal frameworks, tools, and principles strengthen the authority and basis for addressing the imminent and high risks of oil through Line 5, as well as other pipelines.

(1) The Common Law Public Trust Doctrine

As described in earlier submissions from FLOW, the public trust provides a powerful legal basis to prevent or reduce the high magnitude of harm that Line 5

[69] Enbridge Infographic, "Line 5," Michigan ("The natural gas liquids (NGLs) transported through Line 5 – nearly half of the line's throughput, in fact – include propane…"), p. 3, http://www.enbridge.com/InYourCommunity/Enbrideg-in-Michigan
[70] Ellison, "Refinery Drops Plans to Ship Heavy Crude Oil Across Great Lakes," Michigan Live, August 7, 2015. http://www.michiganlive/news/grand-rapids/Index.

poses to the Straits and the Great Lakes.[71] Under the common law, public trust standards prohibit subordination or alienation by the state for primarily private purposes or control. The public trust also prohibits impairment of the public trust or public trust waters and related resources in navigable waters like the Straits. Further, the public trust imposes a "solemn and perpetual" legally enforceable duty on both government and private persons or entities to prevent impairment or improper alienation of the public trust.[72] This duty includes disclosure of all necessary information required to assure that these public trust principles have not been violated.[73]

When the State passed 1953 Public Act 10, authorizing the State to grant easements for utilities on state bottomlands, it expressly reserved its public trust and proprietary interest and control over the bottomlands and waters of the Great Lakes.[74] Indeed, under the *Illinois Central Railroad v. Illinois* and Michigan court cases,[75] the legislature cannot surrender or transfer this public trust interest and control to a private person or entity like Enbridge. Thus, the 1953 Easement to Enbridge's predecessor could not and did not subordinate or surrender authority to protect the public trust in the Straits from Line 5. Enbridge cannot receive, by a conveyance or agreement to use the waters and bottomlands of the Great Lakes beyond the authority of what the State can convey. If subsequent to the transfer of the 1953 Easement, the State determines that the risk or magnitude of harm to the public trust from the transport of oil is no longer acceptable, then the State is not foreclosed to prohibit or limit the use of Line 5 to protect the public trust or its protected uses.[76]

The Task Force noted in a response to a comment on protection of the public trust under Part 325, NREPA,[77] that "it does not believe it is necessary to take a position on the legal question of whether Enbridge can be required to apply for a Part 325 ["GLSLA"] conveyance or permit for continued operation of its lines."[78] However, the 1953 Easement and the 1953 Public Act 10, specifically reserved

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[71] Letter from James Clift, Elizabeth Kirkwood, et al. to Governor's Task Force, Attorney General Schuette, Director Wyant, and Director Creagh, dated July 1, 2014 (*hereinafter* Joint Line 5 Sign-On Letter (July 1, 2014)).
[72] Opinion of Attorney General of Michigan, Opinion No. 7162 (2004); Collins v. Gerhardt, 237 Mich 38, 211 NW 115, 118 (1926); Obrecht v. National Gypsum Co., *supra*. (1960); see narrative on public trust principles application to Line 5 under the Straits in the Joint Line 5 Sign-On Letter (July 1, 2014). http://flowforwater.org/wp-content/uploads/2014/10/2014-07-01-FINAL-Line-5-Governor-Ltr-Sign-On-1.pdf
[73] Obrecht, supra. The GLSLA and public trust duty requires findings or determinations based on a duly recorded record. See informational duty under the public trust doctrine, addressed in United Plainsmen Ass'n. v. North Dakota State Water Conservation Comm'n, 247 NW2d 457 (1976).
[74] MCL 322.651; 1953 P.A. 10.
[75] Illinois Central v Ill. Rail Rd., 146 U.S. 387 (1892); Obrecht, *supra*; Nedtweg v. Wallace, 237 Mich 14, 17-20 (1926).
[76] State v Venice of America Land Co., 160 Mich 680 (1910); Collins v Gerhardt, *supra* ("high, solemn and perpetual duty").
[77] MCL 32501 et seq. Great Lakes Submerged Lands Act ("GLSLA").
[78] Task Force Report, p. 58.

this public trust interest to the State, and Enbridge took the easement subject to the public trust.[79] Moreover, Enbridge "at all times shall exercise due care of a reasonably responsible person" for the safety of all persons and to prevent harm to such public and private property interests.[80] Enbridge also acknowledged that it has a continuing obligation to comply with all applicable state laws. The public trust doctrine is incorporated into Part 325 and necessarily operates as a limitation on the power of the State to grant a property interest or easement beyond the scope of public trust law. "The public trust doctrine takes precedence…Grants even if purporting to be in fee simple are given subject to the trust and to action by the state necessary to fulfill its trust responsibilities."[81]

Under the public trust doctrine and Part 325, the State has a continuing, non-delegable duty to prevent unacceptable harm to the public trust. As a matter of law, Enbridge's easement interest does not exceed the limits of the public trust in the waters and bottomlands of the Straits. Thus, the State has the authority to demand that Enbridge take action according to the Task Force Report recommendations or other action required to eliminate the risks and endangerment from the transport of oil through Line 5. If Enbridge fails to respond, cooperate, or comply with these necessary actions, the State can enforce these actions under its duty and powers to protect the public trust in the Straits and the Great Lakes. Accordingly, one of the primary legal tools for the State is to take immediate interim, short-term, and long-term actions to enforce its duties to protect or directly protect the public trust of the State and citizens from an unacceptable harm or high magnitude of subordination or impairment.

(2) The Michigan Constitution and the Michigan Environmental Protection Act

Article 4, Section 52, Michigan Constitution, 1963, confirms that the "air, water, and natural resources" of the State are of "paramount public concern," and that the legislature "shall" pass laws to protect the air, water, and natural resources from pollution, impairment, or destruction." The meaning of "paramount public concern" includes the State's public trust and sovereign property interest in the bottomlands and waters of the Great Lakes.[82] The legislature has a mandatory duty to take action to protect water and natural resources.[83]

[79] Easement, paragraph J.
[80] Easement, paragraph A.
[81] Kootenai Environmental Alliance v. Panhandle Yacht Club, 671 P. 2d. 1085, 1094 (Idaho 1993). See also Arizona Center for Law in the Public Interest v Hassel, 837 P.2d. 158 , 166-168 (App. 1991). The public trust imposes on any conveyance or permits a continuing supervisory, non-delegable duty to protect the public trust from improper subordination actual or high risk of unacceptable harm. National Audubon v Superior Court of Alpine County, 658 P.2d. 709 (1983).
[82] The Michigan Constitution's paramount public concern for water and natural resources embodies the public trust. People v. Babcock, 38 Mich App 336, 348 (1972).
[83] Highway Comm'n v. Vanderkloot, 392 Mich 159, 220 NW2d 416 (1974).

Michigan's legislature passed the Michigan Environmental Protection Act ("MEPA") in 1970.[84] The State's Supreme Court has described the MEPA as the State's response to the constitutional mandate under Art 4, Section 52.[85] The MEPA expressly prohibits any conduct that is "likely to pollute, impair, or destroy the air, water, or natural resources or the public trust in those resources."[86] The Supreme Court has also ruled that both state and local agencies or departments and private entities have a substantive legal duty to prevent degradation of the air, water, and natural resources or public trust in those resources.[87]

Further, state agencies, in the exercise of their regulatory authority and powers, can and must protect water, related water resources, and the public trust by considering and determining whether conduct is likely to pollute or impair water and the public trust. If it is determined that such conduct endangers the public trust or the pollution of water and water resources, it is unlawful unless it is demonstrated that there is "no feasible and prudent alternative" to such conduct.[88] Finally, the State, its attorney general, or any person or entity can file a civil action in the circuit court of Ingham County or the county where conduct is proposed or taking place to prohibit conduct that is "likely to pollute, impair, or destroy the air, water, natural resources, or public trust of those resources."[89]

Accordingly, the State (1) can consider taking direct legal action to prevent or reduce high-level risks of imminent harm; the State can request the company or ask a court to stop, terminate, modify, or alter conduct that is an imminent threat or endangerment, or that is likely to pollute or impair the waters and natural resources or public trust of the State and its citizens;[90] (2) must consider and determine likely effects and whether there are feasible and prudent alternatives to the conduct that is likely to cause such effects; and (3) can and should supplement its statutory framework to further the duties and protection imposed by the MEPA to protect the environment and public trust.[91]

Based on the above, the MEPA provides an essential framework and legal basis to address petroleum pipelines and their location, routing, operation, risks and alternatives in Michigan.

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[84] MCL 324.1701 et seq.

[85] Vanderkloot, *supra*, 220 NW2d at 429 (1974).

[86] MCL 324.1702, 1703, 1705.

[87] Ray v. Mason County, *supra*, 224 NW2d at 888.

[88] MCL 324.1705(2); Vanderkloot, *supra*; Genesco v. DEQ, 250 Mich App 45, 55-56, 645 NW2d 319 (2002).

[89] MCL 324.1702(1).

[90] E.g., Attorney General v. Consumers Power Co., 202 Mich App 74 (1993); Attorney General v. Balkema, 191 Mich App 201 (1991); Attorney General v. Thomas Solvent, 146 Mich App 55 (1985); Attorney General v. Huron County Rd Comm'n., 212 Mich App 510 (1995); People v. Broedell, 365 Mich 201 (1961); People v. Babcock, 38 Mich App 336 (1972).

[91] MCL 324.1705(2); Vanderkloot, *supra*; Ray, *supra*; Genesco, *supra*.

(3) The Great Lakes Submerged Lands Act ("Part 325" or "GLSLA")

The application of the 1955 GLSLA to public trust bottomlands and waters was considered in depth in its letter/report submitted to the Task Force, dated July 1, 2014. The letter demonstrated that because (a) the public trust ownership, control, and duty to protect to the public trust could never be alienated or relinquished, and (b) because this duty is continuing, that the GLSLA would also apply to Line 5 even though the 1953 Easement granted under 1953 Public Act 10 was granted two years earlier.[92] As noted in the above paragraph (1) on public trust law, Act 10 recognized that any pipeline easement was subject to the State's public trust interest, and that the 1953 Easement acknowledged and is subject to the State's continued control and authority over the public trust in the Great Lakes.

The Task Force omitted Part 325 or the GLSLA from its findings on the legal and regulatory framework to address oil pipelines.[93] The Task Force also failed to mention the fundamental legal principles or the GLSLA to address the recognized unacceptable harm and risks from the transport of oil in Line 5.[94]

Finally, as to the Straits and Line 5, there is no mention in discussions on the "Regulatory Framework" or the "Straits Pipeline Issues" sections of the report that addresses Enbridge's applications for permits to improve or expand its occupation of bottomlands and waters of the Straits to install 75 new structural supports to Line 5 between 2002 and July 21, 2015; the State DEQ granted these permits without full review, consideration, or determination that the proposed structures and occupancy and the related continued use and expanded volumes of oil transported in Line 5 under the Straits would improve the public trust interest in these waters, or would not result in significant impairment to the public trust bottomlands and waters as required by the GLSLA. A review of public records made available pursuant to the Freedom of Information Act disclosed that Enbridge requested and the DEQ treated its applications and renewed applications for these new structures as "minor" or "maintenance."[95] Although the DEQ and other state officials had full knowledge of these applications and that no final decision had been made, and that the State lacked information and the risks were

[92] The public trust embodied in the GLSLA is inherent in every existing or future use or occupancy of bottomlands and waters of the Great Lakes. Even Enbridge applied for permits for some of the structures it has placed to support Line 5 under the Straits. This is not surprising, since GLSLA based on public trust in Great Lakes provides continuing supervisory power under State's duty to protect the public trust. See Kootenai Environmental Alliance v. Panhandle Yacht Club, *supra*, 671 P. 2d. at 1094; Arizona Center for Law in the Public Interest v. Hassel, supra, 837 P.2d. at 166-168; National Audubon v. Superior Court of Alpine County, *supra*.

[93] Task Force Report, pp. 25-36.

[94] Id.., pp. 40-48.

[95] There are general and minor categorical permits for activities like residential docks or beach cleaning, or maintenance. MCL 325.32512a. The addition of scores of supports and anchors related to the increase in volume of Line 5 by 20 percent appears to be significantly beyond a minor or maintenance activity.

substantial, the DEQ and the State excused Enbridge from complying with the GLSLA and public trust and allowed Enbridge to avoid full review, public hearings, and the application of standards required for new structures and expanded use of Line 5 in the Great Lakes. Environmental impact, alternatives, necessity, and public trust review was limited to the mere footprints of the structures, and the broader purpose and standards were ignored.

Had the State applied the GLSLA more fully, the State could have properly exercised its continuing and supervisory public trust authority and forced Enbridge to disclose all relevant information on the current status of Line 5, future use and occupancy, worst case scenarios of a release, the magnitude of harm that would devastate public trust waters, fish, habitat, and uses, and the necessity of an alternatives assessment and studies that are inherent under a GLSLA review.

In addition, MEPA's duty to prevent degradation of likely environmental impacts and to consider and determine alternatives should have been applied.[96] In short, the State intentionally narrowed review even though it had knowledge of the concerns and issues surrounding Line 5 in the Straits, and thus neglected to exercise its available authority under the GLSLA and MEPA.[97] Had it applied the impact and alternatives consideration and determination to the broader purpose of these bottomland uses and activities as a whole, the State could have exercised its authority and complied with its duty to prevent degradation through an impact and alternatives assessment.

The structural supports were initially labeled an "emergency" by Enbridge in 2002, and yet the majority of the supports were not applied for or permitted until 12 years later in July 2014.

Since the Task Force Report was issued July 14, 2015, Attorney General Schuette has emphatically stated that if an application under Act 10 and the GLSLA for Line 5 were filed today, it would not be approved for an easement or other agreement to occupy and use the Straits of the Great Lakes for the transport of crude oil.[98]

Part 325 or the GLSLA are and should be seen as primary tools to address the high risk and unacceptable harm to the State and the public's paramount public trust interests in the Great Lakes. Future transport of oil in, under, or across the Great Lakes can simply be prohibited by following the precedent in the GLSLA that prohibits any oil and gas development in the Great Lakes.[99] The transport of

[96] Ray v Mason County, supra; MCL 324.1705(2); Vanderkloot, supra; Genesco, supra.
[97] Id.
[98] News article cite; Note also that Act 10 pipeline easements in the Great Lakes must also comply with the GLSLA. Superior Public Rights v DNR, 80 Mich App 72 (1977) (Defendant utility company obtained easement under Act 10 and occupancy agreement under the GLSLA).
[99] MCL324.32502, 324.32503, 324.32513. The location of a pipeline would require a form of conveyance or occupancy agreement under the GLSLA, and any construction activity in or on waters or bottomland would require permit under GLSLA. Moreover, the GLSLA expressly prohibits any lease or other

oil in Line 5 under the Straits can be eliminated or addressed by demanding Enbridge to take the required actions and interim measures through exercise of the State's continuing duty and supervisory authority under the public trust and the GLSLA.

(4) The Inland Lakes and Streams Act ("Part 321" or "ILSA")

Like the GLSLA, the ILSA requires approval and permits for any crossing or placement of pipelines in or under any inland lake or stream. An approval requires full disclosure and evaluation of purpose, risks, environmental impacts, and feasible and prudent alternatives. It requires a showing that there will be no violation of the public trust, riparian rights, or the aquatic habitat and environment of Michigan's lakes and streams.[100] Moreover, if a feasible and prudent alternative location exists, the pipeline must be located and constructed without crossing a lake or stream, or at a location with less adverse impact.[101]

There are many petroleum pipeline stream crossings in Michigan that remain under the radar. Because of its environmental and public trust authority and review, the ILSA should play an important role in pipeline siting, routing, construction, and prevention of unnecessary harm to the public trust waters, ecosystems, and public and riparian uses, such as community drinking water supplies, businesses, and tourism, as well as fishing, boating, swimming, and other recreation uses made of our lakes and streams.

ILSA and its rules have been supplemented to allow for expedited "general permits" for pipeline repairs, pipeline safety measures, and any new or replacement utility pipeline.[102] If a project qualifies, environmental standards are generally relaxed.[103] While there are exclusions from this general permitting scheme for Wild and Scenic Rivers and rare, sensitive, or unique natural features,[104] the high recreational, tourism, and public and private property values

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conveyance for any oil and gas development in the Great Lakes. MCL 324.32503(2). The Task Force recognizes that the high risk and magnitude of harm from an oil pipeline release, leak or rupture is unacceptable Michigan's Great Lakes; it would seem to follow that the legislature should consider amending Section 32503(2) of the GLSLA to prohibit future oil pipelines in or under the Great Lakes. Further, existing pipelines (there are only two – the Straits and St. Clair River) should be subject to continuing supervisory control and required to obtain reaffirmed approval, with full and comprehensive analyses that demonstrate no high magnitude of harm and that no feasible alternative pipeline route, capacity, or siting exists. Had this been required at the time the 1953 Easement was granted in Great Lakes for the Enbridge Line 5, it undoubtedly would have failed the public purpose test under *Illinois Central Railroad*; since it is undisputed that Line 5 could have been routed where Line 6B is today, across lower Michigan, and that it was allowed only because it was shorter and would save the company the extra expense.

[100] MCL 324.30106; R281.814 (Rule 4). MCL 324.1703, 324.1705(2) and Vanderkloot, Genesco, *supra*.
[101] Id.
[102] MCL 324.30108; R.281.832 (Pipelines and Conduits, generally); General Permit Categories in the State of Michigan, Feb. 18, 2014, Sections L and R.
[103] These are required by ILSA, R 281.814, and the MEPA, MCL 324.1705(2).
[104] Id. General Permit Categories in the State of Michigan, p. ii.

and uses of our inland lakes and streams are paramount public trust resources. As the Kalamazoo River disaster and other pipeline releases and spills have demonstrated, the high risks and magnitude of damage from occupancy and construction of oil pipelines under or across Michigan's navigable waterways constitute far more than a minor repair activity. In sum, petroleum or hazardous liquid pipelines should be expressly removed or excluded from the general permit category.

(5) The Michigan Public Service Commission Act 16 - Pipeline Siting and Control

As noted in the Task Force Report, the MPSC has broad authority to investigate, control, or regulate the location and piping of crude oil and petroleum products in Michigan.[105] This includes regulation of the intrastate portion of pipelines and intrastate pipelines.[106] Consent is required from local governments for intrastate portions of interstate pipelines, so long as it does not interfere with the location or routes; local consent is required to locate intrastate pipelines.[107] The MPSC is authorized to adopt rules to implement the purposes and intent of its authority and control.[108] However, to date it has not done so, except for compliance by pipeline companies for new pipeline applications or changes in existing pipelines.[109]

Further, pipeline companies are not allowed to locate, construct, or operate the pipelines unless they have filed *"full and explicit information"* as to their location and size, capacity, valves, and connections required or used in the operation of any line.[110] As a result, the MPSC may exercise authority to prohibit operation of a pipeline for petroleum or crude oil if a company fails to comply with the "full and explicit information" requirement.

The only standards in Act 16 are "necessity" and "public interest" or "public convenience." However, MPSC decisions have interpreted these standards to include required proof that a pipeline is "needed," "safe," "*routed in a reasonable manner*," and "*in the public interest*."[111] The MPSC has also required consideration of environmental impacts and alternatives. As noted above, the MEPA imposes a duty on public and private entities to prevent environmental

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[105] MCL 483.3, Task Force Report, p. 29.
[106] Dome Pipeline Corp v. MPSC, 176 Mich App 227, 439 NW2d 700 (1969).
[107] Mayor of Lansing v. MPSC, 257 Mich 666 NW2d 298 (2003); App 1, *aff'd* 470 Mich 154, 680 NW2d 840.
[108] MCL 483.3; Task Force Report, p. 29.
[109] R 792.10447.
[110] MCL 483.6.
[111] Re Wolverine Pipe Line Company, 2001 WL 306697 (MPSC, 2001), pp. 6-8. An argument that there are not standards in Act 16 would conflict with the intent of the statute and contradict the inherent basis for jurisdiction, and the fact that the MPSC can establish standards through its decisions. Lakehead Pipeline Co. v. Dehn, 340 Mich 25, 64 NW2d 903 (1954).

degradation,[112] and has a legal duty to consider and determine such likely effects and feasible and prudent alternatives.[113] Indeed, the Court of Appeals recently ruled that the MPSC violated these duties under the MEPA for failing to conduct an adequate consideration of likely effects and alternatives.[114]

In summary, through rule-making, case law, and/or the MEPA, state pipeline siting, routing, and changes in pipelines are subject to regulation under Act 16. The MPSC can strengthen its review and determinations under its broad authority as suggested by the Task Force Report. Moreover, it appears there is ample authority for the MPSC to assert a continuing duty of pipeline companies to submit full and complete information related to capacity, volume, size, product, and operations of a new or modification of an existing pipeline. This would also include adoption of a set of rules to assert continuing control, including provisions that trigger new authorization and approval if there is an increase in capacity, size, or other improvements made to a pipeline.

Conclusion and Requested Interim and Immediate Actions

Failure to take immediate action violates the 1953 Easement duty and covenant to fully exercise "due care of a reasonably prudent person" and the continuing duty and obligations imposed by the paramount interest in these waters and water resources under the public trust common law and GLSLA.

The transport of oil through the two 20-inch Line 5 pipelines under the Strait of Mackinac presents an imminent risk of irreparable harm to 20 percent of the planet's fresh surface water in the Great Lakes. Line 5's margin of safety is seriously limited or compromised because of increased risk of over pressure, weight stresses, endemic corrosion and erosion action, Easement violations, including unilateral change in required supports, aging high risk relationship, misrepresentation or inconsistency of statements by Enbridge, lack of or insufficient information and uncertainty, and human bias or error. Moreover, because of these circumstances, there are significant violations of Enbridge's "reasonably prudent person" duty and covenant in the 1953 Easement and an imminent threat to the continuing and paramount interest of the State, as trustee, and its citizens, as beneficiaries, in the public trust waters, bottomlands, and resources of Michigan. Further, because of the critical unreasonable risk of unacceptable harm or damage, the State, as owner, through its Attorney General, the DEQ, the DNR, as owner, and/or the powers of the Governor's Office should take immediate action.

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112 Ray v. Mason County, *supra*.

113 Vanderkloot v State Hwy Comm'n,, *supra*; Genesco v. DEQ, 250 Mich App 45, 55-56, 645 NW2d 319 (2002).

114 Buggs v. Michigan Public Service Comm'n, 2015 WL 15975 (Mich Ct. App, Jan. 13, 2015) (unpublished) (Court ruled that the MPSC filed to sufficiently consider environmental impacts and alternatives to a pipeline required by the Michigan Environmental Protection Act, MCL 324.1701 et seq); *see also* In the Matter of the Application of North Dakota Pipeline Company LLC for a Certificate of Need and Pipeline Routing Permit for the Sandpiper Pipeline Project in Minnesota, __Minn. __, Ct. App. Case No. A15-0016, decided Sept.14, 2015 (Public Service Commission required to conduct environmental impact statement before a final decision is made on certificate of need and routing for Sandpiper Pipeline).

1. Immediately impose and implement interim measures to reduce the high-level Tier 1 risk in the Straits of Mackinac from transport of oil in Line 5, including halting the transport of oil pending implementation and completion of other immediate actions described below.

2. Establish an independent, unbiased, and qualified study board to implement and complete a standard logistical risk and alternatives assessment (Task Force Specific Recommendation No. 3).

3. Establish an independent, unbiased, and qualified study board (could be the same as No. 2 above) to evaluate the risks, concerns, harm and damage to public health and safety, communities, public and private property, water and ecological resources ecosystems (Task Force Recommendation No. 2). This board will also develop credible release scenarios, including a true "worst-case" scenario based on standard procedures and legal principles, and estimate the amount of financial security or insurance and adequacy of coverage for Line 5 pending final decisions and action.

4. Issue an Executive Order to immediately implement under rule of law the Task Force Report's recommendations, including those required specifically for Line 5, and other actions and measures.

5. The Attorney General, independently or in conjunction with the Directors of the DEQ and the DNR, should enforce the 1953 Easement and assist in obtaining all information required from Enbridge and take other action prudently necessary to prevent or eliminate risk of harm from transport of oil in Line 5.

6. The Attorney General, and/or the DEQ and the DNR, as fiduciary trustees of public trust waters and state resources, and with obligations to prevent environmental degradation and harm to public safety, health, and welfare, must review and demand compliance with consideration of environmental effects and alternatives to Line 5, including demands, cease and desist orders, and court action if Enbridge violates or continues to violate the 1953 Easement, water and environmental laws, or fails to cooperate as a reasonably prudent person.

7. Specifically, although not by way of limitation, review and require full compliance with the DEQ and MPSC obligations to consider and determine likely water, public trust, and environmental effects and alternatives arising out of DEQ Great Lakes Submerged Lands Act jurisdiction over occupancy of bottomlands and waters by pipeline, and additional and necessary supports or other improvements, and the overall effects and alternatives associated with the siting of Line 5 and other matters within the jurisdiction of the MPSC.

8. Order or enact prohibition of any new oil pipelines in, under, or across the Great Lakes within the State of Michigan, and connecting or tributary lakes or streams; order review, likely risk, impact, and alternatives analysis and determination for all existing oil pipelines in, under, or across the Great Lakes or any connecting or tributary waters. If it is determined that a feasible and prudent alternative line, capacity, or new line exists for any existing oil pipeline, then the existing pipeline shall cease to operate and otherwise be decommissioned in accordance with best and safest technology within a reasonable time but not to exceed three (3) years, unless the owner or operator can clearly demonstrate that there is no unreasonable risk of an unacceptable harm, in which case it can request permission to operate for each of two additional successive three-year periods. The State shall impose stringent interim measures pending any review or additional period of transporting oil, including prohibition or reduction of oil through the pipeline segment that poses a risk of unacceptable harm.

FLOW appreciates the opportunity to submit this report, action plan, and comments. As noted at the outset, the purpose is to present findings, comments, and an action plan with interim measures to the State for consideration and action. FLOW will continue to review these important scientific, legal, and public policy issues, and remains available to present and discuss its findings, comments, and recommended actions.

Appendices 1 through 5 are attached to this report.

Courtesy copies of this report have been sent to the Michigan Public Service Commission.

APPENDICES 1 - 5

to

A SCIENTIFIC AND LEGAL POLICY FOLLOW-UP REPORT ON CRUDE OIL PIPELINES IN THE GREAT LAKES

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APPENDIX 1

Engineering and Scientific Issues Affecting the Integrity of Enbridge Line 5 at the Straits of Mackinac

By: Gary Street
August 29, 2015

PREVIOUSLY IDENTIFIED ISSUES

Mussels

Well documented that excrement from Zebra mussels can corrode bare steel.

- ➔ Coating – after 62 years – has deteriorated from abrasion. Subject to corrosion from mussel excrement.

Unrealistic Spill Simulations

Very orchestrated in advance.
Under ideal conditions – not in winter, high winds, or night time.
Meant for PR, not a true test.

- ➔ Do not test actual capability in a true emergency

Dents in Line 5 at the Straits

Enbridge: "There were two minor dents reported in the latest geometry ILI report received in July. They were less than the reporting threshold (less than 2%) but were noted in the report by our ILI vendor. We elected to conduct a visual inspection of the pipe to verify. The final report from this visual inspection has not yet been received from the inspection vendor to confirm the presence of a dent."
Ref: **http://michiganradio.org/post/whats-status-old-oil-pipeline-under-lake-michigan-we-need-more-information-know** (Oct 9, 2014)

- ➔ Enbridge Letters to Task Force in 2014 **do not acknowledge these dents**. (493988-7, p. 11 & 12 and 493944, p. 7)

Enbridge does not share data even with the State

Several issues identified by Task Force were not answered or answered evasively.

Block Valves

Inventory in **each** of the two 20 inch lines ~325,000 gallons.

Valve Closure and Water Hammer (493988-7 – p. 19)
Enbridge claims they can shut block valves in 3 minutes.
Preliminary calculations indicate this may be too fast to prevent water hammer. Depends on line pressure at time of shut down.
If water hammer is severe, line can be destroyed.

ROV Inspection
Done every two years.
Cannot detect small pinhole leaks or "minor" bulges.
Exterior condition obscured by mussels and sediment.

Nearest Response Teams
Bay City
Escanaba

Aerial Patrols
Of little value.
Done every 3 weeks, weather permitting.

- ➔ Strictly a PR exercise. (I have done this in my past life.)

RECENTLY IDENTIFIED ISSUES

Spill Impact and History

Environmental Triangle **(Appendix 1-1)**

Chart – recent spill history (**Appendix 1- 2)**

Amount of leakage due to Material Balance Error (Appendix 1-4)

Enbridge to Task Force: **3350 barrels per day**

Claims 5.3 % accuracy. I calculated 6.25% accuracy (Leak of 3350 bbls/day v. 22.5 million bbls/day).

- ➔ **140,700 gallons per day – could go undetected by mass balance!**

Worst Case Scenario (per Enbridge) – Unrealistic!! --- and Inconsistent!!

Letter to Task Force dated June 27, 2014 (493988-7, p. 22). Worst Case = 8583 barrels (probably both lines).

In another letter dated 02/27/15, worst case for a single line is 4950 barrels (493994, p. 5, item 12). 4950 x 2 = 9900 barrels. **Not Consistent!**

- ➔ **Worst Case – per Enbridge – is NOT the Worst Case!**

Mussels

Most likely Quagga v. Zebra mussels (makes little difference).

(Ref: Ashley Baldridge, PhD, Research Benthic Ecologist, NOAA Great Lakes Environmental Research Laboratory, Ann Arbor, MI)

Issued memo suggesting **mussels could add 27%** to the weight of the pipelines. They were not designed for this extra load.

- ➔ **GLI Report – Opinion only. Does not present scientific evidence to support conclusions. GLI and Enbridge: "Trust Us".**

Impact of Propane to the U.P. if Line 5 is shut down at the Straits (Appendix 1-6)

Propane is currently removed and purified at Rapid River.

Google Earth photo.

EPA confirmation of Depropanizer at Rapid River: **(Appendix 1-6)**

Alternative: Remove and purify Propane at Superior, WI. Pipe it to the existing facility at Rapid River for distribution.

➔ **Conclusion: Shutting down Line 5 at the Straits should have no impact on U.P. propane supply.**

How Much Enbridge Crude goes to MI via Line 5

➔ **Enbridge system maps: 1 Q 2015 shows NO crude going to MI via Line 5 (Appendix 1-7)**

Number of Supports and Supports at 140 foot Separation (493988-7, 06 27 14) **(Appendix 1-8)**

Enbridge admission of not installing supports every 75 feet. See email by GLS, 08 24 15, and emails by Ed Timm.

➔ **Decided (apparently) without State approval that 140 foot support is adequate.**

Winter Spill Response

AG: Do you have a spill response plan for addressing a potential spill when there is ice cover? (493994-7, item 17)

Enbridge: Yes
Coast Guard: No
DEQ: No

US Coast Guard Commandant Admiral Paul Zukunft is "not comfortable" with current contingency plans for a worst case scenario in the Great Lakes. **(Appendix 1-9)**

September 4, 2014 -- the DEQ's oil spill cleanup chief (Robert Wagner) told leaders and local residents at a public forum on Mackinac Island --- "If the Straits are frozen over, cleanup would be far more challenging."

Previous damage to Line 5 at the Straits (493994-7, items 18 & 19)

Enbridge: Response: The in-line inspection tools can very accurately identify and measure if the pipe is damaged by strikes. As described in Question 18, in 60+ years of operation, **there has never been any damage.**

What about known dents as cited in above in Dents in Line 5 at the Straits?

Volume in the Line when shut down

Per Enbridge: (493994-7, item 19) …………the approximate volume of oil released from a single pipeline between the valves would be 4950 barrels.

➔ **Above is NOT CORRECT for a 20" schedule 60 pipeline that is 4.5 miles long. The correct amount is 7793 barrels.**

Leak Impact (Appendix 1-5)

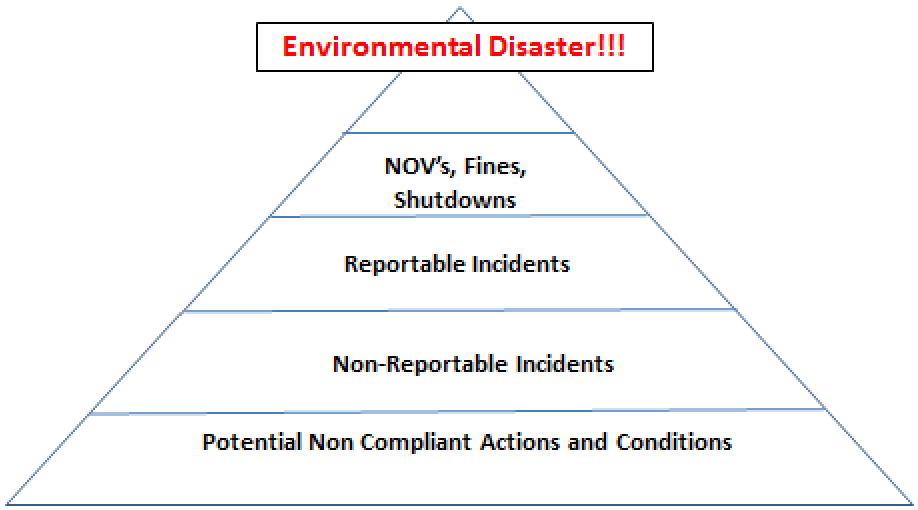
Enbridge claims 99.99930% non-leak rate (system wide). This is equivalent to ~80 gpd for each 20" line, or 160 gpd for both lines.

Suspend the pipeline under the Mackinac Bridge (Appendix 1-3)
Excessive load, both static and dynamic.
Spills can still occur.

Double Walled Pipe
Enbridge: "We are not aware of any double walled pipelines used for the transmission of oil." (493994-7, p. 2)
At a presentation in February (?) 2012 at Petoskey -- Enbridge stated that double walled pipe is used under freeways. Contradicts above.

Evacuation of the Line in the event of a Leak (493994-7, item 15)
They are dreaming. The steps outlined will take a very long time to implement and even then may not work.

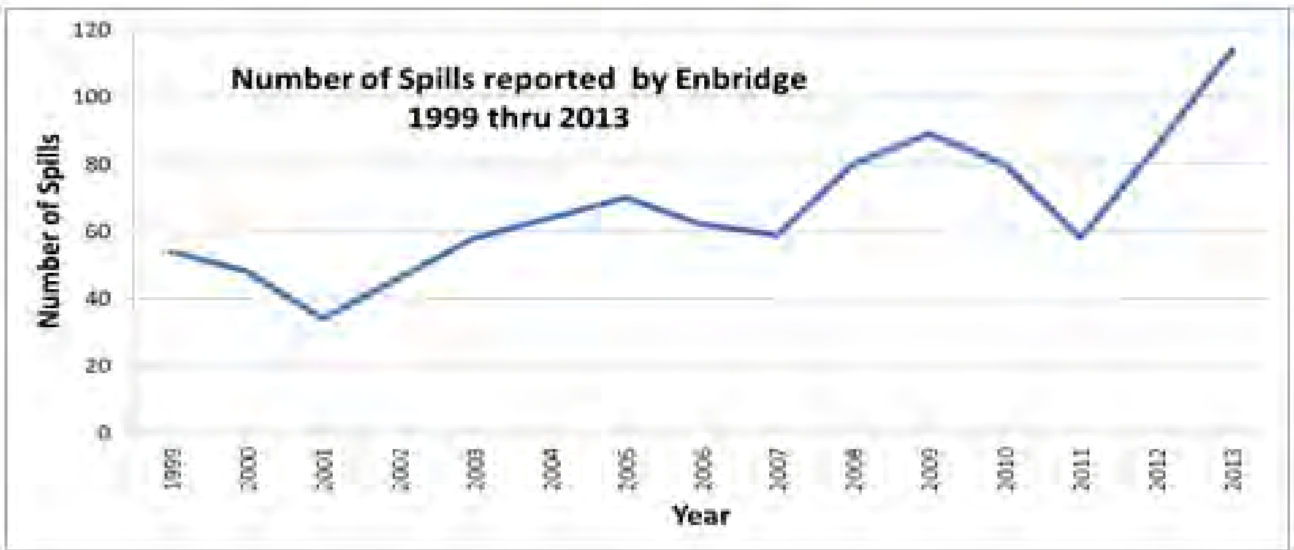
Appendix 1-1



Ladder to an Environmental Disaster !!

Page 6

Appendix 1-2



Page 6

Appendix 1-3

By Gary Street, P.E.

Engineer & FLOW Consultant

What if the two twenty inch diameter pipelines that cross the Straits (part of Enbridge Line 5) were hung from the Mackinac Bridge, rather than immersed in water nearly 300 feet deep?

The engineers on the staff at FLOW took a look at the concept. Is it possible? Does it make the situation less environmentally hazardous? What impact will it have on the Bridge? Was the Bridge designed for the extra load?

So we did some calculations.

The result: In addition to the regular car and truck traffic, for which the Bridge was designed, the pipelines would put the added weight of an additional 2000 to 3500 automobiles onto the Bridge. And not just for a short time, but continuously, 24 hours a day, 365 days per year.

Almost certainly the Bridge was not designed for all this extra weight. And what if the lines were to rupture? The oil still goes into the Straits.

Clearly, not a good idea!

Appendix 1-4

Leak Detection Ability per Enbridge

By: Gary Street

In a June 2014 submittal to the State[1], Enbridge made the following statement:

"The quantity of oil that could be released *without being detected* by the CPM system[2] or line balance calculations is approximately 400m3/day (~3350 bbls/day.) This unlikely scenario assumes that the other overlapping leak detection do not alert the operator of the release."

About 22.5 million gallons of oil per day flow through the two 20 inch pipelines where Line 5 goes under the Straits. Each line therefore carries 11.25 million gallons per day.

Using the Enbridge number of 3350 bbls/day (140,700 gallons per day), for the two lines, taken together, every day 1.25% of the oil in the two 20 inch lines could "leak" almost 141,000 gallons of oil and *not be detected* by Enbridge. If the leak is confined to one line, it could still be 70,350 gallons per day that would NOT be detected.

Ultimately, how would such a leak be detected? Most likely by oil showing up on the water surface, or on the shoreline. And what about a wintertime spill when there is 8 feet of ice in the Straits? It could take days, even weeks before it is detected. In the meantime the spill is continuing to get worse. This is not an acceptable practice, anytime of the year. The damage has been done when the evidence appears!

Using Enbridge's data, they DO NOT have the capability of shutting down the lines based on line balance calculations unless the leak exceeds 140,700 gallons per day (98 gpm). Leaks smaller than this amount could go undetected.

---

[1] Correspondence form Enbridge to Attorney General Bill Schuette and DEQ Director Dan Wyant, June 27,2014, entitled: Enbridge Lakehead Systems Line 5 Pipelines at the Straits of Mackinac, p. 21.

[2] Computational Pipeline Monitoring (CPM): Per Enbridge – "Line 5 is protected by a computer-based pipeline monitoring system that utilizes measurements and pipeline data to detect operational anomalies that indicate possible leaks. This system employs a sophisticated computer model of Line 5 to compare the expected pressures and liquid flow rate in each section of the line to the actual measured pressures and flow rate. Discrepancies between the expected and actual values result in a leak alarm that precipitates the shutdown of the line."

Appendix 1-5

Flow Rates are in U.S. gallons								
Flow rate in each 20" line =		**7,876**	**gpm**	**11,342,100**	**gpd**			
Success Rate		Leak Rate		Amt leaked per day		Amt Leaked in:	1	year
99.99000%		1.00E-04	gpm	1,134	gal	413,987	gal	
99.99900%		1.00E-05	gpm	113	gal	41,399	gal	
99.99930%		7.00E-06	gpm	79	gal	28,979	gal	
99.99990%		1.00E-06	gpm	11	gal	4,140	gal	

Appendix 1-6

Propane Supply to the Upper Peninsula if Line 5 at the Straits is Shut Down

Periodically, Enbridge uses Line 5 to transport LPG (liquefied petroleum gas) to various locations, including a terminal and processing center at Rapid River, MI.

At Rapid River, Enbridge operates a unit (a depropanizer) to separate and purify the propane from other compounds that may be present. After separation the liquefied propane is stored under pressure in large steel cylinders. Propane is then loaded into large trucks which haul it to more localized distribution centers. From the distribution center, propane is loaded into smaller trucks and delivered to residences and small businesses.

Rapid River is centrally located on the southern edge Michigan's Upper Peninsula, about half way between Ontonagon and St. Ignace. It is ideally located to provide propane to most of the U.P., as well as northern Wisconsin.

Concern has been expressed that if Line 5 at the Straits were "shut down", this could prevent delivery of propane to the Upper Peninsula.

From a logistics and engineering view point, there is no basis for this concern. Rapid River is 130 miles west of where Line 5 crosses the Straits, very much "up stream" of the Straits. If Line 5 were shut down at the Straits, the Rapid River facility could continue to receive LPG, processed either on site or at Superior, WI, and load propane into trucks for localized delivery. Given the geography of the Rapid River location, receiving propane via Line 5 would not be impacted by a shutdown of the line at the Straits.

Confirmation of Depropanizer at Rapid River:
http://epa-sites.findthedata.com/l/305924/Rapid-River-Depropanizer-and-Storage-Facility

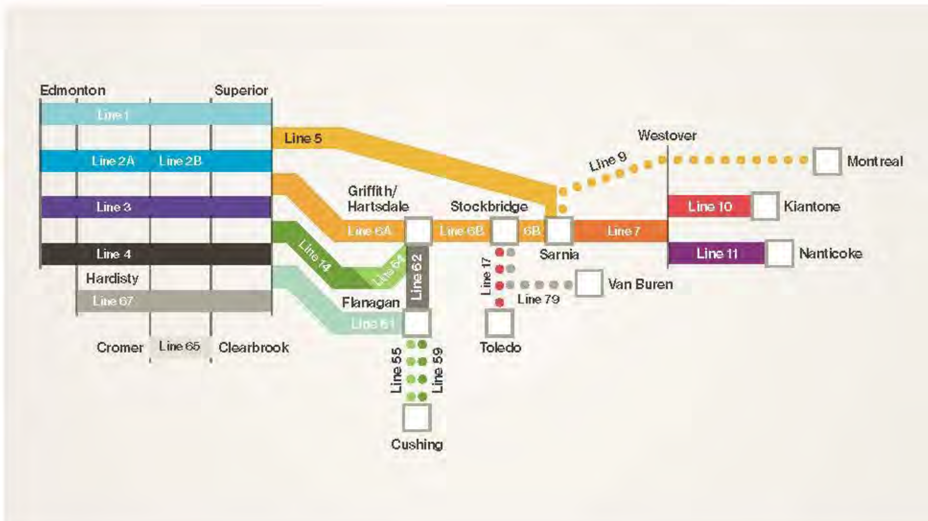
Depropanizer likely located in this area

Enbridge -- Rapid River (MI) Propane Facility

Appendix 1-7

Pipeline System Configuration

Q1,2015



Line 1
37,600 m³/d (237 kbpd)
18"/20" - 1098 miles
- NGL
- Refined Products
- Light

Line 2A
70,300 m³/d (442 kbpd)
24" - 596 miles
- Condensates
- Light

Line 2B
70,300 m³/d (442 kbpd)
24"/26" - 502 miles
- Light

Line 3
62,000 m³/d (390 kbpd)
34" - 1098 miles
- Condensates (Edmonton to Hardisty)
- Light

Line 4
126,500 m³/d (796 kbpd)
36"/48" - 1098 miles
- Heavy
- Medium (Ex-Clearbrook)
- Light (Ex-Clearbrook)

Line 5
85,900 m³/d (540 kbpd)
30" - 645 miles
- NGL
- Light

Line 6A
106,000 m³/d (667 kbpd)
34" - 467 miles
- Light
- Medium
- Heavy

Line 6B
79,500 m³/d (500 kbpd)
30" - 293 miles
- Light
- Medium
- Heavy

Line 7
28,600 m³/d (180 kbpd)
20" - 120 miles
- Light
- Medium
- Heavy

Line 65
29,500 m³/d (186 kbpd)
20" - 313 miles
- Light
- Medium

Line 10
11,800 m³/d (74 kbpd)
12"/20" - 91 miles
- Light
- Medium
- Heavy

Line 11
18,600 m³/d (117 kbpd)
16"/20" - 47 miles
- Condensates
- Light
- Medium
- Heavy

Line 62
37,400 m³/d (235 kbpd)
22" - 75 miles
- Heavy

Line 14/64
50,500 m³/d (318 kbpd)
24" - 467 miles
- Light
- Medium

Line 61
89,000 m³/d (560 kbpd)
42" - 454 miles
- Light
- Medium
- Heavy

Line 67
90,600 m³/d (570 kbpd)
36" - 999 miles
- Heavy

Not part of the Enbridge Mainline System

Line 9
24,200 m³/d (152 kbpd)
30" - 524 miles
- Light

Line 17
16,000 m³/d (101 kbpd)
16" - 88 miles
- Heavy

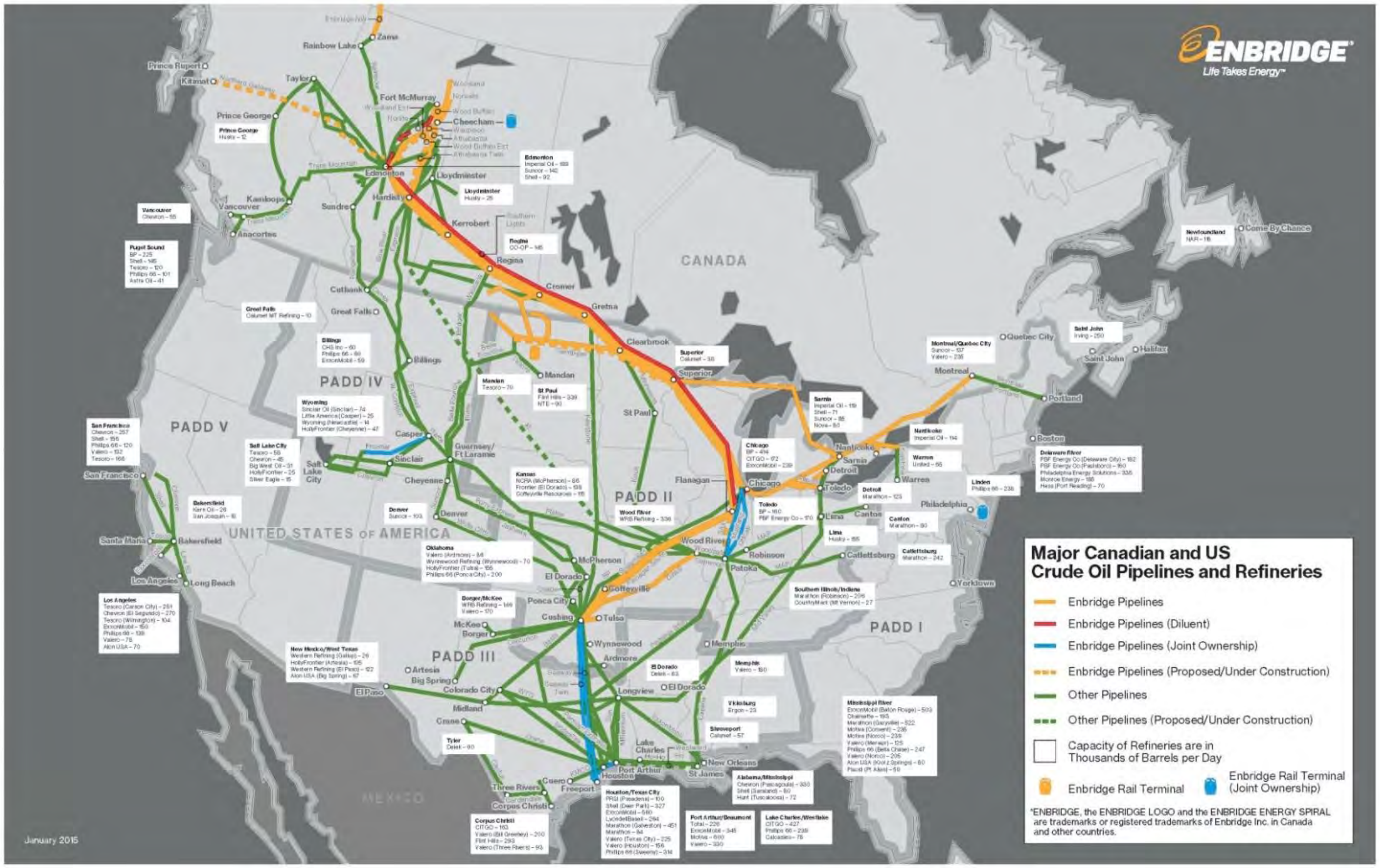
Line 55
30,700 m³/d (193 kbpd)
22"/24" - 575 miles
- Light
- Medium
- Heavy

Line 59
93,000 m³/d (585 kbpd)
36" - 593 miles
- Light
- Heavy

Line 79
12,700 m³/d (80.0 kbpd)
20"/16" - 62 miles
- Heavy

ENBRIDGE
Life Takes Energy™

Notes: Capacities provided are Annual Capacities and do not include current restrictions


ENBRIDGE
Life Takes Energy
Major Canadian and US Crude Oil Pipelines and Refineries
Enbridge Pipelines
Enbridge Pipelines (Diluent)
Enbridge Pipelines (Joint Ownership)
Enbridge Pipelines (Proposed/Under Construction)
Other Pipelines
Other Pipelines (Proposed/Under Construction)
Capacity of Refineries are in Thousands of Barrels per Day
Enbridge Rail Terminal
Enbridge Rail Terminal (Joint Ownership)
*ENBRIDGE, the ENBRIDGE LOGO and the ENBRIDGE ENERGY SPIRAL are trademarks or registered trademarks of Enbridge Inc. in Canada and other countries.
CANADA
UNITED STATES OF AMERICA
MEXICO
PADD I
PADD II
PADD III
PADD IV
PADD V
January 2015

Appendix 1-8

(letter is abridged)

June 27, 2014

SUBMITTED VIA ELECTRONIC MAIL

Hon. Bill Schuette
Attorney General
Michigan Dept. of Attorney General
6th Floor G. Mennen Williams Building
Quality 525 W. Ottawa Street
P.O. Box 30755
Lansing, MI 48909

Hon. Dan Wyant
Director
Michigan Department of
Environmental
Constitution Hall
525 W. Allegan Street
P.O. Box 30473
Lansing, MI 48909

Re: Enbridge Lakehead System Line 5 Pipelines at the Straits of Mackinac

Dear Attorney General Schuette and Director Wyant:

Thank you very much for the opportunity to discuss Enbridge Energy, Limited Partnership's Line 5 pipeline crossing of the Straits of Mackinac. We appreciate the dialog that has already occurred to provide some clarity and understanding in relation to the information requests that accompanied your letter of April 29, 2014.

To eliminate the possibility of currents washing out existing supports, special double screw anchor supports were selected and have been installed over the past ten years to eliminate that risk.

The pipes were laid in a dredged ditch until they were in at least 65 feet of water depth, a depth that was expected to avoid anchor strikes or ice action. Past 65 feet of depth they were laid on the floor of the Straits in a straight line which has proven to be an excellent decision as recent studies have concluded the risk of an anchor drop or drag impacting the pipeline at its exposed depths is highly unlikely.

Enbridge has developed a safer and more permanent solution to counteract the currents in the Straits and prevent wash-outs of pipeline supports. The peer-reviewed calculations of the day, reconfirmed in 2002, indicated the pipelines would be safe with unsupported spans across the bottom of the Straits of up to 140 feet. The State of Michigan set an initial span length of 75 feet in 1953, with the shorter spacing allowing for an added safety factor as it was difficult in the 1950s to inspect the lines and ensure adequate supports were in place. In 2002, to address currents and possible washouts, Enbridge began installing screw anchor pipe supports. The anchors are ten-foot- long steel screws that are augured into the lake bed on either side of the lines and hold a steel saddle that permanently supports the lines. In the 12 years since installation of the screw anchors, Enbridge has yet to observe any wash out of those very durable supports.

GLS Comment: Nothing is said about reviewing the 140 foot distance with the State, nor getting State approval. The 1953 Easement called for support every 75 feet. This appears to be a violation of the 1953 Easement.

Appendix 1-9

Link: http://www.peters.senate.gov/content/commerce-committee-approves-two-peters-amendments

Peters' second amendment to the *Coast Guard Authorization Act* would require the Coast Guard to work with partner agencies including the National Oceanic and Atmospheric Administration (NOAA) to conduct an assessment on the effectiveness of oil spill response activities in the Great Lakes region.

"Michiganders already know the devastating effects an oil spill can have after the 2010 pipeline spill into the Kalamazoo River," said Senator Peters. "The Great Lakes are an essential part of our way of life in Michigan, supporting more than 500,000 jobs and our multibillion dollar shipping, travel and fishing industries. A spill in the Great Lakes would be catastrophic to Michigan's economy and our environment, and we must be prepared protect this vital resource in the event of a spill."

The Great Lakes are particularly vulnerable to an oil spill from 62-year-old twin pipelines that run through the Straits of Mackinac. A spill in the Great Lakes would also be complicated by the lack of research on cleanup of oil spills in bodies of fresh water, especially under heavy ice cover. Current methods of oil spill response and cleanup, such as oil dispersants and mechanical recovery, are not effective in large bodies of fresh water. **In an April 28th Commerce Committee hearing, U.S. Coast Guard Commandant Admiral Paul F. Zukunft said that he "is not comfortable" with the current contingency plans for a worst-case scenario spill in the Great Lakes.**

The assessment required by Peters' amendment will evaluate new research into oil spill impacts and cleanup plans in fresh water under a wide range of conditions. The evaluation will also focus on new and specific improvements to safety technologies and environmental protection systems used in fresh water oil spill response efforts.

APPENDIX 2
With Appendices 2A-2D

Summary Statement Regarding the Current Condition of Enbridge Line 5

Ed Timm, Ph.D.

September 3, 2015

Since I first joined with FLOW as a technical consultant I have been working to determine whether or not any part of Line 5 can be classified as an imminent threat to life and property. As a licensed professional engineer it would not be ethical for me to take the position that Line 5 presents an imminent hazard unless I can back that opinion up with data and calculations. Until recently, the publically available record simply did not contain enough hard information for me to call Line 5 an imminent hazard. With the release of the Governor's Pipeline Task Force reports and a partial response to a FOIA request to the Michigan Public Service Commission regarding Line 5, I now believe I have enough information to change my position on the issue of imminent hazard and believe the data and calculations I have recently completed support that position.

Specifically, Line 5 appears to have many safety issues that are comparable to the issues resulting in the disastrous ruptures of Enbridge Line 6b, Plains All American Line 901and the Exxon-Mobil Pegasus pipeline. Among these issues are:

1. Pipe wall thinning and cracks caused by corrosion and erosion resulting in unrealistic pressure ratings,
2. The addition and deletion of multiple pump stations which have increased the capacity of the line from an original design of 300,000 bbl/d to the current 540,000 bbl/d without appropriate engineering analysis.
3. Multiple configuration changes to Line 5 including the addition of drag reducing agent injection stations without any MPSC records documenting the appropriateness of these changes.
4. Failure of the external protective coating system on the Straits sections of Line 5 resulting in the loss of mandated abrasion protection with subsequent coal tar water barrier abrasive failure and expected corrosion.
5. Mussel encrustation adding stress and a corrosive environment to the Straits sections of Line 5 which was not addressed by the reports supplied by Enbridge to the Task Force.
6. The unwillingness of Enbridge to supply any summary information regarding the multiple In Line Inspections of Line 5. A root cause of the pipeline failures mentioned above was the poor quality of the associated ILI data coupled with unrealistic repair/replace criteria used by pipeline operators.
7. The encroachment of subdivisions and commercial operations on the right of way of Line 5 which results in a much greater hazard to life and property should Line 5 rupture than was originally intended by the MPSC.

My analysis to date of these issues, as documented by several attached reports, now leads me to the conclusion that Line 5 is far more likely to present an imminent threat to health and property than not. This forces me to the ethical conclusion that immediate action should be taken to assure the safety of Line 5 while the legal deliberations go on. **It is my professional opinion that line 5 should be de-rated to its original design capacity of 300,000 bbl/d to reduce the stress on this very old pipeline and its cargo should be restricted to LPG until a full independent analysis of its safety can be made using modern methods and all the information that exists.**

APPENDIX 2A

Ed Timm, Ph.D.

Regarding Operating Pressure Limits and Wall Thinning by Corrosion in Line 5

When Enbridge's 645 mile Line 5 was originally conceived in 1953 the Michigan Public Service Commission (MPSC) approved plans for a 30" Pipeline (2 x 20" under the Straits) without any pump stations in Michigan and a capacity of 120,000 bbl/d. MPSC Order No. D3903-53.1 dated March 31, 1953 and MPSC Order D-3903—53.2, dated May 29, 1953 allowed for the construction of this pipeline with up to four pump stations in Michigan and a capacity of 300,000 bbl/d.

Through a series of fifteen MPSC orders culminating in MPSC Order U-8701 dated April 14, 1987 the capacity of Line 5 was increased to over 500,000 bbl/d through the construction of additional pump stations. MPSC documentation reveals that as many as 19 pump stations in Michigan were proposed at differing times as required to operate Line 5 at more than four times the flow capacity intended without any pump stations. The historical record is not clear as far as which of these stations were actually constructed or constructed and later abandoned resulting in the current configuration of Line 5 with twelve pump stations in Michigan. Table 1. lists these stations along with their approved maximum discharge pressures while Table 2. lists the pump stations that are mentioned in MPSC documentation but were not constructed or abandoned.

Table 1. Current List of Line 5 Pump Stations

2015 Pump Stations	Present Maximum Discharge Pressure, (psig)
Gogebic	633
Iron River	703
Rapid River	633
Manistique	701
Gould City	775
Naubinway	698
Mackinaw	701
Indian River	703
Lewiston	633
West Branch	642
Bay City	779
North Branch	701

Table 2. List of Line 5 Pump Stations Abandoned or Not Constructed

Pump Stations	Present Maximum Discharge Pressure, (psig)
Wakefield	534
Watersmeet	579
Arnold	498
Eagles Nest	602
Vanderbilt	607
Vassar	654
Brockway	614

According to MPSC documentation it appears that the original construction of the non-Straits sections of Line 5 used 30” pipe with varying wall thickness and strength specifications. It is common to construct cross country pipelines using so called “telescoped” construction where pipe wall thickness is reduced as the distance from a pump station increases and pressure falls due to friction between the cargo and the walls of the pipe. The fact that the non-Straits sections of Line 5 uses pipe with 9/32”, 5/16”, 11/16” and 3/8” wall thickness at various locations suggests that Line 5 was constructed following usual practice and pipe with quite thin walls is used some places.

When a pipeline like Line 5 is retrofitted with additional pump stations to increase capacity, each section between pump stations is treated as a separate pipeline segment with associated pressure limitations on each section. Enbridge has followed this practice with Line 5 and all the pipe segments between the pump stations listed in Table 1. has an individualized pressure restriction. In the numerous MPSC orders regarding the changes necessary to increase the capacity of Line 5 from its original design of 300,000 bbl/d to its current capacity of 540,000 bbl/d, Enbridge frequently states that the pressure limitations found in Table 1. do not exceed 65% of the calculated yield pressure for that pipe segment. This is consistent with ASME B31.4 “Transportation Systems for Liquid Hydrocarbons and Other Liquids” which has the force of law regarding the design of oil pipelines. ASME B 31.4 requires that the maximum pressure on a pipeline segment be no more than 72% of the system yield pressure which implies a design safety factor of 1.39.

By choosing to operate its system at 65% of yield pressure instead of the 72% allowed under ASME B31.4, Enbridge has increased the safety factor on its system to 1.54. Even though Enbridge could transport more oil by operating its system at the maximum allowed by code it has chosen to add an allowance of 7% (72%-65%) to increase the safety of the system. It is likely that this 7% allowance reflects a conservative rating for what is a very old pipe. Considering this as a corrosion allowance would allow for a 7% wall thickness loss over the service life of the pipe while still complying with ASTM B31.4. Thickness losses of more than 7% would put the non-Straits sections of Line 5 out of compliance with B 31.4 and require repair or replacement of the affected pipe segment.

In spite of the efforts of the Governor’s Task Force regarding Line 5, there is very little publicly available data regarding the internal and external corrosion of Line 5 over its current 62 year service life. In a report titled Enbridge Energy Partners, Limited

Partnership, Operational Reliability Plan, Line 5 and Line 5 Straits of Mackinac Crossing (https://www.enbridgepartners.com/~/media/EepEeqMep/Site%20Documents/Shared%20Content/Media%20Center/Enbridge_Line_5_Operational_Reliability_Plan.pdf?la=en) Enbridge presents data on average corrosion rates for Line 5. Table 3. is taken from this 2014 Enbridge report.

Table 3. Enbridge Corrosion Data

Enbridge Operational Reliability Report on Corrosion Rates

P. 14 **Industry Guidelines for CGR Compared to Line 5 CGRS**

Standard/Guideline Recommendations	
NACE RP0102	0.3mm/yr: 80% confidence max rate with 'good' CP
ASME B31.8S	0.31mm/yr max rate for active corrosion in low resistivity soils
GRI-00/0230	0.56mm/yr for pitting; 0.3mm/yr for general corrosion
Line 5 Avg. Rates	External Corrosion 0.038mm/yr – 0.068mm/yr
Line 5 Avg. Rates	Internal Corrosion 0.018mm/yr – 0.046mm/yr
Line 5 Straits of Mackinac	**Int. and Ext. Corrosion No observed corrosion growth**

p. 15 **Line 5 In-Line Inspection Metrics — Cracking**

Depth of ILI Crack Tool Anomalies			
Feature Depth	0.040" - 0.080"	0.080" - 0.120"	> 0.120"
# Features	661	48	0
# Features per Mile	1.032/mi	0.070/mi	0.000/mi

Table 3. compares the average corrosion rates for the non-Straits sections of Line 5 with industry norms and concludes that the rates found for Line 5 are very low compared to the industry norms. Although the rates reported by Enbridge are very low, Line 5 is very old and a calculation of the effect of these rates over time is warranted.

Table 4. is an EXCEL spreadsheet that abstracts the data shown in Table 3. and compares the resultant wall thinning over 62 years of service with the wall thicknesses of the pipe used in Line 5.

Table 4a. Extrapolation of Average Corrosion Rate over Service Life

		Lower Value	Upper Value	Average
Internal Corrosion Rate, (mm/yr)		0.018	0.046	0.032
External Corrosion Rate, (mm/yr)		0.038	0.068	0.053
	Average Internal Corrosion Rate, (in/yr)			0.0013
	Average External Corrosion Rate, (in/yr)			0.0021
	Years in Service		62	
	Total Internal Corrosion over Service Life, (in)			0.078
	Total External Corrosion over Service Life, (in)			0.129

Table 4b. Wall Thinning of Line 5 Pipe by Extrapolated Corrosion Rates

Pipe Size	Wall Thickness	Average External Thickness Loss	Average Internal Thickness Loss
30" x 9/32	0.281	46%	28%
30" x 5/16	0.312	41%	25%
30" x 11/32	0.344	38%	23%
30" x3/8	0.375	34%	21%
30" x 1/2	0.500	26%	16%
30" x 11/16	0.687	19%	11%
20" x 7/8*	0.813	16%	10%

* Straits sections of Line 5 have unique pressure restrictions and do not meet the 65% criteria.

As can be seen from Table 4b., the 7% corrosion allowance used by Enbridge to establish safe working pressures on the non-Straits sections of Line 5 appears to have been exceeded by a significant margin over the 62 year life of Line 5. This calculation results in the conclusion that, based on the only data available from Enbridge or other public sources, the pressure limits set by MPSC order in the past no longer comply with the requirements of ASTM B31.4 and should be re-considered based on a thorough examination of all data that exist regarding the current amounts of wall thinning due to corrosion on Line 5.

A further consideration regarding appropriate safety factors and pressure limitations on Line 5 involves the nature of the cargos carried and real estate development that has occurred since 1953 when the line was constructed. As much as 20% of the cargo carried by Line 5 is believed to be Natural Gas Liquids (NGL) which is a mixture of ethane, propane and butane that exists as a gas at atmospheric pressure and temperature. In the event of a rupture, NGL's vaporize and present the fire and explosion hazard typically found associated with high pressure natural gas lines. The fire and explosion hazard associated with gas pipelines has resulted in a separate section of the ASME Piping Code titled ASME B 31.8 "Gas Transmission and Distribution Piping systems."

ASME B31.8 requires gas transmission piping to use much higher design safety factors particularly where the pipes transit heavily habitated areas. This is done because the risk of catastrophic explosion with resultant loss of life is much greater when a gas cloud forms after a pipeline rupture than it would be with an oil spill which primarily presents an ecological hazard. Table 5. is abstracted from ASME B31.8 and presents the safety factors required under code for gas transmission lines in varying areas.

Most of the route take by Line 5 covers rural territory and the safety factor for Class 1, Division 1 or 2 service would be applicable and is consistent with the safety factor required under ASTM B 31.4 as used for the design of Line 5. However, some sections of Line 5 have had developed within the easement location and would meet the requirements of Class 3 or Class 4 service if Line 5 is considered as a gas transmission pipeline when carrying NGLs.

Table 5. ASME B31.8 Limitations for GAs pipelines in Populated Areas

Table 841.114A, Basic Design Factor, F		
Location Class	Design Factor, F	Safety Factor
Location Class 1, Division 1	0.8	1.25
Location Class 1, Division 2	0.72	1.39
Location Class 2	0.6	1.67
Location Class 3	0.5	2.00
Location Class 4	0.4	2.50

A good example of this kind of post construction development can be found where Line 5 crosses the Indian River in Cheboygn County. When Line 5 was constructed the area shown in Figure 1. was a marsh. Now a canal subdivision and marina sit above Line 5.

Figure 1. Indian River Crossing of Line 5 Showing Post construction Development

It is possible to argue that when Line 5 carries NGLs it should legally be classified as an gas pipe line and ASME B 31.8 safety factors should apply. The residents of the area shown in Figure 1. are at the same risk when Line 5 is transporting NGLs as they would be if it was a gas transmission line rated for Division 3 or Division 4 service. The example shown in Figure 1. is one of many areas where development has encroached on the Line 5 right of way. The question of whether the appropriate safety factors exist and Line 5 is in compliance with code should be carefully considered due to this kind of encroachment. Regardless of the niceties of the ASME code, Line 5 presents all the hazards of a gas transmission line when carrying natural gas liquids or propane.

APPENDIX 2B

Ed Timm, Ph.D.

Regarding the Protective Coating and Support Requirements of Line 5.

Effective corrosion protection and support are critical to the longevity of pipelines. This fact was recognized by the State of Michigan when permission to build and operate Line 5 was granted in 1953. The following documents support this conclusion:

1953 Easement Restrictions Regarding Corrosion Protection and Support

(8) Cathodic protection shall be installed to prevent deterioration of the pipe

(9) All pipe shall be protected by asphalt primer coat, by inner wrap and outer wrap composed of glass fiber fabric material and one inch by four inch (1" x 4") slats prior to installation.

(10) The maximum span or length of pipe unsupported shall not exceed seventy-five (75) feet.

1953 MPSC Order Regarding Corrosion Protection

The entire pipe line will be properly cleaned, primed, and coated with a single application of coal tar. The coating will be reinforced by a spiral wrap of glass material and covered by a spiral wrap of special glass outer wrap. Penetrations will be made for cathodic protection.

Engineering and Construction Considerations for the Mackinac Pipeline Company's Crossing of the Straits of Mackinac" submitted by Mackinac Pipeline Company/Lakehead Pipeline Company to the Michigan Department of Conservation, January, 1953

After coating with asphalt primer, fiberglass inner wrap and an asbestos felt outer wrap, and after attaching 1" x 4" wood slats to the full circumference of the pipe, it will be lowered onto a previously prepared "bed" on the floor of the Straits.

While there is some inconsistency in these documents concerning the exact details of Line 5, the language regarding the coating system for the Straits sections of Line 5 as found in both the Easement and the Engineering report is consistent. Because the unburied Straits sections of Line 5 rest on a prepared gravel bed and is not supported off the lake bottom, it is critical to the long term longevity of this line that there is a layer of wooden slats around the circumference of the line to prevent abrasion of the coal tar water barrier coating. Otherwise, the motions of the pipe as it shifts on its gravel bed due to temperature gradients, currents and internal pressure changes would cause water barrier coating failure due to mechanical abrasion.

Recent underwater surveys by both Enbridge and the National Wildlife Federation reveal that the mandated slats are no longer in place. At the time Line 5 was placed in the Straits, these slats were held in place by circumferential steel bands. These bands appear to have rusted away and the slats they once secured are missing. Figure 1. is a photo taken by the NWF that shows the rusted out circumferential bands and Figure 2. is a photo clipped from an Enbridge video that appears to show what remains of the slats the previously encircled the pipe.

Figure 1. Picture of Line 5 Taken by NWF that Erroneously Identifies Corroded Circumferential Bands as Broken Supports

Figure 2. Frame Clipped from Enbridge Video Apparently Showing Detached Slats
Because washouts caused by unforeseen currents in the Straits have left sections of the pipe unsupported in violation of seventy five foot requirement stated in the 1953 easement, Enbridge has been retrofitting the Straits Sections of Line 5 with modern, screw anchor supports. Enbridge Table 2. is a summary of these efforts.

Table 2 ROV Inspection and Span Support Installation History of Line 5 Straits of Mackinac

Year of ROV Inspection	Follow up Actions (Anchor Support Installation)	Type of Support Installed
1963	None	
1972	None	
1975	3	Grout Bags
1979	None	
1982	None	
1987	7	Grout Bags
1989	None	
1990	None	
1992	6	Grout Bags
1997	None	
2001	8	Grout Bags and mechanical support
2003	16	Mechanical Screw Anchors
2004	16	Mechanical Screw Anchors
2005	14	Mechanical Screw Anchors
2006	12	Mechanical Screw Anchors
2007	None	
2010	7	Mechanical Screw Anchors
2012	17	Mechanical Screw Anchors

As can be seen from this table, there has been a continuing effort since 1975 to comply with mandated support requirements. This effort culminated in 2014 when a large number of supports were added and a table of all supports in place was submitted by Enbridge to the Attorney General in response to a query about the adequacy of support. This table can be found in the online report of the governor's Pipeline Task Force in the following document. Appendix_B4_493991_7.pdf. By summing the lengths of the supported spans in this document and computing the distance between the burial exits of both segments of the Straits sections of Line 5, it can be shown that about:

1. The East span is supported off the lake bottom for a distance of 1.03 out of 2.1 miles of unburied pipe,

2. The West span is supported off the lake bottom for a distance of 1.02 out of 2.3 miles of unburied pipe.

Based on the numbers presented above, over 50% of the unburied sections of the Straits sections of Line 5 still rest directly on what remains of the bed prepared in 1953 on the Lake Michigan bottom. This part of Line 5 appears to have lost its abrasion resistant lagging of wooden slats due to corrosion of the circumferential retaining bands and is subject to abrasive attack on the coal tar water barrier coating. This is a clear legal violation of the terms of the 1953 easement and is not something contemplated in the original design of Line 5. Technically, it can be expected that the unburied, unsupported off the bottom sections of Line 5 are suspect for coating failure due to mechanical abrasion with resultant accelerated corrosion.

APPENDIX 2C

Regarding Enbridge Line 5 Pump Station Reconfiguration and the Use of Drag Reducing Agents

From March, 1953 when the MPSC granted permission to the Lakehead Pipeline Company to construct Line 5 through April, 1993 the MPSC issued about twenty five orders regarding the configuration of Line 5. Pump stations were added, pressure limitations were changed, new valve stations were inserted and other mechanical details were modified during this period. Following the April, 1993 MPSC order FOIA requests have not revealed any further MPSC orders until July, 2012 when Enbridge notified the MPSC that it intended to make changes to several pump stations along Line 5. This informal notification was followed by a notification of the changes made by Enbridge in June 2014. No formal MPSC orders appear to have been issued regarding these changes or any other changes to Line 5 in the period from April, 1993 until June, 2012.

Line 5 was reconfigured from its original design through a series of MPSC orders culminating in MPSC Order U-8701 dated April 14, 1987 which finalized the maximum allowable discharge pressures at the nineteen pump stations listed below.

1. Arnold
2. Bay City
3. Brockway
4. Eagles Nest
5. Gogebic
6. Gould City
7. Indian River
8. Iron River
9. Lewiston
10. Mackinaw
11. Manistique
12. Naubinway
13. North Branch
14. Rapid River
15. Vanderbilt
16. Vassar
17. Wakefield
18. Watersmeet
19. West Branch

As of the current date, Enbridge documentation shows that there are a total of twelve operating pump stations in Michigan on Line 5. The locations of the current pump stations are listed below.

1. Gogebic

2. Iron River
3. Rapid River
4. Manistique
5. Gould City
6. Naubinway
7. Mackinaw
8. Indian River
9. Lewiston
10. West Branch
11. Bay City
12. North Branch

As can be seen from comparing these lists, Enbridge appears to have abandoned six intermediate pump stations along Line 5. This action has been taken while maintaining the flow capacity of Line 5 above 500,000 bbl/d and without raising pressure ratings. The manner in which this engineering feat was accomplished raises two questions.

1. What technical changes were made that allowed capacity to be maintained while removing six pump stations?
2. Why aren't there any MPSC orders documenting the reconfiguration of Line 5 in the period from 1993 through 2012?

The answer to the first of these questions will be considered below while the answer to the second question is beyond the scope of this document and is legal in nature.

After the 1972 OPEC oil embargo the petrochemical industry developed technology to maximize the flow capability of pipelines. It was found that the injection of small quantities of certain long chain polymers could suppress boundary layer turbulence in pipeline flow resulting in a significant reduction in wall friction. In controlled experiments, it was found that as little as 50 parts per million (ppm) of injected polymer could cut friction losses up to 80%. This technology was enthusiastically adopted by the pipeline industry which resulted in the need for fewer pumping stations to achieve rated flow without increasing pressures. These substances when used in pipelines are called drag reducing agents (DRAs).

In a letter to the MPSC dated July 16, 2012 Enbridge notified the MPSC of a project to modify several Line 5 pump stations. Quoting from this latter: "The scope of this project, referenced as Line 5 - DRA Project ("Project"), involves the installation of new, and replacement of existing, DRA (drag reducing agent) skids, including all valves and appurtenances, as described in more detail on Table No. 1 below. In addition, the Project involves making certain minor modifications to the header piping and pumping assemblies at Indian River and Bay City Station sites, and installing a spare meter run at the existing Marysville Station in Marysville, Michigan."

Table No. 1 Project Scope for Line 5 – DRA Project					
Exhibit No	Station	State	County	Scope of Work	Station Plot Plan
B.1	Gogebic	MI	Gogebic	• Install new DRA skid including all valves and appurtenances	B.1.a
B.2	Iron River	MI	Iron	• Deactivate existing DRA skid • Install new DRA skid including all valves and appurtenances	B.2.a
B.3	Gould City	MI	Mackinac	• Install new DRA skid including all valves and appurtenances	B.3.a
B.4	Indian River	MI	Cheboygan	• Deactivate existing DRA skid • Modify existing pumping assembly including all unit piping, valves and appurtenances • Replace certain station header piping including all valves and appurtenances	B.4.a
B.5	Bay City	MI	Bay	• Deactivate existing DRA skid • Install new DRA skid including all valves and appurtenances • Modify existing pumping assembly including all unit piping, valves and appurtenances • Replace certain station header piping including all valves and appurtenances	B.5.a
B.6	North Branch	MI	Lapeer	• Deactivate existing DRA skid • Install new DRA skid including all valves and appurtenances	B.6.a
B.7	Marysville	MI	St. Clair	• Install spare meter run including all valves and appurtenances at existing meter station site	B.7.a

As shown in the above table, Enbridge notified the MPSC that it plans to make changes to several pump stations primarily involving the addition of skid mounted units intended to inject drag reducing agents into Line 5. The text of this letter makes it clear that some of these skid units are being moved from previous locations on Line 5. An Enbridge letter dated June 5, 2014 confirms the completion of this construction project. These letters coupled with the 1993-2012 chronological gap in MPSC documentation raises several questions of procedure and substance.

1. The documentation gap mentioned above suggests either a loss of critical safety information regarding operation pressures and procedures on Line 5 or a change in MPSC procedures where the documentation of critical changes is either held in confidence or missing.

2. Very significant changes occurred in the 1993-2012 time frame including the apparent abandonment of six pump stations and the addition of many drag reducing polymer injection units. No information is available regarding how these changes impacted Line 5 pressure profiles, compliance with ASME piping codes or other matters that affect Line 5 safety.

3. The use of drag reducing agents to reduce pumping losses in pipelines is a widely employed technology, however, it is not without risk. These agents are usually long chain polymers which break down due to turbulent shear forces and lose their effectiveness. This is why more agent must be added at intervals along the pipeline to maintain the reduced wall friction that makes these agents effective. The use of drag reducing agents can have unintended consequences which affect operational reliability and safety. Among these consequences are the following:

    a. DRA injection modifies the pressure profile along the length of the line. This profile is usually a linear function of distance from the injection point but, because the DRA degrades along the length of the pipe, pressure profiles become non-linear and may exceed expected values.
    b. Failure of DRA injecting equipment can result in sudden pressure spikes resulting in unsafe pressures that exceed code and regulated pressure levels with subsequent possibility of pipe rupture.
    c. Because DRA's are only effective at high flow rates or Reynolds numbers, initiating flow in a line containing DRAs can cause elevated pressures until flow is fully established. This transition from flow rates where DRAs are ineffective to flow rates where DRAs are effective can cause flow instabilities and pressure spikes with unintended consequences.

Because of the chronological gap in the MPSC record for Line 5, it is impossible to determine if Line 5 is being operated in compliance with MPSC orders and applicable codes. Similarly, the use of DRAs in Line 5 seems to have been developed without Enbridge submitted engineering calculations and other descriptions that would have made it possible to address some of the issues mentioned above. Because of these omissions coupled with the considerations raised in the previous briefs, the operating condition of Line 5 cannot be determined from the public record and it appears the MPSC is allowing Enbridge to operate Line 5 in ways that were not contemplated by the original designers and in ways that may present a greater hazard of rupture than was intended by the State of Michigan when it granted permission to construct this line.

APPENDIX 2D

Quality Control and Interpretation of Pipeline In-Line-Inspection (ILI)

Ed Timm, Ph.D.

All aging steel pipelines are structurally degraded as a result of erosion, corrosion, cracking and mechanical damage. The pipeline industry addresses this loss of structural integrity through inspection technology that attempts to determine the extent of this damage in conjunction with structural models that attempt to predict the effect of the damage on safe operation. Since most pipelines are buried and covered with protective coating systems, external inspection is often impractical. The pipeline industry relies on internal inspection technology in the form of instrumented pipeline "pigs" that are pushed through the pipe while recording data. These instrumented pigs or "smart pigs" utilize mechanical, magnetic and ultrasonic sensors to measure the damage to the line and subsequently allow the calculation of the hazard presented by age related damage. The areas of the pipe that are found by smart pigs to be compromised are called "features" and the use of in line inspection (ILI) technology to characterize these features enables the presumably safe operation of aging pipelines.

As is usual in the process industries, pipeline in line inspection is the subject of numerous industry developed standards that describe best practices with the aim of producing reliable, reproducible and accurate measurements. API 1163, In-Line Inspection Systems Qualification, and NACE SP0102, In-Line Inspection of Pipelines, are the cornerstone standards governing the in line inspection of pipelines. These standards lay out in great detail how to conduct an in line inspection, generate appropriate documentation and verify the quality of the data produced. These standards do not cover any aspect of the actual ILI technology used although they do cover how to determine how well the chosen inspection technology conforms to manufacturer's specifications. Neither of these standards say anything about how ILI data is to be interpreted to verify the safety of the line.

Raw ILI data is processed using proprietary computer applications to categorize and quantify the size of the various features detected by the ILI run. Features are categorized as pits, trenches, cracks, crack colonies, overall metal loss, etc. and their locations and sizes are calculated. The most severe of these features are then subjected to engineering analysis to calculate their probable risk of causing a rupture. Pipeline operators use this information to schedule repair or replacement of any pipe with features that exceed company criteria for risk of rupture. Many ILI contractors offer a complete "pipeline integrity management program" that takes responsibility for assuring the integrity of a line and the quality of the ILI data on which decisions are based.

API 1163 provides a complete roadmap to the process of assuring the quality of ILI data. An individual inspection run on a pipeline may be validated as either Level 1, Level 2 or Level 3 depending on the quality of both the documentation and the data. A Level 1 validation means that the measuring instruments appear to have worked to manufacturer's standards and the documentation meets minimal standards. A Level 3 validation requires very extensive documentation as well as testing to determine the accuracy and sensitivity of the instruments used. Many complex statistical criteria are set forth in API 1163 to assure data quality from a Level 3 run. Beyond these internal checks for data quality, API 1163 also recognizes the importance of using ILI data to locate significant features in the pipe wall then digging up the pipe and examining these features in detail. The very best data is produced when the feature is actually cut out of the pipe and examined in a lab where is compared to the ILI data. If the type, location and size of the features found in the metallurgical lab coincides with the information about them produced by the ILI run, the pipeline operater can have high confidence in the data and subsequent risk analysis.

When a group of objects are measured with two different techniques, statisticians have a simple method of visually evaluating the quality of the data. A plot that has the size of features determined by one measurement technique as a horizontal axis and the size of the same features as determined by a different technique as the vertical axis is called a scatter plot. If the size of an individual feature is determined to be the same by both measuring techniques, the point will fall on an equiaxedb line. Points on this line represent perfect agreement between measuring techniques and points off the line indicate the two techniques are giving different results. Usually, the measurement technique considered most reliable is plotted on the horizontal axis.

API 1163 incorporates the scatter plot method (so called because the data scatters around the line of perfect correlation) to quickly assess data quality. In the ILI industry these plots are called "Unity Plots" because they attempt to unify the ILI data with the measurements produced by digging up the pipeline and physically inspecting the significant features. An example of a unity plot is given in API 1163 as Figure C.1. In this plot the size of a feature as a fraction of original pipe wall thickness as determined by physical inspection (the Ditch Depth (wt%)) is on the horizontal axis and the size of the feature as determined by the ILI instrumentation is plotted on the vertical axis (ILI Depth (wt %)). The red line represents perfect correlation between the two measuring techniques, a condition that rarely happens. Since each data point on a unity point is a result of both an ILI inspection run and costly excavation with subsequent physical inspection, unity plots are expensive to produce. However, since hazardous features are repaired during the physical inspection process the overall cost to a pipeline operator is mostly in the form of documentation and analysis.

In Figure C.1, all data points that fall above the red line are of features where the ILI instrumentation measured the feature to be bigger than it turned out to be on examination. Inversely, all data points that fall below the line are of features that turned out to be bigger than the ILI measurement. While a certain amount of scatter will always exist when something is measured using two techniques, a unity plot that shows a lot of data lying far from the line of perfect correlation suggests problems with the overall data quality of the ILI run. Data points far from the correlation line in the lower right corner of the unity plot are particularly undesirable because these are points where the ILI instrumentation has under-measured a feature by a large margin. Under-measurement means there are features that may well cause pipeline rupture in the future that are not examined for potential hazard and subsequent repair.

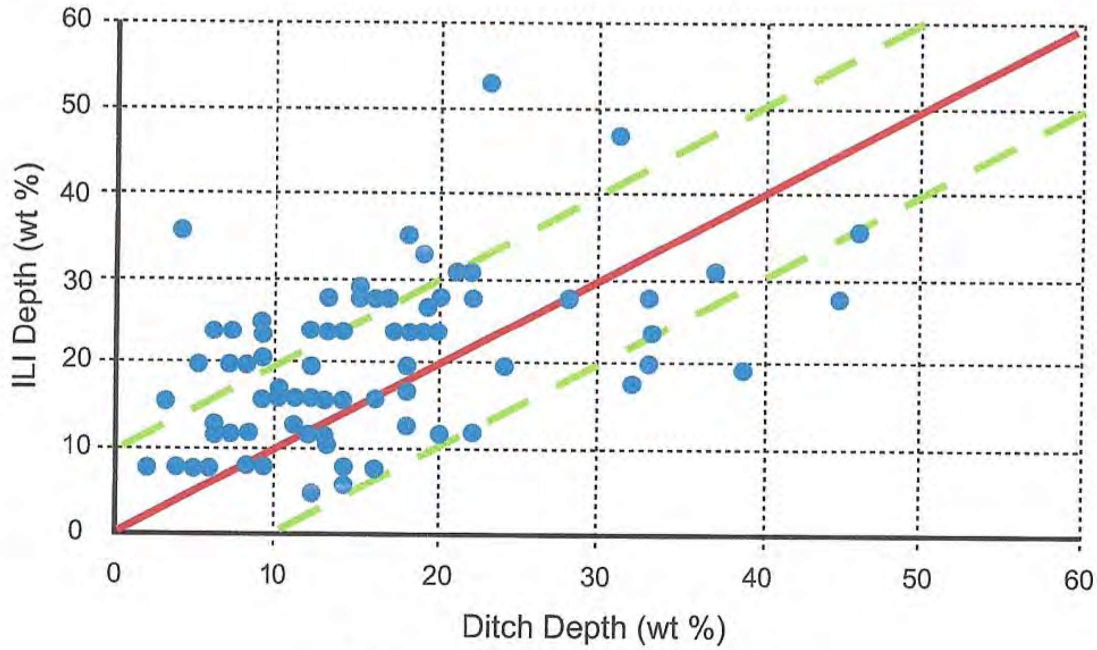


Figure C.1—Unity Chart Example

Figure C.1 is a typical example of a unity plot for pit, trench or other thickness loss features but similar plots can be prepared for measurements of individual cracks and midwall crack colonies.

When pipeline operators discuss In Line Inspection (ILI) and the resultant Integrity Management System (IMS) it is important to remember that all such activity is not equal. An IMS that relies on ILI data that is only validated to Level 1 or Level 2 may well not utilize data of high enough quality to assure pipeline safety. Even an integrity management program that utilizes data validated to Level 3 will not be successful unless the data is analyzed in a way that critical flaws are detected and promptly repaired by the pipeline operator. The critical flaw in Enbridge Line 6B was detected by numerous ILI runs according to PHMSA reports but it was not repaired because the models and criteria Enbridge used to trigger repair action were unrealistic. Ultimately, ILI data should result in lines that are flawed beyond realistic repair being shut down and replaced.

APPENDIX 3

FLOW Technical Advisory Team Line 5 Immediate Implementation and Action Plan for Enbridge Line 5 –

FLOW Science Advisory Team, August 31, 2015

The MPPTF issued recommendations, if implemented through immediate action, will aid risk reduction, safety, and water, environmental, and protection of public property and communities for pipelines in Michigan (*Michigan Petroleum Pipeline Task Force Report, July 2015*[1]) and the Enbridge Line 5 crossing at the Straits of Mackinac, in particular. MPPTF was launched by Governor Snyder and led by Attorney General Bill Schuette and DEQ Director Dan Wyatt. The report was a key MPPTF deliverable, and now the next step is to establish a high priority action plan to act promptly on the recommendations, especially those that are relevant or applicable to the completion of the specific recommendations for Enbridge Line 5.

This paper presents background information for an action framework to implement the recommendations for Line 5. Because of the high level of risk and high magnitude or unacceptable harm that the Enbridge Line 5 poses in and under the Mackinac Straits crossing segment, there are two basic categories of actions that need to implemented, in parallel, immediately:

A. **Convene, Conduct, and Complete the Alternatives Assessment** This will require involvement of multiple stakeholder groups and subject-matter experts. Although the alternative assessment could take some time to complete from the initiation to the implementation of the best alternative to eliminate the risk of a crude oil spill in the Straits of Mackinac, it should be undertaken immediately.

B. **Immediately Impose and Implement Stringent Measures to Reduce the High Level Risk to a Temporary Lower Risk Pending Completion of the Alternatives Assessment and Implementation.** This requires temporary measures that can be immediately imposed and accomplished, including temporary halt or reduction of flow of crude oil through Line 5 under the Straits segment necessary to remove transport of oil in Straits from "Tier 1" or unacceptable risk of high magnitude of harm, additional monitoring, staging of emergency response resources and personnel at the Straits capable of responding to an approved scenario for a major release, assessment of credible worst case release scenario, review and establishment of adequate financial assurance to cover a worst-case release; note that the temporary measures for response capability, and financial insurance and assurances must be maintained until the alternative option for risk elimination is fully implemented.

For convenience, the MPPTF recommendations are listed below in abbreviated form. As noted later in this Immediate Implementation Action Plan Report for Line 5 under the Straits of

[1] MPPTF Report

Mackinac, it should be noted that general recommendations 5, 9,11, 12, and 13 should be complied with in order to implement the specific Line 5 recommendations 1 through 4.

Straits Specific Recommendations

1. Prohibit transportation of heavy crude oil
2. Independent risk analysis and adequate financial assurance
3. Independent and comprehensive alternatives analysis and assessment
4. Obtain all necessary additional information from Enbridge to implement MPPTF Recommendations for Line 5.

Statewide Recommendations for Petroleum Pipelines in Michigan

5. (1) Coordinate mapping of existing pipelines
6. (2) Collaborate on emergency planning and spill response
7. (3) Coordinated emergency response training exercises and drills
8. (4) Regular consultation with federal Pipeline and Hazardous Materials Safety Administration (PHMSA)
9. (5) Consider legislation on oil spill response plans, reporting and robust civil fines
10. (6) Evaluate a Hazardous Liquids Pipeline Safety Program
11. (7) Consider legislation to improve new petroleum pipeline siting process
12. (8) Consider an Executive Order creating a Pipeline Safety Advisory Committee
13. (9) Create a continuing Petroleum Pipeline Information website

1. High or Unacceptable Risk - The Situation That Exists Today

Substantial risks have been identified within the MPPTF Report and other sources that place it in a "Tier 1" or unacceptably high risk category. Under these conditions standard protocol requires immediate action to (1) if possible reduce the risk below a so-called "Tier 1"[2] category pending implementation of final action; (2) assess, decide, and implement final action to eliminate the high or unacceptable risk. Accordingly, the following information is provided to understand the serious degree of risk and harm regarding the Line 5 segment under the Straits of Mackinac.

Oil and Gas, transportation, and insurance industry and government practices define and manage "risk" as a function of "probability" and "consequences" (risk = probability X consequences). The MPPTF Report highlights the catastrophic consequences of a leak from a Line 5 failure at the Straits. One component of risk, the probability of a leak or major failure is not addressed because Enbridge will not provide the MPPTF or stakeholders with adequate information to understand or determine the likelihood of a failure. Broad, overly optimistic comments by Enbridge on Line 5 operations and mechanical integrity do not standup to basic scrutiny by scientific, engineering and pipeline experts. Based on information that is available, such as other pipeline failures, assessments of failure modes and published probabilities, and pipeline integrity management programs, it is concluded that **the probability that a single or combination of failure modes could lead to a leak in the Straits is a "Tier 1" risk and**

2

<u>unacceptably high. This risk requires immediate temporary and long-term measures to eliminate this high unacceptable risk</u>.

Using the basic definition of "risk" as a function of "probability" and "consequences" (risk = probability X consequences), qualitative and quantitative risk assessments typically categorize risks into 3 tier levels. Required actions for the lowest risk, Tier 3 may include management procedures and close monitoring. Required actions for Tier 2, the medium tier, require elimination or at least a reduction to Tier 3 within 2 years and if an immediate reduction cannot be achieved; temporary measures to reduce the level to a Tier 3 during the mitigation period are required.

Industry actions for the highest risk level, <u>Tier 1, which is the current risk level for Line 5</u> at Straits Crossing, require one of two options.

Option 1: Immediately remove oil from transport through Line 5 in the Straits segment until the high unacceptable risk can be eliminated; or

Option 2: Immediately identify and implement temporary measures to eliminate, impossible, and if no alternatives exist to eliminate the risk; then reduce the risk (consequences, probability) until a permanent solution that eliminates the unacceptable risk is identified and in place. It should be noted as a matter of precaution, that temporary measures are typically not as effective as permanent measures, and are often based on monitoring and procedures that only temporarily mitigate the risk, but do not eliminate the unacceptable risk using inherently safe options or solutions. Approved temporary measures "buy time" for the Operator during the study, engineering and implementation periods for a permanent risk reduction solution.

Based on current information and the above, at present time, Option 2 is recommended as an approach for Line 5 under the Straits, unless at any time in the near future evidence indicates that the temporary measures are failing, insufficient, or there are additional or newly identified risks that render Option 2 no longer viable to mitigate risks to an acceptable level. In such event, Option 1, shutdown of the flow of oil under the Straits segment of Line 5, should be implemented immediately. Generally recognized risk management practice is to identify and reduce the current Tier 1 risk to a Tier 3 through the implementation of temporary measures. In other words, temporary mitigation to Tier 3 risks is not an acceptable final option, but is allowed if it reasonably can reduce risks from Tier 1 risks until a final option or solution is identified and implemented.

<u>2.</u> Immediate Action Plan to Implement Task Force Recommendations and Eliminate Unacceptably High Risk for Line 5

A. Alternatives Assessment

A key MPPTF recommendation is to conduct Alternatives Assessment, Recommendation # 3[1]. An Alternatives Assessment or an "analysis of alternatives" is used to identify, analyze and develop options for risk elimination or reduction. The approach is used to address a wide range of issues including private and government sector infrastructure, facilities, environmental protection, protection of public health, safety, property and communities, and establishment of sustainability projects. The purpose of an Alternatives Assessment is to move beyond the justification of a single alternative, in this case the existing Line 5 Straits Crossing, which continues the underlying conditions and circumstances that result in a high risk category, to an exploration of multiple options to establish the best possible option in a rational defensible manner, which considers all stakeholder requirements for risk, uncertainty, and citizen, environmental, public safety, and public and private property protections.

The Alternatives Assessment will address or require information from several of the MPPTF recommendations, including Straits specific Line 5 recommendations 3 and 4, and statewide recommendations 5, 9, 11, 12, and 13. To identify and analyze possible options, work groups must be established and composed of stakeholders, qualified and independent subject matter experts, government and industry and company personnel. The assessment would identify all feasible alternatives, such as continued use of Line 5, other interstate and/or Canadian pipelines, different shipping modes, restriction of transportation to low environmental impact petroleum materials (NGL's or other lower risk products only), continuation of current operations and etc. After evaluation of this list of alternatives, a shorter-list of alternatives is developed; this short list is they evaluated, studied and analyzed in-depth analysis for feasibility, prudence, safety, health, and impacts on water and natural resources, environmental impact, communities, private and public property, infrastructures, facilities, services, and private and public property and their public and private uses, including commercial and recreational.

Based on the high Tier 3 or unacceptable risk of the Line 5 segment under the Straits, the state should establish immediately, not later than 90 days, an qualified independent board to identify and implement the Alternatives Assessment; the board should be charged with completion of its task as soon as reasonably appropriate, but not later than customary time frames for the risks and circumstances. On completion of the Alternatives Assessment, the alternative identified that eliminates or substantially reduces the unacceptable risk should be implemented.

Because an Alternatives Assessment also require independent risk analysis, including worse-case scenarios, and additional information from Enbridge or others, those recommendations, such as MPPTF specific recommendation 1 and 3, and state-wide recommendations 5, 9. 11, 12, 13 should be implemented simultaneously with the establishment of the Alternatives Assessment. The information and results should be provided to the Alternatives Assessment board.

As noted above and described in section B below, all required interim or temporary measures that are required to reduce the risk below a Tier 1 risk should me immediately identified, implemented, and in place pending completion of the Alternatives Assessment process.

A simplified process diagram for an Alternatives Assessment is presented in the attached **Appendix C.**

B. Immediate Identification and Implementation of Temporary Measures

Actions to reduce the existing Tier 1 risk at the Straits to at least a temporary Tier 3 level during the period when the alterative assessment is completed and a permanent solution identified and implemented are mandatory and normal industry practice. Specific temporary actions can be categorized as follows:

1. Limit the petroleum mix transported to lower environmental impact materials;
2. Establish safer operating conditions and set limitations;
3. Determine credible release scenarios for monitoring and emergency response;
4. Establish continuous monitoring for leaks and pipeline damage; and
5. Put in place a strong, local emergency response capability

1. Limit the petroleum mix transported to lower environmental impact materials [3]

Straits Specific Recommendation # 1 in The MPPTF Report prevents the shipment of heavy crude oil through Line 5. This action will prevent the shipment of the heavy tar sands and diluted bitumen grades of crude oil which are not currently transported in Line 5 and which Enbridge had previously stated that they have no plans for.

Currently, Line 5 transports natural gas liquids and crude oil. Restricting or limiting the petroleum mix to NGL's only would reduce unacceptable risk of harm and damage to a Tier 3 risk. NGL's if released at the Straits would evaporate or could be burned off the water-surface; shoreline and subsurface damage would be lower compared to a crude oil release. A safety risk would obviously still exist and be subject to all required and the other additional temporary measures.

2. Establish safer operating conditions and set limitations[4]

Several physical changes (installation of new pumps, valves, control systems and etc.) and operating condition changes (flow rate, pressure, temperature and etc.) have been made over the years upstream and downstream from Line 5 Straits Crossing. Current operations should be returned to conditions close to the less severe original design conditions to lower the risk for pipeline failure. The physical and operating changes implemented since Line 5 was installed can then be evaluated for risk and compliance to all management-of-change, notification and permitting requirements.

3. Determine credible release scenarios for monitoring and emergency response

[3] Ed Timm reference
[4] Ed Timm reference

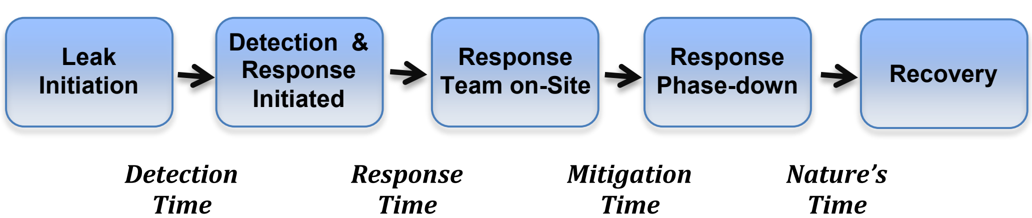
There are at least 2 basic release cases to consider for safety, environmental, community, public and private property and uses protections and response. Detailed, vetted and preferably state regulatory or otherwise legally and scientifically recognized scenarios should be developed for:

> a) Releases (leaks) below the detection threshold for the pipeline leak detection system and operating procedures[5]
>
> b) A "credible worst-case scenario" release from an accident, system failure or natural disaster

Recognized good engineering and emergency response practices for safety and environmental protection address the impact of events that can occur below the detection limits or accuracy of measurement, material balance and control systems. Typical measurement system accuracy for process and pipeline systems is +/- 1.0% to 1.5% of total flow. Given a daily Line 5 flow rate 23 million gallons, this could result in an undetected leak of 230,000 to 345,000 gallons per day. Environmental impact evaluations or assessments use 90 days or less as the period from leak initiation to eventual detection by the operator or a citizen. Discovery is often finding the presence of the spill on the shoreline of a lake or river. For the Straits, the winter ice cover and the absence of people along shorelines increases the probability that a leak below the system detection threshold could occur over a long time period.

An approved "credible worst-case scenario" (WCS) is essential information used in developing emergency response plans and putting resources in place. Current regulatory requirements for calculating a pipeline WCS are inadequate compared to EPA regulations for the refinery and chemical process industries. Several recent pipeline failures and releases are evidence that the failures greatly exceeded the planning scenarios, response plans and resources that were put in place by the pipeline operators. After investigation and corrective actions, the operators return to unrealistic worst-case scenarios, resulting in continued under estimation of planning and response requirements.

Using the release scenarios, the overall objective is then to minimize time lags. These time lags are:



"**Detection time**", the time from leak initiation to detection and initiation of response can be potentially long for leaks that are below the system detection threshold. Detection typically results from citizen reports on safety concerns or observation of environmental damage. For large spills, detection time is affected by Operator confidence in instrument and control systems and management, decision-making procedures.

---

[5] Gary Street reference

"**Response time**", starts when the alarm is sounded and the necessary resources arrive on-the-scene. Obviously, the more remote the incident is from resources, resource availability and required type all affect the response time.

"**Mitigation time**" covers the time to stop the leak and complete the cleanup protocol. Oil spill cleanup depends on the composition of the material released, resources available, geography and terrain, on-shore, offshore and weather conditions. Time to cleanup can range from months to years and the results are often superficial and ineffective in rough terrain and offshore areas.

"**Nature's time**" is the period required for natural processes to decompose the petroleum products and for the environment to recover. This period can be generations long in areas such as Northern Michigan where temperatures and biological activity to degrade residual crude oil is very low greatly extending the recovery time.

4. Establish continuous monitoring for leaks and pipeline damage

Normal industry practice, operating company senior management, regulatory agencies and stakeholders demand the implementation of temporary measures to reduce a Tier 1 risk to an interim acceptable level until a permanent solution is in place. "Business as usual" or cursory actions are not acceptable for a Tier 1 risk. Immediate interim actions need to be identified based on input from stakeholders; Enbridge, regulators and these actions should be approved, verified and routinely audited by the State.

Examples of measures that should be implemented include but are not limited to the following with the objective of reducing the critical "detection time" and as an additional layer-of-protection for existing detection system deficiencies:

- Increased oversight of control room operations specifically for Line 5, implement more effective, rapid, fail-safe decision-making processes
- Regulatory agency approved and audited maintenance integrity, calibration and management-of-change processes for Line 5 leak detection and emergency operation equipment (instrumentation, values, back-up electrical systems and etc.). In other words, implement "general duty" requirements as practiced by operators of high hazard processes such as under the Clean Air Act
- Implement daily physical-manual, on-the-scene shoreline and offshore inspections for evidence of spills in high probability areas as determined by modeling and stakeholder input
- Implement weekly physical-manual inspections for evidence of spills in the lower probability areas
- Physical shoreline and offshore inspection during winter conditions meeting daily and weekly requirements as noted above using special inspection processes for ice cover

- Increase underwater inspections (weekly/monthly) using remote-operated vehicles (CCTV/video) to detect Line 5 anomalies, damage, leaks and etc. to reduce the time from leak initiation to detection
- Issue quarterly updates on all near misses, anomalies, shutdown system activations, and challenges to the safety systems and actual incidents to appropriate Michigan regulatory agencies. This may not be required by current law but would be appropriate for an operator with a Tier 1 risk.

5. Put in place a strong, local emergency response capability

The MPPTF Report provides excellent comments and recommendations on information sharing, emergency planning and response. The large drill scheduled for September 2015 at the Straits is a very important element for protection of the Great Lakes. But it is also important to recognize that emergency response is used when a large spill has already occurred and in most cases, the response is limited in effectiveness in preventing widespread environmental damage.

- Extensive planning has occurred with Enbridge, the US Coast Guard, contractors and public sector response agencies for the September 2015 drill based on news reports. As detailed public information is generally not available, subject matter experts from other stakeholder and environmental groups are not in a position to provide input to the drill. **It will be important for these stakeholder groups to have access to the information from the "drill hot-wash" and final conclusions to enable them to participate in developing recommendations for improvement.**

- **For effective response planning, resource allocation and public awareness and approval, it is vital that realistic, credible worst-case scenarios be defined and the alignment and effectiveness of the emergency response plans analyzed and adjusted.**

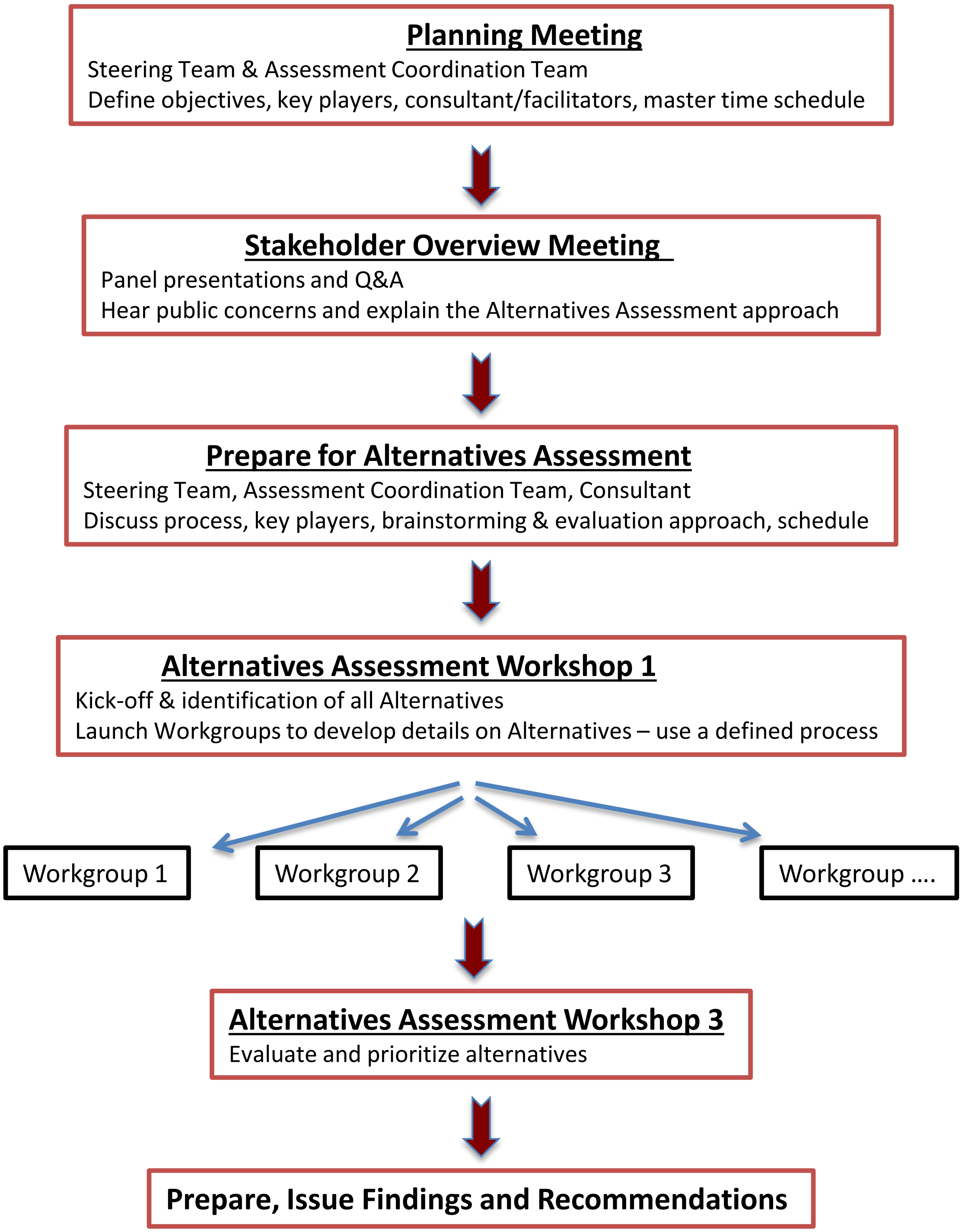
- **Defining the different spill scenarios that need to be addressed and aligning and effective response plan for each scenario is vitally important.** The public should also have information on the maximum response capability and the effectiveness in attacking the "credible worst-case scenario" release. This is a very important scenario that needs to be communicated, understood and available for comment by all stakeholders. Current regulatory requirements allow pipeline operators to calculate worst-case scenarios using their assumptions which take "mitigation credit" for the functioning of instrumentation, control and mechanical systems and procedures that are not 100% reliable and subject to single mode and common cause failures. Essentially, pipeline operators use "best case" reaction scenarios for planning and public relations and not worst-case. This approach is not allowed for other industrial sectors managing hazardous operations and several recent major spills greatly exceeded the previously publically available information on the worst-case scenarios.

- **A specific integrated contingency plan (ICP) should be developed for Line 5 in the Strait area and made available in an un-redacted version.** The Enbridge ICP covers the "Superior Region" and appears to meet regulatory requirements but it is not specific enough, or easily analyzed or useful due to the redaction of detailed information and the shear scope and coverage of the ICP. ICP information for other hazardous industries is available to the public when it is required for emergency planning and the information is not redacted when required to be made available under citizen and community right-to-know rules. Security specific information can be redacted when required by regulation and vetted as appropriate by the Federal agencies. The extensive redaction of the Enbridge ICP is not a normal industry practice and may violate regulatory processes.

- **Because Line 5 at the Straits is a Tier 1 Risk – extensive emergency response capability should be in place, locally for immediate response.** "Business as usual" in the Straits Crossing and management using a "regional ICP" for a Tier 1 risk not a normal or recommended practice. Extra-ordinary response resources, equipment and personnel should be continuously in place at the Straits as an interim risk reduction measure until the permanent solution defined by the Alternative Assessment is fully implemented.

- In the future, full exercises should be required at the Straits not less than every 18 months as defined in US Coast Guard regulations for high hazard operations.

Alternatives Assessment Process



Appendix 3-B

Excerpt from MPPTF Final Report - July 2015

Attorney General Bill Schuette and DEQ Director Dan Wyant

Specific Recommendations regarding the Straits Pipelines

1. Prevent the transportation of heavy crude oil through the Straits Pipelines.
2. Require an independent risk analysis and adequate financial assurance for the Straits Pipelines.
3. Require an independent analysis of alternatives to the existing Straits Pipelines.
4. Obtain additional information from Enbridge relating to the Straits Pipelines.

Statewide Recommendations

1. Coordinate mapping of existing pipelines among state agencies.
2. Ensure that state agencies collaborate on emergency planning and spill response.
3. Ensure coordinated emergency response training exercises and drills.
4. Ensure regular state consultation with the federal Pipeline and Hazardous Materials Safety Administration (PHMSA) on hazardous liquid (including petroleum) pipelines.
5. Consider legislation requiring state review and approval of oil spill response plans, improved spill reporting, and more robust civil fines.
6. Evaluate whether to establish a Hazardous Liquids Pipeline Safety Program in Michigan.
7. Consider legislation or rulemaking to improve siting process for new petroleum pipelines.
8. Consider issuing an Executive Order creating an Advisory Committee on Pipeline Safety.
9. Create a continuing Petroleum Pipeline Information website.

APPENDIX 4

A SCIENTIFIC AND LEGAL POLICY FOLLOW-UP REPORT ON CRUDE OIL PIPELINES IN THE GREAT LAKES

Oil Spill in the Great Lakes?

How Safe Are The Pipelines?

Two aging pipelines owned by Enbridge Energy run across the Straits of Mackinac on Lake Michigan bottomlands, transporting 23 million gallons of oil daily. A University of Michigan study called it *"the worst possible place" in the Great Lakes for an oil spill*.

A presentation by Dr. Ed Timm, PhD

"Using Enbridge's own data I calculated that the non-Straits sections of line 5 have, on the average, lost 45% of their wall thickness due to internal and external corrosion."

Dr. Timm, a retired chemical engineer from Dow Chemical, will discuss the design and condition of Enbridge Line 5 oil pipeline which runs the entire length of Michigan. Carrying oil from Canada and North Dakota, Line 5 traverses at least 45 Michigan waterways before it crosses the St. Clair River to a refinery in Sarnia, Ontario, Canada.

Tuesday, August 4, 6:30 PM

Charlevoix Public Library

220 W. Clinton St., Community Room B

Sponsored by: Friends of the Jordan River Watershed, WATCH (Water Air Team Charlevoix)

Regarding the Design and Condition of Enbridge Energy Partners Line 5 and Straits of Mackinac Crossing

Edward E. Timm, PhD, PE
Harbor Springs, Michigan
EdTimm@gmail.com   231-526-7159

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Edward E. Timm, PhD, PE

- BS, MS, PhD in Chemical Engineering from University of Michigan
- Licensed Professional Engineer, Michigan
- Retired as Senior Scientist, The Dow Chemical Company after 27 years
- 26 US Patents
- Expertise in all areas of chemical engineering with an emphasis on innovation, design, troubleshooting and new business analysis
- Hands on experience with most petrochemical and refinery processes
- Last years of Dow career devoted to Environmental Operations and cleanup technology

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Sources of Information

Enbridge Energy Partners Limited, Operational Reliability Plan, Line 5 and Line 5 Straits of Mackinac Crossing, Issued 2014

Michigan Public Service Commission, Opinion and Order D-3903-53 1, Issued march 31, 1953

Michigan Conservation Commission, Straits of Mackinaw Pipeline Easement to Lakehead Pipeline Company, April 23, 1953

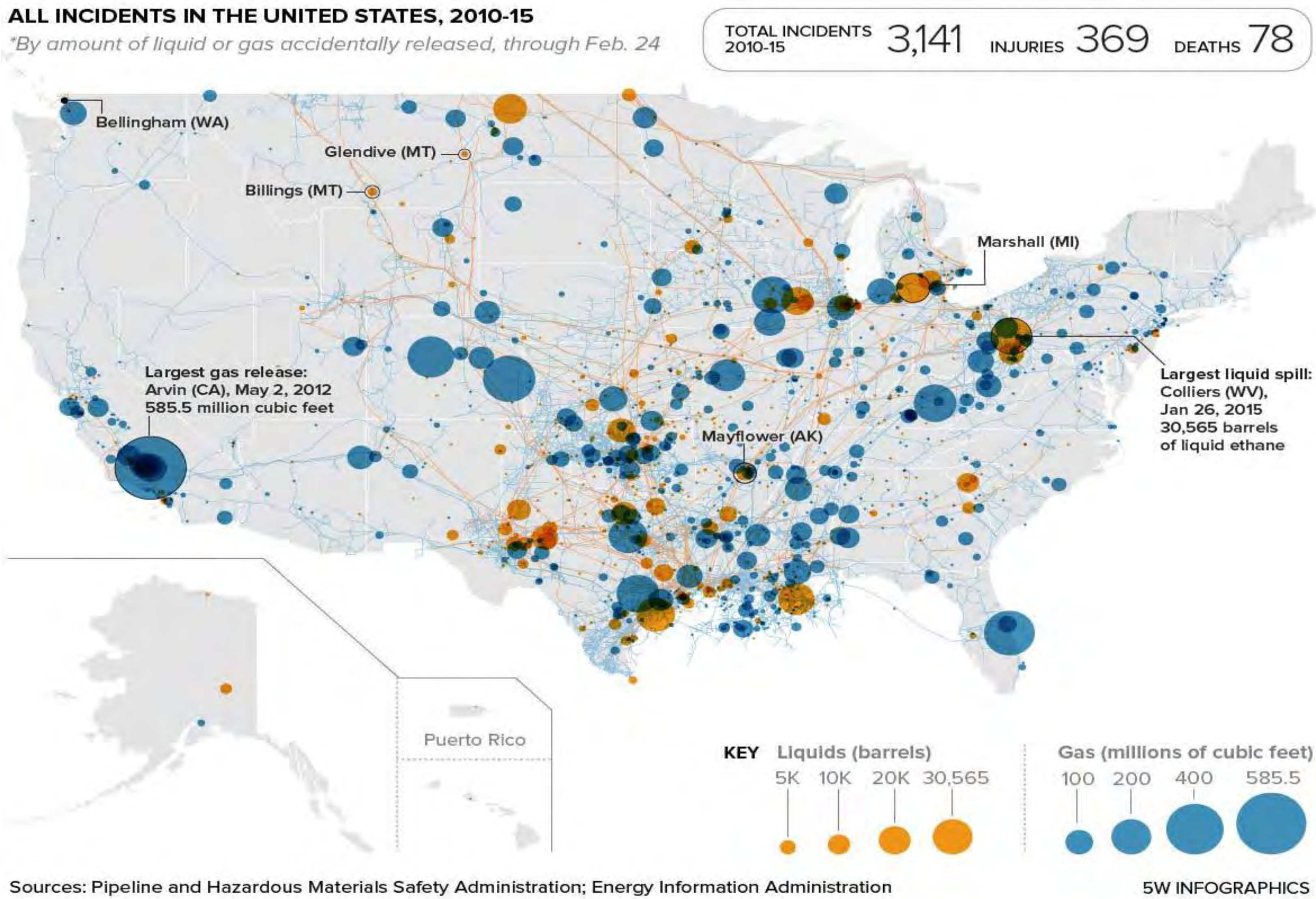
“Engineering and Construction Considerations for the Mackinac Pipeline Company’s Crossing of the Straits of Mackinac” and “Report on the Structural Analysis of the Subaqueous Crossing of the Mackinac Straits,” submitted by Mackinac Pipeline Company/Lakehead Pipeline Company to the Michigan Department of Conservation, January, 1953

Openly published Enbridge documentation

Information obtained by FLOW from the State of Michigan under FOIA

Numerous technical publications, both current and those available in 1953

Pipeline Failures Since 2010



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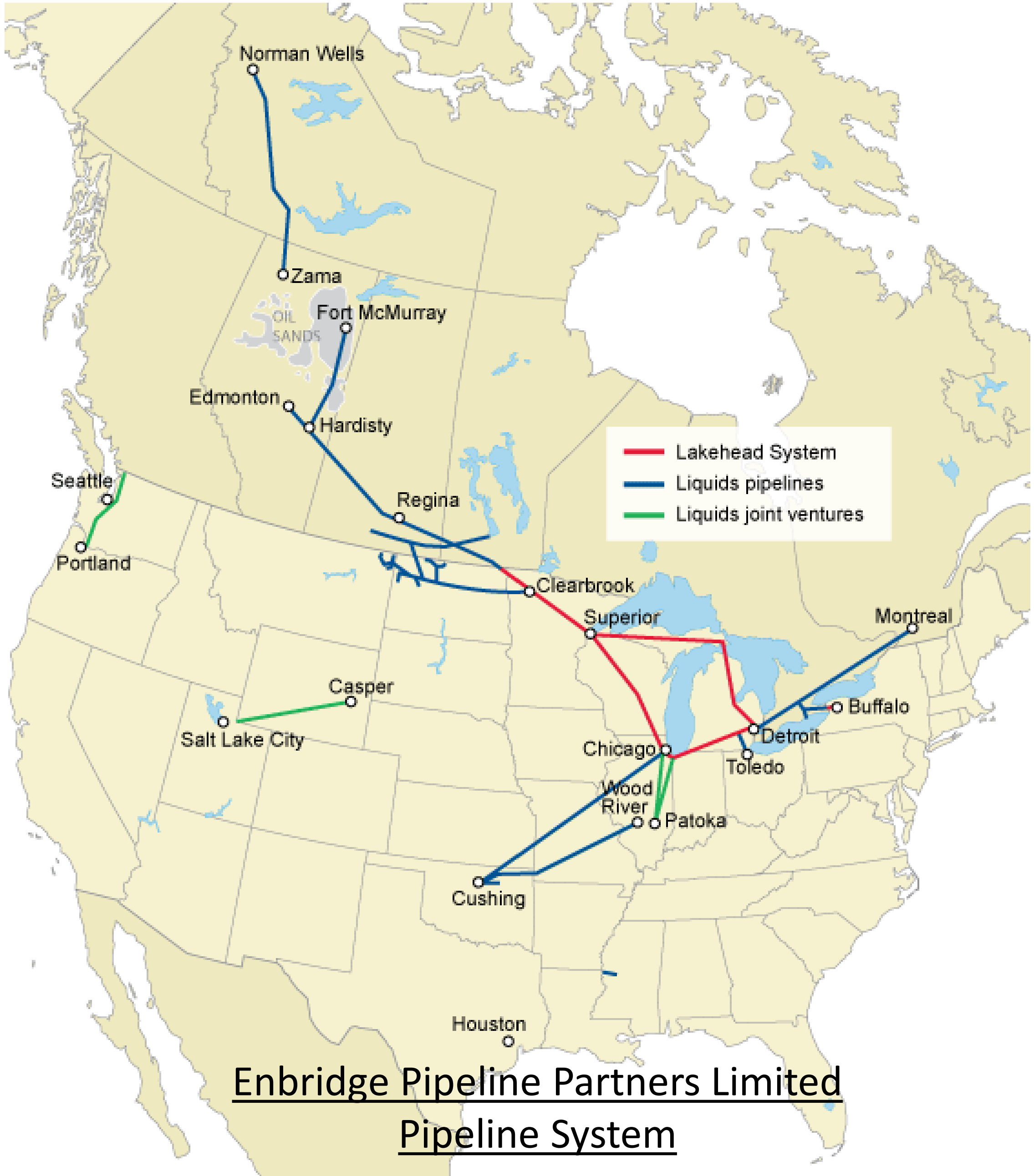
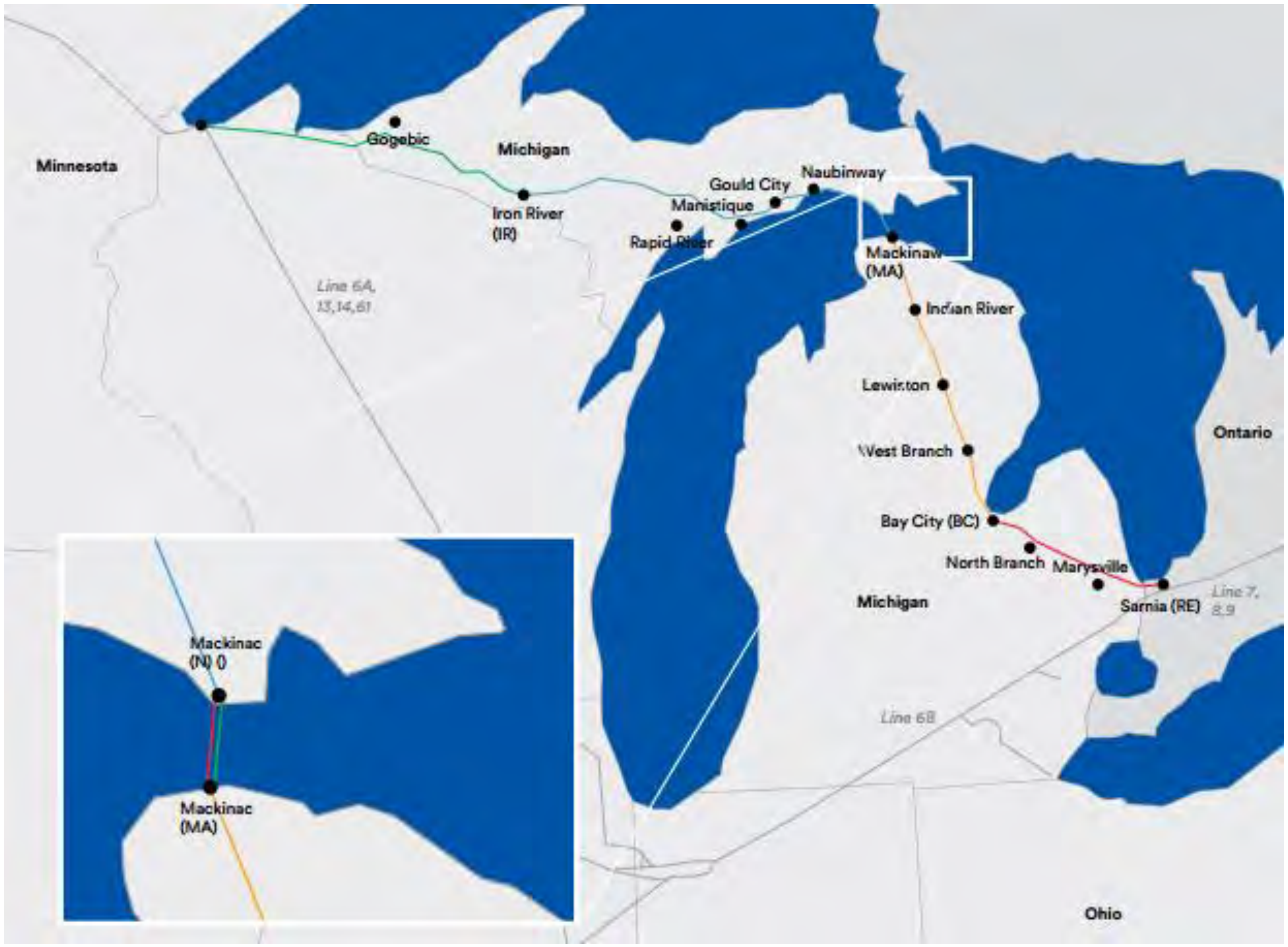


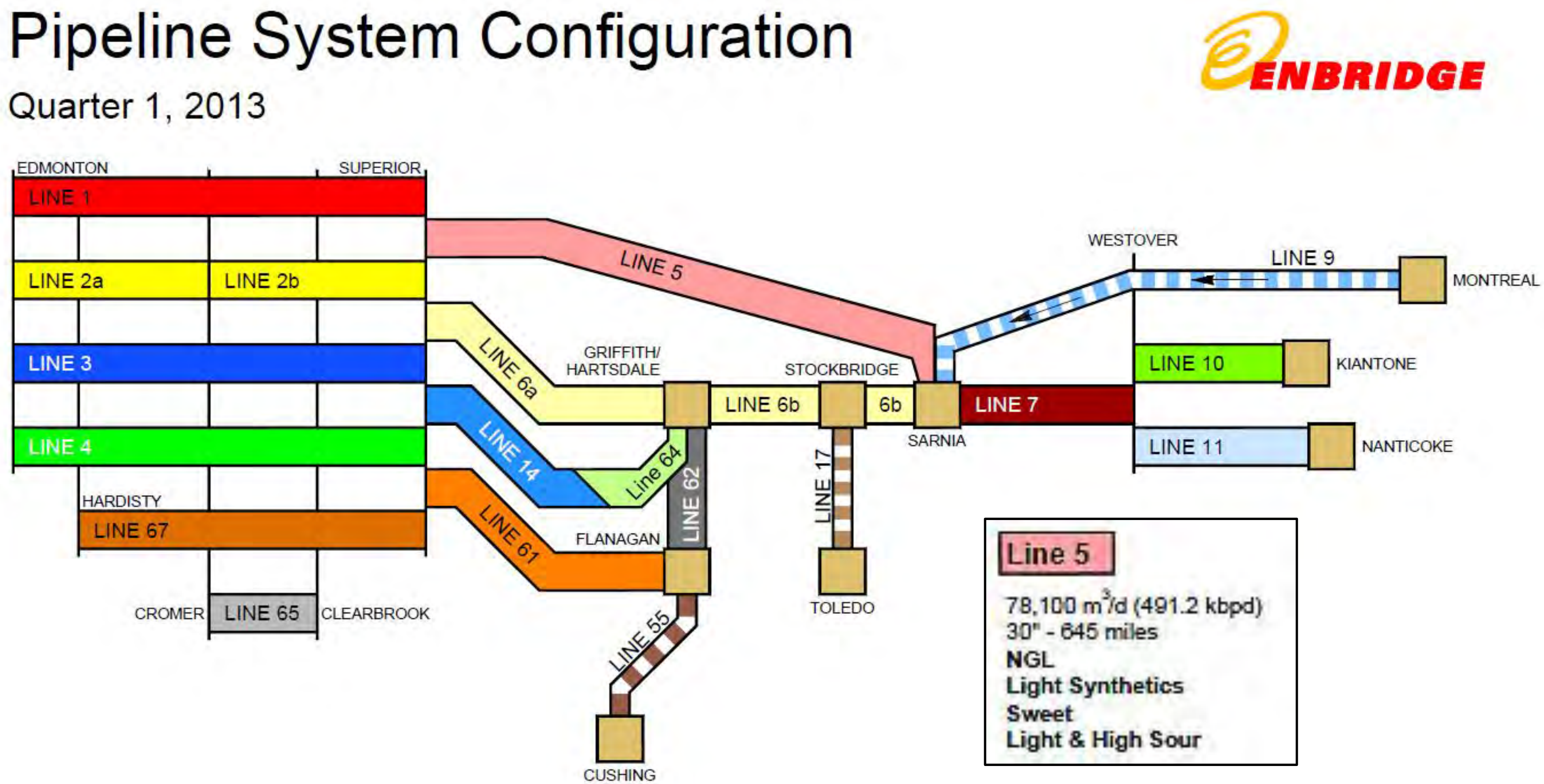
Enbridge Pipeline Partners Limited Pipeline System

A-124

Enbridge Line 5, Michigan Route and Pump Stations



Where and What Does Line 5 Transport?



1953 Easement and MPSC Order Do Not Restrict Line 5 Cargo

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Rapid River Pump Station and LPG Extraction Facility

Enbridge Energy Limited Partners Line 5

MPSC Order D-309-53.1 of 3/21/1953 Excerpts

"Lakehead Pipeline Company, Inc. is a common carrier for the transportation of oil and petroleum in interstate and foreign commerce.

Pipeline to transport oil from Redwater Area, Calgary, Alberta

No pumping stations to be built in 1953 but in the future there may be stations at:

Watersmeet, Gegobic County,
Gulliver, Schoolcraft County,
Indian River, Cheboygan County,
Bay City, Bay County.

The capacity of the line with no pumping stations in Michigan will be **120,000** barrels/day and when all of the four pumping stations are completed and in operation the capacity will be **300,000** barrels/day."*

- **As of 2012 Line 5 was rated at 490,000 barrels/day using 12 pump stations. How and when the capacity was raised to this level from the design level of 300,000 is not currently known.**
- **In 2013 the capacity of Line 5 was raised to 540,000 barrels/day and the pump stations were extensively upgraded. Line 5 is now operating at 80% higher flow than design.**

The Straits of Mackinac
A Difficult Crossing

A-129


BECHTEL


PITTSBURGH TESTING LABORATORY
PITTSBURGH TESTING LABORATORY
MOBILE RADIOGRAPHIC UNIT 4


IDENTIFIED with EXPERIENCE
in ENGINEERING CONSTRUCTION
ENGINEERING CONSTRUCTION DIVISION
MERRITT-CHAPMAN & SCOTT CORPORATION

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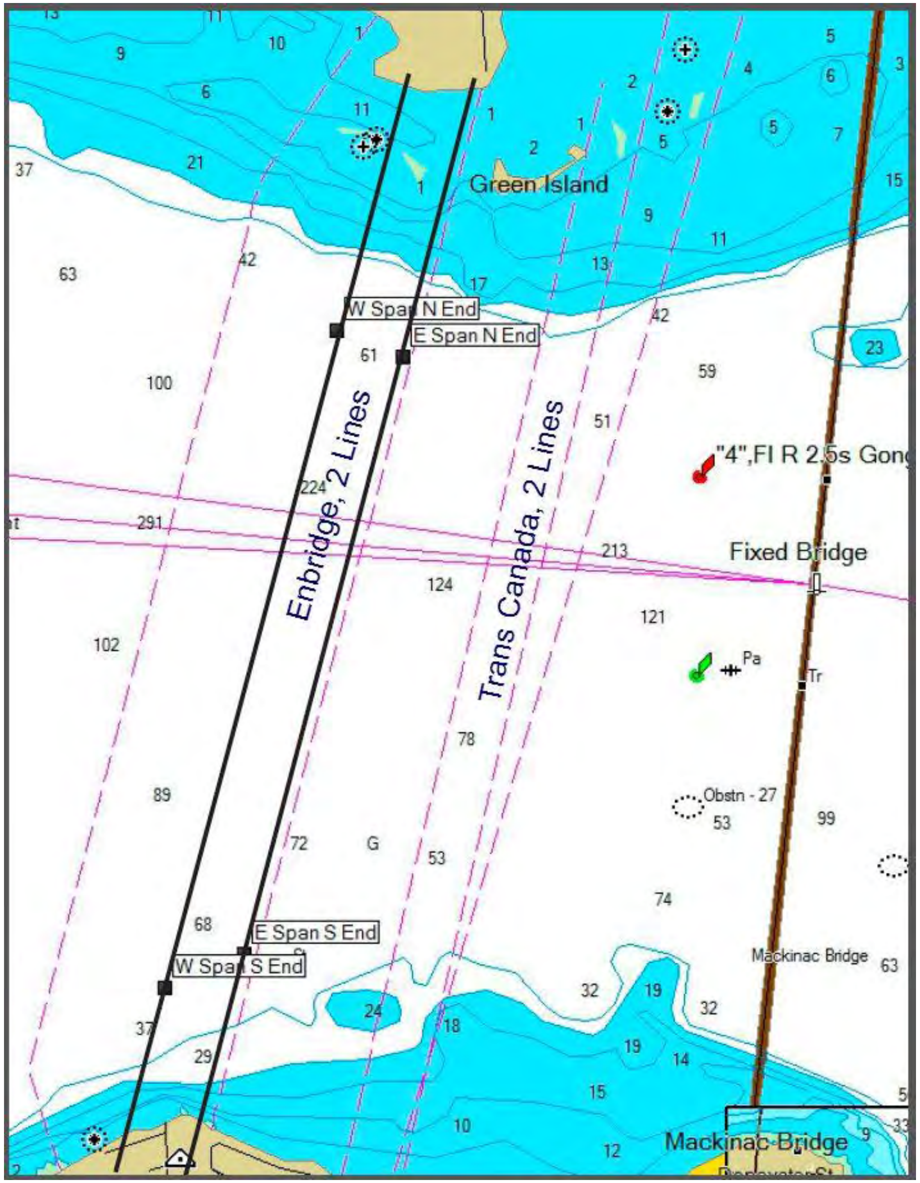
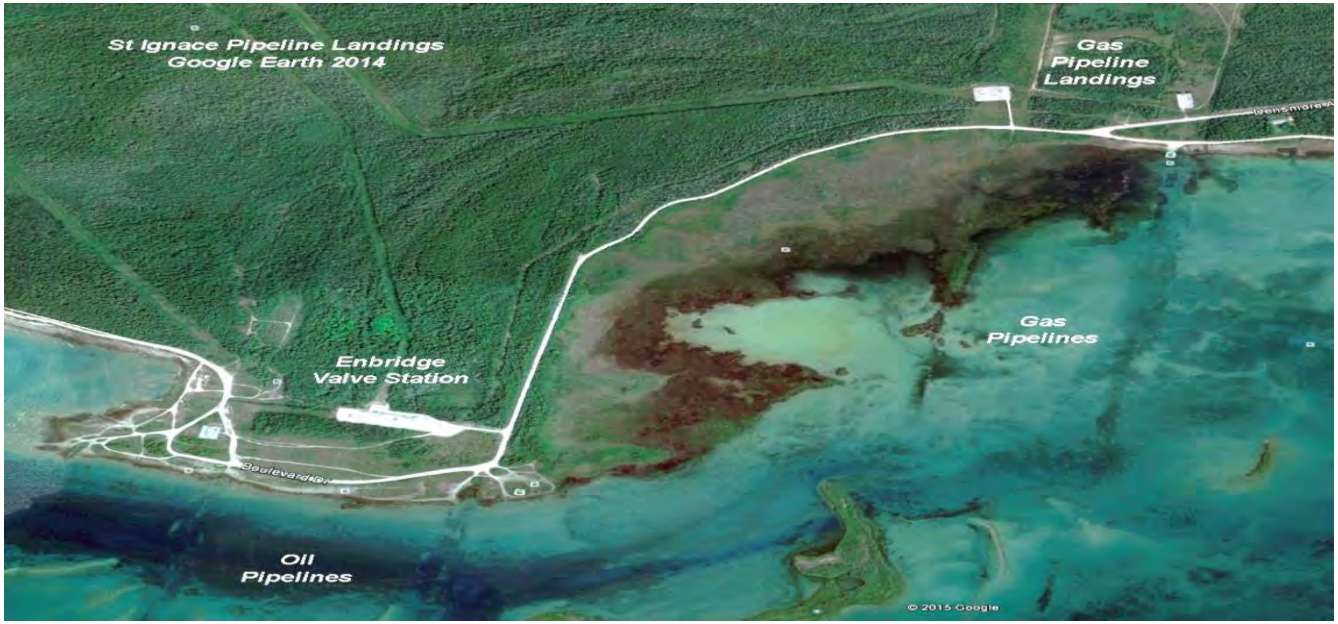
Straits of Mackinac

Two Oil Pipelines, Two Natural Gas Pipelines, Two + Cable Crossings



A-131


St Ignace Pipeline Landings
Google Earth 2014
Gas
Pipeline
Landings
Enbridge
Valve Station
Gas
Pipelines
Boulevard Dr
Oil
Pipelines
© 2015 Google


Mackinaw City Pipeline Landings
Gas
Pipelines
David Dr
Enbridge
Pump
Station
Ridge Rd
Wenniway Rd
Valley Dr
W Central Ave
Gas
Pipeline
Landings
© 2015 Google

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Naubinway Pump Station

35 Miles to St Ignace

Mackinaw City Pump Station

48 Miles to Wolverine

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Wolverine Pump Station

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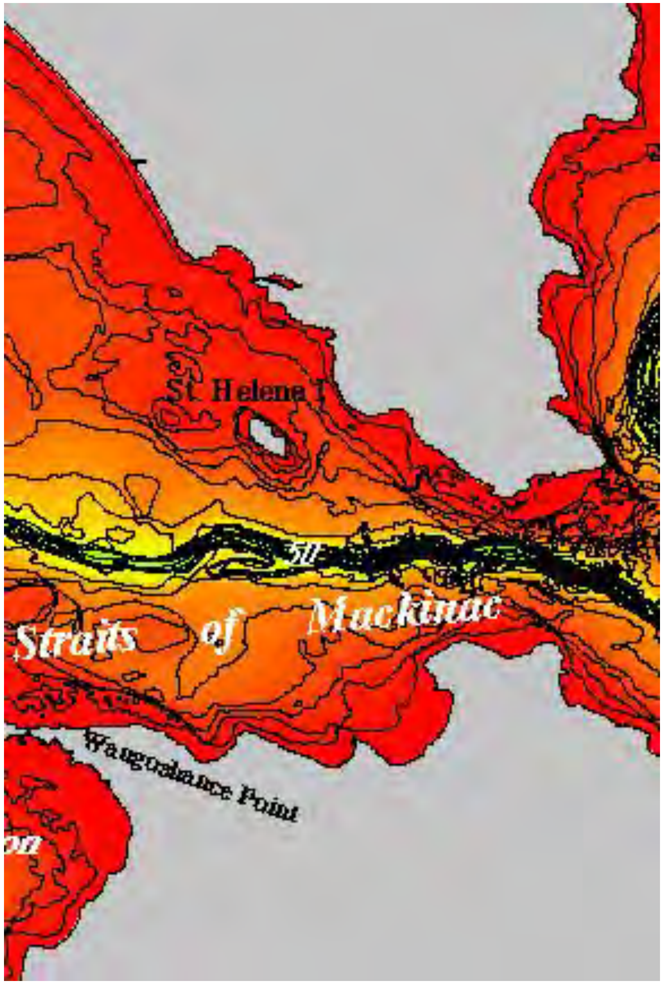
Bottomlands of the Straits of Mackinaw



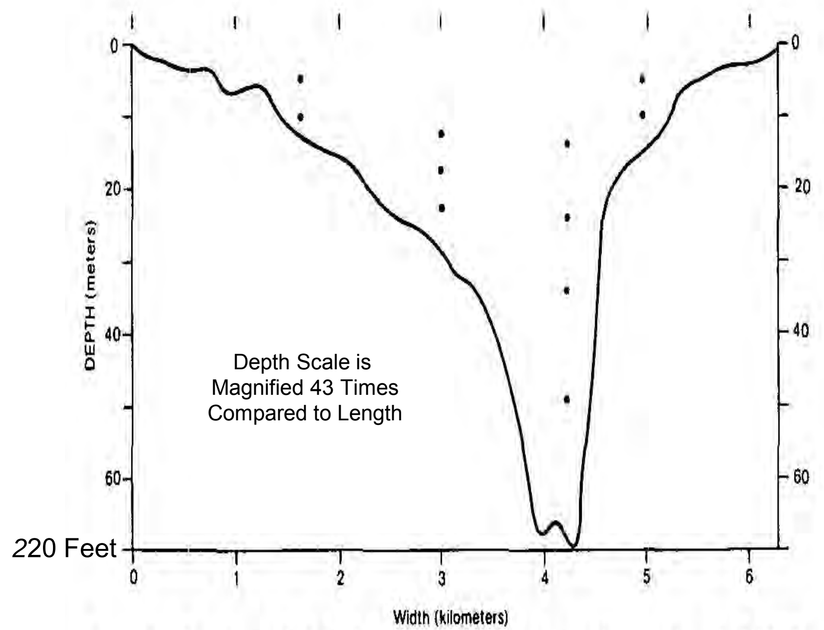
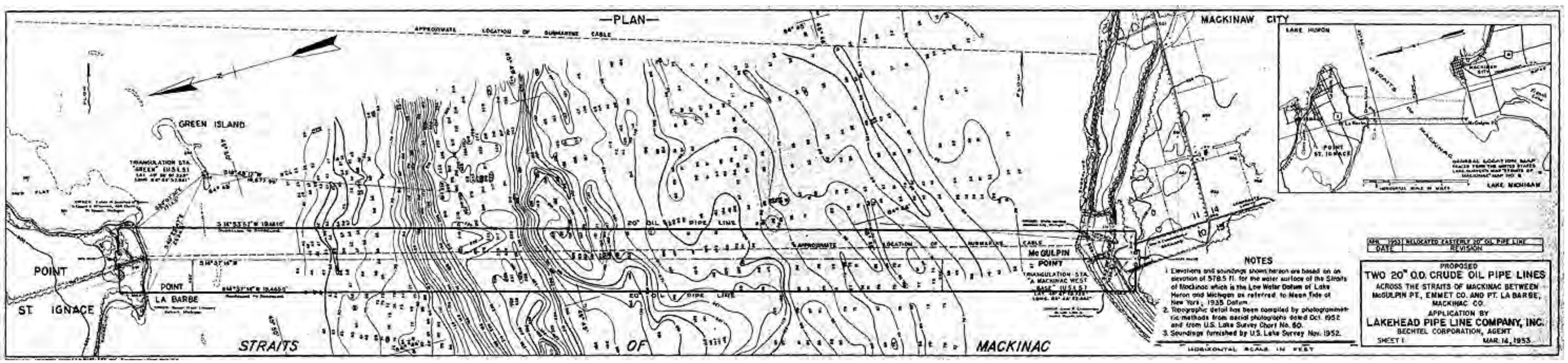


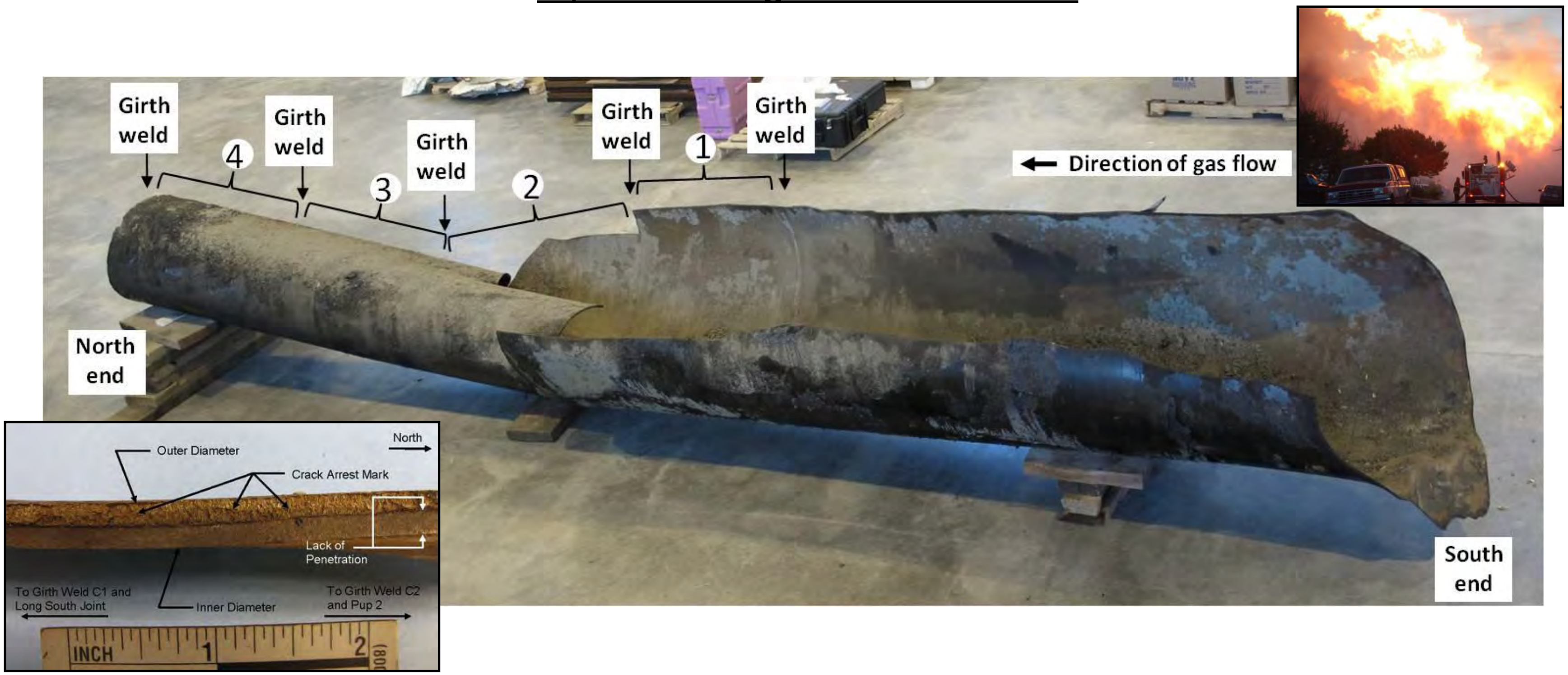
FIG. 2. Straits of Mackinac cross section along the 84°45′W meridian showing current meter configuration.

