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5706 McIntyre Street
Golden, CO 80403

January 28, 2021

Michael Nystrom, Chairman
Mackinac Straits Corridor Authority

Re: Summary of Great Lakes Tunnel Project Activity

Dear Chairman Nystrom,

I am writing to summarize key activities of the Great Lakes Tunnel Project (GLTP) for the time period March 1 to December 31, 2020. My summary will address (1) Enbridge submittals required per the Tunnel Agreement; (2) joint development of tunnel specifications; (3) design of the tunnel; and (4) independent quality assurance contractor.

1. Enbridge Submittals

Per their April 30, 2020 submittal, Enbridge completed the activities identified in their Preliminary Engineering Activities Work Plan (PEAWP). Completion of PEAWP activities was required per Tunnel Agreement Section 7.5b by April 30, 2020 or 120 days after completion of the geotechnical investigations, whichever is later. The PEAWP itself was submitted Feb. 1, 2019 (deliverable #1 in Table 1 below).

Per document deliverable #7 from Enbridge, PEAWP activities included the following:

- Geotechnical investigations: including desktop study, lake bottom profile, geophysical surveys, and the gathering of geotechnical subsurface data along the proposed tunnel corridor through a boring, in-situ testing and laboratory testing program. ***Geotechnical investigations were carried out principally in 2019. I addressed these in my Feb 28, 2020 report.***
- Development of geotechnical data report (GDR): a compilation of information collected during the geotechnical investigations. ***Enbridge submitted a GDR as deliverable #6 (Table 1) in December 2019. An updated GDR, including additional laboratory test data, was submitted by Enbridge on March 31, 2020.***
- Initiated a geotechnical baseline report (GBR): a document that describes the anticipated 'baseline' geotechnical conditions along the tunnel alignment. ***The GBR was initiated and has since progressed along with design.***
- Project risk assessment: including risk workshops to identify potential project risks, develop risk mitigation strategies, and establish a process for continuous management of each risk. ***Enbridge has developed and maintains a risk register.***
- Assembling of a project specifications team and begin to develop project specifications. ***The project specifications team was identified (submittal #2) and joint development of specifications began thereafter.***

- Provide input into regulatory and environmental permit and approval applications. ***Three major permit applications (Michigan Public Service Commission; Michigan Environment, Great Lakes, and Energy; joint to EGLE and US Army Corps of Engineers) were submitted by Enbridge in April 2020.***
- Further refine tunnel design aspects, including alignment, cross section, and north/south shore access locations and configurations. ***Enbridge completed 30% design in March 2020, and have since progressed to 90% design.***

I find that the PEAWP activities to be satisfactorily completed in accordance with the Tunnel Agreement.

Table 1. Summary of Enbridge Deliverables Provided to the MSCA per the Tunnel Agreement

#	Deliverable	Due Date	Received by MCSA	Satisfactory?
1	Preliminary Engineering Activities Work Plan	Feb. 4, 2019	Feb. 1, 2019	Yes
2	Identify Project Specifications Team	March 1, 2019	Feb. 28, 2019	Yes
3	Draft Procurement and Contracting Execution Plan	April 30, 2019	April 30, 2019	Yes
4	Draft Procedures for Establishing Escrow Accounts	Sept 16, 2019	Aug. 30, 2019	No opinion[1]
5	Draft Request for Proposals	April 30, 2020	Aug. 19, 2019	yes
6	Geotechnical Data Report	Dec. 31, 2019	Dec. 23, 2019	Yes
7	Completion of Prelim Engineering Activities Work Plan	April 30, 2020	April 30, 2020	Yes

2. Joint Development of Tunnel Project Specifications

MSCA acceptance of Tunnel ownership requires it to be constructed in accordance with the agreed upon Project Specifications. Per Tunnel Agreement Section 7.2, Enbridge and the MSCA identified members of a team to jointly develop the Project Specifications related to design and construction of the tunnel. The team was identified in deliverable #2 (Table 1). The Tunnel Agreement states that the jointly developed Project Specifications pertaining to the tunnel are to be submitted to the MSCA for approval.