A-136

Pipeline Location Chart from 1953 Easement



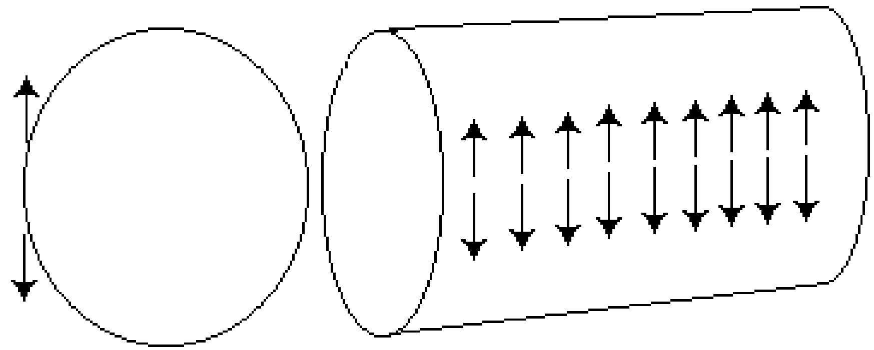
Pipeline Design Considerations



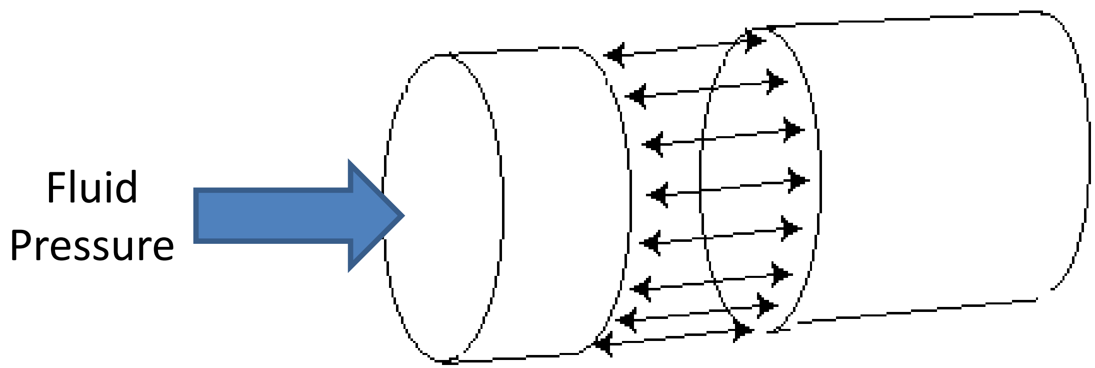
PG&E San Bruno Gas Pipeline Failure - Eight Dead

In January 2011, federal investigators reported that they found numerous defective welds in the pipeline.
The thickness of the pipe varied, and some welds did not penetrate the pipes completely.
As PG&E increased the pressure in the pipes to meet growing energy demand, the defective welds were further weakened until their failure. As the pipeline was installed in 1956, modern testing methods such as X-rays were not available to detect the problem at that time. (Incorrect regarding X-ray availability, ET)

Stresses in a Pipe Caused by Internal Pressure

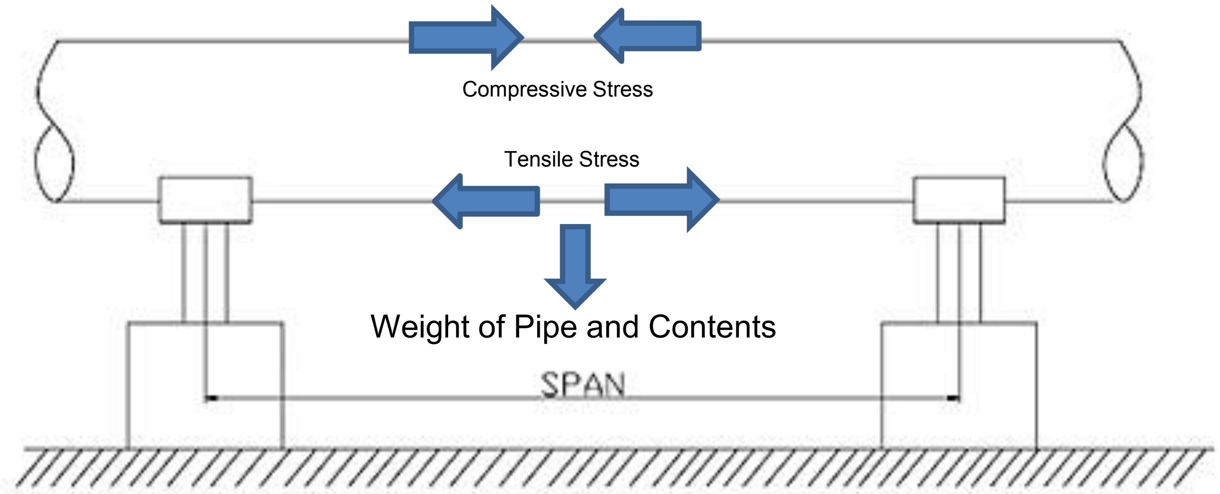


Circumferential Stess or Hoop Stress



Longitudinal Stress or Axial Stress

Bending Stress in a Supported Pipeline
Due to Weight of Pipe and Contents



Tensile Stress on Bottom and Compressive Stress on Top between Supports
Compressive Stress on Bottom and Tensile Stress on Top at Supports

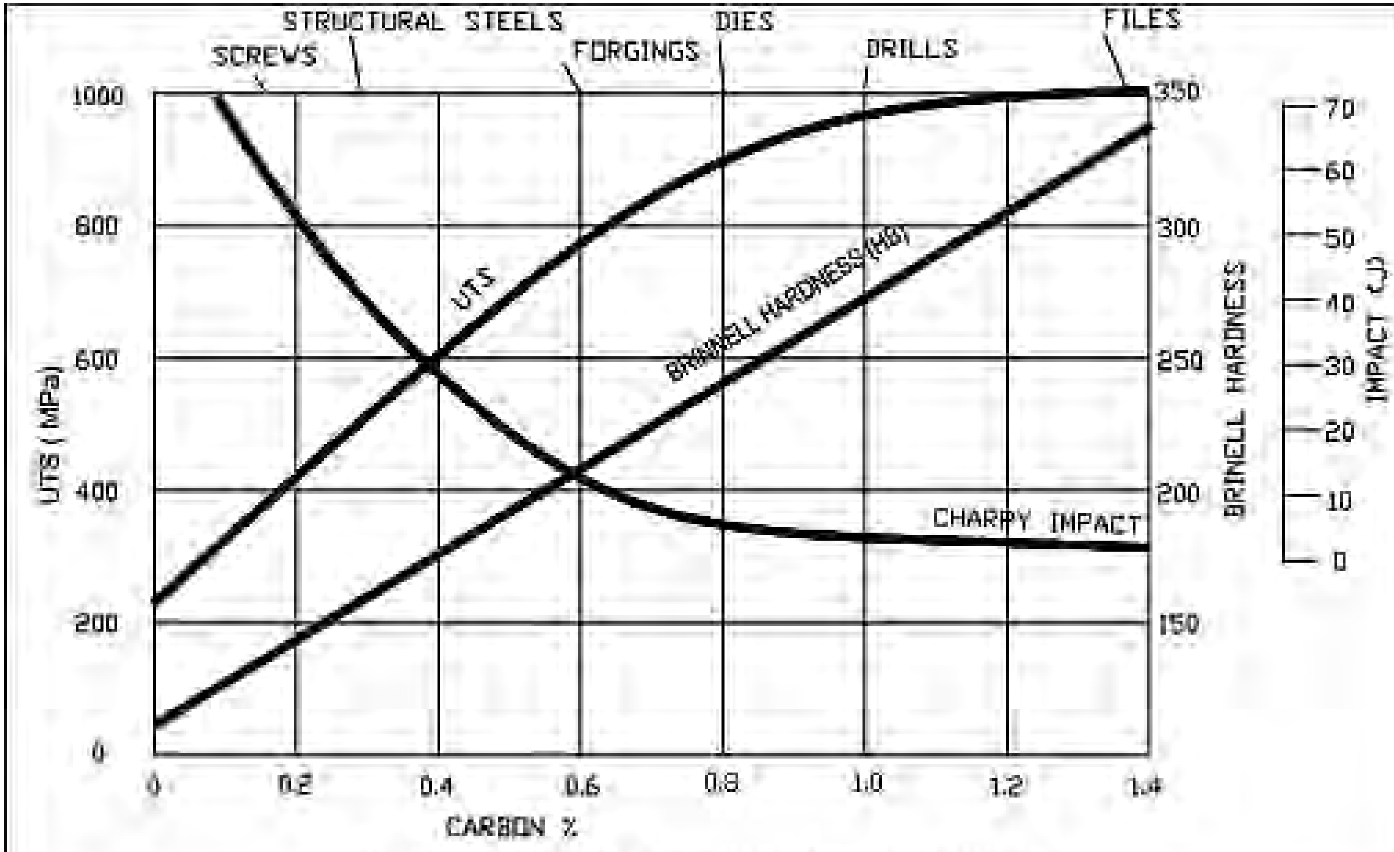
1953 Easement Support Requirement

(10) The maximum span or length of pipe unsupported shall not exceed seventy-five (75) feet.

Iron and Carbon = Steel

1953 Easement Restriction

(12) The maximum carbon content of the steel from which the pipe is manufactured shall not be in excess of 0.247 percent



STEEL -- EFFECT OF DIFFERENT CARBON CONTENT.

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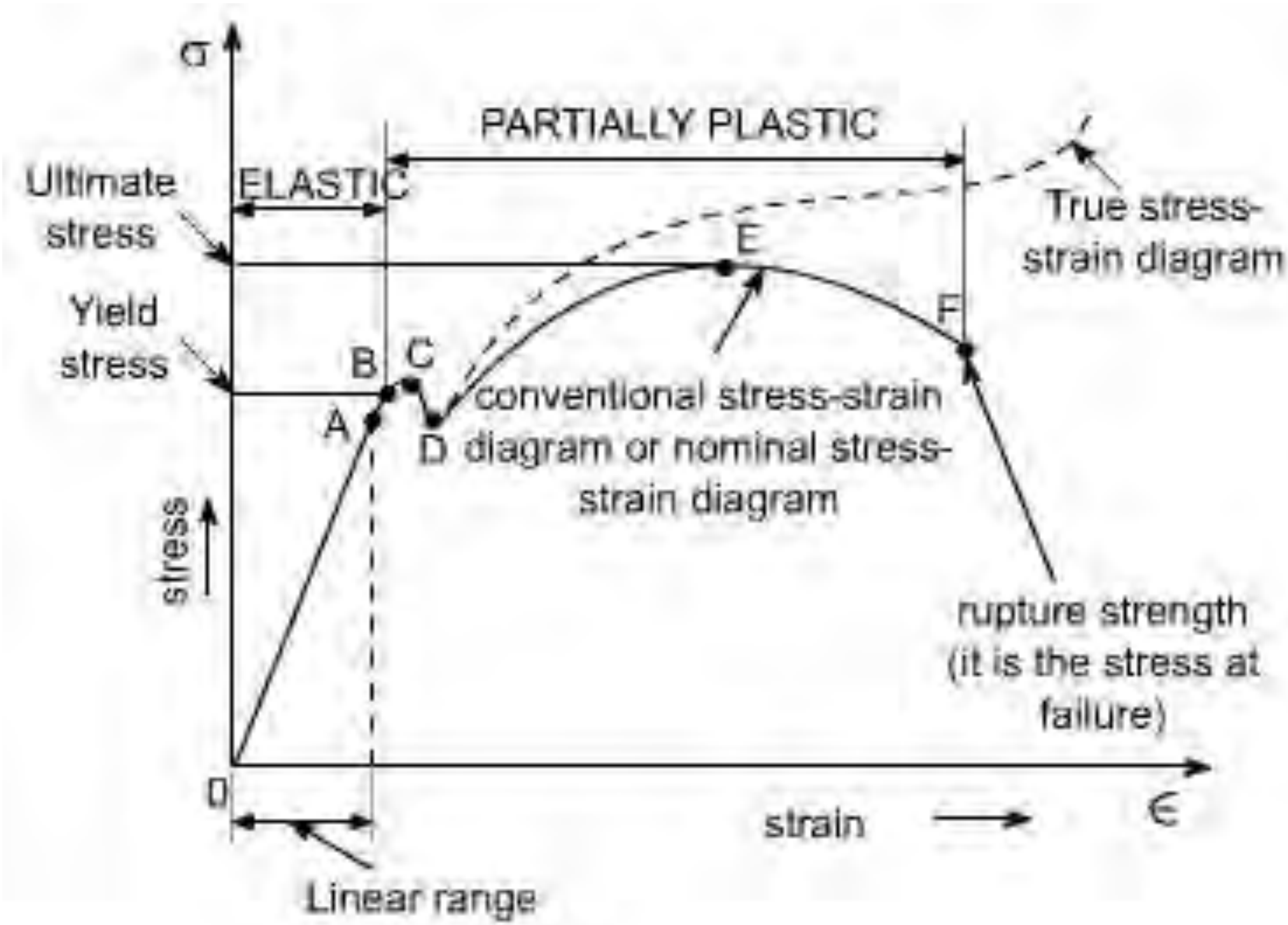
Mechanical Properties of Low Carbon Steel
Stress Strain Plot



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Design of a Pipeline for Adequate Strength

Hoop Stress, Longitudinal Stress and Bending Stress
are Combined to Give the Maximum Principal Stress

The Yield Strength of the Steel Divided by the Maximum Principal Stress
is the **Safety Factor**

The Safety Factor Used depends on the Details of the Pipeline Construction
and the Risk Associated with Catastrophic Failure

The Design Process is Iterative Until Operational Requirements
are Met Without the Maximum Principal Stress Exceeding
the Yield Stress Multiplied by the Safety Factor

Economics are Always a Important!

Line 5 Piping Specifications from Enbridge OR Report

Table 1: Line 5 Pipeline Construction Specifications

Pipe Properties	PE-IR	IR-Straits	East Straits	West Straits	MA-BC	BC-RW
Outside Diameter / Wall Thickness / Grade	762mm (30") / 7.14mm, 7.92mm, 8.74mm, 9.53mm (0.281", 0.312", 0.344", 0.375") / 318MPa, 359MPa (X46, X52)	762mm (30") / 7.14mm, 7.92mm, 8.74mm, 9.53mm (0.281", 0.312", 0.344", 0.375" / Grd. B, 318MPa, 359MPa (X46, X52)*	508mm (20") / 20.62mm (0.813") / Grd. B, 241MPa (X35)**	508mm (20") / 20.62mm (0.813") / Grd. B, 241MPa (X35)**	762mm (30") / 7.14mm, 7.92mm, 8.74mm, 17.45mm (0.281", 0.312", 0.344", 0.687") / Grd. B, 318MPa, 359MPa (X46, X52)	762mm (30") / 7.14mm, 7.92mm, 9.53mm, 12.70mm (0.281", 0.312", 0.375", 0.500") / Grd. B, 318MPa, 359MPa (X46, X52)
Coating	Coal Tar Enamel	Coal Tar Enamel	Coal Tar Enamel**	Coal Tar Enamel**	Coal Tar Enamel	Coal Tar Enamel
Long Seam Weld Type	SAW	SAW	SMLS**	SMLS**	SAW	SAW, DSAW***
Vintage	1953	1953	1953	1953	1953	1953
Section Length Km (Miles)	279.631 (173.75)	327.968 (203.79)	6.585 (4.09)	6.585 (4.09)	252.616 (156.97)	170.260 (105.79)
Manufacturer	National Tube (NT), Consolidated Western (CWNT)	National Tube, Consolidated Western, Wickwire Spencer (WS)****	National Tube	National Tube	National Tube, Consolidated Western	National Tube, Consolidated Western

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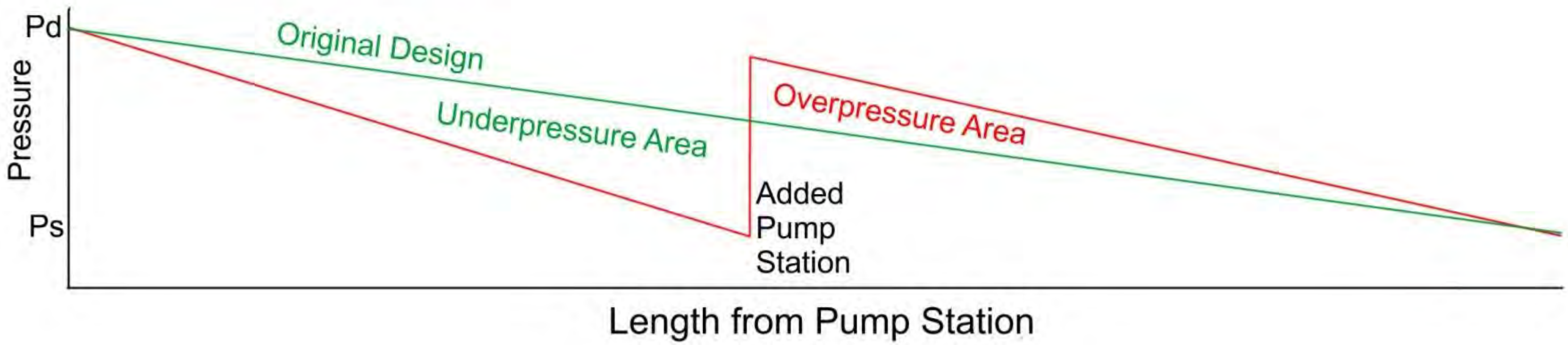
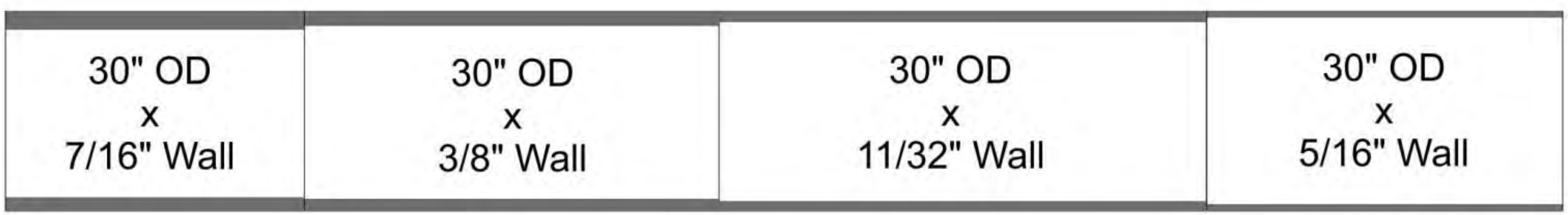
Line 5 Piping Specifications and Telescoped Pipeline Construction





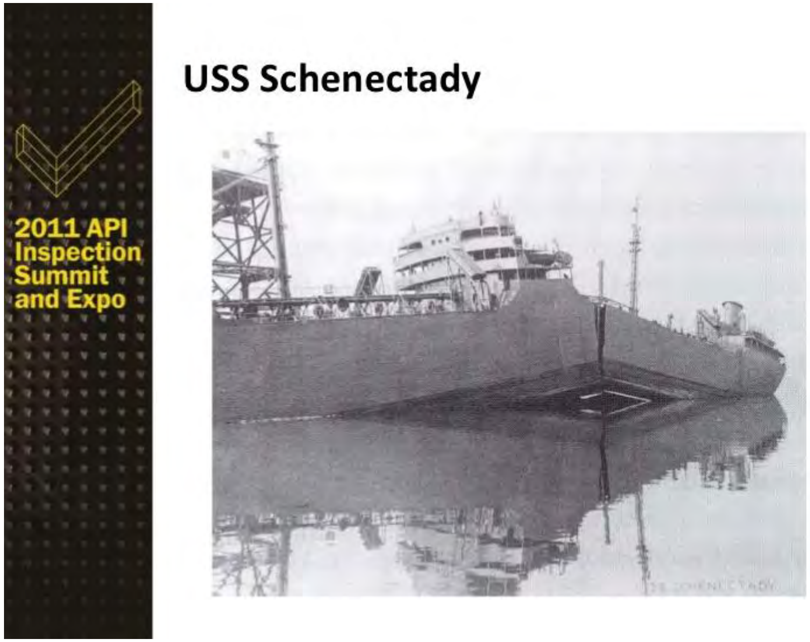
"Telescoped" Pipeline Construction

If Line 5 was constructed with telescoped construction and new pump stations were added later has this caused sections of the pipe to be overpressured?

Arc Welded Marine Structures

Shipping demands of World War Two led to the development of arc welding for the rapid production of large marine structures

Lack of understanding of steel properties, weld metallurgy, stress concentration and residual stress led to the failure of many large marine structures

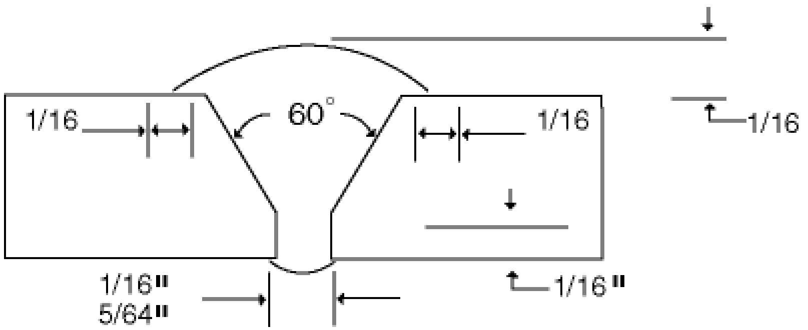


Constructed November, 1942 and failed structurally in January, 1943.
Cause of failure is still discussed
Service life = 1 month

Constructed in 1957 and failed structurally in November, 1975.
Cause of failure is still discussed
Service life = 18 years

A-146

Pipeline Welding



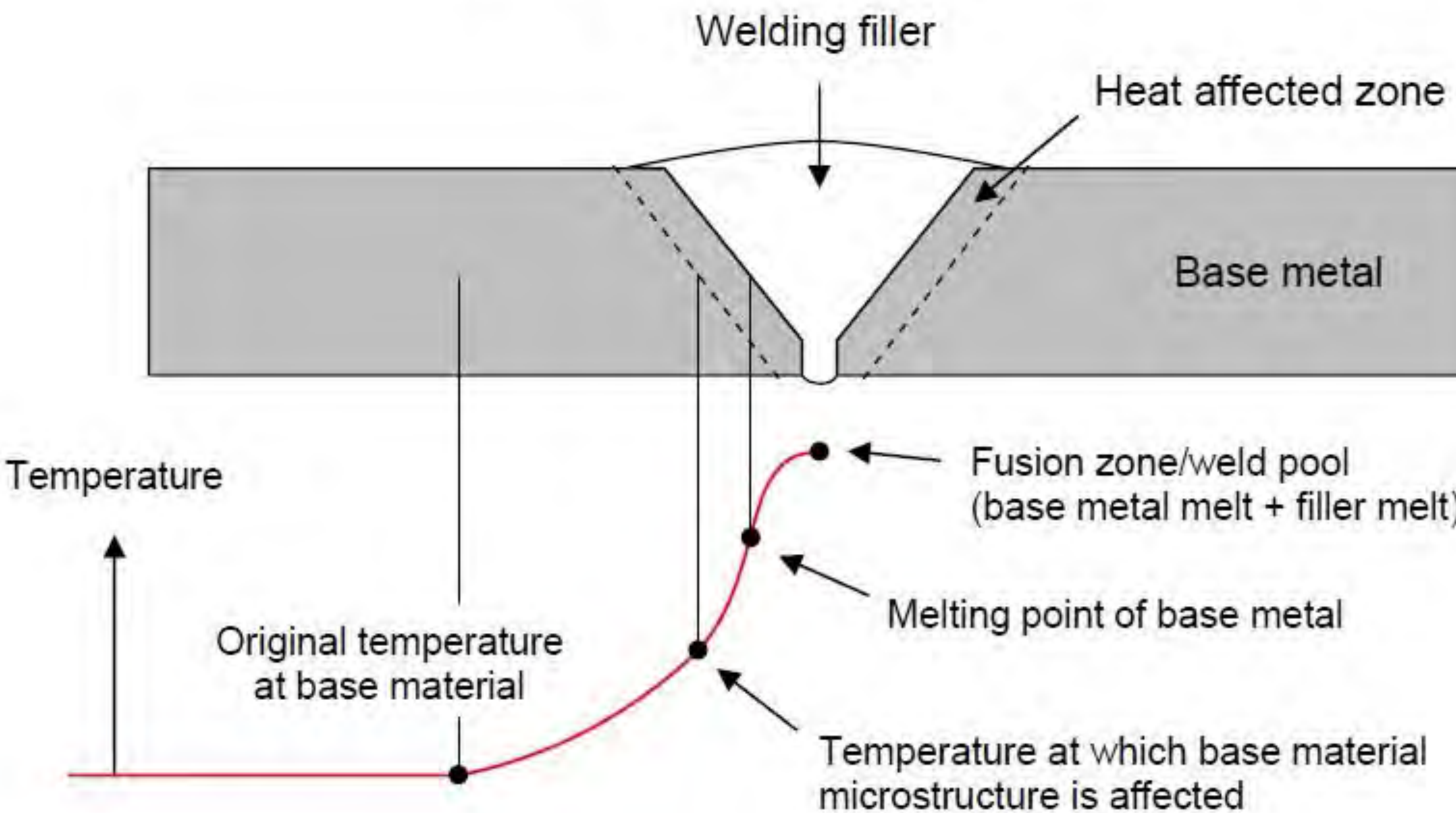
Typical Pipe Joint Detail
FIGURE 3

Pipeline Girth Weld Showing Completed Root Pass and Details of Second Pass

A-147

Welding Metallurgy

Figure 17.1 Heat Affected Zone



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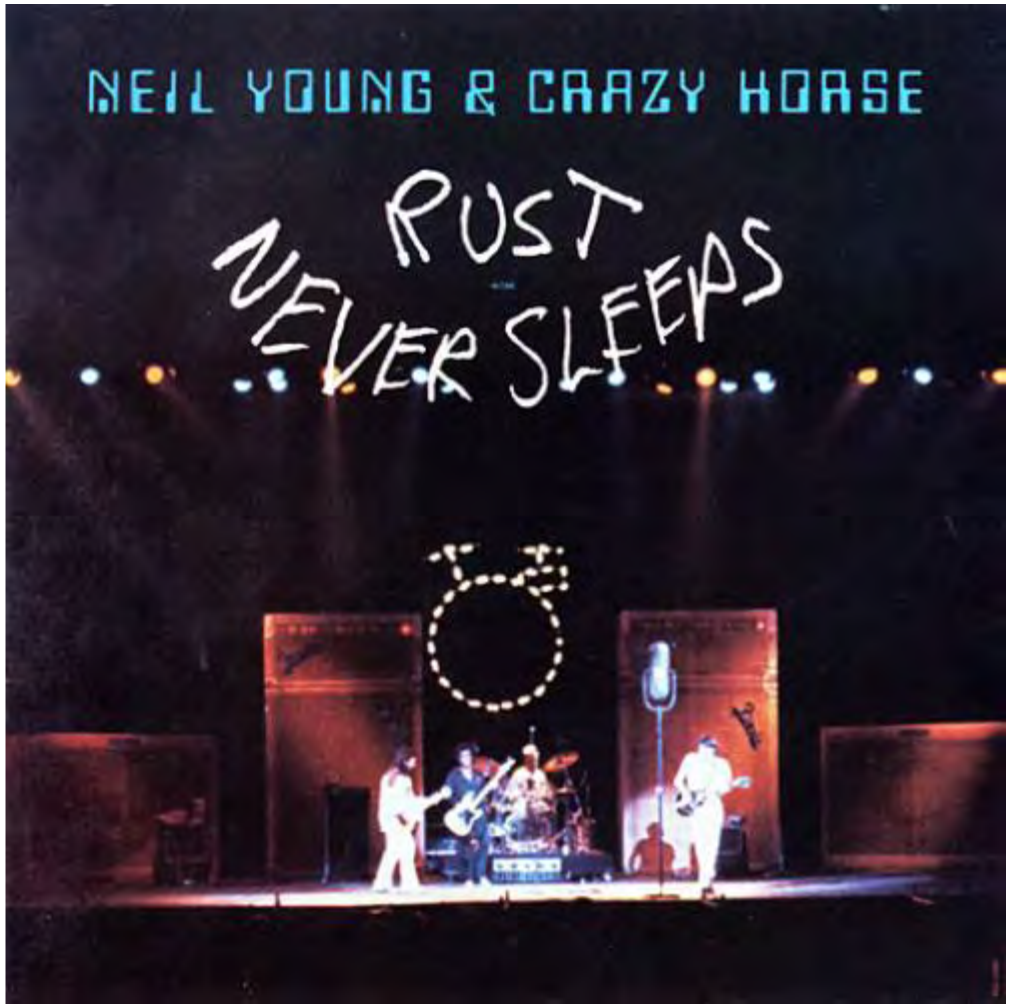
Why Pipelines Fail



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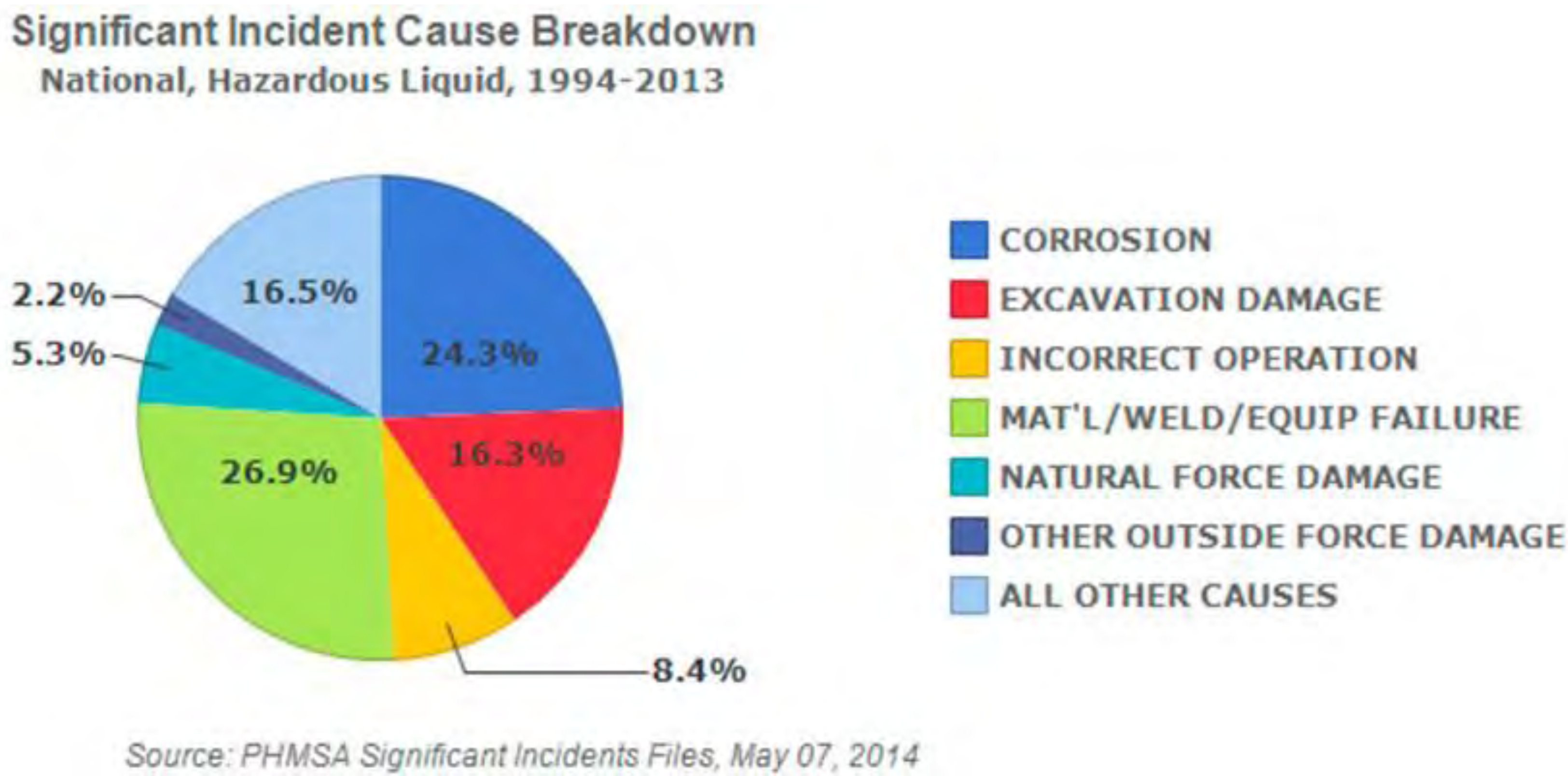
PHMSHA Data on Cause of Significant Pipeline Failures



60% of failures are caused by corrosion, mechanical failure or mis-operation.
All these causes are under the control of the pipeline operator.

Erosion and Corrosion
Overstress and Cracking

Erosion is material loss due to abrasive particulates in the cargo

Corrosion is material degradation caused by chemical reactions

Inside and outside of pipelines must be considered separately

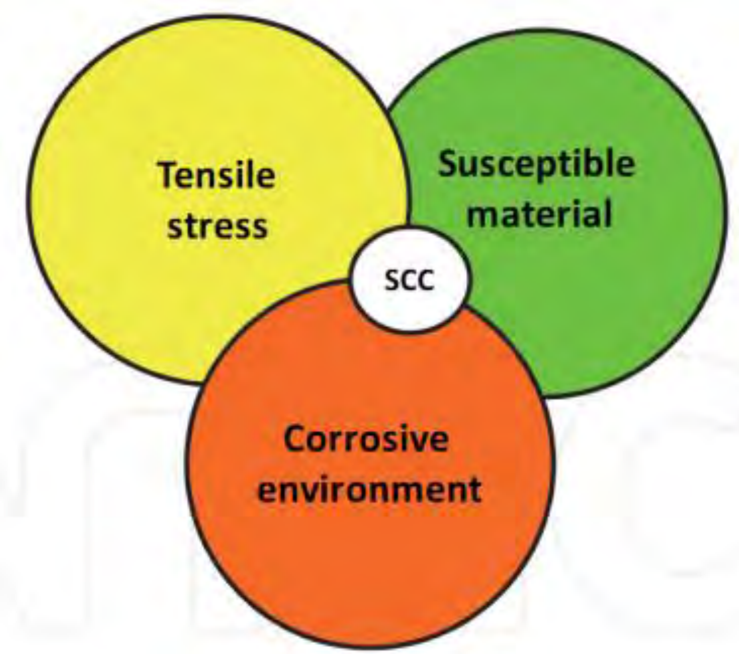
Cracks can form in the bulk of the pipeline wall too.

In low carbon steel pipelines the primary corrosion product is rust

Failure usually results when a crack formed by either wall thinning or stress corrosion cracking reaches a critical size for the existing stress and propagates

Mis-operation can always blow up a pipeline.

The Combination of Stress and a Corrosive Environment Can Cause Cracking



Stress corrosion cracking is the most common cause of pipeline failure

Control of SCC requires careful selection of material and protection of that material from the corrosive environment

The Straits section of line 5 is made from low carbon steel because it is not particularly susceptible to SCC compared to higher strength steels.

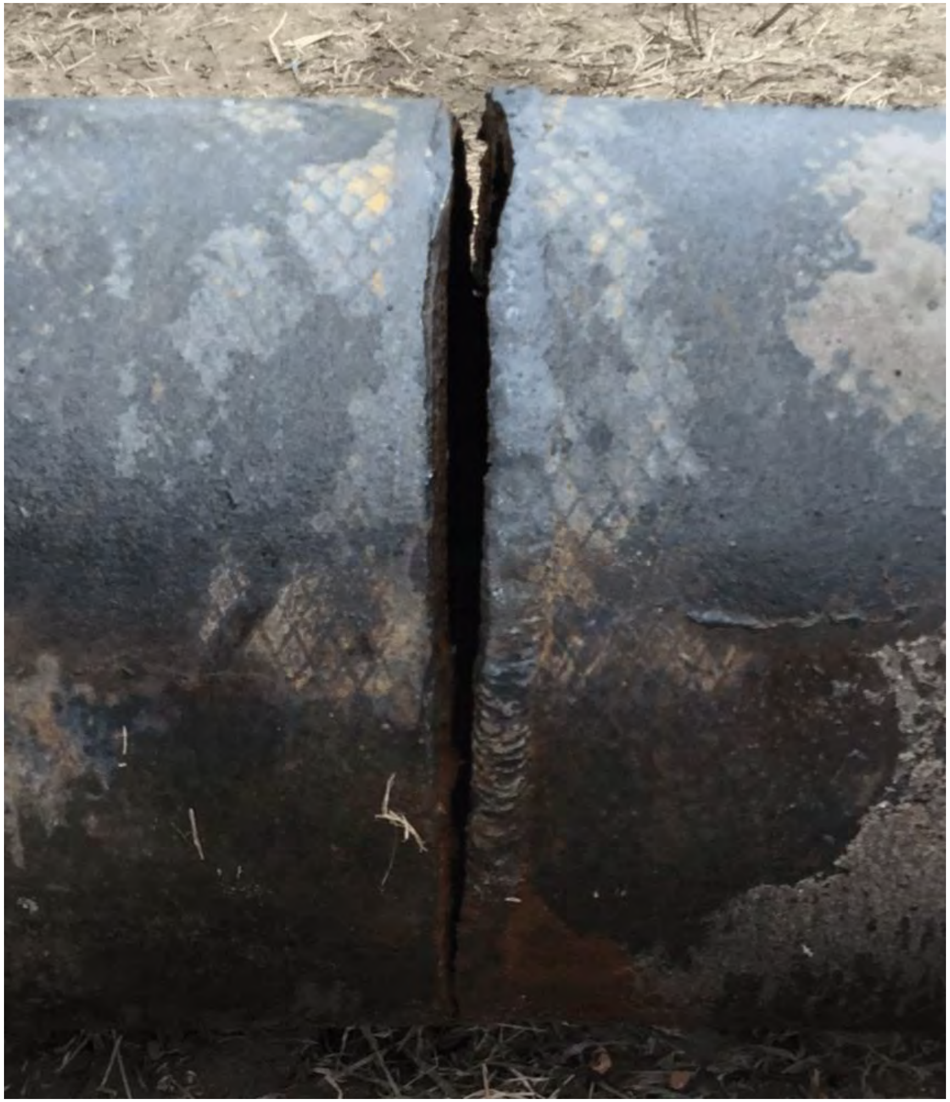
Even low carbon steel can have SCC problems when Hydrogen Sulfide is present.

Enbridge Line 6B Failure

Failure in the heat affected zone of the longitudinal seam weld.
Crack initiated by stress and corrosion (SCC) due to coating failure
The crack ran nearly ten feet before enough stress was relieved to stop it

"(Richard) Kuprewicz has seen this problem before. He researched the US federal investigation into the Kalamazoo, Michigan dilbit spill – the largest onshore oil spill in US history on behalf of various concerned parties. **The disbondment of PE-tape on Enbridge's Line 6B pipeline and subsequent SCC on the pipe caused the rupture**."

Bridger Pipeline Yellowstone River Spill



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Enbridge St Ignace Valve Station, Looking West

1953 Restrictions on Line 5 Operating Pressure

1953 Easement Restrictions for Straits

(2) Minimum testing specifications of the twenty inch (20") OD pipelines shall not be less than the following:

Shop Test	1,700 pounds per square inch gauge
Assembly Test	1,500 pounds per square inch gauge
Installation Test	1,200 pounds per square inch gauge
Operating Pressure	600 pounds per square inch gauge

1953 MPSC Order for All of Line 5

Pipe Specification	Minimum Mill Test Pressure, (psi)	Maximum Working Pressure, (psi)
30' OD x ½ " Wall	1242	894
30" OD x 3/8" Wall	965	695
30" OD x 11/32" Wall	878	632
30" OD x 5/16" Wall	790	570
30" OD x 7/16" Wall	1097	790
20" OD x 0.813 Wall	1700	1200

Pipe line to be designed for a working pressure of 500-550 psi except at the Superior pump station discharge where it is limited to 700 psi until station 2 is put into operation.

The capacity of the line with no pumping stations in Michigan will be 120,000 barrels/day and when all the Michigan pumping stations are completed and in operation the capacity will be 300,000 barrels/day. (Currently approved for 540,000 barrels/day in 2013, 80% Over Original Design)

Reliability of Line 5 Straits Crossing…the Stress due to Pressure

Summary of Pressure Calculations for Line 5

Oil Temperature On Land, (F) = 50
Oil Temperature Underwater, (F) = 41

	Pipeline Cargo			
	Synthetic Light Oil (CNS)	Light Sour Blend (LSB)	Mixed Blend Sour (SO)	Diluted Bitumen (AWB)
API Gravity =	34.8	38.0	31.1	21.7
Flow Rate, (barrels/day) =	540000	540000	540000	540000
	Pressure in PSI			
Pressure at Discharge of Naubinway Pump Station Discharge =	473	485	652	1207
Pressure at St Ignace Valve Station =	167	171	219	303
Pressure at Straits Deep =	237	239	276	417
Pressure at Mackinaw City Valve Station =	44	44	48	62
Pressure at Mackinaw City Pump Station Inlet =	30	30	30	30
Static Head at Straits Deep without Flow =	136	134	139	148
Ambient Pressure at Straits Deep with Flow =	120	122	159	300
Pump Station Power, (Hydraulic Horsepower), =	6396	5016	6284	12984

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Summary of non-Isothermal Pressure Calculations for Line 5 with Drag Reduction

Can line 5 transport DILBIT?

	Pipeline Cargo	
	Diluted Bitumen (AWB)	
API Gravity =	21.7	
Flow Rate, (barrels/day) =	540000	
Soil Temperature, (F) =	42	
Water Temperature, (F) =	42	
Temperature at Naubinway Pump Station Discharge, (F) =	**200**	
Temperature at Mackinaw City Pump Station Inlet, (F) =	189.9	
	Straits	Onshore
Drag Reducing Agent Efficiency, (% Friction Reduction) =	**25%**	**25%**
	Pressure in PSI	
Pressure at Discharge of Naubinway Pump Station =	583	
Pressure at St Ignace Valve Station =	166	
Pressure at Straits Deep =	232	
Pressure at Mackinaw City Valve Station =	49	
Pressure at Mackinaw City Pump Station Inlet =	30	
Static Head at Straits Deep without Flow =	148	
Pump Station Power, (Hydraulic Horsepower) =	5129	

“Washout” of Underwater Pipelines

In areas of strong currents, pipelines laid on the bottom can be undercut or “washed out” resulting in unsupported spans

Unsupported Section of Line 5

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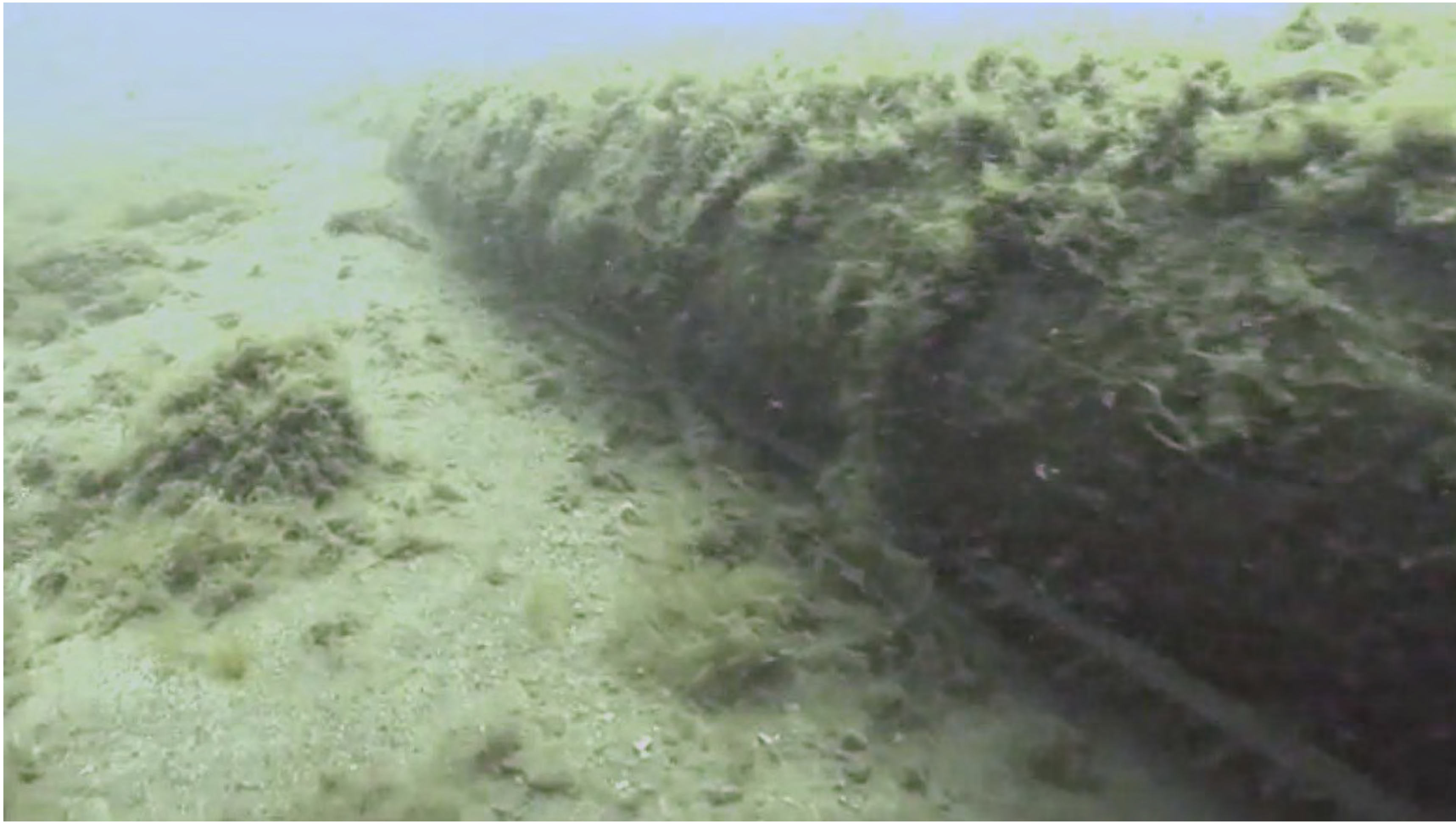
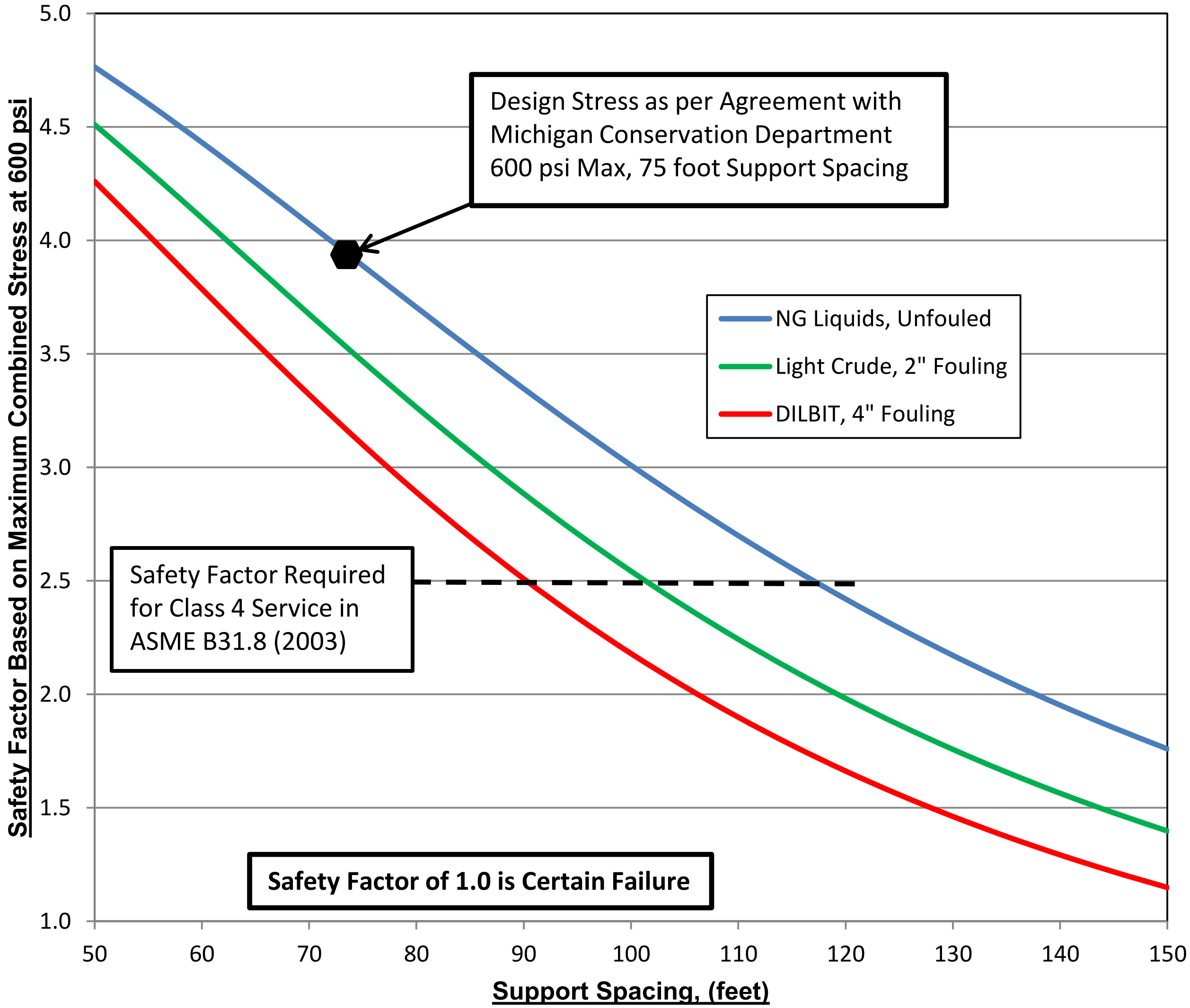
Line 5 Biological Fouling

Pipeline designers did not contemplate the fouling that came with the introduction of invasive species thought the St Lawrence Seaway which opened in 1959



Is the weight added to line 5 by fouling and cargo changes significant?

Reliability of Line 5 Straits Crossing…the Stress due to Gravity



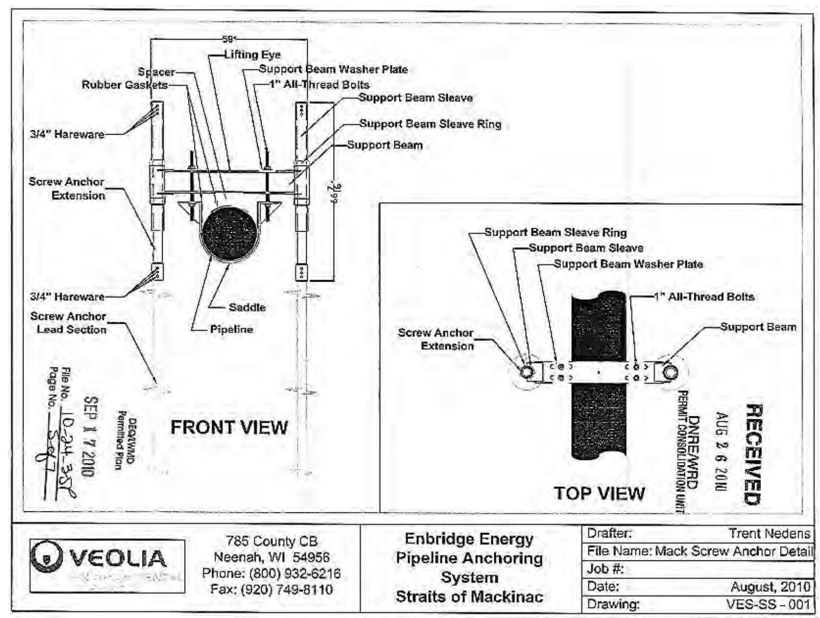
Line 5 Supports

Enbridge Operational Reliability Plan Report 2014

"Federal regulation requires that underwater laterals such as the Straits pipelines be inspected every five years. Enbridge instead chose a more conservative, voluntary inspection cycle of two years. During our regular two-year underwater inspections, if we should find any washout of existing earthen supports, we install new, screw anchor pipe supports at the affected location(s), ensuring a permanent support solution. The maximum spans we have discovered in the last ten years are approximately 90 feet, or about 64 percent of the maximum safe span distance. As a result of the support installation program that ended in 2012, Enbridge achieved an average span length of less than 75 feet, or a "two times" safety factor. With the additional anchors to be installed in 2014 and the existing supports, the average span distance will drop to less than 50 feet or, on average, a "three times" safety margin. This safety margin is reflective of the environmental importance of this significant water crossing."

Enbridge Work Permits Reveal Unsupported Spans of ca. 140 Feet in the Past

Gravel Bed Support



Veolia Screw Anchor Support

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Enbridge History of ROV Inspections and Support Additions

Table 2 ROV Inspection and Span Support Installation History of Line 5 Straits of Mackinac

Year of ROV Inspection	Follow up Actions (Anchor Support Installation)	Type of Support Installed
1963	None	
1972	None	
1975	3	Grout Bags
1979	None	
1982	None	
1987	7	Grout Bags
1989	None	
1990	None	
1992	6	Grout Bags
1997	None	
2001	8	Grout Bags and mechanical support
2003	16	Mechanical Screw Anchors
2004	16	Mechanical Screw Anchors
2005	14	Mechanical Screw Anchors
2006	12	Mechanical Screw Anchors
2007	None	
2010	7	Mechanical Screw Anchors
2012	17	Mechanical Screw Anchors

Total of 106 Supports Added by 2012

Enbridge Span Information Supplied to Michigan Attorney General 11/19/14

Span Identifier	2014 Length	2014 Span Height	2014 Support Length	2012 Length	2010 Length	2007 Length	2006 Length	2005 Length	Touch Down Position and Type (Year Install)	Support Depth	Latitude	Longitude
Southern Exposure Point	NA	NA	NA	NA	NA	NA	NA	NA	Only/Sand	66	45.79740051 N	84.76828612 W
E-75	NA	NA	NA	Silted In	70	69	73	80	NA	NA	NA	NA
									NA	NA	NA	NA
E-74A	50	0.5	240' to Bury	80	61	67	67	71	South/Sand	69	45.79803465 N	84.76803487 W
									North/Anchor (2004)	70	45.79817336 N	84.76798054 W
E-74B South	70	0.5	Shared Touch Down ^	56	109	100			South/Anchor (2004)	70	45.79817336 N	84.76798054 W
									North/Anchor (2010)	71	45.79836191 N	84.76790185 W
E-74B North	47	0.5	Shared Touch Down ^	48					South/Anchor (2010)	71	45.79836191 N	84.76790185 W
									North/Anchor (2006)	70	45.79848622 N	84.76785431 W
E-74C	28	1	Shared Touch Down ^	16	13	14			South/Anchor (2006)	70	45.79848622 N	84.76785431 W
									North/Sand	69	45.79855919 N	84.7678226 W
E-71A	30	0.5	111' to E74C North	76	87	86	86	84	South/Sand	71	45.79885179 N	84.76772027 W
									North/Anchor (2014)	71	45.79893197 N	84.76769084 W
E-71B	49	0.5	Shared Touch Down ^						South/Anchor (2014)	71	45.79893197 N	84.76769084 W
									North/Anchor (2005)	72	45.79906039 N	84.76764254 W
E-72	44	0.5	Shared Touch Down ^	40	40	38	36	48	South/Anchor (2005)	72	45.79906039 N	84.76764254 W
									North/Sand	72	45.79917455 N	84.76759603 W
E-77	37	1	9' to E-72	34	44	52	44	42	South/Sand	72	45.79919654 N	84.76758791 W
									North/Sand	72	45.799292 N	84.76754813 W
E-26	54	1	202' to E77	48	54	45	48	51	South/Clay	76	45.79982164 N	84.76734294 W
									North/Sand	76	45.7999639 N	84.76728235 W
E-25A	38	0.5	42' to E-26	87	91	85	84	96	South/Sand	81	45.80007298 N	84.76724349 W
									North/Anchor (2014)	80	45.80017387 N	84.76720464 W
E-25B	48	0.5	Shared Touch Down ^						South/Anchor (2014)	80	45.80017387 N	84.76720464 W
									North/Sand	79	45.80029924 N	84.76715103 W
E-24	44	0.5	114' to E25B	44	50	45	46	37	South/Sand	81	45.80059751 N	84.76703994 W
									North/Sand	82	45.80071223 N	84.76699755 W
E-23A South	28	0.5	96' to E-24	86	85	81	86	84	South/Sand	83	45.80096148 N	84.76690243 W
									North/Anchor (2014)	85	45.80103603 N	84.76687496 W
E-23A North	58	0.5	Shared Touch Down ^						South/Anchor (2014)	85	45.80103603 N	84.76687496 W
									North/Anchor (2003)	85	45.80118708 N	84.7668158 W
E-23B South	61	0.5	Shared Touch Down ^	66	87	86	90	90	South/Anchor (2003)	85	45.80118708 N	84.7668158 W
									North/Anchor (2012)	84	45.80134576 N	84.76674988 W
E-23B North	31	1	Shared Touch Down ^	26					South/Anchor (2012)	84	45.80134576 N	84.76674988 W
									North/Sand	83	45.80142404 N	84.76671263 W
E-27	63	0.5	78' to E23B North	58	69	65	66	74	South/Sand	82	45.80162764 N	84.76663722 W
									North/Sand	81	45.80179248 N	84.76657389 W
E-28A South	37	1	52' to E-27	70	81	73	74	81	South/Sand	82	45.80193012 N	84.76652267 W
									North/Anchor (2014)	83	45.8020281 N	84.76649157 W
E-28A North	38	1	Shared Touch Down ^						South/Anchor (2014)	83	45.8020281 N	84.76649157 W
									North/Anchor (2005)	83	45.80212884 N	84.76645585 W
E-28B	63	1	Shared Touch Down ^	66	69	65	64	72	South/Anchor (2005)	83	45.80212884 N	84.76645585 W
									North/Sand	81	45.80229567 N	84.76639508 W
E-29	59	1	25' to E28B	60	55	44	63	53	South/Sand	81	45.8023587 N	84.76636855 W
									North/Sand	79	45.80251327 N	84.76631514 W
E-30A	38	1	22' to E29	72	83	82	82	89	South/Sand	78	45.80256885 N	84.76629197 W
									North/Anchor (2014)	77	45.80267125 N	84.76626081 W
E-30B	36		Shared Touch Down ^						South/Anchor (2014)	77	45.80267125 N	84.76626081 W
									North/Sand	76	45.80276442 N	84.76622516 W
E-38	36	1	86 to E-30B	34	45	32	37	46	South/Sand	73	45.80299189 N	84.76614415 W
									North/Sand	72	45.80308618 N	84.76611094 W
E-37	56	1	155' to E-38	54	54	50	54	53	South/Sand	74	45.80349412 N	84.7659669 W
									North/Sand	74	45.80363883 N	84.76590965 W
E-36	50	0.5	12' to E-37	42	41	48	42	34	South/Sand	73	45.80366947 N	84.76589995 W
									North/Sand	73	45.80380204 N	84.76585057 W
E-35A	36	0.5	33' to E-36	60	67	66	67	63	South/Sand	73	45.80389819 N	84.76581718 W
									North/Anchor (2014)	75	45.80399347 N	84.7657808 W
E-35B	36	0.5	Shared Touch Down ^						South/Anchor (2014)	75	45.80399347 N	84.7657808 W
									North/Sand	76	45.80408779 N	84.76574484 W
E-34A	58	1	25' to E35B	58	62	54	61	59	South/Sand	77	45.80415409 N	84.76572209 W
									North/Anchor (2003)	79	45.80430605 N	84.76566353 W
E-34B South	53	1	Shared Touch Down ^	73	80	82	74	75	South/Anchor (2003)	79	45.80430605 N	84.76566353 W
									North/Anchor (2014)	78	45.80444616 N	84.76561487 W
E-34B North	21	1	Shared Touch Down ^						South/Anchor (2014)	78	45.80444616 N	84.76561487 W
									North/Sand	79	45.80450136 N	84.76558981 W
E-33	43	1	109 to E34B North	46	52	47	45	39	South/Sand	82	45.80478655 N	84.76548042 W
									North/Sand	86	45.80490015 N	84.76543833 W
E-32A-A	6		21' to E-33	Silted In	11	17			South/Clay	88	45.80495542 N	84.76541633 W
									North/Anchor (2006)	88	45.80497238 N	84.76541225 W
E-32A South	40	1	Shared Touch Down ^	47	92	89			South/Anchor (2006)	88	45.80497238 N	84.76541225 W
									North/Anchor (2012)	92	45.80507422 N	84.76536839 W
E-32A North	47	1.5	Shared Touch Down ^	40					South/Anchor (2012)	92	45.80507422 N	84.76536839 W
									North/Anchor (2003)	94	45.80519687 N	84.76532216 W
E-32B South	67	1	Shared Touch Down ^	88	87	97	85	79	South/Anchor (2003)	94	45.80519687 N	84.76532216 W
									North/Anchor (2014)	96	45.80537562 N	84.76525738 W
E-32B North	22	1	Shared Touch Down ^						South/Anchor (2014)	96	45.80537562 N	84.76525738 W
									North/Clay	95	45.80543416 N	84.7652347 W
E-31	36	1	22' to E32B North	34	36	42	42	37	South/Clay	95	45.80549271 N	84.76521037 W
									North/Clay	96	45.80558613 N	84.76517358 W
E-39	63	1	58' to E-31	74	83	67	78	66	South/Clay	98	45.80573967 N	84.76511784 W
									North/Sand	98	45.80590475 N	84.76505337 W
E-40A	22	1	370' to E39	85	82	80	90	97	South/Sand	103	45.80688466 N	84.7646828 W
									North/Anchor (2014)	104	45.80694103 N	84.7646623 W
E-40B	60	1	Shared Touch Down ^						South/Anchor (2014)	104	45.80694103 N	84.7646623 W
									North/Sand	104	45.80709655 N	84.76459532 W

Discrete Supports Have One Disadvantage

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GEI Consultants

Effect of Mussel Encrustation on Line 5

"GEI did not find literature which reported increased bacterial loads on pipes or increase in corrosion rates due to higher bacterial loads. "

"It is GEI's professional opinion based on the literature and examination of these mussels that this relatively thin layering of mussels over the pipe beneath the Straits of Mackinaw result in negligible additional load on the pipe should have no adverse impact on the pipe. "

US Army Corps of Engineers Zebra Mussel Control Handbook for Facility Operators

"When a thick layer of zebra mussels covers a metallic surface, it can cause anoxia and pH reduction, exacerbating corrosion rates."

ET Conclusions Regarding GEI Mussel Encrustation Report

- Report does not contain useful engineering information such as the wet density of the mussels or an estimate of their volume or information on their growth rate
- Report does not address the corrosive environment produced in the mussel colony
- GEI Consultants focused on biology and no stress calculations were done
- Where did Enbridge get that piece of pipe?........(No chain of custody info)

Excessive Curvature and Pipe Bending in Pipe Laying Operations

A-167

Bending Stress as a Function of Pipe Curvature

1953 Easement Restriction

(4) The minimum curvature of any section of pipe shall be no less than two thousand and fifty (2,050) foot radius.

Sb= (Es*r)/R

where Sb = bending stress

Es = Youngs modulus for steel

r = Pipe Radius

R = radius of curvature of pipeline

Young's Modulus for Steel, (psi) =	2.90E+07
Pipe Radius (ft) =	0.83
Radius of Curvature, (ft) =	2050
Calculated Bending Stress, (psi) =	1.18E+04
Calculated Bending Stress, (% Yield) =	34%

Conclusions Regarding Line 5 Stresses

The restrictions in the 1953 easement led to a very conservative and safe design for the Straits crossing of line 5 but my calculations show that the 1953 MPSC Order may have been superseded regarding the 500-550 psi maximum pressure limit.

The 600 psi maximum pressure restriction in the easement is unlikely to be exceeded in normal pipeline operations. Two scenarios could overpressure the line:

1. The line is valved off in Mackinaw City while the pumps are left running in Naubinway (Deadheaded).
2. Mis-operation of the line causes a severe pressure surge (Water Hammer).

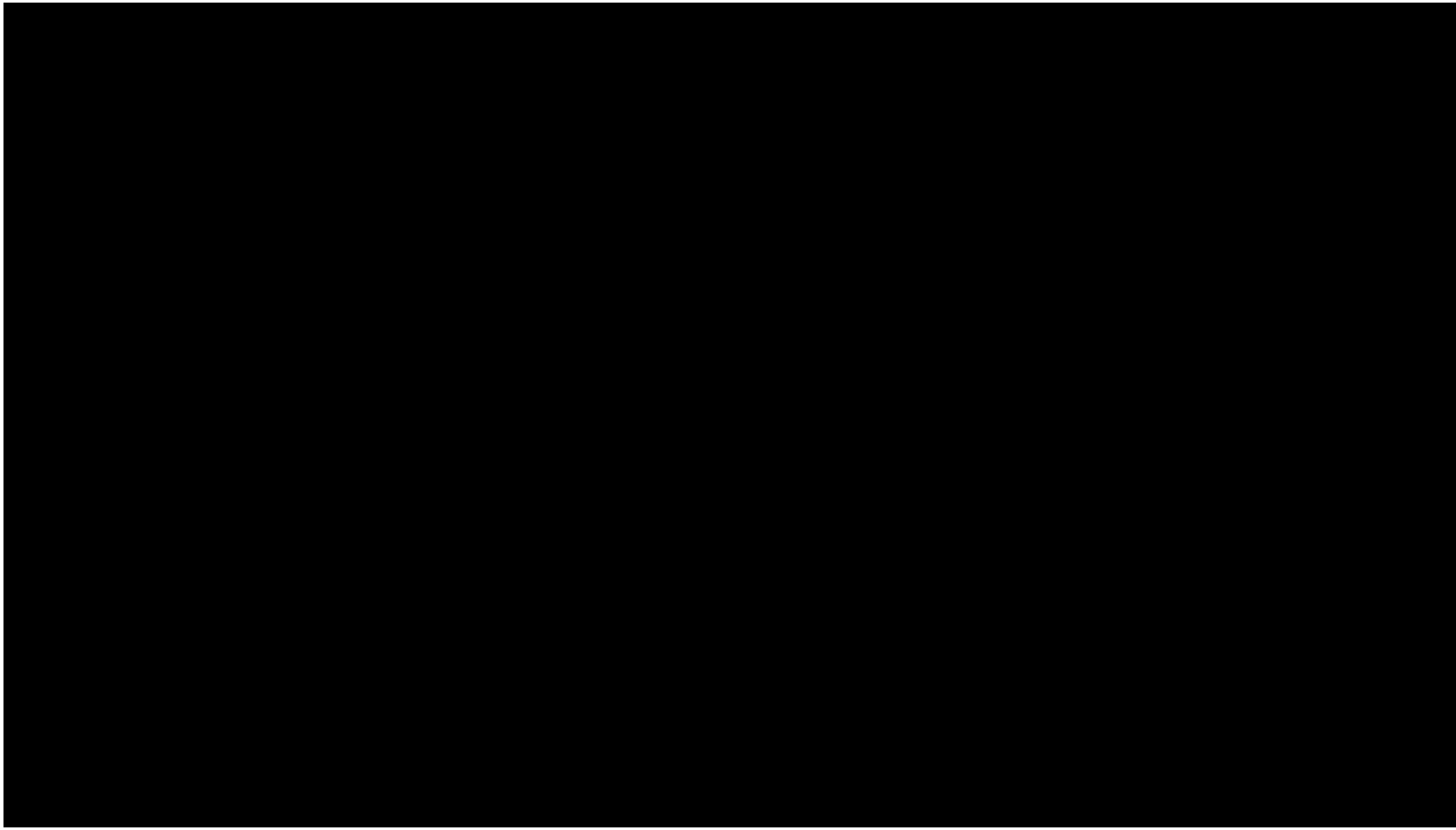
The average pressure on the line has been significantly increased by the addition of pump stations in Michigan. Nothing is publically available about how this affects risk!

The seventy five foot maximum unsupported length restriction resulted in very safe bending stresses in line five at the time of design. Since then, changes in cargo density and the growth of marine life on the line has increased the bending stress on line 5 so that the safety factors originally used by the designers and approved by the State of Michigan no longer apply.

Because the pipeline was originally supported by a gravel bed that has proved susceptible to washouts, unsupported spans on the order of 140 feet have resulted in a reduced safety margin compared to that which was originally contemplated by the designers and approved by the State of Michigan.

Enbridge has currently added around 122 (?) discrete supports to the pipeline but about 300 would be required for complete support of unburied segments of the line.

A Diver, a Shovel and a Washout (?)



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Pipeline Coating Integrity is Critical for Minimization of Stress Corrosion Cracking

1953 Easement Restrictions Regarding Corrosion Protection

(8) Cathodic protection shall be installed to prevent deterioration of the pipe

(9) All pipe shall be protected by asphalt primer coat, by inner wrap and outer wrap composed of glass fiber fabric material and one inch by four inch (1" x 4") slats prior to installation.

"Engineering and Construction Considerations for the Mackinac Pipeline Company's Crossing of the Straits of Mackinac" submitted by Mackinac Pipeline Company/Lakehead Pipeline Company to the Michigan Department of Conservation, January, 1953

"After coating with asphalt primer, fiberglass inner wrap and an asbestos felt outer wrap, and after attaching 1" x 4" wood slats to the full circumference of the pipe, it will be lowered onto a previously prepared "bed" on the floor of the Straits."

- Enbridge documentation claims that the coating is a coal tar based product not asphalt and has no information about reinforcing fabrics or how the girth welds were coated.
- Enbridge documentation makes no mention of slats or lagging

The Mystery of the Missing Slats

ET Photo of Propeller Shaft for Cutter Mackinaw

Temporary Lagging on a Pipeline for Abrasion Protection

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Pipeline Lagging on Line 5

Enbridge Dent Inspection Video

National Wildlife Federation Photo

NIST Special Publication 1044

Advanced Coatings R&D for Pipelines and Related Facilities

The proceedings of a workshop held June 9-10, 2005

at the National Institute of Standards and Technology,

Pipeline Operators Viewpoint on Underground Coatings Issues

Jeff Didas

Colonial Pipeline Company

Coal Tar Adhesion Failure

Failed Coal Tar Coating

Jeff Didas, Colonial Pipeline Company

Summary of Issues

- Repair & Rehabilitation Coatings are the major issue for pipeline operators.
- Deterioration & Aging of Existing Coatings are an ongoing issue for pipeline operators.
- Improving handling properties for new pipeline coatings, flexibility of new coatings, as well as weld joint coatings (quality) and in field repairs (quality) for the coating are major issues for pipeline operators.

Coating Integrity is Critical to Pipeline Longevity

The coating cannot be visually inspected wherever there is lagging or where the line is supported by the gravel bed or where the line is covered with mussels and algae

The cathodic protection system will not prevent local corrosion and can cause coating disbondment

Because of the low conductivity of fresh water, electrical leakage cannot be used to determine coating defects

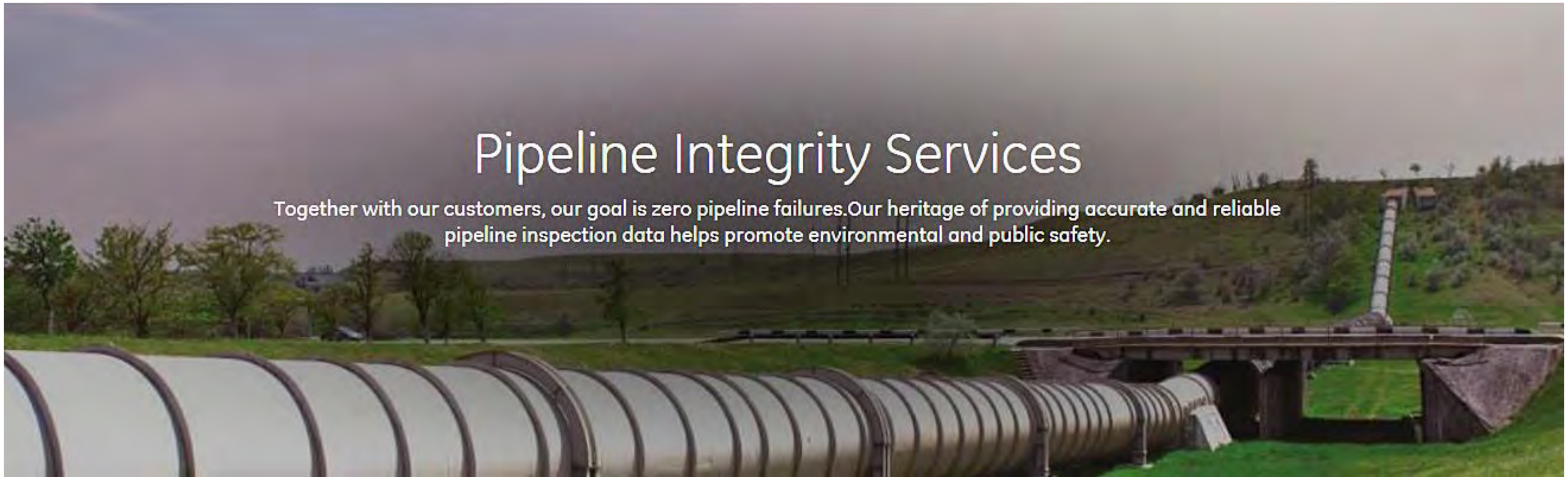
Enbridge “ensures” coating integrity by using In Line Inspection (ILI) tools to look for metal loss and cracking

The business of running aging steel pipelines depends on ILI technology to find “features” that can be analyzed and compared to corporate risk standards to determine if repair or eventually replacement is warranted. Corporate risk standards vary as do action plans.

In Line Inspection and Integrity Management Services

....a very big business
GE is one of many tool, service and integrity management firms

GE Oil & Gas



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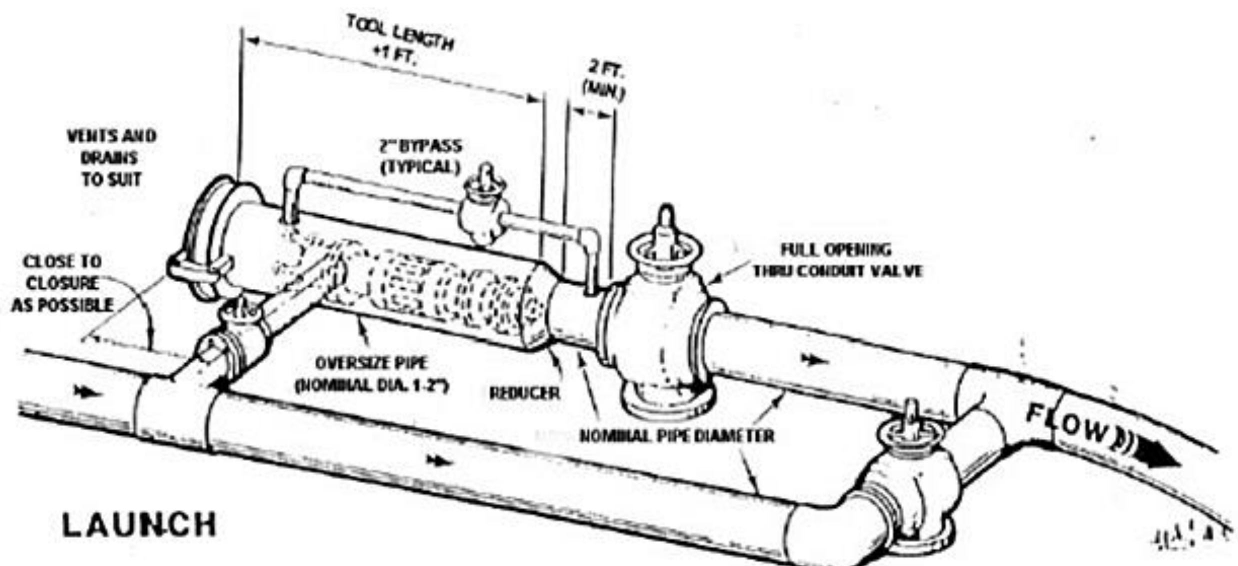
Complex Pig and Pig Launcher



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PII Pipeline Solutions
a GE Oil & Gas and Al Shaheen joint venture

The right technology
for every integrity challenge

CalScan EP — Enhanced for geometry, mapping and welds

CalScan XR — Increased resolution and reporting detail

MagneScan HR/SHR — Higher accuracy MFL inspection

SmartScan — Inspect previously unpiggable pipelines

TranScan TFI — Detect axial flaws with confidence

UltraScan WM — Precise, direct wall-thickness measurement

UltraScan Duo — One tool for metal loss and cracking

UltraScan CD — Most accurate crack inspection (liquid)

EmatScan — Most accurate crack inspection (gas)

Tools not to scale

— Calipers
— Magnetics
— Ultrasonics

● Best fit
● Good fit
○ Optional

Application Specifics

Tool	Gas medium	Liquid medium	Multi/Dual-diameter	Thick wall pipe	High-flow velocity
CalScan EP	Best fit	Best fit	Good fit	Best fit	Good fit
CalScan XR	Best fit	Best fit	Good fit	Best fit	Best fit
MagneScan HR	Best fit	Best fit	Good fit	Good fit	Best fit
MagneScan SHR	Best fit	Best fit	Good fit	Good fit	Best fit
SmartScan	Best fit	Best fit	Best fit	Good fit	Good fit
TranScan TFI	Best fit	Best fit	Good fit	Good fit	Good fit
UltraScan WM	Good fit	Best fit	Good fit	Best fit	Good fit
UltraScan Duo	Good fit	Best fit	Best fit	Best fit	Good fit
UltraScan CD	Good fit	Best fit	Good fit	Best fit	Best fit
EmatScan	Best fit	Best fit	Optional	Optional	Good fit

Metal Loss Features

Tool	General corrosion	Shallow pitting	Deep pitting	Pinholes	Axial groove	Narrow axial external corrosion	Wall thinning/erosion	Laminations
CalScan EP								
CalScan XR								
MagneScan HR	Best fit	Best fit	Best fit	Good fit	Good fit	Good fit		
MagneScan SHR	Best fit	Best fit	Best fit	Best fit	Best fit	Best fit		
SmartScan	Good fit	Good fit	Good fit		Good fit	Good fit		
TranScan TFI	Good fit	Good fit	Good fit		Best fit	Best fit		
UltraScan WM	Best fit	Good fit	Optional	Optional	Best fit	Best fit	Best fit	Best fit
UltraScan Duo	Best fit	Good fit	Good fit	Optional	Best fit	Best fit	Best fit	Best fit
UltraScan CD								
EmatScan								

Crack Features

Tool	Hook/seam weld crack	Hydrogen inducted crack	Fatigue crack	Shrinkage crack	Circumferential crack	SCC	Lack of fusion
CalScan EP							
CalScan XR							
MagneScan HR							
MagneScan SHR							
SmartScan							
TranScan TFI	Good fit	Good fit	Good fit	Good fit		Good fit	Good fit
UltraScan WM							
UltraScan Duo	Best fit	Best fit	Best fit	Best fit	Optional	Best fit	Best fit
UltraScan CD	Best fit	Best fit	Best fit	Best fit	Optional	Best fit	Best fit
EmatScan	Good fit	Best fit	Best fit	Best fit		Best fit	Best fit

Deformation & Geometry

Tool	Plain dent	Dents with metal loss	Small dents (1" diameter)	ID expansions	Buckle/wrinkle	Bend	Bending strain/pipe movement
CalScan EP	Good fit	Good fit	Good fit	Best fit	Best fit	Best fit	Best fit
CalScan XR	Best fit	Good fit	Best fit	Best fit	Best fit	Best fit	Optional
MagneScan HR	Good fit	Best fit	Good fit	Best fit	Best fit	Best fit	Best fit
MagneScan SHR	Best fit	Best fit	Best fit	Best fit	Best fit	Best fit	Best fit
SmartScan							
TranScan TFI	Good fit	Good fit	Good fit	Good fit	Good fit	Good fit	Good fit
UltraScan WM							
UltraScan Duo							
UltraScan CD							
EmatScan							

Integrity Assessments

Tool	Corrosion growth assessment	Fitness-for-purpose (FFP)	Dent strain assessment	Crack threat integrity assessments	Bending strain assessment	Centerline mapping
CalScan EP		Best fit	Best fit		Best fit	Best fit
CalScan XR		Best fit	Best fit		Optional	Optional
MagneScan HR	Best fit	Best fit	Best fit		Best fit	Best fit
MagneScan SHR	Best fit	Best fit	Best fit		Best fit	Best fit
SmartScan	Best fit	Best fit			Best fit	Best fit
TranScan TFI	Best fit	Best fit	Best fit	Best fit	Optional	Optional
UltraScan WM	Best fit	Best fit				
UltraScan Duo	Best fit	Best fit		Best fit		
UltraScan CD		Best fit		Best fit		
EmatScan		Best fit		Best fit		

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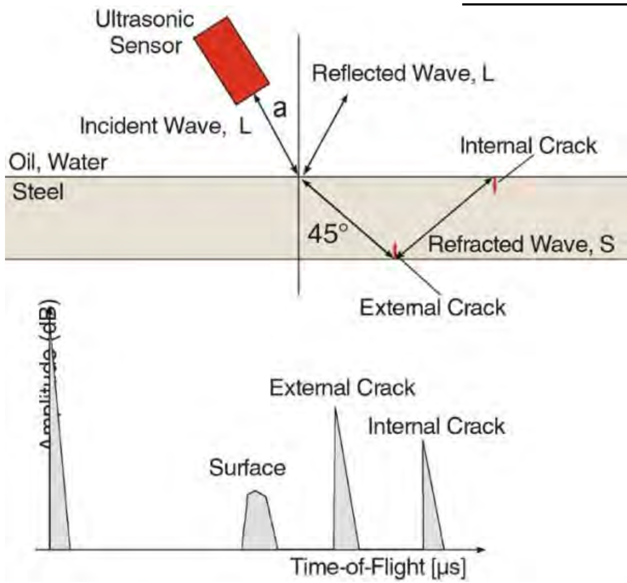
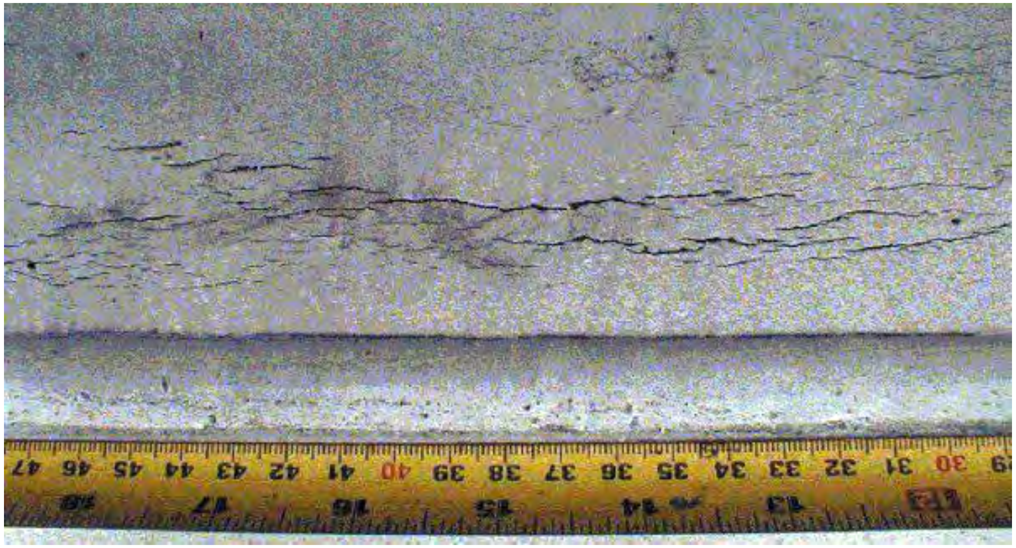
Stutensee, Germany
T +49 7244 732 0
F +49 7244 732 123

GE Ultrascan CD Intelligent Pig



Ultrasonic Crack Detection

Ultrasonic Array

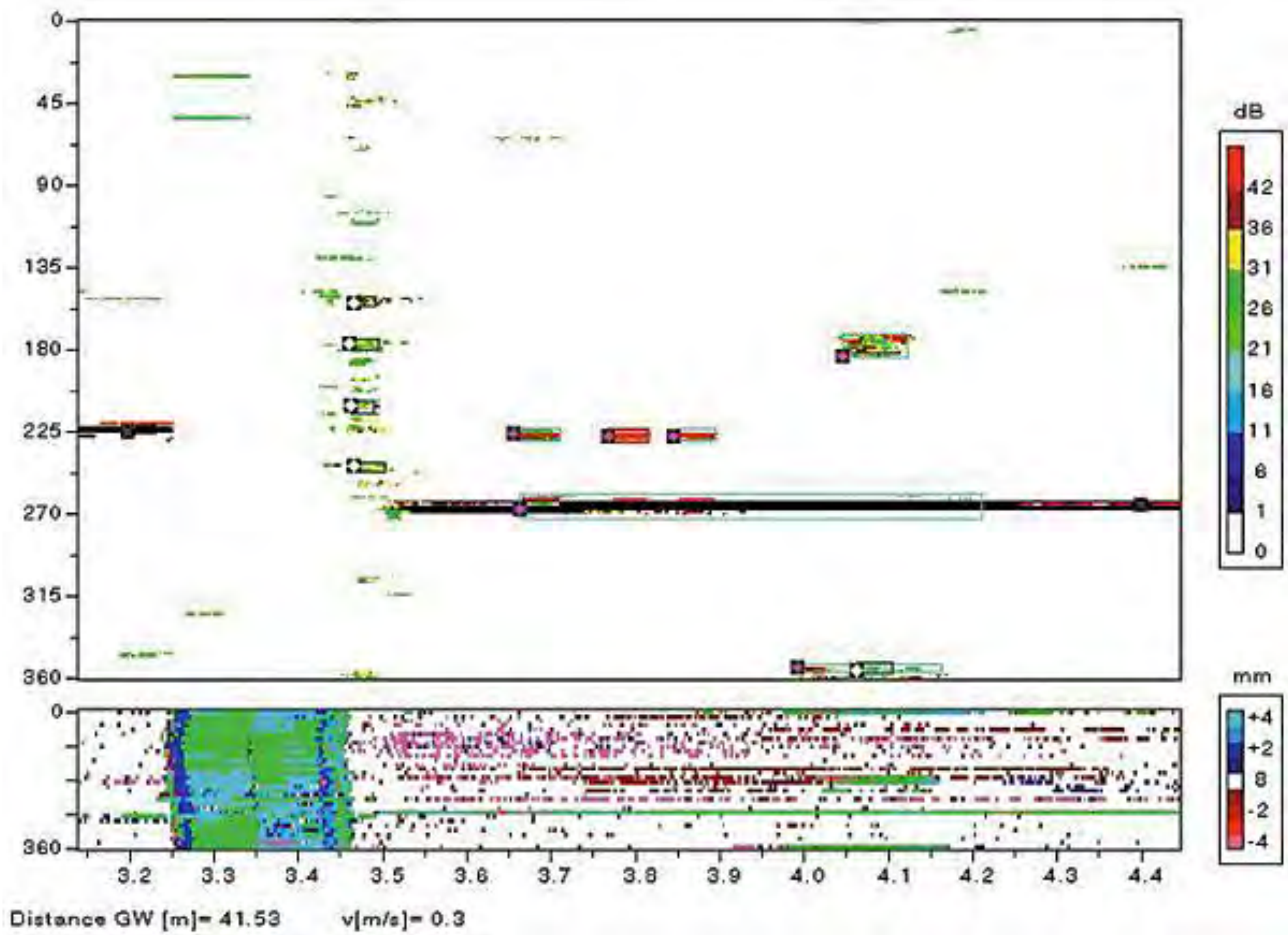


Stress Corrosion Crack Colony

A-180

ILI Inspection Data…Lots of It!

A travel through 100 km of 24” pipeline generates around 100 terabytes of primary data. Data must be processed onboard to compress it for storage and post processed to identify significant features



A-181

API 1163 Qualification of In Line Inspection Systems

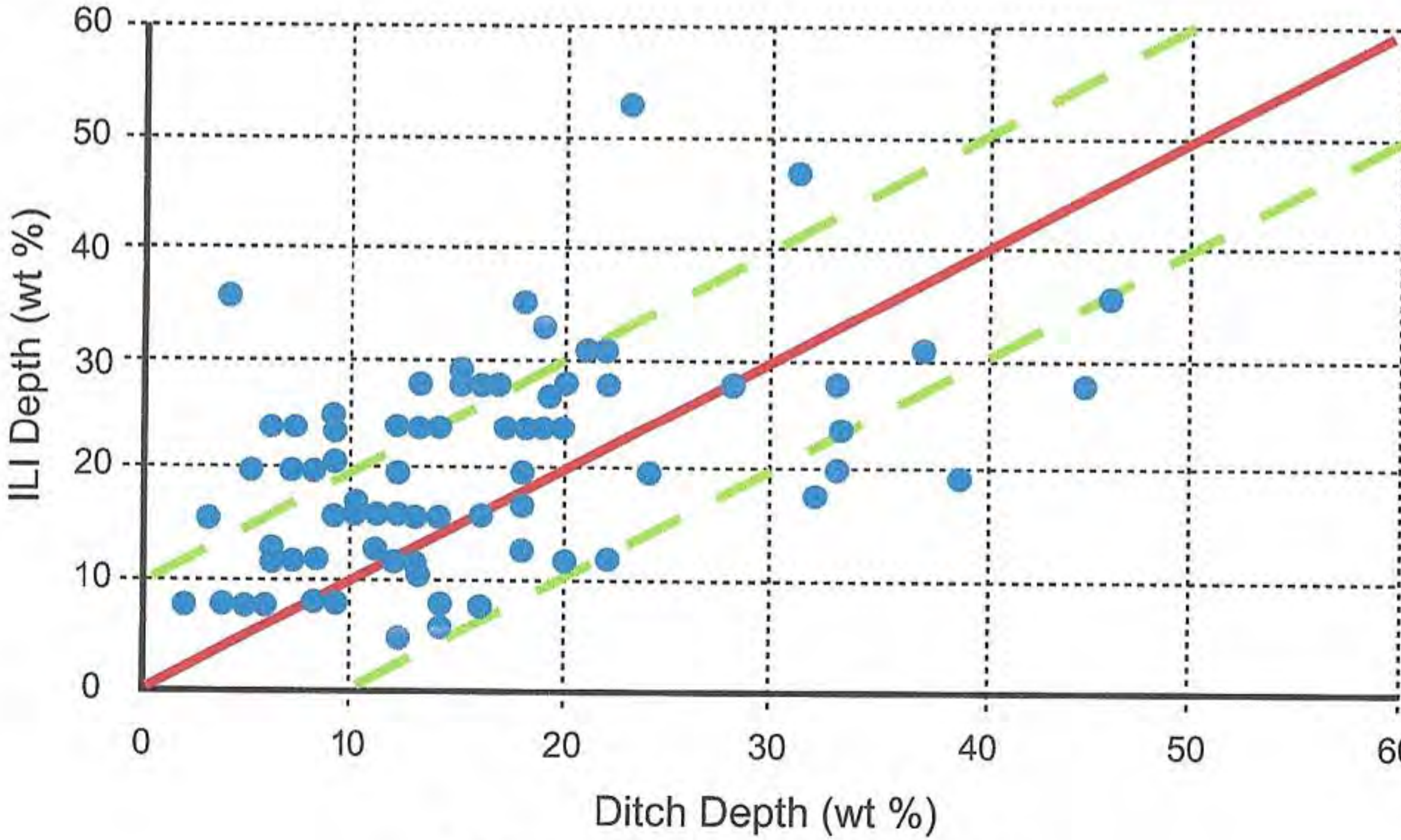


Figure C.1—Unity Chart Example

Can the Remaining Life of Line 5 be Predicted?

PHMSA Report on Enbridge Line 6B Failure

“Enbridge’s integrity management program was inadequate because it did not consider the following: a sufficient margin of safety, appropriate wall thickness, tool tolerances, use of a continuous reassessment approach to incorporate lessons learned, the effects of corrosion on crack depth sizing, and accelerated crack growth rates due to corrosion fatigue on corroded pipe with a failed coating.”

Three Approaches to Lifetime Prediction

1. Extrapolation of ILI data to endpoint,

2. Statistical prediction based on large data sets,

3. Statistical prediction based on ILI and incident records for an individual pipeline.
    a. All incidents are important. A record of frequent small incidents is predictive of a big one.
    b. Long term successful operation without a major failure is not evidence that it will never happen.

Enbridge Operational Reliability Report
In Line Inspection Data for Corrosion and Cracking

P. 14 **Industry Guidelines for CGR Compared to Line 5 CGRS**

Standard/Guideline Recommendations

NACE RP0102	0.3mm/yr: 80% confidence max rate with 'good' CP
ASME B31.8S	0.31mm/yr max rate for active corrosion in low resistivity soils
GRI-00/0230	0.56mm/yr for pitting; 0.3mm/yr for general corrosion

Line 5 Avg. Rates	**External Corrosion 0.038mm/yr – 0.068mm/yr**
Line 5 Avg. Rates	**Internal Corrosion 0.018mm/yr – 0.046mm/yr**
Line 5 Straits of Mackinac	**Int. and Ext. Corrosion No observed corrosion growth**

p. 15 **Line 5 In-Line Inspection Metrics — Cracking**

Depth of ILI Crack Tool Anomalies

Feature Depth	0.040" - 0.080"	0.080" - 0.120"	> 0.120"
# Features	661	48	0
# Features per Mile	1.032/mi	0.070/mi	0.000/mi

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Enbridge Corrosion Rate Data Analysis

	Lower Value	Upper Value	Average
Internal Corrosion Rate, (mm/yr)	0.018	0.046	0.032
External Corrosion Rate, (mm/yr)	0.038	0.068	0.053
		Total Corrosion Rate, (mm/yr)	0.085
		Total Corrosion Rate, (in/yr)	0.0033
	Years in Service	62	
		Total corrosion over Service Life, (in)	0.207

Pipe Size	Wall Thickness	Average Thickness Loss
30" x 9/32	0.281	74%
30" x 5/16	0.312	67%
30" x 11/32	0.344	60%
30" x3/8	0.375	55%
30" x 1/2	0.500	41%
30" x 11/16	0.687	30%
20" x 7/8	0.813	26%

“Bulge” Repair on Line 5 in 2012
Photo taken between I-75 and Eagles Nest Road at Learning Road

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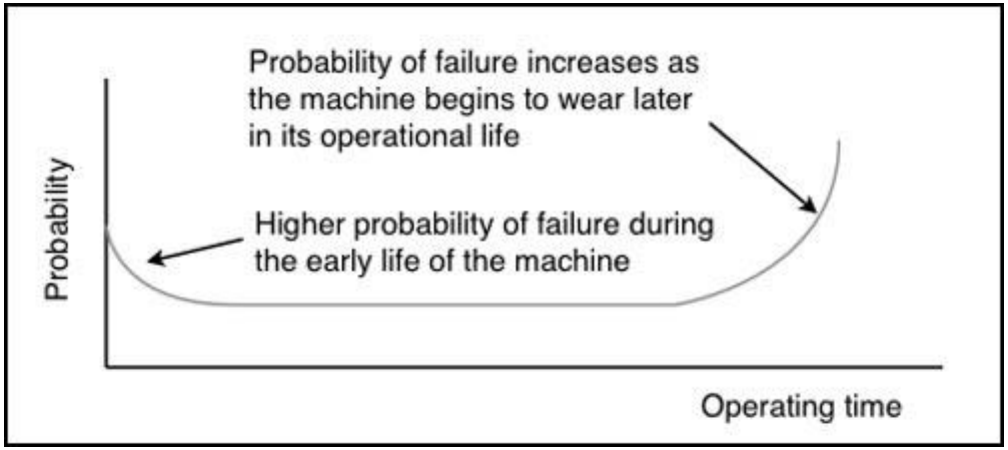
Enbridge Operational Reliability Report on Corrosion Rates

P. 14 **Industry Guidelines for CGR Compared to Line 5 CGRS**		
Line 5 Avg. Rates	External Corrosion	0.038mm/yr – 0.068mm/yr
Line 5 Avg. Rates	Internal Corrosion	0.018mm/yr – 0.046mm/yr
Line 5 Straits of Mackinac	**Int. and Ext. Corrosion**	**No observed corrosion growth**

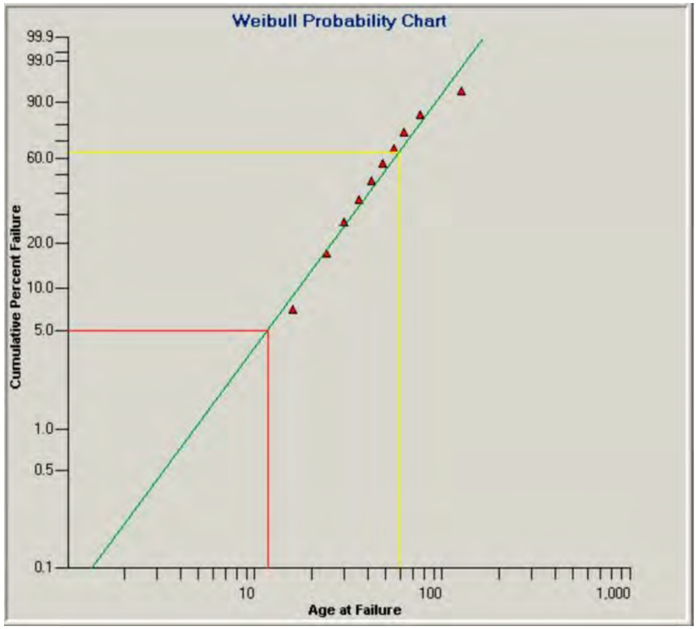
Enclosure to June 27, 2014 (Enbridge) Letter to Hon. Schuette & Hon. Wyant
Responses to Questions and Requests for Information Regarding the Straits Pipelines

The two crossings have been regularly inspected using ILI tools over the years. There are no features that meet excavation criteria reported to date. Note that two corrosion validation digs were executed in 2009 following the 2008 ILI run on the West crossing. Shallow corrosion features were found at ILI tool called area. The field non-destructive examination (NDE) reports of these two digs are provided in the folder titled "C1".

Statistical Reliability Prediction



Failure Probability in an Increment of Time



Cumulative Probability of Failure as Machine Ages

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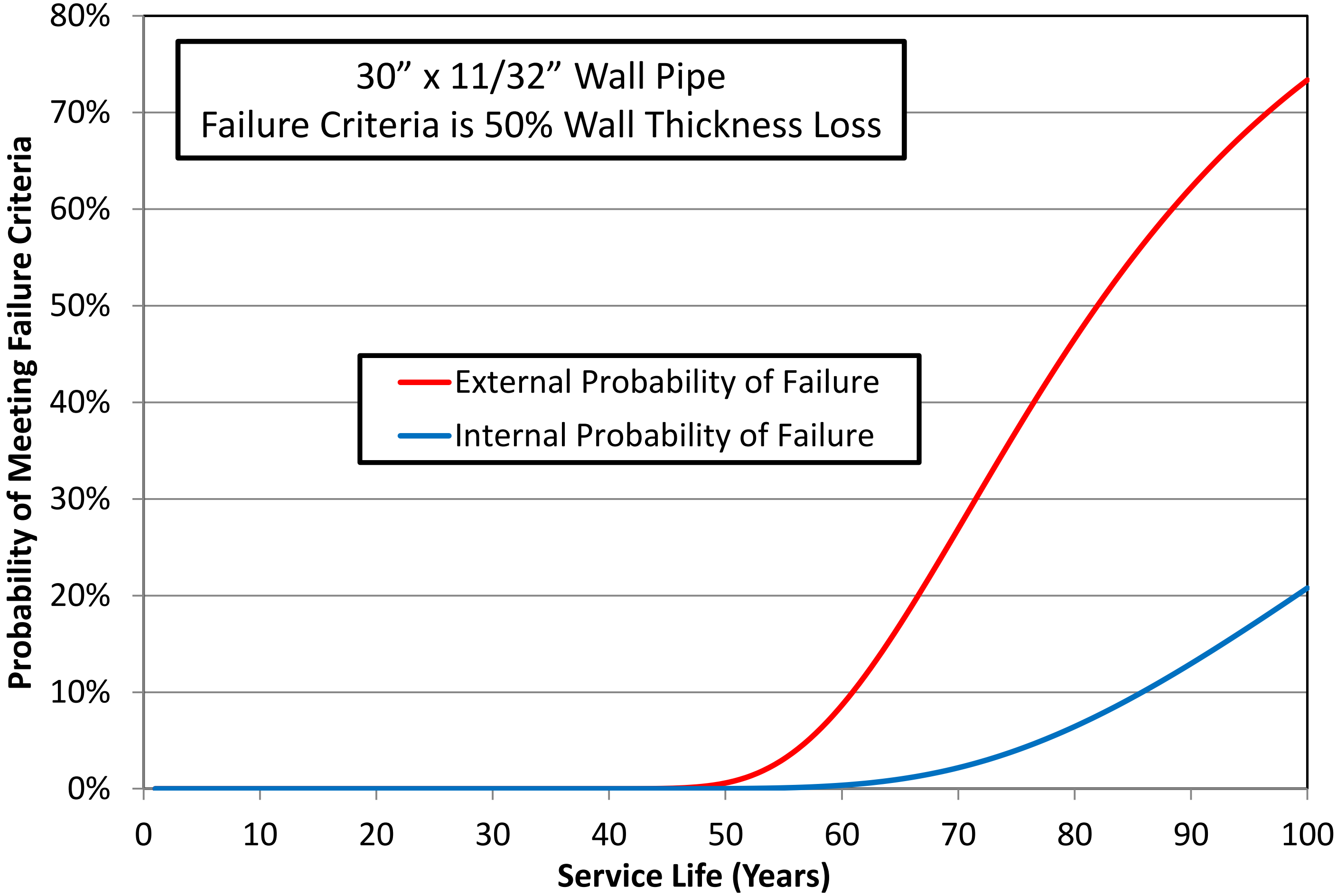
Weibull Analysis of Enbridge Corrosion Data
Service Life of Line 5



A-189

Pipelines Can Be Insured
The Best Analysts of Pipeline Risk Work for Insurance Underwriters

- One study in Europe found that age was not a factor in pipeline failures up to the 30 year limit of their data

- No knowledge of how insurance and re-insurance carriers analyze risk

Pipeline Insurance – Technical Aspects Of Underwriting And Claims

Richard Radevsky, Technical Director**,** Charles Taylor Consulting plc, London, UK
Doug Scott, Risk Engineering Consultant, Charles Taylor Consulting plc, London, UK

"Insurance polices protect against a variety of specific perils and not against all causes of damage. For example, it is not possible to insure against corrosion of a pipeline, although the consequences of corrosion, such as clean up costs following leakage of materials from a corroded pipeline are insurable."

Conclusions

- The entire public record including information which has been obtained to date through the FOIA process is insufficient to adequately assess the reliability of line 5
- My analysis to date has raised far more questions than have been answered
- Enbridge's Operational Reliability Report lacks the technical detail necessary to support its conclusions
- Ensuring the safety of line 5 through the use of in line inspection tools is problematic
- Inspection without repair criteria and ongoing repair efforts is meaningless (The fatal line 6B flaw was known to Enbridge management for 5 years without triggering their repair process.)

Enbridge Energy Partners Limited
Line 5, Straits of Mackinaw Crossing
Engineering Opinion Report
Edward E. Timm, PhD, PE, March 14, 2015

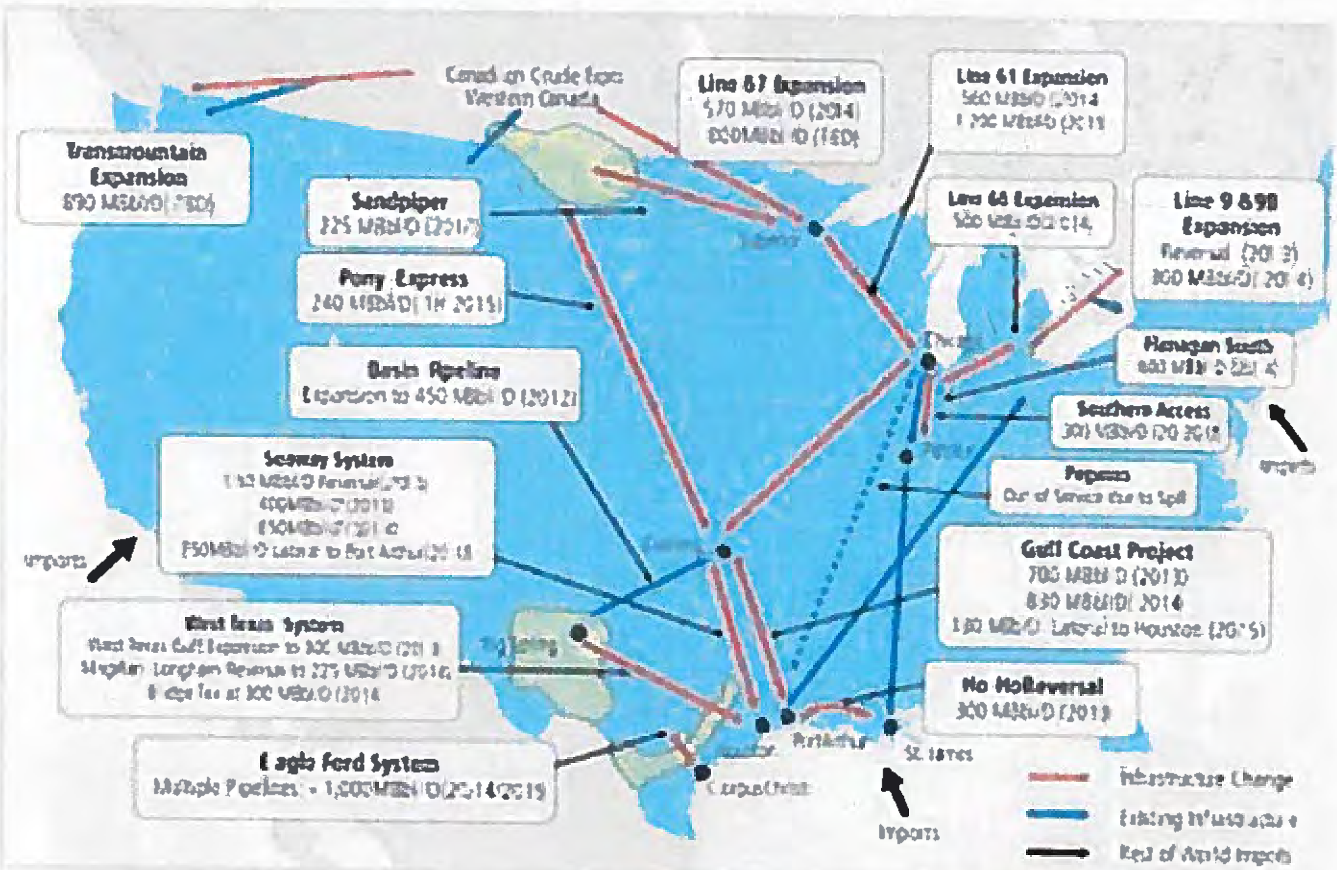
I believe it is likely that line 5 as it exists and operates in 2015 presents unacceptable risk for service that would be considered greater than Class 4 if it were a gas transmission pipeline.

It is my professional opinion that line 5 should be de-rated to its original design capacity of 300,000 bbl/d to reduce the stress on this very old pipeline and its cargo should be restriced to NGL's until a full analysis of its safety can be made using modern methods and all the information that exists.

APPENDIX 5

Subject: Map of Pipeline Expansion Plans to Move Tars to Markets through North America

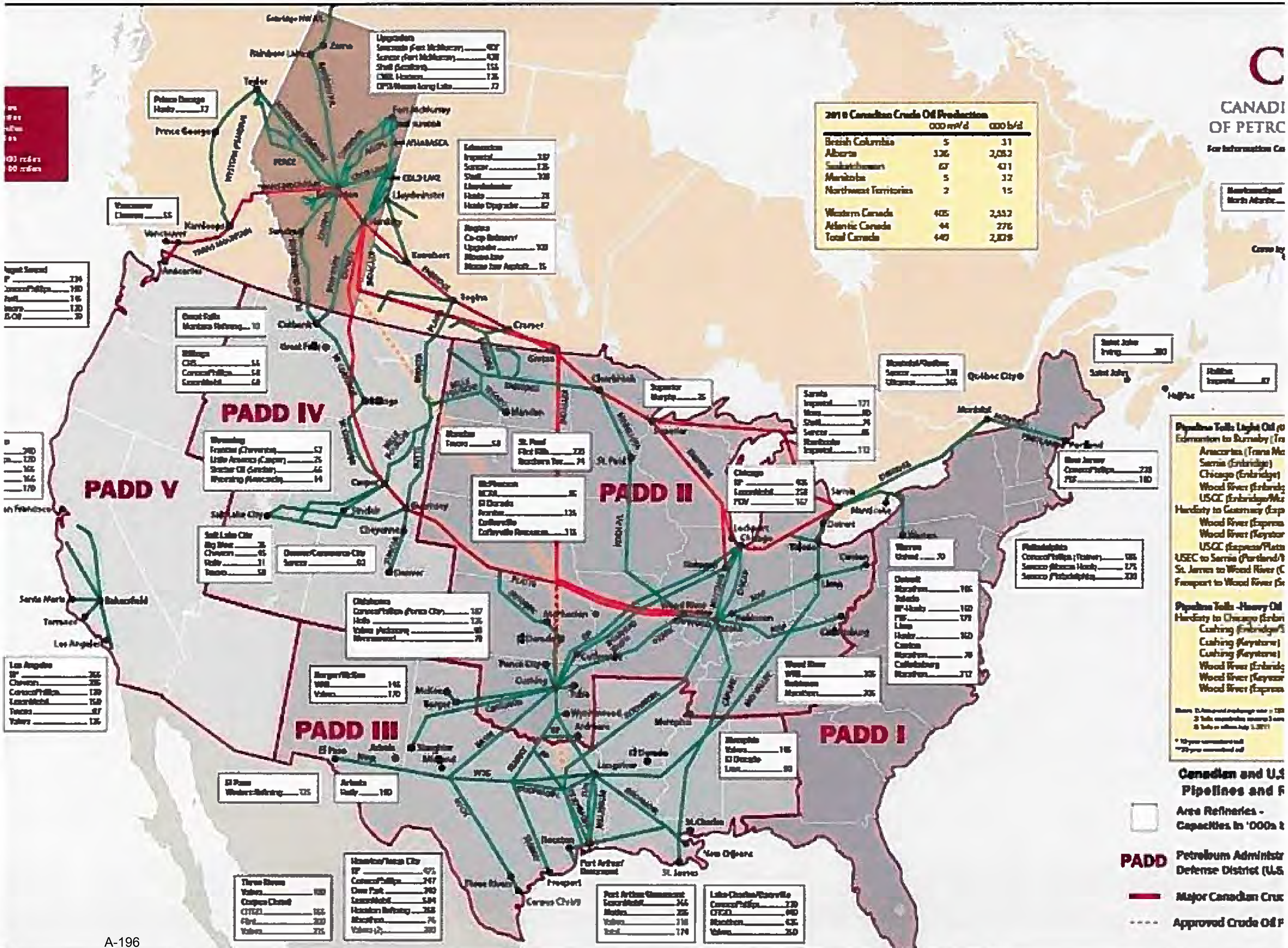
Pipeline & Gas Journal for June 2015, at p. 46, that is great and wanted to share.



There have been substantial pipeline additions and some reversals of pipeline product flows to accommodate the changes in domestic production regions and the volumes of product that are being transported


Proposed Atlantic route
Kitimat
Enbridge Gateway
Trans Mountain
Edmonton
Hardisty
Anacortes
Enbridge Alberta Clipper
Enbridge (North Dakota) Expansion
Clearbrook
Superior
Montreal
Saint John
Portland
TransCanada Keystone XL
St. Paul
Enbridge
Guernsey
Salt Lake City
Sarnia
Flanagan
Chicago
Philadelphia
TransCanada Keystone & Cushing Extension
Spearhead South
Wood River
Patoka
Spearhead North
Mustang
Cushing
Centurion Pipeline
ExxonMobil/ Enbridge Pegasus
Port Arthur
Houston
Canadian and U.S. Oil Pi
Enbridge Pipelines, AB C and connections to the U
Kinder Morgan Express
Kinder Morgan Trans Mo
TransCanada Keystone
Proposed pipelines to th
Existing / Proposed pipe
Expansion to existing pip

A-195



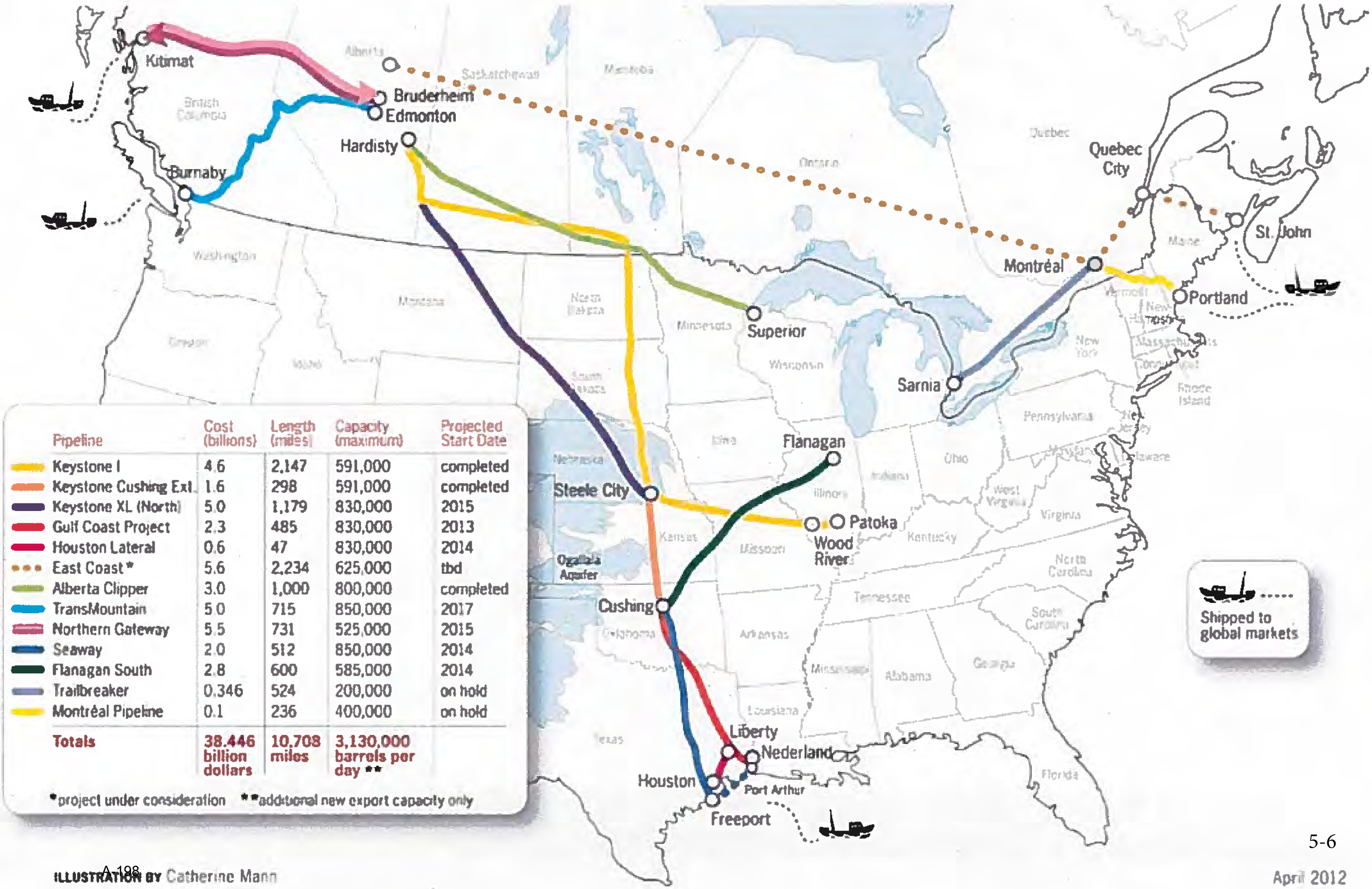
PADD IV
PADD V
PADD II
PADD III
PADD I
CANADI
OF PETRC
Canadian and U.S
Pipelines and F
Area Refineries - Capacities in '000s
PADD
Petroleum Administ Defense District (U.S.
Major Canadian Cru
Approved Crude Oil P

to Pump Tar Sands Through Eastern Canada and New England

inside climate news

THE TAR SANDS PIPELINE BOOM

Industry has announced the intention to build more than 10,000 miles of pipelines at a cost of almost $40 billion over the next five years to send an additional 3.1 million barrels a day of crude oil from Canada's oil sands to global markets.

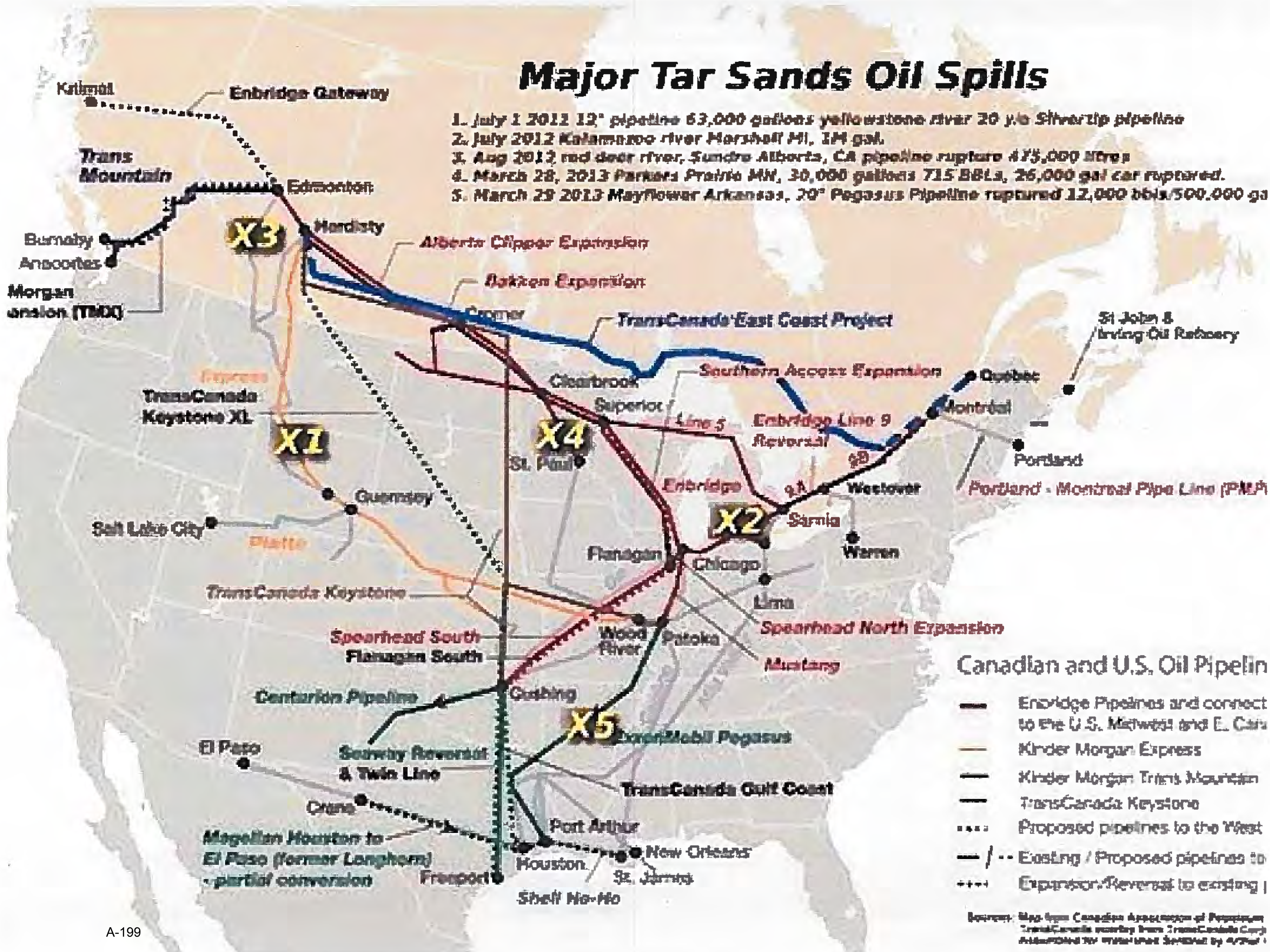


Pipeline	Cost (billions)	Length (miles)	Capacity (maximum)	Projected Start Date
Keystone I	4.6	2,147	591,000	completed
Keystone Cushing Ext.	1.6	298	591,000	completed
Keystone XL (North)	5.0	1,179	830,000	2015
Gulf Coast Project	2.3	485	830,000	2013
Houston Lateral	0.6	47	830,000	2014
East Coast*	5.6	2,234	625,000	tbd
Alberta Clipper	3.0	1,000	800,000	completed
TransMountain	5.0	715	850,000	2017
Northern Gateway	5.5	731	525,000	2015
Seaway	2.0	512	850,000	2014
Flanagan South	2.8	600	585,000	2014
Trailbreaker	0.346	524	200,000	on hold
Montréal Pipeline	0.1	236	400,000	on hold
Totals	**38.446 billion dollars**	**10,708 miles**	**3,130,000 barrels per day ****	

*project under consideration **additional new export capacity only

ILLUSTRATION BY Catherine Mann

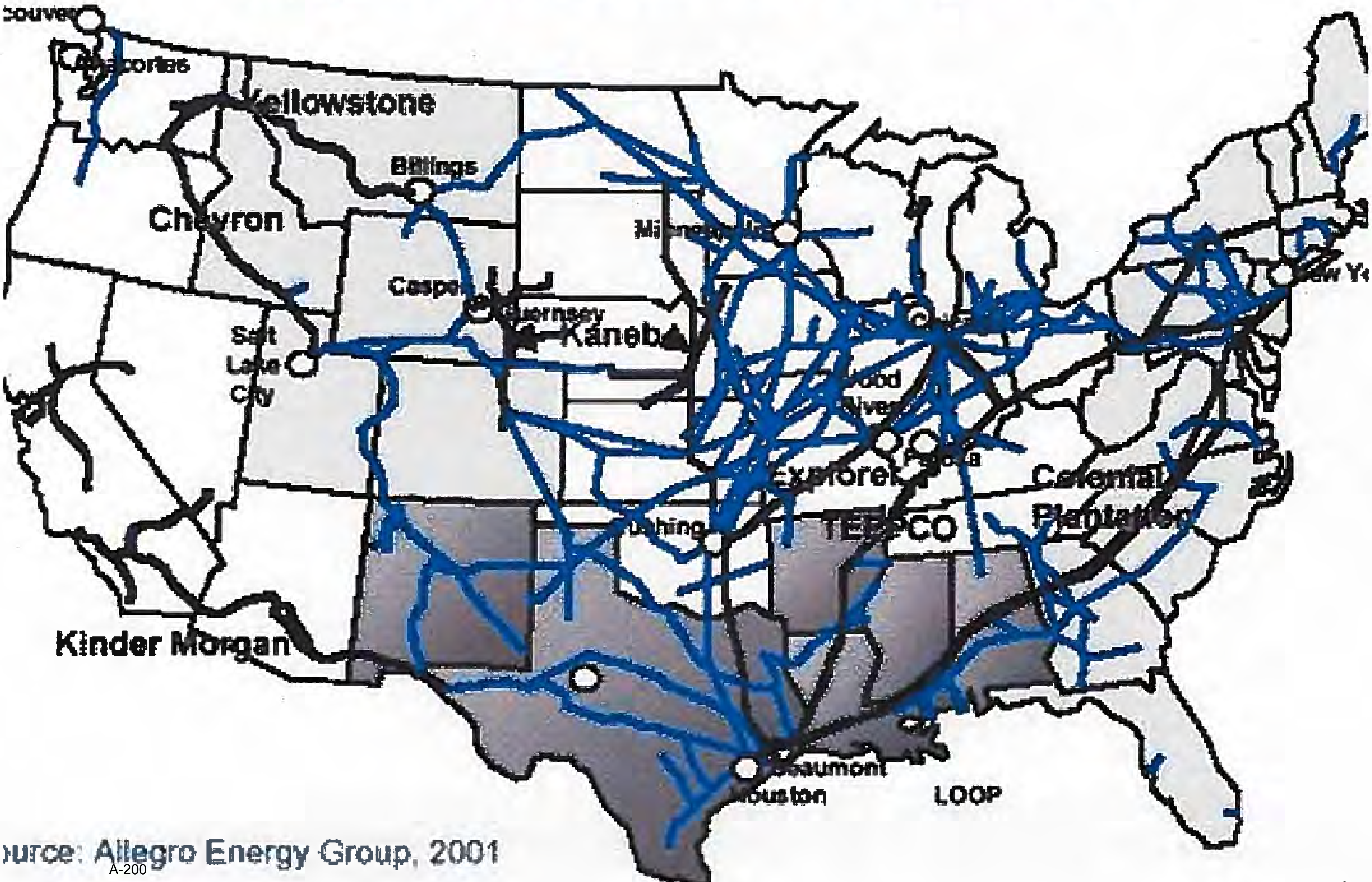
April 2012



Major Tar Sands Oil Spills
1. July 1 2011 12" pipeline 63,000 gallons yellowstone river 20 y/o Silvertip pipeline
2. July 2012 Kalamazoo river Marshall MI, 1M gal.
3. Aug 2012 red deer river, Sundre Alberta, CA pipeline rupture 475,000 litres
4. March 28, 2013 Parkers Prairie MN, 30,000 gallons 715 BBLs, 26,000 gal car ruptured.
5. March 29 2013 Mayflower Arkansas, 20" Pegasus Pipeline ruptured 12,000 bbls/500,000 ga
X1
X2
X3
X4
X5
Enbridge Gateway
Trans Mountain
Edmonton
Hardisty
Burnaby
Anacortes
Alberta Clipper Expansion
Bakken Expansion
Cromer
TransCanada East Coast Project
St John &
Irving Oil Refinery
Clearbrook
Southern Access Expansion
Quebec
Montreal
TransCanada
Keystone XL
Superior
Line 5
Enbridge Line 9
Reversal
Portland
St. Paul
Enbridge
Westover
Portland - Montreal Pipe Line (PMPL)
Guernsey
Sarnia
Salt Lake City
Platte
Warren
Flanagan
Chicago
Lima
TransCanada Keystone
Spearhead North Expansion
Wood River
Patoka
Spearhead South
Flanagan South
Mustang
Canadian and U.S. Oil Pipelin
Centurion Pipeline
Cushing
ExxonMobil Pegasus
El Paso
Seaway Reversal
& Twin Line
TransCanada Gulf Coast
Crane
Port Arthur
Magellan Houston to
El Paso (former Longhorn)
- partial conversion
Houston
New Orleans
Freeport
St. James
Shell Ho-Ho
Enbridge Pipelines and connect
to the U.S. Midwest and E. Can
Kinder Morgan Express
Kinder Morgan Trans Mountain
TransCanada Keystone
Proposed pipelines to the West
Existing / Proposed pipelines to
Expansion/Reversal to existing

A-199

Major Refined Products Pipelines



Source: Allegro Energy Group, 2001

FLOW
FOR LOVE OF WATER

Protecting the Common Waters of the Great Lakes Basin
Through Public Trust Solutions

**BEFORE THE MICHIGAN PIPELINE SAFETY ADVISORY BOARD,
MICHIGAN ATTORNEY GENERAL WILLIAM SCHUETTE, AND
MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY DIRECTOR DAN WYANT**

ELIMINATING THE LINE 5 OIL PIPELINES' UNACCEPTABLE RISK TO THE GREAT LAKES THROUGH A COMPREHENSIVE ALTERNATIVES ANALYSIS AND SYSTEMS APPROACH

December 14, 2015

Submitted by:

**FLOW (For Love of Water)
Great Lakes Water Law and Policy Non Profit
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FLOW
FOR LOVE OF WATER

Protecting the Common Waters of the Great Lakes Basin
Through Public Trust Solutions

NEW STUDY ANSWERS "NO" TO THE QUESTION: DO WE NEED LINE 5 IN THE STRAITS? EXPERTS TAKE COMPREHENSIVE LOOK AT ENBRIDGE'S RISKY PIPELINES AND OUR ENERGY INFRASTRUCTURE

EXECUTIVE SUMMARY

December 14, 2015

Governor Rick Snyder's Executive Order 2015-12 created and directed the Michigan Pipeline Safety Advisory Board ("Advisory Board") to implement the recommendations of the Michigan Petroleum Pipeline Task Force Report ("Task Force") on the future of oil transport through the Line 5 pipeline in the Straits of Mackinac and pipelines throughout the State of Michigan.

The July 2015 Task Force Report concludes that Line 5 in the Straits presented the "most acute potential threat" of a catastrophic oil spill given the location if this 62-year old pipeline resting on Great Lakes bottomlands. The Task Force Report accordingly calls for an independent alternatives analysis, including as an alternative the decommissioning of Line 5 in the Straits for oil transport. Other reports, including FLOW's (For Love of Water) September 2015 Expert Report, have substantiated that the transport of oil through Line 5 in the Straits constitutes an unacceptable high-level risk and imminent harm to our waters for drinking, recreation, commerce, navigation, tourism, and our *Pure Michigan* way of life. Immediate action therefore is necessary, including the orderly completion of the alternatives and risk analyses and interim actions to eliminate imminent harm.

FLOW now submits this report titled, *Eliminating the Line 5 Oil Pipelines' Unacceptable Risk to the Great Lakes through a Comprehensive Alternatives Analysis and Systems Approach*, to the Advisory Board to assist in implementing a comprehensive alternatives analysis to Line 5 in the Straits per the recommendations of the Task Force Report. This report and attached technical reports also are intended to help the public better understand the nature and scope of a proper alternatives analysis and to demonstrate that decommissioning of Line 5 in the Straits is a viable option given the existing capacity and supply-and-demand needs of the overall pipeline system around the Great Lakes. A preliminary review of the existing pipeline capacity and regional refinery demands affirms that Line 5 in the Straits is not vital energy infrastructure to Michigan's economy and energy security. This report makes the following conclusions:

1. **All alternative options must be considered. A comprehensive and full range of options is needed to comply with the Michigan Petroleum Pipeline Task Force recommendations and the Governor's Executive Order establishing the Michigan Pipeline Safety Advisory Board.** Alternatives explored must not

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FLOWFORWATER.ORG

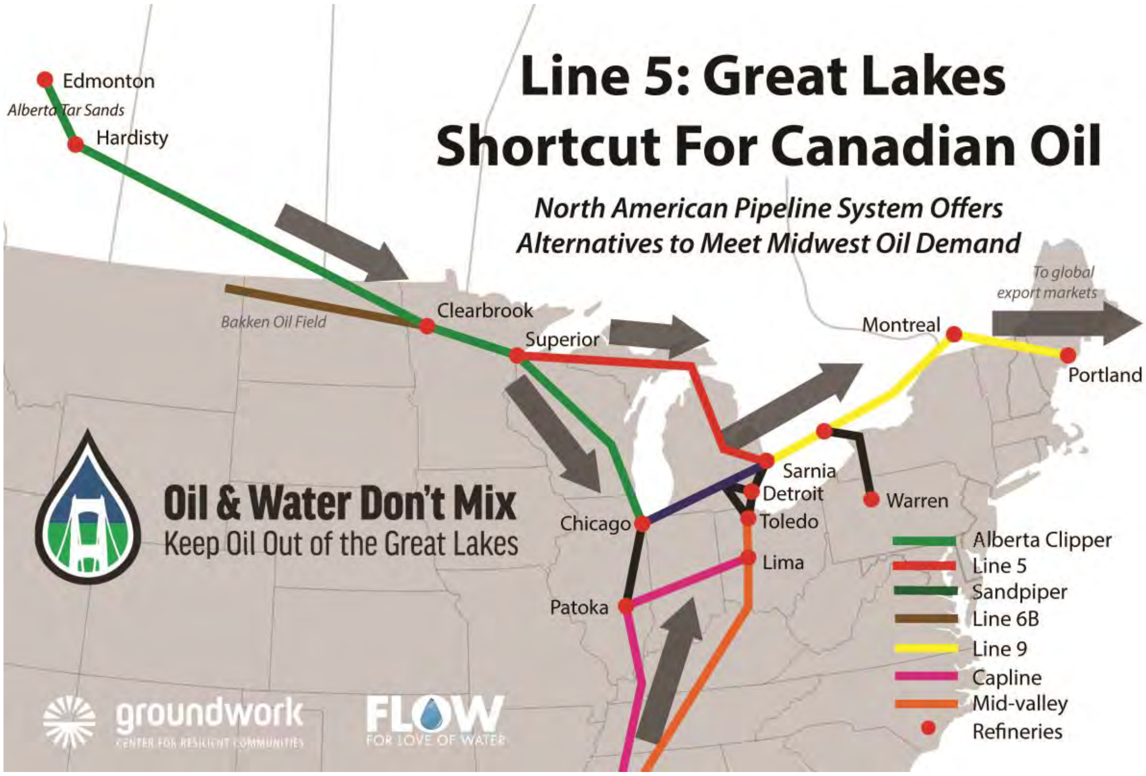
be limited solely to options for transporting liquid petroleum currently carried by Line 5 in the Straits. A comprehensive alternatives analysis should review the transport of crude oil through the lens of the entire Great Lakes region's system of oil pipelines, routes, capacity and ability to deliver liquid petroleum currently carried by Line 5 in the Straits. Without a comprehensive pipeline systems view, state and federal decision-makers are unable to identify and evaluate the best alternative to Enbridge's Line 5 twin pipelines in the Straits of Mackinac.

2. **Preliminary findings in the FLOW report show that Line 5 through the Straits of Mackinac is not vital energy infrastructure to Michigan's economy. The overall pipeline system is flexible enough to meet existing demand if Line 5 through the Straits were decommissioned.** Realistic alternatives to Line 5 in the Straits could be met without disrupting distribution of natural gas liquids, including propane, to Michigan's Upper Peninsula. Alternatives to the Line 5 segment in the Straits would eliminate unacceptable harm to the Great Lakes and Michigan communities while still meeting our energy needs.

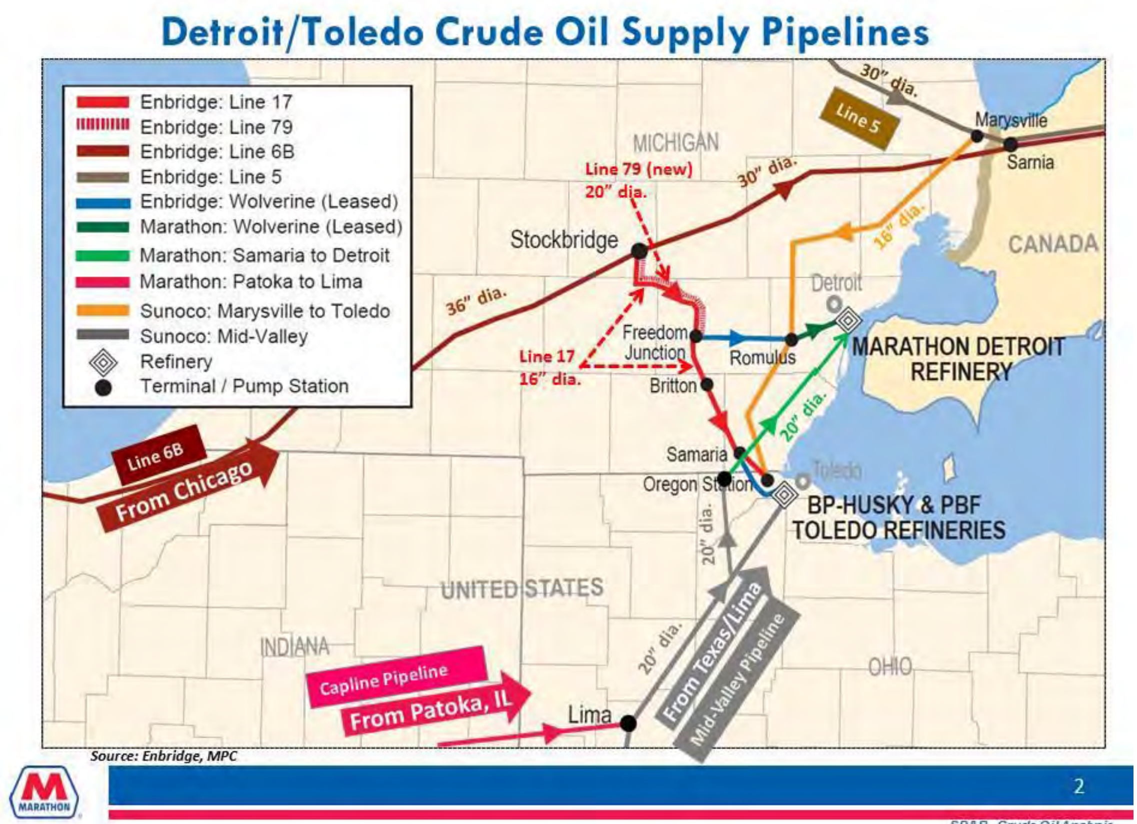
3. **Decommissioning Line 5 in the Straits is the best option.** FLOW's report concludes that decommissioning Line 5 in the Straits is the best option because it would eliminate or avoid the unacceptable and imminent harm and high risk to the Straits and Great Lakes. Moreover, the dynamic pipeline system serving Michigan, the Great Lakes region, and elsewhere meets the purposes of the larger regional system of petroleum distribution and Enbridge could continue transporting substantial volumes of crude oil.

4. **Segment-by-segment, Enbridge has effectively built its own version of the now rejected "Keystone XL Pipeline" through the center of the Great Lakes and across Michigan without public, state, and federal consideration and evaluation of the full range of existing alternatives.** In Michigan, following its 2010 Kalamazoo oil spill disaster, Enbridge applied for "maintenance and integrity" measures for Line 6B before the Michigan Public Service Commission, when in fact, it built a brand new Line 6B that more than doubled its capacity to as much as 800,000 bpd. Had Enbridge disclosed its larger project intentions, a more properly scoped alternative analysis would have evaluated Line 5, Line 6B, other pipelines, needs of users, and the pipeline system as a whole, and the imminent and unacceptable harm to the Straits could and would have been addressed.

5. **Immediate interim measures should be imposed on Enbridge, including the shutoff of oil though Line 5 in the Straits given the imminent harm and risk and the stated inability of Enbridge and the U.S. Coast Guard to clean up a catastrophic oil spill in the open waters of the Great Lakes**.



Line 5: Great Lakes Shortcut For Canadian Oil
North American Pipeline System Offers Alternatives to Meet Midwest Oil Demand
Edmonton
Alberta Tar Sands
Hardisty
Bakken Oil Field
Clearbrook
Superior
To global export markets
Montreal
Portland
Sarnia
Detroit
Warren
Toledo
Chicago
Lima
Patoka
Oil & Water Don't Mix
Keep Oil Out of the Great Lakes
Alberta Clipper
Line 5
Sandpiper
Line 6B
Line 9
Capline
Mid-valley
Refineries
groundwork
FLOW
FOR LOVE OF WATER



Detroit/Toledo Crude Oil Supply Pipelines
Enbridge: Line 17
Enbridge: Line 79
Enbridge: Line 6B
Enbridge: Line 5
Enbridge: Wolverine (Leased)
Marathon: Wolverine (Leased)
Marathon: Samaria to Detroit
Marathon: Patoka to Lima
Sunoco: Marysville to Toledo
Sunoco: Mid-Valley
Refinery
Terminal / Pump Station
MICHIGAN
Line 79 (new)
20" dia.
30" dia.
Line 5
Marysville
Sarnia
CANADA
16" dia.
Stockbridge
36" dia.
Detroit
Freedom Junction
Romulus
MARATHON DETROIT REFINERY
Line 17
16" dia.
Britton
20" dia.
Samaria
Oregon Station
Toledo
BP-HUSKY & PBF TOLEDO REFINERIES
Line 6B
From Chicago
UNITED STATES
INDIANA
OHIO
Capline Pipeline
From Patoka, IL
Lima
From Texas/Lima
Mid-Valley Pipeline
Source: Enbridge, MPC
2
SD&P - Crude Oil Analysis

I. Overview

FLOW (For Love of Water) submits this report titled, *Eliminating the Line 5 Oil Pipelines' Unacceptable Risk to the Great Lakes through a Comprehensive Alternatives Analysis and Systems Approach*, to assist the state officials and the Michigan Pipeline Safety Advisory Board ("Advisory Board") in the implementation and completion of the alternatives analysis regarding crude oil transport in, through, and out of the Great Lakes Basin and Michigan, including Line 5 in the Straits of Mackinac.[1] This report consists of two parts, followed by appendices:

Part I The legal framework and principles for the alternatives analysis of the transport of crude oil in the pipeline system into, through, and out of the Great Lakes Basin.

Part II The key findings of three technical reports (attached as appendices to this report) that show:

(A) The dynamic nature of the evolving crude oil pipeline system in the Great Lakes region (Appendix A: R. Kane Report);

(B) The capacity and flexibility within the crude oil pipeline system in Michigan and the Great Lakes region to achieve and provide adequate alternatives to Line 5 in the Straits of Mackinac to transport oil to users (Appendix B: G. Street Report); and

(C) An example of an alternatives analysis within this crude oil pipeline system and a credible option for the "decommissioning of Line 5 in the Straits segment"[2] that reasonably meet the basic overall purpose and objective of transporting crude oil to the various refineries within and beyond the Great Lakes region (Appendix C: R. Kane Report).

This report then concludes with (1) a summary of the legal framework for the overall system, nature, scope and stands for a proper alternatives analysis, (2) the dynamic and evolving nature of the Great Lakes crude oil pipeline system and its capacities and opportunities, and (3) a demonstration of one alternative – decommissioning Line 5 in the Straits segment – as a model and viable option that would continue to support Michigan's energy needs *and* eliminate the catastrophic risk of an oil spill in the Great Lakes.

---

[1] This report is authored by James Olson, President, Liz Kirkwood, Executive Director, Kelly Thayer, Project Communications Consultant, FLOW (For Love of Water), which is based on three attached technical reports authored by members of FLOW's scientific and legal policy advisors: Richard J. Kane, QEP, CHMM, CPP and Gary L. Street, P.E., formerly Director of Engineering, DOW Environmental (Eastern Operations). For a more complete description of the authors' qualifications and experience, see paragraph 2., p. 7, FLOW Composite Summary of Expert Comments, Findings and Opinions on Enbridge Line 5, submitted to Michigan Petroleum Pipeline Task Force, April 30, 2015 (hereinafter "FLOW April 2015 Expert Report").

[2] "Decommissioning Line 5" as used in this report includes (a) retiring use of the Line 5 in the Straits segment, or others if deemed proper as part of the overall analysis, and/or (b) prohibiting the use of Line 5 in the Straits segment for the transport of crude oil. It follows that if option (a) is viable because of overall system and infrastructure capacity, options, adjustments or changes, then (b) is viable.

II. BACKGROUND

The 1953 Easement

The 1953 Easement between the State of Michigan and Enbridge to construct and operate a petroleum pipeline in the Straits of Mackinac (a segment of Line 5 consisting of two 20-inch 4.5 mile pipelines) is subject to the authority of Act 10 and the reserved rights and interests of the state as owner and trustee of the waters and bottomlands of the Great Lakes.[3] The public trust imposed on the waters and bottomlands of the Great Lakes establishes a paramount and specially protected interest in citizens, as recognized beneficiaries, for preferred uses that cannot be subordinated to other private purposes and cannot be significantly impaired; public trust uses include navigation, commerce, drinking water, fishing, boating, swimming, and similar public uses and recreational activities.[4] As such, these waters and bottomlands have a rare, unique status, dedicated to the public in perpetuity.[5]

In the 1953 Easement, Enbridge also recognized the paramount public trust interest of the State in these waters and bottomlands. Enbridge (through Lakehead, its former company) expressly covenanted that it "*at all times* shall exercise the due care of a ***reasonably prudent person*** for the safety and welfare of all persons and of all *public* and private property, and shall comply with all laws of the State of Michigan and the Federal Government."[6] Enbridge expressly recognized that the duty to protect public and private property and to comply with state and federal law was continuing, and not fixed as to time, and that its obligation extended to public trust waters and bottomlands as "public property" of the State of Michigan.

Affirmative Public Trust Duty and Principles

The State of Michigan must manage and protect the Great Lakes and bottomlands, and these public uses, as a public trust, and in this sense, these special water and aquatic features are similar to, but perhaps more stringently protected than parklands dedicated to the public for park purposes.[7] Specifically, any alternative analysis and assessment of petroleum pipelines necessarily must be conducted within the context of the solemn duty and protective standards

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[3] Illinois Central R Rd v Illinois, 146 US 387, 454-455 (1892); Obrecht v. Nat'l Gypsum Co., 105 N.W.2d 143, 149-151 (Mich. 1960) and Collins v. Gerhardt, 237 Mich 38; 211 NW 115 (1926); Act 10 of 1953, Part 322, NREPA, MCL 324.32201.

[4] Id., Collins v. Gerhardt, supra note32, at 49. See generally Bertram C. Frey and Andrew Mutz, *The Public Trust in the Surface Waters and Submerged Lands in the Great Lakes*, 4 U. Mich J. L. Reform 907-993 (2007).

[5] The public trust covers "property of a special character like navigable waters, such as the Great Lakes. Illinois Central, supra note 2, 146 US at 453-454.

[6] 1953 Easement, paragraph A; Michigan Petroleum Pipeline Task Force Report, July 14, 2015, p. 42 (hereinafter "Task Force Report") https://www.michigan.gov/documents/deq/M_Petroleum_Pipeline_Report_2015-10_reducedsize_494297_7.pdf

[7] See also James Olson and Liz Kirkwood, *A Scientific and Legal Policy Report on the Transport of Oil in the Great Lakes*, September 21, 2015 (submitted to Attorney General William Schuette, DEQ Director Dan Wyant, et al. as follow up to the Task Force Report), footnotes 63 and 64, and accompanying text (hereinafter "FLOW September 2015 Expert Report").

imposed by the public trust in the Great Lakes. As stated by the Michigan Supreme Court, "the state has the constitutional power to insist that its natural advantages remain unimpaired."[8]

The Michigan Petroleum Pipeline Task Force Report Demands a "Comprehensive" and "Full-Range" Alternatives Analysis for Line 5.

According to University of Michigan researchers, a spill or release in the Straits is the "worse possible place" in the Great Lakes.[9] In reviewing important scientific studies like this, the Task Force determined that the consequences of a crude oil spill or release from Line 5 in the Straits of Mackinac would be "very significant"[10] with Task Force members unanimously agreeing that there should never be a release of crude oil from Line 5 in the Straits.[11] The Task Force Report soundly rejected Enbridge's assertion that "the existing 61-year-old Straits Pipelines can be operated indefinitely and that it neither has, nor needs to consider, a plan to replace them."[12] The report criticized this reasoning: "This is not a reasonable position."[13]

Accordingly, the Task Force Report concluded that an alternatives analysis and assessment is critical for preventing the high-level risk and unacceptable harm of a spill or release in the Straits[14] and is based in law. "Thus, from a legal perspective, decisions about the future operation of the Straits Pipelines must be informed by careful consideration of the full range of alternatives available."[15] The Report went on to say: "there is a need for, and importance of, a comprehensive alternatives analysis,"[16] and "[F]or all these reasons, a comprehensive analysis of alternatives to the existing Straits pipelines is needed."[17]

The Task Force Report for the Straits Pipelines thus recommended that the state:

> 3. Require an Independent Analysis of Alternatives to the Existing Straits Pipelines. These alternatives should include:
>
> a. Constructing alternative pipelines that do not cross the open waters of the Great Lakes and then decommissioning the existing pipelines;
>
> b. Utilizing alternative transportation methods and decommissioning the existing pipelines;

[8] Obrecht, supra note 3, 361 Mich at 414-415; State v Venice of America Land Co., 125 N.W. 770, 772 (Mich. 1910); State v. Lake St. Clair Fishing & Shooting Club, 127 Mich. 580, 586, 87 N.W. 117 (1901); Lincoln v. Davis, 53 Mich. 375, 388, 19 N.W. 103 (1884). The Michigan Supreme Court has characterized the states and all three branches of government as the "sworn guardians" of this "solemn and perpetual" duty. Obrecht, supra note 3, 105 NW2d at 149-151; Collins, supra note 3, 237 Mich at 49.
[9] Task Force Report, p. 17 fn 56.
[10] Id. at p.43.
[11] Proceedings, Michigan Petroleum Pipeline Task Force, December 15, 2014.
[12] Task Force Report, pg. 47.
[13] Id.
[14] Id.
[15] Id.
[16] Task Force Report, p. 48.
[17] Id.

c. Replacing the existing pipelines using the best available design and technology;

d. Managing the status quo, including an analysis of the effective life of the existing pipelines.

The report states only that the analysis "should include," and is not meant to be all inclusive. As noted above, the Task Force Report reasoned that the analysis must be "comprehensive" and consider a "full range" of alternatives. Decommissioning and/or removing oil from Line 5 in the Straits segment, for example, would also include the alternative that would prohibit oil transport in the Straits segment, since it is a reasonable alternative for purposes of analysis, given the fact that Line 6B in lower Michigan has been recently doubled in capacity.[18] Indeed, reading the list as all inclusive or limited to the literal reading of the listed alternatives a. through d. would be contrary to the legal perspective behind the recommendation, and violate basic legal requirements for "full" range and thorough evaluation of alternatives, as described in Part I of this Report.

Despite Line 5's unacceptable high risk of catastrophic harm to the Straits and public trust, alternative routes and capacity, or new routes, to oil transport through this pipeline in the Straits were never considered in 1953. Since then, laws in the past 60 years governing everything from public safety, hazardous materials, and public lands, parklands, and the environment all uniformly required alternative analyses.[19] And yet, neither Enbridge nor the State, through its review and approval of significant pipeline improvements, expansion, or replacements, such as Line 6B after the Kalamazoo River disaster, have submitted or conducted any alternative analyses or studies to the pipeline system and its capacities within Michigan or the Great Lakes region.

For example, when Enbridge decided to build a new Line 6B and obtain approval from the Michigan Public Service Commission ("MPSC") over a period of years from 2011 to 2013, it applied for permits in piecemeal fashion. Enbridge applied for and obtained approval of smaller segments of a new 36-inch Line 6B that doubled its capacity for transporting crude oil, by characterizing in applications the project was for "maintenance and integrity." In effect, Enbridge's actions avoided and the MPSC failed to conduct, an alternative study for transport of crude oil through Michigan and its pipeline systems connected outside of the Great Lakes region. In fairness, Enbridge is not in a position to challenge the missing comprehensive, "full-range" alternative analysis directed by the Task Force, when it carefully avoided it to double its capacity to transport crude oil in the Great Lakes region, including Michigan; in effect, it appears that Enbridge has built its own "Keystone XL" pipeline through the center of the Great Lakes without full disclosure or consideration by the state of this fundamental objective and purpose.[20]

The Michigan Petroleum Pipeline Task Force Report Bans "Heavy Crude Oil," Reasoning that Spills of Heavy Crude Oil Into Open Water Cannot Be Effectively Cleaned Up.

The Task Force Report's first recommendation bans heavy crude oil transport through Line 5 based on the following rationale:

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[18] See Part II, infra, p.18.
[19] Part I, infra, p.16.
[20] See R. Kane Report, Appendix A, p. 6.

> The U.S. Coast Guard has publicly stated that spills of heavy crude oil into open water cannot be effectively cleaned up. Transporting such material through the Straits Pipelines would unreasonably risk environmental and economic harm. The 1953 Straits Pipeline Easement requires Enbridge at all times in operating the Pipelines to "exercise the due care of a reasonably prudent person for the safety and welfare of all persons and of all public and private property."[21]

In short, the Task Force Report concluded that the risks associated with diluted bitumen or "heavy" crude oil from the "tar sands" in Alberta, transported by Enbridge and other pipeline companies constitute an "unreasonable risk of harm," because a release of "heavy" or "tar sands" oil "could not be effectively cleaned up."[22] Current methods available to the U.S. Coast Guard as first responders are inadequate to clean up a "heavy" or diluted heavy crude oil spill in the Great Lakes. In fact, a spill or release of any form of crude oil, including "tar sands" oil that has been diluted to be labeled "synthetic light" or "medium" crude oil, cannot be effectively cleaned up in winter months or windy, stormy conditions,[23] and cannot be adequately cleaned up anytime of the year, even under normal conditions.[24] In turn, this inadequate response would violate the standard of "reasonably prudent person" in the Enbridge Easement.

In September 2015, the State of Michigan determined and Enbridge agreed that no heavy or diluted bitumen crude oil transport through Line 5, thus relying on other alternatives in the overall pipeline system to transport "tar sands" or "heavy" crude oil to various destinations in the U.S. and Canada, or for export to other refineries from Montreal or Maine.[25] Given the inadequate emergency clean up response to all crude oil, especially in winter, the State of Michigan should extend this same logic and reasoning to all crude oil transported in Line 5 in the Straits.

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[21] Task Force Report, p. 45.
[22] Id. See also National Academy of Science. "Spills of Diluted Bitumen from Pipelines: A Comparative Study of Environmental Fate, Effects, and Response." December 2015, pp.45-47. http://www.nap.edu/catalog/21834/spills-of-diluted-bitumen-from-pipelines-a-comparative-study-of "The Great Lakes system of the U.S. and Canada has distinct characteristics that would affect the behavior and impacts of an oil spill. Transmission pipelines capable of transporting diluted bitumen products [iv] cross the Great Lakes system at two points: the Straits of Mackinac between Lake Michigan and Lake Huron,[70] and the St. Clair River upstream of Detroit and Lake Erie. A release at either the Mackinac Straits or the St. Clair River would lead to movement of oil into the lakes. Additionally, pipelines cross many streams and rivers that flow short distances to either the southwestern shores of Lake Superior or the southern shores of Lake Michigan. Currents can be complex in the Great Lakes, with currents in the Straits of Mackinac depending on relative water levels of Lakes Michigan and Huron as well as on wind speed and direction. It could be very difficult to anticipate the movement of the spilled oil and to recover the oil, even at the surface, due to the expansive area and potential for strong wave action. Ice cover during winter could impede detection and recovery of spilled oil." Id. at pp. 45-47 (footnotes omitted).
[23] Task Force Report, p. 45; Keith Matheny, "Oil spill, high waves: A Great Lakes disaster scenario," USA Today/Detroit Free Press, December 6, 2015, http://www.usatoday.com/story/experience/food-and-wine/news-festivals-events/2015/12/06/oil-spill-high-waves-great-lakes-disaster-scenario/76890650/.
[24] Keith Matheny, "A readiness test: What if oil spewed into Great Lakes?" Detroit Free Press, September 25, 2015 http://www.freep.com/story/news/local/michigan/2015/09/24/enbridge-line5-oil-pipeline-straits-mackinac-spill-great-lakes/72582654/; Garret Ellison, "'All hands on deck' Enbridge oil spill drill planned for Mackinac straits" MLive, August 13, 2015 http://www.mlive.com/news/grand-rapids/index.ssf/2015/08/enbridge_spill_drill_mackinac.html
[25] Agreement, State of Michigan and Enbridge, September 3, 2015.

Executive Order No. 2015-12 and the Michigan Pipeline Safety Advisory Board

In September 2015, Governor Rick Snyder also established the Michigan Pipeline Safety Advisory Board to implement recommendations of the Task Force, including the alternative analysis, of the Task Force Report for Line 5.[26] Presently, the Advisory Board is reviewing and establishing a "draft scope of work" to implement the independent analysis of alternatives called for by the Task Force Report and Executive Order.

To assist the Attorney General, Department of Environmental Quality, Department of Natural Resources, Governor, and newly established Advisory Board, FLOW has prepared this report to define the proper framework, scope, and principles for the State of Michigan's alternatives analysis called for by the Task Force Report and Executive Order 2015-12; the report also includes the accompanying technical reports from FLOW's science and policy advisors. Part I of this report sets forth the basic framework and principles for a comprehensive and full-range alternatives analysis. Part II of this report illustrates that there is ample capacity in the evolving crude oil pipeline system into, around, through, and from the Great Lakes region for achieving a comprehensive analysis, and demonstrates, by using one of the listed alternatives in the Task Force Recommendation No.3.

PART I: A PROPER FRAMEWORK AND PRINCIPLES FOR A COMPREHENSIVE ALTERNATIVES ANALYSIS

There are two legal approaches to alternatives analyses when addressing imminent hazards, harm to the environment, and public health and safety. The first approach is based on laws and directives, such as E.O. 2015-12, that intend to prevent, eliminate or significantly reduce loss, harm or imminent risks to recognized and important values associated with public lands, waters, bottomlands, and natural resources; these protected and highly valued resources include wetlands, parklands, or wilderness areas, open space, natural areas, sand dunes, historic resources, and public trust waters and bottomlands, and their water dependent uses. The second is based on federal or state laws that require full disclosure of impacts and consideration of a full range of alternatives to avoid or minimize impacts associated with the existing or proposed conduct under review; this typically includes federal and state laws or rules that require environmental impact statements or studies or consideration of impacts and alternatives.[27] Both of these approaches provide useful guidance for the direction from the Task Force and Governor Snyder to conduct an independent alternatives analysis to the transport of oil in the Great Lakes, including Line 5 in the Straits of Mackinac.

The first approach is central to the alternatives analysis because the protection and prevention of unacceptable harm and unreasonable risk to the Straits and Great Lakes is well-established in the basic structure of environmental and natural resources law and policy of Michigan.[28] The

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[26] Executive Order No. 2015-12, Sept. 15, 2015 (hereinafter "E.O.").
[27] E.g., National Environmental Policy Act, 42 USCA 4332(C) ("NEPA"); Part 13, NREPA, MCL 324.1701 et seq.; Vanderkloot, supra note 3, 392 Mich at 184-186; see Part I, B, infra.
[28] E.g., Mich. Const., art. 4, Sec. 52 (the "air, water and natural resources… are of "paramount public concern" and the legislature "shall" provide by law for the "protection of air, water, and natural resources from pollution,

prohibition of conduct that would impair or destroy these important resources is consistent with this law and policy, unless it can be demonstrated that here are no alternatives. Specifically, these waters and bottomlands are protected by the public trust doctrine and Michigan law, and that legally recognized protected public trusts uses are paramount to all other uses.

A. Loss, Damage, and Unacceptable or Imminent Harm to Highly Valued Public Lands, Waters, and Natural Resources Must Be Prevented, Eliminated, or Significantly Reduced.

This first type of alternatives analysis is based on statutory, regulatory, or common law government directives that intend a clear showing that alternatives do not exist or are not suitable, feasible or prudent in order to prevent the loss or unnecessary likely loss, harm or unreasonable risks to health, safety, natural resources, lands, and the environment. This first approach is aimed at avoidance or elimination of the loss, harm or significant or unreasonable risk, where possible, to protect special water and/or lands – such as parklands,[29] wetlands,[30] or public trust waters[31]– or unwanted hazardous risks to the environment,[32] historic resources,[33] or risks to public health and safety.[34]

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impairment, and destruction;" Part 17, NREPA, MCL 324.1701 et seq. (mandates protection of "air, water, natural resources, or the public trust in those resources" from likely pollution or impairment" pursuant to art 4, sec. 52.

[29] Citizens to Preserve Overton Park v Volpe, 401 US 402, 91 S Ct. 814 (1971). Section 4(f) of the Federal DOT Act prohibits use of public parks or other special public lands unless it is shown there are no feasible and prudent alternatives to a project. 49 U.S.C. 1653(f).

[30] E.g., Michigan Wetlands Protection Act, Part 303, NREPA, MCL 324.30311(4)(b). "[O]ur Legislature, following the lead of the United States Congress, passed comprehensive legislation to protect Michigan's wetlands for the benefit of its citizens. This represents a clear public policy determination and statement of the importance to the citizens of this **379 state, including property owners, of preserving wetlands for public welfare. M.C.L. § 324.30302. Moreover, the Michigan Constitution provides that "[t]he legislature shall provide for the protection of the air, water and other natural resources of this state...." Const. 1963, art. 4, § 52. In keeping with this mandate, the Legislature enacted the Natural Resources and Environmental Protection Act (NREPA), M.C.L. § 324.101 *et seq.,* which contains the WPA. The Legislature vests the DEQ with the responsibility for guarding our state's valuable natural resources on behalf of the citizens of this state. M.C.L. § 324.501; K & K Const., Inc. v. Dep't of Envtl. Quality, 267 Mich. App. 523, 549, 705 N.W.2d 365, 378-79 (2005); see also Northland Properties v DEQ, 2010 WL 4628645 (2010). See also Carabell v DNR, 191 Mich App 610 (1961) (denial of wetlands permit not a takings of property where there existed feasible and prudent alternatives).

[31] Public trust in Great Lakes is incorporated into MEPA, MCL 324.1703, and the Great Lakes Submerged Lands Act, MCL 324.32501 et seq.

[32] Schmude Oil v DEQ, 306 Mich App 35 (2014) (Statute demanded prudent development in Pigeon River Country State Forest natural area, and lawfully prohibits drilling permits where there is no showing of or there exist feasible and prudent alternatives).

[33] Grosse Pte. Park v Detroit Historic Comm'n, 2012 WL 1367533 (Mich App No. 298802, 2012) (protection of historical buildings where no showing that there was no feasible use or development alternatives).

[34] Industrial Union AFL-CIO v Hodgson, 449 F2d 467, 477-478 (1974) (Secretary of Labor finds significant material risk to health, Secretary can establish new "most protective" standard to avoid the risk, where feasible, and increased costs or lower profits, in light of the protective intent, is not sufficient to reject an alternative); See also, Airport and Airway Improvement Act ("AAIA"), 49 USC 47106(c)(1)(B). The Secretary of Transportation, after assessing environmental and safety risks can approve a project "only after finding that no possible and prudent alternative to the project exists." Id. Like Sec. 4(f) in the DOT Act, addressed in Overton Park, supra note 29, the AAIA provision seeks to avoid the use of publicly owned lands, such as parks, recreation areas, wildlife refuges, or historic sites.

This first approach is uniquely suited for the independent alternatives analysis directed by the Task Force and E.O. 2015-12. The Great Lakes and public trust are highly valued waters, resources, and public trust and riparian uses that all agree should be protected from unacceptable harm and risks such as a catastrophic oil spill.

For example, the Michigan Environmental Protection Act ("MEPA") applies to all state and local government agencies, boards, or other government bodies in Michigan.[35] There is an affirmative duty to prevent, or, if determined to be not feasible or prudent, then minimize likely degradation of the environment or public trust.[36] Where there is a demonstrated "likely"[37] pollution or impairment of air, water, natural resources, or the public trust in those resources, the conduct must be prohibited or modified to eliminate the harm or serious endangerment of pollution or impairment, where it is shown that there are no feasible and prudent alternatives.[38] In Michigan, under the MEPA, the burden of proof rests with the person engaging in the conduct to demonstrate there are truly unusual factors of an extraordinary magnitude to show an alternative does not exist or cannot be implemented. Inconvenience and increased costs, as a rule, are not sufficient reasons to reject an alternative.[39]

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[35] Part 17, NREPA, MCL 324.1701 et seq.; Vanderkloot, supra note 3; MCL 324.1703, Nemeth v Abonmarche Development Co, 457 Mich 16; 576 NW2d 641 (1998); Wayne County Health Dept v Olsonite, 79 Mich App 668 (1977) (defendant required to implement feasible and prudent paint-spray technology to eliminate or reduce likely pollution and health risks, particularly where studies of alternatives were inadequate).

[36] See FLOW September 2015 Expert Report, pp.7, 25-26. Ray v Mason Co Drain Comm'r, 393 Mich 294; 224 NW2d 883 (1975). The Court recognized that "likely" is a function of probability and magnitude of harm or impairment. If the magnitude of harm is high, then the threshold for "likely" pollution or impairment is correspondingly lower. See Env. Action Council v Natural Resources Comm'n, 405 Mich 741 (1979) (despite unknown extent or probability, the Court found a prima facie "likely" impairment because oil and gas development based on evidence could alter the return of a rare, unique elk herd population in the Pigeon River Country Forest).

[37] The term "likely" is a function of magnitude of harm and probability that determine risk. A release of crude oil, as recognized by Trask Force Report, is an unreasonably high risk that should be prevented or avoided. Such a high or unreasonable risk is tantamount to "likely." Ray, supra note 36, 393 Mich at 308.

[38] Wayne County Health Dept., supra note 35, 79 Mich App at 703-707. This case and others provide a clear substantive set of standards and principles regarding the nature, approach, scope. and substantive standards for an alternative analysis. See also Nemeth, supra note 35; Ray, supra note 36.

[39] Id., 79 Mich App at 704-705. The court noted: "This interpretation of 'prudent alternative' is bolstered by recognition that the Legislature rejected an amendment which would have inserted the phrase, 'considering all relevant surrounding circumstances and factors' before the 'feasible and prudent' language of s 3(1). See, *[at] 706 Note, Michigan's Environmental Protection Act: Political Background, 4 U.Mich.J.L.Ref. 358, 363 (1970), and Thibodeau, Michigan's Environmental Protection Act of 1970: Panacea or Pandora's Box, 48 Journal of Urban Law 579, 586 (1971). co_anchor_F191978145567_1 Applying the cited cases to the facts at hand, we conclude that the defendant has failed to show the technical, economic infeasibility and the imprudence of alternatives to defendant's conduct. Although the adoption of additional pollution controls may financially burden Olsonite and adversely affect its profit margin, Hodgson, supra, we believe, in light of the revenue data noted, supra, that the company is fully able to finance the added cost of restraining odorous emissions. The costs involved do not approach 'extraordinary magnitude' or 'truly unusual factors', Overton Park, supra, refute the demonstrated prudence of alternative systems. We believe that a reasonable, cost-effective solution to Olsonite's odor problem can be achieved if an earnest examination of other abatement methods is made. Defendant's conduct, then, will no longer be inconsistent with the promotion of public health, safety and welfare in light of Michigan's paramount concern for the natural resources of the state." See also STOP H-3 Ass'n v Dole, 740 F3d 1442 (9th Cir. 1984).

Parklands are protected against highway routes and development where there exist feasible and prudent alternatives.[40] Risks, impacts, harms and loss of natural public lands or property are protected where there are alternatives for the location of airport facilities.[41] Similarly, given the common law and statutory recognition of the importance of public trust in the Great Lakes, the Straits of Mackinac are legally protected from likely harm or endangerment, where feasible and prudent alternatives exist.

Accordingly, the state's independent alternatives analysis of the crude oil pipeline system in the Great Lakes region, including the Line 5 segment in the Straits of Mackinac, should follow the legal framework for the study of alternatives that protect the public trust, water, and natural resources in the Straits and Great Lakes and avoid alternatives like oil transport in the Straits – especially where the analysis reveals that the greater pipeline system can address or adjust through other suitable pipeline options and alternatives.

B. Environmental Impact and Alternatives Statements and Assessments "Rigorously" Evaluate Potential Impacts and a Comprehensive and "Full Range" of Potential Alternatives That Would Avoid or Minimize Such Impacts.

This second type of alternatives analysis is found in government actions that require consideration of possible impacts and alternatives, so called environmental impact statements ("EIS") or reports, including evaluation of alternatives.[42] The EIS or National Environmental Protection Act ("NEPA") assessment of impacts is considered a procedural *disclosure requirement*, and not a *substantive* standard to approve or reject a project or operation, such as those described in Part I, A. above.[43] Typically, the EIS or assessment must evaluate a full range of reasonably possible alternatives to accomplish the basic purpose of the project under review[44] – that is, a detailed disclosure of alternative ways or methods that would avoid or reduce impact and accomplish the goal or purpose.[45] However, in doing so, the government body must conduct a thorough evaluation and provide detailed reasons for its conclusions.[46]

This second approach provides a useful guideline for government bodies in determining the scope of the substantive framework and principles that underlie the nature of the substantive

[40] Overton Park, supra note 29.
[41] See supra note 34 on the Airport and Airways Improvement Act, 42 USC 47106(c)(1)(B), which has an alternative analysis based on avoiding or reducing risks to public safety, nuisance, and noise.
[42] E.g. Section 4332(C), National Environmental Policy Act, 42 USCA 4332(C) (hereafter "NEPA" and its "EIS" requirement); Calvert Cliffs Coordinating Committee v Atomic Energy Comm'n, 449 F 2d 1109 (D.C. Cir. 1971); Michigan Environmental Protection Act, Part 17, NREPA, 324.1705(2) ("MEPA"– government must consider and determine likely effects and existence of alternatives that would avoid those effects); Vanderkloot, supra note 3, (duty consider likely effects and alternatives).
[43] E.g., Village of Palatine v US Postal Service, 742 F Supp 1377 (N. D. Ill 1990); Sierra Club v Coleman 421 F Supp 63 (D.C. Dist. 1976).
[44] E.g., Council of Environmental Quality rules on NEPA impact and alternative studies and statements. 40 CFR 1500.
[45] Id. NEPA EIS, Alternatives requirement, 42 USCA 4332(C)(3). "The purpose of an EIS is a "full and fair discussion [to] inform decision makers of environmental impacts... and reasonable alternatives which would avoid or minimize adverse impacts." 40 CFR 1502.1; Stewart Park & Reserve Coal Inc. v Slater, 352 F 3d 545, 557 (2d Cir. 2003).
[46] Sierra Club v Coleman, supra note 43.

analysis required under the first type of approach described in Part I, A above. The Task Force Report concludes there must be a "comprehensive" analysis of a "full range" of alternatives. E.O. 2015-12 charges the Pipeline Safety Advisory Board with implementing this Task Force recommendation. Likewise, EIS and NEPA guidelines encourage thorough analysis and demand a full and detailed study of alternatives and impacts where reasonably possible. For example, the requirements for a federal NEPA-type EIS analysis of alternatives must be based on a full evaluation and disclosure of all possible approaches or paths that would avoid or lessen impacts to the environment.[47] NEPA's principles include "rigorous" detailed study of effects and alternatives.[48] A wide range of possible paths of reasonable alternatives must be considered to eliminate or minimize possible impacts. A "hard look" detailed evaluation of alternatives is required.[49] Moreover, the approach to the alternative requirement cannot be drawn too narrowly where it would result in the impacts or significant risks that are to be disclosed or avoided.[50] In sum, an agency is forbidden to limit the range of reasonably possible alternatives.

The common law of environmental quality that has evolved under MEPA, Part 17, Natural Resources and Environmental Protection, also requires a consideration of the likely impacts of a project or on-going operation and full range of alternatives, before a government body approves or allows a project to operate.[51]

In *Ray*, the Michigan Supreme Court imposed a substantive duty on both public and private entities alike "to prevent and minimize" likely impairment, pollution, or degradation of the environment."[52] In other words, there is an enforceable duty that those engaged in conduct or review such conduct must seek to prevent, if possible, threatened or likely environmental degradation.

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[47] Calvert Cliffs Coordinating Comm., supra note 42.
[48] 40 C.F.R. 1506(a)(2).
[49] E,g., State of California v Bergland, 483 F Supp. 465 (1980); Citizens for Env. Quality v U.S., 731 F Supp 970 (1989).
[50] 40 CFR 1502.14. "[A]gencies shall: (a) Rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated. (b) Devote substantial treatment to each alternative considered in detail including the proposed action so that reviewers may evaluate their comparative merits. (c) Include reasonable alternatives not within the jurisdiction of the lead agency." This is similar to Michigan wetlands law, which discourages alternative analysis that draws the purpose or conduct in question so narrowly as to preclude consideration of alternatives that would eliminate or significantly reduce the loss of wetlands or natural resources that are threatened. MCL 303011(b)(4); R281. DEQ WPA rules prohibit "unduly narrowing" the basic project purpose to avoid considering alternatives, as did the respondent in this case. Applicant cannot narrow the purpose and must prove it has considered and established least damaging or wetland loss alternatives are not feasible and prudent. R281.922a(4), .922a(8); .922(A)(6).
[51] Id.,Vanderkloot, supra note 3, 392 Mich at 185-186. While [MEPA] creates a procedural cause of action, [MEPA] also establishes substantive standards imposed upon those engaging in, or likely to engage in, pollution, impairment, or destruction of the air, water or other natural resources or the public trust therein. "In relevant part [MEPA] proscribes such pollution, impairment, or destruction unless it is demonstrated that "...There is no feasible and prudent alternative to (the polluting, impairing, or destroying entity's) conduct and that such conduct is consistent with the promotion of the public health, safety, and welfare in light of the state's paramount concern for the protection of its natural resources from pollution, impairment or destruction"
[52] 393 Mich at 308 ("such a showing is not restricted to actual environmental degradation… Obviously the evidence necessary to constitute a Prima facie showing will *vary with the nature of the alleged environmental degradation involved*.")

In *Vanderkloot*, the Michigan Supreme Court ruled that the MEPA established two fundamental and enforceable duties on the part of government bodies. One, the government body must consider the possible impacts and full range of alternatives that would avoid or minimize the possibility or likelihood of impacts. Two, where there are likely effects that would pollute or impair the air, water, natural resources, or public trust, the conduct is not to be allowed if there exist feasible and prudent alternatives, as described in Part I, A, above.[53] The Court invalidated the decision on a highway route and development because the department had failed to comprehensively consider alternatives.[54] In addressing the scope of alternative analyses the Court stated,[55] the MEPA is designed to accomplish two distinct results:

> (a) to provide a Procedural cause of action for protection of Michigan's natural resources; and
> (b) to prescribe the Substantive environmental rights, duties and functions of subject entities.
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> ***
>
> '3. Evaluation of alternatives... "[S]hould include a *full* explanation of the reasons why the agency decided to pursue the action in its contemplated form rather than an alternative course of action"

Indeed, the Court in *Vanderkloot* advised government bodies to look to the NEPA EIS requirements under federal law when considering the effects of a project and conducting a "full" alternatives analysis under the MEPA.[56]

In summary, the Task Force Report calls for a "full range" and "comprehensive" alternatives analysis of crude oil transport in the Straits segment of Line 5. As shown in Section A and B above, the law and court principles support this recommendation. The following framework, nature, scope, and principles should be applied to assure that a legally proper independent alternatives analysis is followed for the transport of crude oil through Line 5 in the Straits of Mackinac.

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[53] MCL 324.1705(2). For principles and standards on the meaning of "feasible" and "prudent," see Wayne County Health Dept, supra, note 35 at 704-707.

[54] Vanderkloot has been affirmed by subsequent appellate cases. Genesco v MDEQ, 250 Mich App 45 (2002); Buggs v Michigan Public Service Comm'n, 2015 WL 159795 (Mich App Nos. 315058, 315064, Jan. 13, 2015).It is most important to note that EPA does not, as both parties imply, merely provide a separate Procedural route for protection of environmental quality, it also is a source of supplementary substantive environmental law. See Sax and Conner, 'Michigan's Environmental Protection Act of 1970: A Progress Report,' 70 Mich. L.R. 1004, 1054—1064 (1972).

[55] 392 Mich at 187-188.

[56] Id. The Court noted that although NEPA did not apply, it was useful guidance to a government body in fulfilling its duty to consider impacts and a range of alternatives when reviewing a project: "While Executive Directive 1971—10 quoted by the Commission (Commission's Brief pp. 37—38) was not issued until September 30, 1971 and was not in effect when the Statement of Necessity in this case was filed May 12, 1971, it usefully illustrates; and the Commission indicates adoption as, a proper executive interpretation of Const.1963, art. 4, s 52 and, more particularly, the 'no feasible and prudent alternative' provision of [M]EPA." Id., at p. 188.

1. The nature and purpose of the independent alternatives analysis of the transport of crude oil through Line 5 in the Straits is to prevent or eliminate the risk of a crude oil leak, spill, or release in the Great Lakes and Straits of Mackinac.

2. To prevent or avoid a leak, spill or release from Line 5, the transport of crude oil in the Straits segment should be eliminated or prohibited unless it is demonstrated there are or is no feasible and prudent alternative to this conduct.

3. The approach and scope should be comprehensive and evaluate the "full range" or reasonable alternatives to the transport of crude oil in the Straits through the location, capacity, adaptability, and reasonable potential to achieve the overall dynamic purposes served by the crude oil pipeline system through and around the Great Lakes.

4. The overall purposes of the crude oil pipeline network in and around the Great Lakes must not be drawn or evaluated too narrowly; in other words, segments of the whole system should not be isolated from the evaluation of the system as a whole.

5. The standards for evaluating an alternative location, route, and capacity exists or can be put into place in the future are whether the alternative or alternatives in combination are "feasible," "prudent," or "suitable." Mere inconvenience or additional or increased costs are not proper reasons for finding an alternative does not exist. Other factors, such as social, public health, safety, relative costs and benefits, risk to tourism, loss of public uses, harm to public and private property maybe considered, but the balancing of these factors cannot be used as a substitute to the feasible, prudent, or suitable standards.

6. The burden of information to establish alternatives do not exist generally on the entity, like Enbridge, whose conduct has been determined to require a full alternatives analysis.

PART II DYNAMIC AND EVOLVING CRUDE OIL PIPELINE SYSTEM IN, THROUGH, OUT OF GREAT LAKES REGION AND THE DEMONSTRATION OF ADEQUATE CAPACITY AND ALTERNATIVES TO TRANSPORT CRUDE OIL WITHOUT USING LINE 5 IN STRAITS OF MACKINAC

FLOW's scientific and technical advisors have prepared three separate reports (attached as Appendices), based on publicly available information, to:

(1) describe the current dynamic and evolving crude oil pipeline system into, through, around, and out of the Great Lakes Basin;

(2) evaluate the capacity and reasonable adjustments and alternatives that can accommodate the purposes and objectives of the pipeline system, and

(3) demonstrate by example the evaluation of an alternative that, if applied, would eliminate the transport of crude oil in Line 5 in the Straits.

A. The Dynamic Nature of the Evolving Crude Oil Pipeline System in the Great Lakes Region

This section summarizes the key findings and conclusions of Rick Kane's Report, "*The Context: Understanding the Evolving North American Oil Pipeline System in Preparation for Considering Alternatives to Enbridge's 'Line 5' in the Mackinac Straits,*" which is attached in Appendix A.

The proper context for considering and conducting the State of Michigan's forthcoming assessment of alternatives to the Enbridge Line 5 oil pipelines is a "systems" view and understanding, rather than a segmented approach.

The search for alternatives to the "Line 5" oil pipelines must be understood in a larger "systems" context rather than an isolated debate about the importance of the pipeline's continued operation, pipeline reliability versus other transportation modes, and emergency response capability. Enbridge's 645-mile Line 5 pipeline is just one segment of a vast pipeline system involving complex strategies among producers, pipeline operators and other transporters, refineries, and end users. A pipeline "systems view" and understanding of company strategies is an essential step in protecting the public trust waters and bottomlands of the Great Lakes and their protected uses, including for navigation, swimming, fishing, and community drinking waters supplies, and in protecting the water-based economy and ensuring energy supply security.

The hazardous liquids (oil and natural gas liquids) transport sector operates as a complex, dynamic, and evolving system that has a significant impact of public safety, the environment, citizen rights, the economy, and national energy security. For example, the North American crude oil and natural gas liquids ("NGLs") supply-chain system has witnessed a rapid evolution driven largely by the development of NGL and crude oil shale reserves in North Dakota and tar-sands crude oil reserves in Alberta, Canada and more recently the Marcellus and Utica shale reserves in Pennsylvania, West Virginia and Ohio. As a result, crude oil and NGLs that once flowed from the Gulf of Mexico north to Great Lakes refineries, are being reversed so that the Gulf and the East Coast are the final destinations or raw and refined crude from the north.

Surprisingly, however, a comprehensive systems view about the sector's evolving nature is not available to government agencies and the public at large, which hampers their ability to make fully informed decisions about public trust resources like the Great Lakes and other impacts of pipeline and related projects and existing operations at the local, state, and federal levels. Without a comprehensive pipeline systems view, state and federal decision-makers are unable to identify and evaluate better alternatives, and, in turn, are unable to eliminate high-level risks and unacceptable harm, as in the case with the location of Enbridge's Line 5 twin pipelines in the Straits of Mackinac.

Key systems drivers and assumptions in the oil and gas, chemical, and energy sectors include, among others, (a) the development of new crude oil and NGLs reserves, (b) global events altering supply, demand, and pricing of these global commodities, and (c) pipelines

preferred over other transportation modes where large, long-term reserves are being exploited.

Key system drivers and assumptions are critical to understanding a systems approach. As noted above, the development of the Bakken crude shale and Alberta tar sands has transformed North American energy, shifted the direction of the flow of petroleum products, and even created excess for export. Refinery operators and petrochemical and energy producers accordingly have evolved, invested in, and modified their assets[57] based on forecasted availability and pricing for the different feedstock. Similarly, pipeline companies and rail carriers have adapted and expanded their networks to meet the needs of the producers or feedstock shippers. As between the different modes of transportation (particularly in light of major rail accidents), pipelines are the preferred and safest option for transporting crude oil and NGLs.[58]

Segment-by-segment pipeline expansion of the Enbridge network results in understated impacts, harm, and risk, and conceals existing capacity within, and other alternatives to, the overall pipeline system.

In the past decade, North American pipeline system owners are expanding and modifying their networks to transport Bakken crude oil and Alberta tar-sands crude oil to the coasts. While public attention has focused on the now-rejected Keystone XL pipeline, Enbridge has quietly and strategically expanded capacity in a segment-by-segment fashion, resulting in a system-wide redirection of Bakken crude oil and Alberta tar sands to the East Coast (Montreal and Portland, Maine), the Gulf Coast, and the Canadian West Coast.[59]

In Michigan, for example, the Public Service Commission ("MPSC") missed an important opportunity to examine Enbridge's Lakehead pipeline system and alternatives to Line 5 in the Straits of Mackinac, when Enbridge requested the Line 6B pipeline replacement, following its unprecedented, nearly million-gallon heavy tar sands oil spill in 2010 into the Kalamazoo River and its watershed. Had the MPSC conducted a proper systems alternatives analysis, the agency would have considered the high-level risk and imminent harm associated with Line 5 in the Straits and concluded whether this pipeline pathway is an acceptable and necessary alternative.

Instead, the MPSC's review was too narrowly construed, enabling Enbridge to capitalize on this opportunity to double the capacity of its Line 6B from its original, pre-spill[60] volume of 400,000 barrels per day (bpd) to 800,000 bpd. This Michigan example illustrates why decision-makers

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[57] For example, some Great Lakes refineries like Marathon have been retrofitted to process tar sands.
[58] Parfomak, Paul W. (2015). *DOT's Federal Pipeline Safety Program: Background and Key Issues for Congress.* (CRS Report No. R44201). p. 2 n 5, Retrieved from Congressional Research Service, https://www.fas.org/sgp/crs/misc/R44201.pdf.
[59] Song, Lisa, "Map: Another Major Tar Sands Pipeline Seeking U.S. Permit. Canadian energy giant Enbridge is quietly building a 5,000- mile network of new and expanded pipelines that would achieve the same goal as the Keystone," Inside Climate News, Jun 3, 2013, http://insideclimatenews.org/news/20130603/map-another-major-tar-sands-pipeline-seeking-us-permit.
[60] Line 6B was restricted to 240,000 bpd from 400,000 bpd after the Kalamazoo River spill, and before replacement. See Matheny, Keith, "Enbridge's expanded oil pipeline draws ire of homeowners in its path," Detroit Free Press, June 24, 2013, and Hasemyer, David, Michigan Pipeline to Restart, Now New and Double the Capacity, InsideClimate News, April 10, 2014.

must properly scope this alternatives analysis to examine the pipeline system rather than focusing merely on Line 5 as a debate between alternative transportation modes.

Understanding Enbridge's current North American and Great Lakes pipeline network strategies are critical to evaluating the role of Line 5 in Michigan.

Enbridge is the largest crude oil transporter in North America, and thus, it is critical to understand both their overall and their Great Lakes pipeline network strategies. Based on publicly available information, Enbridge's apparent strategy[61] is to expand its pipeline network capacity across the northern tier to their Superior, Wisconsin, terminal, down to and south of the Chicago area, across southern Michigan to Sarnia, Ontario, on to Montreal, and through partnerships, eventually to Portland, Maine. This multi-billion collection of projects completed and underway will enable transporters to move Bakken and Alberta crude oil in large quantities to refineries along the way and for export or maritime shipment from Montreal and eventually Portland.

Line 5 Light Crude Oil: As for Enbridge's Line 5, this pipeline carries approximately 80 percent light crude oil products (including synthetic or partially processed tar sands) and 20 percent NGLs. The overwhelming majority of Line 5's Canadian light crude product returns to Canada in Sarnia, via the crossing at Marysville, Michigan. Relatively small batches of oil from Michigan fields[62] are transported in Line 5 below the Straits of Mackinac crossing in Lewiston, Michigan. Thus, Enbridge's 2013 Line 5 capacity expansion of 10 percent to 540,000 bpd optimizes its light crude and NGLs shipments so that it can concentrate heavy crude oil shipments in larger quantities through existing pipelines in Wisconsin and southern Michigan to the east and southbound to the U.S. Gulf Coast.

Line 5 NGLs: Line 5 services NGLs to Northern Wisconsin, Michigan's Upper Peninsula residents via a depropanizer in Rapid River near Escanaba (before reaching the Mackinac Straits), and petrochemical producers in Sarnia, Ontario. The study of alternatives to Line 5 in the Mackinac Straits also must consider supply system alternatives involving pipeline and trucks for delivering propane that would allow Line 5 to be shut down at the Straits of Mackinac. Alternative NGLs supply routes to Sarnia also are under development, including Kinder Morgan's project from the Marcellus shale play, the Sunoco Mariner Pipeline, and Gulf Coast projects.

B. The Crude Oil Pipeline System in Michigan and the Great Lakes Region Provide Sufficient Capacity and Opportunities to Serve Users In and Out of the Region without Transport of Oil In the Straits.

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[61] It should be noted that Enbridge's pipeline strategy for its numerous projects is not publicly available.

[62] See *Appendix B:* Street, Gary L., M.S., P.E., *"Current and Possible Alternative Supply Systems for Transporting Oil and Natural Gas Liquids to Refineries in Detroit, MI; Toledo, OH; Warren, PA; and Sarnia, ON, and Propane for the Upper Peninsula of Michigan,"* Prepared for and in partnership with FLOW, December 14, 2015. Roughly 10,000 bpd of light crude are routinely added to Line 5 from sources in Northern Lower Michigan, reducing the need for medium crude for Marathon refinery from outside of Michigan to 20,000 bpd.

This section summarizes the key findings and conclusions of Gary Street's Report, *"Current and Possible Alternative Supply Systems for Transporting Oil and Natural Gas Liquids to Refineries in Detroit, MI; Toledo, OH; Warren, PA; and Sarnia, ON, and Propane for the Upper Peninsula of Michigan,"* which is attached in Appendix B.

Enbridge "Line 5" in the Mackinac Straits is not vital energy infrastructure to Michigan's economy nor energy security, with other pipelines owned by Enbridge and competitors in place serving the same refineries in Detroit, Toledo, and Sarnia, Ontario, and having the available capacity to replace Line 5's crude oil supply. As for propane, based on an analysis of alternatives, there appears to be no valid reason for a disruption of propane in the Upper Peninsula or Northern Wisconsin if Line 5 is shut down at the Straits of Mackinac.

This report considers current and possible replacement sources of crude oil to refineries in Detroit, Toledo, and Sarnia, Ontario, and propane to customers in Northern Michigan and Michigan's Upper Peninsula that are currently served by Enbridge's Line 5.

Crude oil coming from the following sources:

- Bakken crude from North Dakota (Light, sweet crude)
- Alberta Tar Sands (Heavy crude)
- U.S. Gulf Coast – Louisiana and Texas (Light, sweet crude)
- Northern Lower Peninsula of Michigan (Light, sweet crude)

Refineries in Detroit and Toledo served by Enbridge, and others:

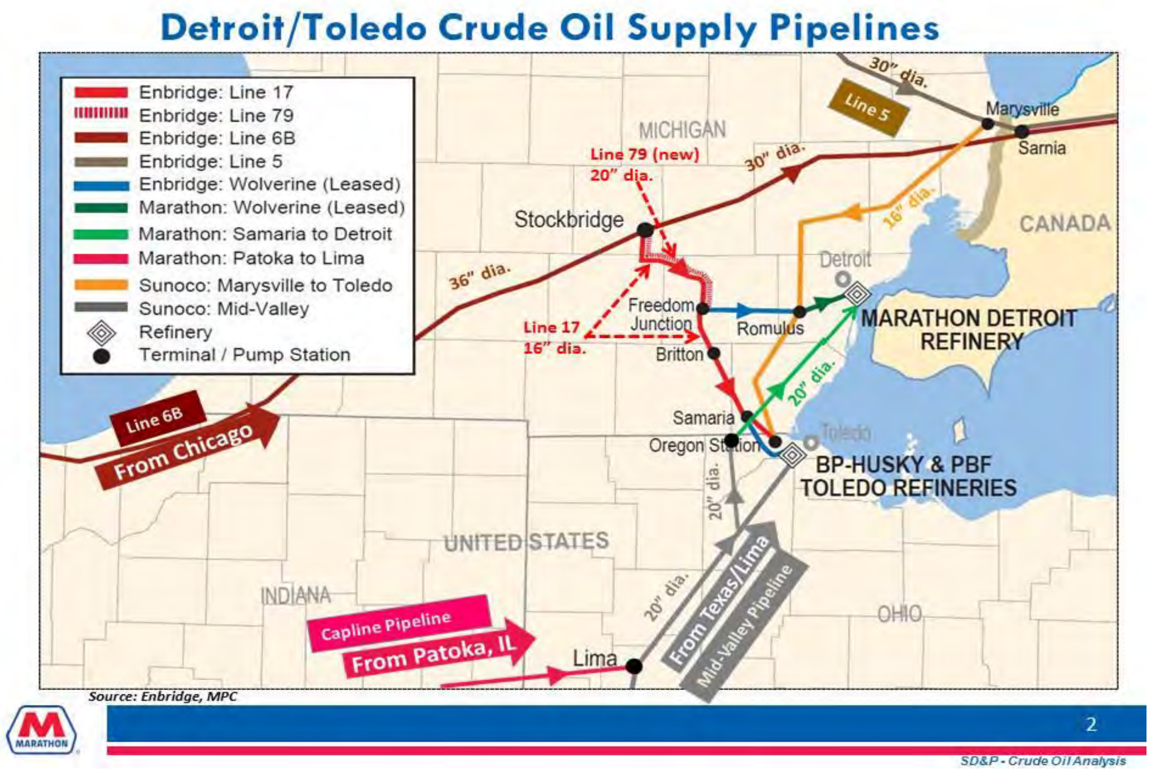
1. Marathon – Detroit; Crude capacity = 130,000 barrels per day (bpd)[63]
2. BP-Husky – Toledo; Crude capacity = 160,000 bpd[64]
3. PBF[65] – Toledo; Crude capacity = 170,000 bpd[66]
4. United Refining (Warren, PA) = 70,000 bpd[67]

Refineries in Sarnia[68] served by Enbridge:

1. Imperial – Sarnia, Crude capacity = 121,000 bpd[69]
2. Shell – Sarnia, Crude capacity = 75,000 bpd[70]
3. Suncor – Sarnia, Crude capacity = 85,000 bpd[71]

[63] Source: Marathon Detroit Refinery, March 2015.
[64] Source: BP-Husky, "What do we do?," 2015. http://www.bp.com/en_us/bp-us/what-we-do/refining/toledo.html
[65] In December 2010, Sunoco sold its refinery in Toledo, Ohio, to PBF Energy for US $400 million.
[66] Source: PBF Energy, 2015.
[67] https://en.wikipedia.org/wiki/United_Refining_Company
[68] A recent step by Enbridge has exacerbated the issue of supply to Sarnia by eliminating a previous source of crude oil to Sarnia. In March, 2014, the National Energy Board of Canada approved a request by Enbridge to reverse the flow of Line 9. Instead of crude coming from Montreal to Sarnia, it now flows from Sarnia to Montreal, for export outside of Canada. This development has removed an important source of crude oil for the Sarnia refineries.
[69] http://www.imperialoil.ca/Canada-English/operations_refineries_sarnia.aspx
[70] http://www.shell.ca/en/aboutshell/our-business-tpkg/downstream/oil-products/sarnia.html

(Map 2 in full report)



(Original map by Marathon has been revised)

While Enbridge Line 5 carries light crude, the Marathon refinery in Detroit uses primarily heavy crude from the Alberta Tar Sands via the recently expanded Enbridge Line 6B, which can also meet Marathon's light crude needs from the Bakken formation in North Dakota.

- After its Line 6B burst in 2010 spilling nearly a million gallons of heavy crude into the Kalamazoo River watershed, Enbridge installed a new Line 6B from Griffith, IN, to Marysville, MI.[72] In doing so, Enbridge increased its capacity to ship heavy crude to Sarnia via this route by 200 percent, and boosted the crude capacity of the segment between Griffith, Indiana, and Stockbridge, Michigan, by over 300 percent. The old Line 6B has been shut down, but not removed.

- Marathon consumes 130,000 barrels per day (bpd) of crude. Of this amount, they can utilize 100,000 bpd of heavy crude, which arrives by Line 6B. This leaves a need for 30,000 bpd of light or medium crude. Since Line 5 transports 23,000,000 gallons per day or 540,000 bpd, <u>the maximum demand by Marathon on Line 5 is 30,000/540,000 = 5.6 percent.</u>

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[71] http://www.suncor.com/en/about/232.aspx
[72] Pre-Filed Testimony of Thomas Hodge before the State of Michigan Public Service Commission, April 16, 2012, PDF, pg. 11.

- Light crude can also be transported from the southern United States via the Mid-Valley and Capline pipelines to Marathon and the two Toledo refineries. Light crude is also available via Line 6B from the Bakken formation in North Dakota. Further, roughly 10,000 bpd of light crude are routinely added to Line 5 from sources in Northern Lower Michigan, reducing the need for medium crude for Marathon from outside of Michigan to 20,000 bpd.

- Based on the above, it is reasonable to conclude that only a small portion of the capacity of Line 5 is used by Marathon.[73] And even this can be supplied by other pipelines.

The BP-Husky refinery in Toledo also receives heavy crude from Line 6B, as well as light crude from as many as three pipelines (possibly including Line 5), and plans to convert to processing only heavy crude within a few years.

- BP-Husky (Toledo) consumes 160,000 bpd of crude oil. They are able to receive 60,000 bpd of heavy crude from Enbridge Line 6B, in conjunction with Line 17. In the near future they will also receive heavy crude via a new line, Enbridge Line 79 (See Map).

- While it is possible that BP-Husky is currently receiving some of the remaining 100,000 bpd via Line 5, it is also possible they receive it now, or could receive it in the future, via the Mid-Valley and Capline pipelines, which bring light and medium crude up from the southern United States (See Map).

- Several references[74] to BP-Husky converting entirely to heavy crude feedstock were discovered. The schedule for the conversion is varied, but even the most cautious estimate is that it will be complete by 2020. Assuming this happens, when the conversion is complete, BP-Husky in Toledo will be totally independent of a light crude supply, such as that from Line 5, Bakken, or Mid-Valley.

The PBF Energy refinery in Toledo has the capacity to process light, medium, and heavy crude, and receives light and medium crude via the Mid-Valley and Capline pipelines and likely *not* from Line 5.

- Nothing was found to suggest that PBF Energy (Toledo) has the capacity to process heavy crude. They are receiving light and medium crude via the Mid-Valley and Capline pipelines. While it may be possible for PBF Energy to receive crude via Line 5, and a Sunoco line running from Marysville to Toledo, it is unlikely they use this source.

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[73] As mentioned above, the percent of crude in Line 5 that goes to Marathon is approximately 5.6%. However, the percent of crude in the feed stock that Marathon **consumes,** which comes from Line 5 is 30,000/130,000 = 23%. But this number does not take into account 14,000 bpd that come from Northern Lower Michigan. When that is factored in, the percent of light crude, originating in Canada and supplied by Line 5 to Marathon, is 16,000/130,000 = 12.3% of what Marathon consumes daily. Since the crude coming from Northern Lower Michigan does not cross the Straits, it would not be affected by shutting down Line 5 at the Straits.

[74] Pre-Filed Direct Testimony of Mark Sitek before the State of Michigan Public Service Commission, April 16, 2012, U-16937, pdf pp. 16, 21, 44, 69.

Conclusions regarding the Refineries in Detroit and Toledo:

- Based on the information available, we conclude that no more than 5-10 percent of the crude oil in Line 5 is going to the Detroit and Toledo refineries. In reality, it is most likely closer to 5 percent than 10 percent.

- If Line 5 is shutdown, this amount of light and medium crude could be supplied from the Capline and Mid-Valley pipelines, along with crude from Northern Michigan. These sources are currently transporting crude to the area, and could most likely make up the relatively small amount that may be coming to the U.S. from Line 5. In addition, Bakken light crude could also be transported to the area via Line 6B.

- As another alternative, if Line 5 is shut down at the Mackinac Straits, but the remainder of it is kept operational from Lewiston, Michigan, southward, Michigan crude can continue to be transported to refineries in Detroit and Toledo.

Refineries in Sarnia, Ontario, receive the great majority of Line 5's light crude, using the Mackinac Straits as a high-risk shortcut for moving Canadian light crude to Canadian markets further to the east.

- The overwhelming majority of Line 5 crude goes back into Canada via the crossing at Marysville, MI, to Sarnia, ON, and then on to Canadian markets.

Regarding propane, Line 5's flow is from Wisconsin to Michigan or west to east, so the Mackinac Straits segment of Line 5 is not needed to deliver propane to residents in Northern Wisconsin, the Upper Peninsula, or in the northern Lower Peninsula. Propane via Line 5 is separated and offloaded at a terminal and processing center at Rapid River, MI, near Escanaba, in the Upper Peninsula, stored, loaded into large trucks that haul it to localized distribution centers (or directly to large end-customers), then loaded into smaller trucks for local delivery to residences.

- Regarding propane, preliminary engineering alternatives have been developed during this investigation that show that the transport of crude oil in Line 5 at the Straits of Mackinac can be shut down, but still provide customers in the Upper Peninsula and Northern Wisconsin with propane, by Enbridge, or by some other supplier, should Enbridge chose not to continue to do so.

- Based on analysis of alternatives, there appears to be no valid reason for a disruption of propane in the Upper Peninsula or Northern Wisconsin if Line 5 is shut down at the Straits of Mackinac.

C. Evaluating the "Decommission Line 5 in the Straits" Alternative to Demonstrate that Existing Pipeline Infrastructure Alternatives Can Meet the Purposes and Objectives of Regional Refineries, Suppliers, and End Users and Simultaneously Eliminate the Unacceptable Risk to the Great Lakes.

This section summarizes the key findings and conclusions of Rick Kane's Report, "*Evaluating Alternatives: A Model for Evaluating Alternatives to Enbridge's "Line 5" Pipelines in the Mackinac Straits and Eliminating Unacceptable Risk to the Great Lakes,*" which is attached in Appendix C.

An alternatives analysis identifies objectives for the system, and then evaluates and develops options for risk elimination and reduction.

This alternatives analysis approach identifies objectives and assumptions and then evaluates the alternative by identifying and analyzing a well-defined *system*. The primary system objectives for the Line 5 pipeline analysis include:

1. Supply propane to Michigan Upper Peninsula customers;
2. Support crude oil shipments from Michigan's Lower Peninsula oil fields;
3. Supply Marathon Detroit, Toledo, Ohio, and eastern Canada refineries;
4. Supply natural gas liquids ("NGLs") to Sarnia, Ontario, petrochemical producers; and
5. Enable crude oil exports via Montreal, eventually Portland, ME (lowest priority).

The advantage of developing an alternatives analysis is to move beyond the justification of a single alternative (as in the case of the existing Line 5 Straits Pipelines with its high-level of risk) towards multiple options and a best possible option that considers all stakeholder requirements for risk, uncertainty, and citizen, environmental, public safety, and public and private property protections.

A comprehensive analysis should be launched immediately on this alternative – *decommission Line 5* – because the current debates have focused *only* on Line 5 (i.e., the consequences and likelihood of a failure, company pipeline operations and integrity management programs) and have *not* explored the feasibility of operating without this pipeline.

The current public discourse around Line 5 is narrowly drawn and primarily centers on alternative modes of transportation as between pipeline, rail, ship/barge, and truck. Notably missing from the Task Force Report's Recommendation Three alternative list, for example, is an alternative analysis of the existing pipeline system network to transport Line 5's crude oil supply. This is a critical issue because by framing the alternative analysis between alternative modes of transportation, pipelines are considered the safest and will necessarily trump the other transportation alternatives. In other words, a true alternative analysis must evaluate the overall system, such that Enbridge's 645-mile Line 5 pipeline is understood as just one segment of a vast pipeline system involving complex strategies among shippers, pipeline operators, refineries, and end users.

The Advisory Board should ensure that the comprehensive alternatives analysis requires information on business and operating strategies, supply and demand forecasts, engineering design, pipeline integrity, and end-of-life predictions. A system like this that includes supply-chain operators, customers, government agencies, and citizens is inherently complex yet dynamic and flexible in nature. For example, systems face new inputs and new constraints, and necessarily must evolve and adapt to support new supply sources, changes in materials being shipped, desired final destinations, and regulatory requirements.

The alternative "Decommissioning Line 5 in the Straits" is a strong possible best-case option.

While recognizing that a review of other options needs to done in parallel, the State of Michigan should make a pre-determination that the "decommission Line 5 in the Straits" alternative is a strong possible best-case option. The rationale for exploring a model alternatives assessment for the shutdown of Line 5 is that it provides a credible option to protect the Great Lakes, drinking water supplies, local communities, navigation, public and private riparian land, fishing, habitat and ecosystem, while also safeguarding the state's tourist-driven economy and securing Michigan's energy needs.

This model demonstrates that Line 5 can be decommissioned without a negative strategic impact on key stakeholders. Pipeline system goals can be met without Line 5 because other existing pipelines exist around the Great Lakes to accommodate additional capacity and this alternative eliminates the current and unacceptable risk to the Straits of Mackinac and the Great Lakes. A comprehensive assessment must not be delayed while studying other options that, by definition, do not fully meet the upfront stated objective to eliminate the risk and to protect Michigan's greatest natural resource – the Great Lakes.

A model "Decommissioning Line 5 in the Straits" alternative demonstrates that this pipeline is not vital to Michigan's energy infrastructure, that the system has considerable flexibility, and that this option will eliminate the high-level risk of imminent harm demanded by the Easement's Reasonably Prudent Person and Public Trust Standards.

The key model alternative conclusions include the following:

1. Line 5 is not vital to supply propane to U.P. customers, and other suppliers also serve the area using bulk tank truck shipments. Supply to U.P. customers would not be affected at all if crude oil is not shipped in the Straits segment of Line 5.
2. If Line 5 is decommissioned at the Mackinac Straits, with modification, the existing line below Lewiston could be used or a new pipeline installed along the corridor for the smaller quantity of material being shipped.
3. The original Line 6B that failed in 2010 has been replaced and the capacity expanded by approximately 200 percent over the pre-disaster capacity limit. Line 6B is a multi-

purpose pipeline and can transport NGLs, light condensate, and intermediate and heavy crude oil, including dilbit.

4. Marathon and the Ohio refineries also can receive crude oil from the southern United States via Marathon- and Sunoco-operated pipelines in Indiana and Ohio.[75, 76] Rail shipments can provide emergency backup in the event of any operating problems in the network.
5. Based on available information, a material balance indicates that with Line 5 decommissioned, there is an adequate supply of feedstock via Line 6B and pipelines from the south into the Great Lakes – St. Lawrence Basin to support refineries.
6. The most likely net impact would be lower quantities of heavy tar-sands crude that could be shipped to export customers via eastern Canada and Portland. However, shippers still have the alternative option to export light, medium, and heavy crude oil from the U.S. Gulf Coast and Canadian West Coast.
7. Defining the scope for the system as the Great Lakes – St. Lawrence Basin, and not a specific company's assets, adds the Kinder Morgan and Sunoco pipeline networks into the system, as well as possible better costs for the customers.
8. Under the terms of the 1953 Easement, Enbridge must act as a "reasonably prudent person;" however, this model highlights that Enbridge's apparent strategy for using Line 5 is risking a Great Lakes incident for an incremental export opportunity to the East Coast.

Interim measures should be imposed immediately on Line 5 in the Straits of Mackinac.

While the Michigan Pipeline Safety Advisory Board completes comprehensive risk and alternatives analyses in 2016, the State of Michigan simultaneously should impose interim measures to halt the transport of oil in Line 5 in the Straits of Mackinac given the high-level risk, imminent hazard, and high magnitude of harm posed by a potential oil spill or release.

According to the U.S. Coast Guard, a spill or release of any form of crude oil, (heavy or light), cannot be effectively cleaned up in winter months,[77] and cannot be adequately cleaned up anytime of the year, even under ideal conditions.[78] Given this dire situation, all forms of crude oil should be removed from transport through Line 5 in the Straits. And yet the State of Michigan in its Task Force Report chose not to apply the same logic and reasoning to all forms of crude oil and not to impose any interim measures, leaving the Great Lakes at great risk to a catastrophic spill.

[75] See Appendix B.
[76] See Appendix A.
[77] See supra note 24.
[78] See supra note 23.

IV. CONCLUSION AND SUMMARY

Governor Executive Order 1015-12 created and directed the Michigan Pipeline Safety Advisory Board to implement the recommendations of the Michigan Petroleum Pipeline Task Force Report on the future of oil transport through Line 5 in the Straits of Mackinac and pipelines throughout the state. The July 2015 Task Force Report concludes that Line 5 in the Straits presented the most acute threat given the potential for a catastrophic spill in the heart of the Great Lakes. The Task Force Report accordingly calls for an independent alternatives analysis, including the decommissioning of Line 5 in the Straits for oil transport. Other reports, including FLOW's (For Love of Water) September 2015 Expert Report, have substantiated that the transport of oil through Line 5 in the Straits constitutes an unacceptable high-level risk and imminent harm to our waters for drinking, recreation, commerce, navigation, tourism, and our *Pure Michigan* way of life. Immediate action therefore is necessary, including the orderly completion of the alternatives and risk analyses and interim actions to eliminate imminent harm.

FLOW now submits this report titled, *Eliminating Line 5 Oil Pipeline's Unacceptable Risk to the Great Lakes through a Comprehensive Alternatives Analysis and Systems Approach*, to the Advisory Board to assist in implementing a comprehensive alternatives analysis to Line 5 in the Straits per the recommendations of the Task Force Report.

Part I of the foregoing Report lays out the background, framework, scope, and standards for the alternatives analysis directed by the Advisory Board and the Executive Order. Part II provides a factual analysis of the crude oil pipeline system in the Great Lakes, including Line 5, identifies the capacity of this system, and demonstrates the adaptability of this system to accommodate and meet the needs related to the transport of crude oil into, around, through and out of the Great lakes region and, at the same time, eliminate the transport of crude oil in the Straits of Mackinac.

This report makes the following conclusions:

1. The approach to an alternatives analysis must account for the legally recognized highly valued public trust waters, bottomlands, and protected public uses and duties under the public trust doctrine in the Great Lakes and Michigan law, such as the Michigan Environmental Protection Act ("MEPA"), Part 17, NREPA. Part 17 expressly incorporates the protection of the public trust in water and related natural resources, and it imposes a duty on governmental bodies to prevent imminent harm or likely degradation or impairment of the waters and public trust of the Straits of Mackinac. The nature of analysis under Part 17 also recognizes – as is the case with Line 5 – that the threshold of harm or impairment is met where the magnitude of harm and risk is high or unacceptable or imminent. Consistent with the Task Force Report and Executive Order, the law requires a "comprehensive" analysis of a "full" range of alternatives. Therefore, the alternatives analysis should review the transport or crude oil in the context of the purposes and objectives of the overall system of oil pipelines, routes, capacity, and adaptability into, though, around, and out of Michigan and the Great Lakes region; this is because alternatives analysis principles forbid or discourage a limited or unduly narrow

review of alternatives that would preclude other potentially viable and reasonable alternatives. Moreover, evaluating an alternative, it should not be rejected if it is "feasible" and "prudent" and otherwise suitable as those terms have been interpreted in law; in other words, it cannot be rejected unless there are truly unusual factors, such as an extraordinarily high magnitude of obstacles or cost-prohibitive circumstances. Mere inconvenience, new adjustments or actions, lower profits or increased costs in themselves are not a proper basis for rejecting an alternative.

2. As determined by FLOW's scientific and policy advisors' reports, the proper context for a "full" and "comprehensive" alternatives analysis requires an understanding of the crude oil transport system in the Great Lakes region. If the alternatives analysis is limited to simply Line 5, it prevents review of potentially better, viable and feasible or prudent alternatives for transport of crude oil to meet the needs and purposes of the overall system, as well as Enbridge, the operator of Line 5. In short, viewing only Line 5 would segment the analysis, and could prevent consideration of alternatives that would eliminate Line 5 in the Straits and still meet the overall needs and objectives of the pipeline system in Michigan, the Great Lakes region and beyond. The very nature of crude oil pipelines is dynamic and evolving, based on changing factors or "drivers" that occur in the present and overtime. Key system "drivers" include capacity and flow volumes, changing user needs, new crude oil and NGL reserves, changing domestic and global markets, supplies and demands, changing legal barriers for imports and exports, shifted directions of flows to meet demands and needs elsewhere, changes in feedstock sources and prices, and changes to meet long-term, long-range pipeline forecasts and needs.

3. The segment-by-segment approach by Enbridge in the State of Michigan, including Line 5 and Line 6B around Chicago, through Indiana, and across southern Michigan to Sarnia, with spurs to Detroit and Toledo, over the last several years has precluded this state from reasonably considering the full range of viable alternatives, including Line 5 in the Straits. For example, on its own accord, Enbridge added pump stations and anti-friction injection systems to increase flows in Line 5 from 300,000 barrels per day (bpd) to 540,000 bpd in 2013. In addition, after the 2010 Kalamazoo oil spill disaster, Enbridge applied for "maintenance and integrity" measures for Line 6B before the Michigan Public Service Commission, when in fact, it built a brand new Line 6B that more than doubled its capacity to as much as 800,000 bpd. Segment-by-segment, Enbridge has effectively built its own version of the now rejected "Keystone XL Pipeline" through the center of the Great Lakes and across Michigan without public, state, and federal consideration and evaluation of the full range of existing alternatives. Had Enbridge disclosed its larger project intentions, a more properly scoped alternative analysis would have evaluated Line 5, Line 6B, other pipelines, needs of users, and the pipeline system as a whole, and the imminent and unacceptable harm to the Straits could and would have been addressed. If implemented and completed properly, the alternative analysis can help correct this legal deficiency.

4. Applying a comprehensive and full evaluation of the entire basic pipeline system reveals feasible, prudent, and suitable alternatives to Line 5 in the Straits. The primary transport of crude oil to Canada or the three refineries in the Detroit-Toledo area could still be met,

and natural gas liquids, including propane distribution to Michigan's Upper Peninsula would not be affected. Indeed, such alternatives offer the advantage of eliminating the unacceptable harm to the Great Lakes and Straits, high and imminent risks to communities, and public and private property in the Straits.

5. The crude oil pipeline transport system in Michigan and the Great Lakes region provides sufficient capacity and opportunities to meet demand without putting the Great Lakes in peril. Line 5 is not a vital infrastructure to Michigan's economy, poses substantial security and environmentally unacceptable risks, and propane service to customers in the Upper Peninsula will continue.

6. The Task Force Report identified some of the alternatives that can be evaluated. One of those was decommissioning Line 5 in the Straits. FLOW's technical advisor analyzed this alternative as an example or "model" of a properly conducted alternative analysis based on the basic crude oil pipeline system of the Great Lakes region. Proper alternatives analysis should identify, evaluate, and develop options for risk elimination and reduction. It would require information on business and operating strategies (such as back-up pipeline routing or plan, current and future plans), supply and demand forecasts, engineering designs and options, pipeline integrity, and end-of-life predictions.[79]

7. Based on such a comprehensive alternatives analysis, the model to decommission Line 5 in the Straits (by implication this would necessarily include the alternative of no crude oil in the Straits) concluded that (a) it would eliminate or avoid the unacceptable and imminent harm and high risk to the Straits and Great Lakes, (b) that the dynamic pipeline system serving Michigan, the Great Lakes region, and elsewhere has the capacity and would adjust to meet the purposes of the system, and (c) Enbridge could continue to transport substantial volumes of crude oil. The decommissioning of Line 5 in the Straits is a strong best-case option or alternative.

8. Because of the imminent harm and high risk from the transport of crude oil in the Straits, a full and comprehensive alternative analysis and assessment must be completely immediately to eliminate a potential catastrophic oil spill in the Great Lakes.

9. As previously concluded in FLOW's September 2015 Expert Report, and further highlighted by more recent investigations concerning the inability to respond adequately

[79] It should be recognized that as in any alternatives analysis, a reasonable time should be factored for the system to adjust, except in the case where high-level risk must be eliminated. As noted in Part of the legal analysis, an alternative is still feasible and prudent even though it does not include an identical route, pipeline, or volume of flow, or other inconvenience or increased costs. Part I, supra, pp. 7-13. Thus, while the no oil alternative is feasible, prudent, and reasonable, especially given the importance of eliminating the high and unacceptable risk of a release in the Straits, there would be a natural and temporary adjustment period in the pipeline system that serves Michigan and the Great Lakes region. Moreover, as described above, Enbridge has strategically constructed major new pipelines and capacity in Line 6B and Line 5 and avoided a comprehensive alternatives analysis and review required by law. In doing so, Enbridge is responsible for its decisions, and is equitably estopped from claiming imprudence or infeasibility with respect to the alternative that eliminates the high risk and harm to the Straits, when it could have avoided by full disclosure of the objectives of its massive increase in capacity into, through and out of the Great Lakes. It is not up to the state to bail out a pipeline carrier who undertakes a project at its own risk.

to a release of crude oil in the Straits, immediate interim measures should be imposed on Enbridge, including the temporary shutoff of oil, in winter or other times when responses to a release are recognized as inadequate, and stepped-up monitoring, disclosure of products being transported, and in-place capacity and equipment.

APPENDICES

FLOW's scientific advisors prepared the following technical reports:

Appendix A: Kane, Rick. QEP, CHMM, CPP. *"The Context: Understanding the Evolving North American Oil Pipeline System in Preparation for Considering Alternatives to Enbridge's 'Line 5' in the Mackinac Straits,"* Prepared for and in partnership with FLOW, December 14, 2015.

Appendix B: Street, Gary L., M.S., P.E., *"Current and Possible Alternative Supply Systems for Transporting Oil and Natural Gas Liquids to Refineries in Detroit, MI; Toledo, OH; Warren, PA; and Sarnia, ON, and Propane for the Upper Peninsula of Michigan,"* Prepared for and in partnership with FLOW, December 14, 2015.

Appendix C: Kane, Rick. QEP, CHMM, CPP. *"Evaluating Alternatives: A Model for Evaluating Alternatives to Enbridge's "Line 5" Pipelines in the Mackinac Straits and Eliminating Unacceptable Risk to the Great Lakes,"* Prepared for and in partnership with FLOW, December 14, 2015.

APPENDIX A: THE CONTEXT: UNDERSTANDING THE EVOLVING NORTH AMERICAN OIL PIPELINE SYSTEM IN PREPARATION FOR CONSIDERING ALTERNATIVES TO ENBRIDGE'S "LINE 5" IN THE MACKINAC STRAITS

By Rick Kane, QEP, CHMM, CPP
December 14, 2015
Prepared for and in partnership with FLOW (For Love of Water)

I. PURPOSE

The purpose of this report is to describe the evolution and current state of the North American oil pipeline system in order to evaluate the State of Michigan's forthcoming assessment of alternatives to the Enbridge "Line 5" oil pipelines running through the Great Lakes at the Mackinac Straits, where Lake Michigan and Lake Huron converge.

To that end, this report presents an introduction and guidance about the apparent strategies of crude oil and natural gas liquids (NGLs) shippers, pipeline operators, and end users that impact the system of which the Enbridge Line 5 pipeline is a component. A "systems view" and understanding of company strategies is an essential, if not mandatory, step for energy security and for protection of the public trust waters, fishing, drinking water, communities, and the environment. Without a systems approach, the state and its Michigan Pipeline Safety Advisory Board simply cannot conduct a proper alternatives assessment of Line 5.

Line 5 transports light and synthetic crude oil and natural gas liquids (including propane) from Enbridge's terminal in Superior, Wisconsin, across Michigan's Upper Peninsula, through the Straits of Mackinac, across the Lower Peninsula and finally beneath the St. Clair River to Sarnia, Ontario. Under a recent agreement with the State of Michigan, Line 5 does not carry heavy crude oil or diluted tar sands crude oil (diluted bitumen) known as dilbit.[1]

This report was prepared for and in partnership with FLOW (For Love of Water), a Great Lakes water law, science, and policy center located in Traverse City, Michigan, to provide information in support of FLOW's companion report that presents an alternatives analysis model and credible option for the shutdown of Line 5 in order to protect the Great Lakes, drinking water supplies, local communities, navigation, public and private

[1] Michigan Petroleum Pipeline Task Force, *Agreement Between The State Of Michigan And Enbridge Energy, Limited Partnership Regarding The Transportation Of Heavy Crude Oil Through The Straits Of Mackinac Pipelines,* September 3, 2015, www.michigan.gov/pipelinetaskforce.

riparian land, fishing, habitat and ecosystem, and the state's tourist-driven economy while continuing to meet energy needs.

FLOW's team of legal and scientific experts previously documented and concluded that the transport of oil through Line 5 poses high consequence environmental risk and imminent harm to the Great Lakes and should be halted while the state seeks an alternative. [2,3,4]

II. INTRODUCTION

The North American (NA) crude oil and NGLs supply-chain system is undergoing a rapid evolution driven largely by the development of natural gas and crude oil shale reserves in North Dakota and tar sands crude oil reserves in Alberta, Canada. Pipeline networks are a key component of the supply-chain system, as well as railroad, truck, and maritime modes of transportation. For the pipeline network, there are numerous new installations, expansions and modifications, such as reversing the direction of flow in existing pipelines.

Publicly available information on pipelines covers specific projects and their justification but typically not the alternative options. A consolidated or "systems view" is not available that shows how individual pipeline projects unite to form the supply-chain strategy. Effective planning and regulatory management by federal, state, and local governments requires an understanding of the evolution and future direction of the pipeline system to ensure the protection of citizens, the environment, and the energy supply. As noted at the outset, without a systems view, alternatives cannot be properly evaluated. For the most part, the private sector and company goals and objectives drive the evolution of the system, which remains dynamic because of a number of factors, including supply, demand, regulations, and public policy.

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[2] Olson, James, J.D., LL.M., and Kirkwood, Liz, J.D**.** *A Composite Summary of Expert Comment, Findings, and Opinions on Enbridge's Line 5 Oil Pipeline in The Straits of Mackinac in Lake Michigan,"* compiled by *on behalf of* FLOW's (For Love of Water) Great Lakes Water Policy Project *for submission to the* Michigan Petroleum Pipeline Task Force, April 30, 2015, www.michigan.gov/pipelinetaskforce (Hereinafter *FLOW April 2015 Expert Report*).

[3] Schuette, Bill, Attorney General, and Wyant, Dan, DEQ Director, *Michigan Petroleum Pipeline Task Force Report,* July 2015, www.michigan.gov/pipelinetaskforce.

[4] Olson, James, J.D., LL.M. and Kirkwood, Liz, J.D., *A Scientific and Legal Policy Report on the Transport of Oil in the Great Lakes, (1) Recommended Immediate Actions on the Transport of Oil Through the Line 5 Under the Straits of Mackinac; and (2) Supplemental Comments on the Michigan Petroleum Pipeline Task Force Report,* September 21, 2015 FLOW (For Love of Water), www.flowforwater.org (hereinafter "FLOW September 2015 Expert Report").

III. BACKGROUND

Pipelines, rail tank cars, tank trucks, barges, and ships are transportation modes used for crude oil and NGLs. Pipelines are viewed as the safest mode.[5] Natural gas is normally shipped by pipeline unless imported or exported where it is shipped from main ports in liquefied form (LNG). Historically, refineries and petrochemical producers in the Chicago and Michigan areas and eastern Canada received feedstock from the U.S. Gulf Coast, Southwest, and northwest United States, as well as from Alberta, Canada, and via import (See Figure 1).

Refinery operators and petrochemical and energy producers invest in and modify their assets based on forecasted availability and pricing for the different feedstock, such as natural gas versus crude oil or refined products. They also invest to have feedstock flexibility and multiple supply options, giving them a competitive advantage. Pipeline companies and rail carriers build their networks to meet the needs of the producers or feedstock shippers.

With the development of new or improved technologies, such as high-volume liquid or other fracking techniques to extract oil from shale and the recovery of heavy oil, shale oil, and tar sands oil, new reserves are being opened up and the pipeline system is constantly evolving (See Figures 1 and 2). This collection of industries and companies comprises U.S. and Canadian critical infrastructure and is referred to by the governments as the oil and gas, chemical, and energy sectors. These sectors are connected by supply-chains and the whole interacts as a dynamic *system* that evolves to meet the objectives of system drivers such as:

- **Sector players** – oil and gas producers, pipeline operators, refiners, chemical producers, etc.
- **External stakeholders** – government agencies, communities, other businesses, nonprofit organizations, citizens, etc.
- **External factors** – supply disruptions, natural disasters, law and policy requirements and changes, etc.

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[5] Parfomak, Paul W. (2015). *DOT's Federal pipeline safety program: Background and key issues for Congress.* (CRS Report No. R44201). p. 2 fn 5, Retrieved from Congressional Research Service, https://www.fas.org/sgp/crs/misc/R44201.pdf

Key crude oil pipeline *system* drivers and assumptions used in this report include:

- Crude oil and NGLs are global commodities, but there can be local/regional cost differentials caused by availability, processing capability of users, and supply-chain cost. For example, some refineries cannot use tar sands crude oil. and some refineries that *can* are located closer to the source fed by a pipeline and will have a lower feedstock cost.
- Events in other regions of the world can affect supply, demand, and pricing.
- Pipeline shipments are preferred due to safety and lower cost compared to rail and truck shipments. However, the investment cost for new pipelines is high with lengthy regulatory approval times. Moreover, pipelines also carry high safety risks or risks of high consequences or harm.
- Crude oil rail shipments have increased dramatically and rail transportation is more flexible and faster than pipeline shipments. However, major rail accidents have occurred, resulting in new regulatory requirements for rail tank cars which are in short supply, and new train control regulations that slow or restrict shipments.
- Crude oil transportation by ship/barge in the Great Lakes is not addressed in this report. The risk of a spill and resultant major environmental damage is so high that this shipment mode has not been allowed because of the substantial imminent harm and endangerment of freshwater and aquatic resources.
- Tank trucks were not considered in this report as they are effectively only an option for short distances or for limited time periods such as during emergencies, since large numbers of vehicles would be required to replace rail tank cars or pipelines.

IV. The System and Evolution

The oil and gas sector operates as a complex, dynamic, and evolving system, as do many other industry sectors. However, the oil and gas sector supply-chain system is unique because of the huge impact that operations have on public safety, the environment, national energy security, citizen rights, and other economics. Unfortunately, a comprehensive view of the system and how it is evolving is not available to government agencies that would enable them to make fully informed decisions and for citizens and other interests to understand the impact of projects and operations on their communities.

This lack of a comprehensive pipeline system view also inhibits the identification and analysis of better alternatives. The lack of a systems view or starting point unduly narrows the range of purposes or overall goals, thereby restricting the range of alternatives considered. At a minimum, a systems view and understanding of the evolution are needed for government agencies to set limits and boundaries, eliminate unacceptable harms or high level risks, and protect people's rights. See Box A for an example.

BOX A

Line 5 Crossing the Straits of Mackinac
A time to implement a better alternative - today

The Enbridge Line 5, crude oil/NGL pipeline was installed in 1953 across the Michigan Upper Peninsula, the Straits of Mackinac and Lower Peninsula, the shortest, most expedient route from Superior Wisconsin to Sarnia Ontario. New pipelines installed 15 to 20 years later were routed west of Lake Michigan and around Chicago, and across southern Michigan, a longer route but avoiding highly sensitive environmental areas or areas of high level risks and unacceptable harm, such and the Great Lakes crossing at the Straits.

As a result of numerous pipeline failures in North America, including Enbridge's 2010 Line 6B pipeline disaster causing the largest inland oil spill in U.S. history along the Kalamazoo River, and the risk of Line 5 in the Straits and other pipelines in Michigan, Governor Snyder created the Michigan Petroleum Pipeline Task Force in 2014. The final report issued by the Task Force in July 2015 included a recommendation for an *alternatives analysis study*.

Companies routinely conduct alternatives analyses following identified risk management issues or major incidents or near misses, as well as for investment projects. Board of Directors, shareholders, and insurers demand such assessments as part of normal practice. Similarly, government regulators demand proper alternative analyses in situations where there are public trust concerns, operational reliability/safety questions, major environmental risks and when permit requests or renewals are submitted. To date, company, government, and public focus has been on Line 5, and not on other better possible or feasible and prudent alternatives.

Unfortunately, there is no clear, consolidated supply-chain strategy for pipelines in the Great Lakes – St. Lawrence Basin. However, this report highlights the apparent strategy and evolution of the system based on publicly available information. This report provides the basis for an alternatives analysis model showing how system goals can be met without Line 5.[6]

[6] Kane, Richard J. QEP, CHMM, CPP, *A Model for Evaluating Alternatives to Line 5 Pipeline and Eliminating Unacceptable Risk to the Great Lakes,"* December 11, 2015. FLOW (For Love of Water) www.flowforwater.org (Hereinafter *Appendix C Report*).

Historically, as previously mentioned, crude oil and NGLs flowed to the Great Lakes – St. Lawrence Basin from the Gulf Coast and the Southwest United States, as well as Alberta, Canada, and the East Coast (See Figure 3). Today, the crude oil and NGL sources and destinations have changed and the pipeline system is evolving to support shipments. Enbridge, Kinder Morgan, and PanCanada are expanding and modifying their networks to transport Bakken crude oil and Alberta tar sands crude oil to the coasts. The PanCanada Keystone XL pipeline project down through the central United States is well known, and the Obama Administration recently rejected the project. Meanwhile, their competitor, Enbridge, is working on multiple projects to expand capacity and redirect flows to transport Bakken crude oil and tar sands crude oil to the East Coast (Montreal and Portland, Maine), the U.S. Gulf Coast, and the Canadian west coast. The Enbridge strategy will provide feedstock to refineries in these regions and to main ports for export (See Figure 4).

Nationally, the Keystone XL project is highly visible and the strategy is transparent. Enbridge's pipeline network strategy is less obvious, especially to government regulators and the general public, as it is being implemented segment-by-segment and involves several partners. Segment-by-segment implementation is a typical company engineering and investment approach, and a few state and local regulators might review the individual segments for piece-meal permitting, but state officials and the public often do not know about these incremental changes because there is no review of the overall project or purpose. The Michigan Public Service Commission (MPSC) reviewed single pump stations and new or old line replacements of Line 6B, but not the overall system and purpose; this resulted in a lack of adequate study of alternatives in light of the overall project purpose. However, a segmented approach without the availability of a comprehensive and <u>consolidated systems view</u> hinders stakeholders from understanding the impact and identifying better alternatives. It also results in a lack of establishment of constraints on a project.

Segment-by-segment implementation can be a classic *divide and conquer* strategy for obtaining approvals. The system then evolves without an appropriate consideration of better options for citizen safety and environmental protection. The segment-by-segment understates harms and risks, and fails to properly assess alternative pipelines, systems, and capacities.

The current Enbridge Line 5 controversy is an example of a segmented strategic approach by the company to maintain the status quo. The debate is primarily centered on Line 5; the company defends the importance for continued operation, pipeline reliability, and emergency response capability, while citizen groups focus on the imminent hazard and catastrophic consequences of a major release. The State of Michigan now recognizes that an alternatives analysis is needed. Priority action is needed. As the debate continues, the system continues to evolve, potentially missing opportunities for a better solution or possibly leading to an actual oil spill.

It also should be noted that during the past several years as Enbridge has incrementally expanded its capacity and replaced Line 6B across southern Michigan to Sarnia, with *spur* pipelines to Toledo and Detroit, the MPSC could have, but did not, adopt a systems view and consider alternative options for Enbridge and crude oil pipeline transport in Michigan. For example, a proper alternative analysis or study by the MPSC for the doubling of the capacity or flow volume of Line 6B would have considered high level risk and imminent harm associated with Line 5 under the Straits, or considered whether crude oil transport and the risk of such an unacceptable harm is necessary or an acceptable alternative. Fortunately, given the expansion and enlargement of Line 6B and the recommendation of the Pipeline Task Force, the state's alternative analysis is underway (See FLOW's companion Alternatives Analysis Report).[7]

V. THE PIPELINE NETWORK IN THE GREAT LAKES REGION AND SYSTEM EVOLUTION

Prior to the Enbridge Line 6B Kalamazoo River crude oil spill in 2010, pipeline system strategic goals were different but beginning to change rapidly. Crude oil and NGLs feedstock to the Great Lakes – St. Lawrence Basin was primarily inbound from western Canada, U.S. Gulf Coast, southwest U.S. and imports or maritime shipments via the East Coast and Montreal. Figure 5 shows the main refineries in the Great Lakes and St. Lawrence Basin. However, the new goals of the oil and gas sector as well as the U.S. and Canadian governments are to capture the benefits of the Bakken, Alberta, shale and tar sands reserves and the Utica and Marcellus shale reserves in Pennsylvania, Ohio, and West Virginia; to reduce energy dependence on imports; increase employment; and use the lower-cost feedstock to expand economic growth and promote crude oil exports. These goals are driving major changes in the crude oil and NGLs supply-chain system, especially the pipeline network.

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[7] Id.

Based on publicly available information, the oil and gas sector strategy as affecting the Great Lakes – St. Lawrence Basin region includes the following:

- Exploit domestic U.S. and Canadian crude oil, tar sands, and natural gas reserves in the Bakken, Utica, and Marcellus shale and Alberta tar sands regions as lower cost sources, for less dependence on imports, increased economic development including jobs, and stronger energy security. Thus, use oil and gas resources within North America but also take advantage of export opportunities.

- For North America, maximizing pipeline network utilization aids in reducing railroad transportation, which has a higher safety risk. However, railroad transportation will remain as a key mode and government regulators are moving to reduce risk through new regulations on tank car specifications and positive train control.

- For Enbridge specifically, the apparent strategy is to expand their pipeline network capacity across the northern tier to their Superior, Wisconsin terminal, down to and south of the Chicago area, across Michigan to Sarnia, Ontario, on to Montreal, and through partnerships, eventually to Portland, Maine. This collection of projects completed and underway will enable shippers to move Bakken and Alberta crude oil in large quantities to refineries along the way and for export or maritime shipment from Montreal and eventually Portland (See Figure 6).

- The Enbridge and partner pipeline projects also will enable connections to southbound pipelines to refineries and export ports in the Gulf Coast region. Existing pipelines from the Gulf Coast to the north now are underutilized. Projects are underway that will reverse the flow to carry crude oil southbound. Smaller south-to-north pipelines may be installed and the larger existing lines used for shipments south (See Figure 7).

The projects under development or completed to implement the above Supply-Chain System Strategies include (See Figure 8):

1. **The Alberta Clipper and Southbound Wisconsin Pipeline Network** – The Alberta Clipper or Enbridge Line 67 runs from Hardisty, Alberta, to Superior, Wisconsin. Line 67 was put in service in 2010 with a capacity of 450,000 barrels per day (bpd). A Phase 1 expansion increased it to 570,000 bpd in 2014. A Phase 2 expansion is in the permitting / approval process and will take the capacity to 880,000 bpd.

2. **Line 5, Michigan U.P., Straits, L.P.** – Early in the evolution to ship heavy and tar sands crude oil eastward, Line 5 and the installation of a new parallel line were considered. This plan was dropped and the existing Line 5 was expanded through the addition of new pumping and friction reducing agent injection stations over a number of years. In September 2015, an agreement to prevent shipment of heavy crude oil in Line 5 was reached with the State of Michigan, but this is not a permanent ban. Enbridge's operations optimize the use of Line 5 for shipment of light crude and NGLs enabling heavy and tar sands crude oil to be shipped in larger quantities through Wisconsin and southern Michigan to the East and southbound to the U.S. Gulf Coast. The overwhelming majority of Line 5 crude oil goes back into Canada via the crossing at Marysville, Michigan, to Sarnia, Ontario.[8]

3. **Line 6B, southern Michigan** – Enbridge replaced the old Line 6B that failed in 2010. The new parallel line was completed in 2014 and expands capacity from the restricted flow on the original 6B of 240,000 bpd to 800,000 bpd.

4. **Flanagan South Pipeline Project** – Enbridge completed pipeline construction in 2014 to ship heavy crude oil from collection terminals in Pontiac, Illinois, to a Cushing, Oklahoma, storage hub. It is carrying 585,000 bpd with an ultimate capacity of 880,000 bpd to support refineries on the U.S. Gulf Coast and export opportunities.

5. **Line 9 Flow Reversal**[9] – Enbridge pipeline from Sarnia, Ontario, to Montreal, Quebec. Line 9 originally supplied crude oil from the west to eastern Canadian refineries. It was reversed in 1998, flowing east to west, to supply cheaper imported crude oil to eastern Canada refineries. The flow is being returned west to east to enable refineries to access Bakken and tar sands crude oil and enable maritime shipments and exports from Montreal. Line 9 has a current capacity of 240,000 bpd.

6. **Portland – Montreal Pipeline** – This is an old pipeline network to ship crude oil imported through Portland, Maine, to Montreal. The business has dropped dramatically as the imported oil is not cost competitive in the current market. Enbridge is working with their partners to develop a project to reverse the flow,

[8] Street, Gary L., M.S., P.E., *Current and Possible Alternative Supply Systems for Refineries in Detroit, MI and Toledo, OH, and Propane Supply for the Upper Peninsula,* December 14, 2015.). www.flowforwater.org, (Hereinafter *Appendix B Report*).
[9] Tobben, Sheela and Murtaugh, Dan**.,** *Enbridge Line 9B Said to Deliver Crude Oil to Eastern Canada* December 2, 2015, http://www.bloomberg.com/news/articles/2015-12-02/enbridge-line-9b-said-to-deliver-crude-oil-to-eastern-canada

enabling heavy and tar sands crude oil maritime shipments from Portland. This project is being strongly resisted by the Portland community.

7. **Enbridge Trunkline Project** – Enbridge will convert an existing natural gas pipeline to crude oil service and reverse the flow to ship crude oil from Patoka, IL, to St. James, LA. Capacity would be increased from 420,000 bpd to 660,000 bpd and transport U.S. and Canadian Bakken crude oil to support Gulf Coast refineries (See Figure 8).

8. **Capline Pipeline** – Marathon operates this pipeline, the largest crude oil pipeline in the United States, with a capacity of 1,200,000 bpd. It currently ships from St. James, Louisiana, to Patoka, Illinois. A project is under study that will reverse the flow because utilization has dropped in recent years with crude oil from the Gulf Coast region being displaced by crude oil from the Bakken/Alberta regions in northern refineries. Plans to reverse the flow may include the installation of a smaller south-to-north pipeline to maintain smaller volume shipments along the historical route. This would connect these crude oil sources through Enbridge pipelines both south and east. In effect, along with the incremental expansion and doubling of Line 6B, it appears that Enbridge has been building, piece-by-piece, its own version of the Keystone XL Pipeline recently rejected by U.S. President Obama (See Figure 7).

9. **MPLX Patoka, IL, to Lima, OH, Pipeline** – Marathon operates this pipeline with a 249,000 bpd capacity. A study is underway incrementally expanding the pipeline. This line feeds the network to Toledo, Ohio, and Detroit, Michigan (See Figure 9).

10. **Detroit Marathon Refinery** – This refinery is continuing to expand capabilities to consume tar sands crude oil that has a lower cost. The refinery currently receives crude oil from Enbridge Line 6B via Enbridge Line 17 and Line 79 from Stockbridge, Michigan, to Freedom Junction and then on through the leased Wolverine Pipeline to the refinery. The refinery also receives light crude oil from Line 5 via the Sunoco Pipeline and crude oil from the Mid-Valley and Capline pipelines (See Figure 10). The following information is summarized from an analysis conducted by G. Street,[10] which provides a detailed material balance or quantitative analysis of system capabilities.

    Marathon currently consumes 130,000 barrels per day of crude at capacity. They likely use 100,000 bpd of heavy crude and dilbit via Line 6B as noted above,

[10] Id. *Appendix B Report.*

leaving 30,000 bpd demand for light crude. This small volume, now supplied by Line 5, could alternatively be supplied by the Mid-Valley, MPLX, and Capline pipeline network, which is partly owned by Marathon.

11. **Toledo Area Refineries** – BP-Husky (Toledo) consumes 160,000 bpd of crude oil at capacity with 100,000 bpd of heavy crude from Enbridge Line 6B via Line 17 and a new line, Enbridge Line 79 (See Figure 10). While BP-Husky may receive part of the remaining 60,000 bpd of light crude oil via Line 5, it is more likely received via the Mid-Valley and Capline pipelines from the southern United States.

    PBF Energy (Toledo) does not appear to be processing heavy crude oil or dilbit and are most likely receiving light and medium crude oil via the Mid-Valley and Capline pipelines.[11]

VI. Natural Gas Liquids in the Great Lakes – St. Lawrence Basin

Natural gas liquids (NGLs) contain lighter hydrocarbon materials (ethane, propane, butane) and can be liquefied and shipped in the same pipelines as crude oil. NGLs are "coproduced" during natural gas and crude oil production. NGLs consist of ethane, used in petrochemical production; propane, used for heating and chemical production; and butane, used in gasoline blending and chemical production. "Light condensates" have the same components as NGLs but higher amounts of butane, pentane, and hexane. Light condensates are also known as "natural gasoline."

Tar sands crude oil at the point-of-origin is highly viscous and cannot be directly pumped through pipelines. By diluting tar sands crude with NGLs and/or light condensates, the physical properties of the resulting blend, called dilbit, are then similar to heavy crude oil enabling pipeline shipment. NGLs and light condensates are sent to the tar sands regions in large quantities for blending into dilbit.

NGLs are shipped from the Northwest in Line 5 to petrochemical producers in Sarnia Canada (See Figure 11). At Rapid River, Michigan, some of the NGLs are diverted through a de-propanizer unit to extract propane and the remainder of the stream (ethane, butane) is then re-injected into Line 5 for shipment to Sarnia. The extracted propane is used for home and commercial heating in the Michigan Upper Peninsula. Other suppliers using tank trucks also supply propane to the Upper Peninsula.

Alternative supply routes for NGLs to Sarnia are under development:

[11] Id. *Appendix B Report.*

- Kinder Morgan has a project to ship NGLs and light condensate from the Marcellus Pennsylvania shale oil and gas fields via the Cochin Pipeline to Riga, Michigan, then to Windsor, Ontario and from there through a Canadian line to chemical manufacturers in Sarnia. This routing is in competition to Enbridge Line 5. The Cochin Pipeline will also transport NGLs and light condensates west and north to be used as diluent for the Alberta tar sands crude oil (See Figures 12 and 13).

- The Sunoco Mariner Pipeline will transport NGLs and light condensate from the Marcellus and Utica shale gas fields to the Toledo, Ohio, area where it can then move north to Sarnia (See Figure 13).

- New projects are also being implemented to ship light condensate from the Gulf Coast Region to Alberta for blending into dilbit.

VII. The Current Pipeline System Evolution and the Role of Line 5

Crude oil and NGL sources are changing and driving pipeline company strategies. Enbridge and PanCanada are expanding and modifying their networks to transport Bakken and Alberta tar sands crude oil to North American refineries and export ports on the East, West, and Gulf Coasts.

The recently rejected PanCanada Keystone XL pipeline project through the central United States is well known and the strategy is visible to government agencies and the public. Enbridge, their competitor, is working on multiple projects to expand capacity and redirect flows to transport Bakken crude oil and tar sands crude oil to the East Coast (Montreal, Maine), U.S. Gulf Coast, and the Canadian west coast and to refineries along the routes or at the destinations.

Enbridge's pipeline strategy has not been so visible or obvious, as a consolidated view of their numerous projects is not readily available. The Enbridge pipeline network is being expanded and modified segment-by-segment and integrated with pipeline partners. Segment-by-segment implementation is a typical company engineering and investment approach; however, without disclosure or a transparent overall view, this avoids and hinders government agencies and citizen stakeholders from understanding the impact and considering, identifying, and requiring better alternatives with the elimination of potential for unacceptable or high level risks of catastrophic harm such as that posed by Line 5 under the Straits. Segment-by-segment review and development result in an overall higher level of risk and potential catastrophic harm, like a spill of crude oil in the Great Lakes at the Straits, than would the overall project or risk and alternatives analysis.

The end result is that government regulators and the general public cannot launch effective alternative analyses that may result in better solutions or, at a minimum, ensure that government agencies set adequate regulatory constraints. Without transparency and alternative analyses on the appropriate parts of the overall *system*, the pipeline network evolves in an optimum direction for the oil and gas sector and the evolution may not adequately address citizen safety and environmental protection.

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Figure 1. Shale Plays Driving Pipeline System Evolution

In Great Lakes – St Lawrence Basin

Source: U.S. Energy Information Administration based on data from various published studies. Canada and Mexico plays from ARI.
Updated: May 9, 2011

☆ The primary shale areas ("plays") that are driving changes in the pipeline network in the Great Lakes – St. Lawrence Basin for crude oil, NGL's, light condensates and natural gas are the BAKKEN UTICA and MARCELLUS plays

Figure 2. Canada Oil Sands Areas Driving Pipeline System Evolution in

Tar-sands areas that are driving changes in the pipeline network in the Great Lakes – St. Lawrence Basin. Tar-sands crude oil is extracted and either partially processed to "synthetic crude oil" or diluted to create "Dilbit", which has a lower viscosity and can be shipped by pipeline

Figure 3. Historic Crude Oil, NGL Flows to the Great Lakes – St Lawrence Basin

Historic, crude oil and NGL flows - Alberta, the U.S. Southwest and Gulf Coast, imports from the east.

Figure 4. Evolving Crude Oil, NGL, Light Condensate Flows to the Great Lakes – St Lawrence Basin

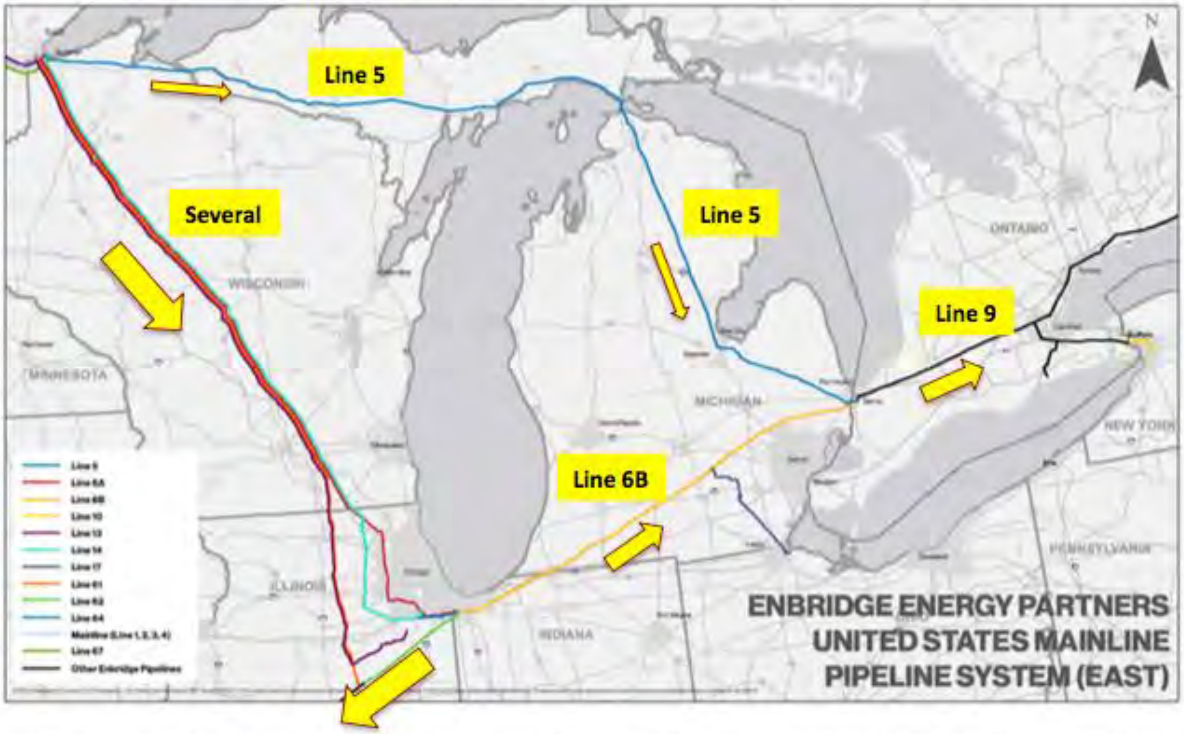
'he pipeline system is evolving and directions changing. Projects are being implemented to move crude oil from ɩorth Dakota/Alberta to the Chicago area and on to the east and south to serve refineries enable maritime :hipments and exports from the East Coast and Gulf Coast. Light condensate and NGL's pipeline projects will ɜnable shipments from Pennsylvania, Ohio and West Virginia to the Detroit, Windsor and Sarnia areas.

Figure 5. **Refineries in the Great Lakes - St. Lawrence Basin**

State/Province	City	Company	Refining capacity (bpd)
Indiana	Whiting	BP	400,000
Michigan	Detroit	Marathon	123,000
Ohio	Lima	Husky Energy	165,000
	Oregon	BP/Husky Oil	155,000
	Oregon	PBF	540,000
Wisconsin	Superior	Calumet	45,000
Quebec	Montreal	Suncor Energy	137,000
Ontario	Nanticoke	Imperial Oil	112,000
	Sarnia	Imperial Oil	121,000
	Sarnia	Suncor Energy	85,000
	Corunna	Shell Canada	72,000

Reference 5. Great Lakes Commission report on crude oil shipments in the Great Lakes – St Lawrence Basin

Figure 6. Enbridge Strategy – Expand to Ship Bakken and Tar Sands Crude Oil to the Midwest and East Coast



Enbridge is expanding its network to maximize Bakken and tar-sands crude oil shipment capability into the Great Lakes region and then on to East and Gulf Coasts refineries and ports for export.

Figure 7.

Pipeline Projects to Transport Crude Oil South Bound

1 – Line 67, Alberta Clipper and others
2 - Flanagan South Pipeline **3** – Capline Flow Reversal

Figure 8. Pipeline Projects to Transport Crude Oil South and East Bound

Figure 9.

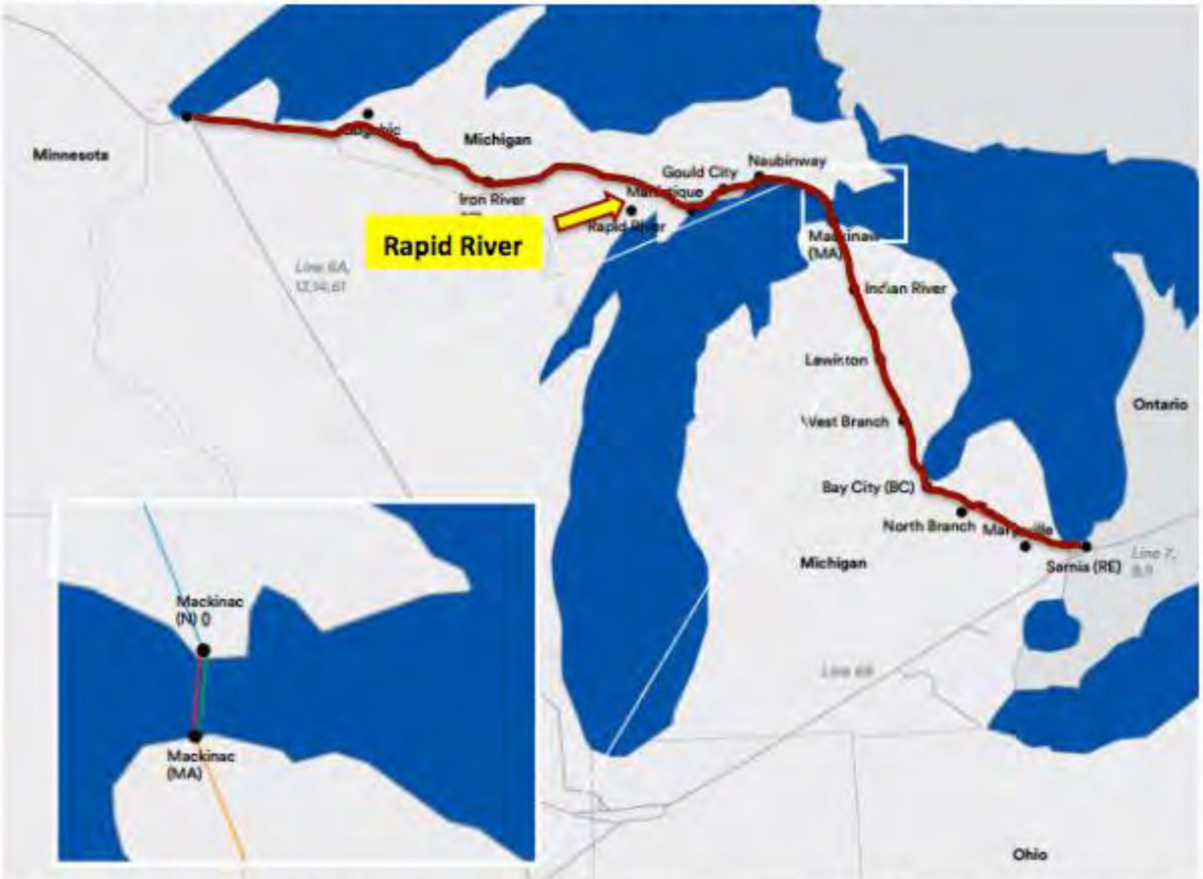
MPLX (Marathon) Pipeline Project From Patoka, IL to Lima, OH

An expansion that will increase crude oil shipment capacity to Toledo Refineries and the Detroit Marathon Refinery

Figure 10 Detroit/Toledo Crude Oil Supply Pipelines

Reference 7. (Original map by Marathon has been revised by FLOW)

Figure 11. Enbridge Line 5 Transports NGL's and Crude Oil



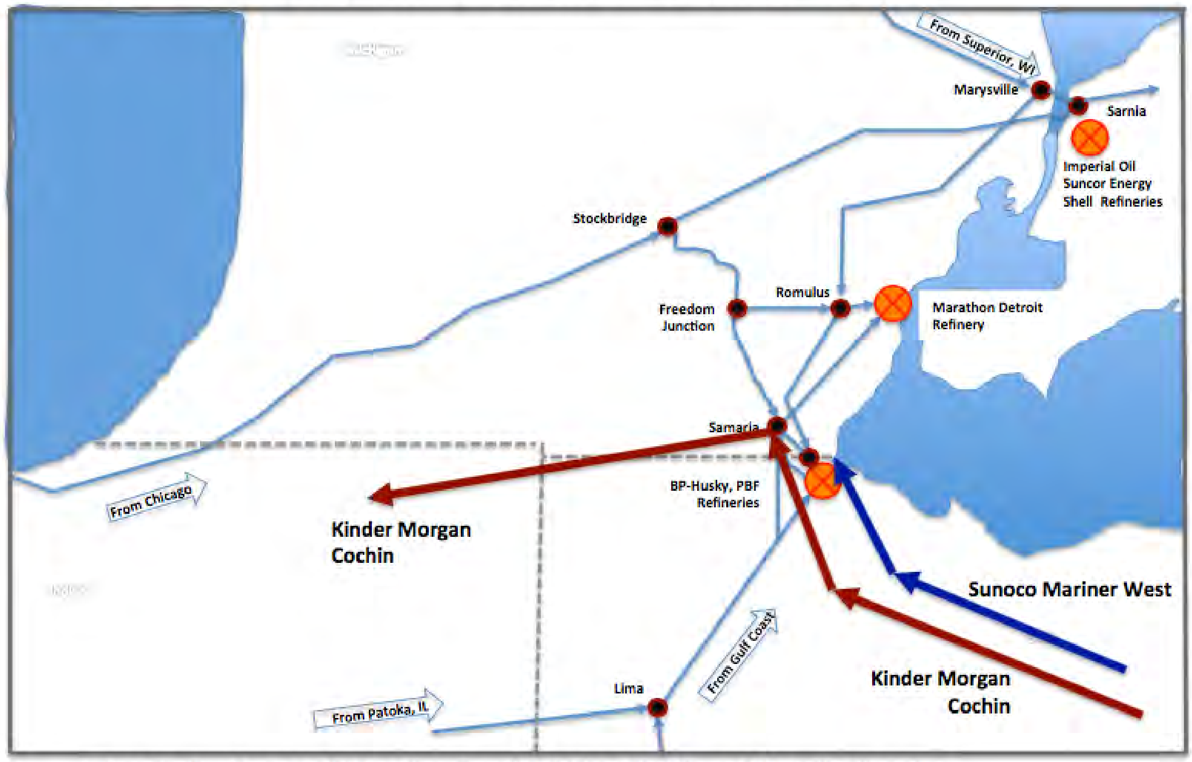
Propane is extracted at Rapid River and for commercial and home heating in the Upper Peninsula

Figure 12.

NGL's and Light Condensate Shipments from Ohio and Pennsylvania

NGL's and light condensate feedstock will move from the Utica and Marcellus Shale Plays into the Windsor-Sarnia area to provide low cost feedstock to petrochemical producers in Canada

Figure 13. Kinder Morgan Cochin and Sunoco Mariner West Pipelines



These pipelines transport light condensate and NGLs' from the Utica and Marcellus Shale Plays

Appendix B: Current and Possible Alternative Supply Systems for Transporting Oil and Natural Gas Liquids to Refineries in Detroit, MI; Toledo, OH; Warren, PA; and Sarnia, ON, and Propane for the Upper Peninsula of Michigan

By: Gary L. Street, M.S., P.E.
December 14, 2015
Prepared for and in partnership with FLOW (For Love of Water)

Report Status: The report that follows is based on an initial and ongoing investigation. New information is frequently uncovered. As new information is found and verified, it will be added to the report, as a revision or supplement.

Purpose

1. To identify the sources and amounts of crude oil that can be transported by pipeline to the Detroit refinery and two Toledo refineries, plus a refinery in Warren, PA.
2. Review the crude oil source for refineries in Sarnia, ON.
3. Consider supply system alternatives for delivering crude oil to the refineries – via pipeline – that would allow Line 5 to be shut down at the Straits of Mackinac.
4. Consider supply system alternatives involving pipeline and trucks for delivering propane to the Upper Peninsula and Northern Wisconsin that would allow Line 5 to be shut down at the Straits of Mackinac.

Summary

- **Refineries in Detroit and Toledo served by Enbridge, and others:**
  1. Marathon – Detroit; Crude capacity = 130,000 barrels per day (bpd)[1]
  2. BP-Husky – Toledo; Crude capacity = 160,000 bpd[2]
  3. PBF[3] – Toledo; Crude capacity = 170,000 bpd[4]

- **Refineries in Sarnia served by Enbridge:**
  1. Imperial – Sarnia, Crude capacity = 121,000 bpd[5]
  2. Shell – Sarnia, Crude capacity = 75,000 bpd[6]
  3. Suncor – Sarnia, Crude capacity = 85,000 bpd[7]

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[1] Source: Marathon Detroit Refinery, March 2015.
[2] "What do we do?," BP Husky. http://www.bp.com/en_us/bp-us/what-we-do/refining/toledo.html
[3] In December 2010, Sunoco sold its refinery in Toledo, Ohio, to PBF Energy for US $400 million.
[4] Source: PBF Energy, 2015.
[5] "Operations: Sarnia manufacturing site," http://www.imperialoil.ca/Canada-English/operations_refineries_sarnia.aspx .
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[7] "Refining," Suncor, http://www.suncor.com/en/about/232.aspx.

- A recent step by Enbridge has exacerbated the issue of supply to Sarnia by eliminating a previous source of crude oil to Sarnia. In March, 2014, the National Energy Board of Canada approved a request by Enbridge to reverse the flow of Line 9. Instead of crude coming from Montreal to Sarnia, it now flows from Sarnia to Montreal, for export outside of Canada. This development has removed an important source of crude oil for the Sarnia refineries.

- It is not the responsibility of the citizens of Michigan, nor other Great Lakes states and provinces, to risk an environmental disaster, simply to meet the demands of Canadian refineries, or a Canadian pipeline company, which serve a multi-national market, far beyond the needs of the Great Lakes region.

- After its Line 6B burst in 2010 spilling one million gallons of heavy crude into the Kalamazoo River watershed, Enbridge installed a new Line 6B from Griffith, IN, to Marysville, MI.[8] In doing so, Enbridge increased its capacity to ship heavy crude to Sarnia via this route by 200 percent, and boosted the ultimate crude capacity of the segment between Griffith, Indiana, and Stockbridge, Michigan, by over 300 percent. The old Line 6B has been shut down, but not removed.

- Marathon consumes 130,000 barrels per day (bpd) of crude. Of this amount, they utilize 100,000 bpd of heavy crude, which arrives by Line 6B. This leaves a need for 30,000 bpd of light or medium crude. Since Line 5 transports 22,680,000 gallons per day or 540,000 bpd, the maximum demand by Marathon on Line 5 is 30,000/540,000 = 5.6%.

- Roughly 14,000 bpd[9] of light crude are routinely added to Line 5 from oil wells in the **Northern Lower Peninsula of Michigan**, reducing the need for medium crude for Marathon - from outside of Michigan - to 16,000 bpd, or 12% of Marathon's daily crude demand. Since the Michigan crude is extracted south of the Straits, it can continue flowing to Marathon, via Line 5, even if Line 5 at the Straits is shutdown.

- Light crude can also be transported from the southern United States via the Mid-Valley and Capline pipelines to Marathon and the two Toledo refineries. In addition, light crude is also available via Line 6B from the Bakken formation in North Dakota.

- Based on the above, it is reasonable to conclude that only a small portion of the capacity of Line 5 is needed by Marathon and can be supplied by other existing pipelines.

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[8] Pre-Filed Testimony of Thomas Hodge before the State of Michigan Public Service Commission, April 16, 2012, PDF, pg. 11.

[9] "How does Michigan benefit? Line 5 keeps the wheels turning in Michigan," http://www.enbridge.com/Line-5/Benefits.aspx .

- BP-Husky (Toledo) consumes 160,000 bpd of crude. They are able to receive 60,000 bpd of heavy crude from Enbridge Line 6B, in conjunction with Line 17. In the near future they will also receive heavy crude via a new line, Enbridge Line 79 (See Map 2).

- While it is possible that BP-Husky is currently receiving some of the remaining 100,000 bpd via Line 5, it is also possible they receive it now, or could receive it in the future, via the Mid-Valley and Capline pipelines, which transport light and medium crude from the southern United States (See Map 2).

- Several references[10] to BP-Husky converting entirely to heavy crude feed stock were discovered. The schedule for the conversion is varied, but even the most cautious estimate is that it will be complete by 2020. Assuming this happens, when the conversion is complete, BP-Husky in Toledo will be totally independent of a light crude supply, such as that from Line 5, Bakken, or Mid-Valley.

- Nothing was found to suggest that PBF Energy (Toledo) has the capacity to process heavy crude. They are receiving light and medium crude via the Mid-Valley and Capline pipelines. While it may be possible for PBF Energy to receive crude via Line 5, and a Sunoco line running from Marysville to Toledo, it is unlikely they use this source.

- Regarding propane, preliminary engineering alternatives have been developed during this investigation that show that Line 5 at the Straits of Mackinac can be shut down, but still provide customers in the Upper Peninsula and Northern Wisconsin with propane, by Enbridge, or by some other supplier, should Enbridge chose not to continue to do so.

CONCLUSION

- Based on the information available, we conclude that no more than five to tenpercent of the crude oil in Line 5 is going to the Detroit and Toledo refineries. In reality, it is most likely closer to five percent than ten percent.

- If Line 5 were shutdown, this amount of light and medium crude could be supplied from the Capline and Mid-Valley pipelines, along with crude from northern Michigan. These sources are currently transporting crude to the area, and could most likely make up the relatively small amount that may be coming to the U.S. from Line 5. In addition, Bakken light crude could also be transported to the area via Line 6B.

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[10] Pre-Filed Direct Testimony of Mark Sitek before the State of Michigan Public Service Commission, April 16, 2012, U-16937, pdf pgs. 16, 21, 44, 69.

- The overwhelming majority of Line 5 crude goes back into Canada via the crossing at Marysville, MI, to Sarnia, ON.

- Based on analysis of alternatives, there appears to be no valid reason for a disruption of propane in the Upper Peninsula or Northern Wisconsin if Line 5 is shut down at the Straits of Mackinac.

- If Line 5 is shut down at the Mackinac Straits, but the remainder of it is kept operational from Lewiston, MI, southward, Michigan crude can continue to be transported to refineries in Detroit and Toledo.

SCOPE

This report considers crude oil coming from the following sources:

- Bakken crude from North Dakota (Light, sweet crude)
- Alberta Tar Sands (Heavy crude)
- U.S. Gulf Coast – Louisiana and Texas (Light, sweet crude)
- Northern Lower Peninsula of Michigan (Light, sweet crude)

I. Bakken Crude from North Dakota (Light, sweet crude)

Bakken crude is further described by the North Dakota Petroleum Council.[11] There are numerous references in testimony to the Michigan Public Service Commission (MPSC) that Bakken crude is readily available to Marathon and BP-Husky at this time,[12] particularly via Line 6B.

II. Alberta Tar Sands (Heavy crude) and the Possibility of Crossing the Straits

In 2012, Enbridge considered an expansion of Line 5 rather than replacing Line 6B.[13] <u>Since Line 6B is primarily a line for heavy crude, the new Line 5, as considered by Enbridge, would also have carried heavy crude.</u> This did not happen, and with the agreement to ban heavy oil in Line 5 recently reached between the State of Michigan and Enbridge, it may not happen.

"Enbridge evaluated expansion of its Line 5 pipeline, which would require the construction of a second, 645-mile parallel pipeline from Superior to Sarnia. This approach would not provide the incremental pipeline capacity in the timeframe needed. Additionally, it would be more intrusive to landowners, local communities and the environment, and would not provide the immediate capacity requirements of shippers on Line 6B. Therefore, Enbridge dismissed this alternative and no further studies were conducted."

III. Upgrade of Line 6B

(From testimony by Thomas Hodge of Enbridge before the Michigan Public Service Commission,[14] ("MPSC"))

MPSC: *"Will this project increase the operating pressure ofLine 6b?"*
Hodge: *"Yes."*

MPSC: "*Please explain."*
Hodge: *"Replacement of these remaining segments will restore the original ultimate pipeline capacity of Line 6B.[15] As Line 6B is expected to continue to operate at pressures below the*

[11] "Bakken Crude Properties," North Dakota Petroleum Council, http://www.ndoil.org/resources/bkn/.
[12] Testimony by Michael Ashton before the Michigan Public Services Commission, Case # U16937, May 24, 2012.
[13] Enbridge, Line 6B Phase 2 Replacement Project, June 15, 2012, p. 14.
[14] Pre-Filed Testimony of Thomas Hodge before the State of Michigan Public Service Commission, April 16, 2012.

previous maximum operating pressure, the available pipeline capacity on Line 6B is reduced as a direct result. By replacing the remaining segments of Line 6B with new pipeline, Enbridge will be able to achieve its original ultimate capacity and also provide the pipeline capacity necessary to meet its shippers' current transportation requirements.

Shippers are also forecasting a need for additional capacity above current demands. Since Line 6B has experienced periodic apportionment based on monthly shipper demand, Enbridge anticipates that the frequency of apportionment will only increase, especially as demand for additional pipeline capacity rises to meet the feedstock requirements of the refineries directly and indirectly served from Line 6B.

Enbridge plans to replace certain segments of Line 6B with a 36-inch diameter pipe and to install new facilities at certain existing station locations in order to meet its shipper's future transportation requirements."

A. Impact of Reduced Flow in Line 6B and Subsequent Total Replacement

Enbridge repeatedly has stressed that it replaced the entire length of Line 6B, from Griffith, IN, to Maryville, MI, due to "Integrity and Maintenance" considerations. While these factors may have contributed to the decision, the evidence clearly shows the over-riding consideration to be economic.

After the spill at Marshall on July 25, 2010, Enbridge was ordered by the Pipeline and Hazardous Materials Safety Administration (PHMSA) to reduce the operating pressure of Line 6B to 80 percent of its pre-spill amount.[16] This meant the operating pressure could not exceed 340 psig (prior to the rupture, the line was operated at 425 psig). The reduced operating pressure in turn reduced the flow in the line from roughly 400,000 bpd[17,18] to a maximum of 240,000 bpd.[19,20] Such a capacity reduction represented a loss of revenue for Enbridge, and may have created supply problems for Marathon. In addition, Mr. Warner[21] of the Michigan Public Service

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[15] In reality, the project does more than "restore the original capacity," it increases the capacity of Line 6B substantially.

[16] Travis Warner, a Public Utilities Engineer in the Gas Operations Section of the Commission's Operations and Wholesale Markets Division, before the Michigan Public Service Commission, History of Proceedings, Case # U-17020, January 31, 2013, pg. 13.

[17] Matheny, Keith, "Enbridge's expanded oil pipeline draws ire of homeowners in its path," *Detroit Free Press*, June 24, 2013.

[18] Hasemyer, David, "Michigan Pipeline to Restart, Now New and Double the Capacity," *Inside Climate News*, April 10, 2014.

[19] Matheny, Keith, "Enbridge's expanded oil pipeline draws ire of homeowners in its path," *Detroit Free Press,* June 24, 2013.

[20] See *supra* note 18.

[21] Testimony by Travis Warner, a Public Utilities Engineer in the Gas Operations Section of the Commission's Operations and Wholesale Markets Division, before the Michigan Public Service Commission, Case # U-17020, January 31, 2013, pg. 13.

Commission staff stated, "[T]here is no guarantee that PHMSA will ever allow Enbridge [to] operate Line 6B at its original design pressure and the subsequent capacity."

To counter this, Enbridge installed an entire new line from Griffith, IN, to Marysville, MI[22]. The cost, as reported by Enbridge,[23] was $2.8 billion. However the new line is 36 inches in diameter from Griffith, Indiana, to Stockbridge, Michigan, then 30 inches in diameter from Stockbridge to Marysville, Michigan. It is important to note that the old Line 6B was 30 inches in diameter for its entire path, not 36 inches from Griffith to Stockbridge.

Taking into account the larger diameter, and the removal of federal restrictions on operating pressure due to the installation of a new pipeline, Enbridge now has an Ultimate Annual Capacity in the 36-inch diameter portion (Griffith to Stockbridge) of 800,000 bpd, and an Ultimate Annual Capacity in the 30-inch diameter section (Stockbridge to Marysville) of 525,000 bpd. When this is compared to the 240,000 bpd that Enbridge was restricted to with the "old" Line 6B, it is obvious why they sought to replace the entire Line 6B, even at the cost of $2.8 billion (See Table 1).

It appears that the total replacement of Line 6B from Stockbridge to Marysville was primarily motivated by economic considerations – the ability to operate at even higher flow rates in the future. Other considerations, such as safety, environmental, and disruption of landowners, while valid, were secondary.

This conclusion is borne out by testimony before the MPSC by Mr. Thomas Hodge of Enbridge.[24] In April, 2012, he stated, "*This will enable Enbridge to restore Line 6B to its original ultimate pipeline capacity and along with certain facility installations at existing station sites, to provide the pipeline capacity necessary to meet its shippers' current and future transportation requirements.*" For the definition of "capacity" terms as used by Enbridge, see Addendum 1.

In January 2013, in testimony before the MPSC, Mr. Hodge A once again was quoted regarding an increase in capacity if Line 6B were completely replaced.[25]

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[22] Pre-Filed Testimony of Thomas Hodge before the State of Michigan Public Service Commission, April 16, 2012, pg. 12.
[23] Neiles, Byron, "Enbridge Major Projects," Enbridge Day 2014, http://www.enbridge.com/~/media/www/Site%20Documents/Investor%20Relations/2014/ENBDays/3_Major_Projects.pdf.
[24] Pre-Filed Testimony of Thomas Hodge before the State of Michigan Public Service Commission, April 16, 2012, Exhibit A-2, pg. 5
[25] Michigan Public Service Commission, Order Approving Application, U-17020, January 31, 2013, pg. 9.

"*Mr. Hodge also explained that the improvements to Line 6B will allow for operation of the pipeline at an increased operating pressure, which will increase its capacity. The details of the pre- and post-construction operating specifications appear on Table No. 3 at 6 Tr 364.*"

From Enbridge on April 2, 2014
From the various statements by Enbridge, cited above, it is obvious that replacement of Line 6B not only satisfied regulatory conc: "*Then after the completion of the full replacement of 6B, there will be work involving pump upgrades and terminal work as well as the construction of five additional tanks at Stockbridge all of this for 2016.*"[26]

The pump upgrades and additional storage tanks are all part of increasing the flow in Line 6B to the Ultimate Annual Capacity, as defined by Enbridge. The footnotes in Table 1 further confirm this conclusion.

erns, but it also provided the opportunity to significantly increase the flow of heavy crude to Michigan, Ohio, Ontario, and Pennsylvania.

Specifics of the Line 6B Phase 2 Replacement Project.[27] Enbridge Energy Partners, L.P., has replaced approximately 210 miles of existing 30-inch diameter Line 6B pipeline in Indiana and Michigan by installing new pipe.[28] Per Enbridge, "*The Line 6B Phase 2 Replacement Project responds to growing demand for pipeline transportation capacity while also reducing the frequency of future integrity inspections and individual repairs in the replacement segments. This is a combination capacity/integrity-driven project and is distinct from the integrity-driven Line 6B 2012 Maintenance and Rehabilitation Program…* "

B. Justification for the Increased Capacity in the New Line 6B:

The History of Proceedings for Order of Approval[29] issued by the MPSC, mentions, in several places, the justification used by Enbridge and the State to increase the capacity of Line 6B.

A typical statement from the MPSC.[30] "*The Staff agrees that it would be in the public interest to replace the existing Line 6B with the new project, which would address the integrity issue, reduce future maintenance digs, and increase capacity to serve the present and future needs of shippers and local refineries. Indeed, Staff witness Warner testified that he had recently confirmed the need for additional pipeline capacity at the site of Marathon's Detroit refinery.*"

[26] Thomson Reuters Street Events, Edited Transcript, EEP and MEP Investor Day, April 2, 2014, pg. 15.
[27] "Pipeline Safety Trust: About Pipelines, Enbridge Expansion backgrounder," http://pstrust.org/about-pipelines1/enbridge-expansion-backgrounder/.
[28] Hasemyer, David, "Michigan Pipeline to Restart, Now New and Double the Capacity," *Inside Climate News*, April 10, 2014.
[29] Michigan Public Service Commission, Order Approving Application, U-17020, January 31, 2013, pgs. 9, 14, & 18.
[30] Id.

Table 1, and the other sources cited above, Enbridge used the opportunity to not only replace Line 6B, which very likely had additional "integrity" issues, but also increased their Initial Annual Capacity to send heavy crude between Griffith and Stockbridge by 208 percent (500,000 bpd/240,000 bpd = 208 percent).

Lastly, should Enbridge install additional pumps and other hardware, taking Line 6B to its Ultimate Annual Capacity, this same segment could see an increase of 333 percent (800,000 bpd/240,000 bpd = 333 percent).

Map 1 – Upgraded Enbridge Line 6B[31]

[31] Pre-Filed Direct Testimony of Mark Sitek before the State of Michigan Public Service Commission, April 16, 2012.

Table 1 – Existing Line 6B Capacity and Increased Line 6B Capacity[32]

Pipeline Capacity	Existing Line 6B 30-Inch (BPD)*	Post-Construction 36-Inch (BPD) **	Post-Construction 30-Inch (BPD) **
Ultimate Design Capacity	450,000*	889,000	583,333
Ultimate Annual Capacity	Ranged from 400,000 (bpd) to 410,000 (bpd)*	800,000	525,000
Initial Design Capacity		550,000	550,000
Initial Annual Capacity		500,000	500,000
Maximum Operating Pressure (72% of maximum yield strength)	624 psi*	1400 psi	1260 psi

The above Table No. 3 is from Exhibit A-2 of the Application

* Prior to Sept. 2010

** Stated capacity includes station upgrades indicated in Section 6 of Exhibit A-2 of this Application

IV. Enbridge Lines 17 and 79

Line 17 is 16 inches in diameter and runs from Stockbridge, MI, to Toledo, OH. It is mainly used to deliver crude to BP-Husky in Toledo[33] (See Map 2.)

Enbridge Line 79 is used to transport western Canadian heavy crude.[34] It is 20 inches in diameter.[35] Line 79 was installed adjacent to Line 17 and was scheduled to start up in 2013.[36] The capacity of Line 79 is 80,000 bpd.[37]

In testimony before the Michigan Public Service Commission,[38,39] Mr. Neil Earnest, a Vice President and Director of Muse, Stancil & Co. of Addison, TX, stated, "*With only one refinery in North Dakota, much of the state's crude oil production is delivered throughout the Midwest via the Enbridge Mainline System. The Marathon Detroit Refinery currently can receive Bakken production via Enbridge's Line 5, a pipeline segment devoted to light and medium crude oil types (Bakken crude oil is light). The BP-Husky Toledo Refinery currently does not have direct*

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32 Pre-Filed Testimony of Thomas Hodge before the State of Michigan Public Service Commission, April 16, 2012.
33 Testimony before the Michigan Public Service Commission, January 12, 2012, p. 6.
34 Testimony before the Michigan Public Service Commission, January 12, 2012, p. 7.
35 Testimony before the Michigan Public Service Commission, January 12, 2012, p. 13.
36 Kasler, Dale. "Federal energy agency supports California in dispute with JPMorgan Chase," The Terra News. June 6, 2013. http://www.theterranews.com/content/?m=20130606.
37 Pre-Filed Testimony of Thomas Hodge before the State of Michigan Public Service Commission, May 3, 2012, pdf pg. 63.
38 Pre-Filed Testimony of Neil Earnest before the State of Michigan Public Service Commission, May 3, 2012, pdf pg. 44, U-16937.
39 Id, pdf pg. 45.

pipeline access to Bakken supplies; however, with the additional capacity available for this refinery on Line 17 with the completion of this Project, Enbridge will be able to periodically batch supplies of Bakken crude to BP-Husky via Line 17."

There is no mention in any of the testimony that the PBF refinery in Toledo will be served by either Line 17 or Line 79.

Conclusion: Lines 17 and 79 can supply either heavy crude or light crude to Marathon and BP-Husky, but do not supply any crude to PBF.

V. Enbridge "Project 24": Recent and Planned Expansion of the Capacity of the Lakehead System [40]

Enbridge has requested approval from the Federal Energy Commission (FERC) to increase the capacity of portions of its Lakehead System. The other pipelines involved are Line 61, Line 67, Line 62, and Line 6B.

Table 2: Summary of Capacity Increases – Project 24

Line Number	Description	Timing
61	Increase capacity to 1,200,000 bpd	3 Q 2015
67	Increase capacity to 800,000 bpd	mid - 2015
62	New "twin" line. Initial capacity to be 570,000 bpd	3 Q 2015
6B	Increase current annual capacity from 500,000 bpd to 570,000 bpd. See Table 1.	1 Q 2016

Quoting FERC,[41] "*According to Enbridge Energy, the Line 6B Expansion will enhance the Line 6B facilities between Griffith, Indiana, and Stockbridge, Michigan. Enbridge Energy points out that this segment of Line 6B was replaced recently, and the replacement pipe will not be expanded further. Instead, continues Enbridge Energy, the expansion will include pump station modifications and new tankage at the Hartsdale and Stockbridge terminals, which will increase the total capacity of Line 6B from 500,000 bpd*[42] *to approximately 570,000 bpd. Enbridge*

[40] FERC, Federal Energy Regulatory Commission, 150 FERC 61,069, February 2, 2015.
[41] Id., pg. 4.
[42] See

Table 1 and addendum 1 for definition and use of "Capacity."

Energy expects the Line 6B expansion to commence service during the first quarter of 2016 or earlier, at a cost of $365 million."

VI. Marathon Refinery in Detroit

Marathon – Detroit; Crude Capacity = 130,000 bpd[43].
Crude oil demand at Marathon's Detroit, Michigan, refinery is supplied exclusively by pipeline[44].

The capacity for processing heavy crude at Marathon in Detroit was reported to be 100,000 bpd in 2015[45]. Citing Marathon's web site - *Upon completion of the DHOUP (Detroit Heavy Oil Upgrade Project) in 2012,[46] the refinery became able to process 100,000 bpd of heavy Canadian crude.*

The capacity to process heavy crude at Marathon was further confirmed by the testimony of Clifford Cook[47] (Marathon, Senior Vice President). Mr. Cook stated that at the time of his testimony, Marathon could process 25,000 bpd of heavy crude from Canada. He then referred the need for a new pipeline between Samaria, MI, and Detroit so the volume of heavy crude processed could be increased by 75,000 bpd. The DHOUP Project, referred to above, and now operational, increased the capacity to 100,000 bpd.

In addition to crude received from Alberta, Marathon receives 14,000 bpd of crude from the northern Lower Peninsula of Michigan[48] via Line 5. Taking this into account, their total need of 130,000 bpd, along with the 100,000 bpd they receive by Line 6B, says they only need 16,000 bpd from some other pipeline source – equal to about 12% of their daily demand. (130,000 – 14,000 = 16,000. 16,000/130,000 = 12.3%)

Conclusion: The section of Line 5, in the Lower Peninsula, between Lewiston and Marysville, could remain in operation if Line 5 were shut down at the Straits, and continue to supply 16,000 bpd of crude to Marathon.

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[43] Marathon Petroleum Company, Marathon Detroit Refinery, March 2015, www.marathonpetroleum.com.
[44] Pre-Filed Direct Testimony of Clifford C. Cook before the State of Michigan Public Service Commission, March 23, 2007 (Cook, at the time of the testimony, was Senior Vice President for Supply and Distribution, Marathon Petroleum Company).
[45] Lefebvre, Ben. "Marathon Petroleum restarts Detroit refinery after major expansion project," Hydrocarbon Processing. November 6, 2012. http://www.hydrocarbonprocessing.com/Article/3113909/Marathon-Petroleum-restarts-Detroit-refinery-after-major-expansion-project.html.
[46] Id.
[47] Testimony of Clifford Cook, Marathon, before the Michigan Public Service Commission, May 3, 2007, Case # U-15251, 225540.doc2, p. 8., *https://efile.mpsc.state.**mi**.us/efile/docs/**15251**/0002.pdf*
[48] "How does Michigan benefit? Line 5 keeps the wheels turning in Michigan," http://www.enbridge.com/Line-5/Benefits.aspx .

Marathon has a pipeline from Samaria to Detroit.[49] This line is 16 inches in diameter.

Enbridge, Wolverine, and Marathon, have a sequential pipeline system from Line 6B to Freedom Township, then to Romulus, MI, and finally to the Marathon refinery (See Map 2).

VII. The MPLX Crude Oil Pipeline System[50]
(**MPLX** was spun off from Marathon about 2 years ago. **MPLX** LP is a master limited partnership formed by Marathon Petroleum Corporation (MPC).

Table 3

Crude Oil Pipelines System : Overview

Crude Oil Pipeline System	Diameter (Inches)	Length (miles)	Capacity (MBPD)[1]	Initial Term (Years)	MPC Min. Commitment (MBPD)[1]
Patoka to Lima	20" / 22"	302	249	10	40
Catlettsburg and Robinson	20" / 24" / 20"	484	495	10	380
Detroit	16" / 16"	61	320	10	155
Wood River to Patoka	22" / 12"	115	314	5	130
Wood River Barge Dock	–	–	84	5	40
Total	–	962	1,462	–	745

Market Realist

Source : MPLX LP

Patoka to Lima Crude Pipeline System
From Table 3 the Pakota to Lima crude pipeline system is made up of approximately 302 miles. (MPC = Marathon Petroleum Corporation)

Crude is delivered to MPC's tank farm in Lima, from where it is shipped to MPC's Canton, Ohio, refinery, or to other third-party refineries in Lima and Toledo, Ohio. Crude is also shipped to MPC's Detroit refinery through the Samaria to Detroit pipeline.

VIII. PBF Energy and the PBF Refinery in Toledo
PBF – Toledo: Crude Capacity = 170,000 barrels/day[51]

[49] Banz, Keisha. "The MPLX crude oil pipeline system," December 16, 2014. http://finance.yahoo.com/news/mplx-crude-oil-pipeline-system-183449008.html, and Marathon Pipeline LLC Operated Pipeline Systems, May, 2015.
[50] Banz, Keisha. "The MPLX crude oil pipeline system," December 16, 2014. http://finance.yahoo.com/news/mplx-crude-oil-pipeline-system-183449008.html,
[51] PBF Energy, 2015

PBF is a petroleum refiner and supplier of unbranded transportation fuels, heating oils, lubricants, petrochemical feedstocks, and other petroleum products, founded in 2008 with headquarters in Parsippany, New Jersey. The company's three refineries include one in Toledo, Ohio, one at the Port of Paulsboro in Gibbstown, New Jersey, and the Delaware City Refinery in Delaware City.

Sources of Crude
From the 2014 PBF Energy Annual Report.[52]

"Toledo has a throughput capacity of approximately 170,000 bpd and a Nelson Complexity Index of 9.2. Toledo primarily processes a slate of light, sweet crudes from Canada, the Mid-Continent, the Bakken region and the ***U.S. Gulf Coast.***

Crude is delivered to the Toledo refinery through three primary pipelines: (1) Enbridge from the north, (2) Capline from the south and (3) Mid-Valley from the south. Crude is also delivered to a nearby terminal by rail and from local sources by truck to a truck unloading facility within the refinery."

While PBF states that it gets light crude via "Enbridge from the north," it does not mean it must come by way of Line 5. It could also come by way of Line 6B.

There is no mention of heavy crude or dilbit.

Conclusion: There is no evidence that the PBF refinery in Toledo has the capability to process heavy crude, nor plans to do so in the near future.

IX. Capline Pipeline: The Capline crude pipeline[53] is the biggest pipeline in the mainland United States. It is 40 inches in diameter, and runs 632 miles. It can handle 1.2 million bpd. It is co-owned by Marathon, Plains All-American, and BP. It transports crude northward from the **Gulf Coast**, originates in St. James, LA, and terminates at Patoka, IL (See Map 2).

X. Mid -Valley Pipeline: The Mid-Valley Pipeline Company owns a pipeline, which originates in Longview, TX, and terminates in Samaria, MI.[54,55] It transports crude oil to refineries primarily in the Midwest United States. The pipeline is 20 inches in diameter in some sections, and elsewhere, 22 inches in diameter.[56] It is 1,100 miles long.[57] The crude oil that is transported

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[52] PBF Energy Inc. *2014 Annual Report*, p. 19.
[53] Resnick-Ault, Jessica, "UPDATE 2-Capline, biggest U.S. crude conduit, to study future options," Reuters, Oct. 30, 2014, http://www.reuters.com/article/2014/10/30/marathonpetroleum-capline-idUSL1N0SP18220141030.
[54] "Sunoco Logistics Asset Map," http://www.sunocologistics.com/Customers/Business-Lines/Asset-Map/241/.
[55] "Sunoco Logistics Asset Map," http://www.sunocologistics.com/Customers/Business-Lines/Crude-Oil-Pipeline-System/55/.
[56] Sunoco Pipeline L.P./Inland Corporation/Mid-Valley Pipeline Company, 2015.
[57] Sunoco Pipeline L.P./Inland Corporation/Mid-Valley Pipeline Company, 2015.

in the Mid-Valley pipeline is Light Texas Crude. The pipeline has a reported capacity of 238,000 bpd[58] to 280,000 bpd[59] of Light Texas Crude (LTC).

On November 5, 2015, Reuters reported[60] that, "Sunoco Logistics expects to return its 280,000 barrels per day Mid-Valley pipeline to full capacity early next year once it completes hydro-testing on the system."