Project Specifications include the technical requirements for the tunnel as well as construction specifications. The technical requirements convey performance requirements such as design service life, allowable water infiltration limits, tunnel-induced settlement limits, noise and vibration limits, etc., as well as design requirements as stipulated in the Tunnel Agreement, e.g., minimum diameter, structural liner, accommodation of third-party utilities, prevention of any pipeline liquids leakage into lakebed or Straits. The technical requirements also identify the prevailing codes and standards to be adhered to during design, e.g., various American Concrete Institute (ACI) code sections, American Association of State Highway and Transportation Officials (AASHTO) Tunnel Design Guide, International Tunneling Association (ITA) guidelines, National Fire Protection Association (NFPA) codes and standards, etc.

The jointly developed tunnel Project Specifications include nine construction specification sections that pertain to the permanent tunnel structure that the MSCA will ultimately assume ownership of per the Tunnel

[1] Satisfactory per assessment by Ryan Mitchell (MDOT)

Agreement. The nine jointly developed Project Specification sections and key contents of each are summarized in Table 2.

Table 2. The Nine Sections of Jointly-Developed Tunnel Project Specifications

Structural Concrete Materials Specifies: cementitious materials and aggregates to be used in concrete mixes for all concrete structures except precast concrete tunnel lining (PCTL); performance criteria for various mixes; delivery, storage, handling requirements; quality control sampling, testing and acceptance requirements; document submittals by contractor; qualifications of material and ready-mix concrete manufacturers.
Cast-In-Place Concrete Specifies cast-in-place concrete, including formwork, reinforcement and finishes for diaphragm walls and capping beams, slabs-on-grade, drilled shafts, and miscellaneous works. Includes: qualifications for ready-mix manufacturers, installers, welders, testing agencies; material requirements including steel reinforcement; field condition guidelines; formwork materials and installation; concrete placement, finishing and curing; repair materials and methods; quality control sampling, testing and acceptance requirements.
Precast Structural Concrete Specifies requirements for precast sump roadway units to be installed in the center deep section of the tunnel. Includes: qualifications of precast fabricator/manufacturer, installer, field auditor; structural performance criteria; requirements for steel reinforcement, connectors, molds and grout materials; fabrication requirements including dimensional tolerances and finishing; installation guidelines; repair procedures and criteria; quality control inspection, sampling, testing and acceptance requirements.
Precast Concrete Tunnel Lining Specifies the requirements for manufacturing, handling, transporting and installing the gasketed precast concrete tunnel lining (PCTL) segments that form the permanent tunnel structure for the 99 year design service life. Includes PCTL mix design requirements and performance criteria; steel rebar and steel/poly fiber requirements; qualifications for PCTL and materials manufacturers, independent testing laboratories; material certifications; dimensional tolerances; document submittals by contractor; segment casting, curing, and transporting requirements; damage criteria, and repair materials and procedures; quality control sampling, testing and acceptance requirements; segment tracking and record keeping.
Sealing Leaks Specifies requirements for minimizing water infiltration from leaks through tunnel and shaft/portal concrete. Includes: workplan submittal requirements; qualification requirements for personnel; crack sealing product performance requirements; methodologies for sealing cracks, joints, grout sockets; quality control and record keeping requirements.
Excavation by Tunnel Boring Machine As related to permanent tunnel structure, specifies the installation of PCTL and placement of annular backfill grout between the excavated ground and exterior of PCTL. Includes: lining ring erection and assembly procedures and requirements, segment handling and transport, methods for correct positioning and measurement; backfill injection system requirements; lining monitoring and control; segment documentation requirements; qualifications for segment installer, TBM operators; thrust jack load limits on segments; water infiltration criteria; as-build tunnel lining survey.