Note: This pipeline is NOT transporting heavy crude. The pipeline system in the Toledo area for this line becomes somewhat complex.[61]

XI. BP-Husky Refinery in Toledo
BP-Husky – Toledo; Crude Capacity = 160,000 bpd[62]

Sources of Crude:

1. Toledo Oil Pipeline[63] (aka Enbridge Line 17). From Stockbridge, MI, to the refinery. See **Map 2.** Design Capacity of Line 17[64,65] is 100,000 bpd. Annual Capacity of Line 17: 90,000 bpd. Since this line is a spur of Line 6B, it most likely is supplying heavy crude to the refinery. However it could also be used to supply light crude.

2. The Mid-Valley pipeline is owned by Sunoco.[66] Mid-Valley Pipeline includes 20-inch and 22-inch diameter sections. It has a nominal capacity of 280,000 bpd[67]. The pipeline, "*….originates in Longview, Texas and passes through Louisiana, Arkansas, Mississippi, Tennessee, Kentucky, and Ohio, and terminates in Samaria, Michigan*."[68]

   Considering the source of the Mid-Valley pipeline, it is not supplying BP-Husky with heavy crude. Rather it is a source of lighter crude, similar to that currently in Line 5.

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[58] Zacks Equity Research. "Sunoco Logistics; Mid-Valley Pipeline Spills," *Zacks*. March 20, 2014. http://www.zacks.com/stock/news/127113/sunoco-logistics-midvalley-pipeline-spills.
[59] Hampton, Liz. "Sunoco Logistics Mid-Valley pipeline to return to full capacity early next year," *Market News*. December 10, 2015. http://www.ubs.wallst.com/ubs/mkt_story.asp?docKey=1329-L1N1301QL-1&first=0.
[60] Ibid.
[61] Doherty, Kevin E. "Sunoco Logistics," http://sitemanager.pdigm.com/user/file/Ohio/Sunoco_Pipeline_LP_Inland_Corporation_Mid_Valley_Pipeline_Company.pdf.
[62] "What do we do?" BP Husky. http://www.bp.com/en_us/bp-us/what-we-do/refining/toledo.html
[63] "Toledo Oil Pipeline," http://abarrelfull.wikidot.com/toledo-oil-pipeline.
[64] "Toledo Oil Pipeline," http://abarrelfull.wikidot.com/toledo-oil-pipeline.
[65] Testimony before the Michigan Public Service Commission, Sitek, et. al., May 3, 2012, U-16937, pdf pg. 6.
[66] "Toledo Oil Pipeline," http://abarrelfull.wikidot.com/mid-valley-crude-oil-pipeline.
[67] Williams, Nia. "Husky says Mid-Valley pipeline curtailment into Lima refinery may last into 2015," *Reuters*. October 23, 2014. http://www.reuters.com/article/2014/10/23/husky-energy-pipeline-lima-idUSL2N0SI1TP20141023#YLKzOwfe1WR9HPYd.97.
[68] Ibid.

3. The BP-Husky Refinery near Toledo is being converted to process ONLY heavy crude.[69,70] The conversion is expected to be complete sometime between 2016 and 2020.

   [71] *"The partners plan to invest $2.5bn in the refinery by 2015 to increase processing capacity and enable it to process crude oil produced at the Sunrise field. Located in the Canadian oil sands, the Sunrise field produces bitumen which is heavy, black and viscous in nature. The investment will increase the capacity of the refinery to 170,000 bpd of heavy oil and bitumen."*

4. Based on our investigation to date, the heavy crude that BP Husky is using is coming – and will come in the future - from Line 6B.

XII. United Refinery in Warren PA Supply of Crude Oil[72]

Substantially all of our crude supply is sourced from Canada and the Northern Plains states through the Enbridge pipeline. <u>We are however, not dependent on this source alone</u>. While not utilized during the closure of the Enbridge 6B pipeline because of the anticipated length of the disruption, <u>we could within 90 days shift up to 70% of our crude oil requirements to some combination of domestic and offshore crude. With additional time, 100% of our crude requirements could be obtained from non-Canadian sources.</u>

We access crude through the Kiantone Pipeline, which connects with the Enbridge pipeline system in West Seneca, New York, which is near Buffalo. The Enbridge pipeline system provides access to most North American and foreign crude oils through three primary routes: (i) Canadian crude oils are transported eastward from Alberta and other points in Canada, (ii) foreign crude oils unloaded at the Louisiana Offshore Oil Port are transported north via the Capline and Chicap pipelines which connect to the Enbridge pipeline system at Mokena, Illinois, and (iii) foreign crude unloaded at Portland, Maine shipped to Montreal then shipped on Enbridge's line 9 to Sarnia, Ontario. Enbridge has announced the Phase I (partial) reversal of Line 9. This reversal includes the segment from Westover to Sarnia. It does not interfere with crude deliveries from Montreal to Westover and deliveries into West Seneca.

The Kiantone Pipeline, a 78-mile Company-owned and operated pipeline, connects our West Seneca, New York terminal at the pipeline's northern terminus to the refinery's tank farm at its southern terminus. We completed construction of the Kiantone Pipeline in 1971 and have operated it continuously since then. We are the sole shipper on the Kiantone Pipeline, and can

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[69] "BP-Husky Toledo Refinery, United States of America," http://www.hydrocarbons-technology.com/projects/bp-husky/.

[70] McLendon, Kelly. "Oil sands project called critical for local refinery," *Toledo Blade*. June 6, 2013. http://www.toledoblade.com/Energy/2013/06/06/Oil-sands-project-called-critical-for-local-refinery.html.

[71] "BP-Husky Toledo Refinery, United States of America," http://www.hydrocarbons-technology.com/projects/bp-husky/.

[72] "United States Securities and Exchange Commission, Form 10-K" August 31, 2011. http://www.sec.gov/Archives/edgar/data/101462/000119312511324609/d257760d10k.htm

currently transport up to 70,000 bpd along the pipeline. Our right to maintain the pipeline is derived from approximately 265 separate easements, right-of-way agreements, licenses, permits, leases and similar agreements.

The pipeline operation is monitored by operators using a recently upgraded SCADA system at the refinery. Shipments of crude arriving at the West Seneca terminal are separated and stored in one of the terminal's three storage tanks, which have an aggregate storage capacity of 485,000 barrels. The refinery tank farm has two additional crude storage tanks with a total capacity of 200,000 barrels. An additional 35,000 barrels of crude can be stored at the refinery.

XIII. Propane Supply to the Upper Peninsula If Line 5 is Shut Down at the Straits of Mackinac

Concern has been expressed that if Line 5 at the Straits were "shut down," it would prevent delivery of propane to the Upper Peninsula.

Periodically, Enbridge uses Line 5 to transport natural gas liquids (NGLs) to various locations, including a terminal and processing center at Rapid River, MI. The compounds making up NGLs are shown in Table 4.

At Rapid River, Enbridge operates a "depropanizer" to separate and purify the propane from the other compounds that are present. After separation, the liquefied propane is stored under pressure in large steel cylinders. Propane is then loaded into large trucks that haul it to localized distribution centers, or in some cases, directly to the end-customer. If not taken directly from Rapid River to an end-customer, but instead taken to a localized distribution center, the propane is loaded into smaller trucks, for local delivery to residences, small businesses, offices, etc.

Rapid River is centrally located on the southern edge of Michigan's Upper Peninsula, about half way between Ontonagon and St. Ignace. It is ideally located to provide propane to most of the Upper Peninsula, as well as Northern Wisconsin.

From a logistics and engineering viewpoint, there is no basis for concern. Rapid River is 130 miles west of where Line 5 crosses the Straits, very much "upstream" of the Mackinac Straits. If Line 5 were shut down at the Straits, the Rapid River facility could continue to receive NGLs, and process them to remove and purify the propane. Given the geography of the Rapid River location, receiving propane via Line 5 would not be impacted. The Superior to Rapid River segment of Line 5 could remain in operation.

Attached are preliminary Process Flow Diagrams that show (1) the existing propane purification tower (depropanizer) and propane storage tanks at Rapid River; and (2) two workable and straightforward alternatives. There are likely additional options. Enbridge engineers, if not constrained by the status quo, could likely come up with these same alternatives – and more.

The first drawing (Figure 1) shows the depropanizer at Rapid River as it likely exists today. Figure 2 assumes the depropanizer remains at Rapid River, MI, but continues to produce propane for the local area. It uses the hardware that is currently in place to produce the propane. All of the propane is then stored in tanks for distribution to the Upper Peninsula and Northern Wisconsin. None is sent to the Lower Peninsula. Figure 3 assumes the depropanizer is moved to Superior, WI, where it could produce propane for the Upper Peninsula and Northern Wisconsin. As with Figure 2, this option will continue to supply propane to the areas mentioned, even if Line 5 at the Straits is shutdown.

Any of the alternatives shown would allow Line 5 to be shut down at the Straits, without interfering with distribution of propane in the Upper Peninsula or Northern Wisconsin. From an engineering viewpoint, the alternatives are straightforward, and are very doable.

There would be a relatively small capital expenditure associated with either of the two alternatives, as shown in Figure 2 and Figure 3. However, considering the cost to Enbridge of a spill at the Straits, it would be nearly trivial.

The alternative presented in Figure 3 is slightly more complicated, and likely a little more costly. However, it provides for the greatest flexibility in the future, and therefore may be preferred by Enbridge. Regardless, either of the alternatives shown (Figure 2 or Figure 3) would be acceptable.

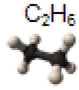
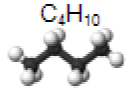
The alternatives presented are conceptual. While several details would need to be addressed, there are none, in our opinion, that would prevent implementation.

Finally, we have looked at the propane supply alternatives ONLY from an Enbridge view point. It is nearly certain that if Enbridge ceased to supply propane to the Upper Peninsula and/or Northern Wisconsin, some other company would be eager to pick up this business.

Conclusion: Alternatives have been identified that allow Line 5 at the Straits to be shut down but permit Enbridge – or other Companies – to supply propane to the Upper Peninsula and Northern Wisconsin.

Table 4

What are natural gas liquids and how are they used?[73]

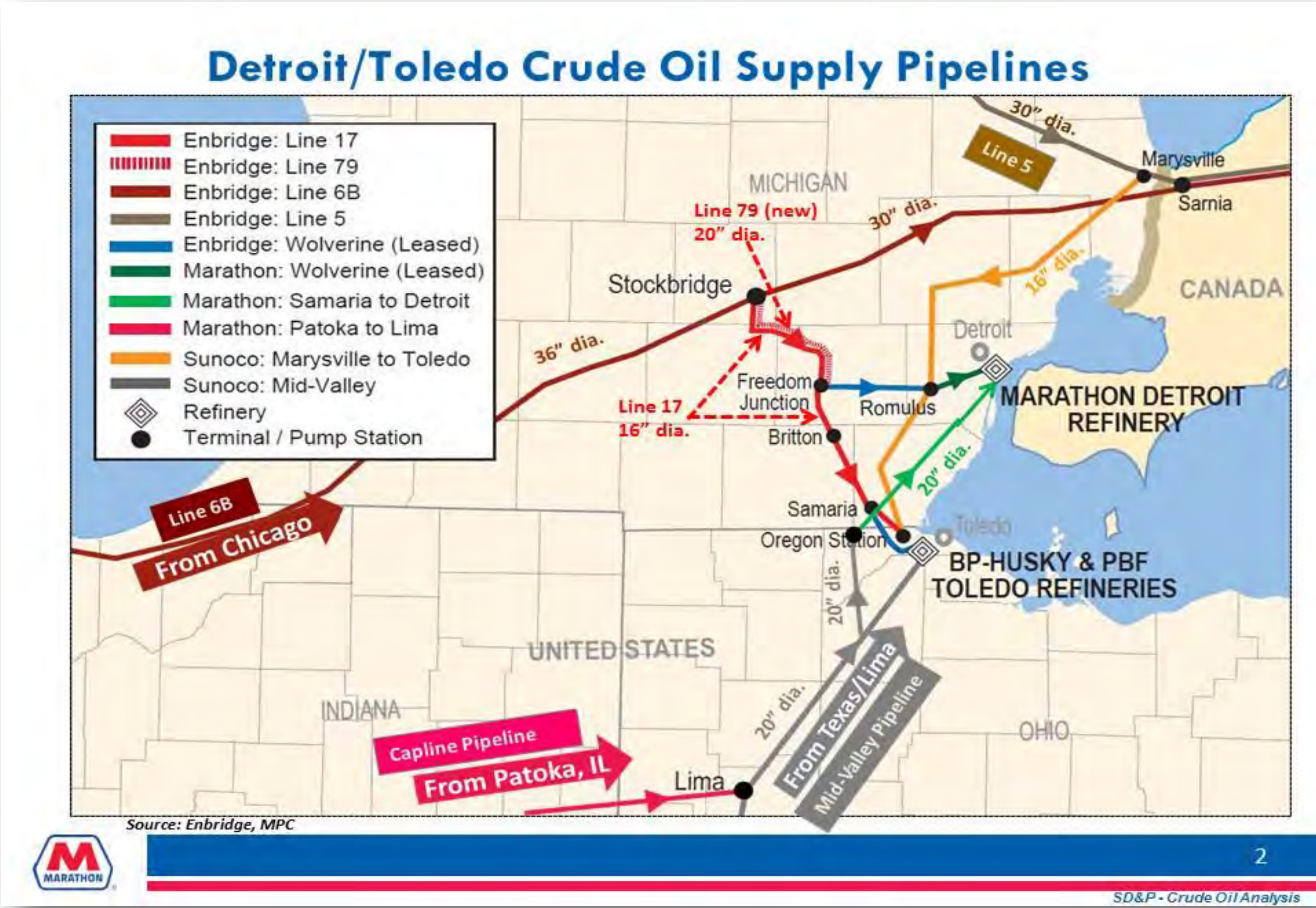
NGL Attribute Summary				
Natural Gas Liquid	**Chemical Formula**	**Applications**	**End Use Products**	**Primary Sectors**
Ethane	C_2H_6 	Ethylene for plastics production; petrochemical feedstock	Plastic bags; plastics; anti-freeze; detergent	Industrial
Propane	C_3H_8 	Residential and commercial heating; cooking fuel; petrochemical feedstock	Home heating; small stoves and barbeques; LPG	Industrial, Residential, Commercial
Butane	C_4H_{10} 	Petrochemical feedstock; blending with propane or gasoline	Synthetic rubber for tires; LPG; lighter fuel	Industrial, Transportation
Isobutane	C_4H_{10} 	Refinery feedstock; petrochemical feedstock	Alkylate for gasoline; aerosols; refrigerant	Industrial
Pentane	C_5H_{12} 	Natural gasoline; blowing agent for polystyrene foam	Gasoline; polystyrene; solvent	Transportation
Pentanes Plus*	Mix of C_5H_{12} and heavier	Blending with vehicle fuel; exported for bitumen production in oil sands	Gasoline; ethanol blends; oil sands production	Transportation

C indicates carbon, H indicates hydrogen; Ethane contains two carbon atoms and six hydrogen atoms
*Pentanes plus is also known as "natural gasoline." Contains pentane and heavier hydrocarbons.

Natural gas liquids (NGLs) are hydrocarbons, in the same family of molecules as natural gas and crude oil, composed exclusively of carbon and hydrogen. Ethane, propane, butane, isobutane, and pentane are all NGLs (see table above).

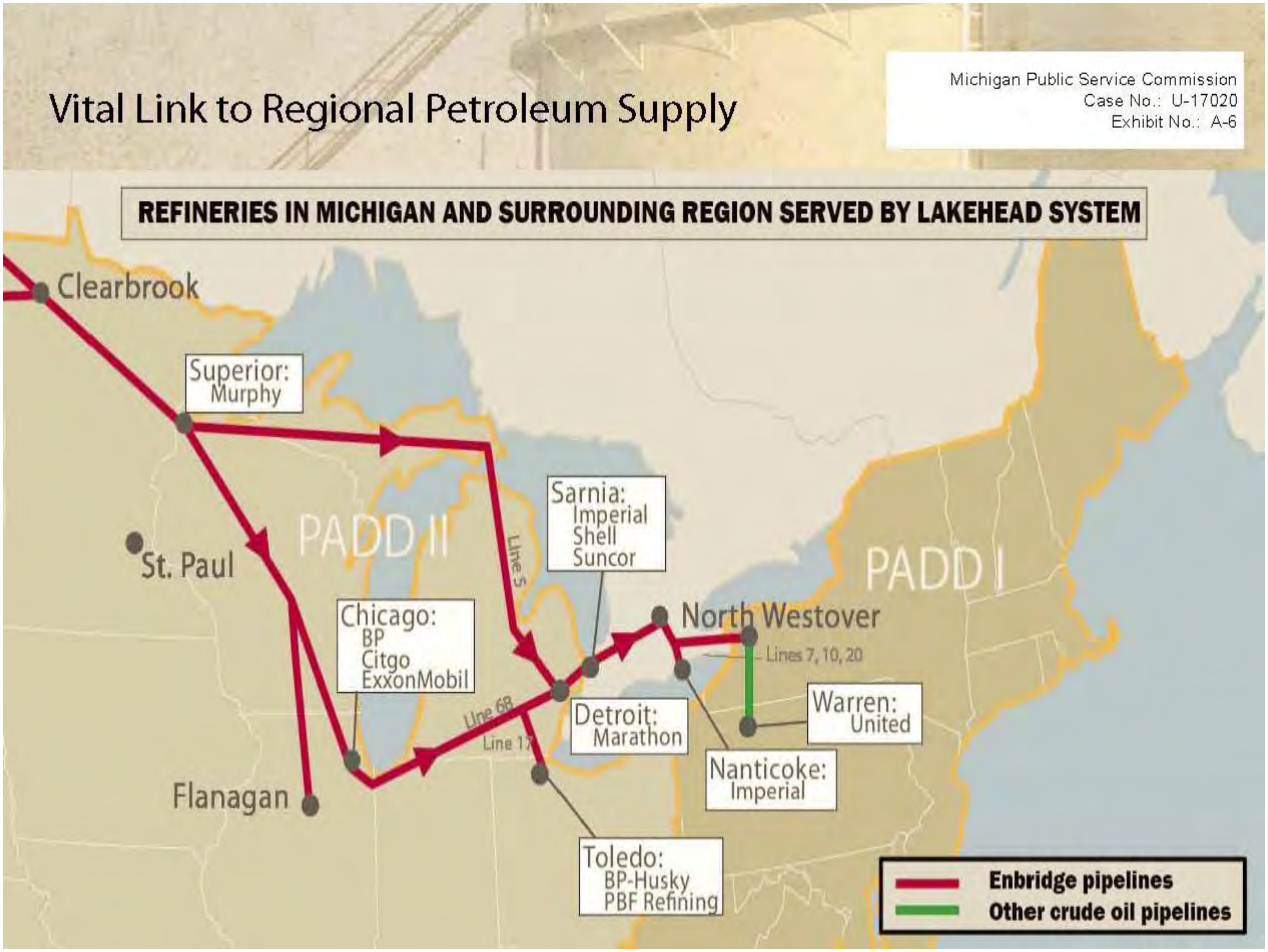
[73] "What are natural gas liquids and how are they used?" U.S. Energy Information Administration, Bentek Energy LLC, April 20, 2012. http://www.eia.gov/todayinenergy/detail.cfm?id=5930.

Map 2



(Note: Original map by Marathon has been revised)

Map 3



Vital Link to Regional Petroleum Supply
Michigan Public Service Commission
Case No.: U-17020
Exhibit No.: A-6
REFINERIES IN MICHIGAN AND SURROUNDING REGION SERVED BY LAKEHEAD SYSTEM
Clearbrook
Superior:
Murphy
St. Paul
PADD II
Line 5
Sarnia:
Imperial
Shell
Suncor
PADD I
Chicago:
BP
Citgo
ExxonMobil
North Westover
Lines 7, 10, 20
Warren:
United
Line 6B
Line 17
Detroit:
Marathon
Nanticoke:
Imperial
Flanagan
Toledo:
BP-Husky
PBF Refining
Enbridge pipelines
Other crude oil pipelines

Figure 1

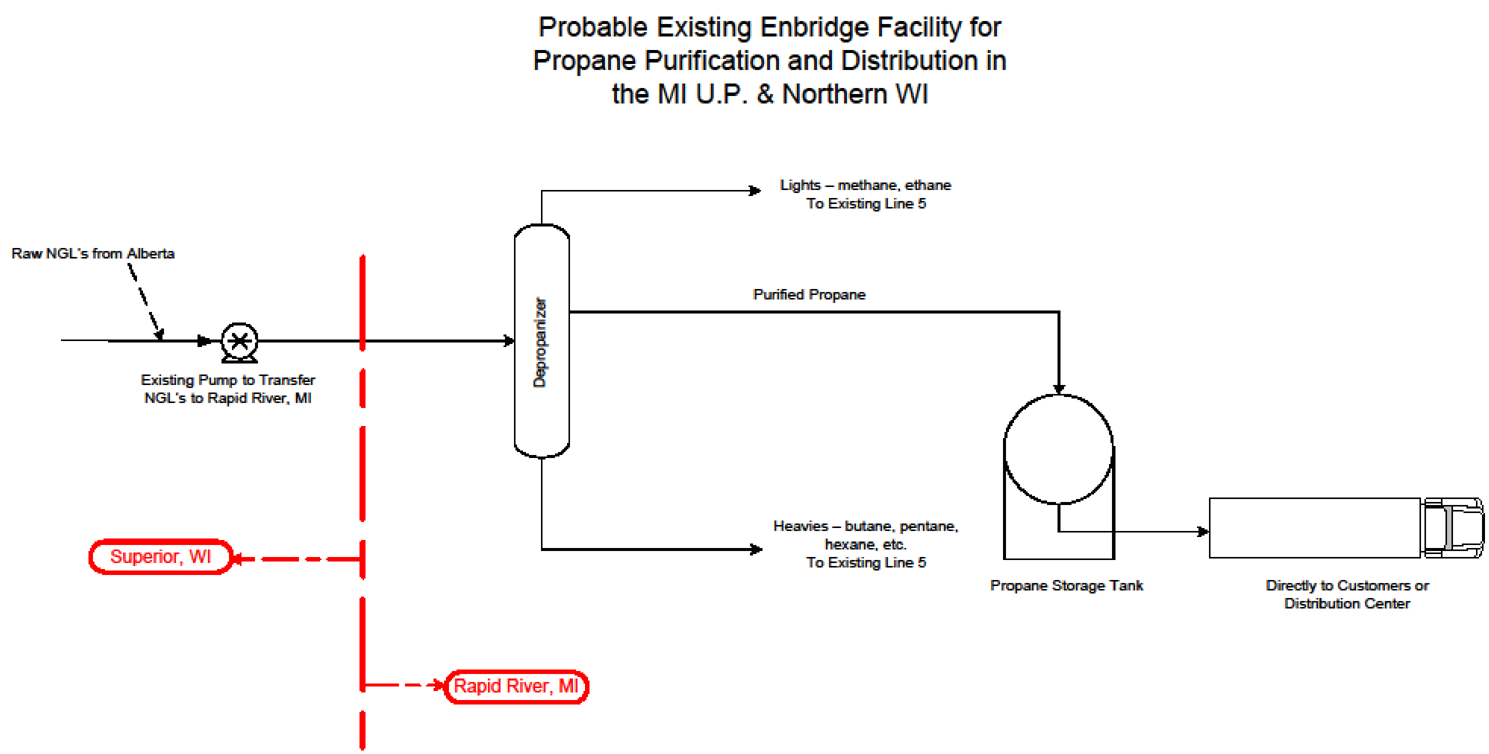

Probable Existing Enbridge Facility for Propane Purification and Distribution in the MI U.P. & Northern WI
Lights – methane, ethane To Existing Line 5
Raw NGL's from Alberta
Purified Propane
Depropanizer
Existing Pump to Transfer NGL's to Rapid River, MI
Heavies – butane, pentane, hexane, etc. To Existing Line 5
Superior, WI
Propane Storage Tank
Directly to Customers or Distribution Center
Rapid River, MI

Figure 2

Facility for Propane Purification and Distribution in MI U.P. & Northern WI w/ Line 5 Shut Down at the Straits --
Continue Depropanizer and Distributon from Rapid River

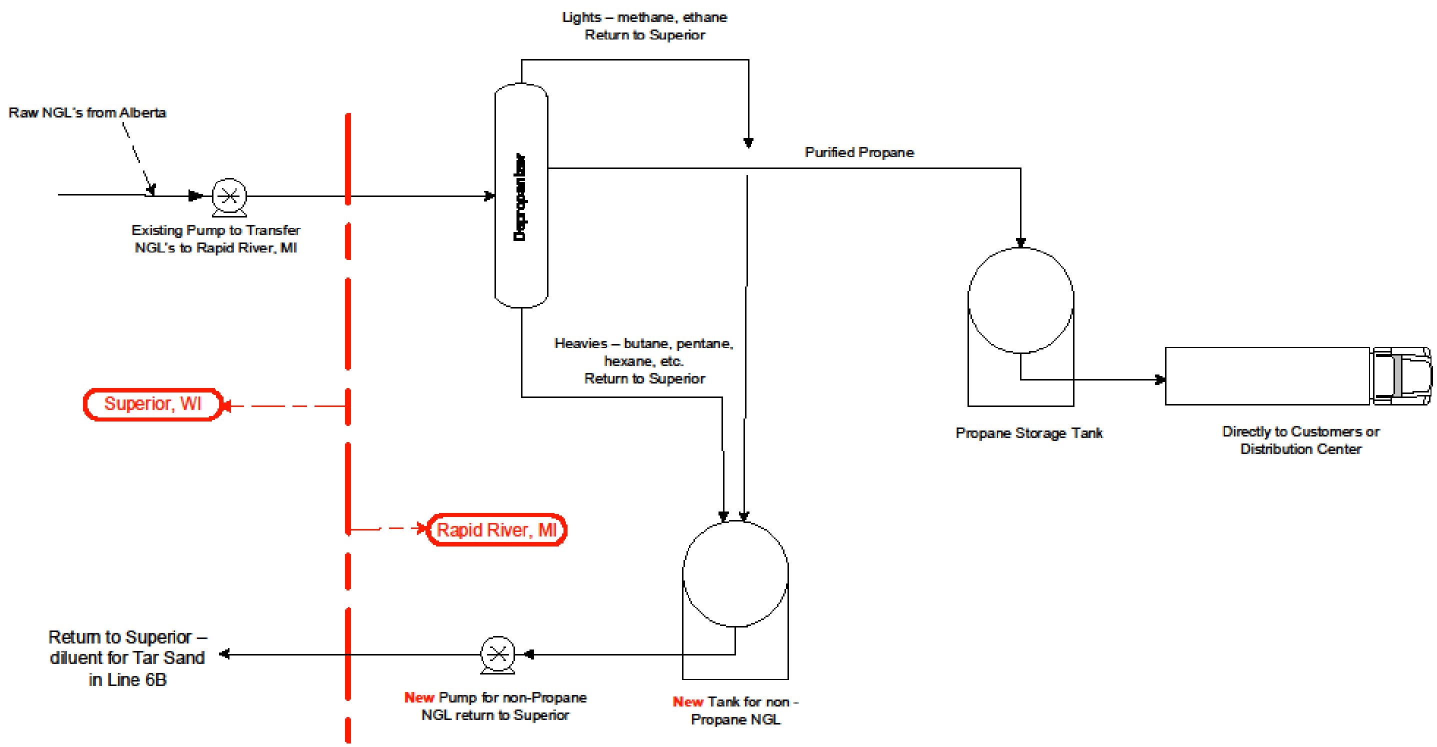
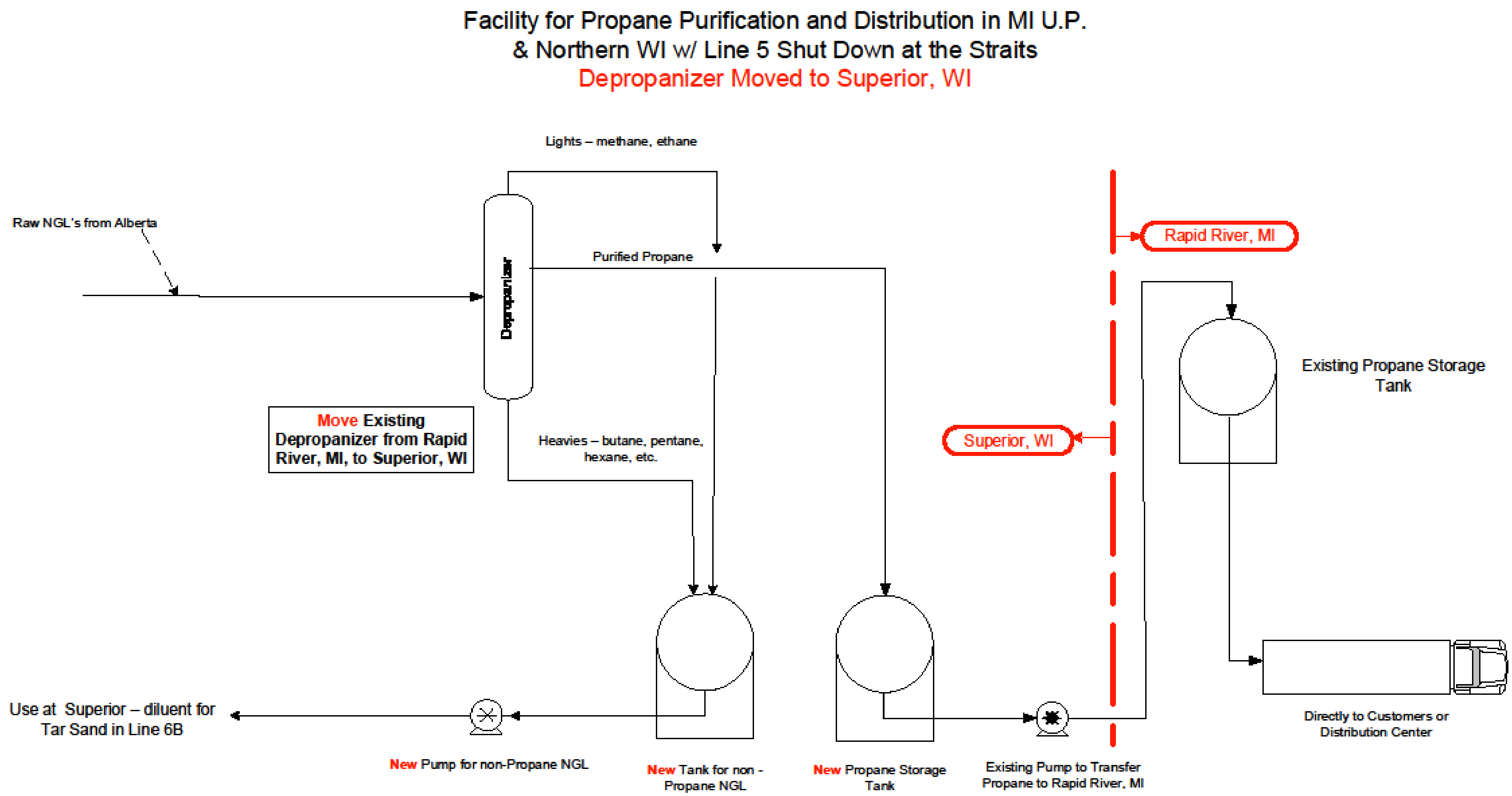


Figure 3


Facility for Propane Purification and Distribution in MI U.P.
& Northern WI w/ Line 5 Shut Down at the Straits
Depropanizer Moved to Superior, WI
Lights – methane, ethane
Raw NGL's from Alberta
Purified Propane
Depropanizer
Rapid River, MI
Existing Propane Storage Tank
Move Existing Depropanizer from Rapid River, MI, to Superior, WI
Heavies – butane, pentane, hexane, etc.
Superior, WI
Use at Superior – diluent for Tar Sand in Line 6B
New Pump for non-Propane NGL
New Tank for non - Propane NGL
New Propane Storage Tank
Existing Pump to Transfer Propane to Rapid River, MI
Directly to Customers or Distribution Center

ADDENDUM 1: ENBRIDGE DEFINITION OF VARIOUS "CAPACITY" TERMS[74]

Michigan Public Service Commission (MPSC) to Enbridge: DEFINE THE MEANING OF THE TERMS: "ULTIMATE CAPACITY," "DESIGN CAPACITY," AND "ANNUAL CAPACITY" OF A CRUDE OIL AND PETROLEUM PIPELINE.

Hodge (Enbridge)[75]: Typically, there are three definitions used to describe pipeline capacity for a crude oil and petroleum pipeline. They are "Ultimate Capacity," "Design Capacity," and "Annual Capacity."

- **"Ultimate Capacity"** is the maximum capacity of an individual line. **In order to achieve the ultimate capacity, the pipeline requires maximum horsepower over its current design.**

- **"Design Capacity"** is the theoretical capacity of the pipeline for given types of liquids and their batch sequence. Design Capacity is calculated assuming theoretically ideal operating conditions with a given amount of horsepower available. Design Capacity in liquid petroleum pipelines context describes the maximum instantaneous throughput that a particular pipeline is capable of achieving under design conditions for a particular suite of commodities. With replacement and station installations, the Initial Design Capacity of Line 6B post-construction is 550,000 barrels per day (bpd).[76]

- **"Annual Capacity"** is the average sustainable throughput over a year. Annual Capacity is calculated assuming historic average annual and operating conditions. These operating conditions include scheduled and unscheduled maintenance activities, normal operating variables and crude supply availability. Annual Capacity of a pipeline is typically 90 percent of Design Capacity.

- Table 1 provides design data pertinent to the proposed new 36-inch or 30-inch pipeline segments.

[74] Pre-Filed Testimony of Thomas Hodge before the State of Michigan Public Service Commission, U-17020, April 16, 2012, pg. 13.
[75] Ibid
[76] This is only for the 30-inch diameter segment, between Stockbridge and Marysville.

ADDENDUM 2: UNDERSTANDING CAPACITY DEFINITIONS AS USED BY ENBRIDGE

Design Capacity could be achieved only if the facility (in this case, a pipeline) runs 100 percent of the ***allotted* hours per year, at full operating rate, and as noted above, with the installed hardware**. Even here the numbers may mean different things to different people. For example, the allotted hours might mean 24 hr/day, 5 days per week, 52 weeks per year. Or they might mean 24 hr/day, 365 days/year, or perhaps some other definition. Obviously this definition – or "basis" – can have a big impact on the Annual Capacity number. It must be clearly stated for each process.

Another issue is "Operating Factor". No facility can operate 100 percent of the time, and at full capacity. For example, routine maintenance must be done; allowance must be made for unscheduled maintenance; unforeseen interruptions may occur.

Enbridge uses 90 percent as the Operating Factor, which is perhaps a little on the low side, considering that pipeline technology is well established, but still reasonable.

Finally, Enbridge uses the term " Ultimate Capacity." This refers to what the facility is capable of **if all the hardware is eventually installed and made operational.**

How Does This Relate to Enbridge and Table 1?

Quoting Thomas Hodge of Enbridge:[77] "*Enbridge plans to replace the remaining pipeline segments of its Line 6B in the Griffith to Stockbridge section with new 36-inch diameter pipe and the pipeline segment east of Ortonville to the St. Clair River near Marysville with new 30-inch diameter pipe.*"

Based on Enbridge documentation (See **Table 1– Existing Line 6B Capacity and Increased Line 6B Capacity),** the Griffith to Stockbridge pipeline was sized for future potential needs. The additional hardware, such as more pumping stations, and/or larger pumps, was NOT installed when Line 6B was recently completely replaced. Ultimate Capacity, as Enbridge defines it, is the potential capacity in the future when all of the hardware is installed and is fully operational.

Why wouldn't Enbridge install all the hardware on day 1? There are at least three reasons:

1. The additional capacity may never be needed due to unforeseen circumstances. If so, excess capital has been invested, with no return.

[77] Pre-Filed Testimony of Thomas Hodge before the State of Michigan Public Service Commission, April 16, 2012, Exhibit A-2, pg. 3.

2. Even if it is a 100 percent certainty that, in the future, the hardware will be needed, it is better, based on the concept of "Time Value of Money," to postpone the expenditure until that time.

3. Lastly, technology may change. In the future, an improved version of the hardware may become available. If you commit too soon, you may not be able to take advantage of future developments.

In addition, pumping stations can be upgraded. New pumping stations can be constructed. Larger pumps can be installed. But once the pipe is in the ground, it is very difficult, and expensive, to replace it with a larger-diameter pipe.

In Table 1, Enbridge alludes to "future improvements," as well as the capacity reduction mandated by PHMSA in July 2010, following the rupture at Marshall, MI, of Line 6B.

RECOMMENDATIONS

Since Enbridge plans to modify the hardware associated with Line 6B as needed to continue meeting the demands of the refineries, it is reasonable to base our evaluation on the Ultimate Capacity. Based on the above discussion and the data provided by Enbridge to the Michigan Public Service Commission, the following Ultimate Capacity values are recommended:

Line 6B Segment	Diameter, new Line 6B, inches	Ultimate Capacity, bpd
Stockbridge Griffith -	36	800,000
Stockbridge - Marysville	30	525,000
Marysville - Sarnia	30	525,000

Even then, Design Capacity could be achieved only if the facility ran 100 percent of the ***allotted* hours per year, at full operating rate, and as noted above, with the installed hardware**.

The numbers may mean different things to different people. For example, the allotted hours might mean 24 hr/day, 5 days per week, 52 weeks per year. Or they may mean 24 hr/day, 365 days/year, or perhaps some other definition. Obviously this definition or "basis" can have a significant impact on the Annual Capacity number. It must be clearly stated for each process.

Another issue is "Operating Factor". No facility can operate 100 percent of the time, and at full capacity. For example, routine maintenance must be done; allowance must be made for unscheduled maintenance; unforeseen interruptions may occur.

The "Operating Factor," particularly for a completely new process, is somewhat subjective. Since the process is new, there is no actual experience to base it on. Given the technology of pipeline systems is well established, it would seem an Operating Factor of 95% might be achievable.

Enbridge uses 90% as the Operating Factor. Perhaps a little on the low side, considering that the technology is well established, but still reasonable.

APPENDIX C: EVALUATING ALTERNATIVES: A MODEL FOR EVALUATING ALTERNATIVES TO ENBRIDGE'S "LINE 5" PIPELINES IN THE MACKINAC STRAITS AND ELIMINATING UNACCEPTABLE RISK TO THE GREAT LAKES

By Rick Kane, QEP, CHMM, CPP
December 14, 2015
Prepared for and in partnership with FLOW (For Love of Water)

I. PURPOSE

The purpose of this report is to provide an illustrative example or model for conducting an alternatives analysis for the benefit of the State of Michigan in its forthcoming assessment of alternatives to the Enbridge "Line 5" oil pipelines running through the Great Lakes at the Straits of Mackinac, where Lake Michigan and Lake Huron converge.

To that end, this report presents a credible option for the shutdown of Line 5 in order to protect the Great Lakes, drinking water supplies, local communities, and the state's tourist-driven economy while continuing to meet energy needs. This report builds upon and elaborates on *Report – The Context: Understanding the Evolving North American Oil Pipeline System in Preparation for Considering Alternatives to Enbridge's "Line 5" in the Mackinac Straits*.

Line 5 transports light and synthetic crude oil and natural gas liquids (including propane) from Enbridge's terminal in Superior, Wisconsin, across Michigan's Upper Peninsula, through the Straits of Mackinac, across the Lower Peninsula and finally beneath the St. Clair River to Sarnia, Ontario. Under a recent agreement with the State of Michigan, Line 5 does not carry heavy crude oil or diluted tar sands crude oil (diluted bitumen) known as dilbit.[1]

This report was prepared for and in partnership with FLOW (For Love of Water), a Great Lakes water law, science, and policy center located in Traverse City, Michigan. FLOW's team of legal and scientific experts previously documented and concluded that the transport of oil through Line 5 poses high consequence environmental risk and imminent harm to the Great Lakes and should be halted while the state seeks an alternative.[2,3,4]

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[1] Michigan Petroleum Pipeline Task Force, *Agreement Between The State Of Michigan And Enbridge Energy, Limited Partnership Regarding The Transportation Of Heavy Crude Oil Through The Straits Of Mackinac Pipelines*, September 3, 2015, www.michigan.gov/pipelinetaskforce.

[2] Olson, James, J.D., LL.M., and Kirkwood, Liz, J.D. *A Composite Summary of Expert Comment, Findings, and Opinions on Enbridge's Line 5 Oil Pipeline in The Straits of Mackinac in Lake Michigan*, compiled by *on behalf of* FLOW's (For Love of Water) Great Lakes Water Policy Project *for submission to the* Michigan Petroleum Pipeline Task Force, April 30, 2015, www.michigan.gov/pipelinetaskforce

II. INTRODUCTION

After nearly a year's study, the Michigan Petroleum Pipeline Task Force in July 2015 issued its final report and concluded that a release of oil from Line 5 in the Straits of Mackinac would cause "devastating ecological and economic damage."[5] It outlined four recommendations specific to Line 5 in the Straits:

(1) Prevent the transportation of heavy crude oil through the Straits Pipelines;

(2) Require an independent risk analysis and adequate financial assurance for the Straits Pipelines;

(3) Require an independent analysis of alternatives to the existing Straits Pipelines; and

(4) Obtain additional information from Enbridge relating to the Straits Pipelines.[6]

Notably, Recommendation Three's independent alternatives analysis included exploring several options, including among others: "Constructing alternative pipelines that do not cross the open waters of the Great Lakes and then decommissioning the existing pipelines."[7]

(hereinafter "FLOW April 2015 Expert Report").

[3] Schuette, Bill, Attorney General, and Wyant, Dan, DEQ Director, *Michigan Petroleum Pipeline Task Force Report,* July 2015, https://www.michigan.gov/documents/deq/M_Petroleum_Pipeline_Report_2015-10_reducedsize_494297_7.pdf (hereinafter "Task Force Report").

[4] Olson, James, J.D., LL.M. and Kirkwood, Liz, J.D., *A Scientific and Legal Policy Report on the Transport of Oil in the Great Lakes, (1) Recommended Immediate Actions on the Transport of Oil Through the Line 5 Under the Straits of Mackinac; and (2) Supplemental Comments on the Michigan Petroleum Pipeline Task Force Report***,** September 21, 2015 FLOW (For Love of Water), www.flowforwater.org (hereinafter "FLOW September 2015 Expert Report").

[5] Task Force Report, *supra* note 3, Executive Summary.

[6] Id. at 49-50. Recommendation Three included four alternatives outlined below along with a clear rationale: "3. Require an Independent Analysis of Alternatives to the Existing Straits Pipelines. These alternatives should include: a. Constructing alternative pipelines that do not cross the open waters of the Great Lakes and then decommissioning the existing pipelines; b. Utilizing alternative transportation methods and decommissioning the existing pipelines; c. Replacing the existing pipelines using the best available design and technology; d. Maintaining the status quo, including an analysis of the effective life of the existing pipelines. Rationale: The 1953 Easement requires Enbridge to "exercise the due care of a reasonably prudent person for the safety and welfare of all persons and of all public and public and private property." What a reasonably prudent person would do depends on the circumstances involved, including the alternatives available and the associated risks and benefits. Decisions about the future of the Straits Pipelines must be informed by an independent, comprehensive analysis of the alternatives. The State should require Enbridge to pay for (but not control) a study by relevant experts of the feasibility, costs, including the specific costs to Michigan, and public risks and benefits of alternatives to the existing Straits pipelines."

[7] Id.

On September 3, 2015, Governor Snyder created the State of Michigan's Pipeline Safety Advisory Board by Executive Order to review and make recommendations for statutory, regulatory, and contractual implementation of the Task Force Report. Chaired by Executive Director of the Michigan Agency for Energy, Valerie Brader, and Department of Environmental Quality Director Dan Wyant, this Advisory Board is currently finalizing scoping documents for conducting both a risk analysis and an independent alternatives analysis.

This report accordingly presents an alternatives analysis model to evaluate Line 5 as part of a proper "systems view" or framework (See Appendix A for a full discussion) thereby eliminating unacceptable risk to the Great Lakes. In addition, this report specifically evaluates one of the Task Force report's alternatives (decommissioning Line 5[8]) to demonstrate a systems approach that necessarily evolves to support supply sources, demands, business strategies, changes in shipped products, and public safety and environmental regulatory requirements. The rationale for selecting this alternative was the Task Force Report's, FLOW reports, and other studies that demonstrate that a release from Line in the Straits is unacceptable and should be prevented if there are other viable options or alternatives within and/or through suitable changes within the pipeline system infrastructure that serves Michigan and other users.

This alternatives analysis approach identifies objectives and assumptions and then evaluates the alternative by identifying and analyzing a well-defined *system*. If the appropriate system is not well-defined, erroneous or suboptimum solutions will be obtained. In analyzing the system, it is also important to understand its dynamics, as it will evolve due to actions by stakeholders to capture opportunities and respond to constraints placed on it.[9, 10] The primary system objectives for this analysis include:

- Supply propane to Michigan's Upper Peninsula customers;
- Support crude oil shipments from Michigan's Lower Peninsula oil fields;
- Supply Marathon Detroit, Toledo, Ohio, and eastern Canada refineries;
- Supply natural gas liquids (NGLs) to Sarnia, Ontario, petrochemical producers; and
- Enable crude oil exports via Montreal, eventually Portland, ME (lowest priority).

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8 "Decommissioning Line 5" as used in this report includes (a) retiring use of the Line 5 in the Straits segment, or others if deemed proper as part of the overall analysis, and/or (b) prohibiting the use of Line 5 in the Straits segment for the transport of crude oil. It follows that if option (a) is viable because of overall system and infrastructure capacity, options, adjustments or changes, then (b) is viable.

9 O'Brien, Mary, *Making Better Environmental Decisions, An Alternative to Risk Assessment***,** The MIT Press, 2000.

10 Meadows, D. H., *Thinking in Systems,* Chelsea Green Publishing, Sustainability Institute, 2008.

An additional goal of this report is to move the debate *beyond* the narrow focus on the continued use of Line 5 as the best and only option. This report illustrates that the current high risk to the Straits of Mackinac and Great Lakes from the transport of crude oil in Line 5 in the Straits can be can be eliminated entirely within the existing and/or modest adjustments or modifications to the overall pipeline system and infrastructure. It should be readily apparent from the Task Force Report and others that there is an urgent need to expand the overall analysis of options and alternatives that would accommodate or provide for the transport of oil through other pipelines or system options – to protect the unacceptable Straits of Mackinac, drinking water supplies, water resources and uses, public safety, and the water-dependent economy.

III. Background

Since Enbridge's 2010 Kalamazoo Line 6B pipeline disaster (causing the largest inland oil spill in U.S. history), the State of Michigan and the public have tuned into pipeline issues throughout the Great Lakes State. The pipeline that has captured the most attention is Enbridge's Line 5 petroleum pipeline, which is located in public waters and bottomlands of the Great Lakes and transports nearly 23 million gallons of oil every day under the Straits of Mackinac where Lakes Michigan and Huron converge. Crossing 34 major waterway tributaries, as well as the Straits of Mackinac, this 62-year-old pipeline poses a high level of risk and unacceptable harm to the Great Lakes and substantial endangerment to public safety and environmentally sensitive areas along its route across Michigan.

In response to government and citizen concerns about Enbridge's lack of compliance with the 1953 Easement with the State of Michigan, Governor Snyder created in mid-2014 the Michigan Petroleum Pipeline Task Force ("Task Force) to evaluate and recommend actions. Chaired by Attorney General Bill Schuette, and Michigan Department of Environmental Quality (DEQ) Director Dan Wyant, the Task Force heard from different stakeholders and published a formal report with recommendations nearly a year later in July 2015.[11]

FLOW (For Love of Water) – a Great Lakes water law and policy center based in Traverse City – authored two significant expert reports to help inform and shape the recommendations of the State's Task Force.[12, 13]

Key FLOW issues and recommendations presented in these previous submissions included:

[11] Task Force Report *supra* note 3, p. 49-50.
[12] FLOW April 2015 Expert Report, *supra* note 2.
[13] FLOW September 2015 Expert Report, *supra* note 4.

- The Straits are covered by the 1953 Easement from the State to Enbridge that contains a "reasonably prudent person" standard, and the public trust interest and responsibility in the Great Lakes and navigable waters, both of which require public officials and Enbridge to investigate and eliminate the imminent or high risk or hazard.
- The Straits pipelines are an imminent hazard and substantial endangerment, given the potential consequences and magnitude of harm. An "imminent hazard" or "substantial endangerment" of high magnitude of harm for transporting hazardous materials, like crude oil, is defined by statute, and action must be taken because of the potential consequences. Based on imminent harm and substantial endangerment from hazardous materials principles, the degree of probability, high or low, is *not* a factor to be considered. The risk must be eliminated or substantially reduced to prevent the risk of high magnitude of harm. [14]
- Extraordinary monitoring and emergency response resources must immediately be put in place locally beyond those currently available, including prohibiting oil transport until a permanent risk-elimination alternative has been implemented. The importance of these two factors is well known as being vital in early detection and prevention or mitigation of damage from a pipeline failure.

In addition, FLOW recommended that the State of Michigan conduct a comprehensive alternatives assessment with the objective of identifying and implementing a permanent solution that eliminates the risk of a spill in the Mackinac Straits and ideally reduces public safety and environmental risk along the environmentally sensitive route through Michigan's Upper and Lower Peninsulas. The Task Force incorporated this recommendation in its final report as a key methodology for evaluating risk, harm, and a permanent solution.[15]

IV. Understanding an Alternatives Analysis for a Pipeline System

Risk assessments in the oil and gas, chemical, and transportation sectors are routinely conducted for a number of reasons, including:

- Company business continuity and risk management planning for the protection of stakeholders, such as employees, shareholders, customers, and communities;
- After accidents, incidents, and near-miss events;
- Regulatory and insurance requirements, audits, and investigations;

[14] See e.g. Ethyl Corp v. EPA, 541 F2d 1, 18-20 (D.C. Cir. 1976); FLOW September 2015 Expert Report, *supra* note 4, p. 14-15.
[15] Task Force Report, *supra* note 3, p. 26.

- Company policy for high risk operations, investment project approval, significant changes in suppliers, customers and supply-chains; and
- A standard industry best-management practice.

Several of the reasons above justify a comprehensive risk review of Line 5, especially as detailed in the previously referenced Task Force and FLOW reports. An alternatives analysis is an important and normal part of a comprehensive review. A definition of an alternatives analysis is a helpful starting point:

> An Alternatives Analysis is used to identify, analyze and develop options for risk elimination or reduction. The approach is used to address a wide range of issues including private and government sector infrastructure, facilities, environmental protection, protection of public health, safety, property and communities, and establishment of sustainability projects. The purpose of an Alternatives Analysis is to move beyond the justification of a single alternative, in this case the existing Line 5 Straits Crossing, which continues the underlying conditions and circumstances that result in a high risk category, to an exploration of multiple options to establish the best possible option in a rational defensible manner, which considers all stakeholder requirements for risk, uncertainty, and citizen, environmental, public safety, and public and private property protections.[16]

An alternatives analysis is conducted by starting with a high-level view. For complex, interrelated issues, understanding the system is vital. An alternatives analysis avoids a narrow focus on an issue, examining in-place assets or being bounded by limited stakeholder objectives. In the case with pipelines, for example, an alternatives analysis would not be merely limited to an evaluation of different modes of transport, meaning pipeline versus railroad, trucks, or barge. Rather, an alternatives analysis identifies the *system* and has the goal to eliminate risks through new and better solutions.

The basic steps for an alternatives analysis are presented below:

(1) Assemble a team of multi-functional experts;
(2) Define the mission and scope of the analysis;
(3) Define high-level objectives and desired outcomes;
(4) Identify the appropriate *system* and boundaries;
(5) Identify all options, screen and develop a short list;
(6) Identify facts, assumptions, bases and relevant sub-systems;

[16] See FLOW April 2015 Expert Report, *supra* note 2.

(7) Conduct an analysis on the short list; and

(8) Issue recommendations and an action plan.

Examples of possible alternatives are presented in Addendum A.

V. Examining One Alternative to Line 5

This report provides a qualitative example, with objectives, to demonstrate the process and advance the pursuit of better solutions from a proper purposes-and-systems framework. The alternative analyzed is:

> **"Decommission Line 5"**[17]
>
> The partial use of assets on either side of the Mackinac Straits is allowed, but not a Mackinac Straits crossing.

Decommissioning Line 5 was selected for analysis to explore the other end of the range of options, as current debates have largely focused only on Line 5 – the consequences and likelihood of a failure, company pipeline operations, mechanical integrity programs, emergency management – and *not* the feasibility of operating without Line 5. Defining and understanding the supply-chain system and its potential evolution are very important in developing the best solution. The model-example will demonstrate better solutions through proper crude oil pipeline system and infrastructure definition and understanding.

A. The Existing System and Infrastructure, Projected Evolution and Role of Line 5

The historical pipeline network and the evolution of the system and related infrastructure are addressed in the Appendix A Report filed simultaneously with this report on alternatives analysis.[18] This document should be reviewed to obtain an understanding of the relevant system and evolution. The key findings are summarized as follows.

The oil and gas sector as affecting the Great Lakes – St Lawrence Basin has and continues to undergo a major evolution with the development of Bakken, Utica, and Marcellus shale crude oil and gas reserves and Alberta tar sands crude oil reserves. As these reserves are not located in traditional production areas, the supply-chains (pipelines, rail and ships/barges) also are evolving to support shippers moving the materials to

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[17] As noted earlier, "Decommissioning Line 5" also includes decommissioning the Straits segment, or prohibiting the transport of crude oil through Line 5 in the Straits segment.

[18] Kane, Richard J. QEP, CHMM, CPP, *Report – The Context: Understanding the Evolving North American Oil Pipeline System in Preparation for Considering Alternatives to Enbridge's "Line 5" in the Mackinac Straits,* December 14, 2015. FLOW (For Love of Water) www.flowforwater.org

refineries, chemical producers, fuel consumers, and export markets. Figures 1 and 2 show the historic and evolving supply-chain system.

The most visible project is the PanCanada Keystone XL Pipeline Project, but moving in competition are several Enbridge / partner projects; building a network to the East, West, and Gulf Coasts. This network is being implemented segment-by-segment. Using a segmented approach is practical for engineering and investment and simplifies local and state regulatory permitting. The segment-by-segment approach results in their overall strategy being less transparent to government agencies and citizen groups and makes the identification and implementation of better alternatives extremely difficult and systemically flawed. [19]

Line 5 is part of Enbridge's strategy to maintain the leading position in supplying Bakken and tar sands crude oil refineries on the network and to the coasts for export. Heavy crude and tar sands crude oil (diluted bitumen, known as "dilbit") shipments were once planned for Line 5; but are now not allowed by agreement with the State of Michigan. Line 5 is now used to ship light and synthetic crude oil (derived from "tar sands" heavy oil) and NGLs, enabling near dedicated shipment of heavy crude oil through the greatly expanded pipeline network in Wisconsin, to Illinois, Indiana, and then across southern Michigan – the expanded Line 6B in 2012 that recently replaced the 6B, out of service after the Kalamazoo river release disaster in 2010. Line 5 provides a measure of cost efficiency, and also enables maximum shipment of heavy crude oil east by Enbridge via other pipelines, including the doubled-capacity (400,000 to 800,000 bpd) that exists in the new Line 6B.[20]

B. Objectives for This Model Analysis

The NGLs and crude oil supply chain overall, and pipeline network in particular, must be viewed as a system that is evolving to support new supply sources, changes in materials being shipped, desired final destinations, and regulatory requirements. The primary drivers for system evolution are the business strategies of the producers/shippers, pipeline operators and end-users (refineries and exporters). Public safety and environmental protection are constraints that are placed on the system, but unfortunately a consolidated strategy providing a transparent view of the system, evolution, and risks is normally not available to government agencies and citizens; that is, those setting the constraints.

As the pipeline system is evolving, can objectives and constraints be set to drive the evolution to a better alternative scenario, eliminating the need for Line 5? The analysis

[19] Id. pp. 3-5, 9.

[20] See Appendix A, R. Kane. After the Kalamazoo spill, former Line 6B was reduced to 240,000 bpd, so at time of replacement in 2012 with the new 36-inch line, Enbridge's infrastructure capacity to transport crude oil in Michigan was increased by 560,000 bpd, more than the capacity of Line 5, which was increased to 540,000 bpd from the original 300,000 bpd during and after approval and construction of the new Line 6B.

of one alternative, "Decommission Line 5" has the following objectives:

- Decommission Line 5 under the Straits of Mackinac at a minimum, entirely if possible;
- Ensure that the Upper Peninsula propane heating supply is adequate and reliable;
- Provide transportation for crude oil produced in the northern Lower Peninsula to refineries; further south;
- Prioritize regional refineries and chemical producers over export markets; and
- Retain attractive business supply-chain system for operators.

C. Assumptions

This is a qualitative analysis and does not presume to provide an optimum solution for the objectives. Detailed engineering, safety, environmental, risk, and economic analyses are required using information from a range of stakeholders to fully assess the scenarios. The assumptions listed below are presented so they can be challenged and modified to improve the analysis:

1. **Drivers affecting the North American supply-chain and pipeline system evolution in the Great Lakes – St Lawrence Basin**
   - Markets for Bakken and Alberta tar-sands crude oil are refineries in the Midwest, East, West, and Gulf Coasts, and export customers accessed by maritime ports in these regions.
   - U.S. law currently does not allow crude oil exports except in some cases to Canada. Canada *does* allow exports, and in anticipation of the U.S law changing, pipeline companies are racing to expand and modify their networks to U.S. and Canadian maritime ports.
   - The Obama Administration has rejected the TransCanada Keystone XL pipeline project. In reports to the shareholders, Enbridge stated that their North American pipeline investment plan is profitable with Keystone XL in place. Enbridge's profitability is better with Keystone's delay cancellation, as their network, integrated with other pipeline company partners, will serve the East, West, and Gulf Coasts.
   - Over-water crude oil shipments (ships and barges) were not addressed in this assessment, but should be evaluated for "completeness" of the alternatives assessment process. This alternative poses a high risk to the Great Lakes and approval is highly unlikely.
   - Rail tank car shipments are an acceptable crude oil transportation mode and should also be analyzed. Pipeline shipment is recognized as a safer mode and

does not create many of the problems posed by the large number of rail tank cars required to replace a pipeline. However, a network that includes linked pipeline and rail shipments (multi-mode) may provide acceptable risk, flexible shipment scheduling, and back-up supply options for some regions.

- Existing pipelines from the Gulf Coast to Midwest are being studied for flow reversal to enable shipment of Bakken and Alberta tar-sands crude oil to the south and east.
- Not all refineries in the Midwest and eastern Canada can use heavy crude oil. Those that can or are expanding or modifying operations to capture a feedstock cost advantage.
- Moving heavy crude through the region and on to main ports in the East and Gulf Coasts is a primary driver in the evolution of the pipeline network.
- One element of the "Enbridge US Mainline System East" and "Enbridge Canadian Mainline System East" strategy, of which Line 5 is a part, is to implement projects to move crude oil east to Montreal for export and eventually to Portland, Maine, for maritime shipments and export.
- Agreements currently restrict Line 5 from transporting heavy and tar-sands crude oil; only light crude oil and NGLs are shipped. Line 6B is then dedicated as much as possible to maximize transportation of heavy crude oil.
- Western Ontario petrochemical producers are historic customers for Line 5 NGLs and light condensates. They are new customers for these materials from the Utica and Marcellus plays (Pennsylvania, Ohio, and West Virginia).

2. Assumptions to analyze Line 5 pipeline, specifically:

- Options are analyzed from the perspective of a "reasonably prudent person," with goals to eliminate or reduce major safety and environmental risks.
- The analysis is based on publicly available information.
- The boundaries of the systems analysis include existing assets and new projects under study. The system is not restricted to assets of a specific company or geography of a state or country.
- Eliminating crude oil pipeline shipments through the Straits of Mackinac or elsewhere on the Great Lakes eliminates the primary risk of environmental disaster.
- The highest business priority for the supply-chain is to support U.S. and Canadian markets. Supplying Bakken and Alberta tar-sands crude oil to the export market is a subordinate priority to the shutdown of Line 5.
- The Marathon refinery in Detroit is increasing the capability to use heavy crude oil feedstock to capture the cost advantage. Other refineries along the

route consume little or do not have a strategy to use heavy crude.

- Other priorities in the region include propane supply to heating fuel customers in Michigan's Upper Peninsula, crude oil transportation for producers in the northern area of Michigan's Lower Peninsula, and NGL and light condensate feedstock for petrochemical producers in western Ontario.

D. Alternatives Analysis

Presented below is a simplified approach for analyzing alternatives for Line 5; it is a qualitative approach or "pre-screen" that would indicate if a comprehensive analysis would be warranted. For a comprehensive assessment, the multi-disciplinary team would have responsibility for defining the system, objectives, and alternative options, and conducting the analysis. Definition of the system is vital or the best solution may be missed.

For this model analysis:

- The objectives (or fundamental purposes) were defined above.
- The system is fundamentally pipelines surrounding the Great Lakes – St Lawrence Basin and adjacent states. All transportation modes would be considered, but in this case only the pipeline network was reviewed. Addendum A has a partial listing of other options as well ones identified by the Michigan Pipeline Safety Advisory Board.[21,22]
- The analysis is not constrained by self-limiting company or state or national boundaries.
- The alternative scenario is "Decommission Enbridge Line 5."[23]

E. Decommission Enbridge Line 5

As noted above, this analysis is based on publicly available information. A comprehensive assessment would require information on business and operating strategies, supply and demand forecasts, engineering design, pipeline integrity, and end-of-life predictions. System modifications may be required as well as regulatory approvals for alternatives.[24] By contrast, however, it appears Enbridge, through its internal business decisions, has successfully avoided a comprehensive review of its

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[21] Michigan Pipeline Safety Advisory Board, *Independent Analysis of Alternatives to the Existing Straits Pipelines,* October 28, 2015 http://michigan.gov/som/0,4669,7-192-45414_45416-368183--,00.html.

[22] Michigan Pipeline Safety Advisory Board, *Draft Scope of Work Independent Risk Analysis for the Straits Pipelines,* October 28, 2015 http://michigan.gov/som/0,4669,7-192-45414_45416-368183--,00.html.

[23] This includes decommissioning Line 5 in the Straits segment, or prohibiting crude oil in the Straits segment.

[24] R. Kane, *supra* note 16, p. 3-4.

pipeline system and instead instituted strategic changes segment-by-segment, with little disclosure of its basic objective to greatly expand its overall system and infrastructure during State of Michigan review, and no comprehensive alternative assessment.[25]

As the system includes suppliers, supply-chain operators, customers, government agencies, and citizens, it is complex and dynamic and inputs and constraints placed on it will change its dynamics and evolution. For this alternative, the primary constraint is "a notice that action will be taken resulting in Line 5 not being available after a limited adjustment period." The key question is then: "Can the system meet and/or evolve to meet the objectives of key players and the goals of a reasonable, prudent person?"

Line 5 has the current customers or shippers requiring support if Line 5 is decommissioned:

1. Michigan Upper Peninsula propane heating customers;
2. Michigan Lower Peninsula oil field shipments, southbound;
3. Marathon Detroit, Toledo, Ohio, and eastern Canada refineries;
4. Sarnia NGL petrochemical customers; and
5. Crude oil exports via Montreal, and eventually Portland, ME (lower priority).

1. Michigan Upper Peninsula Propane Heating Customers

Line 5 is currently important to propane heating customers in the Upper Peninsula. Propane is extracted from NGLs using a depropanizer at Rapid River, Michigan, where NGLs are shipped through the line. The remaining portion of the NGL stream (ethane, butane, etc.) is re-injected for shipment east and southbound (See Figure 3). An analysis of options was conducted by G. Street on behalf of FLOW.[26] Options included partial use of Line 5 and the Rapid River facility, or relocation of the depropanizer to Superior, Wisconsin, and using Rapid River as a distribution facility. The primary conclusion is that Line 5 is not vital to supply propane to U.P. customers, and other suppliers also serve the area using bulk tank truck shipments. Supply to U.P. customers would not be affected at all if crude oil is not shipped under the Straits segment of Line 5.

2. Michigan Lower Peninsula Crude Oil Shipments, Southbound

Crude oil from oil fields in Michigan's northern Lower Peninsula is gathered by the MarkWest Michigan Pipeline Company and injected into Line 5 at Lewiston, Michigan,

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[25] Id.

[26] Street, Gary L., M.S., P.E., *Current and Possible Alternative Supply Systems for Refineries in Detroit, MI and Toledo, OH, and Propane Supply for the Upper Peninsula,* December 14, 2015. www.flowforwater.org (hereinafter Appendix Report B).

for shipment southbound (See Figure 4). If Line 5 is decommissioned at the Mackinac Straits, with modification, the existing line below Lewiston could be used or a new pipeline installed along the corridor for the smaller quantity of material being shipped.

3. Marathon Detroit, Toledo, Ohio, Sarnia and Eastern Canada Refineries

Figures 5 and 6 show refineries and the pipeline network in southern Michigan and Ohio. Line 5 currently supplies an estimated 5 percent to 20 percent of Marathon's light crude oil needs. Heavy and tar-sands based crude oil grades are supplied by Line 6B from south of Chicago through connecting Enbridge Lines 17 and 79 to Marathon and Ohio refineries capable of using it. The original Line 6B that failed in 2010 has been replaced and the capacity expanded by approximately 200 percent over the pre-disaster capacity limit. Line 6B is a multi-purpose pipeline and can transport NGLs, light condensate, and intermediate and heavy crude oil, including dilbit.

Marathon and the Ohio refineries also can receive crude oil from the southern United States via Marathon- and Sunoco-operated pipelines in Indiana and Ohio.[27, 28] Rail shipments can provide emergency backup in the event of any operating problems in the network.

The Capline, Trunkline, and MPLX pipelines transport oil from the Gulf Coast, West Texas, Oklahoma, and Louisiana to the Chicago and Toledo areas. Flow reversal projects are being studied to carry Bakken and Alberta tar-sands oil southbound to Gulf Coast refineries and maritime ports using one or more of these pipelines. Major expansions of the Enbridge network between North Dakota/Alberta (Alberta Clipper Project) to the south Chicago area have created the capability to transport large quantities of crude oil to the Midwest and then southbound.

Introducing a constraint into the system, "decommission Line 5" would drive changes in strategy for Line 6B and networks in southeast Michigan and northern Ohio. The key players in this area most likely already have business continuity plans in place to adjust operations accounting for a Line 5 shutdown. Preliminary material balances indicate that the network can absorb the impact of a shutdown; maritime shipments and exports may be lower from the East Coast; however, the system will adjust to move the flow southbound from the Chicago area to the Gulf Coast.

Figure 5 shows the refineries in the Great Lakes – St Lawrence Basin. Refineries in Ontario receive crude oil by Line 9. In the beginning, the Line 9 flowed from west to east and later changed to flow from east to west to carry imported crude oil from ports in Montreal and Portland, Maine. Line 9 flow is being reversed again to enable Canadian

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[27] Appendix Report B, *supra* note 22.
[28] R. Kane, *supra* note 15.

refineries to consume domestic feedstock from the west and supply the export markets from Montreal and potentially Portland.

In summary, based on available information, a material balance indicates that with Line 5 decommissioned, there is an adequate supply of feedstock via Line 6B and pipelines from the south into the Great Lakes – St. Lawrence Basin to support refineries. Line 6B's operation may be less efficient without Line 5 as there may be more frequent changes in the material mix shipped. Pipeline operators like to ship fewer products, as scheduling and control of product separation is easier. The most likely net impact would be lower quantities of heavy tar-sands crude that could be shipped to export customers via eastern Canada and Portland. However, shippers still have the alternative option to export light, medium, and heavy crude oil from the U.S. Gulf Coast and Canadian West Coast.

4. Sarnia NGL Petrochemical Customers

Petrochemical producers in Sarnia, Ontario, are the primary customers for NGLs shipped in Line 5. There are alternative options to Line 5. Enbridge can ship NGLs in Line 6B and make appropriate connections in the system near Sarnia to get the NGLs to the customers. This action will impact the efficiency of Line 6B's operation, but shipping different materials and optimizing scheduling is a fundamental pipeline operator business practice. Again, the net impact may be a reduction in heavy crude oil export capability from Montreal and the East Coast.

Defining the scope for the system as the Great Lakes – St. Lawrence Basin, and not a specific company's assets, adds the Kinder Morgan and Sunoco pipeline networks into the system, as well as possible better costs for the customers. The Kinder Morgan is studying a project to use their Cochin pipeline to move NGLs and light condensates from the Utica and Marcellus plays in Pennsylvania, Ohio, and West Virginia, and to the Detroit area, Windsor, and on to Sarnia. This network provides an alternative option to Line 6B and supports the Line 5 decommissioning. Sunoco is also considering a similar project with their Sunoco Mariner West Pipeline. The attractiveness of the competing projects actually improves with Line 5 out of the network (See Figure 7).

5. Export Markets from Eastern Canada / United States

Elements of this strategy were previously covered; summarizing, Enbridge and their partners are establishing the leading pipeline network to support shippers of Bakken, Alberta, and tar-sands crude oil to markets in the Midwest, East, West, and Gulf Coasts for maritime shipments and exports. Current agreements with the State of Michigan do not allow the shipment of heavy crude oil through Line 5 but using it for NGLs and light crude oil reduces the number of materials shipped through Enbridge's Line 6B (increases logistics efficiency) and enables larger quantities of heavy crude oil to be shipped eastward for export. **Thus, a "reasonably prudent person" is risking a Great Lakes incident with Line 5 for an incremental export opportunity.** Exports could alternatively be done from the West and Gulf Coasts (See Figure 8).

VI. CONCLUSION

This model provides an approach to conducting a qualitative alternatives assessment. A comprehensive alternative analysis of the system and infrastructure would identify all possible alternatives to the current "status quo option," screen for feasibility, and then conduct an in-depth analysis of alternatives on the "short-list." For this model one alternative was selected, "Decommission Line 5," to demonstrate the approach, and move the "Line 5 debate" beyond Line 5 to a consideration of an alternative based on a proper definition of the system.

This model defines objectives, selects a feasible alternative, lists the assumptions and bases for an analysis, defines the system and addresses the objectives. If the appropriate system is not defined, a viable, best solution might be missed. In addition, the dynamics and evolution of the system must be analyzed. The technologies, reserves, and economics of crude oil supplies are changing; the demands and constraints on the supply chain and business strategies for refiners and exporters also are changing, creating a dynamic system. While setting one constraint, for example "decommission Line 5," may change the system equation, the system is designed to evolve to meet new objectives. All key stakeholders must participate as needed to forecast the evolution.

This model does not claim to represent necessarily the best or only solution, but it does show that "decommissioning Line 5" is a viable alternative, especially when the system and dynamics are properly defined. In this case, the system boundaries are defined by the network, use, and possible modifications, and not limited to a specific company's assets or state or country boundary. The model shows that the system has considerable flexibility and with limited scope projects and operating changes, Line 5 can be shut down, and the model represents an option or alternative that eliminates the high-level risk of imminent hazard and harm that would meet the "reasonably prudent person" requirement in the Enbridge 1953 Easement or other law as recommended by the Task Force Report.

The strategic needs of refineries, chemical producers, and propane heating customers would not be affected, as the system can adjust to meet their needs and continue to evolve to meet new unforeseen conditions. Maintaining an imminent environmental hazard at the Straits of Mackinac, Line 5, to supply East Coast export markets is not a strategic need as determined by a "reasonably prudent person."

In analyzing the system, "Decommissioning Line 5" was also found to reduce public safety risk from an aging line traversing populated areas, and also to reduce environmental risk to nationally recognized and extremely sensitive watersheds, streams, and rivers which feed the Great Lakes.

VII. RECOMMENDATIONS

This simple process and example demonstrates that Line 5 can be decommissioned without a negative strategic impact on key stakeholders. Due to the imminent hazard Line 5 presents to the Great Lakes and public safety risk along its route:

- The comprehensive alternatives analyses and assessment should embrace the overall pipeline system and infrastructure, including capacity, options, modifications, such as the recently expanded new Line 6B, and be undertaken and completed as expeditiously as possible.
- While recognizing that a review of other options needs to done in parallel, the state should make a pre-determination that the "decommission Line 5" (as defined in this report) alternative is a strong possible best-case option. The comprehensive assessment must not be delayed while studying other options that, by definition, do not fully meet the upfront stated objective to eliminate the risk.
- Interim measures, such as those recommended in FLOW's September 2015 Expert Report (See www.FLOWforWater.org), should be imposed immediately on Line 5 under the Mackinac Straits because of the high-level risk, imminent hazard, and high magnitude of harm in the event of an oil spill or release during the completion of the comprehensive assessment.

Addendum A – Examples of Possible Alternatives

The following is list of possible alternatives provided as examples. The list is not comprehensive. When conducting the alternatives assessment, the list would be developed by the assessment team, condensed to a feasible short-list, and then the remaining options analyzed in detail against the objectives.

- Maintain status quo of current activities.
- Upgrade Line 5 monitoring, integrity management, and emergency response capability.
- Restrict Line 5 operating criteria and capacity to less severe conditions.
- Decommission Line 5.
- Replace Line 5 with rail and/or truck shipments, as needed, to supplement other pipelines, not necessarily in total for Line 5 capacity.
- Use a portion of Line 5 or the right-of-way to support the propane market in the Upper Peninsula. Line 5 downstream and across the Straits would be decommissioned.
- Use a portion of Line 5 or the right-of-way to support crude oil shipments from the Lower Peninsula southbound. Line 5 upstream and across the Straits would be decommissioned.
- Replace Line 5 with a new best-in-class pipeline.

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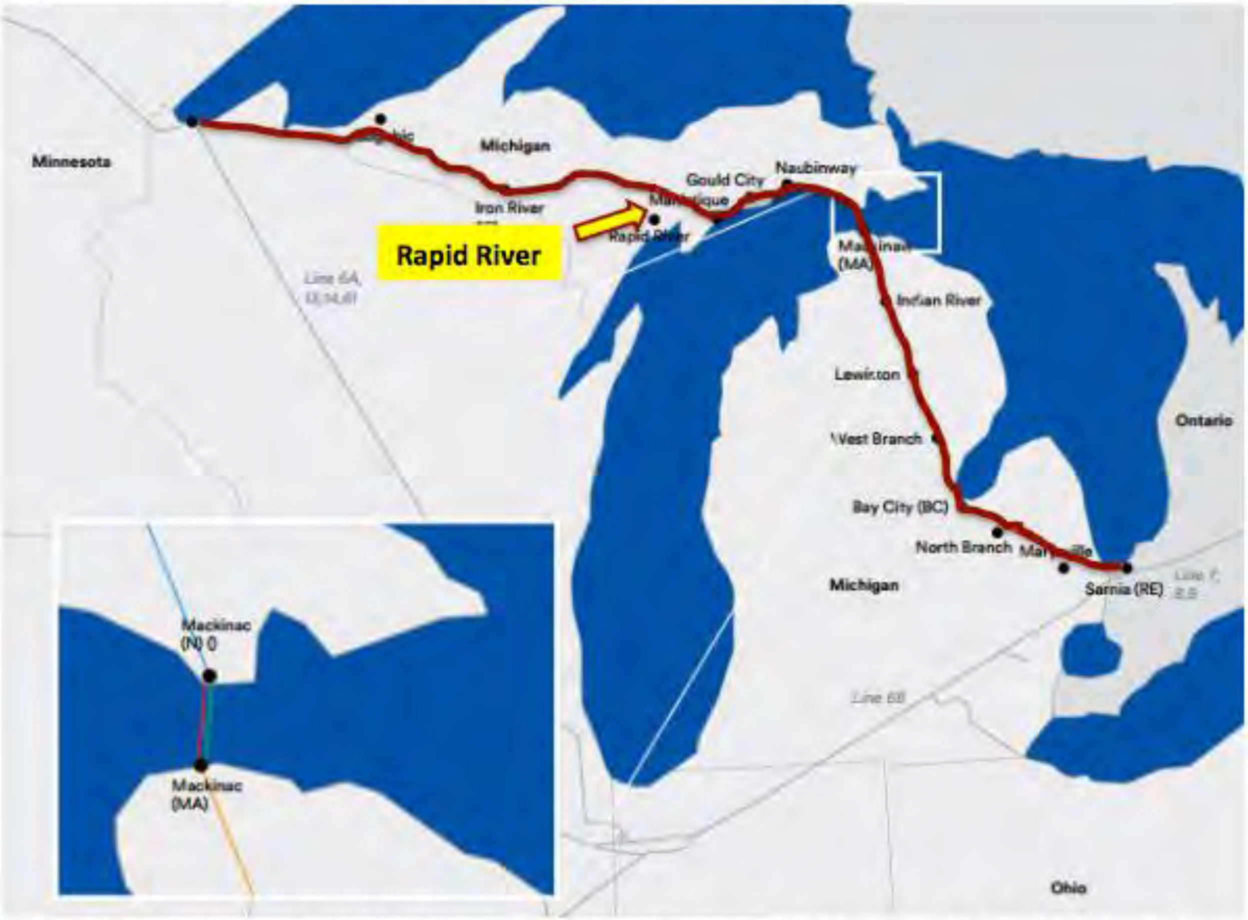
Figure 1. Historic Crude Oil, NGL Flows to the Great Lakes – St Lawrence Basin

Historic, primary NGL and crude oil flows were from Alberta, the U.S. Southwest and Gulf Coast to the Midwest and imports from the east into Canada.

Figure 2. Evolving Crude Oil, NGL, Light Condensate Flows to the Great Lakes – St Lawrence Basin

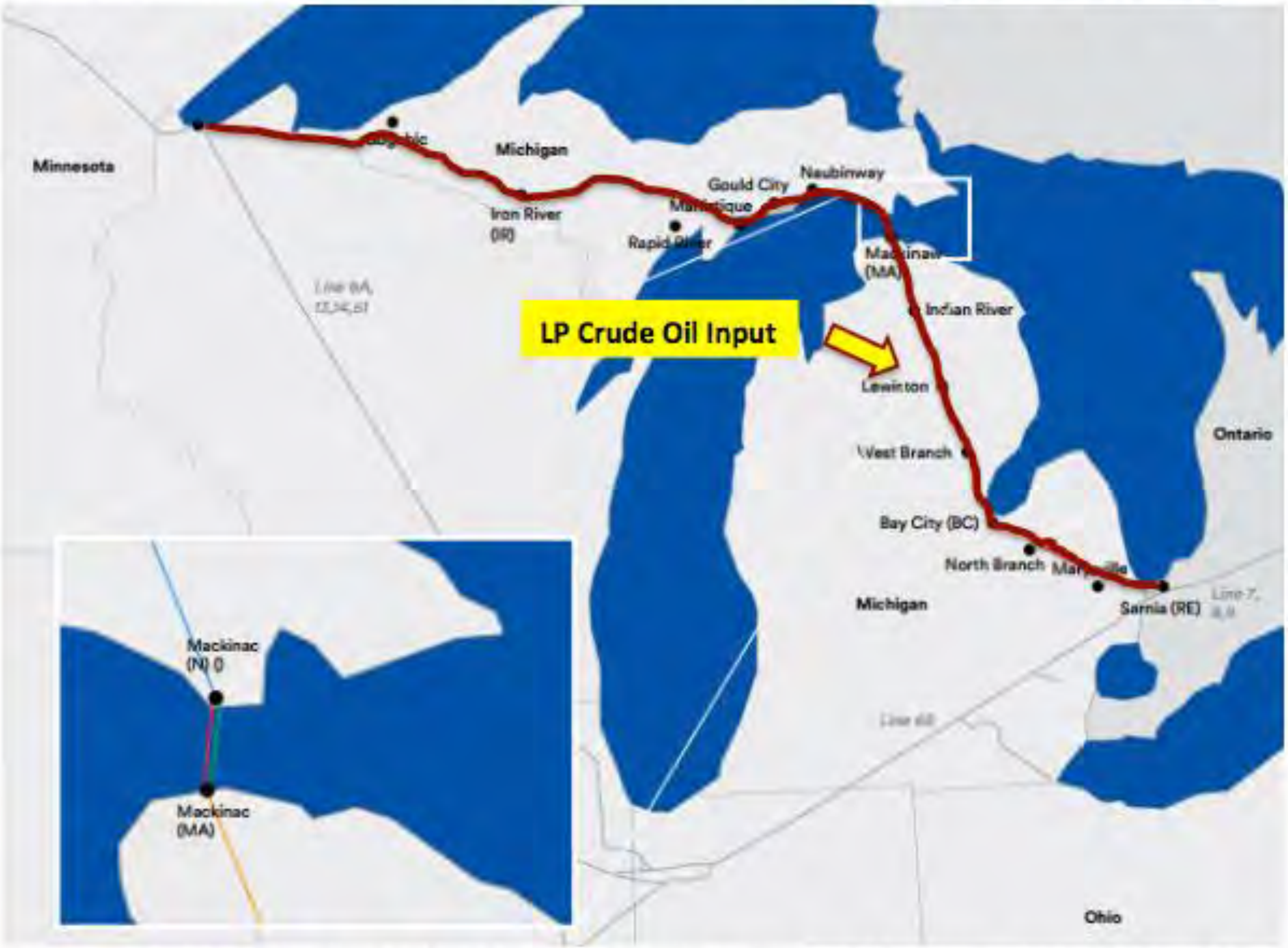
The pipeline system is evolving and directional flows are changing. Projects are being implemented to move crude oil from North Dakota/Alberta to the Chicago area and on to the east and south to serve refineries enable maritime shipments and exports from the East Coast and Gulf Coast. Light condensate and NGL's pipeline projects will enable shipments from Pennsylvania, Ohio and West Virginia to the Detroit, Windsor and Sarnia areas.

Figure 3.   Enbridge Line 5 Transports NGL's and Crude Oil



Propane is extracted at Rapid River and used for commercial and home heating in the Michigan Upper Peninsula. With Line 5 shutdown at the Straits, the upstream segment ahead of Rapid River could be used to operate the depropanizer, or ship propane or use the right-of-way or move the operation to Superior Wisconsin.

Figure 4. Lower Peninsula Crude Oil Production Feed Point to Enbridge Line 5



Options: use the existing line and batch ship crude oil, modify Line 5 for lower through put, use the right-of-way with a smaller line, decommission and use an alternative shipment mode.

Figure 5. Refineries in the Great Lakes - St. Lawrence Basin

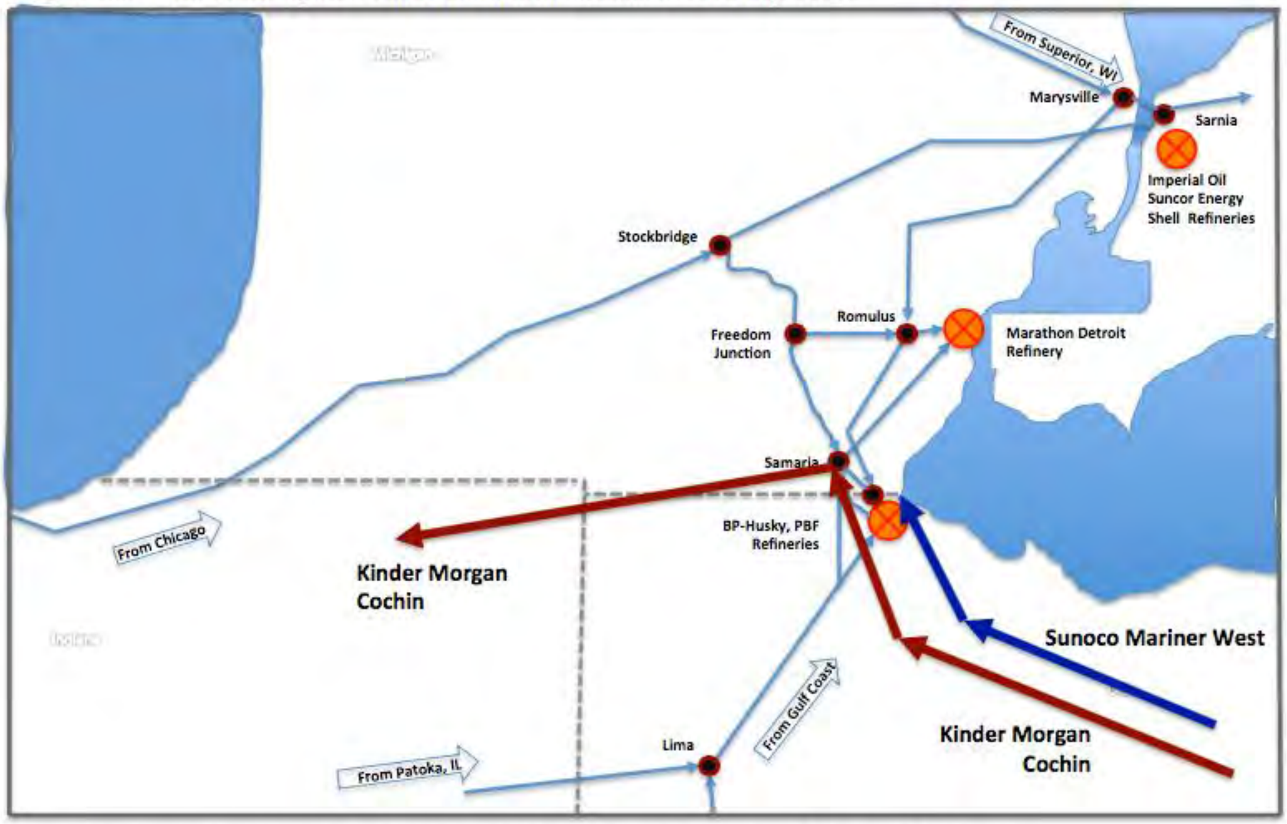
State/Province	City	Company	Refining capacity (bpd)
Indiana	Whiting	BP	400,000
Michigan	Detroit	Marathon	123,000
Ohio	Lima	Husky Energy	165,000
	Oregon	BP/Husky Oil	155,000
	Oregon	PBF	540,000
Wisconsin	Superior	Calumet	45,000
Quebec	Montreal	Suncor Energy	137,000
Ontario	Nanticoke	Imperial Oil	112,000
	Sarnia	Imperial Oil	121,000
	Sarnia	Suncor Energy	85,000
	Corunna	Shell Canada	72,000

Reference 5. Great Lakes Commission report on crude oil shipments in the Great Lakes – St Lawrence Basin

Figure 6 Detroit/Toledo Crude Oil Supply Pipelines

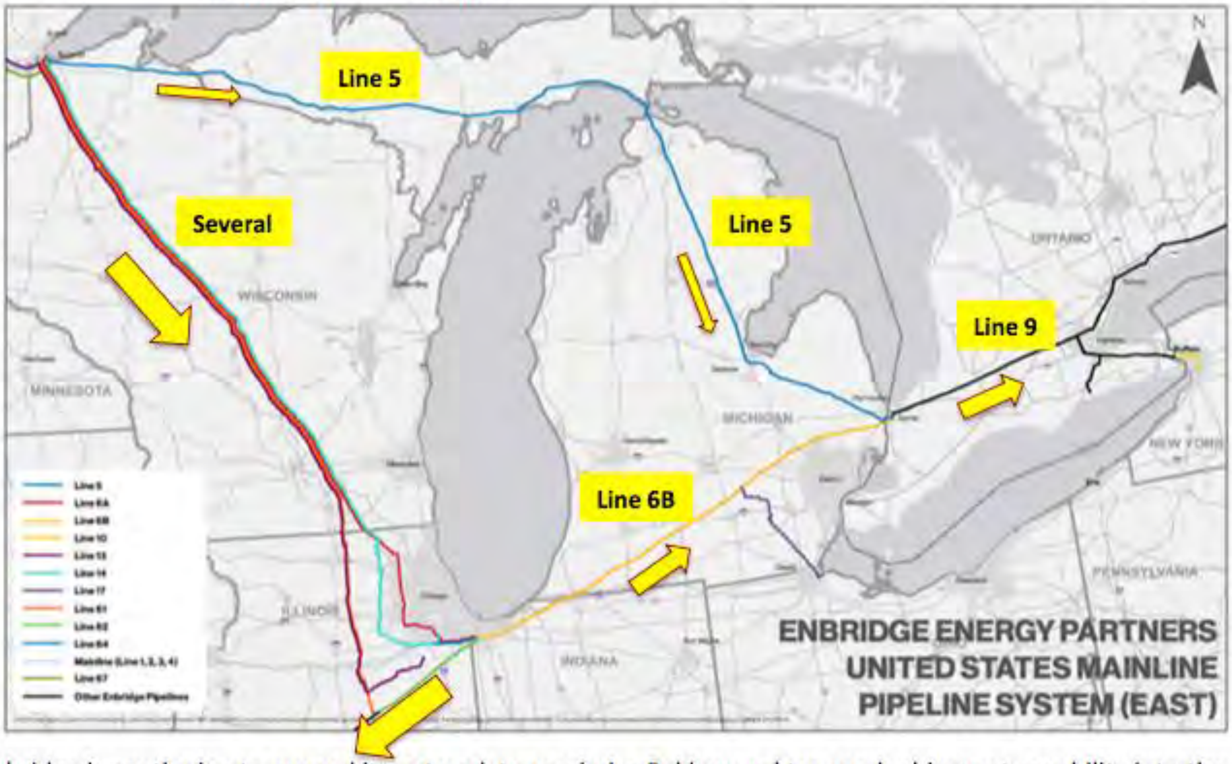
(Original map by Marathon has been revised by FLOW) **Reference 7. G. Street**

Figure 7. Kinder Morgan Cochin and Sunoco Mariner West Pipelines



These pipelines transport light condensate and NGLs' from the Utica and Marcellus Shale Plays

Figure 8. Enbridge Strategy – Expand to Ship Bakken and Tar Sands Crude Oil to the Midwest and East Coast



Enbridge is continuing to expand its network to maximize Bakken and tar-sands shipment capability into the Great Lakes region for refineries and transshipment to the East and Gulf Coasts to refineries and ports for export.

APPENDICES TO FLOW PUBLIC COMMENTS ON THE JOINT APPLICATION OF ENBRIDGE ENERGY TO OCCUPY GREAT LAKES BOTTOMLANDS FOR ANCHORING SUPPORTS TO TRANSPORT CRUDE OIL IN LINE 5 PIPELINES IN THE STRAITS OF MACKINAC AND LAKE MICHIGAN [2RD-DFDK-Y35G]

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APPENDIX B

Summary of Enbridge Files Obtained from the MI DEQ
Line 5 at the Straits

Original Draft: May 1, 2014
Revised: August 23, 2016
By: Gary Street, M.S., PE

Overview

The files shared in Appendix B were provided by a FOIA request submitted by FLOW to the MDEQ, and primarily covered the period of 2001 -2010, proceed through the subsequent years, and finally include a few entries from 2012.

Since 2001, Enbridge has engaged in numerous projects (6 or more) to install additional supports for Line 5 at the Straits. Questions raised by this information include:

- Why did they not install all of the needed supports in 2001?
- By postponing the installation of all the supports, did Enbridge expose the Straits unnecessarily to a major spill? Is that still the case?
- Given the record of multiple support installations, how can we be sure that even more supports are not needed?
- For at least three of the projects, no Notice of Completion was found in the DEQ files. Were the projects never completed?
- The East and West Leg Blueprints raise questions about Enbridge's compliance with the Radius of Curvature provision in the 1953 Easement. Violations compromising the integrity of the pipelines may have occurred during construction and installation on the irregular topography of the lakebed (see East and West Leg Blueprints, Appendix B pp. 3-4; FLOW April 13, letter, p. 11).

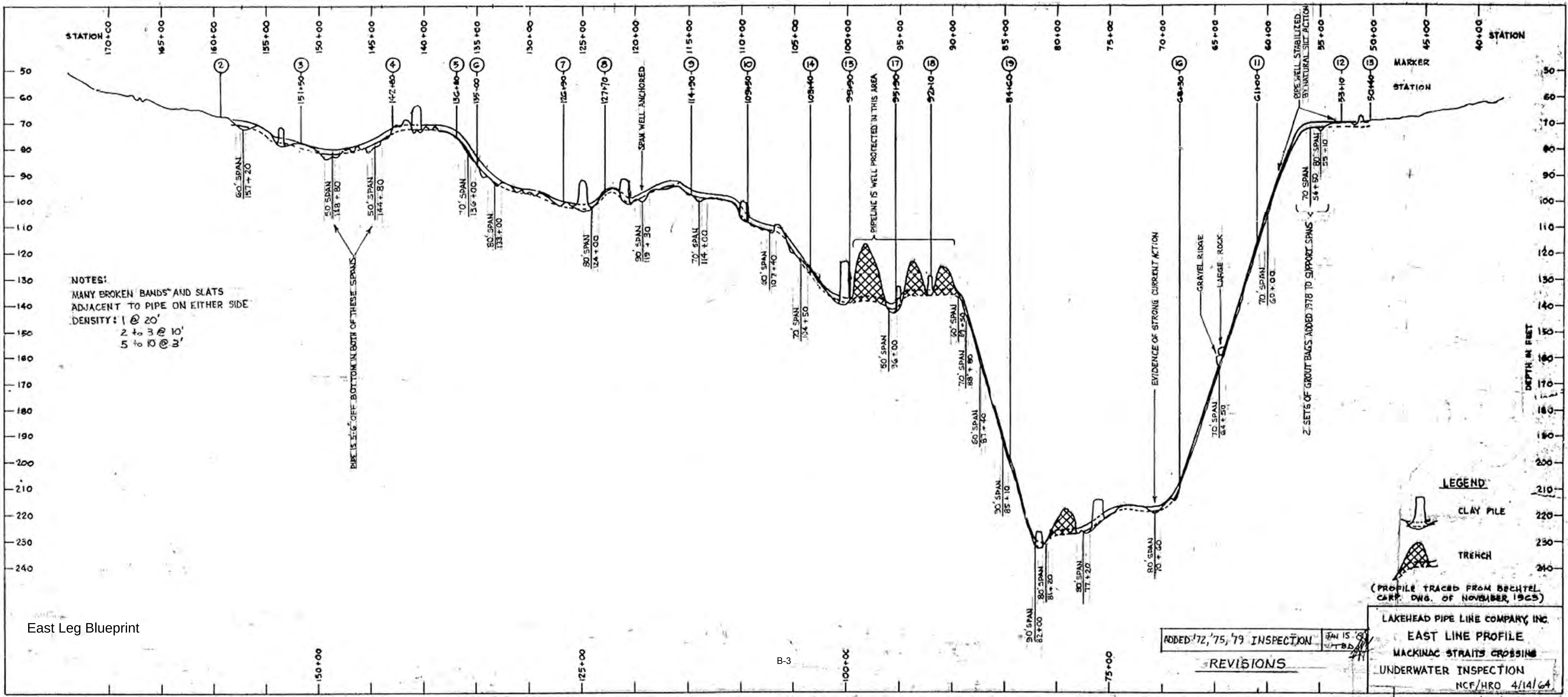
Enbridge engineers have clearly recognized the hazard the lack of proper supports poses. They repeatedly said the situation was urgent, and there were no other alternatives. Nevertheless, installation was not always done promptly.

Table 1 is a Summary of the instances when Enbridge sought to install more supports between 2001 and 2010. It includes documented comments by Enbridge employees regarding the urgent need for these additional supports.

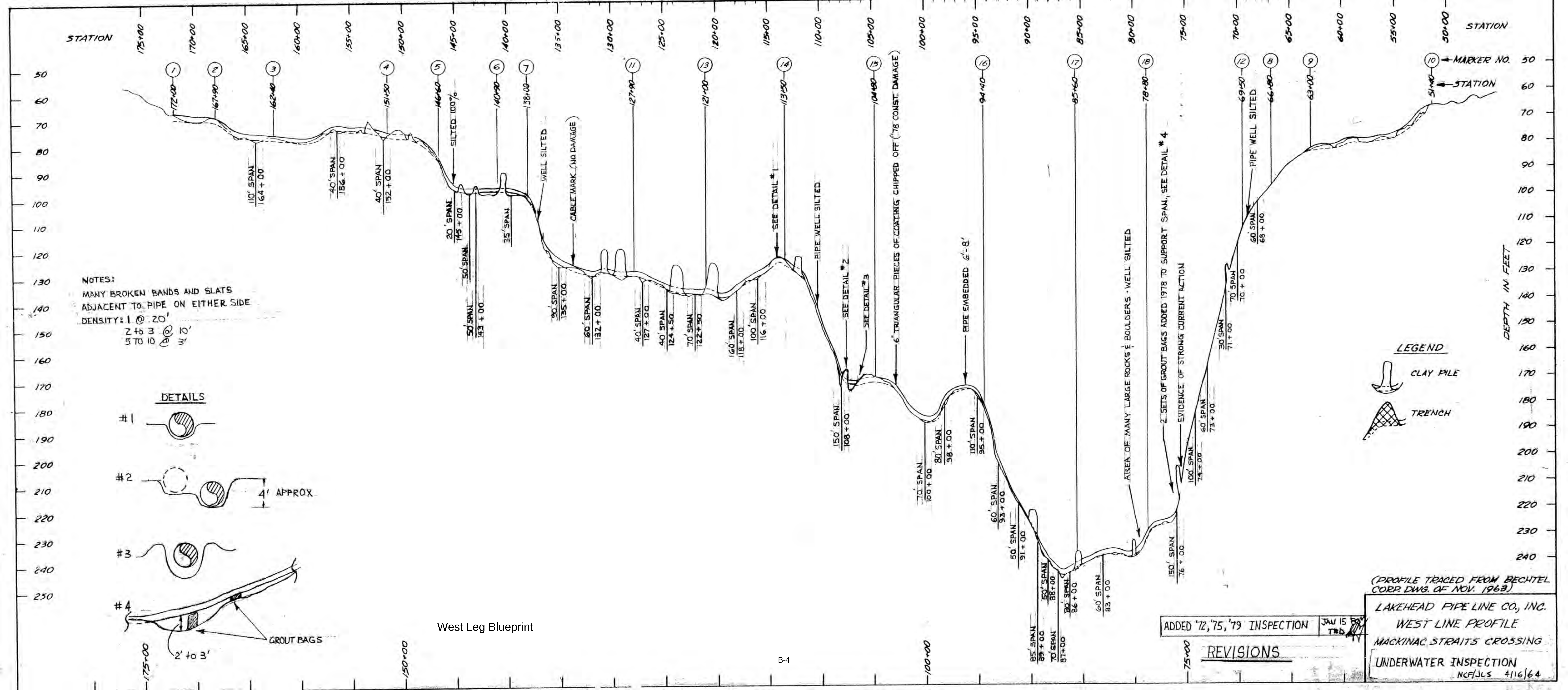
Table 1: Summary of Enbridge Requests for Installation of Supports – 2001 to 2010

Permit Request Date	Notice of Completion	Type of Support	Number of Supports	Comments - Urgency as Expressed by Enbridge
9/14/2001	12/5/2001	Grout bags	n/a	"These emergency preventative maintenance repairs must be completed as soon as possible. We are scheduled to begin work on Sunday morning, Sep. 16, 2001." "These maintenance repairs can wait no longer."
10/2/2001	12/5/2001	Grout bags?	8	"These emergency preventative maintenance repairs must be completed as soon as possible." "We appreciate your work to expedite the process."
05/20/2003	n/a	Auger	n/a	"Each of these indications[1] have un-supported spans that are in need of repair." "If additional un-supported sections of the pipeline requiring repair are located, we will issue an additional map indicating their location."
03/14/2005	7/22/2005	Auger	10	"Each of these indications[1] have un-supported spans that are in need of repair." "If additional un-supported sections of the pipeline requiring repair are located, we will issue an additional map indicating their location." "The purpose of this project is to provide support beneath our pipelines in sections where the pipeline is unsupported over too great a distance." "In order to maintain integrity and safety additional supports are necessary under lengthy unsupported spans of the pipeline."
05/03/2006	n/a	Auger	20	"The purpose of this project is to provide support beneath our pipelines in sections where the pipeline is unsupported over too great a distance." "In order to maintain integrity and safety additional supports are necessary under lengthy unsupported spans of the pipeline." "The purpose of this project is to enhance support beneath the pipelines where the span is currently unsupported for extended distances."
08/26/2010	n/a	Auger	10+	"In order to maintain integrity, installation of additional supports to minimize the distance between presently unsupported pipeline spans is necessary." "Project is for up to 10 anchoring structures to hold the pipeline to the bottom of Lake Michigan." "Do nothing or the no-build alternative presents a future risk to the pipeline. The no build is not an option."
9/16/2010				"The application is currently on hold at the request of Enbridge."

[1] Enbridge's term "Indications" signifies problems or potential problems.



East Leg Blueprint



West Leg Blueprint

153 ½ E. Front Street | Suite 203C | Traverse City, MI 49684 | 231.944.1568

August 1, 2014

Freedom of Information Act Coordinator
Michigan Department of Environmental Quality
Water Resources Division
Land and Water Programs
P.O. Box 30204
Lansing, MI 48909-7704

RE: Freedom of Information Act Request, MCL 15.231, et seq., re: All permits related to Lakehead Pipeline Company, Inc. and Enbridge Energy's Line 5 and Line 6B pipelines in Sanilac County and under the St. Clair River

Dear Freedom of Information Act Coordinator:

Under the provisions of the Freedom of Information Act (FOIA), I request, on behalf of FLOW, a Michigan nonprofit corporation, access to and copies of all documents contained in your file relating to all permits issued to Lakehead Pipeline Company's and Enbridge's pipelines known as Line 5 and Line 6B, located in Sanilac County and under the St. Clair Ri~~ver.~~

Specifically, I request copies of all public documents prepared by or in possession of Michigan Department of Environmental Quality (MDEQ) Land and Water Management Division (LWMD), its divisions, and its field offices related to all permits for Lakehead Pipeline Company's and Enbridge's pipelines known as Line 5 and Line 6B located in Sanilac County and under the St. Clair River.

The terms "documents" and "materials," as used in this FOIA request, should be construed in the broadest possible manner and include any written, graphic, or recorded matter, electronic, or a combination of these, however produced or reproduced, of any kind or description, including both sides of any two-sided writing, drafts and marked copies.

If there are any fees for searching for or copying the records I have requested, please advise and we will remit those fees at once, so long as the cost is within the limits of the Freedom of Information Act. If you believe that the volume of material contained in your file is so great that it would result in costs in excess of $100.00, please notify me and provide an estimate of the total cost of this request, so that I may personally review the file or otherwise attempt to narrow the scope of this request.

153 ½ E. Front Street | Suite 203C | Traverse City, MI 49684 | 231.944.1568

If your file contains large-scale plans or drawings, rather than photocopying them piecemeal, please let me know, identifying the contents and/or subject matter, and suggest some way in which full-size copies can be obtained. Likewise, if your file contains any other "writing," as defined by the FOIA to include photographic films, prints, microfilm, microfiche, cards, disks, or other ways of recording or retaining meaningful information (such as audio or video tapes, CD, DVD, or information stored on computer), please advise, identifying contents and/or subject matter, as well as the format, and suggest some way in which we can obtain usable copies.

If all or any part of this request is denied, please cite the specific exemptions to justify your refusal to release the information, under Section 13 of the Act, and the reason why you have not invoked your discretion to release the requested documents in the public interest. We further request any segregable portion of any document you might otherwise withhold. For each record or portion of a record that you withhold, we specifically request a particularized description of the basis for withholding it.

Because FLOW is a Michigan nonprofit corporation researching public water and related policy for the benefit of Michigan and Great Lakes region, and working for the public interest, we request that fees be waived pursuant to Section 4 of the Freedom of Information Act (MCL 15.234(1)). A copy of 501(c)(3) letter is attached. This request for fee waiver should not be understood as consent to any extension to the statutory time period for responding to this request.

As I am sure you are aware, a response to a request under the FOIA must be completed within five business days. Because of the numerous items requested, within 5 days of this request please contact my office and advise if additional time is needed.

I thank you in advance for your cooperation and attention to this matter.

Sincerely,

E Kirkwood

Elizabeth R. Kirkwood
Executive Director, FLOW

01 24 0046 Initial Supports\Supports 09 14 01 A

Enbridge Energy Company, Inc.
Lake Superior Place
21 West Superior Street
Duluth, MN 55802-2067
Tel 218 725 0100
Fax 218 725 0564
www.enbridgepartners.com

ENBRIDGE

September 14, 2001

Craig Outwater
Michigan Department of Environmental Quality

Subject: Enbridge Energy Partners (formally Lakehead Pipe Line) shuts down Michigan liquid petroleum pipeline for unscheduled maintenance.

Enbridge Energy Partners (formerly Lakehead Pipe Line) operates a 645-mile liquid petroleum pipeline from Superior, WI to Sarnia, Ontario. This pipeline, also referred to as Line 5 transports crude oil and natural gas liquids in batches and is routed across the Upper Peninsula of Michigan. The 30-inch pipeline then splits into two 20-inch pipelines for the underwater crossing at the Straits of Mackinac.

This notice is to inform you of some unscheduled maintenance work on the two parallel 20-inch liquid petroleum pipelines at the Straits. A routine scheduled inspection of the underwater crossing of Line 5 identified a loss of existing support to some segments of the pipeline due to lakebed erosion. While the company is still completing underwater inspections, we have initiated a plan to expedite needed repairs to replace supports under the pipe segments. These repairs will require the line to be shutdown for the next four to seven days, weather and equipment dependent.

While Enbridge does not anticipate a problem and there has been no incident or leakage, this advisory seemed appropriate, as we believe you may receive questions from the public in light of the visibility of the barges completing the maintenance. As well, today the company filed a "Safety Related Condition" report with the U.S. Department of Transportation, Office of Pipeline Safety.

We do not expect the need for any response action on your part during the repair work and this advisory is for your information only.

An effort is underway to move a batch of natural gas liquid to displace the crude oil. This both reduces the stress load on the pipelines and lowers the environmental risk. A barge and other equipment are enroute to the area and will begin work once the NGL is locked into place and the pipeline shutdown beginning late afternoon today.

As always, we are available should you have any questions. I can be reached at (715) 394-0410.

Sincerely,
Lindsay Sander (for)
Mark Sitek
Regional Manager

Enbridge Energy Company, Inc.
Lake Superior Place
21 West Superior Street
Duluth, MN 55802-2067
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ENBRIDGE™

September 14, 2001

Mr. John Arevalo
Michigan Department of Environmental Quality
Gaylord District
2100 West M-32
Gaylord, MI 49735

Re: Enbridge Energy's Joint Permit Application for Repair Work to be Completed on Crude Oil Transmission Pipelines Located in the Straits of Mackinac.

Dear Mr. Arevalo:

As follow-up to our telephone conversation held yesterday regarding the above referenced project, enclosed is a Joint Permit Application for repair work to be conducted on Enbridge's (formerly Lakehead Pipeline) two 20-inch diameter pipelines. We have been in contact with the U.S. Army Corp of Engineers and they will be issuing a permit for this repair work today. They have assigned case number 880161211 to the project. These emergency preventative maintenance repairs must be completed as soon as possible. We are scheduled to begin repair work on Sunday morning, September 16, 2001.

We appreciate your work to expedite the approval process. If you have any questions or comments, please feel free to contact me at (218) 725-0548.

Sincerely,

Adam Erickson

Adam J. Erickson
Engineer

Enclosure: Joint Permit Application
Indications map

c: John Sobojinski – LPL
Grant Henningsen – LPL
Barry Power – LPL

US Army Corps of Engineers (USACE) | Michigan Department of Environmental Quality (MDEQ) DEQ

AGENCY USE

Previous USACE Permit or File Number	Date Received	Land and Water Management Division, MDEQ File Number 01-24-0046P
USACE File Number	Received LWMD/DEQ SEP 17 2001 GAYLORD	*Marina* Operating Permit Number
		Fee received $ $50.00 #833

- **Print in black, blue, or red ink and complete all items in Sections 1 through 9 and those items in Sections 10 through 21 that apply to your proposed project.**

1 PROJECT LOCATION INFORMATION

- Refer to your property's legal description for the Township, Range, and Section information, and your property tax bill for your Property Tax Identification Number(s).

Address: LAKE MICHIGAN BETWEEN UPPER & LOWER PENINSULA		Township Name(s): N/A	Township(s): 39 N	Range(s): 3 W	Section(s): N/A
City/Village: N/A	County(ies): N/A	Property Tax Identification Number(s): N/A			
Name of Waterbody: LAKE MICHIGAN	Project Name or Job Number: SCN 8122	Subdivision/Plat: N/A	Lot Number	Private Claim	

Project types (check all that apply): ☐ private ☐ building addition ☐ other (explain) ☐ public/government ☐ new building or *structure* ☒ industrial ☐ building renovation or restoration ☐ commercial ☐ river restoration ☐ multi-family ☐ single-family

The proposed project is on, within, or involves **(check all that apply)**
☐ a stream ☐ a river ☐ a ditch or drain ☐ a *floodway* area ☐ a pond (less than 5 acres) ☐ a channel/canal ☐ an *inland lake* (more than 5 acres) ☐ a *100-year floodplain* ☐ a legally established County Drain (date established)
☒ a Great Lake or *Section 10 Waters* ☐ a designated *high risk erosion area* ☐ a designated *critical dune area* ☐ a designated *environmental area* ☐ a *natural river* ☐ a *dam* ☐ a wetland ☐ 500 feet of an existing waterbody ☐ a *structure* removal ☐ a utility crossing

2 DESCRIBE PROPOSED PROJECT AND ASSOCIATED ACTIVITIES, AND THE CONSTRUCTION SEQUENCE AND METHODS

- Attach separate sheets, as needed, including necessary drawings, sketches, or plans. PROJECT IS TO PROVIDE SUPPORT UNDERNEATH OUR PIPELINES IN SECTIONS WHERE THE PIPELINE SPANS UN-SUPPORTED OVER TOO GREAT A DISTANCE. GROUT BAGS WILL BE PLACED BENEATH THE UNSUPPORTED SECTIONS THEN FILLED WITH GROUT VIA A PUMPING RIG LOCATED ON A BARGE AT THE SURFACE. GROUT HOSES WILL BE CONNECTED BY DIVERS.

3 APPLICANT, AGENT/CONTRACTOR, AND PROPERTY OWNER INFORMATION

- The applicant can be either the property owner or the person or company that proposes to undertake the activity.
- If the applicant is a corporation, both the corporation and it's owner must provide a written document authorizing the agent/contractor to act on their behalf.

Applicant (individual or corporate name): ENBRIDGE ENERGY LIMITED PARTNERSHIP	Agent/Contractor (firm name and contact person)
Mailing Address: 21 WEST SUPERIOR STREET	Address
City: DULUTH State: MN Zip Code: 55802	City State Zip Code
Daytime Telephone Number with Area Code: (218) 725-0548	Daytime Telephone Number with Area Code
Fax: (218) 725-0564 E-mail: ADAM.ERICKSON@USPL.ENBRIDGE.COM	Fax E-mail

Is the applicant the sole owner of all property on which this project is to be constructed and all property involved or impacted by this project? ☐ No ☒ Yes
(If No, provide a letter signed by the property owner authorizing the agent/contractor to act on his or her behalf or a copy of easements or right-of-ways. If multiple owners, please **attach** all property owners' names, mailing addresses, and telephone numbers.)

Property Owner's Name (If different from applicant)	Mailing Address
Daytime Telephone Number with Area Code	City State Zip Code

4 PROPOSED PROJECT PURPOSE, INTENDED USE, AND ALTERNATIVES CONSIDERED (Attach additional sheets if necessary)

- The purpose must include any new development or expansion of an existing land use.
- Include a description of alternatives considered to avoid or minimize resource impacts. Include factors such as, but not limited to, alternative construction technologies; alternative project layout and design; alternative locations; local land use regulations and infrastructure; and pertinent environmental and resource issues.
- For utility crossings, include both alternative routes and alternative construction methods.

IN ORDER TO MAINTAIN PIPELINE INTEGRITY & SAFETY - THESE MAINTENANCE REPAIRS CAN WAIT NO LONGER. THIS METHOD OF REPAIR IS THE MOST ENVIRONMENTALLY FRIENDLY METHOD WHICH WE ARE AWARE OF.

5 LOCATING YOUR PROJECT SITE

- Provide the requested information listed below that will help staff in locating your project site.
- Attach a copy of a map, such as a plat, county, or USGS topographic map, clearly showing the site location and include an arrow indicating the north direction.

Is there an access road to the project? ☐ No ☐ Yes (**If Yes,** type of road, **check all that apply**) ☐ private ☐ public ☐ improved ☐ unimproved

Name of roads at closest main intersection and

Directions from main intersection

Style of house or other building on site ☐ ranch ☐ 2-story ☐ cape cod ☐ bi-level ☐ cottage/cabin ☐ pole barn ☐ none ☐ other (describe)

Color Color of adjacent property house and/or buildings

House number Address is visible on ☐ house ☐ garage ☐ mailbox ☐ sign ☐ other

Street name Fire lane number Lot number

How can your site be identified if there is no visible address?

Provide directions to the project site, with distances from the best and nearest visible landmark and waterbody IT IS LOCATED BETWEEN THE UPPER & LOWER PENINSULA OF MICHIGAN AT THE MACKINAC STRAITS.

Does project cross boundaries of two or more political jurisdictions? (City/Township, Township/Township, County/County, etc.)
☐ No ☐ Yes (If Yes, list jurisdiction names.) UNKNOWN

6 List all other federal, interstate, state, or local agencies authorizations required for the proposed activity, including all approvals or denials received.

Agency	Type approval	Identification number	Date applied	Date approved / denied	If denied, reason for denial
USACE	NATIONWIDE PERMIT	NW03	9-12-01	9-14-01	

7 If a permit is issued, date activity will commence (M/D/Y) 9-15-01 P.E.

Proposed completion date (M/D/Y) 10-15-01

Has any construction activity commenced or been completed in a regulated area? ☒ No ☐ Yes
If Yes, identify the portion(s) underway or completed on drawings or attach project specifications and give completion date(s) (M/D/Y)

Were the regulated activities conducted under a MDEQ permit? ☐ No ☐ Yes
If Yes, list the MDEQ permit number

Are you aware of any unresolved violations of environmental law or litigation involving the property? ☒ No ☐ Yes (**If Yes,** please explain)

8 PUBLIC NOTIFICATION (Attach additional sheets if necessary)

- Complete information for all *adjacent and impacted property owners* and the lake association or established lake board including the contact person's name.
- If you own the adjacent lot, provide the requested information for the first adjacent parcel beyond your property line.

Property Owner's Name	Mailing Address	City	State	Zip Code
N/A				

Name of ☐ Established Lake Board ☐ or Lake Association and the Contact Person's Name Telephone Number Mailing Address City State Zip Code

9 APPLICANT'S CERTIFICATION **READ CAREFULLY BEFORE SIGNING**

I am applying for a permit(s) to authorize the activities described herein. I certify that I am familiar with the information contained in this application, that it is true and accurate, and, to the best of my knowledge, is in compliance with the State *Coastal Zone Management Program* and the *National Flood Insurance Program.* I understand that there are penalties for submitting false information and that any permit issued pursuant to this application may be revoked if information on this application is untrue. I certify that I have the authority to undertake the activities proposed in this application. By signing this application, I agree to allow representatives of the MDEQ and the USACE to enter upon said property in order to inspect the proposed activity site and the completed project. I understand that I must obtain all other necessary local, county, state, or federal permits and that the granting of other permits by local, county, state, or federal agencies does **not** release me from the requirements of obtaining the permit requested herein before commencing the activity. I understand that the payment of the application fee does **not** guarantee the issuance of a permit.

- All applicants must complete all the items in Sections 1 through 9 on pages 1 and 2 of this application.
- Complete those items in Sections 10 through 21 that apply to your project. It is necessary to submit only those pages where you have provided information.
- Please list here the application page numbers being submitted and a brief description of other attachments included with your application.

☐ Property Owner
☐ Agent/Contractor
☒ Corporation – Title Enbridge Energy, Limited Partnership Printed Name Adam Erickson Signature Adam Erickson Date 9/14/01

10 PROJECTS IMPACTING WETLANDS OR FLOODPLAINS OR LOCATED ON AN INLAND LAKE OR STREAM OR A GREAT LAKE

- Check boxes A through N that may be applicable to your project and provide the requested information.
- If your project may affect wetlands, also complete Section 12. If your project may impact regulated *floodplains*, also complete Section 13.
- Provide an overall site plan showing existing lakes, streams, wetlands, and other water features; existing *structures*; and the location of all proposed *structures*, land change activities and *soil erosion and sedimentation control measures*. Please review sample drawings for guidance in completing site-specific drawings for your project.
- On a Great Lake use *IGLD 85* [X] surveyed [ ] converted from observed still water elevation. On inland waters, [ ] *NGVD 29* [ ] local datum [ ] other
  Observed water elevation (ft) 584.203, date of observation (M/D/Y)

[X] **A. PROJECTS REQUIRING FILL** (See All Sample Drawings) GROUT BAGS
- To calculate volume in cubic yards (cu yd), multiply the average length in feet (ft) times the average width (ft) times the average depth (ft) and divide by 27.
- Attach both plan and *cross-section* views to scale showing maximum and average fill dimensions.

(Check all that apply) [ ] *floodplain* fill [ ] wetland fill [ ] *riprap* [ ] *seawall, bulkhead,* or *revetment* [ ] bridge or culvert
[ ] boat launch [ ] off-shore swim area [ ] beach sanding [ ] boatwell [ ] crib *dock* [ ] other

Fill dimensions (ft) Length 5 width 7 maximum depth 1.5 | Fill volume (cu yd) 2 EACH | Maximum water depth in fill area (ft) 250

Type of clean fill [ ] pea stone [ ] sand [ ] gravel [ ] wood chips [X] other GROUT | Will *filter fabric* be used under proposed fill? [ ] No [ ] Yes (If Yes, type) GROUT BAG

Source of clean fill [ ] on-site, **If on-site,** show location on site plan [ ] commercial [X] other, **If other,** attach description of location PUMPED FROM BARGE

Fill will extend VARIETY OF feet into the water from the *shoreline* and *upland* 0 feet out of the water. VARIETY OF LOCATIONS UNDER PIPELINE

[ ] **B. PROJECTS REQUIRING DREDGING OR EXCAVATION** (See All Sample Drawings)
- To calculate volume in cubic yards (cu yd), multiply the average length in feet (ft) times the average width (ft) times the average depth (ft) and divide by 27.
- Attach both plan and *cross-section* views to scale showing maximum and average dredge or excavation dimensions.
- The applicant will be notified if sediment sampling will be required.

(Check all that apply) [ ] *floodplain* excavation [ ] wetland dredge or draining [ ] *seawall, bulkhead, or revetment*
[ ] navigation [ ] *boat well* [ ] boat launch [ ] other

Dredge volume (cu yd) | Method and equipment for dredging

Has proposed dredge material been tested for contaminants? [ ] No [ ] Yes (**If Yes,** attach testing results)

Has this same area been previously dredged? [ ] No [ ] Yes (**If Yes,** provide date and permit number, if available) (M/D/Y)
If Yes, are you proposing to enlarge the previously dredged area [ ] No [ ] Yes

Is long-term maintenance dredging planned? [ ] No [ ] Yes (**If Yes,** when and how much?)

[ ] **C. PROJECTS REQUIRING RIPRAP** (See Sample Drawings 2, 3, 8, 12, 14, 17, 22, and 23. Others may apply)

Riprap waterward of the [ ] *shoreline* OR [ ] *ordinary high water mark* | Dimensions (ft) length width depth | Volume (cu yd)

Riprap landward of the [ ] *shoreline* OR [ ] *ordinary high water mark* | Dimensions (ft) length width depth | Volume(cu yd)

Type of *riprap* [ ] field stone [ ] angular rock [ ] other

Will *filter fabric* be used under proposed *riprap*? [ ] No [ ] Yes (**If Yes,** type)

[ ] **D. SHORE PROTECTION PROJECTS** (See Sample Drawings 2, 3, and 17)

(check all that apply) [ ] *riprap* [ ] *seawall/bulkhead* [ ] *revetment*

[ ] **E. DOCK - PIER - MOORING PILINGS** (See Sample Drawing 10)

Type [ ] open pile [ ] filled [ ] crib | *Seasonal structure*? [ ] No [ ] Yes

Proposed *structure* dimensions (ft) length width | Dimensions of nearest adjacent *structures* (ft) length width

[ ] **F. BOAT WELL** (No Sample Drawing available)

Type of bank stabilization [ ] wood [ ] steel [ ] concrete [ ] vinyl [ ] *riprap* [ ] other

Boat well dimensions (ft) Length width depth | Number of boats

Volume of backfill behind sidewall stabilization (cu yd) | Distances of *boat well* from adjacent property lines (ft)

[ ] **G. BOAT LAUNCH** (No Sample Drawing available)

(check all that apply) [ ] new [ ] existing [ ] public [ ] private [ ] commercial | Type of material [ ] concrete [ ] wood [ ] stone [ ] other

Overall boat launch dimensions (ft) Length width depth | Boat launch dimensions (ft) below *ordinary high water mark* length width depth

Distances of launch from both property lines (ft) | Number of skid *piers* | Skid *pier* dimensions (ft) width length

[ ] **H. BOAT HOIST** (No Sample Drawing available)

(Check all that apply) [ ] *seasonal* [ ] permanent [ ] cradle [ ] side lifter [ ] other | located on [ ] *seawall* [ ] *dock* [ ] bottomlands

[ ] **I. BOARDWALKS AND DECKS IN WETLANDS OR FLOODPLAINS** (See Sample Drawings 5 and 6)

(Check all that apply) [ ] boardwalk [ ] deck [ ] wetlands [ ] *floodplain* | Boardwalk or deck is on [ ] fill [ ] *piling*

01-24-46-P

Enbridge (U.S.) Inc.
Lake Superior Place
21 West Superior Street
Duluth, Minnesota 55802
Telephone: (218) 725-0100
Fax: [218] 725=0564
www.enbridge.com

Dana A. Slade Environmental Analyst II
Scott Lounsbury Supervisor, Environment
Barry F. Power Environmental Engineer

ENBRIDGE

October 2, 2001

Mr. John Arevalo
Michigan Department of Environmental Quality
Gaylord District
2100 West M-32
Gaylord, MI 49735

Re: Final phase of indications requiring repair work on Enbridge Energy's Crude Oil Transmission Pipelines Located in the Straits of Mackinac.

Dear Mr. Arevalo:

Enbridge Energy has recently located the final eight indications along our pipeline where additional support is required beneath our pipelines which cross the Straits of Mackinac. Each of these indications have un-supported spans exceeding 130 feet and are in need of repair. As with the earlier indications, these repairs will be completed through the use of grout bags. This work will be conducted coincident with our on-going repair program in the Straits as previously documented in our September 14, 2001 letter to the MDEQ. We are requesting authorization under our existing permit (#01-24-0046-P) which was issued on September 17, 2001.

These preventative maintenance repairs must be completed as soon as possible. We are scheduled to begin repair work on these final eight indications on Wednesday or Thursday, October 3 & 4, 2001. This is the last set of indications requiring repair on the un-supported sections of pipeline. Upon completion of these eight repairs, we will submit a notice of project completion to your office.

We appreciate your work to expedite the approval process. If you have any questions or comments, please feel free to contact me at (218) 725-0143.

Sincerely,

Barry Power

Barry F. Power, P.E.
Engineer

Enclosure: Indications map
Span locations

c: John Sobojinski – Enbridge Energy
Grant Henningsen – Enbridge Energy
Adam Erickson – Enbridge Energy

01-24-46-P

Enbridge Energy Company, Inc.
Lake Superior Place
21 West Superior Street
Duluth, MN 55802-2067
Tel 218 725 0100
Fax 218 725 0139
www.enbridgepartners.com

Scott W. Lounsbury Supervisor, Environment
Dana A. Slade Senior Environmental Analyst
Kris H. Benson Environmental Analyst
Barry F. Power Environmental Engineer

ENBRIDGE™

Received
LWMD/DEQ
DEC 10 2001
GAYLORD

December 5, 2001

Mr. John Arevalo
Michigan Department of Environmental Quality
Gaylord District
2100 West M-32
Gaylord, MI 49735

Re: Temporary completion of repairs on indications requiring work on Enbridge Energy's crude oil transmission pipelines located in the Straits of Mackinac.

Dear Mr. Arevalo:

Enbridge Energy has finished the 2001 repairs on indications along our pipeline where additional support was required beneath our pipelines which cross the Straits of Mackinac. However, this notification does not serve as the project Notice of Completion. Once we determine additional locations requiring repair, we will resume activities during 2002. Prior to initiating the 2002 repairs, we will submit a map showing the target locations and request for authorization to complete repairs.

If you have any questions or comments, please feel free to contact me at (218) 725-0143.

Sincerely,

Barry F. Power, P.E.
Environmental Engineer

c: John Sobojinski – EEP
Grant Henningsen – EEP
Adam Erickson - EEP
Scott Lounsbury – EEP

Letter to add supports 05 20 03

Enbridge Pipelines (Lakehead) L.L.C.
119 N. 25th Street East
Superior, WI 54880
www.enbridgepartners.com

Grant P. Henningsen
Supervisor, Civil/Mechanical Engineering
Adam J. Erickson
Engineer
Tel 715 394 1548
Fax 715 394 1564
adam.erickson@enbridge.com

ENBRIDGE™

May 20, 2003

RECEIVED
DEQ-GLMD
MAY 21 2003
GAYLORD

Mr. John Arevalo
Michigan Department of Environmental Quality
Land and Water Management Division
Gaylord District
2100 M-32 West
Gaylord, MI 49735

Re: Enbridge Energy's Joint Permit Application for Repair Work to be Completed on Crude Oil Transmission Pipelines Located in the Straits of Mackinac. MDEQ Permit Number: 01-24-0046-P

Dear Mr. Arevalo:

Enbridge Energy has recently located sections along our pipeline where additional support is required beneath our pipelines which cross the Straits of Mackinac. Each of these indications have un-supported spans that are in need of repair. These repairs will be completed through the use of the augered supports we discussed in our phone conversation several months ago. Figures depicting repair locations and the equipment to be used are included with this letter. We are requesting either a new authorization or a revised Joint Permit Application Approval for Permit number 01-24-0046-P.

We are scheduled to begin repair work on these additional indications in June of this year. If additional un-supported sections of pipeline requiring repair are located, we will issue an additional map indicating their locations. Please note that we are also seeking approval from the U.S. Army Corp. of Engineers.

We appreciate your work to expedite the approval process. If you have any questions or comments, please feel free to contact me at (715) 394-1548.

Sincerely,

Adam Erickson

Adam J. Erickson
Engineer

Enclosure: Repair Locations Map
Typical Suspension Support Sketches
Joint Permit Application

c: John Sobojinski – Enbridge
Grant Henningsen – Enbridge
bc: Law

JOHN - I WAS NOT SURE IF I SHOULD INCLUDE THE $50 APPLICATION FEE (IF RENEWAL) (IF REVISED) PLEASE CALL IF NEEDED ADAM

Support Letter 03 14 05

Enbridge Pipelines (Lakehead) L.L.C.
Superior Region Office
119 North 25th Street East
Superior, WI 54880-5247
www.enbridgepartners.com

Adam J. Erickson
Region Engineer
Tel 715 394 1548
Fax 715 394 1405
adam.erickson@enbridge.com

ENBRIDGE™

March 14, 2005

Mr. John Arevalo
Michigan Department of Environmental Quality
Land and Water Management Division
Gaylord District
2100 M-32 West
Gaylord, MI 49735

Re: Enbridge Energy's Joint Permit Application for Repair Work to be Completed on Crude Oil Transmission Pipelines Located in the Straits of Mackinac.

MDEQ Permit Number: 01-24-0046-P

Dear Mr. Arevalo:

Enbridge Energy is planning to repair sections along our pipeline where additional support is required beneath our pipelines which cross the Straits of Mackinac. Each of these indications have un-supported spans that are in need of repair. These repairs will be completed through use of the augered supports we have utilized the past few years. Figures depicting repair locations and the equipment to be used are included with this letter. We are requesting a new Joint Permit Application Approval for this project.

We are scheduled to begin repair work on these additional indications in June of this year. If additional un-supported sections of pipeline requiring repair are located or revised during our ROV (Remote Operating Vehicle) inspection, we will issue another map indicating their locations prior to initiating the repairs. Please note that we are also seeking approval from the U.S. Army Corp. of Engineers. Attached are three copies of the enclosures for distribution within the agency. A check in the amount of $500 is included with this letter to cover the permit application filing fee.

We appreciate your assistance with approval of this project. If you have any questions or comments, please feel free to contact me at (715) 394-1548.

Sincerely,

Adam J. Erickson

Adam J. Erickson
Engineer

Received
LWMD/DEQ
MAR 21 2005
GAYLORD FIELD OFFICE

Enclosure: Repair Locations Map
Typical Suspension Support Sketches
Joint Permit Application

c: John Sobojinski – Enbridge
Grant Henningsen – Enbridge

Enbridge Pipelines (Lakehead) L.L.C. Adam J. Erickson Superior Region Engineer
119 N. 25th Street East
Superior, WI 54880
Tel 715 394 1400
Fax 715 394 1570
www.enbridgepartners.com

ENBRIDGE™

April 13, 2005

RECEIVED
APR 19 2005
MDEQ/LWMD
PERMIT CONSOLIDATION UNIT

Mr. John Gustafson
Permit Consolidation Unit
Michigan Department of Environmental Quality
Land and Water Management Division
P.O. Box 30204
525 W. Allegan Street
Lansing, MI 48909-7704

Re: Application Correction Request for Enbridge Energy's Repair Work to be Completed on Crude Oil Transmission Pipelines Located in the Straits of Mackinac.

MDEQ File Number: 05-24-0013-P

Dear Mr. Gustafson:

This letter is an addendum to our previous submittal and serves to address the comments detailed in your March 28, 2005 letter (attached) requesting additional information regarding the above referenced project. Each of the items discussed in that letter are addressed below:

1. Section 3 of the joint permit application has been completed that indicates who the sole property owner is. Since the work to be completed will take place in Lake Michigan, the State of Michigan is considered the property owner. The joint permit application reflecting this information is included with this letter.
2. The property owners where the pipeline enters/exits the shoreline of Lake Michigan in both Emmet and Mackinac counties are included in Section 8 of the joint permit application.
3. The supports will be drilled approximately six feet into the lake bottom. A typical support structure is five feet wide by five feet tall, plus an anchor length of approximately six feet. There are two 20-inch crude oil transmission pipelines that will be worked on/supported.

We appreciate your assistance with approval of this project. If you have any questions or comments, please feel free to contact me at (715) 394-1548.

Sincerely,

Adam J. Erickson

Adam J. Erickson
Engineer

Enclosures: Application Correction Request Letter
Joint Permit Application

c: John Sobojinski – Enbridge
Grant Henningsen – Enbridge
John Korienek - NREC

bc: Law

US Army Corps of Engineers (USACE) | Michigan Department of Environmental Quality (MDEQ) DEQ

AGENCY USE		Date Received		AGENCY USE
	Previous USACE Permit or File Number	Received LWMD/DEQ MAR 21 2005 GAYLORD FIELD OFFICE	Land and Water Management Division, MDEQ File Number 05-24-0013P	
	USACE File Number		Marina Operating Permit Number	
			Fee received $ 500.00 #2035	

• Complete all items in Sections 1 through 9 and those items in Sections 10 through 21 that apply to your proposed project.

1 PROJECT LOCATION INFORMATION

• Refer to your property's legal description for the Township, Range, and Section information, and your property tax bill for your Property Tax Identification Number(s).

Address	Township Name(s)	Township(s)	Range(s)	Section(s)
Lake Michigan between Upper and Lower Penninsula	N/A	39N	3W	N/A

City/Village	County(ies)	Property Tax Identification Number(s)
N/A	N/A	N/A

Name of Waterbody	Project Name or Job Number	Subdivision/Plat	Lot Number	Private Claim
Lake Michigan	Underwater Inspections	N/A	N/A	N/A

Project types (check all that apply):
☐ private ☐ building addition ☐ other (explain) ☐ public/government ☐ new building or *structure* ☒ industrial ☐ building renovation or restoration ☐ commercial ☐ river restoration ☐ multi-family ☐ single-family

The proposed project is on, within, or involves (check all that apply):
☐ a legally established County Drain (date established)
☐ a stream ☐ a pond (less than 5 acres) ☒ a Great Lake or *Section 10 Waters* ☐ a *natural river* ☐ a new marina
☐ a river ☐ a channel/canal ☐ a designated *high risk erosion area* ☐ a *dam* ☐ a *structure* removal
☐ a ditch or drain ☐ an *inland lake* (5 acres or more) ☐ a designated *critical dune area* ☐ a wetland ☐ a utility crossing
☐ a *floodway* area ☐ a *100-year floodplain* ☐ a designated *environmental area* ☐ 500 feet of an existing waterbody

2 DESCRIBE PROPOSED PROJECT AND ASSOCIATED ACTIVITIES, AND THE CONSTRUCTION SEQUENCE AND METHODS

• Attach separate sheets, as needed, including necessary drawings, sketches, or plans.

The purpose of this project is to provide support beneath our pipelines in sections where the pipeline span is unsupported over too great a distance. Supports will be placed around the unsupported sections of the pipeline and will then be augered into the sediment. A certified diver will be deployed to oversee the installation.

3 APPLICANT, AGENT/CONTRACTOR, AND PROPERTY OWNER INFORMATION

• The applicant can be either the property owner or the person or company that proposes to undertake the activity.
• If the applicant is a corporation, both the corporation and it's owner must provide a written document authorizing the agent/contractor to act on their behalf.

Applicant (individual or corporate name)	Agent/Contractor (firm name and contact person)
Enbridge Energy, Limited Partnership	
Mailing Address: 119 North 25th Street East	Address:
City: Superior State: WI Zip Code: 54880	City: State: Zip Code:
Daytime Telephone Number with Area Code: (715) 394-1400	Daytime Telephone Number with Area Code:
Fax: (715) 394-1405 E-mail: Adam.Erickson@enbridge.com	Fax: E-mail:

Is the applicant the sole owner of all property on which this project is to be constructed and all property involved or impacted by this project? ☐ No ☐ Yes
(**If No**, provide a letter signed by the property owner authorizing the agent/contractor to act on his or her behalf or a copy of easements or right-of-ways. If multiple owners, please **attach** all property owners' names, mailing addresses, and telephone numbers.)

Property Owner's Name (If different from applicant)	Mailing Address
Daytime Telephone Number with Area Code	City State Zip Code

4 PROPOSED PROJECT PURPOSE, INTENDED USE, AND ALTERNATIVES CONSIDERED (Attach additional sheets if necessary)

• The purpose must include any new development or expansion of an existing land use.
• Include a description of alternatives considered to avoid or minimize resource impacts. Include factors such as, but not limited to, alternative construction technologies; alternative project layout and design; alternative locations; local land use regulations and infrastructure; and pertinent environmental and resource issues.
• For utility crossings, include both alternative routes and alternative construction methods.

In order to maintain pipeline integrity and safety, additional supports are necessary under lengthy unsupported spans of pipeline. Indications of the span locations are shown in the enclosed map. Depictions of the augering method, equipment utilized as well as the structure of the supports themselves are located in the attachments. This support method is the most environmentally friendly method of which we are aware. There will be no expansion of existing land use. This project is not for the installation of a new utility crossing.

5 LOCATING YOUR PROJECT SITE

- Provide the requested information listed below that will help staff in locating your project site.
- Attach a copy of a map, such as a plat, county, or USGS topographic map, clearly showing the site location and include an arrow indicating the north direction.

Is there an access road to the project? ☒ No ☐ Yes **(If Yes, type of road, check all that apply)** ☐ private ☐ public ☐ improved ☐ unimproved

Name of roads at closest main intersection and

Directions from main intersection

Style of house or other building on site ☐ ranch ☐ 2-story ☐ cape cod ☐ bi-level ☐ cottage/cabin ☐ pole barn ☐ none ☐ other (describe)

Color Color of adjacent property house and/or buildings

House number Address is visible on ☐ house ☐ garage ☐ mailbox ☐ sign ☐ other

Street name Fire lane number Lot number

How can your site be identified if there is no visible address?

Provide directions to the project site, with distances from the best and nearest visible landmark and waterbody *It is located betweeen the Upper and Lower Peninsula's of Michigan in the Straits of Mackinac. Please refer to the enclosed map.*

Does project cross boundaries of two or more political jurisdictions? (City/Township, Township/Township, County/County, etc.)
☐ No ☐ Yes (If Yes, list jurisdiction names.) *Unknown*

6 List all other federal, interstate, state, or local agency authorizations required for the proposed activity, including all approvals or denials received.

Agency	Type approval	Identification number	Date applied	Date approved / denied	If denied, reason for denial
USACE	*Nationwide Permit*	*NW03*	*May 20, 2003*	*May 27, 2003*	

7 If a permit is issued, date activity will commence (M/D/Y) *06/01/2005*

Proposed completion date (M/D/Y) *10/31/2005*

Has any construction activity commenced or been completed in a regulated area? ☒ No ☐ Yes
If Yes, identify the portion(s) underway or completed on drawings or attach project specifications and give completion date(s) (M/D/Y)

Were the regulated activities conducted under a MDEQ permit? ☐ No ☐ Yes
If Yes, list the MDEQ permit number

Are you aware of any unresolved violations of environmental law or litigation involving the property? ☒ No ☐ Yes (**If Yes,** please explain)

8 PUBLIC NOTIFICATION (Attach additional sheets if necessary)

- Complete information for all *adjacent and impacted property owners* and the lake association or established lake board including the contact person's name.
- If you own the adjacent lot, provide the requested information for the first adjacent parcel beyond your property line.

Property Owner's Name	Mailing Address	City	State	Zip Code
City of St. Ignace	*396 North State Street*	*St. Ignace*	*MI*	*49781*
Edison Sault Electric Company	*725 East Portage Ave.*	*Sault Ste. Marie*	*MI*	*49783*
Todd & Shirley Harburn	*4060 Leeward Drive*	*Okemos*	*MI*	*48864*
Neil & Jeannette Downing	*6819 David Drive Box 747*	*Mackinaw City*	*MI*	*49701*
Elizabeth J. Hayes & Richard L. Hayes	*14029 - 16th Court SE*	*Mill Creek*	*WA*	*98012*

Name of ☐ Established Lake Board ☐ or Lake Association
and the Contact Person's Name, telephone number, and mailing address *N/A*

9 APPLICANT'S CERTIFICATION READ CAREFULLY BEFORE SIGNING

I am applying for a permit(s) to authorize the activities described herein. I certify that I am familiar with the information contained in this application, that it is true and accurate, and, to the best of my knowledge, is in compliance with the State *Coastal Zone Management Program* and the *National Flood Insurance Program.* I understand that there are penalties for submitting false information and that any permit issued pursuant to this application may be revoked if information on this application is untrue. I certify that I have the authority to undertake the activities proposed in this application. By signing this application, I agree to allow representatives of the MDEQ, USACE, and/or their agents or contractors to enter upon said property in order to inspect the proposed activity site and the completed project. I understand that I must obtain all other necessary local, county, state, or federal permits and that the granting of other permits by local, county, state, or federal agencies does **not** release me from the requirements of obtaining the permit requested herein before commencing the activity. I understand that the payment of the application fee does **not** guarantee the issuance of a permit.

- All applicants must complete all the items in Sections 1 through 9 on pages 1 and 2 of this application.
- Complete those items in Sections 10 through 21 that apply to your project. Submit only those pages where you have provided information.
- **Please list here the application page numbers being submitted and a brief description of other attachments included with your application.**
- Your permit decision will be delayed if forms are incomplete or maps and/or drawings are not submitted.

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☐ Property Owner
☐ Agent/Contractor
☒ Corporation – Title *Engineer* Printed Name *Adam Erickson* B-18 Signature Adam Erickson Date *4/14/05*

10 PROJECTS IMPACTING WETLANDS OR FLOODPLAINS OR LOCATED ON AN INLAND LAKE OR STREAM OR A GREAT LAKE

- Check boxes A through N that may be applicable to your project and provide the requested information.
- If your project may affect wetlands, also complete Section 12. If your project may impact regulated *floodplains*, also complete Section 13.
- Provide an overall site plan showing existing lakes, streams, wetlands, and other water features; existing *structures*; and the location of all proposed *structures*, land change activities and *soil erosion and sedimentation control measures*. Please review sample drawings for guidance in completing site-specific drawings for your project.
- Some projects on the Great Lakes require an application for conveyance prior to Joint Permit Application completeness. Call 517-373-3894 for applicability.
- On a Great Lake use *IGLD 85* ☒ surveyed ☐ converted from observed still water elevation. On inland waters, ☐ *NGVD 29* ☐ local datum ☐ other

Observed water elevation (ft) , date of observation (M/D/Y)

☐ A. PROJECTS REQUIRING FILL (See All Sample Drawings)

- To calculate volume in cubic yards (cu yd), multiply the average length in feet (ft) times the average width (ft) times the average depth (ft) and divide by 27.
- Attach both plan and *cross-section* views to scale showing maximum and average fill dimensions.

(Check all that apply) ☐ *floodplain* fill ☐ wetland fill ☐ *riprap* ☐ *seawall, bulkhead*, or *revetment* ☐ bridge or culvert ☐ boat launch ☐ off-shore swim area ☐ beach sanding ☐ boatwell ☐ crib *dock* ☐ other

Fill dimensions (ft) length width maximum depth | Fill volume (cu yd) | Maximum water depth in fill area (ft)

Type of clean fill ☐ pea stone ☐ sand ☐ gravel ☐ wood chips ☐ other | Will *filter fabric* be used under proposed fill? ☐ No ☐ Yes (**If Yes,** type)

Source of clean fill ☐ on-site, **If on-site,** show location on site plan ☐ commercial ☐ other, **If other,** attach description of location

Fill will extend feet into the water from the *shoreline* and *upland* feet out of the water.

☐ B. PROJECTS REQUIRING DREDGING OR EXCAVATION (For dredging projects, see Sample Drawing 7, for excavation, see other applicable Sample Drawings)

- To calculate volume in cubic yards (cu yd), multiply the average length in feet (ft) times the average width (ft) times the average depth (ft) and divide by 27.
- Attach both plan and *cross-section* views to scale showing maximum and average dredge or excavation dimensions.
- The applicant will be notified if sediment sampling will be required.

(Check all that apply) ☐ *floodplain* excavation ☐ wetland dredge or draining ☐ *seawall, bulkhead, or revetment* ☐ navigation ☐ *boat well* ☐ boat launch ☐ other

Dredge/excavation volume (cu yd) | Dimensions (ft) length width depth | Method and equipment for dredging

Has proposed dredge material been tested for contaminants? ☐ No ☐ Yes (**If Yes,** attach testing results) | Will dredged or excavated spoils be placed ☐ on-site ☐ off-site? Attach a detailed disposal area site plan and location map.

Has this same area been previously dredged? ☐ No ☐ Yes (**If Yes,** provide date and permit number, if available) (M/D/Y)
If Yes, are you proposing to enlarge the previously dredged area? ☐ No ☐ Yes

Is long-term maintenance dredging planned? ☐ No ☐ Yes (**If Yes,** when and how much?)

☐ C. PROJECTS REQUIRING RIPRAP (See Sample Drawings 2, 3, 8, 12, 14, 17, 22, and 23. Others may apply)

Riprap **waterward** of the ☐ *shoreline* **OR** ☐ *ordinary high water mark* | Dimensions (ft) length width depth | Volume (cu yd)

Riprap **landward** of the ☐ *shoreline* **OR** ☐ *ordinary high water mark* | Dimensions (ft) length width depth | Volume (cu yd)

Type of *riprap* ☐ field stone ☐ angular rock ☐ other

Will *filter fabric* be used under proposed *riprap*? ☐ No ☐ Yes (**If Yes,** type)

☐ D. SHORE PROTECTION PROJECTS (See Sample Drawings 2, 3, and 17)

(check all that apply)
☐ riprap – length ft. ☐ seawall/bulkhead – length ft. ☐ revetment – length ft. | Distances of project from both property lines (ft)

☐ E. DOCK - PIER - MOORING PILINGS (See Sample Drawing 10)

Type ☐ open pile ☐ filled ☐ crib | *Seasonal structure*? ☐ No ☐ Yes

Proposed *structure* dimensions (ft) length width | Dimensions of nearest adjacent *structures* (ft) length width

☐ F. BOAT WELL (No Sample Drawing available)

Type of bank stabilization ☐ wood ☐ steel ☐ concrete ☐ vinyl ☐ *riprap* ☐ other

Boat well dimensions (ft) length width depth | Number of boats

Volume of backfill behind sidewall stabilization (cu yd) | Distances of *boat well* from adjacent property lines (ft)

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☐ G. BOAT LAUNCH (No Sample Drawing available) (check all that apply) ☐ new ☐ existing ☐ public ☐ private ☐ commercial ☐ replacement

Proposed overall boat launch dimensions (ft) length width depth | Type of material ☐ concrete ☐ wood ☐ stone ☐ other

Existing overall boat launch dimensions (ft) length width depth | Boat launch dimensions (ft) below *ordinary high water mark* length width depth

Distances of launch from both property lines (ft) | Number of skid *piers* | Skid *pier* dimensions (ft) width length

☐ H. BOAT HOIST (No Sample Drawing available)

(Check all that apply) ☐ *seasonal* ☐ permanent ☐ cradle ☐ side lifter ☐ other | located on ☐ *seawall* ☐ *dock* ☐ bottomlands

☐ I. BOARDWALKS AND DECKS IN ☐ WETLANDS – OR - ☐ FLOODPLAINS (See Sample Drawings 5 and 6)

(Check all that apply) ☐ boardwalk ☐ deck | Boardwalk or deck is on ☐ fill ☐ *piling* | Dimensions (ft) length width

10 Continued - PROJECTS IMPACTING WETLANDS OR FLOODPLAINS OR LOCATED ON AN INLAND LAKE OR STREAM OR A GREAT LAKE

☐ **J. INTAKE PIPES** (See Sample Drawing 16) ☐ **OUTLET PIPES** (See Sample Drawing 22)

Type ☐ headwall ☐ end section ☐ pipe ☐ other

If outlet pipe, discharge is to ☐ wetland ☐ *inland lake* ☐ stream, drain, or river ☐ Great Lake ☐ other

Dimensions of headwall OR end section (ft) length width depth | Number of pipes | Pipe diameters and invert elevations

☐ **K. MOORING AND NAVIGATION BUOYS** (No Sample Drawing available)

- Provide an overall site plan showing the distances between each buoy, distances from the shore to each buoy, and depth of water at each buoy in feet.
- Provide cross-section drawing(s) showing anchoring system(s) and dimensions.

Number of buoys | Type of anchor system | Purpose of buoy ☐ mooring ☐ navigation

Dimensions of buoys (ft) width height

Do you own the property along the *shoreline*? ☐ No ☐ Yes **(If No,** you must provide an authorization letter from the property owner(s))

☐ **L. GROINS** (No Sample Drawing available)

- Provide an overall site plan showing the distances (ft) of the outermost *groins* from the property lines, distances between *groins*, length and width of each *groin*, and the distance from the existing toe of the bluff to the lakeward end of the *groins*.
- If existing *groins* are located on adjacent properties, provide distances (ft) from closest neighboring *groin* to your property lines on the site plan. Provide *cross-section* views showing the length and height of each *groin* and the height of *groin* ends above the observed water level (date and time). If step down type, show the height of each section above the observed water level.

Number of *groins* | Type of *groin* ☐ steel ☐ wood ☐ other

Will *groin* be placed on a foundation? ☐ No ☐ Yes **(If Yes,** dimensions of foundation (ft)) length width height

☐ **M. FENCES IN WETLANDS, STREAMS, OR FLOODPLAINS** (No Sample Drawing available)

- Provide an overall site plan showing the proposed fencing through wetlands, streams, or *floodplains*.
- Provide drawing of fence profile showing the design, dimension, post spacing, board spacing, and distance from ground to bottom of fence (if in a *floodplain*).

(check all that apply) ☐ wetlands ☐ streams ☐ *floodplains* | Total length (ft) of fence through wetlands streams *floodplains* | Fence height (ft) | Fence type and material

☒ **N. OTHER** - e.g., *structure* removal, *marine railway*, *low sand trap wall*, *breakwater*, and structural foundations in wetlands or *floodplains*

Please see Section 4 for a detailed description of this pipeline support project

11 EXPANSION OF AN EXISTING OR CONSTRUCTION OF A NEW LAKE OR POND (See Sample Drawings 4 and 15)

Which best describes your proposed waterbody use **(check all that apply)**

☐ wildlife ☐ *stormwater retention basin* ☐ *stormwater detention basin* ☐ recreation ☐ wastewater basin ☐ other

Water source for lake/pond

☐ groundwater ☐ natural springs ☐ *Inland Lake or Stream* ☐ stormwater runoff ☐ pump ☐ sewage ☐ other

Location of the lake/basin/pond ☐ floodplain ☐ wetland ☐ upland

Will project involve construction of a *dam*, dike, outlet control *structure*, or *spillway*? ☐ No ☐ Yes **(If Yes,** complete Section 17)

12 ACTIVITIES THAT MAY IMPACT WETLANDS

- For information on the MDEQ's *Wetland Assessment* Program, please visit the LWMD website or call 517-241-8485.

(check all that apply) ☐ fill (Section 10A) ☐ dredge or excavation (Section 10B) ☐ boardwalk or deck (Section 10I) ☐ fences (Section 10M) ☐ bridges and culverts (Section 14) ☐ draining surface water ☐ other

Has a professional wetland delineation been conducted for this parcel? ☐ No ☐ Yes **(If Yes,** please provide a copy; if federal method was used, supply data sheets)

Applicant purchased property ☐ before **OR** ☐ after October 1, 1980.

Is there a recorded MDEQ easement on the property? ☐ No ☐ Yes **(If Yes,** please provide the number)

Has the MDEQ conducted a *wetland assessment* for this parcel? ☐ No ☐ Yes **(If Yes,** please provide a copy)

Describe the wetland impacts, proposed use or development, and efforts to avoid/minimize impacts. Describe the wetland alternatives and provide the type and amount of mitigation proposed if more than 1/3 acre is to be impacted.

Is any grading or mechanized land clearing proposed? ☐ No ☐ Yes **(If Yes,** please show locations on site plan)

Has any of the proposed grading or mechanized land clearing been completed? ☐ No ☐ Yes **(If Yes,** please label and show locations on site plan)

- Complete the wetland dredge and wetland fill dimension information for **each** impacted wetland area. Attach additional sheets if necessary and label the impacted wetland areas on a site plan drawn to scale. Please attach at least one typical *cross-section* for each wetland dredge and/or fill area. (See Sample Drawings 8 & 9)
- Also complete Section 10A for fill and Section 10B for dredge or excavation activities.
- If dredge material will be disposed of on site, please show the location on site plan in an *upland* area and include *soil erosion and sedimentation control measures*.

Wetland dredge dimensions	maximum length (ft)	maximum width (ft)	dredge area ☐ acres ☐ sq ft	average depth (ft)	dredge volume(cu yd)
Wetland fill dimensions	maximum length (ft)	maximum width (ft)	fill area ☐ acres ☐ sq ft	average depth (ft)	fill volume(cu yd)

Total wetland dredge area ☐ acres ☐ sq ft | Total wetland dredge volume (cu yd)

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Total wetland fill area ☐ acres ☐ sq ft | Total wetland fill volume (cu yd)

APR 1 9 2005

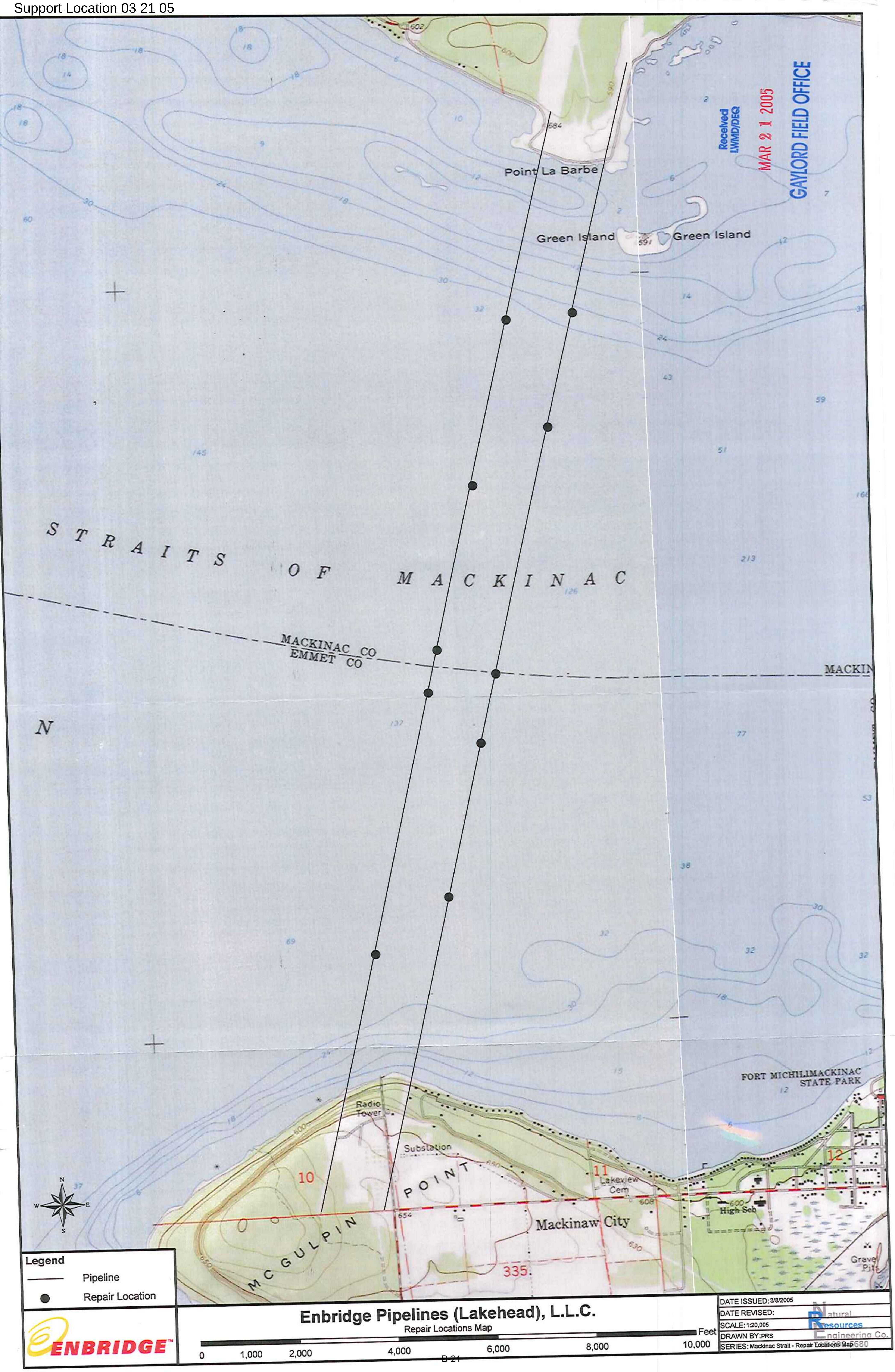
The proposed project will be serviced by ☐ public sewer ☐ private septic system **(If septic system,** show existing and new or expanded system on plans)

If septic system, has application been made to the County Health Department for a permit? ☐ No ☐ Yes

If Yes, has permit been issued? ☐ No ☐ Yes (If Yes, provide copy)

MDEQ/LWMD PERMIT CONSOLIDATION UNIT

B-20



Point La Barbe
Green Island
Green Island
Received LWMD/DEQ
MAR 2 1 2005
GAYLORD FIELD OFFICE
STRAITS OF MACKINAC
MACKINAC CO
EMMET CO
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N
FORT MICHILIMACKINAC STATE PARK
Radio Tower
Substation
MCGULPIN POINT
Lakeview Cem
Mackinaw City
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Gravel Pits
10
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Legend
Pipeline
Repair Location
ENBRIDGE
Enbridge Pipelines (Lakehead), L.L.C.
Repair Locations Map
Feet
0
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2,000
4,000
6,000
8,000
10,000
DATE ISSUED: 3/8/2005
DATE REVISED:
SCALE: 1:20,005
DRAWN BY: PRS
SERIES: Mackinac Strait - Repair Locations Map
Natural Resources Engineering Co.

Natural Resources Engineering Co.

Natural Resources Engineering Company
69 North 28th Street - Suite 27
Superior, Wisconsin 54880
Telephone (715) 395-5680 Fax [715] 395-5681

file

July 22, 2005

Mr. John Arevalo
Michigan Department of Environmental Quality
Gaylord District
2100 West M-32
Gaylord, MI 49735

Received
LWMD/DEQ
JUL 26 2005
GAYLORD FIELD OFFICE

RE: MDEQ Permit Number 05-24-0013-P

Dear Mr. Arevalo:

This letter serves as a Notice of Completion for Enbridge Pipelines (Lakehead) LLC project involving the installation of support structures on our crude oil transmission pipeline in Lake Huron at St. Ignace, Michigan. The project was completed on July 1, 2005. We will notify the MDEQ prior to initiating our 2006 project.

In the event you have questions or comments, please feel free to give me a call. I can be reached at (715) 395-5680 Ext. 120.

Sincerely,

John J Korienek

John J. Korienek, P.E.
Environmental Engineer

cc: Adam Erickson – Enbridge: Superior Region

Supports 05 03 06

Enbridge Pipelines (Lakehead) L.L.C.
119 N. 25th Street East
Superior, WI 54880
Tel 715 394 1400
Fax 715 394 1570
www.enbridgepartners.com

Scott W. Lounsbury Supervisor, Environment
Kris H. Benson Environmental Analyst II
Paul R. Meneghini Sr. Environmental Analyst
Rachael A. Shetka Environmental Analyst
David M. Hoffman Sr. Environmental Analyst
Joseph P. Peterson Environmental Analyst II

ENBRIDGE™

May 3, 2006

Ms. Wendy Fitzner
Michigan Department of Environmental Quality
WMD - PCU
P.O. Box 30204
Lansing, MI 48909-7704

RE: Joint Permit Application for Pipeline Inspection and Repair Activities to be Conducted Along Pipeline Crossing at the Straits of Mackinac

Dear Ms. Fitzner:

Please see attached Joint Application for coverage of proposed pipeline maintenance activities. Currently Enbridge has coverage for similar maintenance work under permit #05-24-0013, however, because the current permit expires prior to the planned execution of the proposed activities and because the number of additional locations identified for repair is deemed significant by the Agency, Enbridge has been requested to resubmit a Joint Permit Application to cover the additional repairs.

As I discussed with the Agency contact (John Arevalo) earlier this week, the proposed project is similar in terms of method to that previously covered under the existing permit. As shown on the attached figures, the proposed work involves conducting underwater inspections along the pipeline and installing a brace over the pipe, secured by anchors augured into the lake bed at twenty locations (refer to Project Location Map). The work will be conducted using a barge platform to lower the weights which will be installed by a certified diver. The proposed project execution date is scheduled for June 1st with an anticipated completion date of June 15th, contingent on maritime conditions.

I appreciate your assistance with this request. Please feel free to contact me if you have any questions or require further information at (715) 394-1572 or by email at *Kris.Benson@Enbridge.com*.

Sincerely,

Kris Benson

Kris Benson
Environmental Analyst II, CHMM

Enclosures: Proposed Project Locations Site map
Project Schematics (3)

c: Dan Klarner – Enbridge Regional Engineer

Permit for Add. Supports 03 21 05

US Army Corps of Engineers (USACE) — Michigan Department of Environmental Quality (MDEQ) DEQ

AGENCY USE

Previous USACE Permit or File Number	Date Received	Land and Water Management Division, MDEQ File Number
	Received LWMD/DEQ	05-24-0013P
USACE File Number	MAR 2 1 2005	Marina Operating Permit Number
	GAYLORD FIELD OFFICE	Fee received $ 500.00 #2035

- **Complete all items in Sections 1 through 9 and those items in Sections 10 through 21 that apply to your proposed project.**

1 PROJECT LOCATION INFORMATION

- Refer to your property's legal description for the Township, Range, and Section information, and your property tax bill for your Property Tax Identification Number(s).

Address	Township Name(s)	Township(s)	Range(s)	Section(s)
Lake Michigan between Upper and Lower Peninsula	*N/A*	*39N*	*3W*	*N/A*

City/Village	County(ies)	Property Tax Identification Number(s)
N/A	*N/A*	*N/A*

Name of Waterbody	Project Name or Job Number	Subdivision/Plat	Lot Number	Private Claim
Lake Michigan	*Underwater Inspections*	*N/A*	*N/A*	*N/A*

Project types **(check all that apply)**
☐ private ☐ public/government ☒ industrial ☐ commercial ☐ multi-family
☐ building addition ☐ new building or *structure* ☐ building renovation or restoration ☐ river restoration ☐ single-family
☐ other (explain)

The proposed project is on, within, or involves **(check all that apply)** ☐ a legally established County Drain (date established)
☐ a stream ☐ a pond (less than 5 acres) ☒ a Great Lake or *Section 10 Waters* ☐ a *natural river* ☐ a new marina
☐ a river ☐ a channel/canal ☐ a designated *high risk erosion area* ☐ a *dam* ☐ a *structure* removal
☐ a ditch or drain ☐ an *inland lake* (5 acres or more) ☐ a designated *critical dune area* ☐ a wetland ☐ a utility crossing
☐ a *floodway* area ☐ a *100-year floodplain* ☐ a designated *environmental area* ☐ 500 feet of an existing waterbody

2 DESCRIBE PROPOSED PROJECT AND ASSOCIATED ACTIVITIES, AND THE CONSTRUCTION SEQUENCE AND METHODS

- Attach separate sheets, as needed, including necessary drawings, sketches, or plans.

The purpose of this project is to provide support beneath our pipelines in sections where the pipeline span is unsupported over too great a distance. Supports will be placed around the unsupported sections of the pipeline and will then be augered into the sediment. A certified diver will be deployed to oversee the installation.

3 APPLICANT, AGENT/CONTRACTOR, AND PROPERTY OWNER INFORMATION

- The applicant can be either the property owner or the person or company that proposes to undertake the activity.
- If the applicant is a corporation, both the corporation and it's owner must provide a written document authorizing the agent/contractor to act on their behalf.

Applicant (individual or corporate name)	Agent/Contractor (firm name and contact person)
Enbridge Energy, Limited Partnership	
Mailing Address: *119 North 25th Street East*	Address
City: *Superior* State: *WI* Zip Code: *54880*	City State Zip Code
Daytime Telephone Number with Area Code: *(715) 394-1400*	Daytime Telephone Number with Area Code
Fax: *(715) 394-1405* E-mail: *Adam.Erickson@enbridge.com*	Fax E-mail

Is the applicant the sole owner of all property on which this project is to be constructed and all property involved or impacted by this project? ☐ No ☐ Yes
(If No, provide a letter signed by the property owner authorizing the agent/contractor to act on his or her behalf or a copy of easements or right-of-ways. If multiple owners, please attach all property owners' names, mailing addresses, and telephone numbers.)

Property Owner's Name (If different from applicant)	Mailing Address
Daytime Telephone Number with Area Code	City State Zip Code

4 PROPOSED PROJECT PURPOSE, INTENDED USE, AND ALTERNATIVES CONSIDERED (Attach additional sheets if necessary)

- The purpose must include any new development or expansion of an existing land use.
- Include a description of alternatives considered to avoid or minimize resource impacts. Include factors such as, but not limited to, alternative construction technologies; alternative project layout and design; alternative locations; local land use regulations and infrastructure; and pertinent environmental and resource issues.
- For utility crossings, include both alternative routes and alternative construction methods.

In order to maintain pipeline integrity and safety, additional supports are necessary under lengthy unsupported spans of pipeline. Indications of the span locations are shown in the enclosed map. Depictions of the augering method, equipment utilized as well as the structure of the supports themselves are located in the attachments. This support method is the most environmentally friendly method of which we are aware. There will be no expansion of existing land use. This project is not for the installation of a new utility crossing.

5 LOCATING YOUR PROJECT SITE
- Provide the requested information listed below that will help staff in locating your project site.
- Attach a copy of a map, such as a plat, county, or USGS topographic map, clearly showing the site location and include an arrow indicating the north direction.

Is there an access road to the project? ☒ No ☐ Yes **(If Yes, type of road, check all that apply)** ☐ private ☐ public ☐ improved ☐ unimproved

Name of roads at closest main intersection and

Directions from main intersection

Style of house or other building on site ☐ ranch ☐ 2-story ☐ cape cod ☐ bi-level ☐ cottage/cabin ☐ pole barn ☐ none ☐ other (describe)

Color Color of adjacent property house and/or buildings

House number Address is visible on ☐ house ☐ garage ☐ mailbox ☐ sign ☐ other

Street name Fire lane number Lot number

How can your site be identified if there is no visible address?

Provide directions to the project site, with distances from the best and nearest visible landmark and waterbody *It is located betweeen the Upper and Lower Peninsula's of Michigan in the Straits of Mackinac. Please refer to the enclosed map.*

Does project cross boundaries of two or more political jurisdictions? (City/Township, Township/Township, County/County, etc.)
☐ No ☐ Yes (If Yes, list jurisdiction names.) *Unknown*

6 List all other federal, interstate, state, or local agency authorizations required for the proposed activity, including all approvals or denials received.

Agency	Type approval	Identification number	Date applied	Date approved / denied	If denied, reason for denial
USACE	*Nationwide Permit*	*NW03*	*May 20, 2003*	*May 27, 2003*	

7 If a permit is issued, date activity will commence (M/D/Y) *06/01/2005* — Proposed completion date (M/D/Y) *10/31/2005*

Has any construction activity commenced or been completed in a regulated area? ☒ No ☐ Yes
If Yes, identify the portion(s) underway or completed on drawings or attach project specifications and give completion date(s) (M/D/Y)

Were the regulated activities conducted under a MDEQ permit? ☐ No ☐ Yes
If Yes, list the MDEQ permit number

Are you aware of any unresolved violations of environmental law or litigation involving the property? ☒ No ☐ Yes **(If Yes, please explain)**

8 PUBLIC NOTIFICATION (Attach additional sheets if necessary)
- Complete information for all *adjacent and impacted property owners* and the lake association or established lake board including the contact person's name.
- If you own the adjacent lot, provide the requested information for the first adjacent parcel beyond your property line.

Property Owner's Name	Mailing Address	City	State	Zip Code
City of St. Ignace	*396 North State Street*	*St. Ignace*	*MI*	*49781*
Edison Sault Electric Company	*725 East Portage Ave.*	*Sault Ste. Marie*	*MI*	*49783*
Todd & Shirley Harburn	*4060 Leeward Drive*	*Okemos*	*MI*	*48864*
Neil & Jeannette Downing	*6819 David Drive Box 747*	*Mackinaw City*	*MI*	*49701*
Elizabeth J. Hayes & Richard L. Hayes	*14029 - 16th Court SE*	*Mill Creek*	*WA*	*98012*

Name of ☐ Established Lake Board ☐ or Lake Association
and the Contact Person's Name, telephone number, and mailing address *N/A*

9 APPLICANT'S CERTIFICATION **READ CAREFULLY BEFORE SIGNING**

I am applying for a permit(s) to authorize the activities described herein. I certify that I am familiar with the information contained in this application, that it is true and accurate, and, to the best of my knowledge, is in compliance with the State *Coastal Zone Management Program* and the *National Flood Insurance Program*. I understand that there are penalties for submitting false information and that any permit issued pursuant to this application may be revoked if information on this application is untrue. I certify that I have the authority to undertake the activities proposed in this application. By signing this application, I agree to allow representatives of the MDEQ, USACE, and/or their agents or contractors to enter upon said property in order to inspect the proposed activity site and the completed project. I understand that I must obtain all other necessary local, county, state, or federal permits and that the granting of other permits by local, county, state, or federal agencies does not release me from the requirements of obtaining the permit requested herein before commencing the activity. I understand that the payment of the application fee does **not** guarantee the issuance of a permit.

- All applicants must complete all the items in Sections 1 through 9 on pages 1 and 2 of this application.
- Complete those items in Sections 10 through 21 that apply to your project. Submit only those pages where you have provided information.
- **Please list here the application page numbers being submitted and a brief description of other attachments included with your application.**
- Your permit decision will be delayed if forms are incomplete or maps and/or drawings are not submitted.

RECEIVED
APR 1 9 2005
MDEQ/LWMD
PERMIT CONSOLIDATION UNIT

☐ Property Owner
☐ Agent/Contractor
☒ Corporation – Title *Engineer* Printed Name *Adam Erickson* Signature Adam Erickson

From: Wendy Fitzner
To: John Gustafson
Date: 5/9/06 11:42AM
Subject: Fwd: Re: Request for Permit Extension (#05-24-0013)

John, this just came in as 06-24-0016. Can you process it within the next couple of days? Thanks.

>>> John Arevalo 05/02/06 2:47 PM >>>
Dear Ms. Benson: We have discussed this matter internally. The work which you are requesting will require a new permit application, site plans, $500 fee and public noticing. This is consistent with what we are doing statewide, and the new work exceeds (by two times) the work permitted under 05-24-0013-P. Note that this email was cc:'d to Wendy Fitzner, LWMD, Permit Consolidation Unit Chief. It should be a simple matter for you to submit a new application by updating/revising your '05 app. You already have the site plans in your PDF file. Wendy advised that if you submit a completed app. + fee, she anticipates being able to prepare the public notice within a few days after that. The public notice period comment period lasts 20 days. If Wendy assigns the file to me, I should be able to issue a permit for Enbridge in time for them to begin work by 6/1/06. Applications can also be submitted on-line. Feel free to contact Wendy for assistance w/that process. If you do not have a copy of your '05 application form and materials, let me know, and I will fax them to you. Wendy's tx number is 517-373-8798.

>>> <Kristen.Benson@enbridge.com> 05/02/06 1:21 PM >>>
Mr. Arevalo,

As we discussed this morning, please see attached letter requesting an extension of Permit #05-24-0013. As noted in the letter, the proposed project involves work identical to that already covered in the permit, although at an additional 20 locations. Should you have any questions or need additional clarification, please do not hesitate to contact me at the number listed below.

Kris H. Benson
Environmental Analyst II, CHMM
Enbridge Energy, Superior Office
Phone: 715-394-1572
Fax: 715-394-1570

John Arevalo
Cadillac District Supervisor
Land and Water Management Division
Gaylord Phone: 989-705-3450

Support Permit 05 11 06 original of fax copy rec'd 5-4-06

US Army Corps of Engineers (USACE) — Michigan Department of Environmental Quality (MDEQ) DEQ

AGENCY USE		Date Received		AGENCY USE
	Previous USACE Permit or File Number	Land & Water Mgt. Div.	Land and Water Management Division, MDEQ File Number 06-24-16-P	
	USACE File Number	MAY 11 2006	Marina Operating Permit Number	
	Gaylord - Arevalo	Permit Consolidation Unit	Fee received $ 500 —	

- Complete all items in Sections 1 through 9 and those items in Sections 10 through 21 that apply to the project. Clear drawings and cross sections must be provided.

1 PROJECT LOCATION INFORMATION

- Refer to your property's legal description for the Township, Range, and Section information, and your property tax bill for your Property Tax Identification Number(s).

Address: Lake Michigan (all in-water work) between Upper and Lower Peninsula		Township Name(s): N/A	Township(s): 39N	Range(s): 3W	Section(s): N/A
City/Village: N/A	County(ies): Mackinaw and Emmet (in Straits)	Property Tax Identification Number(s): N/A			
Name of Waterbody: Lake Michigan	Project Name or Job Number: Pipeline Inspection	Subdivision/Plat: N/A	Lot Number: N/A	Private Claim: N/A	

Project types (check all that apply): ☐ private ☐ building addition ☐ other (explain) ☐ public/government ☐ new building or *structure* ☐ industrial ☐ building renovation or restoration ☐ commercial ☐ river restoration ☐ multi-family ☐ single-family

The proposed project is on, within, or involves (check all that apply) ☐ a legally established County Drain (date established ____________)

☐ a stream ☐ a pond (less than 5 acres) ☑ a Great Lake or *Section 10 Waters* ☐ a *natural river* ☐ a new marina
☐ a river ☐ a channel/canal ☐ a designated *high risk erosion area* ☐ a *dam* ☐ a *structure* removal
☐ a ditch or drain ☐ an *inland lake* (5 acres or more) ☐ a designated *critical dune area* ☐ a wetland ☐ a utility crossing
☐ a *floodway* area ☐ a *100-year floodplain* ☐ a designated *environmental area* ☐ 500 feet of an existing waterbody

2 DESCRIBE PROPOSED PROJECT AND ASSOCIATED ACTIVITIES, AND THE CONSTRUCTION SEQUENCE AND METHODS

- Attach separate sheets, as needed, including necessary drawings, sketches, photographs, aerials, or plans.

The purpose of this project is to enhance support beneath the pipelines where the span is currently unsupported for extended distances. The work will involve the installation of a brace and anchoring system over each proposed location to increase support; the anchors will be augured directly into the lake bed. A certified diving contractor will be employed to oversee the installation.

3 APPLICANT, AGENT/CONTRACTOR, AND PROPERTY OWNER INFORMATION

- The applicant can be either the property owner or the person or company that proposes to undertake the activity.
- If the applicant is a corporation, both the corporation and its owner must provide a written document authorizing the agent/contractor to act on their behalf.

Applicant (individual or corporate name): Enbridge Energy, Limited Partnership	Agent/Contractor (firm name and contact person)
Mailing Address: 119 N. 25th St. E.	Address
City: Superior, State: WI Zip Code: 54880	City State Zip Code
Daytime Phone Number with Area Code: (715) 394-1414 Cell Phone Number	Daytime Phone Number with Area Code Cell Phone Number
Fax: (715) 394-1405 E-mail: Dan.Klarner@Enbridge.com	Fax E-mail

Is the applicant the sole owner of all property on which this project is to be constructed and all property involved or impacted by this project? ☐ No ☐ Yes
If No, provide a letter signed by the property owner authorizing the agent/contractor to act on his or her behalf or a copy of easements or right-of-ways. If multiple owners, attach all property owners' names, mailing addresses, and telephone numbers. Disclose any DEQ conservation easements or other easements, deed restrictions, leases, or any other encumbrance upon the property in the project area. A copy of the land restriction must be provided.

Property Owner's Name (If different from applicant)	Mailing Address
Daytime Phone Number with Area Code Cell Phone Number	City State Zip Code

4 PROPOSED PROJECT PURPOSE, INTENDED USE, AND ALTERNATIVES CONSIDERED (Attach additional sheets if necessary)

- The purpose must include any new development or expansion of an existing land use.
- Include a description of alternatives considered to avoid or minimize resource impacts. Include factors such as, but not limited to, alternative construction technologies; alternative project layout and design; alternative locations; local land use regulations and infrastructure; and pertinent environmental and resource issues.
- For utility crossings, include both alternative routes and alternative construction methods.

In order to maintain pipeline integrity, installation of additional supports to minimize the distance between presently unsupported pipeline spans. The proposed locations for installation of the anchoring structures are provided on the attached map. Shematics showing the auagurung apparatus and method as well as equipment utilized for installation are included with the attachments. The support method is anticipated to incur minimal or no environmental impact. Note: This project is considered pipeline maintenance and is not associated with a new utility installation.

5 LOCATING YOUR PROJECT SITE

- Provide the requested information listed below to help staff locate your project site.
- Attach a copy of a map, such as a plat, county, or USGS topographic map, clearly showing the site location and include an arrow indicating the north direction.
- Project area must be staked at the time of application submittal.

Is there an access road to the project? ☑ No ☐ Yes (If Yes, type of road, check all that apply) ☐ private ☐ public ☐ improved ☐ unimproved

Name of roads at closest main intersection N/A - work entirely conducted in and ____

Directions from main intersection

Style of house or other building on site ☐ ranch ☐ 2-story ☐ cape cod ☐ bi-level ☐ cottage/cabin ☐ pole barn ☐ none ☐ other (describe)____

Color____Color of adjacent property house and/or buildings____

House number ____Address is visible on ☐ house ☐ garage ☐ mailbox ☐ sign ☐ other ____

Street name ____ Fire lane number____ Lot number ____

How can your site be identified if there is no visible address? ____

Provide directions to the project site, with distances from the best and nearest visible landmark and waterbody ____

Project locations (20) all located within the Straits of Mackinaw in Lake Michigan; all work will be conducted along underwater pipeline crossing

Does project cross boundaries of two or more political jurisdictions? (City/Township, Township/Township, County/County, etc.)
☐ No ☐ Yes (If Yes, list jurisdiction names.) Unknown

6 List all other federal, interstate, state, or local agency authorizations required for the proposed activity, including all approvals or denials received.

Agency	Type approval	Identification number	Date applied	Date approved / denied	If denied, reason for denial
USACE	Nationwide Permit	NW03	3/14/2005	4/13/2005	

7

If a permit is issued, date activity will commence (M/D/Y) 06/01/2006

Proposed completion date (M/D/Y) 07/01/2007

Has any construction activity commenced or been completed in a regulated area? ☑ No ☐ Yes
If Yes, identify the portion(s) underway or completed on drawings or attach project specifications and give completion date(s) (M/D/Y)

Were the regulated activities conducted under a MDEQ permit? ☐ No ☐ Yes
If Yes, list the MDEQ permit number

Are you aware of any unresolved violations of environmental law or litigation involving the property? ☑ No ☐ Yes (If Yes, explain)

8 PUBLIC NOTIFICATION (Attach additional sheets if necessary)

- Complete information for all *adjacent and impacted property owners* and the lake association or established lake board, including the contact person's name.
- If you own the adjacent lot, provide the requested information for the first adjacent parcel beyond your property line.

Property Owner's Name	Mailing Address	City	State	Zip Code
See attached word document for landowner information				

Name of ☐ Established Lake Board ☐ or Lake Association
and the Contact Person's name, phone number, and mailing address

9 APPLICANT'S CERTIFICATION READ CAREFULLY BEFORE SIGNING

I am applying for a permit(s) to authorize the activities described herein. I certify that I am familiar with the information contained in this application, that it is true and accurate, and, to the best of my knowledge, is in compliance with the State *Coastal Zone Management Program* and the *National Flood Insurance Program.* I understand that there are penalties for submitting false information and that any permit issued pursuant to this application may be revoked if information on this application is untrue. I certify that I have the authority to undertake the activities proposed in this application. By signing this application, I agree to allow representatives of the MDEQ, USACE, and/or their agents or contractors to enter upon said property in order to inspect the proposed activity site and the completed project. I understand that I must obtain all other necessary local, county, state, or federal permits and that the granting of other permits by local, county, state, or federal agencies does not release me from the requirements of obtaining the permit requested herein before commencing the activity. I understand that the payment of the application fee does not guarantee the issuance of a permit.

- All applicants must complete **all** of the items in Sections 1 through 9 on pages 1 and 2 of this application.
- Complete those items in Sections 10 through 21 that apply to the project. Submit only those pages where you have provided information.
- Your application will not be processed if the application form is not completely filled out.
- List here the application page numbers being submitted and a brief description of other attachments included with your application.
- Submit 8.5" by 11," 8.5" by 14" or 11" by 17" size drawings with 4 copies. The USACE requires one set of drawings on 8.5" x 11" paper, with all notations clearly legible. Larger copies may be submitted in addition to the standard size copies.
- A letter of authorization from the owner must be included if not signed below by the owner.

☐ Property Owner ☐ Agent/Contractor ☑ Corporation - Title Engineer	Printed Name: Dan Klamer	Signature: Daniel W Klamer	Date: 5-3-06

Land & Water Mgt. Div.
MAY 11 2006
...it Consolidation Unit

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY PERMIT

Enbridge Energy
119 North 25th Street East
Superior, WI 54880

Permit No. 06-24-0016-P
Issued June 8, 2006
Extended
Revised
Expires June 8, 2007

Under the provisions of the Natural Resources and Environmental Protection Act 451, PA 1994, as amended and specifically:

- ☐ **Part 301 Inland Lakes and Streams**
- ☒ **Part 325 Great Lakes Submerged Lands**
- ☐ **Part 303 Wetland Protection**
- ☐ **Part 31 Floodplain/Water Resources Protection**
- ☐ **Part 315 Dam Safety**
- ☐ **Part 323 Shorelands Protection and Management**
- ☐ **Part 353 Sand Dune Protection and Management**

Permission is hereby granted, based on permittee assurance of adherence to State requirements and permit conditions to:

Auger 20 five by five foot support structures into the lakebed in the Straits of Mackinaw to hold two existing 20 inch pipelines in place, in accordance with attached plans and following conditions.

Water Course Affected: Lake Michigan
Property Location: Emmet **County,** Wawatam Township, **Section** 10 11
Town/Range 39N, 4W

Authority granted by this permit is subject to the following limitations:

A. Initiation of any work on the permitted project confirms the permittee's acceptance and agreement to comply with all terms and conditions of this permit.
B. The permittee in exercising the authority granted by this permit shall not cause unlawful pollution as defined by Part 31, Floodplain/Water Resources Protection of the Natural Resources and Environmental Protection Act 451, PA 1994, as amended.
C. This permit shall be kept at the site of the work and available for inspection at all times during the duration of the project or until its date of expiration.
D. All work shall be completed in accordance with the plans and the specifications submitted with the application and/or plans and specifications attached hereto.
E. No attempt shall be made by the permittee to forbid the full and free use by the public of public waters at or adjacent to the structure or work approved herein.
F. It is made a requirement of this permit that the permittee give notice to public utilities in accordance with Act 53 of the Public Act of 1974 and comply with each of the requirements of that act.
G. This permit does not convey property rights in either real estate or material, nor does it authorize any injury to private property or invasion of public or private rights, nor does it waive the necessity of seeking federal assent, all local permits or complying with other state statutes.
H. This permit does not prejudice or limit the right of a riparian owner or other person to institute proceedings in any circuit court of this state when necessary to protect his rights.
I. Permittee shall notify the Department of Environmental Quality within one week after the completion of the activity authorized by this permit, by completing and forwarding the attached, preaddressed post card to the office addressed thereon.
J. This permit shall not be assigned or transferred without the written approval of the Department of Environmental Quality.
K. Failure to comply with conditions of this permit may subject the permittee to revocation of permit and criminal and/or civil action as cited by the specific State Act, Federal Act and/or Rule under which this permit is granted.
L. Work to be done under authority of this permit is further subject to the following special instructions and specifications:

Corps Approval 07 19 06

DEPARTMENT OF THE ARMY
DETROIT DISTRICT, CORPS OF ENGINEERS
BOX 1027
DETROIT, MICHIGAN 48231-1027

July 19, 2006

Received
LWMD/DEQ

JUL 27 2006

GAYLORD FIELD OFFICE

IN REPLY REFER TO

Engineering & Technical Services
Regulatory Office
File No. 88-016-121-4

RECEIVED
JUL 24 2006
DEQ-LWMD

Dan Klamer
Enbridge Energy Limited Partnership
119 North 25th Street East
Superior, Wisconsin 54880

Dear Mr. Klamer:

Reference your application for a Department of the Army permit to repair a pipeline in Lake Michigan at Straits of Mackinac, St. Ignace, Michigan (Section 10, 11, 23-26, Township 39N, 40N, Range 4W).

We have verified that the project is authorized by nationwide permit as published in the Federal Register. As indicated on the enclosed plans prepared May 3, 2006, the following work is authorized under NW03:

Install support harnesses with anchors at 20 locations along a submerged oil pipeline. The support structures will be installed using hydraulically driven auger heads supported by a barge mounted power supply.

This authorization is contingent upon compliance with the following terms and conditions:

a. The enclosed nationwide permit(s) and the general conditions.

b. The following special conditions:

1. The permittee shall contact the U.S. Coast Guard so that a notice to mariners can be circulated prior to commencement of the work.

2. The permittee understands and agrees that, if future operations by the United States require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby,

without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

We also direct your attention to Paragraph D.2 under Further Information, which states, "NWPs do not obviate the need to obtain other Federal, state, or local permits, approvals, or authorizations required by law." We suggest that you contact the Michigan Department of Environmental Quality, Lansing, Michigan, telephone 517-373-9244, to determine if state approval is required. Work should not commence until State approval is obtained.

Any construction activity other than that shown on the plans may not qualify for the authorization. If you contemplate any changes or additional activities from those depicted on the plans, please submit them to this office for authorization review prior to any construction. Upon completion of the work, fill in and return the enclosed COMPLETION REPORT.

This verification is valid until the NWP is modified, reissued, or revoked. All existing NWPs are scheduled to be modified, reissued, or revoked prior to March 18, 2007. It is incumbent on you to remain informed of changes to the NWPs. We will issue a public notice when the NWPs are reissued. If you commence or are under contract to commence this activity before the date that the relevant nationwide permit is modified or revoked, you will have twelve (12) months from the date of the modification or revocation of the NWP to complete the activity under the present terms and conditions of this NWP. If you have any questions on this matter, contact me at (313) 226-3396 and refer to File Number: 88-016-121-4.

Sincerely,

ORIGINAL SIGNED BY

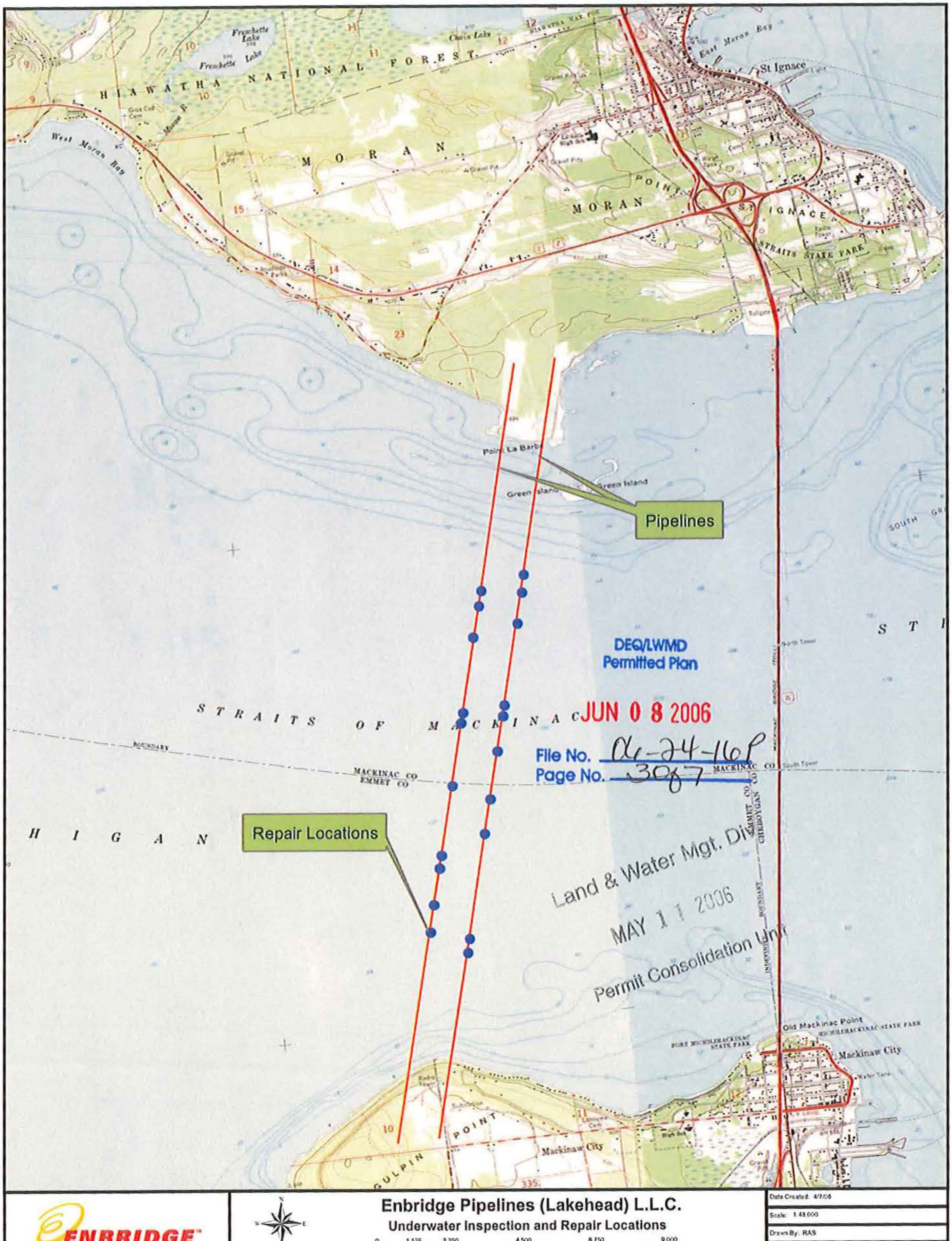
James D. Luke
Project Manager
Permit Evaluation Branch A

Enclosures

Copy Furnished

MDEQ, Upper Peninsula District Office (06-24-16), w/encl.
Sault Ste. Marie Field Office, w/encl.
NOAA, w/print

Supports 06 08 06



DEQ

Department of Environmental Quality
Land and Water Management Division

PROJECT REVIEW REPORT

File # 06-24-16-P

Name of reviewer: Arevalo

Date of ~~field~~ review: 6/8/06

GENERAL INFORMATION:

1. Name of applicant: Enbridge Energy
2. Name of property owner:
3. Waterbody type: (check all that apply) ☐ Wetland ☐ Warm water stream ☒ Great Lake ☐ Canal (Great Lake) ☐ Floodplain ☐ Cold water stream ☐ Inland lake ☐ Canal (Inland lake or stream)
4. Jurisdictional determination (for Part 303):
   a. Is the wetland contiguous, as defined in Section 30301? ☐ Yes ☐ No
   b. Approximate size of wetland = ________ acres
   c. Is the project within a county with a population > 100,000? ☐ Yes ☐ No
5. A permit is required under: ☐ Part 301 ☐ Part 303 ☐ Part 323 ☒ Part 325 ☐ Part 31 ☐ Sec. 404 ☐ ________
6. Is the application drawing complete and accurate? ☒ Yes ☐ No If no, why? ________

FIELD REVIEW (for Part 303):

7. Total wetland acreage owned by property owner = ________ acres
8. Total wetland acreage to be impacted by proposed activity = ________ acres

Dominant plants	Indicator status	Other plants	Indicator status	Soils (description)	Depth

DESCRIBE HYDROLOGIC INDICATORS:

GENERAL FIELD NOTES/COMMENTS: (Attach other page(s) for additional notes/comments)

See earlier files 01-24-46-P, 02-24-41-P, 05-24-13-P, for similar reviews. This in-office review was simply for addition sites where the applicant needs to hold the existing pipelines on to the lakebed. Tim Grunland, American Transmission P.O. Box 2020, Kingsford, MI 49802, tx # 906-396-1566, asked to be cc:'d with permit. They have pipelines nearby.

EQ 2725-1
(Revised April 2000)

FILE REVIEW:

9	a. Is there reasonable potential for impacts to state or federally listed threatened or endangered species?	☐ Yes ☑ No
	b. If yes, has the MDNR and/or US FWS reviewed and signed off on potential impacts?	☐ Yes ☐ No
10.	Would the project adversely affect fish and wildlife?	☐ Yes ☑ No
11.	Would the project adversely affect recreation and aesthetics?	☐ Yes ☑ No
12.	Would the project adversely affect navigation?	☐ Yes ☑ No
13.	Would the project adversely affect historic or archeological sites?	☐ Yes ☑ No
14.	Would the project comply with state Water Quality Standards?	☑ Yes ☐ No
15.	Would the project comply with the Michigan Natural Rivers Act? N/A	☐ Yes ☐ No
16.	Would the project comply with NREPA, Part 323 (Shorelands Protection and Management)?	☑ Yes ☐ No
17.	Would the project comply with the Michigan Coastal Zone Management Program?	☑ Yes ☐ No
18.	**If the project is proposed under Part 301 or 325:** a. Would the project adversely affect riparian rights?	☐ Yes ☑ No
	b. Would the project adversely affect the public trust?	☐ Yes ☑ No
	c. Would the project adversely affect other criteria listed in Section 30106 or 32515 as appropriate?	☐ Yes ☑ No
	d. Would the project involve work on state-owned bottomlands of the Great Lakes?	☑ Yes ☐ No
	e. If yes, would a conveyance be required? * likely obtained when pipeline installed	☐ Yes ☑ No
	f. Would the project be consistent with similar structures or other permitted projects in the area?	☑ Yes ☐ No
19.	**If the project is proposed under Part 303:** a. Would the activity be in the public interest?	☐ Yes ☐ No
	b. Is a permit necessary to realize the benefits derived from the activity?	☐ Yes ☐ No
	c. Would adverse secondary or cumulative effects occur due to the probable impacts of the proposed project in addition to the existing and anticipated activities in the watershed?	☐ Yes ☐ No
	d. Is the activity otherwise lawful?	☐ Yes ☐ No
	e. Has the applicant shown that an unacceptable disruption to the aquatic resources would not result?	☐ Yes ☐ No
	f. Has the applicant shown that the proposed activity is wetland dependent, OR Has the applicant shown that no feasible and prudent alternatives exist?	☐ Yes ☐ No
20.	**If the project is proposed as a Minor Project (Part 301 or 325) or General Permit (Part 303):** a. Is the activity listed by the Department as a category for a minor project or under a general permit?	☐ Yes ☐ No
	b. Would the activity have only minimal adverse environmental effects when performed separately?	☐ Yes ☐ No
	c. Would the activity have only minimal adverse environmental effects cumulatively?	☐ Yes ☐ No
	d. If proposed under a GP, would the activity comply with Part 303 review criteria in #20 a-f?	☐ Yes ☐ No

EXPLANATION OF FINDINGS AND RECOMMENDATION: (Attach other page(s) for additional explanation)

minimal environmental impact. Same activities authorized previously.

Recommendation: ☑ Issue ☐ Deny ☐ Modify   Date of review completion: 6/8/06

ENBRIDGE ENERGY PARTNERS
1100 LOUISIANA, SUITE 3300
HOUSTON, TEXAS 77002
713-650-8900

DATE 03-MAY-06

ENBRIDGE

CHECK NUMBER 1111103425

INVOICE NUMBER	INVOICE DATE	DESCRIPTION	DISCOUNT	NET AMOUNT
02-MAY-2006	02-MAY-06	MDEQ PERMIT	0.00	500.00

Original not rec'd yet

RECEIVED
MAY 0 4 2006
MDEQ/LWMD
PERMIT CONSOLIDATION UNIT

PAY TO NAME		DISCOUNT TOTAL	NET TOTAL
MICHIGAN		0.00	500.00

LASALLE BANK NA.
CHICAGO, IL 60661

ENBRIDGE ENERGY PARTNERS
1100 LOUISIANA, SUITE 3300
HOUSTON, TEXAS 77002
713-650-8900

ENBRIDGE

CHECK NUMBER
1111103425
CHECK DATE
03-MAY-06

PAY Five Hundred Dollars And 00 Cents**********************************

AMOUNT OF CHECK
*********500.00

TO THE ORDER OF MICHIGAN
DEPT OF ENVIRONMENTAL QUALITY
CASHIERS OFFICE
PO BOX 30657
LANSING, MI 48909-8157

⑈1111103425⑈ ⑆071923022⑆ 5590030002⑈

Rasmusson, Scott (DNRE)

From: Arevalo, John (DNRE)
Sent: Friday, October 01, 2010 10:46 AM
To: Rasmusson, Scott (DNRE)
Subject: FW: Enbridge

Read this, and add it to Enbridge's file. I hope that the information is something that you don't need, but you need to know.

John Arevalo, PWS
Water Resource Cadillac District Supervisor
Water Resources Division
Michigan Department of Natural Resources and Environment
Gaylord Field Office
989-705-3450
arevaloj@michigan.gov

From: Masterson, Mike (DNRE)
Sent: Monday, September 20, 2010 9:11 AM
To: Arevalo, John (DNRE)
Subject: RE: Enbridge

Transmission of crude oil through pipelines is regulated by the Pipeline Hazardous Materials Safety Administration which is housed in the Department of Transportation. If a spill should occur in the Great Lakes (probably all section 10 waters), the Coast Guard would be the primary emergency responder and would establish the incident command structure. If the spill occurs inland affecting surface waters, then EPA would be the primary emergency responder and would establish the incident command structure. In either case, the State would be involved within the established command structure to ultimately ensure that all state regulations are adhered to as well. Helpful?

From: Arevalo, John (DNRE)
Sent: Monday, September 20, 2010 8:50 AM
To: Masterson, Mike (DNRE)
Subject: Enbridge

Our permit was issued Friday, so we're all set for now. Given your experience w/the Marshall spill, I was hoping that you could give information regarding who reviews the inspection information obtained by Enbridge for their Straits crossing. Since it runs from WI to Sarnia, Mary Dettloff thought that PHMSA would be involved. I am interested in who has oversight, and the chain of command should there be a spill someday. I anticipate more inquiries similar to the letter to our file which you read. Although it does not come under our jurisdiction, I would like more information for myself, just so I know. The other WRD staff who are working w/NDPES permitting for Enbridge will (hopefully) continue to keep me in the loop regarding Enbridge's app. w/them. Thanks.

John Arevalo, PWS
Water Resource Cadillac District Supervisor

Great Lakes Environmental Law Center, West Michigan Environmental Action Council, Natural Resources Defense Council, National Wildlife Federation, Tip of the Mitt Watershed Council, Sierra Club

September 14, 2010

VIA ELECTRONIC MAIL and U.S. MAIL

Scott Rasmusson
Michigan Department of Natural Resources and Environment
Land and Water Management Division
2100 West M-32
Gaylord, MI 49735-9282
989-731-4920
rasmussons@mi.gov

Received
LWMD/DEQ
SEP 17 2010
GAYLORD FIELD OFFICE

Re: Comments on Draft Permit to Drill Support Structures in the Great Lakes, File No. 10-24-0035P, Enbridge Pipelines (Lakehead), LLC

Dear Mr. Rasmusson,

Please accept these comments submitted on behalf of the Great Lakes Environmental Law Center, West Michigan Environmental Action Council, Natural Resources Defense Council, National Wildlife Federation, Tip of the Mitt Watershed Council, and Sierra Club regarding the Michigan Department of Natural Resources and Environment ("MDNRE") draft Permit to Drill, File No. 10-24-0035P ("Draft Permit"), for the T39N, R04W, Section 10, Wawatam Township, Emmet County, MI proposed by Enbridge Pipelines (Lakehead), LLC. ("Enbridge")

For the reasons set forth below, we request that the MDNRE only approve this permit after ensuring that all safety measures and best management practices are in place to protect Michigan's fragile fresh water ecosystem. Public notice for the Draft Permit states that written comments will be accepted 20 days after August 27, 2010. Therefore, these comments are timely submitted.

I. INTRODUCTION

Enbridge is seeking a permit to drill support structures on the bottom of Lake Michigan to maintain the integrity and safety of existing pipeline structures. A permit is required before Enbridge takes any action pursuant to part 325 of the Submerged Lands Act. Under the Submerged Lands Act, a permit is necessary to protect the waters of the Great Lakes and the Great Lakes bottomlands. Enbridge is seeking to conduct maintenance on an oil/gas pipeline that runs under the Straits of Mackinac. Following the known failures of Enbridge to comply with federal pipeline maintenance recommendations and the subsequent multiple and devastating infractions against our fresh water resources, MDNRE must proceed with all precautionary measures at its disposal to require that any pipeline maintenance in these submerged waters, subject to the Public Trust, be carried out in the safest possible fashion. In light of the valid concerns about the safety and lack of maintenance on decades old, Enbridge-owned and/or operated pipelines, to protect the ecological health of the Great Lakes and the health and safety of the surrounding communities, this pipeline must be shut down and flushed prior to any maintenance operations and MDNRE must require strict safety measures and adoption of best management practices.

II. Pipes Act of 2006 – Nine Elements of Effective Damage Prevention

In 2006 President Bush signed the PIPES Act to strengthen and improve Federal and State pipeline safety programs. The Pipes Act specifies nine elements which should be implemented to prevent pipeline damage. These nine elements (including Damage Prevention and Corrosion Control) are considered consistent and congruent with the Common Ground Alliance (CGA) Best Practices.[1] MDNRE must require Enbridge to adopt the nine elements in its safety program to ensure the protection of the Great Lakes.

III. Best Management Practices

In 1999, the U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration ("PHMSA") published the Common Ground Study of One-Call Systems and Damage Prevention Best Practices. (The Best Practices have since been updated, most recently in 2010). The Common Ground Best Practices are intended to be shared among stakeholders involved with and dependent upon the safe and reliable operation, maintenance, construction, and protection of underground facilities, including oil and gas pipelines.[2] The MDNRE should determine if Enbridge has adopted the Common Ground Alliance Best Practices, and if not, encourage Enbridge to adopt the Best Practices as appropriate. The PHMSA has stated that excavation damage continues to be the leading cause of serious pipeline incidents. [3] To prevent the potential damage caused by any excavation on this project, the MDNRE must require Enbridge to adopt the damage prevention practices as set forth by the PHMSA.

IV. Risk Assessments and Safety Inspections

To help ensure the reliability and integrity of oil pipelines, the industry has taken a risk management approach. The American Petroleum Institute has developed the API 1160 Managing System Integrity for Hazardous Liquid Pipelines. The API 1160 is a key industry standard which lays out a framework for conducting risk assessments for pipeline systems. The MDNRE must ensure Enbridge has adopted the API 1160 risk assessments and, if not, require its incorporation. MDNRE must inquire as to what risk assessments and/or safety inspections Enbridge and the PHMSA have conducted on the Lakehead pipeline system and scrutinize the results, particularly anomalies found in the proposed project area, prior to making a determination on this permit request. MDNRE must also inquire as to what other problems or concerns were detected along this section of the pipeline in Enbridge's pipeline integrity management program. Finally, MDNRE should take action to ensure that any anomalies in the pipeline identified as potential risks to the watershed are addressed as part of the proposed project and subsequent permit.

[1] CGA Best Practices, Version 7.0, March 2010. (www.commongroundalliance.com).

[2] http://www.commongroundalliance.com/Template.cfm?Section=Best_Practices.

[3] http://primis.phmsa.dot.gov/comm/DamagePrevention.htm?nocache=4560

V. Corrosion

The PHMSA has determined that corrosion accounts for 25% of all significant pipeline incidents.[4] Corrosion is a serious issue and any corrosion of the pipeline at issue should be investigated by MDNRE prior to making a determination on Enbridge's permit application. Corrosion can affect all types of pipelines, including pipelines submerged in fresh water. Without proper maintenance, corrosion can completely deteriorate a pipeline causing significant damage. Pipeline support structures are the main areas where pipe corrosion becomes a problem. Corrosion at support structures is commonplace because support saddles create crevices which can, overtime, undermine the structural integrity of the pipe. If not addressed immediately, corrosion can undercut paint film and eventually cause rapid pipe wall loss. There is available technology that can reduce the likelihood of corrosion at support structures. These technologies include, but are not limited to, protective coatings and linings, cathodic protection, materials selection, and inhibitors.[5]

These best practices are widely adopted by the industry, and MDNRE must evaluate the tools and technologies that Enbridge plans to utilize in anchoring down the pipes on the Great Lakes bottomlands. Economics and cost savings must not be the only driving force in Enbridge's choice of anchoring systems. MDNRE must ensure that Enbridge has considered the possibility of other, safer, anchoring systems that limit pipe corrosion.

VI. Emergency Preparedness

There are additional questions about the scope of proposed work on the pipeline that were not addressed in the permit application. What contingency plans have been adopted in case of an oil leak or spill during the pipeline anchoring? Have on-site and off-site emergency preparedness plans been filed with state and local government and first responders? MDNRE officials must be on-site for the duration of the project to ensure compliance with applicable federal and state laws and regulations.

CONCLUSION

For all of the above reasons, we respectfully request that the Michigan Department of Natural Resources and Environment fulfill its duty to protect the environment and health of Michigan's residents by closely scrutinizing this permit application, requiring stringent safety measures, utilizing the most environmentally protective best management practices, and requiring this pipeline to be shut down and flushed prior to any maintenance operations.

[4] http://primis.phmsa.dot.gov/comm/reports/safety/SigPSIDet_2000_2009_US.html?nocache=3616#_liquid
[5] http://www.nace.org/content.cfm?parentid=1046&currentID=1424.

Submitted on this 14th day of September, 2010.

Nick Schroeck
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West Michigan Environmental Action Council

Thom Cmar
Midwest Program Attorney
Natural Resources Defense Council

Marc Smith
Senior Policy Manager
National Wildlife Federation

Grenetta Thomassey, PhD
Program Director
Tip of the Mitt Watershed Council

Anne Woiwode
State Director
Sierra Club, Michigan Chapter

DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENT PERMIT

ISSUED TO:

Enbridge Energy
Attn: Jacob Jorgensen, Assoc. Engineer
1320 Grand Avenue
Superior, WI 54880

Permit No.	10-24-0035-P
Issued	September 17, 2010
Revised	
Expires	September 17, 2015

This permit is being issued by the Michigan Department of Natural Resources and Environment (MDNRE) under the provisions of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA) and specifically:

- ☐ Part 301 Inland Lakes and Streams
- ☐ Part 315 Dam Safety
- ☒ Part 325 Great Lakes Submerged Lands
- ☐ Part 323 Shorelands Protection and Management
- ☐ Part 303 Wetlands Protection
- ☐ Part 353 Sand Dune Protection and Management
- ☐ Part 31 Floodplain/Water Resources Protection

Permission is hereby granted, based on permittee assurance of adherence to State requirements and permit conditions to:

Place helical anchoring structures approximately five feet wide, saddle mounted around two existing 20 inch diameter pipelines and augured into the lake bed in at least ten locations to maintain the integrity of the pipelines, as shown on the attached plans.

Water Course Affected: Lake Michigan
Property Location: Emmet **County,** Wawatam Township, **Section** 10 11
Town/Range 39N, 4W

Authority granted by this permit is subject to the following limitations:

A. Initiation of any work on the permitted project confirms the permittee's acceptance and agreement to comply with all terms and conditions of this permit.
B. The permittee in exercising the authority granted by this permit shall not cause unlawful pollution as defined by Part 31, Floodplain/Water Resources Protection of the NREPA.
C. This permit shall be kept at the site of the work and available for inspection at all times during the duration of the project or until its date of expiration.
D. All work shall be completed in accordance with the plans and the specifications submitted with the application and/or plans and specifications attached hereto.
E. No attempt shall be made by the permittee to forbid the full and free use by the public of public waters at or adjacent to the structure or work approved herein.
F. It is made a requirement of this permit that the permittee give notice to public utilities in accordance with Act 53 of the Public Act of 1974 and comply with each of the requirements of that act.
G. This permit does not convey property rights in either real estate or material, nor does it authorize any injury to private property or invasion of public or private rights, nor does it waive the necessity of seeking federal assent, all local permits or complying with other state statutes.
H. This permit does not prejudice or limit the right of a riparian owner or other person to institute proceedings in any circuit court of this state when necessary to protect his rights.
I. Permittee shall notify the MDNRE within one week after the completion of the activity authorized by this permit, by completing and forwarding the attached, preaddressed post card to the office addressed thereon.
J. This permit shall not be assigned or transferred without the written approval of the MDNRE.
K. Failure to comply with conditions of this permit may subject the permittee to revocation of permit and criminal and/or civil action as cited by the specific State Act, Federal Act and/or Rule under which this permit is granted.
L. Work to be done under authority of this permit is further subject to the following special instructions and specifications:

1. *Enbridge and/or its consultants shall provide the MDNRE a site map showing the total number and locations of the anchoring structures that were installed under this permit. This information can be emailed to rasmussons@michigan.gov.*

2. Authority granted by this permit does not waive any jurisdiction of the U.S. Corps of Engineers (USACE) or the need for a federal permit, if required.

3. In issuing this permit, the MDNRE has relied on the information and data which permittee has provided in connection with the permit application. If, subsequent to the issuance of this permit, such information and data prove to be false, incomplete, or inaccurate, the MDNRE may modify, revoke, or suspend the permit, in whole or in part, in accordance with the new information.

4. The authority to conduct the activity as authorized by this permit is granted solely under provisions of the governing act as identified above. This permit does not convey, provide, or otherwise imply approval of any other governing act, ordinance, or regulation, nor does it waive the permittee's obligation to acquire any local, county, state or federal approval or authorizations necessary to conduct the activity.

5. The permittee shall indemnify and hold harmless the State of Michigan and its departments, agencies, officials, employees, agents and representatives for any and all claims or causes of action arising from acts or omissions of the permittee, or employees, agents, or representatives of the permittee, undertaken in connection with this permit. This permit shall not be construed as an indemnity by the State of Michigan for the benefit of the permittee or any other person.

6. If any change or deviation from the permitted activity becomes necessary, the permittee shall request, in writing, a revision of the permitted activity and/or mitigation plan from the MDNRE. Such revision requests shall include complete documentation supporting the modification and revised plans detailing the proposed modification. Proposed modifications must be approved, in writing, by the MDNRE prior to being implemented.

7. This permit is being issued for the maximum time allowed under Part 325, Great Lakes Submerged Lands, of the Natural Resources and Environmental Protection Act, PA 451 of 1994, as amended, including all permit extensions allowed under the administrative rule R322.1011(f), as determined by the MDEQ. Therefore, no extensions of this permit will be granted. Initiation of the construction work authorized by this permit indicates the permittee's acceptance of this condition. The permit, when signed by the MDEQ, will be for a five-year period beginning at the date of issuance.

Rebecca A. Humphries, Director
Michigan Department of Natural Resources and Environment

By ______________________
Scott Rasmusson
Water Resources Division
989-705-3437

cc: Wawatam Township
Moran Township
Barr Engineering
Ms. Gina Nathan, USACE, Detroit (LRE-2010-00463-56)
Mr. Steve Casey, MDNRE

US Army Corps of Engineers (USACE) — Michigan Department of Environmental Quality (MDEQ) DEQ

AGENCY USE			
Previous USACE Permit or File Number	Date Received: RECEIVED AUG 2 6 2010 DNRE/WRD PERMIT CONSOLIDATION UNIT	Land and Water Management Division, MDEQ File Number 10-24-0035-P	AGENCY USE
USACE File Number		Pre-application Number or Marina Operating Permit Number	
District Office Gaylord - Scott Rasmussen		Fee received $ 500 CC	

Read Instructions pages i - iii. All of the following boxes below must be checked and information provided for the application to be processed:

- ☐ All items in Sections 1 through 9 are completed
- ☐ Date project was staked
- ☐ Items in Sections 10 through 21 that apply to the project are completed
- ☐ Application fee is attached
- ☐ Dimensions, volumes and calculations are provided
- ☐ All requested supplementary attachments (➡) are included
- ☐ Reproducible location map, site plan(s), cross sections and photographs are provided, one set must be black and white on 8 ½ by 11 inch paper.
- ☐ List any additional attachments, tables, etc.:

1 PROJECT LOCATION INFORMATION

- Refer to your property's legal description for the Township, Range, and Section information, and your property tax bill for your Property Tax Identification Number(s).

Site location Address (road, if no street address)	Zip Code	Township Name(s)	Township(s)	Range(s)	Section(s)
Lake Michigan (all in-water work) between Upper and Lower Peninsula			*40N & 39N*	*4W & 4W*	*25 & 10/11*

City/Village	County(ies)	Property Tax Identification Number(s)
N/A	*Mackinac and Emmet (in Straights)*	*N/A*

Name of Waterbody	Project Name or Job Number	Subdivision/Plat	Lot Number	Private Claim
Lake Michigan	*Pipeline Inspection*	*N/A*	*N/A*	*N/A*

Project types (check all that apply): ☐ private ☐ public/government ☐ industrial ☐ commercial ☐ multi-family ☐ building addition ☐ new building or structure ☐ building renovation or restoration ☐ river restoration ☐ single-family ☐ project is receiving federal transportation funds ☐ other (explain)

The proposed project is on, within, or involves (check all that apply): ☐ a legally established County Drain (date established) (M/D/Y) / /

☐ a stream ☐ a pond (less than 5 acres) ☒ a Great Lake or Section 10 Waters ☐ a natural river ☐ a new marina
☐ a river ☐ a channel/canal ☐ a designated high risk erosion area ☐ a dam ☐ a structure removal
☐ a ditch or drain ☐ an inland lake (5 acres or more) ☐ a designated critical dune area ☐ a wetland ☐ a utility crossing
☐ a floodway area ☐ a 100-year floodplain ☐ a designated environmental area ☐ 500 feet of an existing waterbody

2 DESCRIBE PROPOSED PROJECT AND ASSOCIATED ACTIVITIES, AND THE CONSTRUCTION SEQUENCE AND METHODS (attached additional sheets)

Written Summary of All Proposed Activities. *See Attached*

Construction Sequence and Methods.

3 APPLICANT, AGENT/CONTRACTOR, AND PROPERTY OWNER INFORMATION

Owner/Applicant	Agent/Contractor
(individual or corporate name) *Enbridge Energy, Limited Partnership* *Jacob Jorgensen, Associate Region Engineer*	(firm name and contact person)
Mailing Address *1320 Grand Avenue*	Address
City *Superior* State *WI* Zip Code *54880*	City State Zip Code
Daytime Phone Number with Area Code *715-394-1551* Cell Phone Number *218-248-0808*	Daytime Phone Number with Area Code - - Cell Phone Number - -
Fax *832-325-5602* E-mail *Jacob.Jorgensen@enbridge.com*	Fax - - E-mail

☐ No ☐ Yes Is the applicant the sole owner of all property on which this project is to be constructed and all property involved or impacted by this project?
➡ If no, attach letter(s) of authorization from all owners. A letter signed by each property owner authorizing the agent/contractor/other owner to act on his or her behalf or a copy of easements or right-of-ways must be provided. If multiple property owners, also attach a list of all owners along with their names, mailing addresses, and telephone numbers. If the applicant is a corporation, a corporate officer must provide written document authorizing any agent/contractor listed above to act on its behalf.
A letter of authorization must be provided from an owner receiving dredge spoils on their property, or where access through their property is required..

Property Owner's Name (If different from applicant)	Mailing Address
Daytime Phone Number with Area Code - - Cell Phone Number - -	City State Zip Code

[ ] No [ ] Yes Is there a MDEQ conservation easement or other easement, deed restriction, lease, or other encumbrance upon the property in the project area?
→ If yes, attach a copy.

4 PROPOSED PROJECT PURPOSE, INTENDED USE, AND ALTERNATIVES CONSIDERED (Attach additional sheets if necessary)

Purpose/Intended Use: The purpose must include any new development or expansion of an existed land use. *See attached*

Alternatives: Include a description of alternatives considered to avoid or minimize resource impacts. Include factors such as, but not limited to, alternative construction technologies; alternative project layout and design; and alternative locations. For utility crossings, include both alternative routes and alternative construction methods.
See attached

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5 LOCATING YOUR PROJECT SITE

→ Attach a black and white, legible copy of a map that clearly shows the site location and road from the nearest major intersection, and includes a north arrow.

Is there an access road to the project? [X] No [ ] Yes (If Yes, type of road, check all that apply) [ ] private [ ] public [ ] improved [ ] unimproved

Name of roads at closest main intersection *N/A - work conducted entirely in water* and

Directions from main intersection

Style of house or other building on site [ ] ranch [ ] 2-story [ ] cape cod [ ] bi-level [ ] cottage/cabin [ ] pole barn [ ] none [ ] other (describe)

Color | Color of adjacent property house and/or buildings | House number | Street name

Fire lane number | Lot number | Address is visible on [ ] house [ ] garage [ ] mailbox [ ] sign [ ] other (describe)

How can your site be identified if there is no visible address?

Provide directions to the project site, with distances from the best and nearest visible landmark and waterbody *Project locations all located within the Straits of Mackinac in Lake Michigan; all work will be conducted along underwater pipeline crossing.*

Does the project cross the boundaries of two or more political jurisdictions? (City/Township, Township/Township, County/County, etc.)
[ ] No [ ] Yes → If Yes, list jurisdictions: *Unknown*

6 List all other federal, interstate, state, or local agency authorizations required for the proposed activity, including all approvals or denials received.

Agency	Type approval	Identification number	Date applied	Date approved / denied	If denied, reason for denial
US Coast Guard	*Notification*				
Mackinac Bridge Authority	*Notification*				

7 COMPLIANCE

If a permit is issued, date activity will commence (M/D/Y) / / — Proposed completion date (M/D/Y) / /

Has any construction activity commenced or been completed in a regulated area? [ ] No [ ] Yes
→ If Yes, identify the portion(s) underway or completed on drawings or attach project specifications and give completion date(s) (M/D/Y) / /

Were the regulated activities conducted under a MDEQ permit? [ ] No [ ] Yes
If Yes, list the MDEQ permit number

Are you aware of any unresolved violations of environmental law or litigation involving the property? [X] No [ ] Yes (If Yes, explain)

8 ADJACENT/RIPARIAN AND IMPACTED OWNERS (Attach additional sheets if necessary)

- Complete information for all adjacent and impacted property owners and the lake association or established lake board, including the contact person's name.
- If you own the adjacent lot, provide the requested information for the first adjacent parcel that is not owned by you.

Property Owner's Name	Mailing Address	City	State	Zip Code
See attached for landowner information.				

Name of [ ] Established Lake Board [ ] or Lake Association
and the Contact Person's name, phone number, and mailing address

9 APPLICANT'S CERTIFICATION **READ CAREFULLY BEFORE SIGNING**

I am applying for a permit(s) to authorize the activities described herein. I certify that I am familiar with the information contained in this application; that it is true and accurate; and, to the best of my knowledge, that it is in compliance with the State Coastal Zone Management Program. I understand that there are penalties for submitting false information and that any permit issued pursuant to this application may be revoked if information on this application is untrue. I certify that I have the authority to undertake the activities proposed in this application. By signing this application, I agree to allow representatives of the MDEQ, USACE, and/or their agents or contractors to enter upon said property in order to inspect the proposed activity site and the completed project. I understand that I must obtain all other necessary local, county, state, or federal permits and that the granting of other permits by local, county, state, or federal agencies does not release me from the requirements of obtaining the permit requested herein before commencing the activity. I understand that the payment of the application fee does not guarantee the issuance of a permit.

	Printed Name	Signature	Date (M/D/Y)
[ ] Property Owner [ ] Agent/Contractor [X] Corporation/Public Agency – Title *Associate Region Engineer*	*Jacob Jorgensen*	Jacob P. Jorgensen	*08/26/2010*

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16 DRAWDOWN OF AN IMPOUNDMENT

- If wetlands will be impacted, also complete Section 12.

Type of drawdown ☐ over winter ☐ temporary ☐ one-time event ☐ annual event ☐ permanent (dam removal) ☐ other

Reason for drawdown

Has there been a previous drawdown? ☐ No ☐ Yes (If Yes, provide date (M/D/Y) / / | Previous MDEQ permit number, if known

Does waterbody have established legal lake level? ☐ No ☐ Yes ☐ Not Sure | Dam ID Number, if known

Extent of vertical drawdown (ft)	Impoundment design head (ft)	Number of adjacent or impacted property owners
Date drawdown would start (M/D/Y) / /	Date drawdown would stop (M/D/Y) / /	Rate of drawdown (ft/day)
Date refilling would start (M/D/Y) / /	Date refill would end (M/D/Y) / /	Rate of refill (ft/day)
Type of outlet discharge structure to be used ☐ surface ☐ bottom ☐ mid-depth	Impoundment area at normal water level (acres)	Sediment depth behind impoundment discharge structure (ft)

17 DAM, EMBANKMENT, DIKE, SPILLWAY, OR CONTROL STRUCTURE ACTIVITIES (See Sample Drawing 15)

- For more information go to www.michigan.gov/deqdamsafety
- If wetlands will be impacted, also complete Section 12.

➾ Attach site-specific conceptual plans for construction of a new dam, reconstruction of a failed dam, or enlargement of an existing dam for resource impact review.

- Detailed engineering plans are required once the activity has been determined to be permitable from an environmental standpoint.

➾ Attach detailed engineering plans for a dam repair, dam alteration, dam abandonment, or dam removal.

Which one best describes your project? ☐ new dam construction ☐ reconstruction of a failed dam ☐ enlargement of an existing dam ☐ dam repair ☐ dam alteration ☐ dam abandonment ☐ dam removal ☐ other

Dam ID Number If known	Type of outlet discharge structure ☐ surface ☐ bottom ☐ mid depth	Will proposed activities require a drawdown of the waterbody to complete the work? ☐ No ☐ Yes (If Yes, also complete Section 16)	
Riprap Volume (cu yd)	Dredging/excavation Volume (cu yd)	Fill volume (cu yd)	Does structure allow complete drainage of waterbody? ☐ No ☐ Yes
Benchmark elevation (ft)	Datum used ☐ Local ☐ NGVD 29 ☐ other	Describe benchmark and show on plans	

Have you engaged the services of a Licensed Professional Engineer? ☐ No ☐ Yes If Yes, provide name, registration number, and mailing address.
Name Registration Number Mailing Address

Will a water diversion during construction be required? ☐ No ☐ Yes If Yes, describe how the stream flow will be controlled through the dam construction area during the proposed project activities:

COMPLETE THE FOLLOWING FOR A NEW DAM, RECONSTRUCTION OF A FAILED DAM, OR ENLARGEMENT OF AN EXISTING DAM

Describe the type of dam and how you will design the dam and embankment to control seepage through and underneath the dam.

Embankment top elevation (ft)	Streambed elevation at downstream embankment toe (ft)	Structural height (difference between embankment top elevation and streambed elevation at downstream embankment toe) (ft)	
Embankment length (ft)	Embankment top width (ft)	Embankment bottom width (ft)	Embankment slopes (vertical / horizontal) Upstream Downstream
Proposed normal pool elevation (ft)	Impoundment flood elevation (ft)	Maximum vertical drawdown capability (ft) (Attach operational procedure of the proposed structure, if available)	
Have soil borings been taken at dam location? ☐ No ☐ Yes ➾ If Yes, attach results.	Will a cold water underspill be provided? ☐ No ☐ Yes If Yes, invert elevation (ft)	Do you have flowage rights to all proposed flooded property at the design flood elevation? ☐ No ☐ Yes	

18 UTILITY CROSSINGS (See Sample Drawings 12 and 13, and EZ Guide)

- If side casting is required, complete Sections 10A and 10B. If spoils will be placed in wetlands or wetlands may be impacted, complete Section 12.

➾ Attach additional sheets or tables with the requested information as needed for multiple crossings.

What method will be used to construct the crossings? ☐ flume ☐ plow ☐ open trench ☐ jack and bore ☐ directional drilling

Crossing of ☐ Inland Lake or Stream ☐ floodplain ☐ international waters ☐ wetlands (also complete Section 12)

Type	Number of wetland crossings	Number of inland lake or stream crossings	Pipe diameter (in)	Pipe length per crossing (ft)	Distance below streambed or wetland (in)	Trench width (ft)
☐ sanitary sewer						
☐ storm sewer						
☐ watermain						
☐ cable						
☒ oil/gas pipeline			20"	21,000		

MDNRE and USACE - Joint Permit Application
Enbridge Pipelines (Lakehead), L.L.C.
Straits of Mackinac Maintenance and Inspection Project, Line 5
Mackinac and Emmet Counties, Michigan

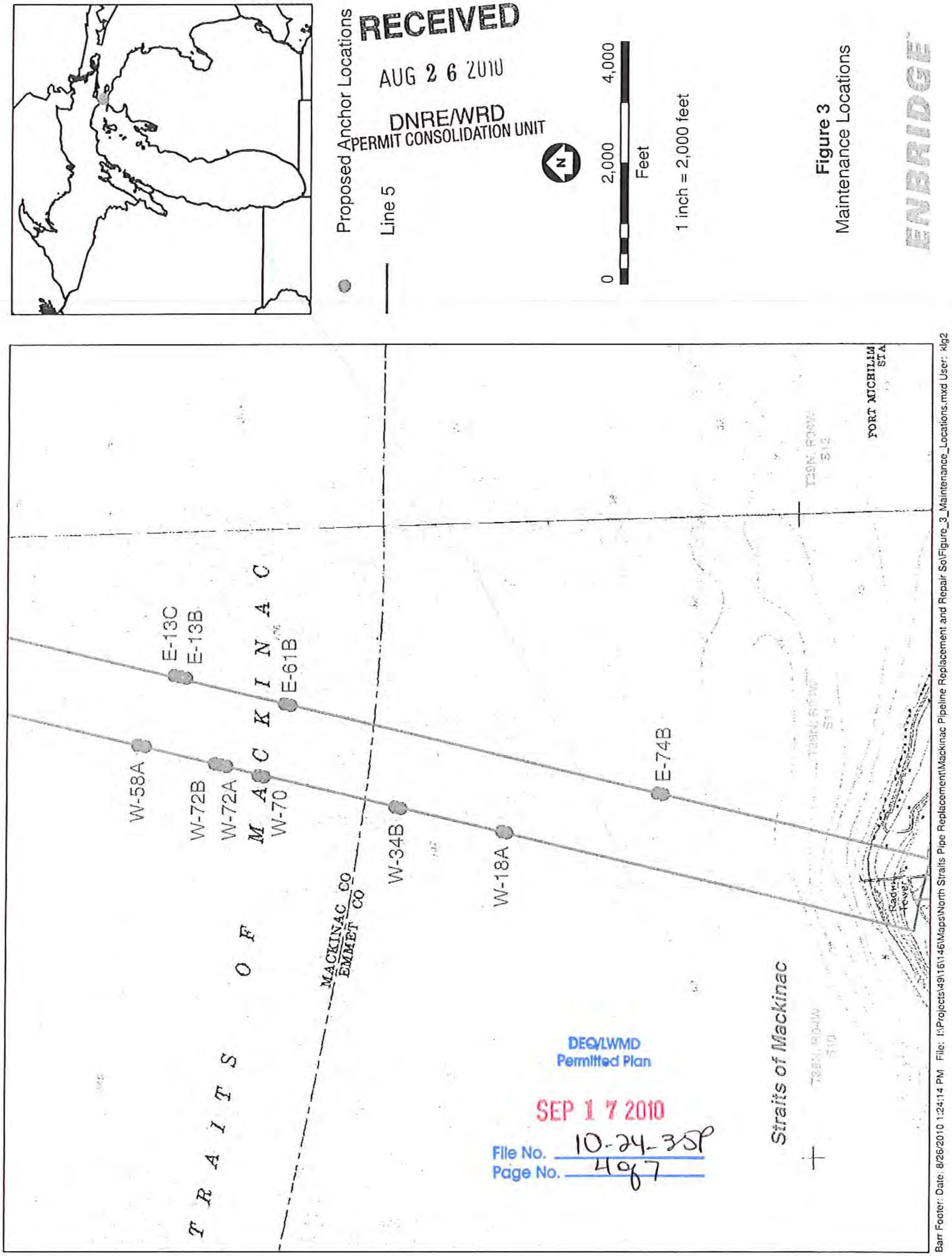
Project Descripton

2 – Describe proposed project and associated activities, and the construction sequence and methods.
The purpose of the project will be to perform visual inspection of the existing 20-inch pipelines installed beneath the Straits of Mackinac and install support structures in more than 10 locations along the pipeline. The most of the location of the existing pipelines is shown on the attached site location Figures 1,2,3, & 4 in attachment "FIGURES AND CONTRUCTION TYPICALS".T he work will involve the installation of a helical anchoring system with saddle mounted about the pipeline in each proposed location to increase support; the anchors will be augered directly into the lake bed. The proposed locations for installation of the anchoring structures are provided on the attached map. During the underwater inspection additional location requiring maintenance may be identified. Installation of support structures in these locations would occur during this project. Schematics showing the auguring apparatus and method as well as equipment utilized for installation are included with the attachments.

Work will be conducted from barges and a certified diving contractor will be employed to oversee the installation. Work is scheduled to begin September 17, 2010 and is expected to take 10 days at the minimum with very good weather conditions and up to 30 days with poor weather conditions.

4 – Proposed project purpose, intended use, and alternative considered.
In order to maintain pipeline integrity, installation of additional supports to minimize the distance between presently unsupported pipeline spans is necessary. The proposed locations for installation of the anchoring structures are provided on the attached map. Schematics showing the auguring apparatus and method as well as equipment utilized for installation are included with the attachments. The support method is anticipated to incur minimal or no environmental impact. This project is considered pipeline maintenance and is not associated with a new utility installation.

The proposed work is necessary to provide better overall pipeline integrity and safety. Do nothing or the no-build alternative presents a future risk to the pipeline. The no build is not a viable option.



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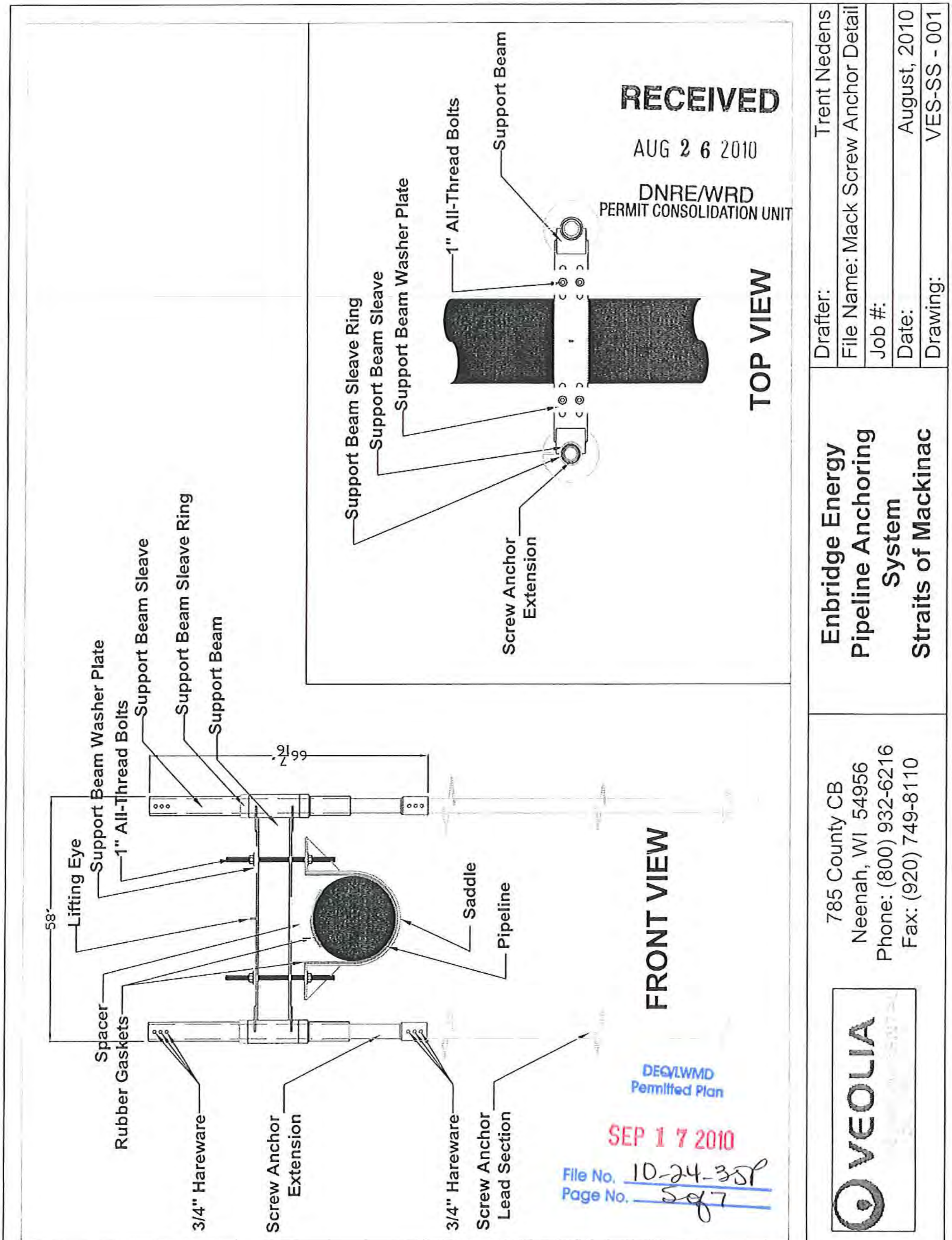
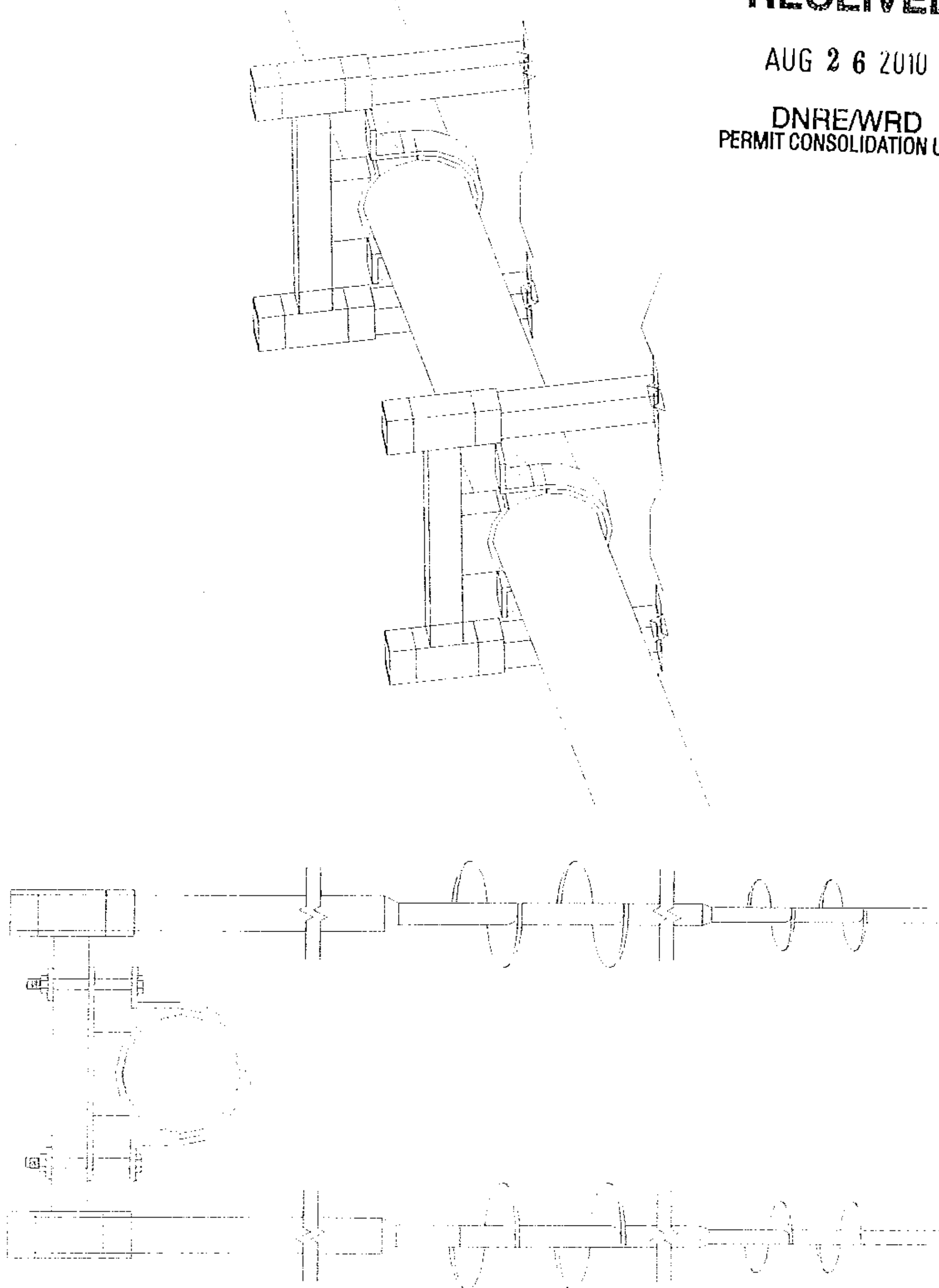
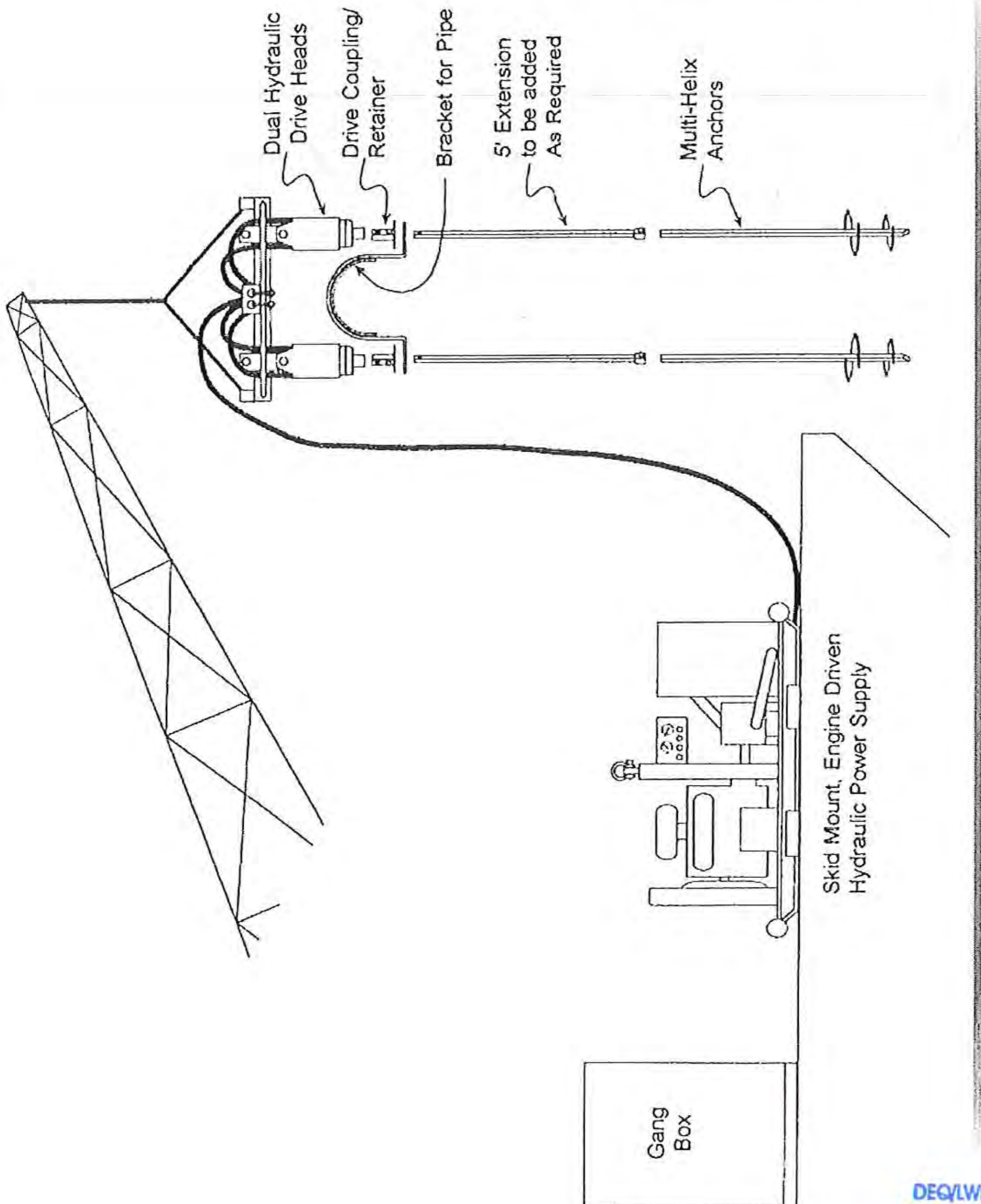
Proposed Anchor Locations
Line 5
0
2,000
4,000
Feet
1 inch = 2,000 feet
N
Figure 3
Maintenance Locations
ENBRIDGE
STRAITS OF MACKINAC
E-13C
E-13B
E-61B
E-74B
W-58A
W-72B
W-72A
W-70
W-34B
W-18A
MACKINAC CO
EMMET CO
FORT MICHILIMACKINAC STA
Straits of Mackinac
DEQ/LWMD
Permitted Plan
SEP 1 7 2010
File No. 10-24-35P
Page No. 4 of 7
Barr Footer: Date: 8/26/2010 1:24:14 PM File: I:\Projects\49\16\1146\Maps\North Straits Pipe Replacement\Mackinac Pipeline Replacement and Repair Sol\Figure_3_Maintenance_Locations.mxd User: klg2

Details of Support Installation 08 2010

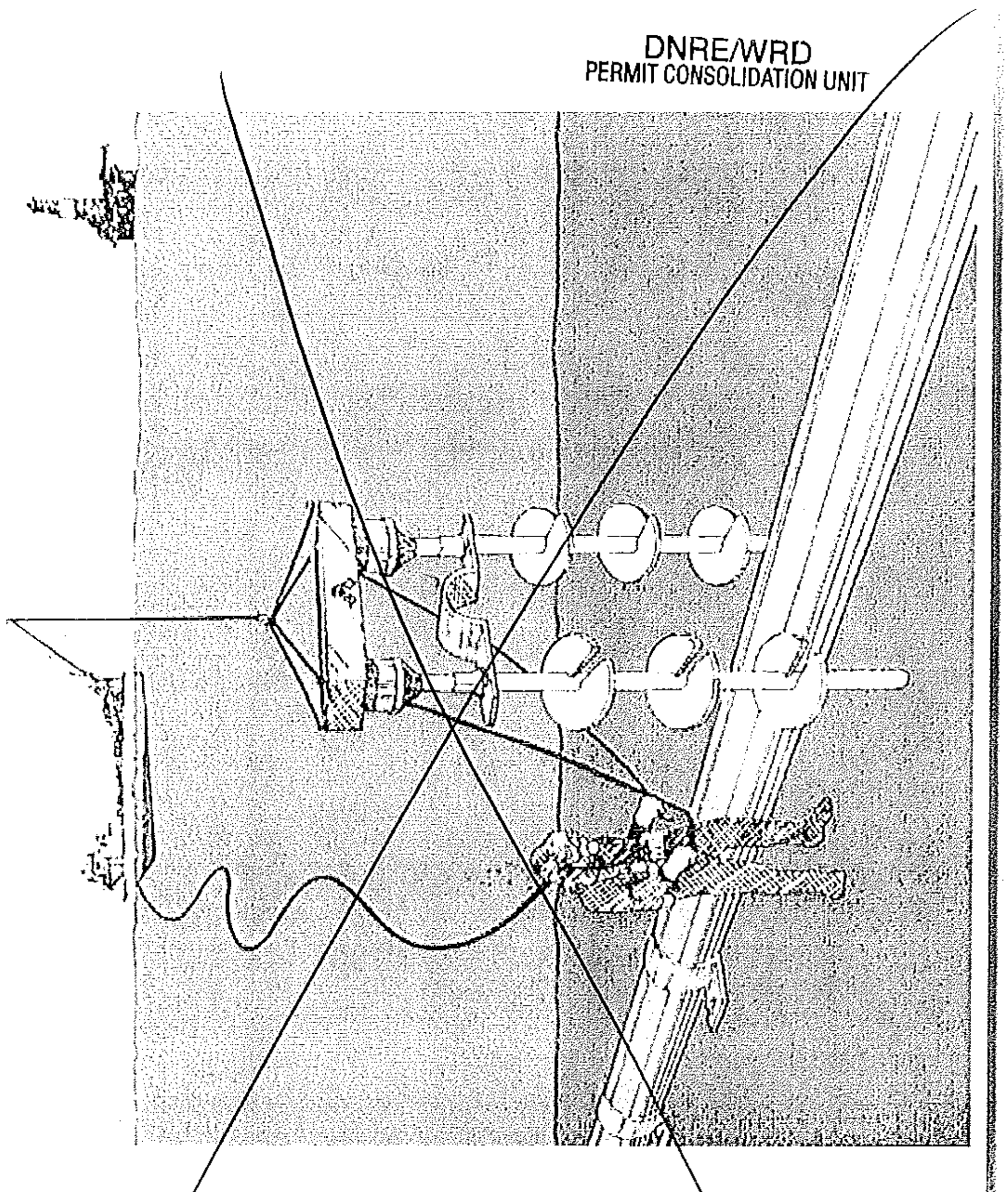


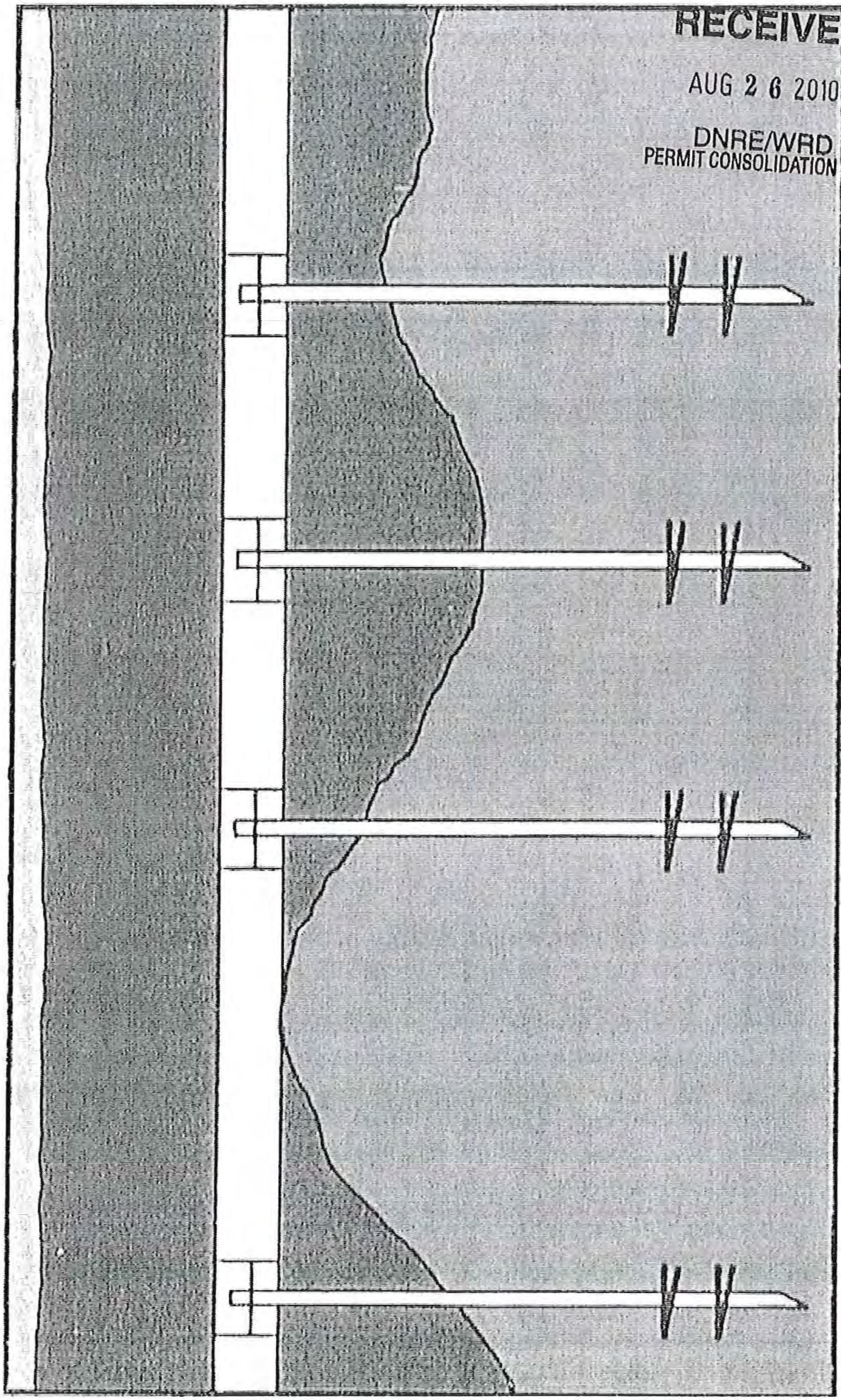


ENBRIDGE


Dual Hydraulic Drive Heads
Drive Coupling/ Retainer
Bracket for Pipe
5' Extension to be added As Required
Multi-Helix Anchors
Skid Mount, Engine Driven Hydraulic Power Supply
Gang Box

ENBRIDGE





ENBRIDGE

Department of Natural Resources and Environment
Land and Water Management Division

PROJECT REVIEW REPORT

File # 10-24-0035-P

Name of reviewer: Scott Rasmusson Date of field review: Desktop

GENERAL INFORMATION:

1. Name of applicant: Enbridge Energy

2. Name of property owner: various

3. Waterbody type: (check all that apply)
   ☐ Wetland ☐ Warm water stream ☒ Great Lake ☐ Canal (Great Lake)
   ☐ Floodplain ☐ Cold water stream ☐ Inland lake ☐ Canal (Inland lake or

4. Jurisdictional determination (for Part 303):
   a. Is the wetland contiguous, as defined in Section 30301? ☐ Yes ☐ No
   b. Approximate size of wetland = acres
   c. Is the project within a county with a population > 100,000? ☐ Yes ☐ No

5. A permit is required under: ☐ Part 301 ☐ Part 303 ☐ Part 323 ☒ Part 325 ☐ Part 31 ☐ Sec. 404 ☐

6. Is the application drawing complete and accurate? ☒ Yes ☐ No If no, why?

FIELD REVIEW (for Part 303):

7. Total wetland acreage owned by property owner = acres

8. Total wetland acreage to be impacted by proposed activity = acres

Dominant plants	Indicator status	Other plants	Indicator status	Soils (description)	Depth

DESCRIBE HYDROLOGIC INDICATORS:

GENERAL FIELD NOTES/COMMENTS: (Attach other page(s) for additional notes/comments)

Project is for up to 10 anchoring structures, to hold the pipeline along the bottom of Lake Michigan.

Several other permits have been issued by this office for maintenance of this and other pipelines in the area.

EQ 2725-1
(Revised January 2010)

Arevalo, John (DNRE)

From: Arevalo, John (DNRE)
Sent: Tuesday, September 07, 2010 8:27 AM
To: Kristen Benson
Cc: 'Alina M. Heydt'; Tammy Leinweber
Subject: RE: Straits of Mackinac project (MDNRE File #10-24-0035-P)

Because you have crossing easements which presumably have language about maintaining the pipelines, you could provide me with those specific pages of the easement documents in lieu of getting letters of authorization to act as the riparian owner's agent in this matter. I do not need copies of the entire easement documents, just pertinent language regarding Enbridge's ability to maintain the pipeline.

John Arevalo, PWS
Water Resource Cadillac District Supervisor
Water Resources Division
Michigan Department of Natural Resources and Environment
Gaylord Field Office
989-705-3450
arevaloj@michigan.gov

From: Kristen Benson [mailto:Kristen.Benson@enbridge.com]
Sent: Thursday, September 02, 2010 1:42 PM
To: Arevalo, John (DNRE)
Cc: 'Alina M. Heydt'; Tammy Leinweber
Subject: RE: Straits of Mackinac project (MDNRE File #10-24-0035-P)

John,

No, these properties are not Enbridge owned although we do have crossing easements. I believe the property ownership on the UP is city-owned and on the lower side, county-owned, as I believe it is noted in the application.

Please let me know if you need any additional information. If you have any questions specific to the application, you may contact Alina Heydt at Barr Engineering; she is cc'd on this note so you have her email; her phone # is 218-343-7777.

Sincerely,

Kris Benson
Senior Environmental Analyst
Enbridge
119 n. 28th St. E.
Superior, WI. 54880
Office: 715-394-1572
Cell: 218-348-1177

From: Arevalo, John (DNRE) [mailto:AREVALOJ@michigan.gov]
Sent: Thursday, September 02, 2010 12:35 PM
To: Kristen Benson
Subject: Straits of Mackinac project (MDNRE File #10-24-0035-P)

Ms. Benson: is Enbridge Energy the riparian owner in the upper and lower peninsulas of Michigan where the pipelines come ashore? FYI, your file is now here in my office in Gaylord. Thank you.

John Arevalo, PWS
Water Resource Cadillac District Supervisor
Water Resources Division
Michigan Department of Natural Resources and Environment
Gaylord Field Office
989-705-3450
arevaloj@michigan.gov

Arevalo, John (DNRE)

From: Arevalo, John (DNRE)
Sent: Friday, September 03, 2010 9:59 AM
To: Kristen Benson
Subject: RE: Straits of Mackinac project (MDNRE File #10-24-0035-P)

Because Enbridge does not own the two properties, I would like you to mail me writen authorization from the two affected prop. owners giving Enbridge the authorization to be their agent to apply for this permit, since they are the riparian owners. I understand that you have an easement, but this letter of authorization would suffice. Thank you.

-----Original Message-----
From: Kristen Benson [mailto:Kristen.Benson@enbridge.com]
Sent: Thu 9/2/2010 1:42 PM
To: Arevalo, John (DNRE)
Cc: 'Alina M. Heydt'; Tammy Leinweber
Subject: RE: Straits of Mackinac project (MDNRE File #10-24-0035-P)

John,

No, these properties are not Enbridge owned although we do have crossing easements. I believe the property ownership on the UP is city-owned and on the lower side, county-owned, as I believe it is noted in the application.

Please let me know if you need any additional information. If you have any questions specific to the application, you may contact Alina Heydt at Barr Engineering; she is cc'd on this note so you have her email; her phone # is 218-343-7777.

Sincerely,

Kris Benson
Senior Environmental Analyst
Enbridge
119 n. 28th St. E.
Superior, WI. 54880
Office: 715-394-1572
Cell: 218-348-1177

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Sent: Thursday, September 02, 2010 12:35 PM
To: Kristen Benson
Subject: Straits of Mackinac project (MDNRE File #10-24-0035-P)

Ms. Benson: is Enbridge Energy the riparian owner in the upper and lower peninsulas of Michigan where the pipelines come ashore? FYI, your file is now here in my office in Gaylord. Thank you.

John Arevalo, PWS
Water Resource Cadillac District Supervisor Water Resources Division Michigan Department of Natural Resources and Environment Gaylord Field Office 989-705-3450
arevaloj@michigan.gov

US Army Corps of Engineers (USACE) | Michigan Department of Environmental Quality (MDEQ) DEQ

AGENCY USE			
Previous USACE Permit or File Number	RECEIVED	Land and Water Management Division, MDEQ File Number 10-24-0035-P	AGENCY USE
USACE File Number	Date Received AUG 2 6 2010	Pre-application Number or Marina Operating Permit Number	
District Office Gaylord - Scott Rasmussen	DNRE/WRD PERMIT CONSOLIDATION UNIT	Fee received $ 500 CC	

Read Instructions pages i - iii. All of the following boxes below must be checked and information provided for the application to be processed:

- ☐ All items in Sections 1 through 9 are completed
- ☐ Date project was staked
- ☐ Items in Sections 10 through 21 that apply to the project are completed
- ☐ Application fee is attached
- ☐ Dimensions, volumes and calculations are provided
- ☐ All requested supplementary attachments (➡) are included
- ☐ Reproducible location map, site plan(s), cross sections and photographs are provided, one set must be black and white on 8 ½ by 11 inch paper.
- ☐ List any additional attachments, tables, etc.:

1 PROJECT LOCATION INFORMATION

- Refer to your property's legal description for the Township, Range, and Section information, and your property tax bill for your Property Tax Identification Number(s).

Site location Address (road, if no street address)	Zip Code	Township Name(s)	Township(s)	Range(s)	Section(s)
Lake Michigan (all in-water work) between Upper and Lower Peninsula			*40N & 39N*	*4W & 4W*	*25 & 10/11*

City/Village	County(ies)	Property Tax Identification Number(s)
N/A	*Mackinac and Emmet (in Straights)*	*N/A*

Name of Waterbody	Project Name or Job Number	Subdivision/Plat	Lot Number	Private Claim
Lake Michigan	*Pipeline Inspection*	*N/A*	*N/A*	*N/A*

Project types (check all that apply): ☐ private ☐ public/government ☐ industrial ☐ commercial ☐ multi-family ☐ building addition ☐ new building or structure ☐ building renovation or restoration ☐ river restoration ☐ single-family ☐ project is receiving federal transportation funds ☐ other (explain)

The proposed project is on, within, or involves (check all that apply) ☐ a legally established County Drain (date established) (M/D/Y) / /

☐ a stream ☐ a pond (less than 5 acres) ☒ a Great Lake or Section 10 Waters ☐ a natural river ☐ a new marina
☐ a river ☐ a channel/canal ☐ a designated high risk erosion area ☐ a dam ☐ a structure removal
☐ a ditch or drain ☐ an inland lake (5 acres or more) ☐ a designated critical dune area ☐ a wetland ☐ a utility crossing
☐ a floodway area ☐ a 100-year floodplain ☐ a designated environmental area ☐ 500 feet of an existing waterbody

2 DESCRIBE PROPOSED PROJECT AND ASSOCIATED ACTIVITIES, AND THE CONSTRUCTION SEQUENCE AND METHODS (attached additional sheets)

Written Summary of All Proposed Activities. *See Attached*

Construction Sequence and Methods.

3 APPLICANT, AGENT/CONTRACTOR, AND PROPERTY OWNER INFORMATION

Owner/Applicant	Agent/Contractor
(individual or corporate name) *Enbridge Energy, Limited Partnership* *Jacob Jorgensen, Associate Region Engineer*	(firm name and contact person)
Mailing Address *1320 Grand Avenue*	Address
City *Superior* State *WI* Zip Code *54880*	City State Zip Code
Daytime Phone Number with Area Code *715-394-1551* Cell Phone Number *218-248-0808*	Daytime Phone Number with Area Code - - Cell Phone Number - -
Fax *832-325-5602* E-mail *Jacob.Jorgensen@enbridge.com*	Fax - - E-mail

☐ No ☐ Yes Is the applicant the sole owner of all property on which this project is to be constructed and all property involved or impacted by this project?
➡ If no, attach letter(s) of authorization from all owners. A letter signed by each property owner authorizing the agent/contractor/other owner to act on his or her behalf or a copy of easements or right-of-ways must be provided. If multiple property owners, also attach a list of all owners along with their names, mailing addresses, and telephone numbers. If the applicant is a corporation, a corporate officer must provide written document authorizing any agent/contractor listed above to act on its behalf.
A letter of authorization must be provided from an owner receiving dredge spoils on their property, or where access through their property is required..

Property Owner's Name (If different from applicant)	Mailing Address
Daytime Phone Number with Area Code - - Cell Phone Number - -	City State Zip Code

[ ] No [ ] Yes Is there a MDEQ conservation easement or other easement, deed restriction, lease, or other encumbrance upon the property in the project area?
→ If yes, attach a copy.

4 PROPOSED PROJECT PURPOSE, INTENDED USE, AND ALTERNATIVES CONSIDERED (Attach additional sheets if necessary)

Purpose/Intended Use: The purpose must include any new development or expansion of an existed land use. *See attached*

Alternatives: Include a description of alternatives considered to avoid or minimize resource impacts. Include factors such as, but not limited to, alternative construction technologies; alternative project layout and design; and alternative locations. For utility crossings, include both alternative routes and alternative [construction methods].
See attached

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5 LOCATING YOUR PROJECT SITE

→ Attach a black and white, legible copy of a map that clearly shows the site location and road from the nearest major intersection, and includes a north arrow.

Is there an access road to the project? [X] No [ ] Yes (If Yes, type of road, check all that apply) [ ] private [ ] public [ ] improved [ ] unimproved

Name of roads at closest main intersection *N/A - work conducted entirely in water* and

Directions from main intersection

Style of house or other building on site [ ] ranch [ ] 2-story [ ] cape cod [ ] bi-level [ ] cottage/cabin [ ] pole barn [ ] none [ ] other (describe)

Color | Color of adjacent property house and/or buildings | House number | Street name

Fire lane number | Lot number | Address is visible on [ ] house [ ] garage [ ] mailbox [ ] sign [ ] other (describe)

How can your site be identified if there is no visible address?

Provide directions to the project site, with distances from the best and nearest visible landmark and waterbody *Project locations all located within the Straits of Mackinac in Lake Michigan; all work will be conducted along underwater pipeline crossing.*

Does the project cross the boundaries of two or more political jurisdictions? (City/Township, Township/Township, County/County, etc.)
[ ] No [ ] Yes → If Yes, list jurisdictions: *Unknown*

6 List all other federal, interstate, state, or local agency authorizations required for the proposed activity, including all approvals or denials received.

Agency	Type approval	Identification number	Date applied	Date approved / denied	If denied, reason for denial
US Coast Guard	*Notification*				
Mackinac Bridge Authority	*Notification*				

7 COMPLIANCE

If a permit is issued, date activity will commence (M/D/Y) / /

Proposed completion date (M/D/Y) / /

Has any construction activity commenced or been completed in a regulated area? [ ] No [ ] Yes
→ If Yes, identify the portion(s) underway or completed on drawings or attach project specifications and give completion date(s) (M/D/Y) / /

Were the regulated activities conducted under a MDEQ permit? [ ] No [ ] Yes
If Yes, list the MDEQ permit number

Are you aware of any unresolved violations of environmental law or litigation involving the property? [X] No [ ] Yes (If Yes, explain)

8 ADJACENT/RIPARIAN AND IMPACTED OWNERS (Attach additional sheets if necessary)

- Complete information for all adjacent and impacted property owners and the lake association or established lake board, including the contact person's name.
- If you own the adjacent lot, provide the requested information for the first adjacent parcel that is not owned by you.

Property Owner's Name	Mailing Address	City	State	Zip Code
See attached for landowner information.				

Name of [ ] Established Lake Board [ ] or Lake Association
and the Contact Person's name, phone number, and mailing address

9 APPLICANT'S CERTIFICATION **READ CAREFULLY BEFORE SIGNING**

I am applying for a permit(s) to authorize the activities described herein. I certify that I am familiar with the information contained in this application; that it is true and accurate; and, to the best of my knowledge, that it is in compliance with the State Coastal Zone Management Program. I understand that there are penalties for submitting false information and that any permit issued pursuant to this application may be revoked if information on this application is untrue. I certify that I have the authority to undertake the activities proposed in this application. By signing this application, I agree to allow representatives of the MDEQ, USACE, and/or their agents or contractors to enter upon said property in order to inspect the proposed activity site and the completed project. I understand that I must obtain all other necessary local, county, state, or federal permits and that the granting of other permits by local, county, state, or federal agencies does not release me from the requirements of obtaining the permit requested herein before commencing the activity. I understand that the payment of the application fee does not guarantee the issuance of a permit.

	Printed Name	Signature	Date (M/D/Y)
[ ] Property Owner [ ] Agent/Contractor [X] Corporation/Public Agency – Title *Associate Region Engineer*	*Jacob Jorgensen*	Jacob P. Jorgensen	*08/26/2010*

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16 DRAWDOWN OF AN IMPOUNDMENT

- If wetlands will be impacted, also complete Section 12.

Type of drawdown ☐ over winter ☐ temporary ☐ one-time event ☐ annual event ☐ permanent (dam removal) ☐ other

Reason for drawdown

Has there been a previous drawdown? ☐ No ☐ Yes (If Yes, provide date (M/D/Y) / / | Previous MDEQ permit number, if known

Does waterbody have established legal lake level? ☐ No ☐ Yes ☐ Not Sure | Dam ID Number, if known

Extent of vertical drawdown (ft)	Impoundment design head (ft)	Number of adjacent or impacted property owners
Date drawdown would start (M/D/Y) / /	Date drawdown would stop (M/D/Y) / /	Rate of drawdown (ft/day)
Date refilling would start (M/D/Y) / /	Date refill would end (M/D/Y) / /	Rate of refill (ft/day)
Type of outlet discharge structure to be used ☐ surface ☐ bottom ☐ mid-depth	Impoundment area at normal water level (acres)	Sediment depth behind impoundment discharge structure (ft)

17 DAM, EMBANKMENT, DIKE, SPILLWAY, OR CONTROL STRUCTURE ACTIVITIES (See Sample Drawing 15)

- For more information go to www.michigan.gov/deqdamsafety
- If wetlands will be impacted, also complete Section 12.

➡ Attach site-specific conceptual plans for construction of a new dam, reconstruction of a failed dam, or enlargement of an existing dam for resource impact review.

- Detailed engineering plans are required once the activity has been determined to be permitable from an environmental standpoint.

➡ Attach detailed engineering plans for a dam repair, dam alteration, dam abandonment, or dam removal.

Which one best describes your project? ☐ new dam construction ☐ reconstruction of a failed dam ☐ enlargement of an existing dam ☐ dam repair ☐ dam alteration ☐ dam abandonment ☐ dam removal ☐ other

Dam ID Number If known	Type of outlet discharge structure ☐ surface ☐ bottom ☐ mid depth	Will proposed activities require a drawdown of the waterbody to complete the work? ☐ No ☐ Yes (If Yes, also complete Section 16)	
Riprap Volume (cu yd)	Dredging/excavation Volume (cu yd)	Fill volume (cu yd)	Does structure allow complete drainage of waterbody? ☐ No ☐ Yes
Benchmark elevation (ft)	Datum used ☐ Local ☐ NGVD 29 ☐ other	Describe benchmark and show on plans	

Have you engaged the services of a Licensed Professional Engineer? ☐ No ☐ Yes If Yes, provide name, registration number, and mailing address.
Name Registration Number Mailing Address

Will a water diversion during construction be required? ☐ No ☐ Yes If Yes, describe how the stream flow will be controlled through the dam construction area during the proposed project activities:

COMPLETE THE FOLLOWING FOR A NEW DAM, RECONSTRUCTION OF A FAILED DAM, OR ENLARGEMENT OF AN EXISTING DAM

Describe the type of dam and how you will design the dam and embankment to control seepage through and underneath the dam.

Embankment top elevation (ft)	Streambed elevation at downstream embankment toe (ft)	Structural height (difference between embankment top elevation and streambed elevation at downstream embankment toe) (ft)	
Embankment length (ft)	Embankment top width (ft)	Embankment bottom width (ft)	Embankment slopes (vertical / horizontal) Upstream Downstream
Proposed normal pool elevation (ft)	Impoundment flood elevation (ft)	Maximum vertical drawdown capability (ft) (Attach operational procedure of the proposed structure, if available)	
Have soil borings been taken at dam location? ☐ No ☐ Yes ➡ If Yes, attach results.	Will a cold water underspill be provided? ☐ No ☐ Yes If Yes, invert elevation (ft)	Do you have flowage rights to all proposed flooded property at the design flood elevation? ☐ No ☐ Yes	

18 UTILITY CROSSINGS (See Sample Drawings 12 and 13, and EZ Guide)

- If side casting is required, complete Sections 10A and 10B. If spoils will be placed in wetlands or wetlands may be impacted, complete Section 12.

➡ Attach additional sheets or tables with the requested information as needed for multiple crossings.

What method will be used to construct the crossings? ☐ flume ☐ plow ☐ open trench ☐ jack and bore ☐ directional drilling

Crossing of ☐ Inland Lake or Stream ☐ floodplain ☐ international waters ☐ wetlands (also complete Section 12)

Type	Number of wetland crossings	Number of inland lake or stream crossings	Pipe diameter (in)	Pipe length per crossing (ft)	Distance below streambed or wetland (in)	Trench width (ft)
☐ sanitary sewer						
☐ storm sewer						
☐ watermain						
☐ cable						
☒ oil/gas pipeline			20"	21,000		

MDNRE and USACE - Joint Permit Application
Enbridge Pipelines (Lakehead), L.L.C.
Straits of Mackinac Maintenance and Inspection Project, Line 5
Mackinac and Emmet Counties, Michigan

Project Descripton

2 – Describe proposed project and associated activities, and the construction sequence and methods.
The purpose of the project will be to perform visual inspection of the existing 20-inch pipelines installed beneath the Straits of Mackinac and install support structures in more than 10 locations along the pipeline. The most of the location of the existing pipelines is shown on the attached site location Figures 1,2,3, & 4 in attachment "FIGURES AND CONTRUCTION TYPICALS".T he work will involve the installation of a helical anchoring system with saddle mounted about the pipeline in each proposed location to increase support; the anchors will be augered directly into the lake bed. The proposed locations for installation of the anchoring structures are provided on the attached map. During the underwater inspection additional location requiring maintenance may be identified. Installation of support structures in these locations would occur during this project. Schematics showing the auguring apparatus and method as well as equipment utilized for installation are included with the attachments.

Work will be conducted from barges and a certified diving contractor will be employed to oversee the installation. Work is scheduled to begin September 17, 2010 and is expected to take 10 days at the minimum with very good weather conditions and up to 30 days with poor weather conditions.

4 – Proposed project purpose, intended use, and alternative considered.
In order to maintain pipeline integrity, installation of additional supports to minimize the distance between presently unsupported pipeline spans is necessary. The proposed locations for installation of the anchoring structures are provided on the attached map. Schematics showing the auguring apparatus and method as well as equipment utilized for installation are included with the attachments. The support method is anticipated to incur minimal or no environmental impact. This project is considered pipeline maintenance and is not associated with a new utility installation.

The proposed work is necessary to provide better overall pipeline integrity and safety. Do nothing or the no-build alternative presents a future risk to the pipeline. The no build is not a viable option.

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Arevalo, John (DNRE)

From: Klemans, Diana (DNRE)
Sent: Thursday, September 16, 2010 9:17 AM
To: Graf, Tom (DNRE); Fitzner, Wendy (DNRE); Dettloff, Mary (DNRE); Rasmusson, Scott (DNRE); Arevalo, John (DNRE)
Cc: Saalfeld, Jerry (DNRE); Ostlund, Peter (DNRE); Syts, Sean (DNRE)
Subject: RE: More reporter questions

Hi All,

Enbridge submitted an application for coverage under a general NPDES permit to discharge any petroleum impacted dewatering wastewater generated from the maintenance project proposed for the pipeline crossing the Straits. The application is currently on hold at the request of Enbridge. The NPDES permit (if issued) can deal only with potential impacts resulting from the dewatering discharge. Although it is not exactly clear from these notes what special safety requirements and additional information the public would like to see brought into the DNRE's regulatory process, it is unlikely that the NPDES permit can deal with them. Jerry Saalfeld or Sean Syts can provide more info if needed.

The WRD also administers Part 5, Spillage of Oil and Polluting Materials, but this appears to deal only with on land storage facilities. Pete Ostlund is looking into this more closely to determine for sure whether we have/don't have some leverage (i.e. for safety) under this Part. He is in a meeting all day today so he will get back to everyone tomorrow or Monday.

Dina

-----Original Message-----
From: Graf, Tom (DNRE)
Sent: Wednesday, September 15, 2010 2:26 PM
To: Fitzner, Wendy (DNRE); Dettloff, Mary (DNRE); Rasmusson, Scott (DNRE); Arevalo, John (DNRE)
Cc: Klemans, Diana (DNRE)
Subject: RE: More reporter questions

Mary -

Scott hit the nail on the head - we can only react to the work proposed in the permit application and evaluate the impacts of the proposed work pursuant to Part 325. We do not have authority under Part 325 to regulate the operation of the pipeline. Might

APPENDICES TO FLOW PUBLIC COMMENTS ON THE JOINT APPLICATION OF ENBRIDGE ENERGY TO OCCUPY GREAT LAKES BOTTOMLANDS FOR ANCHORING SUPPORTS TO TRANSPORT CRUDE OIL IN LINE 5 PIPELINES IN THE STRAITS OF MACKINAC AND LAKE MICHIGAN [2RD-DFDK-Y35G]

TABLE OF CONTENTS

APPENDIX C

Jim Olson

From: Karla Gerds
Sent: Monday, July 25, 2016 3:10 PM
To: Jim Olson
Subject: FW: FOIA 2016-01788 Re: Lakehead/Enbridge "Line 5"
Attachments: 9-20-12 Call Notes.pdf; 9-30-11 Call Notes.pdf; 9-30-11 Call Notes2.pdf; 2012 DRA Project Notification.pdf; 2014 DRA Project As-Builts.pdf; FW: 369 signers: The Straits of Mackinac Enbridge, Inc. Pipeline petition; RE: Oil under the Mackinac Bridge: Protest planned this weekend over Enbridge pipeline | MLive.com; Target in-service date for increased thru-put on Line 5; Update on construction status for Line 5 DRA Project

Jim,

Below is the response from LARA for the FOIA request that I sent on behalf of FLOW on June 30.
I have put all of the responses in an excel spreadsheet. Which is here: S:\WPFILES\!CLIENTS\FLOW for Water-5836 klg\Line 5 Straits of Mackinac\FOIA\Response to 6-30-16 FOIA Request.xlsx

Thank you,

Karla Gerds
Legal Assistant
Olson, Bzdok & Howard
karla@envlaw.com
www.envlaw.com

Traverse City Office
420 East Front Street
Traverse City, MI 49686
(231) 946-0044

Frankfort Office
427 Main Street
P.O. Box 1782
Frankfort, MI 49635

From: LARAFOIAInfo [mailto:LARAFOIAInfo@michigan.gov]
Sent: Monday, July 25, 2016 9:07 AM
To: Karla Gerds
Subject: FOIA 2016-01788 Re: Lakehead/Enbridge "Line 5"

Karla Gerds
Olson, Bzdok & Howard
karla@envlaw.com

Dear Ms. Gerds:

The Michigan Department of Licensing and Regulatory Affairs (LARA) has received your request for public records and has processed it under the provisions of the Michigan Freedom of Information Act (FOIA), 1976 PA 442, MCL 15.231 *et seq.* Because of the nature of your request it was sent to the Michigan Public Service Commission (MPSC) to search for any non-exempt records that may be responsive to your request.

Your request has been **granted in part and denied in part**. Portions of your request are exempt from disclosure based on provisions set forth in the Act. (See comments below.)

Comments:

First, the website links below respond to the corresponding item numbers stated in the request:

1. Dockets listed below may contain this information.
2. Dockets U-286, U-983, U-1869, U-2391, U-2606, U-2804, and U-3207 may contain applications to the MPSC for increases in operating pressures.
3. Dockets U-286, U-983, U-1869, U-2391, U-2606, U-2804, and U-3207 contain MPSC approvals altering Line 5 facilities resulting in progressive increases in capacity. Links to MPSC orders are provided below.
4. See response to Request #3 above.
5. Dockets listed below may contain this information. Otherwise, Staff are not aware of any additional documents.
6. Dockets listed below may contain this information. Otherwise, Staff are not aware of any additional documents.

Below are all the orders in the MPSC system containing the company name "Lakehead" and pertaining to Line 5. The complete docket may be present in MPSC microfilm reels. The page numbers are the number of pages we've found in the microfilm for that docket.

U-286 – unknown pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-286 07-07-1960.PDF

U-983 - unknown pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-983 05-17-1962.PDF

U-1869 - unknown pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-1869 03-25-1965.PDF

U-2391 - unknown pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-2391 06-02-1966.PDF

U-2606 - unknown pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-2606 12-15-1966.PDF

U-2804 - unknown pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-2804 10-19-1967.PDF

U-2807 - unknown pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-2807 07-13-1967.PDF

U-2950 - unknown pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-2950 12-14-1967.PDF

U-3080 - unknown pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-3080 04-11-1968.PDF

U-3207 - unknown pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-3207_08-15-1968.PDF

U-3547 - unknown pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-3547_11-26-1969.PDF

U-8701 – 47 pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-8701_04-14-1987.PDF

U-9381 – 11 pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-9381_08-01-1989.PDF

U-9944 – 38 pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-9944_09-25-1991.PDF

U-9980 – 503 pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-9980_11-08-1991.PDF

U-10073 – unknown pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-10073_04-15-1992.PDF

U-10097 – 37 pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-10097_06-12-1992.PDF

U-10104 – 38 pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-10104_06-12-1992.PDF

U-10113 – 24 pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-10113_07-10-1992.PDF

U-10287 – 26 pages
http://www.dleg.state.mi.us/mpsc/orders/archive/pdfs/U-10287_04-22-1993.PDF

Second, see the attached documents which correspond to items #7, #8, and #10.

Third, item #9 is denied. No records currently exist.

To the best of the LARA's knowledge, information, and belief, under the information provided by you or by any other description reasonably known to MPSC, the public records do not exist. (MCL 15.235(5)(b)).

If you have questions concerning this matter, please feel free to contact the LARA FOIA Office at LARAFOIAInfo@michigan.gov. To review a copy of LARA's written public summary, procedures, and guidelines, go to www.michigan.gov/lara.

Section 10 of the FOIA provides that if a public body denies any portion of your FOIA, or charges a fee that exceeds the amount permitted under its publicly available procedures and guidelines, you may submit a written appeal to Director, Department of Licensing and Regulatory Affairs, P.O. Box 30004, Lansing, MI 48909. Your FOIA appeal must specifically state the word "appeal" and identify the reason(s) the fee or disclosure denial(s) should be reversed. You may also seek judicial review in an appropriate Michigan court within 45 days after a fee charge, or within 180 days after a denial notice. If you prevail in a court action regarding a fee charged or a disclosure denial, the court may award you reasonable attorney fees and punitive damages.

Sincerely,

LARA FOIA Office
hk

Jim Olson

From: Creisher, Cynthia (LARA) <CreisherC@michigan.gov>
Sent: Thursday, July 11, 2013 5:26 PM
To: Palnau, Judy (LARA)
Cc: Ballinger, Brian (LARA); Chislea, David (LARA); Warner, Travis (LARA)
Subject: RE: Oil under the Mackinac Bridge: Protest planned this weekend over Enbridge pipeline | MLive.com
Attachments: FW: Enbridge Line 5 News release

Judy,

I found the news release (attached) that Enbridge sent us shortly after they discussed the expansion with us, but it doesn't give much detail other than it "can be economically achieved with upgrades or modifications of facilities and does not require installation of new pipeline."

I also found my notes from when they briefed us about the announcement. I noted that they would be upgrading pump stations, adding drag reducing agent to reduce friction in oil, and hydrostatically testing segments to eliminate pressure reductions to allow them to increase operating pressure.

Thanks,
Cindy

-----Original Message-----
From: Ballinger, Brian (LARA)
Sent: Thursday, July 11, 2013 8:09 AM
To: Chislea, David (LARA); Warner, Travis (LARA); Creisher, Cynthia (LARA)
Subject: Oil under the Mackinac Bridge: Protest planned this weekend over Enbridge pipeline | MLive.com

http://www.mlive.com/news/index.ssf/2013/07/oil_under_the_mackinac_bridge.html#incart_river_default

Jim Olson

From: Claudia Schrull <Claudia.Schrull@enbridge.com>
Sent: Tuesday, December 04, 2012 10:00 AM
To: Ballinger, Brian (LARA); Chislea, David (LARA); Warner, Travis (LARA)
Cc: Thomas Hodge; Lisa Wilson; Arshia Javaherian; Amy Back
Subject: Target in-service date for increased thru-put on Line 5

Hi Brian,
I received confirmation today that March 31, 2013 is our target in-service date for increasing the flow rate on Line 5. I will keep you posted if that date changes.
Best regard ..cs
Claudia Schrull
Sr. Mgr, US Regulatory Pipeline Development, EUS Legal
Enbridge Energy Company, Inc.
1100 Louisiana, Suite 3300
Houston,,Tx 77002
Office: 713-821-2045
Cell: 832-731-9535
Email: claudia.schrull@enbridge.com

From: Claudia Schrull
Sent: Monday, December 03, 2012 12:53 PM
To: Brian Ballinger (ballingerb2@michigan.gov); Chislea, David (LARA) (chislead@michigan.gov); Travis Warner (warnert3@michigan.gov)
Cc: Thomas Hodge (thomas.hodge@enbridge.com); Lisa Wilson (lisa.wilson@enbridge.com); Arshia Javaherian; Amy Back
Subject: FW: Update on construction status for Line 5 DRA Project
Hi Brian,
As a follow-up to our bi-weekly meeting last week, please find attached Line 5's construction status report that was sent to Travis and Dave on Nov. 19, 2012. Also, I am checking on your other question relative to the in-service date for increasing the flow rate on Line 5 from 490,000 barrels per day (bpd) to 540,000 bpd. I will forward to everyone the results of my findings upon receipt.
Dave and Travis, I have also attached the station plot plan for the DRA skid that will be installed within the existing Naubinway Station site.
Please feel free to call or email with any questions.
Best regards ...cs
Claudia Schrull
Sr. Mgr, US Regulatory Pipeline Development, EUS Legal
Enbridge Energy Company, Inc.
1100 Louisiana, Suite 3300
Houston, Tx 77002
Office: 713-821-2045
Cell: 832-731-9535
Email: claudia.schrull@enbridge.com

From: Claudia Schrull
Sent: Monday, November 19, 2012 6:14 AM
To: David (Dave) Chislea (chislead@michigan.gov); Travis Warner (warnert3@michigan.gov)
Cc: Thomas Hodge (thomas.hodge@enbridge.com); Lisa Wilson (lisa.wilson@enbridge.com); Arshia Javaherian; Amy Back
Subject: Update on construction status for Line 5 DRA Project

Hi Dave and Travis,

In accordance with your request, please find attached the construction status report for the Line 5 DRA Project. For your convenience, all updates are shown in red.

Please note that in the last 30-days, the Line 5 DRA Project has been updated to also include a new DRA skid at Enbridge's existing Naubinway Station site (as shown on Page 1 of the updated table). The scope of work at this station site is the same as all other DRA installations that are part of this Project. All work activities will be located within the existing station on land owned in fee by Enbridge. No new land will be required and no landowners will be affected by this station work. A plot plan for the Naubinway Station is being developed and will be provided to you as soon as it is completed.

Please feel free to call or email me if you have any questions or concerns.

Hope you have a wonderful Thanksgivings with your family. Look forward to talking with you on Thursday, November 29, 2012 at our bi-weekly meeting.

Best regards ...cs

Claudia Schrull
Sr. Mgr, US Regulatory Pipeline Development, EUS Legal
Enbridge Energy Company, Inc.
1100 Louisiana, Suite 3300
Houston, Tx 77002
Office: 713-821-2045
Cell: 832-731-9535
Email: claudia.schrull@enbridge.com

ENBRIDGE

Enbridge Energy, Limited Partnership
1100 Louisiana, Suite 3300
Houston, Texas 77002

Claudia Schrull
Manager, Regulatory Pipeline Development
Tel (713) 821-2045
Cell (832) 731-9535
Claudia.schrull@enbridge.com

July 16, 2012

Ms. Mary Jo Kunkle
Executive Secretary
Michigan Public Service Commission
4300 W. Saginaw
Lansing, MI 48917-2171

RECEIVED
MICHIGAN PUBLIC SERVICE COMMISSION
JUL 16 2012
OPERATIONS & WHOLESALE MARKETS DIVISION

RE: Enbridge Energy, Limited Partnership
Line 5 – DRA Project

Dear Ms. Kunkle:

Consistent with 1929 PA 16; MCL 483.1 et seq., this correspondence is to provide notification to the Michigan Public Service Commission ("MPSC" or "Commission") of Enbridge Energy, Limited Partnership's ("Enbridge") plans to make minor upgrades to seven of its existing pump stations on Line 5[1] in Gogebic, Iron, Mackinac, Cheboygan, Bay, Lapeer and St. Clair Counties, Michigan. No new land will be required for these minor upgrades as all work activities will be performed within the existing station sites which Enbridge owns in fee. The scope of this project, referenced as Line 5 – DRA Project ("Project"), involves the installation of new, and replacement of existing, DRA (drag reducing agent) skids, including all valves and appurtenances, as described in more detail on Table No. 1 below. In addition, the Project involves making certain minor modifications to the header piping and pumping assemblies at Indian River and Bay City Station sites, and installing a spare meter run at the existing Marysville Station in Marysville, Michigan.

[1] Line 5 is a crude oil and petroleum pipeline, which extends from Superior, Wisconsin through the Upper and Lower Peninsulas of Michigan before terminating at Sarnia, Ontario

Upon the completion of these station upgrades, Enbridge will be able to increase the flow rate of Line 5 from 490,000 barrels per day (bpd) to 540,000 bpd. The increased flow rate is needed in order for Enbridge to meet the rising demand of its shippers to transport additional light crude oil supplies to refinery markets in the upper Midwest and eastern Ontario.

Over the past 12 months, shippers experienced monthly apportionment on this pipeline. However, once completed, this Project will help to alleviate these capacity constraints by increasing the flow rate approximately 50,000 bpd to serve these refinery markets. Based on shipper requests and market assessments, Enbridge plans to start construction in mid-July 2012, with a target in-service date for the increased flow rate in March 31, 2013. This Project will not increase the overall maximum operating pressure of Line 5.

Enbridge plans to hydrotest Line 5 in the counties of Delta, Schoolcraft, Montmorency, Ogemaw, and Bay, Michigan. This will enable Enbridge to verify and document the operating pressure in these sections to be consistent with the overall current maximum operating pressure of Line 5. All hydrotesting will be implemented in compliance with the U.S. Department of Transportation, Pipeline Hazardous Material Safety Administration, Office of Pipeline Safety (OPS) under 49 CFR, Part 195 of OPS' rules and regulations.

An overview map of Line 5 and its existing stations is attached herein as Exhibit A. Additionally, Enbridge encloses as Exhibit B, a full description of each station location and the related station upgrades and modifications as identified on Table No. 1. Each station upgrade is accompanied with a station plot plan, which provides an overview of the related station site and the location of such work activities.

Should the Commission or its Staff require further information or have any questions regarding the upgrades and modifications planned for any of the Line 5 station sites, I am available at the contact numbers identified above.

Very truly yours,

Claudia Schrull

Claudia Schrull
Manager, Regulatory Pipeline Development

Enclosures
cc: Brian Ballinger

Table No. 1 Project Scope for Line 5 – DRA Project					
Exhibit No	**Station**	**State**	**County**	**Scope of Work**	**Station Plot Plan**
B.1	Gogebic	MI	Gogebic	• Install new DRA skid including all valves and appurtenances	**B.1.a**
B.2	Iron River	MI	Iron	• Deactivate existing DRA skid • Install new DRA skid including all valves and appurtenances	**B.2.a**
B.3	Gould City	MI	Mackinac	• Install new DRA skid including all valves and appurtenances	**B.3.a**
B.4	Indian River	MI	Cheboygan	• Deactivate existing DRA skid • Modify existing pumping assembly including all unit piping, valves and appurtenances • Replace certain station header piping including all valves and appurtenances	**B.4.a**
B.5	Bay City	MI	Bay	• Deactivate existing DRA skid • Install new DRA skid including all valves and appurtenances • Modify existing pumping assembly including all unit piping, valves and appurtenances • Replace certain station header piping including all valves and appurtenances	**B.5.a**
B.6	North Branch	MI	Lapeer	• Deactivate existing DRA skid • Install new DRA skid including all valves and appurtenances	**B.6.a**
B.7	Marysville	MI	St. Clair	• Install spare meter run including all valves and appurtenances at existing meter station site	**B.7.a**

ENBRIDGE™

Enbridge Energy, Limited Partnership
1100 Louisiana, Suite 3300
Houston, Texas 77002

Claudia Schrull
Sr. Manager, Regulatory Pipeline Development
Tel (713) 821-2045
Cell (832) 731-9535
Claudia.schrull@enbridge.com

June 5, 2014

RECEIVED
JUN 06 2014
EXECUTIVE SECRETARY

Ms. Mary Jo Kunkle
Executive Secretary
Michigan Public Service Commission
4300 W. Saginaw
Lansing, MI 48917-2171

RE: Enbridge Energy, Limited Partnership
Submittal of Final As-Built Station Plot Plans for Line 5 DRA Project

Dear Ms. Kunkle:

Consistent with 1929 PA 16; MCL 483.1 et seq.; and pertaining to Enbridge Energy, Limited Partnership's ("Enbridge") submittal on July 16, 2012 to the Michigan Public Service Commission ("Commission") of its plans to make minor station upgrades at existing pump/meter station sites on Line 5, as amended in subsequent construction reports. During a scheduled conference call to provide an update of the project, Commission Staff requested Enbridge to provide "as-built" maps upon the completion of the installation of the new and/or upgraded facilities.