Backfill Grout Specifies requirements for performing annulus backfill grouting between exterior of PCTL and excavated ground, ensuring continuous contact of PCTL with surrounding ground. Includes: qualification requirements for grouting manager, testing laboratory and testing personnel; grout material requirements; grouting equipment and measurement system; grout mix design criteria and material requirements; grouting procedures; verification testing requirements; inspection and test plan requirements.
Bored Piles Specifies requirements for bored piles (cast in place drilled shafts) to be used at the shaft/portal areas, including qualifications for bored pile contractor, design engineer, supervisor and testing agency; trial concrete mixes; material performance requirements; excavation procedures and tolerances; steel reinforcement and concrete placement; quality control inspection and test plan requirements.
Diaphragm Walls Specifies requirements for cast-in-place concrete walls (diaphragm walls) that will constitute the shaft and portal structure walls on the north and south shores. Includes: requirements for detailed work plan and design drawings; concrete and slurry fluid support performance requirements; equipment requirements; qualifications requirements for diaphragm wall contractor, engineer, special inspector; excavation; inspection and test plan requirements; field quality control reporting; corrective action;
Earthwork Excavation and Backfill Specifies requirements to excavate soil and rock for shaft/portal construction and to construct embankments/fills for north and south shore structures. Includes blasting requirements, controls, and safety protocols; inspection and test plan requirements including documentation; earthwork compaction criteria; qualifications requirements for blasting and earthworks personnel; requirements for earthwork materials, geotextile, flowable fill and explosives; procedures for dewatering, blasting, excavation and backfilling.

Together with Enbridge and their consultants, a select group of MDOT engineers and consultants, hereafter MSCA Joint Specifications team, jointly developed the nine Project Specification sections throughout 2020 on behalf of the MSCA. MSCA Joint Specifications team members included myself, Ryan Mitchell, Manager of MDOT Innovative Contracting, Matt Chynoweth, MDOT Chief Bridge Engineer, as well as consultants Ihab Darwish, Senior Project Manager at Alfred Benesch & Company, and Mahmoud Khwaja, Tunnels National Discipline Leader with CDM Smith, who participated in the 90% and 95% level review.

The MSCA Joint Specifications team worked with tunnel designer of record Arup during development of the nine tunnel Project Specifications sections. These nine sections built upon the preliminary Project Specifications established in the designer RFP and construction services RFP (deliverable #5 in Table 1).

MSCA Joint Specifications team involvement occurred via a formal comment resolution process that is standard of practice for infrastructure construction projects. The process proceeded as follows:

- Enbridge's tunnel designer of record Arup prepared each draft of the nine Project Specification sections at the 60% design level.
- The MSCA Joint Specifications team conducted a detailed review of the nine sections to insure accordance with tunnel construction best practice and Michigan infrastructure construction practice.
- The MSCA Joint Specifications team submitted point by point written comments to each specification section requesting additions, modifications, deletions and clarifications.
- Arup addressed each comment by written response, e.g., accepting the comment and modifying the specification language, answering the query, explaining the rationale, etc.
- The MSCA Joint Specifications team reviewed each comment response. Comments were closed if the response was deemed acceptable; comments were continued/elaborated if further discussion or action was required.
- Arup prepared 90% design level versions of each of the nine Project Specifications, incorporating MSCA comments and other specification advances that stemmed from furthering their design. The comment resolution process described above was then repeated. A similar process was performed for 95% level specification sections.

Joint specifications development began with a full team kickoff workshop in late March 2020. Beginning in July, the MSCA Joint Specifications team met via conference call weekly to discuss individual reviews, comments and responses. We also met with Enbridge and its consultants (Arup, WSP) weekly via conference call to further the development and finalization of the nine jointly developed Project Specification sections. Overall, the MSCA Joint Specifications team submitted nearly 400 comments to the nine Project Specification sections. Each comment was satisfactorily resolved. I understand there was also a detailed progressive Project Specifications review and comment process involving Enbridge's owners engineer WSP, construction services contractor Great Lakes Tunnel Constructors (GLTC) and other Enbridge consultants. The MSCA Joint Specifications team saw the results of this captured in updated Project Specification sections.