Based on that request, Enbridge hereby submits as Attachment A, the Final As-Built Station Plot Plans for each station site where upgrades have been installed. All station work within the existing station sites has been completed, as listed on Table 1 attached.

Enbridge has successfully increased the flow rate on Line 5 from 490,000 barrels per day (bpd) to 540,000 bpd, without increasing the maximum operating pressure on the line. — Safety —
not a word re: [illegible],
Safety,
Monitoring
[illegible] plans
or [illegible]
Response Plans

Should the Commission or its Staff require further information or have any questions regarding this submission, I am available at the contact numbers identified above.

Very truly yours,

Claudia Schrull

Claudia Schrull
Sr. Manager,
Regulatory Pipeline Development
EUS Law

Attachments: Table 1 and Final As-Built Station Plot Plans

cc: Mr. Travis Warner
Michigan Public Service Commission

Table 1
Line 5 DRA Project

Station	County	State	Scope of Work Completed
Gogebic	Gogebic	Michigan	• DRA Skid completed and in service.
Iron River	Iron	Michigan	• DRA Skid completed and in service.
Gould City	Mackinac	Michigan	• DRA Skid completed. • DRA Skid removed from Gould City and installed at Mackinaw Station.
Naubinway	Mackinac	Michigan	• DRA Skid completed and in service.
Mackinaw	Emmet	Michigan	• DRA Skid completed and in service.
Indian River	Cheboygan	Michigan	• Pumping Unit replaced and in service. • Station Header Piping replaced and in service.
Bay City	Bay	Michigan	• DRA Skid completed and in service. • Pumping Unit replaced and in service. • Station Header Piping replaced and in service.
North Branch	Lapeer	Michigan	• DRA Skid completed and in service.
Marysville	St. Clair	Michigan	• Meter Run including all valves and appurtenances completed and in service.

S T A T E   O F   M I C H I G A N

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the petition of LAKEHEAD PIPE LINE COMPANY, INC., for approval of the installation of a fourth pumping unit at its Gould City pumping station in Mackinac County.	Case No. U-286

At a session of the Michigan Public Service Commission held at its offices in the city of Lansing, Michigan, on the 7th day of July, A. D. 1960.

PRESENT: Hon. George E. Hill, Chairman
Hon. Thomas M. Burns, Commissioner
Hon. James H. Lee, Commissioner

ORDER APPROVING PUMPING STATION CONSTRUCTION

On June 2, 1960, Lakehead Pipe Line Company, Inc., filed a petition with this Commission seeking approval of the installation of a fourth pumping unit in its Gould City pumping station on its 30-inch common carrier crude oil pipeline near Gould City in Mackinac County. This Commission, by its Order D-3903-57.3, dated November 14, 1957, approved the construction of the Gould City pumping station with one 900 hp and two 1,750 hp electric motor-driven units. Such order recognized the petitioner's plan for the addition of a fourth pumping unit in the future. The Michigan portion of the 30-inch pipeline, which is a part of the common carrier system which transports crude oil from Western Canada to Sarnia, Ontario, was constructed under authority of Order D-3903-53.1, dated March 31, 1953. The 30-inch pipeline downstream of the Gould City station was tested to 840 psig after construction, which qualified the pipeline for a maximum operating pressure of 670 psig at the discharge side of the station. The pipeline and the station were constructed and tested in compliance with the requirements of Section 3 of American Standards Association Code B31.1-1955, "Code for Pressure Piping."

Petitioner represents that the forecasted throughput of crude oil for the year 1961 indicates that it is necessary to increase the capacity of the 30-inch pipeline. This augmented capacity will be provided by the installation of the proposed additional 1,750 hp electric motor-driven pumping unit at the Gould City station. The new capacity resulting from this additional horsepower will be approximately 333,500 barrels of crude oil per day.

The company filed an engineering report with its petition showing the specifications of the proposed new pumping unit.

The anticipated hydraulic gradient for the pipeline under maximum flow conditions between Superior, Wisconsin, and Sarnia, Ontario, after completion of proposed construction was also filed to show that the installation of the new pumping unit will not result in excessive operating pressures at any point on the pipeline. It is further represented that the proposed new unit will be designed, constructed and installed in accordance with the same ASA Code B31.1-1955 under which the original installation was constructed, and will be controlled and protected by the same fail-safe system as the existing units.

The Commission has carefully considered the matter and FINDS that no new question of public interest appears to be involved and that the public safety will be adequately protected without the time and expense of a public hearing.

The Commission FURTHER FINDS that the 30-inch oil pipeline as presently constructed and tested is qualified for a maximum discharge pressure at the Gould City pumping station of 670 psig, and that the installation of the proposed fourth pumping unit will not cause maximum operating pressures to be exceeded under conditions proposed in the petition.

NOW, THEREFORE, IT IS HEREBY ORDERED by the Michigan Public Service Commission that the petition of Lakehead Pipe Line

Company, Inc., to install a fourth pumping unit in its Gould City pumping station in Mackinac County be and the same is hereby approved.

IT IS FURTHER ORDERED that, except as modified hereby, the provisions of Orders D-3903-53.1 and D-3903-57.3, covering the original construction of the 30-inch pipeline and the Gould City pumping station, shall remain in effect.

The Commission retains jurisdiction of the matters herein contained and the authority to issue such further order or orders as the facts and circumstances may require.

MICHIGAN PUBLIC SERVICE COMMISSION

(S E A L)

/s/ George E. Hill

Chairman

/s/ Thomas M. Burns

Commissioner

/s/ James H. Lee

Commissioner

By the Commission and pursuant to its action of July 7, 1960

/s/ Norman Berkowitz

Its Secretary

S T A T E   O F   M I C H I G A N

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the petition of LAKEHEAD PIPE LINE COMPANY, INC., for approval of the installation of five additional pumping stations on its 30" common carrier oil pipeline.	)	Case No. U-983

At a session of the Michigan Public Service Commission held at its offices in the city of Lansing, Michigan, on the 17th day of May, A. D. 1962.

PRESENT: Hon. James H. Inglis, Chairman
Hon. Thomas M. Burns, Commissioner
Hon. John E. Tormey, Commissioner

ORDER APPROVING INSTALLATION OF
ADDITIONAL PUMPING STATION FACILITIES

On May 14, 1962, Lakehead Pipe Line Company, Inc., filed a petition with this Commission seeking approval of the installation of five additional pumping stations on its 30" common carrier oil pipeline as follows:

Gogebic, Marenisco Township, Gogebic County
Rapid River, Masonville Township, Delta County
Mackinaw, Wawatam Township, Emmet County
Lewiston, Lovells Township, Crawford County
North Branch, North Branch Township, Lapeer County

Petitioner represents that the capacity of its present oil pipeline system is approximately 333,500 barrels of crude oil per day. The capacity of the system after installation of the said pumping stations will be increased to 416,000 barrels of crude oil per day. Petitioner represents that its throughputs as forecast for 1963 indicates the necessity of the proposed increase in capacity.

Petitioner submitted an engineering study setting forth in detail the exact location of said pumping stations, the specifications of the piping, pumping equipment, controls, power and electric equipment, and protective system.

The proposed maximum discharge pressure of the five stations is as follows:

Gogebic	509 psig
Rapid River	584 psig
Mackinaw	584 psig
Lewiston	492 psig
North Branch	539 psig

Petitioner represents that the pressure test conducted on its main line in 1953 was at least 1.25 times the above proposed maximum discharge pressures and submitted a hydraulic gradient study to show that under the proposed operating conditions the maximum allowable operating pressure of the main pipeline as previously authorized by the Commission would not be exceeded.

Petitioner represents that the station piping will be designed, constructed and tested in accordance with the requirements of the American Standard Code for Pressure Piping, ASA B31.4-1959 "Oil Transportation Piping." The size and number of units for each station are as follows:

Gogebic	1 - 1,250 hp. and 2 - 2,250 hp. units
Rapid River	1 - 900 hp. and 2 - 1,750 hp. units
Mackinaw	1 - 1,250 hp. and 2 - 2,250 hp. units
Lewiston	1 - 1,000 hp. and 2 - 2,000 hp. units
North Branch	1 - 1,250 hp. and 2 - 2,500 hp. units

All pumps will be driven by electric motors, and suitable safety devices will cause shut-down of any station for reasons of excessive pressures, temperatures, or vibration. The proposed installations will be controlled and protected by the same fail-safe system as the existing facilities.

The Commission has carefully considered this matter and FINDS that no new question of public interest appears to be involved and that the public safety will be adequately protected without the time and expense of a public hearing.

The Commission FURTHER FINDS that the 30" oil pipeline as presently constructed and tested is qualified for maximum discharge pressures at the several pump stations as specified above, and that installation of the proposed pump stations will not cause maximum allowable operating pressures to be exceeded under conditions proposed in the petition.

NOW THEREFORE, IT IS HEREBY ORDERED by the Michigan Public

Service Commission that the petition of Lakehead Pipe Line Company, Inc., for authority to install five additional pump stations on its 30" common carrier oil pipeline, located respectively at Gogebic, Rapid River, Mackinaw, Lewiston and North Branch, be and the same is hereby approved.

IT IS FURTHER ORDERED that the maximum discharge pressure at said pumping stations be limited to 509 psig, 584 psig, 584 psig, 492 psig and 539 psig, respectively.

IT IS FURTHER ORDERED that, except as modified by subsequent action of the Commission, the provisions of Order D-3903-53.1 covering the original construction of the 30" pipeline shall remain in effect.

The Commission specifically reserves jurisdiction of the matters herein contained and the authority to issue such further order or orders as the facts and circumstances may require.

(S E A L)

MICHIGAN PUBLIC SERVICE COMMISSION

/s/ James H. Inglis

Chairman

/s/ Thomas M. Burns

Commissioner

/s/ John E. Tormey

Commissioner

By the Commission and
pursuant to its action
of May 17, 1962

/s/ Norman Berkowitz

Its Secretary

S T A T E O F M I C H I G A N

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the application of LAKEHEAD PIPE LINE COMPANY, INC. for authority to increase its pumping stations discharge pressures.	)	Case No. U-1869

At a session of the Michigan Public Service Commission held at its offices in the city of Lansing, Michigan, on the 25th day of March, A. D. 1965.

PRESENT: Hon. Peter B. Spivak, Chairman
Hon. John E. Tormey, Commissioner
Hon. George Washington, Commissioner

ORDER AUTHORIZING INCREASED DISCHARGE PRESSURES OF PUMP STATIONS

On February 2, 1965, Lakehead Pipe Line Company, Inc. (Lakehead) filed an application to increase the discharge pressures at pumping stations on its common carrier oil pipeline system constructed and in operation within the state of Michigan.

After due notice, a public hearing was held in this matter on March 11, 1965.

Lakehead showed that it operates a common carrier pipeline system in the United States in conjunction with the operation of Interprovincial Pipeline Company of Canada (Interprovincial). Interprovincial's system extends from Edmonton, Alberta, Canada, to the United States border near Humboldt, Minnesota, at which point its facilities are connected to Lakehead's system. Lakehead's system extends across northern Minnesota to Superior, Wisconsin, thence across northern Wisconsin to Ironwood, Michigan. From Ironwood, Lakehead's system extends easterly across the Upper Peninsula of Michigan, across the Straits of Mackinac by a submarine crossing, and thence to Marysville, Michigan, where it crosses the United States border to Sarnia, Ontario, where it connects with facilities of Interprovincial. Lakehead showed that it renders service in the United States by delivering crude oil shipments to various points in Wisconsin and Michigan, including Rapid River, West Branch, Bay City, and Port Huron.

Lakehead introduced testimony through its chief engineer, Mr. Roger Clute, showing that the company was initially authorized to construct and operate that portion of its system within the state of Michigan by this Commission's Order D-3903-53.1, dated March 31, 1953, as supplemented by Order D-3903-53.2, dated May 29, 1953. Said order limited the maximum operating pressure of such pipeline system. Such orders anticipated that in the future pump stations would be built in Michigan, but did not specifically authorize construction of same. By order D-3903-57.1, dated

April 10, 1957, this Commission authorized the construction and operation of a pump station at Indian River. Thereafter, by orders dated March 27, 1958, May 22, 1959, and May 17, 1962, this Commission authorized the construction of additional pump stations at Gould City, Bay City, Iron River, Gogebic, Rapid River, Mackinaw, Lewiston, and North Branch. In each case such orders specified the maximum discharge pressures of such pump stations, reflecting the above-mentioned limitation of maximum operating pressure of the pipeline initially specified in the Commission's orders issued in 1953.

Lakehead showed that its pipeline system is constructed of pipe with various wall thicknesses. The presently authorized maximum discharge pressures and proposed increased maximum discharge pressures at its several pump stations are as shown in the following table:

Pump Station	Wall Thickness	Present Maximum Discharge Pressure	Proposed Maximum Discharge Pressure
Gogebic	9/32 in.	509 psig	633 psig
Iron River	5/16 in.	600 psig	703 psig
Rapid River	9/32 in.	584 psig	633 psig
Gould City	11/32 in.	670 psig	775 psig
Mackinaw	9/32 in.	584 psig	633 psig
Indian River	5/16 in.	600 psig	703 psig
Lewiston	9/32 in.	492 psig	633 psig
Bay City	5/16 in.	632 psig	703 psig
North Branch	9/32 in.	539 psig	633 psig

The company represented that increased volumes of medium gravity crude oil shipped by its customers have had the effect of decreasing the capacity of its pipeline from 416,000 barrels per day to 408,000 per day, that requirements of its customers have increased to 425,000 barrels per day, and that such increased capacity may be obtained by increasing the discharge pressures at its several pump stations.

The company further showed that it has successfully tested its pipeline system by application of hydraulic pressure at its several pump stations as follows:

Pump Station	Test pressure
Gogebic	696 psig
Iron River	773 psig
Rapid River	696 psig
Gould City	853 psig
Mackinaw	696 psig
Indian River	773 psig
Lewiston	696 psig
Bay City	773 psig
North Branch	696 psig

Such testing was accomplished during the period from November 1, to November 4, 1964, and the company submitted recording pressure charts in proof thereof.

The company showed that the maximum design pressure of its pipeline system computed in accordance with the requirements of the American Standards Association Code ASA B31.4-1959, Oil Transportation Piping, exceeds the present and proposed maximum discharge pressure at its several pump stations. Such Code provides that a pipeline may be operated at a design pressure resulting in stress equal to 72% of the specified minimum yield of the pipe.

The company further showed that the maximum discharge pressures as proposed would result in stress not to exceed 65% of the minimum yield point of the pipe utilized in construction of its facilities, and that in each case the mill test imposed during manufacture of such pipe substantially exceeds not only the proposed maximum discharge pressure at each of its pump stations but also exceeds the test pressures noted above. The company further showed that the test pressure imposed in November, 1964, will qualify such pipeline system for operation at the proposed maximum discharge pressures, under the requirements of Section 437.4 of said ASA B31.4 Code that such pipelines be tested at 110% of the maximum operating pressure.

The Commission staff introduced a statement into the record indicating that it had checked and agreed with the representations of the company, and it recommended that the authority sought should be granted.

The Commission has given careful consideration to this matter and FINDS that:

A. Lakehead Pipe Line Company, Inc., is a common carrier pipeline company which is subject to the jurisdiction of the Commission, and is presently rendering service in the state of Michigan.

B. The public safety will be reasonably protected if the maximum discharge pressure of petitioner's several pump stations is increased as proposed.

C. The authority sought should be granted.

NOW, THEREFORE, IT IS HEREBY ORDERED by the Michigan Public Service Commission that Lakehead Pipe Line Company, Inc. is hereby authorized to increase the discharge pressures of its several pump stations located on its common carrier oil pipeline system in the state of Michigan as proposed herein.

The Commission specifically reserves jurisdiction of the matters herein contained and the authority to issue such further order or orders as the facts and circumstances may require.

MICHIGAN PUBLIC SERVICE COMMISSION

(S E A L)

/s/ Peter B. Spivak
Chairman

By the Commission and pursuant to its action of March 25, 1965.

/s/ John E. Tormey
Commissioner

/s/ Norman Berkowitz
Its Secretary

/s/ George Washington
Commissioner

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S T A T E   O F   M I C H I G A N

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the petition of LAKEHEAD PIPE LINE COMPANY, INC. for approval of the construction of intermediate pumping stations.	)	Case No. U-2391

At a session of the Michigan Public Service Commission held at its offices in the city of Lansing, Michigan, on the 2nd day of June, A. D. 1966.

PRESENT: Hon. Peter B. Spivak, Chairman
Hon. John E. Tormey, Commissioner
Hon. Willis F. Ward, Commissioner

ORDER APPROVING PUMPING STATION CONSTRUCTION

On May 20, 1966, Lakehead Pipe Line Company, Inc., filed a petition with this Commission seeking approval of the construction and operation of two new pumping stations on its 30" common carrier oil pipeline system, one located near the city of Manistique, Michigan, and the other located near the city of West Branch, Michigan. A report containing engineering specifications applicable to the 30" pipeline and to the pumping stations was attached to the petition. Such report further set forth the test pressures applied to the existing pipeline, and proposed maximum discharge pressures of the subject pumping stations, together with a hydraulic gradient study covering the present and proposed operation of such facilities.

The company represented that its pipeline downstream of both proposed pumping stations is constructed of 30" diameter steel pipe having a wall thickness of .281 inches, manufactured in accordance with American Petroleum Institute specification API 5LX-52, having a minimum specified yield strength of 52,000 psi, mill tested at 880 psig. The maximum allowable operating pressure for pipe having such specifications pursuant to the requirements of the American Standards Association Code B31.4-1959, Oil Transportation Piping, is 701 psig. Such Code further provides that a test pressure of 110% of the maximum operating pressure must be applied before a pipeline subject to same is placed in operation.

The company represented that a test pressure of 808 psig was applied to the pipeline downstream of its proposed Manistique pumping station, which will qualify such pipeline for operation at a maximum pressure of 701 psig. Accordingly, the company proposed to limit the discharge pressure of its Manistique station to 701 psig. The company further represented that a test pressure of 629 psig was applied to the pipeline downstream of its proposed

West Branch pumping station, which will qualify such pipeline for operation at a maximum pressure of 572 psig. Accordingly, the company will limit the discharge pressure of its West Branch station to 572 psig. Both stations will be remotely controlled from Superior, Wisconsin, or if necessary by manual control, and will be equipped with pressure limiting and safety shutdown devices sensitive to anomalies in pressure, temperature, and low voltage.

The station crude oil piping at both stations will be designed, constructed, and tested to qualify same for operation at a maximum pressure of 701 psig under the requirements of said ASA Code B31.4. Sump pump discharge lines will be designed, constructed, and tested to qualify for operation at a maximum pressure of 375 psig. Test pressures will be 770 psig and 413 psig, respectively.

Petitioner represented that its present throughput capacity is approximately 425,000 barrels of crude oil per day, and that the capacity of its system after the proposed pumping stations have been placed in operation will be approximately 480,000 barrels of crude oil per day.

The Commission staff has submitted a report indicating it is in agreement that the 30" Lakehead pipeline is qualified for operation at a maximum pumping station discharge pressure of 701 psig at the Manistique station, and that said pipeline is qualified for a maximum pumping station discharge pressure of 572 psig at the West Branch station, all in accordance with the requirements of ASA Code B31.4. The Commission staff further indicated that in its opinion the public safety would be adequately protected if the subject facilities are operated as proposed.

The Commission has given this matter careful consideration and FINDS that:

A. The public interest in this matter will be adequately protected without the time and expense of a public hearing.

B. The approval sought herein should be granted.

NOW, THEREFORE, IT IS HEREBY ORDERED by the Michigan Public Service Commission that:

1. The petition of Lakehead Pipe Line Company, Inc., to construct and operate a pumping station on its 30" common carrier oil pipeline at Manistique, Michigan, and to construct a pumping station on said pipeline at West Branch, Michigan, be and the same is hereby approved.

2. The maximum discharge pressure of the Manistique station shall be 701 psig, and the maximum discharge pressure of the West Branch station shall be 572 psig.

3. After completion of construction of the subject facilities, Lakehead Pipe Line Company, Inc., shall promptly file a report covering the test pressures applied to the station piping, and successful test operation of the safety shutdown devices.

The Commission specifically reserves jurisdiction of the matters herein contained and the authority to issue such further order or orders as the facts and circumstances may require.

MICHIGAN PUBLIC SERVICE COMMISSION

(S E A L)

/s/ Peter B. Spivak
Chairman

/s/ John E. Tormey
Commissioner

/s/ Willis F. Ward
Commissioner

By the Commission and pursuant to its action of June 2, 1966.

/s/ Knight D. McKesson
Its Secretary

S T A T E O F M I C H I G A N

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the application of LAKEHEAD PIPE LINE COMPANY, INC., for authority to increase operating pressures.	Case No. U-2606

At a session of the Michigan Public Service Commission held at its offices in the city of Lansing, Michigan, on the 15th day of December, A. D. 1966.

PRESENT: Hon. Peter B. Spivak, Chairman
Hon. John E. Tormey, Commissioner
Hon. Willis F. Ward, Commissioner

ORDER APPROVING INCREASED PUMP STATION DISCHARGE PRESSURES

On December 5, 1966, Lakehead Pipe Line Company, Inc., filed an application for authority to increase the maximum discharge pressures of three pump stations known as its Mackinaw, Bay City, and North Branch pump stations located near said communities in Michigan. The company represented that the presently approved maximum discharge pressures at its eight other pump stations will remain unchanged.

The company's application recited the several orders heretofore issued by this Commission applicable to the construction and operation of its common carrier crude oil pipeline transportation facilities, commencing with the construction of its 30-inch pipeline extending approximately 600 miles from Ironwood, Michigan, to Marysville, Michigan, in 1953, and covering the later construction of eleven pump stations located in Michigan over a nine-year period from 1957 to 1966, inclusive. Each of said orders prescribed maximum operating pressure of such pipeline and related maximum discharge pressures of said pump stations. The company's application further cited the Commission's order in Case No. U-1869, dated March 25, 1965, which approved increased discharge pressures at the company's then existing nine pump stations, contingent on hydrostatic tests applied to the sections of the pipeline downstream from the several pump stations. In summary, the company's application sets forth the following tabulation, which covers the present and proposed operations of its systems.

Pump Station	Wall Thickness	Present Maximum Discharge Pressure	Proposed Maximum Discharge Pressure
Gogebic	9/32 in.	633 psig	No change
Iron River	5/16 in.	701 psig	No change
Rapid River	9/32 in.	633 psig	No change
Manistique	5/16 in.	701 psig	No change
Gould City	11/32 in.	775 psig	No change
Mackinaw	9/32 in.	633 psig	701 psig
Indian River	5/16 in.	701 psig	No change
Lewiston	9/32 in.	633 psig	No change
West Branch	9/32 in.	572 psig	No change
Bay City	5/16 in.	701 psig	779 psig
North Branch	9/32 in.	633 psig	701 psig

The company represented that in order to requalify its pipeline for operation under the requirements of the American Standards Association Code B31.4-1959, Oil Transportation Piping Systems, at the proposed pressures, it made a series of hydrostatic pressure tests on the sections of its pipeline downstream from said three pump stations as follows:

Pump Station	Test Pressure
Mackinaw	771 psig
Bay City	857 psig
North Branch	771 psig

Said hydrostatic test pressures were applied between July 19 and October 26, 1966. The test pressures applied are 110% of the proposed maximum discharge pressures, in accordance with the requirements of said ASA B31.4 Code. The company submitted a map showing the location of the sections of pipeline so tested, copies of recording pressure charts showing the hydrostatic test pressures applied to such sections of pipeline and engineering specifications showing that the proposed increases in maximum discharge pressure are in accordance with the requirements of American Standards Association Code B31.4.

The company represented that its present pipeline capacity is 495,000 barrels per day and that after the proposed increase in station discharge pressures, its pipeline capacity will be increased to 505,000 barrels per day. The company represented that present and forecast operations of its pipeline facilities necessitate the proposed increase in capacity.

The Commission staff has submitted a report indicating it has reviewed the map, recording pressure gage charts, and engineering specifications submitted by the company, and in its opinion the public safety will be reasonably protected under the proposed increase in pump station discharge pressures.

The Commission has given this matter careful consideration and FINDS that the authority sought by Lakehead Pipe Line Company, Inc., should be granted.

THEREFORE, IT IS ORDERED by the Michigan Public Service Commission that the maximum discharge pressures of Lakehead Pipe Line Company's Mackinaw, Bay City, and North Branch pump stations shall be 701 psig, 779 psig, and 701 psig, respectively.

IT IS FURTHER ORDERED that Lakehead Pipe Line Company Inc., shall in all other respects comply with the requirements of this Commission's several orders covering the construction and operation of its common carrier crude oil pipeline transportation facilities.

The Commission specifically reserves jurisdiction of the matters herein contained and the authority to issue such further order or orders as the facts and circumstances may require.

MICHIGAN PUBLIC SERVICE COMMISSION

/s/ Peter B. Spivak
Chairman

(S E A L)

/s/ John E. Tormey
Commissioner

/s/ Willis F. Ward
Commissioner

By the Commission and pursuant to its action of December 15, 1966.

/s/ Knight D. McKesson
Its Secretary

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the petition of LAKEHEAD PIPE LINE COMPANY, INC., for approval of construction of intermediate pumping stations and additional pumping units in existing stations.	Case No. U-2804

At a session of the Michigan Public Service Commission held at its offices in the city of Lansing, Michigan, on the 19th day of October, A. D. 1967.

PRESENT: Hon. Peter B. Spivak, Chairman
Hon. Willis F. Ward, Commissioner
Hon. William A. Boos, Jr., Commissioner

ORDER APPROVING CONSTRUCTION OF PUMPING STATIONS AND ADDITIONAL PUMPING UNITS IN EXISTING STATIONS

On June 30, 1967, Lakehead Pipe Line Company, Inc., filed a petition for approval of construction and operation of eight intermediate pumping stations located on its 30-inch common carrier oil pipeline. The company's petition was subsequently amended on October 9, 1967. The locations of said facilities are set forth below.

1.	Wakefield	Located in Section 28, T47N, R44W, Gogebic County
2.	Watersmeet	Located in Section 34, T45N, R39W, Gogebic County
3.	Arnold	Located in Section 1, T42N, R26W, Marquette County
4.	Naubinway	Located in Section 21, T43N, R8W, Mackinac County
5.	Eagles Nest	Located in Section 25, T36N, R3W, Cheboygan County
6.	Vanderbilt	Located in Section 13, T32N, R2W, Otsego County
7.	Vassar	Located in Section 2, T11N, R7E, Tuscola County
8.	Brockway	Located in Section 3, T7N, R14E, St. Clair County

In addition, the company requested approval of the installation and operation of additional pumping units in the following existing pump stations:

1.	Gould City	Located in Section 20, T43N, R11W, Mackinac County
2.	Indian River	Located in Section 21, T34N, R2W, Cheboygan County
3.	Bay City	Located in Section 10, T14N, R4E, Bay County

The company represented that the above facilities are necessary to meet forecast critical through-puts, and that the additional power will increase the present capacity of its pipeline from 480,000 to 563,000 barrels per day.

The company further submitted detailed engineering data covering the design, construction, and operation of the proposed additional pump stations and installation of the additional pumping units at its existing stations, and represented that all piping will be designed and tested to conform with the requirements of the USAS B31.4-1966 Code. The stations will be equipped with remote control and automatic shut-down safety devices to protect the pipeline from overpressure. The company submitted further data showing the test pressures applied to its pipeline and proposed maximum discharge pressures at the eleven pump stations mentioned above will be as follows:

Station	Test Pressure, psi	Proposed Maximum Discharge Pressure, psi
Wakefield	668	534
Watersmeet	594	475
Arnold	622	498
Gould City	853	775*
Naubinway	872	698
Eagles Nest	753	602
Indian River	773	701*
Vanderbilt	657	525
Bay City	857	779*
Vassar	818	654
Brockway	768	614

*Maximum Discharge Pressures at these existing Stations have been approved by Orders of the Michigan Public Service Commission

The company represented that the maximum working pressure at the Wakefield, Watersmeet, Arnold, Naubinway, Eagles Nest, Vanderbilt, Vassar, and Brockway pumping stations will not exceed 80% of the test pressures applied to its 30-inch pipeline at the locations of such stations, and that such pressure limitations will satisfy the requirements of the Code for Pressure Piping, ASA B31.1, Section 3, Oil Piping, and the USAS B31.4-1966, Code for Oil Transportation Piping, both of which require that a pipeline shall be hydrostatically tested to at least 1.25 times the maximum working pressure within the meaning of such Code. As noted above, the Commission's records show it has previously approved the maximum discharge pressures applicable to the Gould City, Indian River, and Bay City pump stations.

The Commission staff has submitted a report indicating it is in agreement that the 30-inch Lakehead pipeline is qualified for operation at the maximum pumping station discharge pressures set forth in the above table, all in accordance with the requirements of said Codes.

The Commission has given this matter careful consideration and FINDS that:

A. The public interest in this matter will be adequately protected without the time and expense of a public hearing.

B. The approval sought herein should be granted.

THEREFORE, IT IS ORDERED by the Michigan Public Service Commission that:

1. The petition of Lakehead Pipe Line Company, Inc., to construct and operate eight intermediate pump stations and to install and operate additional pumping units at three existing pump stations is hereby approved.

2. The maximum discharge pressure at said pump stations shall be limited to the maximum discharge pressures as set forth in the above table.

3. After completion of construction of the subject facilities, Lakehead Pipe Line Company, Inc., shall promptly file a report covering the test pressures applied to the station piping, and successful test operation of the safety shut-down devices.

The Commission specifically reserves jurisdiction of the matters herein contained and the authority to issue such further order or orders as the facts and circumstances may require.

MICHIGAN PUBLIC SERVICE COMMISSION

(S E A L)

/s/ Peter B. Spivak
Chairman

By the Commission and pursuant to its action of Oct. 19, 1967.

/s/ Willis F. Ward
Commissioner

/s/ Knight D. McKesson
Its Secretary

/s/ William A. Boos, Jr.
Commissioner

S T A T E   O F   M I C H I G A N

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * * *

In the matter of the application of LAKEHEAD PIPE LINE COMPANY, INC., for authority to issue and sell $30,000,000 principal amount of ___% Sinking Fund Debentures, Series A, due 1992.	Case No. U-2807

At a session of the Michigan Public Service Commission held at its offices in the city of Lansing, Michigan, on the 13th day of July, A. D. 1967.

PRESENT: Hon. Peter B. Spivak, Chairman
Hon. Willis F. Ward, Commissioner
Hon. William A. Boos, Jr., Commissioner

S E C U R I T I E S

On July 6, 1967, Lakehead Pipe Line Company, Inc. (Lakehead), filed an application with the Commission seeking authority to issue and sell $30,000,000 principal amount of ___% Sinking Fund Debentures, Series A, due 1992. A hearing on the application was held at the offices of the Commission in the city of Lansing, Michigan, on July 11, 1967.

From the application filed and the testimony and exhibits presented at the hearing, the Commission FINDS that:

A. Lakehead is a Delaware corporation with its principal office located in Superior, Wisconsin. It owns and operates a pipeline system extending from the Canadian boundary, adjacent to North Dakota, across the northern portions of the states of Minnesota, Wisconsin, and Michigan, to a point on the Michigan-Ontario boundary near Port Huron, Michigan. Another short section of its line runs from the Ontario-New York boundary to the city of Buffalo, New York.

B. In conjunction with Interprovincial Pipe Line Company (Interprovincial), a Canadian corporation which owns all of the common stock of Lakehead, Lakehead operates as a common carrier for the transportation of crude oil and other liquid hydrocarbons between the producing areas of Western Canada and refining operations located principally in Ontario.

C. Lakehead had outstanding as of April 30, 1967, $28,147,000 principal amount of First Mortgage Pipe Line Bonds, all of which were owned by its parent, Interprovincial. It has issued and outstanding 400,000 shares of its $50 par value capital stock having an aggregate par value of $20,000,000; all of this stock is held by Interprovincial. This Commission has previously authorized the issuance of securities by Lakehead in Order No. D-3902-53.1, dated March 19, 1953, and Order No. D-3902-54.1, dated March 19, 1954.

D. Lakehead is currently engaged in a 1967 construction program which is estimated to require expenditures of approximately $24,000,000, of which approximately $14,000,000 is for 101 miles of 34" line paralleling existing lines from the International boundary crossing in North Dakota into Superior, Wisconsin. An amount of approximately $10,000,000 is being expended for addition of pumping equipment and remote control equipment for existing pumping stations, the construction of additional pumping stations, and certain other facilities. Several of these construction projects are located in Michigan.

E. To provide funds for carrying out the construction program, Lakehead proposes to issue and sell $30,000,000 of its ___% Sinking Fund Debentures, Series A, due 1992. These debentures will be unconditionally guaranteed by Lakehead's parent, Interprovincial.

F. The proposed debentures are to be issued under and pursuant to the provisions of an Indenture and a First Supplemental Indenture to be dated as of July 15, 1967, between Lakehead, Interprovincial as guarantor, and Chemical Bank New York Trust Company as trustee.

G. Lakehead will negotiate the sale of the proposed debentures with a group of underwriters represented by The First Boston Corporation. The negotiations will include the determination of the interest rate, the price to be paid to Lakehead by the underwriters, the price to the public, and the redemption prices if the debentures are redeemed in whole or in part prior to maturity as well as the redemption price for sinking fund purposes. Appropriate filings have been and will be made with the Securities and Exchange Commission under the requirements of the Securities Act of 1933.

H. The use of the capital to be acquired by the issuance and sale of debentures is reasonably necessary and appropriate for Lakehead to carry out its corporate purposes; the funds derived from such issuance and sale are to be applied to lawful corporate purposes; and the issue and amount thereof are essential to the successful carrying out of such purposes.

I. The required security issuance fee of $12,894 has been paid.

IT IS ORDERED that:

1. Lakehead Pipe Line Company, Inc., hereby is authorized to issue and sell $30,000,000 principal amount of ___% Sinking Fund Debentures, Series A, due 1992.

2. Lakehead Pipe Line Company, Inc., hereby is authorized to execute and deliver the Indenture and First Supplemental Indenture supporting said debentures in substantially the form submitted to the Commission as exhibits in this case.

3. On or before January 31, 1968, Lakehead Pipe Line Company, Inc., shall file with the Commission a verified statement setting forth the proceeds received from the issuance of the debentures and the commissions, expenses, and other costs incurred in connection with the sale.

4. On or before January 31, 1968, Lakehead Pipe Line Company, Inc., shall file with the Commission a copy of each of the following documents as finally executed: (A) the Underwriting Agreement; (B) the Indenture; (C) the First Supplemental Indenture; and (D) the final Prospectus.

The Commission specifically reserves jurisdiction of the matters herein contained and the authority to issue such further order or orders as the facts and circumstances may require.

MICHIGAN PUBLIC SERVICE COMMISSION

/s/ Peter B. Spivak
Chairman

(S E A L)

/s/ Willis F. Ward
Commissioner

/s/ William A. Boos, Jr.
Commissioner

By the Commission and pursuant to its action of July 13, 1967.

/s/ Knight D. McKesson
Its Secretary

S T A T E   O F   M I C H I G A N

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * * *

In the matter of the petition of LAKEHEAD PIPE LINE COMPANY, INC., a foreign corporation, for refund of fees paid to the Public Service Commission in connection with the approval and issuance of securities in the years 1953 and 1954.	)	Case No. U-2950

At a session of the Michigan Public Service Commission held at its offices in the city of Lansing, Michigan, on the 14th day of December, A. D. 1967.

PRESENT: Hon. Peter B. Spivak, Chairman
Hon. Willis F. Ward, Commissioner
Hon. William A. Boos, Jr., Commissioner

REFUND OF SECURITY ISSUE FEE

Lakehead Pipe Line Company, Inc., is a Delaware corporation which is authorized to do business in Michigan. It operates an oil pipeline system as a common carrier in interstate and foreign commerce; a portion of the system is located in Michigan.

On December 1, 1967, Lakehead filed a petition requesting a refund of a portion of a security issue fee previously paid. By letter received December 8, 1967, Lakehead requested that an amendment be made in paragraph 7 of its petition.

The following paragraphs contain a brief review of security issues authorized by the Commission and security issue fees paid by Lakehead.

By its order No. D-3902-53.1, dated March 19, 1953, the Commission approved Lakehead's then existent capital structure consisting of 100,000 shares of common stock, $50 par value, First and Second Series Mortgage Bonds in the amount of $18,750,000 and $2,250,000, respectively, and granted Lakehead authority to issue 300,000 additional shares of common stock, $50 par value, and Third Series Mortgage Bonds in the amount of $60,000,000 for the purpose of obtaining funds to pay for the construction of an extension to its pipeline system from Superior, Wisconsin, thence across the Upper and Lower Peninsulas of Michigan to the international boundary in the St. Clair River south of the city of Port Huron.

In connection with the aforesaid application and order, Lakehead paid to the state of Michigan a statutory security fee in the amount of $60,000 and, in respect thereto, the Commission's Order No. D-3902-53.1 provided the following:

> "That a security fee in the amount of $60,000.00 has been tendered and, contingent upon the final amount of securities issued by Applicant at the conclusion of the construction hereinbefore mentioned, the security fee tendered is subject to being increased or the excessive portion thereof, if any, being repaid to Applicant."

Pursuant to said order of the Commission, Lakehead issued the additional 300,000 shares of common stock and its Third Series Mortgage Bonds in the amount of $55,000,000 instead of $60,000,000 as authorized, whereupon following the completion of the pipeline extension a recomputation of the statutory fee owing by Lakehead under its order No. D-3902-53.1 was made by the Commission as follows:

$$\frac{\overset{\text{(Property within Michigan)}}{\$\ 58{,}179{,}007}}{\underset{\text{(Total Property)}}{\$\ 95{,}042{,}952}} \times \begin{array}{l}\$96{,}000{,}000\\ \text{(Securities outstanding}\\ \text{as of December 31, 1953)}\end{array} \times \frac{1}{1{,}000} = \$58{,}764.84$$

Since Lakehead had paid to the Commission a security fee in the amount of $60,000 as aforesaid, it was therefore entitled to a refund of $1,235.16 which it received by way of credit on a subsequent fee owing the Commission described in the succeeding paragraphs hereof.

Pursuant to a written application of Lakehead, the Commission by its order No. D-3902-54.1, dated March 19, 1954, authorized Lakehead to issue the balance of $5,000,000 Third Series Mortgage Bonds which had not theretofore been issued under the Commission's Order No. D-3902-53.1 and further authorized Lakehead to issue Fourth Series Mortgage Bonds in the amount of $15,000,000, all for the purpose of further construction work.

At the time of the issuance of the Commission's Order No. D-3902-54.1 the statutory fee was tentatively computed according to the following formula:

$$\frac{\substack{\text{(Property within Michigan)} \\ \$\,58{,}179{,}007}}{\substack{\$115{,}042{,}952 \\ \text{(Total Property)}}} \times \substack{\$20{,}000{,}000 \\ \text{(Securities authorized} \\ \text{to be issued March 19, 1954)}} \times \frac{1}{1{,}000} = \$10{,}114.31$$

The overpayment of the fee in connection with the Commission's Order No. D-3902-53.1 was credited to the aforesaid fee computed in connection with the Commission's Order No. D-3902-54.1 so that Lakehead then paid the Commission the cash sum of $8,879.15. Under item 14 of the Findings in order No. D-3902-54.1 the said computed fee was made contingent upon the final amount of securities issued by Lakehead at the conclusion of the construction work contemplated. Said item 14 reads as follows:

> "That a security fee in the amount of $8,879.15 has been tendered and contingent upon the final amount of securities issued by Petitioner at the conclusion of the construction hereinbefore mentioned, the security fee mentioned is subject to being increased or the excessive portion thereof, if any, being repaid to the Petitioner."

Pursuant to said order of the Commission (No. D-3902-54.1) Lakehead issued the balance of the Third Series Mortgage Bonds in the amount of $5,000,000 and the Fourth Series Mortgage Bonds in the amount of $8,000,000. The balance of $7,000,000 of the Fourth Series Mortgage Bonds authorized by said order was not issued and, hence, under Article 14 of said order the statutory fee should be recomputed according to the following formula:

$$\frac{\overset{\text{(Property within Michigan)}}{\$\,58{,}462{,}811}}{\underset{\text{(Total Property)}}{\$110{,}881{,}901}} \times \$13{,}000{,}000 \times \frac{1}{1{,}000} = \$\,6{,}854.29$$

After careful consideration of the facts and circumstances set forth above, the Commission FINDS that:

A. Lakehead has issued only $8,000,000 principal amount of its Fourth Series Mortgage Bonds instead of the $15,000,000 principal amount authorized by the Commission in its order No. D-3902-54.1; it does not propose to issue the remaining principal amount of $7,000,000.

B. Lakehead has paid to the state of Michigan its security issue fee based on the anticipated issuance of the full $15,000,000 principal amount of its Fourth Series Mortgage Bonds.

C. Lakehead is entitled to a refund of a portion of its previously paid security issue fee in the amount of $3,260.02 since the full amount of bonds authorized was not actually issued.

D. Authority granted by Commission Order D-3902-54.1 to issue $15,000,000 principal amount of Fourth Series Mortgage Bonds should be amended so as to provide for the issuance of only $8,000,000 principal amount of this series.

IT IS ORDERED that:

1. Authority for Lakehead Pipe Line Company, Inc., to issue $15,000,000 principal amount of its Fourth Series Mortgage Bonds granted in Commission Order D-3902-54.1 hereby is amended to provide for the issuance of $8,000,000 principal amount of said bonds; authority for the issuance of the remaining $7,000,000 principal amount hereby is canceled.

2. Lakehead Pipe Line Company, Inc., is entitled to a refund of $3,260.02, which is the difference between the security issue fee paid ($10,114.31) in connection with the authority granted by the Commission in its order D-3902-54.1 and the proper security issue fee ($6,854.29) based on securities actually issued.

The Commission specifically reserves jurisdiction of the matters herein contained and the authority to issue such further order or orders as the facts and circumstances may require.

MICHIGAN PUBLIC SERVICE COMMISSION

/s/ Peter B. Spivak
Chairman

(S E A L)

/s/ Willis F. Ward
Commissioner

By the Commission and pursuant to its action of December 14, 1967.

/s/ William A. Boos, Jr.
Commissioner

/s/ Earl B. Klomparens
Acting Secretary

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the application of LAKEHEAD PIPE LINE COMPANY, INC., for authority to issue and sell $75,000,000 principal amount of __% Sinking Fund Debentures, Series B, due 1993.	)	Case No. U-3080

At a session of the Michigan Public Service Commission held at its offices in the city of Lansing, Michigan, on the 11th day of April, A. D. 1968.

PRESENT: Hon. Peter B. Spivak, Chairman
Hon. Willis F. Ward, Commissioner
Hon. William A. Boos, Jr., Commissioner

SECURITIES

On March 27, 1968, Lakehead Pipe Line Company, Inc., (Lakehead) filed an application with the Commission seeking authority to issue and sell $75,000,000 principal amount of __% Sinking Fund Debentures, Series B, due 1993. A hearing on the application was held at the offices of the Commission in the city of Lansing, Michigan, on April 5, 1968.

From the application filed and the testimony and exhibits presented at the hearing, the Commission FINDS that:

A. Lakehead is a Delaware corporation with its principal office located in Superior, Wisconsin. It owns and operates a pipeline system extending from the Canadian boundary, adjacent to North Dakota, across the northern portions of the states of Minnesota, Wisconsin, and Michigan, to a point on the Michigan-Ontario boundary near Port Huron, Michigan. Another short section of its line runs from the Ontario-New York boundary to the city of Buffalo, New York.

B. In conjunction with Interprovincial Pipe Line Company (Interprovincial), a Canadian corporation which owns all of the common stock of Lakehead, Lakehead operates as a common carrier for the transportation of crude oil and other liquid hydrocarbons between the producing areas of Western Canada and refining operations located principally in Ontario.

C. Lakehead had outstanding as of December 31, 1967, $30,037,000 principal amount of first mortgage pipe line bonds, all of which were owned by its parent, Interprovincial, and Series A, 6 1/2% Sinking Fund Debentures, principal amount $30,000,000, guaranteed by Interprovincial. It has issued and outstanding 400,000 shares of its $50 par value capital stock having an aggregate par value of $20,000,000; all of this stock is held by Interprovincial. This Commission has previously authorized the issuance of securities by Lakehead in Order No. D-3902-53.1, dated March 19, 1953; Order

No. D-3902-54.1, dated March 19, 1954; and by an order dated July 13, 1967, under Case No. U-2807.

D. Applicant's 1968 construction program is estimated to require expenditures of approximately $84,000,000, of which approximately $76,000,000 is for 464 miles of 34-inch pipeline from Superior, Wisconsin, to the area of Chicago, Illinois. Of the remaining expenditures, $4,000,000 is for 33 miles of 34-inch pipe paralleling Lakehead's existing line near Neche, North Dakota, to Superior, Wisconsin, and the balance is for additional pumping equipment, a tank, and other minor additions.

E. To provide funds for carrying out the construction program, Lakehead proposes to issue and sell $75,000,000 of its __% Sinking Fund Debentures, Series B, due 1993. These debentures will be unconditionally guaranteed by Lakehead's parent, Interprovincial.

F. The proposed debentures are to be issued under and pursuant to the provisions of an Indenture dated as of August 1, 1967, and a Second Supplemental Indenture to be dated as of April 15, 1968, between Lakehead, Interprovincial as guarantor, and Chemical Bank New York Trust Company, as trustee.

G. Lakehead will negotiate the sale of the proposed debentures with a group of underwriters represented by The First Boston Corporation. The negotiations will include the determination of the interest rate, the price to be paid to Lakehead by the underwriters, the price to the public, and the redemption prices if the debentures are redeemed in whole or in part prior to maturity as well as the redemption price for sinking fund purposes. Appropriate filings have been and will be made with the Securities and Exchange Commission under the requirements of the Securities Act of 1933.

H. The use of the capital to be acquired by the issuance and sale of debentures is reasonably necessary and appropriate for Lakehead to carry out its corporate purposes; the funds derived from such issuance and sale are to be applied to lawful corporate purposes; and the issue and amount thereof are essential to the successful carrying out of such purposes.

I. Lakehead and the Commission's staff disagreed concerning the required security issue fee under section 11 of Act 419, P. A. 1919. Lakehead contended that the percentage of Michigan property to total property should be based on a pro forma figure as of December 31, 1968, so as to reflect planned construction to be financed by the proceeds of the proposed debenture issue. This percentage would be 26.8. The staff contended that the percentage should be determined on the latest available factual data, which in this instance is the property distribution at December 31, 1967. This percentage is 38.53. The Commission concludes that the method proposed by the staff is correct. Lakehead has paid the required fee of $28,897.50 on this basis.

IT IS ORDERED that:

1. Lakehead Pipe Line Company, Inc., hereby is authorized to issue and sell $75,000,000 principal amount of __% Sinking Fund Debentures, Series B, due 1993.

2. Lakehead Pipe Line Company, Inc., hereby is authorized to execute and deliver the Second Supplemental Indenture supporting said debentures in substantially the form submitted to the Commission as an exhibit in this case.

3. On or before November 30, 1968, Lakehead Pipe Line Company, Inc., shall file with the Commission a verified statement setting forth the proceeds received from the issuance of the debentures and the commissions, expenses, and other costs incurred in connection with the sale.

4. On or before November 30, 1968, Lakehead Pipe Line Company, Inc., shall file with the Commission a copy of each of the following documents as finally executed: (A) the Underwriting Agreement; (B) the Second Supplemental Indenture; and (C) the final Prospectus.

The Commission specifically reserves jurisdiction of the matters herein contained and the authority to issue such further order or orders as the facts and circumstances may require.

MICHIGAN PUBLIC SERVICE COMMISSION

/s/ Peter B. Spivak
Chairman

(S E A L)

/s/ Willis F. Ward
Commissioner

/s/ William A. Boos, Jr.
Commissioner

By the Commission and pursuant
to its action of April 11, 1968.

/s/ Knight D. McKesson
Its Secretary

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the petition of LAKEHEAD PIPE LINE COMPANY, INC., for approval of revised operating pressures.	)	Case No. U-3207

At a session of the Michigan Public Service Commission held at its offices in the city of Lansing, Michigan, on the 15th day of August, A. D. 1968.

PRESENT: Hon. Peter B. Spivak, Chairman
Hon. Willis F. Ward, Commissioner
Hon. William A. Boos, Jr., Commissioner

ORDER APPROVING REVISED MAXIMUM DISCHARGE PRESSURES AT CERTAIN PUMP STATIONS

On August 2, 1968, Lakehead Pipe Line Company, Inc., filed a petition seeking authority to revise the maximum operating pressures of certain portions of its interstate common carrier oil pipeline system. The company represented that pursuant to various orders issued by this Commission it is presently authorized to operate its pump stations at the following maximum discharge pressures:

Gogebic	633 psig	North Branch	701 psig
Iron River	703 "	Wakefield	534 "
Manistique	701 "	Watersmeet	475 "
West Branch	572 "	Arnold	498 "
Rapid River	633 "	Naubinway	698 "
Gould City	775 "	Eagles Nest	602 "
Mackinaw	701 "	Vanderbilt	525 "
Indian River	703 "	Vassar	654 "
Lewiston	633 "	Brockway	614 "
Bay City	779 "		

The company represented that the present and forecast throughputs of its system necessitate increasing the capacity of its pipeline, and proposes to increase the maximum discharge pressures of certain pump stations as follows:

Station	Present Pressure	Proposed Pressure
Watersmeet	475 psig	579 psig
Vanderbilt	525 "	607 "
West Branch	572 "	642 "

The company represented that such increased maximum discharge pressures will increase the capacity of its system approximately 10,000 barrels per day to a total of approximately 536,000 barrels of crude oil per day.

The company filed an engineering report showing that at present the discharge pressures of said pump stations result in an operating stress of less than 60% of the specified minimum yield strength of the pipe, and that the proposed discharge pressures will result in an operating stress level of approximately 65% of the specified minimum yield strength of the pipe.

The engineering report further shows that the pipeline downstream from each of said three pump stations was retested hydrodynamically for 24 hours at a pressure equal to 125% of the proposed increased discharge pressure, as follows:

Watersmeet Station to Iron River Station - 27.8 miles
Test Pressure - 724 psig

Vanderbilt Station to Lewiston Station - 22.1 miles
Test Pressure - 759 psig

West Branch Station to Bay City Station - 44.6 miles
Test Pressure - 803 psig

The company represented that such requalification test is in accordance with the requirements of the United States Standards Institute Code B31.4-1966, Liquid Petroleum Transportation Piping Systems. Copies of the test pressure charts and other information are included in said engineering report.

The Commission staff has submitted a report indicating a staff member witnessed such hydrodynamic tests, and indicating the staff's agreement that such tests qualify the said sections of pipeline for operation at the proposed maximum discharge pressures at said three pump stations.

The Commission has given this matter careful consideration and FINDS that:

A. The public interest in this matter will be adequately protected without the time and expense of a public hearing.

B. The proposed increased maximum discharge pressures at the Watersmeet, Vanderbilt and West Branch pump stations should be approved.

THEREFORE, IT IS ORDERED that:

1. Lakehead Pipe Line Company, Inc., is hereby authorized to operate the following pump stations at the maximum discharge pressures specified below:

Watersmeet	579 psig
Vanderbilt	607 "
West Branch	642 "

2. The company shall file a report with the Commission indicating the date such increased maximum discharge pressures are placed in effect.

The Commission specifically reserves jurisdiction of the matters herein contained and the authority to issue such further order or orders as the facts and circumstances may require.

MICHIGAN PUBLIC SERVICE COMMISSION

(S E A L)

/s/ Peter B. Spivak
Chairman

By the Commission and pursuant to its action of August 15, 1968.

/s/ Willis F. Ward
Commissioner

/s/ Knight D. McKesson
Its Secretary

/s/ William A. Boos, Jr.
Commissioner

S T A T E   O F   M I C H I G A N

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the application of LAKEHEAD PIPE LINE COMPANY, INC., for authority to issue notes in an aggregate amount of $35,000,000.	Case No. U-3547

At a session of the Michigan Public Service Commission held at its offices in the city of Lansing, Michigan, on the 26th day of November, 1969.

PRESENT: Hon. Willis F. Ward, Chairman
Hon. William A. Boos, Jr., Commissioner
Hon. Lenton G. Sculthorp, Commissioner

S E C U R I T I E S

On October 27, 1969, Lakehead Pipe Line Company, Inc., (Applicant) filed an application seeking authority to issue notes in an aggregate amount of $35,000,000. A hearing on the application was held at the offices of the Commission in the city of Lansing, Michigan, on November 20, 1969.

From the application and the testimony and exhibits presented at the hearing, the Commission FINDS that:

A. Applicant is a Delaware corporation with its principal office located in Superior, Wisconsin. Applicant owns and operates a pipeline system extending from the international boundary line between the United States and Canada near Neche, North Dakota, through the states of North Dakota, Minnesota, Wisconsin, Illinois, Indiana and Michigan to the international boundary line between the United States and Canada near Port Huron, Michigan; and from the international boundary line between the United States and Canada in the Niagara River near the town of Grand Island, New York to the city of Buffalo, New York. Full and detailed information as to the course and location of Applicant's pipeline system in Michigan is on file with the Commission.

B. Applicant's sole business is the operation of the pipeline system as a common carrier for others for the transportation of crude oil and other liquid hydrocarbons in interstate and foreign commerce exclusively.

C. Applicant has a total authorized capital of $25,000,000 consisting of 500,000 authorized shares of Capital Stock, par value of $50 per share. As of June 30, 1969, a total of 400,000 shares of the Capital Stock were issued and outstanding and held by Interprovincial Pipe Line Company.

D. The total book cost of all of Applicant's property, plant and equipment as of December 31, 1968 was $263,510,790 and the total book cost of the property, plant and equipment located in the state of Michigan as of that date was $68,925,995 or 26.16% of the total.

E. Applicant proposes, pursuant to the resolution passed by its Board of Directors on December 11, 1968, to issue to Agency, Bank of Montreal five notes, each in the principal amount of $7,000,000, with interest payable monthly on the outstanding balances at a floating rate equal to one-half of one percent (1/2 of 1%) over the New York prime rate as set by the majority of The Chase Manhattan Bank, Chemical Bank and New York Trust Company and The First National City Bank, all of New York City. The first of these notes will become due and payable on December 31, 1970; the second on December 31, 1971; the third on December 31, 1972; the fourth on December 31, 1973 and the last on December 31, 1974.

F. The purpose of issuing the proposed notes is to refund demand notes issued to Agency, Bank of Montreal as shown below:

Date of Issue	Amount
March 19, 1969	$ 2,500,000
April 2, 1969	1,500,000
April 14, 1969	3,500,000
April 17, 1969	1,000,000
May 5, 1969	1,500,000
May 19, 1969	1,000,000
June 2, 1969	1,500,000
June 9, 1969	3,000,000
June 25, 1969	1,000,000
July 9, 1969	1,000,000
July 29, 1969	2,000,000
July 31, 1969	1,000,000
August 13, 1969	1,500,000
August 18, 1969	500,000
August 28, 1969	1,000,000
September 15, 1969	1,700,000
September 22, 1969	2,000,000
October 14, 1969	5,400,000
October 21, 1969	1,400,000
October 28, 1969	1,000,000
	$35,000,000

G. The use of the capital to be acquired by the issuance of the notes is reasonably necessary and appropriate for Applicant to carry out its corporate purposes; the funds derived from the issuance and sale are to be applied to lawful corporate purposes; and the issue and amount are essential to the successful carrying out of those purposes.

H. The required statutory fee of $9,156, based on the ratio of Applicant's Michigan property to its total property (26.16%), has been paid.

THEREFORE, IT IS ORDERED that:

1. Lakehead Pipe Line Company, Inc., is authorized to issue its notes in an aggregate amount of $35,000,000 as proposed.

2. On or before March 31, 1970, Lakehead Pipe Line Company, Inc., shall file with the Commission a verified statement setting forth the proceeds received from the issuance of its notes and the commissions, expenses, and other costs incurred in connection with the issue.

The Commission specifically reserves jurisdiction of the matters herein contained and the authority to issue such further order or orders as the facts and circumstances may require.

MICHIGAN PUBLIC SERVICE COMMISSION

/s/ Willis F. Ward
Chairman

(S E A L)

/s/ William A. Boos, Jr.
Commissioner

/s/ Lenton G. Sculthorp
Commissioner

By the Commission and pursuant
to its action of Nov. 26, 1969.

/s/ Earl B. Klomparens
Its Secretary

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the application of **LAKEHEAD PIPE LINE COMPANY, INC.** for approval to construct, operate and maintain a pump station in Mackinac County, Michigan.	Case No. U-8701

At a session of the Michigan Public Service Commission held at its offices in the city of Lansing, Michigan, on the 14th day of April, 1987.

PRESENT: Hon. William E. Long, Chairperson
Hon. Edwyna G. Anderson, Commissioner
Hon. Matthew E. McLogan, Commissioner

OPINION AND ORDER

On February 17, 1987, Lakehead Pipe Line Company, Inc. (Lakehead) filed an application pursuant to 1929 PA 16 for approval to construct, operate and maintain a pump station and auxiliary equipment.

Lakehead has an existing 30-inch O.D. common carrier pipeline crossing northern Michigan from a point near Ironwood, Michigan, on the westerly boundary line of the upper peninsula via the Straits of Mackinac to a point on the international boundary in the St. Clair River, south of the city of Port Huron, Michigan. The crude oil or petroleum products can be delivered to points in Michigan, other states and Canada. There are currently 11 pump stations operating on the Michigan portion of this pipeline. Lakehead is proposing to increase the capacity of its northern Michigan pipeline by approximately 20,000 barrels per day through the construction of one additional pump station. The pump station will be equipped with one 2,500 hp electric motor operating a single-stage centrifugal pump.

The pump station will be located on a five-acre tract located adjacent to Lakehead's existing 30-inch O.D. pipeline in the NW/4 of Section 21, T43N, R8W, Hudson Township, Mackinaw County, Michigan.

Filed with the application were a plot plan, site plan, route sheet and general highway map for Mackinaw County. Engineering specifications covering the design, materials, construction, testing and operation of the proposed facilities and applicable codes under which the facilities will be constructed were attached to the application. An Environmental Report was also filed. In addition, Lakehead filed its explicit authorized acceptance of the provisions of 1929 PA 16, as amended.

The Staff has conducted an environmental review of the application and concludes that construction of the proposed facilities would not constitute a "major state activity" as defined in part 4 of the State of Michigan Guidelines for the Preparation and Review of Environmental Impact Statements under Executive Order 1974-4. Therefore, an Environmental Impact Statement was not prepared.

The Commission FINDS that:

a. Jurisdiction is pursuant to 1929 PA 16, as amended, MCL 483.1 et seq.; 1919 PA 419, as amended, MCL 460.51 et seq; 1939 PA 3, as amended, MCL 460.1 et seq.; 1970 PA 127, MCL 691.1201 et seq.; 1969 PA 306, as amended, MCL 24.201 et seq.; and the Commission's Rules of Practice and Procedure, 1979 Administrative Code, R 460.11 et seq.

b. Lakehead has complied with the requirements of 1929 PA 16, as amended, by filing maps showing the location of the proposed facilities, by filing its explicit authorized acceptance of the Act, and by filing engineering specifications and data showing the size and capacity of the proposed pump station and auxiliary equipment.

c. The requirements of the Environmental Impact Review Procedure established by State of Michigan Executive Order 1974-4 have been met.

THEREFORE, IT IS ORDERED that:

A. Lakehead Pipe Line Company, Inc. is authorized to construct, maintain and operate a pump station, with its related fixtures and equipment, as proposed in its application filed on March 17, 1987.

B. Lakehead Pipe Line Company, Inc. shall in all respects comply with the provision of 1929 PA 16, as amended.

The Commission specifically reserves jurisdiction of the matters herein contained and the authority to issue such further order or orders as the facts and circumstances may require.

Any party desiring to appeal this order must perfect an appeal to the appropriate court within 30 days after issuance and notice of this order, pursyant to MCL 462.26.

MICHIGAN PUBLIC SERVICE COMMISSION

/s/ William E. Long
Chairperson

(S E A L)

/s/ Edwyna G. Anderson
Commissioner

/s/ Matthew E. McLogan
Commissioner

By the Commission and pursuant to its action of April 14, 1987.

/s/ Bruce R. Maughan
Its Secretary

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the application of **LAKEHEAD PIPE LINE COMPANY, INC.** for authority to construct, maintain, and operate an emergency reinjection facility and fixtures and equipment appurtenant thereto.	Case No. U-9381

At a session of the Michigan Public Service Commission held at its offices in the city of Lansing, Michigan, on the 1st day of August, 1989.

PRESENT: Hon. William E. Long, Chairperson
Hon. Steven M. Fetter, Commissioner
Hon. Ronald E. Russell, Commissioner

ORDER APPROVING APPLICATION

On June 12, 1989, Lakehead Pipe Line Company (Lakehead) filed an application for approval to construct, maintain, and operate an emergency reinjection facility and related fixtures and equipment.

Lakehead is a Delaware corporation having its principal offices located in Superior, Wisconsin. Lakehead owns and operates, as a common carrier in intrastate, interstate, and foreign commerce, an oil pipeline system for the transportation of crude oil and other liquid hydrocarbons. Lakehead has an existing 30-inch O.D. pipeline that crosses northern Michigan from a point near Ironwood, Michigan via the Straits of Mackinac to a point on the international boundary in the St. Clair River, south of Port Huron, Michigan. There are currently 12 pumping stations operating on the Michigan portion of this pipeline.

Lakehead seeks approval to construct and operate an emergency reinjection facility to facilitate the recovery of oil in the event of a leak along this main line. The emergency reinjection facility will consist of a 40 horse power (h.p.) pump and motor to unload tanker trucks into a 5,000 barrel (bbl.) temporary storage tank. A 75 h.p. pump and motor will be used to pump the crude oil from the tank into the main pipeline. This facility will be located adjacent to its existing 30-inch pipeline at the Bay City, Michigan pumping station in the SW/4 of Section 10, T14N, R4W, Bay County, Michigan.

The Staff of the Commission has conducted an environmental review of the application and concludes that construction of the proposed emergency reinjection facility would not constitute a "major state activity" as defined in Part 4 of the State of Michigan Guidelines for Preparation and Review of Environmental Impact Statements under Executive Order 1974-4. Therefore an Environmental Impact Statement was not prepared for the proposed emergency reinjection facility.

After a review of the application, the Commission finds that ex parte approval is appropriate. The proposal is just, reasonable, and in the public interest.

The Commission FINDS that:

a. Jurisdiction is pursuant to 1929 PA 16, as amended, MCL 483.1 et seq.; 1919 PA 419, as amended, MCL 460.51 et seq; 1939 PA 3, as amended, MCL 460.1 et seq.; 1970 PA 127, MCL 691.1201 et seq.; 1969 PA 306, as amended, MCL 24.201 et seq.; and the Commission's Rules of Practice and Procedure, 1979 Administrative Code, R 460.11 et seq.

b. Lakehead has complied with the requirements of 1929 PA 16, as amended, by filing a map showing the location of the proposed emergency reinjection facility, by filing its explicit authorized acceptance of 1929 PA 16, and by filing engineering specifications and data showing the size and capacity of the proposed emergency reinjection facility.

c. The requirements of the Environmental Review Procedure established by State of Michigan Executive Order 1974-4 have been met.

d. Ex parte approval is appropriate.

THEREFORE, IT IS ORDERED that:

A. Lakehead Pipe Line Company is authorized to construct, maintain, and operate an emergency reinjection facility and related fixtures and equipment in Bay County, Michigan as proposed in its application filed on June 12, 1989.

B. Lakehead Pipe Line Company shall, in all respects, comply with the provisions of 1929 PA 16, as amended.

The Commission specifically reserves jurisdiction of the matters herein contained and the authority to issue such further order or orders as the facts and circumstances may require.

Any party desiring to appeal this order must perfect an appeal to the appropriate court within 30 days after issuance and notice of this order, pursuant to MCL 462.26.

MICHIGAN PUBLIC SERVICE COMMISSION

/s/ William E. Long
Chairperson

(S E A L)

/s/ Steven M. Fetter
Commissioner

/s/ Ronald E. Russell
Commissioner

By the Commission and pursuant to its action of August 1, 1989.

/s/ Dorothy Wideman
Its Executive Secretary

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the application of **LAKEHEAD PIPE LINE COMPANY, INC.** for authority to construct, maintain, and operate a remotely controlled main line valve facility and fixtures and equipment appurtenant thereto.	))))))	Case No. U-9944

At the September 25, 1991 meeting of the Michigan Public Service Commission in Lansing, Michigan.

PRESENT: Hon. Steven M. Fetter, Chairman
Hon. William E. Long, Commissioner
Hon. Ronald E. Russell, Commissioner

ORDER APPROVING APPLICATION

On August 8, 1991, Lakehead Pipe Line Company, Inc. (Lakehead) filed an application for approval to install, maintain, and operate a remotely controlled main line valve facility and related fixtures and appurtenant equipment on an existing oil pipeline at a strategic location in Oscoda County, Michigan. Lakehead explains that the remotely controlled main line valve facility, which will be located on the north side of the Au Sable River between its Lewiston and West Branch pump stations, is needed to minimize the effect of any leak that may occur in that area. The remotely controlled main line valve facility will consist of a 30-inch gate valve with a motor operator. A small building will house electrical equipment necessary to power the motor operator, which will be controlled from the pipeline's control center in Superior, Wisconsin. An access road will be constructed to permit occasional inspection of the valve facility. Upon completion, the valve and communication building will be enclosed by protective fencing.

The Commission Staff has conducted an environmental review of the application and concludes that construction of the proposed remotely controlled main line valve facility would not cause any significant adverse impact. Therefore, an environmental impact statement was not prepared for the proposed facility.

After a review of the application, the Commission finds that ex parte approval is appropriate. The proposal is just, reasonable, and in the public interest.

The Commission FINDS that:

a. Jurisdiction is pursuant to 1929 PA 16, as amended, MCL 483.1 et seq.; 1919 PA 419, as amended, MCL 460.51 et seq.; 1939 PA 3, as amended, MCL 460.1 et seq.; 1970 PA 127, MCL 691.1201 et seq.; 1969 PA 306, as amended, MCL 24.2 et seq.; and the Commission's Rules of Practice and Procedure, 1979 Administrative Code, R 460.11 et seq.

b. Lakehead has complied with the requirements of 1929 PA 16, as amended, by filing a map showing the location of the proposed remotely controlled main line valve facility, by filing its explicit authorized acceptance of 1929 PA 16, and by filing engineering specifications and data showing the size and capacity of the proposed facility.

c. There will be no significant adverse impacts to the environment due to the construction and operation of the main line valve facility.

d. Ex parte approval is appropriate.

THEREFORE, IT IS ORDERED that:

A. Lakehead Pipe Line Company, Inc. is authorized to construct, maintain, and operate a remotely controlled main line valve facility and related fixtures and equipment in Oscoda County, Michigan as proposed in its application filed on August 8, 1991.

B. Lakehead Pipe Line Company, Inc. shall in all respects comply with the provisions of 1929 PA 16, as amended.

The Commission reserves jurisdiction and may issue further orders as necessary.

Any party desiring to appeal this order must do so in the appropriate court within 30 days after issuance and notice of this order, pursuant to MCL 462.26.

MICHIGAN PUBLIC SERVICE COMMISSION

/s/ Steven M. Fetter
Chairman

(S E A L)

/s/ William E. Long
Commissioner

/s/ Ronald E. Russell
Commissioner

By its action of September 25, 1991.

/s/ Dorothy Wideman
Its Executive Secretary

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the application of **LAKEHEAD PIPE LINE COMPANY, LIMITED PARTNERSHIP** for authority to issue and up to $325 million principal amount of first mortgage notes, to issue partnership interests, and to borrow up to $275 million pursuant to a revolving credit facility agreement.	)	Case No. U-9980

At the November 8, 1991 meeting of the Michigan Public Service Commission in Lansing, Michigan.

PRESENT: Hon. Steven M. Fetter, Chairman
Hon. Ronald E. Russell, Commissioner
Hon. John L. O'Donnell, Commissioner

ORDER APPROVING ISSUANCE OF SECURITIES

On October 14, 1991, Lakehead Pipe Line Company, Limited Partnership (the Operating Partnership) filed an application requesting a disclaimer of jurisdiction or, in the alternative, authority to issue and sell up to $325 million principal amount of first mortgage notes, to issue limited and general partnership interests in the Operating Partnership, and to borrow up to $275 million, as amended, pursuant to a revolving credit facility agreement.

On October 18, 1991, a notice of opportunity to comment or request a hearing was published in The Detroit Free Press and The Detroit News, newspapers of general circulation throughout the state of Michigan. No comments or requests for a hearing were filed with the Commission.

Lakehead Pipe Line Company, Inc. (Lakehead) organized the Operating Partnership as follows: that the Lakehead owns a 1.0101% general partnership interest in the Operating Partnership and LPL Investment, Inc., a wholly-owned subsidiary of Lakehead owns the remaining 98.9899% interest as an organizational limited partner. Lakehead proposes to contribute substantially all of its oil pipeline system assets, which consist of that portion of the Interprovincial Pipe Line System located within the United States, to the Operating Partnership. Included in the contribution are facilities located within the state of Michigan. The Operating Partnership will acquire these assets in exchange for: (1) the partnership interests in the Operating Partnership (the 1.0101% general partner interest and the 98.9899% limited partner interest); (2) a cash distribution right of up to $325 million to Lakehead pursuant to the terms of the partnership agreement of the Operating Partnership; and (3) the assumption of certain of Lakehead's outstanding indebtedness and all current liabilities related to the Interprovincial System located within the United States. Lakehead, as general partner, will continue to operate the pipeline.

The Operating Partnership proposes to raise the cash necessary for it to make the cash distribution to Lakehead by the issuance and sale of up to $325 million principal amount of first mortgage notes due in 2011 and secured by a mortgage on substantially all the plant, property, and equipment of the Operating Partnership. The notes will bear interest at a market rate and will be payable in ten equal annual sinking fund payments beginning in the year 2002.

Lakehead and the Operating Partnership propose to enter into a Revolving Credit Facility Agreement (credit agreement) whereby short-term borrowings of up to $275 million may be made. The credit agreement will have an option to convert these borrowings to long-term obligations. Lakehead states it will initially borrow up to $275 million under the credit agreement prior to the transfer of its assets to the Operating Partnership. This indebtedness will be assumed by the LPL Limited Partnership, which will neither own assets in nor operate facilities in Michigan. Subsequently, the credit agreement will permit either the Operating Partnership or the LPL Limited Partnership to borrow up to a maximum of $275 million. The Operating Partnership may require the LPL Limited Partnership to repay any amounts owed by the LPL Limited Partnership under the credit agreement in order to allow the Operating Partnership to borrow under the credit agreement. For this privilege, the Operating Partnership will pay the LPL Limited Partnership a standby fee based upon the amount available to the Operating Partnership under the credit agreement. Neither the LPL Limited Partnership nor the Operating Partnership will be liable for borrowings made by the other unless specifically assumed by the other. Future borrowings under the credit agreement by the Operating Partnership will be used to fund additional capital expenditures and will be secured by either cash collateral or a mortgage on its property equally and ratably with the mortgage given to secure the notes.

Lakehead will also cause to be formed Lakehead Pipe Line Partners L.P. (Master Limited Partnership). Lakehead states the reason for forming the two-tier partnership structure is to simplify ongoing reporting obligations. Lakehead will then transfer to the Master Limited Partnership the 98.9899% limited partnership interest in the Operating Partnership, which will in turn issue and sell limited partner Preference Units representing an approximate 80%

limited partner interest in the Master Limited Partnership. The proceeds from the sale of the Preference Units will be used to collateralize up to $275 million of short-term debt assumed by the LPL Limited Partnership and the remaining net proceeds will be contributed to the Operating Partnership, which will use the funds to repay certain indebtedness and current liabilities assumed from Lakehead. The balance, if any, will be added to the working capital of the Operating Partnership.

After a review of the application, the Commission finds that ex parte approval is appropriate. The Commission is satisfied that the issuance and sale of the securities are reasonably required for lawful corporate purposes and that the issuance and amount are essential for carrying out the purposes described in the application.

The Commission FINDS that:

a. Jurisdiction is pursuant to 1909 PA 144, as amended, MCL 460.301 et seq.; and the Commission's Rules of Practice and Procedure, 1979 Administrative Code, R 460.11 et seq.

b. The issuance and sale of the securities are for lawful corporate purposes, and are essential for carrying out the purposes described in the application.

c. Ex parte approval is appropriate.

d. A security issuance fee of $250 has been paid to the State of Michigan.

THEREFORE, IT IS ORDERED that:

A. Lakehead Pipe Line Company, Limited Partnership is authorized to issue and sell up to $325 million aggregate principal amount of its first mortgage notes and to incur and pay reasonable commissions, fees, and expenses.

B. Lakehead Pipe Line Company, Limited Partnership is authorized to: (1) issue a limited partner interest representing a 98.9899% interest in and to the Lakehead Pipe Line Company, Limited Partnership and a general partner interest representing a 1.0101% interest in and to the Lakehead Pipe Line Company, Limited Partnership; (2) grant a cash distribution right of up to $325 million to Lakehead Pipe Line Company, Inc., pursuant to the terms of the partnership agreement of Lakehead Pipe Line Company, Limited Partnership; and (3) to assume the indebtedness and obligations of Lakehead Pipe Line Company, Inc. in exchange for substantially all of the pipeline system assets of Lakehead Pipe Line Company, Inc.

C. Lakehead Pipe Line Company, Limited Partnership and Lakehead Pipe Line Company, Inc. are authorized to borrow up to $275 million pursuant to a Revolving Credit Term Facility Agreement.

D. Lakehead Pipe Line Company, Limited Partnership and Lakehead Pipe Line Company, Inc. shall file a report or reports after the issuance and sale of any securities as authorized by this order, setting forth the major terms and conditions of each security issuance, including net proceeds. These reports shall be made by an officer of Lakehead Pipe Line Company, Limited Partnership and Lakehead Pipe Line Company, Inc. who has knowledge of the facts of the issuance.

The Commission reserves jurisdiction and may issue further orders as necessary.

Any party desiring to appeal this order must do so in the appropriate court within 30 days after issuance and notice of this order, pursuant to MCL 462.26.

MICHIGAN PUBLIC SERVICE COMMISSION

/s/ Steven M. Fetter
Chairman

(S E A L)

/s/ Ronald E. Russell
Commissioner

/s/ John L. O'Donnell
Commissioner

By its action of November 8, 1991.

/s/ Dorothy Wideman
Its Executive Secretary

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the application of **LAKEHEAD PIPE LINE COMPANY, LIMITED PARTNERSHIP**, for authority to construct, maintain, and operate a remotely controlled main line valve facility and fixtures and equipment appurtenant thereto.	)))))))	Case No. U-10073

At the April 15, 1992 meeting of the Michigan Public Service Commission in Lansing, Michigan.

PRESENT: Hon. Steven M. Fetter, Chairman
Hon. Ronald E. Russell, Commissioner
Hon. John L. O'Donnell, Commissioner

ORDER APPROVING APPLICATION

On February 21, 1992, Lakehead Pipe Line Company, Limited Partnership (Lakehead), filed an application for approval to install, maintain, and operate a remotely controlled main line valve facility and related fixtures and appurtenant equipment on an existing oil pipeline at a strategic location in Dickinson County, Michigan. Lakehead explains that the remotely controlled main line valve facility, which will be located approximately 100 feet east of County Road 422 between its Iron River and Rapid River pump stations, is needed to sectionalize the main line and allow for testing of the pipeline. The remotely controlled main line valve facility will consist of a 30-inch gate valve with a bevel gear operator. Upon completion, the valve will be surrounded by four protection posts.

The Commission Staff has conducted an environmental review of the application and concludes that construction of the proposed remotely controlled main line valve facility would not cause any significant adverse impact. Therefore, an environmental impact statement was not prepared for the proposed facility.

After a review of the application, the Commission finds that ex parte approval is appropriate. The proposal is just, reasonable, and in the public interest.

The Commission FINDS that:

a. Jurisdiction is pursuant to 1929 PA 16, as amended, MCL 483.1 et seq.; 1919 PA 419, as amended, MCL 460.51 et seq.; 1939 PA 3, as amended, MCL 460.1 et seq.; 1970 PA 127, MCL 691.1201 et seq.; 1969 PA 306, as amended, MCL 24.2 et seq.; and the Commission's Rules of Practice and Procedure, R 460.17101 et seq.

b. Lakehead has complied with the requirements of 1929 PA 16, as amended, by filing a map showing the location of the proposed remotely controlled main line valve facility, by filing its explicit authorized acceptance of 1929 PA 16, and by filing engineering specifications and data showing the size and capacity of the proposed facility.

c. There will be no significant adverse impact to the environment due to the construction and operation of the main line valve facility.

d. Because the public interest will be adequately protected without the time and expense of a public hearing, ex parte approval is appropriate.

THEREFORE, IT IS ORDERED that:

A. Lakehead Pipe Line Company, Limited Partnership, is authorized to construct, maintain, and operate a remotely controlled main line valve facility and related fixtures and equipment in Dickinson County, Michigan as proposed in its application filed on February 21, 1992.

B. Lakehead Pipe Line Company, Limited Partnership, shall in all respects comply with the provisions of 1929 PA 16, as amended.

The Commission reserves jurisdiction and may issue further orders as necessary.

Any party desiring to appeal this order must do so in the appropriate court within 30 days after issuance and notice of this order, pursuant to MCL 462.26.

MICHIGAN PUBLIC SERVICE COMMISSION

/s/ Steven M. Fetter
Chairman

(S E A L)

/s/ Ronald E. Russell
Commissioner

/s/ John L. O'Donnell
Commissioner

By its action of April 15, 1992.

/s/ Dorothy Wideman
Its Executive Secretary

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the application of **LAKEHEAD PIPE LINE COMPANY, LIMITED PARTNERSHIP**, for authority to construct, maintain, and operate a main line valve facility and fixtures and equipment appurtenant thereto.	)	Case No. U-10097

At the June 12, 1992 meeting of the Michigan Public Service Commission in Lansing, Michigan.

PRESENT: Hon. Steven M. Fetter, Chairman
Hon. Ronald E. Russell, Commissioner
Hon. John L. O'Donnell, Commissioner

ORDER APPROVING APPLICATION

On April 30, 1992, Lakehead Pipe Line Company, Limited Partnership, (Lakehead) filed an application for authority to install, maintain, and operate a main line valve facility and related fixtures and appurtenant equipment on an existing oil pipeline at a strategic location in Delta County, Michigan. Lakehead explains that the main line valve facility, which will be located approximately 100 feet west of County Highway 529 between its Iron River and Rapid River pump stations, is needed to sectionalize the main line and allow for testing of the pipeline. The main line valve facility will consist of a 30-inch gate valve with a bevel gear operator. Upon completion, the valve will be surrounded by four protection posts.

The Commission Staff has conducted an environmental review of the application and concludes that construction of the proposed main line valve facility would not cause any significant adverse impact. Therefore, an environmental impact statement was not prepared for the proposed facility.

After a review of the application, the Commission finds that ex parte approval is appropriate. The proposal is just, reasonable, and in the public interest.

The Commission FINDS that:

a. Jurisdiction is pursuant to 1929 PA 16, as amended, MCL 483.1 seq.; 1919 PA 419, as amended, MCL 460.51 et seq.; 1939 PA 3, as amended, MCL 460.1 et seq.; 1970 PA 127, MCL 691.1201 et seq.; 1969 PA 306, as amended, MCL 24.201 et seq.; and the Commission's Rules of Practice and Procedure, R 460.17101 et seq.

b. Lakehead has complied with the requirements of 1929 PA 16, as amended, by filing a map showing the location of the proposed main line valve facility, by filing its explicit authorized acceptance of 1929 PA 16, and by filing engineering specifications and data showing the size and capacity of the proposed facility.

c. There will be no significant adverse impact on the environment due to the construction and operation of the main line valve facility.

d. Because the public interest will be adequately protected without the time and expense of a public hearing, ex parte approval is appropriate.

THEREFORE, IT IS ORDERED that:

A. Lakehead Pipe Line Company, Limited Partnership, is authorized to construct, maintain, and operate a main line valve facility and related fixtures and equipment in Delta County, Michigan as proposed in its application filed on April 30, 1992.

B. Lakehead Pipe Line Company, Limited Partnership, shall in all respects comply with the provisions of 1929 PA 16, as amended.

The Commission reserves jurisdiction and may issue further orders as necessary.

Any party desiring to appeal this order must do so in the appropriate court within 30 days after issuance and notice of this order, pursuant to MCL 462.26.

MICHIGAN PUBLIC SERVICE COMMISSION

/s/ Steven M. Fetter
Chairman

(S E A L)

/s/ Ronald E. Russell
Commissioner

/s/ John L. O'Donnell
Commissioner

By its action of June 12, 1992.

/s/ Dorothy Wideman
Its Executive Secretary

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the application of **LAKEHEAD PIPE LINE COMPANY, LIMITED PARTNERSHIP** for authority to construct, maintain, and operate a remotely controlled main line valve facility and fixtures and equipment appurtenant thereto.	Case No. U-10104

At the June 12, 1992 meeting of the Michigan Public Service Commission in Lansing, Michigan.

PRESENT: Hon. Steven M. Fetter, Chairman
Hon. Ronald E. Russell, Commissioner
Hon. John L. O'Donnell, Commissioner

ORDER APPROVING APPLICATION

On May 13, 1992, Lakehead Pipe Line Company, Limited Partnership, (Lakehead) filed an application for authority to install, maintain, and operate a remotely controlled main line valve facility and related fixtures and appurtenant equipment on an existing oil pipeline at a strategic location in Schoolcraft County, Michigan. Lakehead explains that the remotely controlled main line valve facility, which will be located approximately 2,500 feet west of County Road 433 and approximately four miles east of its Manistique pump station, is needed to isolate the main line in the event of a line break in the Manistique River area. The remotely controlled main line valve facility will consist of a 30-inch gate valve with a manual and remote electric operator. Upon completion, the valve will be surrounded by a security fence.

The Commission Staff has conducted an environmental review of the application and concludes that construction of the proposed remotely controlled main line valve facility would not cause any significant adverse impact. Therefore, an environmental impact statement was not prepared for the proposed facility.

After a review of the application, the Commission finds that ex parte approval is appropriate. The proposal is just, reasonable, and in the public interest.

The Commission FINDS that:

a. Jurisdiction is pursuant to 1929 PA 16, as amended, MCL 483.1 et seq.; 1919 PA 419, as amended, MCL 460.51 et seq.; 1939 PA 3, as amended, MCL 460.1 et seq.; 1970 PA 127, MCL 691.1201 et seq.; 1969 PA 306, as amended, MCL 24.201 et seq.; and the Commission's Rules of Practice and Procedure, R 460.17101 et seq.

b. Lakehead has complied with the requirements of 1929 PA 16, as amended, by filing a map showing the location of the proposed remotely controlled main line valve facility, by filing its explicit authorized acceptance of 1929 PA 16, and by filing engineering specifications and data showing the size and capacity of the proposed facility.

c. There will be no significant adverse impact on the environment due to the construction and operation of the main line valve facility.

d. Because the public interest will be adequately protected without the time and expense of a public hearing, ex parte approval is appropriate.

THEREFORE, IT IS ORDERED that:

A. Lakehead Pipe Line Company, Limited Partnership, is authorized to construct, maintain, and operate a remotely controlled main line valve facility and related fixtures and equipment in Schoolcraft County, Michigan as proposed in its application filed on May 13, 1992.

B. Lakehead Pipe Line Company, Limited Partnership, shall in all respects comply with the provisions of 1929 PA 16, as amended.

The Commission reserves jurisdiction and may issue further orders as necessary.

Any party desiring to appeal this order must do so in the appropriate court within 30 days after issuance and notice of this order, pursuant to MCL 462.26.

MICHIGAN PUBLIC SERVICE COMMISSION

/s/ Steven M. Fetter
Chairman

(S E A L)

/s/ Ronald E. Russell
Commissioner

/s/ John L. O'Donnell
Commissioner

By its action of June 12, 1992.

/s/ Dorothy Wideman
Its Executive Secretary

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the application of **LAKEHEAD PIPE LINE COMPANY, LIMITED PARTNERSHIP,** for authority to construct, maintain, and operate a metering facility and fixtures and equipment appurtenant thereto.	)	Case No. U-10113

At the July 10, 1992 meeting of the Michigan Public Service Commission in Lansing, Michigan.

PRESENT: Hon. Steven M. Fetter, Chairman
Hon. Ronald E. Russell, Commissioner
Hon. John L. O'Donnell, Commissioner

ORDER APPROVING APPLICATION

On June 1, 1992, Lakehead Pipe Line Company, Limited Partnership, (Lakehead) filed an application for authority to install, maintain, and operate a metering facility and related fixtures and equipment that will serve two 30-inch oil pipelines at a strategic location in St. Clair County, Michigan. Lakehead explains that the metering facility, which will be located approximately 900 feet west of Interstate 94 in the south half of the northeast quarter of Section 1, Township 5 North, Range 16 East, St. Clair Township, St. Clair County, Michigan, is needed to make simultaneous deliveries from both the north and south lines at Marysville. The metering facility will consist of six 16-inch meter runs and two 30-inch prover loops.

The Commission Staff has conducted an environmental review of the application and concludes that construction of the proposed metering facility would not cause any significant adverse impact. Therefore, an environmental impact statement was not prepared for the proposed facility.

After a review of the application, the Commission finds that ex parte approval is appropriate. The proposal is just, reasonable, and in the public interest.

The Commission FINDS that:

a. Jurisdiction is pursuant to 1929 PA 16, as amended, MCL 483.1 seq.; 1919 PA 419, as amended, MCL 460.51 et seq.; 1939 PA 3, as amended, MCL 460.1 et seq.; 1970 PA 127, MCL 691.1201 et seq.; 1969 PA 306, as amended, MCL 24.201 et seq.; and the Commission's Rules of Practice and Procedure, R 460.17101 et seq.

b. Lakehead has complied with the requirements of 1929 PA 16, as amended, by filing a map showing the location of the proposed metering facility, by filing its explicit authorized acceptance of 1929 PA 16, and by filing engineering specifications and data showing the size and capacity of the proposed facility.

c. There will be no significant adverse impact to the environment due to the construction and operation of the metering facility.

d. Because the public interest will be adequately protected without the time and expense of a public hearing, ex parte approval is appropriate.

THEREFORE, IT IS ORDERED that:

A. Lakehead Pipe Line Company, Limited Partnership, is authorized to construct, maintain, and operate a metering facility and related fixtures and equipment in St. Clair County, Michigan as proposed in its application filed on June 1, 1992.

B. Lakehead Pipe Line Company, Limited Partnership, shall in all respects comply with the provisions of 1929 PA 16, as amended.

The Commission reserves jurisdiction and may issue further orders as necessary.

Any party desiring to appeal this order must do so in the appropriate court within 30 days after issuance and notice of this order, pursuant to MCL 462.26.

MICHIGAN PUBLIC SERVICE COMMISSION

/s/ Steven M. Fetter
Chairman

(S E A L)

/s/ Ronald E. Russell
Commissioner

/s/ John L. O'Donnell
Commissioner

By its action of July 10, 1992.

/s/ Dorothy Wideman
Its Executive Secretary

STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

* * * * *

In the matter of the application of **LAKEHEAD PIPE LINE COMPANY, LIMITED PARTNERSHIP,** for authority to construct, maintain, and operate a main line valve facility and fixtures and appurtenant equipment.	))))))	Case No. U-10287

At the April 22, 1993 meeting of the Michigan Public Service Commission in Lansing, Michigan.

PRESENT: Hon. Steven M. Fetter, Chairman
Hon. Ronald E. Russell, Commissioner
Hon. John L. O'Donnell, Commissioner

ORDER APPROVING APPLICATION

On February 18, 1993, Lakehead Pipe Line Company, Limited Partnership, (Lakehead) filed an application for authority to install, maintain, and operate a main line valve facility and related fixtures and equipment that will serve its 30-inch oil pipeline in Gogebic County, Michigan. The main line valve facility will be located on Lakehead's existing 30-inch pipeline in the NW 1/4 of Section 4, Township 47 North, Range 45 East, Wakefield Township, Gogebic County, Michigan. Installation of this valve will allow Lakehead to isolate the main line in the event of a line break or during routine maintenance.

The Commission Staff has conducted an environmental review of the application and concludes that construction of the proposed main line valve facility would not cause any significant adverse impact. Therefore, an environmental impact statement was not prepared for the proposed facility.

After a review of the application, the Commission finds that ex parte approval is appropriate. The proposal is just, reasonable, and in the public interest.

The Commission FINDS that:

a. Jurisdiction is pursuant to 1929 PA 16, as amended, MCL 483.1 et seq.; 1919 PA 419, as amended, MCL 460.51 et seq.; 1939 PA 3, as amended, MCL 460.1 et seq.; 1970 PA 127, MCL 691.1201 et seq.; 1969 PA 306, as amended, MCL 24.2 et seq.; and the Commission's Rules of Practice and Procedure, R 460.17101 et seq.

b. Lakehead has complied with the requirements of 1929 PA 16, as amended, by filing a map showing the location of the proposed main line valve facility, by filing its explicit authorized acceptance of 1929 PA 16, and by filing engineering specifications and data showing the size of the proposed facility.

c. There will be no significant adverse impact to the environment due to the construction and operation of the main line valve facility.

d. Because the public interest will be adequately protected without the time and expense of a public hearing, ex parte approval is appropriate.

THEREFORE, IT IS ORDERED that:

A. Lakehead Pipe Line Company, Limited Partnership, is authorized to construct, maintain, and operate a main line valve facility and related fixtures and equipment in Gogebic County, Michigan as proposed in its application filed on February 18, 1993.

B. Lakehead Pipe Line Company, Limited Partnership, shall in all respects comply with the provisions of 1929 PA 16, as amended.

The Commission reserves jurisdiction and may issue further orders as necessary.

Any party desiring to appeal this order must do so in the appropriate court within 30 days after issuance and notice of this order, pursuant to MCL 462.26.

MICHIGAN PUBLIC SERVICE COMMISSION

/s/ Steven M. Fetter
Chairman

(S E A L)

/s/ Ronald E. Russell
Commissioner

/s/ John L. O'Donnell
Commissioner

By its action of April 22, 1993.

/s/ Dorothy Wideman
Its Executive Secretary

APPENDICES TO FLOW PUBLIC COMMENTS ON THE JOINT APPLICATION OF ENBRIDGE ENERGY TO OCCUPY GREAT LAKES BOTTOMLANDS FOR ANCHORING SUPPORTS TO TRANSPORT CRUDE OIL IN LINE 5 PIPELINES IN THE STRAITS OF MACKINAC AND LAKE MICHIGAN [2RD-DFDK-Y35G]

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APPENDIX D

Published on *InsideClimate News* (https://insideclimatenews.org)

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Map: Another Major Tar Sands Pipeline Seeking U.S. Permit

Canadian energy giant Enbridge is quietly building a 5,000-mile network of new and expanded pipelines that would achieve the same goal as the Keystone.

By Lisa Song, InsideClimate News

Jun 3, 2013

Canadian company Enbridge Inc. is expanding its network of pipelines to carry thousands of additional barrels of oil to and through the United States each day. Credit: Paul Horn.

While all eyes are on TransCanada's Keystone XL pipeline, another Canadian company is quietly building a 5,000-mile network of new and expanded pipelines that would achieve the same goal as the Keystone. In fact, the project by Enbridge, Inc., Canada's largest transporter of crude oil, would bring even more Canadian oil into the U.S. than the much-debated Keystone project.

Enbridge has already begun growing its existing pipeline infrastructure to increase the flow of Canadian and U.S.-produced oil into refineries and ports in the Midwest, Gulf Coast and Northeastern Canada. The company's plans have largely escaped public scrutiny, in part because its expansion has proceeded in many segments and phases.

The linchpin of Enbridge's Canadian oil transport system is its proposal to increase the capacity of Line 67 (often referred to as the Alberta Clipper pipeline) to bring an additional 430,000 barrels a day of oil into the United States. Line 67 runs from Hardisty, Alberta to Superior, Wisc. and currently ships up to 450,000 barrels of oil a day. Enbridge wants to expand the line's capacity to 570,000 barrels a day, with the possibility of future growth to 880,000 barrels a day. That's larger than the Keystone XL's proposed daily capacity of 830,000 barrels.

Because Line 67 crosses the U.S.-Canada border, it needs a presidential permit from the State Department before it can be expanded. That's the same kind of permit TransCanada is seeking for the northern segment of Keystone XL. The Obama administration is expected to approve or deny the Keystone permit by the end of 2013. For Enbridge, the application process has just begun: the State Department is reviewing public comments on the scope of the environmental review.

Here's a breakdown of Enbridge's current and proposed pipeline projects:

PIPELINE	CURRENT CAPACITY (Barrels Per Day)	PROJECTED CAPACITY (Barrels Per Day)	EXPECTED IN-SERVICE DATE
1 Line 67 Alberta Clipper	450,000	570,000-880,000	Mid 2014
2 Line 6B	240,000	500,000-570,000	Early 2014
3 Line 9	240,000	300,000 (After reversal and expansion)	Spring 2014
4 Line 79	New pipeline	80,000	Early 2013
5 Line 5	491,200	541,000	Mid/late 2013
6 Line 61 Southern Access Project	400,000	560,000-1,200,000	Mid 2014
7 Southern Access Extension	New pipeline	300,000	2015
8 Trunkline	660,000		2015, pending FERC approval
9 Line 62 Spearhead North	135,000	235,000	Early 2014
10 Line 78	New pipeline	TBD. The pipeline will have a diameter of 36 inches	Mid 2015
11 Flanagan South	New pipeline	585,000-800,000	Mid 2014
12 Seaway	400,000	850,000	Early 2014

SOURCES: Enbridge; InsideClimate News research PAUL HORN / InsideClimate News [1]

****Click map to enlarge*****

Line 67 (Alberta Clipper)

Expected in-service date: mid 2014

Origin and destination: Hardisty, Alberta to Superior, Wisc.

Length : 1,000 miles

Description : Expansion of an existing pipeline via construction of new pump stations. The project needs a presidential permit from the State Department. The agency is now reviewing public comments the scope of the Supplemental Environmental Impact Statement.

Curr **ent capacity**: 450,000 barrels per day (bpd)

Expanded capacity: initial capacity of 570,000 bpd , with the possibility of future expansion to 880,000 bpd

Market : increase shipments of Canadian tar sands and conventional oil into the U.S. for refining and export

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Line 6B

Expected in-service date: early 2014 (initial expansion), 2016 (additional expansion). Origin and destination: Griffith, Ind. to Sarnia, Ontario

Length : 293 miles

Description : Expansion via building a new pipeline next to the existing 6B, modifying pump stations and constructing new storage tanks. Construction began in 2012 and is ongoing.

Curr **ent capacity**: 240,000 bpd

Expanded capacity: 500,000 bpd (initial), expected to be in-service in early 2014. An additional expansion from Griffith, Ind. to Stockbridge, Mich. will increase the capacity to 570,000 and is expected to be operational in 2016.

Market : refineries in and around Michigan

Line 9

Expected in-service date: spring 2014

Origin and destination: Sarnia, Ontario to Montreal, Quebec.

Length : 524 miles

Description : Reversing part of the existing Line 9 (from North Westover, Ontario to Montreal) to enable shipment of oil from Sarnia to Montreal. The Application is pending before the Canadian National Energy Board. Regulators approved the reversal of the Sarnia to North Westover segment last year. Total pipeline capacity will be expanded by injecting chemicals into the pipeline to reduce friction.

Curr **ent capacity**: 240,000 bpd

Expanded capacity: 300,000 bpd

Market : Quebec refineries. Environmentalists and pipeline opponents say the Line 9 reversal would allow Enbridge to eventually access the Atlantic Coast and to export oil via new pipelines. In its Line 9 project description, Enbridge says it has "no plans, proposals or infrastructure for pipelines moving product further East than Montreal."

Line 79

Expected in-service date: early 2013

Origin and destination: Stockbridge, Mich. to Freedom Junction, Mich.

Length : 35 miles

Description : New pipeline, which will connect to an existing 29-mile pipeline that Enbridge will lease from Wolverine Pipe Line Company. The Wolverine pipeline runs from Freedom Junction to Romulus, Mich. These two pipelines will allow Enbridge to ship oil from Stockbridge to Romulus.

Capacity in bpd: 80,000

Market : Michigan and Ohio refineries

Line 5

Expected in-service date: mid or late 2013

Origin and destination: Superior, Wisc. to Sarnia, Ontario.

Length : 645 miles

Description : Expansion via boosting power at pump stations

Curr **ent capacity**: 491,200 bpd

Expanded capacity: 541,000 bpd

Market : Refineries in Ontario and Michigan

Line 61 (Southern Access Project)

Expected in-service date: mid 2014, 2016

Origin and destination: Superios, Wisc. to Flanagan, Ill.

Length : 454 miles

Description : Expansion via increased pumping horsepower and constrution of new crude oil tanks.

Curr **ent capacity**: 400,000 bpd

Expanded capacity: 560,000 bpd (initial). In Dec. 2012, Enbridge announced a further expansion, subject to regulatory review and approvals, to increase the capacity to 1.2 million bpd.

Market : Refineries near Chicago

Southern Access Extension

Expected in-service date: 2015

Origin and destination: Flanagan, Ill. to Patoka, Ill.

Length : 165 miles

Description : New proposed pipeline.

Capacity : 300,000 bpd.

Market : Refineries near Patoka

Trunkline

Expected in-service date: 2015, pending approval from the Federal Energy Regulatory Commission

Origin and destination: Patoka, Ill. to St. James, La. and Louisiana Coast.

Length : more than 700 miles

Description : Conversion of an existing natural gas pipeline to crude oil pipeline. Joint project beween Enbridge and Energy Transfer

Capacity : 660,000 bpd

Market : Gulf Coast

Line 62 (Spearhead North)

Expected in-service date: early 2014

Origin and destination: Flanagan, Ill. to Griffith, Ind.

Length : 77 miles

Description : Expansion via increasing power at pump stations

Curr **ent capacity**: 135,000 bpd

Expanded capacity: 235,000 bpd

Market : Midwest refineries

Line 78

Expected in-service date: mid-2015

Origin and destination: Flanagan, Ill. to Griffith, Ind.

Length : 77 miles

Description : New proposed pipeline parallel to the existing Line 62.

Capacity : TBD. The pipeline will have a diameter of 36 inches.

Market : Midwest refineries

Flanagan South

Expected in-service date: mid 2014

Origin and destination: Flanagan, Ill. to Cushing, Okla.

Length : 600 miles

Description : New pipeline

Capacity : 585,000 bpd (initial), with the possibility of increasing to 800,000 bpd.

Market : Gulf Coast

Seaway

Expected in-service date: early 2014

Origin and destination: Cushing, Okla. to Freeport, Texas

Length : 500 miles

Description : Reversal and expansion via building a new pipeline next to the existing Seaway pipeline. Joint project between Enbridge and Enterprise Partners.

Curr **ent capacity**: 400,000 bpd

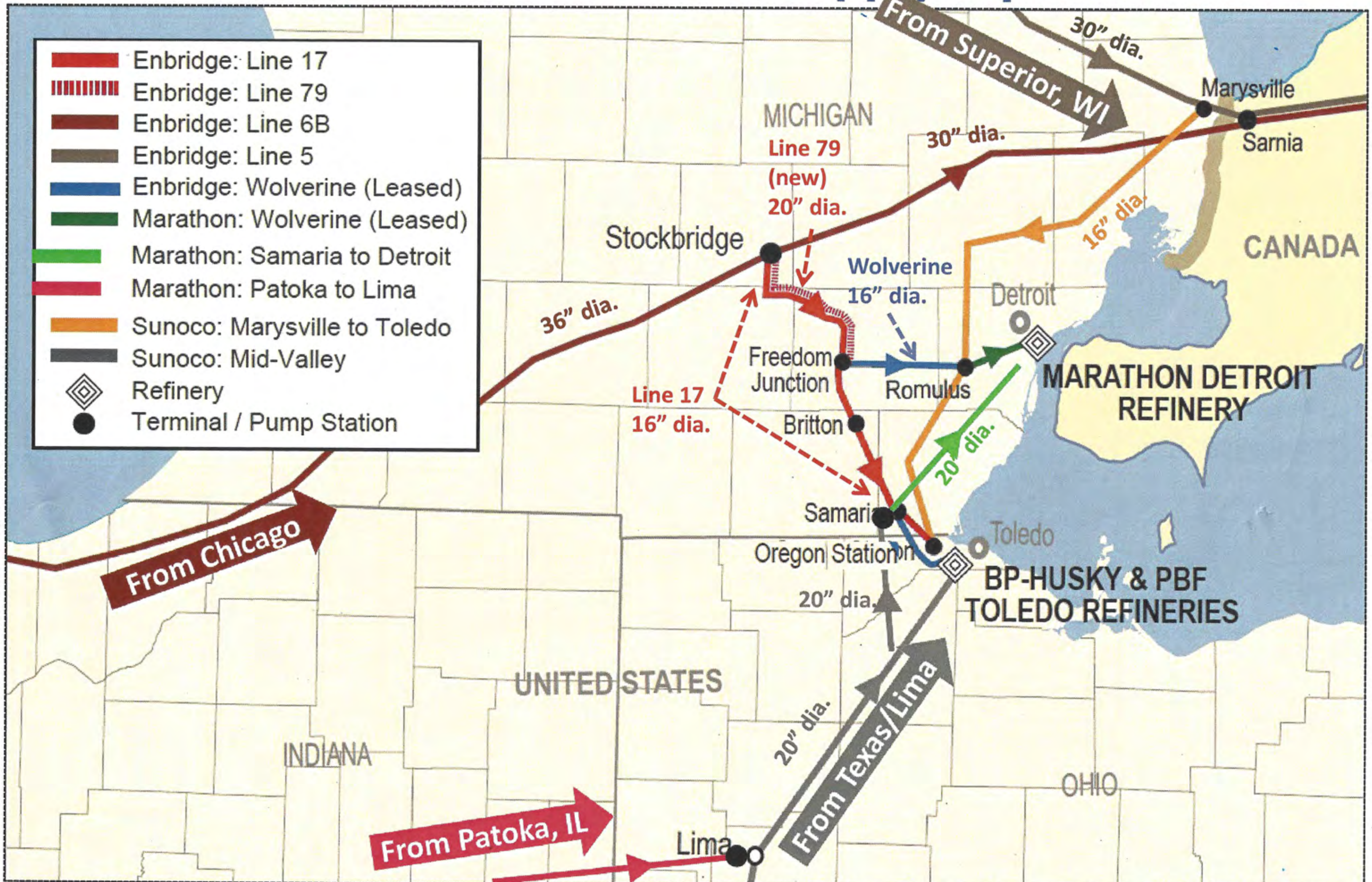
Expanded capacity: 850,000 bpd

Market : Gulf Coast

Sour **ce URL:** https://insideclimatenews.org/news/20130603/map-another-major-tar-sands-pipeline-seeking-us-permit

Links
[1] https://insideclimatenews.org/sites/default/files/assets/2013-05/OilPipelines.jpg

Detroit/Toledo Crude Oil Supply Pipelines



Source: Enbridge, MPC

Enbridge Plans $1B Plus Investment

1. 

Zacks Equity Research

May 14, 2012

Enbridge Inc. (ENB) – the general partner of Enbridge Energy Partners L.P. (EEP) – aims to expend $1.3 billion on its Line 6B in response to the surge in demand from refiners for Canadian crude.

The project involves the replacement of 160 miles of existing pipeline in Michigan as well as another 50 miles of line in Indiana. This comprises the second phase of a replacement plan of the line – stretching from Griffith, Indiana, to Sarnia, Ontario.

The first phase, comprising alternation of 75 miles of pipeline segment, is due for completion later in 2012.Line 6B was closed down for two months following a July 2010 oil spill incident that poured more than 20,000 barrels of crude oil into Michigan river.

In mid-April, Enbridge filed an application with the Michigan Public Service Commission for the replacement of 160 miles of pipeline. The altered line would encompass 110 miles of a 36-inch pipe and 50 miles of a 30-inch pipe. Additionally, 50 miles of pipeline is expected to be altered in Indiana.

Notably, the latest replacement is expected to nearly double the daily capacity of Line 6B to 500,000 barrels of crude oil from the present 240,000 barrels. This will eventually aid eastern Canadian refineries in response to growing crude supplies. The ongoing refinery upgrades and expansion in Michigan and Ohio would also lend support to the growing light crude production at Bakken Shale and Alberta.

Calgary, Alberta based Enbridge Inc. is Canada's No. 2 pipeline operator. It remains engaged in energy transportation and distribution.

Houston, Texas-based Enbridge Energy Partners is engaged in the gathering, processing and transmission of natural gas and crude oil. The partnership is best known for its ownership of the Lakehead System, one of the world's longest petroleum pipeline systems. This system is the U.S. portion of the main artery for crude oil supply from Western Canada to refining centers in the Upper Midwest of the U.S. and Ontario in Canada.

Enbridge Inc. hold a Zacks #4 Rank (short-term Sell rating) and Enbridge Energy holds a Zacks #3 Rank, which is equivalent to a short-term Hold rating.

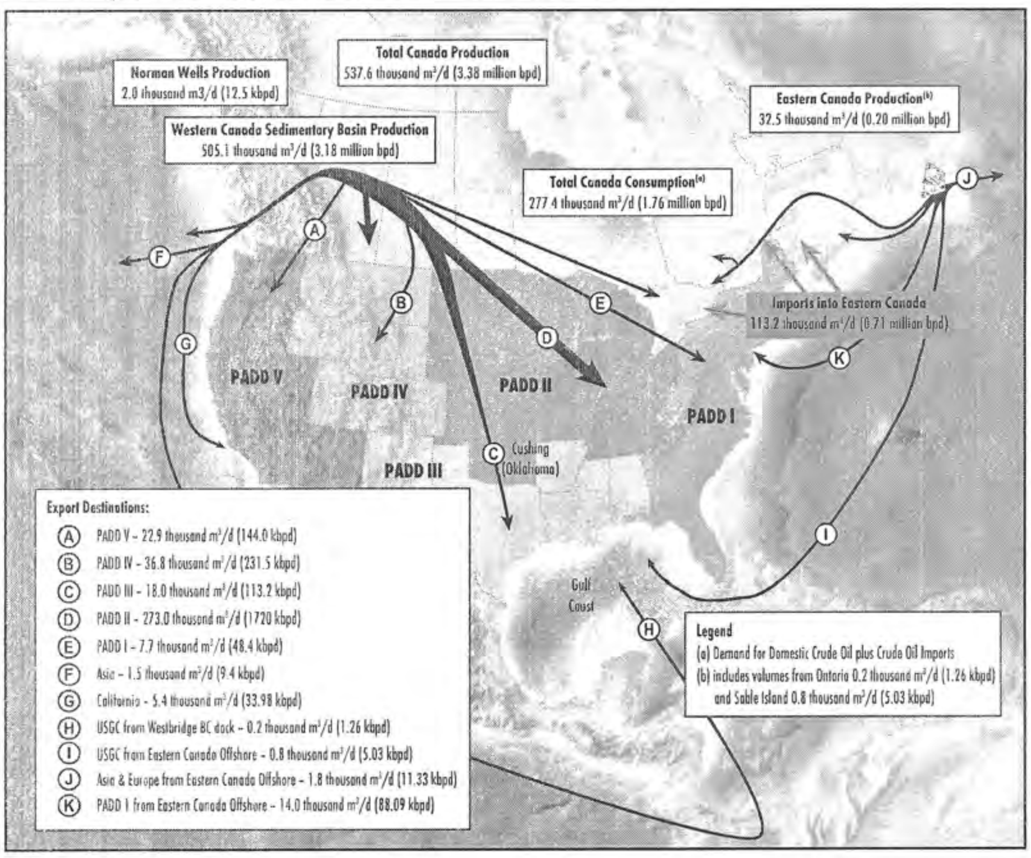
Supply and Disposition of Canadian Oil and Natural Gas

In 2012, Canada produced over 537 000 cubic meters per day (m^3/d) or 3.38 million barrels per day (MMb/d) of crude oil, most of which was shipped via pipeline from western provinces to markets in other provinces or the U.S. (See Figure 2.1)

Canadian natural gas production averaged almost 400 million m^3/d or 13.9 billion cubic feet per day (Bcf/d). The vast majority originated in Western Canada and was transported by pipelines to consumers in other parts of Canada and the U.S. as shown in Figure 2.2.

FIGURE 2.1

2012 Supply and Disposition of Canadian Crude Oil



3.1 Oil and Liquids

3.1.1 Oil and Liquids Pipelines Capacity Utilization and Apportionment

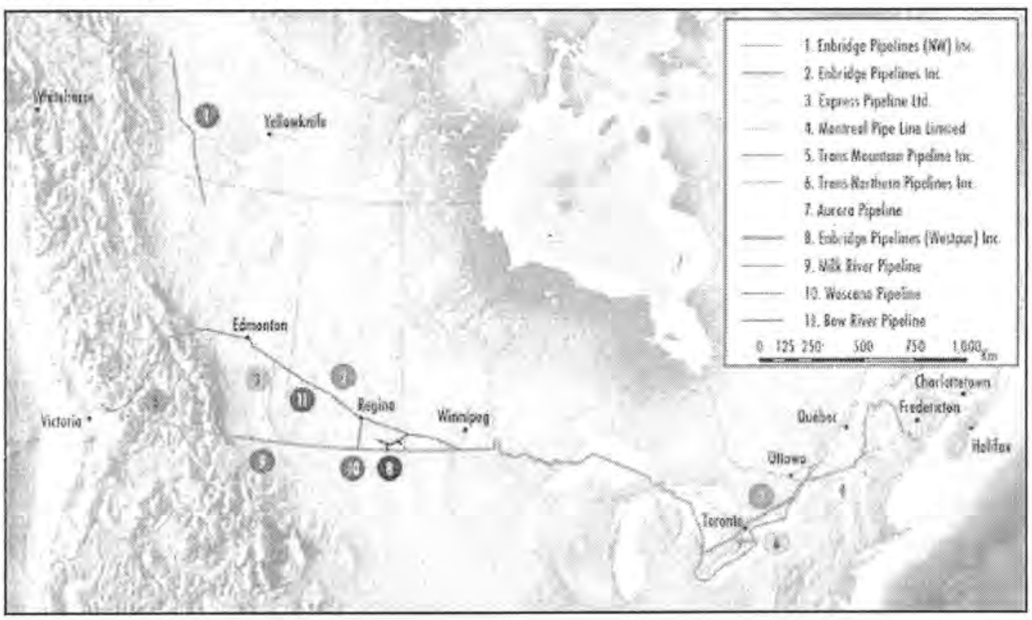
Figure 3.1 shows the major oil pipelines regulated by the National Energy Board. Some oil pipelines operate as common carriers: each month, shippers nominate volumes for delivery into the pipeline. In a given month, if shippers nominate more volume than the pipeline can transport then each shipper's nominated volume is apportioned or reduced by the same percentage. Apportionment can be driven by growing oil supply, increased oil demand, pipeline reconfigurations and reduced pipeline capacity. Recently Enbridge and Trans Mountain significantly apportioned volumes.

Some oil and petroleum products pipelines had spare capacity; however, overall capacity out of Canada was constrained as indicated by significant apportionment on the Enbridge and Trans Mountain systems. Rapid growth in Western Canadian oil sands and U.S. tight oil production created a surplus of oil in the mid continent since 2011, exacerbated by limited pipeline capacity to coastal markets. Oil pipeline capacity has recently been added out of Western Canada; however, constraints on connecting pipelines and capacity reductions on major lines limited capacity from 2010 to 2013. See Appendix 2 for detailed information on oil pipeline use and apportionment.

Rail became an increasingly important alternative method for transporting western Canadian crude oil to higher value markets. From January through November 2013, an average of 19 585 m^3/d or 123 thousand barrels per day (Mb/d) of crude oil was exported to the U.S. by rail., Most of this oil, 17 217 m^3/d (108 Mb/d), went to PADD I and PADD III. During the same period of time, 20 444 m^3/d (129 Mb/d) travelled by pipeline to PADD I and PADD III. (See Figure 2.1 for the locations of PADD I and PADD III.)

FIGURE 3.1

Major Oil Pipelines Regulated by the NEB



D-10

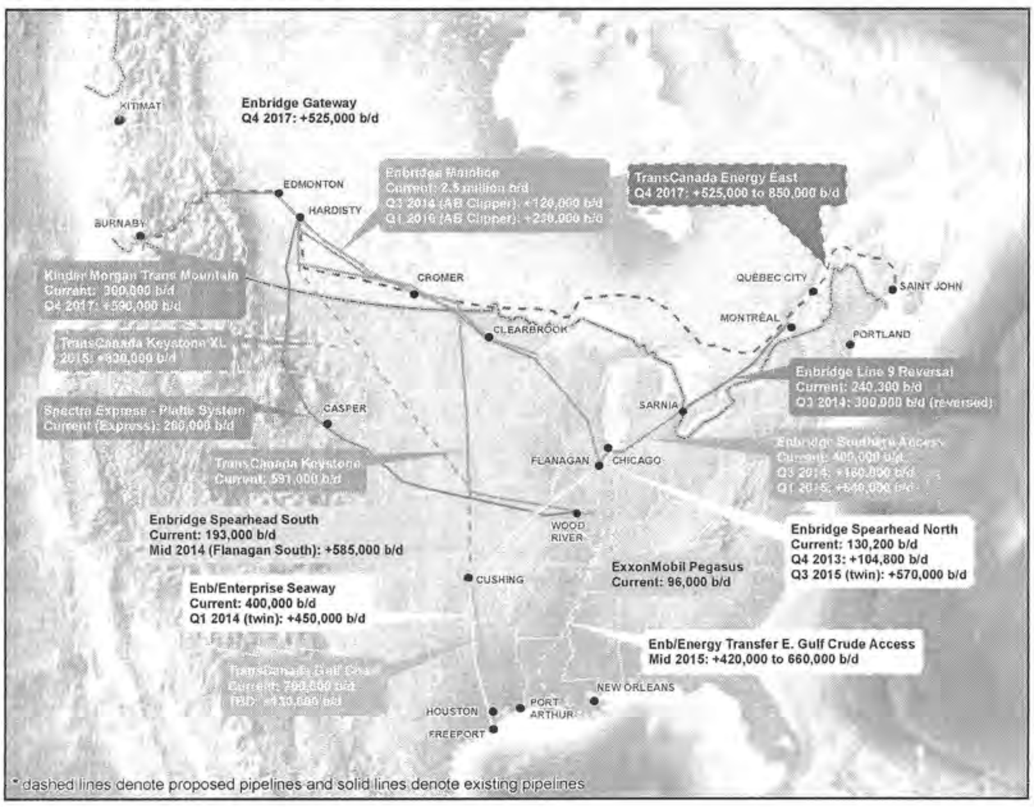
By December 2012, WTI was discounted $22 per barrel compared to Brent[4]. Edmonton Par was further discounted $12 per barrel (therefore $34 less than Brent). In February 2013, the Western Canadian Select discount from WTI reached $40 per barrel[5]. Canadian and U.S. Midcontinent crude oil prices began to increase in the second half of the year with new pipeline takeaway capacity from Cushing, increased crude-by-rail volumes, and fewer refineries undergoing maintenance. However, going into the winter season discounts began to increase again.

The price discounts on Canadian crude oils greatly exceed the cost of pipeline transportation between the markets, and generally exceed the cost of rail transportation. The tolls to ship oil from Edmonton/Hardisty to Cushing are about $5 to $6.55 per barrel, depending on type of oil and which pipeline systems are used. It costs approximately another $3 per barrel to reach the Gulf Coast from Cushing; however, some of these lines require long term committed contracts. Rail costs are roughly double or triple the pipeline tolls.

Price differentials that are higher than tolls provide an incentive to apply to build new pipeline capacity, but it takes many years from the time a pipeline is conceived of to the time it may be put into service. Figure 3.4 shows the many proposed pipelines that are in various stages of development, including the proponents' proposed in-service dates. These proposals are evidence of the market responding to the recent constraints in oil pipeline capacity.

FIGURE 3.4

Canadian and U.S. Crude Oil Pipelines and Proposals



4 Historically, WTI has traded at a slight premium to Brent.

5 Historically, Western Canadian Select has been discounted around $18 from WTI, a reflection of pipeline tolls and Western Canadian Select being heavy and sour.

ENBRIDGE

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Claudia.schrull@enbridge.com

October 22, 2014

RECEIVED
OCT 23 2014
EXECUTIVE SECRETARY

Ms. Mary Jo Kunkle
Executive Secretary
Michigan Public Service Commission
4300 W. Saginaw
Lansing, MI 48917-2171

RE: Enbridge Energy, Limited Partnership
Final As-Built Map for Line 6B (Replacement)
MPSC Docket Nos. U-17020
U-16838
U-16856
U-17478

Dear Ms. Kunkle:

Enbridge Energy, Limited Partnership ("Enbridge") hereby submits as Attachment A to this correspondence, the Final As-Built Map for Line 6B (Replacement). Through a series of replacement segments beginning in 2012, Enbridge has installed approximately 125 miles of new 36-inch diameter pipeline and 100 miles of new 30-inch diameter pipeline, all of which replace the former crude oil and petroleum pipeline known as Line 6B in the counties of Berrien, Cass, St. Joseph, Kalamazoo, Calhoun, Jackson, Ingham, Oakland, Macomb and St. Clair, in the state of Michigan.

Line 6B originates at Griffith, Indiana and extends to the east to traverse the border between Indiana and Michigan, to ultimately cross the US-Canadian International Border at Marysville, Michigan, where it terminates at an affiliated Enbridge terminal in Sarnia, Ontario.

Should the Commission or its Staff require further information or have any questions regarding this submission, I am available at the contact numbers identified above.

Very truly yours,

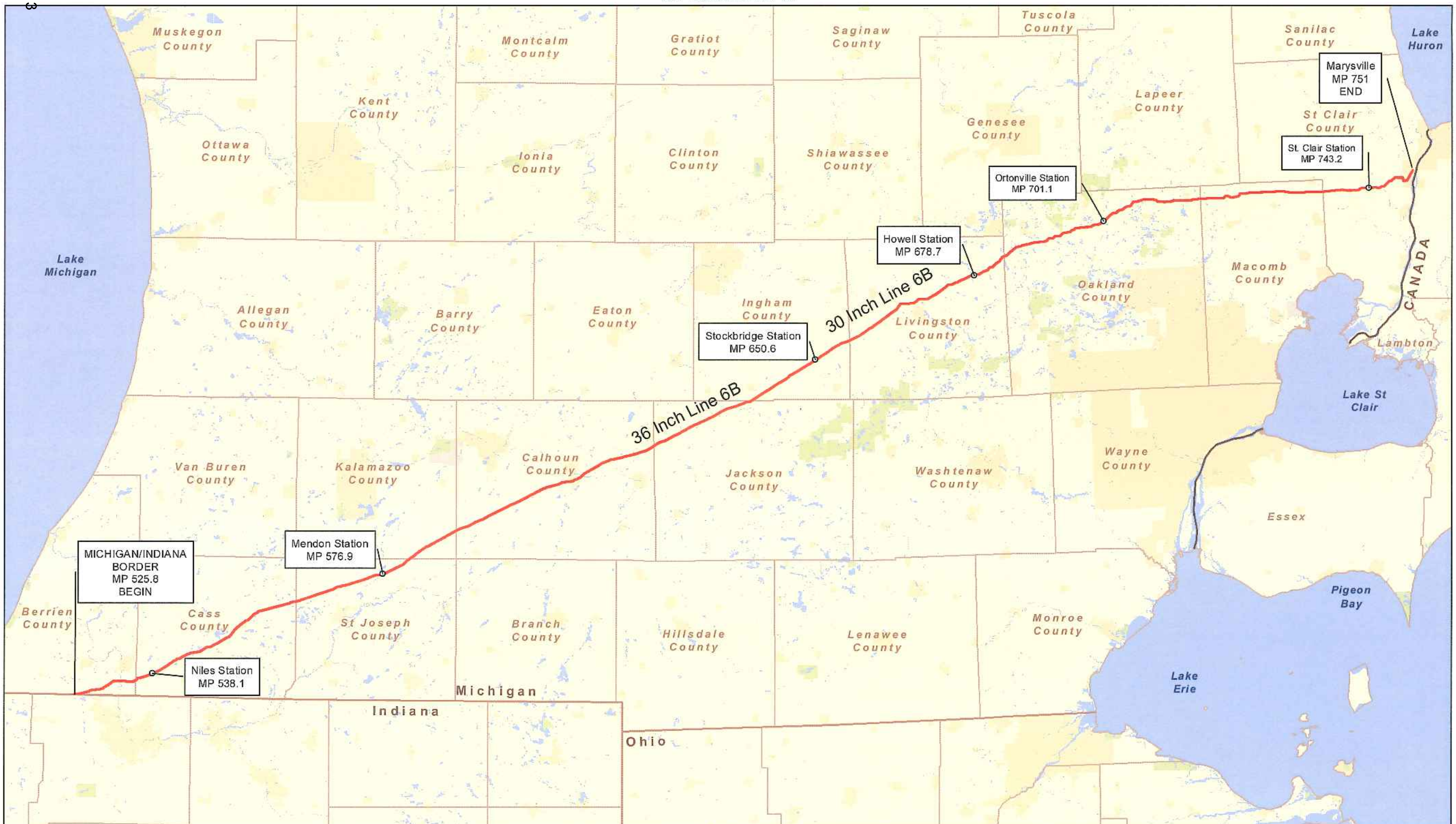
Claudia Schrull

Claudia Schrull
Sr. Manager,
Regulatory Pipeline Development
EUS Law

Attachment A: Final As-Built Map for Line 6B (Replacement)

cc: Mr. Travis Warner

ATTACHMENT A



N
W E
S

NOTES:

Legend

Line 6B As-Built Pipeline

Station Location

0 10 20 Miles

REV	DESCRIPTION	DATE
0	MPSC Submittal	10/1/2014

ENBRIDGE

Line 6B Replacement Project
Final As-Built Map

SCALE: 1 in = 13 miles | DWN BY: MLB | REV: 0

APPENDICES TO FLOW PUBLIC COMMENTS ON THE JOINT APPLICATION OF ENBRIDGE ENERGY TO OCCUPY GREAT LAKES BOTTOMLANDS FOR ANCHORING SUPPORTS TO TRANSPORT CRUDE OIL IN LINE 5 PIPELINES IN THE STRAITS OF MACKINAC AND LAKE MICHIGAN [2RD-DFDK-Y35G]

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APPENDIX E

Enbridge was violating Line 5 easement for years, documents show

Updated on June 2, 2017 at 2:20 AM
Posted on June 2, 2017 at 2:15 AM

BY GARRET ELLISON

State and federal documents indicate that for years the Enbridge Line 5 pipeline under the Straits of Mackinac was out of compliance with easement rules that govern how far the twin pipes can span the lake bottom unsupported.

Although Enbridge's 1953 easement with the state of Michigan specifies the pipeline must have anchor supports across any gaps in the lakebed span greater than 75 feet, a 2003 survey identified 16 unsupported spans greater than 140 feet, with the longest being 224 feet on the east pipe and 286 feet on the west pipe.

The 286-foot unsupported span was nearly four times the allowable length.

The unsupported spans were identified in an October 2016 engineering report prepared by Kiefner & Associates for Enbridge as part of its negotiated settlement with the federal government over the 2010 Kalamazoo River oil spill.

Line 5 inspection reports submitted to a state pipeline board also document nearly 250 instances between 2005 and the most recent inspection in 2016 where unsupported spans on the twin lines have exceeded the 75-foot mark.

Enbridge says it has anchored all previously unsupported spans, but critics say the damage may already be done and that allowing such unsupported span lengths to go unattended for years may have irrevocably compromised the structural integrity of the pipeline, which carries light crude oil and natural gas liquids.

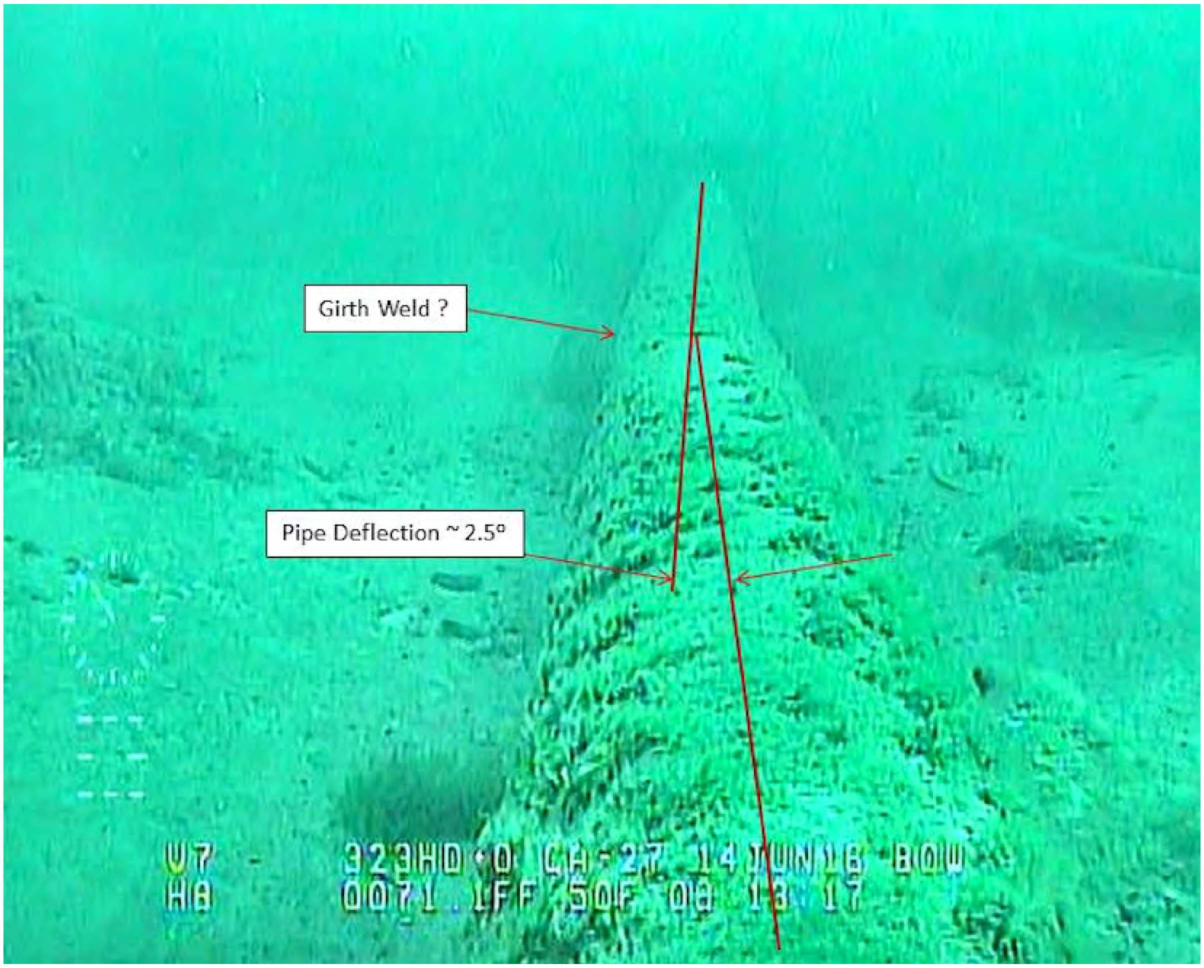
"Clearly, there was a huge period of time when Enbridge just ignored this thing," said Ed Timm, a retired Dow Chemical engineer with a PhD in fluid mechanics who authored an independent technical report on the pipeline integrity this year that was released by the National Wildlife Federation.

Timm believes the pipeline metal is worn out in historically unsupported points after being buffeted for 63 years of stronger currents in the Straits of Mackinac than Enbridge or federal regulators have previously accounted for.

In a report the state gave to independent contractors assessing the risk posed by the pipeline, Timm argued that currents near the straits bottom are higher velocity and more complex than the pipeline's original designers at Bechtel Corp. realized, and the combination of stress over time at key locations has fatigued the metal in ways that can't easily be seen or measured underwater.

Timm has spent three years studying Line 5 and claims that "based on all publicly available data" the company ignored unsupported spans of at least 150 feet until 16 years ago, meaning currents may have been hammering unanchored pipe sections of where the lakebed was washed out since it was installed in 1953.

Evidence of historic neglect in Timm's report includes a 2001 Enbridge application to the Michigan Department of Environmental Quality and U.S. Army Corps of Engineers asking for permission to place grout bags under unsupported spans of "too great a distance" in which an Enbridge engineer writes that "in order to maintain pipeline integrity and safety, these maintenance repairs can wait no longer."



Screenshot of the west leg of Enbridge Line 5 under the Straits of Mackinac that appears to show an area of bent pipe. Image from a June 2016 inspection.

Upon reviewing the June 2016 inspection video, Timm says there appears to be a section of the west pipe that is noticeably bent laterally.

Timm thinks the pipeline is "one peak current event" away from failure.

"This thing needs to be shut down and completely strip-searched with full access to Enbridge document databases so we know what's going on with this pipe," he said.

Jennifer McKay, policy specialist for Tip of the Mitt Watershed Council and member of the state's Pipeline Safety Advisory Board, said she "highly questions" the overall pipeline integrity given the unsupported spans disclosure and Enbridge's recent admission that the pipeline outer anti-corrosion coating has failed in several places.

"The lifespan of a pipeline is determined not only by how it's constructed, but by how it is operated and maintained," she said. "If it has not been properly maintained according to the design and safety specifications that were set for it, that calls into question if, in fact, that line is safe to operate currently and if there are any issues with structural integrity."

The pipeline board is holding its next meeting on June 12 at the Petoskey Middle School Auditorium. Discussion of past unsupported spans is not on the agenda, but DEQ spokesperson Melody Kindraka said "we are aware of this report and have shared it with the independent contractors who are preparing the risk and alternatives reports commissioned by the state."

Enbridge spokesperson Ryan Duffy said that inspection data "shows that the longer span lengths did not affect the integrity of the twin pipelines" in an email.

Enbridge has long argued that unsupported spans of 140-feet are safe. In the Kiefner & Associates report, the 140-foot mark is called the "criterion for taking corrective action" and characterizes the state's 75-foot requirement as "conservative."

Spans longer than 195 feet "would continue to be safe owing to several contributing factors, although it is difficult to precisely quantify the exact margins of safety offered by these factors in some cases," report author Michael Rosenfeld wrote.

Last fall, Enbridge installed four helical screw anchor supports on unsupported spans greater than 75 feet following an inspection. The company asked to install 18 more as a "proactive" measure but the state declined to allow the additional anchors, saying it wanted to wait for the conclusions in the two independent studies.

The board is awaiting the results of two state-ordered studies assessing the risk posed by the line, and alternatives to its crossing the straits bottom, which are being prepared by contractors and are expected to be released this month.

McKay said the state plans a public meeting on the draft reports on July 6.

Duffy said Enbridge is nonetheless planning to add those extra anchors.

> "It is important to point out that currently all spans along Line 5 in the Straits are in full compliance with our easement agreement with the State. We continuously monitor and inspect this section of pipe to ensure its safe and reliable operations. Engineering analysis along with inspections have proven the pipeline is safe to continue operations. This summer we are planning to add 22 more steel anchor supports proactively on Line 5 to further ensure it is secure. More than a decade ago, Enbridge hired Kiefner and Associates to conduct an engineering analysis of the spans that cross the Straits of Mackinac. Surveys conducted in 2001 and 2003 identified some sections of the pipe longer than 140 feet. All spans longer than 140 feet were corrected by Enbridge using steel anchor supports."

Sen. Gary Peters, a Michigan Democrat, introduced legislation last week with Sen. Debbie Stabenow that would tighten up pipeline safety laws by raising the insurance liability cap on Line 5 and giving the U.S. Secretary of Transportation authority to shut down a pipeline not in compliance with operating requirements.

Peters said he's "obviously very concerned" by the Kiefner & Associates report.

"Clearly, there was violations of the easement during that time," he said.

ENBRIDGE

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August 11, 2016

The Honorable Bill Schuette
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Lansing, MI 48909

Dept. of A[illegible]
[illegible]ECE[illegible]E[illegible]
AUG 12 2016
[illegible]AL RESOURCES
DIVISION

Ms. C. Heidi Grether
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Mr. Keith Creagh
Director
Michigan Department of Natural Resources
Executive Division
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Lansing, MI 48933

Dear Attorney General Schuette, and Directors Grether and Creagh:

I am writing to acknowledge receipt of your letter dated August 3, 2016 regarding the Line 5 pipelines across the Straits of Mackinac, specifically the pipeline supports, and Enbridge's compliance with the terms and conditions of the April 23, 1953 "Straits of Mackinac Pipe Line Easement" ("Easement") granted by the State of Michigan to the Lakehead Pipe Line Company, Inc., Enbridge Energy, Limited Partnership's ("Enbridge") predecessor-in-interest.

Enbridge clearly understands the requirements and conditions of the Easement agreement and takes monitoring and management of our obligations under the Easement conditions very seriously. Enbridge has and continues to take all appropriate actions to maintain compliance with the Easement. To that end, and as Enbridge informed the state in July, our biennial inspection program continues to work to assure that the pipelines are being maintained in accordance with our commitments.

In June 2016, as part of Enbridge's ongoing inspection process of Line 5 in the Straits, we conducted underwater inspections of the twin pipelines using a remote operated vehicle and an autonomous underwater vehicle. The intent of the inspections is to provide a visual, external inspection of the pipelines to identify potential areas that need additional examination or remediation.

The inspections identified four points along the crossing requiring additional support anchors in order to meet the 75 foot span reinforcement threshold defined within the Easement. The four spans meeting the threshold for anchor reinforcement were found to be slightly more than the 75-foot requirement, specifically one at 76 feet, two at 77 feet, and one at 78 feet. The current condition of those four spans was created by the normally occurring water currents at the lake bottom which shift the soils around the pipe. Importantly for safety confidence, independent engineering calculations have confirmed that spans up to 140 feet are well within safety acceptability. The remediation threshold defined within the Easement provides a safety factor of nearly double the span capability.

The inspection contractor, Ballard Marine, provided the remediation recommendation to Enbridge on July 14, 2016. Since that date, Enbridge has commenced and is diligently pursuing the work to restore the spans to below 75 feet in length. Enbridge contacted the State on July 22, 2016 regarding the results of the inspection and our plans to restore the spans to less than 75 feet. In addition to the required remediation at the four points, Enbridge will also install another 18 anchors which are not required at this time. However, we view this action as proactively addressing our long-term maintenance approach and work crews mobilized for the required work enable us to complete this additional work efficiently.

Enbridge currently is working with the Michigan DEQ to obtain the necessary permits for the identified remediation work. Once the necessary permits are approved by the state, we anticipate installation of the additional support anchors to begin either by the end of August or early September. The installation is planned to be completed well in advance to the 90-day period noticed by the state in your letter. We will notify the state in writing when the installation of the additional support anchors is complete and all easement conditions are met.

With regard to the requests stated in your letter, Enbridge agrees that we are responsible for promptly correcting any conditions and also for taking effective and reasonable measures for preventing conditions of non-compliance. In November 2014, we indicated to the state that we did not anticipate any spans being greater than 75 feet, per the easement, over the next two years. That was based on the information gathered over decades of monitoring the pipelines crossing the Straits. It is important to note that the slight exceedance beyond 75 feet at the four locations represents only a minor change in erosion pattern and is well within the safety factor that is applied within the predictive maintenance program. In other words, the changes to the lake bottom are not unusual and the remediation process continues to assure a conservative approach.

Enbridge will provide, in a separate letter, and by August 17, 2016, the inspection results of the most recent underwater inspection of the Straits pipelines. This will include, "a detailed description of the methods used to conduct the inspections, as well as findings regarding pipeline support locations, span lengths observed, and changes to the conditions reported in 2014 that have led to the current situation where four spans now exceed 75 feet." A final report from Ballard Marine will be available upon the completion of the anchor installation work, and will be made available in October.

With respect to your request for further information on the predictive maintenance model that Enbridge uses, in brief, the approach is built upon an assessment that examines the erosion trend observed over the many years of operation. For further detail on the approach, we believe that such information would be best reviewed by the state's consultant Dynamic Risk, as part of the State of Michigan review of the risks associated with pipelines crossing the Straits of Mackinac. We are prepared to provide the information you have requested; however, while some of the material you requested will be available shortly, it will not be available within the 14-day timeline you requested. Enbridge commits to providing all the requested information to Dynamic Risk, as part of their engagement, so that a thorough and comprehensive review of our investigation and mitigation process is part of their review and final report to the State.

Enbridge continues to believe that our ability to predict growth of spans is reliable, but we are enhancing our efforts to preclude spans growing to beyond 75 feet. This includes the installation of screw anchors in 2016 on several spans that currently are at approximately 60 feet in length but are not anticipated to reach 75 feet even within two years. Enbridge is also investigating performing side scan sonar of the Straits every year to ensure our approach continues to be appropriate, and that we meet or exceed the letter and spirit of the Easement Agreement.

Enbridge is committed to continuing to work with the State of Michigan on the safe, effective, and reliable operation of the Line 5 pipelines crossing the Straits of Mackinac, vital to meeting the state's energy needs and keeping the Great Lakes protected. Should you have any questions or need further information, please contact me at (952) 607-3430

Sincerely,

ENBRIDGE ENERGY, LIMITED PARTNERSHIP
By Enbridge Pipelines (Lakehead) L.L.C.
Its General Partner

Bradley F. Shamla
Vice President, U.S. Operations

8/19 - Copy to Carol
Peter

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August 17, 2016

The Honorable Bill Schuette
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Ms. C. Heidi Grether
Director
Michigan Department of Environmental Quality
Constitution Hall
525 West Allegan Street
Lansing, MI 48933

Mr. Keith Creagh
Director
Michigan Department of Natural Resources
Executive Division
525 West Allegan Street
Lansing, MI 48933

Dear Attorney General Schuette, Director Grether and Director Creagh:

I am writing to provide the additional information requested in your letter dated August 3, 2016 regarding the Line 5 pipelines across the Straits of Mackinac, specifically the pipeline supports, and Enbridge's compliance with the terms and conditions of the April 23, 1953 "Straits of Mackinac Pipe Line Easement" ("Easement") granted by the State of Michigan to the Lakehead Pipe Line Company, Inc., Enbridge Energy, Limited Partnership's ("Enbridge") predecessor-in-interest.

As committed to in our initial response letter dated August 11, 2016, attached is additional detailed information relating to the 2016 inspections. Appendix A is a detailed description of the methods used to conduct the inspection. Appendix B is the findings regarding pipeline support locations, span lengths observed, and changes to the conditions reported in 2014 that have led to the current situation where the four spans now exceed 75 feet. Appendix C is the preliminary report received July 14th from the inspection contractor, Ballard Marine.

Enbridge is committed to continuing to work with the State of Michigan on the safe, effective, and reliable operation of the Line 5 pipelines crossing the Straits of Mackinac and the protection of the Great Lakes. Should you have any questions or need further information, please contact me at (952) 607-3430.

Sincerely,

ENBRIDGE ENERGY, LIMITED PARTNERSHIP
By Enbridge Pipelines (Lakehead) L.L.C.
Its General Partner

Bradley F. Shamla
Vice President, U.S. Operations

Attachments

Attachment A: Detailed description of the methods used to conduct the inspection:

Before Autonomous Underwater Vehicle (AUV) and Remotely Operated Vehicle (ROV) calibration and inspections operations took place, a Real Time Kinematic Global Positioning System (GPS) base station was setup on shore to provide high accuracy position updates for use by all on-water equipment used during the inspection process, to ensure that the highest level of positioning accuracy possible could be obtained. After setup, the accuracy of the base station was confirmed (through comparison with another known GPS point) to be within 0.03' both horizontally and vertically, verifying proper setup and data input.

Once the base station was established, on-water AUV calibration, or Patch Testing, was performed. The AUV was sent out to collect data at different locations, water depths and bottom types (including sand vs. clay and flat vs. sloped bottoms). After several hours of data collection, all the data was processed to allow for the insertion of correct offsets into the equipment's software. That process ensures that the raw data collected during the actual inspection operations will be of the highest accuracy level possible for the equipment being used.

Following calibration activities, AUV inspection operations began. The AUV was equipped with GPS, underwater positioning equipment, a water sensor (capable of collecting water temperature, pressure, salinity, conductivity, and speed of sound) and fully operational multi-beam, side scan, and forward-looking sonar systems. The AUV has built-in survey software capable of being pre-programmed with the current known pipeline locations and depths for mission planning. Following launch, the AUV traversed over top of the exposed pipelines plus a minimum of 100' north and south of the last exposed portion of each pipeline, at a height of approximately 20' to 25' above the pipelines and lake bottom. The AUV survey crew followed the AUV, in a boat, from one side of the crossing to the other, remaining in constant communication with the vehicle and relaying real time position updates received for the GPS base station to ensure the highest level accuracy. At the end of each day, all data was reviewed for accuracy and completeness. The 2016 inspection consisted of 14 passes made along the two pipelines (7 passes per line), with 12 (6 per line) of the 14 passes performed at a low altitude (20' to 25') for the collection of multi-beam and side scan data collection and 2 (1 per line) of the 14 passes at high altitude (65' to 100') for additional multi-beam and water column data collection.

Following the AUV survey operations, the ROV was placed into service. The ROV system, equipped with underwater positioning sensors, lights, and cameras was calibrated by traversing the ROV to a known pipeline anchor location and verifying the ROV's position against the known position of the anchor. The ROV was then driven to a second anchor location for position verification.

Once position information of the ROV system was verified to be accurate, the ROV, operated from the top-side survey vessel, began traversing along the pipeline. In areas where the pipelines were buried, the ROV traveled along the coordinates as displayed in the real time data positioning software for the pipeline's route. The intent of the ROV inspection was to visually observe the pipelines for items or areas of concern that may be visually apparent; to inspect the overall outside condition of the pipeline; to inspect all support anchors installed on the pipeline to ensure their integrity; and to make general visual observations of the pipelines and their surroundings. Any spans which were determined to be close to or in excess of 75' were inspected in greater detail with both crude oil and NGL batches in the pipeline, to ensure consistent results with varying specific gravity of the fluid being shipped, to verify maximum span length. During the ROV inspection process, video and positioning information was recorded at all times. Noteworthy items in close proximity to the pipe or abnormal pipeline conditions were subjected to a more detailed examination.

For the 2016 ROV inspection, the east and west legs of the pipeline were surveyed from south to north, with the east leg being inspected first.

Appendix B: Findings regarding pipeline support locations, span lengths observed, and changes to the conditions reported in 2014 that have led to the current situation where the four spans now exceed 75 feet:

Evaluation of each instance where pipeline spans were in excess of the 75' Easement-specified limit found that the span length change was attributed to a combination of lake-bottom sand movement and improvements in the inspection accuracy.

Span W-5: Between 2014 and 2016, comparison of inspection results indicated that this span grew from a length of 71' to 78'. The north end of the span was secured by a hill on the lake bottom, while the southern exposure that previously displayed shadowing beneath the pipe was found to increase.

Span W-53A: Between 2014 and 2016, comparison of inspection results indicated that this span grew from a length of 69' to 77'. The north end of the span was secured by an anchor, which prevented any future growth at this location. A reduction of support was observed at the south end of the span where shadowing beneath the pipe had previously been observed.

Span W-69: Between 2014 and 2016, comparison of inspection results indicated that this span grew from 64' to 77'. Shadowing previously observed on both ends of the span were confirmed in this inspection to represent a slight reduction in support, and hence, growth of the span.

Span E-39: Between 2014 and 2016, comparison of inspection results indicated that this span grew from 63' to 77'. The south end of the span was deemed to be well supported by the lake bed topography, while the northern exposure that previously displayed shadowing beneath the pipe was found to increase.

Enbridge Pipelines

Final Report No. 16-154

Assessment of Span Exposures on the 20-inch Petroleum Pipelines Crossing the Straits of Mackinac

Michael Rosenfeld, P.E.

October 12, 2016

Kiefner

0023-0303

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Final Report No. 16-154

Final Report

on

ASSESSMENT OF SPAN EXPOSURES ON THE 20-INCH PETROLEUM PIPELINES CROSSING THE STRAITS OF MACKINAC

to

ENBRIDGE PIPELINES

October 12, 2016

Prepared by

Michael J. Rosenfeld, P.E.
Chief Engineer

Approved by

Benjamin Zand, PhD, P.E.
Principal Engineer

Kiefner and Associates, Inc.
4480 Bridgeway Avenue, Suite D
Columbus, OH 43219

0023-0303

DISCLAIMER

This document presents findings and/or recommendations based on engineering services performed by employees of Kiefner and Associates, Inc. The work addressed herein has been performed according to the authors' knowledge, information, and belief in accordance with commonly accepted procedures consistent with applicable standards of practice, and is not a guaranty or warranty, either expressed or implied.

The analysis and conclusions provided in this report are for the sole use and benefit of the Client. No information or representations contained herein are for the use or benefit of any party other than the party contracting with Kiefner. The scope of use of the information presented herein is limited to the facts as presented and examined, as outlined within the body of this document. No additional representations are made as to matters not specifically addressed within this report. Any additional facts or circumstances in existence but not described or considered within this report may change the analysis, outcomes and representations made in this report.

This report issued as a Final Report in 2016 describes work performed by Kiefner in 2003 and 2004 and reported in Draft form in January 2005. Data, regulations, and other input discussed herein were the most recent available at the time the work was performed. Data, regulations, and other input developed or revised subsequent to the 2005 Draft report are not accounted for and could change the analysis, outcomes, and representations made in this report.

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Assessment of Span Exposures on the 20-inch Petroleum Pipelines Crossing the Straits of Mackinac

M. J. Rosenfeld, PE

INTRODUCTION

Enbridge Pipelines operates two 20-inch OD pipelines that cross the Straits of Mackinac 1.5 miles west of the Mackinaw Bridge. The pipelines, which were constructed in 1953, are part of a system that transports petroleum products from Superior, Wisconsin to Sarnia, Ontario.

Enbridge has periodically conducted subaquatic inspections to monitor the condition of the pipelines. The most recent inspection prior to the preparation of this report was during the summer of 2001. The inspection revealed a number of areas where scouring effects from water currents caused sections of the pipelines to span freely above the bottom. Several sections were determined to have lengths in excess of the 75 ft limit specified in the original easement granted by the State of Michigan in 1953.

Enbridge took prompt action to correct several of the longer spans, and is continuing to develop technical criteria and identify effective means to remediate other spans. At the request of Enbridge, in 2003 and 2004 Kiefner & Associates, Inc. (Kiefner) undertook a study of the following matters:

- the applicable regulations, industry standards, and original construction documents pertaining to the Straits crossings;
- the extent to which spans in excess of the 75-ft limit could be permitted while assuring continued safe operation of the pipelines and compliance to applicable regulations and standards;
- the effect of operating conditions on the spans;
- available options for supporting spans; and
- susceptibility to vibration induced by vortex-shedding.

CONCLUSIONS

Codes, Standard, and Regulations

From a review of applicable pipeline regulations and industry standards, it is clear that the Straits crossings fall within the scope of US Federal pipeline safety regulations. The crossings share all the physical attributes of offshore pipelines in terms of their method of construction as well as the loading and operating environment. For this reason, an offshore pipeline technical standard is the most appropriate place to seek technical guidance on matters such as allowable working stress levels. The offshore section of ASME B31.4 was recommended by convention. Chapter IX therein recommends maximum longitudinal stresses of 80% of specified minimum yield strength (SMYS), and maximum biaxial combined stresses of 90% of SMYS. An alternative criterion for noncyclical displacement-controlled loadings is also permitted. While a strain-based criterion remains a technically feasible option, it has not been recommended because insufficient data concerning material and weld strain capacity is available to develop a criterion having a known degree of conservatism.

Engineering Analysis of Spans

Engineering studies carried out by the original design team for Bechtel (1951) were reviewed in detail. An independent analysis was carried out in conjunction with this study as well. The two studies used similar parameters for static and live loadings on the pipeline. The original design observed an allowable stress criterion of 60% of SMYS, and then adopted an allowable span length for construction of 75 ft corresponding to a stress level of about half this limit. The current study determined that a longitudinal tensile stress limit of 80% of SMYS, used for offshore pipelines, was appropriate and safe. Spans of between 155 ft and 195 ft in length (depending on operating temperature conditions) could meet this limit. Based on these results, it appears that spans longer than 75 ft as specified in the original right of way easement granted by the State of Michigan could be safely permitted.

A span of 140 ft was established by Enbridge as a criterion for taking corrective action. Engineering analyses performed with this study confirmed that Enbridge's criterion safely allows for span growth beyond the original 75-ft specification over time and is conservative for all operating conditions. Spans longer than the 155 to 195 ft limit would continue to be safe owing to several contributing factors, although it is difficult to precisely quantify the exact margins of safety offered by these factors in some cases. Factors that contribute to additional margins of safety include the fact that the allowable longitudinal stress level provides by definition a minimum factor of safety of 1.25 against failure; the pipe and weld materials tend to have greater actual strength than the minimum specified quantities; pipe may potentially have heavier wall thickness than specified; very long spans tend to eventually "touch down" on the

Straits bottom (thereby becoming supported for any continued growth of the span); and the line sometimes transports product (NGL) having a lower density than what was assumed in the analysis (crude oil). The conclusion that longer spans can remain safe is logically supported by recognition that longer spans have historically occurred with no apparent distress to the pipeline, although Enbridge prudently took steps to correct spans in those instances.

Effects of Operating Conditions

Some relief of span sag during the installation of supports would be beneficial because it would immediately transfer some load to the supports. Relief may be accomplished by lifting the line prior to support installation, or by installing supports that provide a jacking or lifting function after installation. Without some means of preloading, the supports do not become effective for reducing sag-induced stresses until the spans extend in length through a continued bottom scour process. However, they will help mitigate vortex-induced vibration without preload.

There is no benefit to reducing the operating pressure during the support installation process from the standpoint of stresses due to internal pressure, because those stress components are too small to make a significant difference. Shutting in flow could reduce span sag due to the line cooling down, but this runs the risk of increasing stress levels in the spans until the supports are installed and flow is restored. Therefore, shutting in the line while the supports are being installed is not preferred. Switching over to natural gas liquids (NGL) will yield only a relatively small change in the sag if the transporting temperature of the NGL is as warm as the crude oil. If the NGL runs cooler than the crude oil, the combination of lower pipe temperature and reduced span weight could reduce span sag so as to make the supports at least partially effective at the present span lengths when crude oil is being transported. The most optimal situation, solely from the standpoint of immediate effectiveness of the supports, is to take the line out of service, including clearing the pipe of product contents. This study did not evaluate the impact of this strategy on operation.

Support Options

Several proven techniques for supporting spans in submerged pipelines were reviewed. Recommendations are as follows for mitigating the spans on the Straits crossings: grout bags for low-clearance spans; screw anchors with mechanical clamps for high-clearance spans; and rock-dumping for permanent system-wide mitigation. An analysis of local stresses in the pipe wall associated with mechanical support clamps determined that the stresses are not excessive.

Vortex-Induced Vibration

A simplified analysis for vibration induced by vortex-shedding was conducted. At water velocities of 2.3 ft/sec or less, which encompasses almost all periods of operation, the flow regime is subcritical (either laminar or transitional) with a periodic wake. The pipe spans are therefore subjected to alternating lift and drag forces having a frequency between 0.04 and 0.77 Hz. Critical span lengths were determined based on the span structural frequency being sufficiently close to the vortex-shedding frequency for vortex "lock-on" to occur. Critical span lengths vary inversely with the water velocity. The critical span lengths for the water velocities where the flow regime produces a periodic wake, up to 2.3 ft/sec, are 140 ft or longer, so vortex-induced vibration (VIV) considerations appear not to be limiting. At the water current velocities expected, drag-induced forces on the span are very low compared to the buoyant weight of the pipe.

RECOMMENDATIONS

Based on considerations for static stresses and susceptibility to vibration induced by vortex shedding, a maximum free span of 140 ft is recommended. Longer spans do not appear to jeopardize the safety of the pipeline, but the stresses would be in excess of conservative levels derived from design code limits.

The rate at which individual spans increase in length or adjacent spans coalesce to form longer spans over time remains unknown. In order to avoid frequent span remediation efforts due to span growth or coalescence processes, spans that occur in series with other spans nearby should be targeted for support even if they are shorter than 140 ft. Annual or biennial bathymetric (bottom) inspections should be undertaken in order to determine span growth rates and identify locations that are susceptible to rapid span formation.

BACKGROUND

Description of the Pipelines

The Straits of Mackinac Crossing is comprised of two individual 20-inch outside diameter (OD), 0.812-inch wall thickness (WT) pipelines. The crossing was constructed in 1953 using Grade A seamless line pipe having an SMYS of 30 ksi and specified minimum tensile strength of 48 ksi, in accordance with the contemporaneous edition of API 5L[1]. The actual yield strength of pipe joints based on mill tests varied from 30 ksi to 44 ksi, with an average of 37 ksi.[2] The construction specifications called for using the lowest strength joints at the deepest elevations in order to take advantage of their perceived greater ductility.

The pipelines were constructed on shore, and the constructed string of pipe floated out and was lowered into place. The pipelines were hydrostatically tested in place at a pressure of 1,200 psig, corresponding to a hoop stress of 49% of SMYS (without correcting for external pressure), for a period of 10 hours.[2]

Pipe joints were welded using the shielded-metal arc welding (SMAW, or stick welding) with E6010 coated electrodes. The construction of the line occurred at about the same time as the first publication of API 1104. Procedure and welder qualification standards and production workmanship standards applied to the construction were generally similar to those of modern editions of API 1104. Pipe chemistry was limited to 0.24 C, 0.90 Mn, 0.045 Ph, and 0.06 S, by weight percent.[2]

The maximum operating pressure (MOP) of each line is 600 psig, corresponding to a hoop stress of 7,389 psi, or 24.6% of SMYS, without correcting for the external pressure associated with the pipeline's submerged depth. The normal operation is at pressures up to 280 psig, with a correspondingly reduced hoop stress level.

The products transported by the lines are crude oil and natural gas liquids (NGL) having specific gravities of 0.868 and 0.547, respectively. The pipes are coated with asphalt primer, fiberglass matting, and asbestos felt in a net thickness of 1.25 inch and having a specific gravity of 1.28. The buoyant (submerged) weight of the lines is 140.3 lb/ft when transporting crude oil, or 103.4 lb/ft when transporting NGL.

The Straits crossing is approximately 5 miles in length, extending from Point La Barbe on the north side to McGulpin Point on the south side of the Straits. The pipelines are located in the pipeline corridor indicated in Figure 1. The direction of flow is from north to south. The two lines are approximately 1,300 ft apart and situated approximately 1.3 miles west of the Mackinaw Bridge. The maximum depth of the crossing is approximately 250 ft. Limited current velocity data indicates currents are 2 knots (1.7 ft/hr). Enbridge is in the process of obtaining additional current velocity data.

The product temperature in the line varies seasonally between 39 F (4 C) and 61 F (16 C). The water temperature varies seasonally and with depth due to stratification and turnover phenomena. Deepwater temperatures vary from 39 F (4 C) to 43 F (8 C), while shallow water temperatures vary over a wider range. The differential between pipeline operating temperature and ambient deepwater temperature are the least in the winter and the greatest in the summer. The temperature difference is expected to vary between 0 F and +20 F, with the pipeline operating warmer than the water.

The lines were buried in a trench at shore approaches out to water depths of 85 ft. (The right of way easement granted by the State of Michigan specified burial to a water depth of only 50 ft.[3]) Where water depths exceeded 85 ft, the lines were laid on the Straits bottom without cover. Due to natural variations in bottom elevation, the pipelines were installed with some free spans of up to 75 ft in length. The minimum radius of curvature was specified to be 1,350 ft, corresponding to an elastic bending strain equal to 0.062% and an elastic bending stress equal to 18.3 ksi or 61% of SMYS. The bottom profiles of the East and West lines are shown in Figure 2.

Recent Assessments

Enbridge has conducted several subaquatic surveys of the condition of the pipelines. Surveys were conducted in 2001 and 2003 by Onyx Superior Special Services, Inc. consisting of side-scan and multi-beam sonar, followed by video examination by remotely operated vehicle (ROV).[4] The sonar imaging revealed the locations and free lengths of exposed spans on the Straits bottom. The 2003 survey identified 7 spans longer than 140 ft in the east leg, with the longest being 224 ft, and 9 spans longer than 140 ft in the west leg, with the longest being 286 ft (due to a failed grout bag support). Both lines exhibited about the same number of spans and distribution with respect to span length. All spans longer than 140 ft were corrected by Enbridge using screw anchor supports.

CODES, STANDARDS, AND REGULATIONS

Federal Pipeline Safety Regulations

Federal regulations set forth in 49 CFR Part 195[5] ("Part 195") provide safety standards for pipelines used to transport hazardous liquids. Enbridge's pipelines crossing the Straits fall within the scope of Part 195. A number of clauses in Part 195 apply to the Straits pipelines, while some others might be incorrectly interpreted as being applicable. These will be reviewed in the following section.

<u>Are the Straits crossings "offshore" pipelines?</u>

The first question is whether or not the Straits crossings are "offshore pipelines" under the regulations. Subpart A – General, 195.2 Definitions states:

> "*Offshore* means beyond the line of ordinary low water along that portion of the coast of the United States that is in direct contact with the open seas and beyond the line marking the seaward limit of inland waters."

This clause perhaps did not contemplate a crossing of the Great Lakes, even though such a crossing would possess all the physical attributes of an offshore pipeline in terms of its construction and its loading environment. If one interprets "open seas" to mean "open waters", the foregoing definition would readily apply to the Straits crossings. Note that although Part 195 defines "offshore", nowhere does it require observance of a particular design code for offshore pipelines, nor does it establish minimum requirements with respect to safety that differ substantially from those for onshore pipelines, except for those of a practical matter (e.g., pipeline marking or underwater surveys).

<u>What design requirements apply?</u>

The Straits crossings were constructed prior to development of Part 195. Under Subpart C – Design Requirements, Paragraph 195.100 states:

> "This subpart prescribes minimum requirements for new pipeline systems…and for relocating, replacing, or otherwise changing existing systems".

> Under Subpart D – Construction, Paragraph 195 states:

> "This subpart prescribes minimum requirements for constructing new pipeline systems… and for relocating, replacing, or otherwise changing existing systems".

Consistent with the approach adopted by most technical codes, this clause refrains from imposing new design or construction requirements on an existing facility that remains essentially unaltered, such as the Straits crossings.

> Under Subpart E – Pressure Testing, Paragraph 195.302 states:

> "(b) Except for pipelines converted under 195.5, the following pipelines may be operated without pressure testing under this subpart: (1) Any hazardous liquid pipeline whose maximum operating pressure is established under 195.406(a)(5) that is – (i) An interstate pipeline constructed before January 8, 1971;"

> Paragraph 195.406 then states:

> "(a) Except for surge pressures and other variations from normal operations, no operator may operate a pipeline at a pressure that exceeds any of the following: … (5) For pipelines under 195.302(b)(1)… that have not been pressure tested under subpart E of this part, 80 percent of the test pressure …to which the pipeline was subjected for 4 or more continuous hours…"

The Straits crossings meet the requirements of 195.302 and 195.406.

The safety requirements under Part 195 applicable to the existing Straits crossings are found primarily under Subpart F, Operations & Maintenance. Hence, the application to an existing facility of standards of a design nature that might be applied to new facilities today remains discretionary on the part of the operator where doing so makes sense.

<u>What allowable stress limits apply?</u>

The only maximum allowable stress levels prescribed by Part 195 are those pertaining to the hoop stress due to internal pressure. There are no maximum allowable levels specified for longitudinal stresses caused by deadweight, thermal expansion, or external loadings acting on the pipeline. Paragraph 195.110 External Pressure states:

"Anticipated external loads (e.g.), earthquakes, vibration, thermal expansion, and contraction must be provided for in designing a pipeline system. In providing for expansion and flexibility, Section 419 of ASME B31.4 must be followed."

A review of the original design documents, to be discussed subsequently, indicates that the expected external loads, such as deadweight and water currents, were considered in detail during the design process.

The provision cited above to follow Section 419[6] deserves discussion because it is sometimes incorrectly applied to pipelines in situations for which it was not intended. Section 419 applies specifically to piping systems where flexibility for absorbing thermal expansion is provided by means of bends, expansion loops, or offsets. The Straits crossing was not constructed in this fashion. It is essentially an axially restrained pipeline with some number of exposed, freely spanning sections. The present-day version of ASME B31.4 recognizes that there is a fundamental difference between piping systems constructed so as to be flexible and those that are not, and specifies differing allowable stress levels accordingly. It also recognizes that exposed spans may be present in otherwise restrained systems and that they should be treated similarly to the balance of the buried pipeline, with the addition of bending stresses due to spanning. These concepts are expressed in paragraph 419.6.4(a):

"There are fundamental differences in loading conditions for the buried, or similarly restrained, portions of the piping and the aboveground portions not subject to substantial axial restraint. Therefore, different limits on allowable longitudinal expansion stresses are necessary."

In any case, the requirement in 195.110 that Section 419 be followed does not apply to the crossings.

<u>What operational provisions apply?</u>

The provisions of operation and maintenance apply to any existing facility, in general. Subpart F – Operation and Maintenance, Paragraph 195.401(b) states:

"Whenever an operator discovers any adverse condition that could affect the safe operation of its pipeline system, it shall correct it within a reasonable time."

This could apply to a situation where, in Enbridge's judgment, the exposed span lengths become excessive. However, Part 195 gives no specific guidance on determining what is "safe". Subpart B – Reporting Accidents and Safety-Related Conditions, Paragraph 195.55 states:

"…each operator shall report … the existence of any of the following safety-related conditions involving pipelines in service:…(2) unintended movement or abnormal loading of a pipeline by environmental causes, such as an earthquake, landslide, or flood, that impairs its serviceability."

This clause goes a step farther than 195.401(b). It would require Enbridge to report conditions involving spans where, in Enbridge's judgment, the stresses exceed reasonably safe levels, or if significant dislocation of the pipelines were evident.

INDUSTRY STANDARDS

ASME B31.4 is an industry consensus safety standard. It is an engineering and technical standard that provides design criteria based on simplified engineering concepts. Chapter I Scope and Definitions, Paragraph 400(b) states:

> "Requirements for all abnormal or unusual conditions are not specifically provided for."
>
> Paragraph 400(e) states:
>
> "It is intended that a designer capable of applying more complete and rigorous analysis to special or unusual problems shall have latitude in … the evaluation of complex or combined stresses. In such cases, the designer is responsible for demonstrating the validity of his approach."

These provisions clearly communicate the latitude for Enbridge to apply methods and criteria that may not be spelled out in detail in the Code, or that are alternative to those in the Code, along with the need to meet the intent of the Code insofar as safety is concerned and to exercise sound engineering judgment.

> Paragraph 400(f) states:
>
> "This Code shall not be retroactive or construed as applying to piping systems installed before date of issuance … insofar as design, materials, construction, assembly, inspection, and testing are concerned. It is intended, however, that the … Code shall be applicable … to the relocation, replacement, and uprating or otherwise changing existing piping systems; and to the operation, maintenance, and corrosion control of new or existing piping systems."

Like the Federal regulations, this means that current requirements of a design matter are not retroactive on existing pipelines systems, though current operations and maintenance requirements apply to all pipelines regardless of installed date.

Are the Straits crossings "offshore" pipelines?

Paragraph 400.1.1 states: "Requirements for offshore pipelines are found in Chapter IX." This indicates that certain requirements apply separately to pipelines constructed offshore. ASME B31.4 comprises a main code body applicable to pipelines in general but usually taken to apply to those located on shore, along with an "offshore chapter" (Chapter IX, Offshore Liquid Pipeline Systems) containing exceptions or additional requirements as befitting the unique aspects of pipelines located offshore. A definition for "offshore" is found in ASME B31.4, Paragraph A400.2, that is similar to the one found in Part 195. Based on the characteristics of the pipeline, where it is located, and the environment it operates in, it is logical to consider the Straits crossings to be "offshore" pipelines rather than "onshore" pipelines that happen to cross a lake.

Other standards exist for offshore pipelines internationally which could be applicable from a technical standpoint. Although there is no regulatory requirement to use ASME B31.4, it would be a logical code choice since B31.4 embodies technical concepts and practices observed by the US pipeline industry and the Straits crossings are located in US waters.

What design requirements apply?

The "onshore" portion of the Code contains provisions to consider hazards from the effects of ambient loadings, such as waves or currents acting on a pipeline crossing a waterway, which could be applied in a general sense to an offshore pipeline as well. However, the offshore chapter addresses the specific concerns for offshore pipelines more directly. Paragraph A401 Design Conditions lists design conditions to be considered for offshore pipelines, including installation (buoyancy, external pressure, laying); environmental loads (waves, currents, ice); and operational loads. These are, for all practical purposes, the same technical considerations applicable to the Straits crossings. Conversely, many of these items are of no concern to a pipeline buried onshore. The offshore chapter more clearly articulates the maximum longitudinal stress levels, and it is no less conservative than the "onshore" part of the Code unless the option to use plastic design concepts is chosen. It would therefore make a better choice from a technical standpoint for addressing the concerns with the Straits crossings than the "onshore" part of the Code.

What allowable stress limits apply?

> Paragraph A402.3.5(a)(2) Longitudinal Stress states:
>
> "For offshore pipeline systems, the longitudinal stress shall not exceed values found from $S_L < F_2 S_Y$."

The term S_L is the absolute value of the longitudinal stress calculated as the sum of axial and longitudinal bending (either tensile or compressive values, whichever gives the higher stress). From Table A402.3.5(a), F_2=0.80, so $S_L \leq$ 80% SMYS. A402.3.5(a)(3) Combined Stress states:

> "For offshore pipeline systems, the combined stress shall not exceed the value given by … $< F_3 S_Y$."

The combined stress is the effective biaxial tensile stress, computed in accordance with either the Maximum Shear (Tresca) Theory or the Distortion Energy (von Mises) Theory. The calculation must consider both tensile and compressive axial and bending components. From Table A402.3.5(a), F_2=0.90, so $S_e \leq$ 90% SMYS.

A third criterion is worth noting, though for conservatism it is not suggested that it be applied in this situation. Paragraph A402.3.5(a)(4) Strain states:

> "When the pipeline experiences a predictable noncyclic displacement of its support (e.g. fault movement along the pipeline route or differential subsidence along the line) or pipe sag before support contact, the longitudinal and combined stress limits may be replaced with an allowable strain limit, so long as the consequences of yielding do not impair the serviceability of the installed pipeline. Where plastic strains are anticipated, … the ability of the weld to undergo such strains without detrimental effect should be considered."

This clearly gives the latitude to exceed the stress limits in A402.3.5(a) and work toward a strain limit instead. A common strain limit used in new construction is 2%. New revisions to the ASME gas pipeline code (B31.8) will allow that for onshore pipelines, and it has been a feature in foreign pipeline codes for many years. One application for this in the Straits crossings is curvature-induced stress imposed by installation settlement of the pipeline onto the Straits bottom, as inferred from in-line inspection. Another would be for exposed spans where the pipe is sagging onto the bottom. A key consideration in developing a strain limit is the quality and properties of the girth welds.

<u>What were the original design requirements?</u>

On a historical note, the 1953 piping code[7] prescribed minimum requirements for various types of piping systems. Section 3 – Oil Piping prescribed requirements for materials selection, pressure design (e.g. allowable hoop stress and minimum wall thickness), hydrostatic testing, and pressure-temperature ratings for valves and flanges. Hoop stress due to internal pressure was limited in API 5L Grade A seamless to a value of 25,500 psi, or 85% of SMYS, computed considering the minimum wall tolerance for the specified pipe product. The hydrostatic test requirement was the greater of 1.25 times the maximum operating pressure or 1.1 times the maximum surge pressure, except that neither the hoop stress from the test pressure nor the biaxial stress were permitted to exceed 90% of SMYS, computed considering the full wall thickness less the manufacturing tolerance. Section 3 imposed no specific allowable longitudinal stress limits on buried or restrained piping systems.

Additional requirements were provided in Section 6 – Fabrication Details, Chapter 3 – Expansion and Flexibility. The only longitudinal stress limits provided therein were in the context of flexibility analysis, a concept that does not apply to restrained pipelines such as the Straits crossings. Separate limits for restrained pipelines or offshore pipelines, such as are found in today's Code, had not yet been developed. In any case, the 1953 Code, Paragraph 620 "Flexibility", required that:

> "(g) Where the piping system is subject to the occasional temperature changes and to combinations of constant stress and minor cycle variable stresses associated with the normal operation of a plant, the maximum allowable combined stress due to bending and pressure shall … be limited to 40 percent of the specified tensile strength…"

There is no evidence that the designers of the Straits crossings specifically followed the provisions in Paragraph 620(g).

The 1953 Code specified welding in accordance with ASME Section IX[8], but the project adopted welding requirements very similar to those found in API 1104[9], though no mention of API 1104 was made in the project specifications.

SUMMARY

From a review of applicable pipeline regulations and industry standards, it is clear that the Straits crossings fall within the scope of US Federal pipeline safety regulations. The crossings share all the physical attributes of offshore pipelines in terms of their method of construction as well as the loading and operating environment. For this reason, an offshore pipeline technical standard is the most appropriate place to seek technical guidance on matters such as allowable working stress levels. The offshore section of ASME B31.4 was identified as the most applicable. Chapter IX therein recommends maximum longitudinal stresses of 80% of SMYS, and maximum biaxial combined stresses of 90% of SMYS. An alternative criterion for noncyclical displacement-controlled loadings is also permitted. While a strain-based criterion remains a technically feasible option, it has not been recommended for the sake of conservatism.

ENGINEERING ANALYSIS

Original Design Studies

At the time that the Straits crossings were conceived, designed, and constructed, they were the deepest offshore pipelines ever built, though not the longest. Extensive design calculations were performed by engineers at George S. Colley, Jr. and Associates under the supervision of Dr. Mario G. Salvadori, Dept. of Civil Engineering, Columbia University.[10] The loadings considered in the design included internal pressure due to operation at 600 psig and hydrostatic testing to 1,200 psig, vertical loading from deadweight and buoyancy, thermal expansion corresponding to a temperature differential of +30 F (with the pipeline operating warmer than the water), horizontal loading due to drag from water currents, torsional loading from the pipe rolling on slopes and from water currents, soil friction, and the effects of catenary action. Limit states considered were tensile overload, biaxial combined stresses, lateral instability, collapse of the empty pipe, and local buckling. The calculations were all performed by hand, using closed-form solutions based on traditional structural engineering methods and assumptions.

The original design study recommended a maximum span length of 140 ft and the recommended minimum bend radius of 1,750 ft, based on a maximum allowable tensile stress of 60% of SMYS (18 ksi). For additional conservatism in order to allow for unanticipated conditions or changes in conditions during operation, a maximum construction span of 75 ft was ultimately suggested. Since stresses other than those induced by operation of the pipeline are roughly proportional to the square of the span length (L^2), a span of 75 ft corresponds to a summed tensile stress of less than 30% of SMYS, which is an extremely conservative operating stress level.

Kiefner Spanning Study

At the request of Enbridge, Kiefner reviewed the original studies, and performed an independent analysis. As discussed in the first part of this report, Kiefner concluded that the appropriate criteria for allowable stress limits are those found in ASME B31.4, Chapter IX, Offshore Liquid Pipeline Systems, rather than those for unrestrained onshore pipelines. These limits are 80% of SMYS for longitudinal stresses, and 90% of SMYS for biaxial effective stresses.

The pipelines were first analyzed using closed-form solutions for a beam with simultaneous lateral and axial loading. Because adjacent spans are unlikely to be of uniform length, while individual spans may be bedded in compliant soil media, engineering judgment suggests that neither full fixity or full rotational freedom accurately represents span end conditions. Rather, actual end restraint conditions were thought to more likely be midway between the two extremes. Consequently, the stresses at any point along the beam were calculated as the average of the fixed and pinned solutions, which is an assumption that is consistent with standard structural analysis methods. The same pressure, weight, and current loadings were considered as in the previous studies. The resulting equations are presented in the following discussion. The pipeline behaves as a catenary with resistance to lateral deflection developed through increased axial tension rather than additional bending stress for spans much in excess of 80 ft.

The equations for the tensioned beam-catenary span, as an average of the fixed and pinned cases, are given below.

$$M_P = \frac{w}{k^2}\left[\frac{1}{\cos(kL/2)} - 1\right], \quad M_F = \frac{w}{k^2}\left[\frac{1}{\sin(kL/2)} - 1\right]$$

$$M_{FP} = \frac{w}{2k^2}\left[\frac{\sin(kL/2) + (kL/2)\cos(kL/2)}{\sin(kL/2)\cos(kL/2)} - 2\right]$$

$$\sigma_b = \frac{MD}{2\,I}\ , \quad \sigma_x = \frac{T}{A}$$

where

M_P	= bending moment for pinned-end condition
M_F	= bending moment for fixed-end condition
k	= $(T/EI)^{1/4}$
T	= axial compressive force
E	= elastic modulus
I	= pipe section moment of inertia
A	= pipe section metal area
L	= pipe span length
w	= resultant lateral load per unit length
σ_b	= bending stress
σ_x	= axial stress

Considering a negligible temperature differential between the transported product and the water temperature results in the solution indicated by the dashed lines in Figure 3. The longitudinal tensile stress component and biaxial stresses converge for long spans. The allowable longitudinal tensile stress of 80% of SMYS is achieved at a span length of 155 ft.

The original design study recognized that deflection of the spans would relieve the compressive stress due to thermal expansion where the pipeline operates at temperatures warmer than the water. The product temperature in the line varies seasonally between 39 F (4 C) and 61 F (16 C). The water temperature varies seasonally and with depth due to stratification and turnover phenomena. Deepwater temperatures vary from 39 F (4 C) to 43 F (8 C), while shallow water temperatures vary over a wider range. The differential between pipeline operating temperature and ambient deepwater temperature is the least in the winter and the greatest in the summer. The temperature difference is expected to vary between 0 F and +20 F, with the pipeline operating warmer than the water. Figure 4 shows the expected seasonal temperature variations.

Relief of the thermal stress by normal span sag from weight and current effects occurs gradually with spans of increasing length greater than 80 ft. Full relief occurs in spans longer than 120 ft. As the compressive stress becomes increasingly relieved with increasing span length between 80 and 120 ft, the span increasingly develops catenary behavior. The equations for a catenary span with fixed ends and compressive axial load relieved by sag are presented below.

$$y + \frac{Ay^3}{16\,I} = \frac{w}{4\,EI}\left(\frac{L}{\pi}\right)^4 \;,\quad T = EA\left(\frac{\pi\,y}{2L}\right)^2$$

$$M = C\frac{wL^2}{12} \;,\quad C = \frac{1}{1 + 0.0107\,(kL^2)}$$

$$\sigma_b = \frac{MD}{2\,I} \;,\quad \sigma_x = \frac{T}{A}$$

where

y = pipe deflection
C = tensioned beam coefficient

and all other variables are as defined above.

The relief of thermal expansion by sagging results in a significantly different relationship between span length and total pipe stress for spans longer than 120 ft compared to the situation where the differential temperature is negligible. Stresses increase with span length, but at a significantly lower rate. This is illustrated by the solid curves in Figure 3 for a temperature differential of +20 F. The span length corresponding to the tensile limit of 80% of SMYS is 195 ft. As with the case with no differential temperature, when the pipeline structural response is governed by catenary behavior the span length is governed by the tensile stress criterion rather than the biaxial stress criterion. The limit of 90% of SMYS on the biaxial stress then governs local curvatures, primarily in areas where the pipeline is already supported on the bottom soil and follows the bottom contours.

The results indicate that with negligible temperature differential, the pipe may begin yielding with spans longer than 170 ft, whereas with the maximum temperature differential the pipe does not begin to yield until spans are at least 225 ft long. The pipe does yield significantly beyond the elastic limit until spans are actually much longer than that amount. This seems to be consistent with the fact that spans longer than 250 ft have occurred without apparent damage to the line. Operating conditions having a differential temperature intermediate between 0 F and +20 F would be bounded by the solutions represented by the dashed and solid curves in Figure 3.

One potential concern with the catenary spans is for girth weld integrity. The pipeline was constructed using shielded metal arc welding (stick welding) using E6010 coated electrodes. While improved incrementally over time, this process is essentially similar to how the vast majority of pipelines are constructed today. The project-specific standards adopted for qualification of the welding procedures and welders, and for acceptance of workmanship in production welds, were not very different from those that are in use today as well, in accordance with API 1104. In order to minimize the chances for cracking, the welds were preheated. Finally, all girth welds were fully radiographed. Given these factors, one can have some confidence that the overall weld quality and integrity is comparable to those produced today using E6010 electrodes on a plain carbon steel pipe such as Grade B.

While fracture toughness characteristics of the welds were never measured, an engineering critical assessment in accordance with a proven methodology[11] indicates that with a minimally ductile weld (having a crack tip opening (CTOD) of 0.005 inch), the allowable workmanship flaw 2-inches long would be safe against brittle fracture even at tensile stress levels of 95% of SMYS, with a factor of safety of '2'. This is consistent with the fact that spans longer than 250 ft have occurred without incident and gives confidence that the proposed allowable span of 140 ft is a sound limit.

Effects of Operating Conditions

New supports installed under an existing span will not relieve the spanning-induced stresses, only the additional stresses due to span extension (increase in length), unless the span is lifted prior to installing the supports or the supports have a jacking capability. Lifting the line prior to support installation, or jacking afterward, would preload the supports and make them at least partially effective in relieving present spanning-induced stresses. Without preload, the supports would carry only the added load caused by span length extension. As an alternative, a reduction in the amount of sag resulting from introducing different operating conditions such as reduced product temperature or reduced product specific gravity could achieve a similar effect to raising the pipe first or jacking the supports.

Four variables could be controlled to adjust the span sag when supports are being installed: line pressurized versus depressurized, flow shut-in versus normal flow, crude oil contents versus NGL contents, and line out-of-service versus in-service. These will be briefly reviewed to determine whether there are operating conditions that should be avoided because they could increase risks during the mitigation process, or that are preferred because they could make the supports more effective.

Pressure

The hoop stress due to the normal operating pressure (NOP) of 220 psig is only 9% of SMYS. The longitudinal stress in the pipe due to internal pressure is between 30% of this value for restrained portions of the line and 50% for unrestrained portions, or 3% to 4.5% of SMYS. It is unlikely that a longitudinal stress component this low could make a significant difference from a safety standpoint even when added to the spanning stresses. Thus it seems unnecessary to require that the line pressure be reduced from normal operation.

Flow

An analysis of the deflection and stresses in the spans considered that the pipes are in a state of compression caused by differential thermal expansion due to the crude oil product in the pipe being warmer than the water temperature of 40 F. This led to the finding that spans must exceed 120 ft in length in order to fully relieve the thermal compression. Longer spans develop catenary behavior from the thermally relieved sag configuration, with resistance to additional vertical sag developed through increased axial tension rather than additional bending stress. In fact, recognition of this phenomenon led to greater allowable spans than would be the case without any initial thermal compression on the pipeline. It follows that if the flow is shut-in for a sufficiently long period of time prior to the span correction, the lines would cool to the ambient water temperature and the thermal compressive stress would be lost. This would result in more tension in the spans and reduced sag. If the supports were to be installed with the line in this condition, then when product flow is restored and the pipe warms to the product temperature, the supports would become loaded by the additional sag induced by thermal expansion of the pipe.

It should be noted that the analysis also showed that without thermal expansion, spans of 140 ft are at the limit of acceptable lengths based on traditional Code stress criteria. This means that after cooling down, the existing long spans that are currently safe but longer than the 140-ft service lengths Enbridge plans to allow, would then be in excess of acceptable stress limits for the period of time between when the line cools down and when the supports are installed. It is likely that the longest spans could experience longitudinal stresses in excess of the yield strength. There are a number of reasons why this is probably not a real structural integrity concern but the safety margins are difficult to quantify with the information available. Thus shutting in the lines while they are full of product is not recommended even though doing so would lead to more effective span support. Shutting in the lines would also interrupt service for however long it takes to complete the support installation process.

Product

If both products are transported at the same temperature, the difference in net unit weight between the crude and NGL conditions would be expected to result in only a small difference in span sag owing to the thermal compression effect. If so, then it may make no significant difference whether the line is transporting crude oil or NGL during support installation. On the other hand, if the product temperature of NGL is lower than the temperature of the crude, there could be as much as a 20% reduction in sag measured from the top of the pipe at the ends of the span compared to when crude is in the line. In that case, it would be preferable to transport NGL while supports are being installed. Note that this would only relieve spanning–induced stresses at the present span lengths when crude oil is being transported, not when NGL is in the line. If the span length extends, then the supports become effective regardless of product.

Service

A fourth option is to take the line out of service completely, including clearing it of product by nitrogen displacement. In this condition, the reduced net weight of the pipe and the equalized pipe temperature would result in the least amount of span sag. This would be the optimal from the standpoint of the immediate effectiveness of the installed supports. However, this strategy would result in the line being out of service for the duration of the span mitigation process. However, with two line crossings this might be operationally feasible.

Summary

Some relief of span sag during the installation of supports would be beneficial because it would immediately transfer some load to the supports. Mechanically, relief is accomplished by lifting the line prior to support installation, or by installing supports that provide a jacking or lifting function after installation. Without some means of preloading, the supports do not become effective for reducing span-induced stresses until the spans extend in length through a continued bottom scour process. However, they will help mitigate vortex-induced vibration without preload.

There is no benefit to reducing the operating pressure during the support installation process from the standpoint of stresses due to internal pressure, because those stress components are too small to make a significant difference. Shutting in flow could reduce span sag due to the line cooling down, but this runs the risk of increasing stress levels in the spans until the supports are installed and flow is restored. Therefore, shutting in the line while the supports are being installed is not recommended. Switching over to NGL will yield only a relatively small change in the sag if the transporting temperature of the NGL is as warm as the crude oil. If the NGL runs cooler than the crude oil, the combination of lower pipe temperature and reduced span weight could reduce span sag making the supports at least partially effective at the present span lengths when crude oil is being transported. The optimal situation, solely from the standpoint of immediate effectiveness of the supports, is to take the line out of service, including clearing the pipe of product contents. This study does not evaluate the impact of this strategy on operation.

SPAN SUPPORTS

Pipe spans vary greatly in length. Enbridge has established that spans exceeding 140 ft will be corrected by the installation of supports, although spans of up to 195 ft meet conservative allowable stress limits conventionally applied to offshore pipelines. The 140-ft span limit is consistent with criteria for remediation employed on the lines previously, and allows for some continued extension over time without serious erosion of safety margins. Free span heights above the Straits bottom vary considerably.

A survey of offshore pipe span support methods was conducted on behalf of Enbridge by J. P. Kenny, Ltd. in 2002.[12] This review draws on the information available in that study. An important part of the survey was estimated costs for materials and installation.

Several methods of support for offshore pipeline spans are available, including:

- trenching;
- rock-dumping;
- mattresses, sandbags, and grout bags;
- mechanical support; and
- pipeline anchors.

The option of trenching is not recommended, since that can only be used in specific bottom soil conditions that may or may not be present consistently. The option of rock-dumping is the most effective long-term mitigation of the effects of scour. It has been used successfully on the Great Lakes Gas Transmission 36-inch Straits crossing, and other submerged pipelines in other offshore locations. If Enbridge wishes to consider a comprehensive span mitigation program, rock-dumping would warrant investigation. However, it may not be the most cost-effective solution for spot repairs of a few individual spans.

For spot repairs, three options remain. All may be effective for the required purposes, depending on the specific conditions.

The grout bags have a stack height of approximately 2 ft. Where the span clearance above the Straits bottom is large (for example 15 ft or more), grout bags may not be an optimal choice because it will be necessary to lay them in a tiered stack (pyramid fashion) for long-term stability resulting in a large number of bags to be placed. Also, grout bags do not offer a pipe-lifting capability in order to preload the supports.

Mechanical supports consist of a two-legged telescoping A-frame device that clamps around the pipeline and supports it off the bottom. They are relatively inexpensive and straightforward to install. Such devices may prove effective where continued scour is not anticipated. However, if the bottom elevation could be expected to continue to lower due to continued scour, they offer only temporary support and might be detrimental if they lose bottom contact.

Pipeline anchors consist of a structural support that is screwed or grouted into the bottom soil. They have been used successfully in similar circumstances to the Straits, including several major US river washouts. They may be the most reliable system where span clearances are large, as well as where current velocities are high (which does not appear to be the case here). The costs for anchor systems will be greater than for mechanical supports.

Recommendations for Mitigation of Spans

Recommendations are as follows for mitigating the spans on the Straits crossings:

- grout bags for low-clearance spans
- anchors for high-clearance spans
- rock-dumping for permanent system-wide mitigation

ANALYSIS OF LOCAL PIPE WALL STRESSES

At the request of Enbridge, an analysis was performed to estimate local stresses in the pipe wall associated with support structures installed to mitigate excessive span lengths. The purpose of the analysis was to address the requirement in 49 CFR 195.110(b):

> "The pipe and other components must be supported in such a way that the support does not cause excess localized stresses. In designing attachments to the pipe, the added stress to the wall of the pipe must computed and compensated for."

The local stresses were evaluated for a maximum span of 140 ft consistent with Enbridge's span mitigation objectives. The average support reaction of a multiple span installation is then 19.6 kips.

The support structures Enbridge has considered for installation are a commercially available system that have been installed successfully on other offshore and marine pipelines. The assembly consists of screw-anchored 4.5-inch OD posts positioned on each side of the pipeline and connected by an overhead 8-inch wide-flange support beam. Collars are used to adjust the support beam height. The pipeline is suspended below the support beam by a saddle bolted to the bottom of the beam. The saddle strap is 8-inches wide and 0.5-inch thick. A spacer is inserted between the top of the pipe and the bottom of the beam. A schematic of the support concept is shown in Figure 5.

The bending stresses on the gross pipe section associated with installation of a pipe support were accounted for in the development of the span limits and are not the subject of §195.110(b). The language of §195.110(b) refers instead to local stresses associated with the attachments. In order to evaluate the local stresses associated with the saddle, a theoretical model was used based on axisymmetric radial pressure around a cylinder.[13] This model was adjusted by recognizing that the bearing pressure at the interface between the pipe and the saddle is concentrated within an arc of between 60 and 120 degrees around the bottom of the pipe section. The local through-wall unit bending moment for this simple idealization is computed as $M=(q/2\lambda^2)(e^{-\lambda a}\sin\lambda a)$, where q is the bearing pressure at the interface, a is half the width of the saddle strap, λ is computed as $[3(1-\nu^2)/(Rt)^2]^{1/4}$, ν is Poisson's Ratio, R is the mean radius of the pipe section, and t is the pipe wall thickness. The local bending stress is then computed as $\sigma=6M/t^2$. The local shear stress is computed as $\tau=qa/2t$, again with q adjusted to consider the limited arc of contact between the pipe and saddle. The results of the analysis are summarized in Table 1 below:

Table 1. Local Pipe Wall Stresses Resulted from Bearing Pressure at Support Locations

Interface Angle, deg	Local Bending Stress, ksi	Local Shear Stress, ksi
60	0.80	1.20
90	0.53	0.80
120	0.40	0.60

The local stresses are observed to be very low. Local stresses much larger than this are normally present within or adjacent to common features in pipelines such as branch connections, attachment welds, flanges, and fittings and are not of significant concern. These stresses, superimposed on the stresses due to normal operation and spanning, do not pose a threat to the integrity of the pipeline. Having determined that the local stresses associated with the support are so low, no further action to address them is recommended.

VIBRATION INDUCED BY VORTEX-SHEDDING

Introduction

The steady flow of fluid around a bluff body creates a wake. Under certain conditions, the wake is characterized by discrete vortices which form and then detach from the trailing surface of the body in an organized periodic fashion from alternating sides of the body. Such a wake is referred to as a vortex street. Examples of such vortices are shown in Figure 6 (laboratory generated on the left and computer generated on the right). As each vortex detaches, momentary hydrodynamic lift and drag forces are produced giving rise to alternating inertial forces acting on the cylinder. If the body is flexible and lightly damped, the alternating forces result in oscillation of the body. If the frequency of vortex shedding is close to the frequency of a fundamental mode of structural vibration, resonance and large oscillation amplitudes occur. Even if the vortex frequency and structural frequency are not closely matched, if the oscillations are large enough the phenomenon of "lock-on" can occur wherein the body and wake frequencies acquire the same value. This can cause structural failure and has done so in pipelines exposed to water or wind currents under these conditions.

The nondimensional shedding frequency is given by the Strouhal Number, St=fD/U, where *f* is the vortex shedding frequency, *D* is the bluff body diameter, and *U* is the mean stream velocity. The Strouhal Number is relatively constant and equal to approximately 0.2 at values of the Reynolds Number below 3.5×10^5. The Reynolds Number is a dimensionless parameter that defines the flow regime, calculated as Re=ρD/μ, where *ρ* is the fluid density, *D* is the diameter of the cylinder, and *μ* is the fluid viscosity. The flow regimes that produce periodic vortices in the wake are indicated in Figure 7.

Vortex Shedding Limitations

The onset of motion of the span is characterized by the reduced velocity, V_r.[14,15] The reduced velocity is given by $V_r = U/(f_n D)$, where *U* is the velocity of steady flow normal to the pipeline, f_n is the natural frequency of the span, and D is the overall diameter of the coated pipeline. Susceptibility to vortex lock-on is considered significant with reduced velocities between 3.5 and 7.0. This occurs when the beam-mode fundamental frequency is within about 35% of the vortex shedding frequency f_s. The response peaks at a reduced velocity near 5.0, which occurs when the two frequencies acquire the same value. This is shown schematically in Figure 8. When the reduced velocity is between 4.0 and 7.0, oscillation of the pipe occurs crosswise to the current flow (i.e., vertically). At reduced velocities between 1.0 and 3.0, the vortices break off of both trailing surfaces simultaneously, resulting in oscillation in line with the current (i.e., horizontally). The magnitude of dynamic response in this mode is much lower than in the cross-current mode.

The natural frequency of the suspended pipeline span may be calculated, neglecting axial effects, from the formula:

$$f_i = \frac{X}{2\pi}\left[\frac{E}{m_e}\frac{I}{L^4}\right]^{1/2}$$

where *X* is the degree of end fixity constant (dimensionless), *E* is Young's Modulus of Elasticity, *L* is the span length, and *I* is the moment of inertia of the steel pipe section. The fixity constant, *X*, was assigned a value of 15.4, corresponding to a fixed-pinned beam (or propped cantilever). The effective mass, m_e, is the sum of the mass of pipe plus coating, the mass of contents inside the pipe, and the mass of water displaced by the pipeline (i.e., the "added mass").

By combining the equation for the reduced velocity with that giving the natural frequency of the suspended pipeline span, the critical span length can be obtained:

$$L_{cr} = \left[\frac{CD_c V_r}{U}\right]^{1/2}$$

where

$$C = \frac{15.4}{2\pi}\left[\frac{EI}{m_e}\right]^{1/2}$$

Current Velocity Data Analysis

Enbridge installed water current monitoring devices at four locations along their crossing in order to obtain better data concerning currents impinging on exposed spans. The devices were placed at representative water depths and locations in the Straits. Currents were monitored at 3-hour intervals between September 26, 2002 and August 8, 2004. Easting and Northing current velocities recorded by the four monitoring units are shown in Figure 9 through Figure 12. A sampling of current velocities in Easting and Northing coordinates is shown in Figure 13. The Easting current velocity component is about 3 times the Northing current velocity component. The velocities are seen to reverse direction every 2 to 3 days, and are predominately oriented in the ENE and WSW direction.

The seasonal variation in average and maximum current velocities is shown in Figure 14. The currents are somewhat lower in late summer months. Mean velocities ranged from 0.1 to 0.7 ft/sec. Maximum absolute velocities were 4 to 5 times the average, ranging up to 2.75 ft/sec. However, readings of this magnitude were actually extremely infrequent, as will be discussed subsequently.

Figure 15 is a plot of all 21,037 velocity measurements in both Easting and Northing directions. Each measurement unit is indicated by a different color. Figure 15 highlights several important observations. For one, the Easting velocity components are greater than the Northing velocity components by a factor of about 3. Currents tend to flow either ENE or WSW, though the degree to which headings were off-axis varied with the measurement station. With all four measurement units, the predominant current heading would be chiefly crosswise to the pipeline spans. Also, there is a significant amount of flow reversal suggested by the scatter. The two dashed gray boxes represent the boundaries of 2 and 3 standard deviations (2σ and 3σ) in the statistical scatter of the readings. (The 1σ box is hidden by the data points.)

Figure 16 and Figure 17 show the statistical distribution of velocity readings by magnitude, for the Easting and Northing coordinates, respectively. Both sets of readings were essentially normally distributed and centered about a velocity of zero as an effect of the flow reversal. The statistical parameters are summarized in Table 2 below. The analysis indicates that 95% of the readings for the Easting current velocities are within ±1.1 ft/sec.

Table 2. Summary of Flow Velocity Analysis

Parameter	Actual Velocity, ft/sec	
	Easting	Northing
Minimum	−2.02	−0.96
Maximum	2.76	0.95
Average	0.01	0.00
1SD (68%)	0.54	0.15
2SD (95%)	1.08	0.30
3SD (99.7%)	1.62	0.45

It may be misleading to evaluate the data in the manner described above in that the flow-reversal implies that the expected velocity would be zero. Therefore, the data was reanalyzed in terms of the absolute value of the velocity, as shown in Figure 18 and Figure 19. The distribution follows a gamma function. The statistical parameters are summarized in Table 3 below. The average current velocity is non-zero but relatively low, about ±0.4 ft/sec in the Easting direction. The mean plus 2-sigma velocity, which envelopes 95% of the readings, was 1.1 ft/sec, about the same as from the analysis using actual water current values.

Using either velocity distribution, the proportion of velocities above the 2.3 ft/sec threshold identified in the VIV discussion is very low. A velocity this high was observed only eight times in 21,037 measurements, or 0.038% of the time.

Table 3. Summary of the Flow Velocity Statistical Parameters

Parameter	Velocity Magnitude, ft/sec	
	Easting	Northing
Minimum	0.00	0.00
Maximum	2.76	0.96
Average	0.41	0.11
Std. Deviation	0.36	0.10
X+1SD (68%)	0.76	0.21
X+2SD (95%)	1.12	0.31
x+3SD (99.7%)	1.48	0.41

The mean plus 3-sigma velocity encompassing over 99% of measured values was approximately 1.5 ft/sec. Hence current velocities in excess of 1.5 ft/sec can be considered rare and infrequent events.

Results

The critical spans determined from the foregoing analysis are shown in Figure 20. The results indicate that as the current velocity increases, the VIV-allowable span length decreases. The allowable span length decreases to less than the 140 ft span length established on the basis of static analysis at current velocities of 2.3 ft/sec or greater. A velocity of 2.3 ft/sec happens to correspond to a Reynolds Number of $3.5x10^5$, above which the wake becomes disorganized and the vortex street is aperiodic. So velocities greater than 2.3 ft/sec would not be expected to limit spans to shorter lengths in consideration of VIV. Moreover, velocities approaching 2.3 ft/sec would be quite rare, and presumably of short duration.

As a conservative assumption, only the stiffness of the steel pipe has been considered in the calculations. The effects of catenary (or sag tension) would in all likelihood allow for slightly greater spans by increasing beam natural frequencies of vibration.

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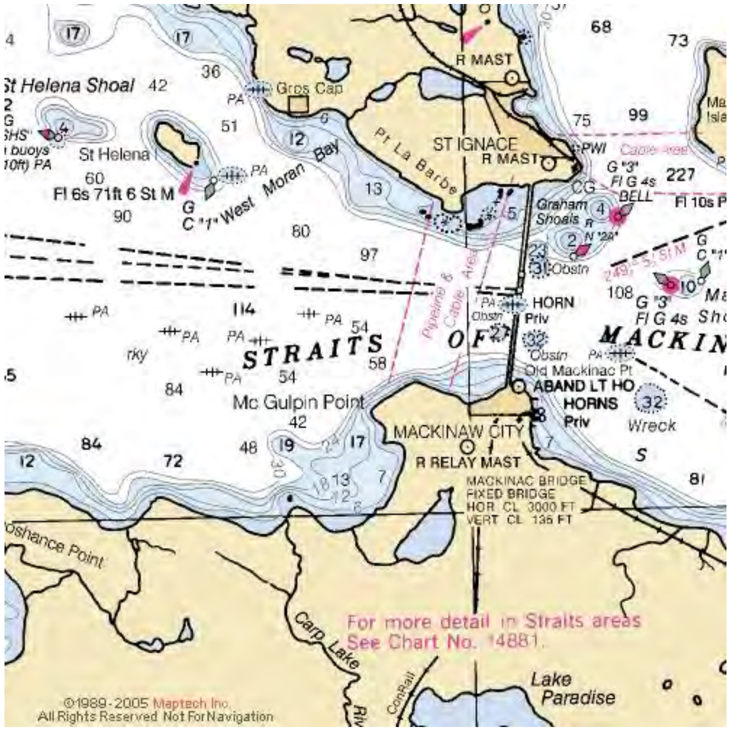


Figure 1. Location of Pipeline Crossing

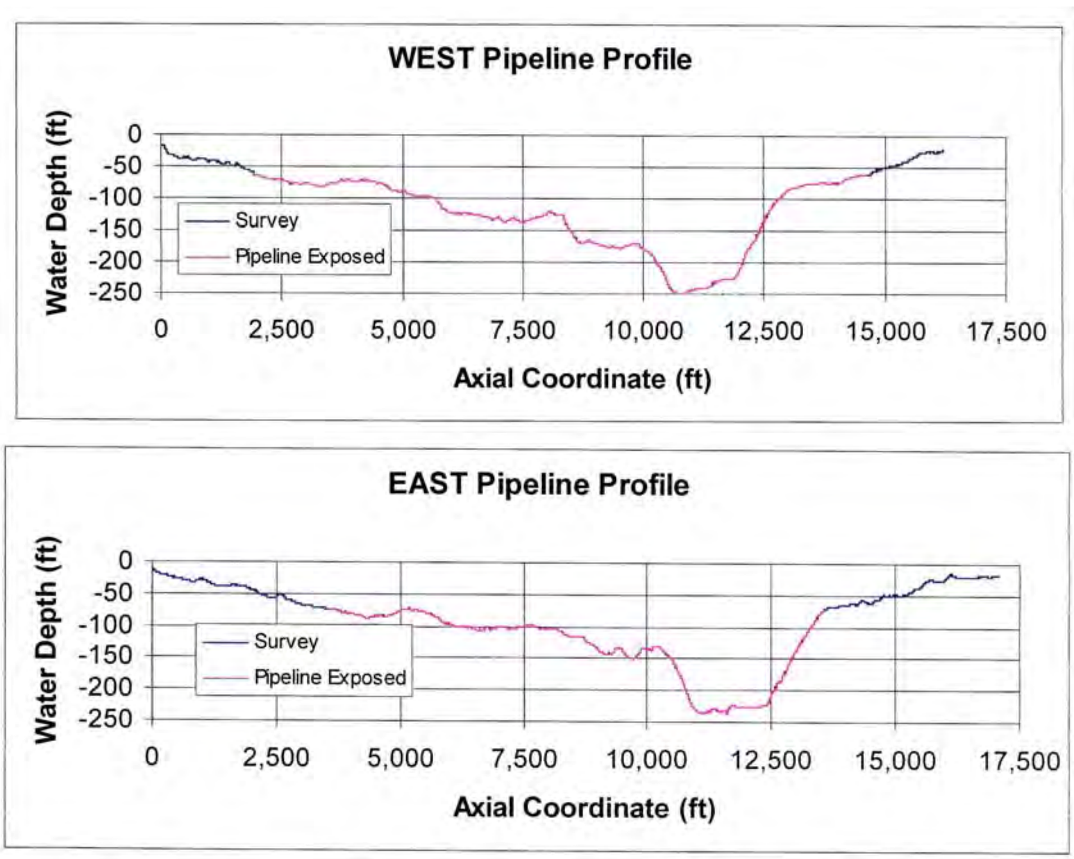


Figure 2. Crossing Bottom Elevation Profiles

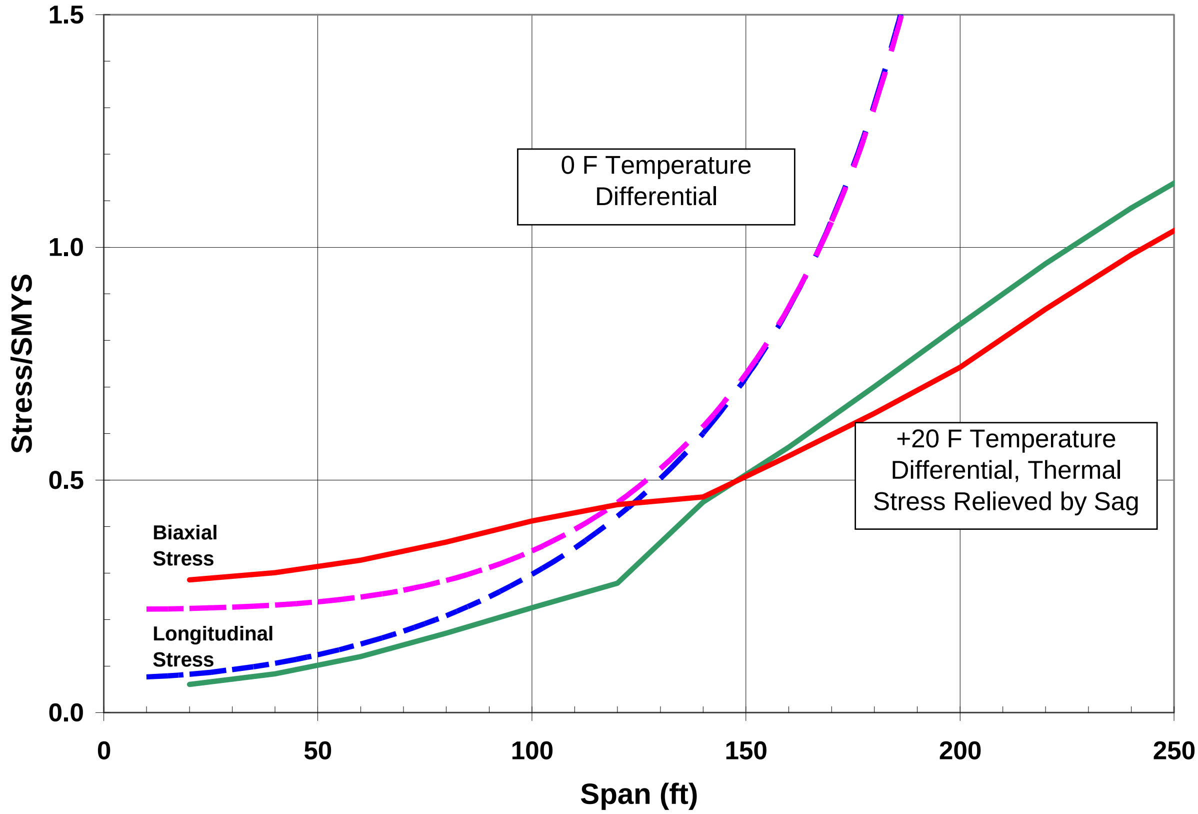


Figure 3. Relationship between Span and Stress

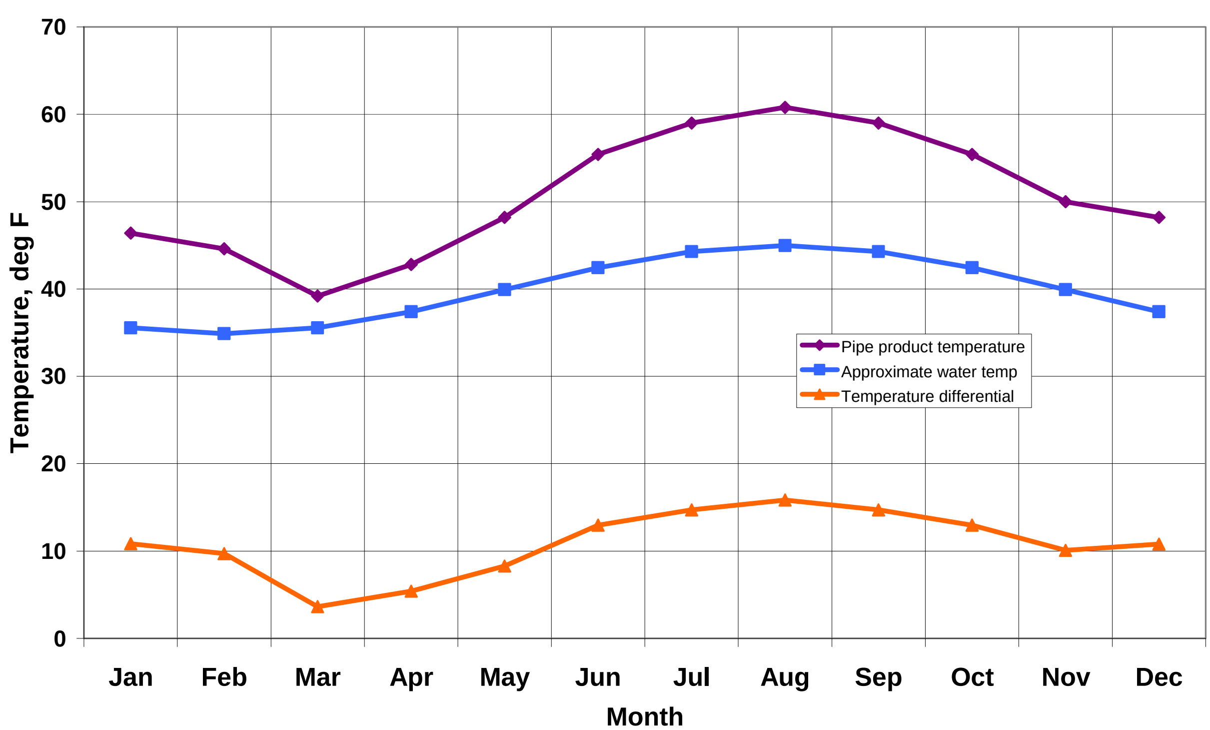


Figure 4. Annual Variation in Temperature

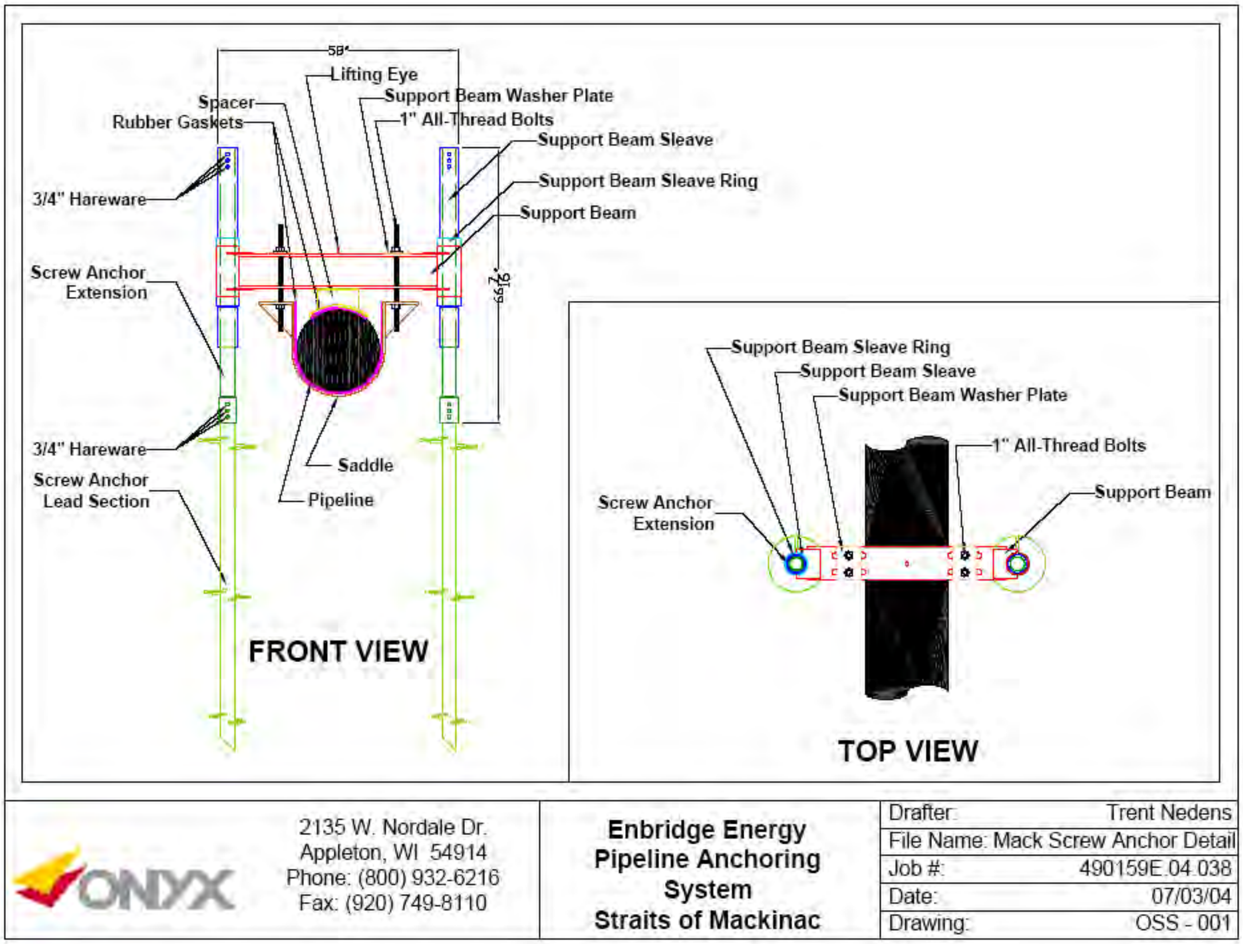


Figure 5. Pipe Support Arrangement

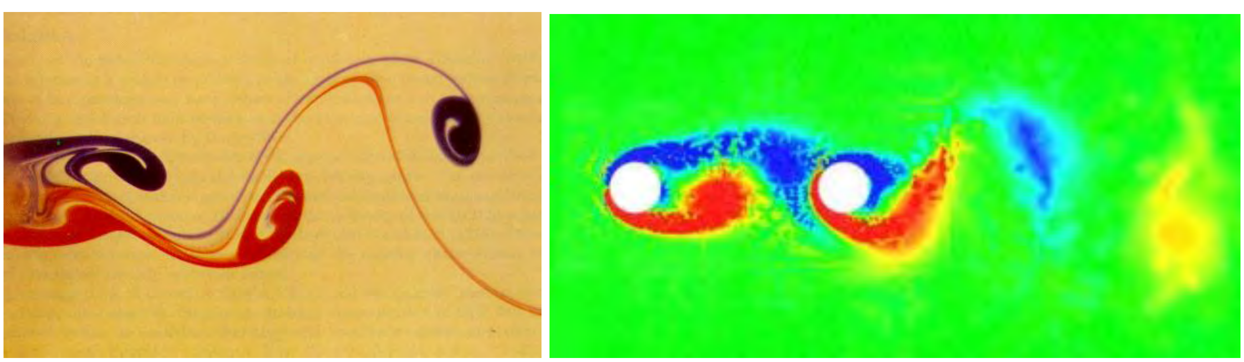


Figure 6. Examples of Periodic Vortex Shedding from Cylindrical Bodies

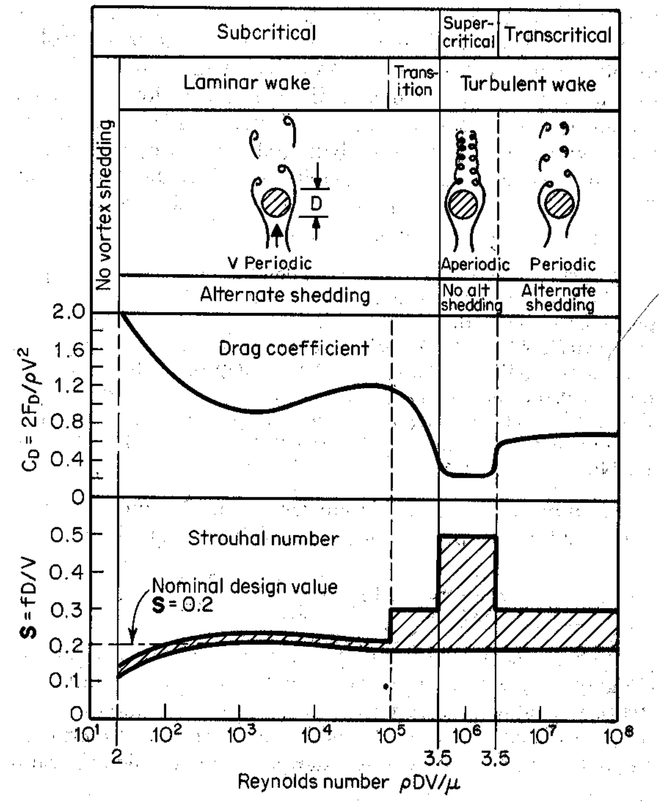


Figure 7. Flow Regimes Susceptible to Periodic Vortex Shedding

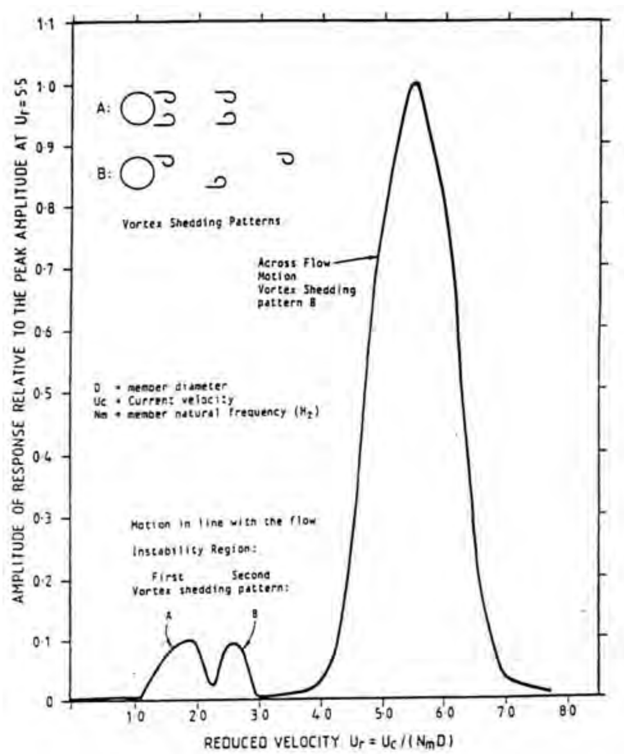


Figure 8. Influence of Reduced Velocity on Dynamic Response

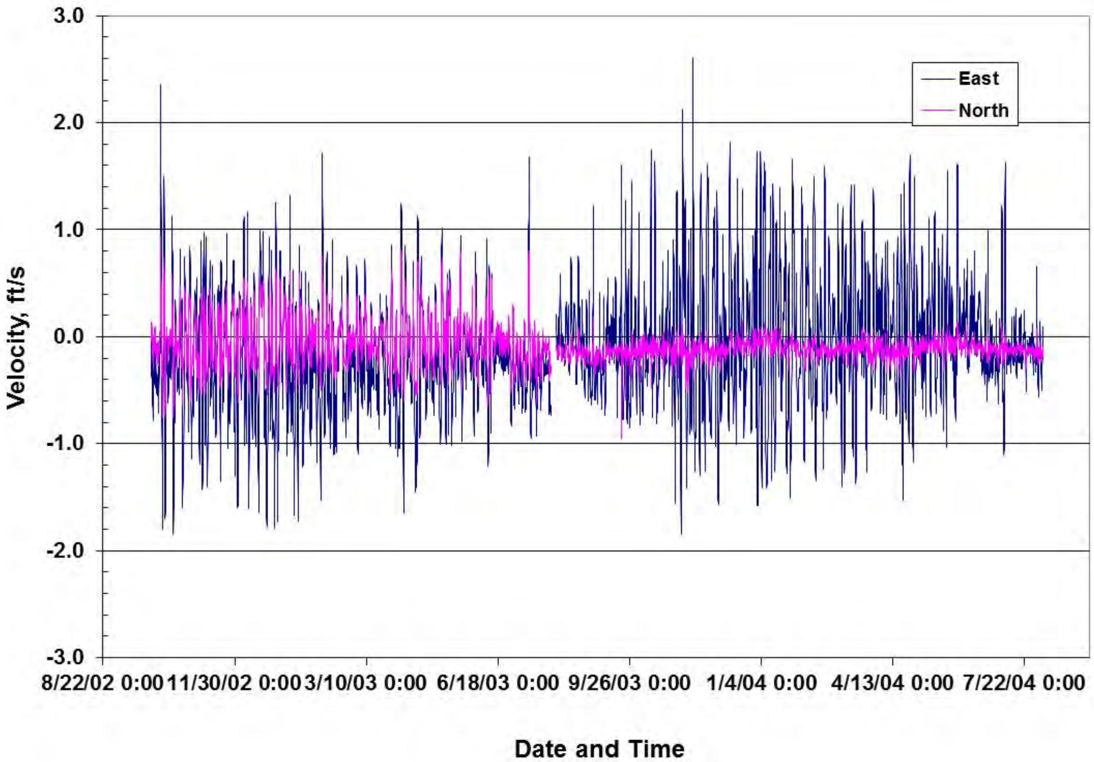


Figure 9. Current Velocity Measurement Unit 1

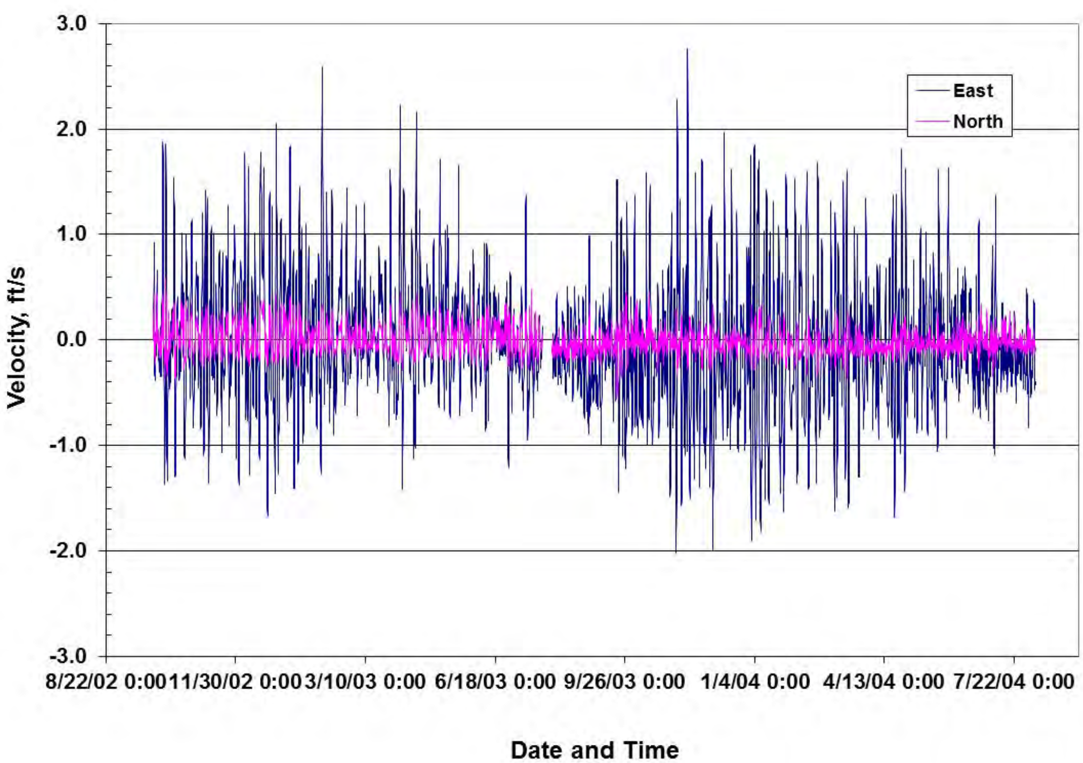


Figure 10. Current Velocity Measurement Unit 2

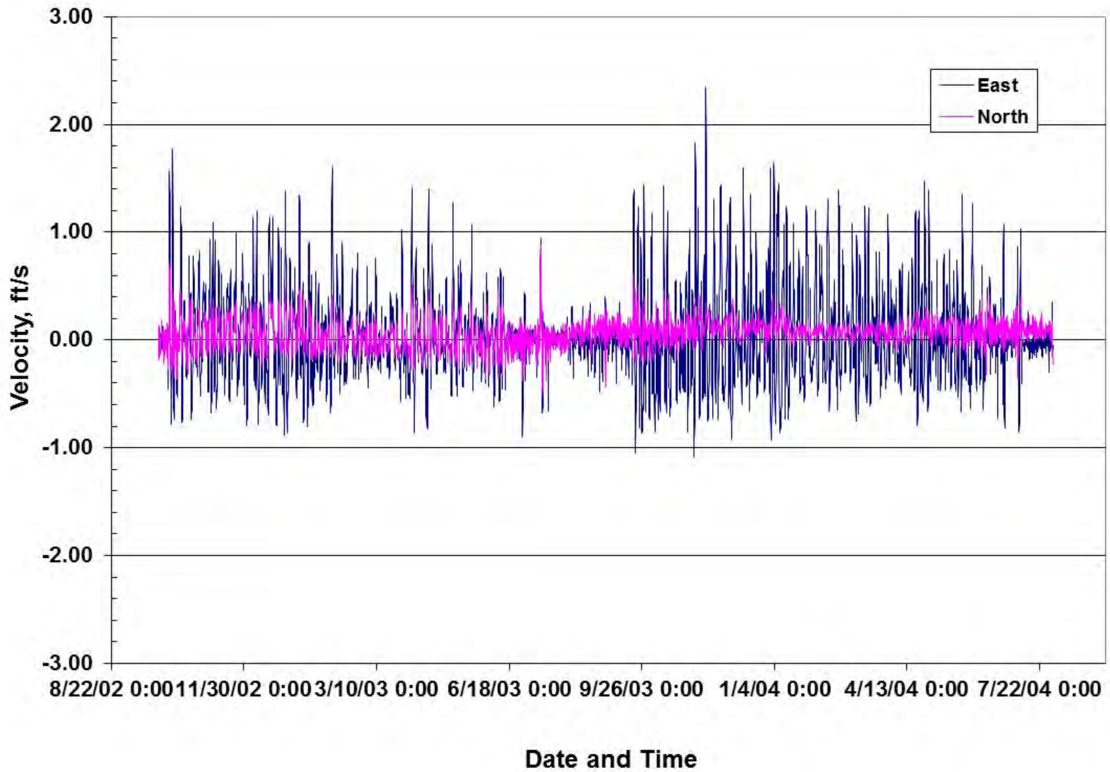


Figure 11. Current Velocity Measurement Unit 3

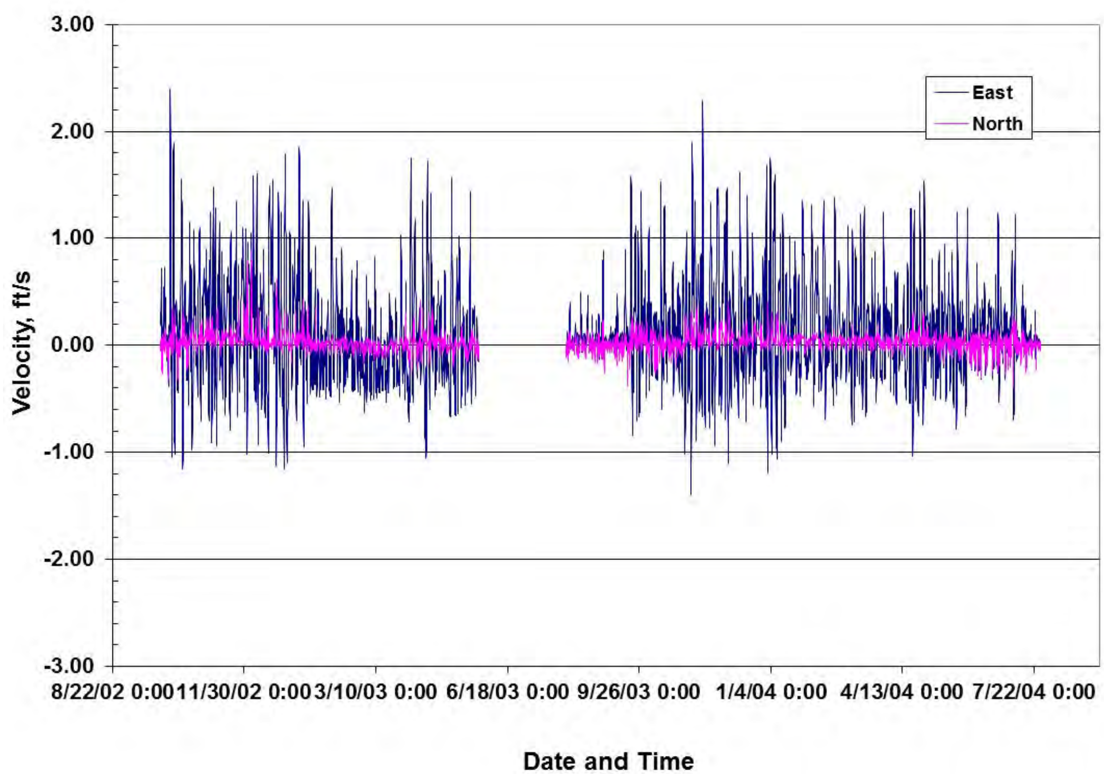


Figure 12. Current Velocity Measurement Unit 4

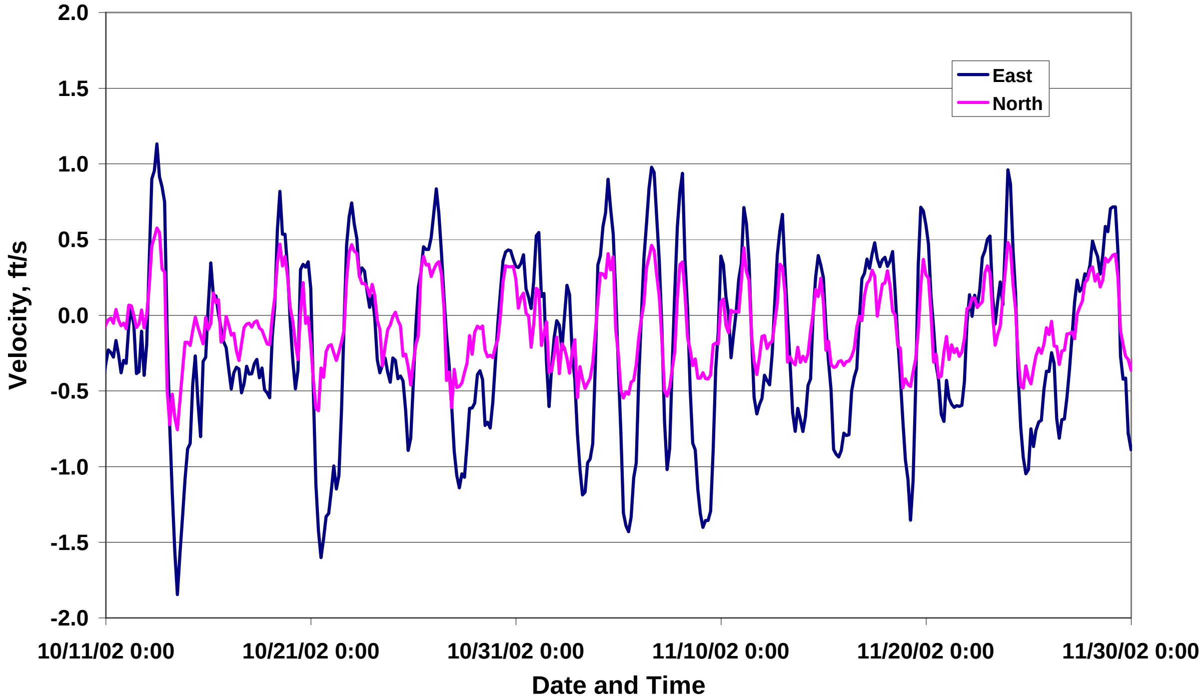


Figure 13. Current Velocity Sampling

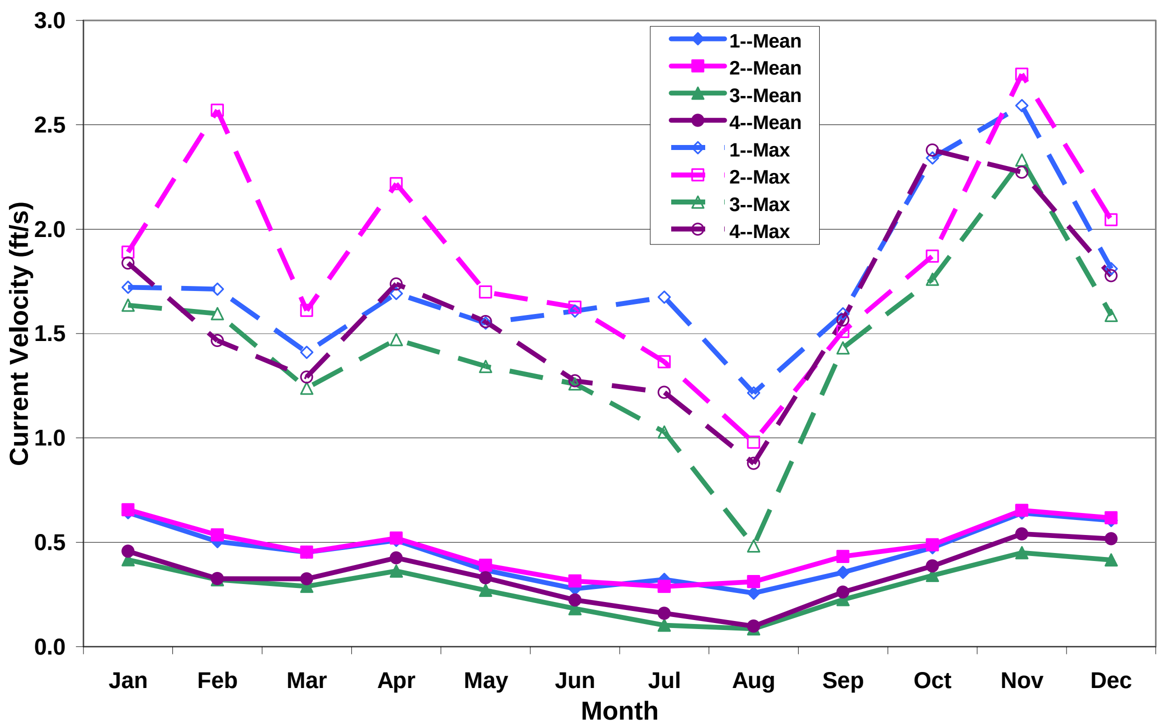


Figure 14. Seasonal Variation in Current Velocity

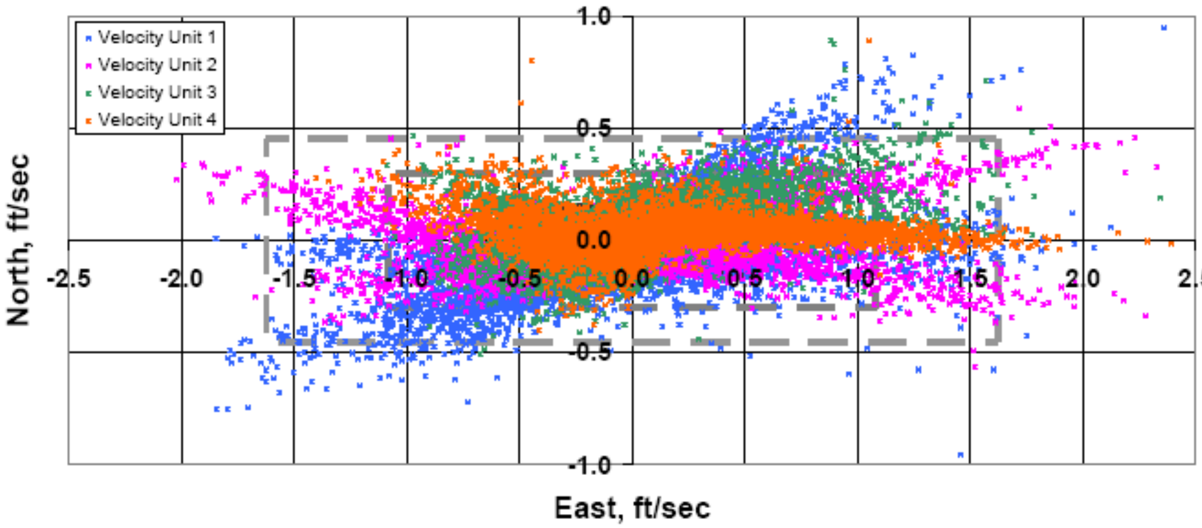


Figure 15. Distribution of Current by Heading and Velocity

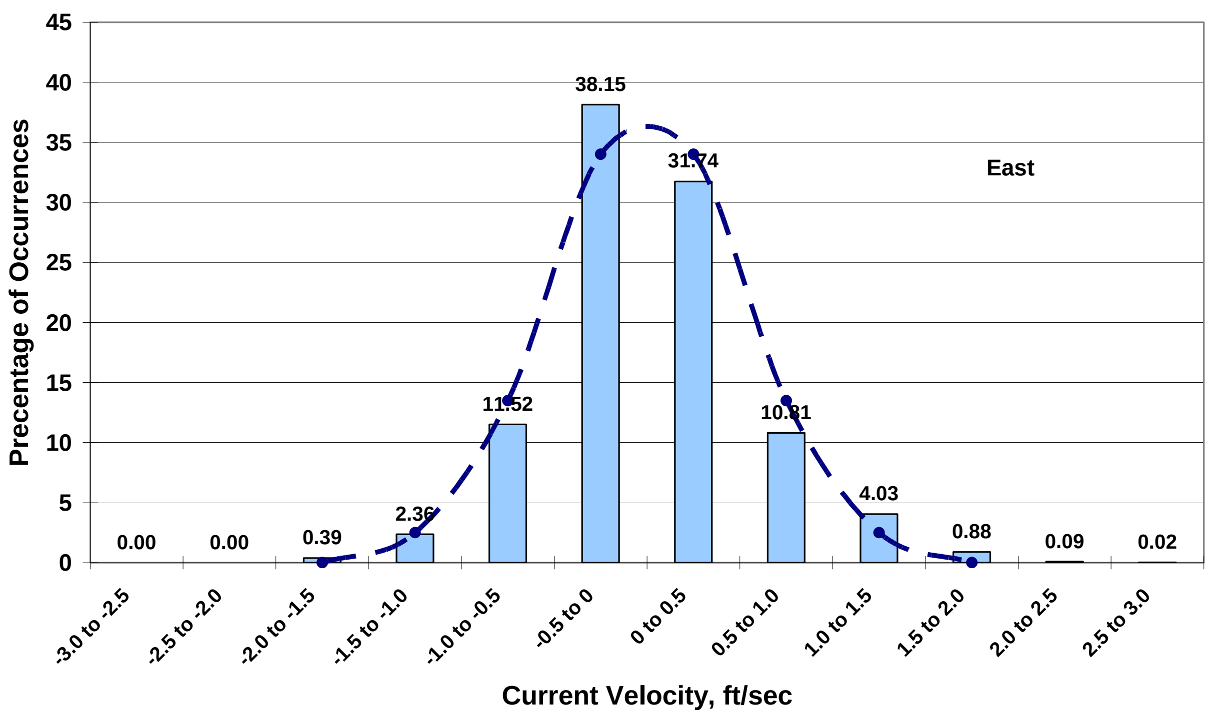


Figure 16. Distribution of Easting Velocity Occurrences

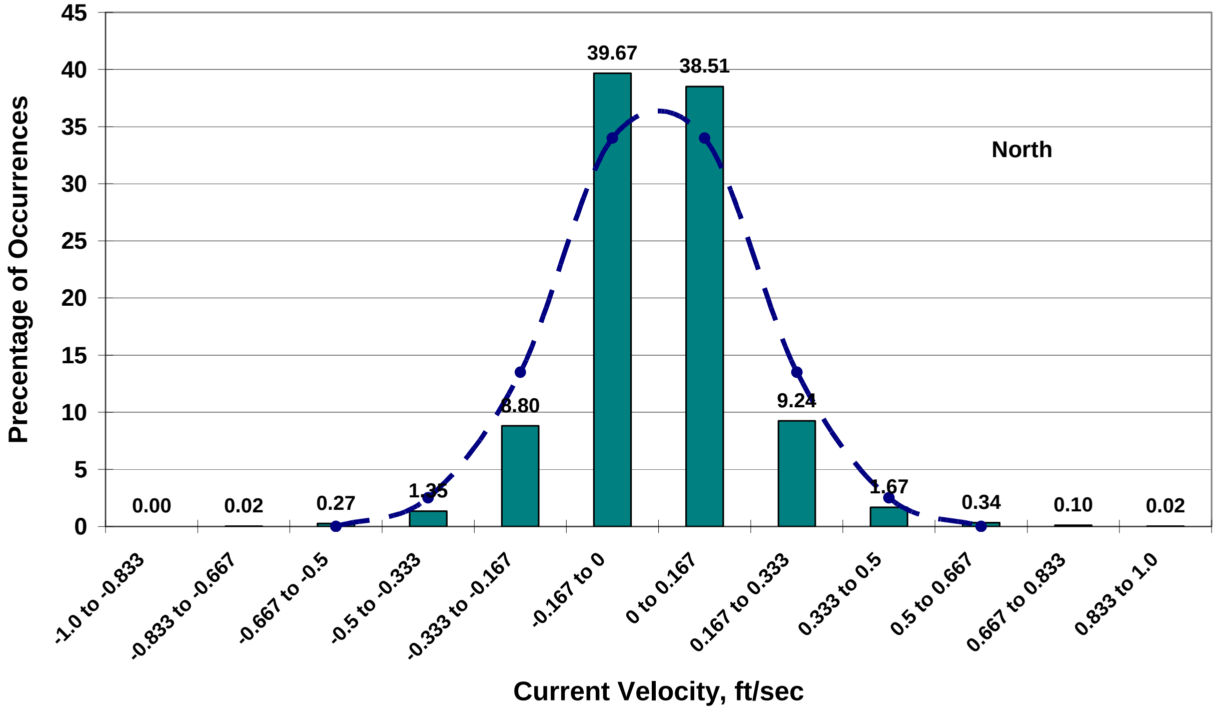


Figure 17. Distribution of Northing Velocity Occurrences

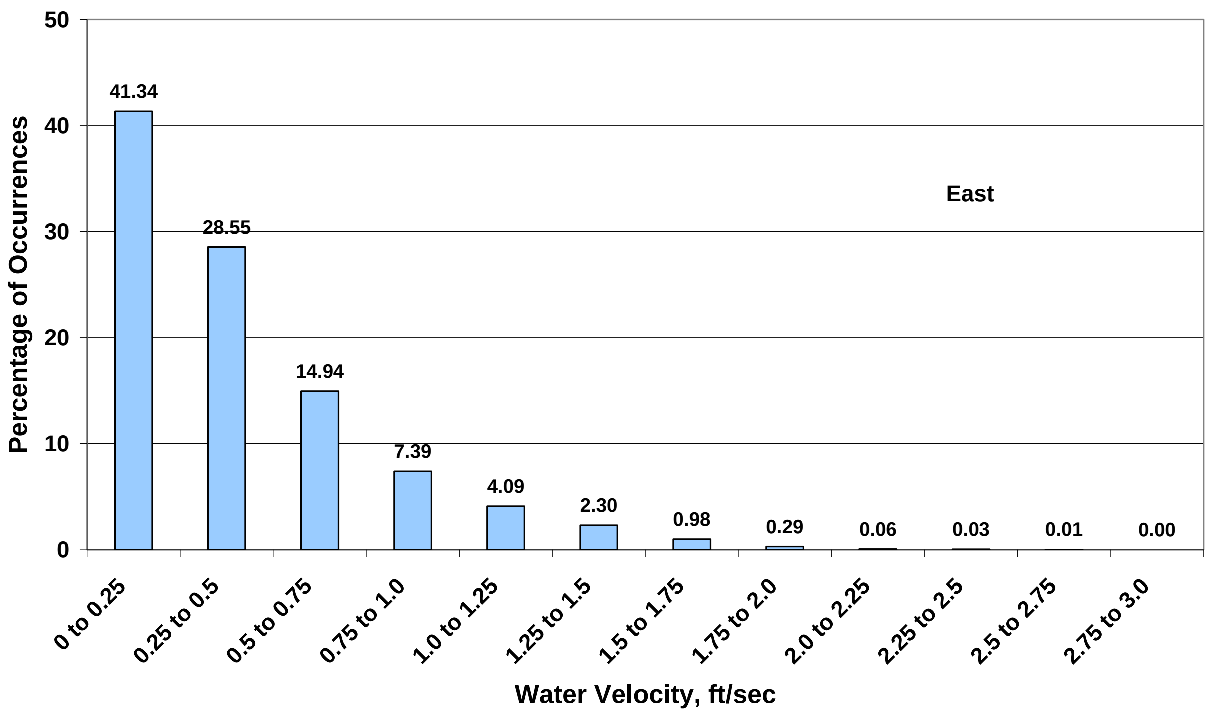


Figure 18. Distribution of Easting Velocity Magnitudes

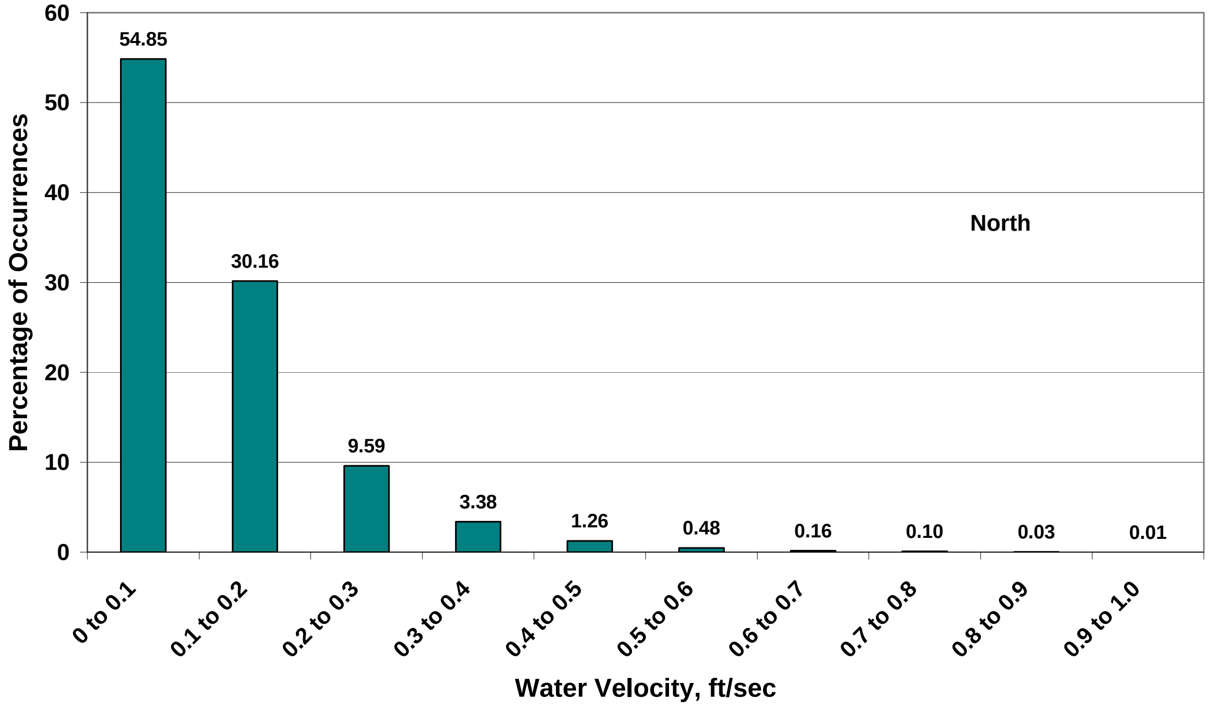


Figure 19. Distribution of Northing Velocity Magnitudes

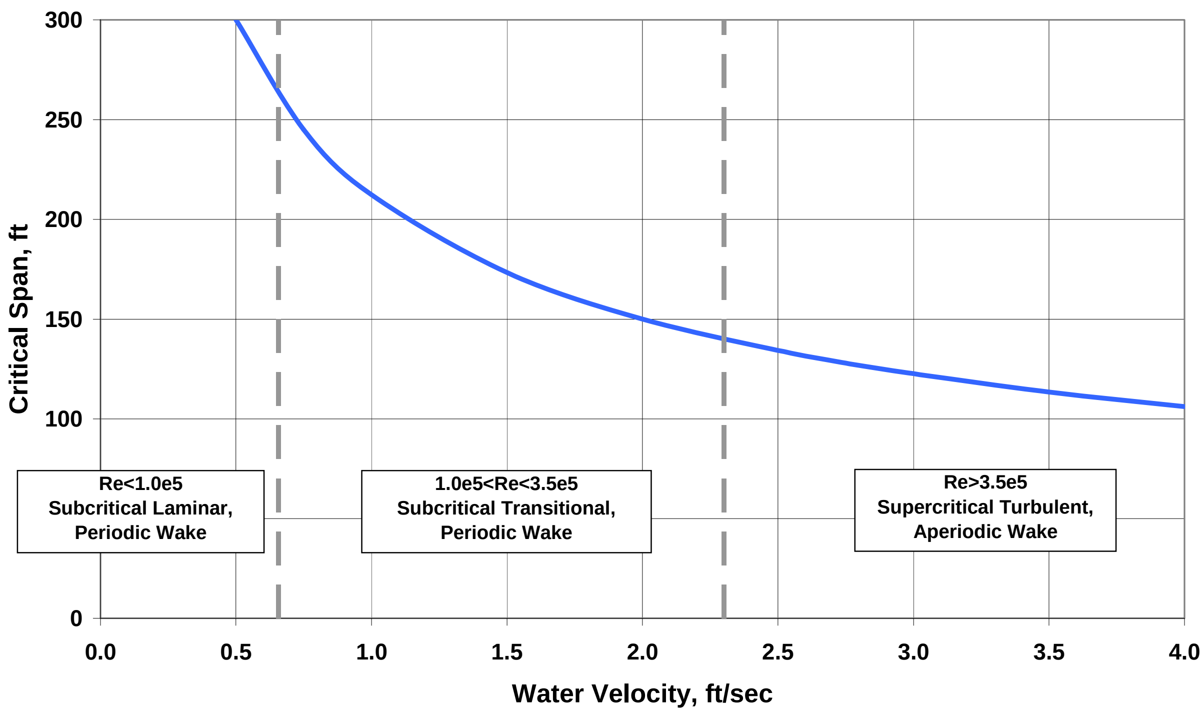


Figure 20. Critical Span Lengths for Vortex-Induced Vibration

Enbridge document shows years of noncompliance for pipeline supports

Arielle Breen (989) 732-1111 abreen@gaylordheraldtimes.com May 31, 2017

File Photo

STRAITS OF MACKINAC — Every 75 feet under the Straits of Mackinac there are supposed to be supports to hold the dual pipeline, known as Line 5, in place.

But according to an underwater inspection document from Enbridge Energy —the pipeline's owner and operating company— those supports have exceeded the length requirements more than 200 times in years past.

Jennifer McKay, Tip of the Mitt Watershed Council policy director and member of the Michigan Pipeline Safety Advisory Board, said the document shows the company to have been in violation of its easement agreement.

“Enbridge, since 1953 was supposed to have no (span) areas greater than 75 feet and if you look there’s a number — a quite substantial number — of spans that violated that requirement,” McKay said. “It means that Enbridge has essentially, at least according to the spreadsheet — been operating the pipeline in violation for a number of years.”

Line 5 is a twin pipeline that separately carries both light crude oil and natural gas liquids from Canada through the Upper Peninsula, Straits of Mackinac and Lower Peninsula, crossing out of the state to Ontario, Canada, beneath the St. Clair River.

The document resides in a collection of information requested by the state of Michigan after the attorney general, Michigan Department of Natural Resources and Michigan Department of Environmental Quality learned in February of documented examples of coating issues on the lines under the Straits in Enbridge’s Biota Investigation Work Plan dated to September 2016.

The 75-foot span regulation was a safety measure included in the original agreement, McKay said.

“So the question then becomes since it’s been operating essentially in violation of that safety measure, what was the actual impact to the integrity of the pipeline?” McKay said.

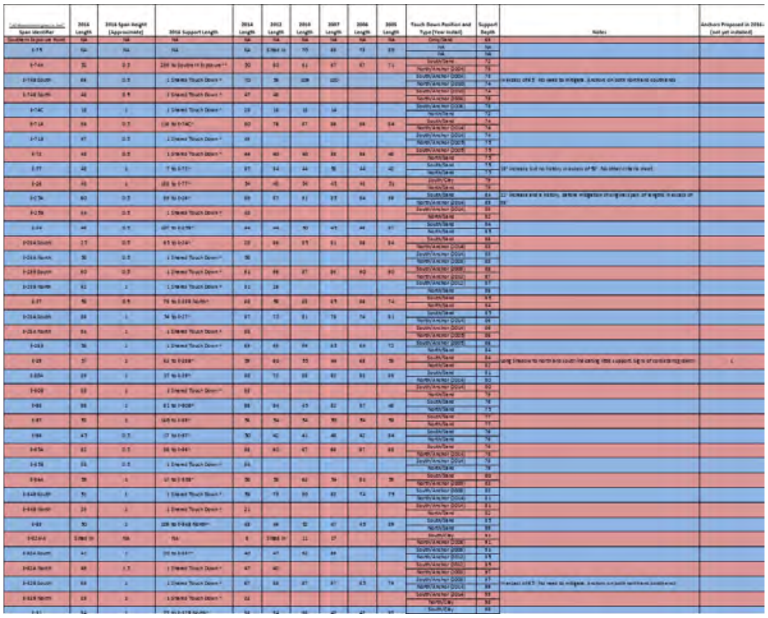
According to the Underwater Inspection spreadsheet document, most of the spans over 75 feet were listed from 2005 to 2010 with some still in 2012.

Out of any of the years listed on the document, the longest span from one support to the next was listed as 54 feet over the 75-foot limit in 2005, along the east pipeline. The next longest span was 50 feet over the limit in 2005, along the northern part of the east pipeline.

Some specific spans are shown to have been in violation, in some cases, for at least five consecutive inspection years which occur every two years.

In total, the document reports nearly 250 instances between the east and west lines of Line 5 over the years where sections have spanned longer than the required 75 feet.

Underwater Inspection Line 5 by Arielle Breen on Scribd



Ryan Duffy, Enbridge's supervisor of regional communications, said the company is not in violation of the easement agreement in any support spans and said most sections are "well below" the 75 feet requirement.

Some sections from the 2016 inspection shown on the document report spans as low as 7 feet. And while 2016 and 2014 numbers generally show shorter span lengths — earlier years show a trend of longer lengths — particularly in 2005 and 2006.

Duffy said any time the span lengths had been discovered to be longer than 75 feet during the underwater inspections, the company had 90 days to fix the situation from the time of discovery.

He said so far, the company has always fixed the span supports within the allotted 90 days.

However, according to the spreadsheet, there are instances where a section of line has consistently had spans in excess of 75 feet for up to five inspection years in a row.

"There's been ongoing maintenance with the anchor supports. Every two years we inspect if we see that some have slipped to (have grown) wider, then we go in and put new anchor supports (in)," Duffy said. "The lakebed is a dynamic environment, there's a lot of currents that are shifting, there's erosion. So, where gaps open up we need to go in and reinforce those areas."

He said the company applied for 18 permits last year in places where the line does not immediately need supports.

The proactive supports were requested in an attempt to close the distance on spans that are nearing the 75-foot mark but were denied by the state.

Last year, the company applied for, and was granted, four supports for areas that were over the 75-foot requirement.

"Much of the pipeline through the Straits follows the bottom contours and rests on the lakebed," Duffy said in an email. "Since 2002, we have added 128 support anchors."

He said this year the company is applying for another 22 anchors for stability.

"Our goal is to complete this work in 2017, as part of our comprehensive maintenance program," Duffy said.

When asked about any potential repercussions of the violations shown in the document — the director of communications with the Michigan Attorney General's office, Andrea Bitely, said "The governor's pipeline risk and alternatives studies are due this summer. The engineering firms doing that work are taking everything into account."

The next Pipeline Safety Advisory Board meeting is scheduled for Monday, June 12 at Petoskey Middle School, 801 Northmen Drive. According to the Michigan Petroleum Pipelines website, the meeting is open for public comment from 9 a.m to noon.

The accompanying documents are available online at mipetroleumpipelines.com

March 29, 2017

The Honorable Bill Schuette
Attorney General
State of Michigan
Department of Attorney General
G. Mennen Williams Building, 7th Floor
525 W. Ottawa Street
Lansing, Michigan 48909

Ms. C. Heidi Grether
Director
Michigan Department of Environmental Quality
Constitution Hall
525 West Allegan Street
Lansing, MI 48933

Mr. Keith Creagh
Director
Michigan Department of Natural Resources
Executive Division
525 West Allegan Street
Lansing, MI 48933

Re: Response to Request for Information Regarding Line 5 Dual Pipelines at the Straits of Mackinac

Dear Attorney General Schuette, Director Grether and Director Creagh:

This letter and information are in response to the Request for Information transmitted to Enbridge with your letter dated March 8, 2017. Enbridge's Responses to the Request for Information are attached to the electronic version of this letter.

In addition to the attached narrative Responses, Enbridge is also providing certain documents and other materials requested as part of the Request for Information. A complete list of the material to be provided appears below. These materials in some cases are too large to be transmitted by email. As a result, I will be forwarding a hard drive with the materials in question by separate cover in the next day or so.

As for the request for information regarding future tests or inspections, Enbridge will inform you or your offices about future tests and inspections regarding the Straits, and in doing so discuss which reports or results the State wishes to receive once the tests or inspections are completed. Please let me know if you would like to discuss this approach going forward.

The materials to be provided separately consist of the following:

- BMC report summarizing findings of visual inspection;
- GEI report summarizing findings of biota survey;
- Line 5 Straits Biota Investigation Videos (6-13-16 East Line Video file, 6-14-16 West Line Video file);
- Line 5 Straits Supplemental Biota Work Plan, dated March 23, 2017;
- 2016 BH CPCM Inspection (East Straits);
- 2016 BH GeoPig Inspection (East Straits);
- 2016 BH CPCM Inspection (West Straits);
- 2016 BH GeoPig Inspection (West Straits);
- 2015 Acoustic Emission Inspection (East Straits); and
- 2015 Acoustic Emission Inspection (West Straits).

We look forward to any comments or questions you might have regarding the Responses.

Sincerely,

ENBRIDGE ENERGY, LIMITED PARTNERSHIP
By Enbridge Pipelines (Lakehead) LLC
Its General Partner

Bradley F. Shamla
Vice President, U.S. Operations

Enclosures

cc: Teresa Seidel, Division Chief, Department of Environmental Quality – WRD
Valerie Brader, Executive Director, Michigan Agency for Energy

Appendix C: East lateral report

Span Identifier	Preliminary 2016 Length	2014 Span Height	2014 Support Length	2014 Length	2012 Length	2010 Length	2007 Length	2006 Length	2005 Length	Touch Down Position and Type (Year install)	Support Depth	Latitude	Longitude	Designated For Repair in 2016
Southern Exposure Point	NA	NA	NA	NA	NA	NA	NA	NA	NA	Only/Sand	66	45.79740051 N	84.76828612 W	No
E-75	NA	NA	NA	NA	Silted In	70	69	73	80	NA	NA	NA	NA	No
										NA	NA	NA	NA	
E-74A	52	0.5	240' to Bury	50	80	61	67	67	71	South/Sand	69	45.79803465 N	84.76803487 W	No
										North/Anchor (2009)	70	45.79817336 N	84.76798054 W	
E-74B South	68	0.5	Shared Touch Down ^	70	56	109	100			South/Anchor (2009)	70	45.79817336 N	84.76798054 W	No
										North/Anchor (2010)	71	45.79836191 N	84.76790185 W	
E-74B North	46	0.5	Shared Touch Down ^	47	48					South/Anchor (2010)	71	45.79836191 N	84.76790185 W	No
										North/Anchor (2006)	70	45.79848622 N	84.76785431 W	
E-74C	22	1	Shared Touch Down ^	28	36	13	14			South/Anchor (2006)	70	45.79848622 N	84.76785431 W	No
										North/Sand	69	45.79855919 N	84.7678226 W	
E-71A	33	0.5	111' to E74C North	30	76	87	86	86	84	South/Sand	73	45.79885179 N	84.76772027 W	No
										North/Anchor (2014)	71	45.79893197 N	84.76769084 W	
E-71B	49	0.5	Shared Touch Down ^	49						South/Anchor (2014)	71	45.79893197 N	84.76769084 W	No
										North/Anchor (2005)	72	45.79906039 N	84.76764254 W	
E-72	44	0.5	Shared Touch Down ^	44	40	40	38	36	48	South/Anchor (2005)	72	45.79906039 N	84.76764254 W	No
										North/Sand	72	45.79917455 N	84.76759603 W	
E-77	50	1	9' to E-72	37	34	44	52	44	42	South/Sand	72	45.79919654 N	84.76758791 W	No
										North/Sand	72	45.799292 N	84.76754813 W	
E-26	50	1	202' to E77	54	48	54	45	48	51	South/Clay	76	45.79982164 N	84.76734294 W	No
										North/Sand	76	45.7999639 N	84.76728235 W	
E-25A	36	0.5	42' to E-26	38	87	93	85	84	96	South/Sand	81	45.80007294 N	84.76724349 W	No
										North/Anchor (2014)	80	45.80017387 N	84.76720464 W	
E-25B	48	0.5	Shared Touch Down ^	48						South/Anchor (2014)	80	45.80017387 N	84.76720464 W	No
										North/Sand	79	45.80029924 N	84.76715103 W	
E-24	46	0.5	114' to E25B	44	44	50	45	46	37	South/Sand	81	45.80059751 N	84.76703994 W	No
										North/Sand	82	45.80071223 N	84.76699755 W	
E-23A South	26	0.5	96' to E-24	28	86	85	81	86	84	South/Sand	83	45.80096148 N	84.76690243 W	No
										North/Anchor (2014)	85	45.80103603 N	84.76687496 W	
E-23A North	58	0.5	Shared Touch Down ^	58						South/Anchor (2014)	85	45.80103603 N	84.76687496 W	No
										North/Anchor (2003)	85	45.80118708 N	84.7668158 W	
E-23B South	60	0.5	Shared Touch Down ^	61	66	87	86	90	90	South/Anchor (2003)	85	45.80118708 N	84.7668158 W	No
										North/Anchor (2012)	84	45.80134576 N	84.76674988 W	
E-23B North	32	1	Shared Touch Down ^	31	26					South/Anchor (2012)	84	45.80134576 N	84.76674988 W	No
										North/Sand	83	45.80142404 N	84.76671063 W	
E-27	59	0.5	78' to E23B North	63	58	69	65	66	74	South/Sand	82	45.80162764 N	84.76663722 W	No
										North/Sand	81	45.80179248 N	84.76657389 W	

E-28A South	37	1	52' to E-27	37	70	81	73	74	81	South/Sand	82	45.80193012 N	84.76652267 W	No
										North/Anchor (2014)	83	45.8020281 N	84.76649157 W	
E-28A North	35	1	Shared Touch Down ^	38						South/Anchor (2014)	83	45.8020281 N	84.76649157 W	No
										North/Anchor (2005)	83	45.80212884 N	84.76645585 W	
E-28B	56	1	Shared Touch Down ^	63	66	69	65	64	72	South/Anchor (2005)	83	45.80212884 N	84.76645585 W	No
										North/Sand	81	45.80229567 N	84.76639508 W	
E-29	66	1	25' to E28B	59	60	55	44	63	53	South/Sand	81	45.8023587 N	84.76636855 W	Yes
										North/Sand	79	45.80251327 N	84.76631514 W	
E-30A	38	1	22' to E29	38	72	83	82	82	89	South/Sand	78	45.80256885 N	84.76629197 W	No
										North/Anchor (2014)	77	45.80267125 N	84.76626081 W	
E-30B	38		Shared Touch Down ^	36						South/Anchor (2014)	77	45.80267125 N	84.76626081 W	No
										North/Sand	76	45.80276442 N	84.76622516 W	
E-38	36	1	86 to E-30B	36	34	45	32	37	46	South/Sand	73	45.80299189 N	84.76614415 W	No
										North/Sand	72	45.80308618 N	84.76611094 W	
E-37	51	1	155' to E-38	56	54	54	50	54	53	South/Sand	74	45.80349412 N	84.7659669 W	No
										North/Sand	74	45.80363883 N	84.76590965 W	
E-36	55	0.5	12' to E-37	50	42	41	48	42	34	South/Sand	73	45.80366947 N	84.76589995 W	No
										North/Sand	73	45.80380204 N	84.76585057 W	
E-35A	32	0.5	33' to E-36	36	60	67	66	67	63	South/Sand	73	45.80389819 N	84.76581718 W	No
										North/Anchor (2014)	75	45.80399347 N	84.7657808 W	
E-35B	35	0.5	Shared Touch Down ^	36						South/Anchor (2014)	75	45.80399347 N	84.7657808 W	No
										North/Sand	76	45.80408779 N	84.76574484 W	
E-34A	60	1	25' to E35B	58	58	62	54	61	59	South/Sand	77	45.80415409 N	84.76572209 W	No
										North/Anchor (2003)	79	45.80430605 N	84.76566353 W	
E-34B South	52	1	Shared Touch Down ^	53	73	80	82	74	75	South/Anchor (2003)	79	45.80430605 N	84.76566353 W	No
										North/Anchor (2014)	78	45.80444616 N	84.76561487 W	
E-34B North	23	1	Shared Touch Down ^	21						South/Anchor (2014)	78	45.80444616 N	84.76561487 W	No
										North/Sand	79	45.80450136 N	84.76558981 W	
E-33	45	1	109 to E34B North	43	46	52	47	45	39	South/Sand	82	45.80478655 N	84.76548042 W	No
										North/Sand	86	45.80490015 N	84.76543833 W	
E-32A-A	NA		21' to E-33	6	Silted in	11	17			South/Clay	88	45.80495542 N	84.76541633 W	No
										North/Anchor (2006)	88	45.80497238 N	84.76541225 W	
E-32A South	40	1	Shared Touch Down ^	40	47	92	89			South/Anchor (2006)	88	45.80497238 N	84.76541225 W	No
										North/Anchor (2012)	92	45.80507422 N	84.76536839 W	
E-32A North	47	1.5	Shared Touch Down ^	47	40					South/Anchor (2012)	92	45.80507422 N	84.76536839 W	No
										North/Anchor (2003)	94	45.80519687 N	84.76532216 W	
E-32B South	62	1	Shared Touch Down ^	67	88	87	97	85	79	South/Anchor (2003)	94	45.80519687 N	84.76532216 W	No
										North/Anchor (2014)	96	45.80537562 N	84.76525738 W	
E-32B North	23	1	Shared Touch Down ^	22						South/Anchor (2014)	96	45.80537562 N	84.76525738 W	No
										North/Clay	95	45.80543416 N	84.7652347 W	
E-31	32	1	22' to E32B North	36	34	36	42	42	37	South/Clay	95	45.80549271 N	84.76521037 W	No
										North/Clay	96	45.80558613 N	84.76517358 W	

E-39	77	1	58' to E-31	63	74	83	67	78	66	South/Clay	98	45.80573967 N	84.76511784 W	Yes
										North/Sand	98	45.80590475 N	84.76505337 W	
E-40A	20	1	370' to E39	22	85	82	80	90	97	South/Sand	103	45.80688466 N	84.7646828 W	No
										North/Anchor (2014)	104	45.80694103 N	84.7646623 W	
E-40B	63	1	Shared Touch Down ^	60						South/Anchor (2014)	104	45.80694103 N	84.7646623 W	No
										North/Sand	104	45.80709655 N	84.76459532 W	
E-46	46	1	220' to E40B	46	86	93	82	72	58	South/Sand	104	45.80767814 N	84.76437691 W	No
										North/Anchor (2006)	104	45.80780151 N	84.76433045 W	
E-45A	59	1	Shared Touch Down ^	58	53	50	49	62	72	South/Anchor (2006)	104	45.80780151 N	84.76433045 W	No
										North/Anchor (2014)	104	45.80795517 N	84.76427079 W	
E-45B	28	1	Shared Touch Down ^	28						South/Anchor (2014)	104	45.80795517 N	84.76427079 W	No
										North/Clay	102	45.80802708 N	84.76423847 W	
E-44	43	1	144' to E45B	45	45	37	33	40	37	South/Clay	100	45.80840536 N	84.76408996 W	No
										North/Clay	98	45.8085226 N	84.76403879 W	
E-43	52	1	67' to E44	56	54	54	59	54	54	South/Clay	102	45.80870068 N	84.76397628 W	No
										North/Clay	103	45.80884836 N	84.76391865 W	
E-42 South	46	1.5	41' to E43	39	45	91	97	97	103	South/Clay	103	45.80895719 N	84.76388102 W	No
										North/Anchor (2012)	103	45.80906046 N	84.76384057 W	
E-42 North	46	1.5	Shared Touch Down ^	46	52					South/Anchor (2012)	103	45.80906046 N	84.76384057 W	No
										North/Clay	101	45.80917946 N	84.7637909 W	
E-41	70	1	130' to E42 North	71	70	74	77	68	84	South/Clay	98	45.80952345 N	84.76366022 W	Yes
										North/Clay	97	45.80971147 N	84.76358754 W	
E-47A	39	1	141 to E41	45	76	75	75	74	75	South/Clay	98	45.81007932 N	84.76344236 W	No
										North/Anchor (2014)	100	45.81019925 N	84.76339755 W	
E-47B	33	1	Shared Touch Down ^	28						South/Anchor (2014)	100	45.81019925 N	84.76339755 W	No
										North/Clay	100	45.8102734 N	84.76336643 W	
E-48A	56	1.5	20' to E47	55	48	59	48	55		South/Clay	100	45.81032483 N	84.76334545 W	No
										North/Anchor (2005)	102	45.81047222 N	84.76329119 W	
E-48B South	56	1	Shared Touch Down ^	60	67	66	82	68		South/Anchor (2005)	102	45.81047222 N	84.76329119 W	No
										North/Anchor (2014)	101	45.81063345 N	84.7632324 W	
E-48B North	15		Shared Touch Down ^	14						South/Anchor (2014)	101	45.81063345 N	84.7632324 W	No
										North/Clay	101	45.81066737 N	84.76321778 W	
E-79	NA	NA	NA	NA	NA	Filled In	19	13		NA	NA	NA	NA	No
										NA	NA	NA	NA	
E-70	51	1	380' to E48B	52	53	54	53	47	52	South/Clay	110	45.81167843 N	84.76283521 W	No
										North/Clay	111	45.81181537 N	84.76278221 W	
E-66A South	21	1	3' to E70	22	22	97	89	97		South/Clay	111	45.81182421 N	84.76277945 W	No
										North/Anchor (2012)	111	45.81188319 N	84.7627559 W	
E-66A North	72	0.5	Shared Touch Down ^	72	77					South/Anchor (2012)	111	45.81188319 N	84.7627559 W	No
										North/Anchor (2005)	113	45.81207618 N	84.76267988 W	
E-66B	50	1	Shared Touch Down ^	52	56	89	89	81		South/Anchor (2005)	113	45.81207618 N	84.76267988 W	No
										North/Clay	113	45.81221358 N	84.76262661 W	

E-56A	39	1.5	32' to E66B	44	45	44	33			South/Clay	113	45.81229737 N	84.76259107 W	No
										North/Anchor (2006)	114	45.81241142 N	84.76254418 W	
E-56B	43	2	Shared Touch Down ^	46	44	42	48			South/Anchor (2006)	114	45.81241142 N	84.76254418 W	No
										North/Clay	112	45.81253217 N	84.76250017 W	
E-55	42	1	35' to E56B	46	45	46	41	50	43	South/Clay	113	45.8126226 N	84.76246303 W	No
										North/Clay	114	45.81274368 N	84.76241929 W	
E-54A	60	3	11' to E55	57	58	62	59	66		South/Clay	114	45.81277307 N	84.76240561 W	No
										North/Anchor (2005)	121	45.81292344 N	84.76234556 W	
E-54B	32	2.5	Shared Touch Down ^	33	32	37	39	29		South/Anchor (2005)	121	45.81292344 N	84.76234556 W	No
										North/Grout Bag (2001)	122	45.8130088 N	84.76231479 W	
E-53A	44	3	Grout Bags ^	44	44	38	33	43		South/Grout Bag (2001)	122	45.8130088 N	84.76231479 W	No
										North/Anchor (2005)	124	45.81312414 N	84.76226755 W	
E-53B	64	3	Shared Touch Down ^	60	57	64	71	63		South/Anchor (2005)	124	45.81312414 N	84.76226755 W	No
										North/Clay	127	45.8132822 N	84.76221172 W	
E-52A	10	2.5	11' toE53B	10	9	15	14	18		South/Clay	127	45.81330927 N	84.76220265 W	No
										North/Anchor (2012)	128	45.81333405 N	84.76219074 W	
E-52B	8	3	Shared Touch Down ^	8	8					South/Anchor (2012	128	45.81333405 N	84.76219074 W	No
										North/Clay	128	45.81335562 N	84.76218435 W	
E-49C	50	2	8 to E-52	51	48	46	36	53	44	South/Clay	129	45.81337589 N	84.76217535 W	No
										North/Anchor (2004)	133	45.81351091 N	84.76212131 W	
E-49B South	50	2	Shared Touch Down ^	42	86	85	82	87	101	South/Anchor (2004)	133	45.81351091 N	84.76212131 W	No
										North/Anchor (2014)	136	45.81362344 N	84.76208421 W	
E-49B North	39	2	Shared Touch Down ^	45						South/Anchor (2014)	136	45.81362344 N	84.76208421 W	No
										North/Anchor (2004)	139	45.81374064 N	84.76203766 W	
E-49A South	64	1	Shared Touch Down ^	67	87	75	93	95	86	South/Anchor (2004)	139	45.81374064 N	84.76203766 W	No
										North/Anchor (2014)	140	45.81391998 N	84.76197483 W	
E-49A North	23	1	Shared Touch Down ^	23						South/Anchor (2014)	140	45.81391998 N	84.76197483 W	No
										North/Clay	141	45.81397636 N	84.7619502 W	
E-58	66	3	87 to E49A North	62'	60	51	66	61	61	South/Clay	141	45.81420665 N	84.76187126 W	No
										North/Clay	144	45.81436938 N	84.76180643 W	
E-61A-A	52	3	196' to E58	57	52	47	59			South/Clay	137	45.81488776 N	84.76160874 W	No
										North/Anchor (2006)	145	45.81503694 N	84.76155307 W	
E-61A	66	4	Shared Touch Down ^	63	65	61	68	120	129	South/Anchor (2006)	145	45.81503694 N	84.76155307 W	No
										North/Anchor (2004)	145	45.81520235 N	84.76149042 W	
E-61B South	46	4	Shared Touch Down ^	46	52					South/Anchor (2004)	145	45.81520235 N	84.76149042 W	No
										North/Anchor (2012)	148	45.81532105 N	84.76144352 W	
E-61B North	68	3	Shared Touch Down ^	70	62	114	113	115	125	South/Anchor (2012)	148	45.81532105 N	84.76144352 W	No
										North/Anchor (2004)	147	45.81550142 N	84.76137607 W	
E-61C South	54	3	Shared Touch Down ^	57	61	85	90	83	78	South/Anchor (2004)	147	45.81550142 N	84.76137607 W	No
										North/Anchor (2012)	142	45.81564713 N	84.76132398 W	
E-61C North	29	2.5	Shared Touch Down ^	29	31					South/Anchor (2012)	142	45.81564713 N	84.76132398 W	No
										North/Clay	139	45.81572031 N	84.76129539 W	

E-62	40	1.5	41' to E61C	39	37	32	29	38	34	South/Clay	135	45.81582864 N	84.76125214 W	No
										North/Clay	130	45.81593382 N	84.76121499 W	
E-63	21	1	9' to E61	21	18	23	22	22	15	South/Clay	129	45.81595831 N	84.76120677 W	No
										North/Clay	130	45.81601262 N	84.7611857 W	
E-64	49	1	20' to E63	49	52	47	51	48	52	South/Clay	132	45.81606385 N	84.76116825 W	No
										North/Clay	132	45.81619121 N	84.76111823 W	
E-22A	67	4	38 to E64	70	76	80	74	76	79	South/Clay	130	45.81629124 N	84.76108022 W	No
										North/Anchor (2014)	130	45.81647888 N	84.76100317 W	
E-22B	12	1	Shared Touch Down ^	7						South/Anchor (2014)	130	45.81647888 N	84.76100317 W	No
										North/Clay	130	45.81649739 N	84.76099431 W	
E-21	50	0.5	40' to E22	53	50	43	48	52	51	South/Clay	128	45.81660352 N	84.76095383 W	No
										North/Clay	129	45.81674293 N	84.7608986 W	
E-20	NA	NA	NA	NA	NA	Filled In	23	25		NA	NA	NA	NA	No
										NA	NA	NA	NA	
E-19A South	23	0.5	67 to E21	23	75	87	76	78	107	South/Clay	133	45.81692151 N	84.76083215 W	No
										North/Anchor (2014)	136	45.8169808 N	84.76080731 W	
E-19A North	60	0.5	Shared Touch Down ^	60						South/Anchor (2014)	136	45.8169808 N	84.76080731 W	No
										North/Anchor (2003)	140	45.81714033 N	84.7607472 W	
E-19B South	59	1	Shared Touch Down ^	58	82	75	80	81	73	South/Anchor (2003)	140	45.81714033 N	84.7607472 W	No
										North/Anchor (2014)	144	45.81729393 N	84.76068901 W	
E-19B North	23	0.5		24						South/Anchor (2014)	144	45.81729393 N	84.76068901 W	No
										North/Clay	145	45.81735826 N	84.76066463 W	
E-18B	24	0.5	33'to E19B North	22	23	25	22	25	16	South/Clay	148	45.81744163 N	84.76063246 W	No
										North/Clay	151	45.81749679 N	84.76061139 W	
E-18C	8	0.5	6' to E18B	15	Silted in	16				South/Clay	151	45.81750978 N	84.7606076 W	No
										North/Clay	154	45.81754778 N	84.760593 W	
E-18A	16	0.5	4' to E18C	17	16	21	22	18	29	South/Clay	154	45.8175558 N	84.76058925 W	No
										North/Clay	156	45.81759883 N	84.76057257 W	
E-17	32	0.5	33' to E18A	38	39	36	40	31	44	South/Clay	161	45.81768298 N	84.76054041 W	No
										North/Clay	167	45.81778351 N	84.7605004 W	
E-16	38	2.5	58' to E17	42	38	48	36	38	47	South/Clay	175	45.81793523 N	84.76044082 W	No
										North/Clay	184	45.81804614 N	84.76039472 W	
E-15A	25	1	4' to E16	28	31	29	25	28		South/Sand	184	45.81805592 N	84.76039102 W	No
										North/Anchor (2005)	192	45.81812989 N	84.7603635 W	
E-15B	50	1	Shared Touch Down ^	50	52	52	51	47		South/Anchor (2005)	204	45.81812989 N	84.7603635 W	No
										North/Grout Bag (2001)	203	45.81826147 N	84.76031158 W	
E-08A	56	1	Grout Bags ^	58	56	54	65	56	62	South/Grout Bag (2001)	203	45.81826147 N	84.76031158 W	No
										North/Anchor (2003)	216	45.81841688 N	84.7602534 W	
E-8B	71	2	Shared Touch Down ^	69	70	71	66	73		South/Anchor (2003)	216	45.81841688 N	84.7602534 W	No
										North/Anchor (2005)	224	45.81859712 N	84.76018457 W	
E-08C/D South	51	3	Shared Touch Down ^	58	76	39	79	97		South/Anchor (2005)	224	45.81859712 N	84.76018457 W	No
						20				North/Anchor (2014)	227	45.81875079 N	84.7601283 W	

E-08C/D North	35	2	Shared Touch Down ^	18						South/Anchor (2014)	227	45.81875079 N	84.7601283 W	No
										North/Sand	227	45.8187984 N	84.76010964 W	
E-09	33	0.5	25 to E08C/D North	35	41	33	33	40	39	South/Sand	229	45.81886442 N	84.76009022 W	No
										North/Sand	230	45.81895739 N	84.76005737 W	
E-10	47	2	72 to E09	47	52	50	49	44		South/Clay	229	45.81914977 N	84.75998662 W	No
										North/Clay	230	45.81927332 N	84.75993637 W	
E-11	70	2	4' to E10	66	63	70	74	69		South/Clay	230	45.81928482 N	84.75993198 W	Yes
										North/Clay	228	45.819459 N	84.75986295 W	
E-12	34	1	58' to E11	34	39	41	88	81	81	South/Clay	228	45.81963584 N	84.75979216 W	No
										North/Clay	227	45.81972489 N	84.75975827 W	
E-13A	29	1	65' to E12	29	27	32	40	34	36	South/Clay	228	45.81989427 N	84.75969496 W	No
										North/Anchor (2004)	230	45.81997078 N	84.75966271 W	
E-13B South	56	1	Shared Touch Down ^	58	56	106	116	112	115	South/Anchor (2004)	230	45.81997078 N	84.75966271 W	No
										North/Anchor (2010)	228	45.82012417 N	84.75960843 W	
E-13B North	56	1	Shared Touch Down ^	57	56					South/Anchor (2010)	228	45.82012417 N	84.75960843 W	No
										North/Anchor (2004)	226	45.82027847 N	84.75955349 W	
E-13C South	53	1.5	Shared Touch Down ^	51	48	107	105	99	102	South/Anchor (2004)	226	45.82027847 N	84.75955349 W	No
										North/Anchor (2010)	225	45.82041043 N	84.75949691 W	
E-13C North	52	1.5	Shared Touch Down ^	52	56					South/Anchor (2010)	225	45.82041043 N	84.75949691 W	No
										North/Clay	216	45.82055076 N	84.75944415 W	
E-3A	26	1	133' to E13C North	27	87	76	68	90	62	South/Clay	217	45.82090248 N	84.75931622 W	No
										North/Anchor (2014)	221	45.82097424 N	84.75928534 W	
E-3B	43	1	Shared Touch Down ^	53						South/Anchor (2014)	221	45.82097424 N	84.75928534 W	No
										North/Anchor (2005)	217	45.82111266 N	84.75922939 W	
E-76A	12	1	11' to E3B	58	58	10	18			South/Clay	217	45.82114141 N	84.75921794 W	No
E-76B	56									North/Clay	217	45.82129123 N	84.75915826 W	
E-02A South	20	0.5	238' to E76A/B	15	76	80	80			South/Sand	218	45.82192295 N	84.75892028 W	No
										North/Anchor (2014)	218	45.82195983 N	84.75890383 W	
E-02A North	45	0.5	Shared Touch Down ^	55						South/Anchor (2014)	218	45.82195983 N	84.75890383 W	No
										North/Anchor (2006)	218	45.82210278 N	84.75884748 W	
E-02B	28	0.5	Shared Touch Down ^	26	32	30	33			South/Anchor (2006)	218	45.82210278 N	84.75884748 W	No
										North/Sand	216	45.82217149 N	84.75882614 W	
E-01A South	22	2.5	20' to E02B	28	81	85	84	88	88	South/Sand	216	45.82222505 N	84.75880875 W	No
										North/Anchor (2014)	217	45.82229766 N	84.75878027 W	
E-01A North	62	2	Shared Touch Down ^	53						South/Anchor (2014)	217	45.82229766 N	84.75878027 W	No
										North/Anchor (2003)	217	45.82244184 N	84.7587229 W	
E-01B-A South	53	3	Shared Touch Down ^	53	39	100	96	96	107	South/Anchor (2003)	217	45.82244184 N	84.7587229 W	No
										North/Anchor (2012)	212	45.82258353 N	84.75866685 W	
E-01B-A North	43	2	Shared Touch Down ^	43	53					South/Anchor (2012)	212	45.82258353 N	84.75866685 W	No
										North/Anchor (2004)	206	45.82269559 N	84.75862499 W	
E-01B-B	53	2	Shared Touch Down ^	48	82	62	74	68	65	South/Anchor (2004)	206	45.82269559 N	84.75862499 W	No
										North/Sand	197	45.82282173 N	84.75857538 W	

E-04A South	13	1	83' to E-01B-B	17	84	82	84	101		South/Sand	186	45.82304007 N	84.75848688 W	No
										North/Anchor (2014)	185	45.82308056 N	84.7584657 W	
E-04A North	64	1	Shared Touch Down ^	59						South/Anchor (2014)	185	45.82308056 N	84.7584657 W	No
										North/Anchor (2006)	176	45.8232365 N	84.75840367 W	
E-04B	20	1	Shared Touch Down ^	19	20	26	23	101		South/Anchor (2006)	176	45.8232365 N	84.75840367 W	No
										North/Sand	173	45.82328669 N	84.75838476 W	
E-05A South	12	1	37' to E04B	27	80	75	82	77	74	South/Sand	169	45.82338631 N	84.75834799 W	No
										North/Anchor (2014)	166	45.82345562 N	84.75831776 W	
E-05A North	61	1	Shared Touch Down ^	55						South/Anchor (2014)	166	45.82345562 N	84.75831776 W	No
										North/Anchor (2003)	157	45.82360285 N	84.75826104 W	
E-05B	60	1	Shared Touch Down ^	67	65	63	62	57	61	South/Anchor (2003)	157	45.82360285 N	84.75826104 W	No
										North/Sand	146	45.8237806 N	84.75819081 W	
E-06	58	1	228' to E-05B	52	60	60	76	65	67	South/Sand	116	45.8243827 N	84.75795786 W	No
										North/Sand	111	45.82452008 N	84.75790456 W	
E-07	60	0.5	54' to E06	52	62	72	74	69	70	South/Sand	104	45.82465949 N	84.75784771 W	No
										North/Sand	97	45.82479445 N	84.75779612 W	
E-65A	56	0.5	458' to E07	62	64	67	67	59		South/Sand	66	45.82600507 N	84.75733017 W	No
										North/Anchor (2005)	66	45.82617024 N	84.75726365 W	
E-65B	58	1	Shared Touch Down ^	61	61	60	65	64		South/Anchor (2005)	66	45.82617024 N	84.75726365 W	No
										North/Sand	66	45.8263332 N	84.75720272 W	
Northern Exposure Point	NA	NA	148' to E-65B	NA	NA	NA	NA	NA	NA	Only/Sand	62	45.82672766 N	84.75706154 W	No

__Appendix C: West lateral report__

Span Identifier	Prelim 2016 Length	2014 Span Height	2014 Support Length	2014 Length	2012 Length	2010 Length	2007 Length	2006 Length	2005 Length	Touch Down Position and Type (Year Install)	Support Depth	Latitude	Longitude	Designated For Repair in 2016
Southern Exposure Point		NA	NA	NA	NA	NA	NA	NA	NA	Only/Sand	65	45.79570801 N	84.77389377 W	No
W-01A	60	2.5	760' to pipe bury	66	65	79	63	66	71	South/Sand	74	45.79772369 N	84.77314096 W	No
										North/Anchor (2003)	75	45.79789806 N	84.77307274 W	
W-01B South	62	2.5	Shared Touch Down ^	59	80	79	83	77	80	South/Anchor (2003)	75	45.79789806 N	84.77307274 W	No
										North/Anchor (2014)	75	45.79805619 N	84.7730173 W	
W-01B North	21		Shared Touch Down ^	21						South/Anchor(2014)	75	45.79805619 N	84.7730173 W	No
										North/Sand	75	45.79810962 N	84.77299804 W	
W-5	78	1	651' to W01B	71	70	81	83	80	74	South/Sand	75	45.79983894 N	84.77235059 W	Yes
										North/Sand	71	45.80002695 N	84.77228089 W	
W-77	NA	----	----	NA	Silted in	37	25	24	11	NA	NA	NA	NA	No
										NA	NA	NA	NA	
W-4	13	1	215' to W5	12	16	13	18	18	14	South/Sand	70	45.8005966 N	84.77206933 W	No
										North/Sand	70	45.80062778 N	84.77205516 W	