I note here a few caveats to the jointly developed Project Specifications. First and as stated above, the jointly developed Project Specifications extend to nine sections that relate to the permanent tunnel and shaft/portal civil/structural infrastructure. Per the Tunnel Agreement, the MSCA Joint Specifications team did not participate in the development of pipeline specifications, Enbridge building specifications or mechanical, electrical, plumbing specifications. The MSCA team scope extended only to those infrastructure assets that the MSCA will assume ownership of. Second, the MSCA Joint Specifications team effort did not extend to a detailed design review or design verification. Per the Tunnel Agreement, the design is Enbridge's responsibility. I discuss Enbridge's independent design review process below. Third, the Joint Specifications will go hand in hand with an issued-for-construction (IFC) drawings set. The MSCA Joint Specifications team review of drawings was completed through the 90% design level. To my understanding, Enbridge will complete and make available IFC drawings during the first half of 2021. Finally, there will be a general section of Project Specifications language that collects common terms, conditions, definitions, etc. to all Project Specification sections, and defines the quality management requirements. Examples of this include the general requirements for Inspection and Test Plans, required adherence to Enbridge policies on quality management, and definitions of Independent Testing Agency. Joint effort on this Project Specification language is ongoing. This language ties into the final development of an agreement between Enbridge and the construction contractor that, to my understanding, is

scheduled for the first half of 2021. We as the MSCA Joint Specifications team will participate in this aspect to completion.

Subject to these caveats, I find the jointly developed tunnel Project Specifications to be comprehensive, detailed and consistent with standards of practice in tunnel design and construction. Taking the precast concrete tunnel lining (PCTL) specification section as an example, all appropriate codes and standards are identified, and are consistent with those established in the RFPs. The performance requirements in the Tunnel Agreement, e.g., 99 year design service life, minimum 10 ft inner diameter, are captured in the specification language and associated drawings.

There were two modifications in technical requirements made from preliminary specifications (RFP stage) to final specifications. First, the maximum overall water infiltration limit was modified from 5000 gallons per day (RFP preliminary specifications) to 7000 gallons per day. The 5000 gallons per day limit a considerably smaller inside diameter tunnel per the Tunnel Agreement while the designed tunnel is 21 ft inside diameter. The increase to 7000 gallons per day is primarily due to the increased surface area resulting from the increase in diameter. Second, a 3 inch minimum concrete cover thickness was listed in the RFP preliminary specifications. However, the required concrete cover thickness is determined during durability analysis/design, and is specified based on that outcome. Accordingly, the concrete cover thickness specified in the drawings is a result of the durability design that itself meets the 99 year service life requirement of the Tunnel Agreement.

3. Design Process

Enbridge and its consultants, namely designer of record Arup and owner's engineer WSP, have been carrying out detailed design of the tunnel and north/south shore shaft/portal structures throughout 2020. Design was completed to 30% level in March 2020, 60% in July 2020 and 90% in October 2020.

In compliance with Tunnel Agreement Section 7.6, Enbridge provided me with access to observe the design process in the following ways: (1) Access to a secure digital documents website, through which I have been able to view design documents and drawings. (2) Access to join, via web conferencing, review meetings hosted by Enbridge that were conducted after 30% and 60% design. A 90% design review is planned in the coming weeks. These review meetings involved design review and value engineering efforts carried out by Enbridge and their consultants. (3) I have joined weekly GLTP calls where Enbridge, WSP, Arup and GLTP address a variety of engineering design, construction and process issues to advance the project.