W-3	43	1.5	3' to W4	42	43	39	41	31	22	South/Sand	71	45.8006356 N	84.77205235 W	No
										North/Sand	71	45.80074826 N	84.77201133 W	
W-2A	57	1.5	4' to W3	53	52	54	54	53		South/Sand	70	45.80076595 N	84.77200487 W	No
										North/Anchor (2006)	72	45.80090546 N	84.77195411 W	
W-2B	12	1.5	Shared Touch Down ^	12	14	10	10	10		South/Anchor (2006)	72	45.80090546 N	84.77195411 W	No
										North/Sand	70	45.80093427 N	84.77193985 W	
W-6A	37	2	11'to W2B	40	72	83	82	72	68	South/Clay	70	45.80096456 N	84.7719274 W	No
										North/Anchor (2014)	70	45.80107298 N	84.77189363 W	
W-6B	35		Shared Touch Down ^	32						South/Anchor(2014)	70	45.80107298 N	84.77189363 W	No
										North/Clay	72	45.80115633 N	84.77185761 W	
W-7	52	2	84' to W6	47	46	Merged 50	34	22	33	South/Clay	70	45.8013792 N	84.77176906 W	No
W-8							22	17	23	North/Clay	70	45.80150413 N	84.77171663 W	
W-9	52	2.5	40' to W7-8	51	53	53	65	55	57	South/Clay	66	45.80160803 N	84.77167766 W	No
										North/Clay	72	45.80174235 N	84.77162408 W	
W-11	52	2.5	114' to W-9	48	52	47	40	46	49	South/Sand	72	45.80204636 N	84.77152015 W	No
										North/Sand	77	45.80216995 N	84.77145889 W	
W-10	65	3	183' to W-11	66	64	69	63	63	53	South/Sand	79	45.80265731 N	84.77128597 W	No
										North/Sand	83	45.80283001 N	84.77120879 W	
W-12A	33	1.5	133' to W10	35	43	91	94	95	97	South/Sand	88	45.80318394 N	84.77107992 W	No
										North/Anchor (2012)	88	45.80327592 N	84.7710389 W	
W-12B	54	1.5	Shared Touch Down ^	56'	46					South/Anchor (2012)	88	45.80327592 N	84.7710389 W	No
										North/Sand	88	45.80342375 N	84.77098542 W	
W-13A	28	3	65'to W12 North	28'	83	87	90	76	75	South/Sand	86	45.80359866 N	84.7709303 W	No
										North/Anchor (2014)	90	45.80367382 N	84.77090546 W	
W-13B	46		Shared Touch Down ^	54						South/Anchor (2014)	90	45.80367382 N	84.77090546 W	No
										North/Sand	91	45.8038143 N	84.7708486 W	
W-14	49	1.5	31' to W13	51	54	51	74	62	48	South/Sand	92	45.803895 N	84.77081842 W	No
										North/Sand	94	45.80402656 N	84.7707635 W	
W-16	44	0.5	24' to W14	40	44	45	42	48	36	South/Sand	94	45.8040894 N	84.77073743 W	No
										North/Sand	95	45.80419549 N	84.77069364 W	
W-15	40	0.5	260' to W-16	37	37	38	39	45	37	South/Sand	96	45.80488293 N	84.7704441 W	No
										North/Sand	97	45.80498015 N	84.77040304 W	
W-17	NA				NA	Filled in	23	36	26	NA	NA	NA	NA	No
										NA	NA	NA	NA	
W-18A_A	12	2	162' to W-15	8	14	15	15	16		South/Sand	105	45.80541373 N	84.77023722 W	No
										North/Anchor (2006)	106	45.80543625 N	84.77022891 W	
W-18A South	46	2.5	Shared Touch Down ^	42	42	41	100	99		South/Anchor (2006)	106	45.80543625 N	84.77022891 W	No
										North/Anchor (2010)	113	45.80554847 N	84.7701857 W	
W-18A North	52	2	Shared Touch Down ^	55	55	55				South/Anchor (2010)	113	45.80554847 N	84.7701857 W	No
										North/Anchor (2004)	117	45.80569713 N	84.77013121 W	
W-18B South	56	1	Shared Touch Down ^	62	82	91	93	87	95	South/Anchor (2004)	117	45.80569713 N	84.77013121 W	No

										North/Anchor (2014)	120	45.80586207 N	84.77007142 W	
W-18B North	26		Shared Touch Down ^	24						South/Anchor (2014)	120	45.80586207 N	84.77007142 W	No
										North/Sand	120	45.80592331 N	84.77004434 W	
W-20	34	0.5	48' to W18B	22'	27	47	45	46	49	South/Sand	122	45.80605223 N	84.77000235 W	No
										North/Sand	122	45.80610853 N	84.76997572 W	
W-24A	12	2.5	38' to W-20	12	17	90	82	86	87	South/Sand	122	45.80620743 N	84.76993569 W	No
										North/Anchor (2012)	123	45.80623916 N	84.76992226 W	
W-24B	68	2	Shared Touch Down ^	70	69					South/Anchor (2012)	123	45.80623916 N	84.76992226 W	Yes
										North/Sand	122	45.80642502 N	84.76984642 W	
W-23A	60	0.5	21' to W-24 North	49	63	63	62	61	68	South/Sand	123	45.80648154 N	84.76982185 W	No
										North/Anchor (2004)	124	45.80661144 N	84.76977471 W	
W-23B	36	1	Shared Touch Down ^	36	23	57	57	56	56	South/Anchor (2004)	124	45.80661144 N	84.76977471 W	No
										North/Sand	124	45.80670768 N	84.76973934 W	
W-22	34	2	66' to W-23B	30	33	34	31	37	39	South/Sand	124	45.80688201 N	84.76967483 W	No
										North/Sand	123	45.80696092 N	84.76964449 W	
W-21	53	2	61' to W-22	51	50	60	58	65	59	South/Sand	124	45.80712413 N	84.76958849 W	No
										North/Sand	126	45.80725987 N	84.76954174 W	
W-25	NA			NA	Silted in	9	30	34	41	NA	NA	NA	NA	No
										NA	NA	NA	NA	
W-26	68	1	226' to W-21	54	53	66	71	72	64	South/Sand	126	45.8078569 N	84.76930883 W	No
										North/Sand	128	45.8079986 N	84.76925521 W	
W-27	NA		NA	NA	Silted in	12	17	23	19	NA	NA	NA	NA	No
										NA	NA	NA	NA	
W-30	62	1.5	160 to W-26	54	57	62	62	62	60	South/Sand	130	45.80842054 N	84.76909002 W	No
										North/Sand	132	45.80856243 N	84.76903767 W	
W-28A South	10	3	156' to W-30	6	70	77	77	84	73	South/Clay	132	45.80897784 N	84.76888725 W	No
										North/Anchor (2014)	133	45.80899415 N	84.76888196 W	
W-28A North	64		Shared Touch Down ^	65						South/Anchor (2014)	133	45.80899415 N	84.76888196 W	No
										North/Anchor (2003)	135	45.80916534 N	84.76881592 W	
W-28B	54	2	Shared Touch Down ^	59	67	70	50	58	58	South/Anchor (2003)	135	45.80916534 N	84.76881592 W	No
										North/Clay	133	45.80932154 N	84.76874888 W	
W-28	33	1	15' to W28B	35	30	34	34	30	28	South/Clay	133	45.80936143 N	84.76873716 W	No
										North/Clay	133	45.80945076 N	84.76870155 W	
W-76	NA				Silted in	20	16	18		NA	NA	NA	NA	No
										NA	NA	NA	NA	
W-31A South	46	0.5	116' to W-28	38	90	90	89	92	92	Clay	132	45.80975754 N	84.76858567 W	No
										North/Anchor (2014)	134	45.80985984 N	84.76855131 W	
W-31A North	42		Shared Touch Down ^	51						South/Anchor (2014)	134	45.80985984 N	84.76855131 W	No
										North/Anchor (2004)	134	45.80999344 N	84.76849255 W	
W-31B South	42	0.5	Shared Touch Down ^	54	78	75	86	83	84	South/Anchor (2004)	134	45.80999344 N	84.76849255 W	No
										North/Anchor (2014)	135	45.81014042 N	84.7684405 W	

W-31B North	35		Shared Touch Down ^	25						South/Anchor (2014)	135	45.81014042 N	84.7684405 W	No
										North/Grout Bags (2001)	134	45.81020833 N	84.76841199 W	
W-34A	29	0.5	14' to W-31B North	26	Silted in	17	10	17		South/Sand	134	45.81024645 N	84.76840035 W	No
										North/Anchor (2006)	134	45.81031762 N	84.76836946 W	
W-34B South	63	1	Shared Touch Down ^	64	64	97	108	110		South/Anchor (2006)	134	45.81031762 N	84.76836946 W	No
										North/Anchor (2010)	133	45.81048695 N	84.76830706 W	
W-34B North	36	1	Shared Touch Down ^	38	35					South/Anchor (2010)	133	45.81048695 N	84.76830706 W	No
										North/Sand	130	45.81058605 N	84.76827156 W	
W-37A	47	1	37' to W-34B North	43	79	76	79	101		South/Sand	129	45.81068589 N	84.76823233 W	No
										North/Anchor (2014)	130	45.8108011 N	84.76819354 W	
W-37B	34		Shared Touch Down ^	36						South/Anchor (2014)	130	45.8108011 N	84.76819354 W	No
										North/Sand	130	45.81089642 N	84.76815787 W	
W-36A	36	1.5	29' to W37	37	37	38	39	38		South/Sand	127	45.81097249 N	84.76812596 W	No
										North/Anchor (2006)	127	45.81107112 N	84.76809122 W	
W-36B	53	1.5	Shared Touch Down ^	54	50	51	53	49		South/Anchor (2006)	127	45.81107112 N	84.76809122 W	No
										North/Grout Bags (2001)	126	45.81121511 N	84.76804264 W	
W-35A	29	0.5	Shared Touch Down ^	27	32	33	25	31	33	South/Grout Bags (2001)	126	45.81121511 N	84.76804264 W	No
										North/Anchor (2004)	125	45.81128571 N	84.76801092 W	
W-35B South	66	0.5	Shared Touch Down ^	61	79	89	90	90	87	South/Anchor (2004)	125	45.81128571 N	84.76801092 W	No
										North/Anchor (2014)	121	45.81144798 N	84.76795339 W	
W-35B North	17		Shared Touch Down ^	24						South/Anchor (2014)	121	45.81144798 N	84.76795339 W	No
										North/Sand	119	45.81150905 N	84.76792436 W	
W-38	66	1	68' to W35B	59	Merged 53	47	36	31	34	South/Sand	120	45.81168887 N	84.76784301 W	No
W-39						26	27	31	17	North/Anchor (2005)	122	45.81184558 N	84.76778121 W	
W-40	44	1	Shared Touch Down ^	45	44	50	46	44	54	South/Anchor (2005)	122	45.81184558 N	84.76778121 W	No
										North/Sand	124	45.81196638 N	84.76774431 W	
W-41A South	38	1.5	170' to W40	37	42	90	87	88	87	South/Sand	131	45.8124196 N	84.76757785 W	No
										North/Anchor (2012)	138	45.8125168 N	84.76753502 W	
W-41A North	46	1.5	Shared Touch Down ^	48	49					South/Anchor (2012)	138	45.8125168 N	84.76753502 W	No
										North/Anchor (2004)	143	45.8126456 N	84.76748895 W	
W-41B	67	1	Shared Touch Down ^	69	66	73	73	68	65	South/Anchor (2004)	143	45.8126456 N	84.76748895 W	Yes
										North/Sand	150	45.81282522 N	84.76741618 W	
W-43A	65	2	32 to W-41B	64	64	63	59	64	68	South/Sand	154	45.81290732 N	84.7673873 W	Yes
										North/Anchor (2003)	162	45.81307278 N	84.76732484 W	
W-43B	65	2	Shared Touch Down ^	65	68	67	69	64	62	South/Anchor (2003)	162	45.81307278 N	84.76732484 W	No
										North/Clay/Mountain	169	45.81324384 N	84.76726106 W	
W-42A	70	1.5	18' to W43B	71	70	72	67	73	73	South/Clay/Mountain	169	45.81329129 N	84.76724157 W	No
										North/Anchor (2003)	168	45.81348091 N	84.76717734 W	
W-42B	69	1	Shared Touch Down ^	67	71	71	77	69	75	South/Anchor (2003)	168	45.81348091 N	84.76717734 W	Yes
										North/Sand	164	45.81366089 N	84.76711461 W	
W-45	29	0.5	9' to W42B	35	27	25	27	26	24	South/Sand	163	45.81368538 N	84.76710678 W	No

										North/Sand	163	45.81377639 N	84.76707143 W	
W-46	48	1	50' to W45	54	44	53	82	82	77	South/Sand	163	45.81390759 N	84.76701534 W	No
										North/Sand	163	45.81405037 N	84.76696836 W	
W-47	41	1.5	150' to W46	41	37	61	69	67	62	South/Clay	172	45.81444824 N	84.76681747 W	No
										North/Clay	170	45.81455828 N	84.76677736 W	
W-51A	16	1.5	20' to W47	16	14	14	11	20		South/Clay	170	45.81461201 N	84.76675686 W	No
										North/Anchor (2006)	170	45.81465648 N	84.7667401 W	
W-51B South	57	1	Anchor	58	82	84	81	80		South/Anchor (2006)	170	45.81465648 N	84.7667401 W	No
										North/Anchor (2014)	174	45.81481348 N	84.76668449 W	
W-51B North	26			24						South/Anchor (2014)	174	45.81481348 N	84.76668449 W	No
										North/Clay	172	45.81487608 N	84.76665789 W	
W-50	13	0.5	38' to W51B	20	Filled in	23	18	26	12	South/Clay	172	45.81497406 N	84.76661907 W	No
										North/Clay	172	45.81502565 N	84.76660073 W	
W-49	50	1.5	29' to W50	50	54	52	61	47	47	South/Clay	172	45.81510113 N	84.76656607 W	Yes
										North/Clay	170	45.81523798 N	84.76652427 W	
W-48A	58	1	3' to W49	54	61	57	60	59	63	South/Clay	170	45.81524574 N	84.76652191 W	Yes
										North/Anchor (2003)	177	45.81539218 N	84.76646868 W	
W-48B	65	1	Shared Touch Down ^	63	67	79	59	72	66	South/Anchor (2003)	177	45.81539218 N	84.76646868 W	Yes
										North/Clay	176	45.81555569 N	84.76639198 W	
W-52	62	1	14' to W48B	59	60	91	61	63	66	South/Clay	175	45.81559247 N	84.76637538 W	No
										North/Clay	174	45.81574877 N	84.76632003 W	
W-53A	77	1	96' to W52	69	67	77	67	75		South/Clay	169	45.8160056 N	84.76622468 W	Yes
										North/Anchor (2005)	169	45.81618886 N	84.76615963 W	
W-53B	32	0.5	Shared Touch Down ^	26	25	31	42	39		South/Anchor (2005)	169	45.81618886 N	84.76615963 W	No
										North/Clay	170	45.81625886 N	84.76613285 W	
W-70 A	44	0.5	109' to W53B	42	43	114	100	109		South/Clay	172	45.81654866 N	84.76602166 W	No
										North/Anchor (2010)	175	45.81666162 N	84.76597665 W	
W-70 B	24	0.5	Shared Touch Down ^	36	25					South/Anchor (2010)	175	45.81666162 N	84.76597665 W	No
										North/Clay	175	45.81675578 N	84.76594127 W	
W-69	77	0.5	55' to W70B	64	70	96	98	81	88	South/Clay	178	45.81690174 N	84.76588593 W	Yes
										North/Clay	182	45.81707239 N	84.76582266 W	
W-68A South	13	1	105' to W69	11	77	85	75	83	69	South/Clay	190	45.81735651 N	84.7657183 W	No
										North/Anchor (2014)	192	45.8173852 N	84.76570621 W	
W-68A North	65		Shared Touch Down ^	66						South/Anchor (2014)	192	45.8173852 N	84.76570621 W	No
										North/Anchor(2003)	191	45.81756257 N	84.7656429 W	
W-68B	45	1	Shared Touch Down ^	62	60	43	48	41	50	South/Anchor (2003)	191	45.81756257 N	84.7656429 W	No
										North/Clay	196	45.81772359 N	84.76557989 W	
W-71A	27	1	88' to W68B	26	77	84	81	84	67	SouthClay	217	45.81795369 N	84.76549024 W	No
										North/Anchor (2014)	224	45.81802422 N	84.76546477 W	
W-71B	45		Shared Touch Down ^	55						South/Anchor (2014)	224	45.81802422 N	84.76546477 W	No
										North/Anchor (2003)	232	45.81816946 N	84.76541244 W	

W-72A South	50	1.5	Shared Touch Down ^	57	57	105	107	108	108	South/Anchor (2003)	232	45.81816946 N	84.76541244 W	No
										North/Anchor (2012)	232	45.81831983 N	84.76535345 W	
W-72A North	55	1	Shared Touch Down ^	47	47					South/Anchor (2012)	232	45.81831983 N	84.76535345 W	No
										North/Anchor (2004)	238	45.81844653 N	84.76530393 W	
W-72B South	32	1.5	Shared Touch Down ^	35	36	100	100	98	99	South/Anchor (2004)	238	45.81844653 N	84.76530393 W	No
										North/Anchor (2012)	242	45.81854156 N	84.76526921 W	
W-72B North	65	1.5	Shared Touch Down ^	61	61					South/Anchor (2012)	242	45.81854156 N	84.76526921 W	No
										North/Anchor (2004)	246	45.81870788 N	84.76521301 W	
W-72C	54	2	Shared Touch Down ^	54	59	56	65	52	56	South/Anchor (2004)	246	45.81870788 N	84.76521301 W	No
										North/Clay	244	45.81885056 N	84.76516087 W	
W-75	59	1	19' to W72C	61	52	77	57	54	44	South/Clay	243	45.81890246 N	84.76513828 W	No
										North/Clay	241	45.819066 N	84.76508084 W	
W-56	54	1	72' to W75	57	59	67	58	60	61	South/Clay	237	45.81925852 N	84.76501189 W	No
										North/Clay	238	45.81940715 N	84.76495466 W	
W-78	NA				NA	Filled in	16	15		NA	NA	NA	NA	No
										NA	NA	NA	NA	
W-54A	57	1	172' to W56	56	56	55	53	60		South/Clay	234	45.81986479 N	84.7647835 W	No
										North/Anchor (2005)	232	45.82001287 N	84.76473484 W	
W-54B	51	1.5	26' to W54A	51	49	88	87	86		South/Clay	232	45.82008325 N	84.76470314 W	No
										North/Clay	232	45.8202238 N	84.76465785 W	
W-57A	47	2.5	65' to W54B	43	79	77	67	78	75	South/Clay	230	45.82040018 N	84.76459954 W	No
										North/Anchor (2014)	230	45.8205126 N	84.76455633 W	
W-57B	30		Shared Touch Down ^	40						South/Anchor (2014)	230	45.8205126 N	84.76455633 W	No
										North/Clay	228	45.82061962 N	84.76451859 W	
W-59A-A	NA				Silted in	6	33			NA	NA	NA	NA	No
										NA	NA	NA	NA	
W-59A South	37	2.5	319' to W-57	36	45	90	91	130		South/Anchor (2006)	221	45.82146702 N	84.76420828 W	No
										North/Anchor (2012)	221	45.82156234 N	84.76416991 W	
W-59A North	47	2.5	Shared Touch Down ^	53	47					South/Anchor (2012)	221	45.82156234 N	84.76416991 W	No
										North/Anchor (2003)	219	45.82170276 N	84.76412053 W	
W-59B South	41	3	Shared Touch Down ^	41	52	104	97	100		South/Anchor (2003)	219	45.82170276 N	84.76412053 W	No
										North/Anchor (2012)	219	45.82180891 N	84.7640712 W	
W-59B North	57	3	Shared Touch Down ^	56	45					South/Anchor (2012)	219	45.82180891 N	84.7640712 W	No
										North/Anchor (2003)	212	45.82195831 N	84.76401066 W	
W-58A South	61	2	Shared Touch Down ^	62	62	126	132	131		South/Anchor (2003)	212	45.82195831 N	84.76401066 W	No
										North/Anchor (2010)	207	45.82212511 N	84.76395711 W	
W-58A North	70	2.5	Shared Touch Down ^	70	70					South/Anchor (2010)	207	45.82212511 N	84.76395711 W	No
										North/Anchor (2003)	190	45.82230838 N	84.7638836 W	
W-58B	36	1.5	Shared Touch Down ^	35	36	38	30	28		South/Anchor (2003)	190	45.82230838 N	84.7638836 W	No
										North/Clay	183	45.8224028 N	84.76385368 W	
W-60A	58	1.5	137' to W58B	56	58	55	52	60	62	South/Clay	165	45.82276582 N	84.76370893 W	No

										North/Anchor (2003)	160	45.82291533 N	84.7636541 W	
W-60B South	51	2	Shared Touch Down ^	50	70	90	91	86	89	South/Anchor (2003)	160	45.82291533 N	84.7636541 W	No
										North/Anchor (2012)	155	45.82304668 N	84.76359861 W	
W-60B North	32	2	Shared Touch Down ^	33	20					South/Anchor (2012)	155	45.82304668 N	84.76359861 W	No
										North/Clay	148	45.82313538 N	84.76356789 W	
W-79	NA				Silted in	15	16			NA	NA	NA	NA	No
										NA	NA	NA	NA	
W-61A	30	1	83' to W60B	27	72	80	85	79	84	South/Clay	135	45.82335415 N	84.76349054 W	No
										North/Anchor (2014)	132	45.82342456 N	84.76346306 W	
W-61B	46		Shared Touch Down ^	45						South/Anchor (2014)	132	45.82342456 N	84.76346306 W	No
										North/Clay	125	45.82354201 N	84.76341513 W	
W-62	46	1	351 to W61	44	46	49	45	44	38	South/Sand	91	45.82447624 N	84.76309011 W	No
										North/Sand	89	45.82459253 N	84.76304185 W	
W-63A	56	1.5	282 to W-62	54	66	57	49	57	55	South/Sand	78	45.82534041 N	84.76275039 W	No
										North/Anchor (2004)	78	45.82548661 N	84.7626958 W	
W-63B	55	1.5	Shared Touch Down ^	53	50	54	54	49	51	South/Anchor (2004)	78	45.82548661 N	84.7626958 W	No
										North/Sand	76	45.8256262 N	84.76264017 W	
W-65A	43	1.5	185' to W-63B	50	77	90	82	86	80	South/Sand	74	45.82611694 N	84.76246404 W	No
										North/Anchor (2014)	74	45.82624713 N	84.76241517 W	
W-65B	26		Shared Touch Down ^	26						South/Anchor (2014)	74	45.82624713 N	84.76241517 W	No
										North/Sand	74	45.82631462 N	84.76238826 W	
W-64A	18	1	8' to W-65	18	20	90	89	90	80	South/Sand	73	45.82633776 N	84.76238098 W	No
										North/Anchor (2012)	73	45.82638189 N	84.76235928 W	
W-64B South	52	1	Shared Touch Down ^	29	71					South/Anchor (2012)	73	45.82638189 N	84.76235928 W	No
										North/Anchor (2014)	73	45.8264624 N	84.7623333 W	
W-64B North	26		Shared Touch Down ^	46						South/Anchor (2014)	72	45.8264624 N	84.7623333 W	No
										North/Sand	72	45.82658693 N	84.76228562 W	
W-67A	52	2'	98' to W-64N	41	89	87	89	100	86	South/Sand	72	45.8268466 N	84.76218543 W	No
										North/Anchor (2014)	72	45.82695668 N	84.762151 W	
W-67B	40		Shared Touch Down ^	50						South/Anchor (2014)	72	45.82695668 N	84.762151 W	No
										North/Sand	70	45.82708749 N	84.76210055 W	
W-66	42	1.5	196' to W-67	43	67	41	45	45	44	South/Sand	70	45.82760434 N	84.76191151 W	No
										North/Sand	70	45.82771752 N	84.76186138 W	
Northern Exposure Point		NA	100' to W-66	NA	NA	NA	NA	NA	NA	Only/Sand	65	45.82798472 N	84.76176355 W	No

Enbridge Response to Request for Information

A. Information currently available to Enbridge

1. Underwater Inspections- Please provide copies of all information available to Enbridge, including, without limitation, documents, reports, photographs, and video recordings, relating to any and all underwater inspections of the dual pipelines conducted after the completion of 2014 inspections performed by Ballard Marine Construction. This includes, but is not limited to, the 2016 underwater inspections referenced in the Plan.

Please find attached (1) a report prepared by Ballard Marine Construction ("BMC") summarizing the findings of the visual inspection of the Line 5 Dual Pipelines conducted for Enbridge in the Straits of Mackinac in 2016 and the repair work done following the inspection and (2) a report prepared by GEI Consultants ("GEI") summarizing the findings of the biota survey of the Dual Pipelines that the firm conducted for Enbridge based on the visual inspection conducted by BMC. These reports were previously submitted to the EPA on January 4, 2017. Also attached is a Supplemental Biota Work Plan submitted by Enbridge to EPA on March 23, 2017. Photographs of areas identified in both the original and supplemental Biota Work Plans are contained in the reports themselves.

BMC conducted a visual inspection of the portion of Line 5 that crosses the Straits in June 2016 and the results were analyzed in July 2016. The attached BMC report explains how the inspection was conducted and summarizes the findings of the inspection.

The attached GEI report describes a survey of biota undertaken based on the visual inspection made of the Dual Pipelines. The Enbridge biota work plan, currently pending approval by EPA, is based in part on the attached GEI report, which is referenced in the Enbridge Biota Work Plan.

Associated video files from the 2016 BMC underwater inspection are also being provided.

The materials provided constitute the key documents relating to the latest underwater inspection, which was performed by BMC in 2016.

2. Clarification and Documentation of Conditions referred to in the Plan- Please:

a. List and explain the criteria used by Enbridge to identify the "holiday" areas referred to in the Plan.

The 18 areas referred to in the Biota Work Plan were identified based on review of the video recording of the 2016 inspection. The areas identified included (i) areas where Biota was not present and (ii) areas where Biota was not present and the pipelines' outer wrap appeared to have anomalies. Enbridge intends to inspect all 18 locations, as per the Biota Work Plan and its supplement, in order to gather any relevant additional data about these areas. Depending on the results of these inspections, Enbridge will make a determination on whether a review of additional areas of the Dual Lines where there are similar or other potential anomalies in biota presence or the outer wrap would yield any additional useful data.

b. For each such identified "holiday" area or "locations with potential delaminated coatings" referred to in the Plan, including, but not limited to those designated in Figures 4 and 5,

i. Provide Enbridge's best estimate of the size of the "holiday" area

The estimated size of the each of the areas identified below in response to Request # A.2.b.v is between 2 – 10 ft2 (with <100ft2 total).

Execution of the Biota Work Plan may allow Enbridge to further assess and refine these estimates.

ii. Indicate whether, and to what extent, bare metal is exposed

Enbridge has seen no evidence that any of the areas identified in the Biota Work Plan as "holiday" areas or areas with "potential delaminated coating" have bare metal exposed. In addition, a CPCM inline inspection was completed and local cathodic protection currents were measured to determine if any bare metal was present. This inspection has not indicated that there are any holidays in the coating.

iii. Describe the "delamination" or other condition that has been observed, e.g., whether and to what extent one or more layer of pipeline wrap and/or coating is missing

In 8 of the identified areas, there is a lack of Biota, but no visible indication of anomalies to the coating and specifically to the outer wrap. In the remaining 10 identified areas, there is a lack of Biota and some indication of anomalies in the outer wrap. In all cases, all other layers of coating appear to be intact and unaffected, including the enamel layer that covers the pipeline.

iv. Indicate whether, and to what extent, "delaminated pipeline coatings" referred to in the Plan have been observed on the lake floor

There is one location (W-12A) among the 18 areas identified in the Biota Work Plan where the outer layer wrap was observed on the lake floor. See also Response to # A.2.c.iv below (regarding second area not referred to in the Biota Work Plan).

v. Identify the time or other frame markings on the 2014 and 2016 underwater video recordings that Enbridge used to identify the holiday area, and if photographs of that specific area are available, provide them.

In the supplied video from the 2016 visual inspection, the 18 identified areas can be seen at the following frame times.

Label	2016 Frame Markings
Between E-74 & E-71	9:27:25
Between E-77 & E-26	9:44:30
Between E-24 & E-25	9:56:50
E-30	10:36:10
E-35	10:47:20
Between E-33 & E-34B	11:02:45
E-39	11:40:04
Near E-48	12:36:44
Near E-70	12:43:44

Between E-02 & E76	14:59:08
E-01B-B	15:21:32
Between W-10 & W-11	9:38:15
W-12A	9:47:55
Between W-15 & W-16	10:33:00
W-35	12:15:23
W-70	13:28:50
W-68	13:46:40
Between W-56 & W-54	14:27:25

Photographs of these areas are contained in both the September 2016 Work Plan and the Supplemental Work Plan. Enbridge has utilized the most recent 2016 data as it provides the best picture of pipeline coating condition.

vi. Provide any document(s), graphs, or figures correlating the visual observations of that area with the results of previous in-line inspections of the same area.

When comparing the identified locations with past In-line Inspection data from corrosion tools, there is no evidence of external corrosion found at any of the locations.

The Cathodic Protection in-line inspection tool deployed on September 27, 2016, found that the coating was protecting the pipe at all locations including the 18 locations identified in the Biota Plan.

c. Indicate whether, in addition to the areas referred to in the Plan and covered in item 2.b., above, Enbridge or its contractors have observed any other areas on the dual pipelines where the external pipeline coating is damaged or absent. If any such other areas have been observed, for each such area, provide the information listed in 2.b. (i.)- (vi.)

i. Provide Enbridge's best estimate of the size of the "holiday" area

The estimated size of the each of the areas identified below in response to Request # A.2.c.v is between 0 – 20 ft2 (with <100ft2 total).

ii. Indicate whether, and to what extent, bare metal is exposed

Enbridge has seen no confirmed locations of bare metal exposed at any point on the lines as shown by inline inspection results, including at the areas addressed in response to Request A.2.b.ii above. Three areas identified in the Supplemental Biota Work Plan will be inspected to determine if any bare metal is exposed. Also, as mentioned previously, our 2016 CPCM inline inspection has not identified any areas of increased usage of cathodic protection indicating that our coating is performing as designed.

iii. Describe the "delamination" or other condition that has been observed, e.g., whether and to what extent one or more layer of pipeline wrap and/or coating is missing

Some areas seen in the 2016 inspection exhibit only a lack of Biota – no visible indication of anomalies to the coating and specifically to the outer wrap. There are also a number of areas where there is a lack of Biota plus some indication of anomalies in the outer wrap. The locations of the areas in the second category are listed in the table provided in response to Request A.2.c.v below. In all cases, all other layers of coating appear to be intact and unaffected.

iv. Indicate whether, and to what extent, "delaminated pipeline coatings" referred to in the Plan have been observed on the lake floor

There is one other location (E-02B) seen in the 2016 Inspection where the outer layer wrap was observed on the lake floor. As noted above, W-12A also has outer coating on the lake floor.

v. Identify the time or other frame markings on the 2014 and 2016 underwater video recordings that Enbridge used to identify the holiday area, and if photographs of that specific area are available, provide them.

In the supplied video for the 2016 visual inspection, the additional areas where the coating appears to have an anomaly can be seen at the following frame times.

Label	2016 Frame Markings, TIME
Between E-25 & E-24	9:54:23
Between E-39 & E-40	11:46:35
E-45	12:08:17
E-48B	12:34:20
E-52	13:17:00
E-61A-A	13:35:18
Between E-12 & E-13A	14:39:04
E-13C	14:48:40
Between E-13C & E-3	14:52:17
E-76B	14:57:15
Between E-76B & E-02A	15:01:21
Between E-76B & E-02A	15:02:44
Between E-76B & E-02A	15:03:37
E-02B	15:11:01
E-01B-A	15:20:10
E-04B	15:28:32
Between E-04B & E-05A	15:29:16
Between E-05B & E-06	15:36:32
Between E-05B & E-06	15:37:17
Between E-05B & E-06	15:37:58
E-07	15:42:18
Between E-07 & E-65A	15:48:21
Between E-65B & Burial	15:55:58
W-01A	8:33:04
Between W01B & W-5	8:40:15
Between W-15 & W-16	10:32:22

Between W-15 & W-16	10:33:41
Between W-15 & W-18	10:38:37
Between W-18B & W-20	10:51:50
W-24	10:56:45
W-24	10:58:38
W-23A	11:00:14
W-23B	11:04:08
Between W-22 & W-21	11:06:48
Between W-22 & W-21	11:07:25
Between W-25 & W-26	11:12:36
Between W-26 & W-27	11:16:54
W-27	11:18:17
W-28	11:36:30
W-31A	11:46:48
W-53A	13:15:03
W-53A	13:17:06
Between W-64 & W-67	15:59:57

vi. Provide any document(s), graphs, or figures correlating the visual observations of that area with the results of previous in-line inspections of the same area.

When comparing the identified locations with past In-line Inspection data from corrosion tools, there is no external corrosion found at any of the locations.

The Cathodic Protection in-line inspection tool deployed on September 27, 2016, found that the coating was protecting the pipe at all locations including the areas listed in the preceding response.

3. Any Other Pipeline Inspection Results or Reports Not Previously Provided to the State- To the extent, if any, that Enbridge has available to it the results or reports of any other inspections of the dual pipelines, including, but not limited to any in-line inspections, conducted after 2013, that have not previously been provided to the State please provide copies of any such inspection results or reports.

Reports or summaries of all in-line inspections of the dual pipelines conducted after 2013 other than those previously provided are attached. These reports include:

- 2016 BH CPCM Inspection (East Straits)
- 2016 BH GeoPig Inspection (East Straits)
- 2016 BH CPCM Inspection (West Straits)
- 2016 BH GeoPig Inspection (West Straits)
- 2015 Acoustic Emission Inspection (East Straits)
- 2015 Acoustic Emission Inspection (West Straits)

Part B: Information Available to Enbridge in the Future. Please provide as soon as possible, and in any event, not later than ten (10) days after the date that each becomes available to Enbridge:

1. The Final, EPA-Approved Work Plan for the Biota Investigation required under Paragraph 69.b. of the proposed Consent Decree.

Enbridge will provide a copy of the approved Work Plan when available.

2. The Final Report of the Biota Investigation and, if applicable, the proposed work plan to address actual or threatened impairments to the dual pipelines required under Paragraph 69.c. of the proposed Consent Decree.

Enbridge will provide a copy of the Final Biota Report when available.

3. Underwater Inspections- Please provide copies of all information that becomes available to Enbridge, including, without limitation, documents, reports, photographs, and video recordings, relating to any and all underwater inspections of the Dual Pipelines conducted after the completion of the 2016 inspection and not already provided in response to Item A.1., above.

Enbridge will inform the State of future visual inspections as they occur.

4. Any Other Pipeline Inspection and Test Results- Please provide copies of all information that becomes available to Enbridge regarding the results or reports of any other inspections or tests of the integrity of the Dual Pipelines, including, but not limited to any in-line inspections, hydrostatic tests, or pipeline movement investigation required under Paragraphs 70 through 73 of the proposed Consent Decree.

Enbridge will inform the State of future inspections or tests of the integrity of the Dual Pipelines as they occur.

June 18, 2017 Supplemental Addendum to Technical Note

Regarding Enbridge Line 5 Non-Compliance with 1953 Easement Requirements
A Mechanistic Analysis of Straits Pipeline Washout Phenomena

Edward E. Timm, PhD, PE
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EdTimm@Gmail.com

The Technical Note "Regarding Enbridge Line 5 Non-Compliance with 1953 Easement Requirements, A Mechanistic Analysis of Straits Pipeline Washout Phenomena"[1] released on 8/20/16 details the history of unsupported spans for the Straits portions of Enbridge Energy Partners Line 5 and suggests insight into the mechanism behind the reoccurring washouts that have resulted in nearly continuous non-compliance with State mandated support requirements since its construction in 1953. A recently released report by Kiefner and Associates entitled "Assessment of Span Exposures on the 20-inch Petroleum Pipelines Crossing the Straits of Mackinac"[2] includes information requiring this addendum to my original report. The Kiefner report documents work done for Enbridge beginning in 2003. The report was issued to Enbridge in draft form in 2005 and re-issued as a final report on October 12, 2016. This report contains information about previously unreported spans as of 2003 as well as information about a contracted study of current velocities in the vicinity of the pipeline done for Enbridge during the period 2002-2004.

The Technical Note of 8/20/16 resulted from a study of old blueprints released by Governor Snyder's Pipeline Task Force. Table 1 is taken from this document.

Table 1. Summary of Spans and Supports as of the 1979 Underwater Inspection of Line 5

1. Data taken from Lakehead Pipeline Company, Inc. drawings released by Michigan Attorney General
2. Drawing originally dated 4/14/64 and noted as being traced from Bechtel, Inc. drawing dated 11/63
3. Drawing updated through 1980 including revisions following 1972, 1975 and 1979 underwater inspections
4. Unsupported spans over 75 feet are prohibited by 1953 easement agreement with the State of Michigan
5. Unsupported spans over 140 feet were calculated to be dangerous to line integrity by original designers at Bechtel

Summary of non-Compliant Unsupported Spans as of 1980

Location	Spans > 75 feet	Spans > 140 feet
West Leg	10	3
East Leg	7	0

The longest unsupported span found in this work was 160 feet on the west leg.

The Kiefner report, which is mostly a calculational study of the stresses imposed on the pipe by gravity due to long unsupported spans, contains the following data about span lengths as of 2003. “The 2003 survey identified 7 spans longer than140 feet in the east leg, with the longest being 224 feet, and 9 spans longer than 140 feet in the west leg, with the longest being 286 feet (due to a failed grout bag support).”

Table1a, Summary of Spans as of 2003 from the Kiefner Report

Summary of non-Compliant Unsupported Spans as of 2003

Location	Spans > 140 feet	Maximum Span, feet
West Leg	7	224
East Leg	9	286

Table 2 is a history of Enbridge’s efforts to provide support under Line 5 taken from my Technical Note.

Table 2 ROV Inspection and Span Support Installation History of Line 5 Straits of Mackinac

Year of ROV Inspection	Follow up Actions (Anchor Support Installation)	Type of Support Installed
1963	None	
1972	None	
1975	3	Grout Bags
1979	None	
1982	None	
1987	7	Grout Bags
1989	None	
1990	None	
1992	6	Grout Bags
1997	None	
2001	8	Grout Bags and mechanical support
2003	16	Mechanical Screw Anchors
2004	16	Mechanical Screw Anchors
2005	14	Mechanical Screw Anchors
2006	12	Mechanical Screw Anchors
2007	None	
2010	7	Mechanical Screw Anchors
2012	17	Mechanical Screw Anchors

Table 2 shows that Enbridge made two efforts to add mandated supports under Line 5 in the period from 1980 through 2000. In 1987, Enbridge added seven grout bag supports and in 1992 Enbridge added six grout bag supports. Beginning in 2001 a more significant effort was made to support the pipe using both grout bags and screw anchors. Assuming that the significant support efforts made in 2003 were done after the survey data reported in Table 1a, it is clear that spans exceeding those reported in this table must have occurred in the years 1980 through 2002 because supports were added to spans not revealed in Table 1a. The overall picture that emerges from this data is that the Straits portions of Line 5 did not comply with the State easement's requirement of no unsupported spans over 75 feet as constructed in 1953. This situation grew steadily worse for lack of maintenance through 2003 and was not rectified until very recently. More seriously, very long unsupported spans in excess of the recommended elastic limit of 140 feet have commonly occurred and some spans grew to such lengths that the pipe was plastically deformed by both the forces of gravity and currents until it either went into catenary mode or the sagging of the pipe was arrested by touching down on the lakebed. Some implications of these conclusions were reported by Timm[3] before the data revealed in the Kiefner report were known and the possibility of metal fatigue caused by the combined forces of gravity and the bi-directional currents that flow through the Straits is made much more likely by the extreme unsupported spans revealed in the Kiefner report.

The Kiefner report also reveals that Enbridge contracted an unknown firm to make current measurements in the vicinity of the pipe during the period from 2002 through 2004. Very little information is revealed about the details of these measurements in the Kiefner report but understanding this data is critical to the understanding of the hydrodynamic forces acting on Line 5 as it differs significantly from the four high quality data sets discussed in the Timm report. Following is a description of the Enbridge current data set taken from the Kiefner report. No information about the location or type of current sensors is included in this report

> Enbridge installed water current monitoring devices at four locations along their crossing in order to obtain better data concerning currents impinging on exposed spans. The devices were placed at representative water depths and locations in the Straits. Currents were monitored at 3-hour intervals between September 26, 2002 and August 8, 2004.

A full discussion of the current data Enbridge has relied on to draw conclusions about the hydrodynamic forces on Line 5 is beyond the scope of this document, however, the following summary of this data set taken from the Kiefner report is indicative that there are problems with the Enbridge current velocity data set.

> The mean plus 3-sigma velocity encompassing over 99% of measured values was approximately 1.5 ft/sec. Hence current velocities in excess of 1.5 ft/sec can be considered rare and infrequent events.

In this statement, the author of the Kiefner report concludes that current velocities in excess of 1.5 ft/sec (1 mph) are rare and infrequent events. Reference to Figure 1, taken from my original Technical Note[1], shows that a current velocity of 1 mph is only sufficient to mobilize and entrain soil particles with a diameter of less than 1 mm. It is extremely unlikely that the severe washouts that have affected Line 5 since its construction would be a factor if the currents under the Straits were only able to entrain very fine soil particles. It is much more probable that the extreme current events associated with extreme weather events in the Great Lakes basin documented in the Timm report and dismissed by the author of the Kiefner report as “rare and infrequent”, are the main factor posing a threat to the long term structural integrity of Line 5 under the Straits. In general, structures are far more likely to be damaged by weather extremes than average conditions and the failure of the author of the Kiefner report to statistically examine the Enbridge data set for extreme values or “Black Swan Events” is a major shortcoming of this work.

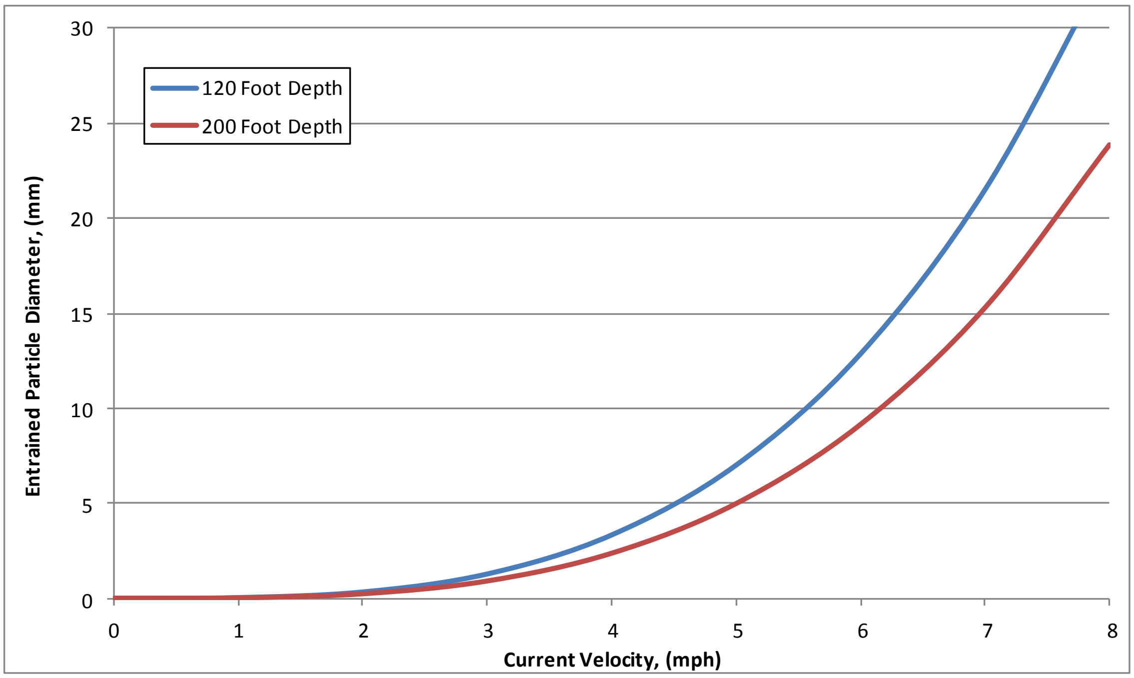

Figure 1. Soil Particle Entrainment Velocity as a Function of Underwater Current Velocity from Reference 1

Another shortcoming of the Enbridge current data set as reported and analyzed in the Kiefner report can be found in the following statement by Brad Shamla, Enbridge VP of US Operations, in a letter[4] to the State of Michigan:

> Four (4) current profilers were deployed to collect the current data, two (2) near the pipeline at the East crossing and two (2) near the pipeline at the West crossing. The current profilers were placed about 2 ft off the lake bottom. In the current velocity calculation, the average current over the elevations of 2 ft – 6 ft above the bottom was used where good quality current data was collected. Currents below 2 ft were calculated using known equations.

It should be obvious to those skilled in the art of fluid mechanics that drag and other forces imposed on a submerged bluff body respond virtually instantaneously to changes in current velocity. In this context, the statement by Enbridge that average (probably 3 hour average) current data was used to analyze hydrodynamic impacts on the stability of Line 5 illustrates another major problem with the conclusions drawn in the Kiefner report. As discussed in the Timm report, the use of average current velocity data and the dismissal of the extreme current events that are likely to impose the greatest forces on Line 5 and its environment make Enbridge's statements about the lack of current induced effects on Line 5 extremely suspect. Another area of discussion where a lack of fluid mechanical understanding has resulted in a flawed conclusion involves sections discussing Vortex Induced Vibration (VIV) in both references 2 and 4. This subject is far beyond the scope of this addendum but Enbridge's dismissal of the possibility that Line 5 has been compromised by VIV is incorrect. Given the importance of this subject and the fact that the extreme spans revealed in the Kiefner report make VIV effects more likely, it is recommended that further investigation of this subject is warranted.

A final observation drawn from Reference 4 and related materials submitted to the State of Michigan in Enbridge's application for a permit to allow placement of 22 additional screw anchors under Line 5 dated 5/9/17 regards a section of the West Leg located in the vicinity of the 15,500 foot chainage measurement. It is noted without further discussion that this section of the pipe includes five bends and two ovaled sections of pipe as revealed by numerous Enbridge ILI runs. Five of the 22 proposed screw anchors requested in the 5/9/2017 permit application are located in this area of what appears to be pipe damaged by unknown circumstances. It is recommended that a full examination of the circumstances leading to the observed damage on the West Leg of Line 5 be conducted before granting permission to place these anchors.

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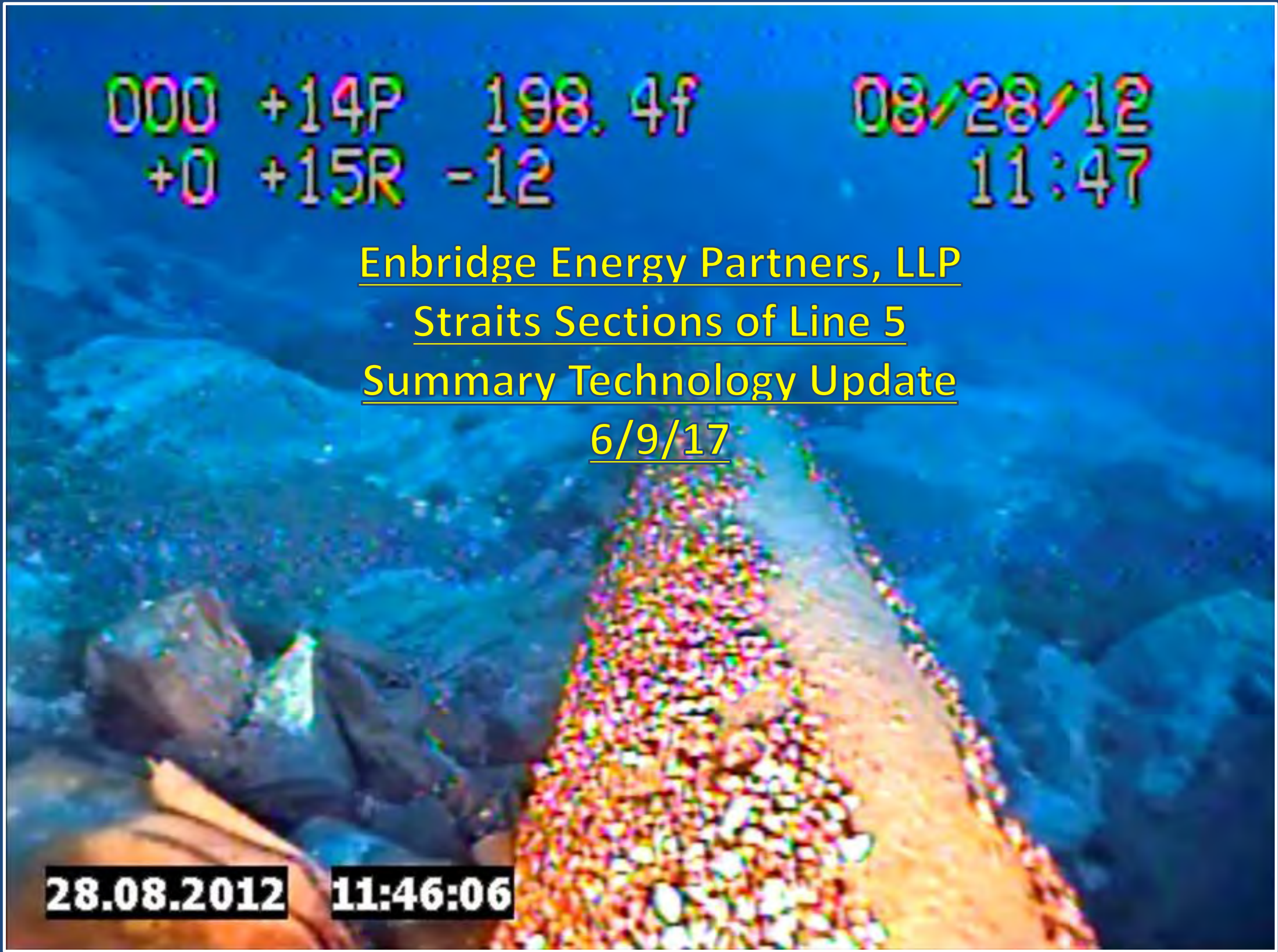
[1] "Technical Note: Regarding Enbridge Line 5 Non-Compliance with 1953 Easement Requirements A Mechanistic Analysis of Straits Pipeline Washout Phenomena", Timm, E. E., August 2016, found as Appendix 1 in Reference 3

[2] "Assessment of Span Exposures on the 20-inch Petroleum Pipelines Crossing the Straits of Mackinac", Rosenfeld, M., Kiefner and Associates, Columbus, OH, October 2016

[3] "Technical Report: An Investigation into the Effect of Near Bottom Currents on the Structural Stability of Enbridge Line 5 in the Straits of Mackinac", Timm, E. E., March 2017, http://blog.nwf.org/wp-content/blogs.dir/11/files/2017/03/2017-Edward-Timm-Currents-and-Stresses-Report.pdf

[4] Letter from Brad Shamla to the State of Michigan entitled "Response to Follow-Up Questions Concerning Enbridge's Forthcoming Application to Install Screw Anchor Supports on the Line 5 Dual Pipelines at the Straits of Mackinac", 4/13/2017

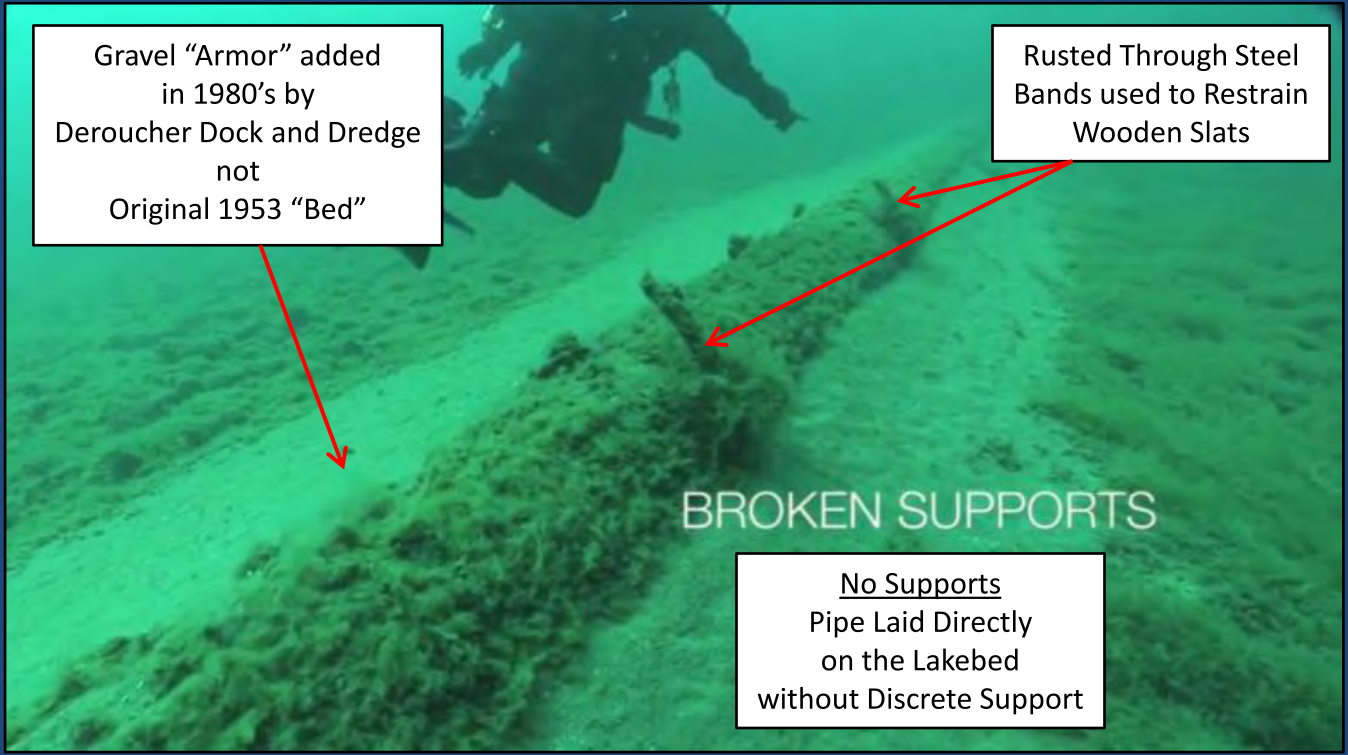
Enbridge Energy Partners, LLP
Straits Sections of Line 5
Summary Technology Update
6/9/17



Enbridge Energy Partners
Straits Sections of Line 5
Technology Update

We have come a long way!

Photo from NWF Report “Sunken Hazard”, 2012



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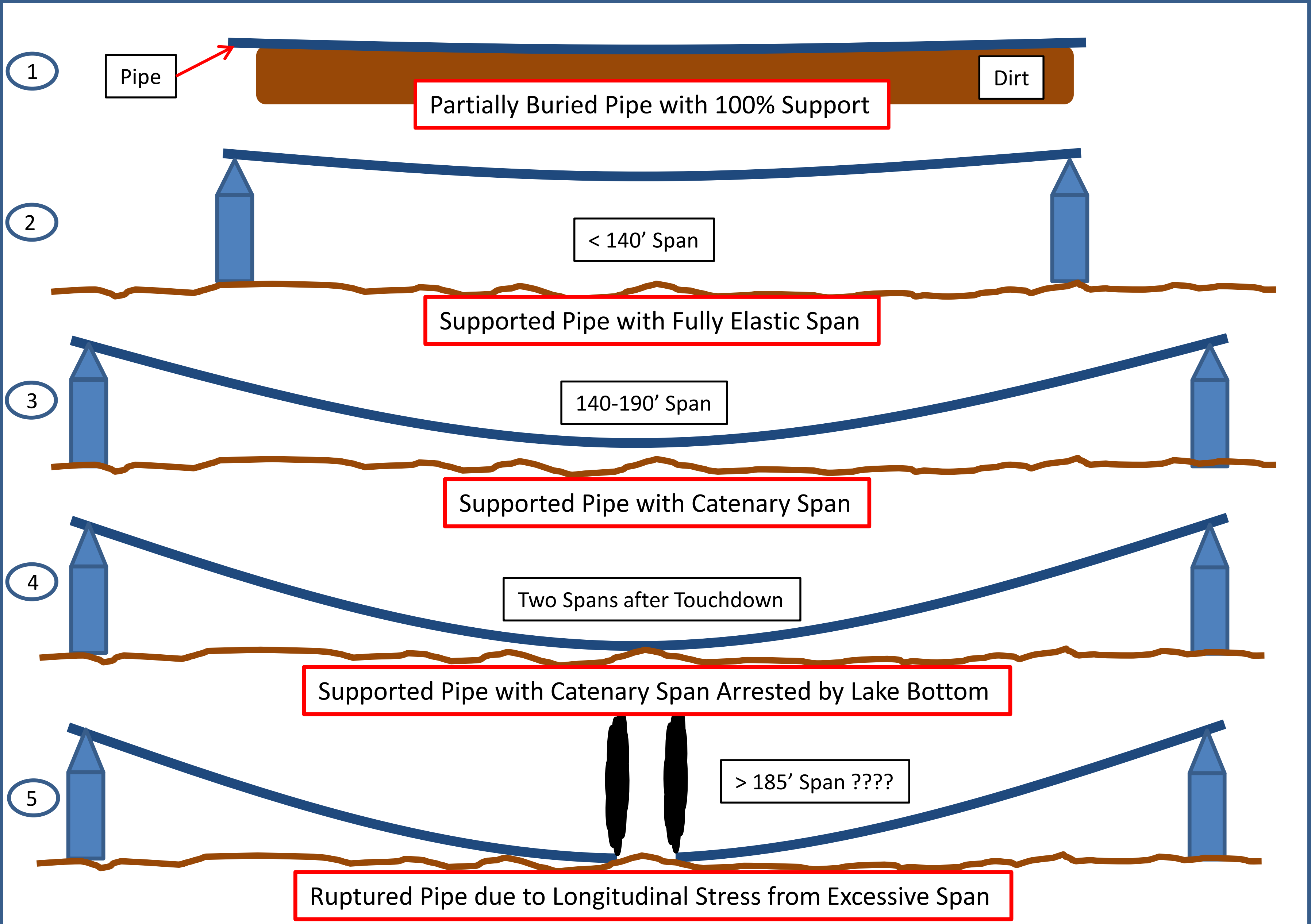
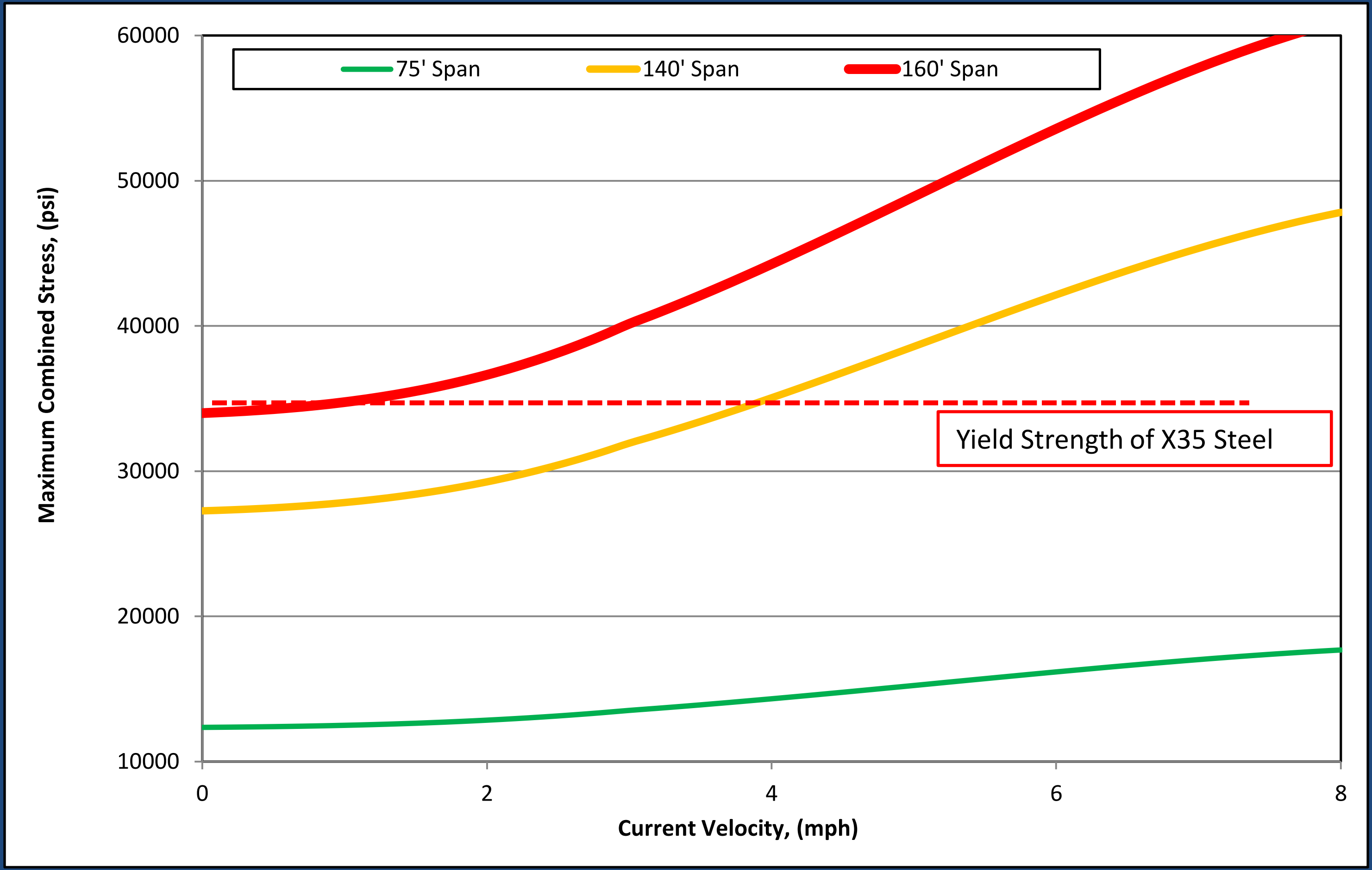
Issues Regarding the Straits Sections of Line 5 – Unsupported Spans and Failure



Issues Regarding the Straits Sections of Line 5 – Stress Due to Current

1953 Easement: "(10) The maximum span or length of pipe unsupported shall not exceed seventy-five (75) feet." (——)

1953 Engineering Report: "Under no circumstance should the unsupported span exceed 140 feet." (——)



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Currents and Stresses, Timm Report

Technical Report

An Investigation into the Effect of Near Bottom Currents on the Structural Stability of Enbridge Line 5 in the Straits of Mackinac

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Harbor Springs, MI 49740
231-526-7159 EdTimm@Gmail.com

Abstract

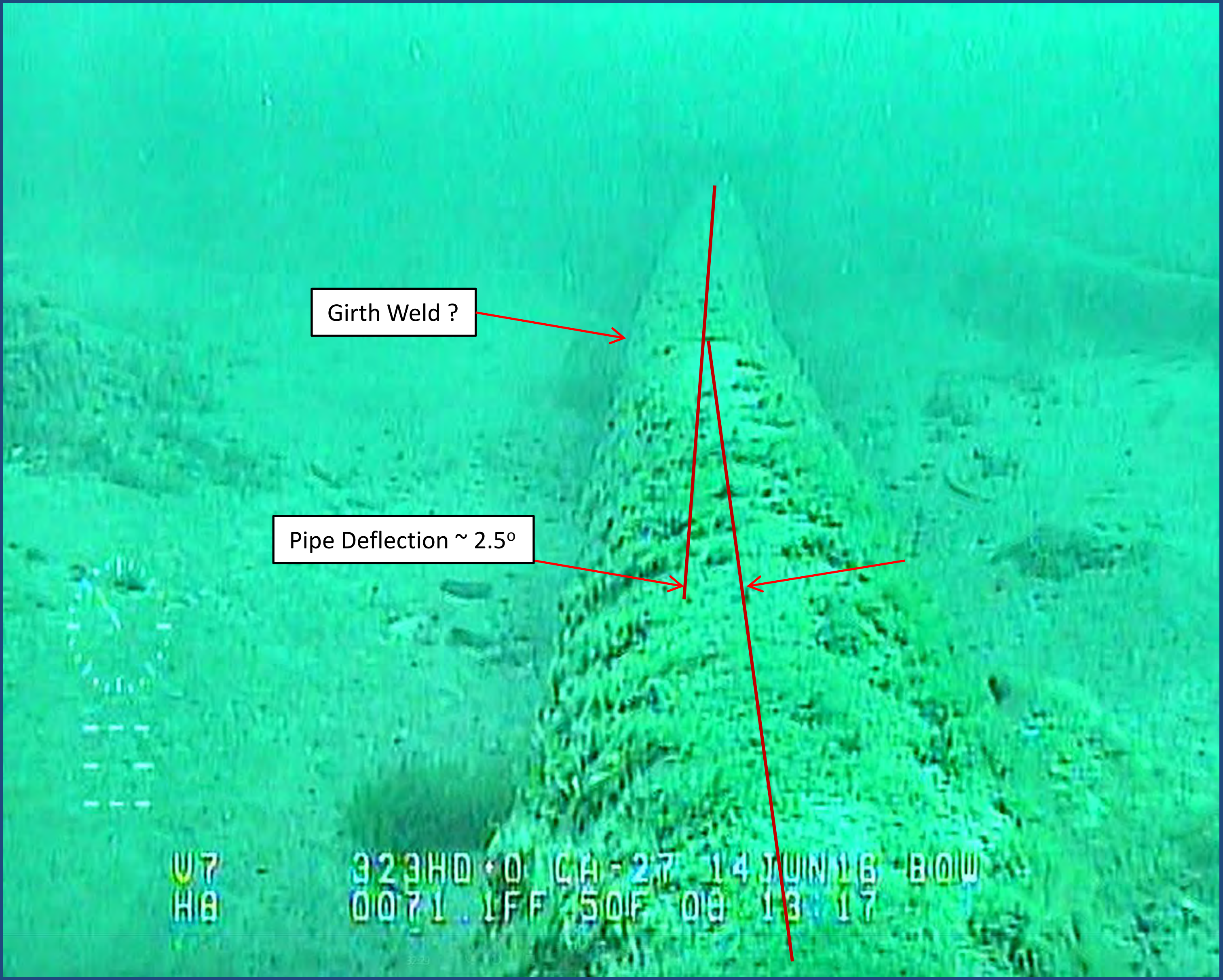
The Straits of Mackinac is a four mile wide channel that connects Lakes Huron and Michigan. Resting on the bottom of the Straits is Enbridge Line 5, a twinned crude oil pipeline that was designed and constructed by Bechtel Corporation in 1953 for the Lakehead Pipeline Company. This was a unique engineering project at the time of construction and the designers attempted to account for the forces on unsupported sections of the pipe resulting from underwater currents. Recent research has shown the currents in the Straits of Mackinac to be stronger and more complex than originally contemplated by the designers of line 5. This paper reviews recent underwater current data for the Straits of Mackinac and draws conclusions about the implications of deficiencies in the original design basis for Line 5.

Conclusions

- Currents stronger than the Line 5 design basis and previously unrevealed long, unsupported spans may have seriously fatigued the metal in the pipe (>160’)
- The Straits sections of Line 5 cannot be considered fit for service until this subject has been thoroughly considered by experts in underwater pipeline integrity
- Consideration should be given to requiring shutdown and inspection of the pipe following an extreme current event in the Straits

2016 Enbridge Inspection Video

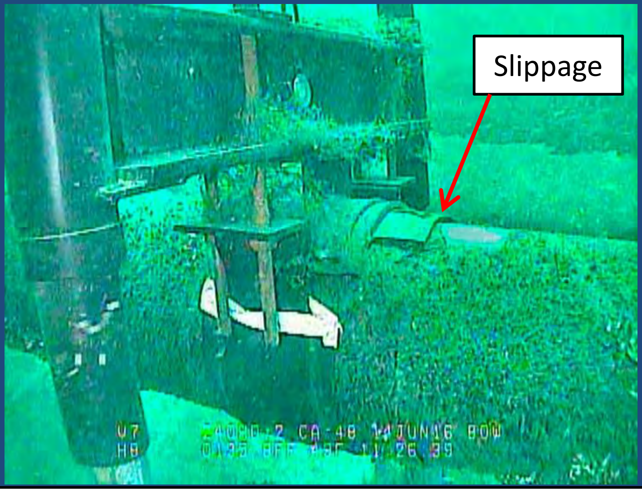
West Leg, South End, Pipe Bend to the West at 15,900' Chainage



Evidence of Lateral Pipe Movement from 2012 and 2016 Inspection Videos

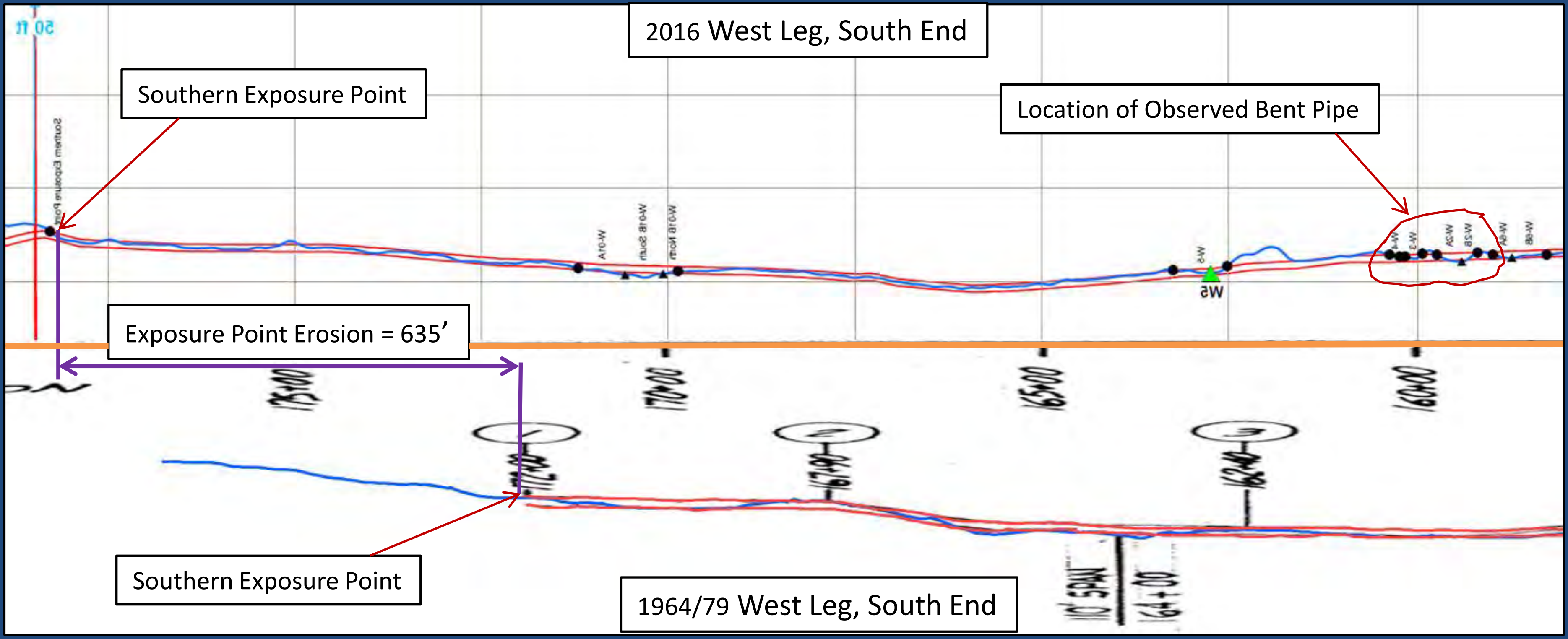
Laterally Deflected Anchor from 2012 Inspection

Laterally Deflected Anchor from 2016 Inspection



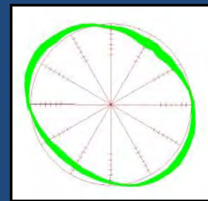
Evidence of Lateral Pipe Slippage through Anchor

Comparison of Line 5 Bottom Profile Drawing from 2016 with 1964/79 Drawing



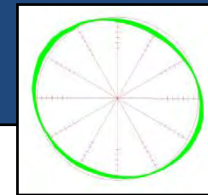
Line 5, West Leg, Pipe Deformities

Enbridge Proposed New Anchors (5)

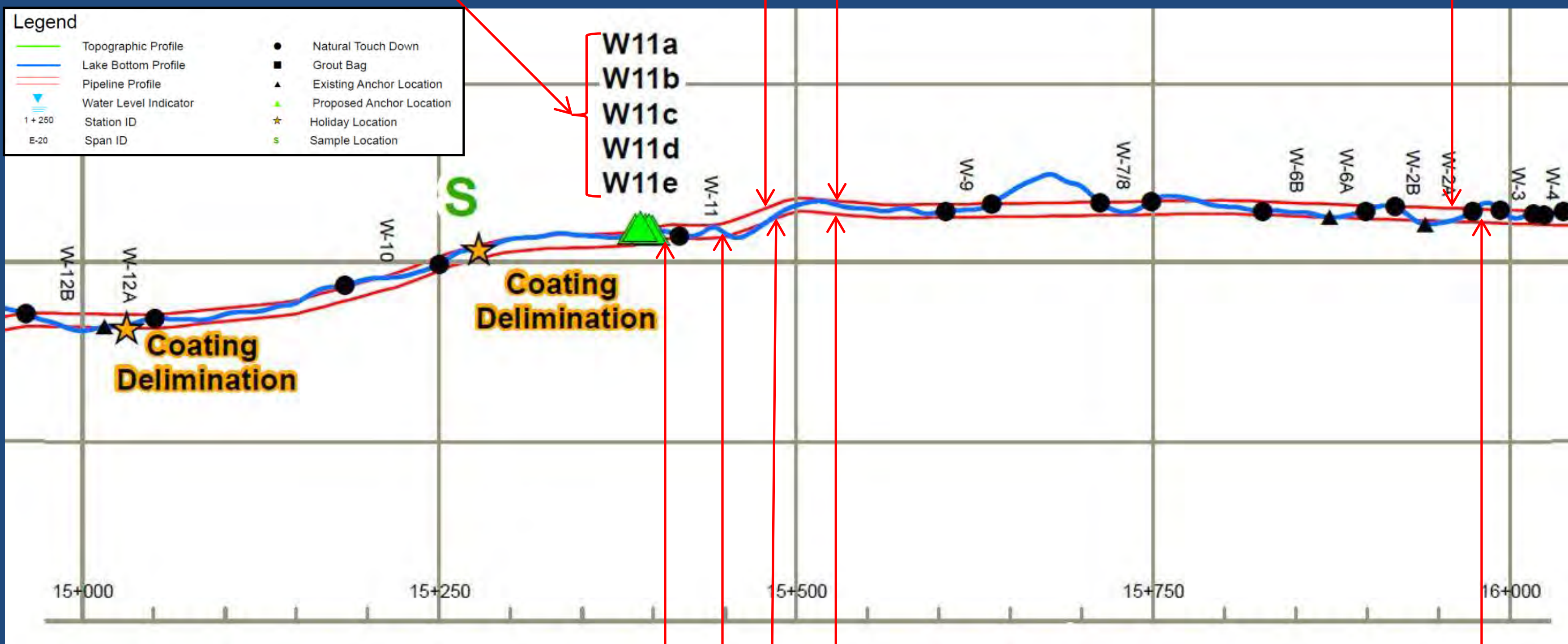


Oval 1
9.2% D

Oval 2
5.7% D



Location of Bent Pipe in Video



Bend 9, 3.1^0 L, 6.1^0 D

Bend 10, 1.6^0 R, 4.2^0 U

Bend 11, 5.1^0 R, 7.7^0 U

Bend 12, 3.1^0 L, 5.1^0 D

Bend 13, 2.1^0 L, 2.1^0 U

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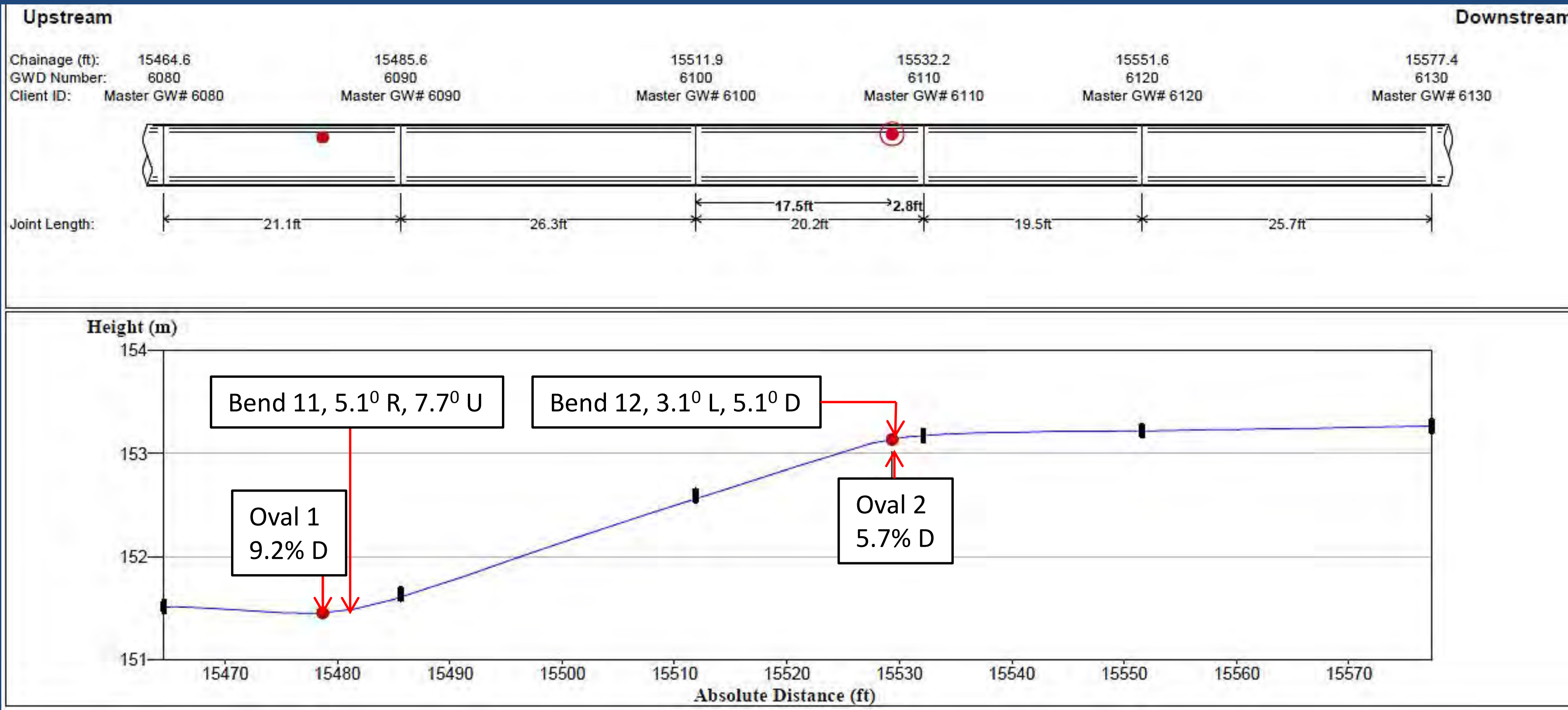
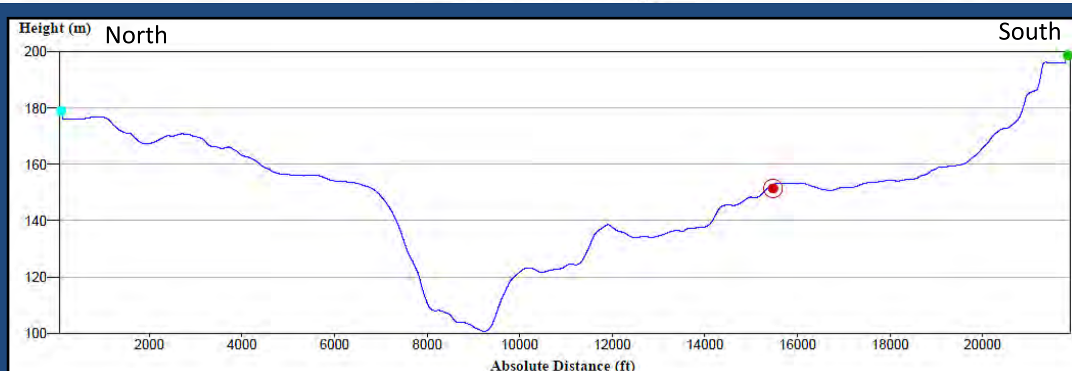
Line 5, West Leg, Pipe Deformities





Flawed Conclusion from 2016 LaMontagne ILI Review

LAMONTAGNE
Pipeline Assessment Corporation

ILI Review – Enbridge Line 5;
East and West Mackinac Straits

Analysis of all ILI data taken from 1998 through 2013 that finds very little metal loss or pitting and only small pipe movements since 2005. The report disclaims being a "Fitness for Service" report.

"Crack-Like Anomalies

The 2014 ultrasonic inspection for circumferential "crack-like" anomalies identified 39 that were all at the minimum tool reporting depth of 5%, save one at 6%. Sixteen were described as potential notches. Three were excavated for field interpretation and found to be innocuous manufacturing related marks on the pipe. A fatigue analysis was made employing the most recent years' operating pressures. All of the delineated anomalies had a remaining life of greater than 50 years."

Conclusion from Timm Report on Stresses and Currents

"It is clear from this report that the possibility of metal fatigue from bending stresses due to current velocities that exceed the design basis of the pipeline were not considered when determining that this pipe has a remaining fatigue life of greater than 50 years."

Kiefner Report on Currents and Stresses in Line 5


Enbridge Pipelines

Final Report No. 16-154

Assessment of Span Exposures on the 20-inch Petroleum Pipelines Crossing the Straits of Mackinac

Michael Rosenfeld, P.E.
October 12, 2016

Kiefner

DISCLAIMER

This document presents findings and/or recommendations based on engineering services performed by employees of Kiefner and Associates, Inc. The work addressed herein has been performed according to the authors' knowledge, information, and belief in accordance with commonly accepted procedures consistent with applicable standards of practice, and is not a guaranty or warranty, either expressed or implied.

The analysis and conclusions provided in this report are for the sole use and benefit of the Client. No information or representations contained herein are for the use or benefit of any party other than the party contracting with Kiefner. The scope of use of the information presented herein is limited to the facts as presented and examined, as outlined within the body of this document. No additional representations are made as to matters not specifically addressed within this report. Any additional facts or circumstances in existence but not described or considered within this report may change the analysis, outcomes and representations made in this report.

This report issued as a Final Report in 2016 describes work performed by Kiefner in 2003 and 2004 and reported in Draft form in January 2005. Data, regulations, and other input discussed herein were the most recent available at the time the work was performed. Data, regulations, and other input developed or revised subsequent to the 2005 Draft report are not accounted for and could change the analysis, outcomes, and representations made in this report.

Kiefner Report on Currents and Stresses in Line 5
Enbridge Current Velocity Data

Current Velocity Data Analysis

Enbridge installed water current monitoring devices at four locations along their crossing in order to obtain better data concerning currents impinging on exposed spans. The devices were placed at representative water depths and locations in the Straits. Currents were monitored at 3-hour intervals between September 26, 2002 and August 8, 2004. Easting and Northing current velocities recorded by the four monitoring units are shown in Figure 9 through Figure 12. A sampling of current velocities in Easting and Northing coordinates is shown in Figure 13. The Easting current velocity component is about 3 times the Northing current velocity component. The velocities are seen to reverse direction every 2 to 3 days, and are predominately oriented in the ENE and WSW direction.

Conclusions Regarding Enbridge Current Data

- Location of current velocity sensors unknown
- Type of current velocity sensors unknown
- Current sampling averaging time unknown
- Data is not referenced in report
- Quality of data is unknown
- Contractor responsible for project is unknown
- Reference 12 looks interesting!

12. Analysis of Spans, J. P. Kenny report to Enbridge, 2003.

Kiefner Report on Currents and Stresses in Line 5
Kiefner Analysis Discussion

Conclusions

Codes, Standards and Regulations Section
Pipeline is considered an Offshore Pipeline under the offshore sections of ASME B31.4

Engineering Analysis of Spans Section
Static analysis of span stresses, does not consider stresses added by currents!

Recommends that spans greater than 75' could be safely permitted

Discloses and supports Enbridge 140' threshold for taking support action

Concludes that spans of 155' to 195' may be safe with disclaimers

Reveals that Enbridge has allowed unsupported spans of up to 286' in the past.

> The 2003 survey identified 7 spans longer than 140 ft in the east leg, with the longest being 224 ft, and 9 spans longer than 140 ft in the west leg, with the longest being 286 ft (due to a failed grout bag support).

1964/79 "As Built" blueprint only revealed three spans longer than 140'

Does not reconcile calculations with video and ILI data to reveal damaged pipe!

Effects of Operating Conditions Section
Raises some new concerns about how the line will accommodate thermal expansion in supported sections

Support Options Section
Recommends screw anchor supports where there is clearance to install them and grout filled bags where there is no clearance for screw anchor installation

Considers option of burying the entire line in rock.......!

Kiefner Report on Currents and Stresses in Line 5
Kiefner Analysis Discussion - 2

Conclusions

Vortex Induced Vibrations Section

Questionable analysis of Enbridge supplied current data

No discussion of turbulent flow field in Straits
No discussion of the importance of instantaneous current velocity data and the masking effect of averaging time
Fails to recognize and quantify the importance of extreme current events as documented by Schwab (2013) and many other authors
Fails to recognize the meteorological events that drive extreme currents
Does not use appropriate statistical methodology for hunting "Black Swans"
Discounts the possibility of VIV based on misunderstood lab scale data
If the report's conclusions about the current velocities under the Straits are correct Line 5 would not be suffering from washout problems!

Questionable Analysis of Fluid Phenomena and Resulting Bending and Fatigue

No discussion of the possibility that extreme current events could plastically deform (bend) long unsupported spans
No recognition that reversing currents could bend the line back and forth causing metal fatigue over 50 years (The word fatigue does not appear in the report)
Author is obviously weak in his fluid mechanical understanding about bluff body flow in a turbulent flow field (Author doesn't recognize flow in the Straits is turbulent)

Pipeline Coating Integrity is Critical for Minimization of External Corrosion Damage

1953 Easement Restrictions Regarding Corrosion Protection

"(8) Cathodic protection shall be installed to prevent deterioration of the pipe

(9) All pipe shall be protected by asphalt primer coat, by inner wrap and outer wrap composed of glass fiber fabric material and one inch by four inch (1" x 4") slats prior to installation."

1953 MPSC Order Regarding Corrosion Protection

"The entire pipe line will be properly cleaned, primed, and coated with a single application of coal tar. The coating will be reinforced by a spiral wrap of glass material and covered by a spiral wrap of special glass outer wrap. Penetrations will be made for cathodic protection."

"Engineering and Construction Considerations for the Mackinac Pipeline Company's Crossing of the Straits of Mackinac" submitted by Mackinac Pipeline Company/Lakehead Pipeline Company to the Michigan Department of Conservation, January, 1953

"After coating with asphalt primer, fiberglass inner wrap and an asbestos felt outer wrap, and after attaching 1" x 4" wood slats to the full circumference of the pipe, it will be lowered onto a previously prepared "bed" on the floor of the Straits."

- Enbridge documentation claims that the coating is a coal tar based in some documents and asphalt based in others. Terminology changed from "coal tar" to "enamel" recently.
- Enbridge documentation makes no mention of slats or lagging.
- Bechtel probably based design life of line on probable coating life.

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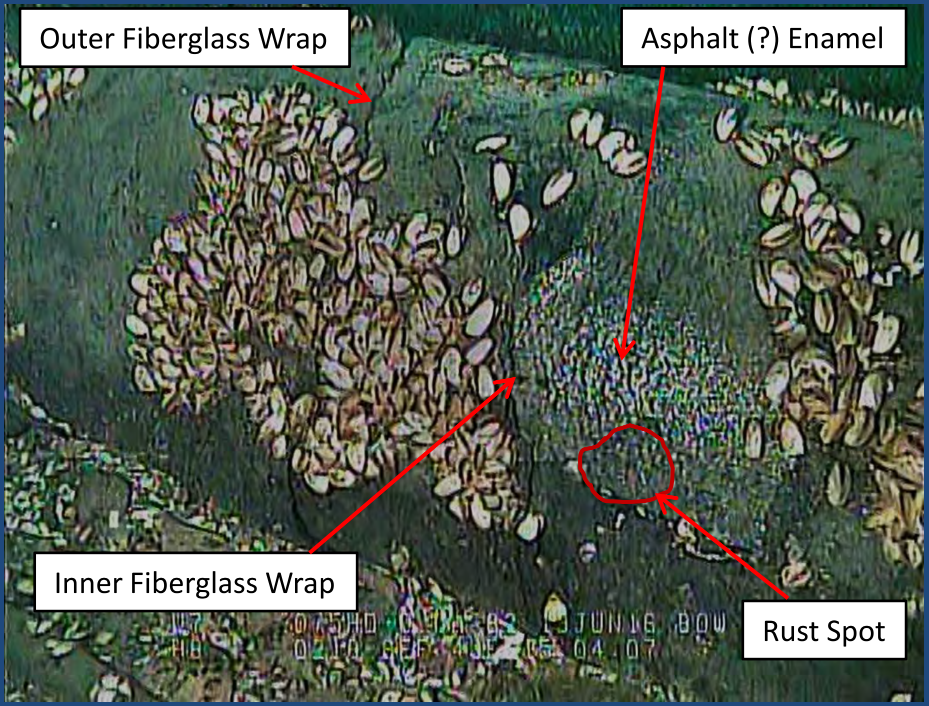
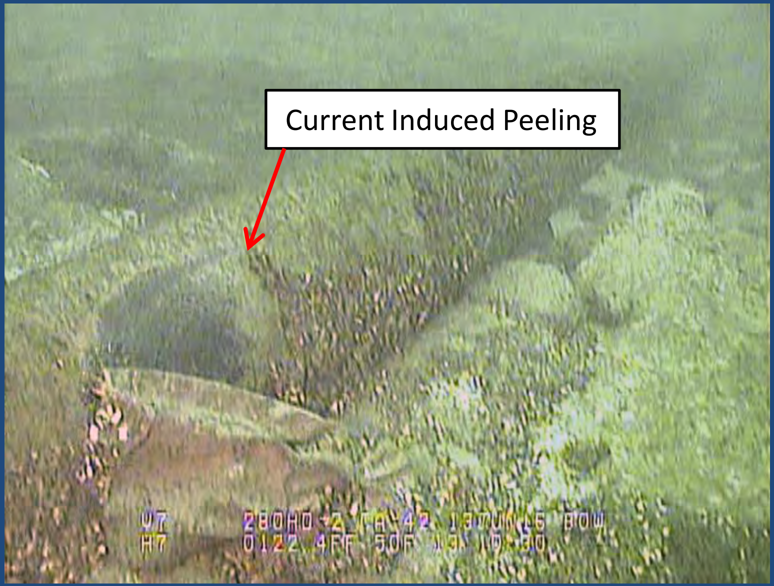
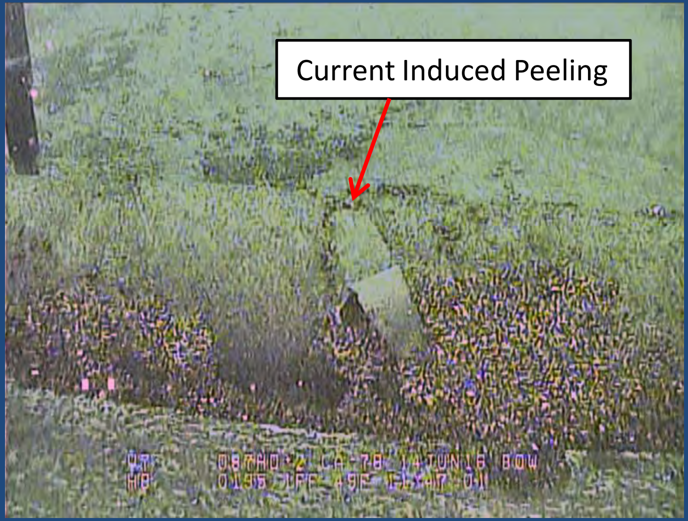
Coating Protective Fiberglass Wrap Delamination (Insert Noun Here) Enamel Primer/Coating and Rust

- Documentation regarding coating type is not definitive
- Enbridge has changed terminology from “Coal Tar” to “Enamel”
- It really makes a difference if it is coal tar or asphalt based
- Salvadori says “Asphalt”
- Failing coatings are the #1 problem of the vintage pipeline operator
  Jeff Didas, Colonial Pipeline company (Material Performance 3/1/17)



Current Induced Peeling of Protective Fiberglass Wrap





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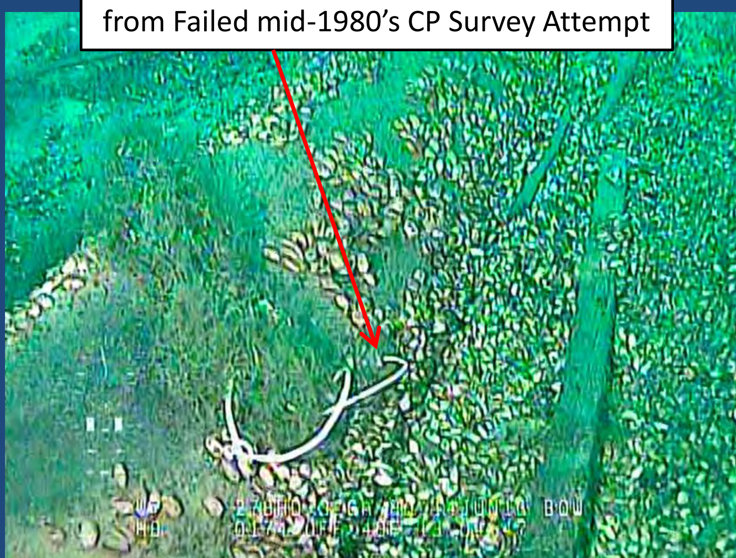
Line 5 and Cathodic Protection

- All pipelines installed since 1970 have Cathodic Protection systems as required by CFR
- It would not be possible to build pipelines out of steel without CP systems
- Effective CP is a tricky business and lines must be surveyed to assure efficacy
- Even a well surveyed underground pipeline can rupture (eg. Enbridge Line 6b)
- Cathodic protection of an underwater pipeline in low conductivity fresh water presents unique challenges
- Apparently, the Straits sections of Line 5 has never had an effective CP survey
- Baker Hughes CPCM inspection tools are a developing technology
- Little is known about the limits of detection of this technology
- Even less is known about the ability of this technology to detect coating breeches in low conductivity fresh water

Cathodic Protection Survey Connection from Failed mid-1980's CP Survey Attempt



BAKER HUGHES

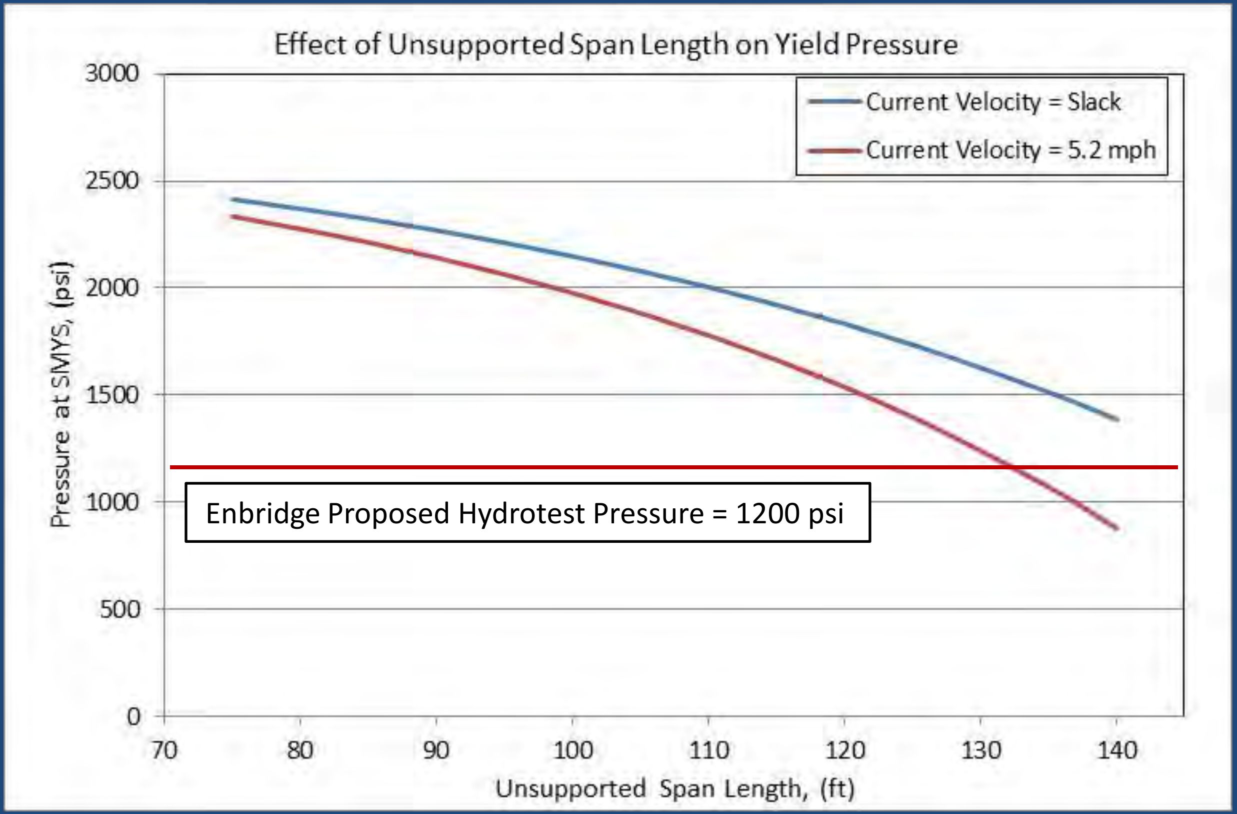
Comments Regarding Hydrotesting

Reference: "The Benefits and Limitations of Hydrotesting", Kiefner, J. F. and Maxey, W. A. , 2013

Industry Expert Opinion

For a pipeline of this criticality, a volumetric hydrotest to yield is the best way to assure integrity

Question from Anabel Drywer, Esq regarding the proposed Enbridge hydrotest of the Straits sections of Line 5: "Should Enbridge be required to hydrotest Line 5 during an extreme current event ?



E-104

Upcoming Events

Task 3.4 from the Biota Report for the Consent Decree

3.4 Engineering Stress Analysis
A structural engineering firm will be engaged to conduct an engineering stress analysis considering the impact of biota on the integrity of the pipelines suspended above the floor at the Straits. The analysis will include the following:

• An allowable suspended span length of the pipeline will be calculated to include the biomass along with operating loads, drag forces, buoyant weight, etc. A sensitivity analysis will be also completed on the impact of the biota mass to allowable span length.

• Vortex induced vibration ("VIV") assessment will be also performed to determine the mode shape and associated vibration periods of pipe free spans with various lengths and the assessed biomass. A sensitivity analysis will also be completed on the impact of the biota mass to allowable span length as part of the VIV assessment

Michigan PSAB Alternatives Analysis, Option 5

5. Maintaining the existing Straits Pipelines, including an analysis of the effective life of the existing pipelines.

   The analysis shall consider maintaining the current Straits Pipelines. This analysis shall include a comprehensive engineering analysis of the current condition and operation of the existing pipelines. The comprehensive engineering analysis of current conditions shall include operator's identified integrity standards for the pipeline and protocols for detecting and responding to departures from those standards. The analysis shall also consider how long the existing pipelines can reasonably be operated without replacement as well as the course of action for replacement based on the estimated useful life of existing pipelines.

Open Questions???

1. Specifications of pipe coating system
2. Video time stamp – geolocation correlation information
3. Complete history of long, unsupported spans including location of spans in Kiefner report
4. J. P. Kenny 2003 report entitled “Analysis of Spans”
5. Enbridge contractor report on 2002-2004 current velocity study
6. Bechtel and Merritt, Chapman and Scott contracts and engineering documents
7. Enbridge field reports leading to emergency ACE permit applications
8. Contracts and reports regarding the mid ‘80’s gravel “armoring” project
9. Other reports regarding the use of a manned submersible for early inspections
10. Any reports or information about cathodic protection surveys
11. Information about the sensitivity of the Baker-Hughes CPCM cathodic protection survey tool
12. Disclosure of all Enbridge materials submitted to Dynamic Risk or DNV for Risk and Alternatives Analysis

Geometry Inspection Report prepared for:

Enbridge Energy Limited Partnership

20" GEOPIG™ Geometry Inspection

NPS20 Line 5 Straights of Mackinac - West Loop

Total Distance: 4.15mi

Pipeline Inspection Date: July 30, 2013

Issue Number: J2008-13 Issue #1

Baker Hughes Pipeline Inspection

4839 – 90th Ave S.E. Calgary, Alberta, Canada, T2C 2S8

Signature Block	Name	Date	Initial
Project Coordinator (QA Analyst) Level III Data Analyst *	Vicky Chan	Oct. 30, 2013.	VC
Inertial Analyst Level III Data Analyst *	for Tao Hu	Oct 30, 2013	TH
Caliper Analyst Level III Data Analyst *	Joshua Joseph	OCT. 29, 2013	JJ

*** As per ILI PQ 2005**

Issue Number	Release Date	Issue Date	Client Data Verified	Description of Changes
J2008-13 - Issue #1	October 29, 2013			Initial Issue

Note:

This report has been specifically prepared for Enbridge Energy Limited Partnership (hereinafter called "Enbridge"). Any use which a third party makes of this report, or any sole reliance on or decisions to be made based on the information contained herein, are the sole responsibility of such third parties. Baker Hughes Pipeline Inspection accepts no responsibility for the damages, if any, suffered by any third party as a result of decisions made or actions based on the information contained in this report.

Information provided herein represents the best efforts of Baker Hughes Pipeline Inspection to evaluate the described lines. Judgements concerning pipe condition are left entirely to Enbridge. All information herein represents only Baker Hughes Pipeline Inspection's opinion of the meaning of the GEOPIG™ information, and shall not be construed as a warranty or guarantee of the structural condition of the pipeline, its fitness for use, or any other condition.

TABLE OF CONTENTS

APPENDICES

1 EXECUTIVE SUMMARY

Baker Hughes Pipeline Inspection has successfully completed an Inertial Geometry survey of Enbridge's 4.15mi NPS20 Oil pipeline, running from St. Ignace to Mackinaw. The successful run was performed on July 30, 2013. The purpose of the inspection was to determine pipeline geometry, which includes plan, profile, bends, weld tally, and pipe wall deformations.

The analysis of the caliper data has identified no dents greater than 2% O.D., and 2 ovalities greater than 5% O.D. No dents were found greater than 1% O.D., which met the criteria of "Dents in Close Proximity" or "Multiple Apex". The largest anomaly is a 1.750in (8.75 % OD) ovality located at absolute chainage 15,478.71ft. The complete anomaly listing is included in Appendix 2.

11 internal diameter restrictions, where the I.D. was less than 90% O.D., were identified during the caliper analysis. The largest minimum I.D. reached 17.35in (86.76%) and was located at absolute chainage 15,478.82ft on an ovality. The internal diameter restriction listing is included in Appendix 3.

The analysis of the inertial data has identified 25 bends with an angle larger than 1.5° and a radius of curvature less than 100D. No bends are tighter than 5D. The bends with are listed in Appendix 5.

GPS coordinates for the receive valve were provided by Enbridge. This information was integrated with the pipe centerline coordinates obtained from the inertial survey, providing a means for locating pipeline anomalies and a foundation for a Geographic Information System (GIS). A listing of the UTM coordinates based on the WSG84 datum appears in Appendix 1.

1 area of pipe replacement since the 2005 survey has been identified spanning the first 209.08ft (up to Master GWD#200) at the launch valve.

The line was analyzed for pipeline movements between the current inspection and 2005 GEOPIG™ Inspection. The reporting threshold is to report pipeline movements with differential bending strain exceeding 0.1%. No areas of pipeline movement, except the rerouted section, meeting the reporting threshold were identified in this line. It is listed in Appendix 4.

One copy of the survey data and the BHI software for viewing is stored on the enclosed DVD. The complete pipeline tally including girth welds, pipe fittings, wall thickness transitions, bends and anomalies can be displayed in BHI's software together with the caliper and inertial data. This information is also available in the Microsoft Excel file "BHI 2013 GEOPIG Survey NPS20 Straights of Mackinac - West Loop.xls", which is located in the directory "\BHI\ NPS20_Line5_StIgnace-Mackinaw-West_Loop\2013_GEOPIG_FINAL REPORT Issue #1" on the DVD. Also included on the DVD-ROM is the pipe tally provided in "comma delimited file" (csv) format for ISAS GIS System.

A hard copy of Enbridge ILI Reporting Profile Standard is included in Appendix 13.

2 Inspection Summary

2.1 Operational Details

Baker Hughes Pipeline Inspections has mobilized equipment and a qualified crew to perform in-line inspections of the following system:

BHI Job Number	J2008-13
Pipeline Operator	Enbridge Energy Limited Partnership
Segment Name	Line 5 Straights of Mackinac - West Loop
Launch Site	907 Boulevard Drive, St. Ignace, Michigan 49781
Receive Site	580 Wilderness Park Drive, Mackinaw City, Michigan 49701
Section Age/Date Constructed	1953
Pipeline Nominal Diameter	20''
Product	Oil
Section Length	4.15mi
Date of GEOPIG™ Inspection	July 30, 2013
Duration of GEOPIG™ Inspection	31 minutes
Field Project Manager	Blaine Titterington

Table 1. Operational Details

After passing all of the Baker Hughes pre-run inspection procedures, the GEOPIG™ was launched at 17:14 on July 30, 2013. The tool entered the receive trap at 17:45 the same day. The GEOPIG™ emerged relatively clean with no visible mechanical damage.

2.2 Reporting threshold

The reporting criterion is to report the anomalies greater than 2% of the nominal O.D. of the pipeline, the ovalities greater than 5% of the nominal O.D. of the pipeline and all dents including those greater than or equal to 1% O.D. in depth, which meet the criteria of “Dents in Close Proximity” or “Multiple Apex”. In addition, areas with either vertical or horizontal bending strain difference exceeding 0.1% with pipeline movement and spanning more than 1 pipe joint are included in this report. The anomaly size definition varies by feature type and is provided in Section 5.4.

3 SURVEY RESULTS

The GEOPIG™ inertial survey provides pipeline plan, profile and bending strain, allowing one to locate the pipeline in the GPS mapping projection, and to detect pipeline movement between runs. The positional information is derived from the onboard strapdown inertial unit, the odometer readings and the GPS coordinates of selected tie points obtained from a GPS survey.

The caliper survey provides the information on the internal diameter and shape of the pipe, allowing for detection and measurement of pipe wall anomalies (dents, ovalities and wrinkles), wall thickness changes, valves, tees and girth welds.

3.1 Chainage

The GEOPIG™ chainage is the distance measured by the GEOPIG's odometers along the pipeline and is denoted as SCh (slack chainage) on the plots. It starts from 76.0ft at the pig launch trap and ends at 21,888ft in the receive trap. A separate client chainage that correlates the GEOPIG™ slack chainage to the Enbridge's As-built chainage has been created. A one-page sample of the BHI – Enbridge chainage correlation listing is included in Appendix 8. The horizontal chainage is also available, and it represents the true horizontal distance of the surveyed pipeline.

3.2 GPS Tie Points

GPS coordinates for the receive valve were provided by Enbridge. This information was integrated with the pipe centerline coordinates obtained from the inertial survey, providing a means for locating pipeline anomalies and a foundation for a Geographic Information System (GIS). A listing of the UTM coordinates based on the WSG84 datum appears in Appendix 1.

3.3 Pipe Anomalies

The caliper data was used for detecting and sizing diameter restrictions and pipe wall anomalies, such as ovalities, dents, and wrinkles. The anomaly size definition is provided in Section 5.4.

The analysis of the caliper data has identified no dents greater than 2% O.D., and 2 ovalities greater than 5% O.D. No dents were found greater than 1% O.D., which met the criteria of "Dents in Close Proximity" or "Multiple Apex". The largest anomaly is a 1.750in (8.75 % OD) ovality located at absolute chainage 15,478.71ft. The complete anomaly listing is included in Appendix 2.

Summary of Pipewall Deformations

Deformations		Dents				Ovalities	Inward Wrinkles	Outward Wrinkles
		All (≥ 1%)	≥ 6%	Top of Pipe	Near GWD			
Total Number		0	0	0	0	2	0	0
Largest	Size (%OD)					8.75		
	Chainage (ft)					15,478.71		

Appendix 10 contains inspection sheets for the largest anomaly. There are three inspection sheets per anomaly: a dig sheet showing the position of the feature in a pipe joint together with the adjacent joints, a plot of pipeline plan and profile between the nearest u/s and d/s reference points, and a plot showing 3 views of the anomaly: 3-D view, pipe cross-section and diameter profile. The 3-D view scale is exaggerated 3 times. The pipe diameter profile consists of 25 lines showing the pipe internal diameter at different clock positions measured by the 25 pairs of opposing caliper arms. The clock positions of these caliper arms are colour coded according to the spectrum displayed on the left side of the plot.

11 internal diameter restrictions, where the I.D. was less than 90% O.D., were identified during the caliper analysis. The largest minimum I.D. reached 17.35in (86.76%) and was located at absolute chainage 15,478.82ft on an ovality. The internal diameter restriction listing is included in Appendix 3.

3.4 Bends

The analysis of the inertial data has identified 25 bends with an angle larger than 1.5° and a radius of curvature less than 100D. No bends are tighter than 5D. The bends with are listed in Appendix 5. Each bend is described in terms of absolute chainage, bend radius and angle, as well as change of direction in horizontal and vertical plane.

3.5 Pipeline Movements

The inertial data from the current and the 2005 GEOPIG™ surveys have been compared in order to identify areas of strain difference greater than 0.1% associated with pipeline movement. No such areas have been identified in this line. 1 area of pipeline replacement has been identified spanning 209.1ft at the launch barrel.

3.6 Pipe Tally

The pipe internal diameter measured by the calipers is used for calculation of pipe wall thickness assuming a constant pipe O.D. The list of valves and tees are included in Appendix 7.

The GEOPIG™ has also detected all the girth welds in the pipeline. They are listed in the worksheet “Weld Log”, which contains the information on the length and start chainage of each pipe joint. The weld log combined with all the other features in the pipeline (valves, tees, wall thickness transitions, anomalies and bends) are listed in the worksheet “Pipe Tally”. A one-page sample of the pipe tally listing is included in Appendix 9.

All the listings included in Appendices 1 to 8 as well as the full pipe tally are available in electronic form in the MS Excel spreadsheet “BHI GEOPIG Survey 2013 NPS20 Straights of Mackinac - West Loop.xls”.

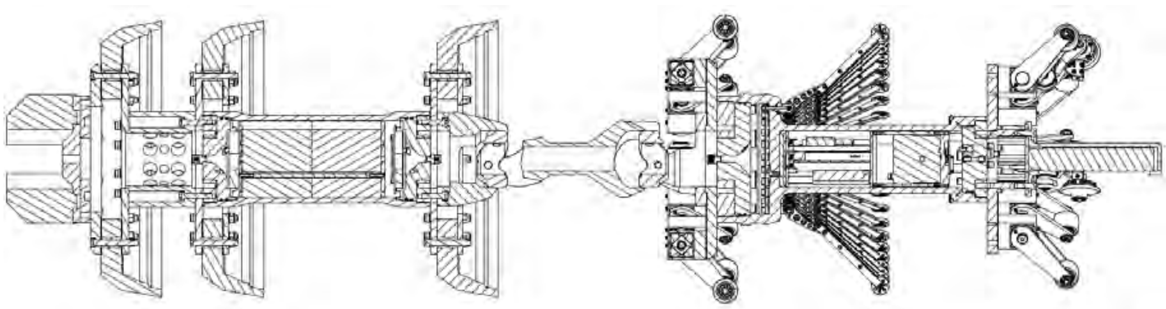
3.7 Plan and Profile

The first plot in Appendix 12 shows the plan, profile, internal diameter and pig velocity, and valves of the entire pipeline. The remaining 8 plots show the pipeline plan, profile, internal diameter and location of selected features, such as valves, tees, anomalies, internal diameter restrictions, and wall thickness transitions at 3,000ft per page.

4 GEOPIG DESCRIPTION

4.1 System Description

The GEOPIG™ is designed to meet a large variety of user requirements using a modular system that integrates a variable number of different sensors. The design of the NPS20 GEOPIG™ consists of two pig carriers, as illustrated bellow.



20" Mechanical Caliper GEOPIG™

A Strapdown Inertial Navigation System is the heart of the GEOPIG™ and delivers position and attitude of the pig along its trajectory within the pipe. Due to the nature of inertial measurements regular "updates" of attitude, position, and velocity are required. External position and attitude are taken from GPS results or alignment sheets.

The GEOPIG™ is suspended in the pipeline by urethane disks at front and rear of the carrier. This restricts the GEOPIG™ to move close and parallel to the pipe centre line. Mechanical calipers are mounted in the middle of the rear carrier and they scan the wall of the pipeline and generate a full picture of the shape of the pipeline. Here the information on dents, ovalities, wrinkles and other features is extracted.

The GEOPIG™ is completed by some other sensors and devices: odometers, which measure the distance travelled, tracking transmitter for location of the GEOPIG™, and finally, storage device and power supply which allow independent operation for long measurement periods.

4.2 Strapdown Inertial Navigation System

The strapdown INS ultimately produces 3-dimensional measurement of inertial acceleration and angular rate directly from orthogonal triads of accelerometers, and single degree of freedom gyros. In the case of a pair of two degree of freedom gyros, a redundant or combined axis measurement is available, and is dealt with appropriately to produce 3 axis orthogonal angular rates. The strapdown accelerometers and gyros are complementary sensors which when coupled deliver the measurements for computing pipeline curvature, orientation of the curvature, and the positioning capability for location of the curvature or other detected features.

4.3 Caliper

One ring of mechanical calipers scans the wall of the pipe. The caliper arms are spaced at precisely machined constant angles around the ring on the pig. An accurate offset was added to these ranges to give the actual distance from the centre of the carrier to the pipe wall. There are 50 mechanical caliper arms mounted in the middle of the carrier.

4.4 Other Sensors and Components

Other sensors and components integrated in the GEOPIG™ are:

- Odometer wheels providing direct measurements of distance traveled (chainage). Velocity is derived from these time tagged distances.
- Temperature and pressure sensors
- A flash memory system
- Interface electronics
- Batteries
- Micro-processor controllers
- Power management module
- Pig Tracking Module (Electromagnetic)

4.5 Survey Accuracy Specifications

The accuracy of the GEOPIG™ measurements are as follows:

- Pipeline position 1:2,000
- Bending strain +/- 0.02%
- Bend angle +/- 0.1 °
- Anomaly size +/- 0.1”
- Temperature +/- 0.1 Deg C
- Pressure 0.1% or +/- 3 PSI (0.2 BARSG)

5 DATA ANALYSIS PROCEDURES

The primary function of the GEOPIG™ inertial survey is to determine the pipeline plan, profile and bending strain. This is achieved by computing the GEOPIG's trajectory during the run using the data collected by the onboard strapdown inertial unit and the odometers. Due to a tight fit of the GEOPIG™ cups into the pipe the tool rides practically along the pipe centreline. The only exception from this is the deviation of the tool trajectory from the pipe centerline due to serious pipe wall deformations, as well as "smoothing out the corners" over the transition length (equal to the distance between the cups) at the bend boundaries and at the girth welds exhibiting noticeable out-of-straightness, i.e. sudden change of direction due to the weld misalignment. That data it is then rotated into the GPS co-ordinates of the selected tie-points along the line (usually a few km apart) to obtain the desired location accuracy in a given UTM mapping projection.

The following paragraphs outline the methods used for processing the odometer and inertial data in order to obtain the pipeline slack and horizontal chainage, client chainage, pipeline position and bending strain.

5.1 Chainage

The following types of chainages are used for referencing the GEOPIG™ data:

- slack chainage - the distance measured by the GEOPIG's odometers along the pipeline.
- horizontal chainage - the true distance along the pipeline projection on the horizontal plane. Not required by the client in this survey.
- client chainage - the reference system used by the pipeline operator (e.g. station number used on the as-built drawings, or KP location from the ROV survey).

5.1.1 Slack Chainage

The GEOPIG™ slack chainage is the distance measured by the GEOPIG's odometers along the pipeline. It starts from zero at the reducer on the pig launcher and ends at the receive trap. The odometer accuracy is 0.1 %.

The chainage from the first run is used as the baseline for all the subsequent runs. The preliminary chainage from the subsequent runs derived from the odometer data is scaled to match the distance between the girth welds from the baseline survey. Therefore any change of pipeline length between runs, e.g. elongation due to temperature differential, is disregarded.

5.1.2 Absolute Chainage

The GEOPIG™ absolute chainage is the distance along the pipeline corresponding to the upstream edge of defects and the centre of other features, measured from the start of the run. The usage of such distance is as per client specifications.

5.1.3 Horizontal Chainage

The GEOPIG™ horizontal chainage represents the true horizontal distance of the surveyed pipeline. It is computed from the slack chainage by projecting it on the horizontal plane first, and then scaling it to match the horizontal distance based on the GPS co-ordinates (Northing and Easting). The scaling is performed between the same tie-points that are used for rotating the inertial survey data into its final position.

5.1.4 Client Chainage

The purpose of a client chainage is to represent any one-dimensional information used by the client, which could be correlated to the slack chainage. Usually the client chainage corresponds to the chainage shown on the as-builts, or to the chainage recorded during another in-line inspection. It can be incorporated into the data at any time after the DVD is issued to the client.

5.2 Pipeline Position

The pipeline position is provided in terms of Northing, Easting and Height as a function of the chainage, in a selected mapping projection (usually UTM) and a specified datum.

5.2.1 Tie Points

Inertial data is translated, rotated and scaled to the "tie points" with known co-ordinates. Those points are typically selected at traps, valves, welds, bends, wall thickness transitions, or any other pipeline features that can be detected directly or indirectly by the GEOPIG™ sensors. The co-ordinates of those points are usually obtained from GPS survey.

This procedure provides correction for long term drifts that can introduce an absolute position error in the inertial survey over time. By transforming the GEOPIG™ trajectory into the tie points, the Northing, Easting, and Height are obtained for any point along the pipe.

The specified accuracy of the inertial survey is 1:2,000 of the distance from the tie points; therefore for the following sample distances between the tie points the following absolute accuracy is obtained:

Distance Between Tie Points [m]	Absolute Accuracy [m]
20,000	5.0
10,000	2.5
5,000	1.25
3,000	0.75

For example, if the data from two GEOPIG™ run have been tied to the points that are 3km apart, then the allowable error in-between the ties points can reach 0.75m, which corresponds to up to 1.5m difference between two runs. To reduce the relative difference between two runs, a procedure described in the next section is applied, which ensures that the actual pipeline movement is measured with centimeter accuracy. There is practically no difference in the pipeline position between the runs in the areas where the pipeline did not move.

5.2.2 Pipeline Movement

Once preliminary processing has been completed, the data from the current and the previous GEOPIG™ surveys are compared in order to identify the areas of strain differences associated with the pipeline movement. Then the current data is reprocessed using the coordinates of the tie points extracted from the baseline GEOPIG™ survey at 100m intervals, except for the previously determined pipeline movement areas. This procedure improves the accuracy of the local pipeline movement measurement by reducing the relative error between two runs. A noticeable error would result from the absolute position accumulation error when only the original tie points (from the GPS survey, at about 1km spacing) were used for scaling and rotating the inertial survey data.

5.3 Bending Strain

The bending strain is computed directly from the curvature of the GEOPIG™ trajectory, typically averaged over the distance of three pipe diameters. The specification for the bending strain measurements from the GEOPIG™ survey is +/- 0.02% strain. When the strain difference between two runs is compared that specification is usually exceeded in the originally straight sections of the line, and the accuracy of +/- 0.005% strain is achieved. The following subsections contain the description of the bending strain measurement and general remarks on interpretation of strain data.

5.3.1 Computation Method

There are two main components of the strain tensor in a pipe wall: the longitudinal strain (in the direction of the pipe axis) and the hoop strain (in the circumferential direction). The longitudinal strain is further separated into the axial component and the bending component that changes linearly along the pipe cross-section (see Figure 5.1).

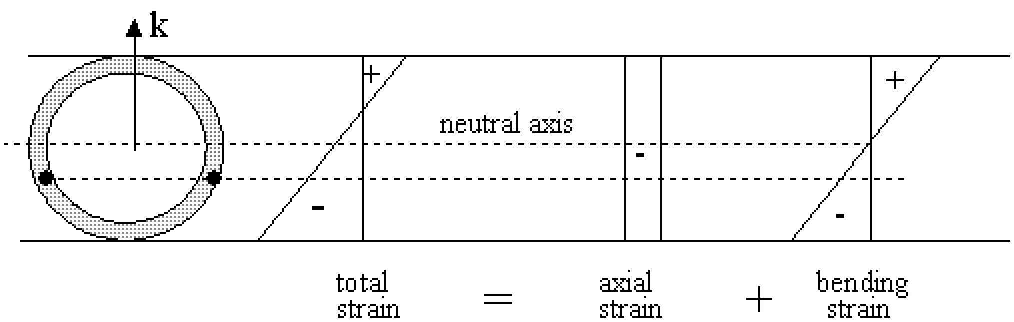


Figure 5.1 Distribution of Axial and Bending Components of Longitudinal Strain in Pipe Cross-section

The bending component of the longitudinal strain at any location in the pipe cross-section can be computed based on the bending strain at two points, e.g. at the top of the pipe (0 o'clock position) and on a right side (3 o'clock position). The bending strain at the bottom of the pipe is called the vertical strain ε_V, because it is induced by bending in the vertical plane (the bending strain at the top of the pipe has the same absolute value, but the opposite sign, i.e. - ε_V). For a similar reason the bending strain on the right side of the pipe is called the horizontal bending strain ε_H (the bending strain on the left side is equal to -ε_H). The maximum bending strain ε in the entire pipe-cross-section is equal to:

$$\varepsilon = \sqrt{\varepsilon_v^2 + \varepsilon_h^2} \ . \qquad (5.1)$$

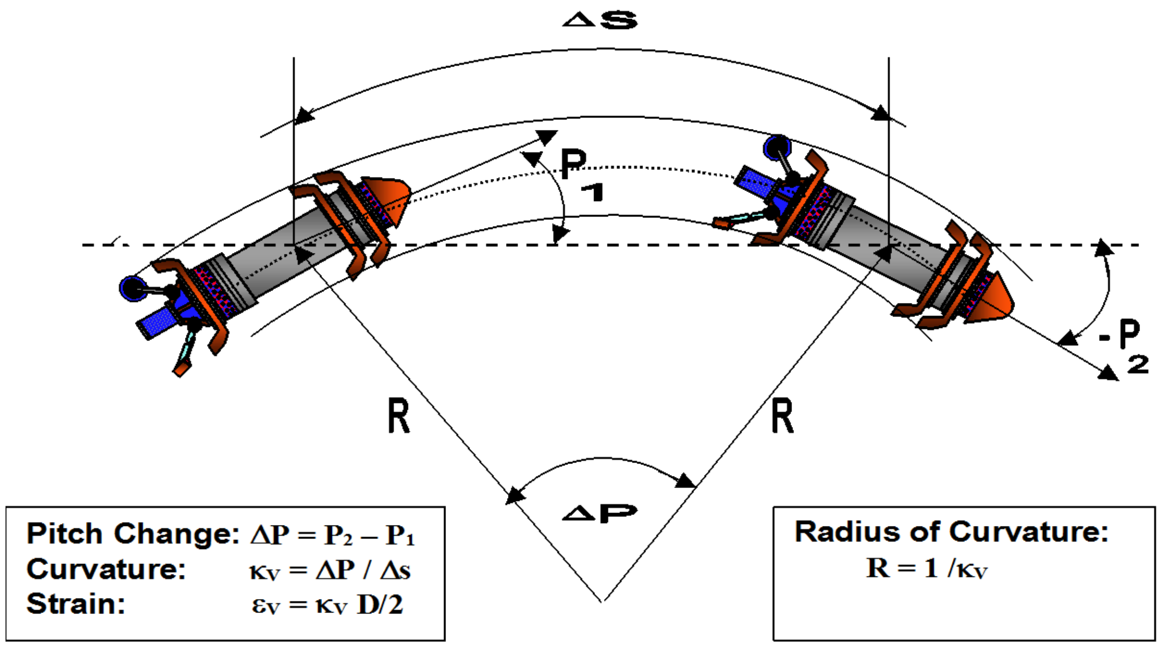


Figure 5.2 Computation of Pipeline Vertical Curvature and Strain from GEOPIG Pitch

Both the vertical and horizontal bending strains are computed from the GEOPIG™ survey using the measurements of the pipe centerline curvature. The curvature of a line in a 3-D space is defined as the change of direction (in radians) over the distance. The distance is measured by the odometers, and the direction of the pipe centerline is computed from the inertial system in terms of azimuth and pitch. The pitch P(s) describes the pipeline tilt with respect to the horizontal plane at chainage s, while the azimuth A(s) specifies the angle between the pipe direction and the north. The horizontal component of the curvature is proportional to the change of the azimuth, and the vertical component is proportional to the change of pitch. The following formulas are used for computation of the pipeline total curvature κ and its vertical κ_V and horizontal κ_h components based on the changes ΔP and ΔA of pitch and azimuth over a distance Δs along the pipe centerline:

$$\kappa = \sqrt{\kappa_v^2 + \kappa_h^2}\,, \qquad \kappa_v = \frac{\Delta P}{\Delta s}\,, \qquad \kappa_h = -\frac{\Delta A}{\Delta s}\cos(P) \qquad (5.2)$$

The relationship between curvature and bending strain is as follows:

$$\varepsilon = \frac{D}{2}\kappa \qquad \varepsilon_v = \frac{D}{2}\kappa_v \qquad \varepsilon_h = \frac{D}{2}\kappa_h \qquad (5.3)$$

where D is the pipe outside diameter.

The curvature radius is the inverse of the curvature. The BHI software reports strain in percents and the radius of curvature in pipe diameters. Strain is a unitless value that can be expressed in percents by multiplying it by 100%; e.g. 0.45% corresponds to 0.0045 strain.

5.3.2 Smoothing Curvature Data

The curvature can be computed according to formula (5.2) using the change of azimuth or pitch over the chainage increment as small as the distance between two inertial samples. The inertial data is collected at the rate of 100 samples per second. If the tool travels at the speed of 2 m/s then the distance between two samples is only 2 cm. The raw curvature computed this way would exhibit a significant level of noise, e.g. due to tool vibrations. In order to reduce that noise the curvature is typically averaged over a distance of 3 – 5 pipe diameters, i.e. 2-3m for 16" diameter pipe. For computational efficiency, instead of calculating the actual average, the curvature is computed using formula (5.2), where the increments ΔP and ΔA of pitch and azimuth are taken over a distance of 2m. This is practically equivalent to averaging curvature over the same distance - if the data are equally spaced, i.e. when the tool velocity is stable. The longer is the averaging length the smoother are the results.

Another smoothing technique is a regression line fit to the pitch or azimuth considered as functions of chainage. That method fits a line to all of the pitch values (or azimuth) over a specified length. This is practically equivalent to fitting a circle to all of the points along the GEOPIG™ trajectory over the specified length, but again much more computationally efficient than actually doing it. The radius of that circle is equal to the radius of curvature of the pipeline. The regression line fit produces smoother results than a regular moving average applied over the same length.

When estimating the bending strain induced by pipe-soil interaction, the curvature can be smoothed out over a length longer than 5 pipe diameters, usually over 5 - 10m. This approach significantly reduces the effect of weld misalignment, pipe wall imperfections and tool dynamics on the computed curvature, and at the same time it doesn't underestimate the bending strain induced by pipeline movement. This approach is particularly suited for calculation of strain difference between two runs. However, averaging over too long distance is not proper for computation of curvature of short features, such as bends or buckles. The bending strain of a feature would be underestimated if the feature was shorter than the effective averaging distance, which includes both the length used in curvature computation and the tool length, i.e. the distance between the cups supporting the pig body (i.e. the inertial canister in case of multi-body tools).

5.3.3 Interpretation of Bending Strain Data

The GEOPIG™ measures the total pipeline bending strain at the time of inspection, which includes strain induced during manufacturing, construction and operation. While pipeline is in operation the strain may be caused by the operating conditions (temperature and pressure differential) or by the external forces affecting the pipeline as the results of sea-bottom scouring, sub-sea currents, slope instability, soil settlement and erosion, etc. As the GEOPIG™ measures the total bending strain, including the plastic component induced during the whole history of loading, the current shape of the pipe and its bending strain cannot be fully explained by taking into consideration only the forces acting on the pipe during the inspection, e.g. the gravity, buoyancy and support reaction.

The GEOPIG™ measures the curvature of the pipe centerline with all its imperfections, including the out-of-straightness at welds that is theoretically described by infinite curvature, although it does not correspond to any bending strain in the pipe wall. When such curvature is measured by the GEOPIG™ is obviously not infinite due to the finite length of the tool and some additional smoothing applied during data processing, but it may still show up as spikes of significant amplitude in the curvature data.

When analyzing the bending strain induced during operation the high residual plastic strain present in the field bends should be disregarded. The main features distinguishing the bending strain induced during operation from the field bends are briefly discussed below. The bending strain in the field bends is usually in the range from 1 to 2% strain and is confined to one pipe joint and is characterized by an abrupt change of strain at the beginning and the end of a bend. The bending strain induced during operation is usually of smaller amplitude, spans more than one pipe joint and undergoes gradual change over longer transition sections.

5.4 Pipewall Anomaly Calculation

The caliper information is processed to provide the internal shape and diameter of the pipeline. The anomaly size D (depth) is calculated as follows:

(1) **Without Ovality**:	$D = D_{Rstr} - 2{*}O_V$	for dents;
(2) **CSAZ662 (Ovality)**:	$D = D_{Max} - D_{Min}$	for ovalities;
	$D_{Rstr} = D_{Nom} - D_{Min}$	
	$O_V = (D_{Max} - D_{Nom})/2$	

where:

- D_{Rstr} - total diameter restriction
- O_V - pipe ovality
- D_{Nom} - inner nominal pipe diameter
- D_{Min} - inner pipe diameter at the feature
- D_{Max} - inner pipe diameter 90° from the feature

The dent length and width are calculated as the axial distance and the circumferential distance between points of zero radial deflection respectively. The ovality length and width are calculated as the axial distance and the circumferential distance over which the feature depth exceeds 50% of its peak value respectively. A dent with the width larger than its length is called an inward wrinkle. The outward wrinkle is characterized by a local increase of pipe diameter.

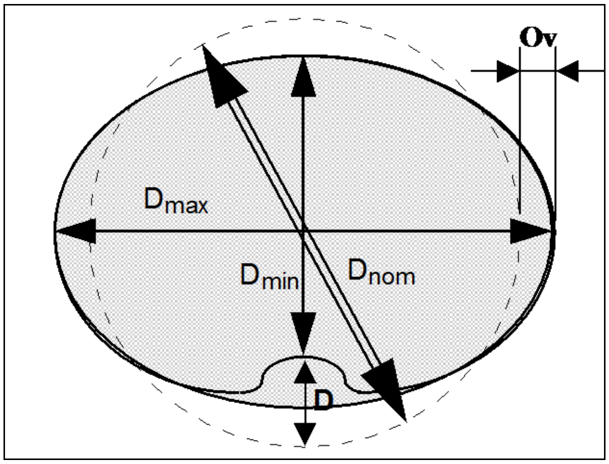


Figure 5.3 Anomaly Sizing

6 BHI Software Installation

The report is accompanied by a DVD-ROM containing the BHI display software and the data from the present survey. The data can be viewed using the GeminiView and GeoDisplay programs running in Microsoft Windows operating system. GeminiView is used to display the 3-D view of the pipe and the inner pipe wall shape measured by the calipers. GeoDisplay is used for displaying the inertial, odometer, weld, caliper, and other data bases (if available).

The directory structure on the DVD is as follows:

\BHI\NPS20_Line5_StIgnace-Mackinaw-West_Loop\2013_GEOPIG, which contains:

- several subdirectories with the GEOPIG™ data from the run
- environment file 2013_GEOPIG_NPS20_St_Ignace-Mackinaw-West_Loop_Issue1.env with the information on the location of the data files from the run. (%RootDir% specifies the path, and %BaseName% - the name)
- configuration file GD.cfg for Geodisplay

\BHI\BHI_Software	with the software stored on two subdirectories:
\GeminiView	with the GeminiView program (GEMINIVIEW.EXE)
\GD	with the GeoDisplay program (GDWIN.EXE)

The entire content of the DVD can be copied to a network drive, or a local hard drive for faster access of the data and the ability to save configurations files with customized displays. The programs can be also stored on the local hard drive while the data is accessed from the DVD or a network drive. In this case only the \BHI_Software subdirectory needs to be copied on the local hard drive.

Geminiview:

To setup the GeminiView program for the first time on a computer:

- Run the setup.exe program in the BHI\BHI_Software\GeminiView directory.

To launch the GeminiView program:

- Double click Geminiview_3.17.0.0.exe

Jobs can then be loaded using the File ⇒ Open menu

GeoDisplay:

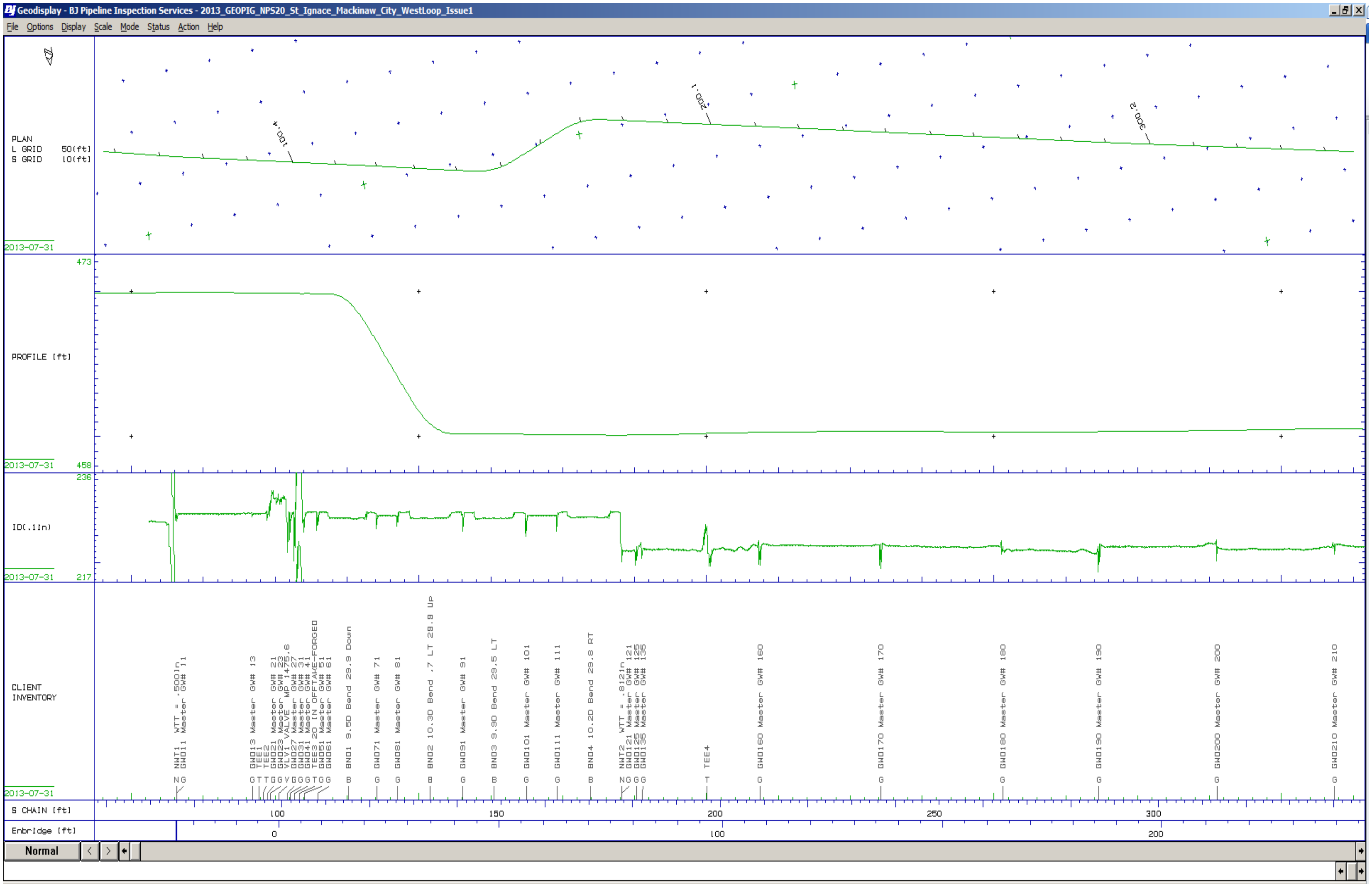
The simplest way to launch GeoDisplay from the DVD is to double click on the application program (GDWIN.EXE) using Windows Explorer.

The recommended way to launch GeoDisplay is to copy the “Geodisplay 2013 GEOPIG NPS20_Line5_StIgnace-Mackinaw-West_Loop” icon onto the computer desktop using the procedure outlined below. It is assumed that the subdirectory \BHI\BHI_Software is stored on the **C:** drive, and the data directory \BHI\NPS20_Line5_StIgnace-Mackinaw-West_Loop is on the **D:** drive. However, the proper drive letters for the DVD, network or hard drive corresponding to the actual location of those directories have to be used.

1) Go to directory C:\BHI\BHI_Software\GD using the Windows Explorer and drag the shortcut icon “Geodisplay NPS20_Line5_StIgnace-Mackinaw-West_Loop (with the blue and white BHI logo) to the desktop.
2) Right click on this new icon and left click on “Properties”.

3) Click on the “Shortcut” tab and make sure the “Target” and “Start in” are set to **C:**BHI\BHI_Software\GD\GDWIN.exe and **D:** \BHI\NPS20_Line5_StIgnace-Mackinaw-West_Loop respectively.
4) Click on the “General” tab and uncheck the “Read-only” box.
5) To start the program, double click on the icon.

Appendix 9. Pipe Tally – Sample Plot



Appendix 12. Plots of Pipeline Plan, Profile, Internal Diameter and Features

PipeWall Anomaly Listing

Client: Enbridge Energy Limited Partnership
Project: NPS 20 GEOPIG Geometry Inspection
Run Date: July 30, 2013
Location: Line 5 Straights of Mackinac - West Loop
Projection: UTM
Datum: WGS 84
Zone: 16
C.M.: -87

Feature Identifier	Absolute Chainage (ft)	Enbridge Chainage (ft)	Nearest U/S GWD	Dist to U/S GWD (ft)	Dist to D/S GWD (ft)	Clock Position h:mm	Depth (in)	Depth (%)	Length (in)	Width (in)	MinID (in)	Ovality (%)	MSP Position (ft)	Half Peak Height Position: US Shoulder (in)	Half Peak Height Position: DS Shoulder (in)	Half Peak Height Position: Circ Start Shoulder (in)	Half Peak Height Position: Circ End Shoulder (in)	Multi Apex (Y/N)	Dent Oriented off Axis (Y/N)	Assoc. Girth Weld (Y/N)	Dent in Close Proximity (Y/N)	Northing (m)	Easting (m)	Height (m)	Comments
OVL 1	15,478.71	15,259.83	6080	14.14	6.92	1:00	1.750	8.75	40.52	10.44	-	-	-	-	-	-	-	-	-	-	-	5,074,486.56	673,176.81	116.22	
OVL 2	15,529.34	15,309.89	6100	17.43	2.81	12:45	1.090	5.45	40.33	9.99	-	-	-	-	-	-	-	-	-	-	-	5,074,471.87	673,172.54	117.92	

Bend Listing

Client: Enbridge Energy Limited Partnership
Project: NPS 20 GEOPIG Geometry Inspection
Run Date: July 30, 2013
Location: Line 5 Straights of Mackinac - West Loop
Projection: UTM
Datum: WGS 84
Zone: 16
C.M.: -87

BAKER HUGHES

Feature Identifier	Absolute Chainage (ft)	Enbridge Chainage (ft)	Nearest U/S GWD	Dist to U/S GWD (ft)	Bend Rad. (D)	Bend Angle (deg.)	Azimuth Change (deg).	Azimuth Dir.	Pitch Change (deg).	Pitch Dir.	Northing (m)	Easting (m)	Height (m)
BND 1	115.19	16.40	61	7.08	9.5	29.9	.3	Right	29.9	Down	5,078,865.97	674,354.97	143.02
BND 2	133.80	34.82	81	7.42	10.3	29.9	.7	Left	29.9	Up	5,078,867.16	674,350.06	140.47
BND 3	148.42	48.91	91	7.12	9.9	29.5	29.5	Left	.0	Up	5,078,868.02	674,345.72	140.26
BND 4	170.41	70.55	111	7.59	10.2	29.8	29.8	Right	.3	Down	5,078,866.47	674,339.22	140.25
BND 5	577.74	479.07	300	14.81	24.9	19.4	19.4	Left	.3	Up	5,078,893.83	674,218.13	140.40
BND 6	598.57	500.17	310	10.86	24.9	21.5	21.5	Left	.3	Up	5,078,893.14	674,211.85	140.38
BND 7	625.53	527.24	320	12.62	26.1	24.0	24.0	Left	.9	Down	5,078,889.25	674,204.68	140.43
BND 8	649.24	550.82	330	10.89	23.1	23.3	23.3	Left	1.5	Up	5,078,883.54	674,200.32	140.44
BND 9	15,173.89	14,957.63	5960	14.34	63.4	1.7	.8	Right	1.5	Up	5,074,576.80	673,198.24	113.24
BND 10	15,419.37	15,201.29	6050	25.81	51.5	3.7	1.7	Left	3.3	Down	5,074,504.28	673,180.18	117.00
BND 11	15,425.66	15,207.51	6060	5.69	49.6	2.7	.9	Left	2.5	Down	5,074,502.41	673,179.80	116.96
BND 12	15,447.98	15,229.55	6070	5.67	47.5	4.4	1.5	Right	4.1	Up	5,074,495.72	673,178.64	116.39
BND 13	15,481.28	15,262.43	6080	16.71	29.6	9.3	5.2	Right	7.7	Up	5,074,485.78	673,176.61	116.25
BND 14	15,529.24	15,309.99	6100	17.33	25.0	6.0	3.1	Left	5.2	Down	5,074,471.85	673,172.53	117.93
BND 15	15,982.22	15,760.13	6280	3.96	45.9	3.0	2.2	Left	2.1	Up	5,074,337.55	673,140.44	117.98
BND 16	20,938.68	20,666.54	8190	15.41	24.2	8.1	.0	Left	8.1	Down	5,072,867.29	672,797.69	148.75
BND 17	21,176.43	20,901.71	8280	21.33	28.8	4.3	.2	Right	4.3	Up	5,072,796.87	672,780.80	151.30
BND 18	21,190.22	20,915.22	8290	7.16	30.0	5.1	.0	Right	5.1	Up	5,072,792.82	672,779.78	151.72
BND 19	21,218.57	20,943.80	8300	11.17	24.4	11.1	10.0	Left	5.2	Up	5,072,784.57	672,777.72	153.26
BND 20	21,251.17	20,976.05	8310	17.53	23.7	18.9	19.6	Left	1.3	Up	5,072,775.01	672,777.08	155.82
BND 21	21,274.86	20,998.75	8320	12.51	22.4	24.2	25.0	Left	2.0	Down	5,072,768.39	672,778.99	157.86
BND 22	21,300.66	21,024.32	8330	14.18	25.0	23.6	22.8	Left	7.6	Down	5,072,762.57	672,783.82	159.83
BND 23	21,323.06	21,046.58	8340	9.72	25.1	15.3	14.2	Left	5.8	Down	5,072,759.36	672,789.74	160.71
BND 24	21,841.93	21,560.09	8620	8.38	25.5	11.4	.3	Right	11.4	Up	5,072,723.10	672,943.70	160.44
BND 25	21,877.64	21,596.42	8640	12.45	27.4	12.4	.6	Left	12.4	Down	5,072,720.62	672,954.08	162.55