Enbridge also shared their independent design review process with the MSCA Joint Specifications team. Arup, as the designer of record, has a design quality management process that involves design coordination, design checks and design reviews. Design coordination includes 3D model reviews, clash reports, and drawing review sessions. Design checks involve checks on analysis and design calculations by engineers not working on the primary design. Design reviews are performed by independent senior discipline engineers and subject matter experts, both internal and external to Arup, to challenge means and methods, review design checks, and

highlight details requiring careful attention. Beyond this, WSP as Enbridge's owner's engineer, performs detailed technical reviews that includes evaluating all tunnel and pipeline designs. In addition, Enbridge reviews all design deliverables internally and has hired external tunnel technical advisors, e.g., Erika Moonin & Associates, to review design outputs and construction means and methods. The construction services contractor GLTP also provides constructability analysis and reviews throughout design. The project uses 30, 60 and 90% design reviews and a detailed comment resolution log, both of which are industry standard processes for tunnel design.

Despite the pandemic-forced shut down of travel, my access to the design process has been sufficient to meet the intent of the Tunnel Agreement. Moreover, the design has progressed from preliminary conceptual level at the beginning of 2020 to near final detailed design and IFC drawings. I have been able to keep abreast of the design process and decisions, the rationale behind decisions, the value engineering efforts, and supporting documents. I am currently reviewing 90% design documents and will participate in Enbridge's upcoming 90% design review meetings. To my understanding, final design will be completed in the first quarter of 2021.

The design process in my view has been and is being rigorously conducted. Arup has involved their key experts from around the world in the design, and has incorporated external subject matter experts for some of the particularly challenging aspects, e.g., high groundwater pressure, face stability with reduced pressure, ground characterization, etc. The design review by WSP and Enbridge's external tunnel advisors adds a layer of assessment that is extremely valuable. While I have not been privy to all aspects of these design reviews, I am confident this is benefitting the project and meeting the project's design needs.

Another critically valuable aspect of the design process has been the early involvement of the pre-construction services contractor GLTC (Obayashi and Jay Dee) and the tunnel boring machine (TBM) manufacturer Herrenknecht. The various constructability analyses carried out by GLTC have fed into the design process. Examples of this include detailed assessments of cutterhead tool wear and compressed air interventions required along potential tunnel alignments. The results of these assessments contributed to the selection of the design tunnel alignment. TBM manufacturer Herrenknecht was chosen early in the design phase and brought in as a formal partner by Enbridge. This has enabled a very detailed assessment of TBM diameter/space proofing for saturation diving interventions, thrust jack forces, production rates, probe hole drill fitout, and other aspects. Much of this fed into the design process and contributed to Project Specifications development.

4. Independent Quality Assurance of Construction

Per Tunnel Agreement Section 5.3, Enbridge will provide the funds necessary for the MSCA to retain an independent quality assurance (IQA) contractor to monitor tunnel construction. Enbridge will require their construction contractor to perform industry standard quality control (QC) procedures and will provide comprehensive quality assurance (QA) for tunnel construction. They are designing, constructing and financing the tunnel and pipeline, and therefore assume primary responsibility for QC, QA and associated risk in ensuring contractor compliance with the requirements of the Tunnel Agreement, Project Specifications, government approvals and applicable law.

Throughout the last quarter of 2020, the MSCA Joint Specifications team worked with Enbridge to ensure clearly defined QC requirements were established in each of the nine jointly developed Project Specification sections. The construction contractor will be required to perform and meet these requirements. Enbridge's QA plan will provide assurance that the Project Specifications are met. Enbridge has provided to us information about their QA policies and preliminary QA plans for the GLTP.

A draft RFP for the MSCA's IQA consultant (contractor) is under development. The IQA scope of work will including providing owner verification documentation, a comprehensive and conclusive record of project QC/QA, testing and inspection, demonstrating that the construction of the tunnel project has met the requirements of the Tunnel Agreement, jointly developed Project Specifications, project specific quality plans (QPs) and Inspection and Test Plans.

In summary, considerable progress has been made since the March 2020 MSCA board meeting. I recommend acceptance of the nine jointly developed Project Specification sections developed to date. Further, I find that Enbridge's submittals, design process and progress, and quality management planning efforts to be acceptable and in accordance with the Tunnel Agreement.

Sincerely,

Michael A. Mooney, PhD, PE

CC: Ryan Mitchell, Manager, Innovative Contracting Unit, MDOT