From:	Blankenship, Melissa
To:	Joe McGaver; Tim Drake
Cc:	Bennett.Micah; Hammer, Edward; McDavid, Alaina; Weaver, Kerryann; Mednick, Adam C - DNR; Haller, Macaulay G - DNR; Sande, William M CIV USARMY CEMVP (USA)
Subject:	following up on the EPA_DNR Enbridge WI Line 5 reroute Macroinvertebrate Sampling Discussion on November 29, 2023
Date:	Thursday, December 14, 2023 8:32:08 AM
Attachments:	Discussion of Macroinvertebrate Impacts DNR FINAL 2023-12-13.docx

Good morning,

On Wednesday, November 29, 2023, EPA and WDNR met to discuss macroinvertebrate sampling for the proposed Enbridge WI Line 5 reroute project.

The attached document, an EPA "do out" from the meeting, is a literature annotation and our thoughts on the literature that we examined.

Let's discuss setting up a time in the new year to reconvene on this topic.

Thank you and take good care,

Melissa

Enbridge Line 5 Wisconsin Reroute-Summary of scientific literature reviewed by EPA to evaluate potential pipeline construction impacts to the benthic macroinvertebrate communities in streams from using open cut crossing methods

Summary and Considerations

- Most studies of pipeline crossing construction effects on macroinvertebrate communities reviewed by EPA report return to pre-construction conditions within one year post-construction. EPA notes that a proper meta-analysis would consider the error/sample size of each study to determine a mean effect, and this has not been undertaken to the Agency's knowledge.
- EPA also notes that the lowest level of taxonomic identification and the specific metric of pre-/post-construction comparison (e.g., total taxa richness, total abundance Ephemeroptera/Plecoptera/Trichoptera (EPT) richness) vary widely among studies. In many cases a limited number of metrics were compared, and most studies are from the gray, non-peer-reviewed literature.
- The studies specific to pipeline crossings generally use sites upstream and downstream of construction sites to evaluate downstream effects of pipeline activities on benthic macroinvertebrate communities. Few studies specifically examined macroinvertebrate community changes and recovery at the construction site (i.e., disturbance area). Therefore, there is limited scientific literature on which to base *a priori* evaluation of potential impacts and recovery of the aquatic resources at the construction site itself. The scientific literature on stream restoration and patch colonization may shed some light on the considerations for likelihood of recovery and recovery time; however, site-specific monitoring would improve certainty and suggest whether additional post-construction restoration measures are necessary.
- Note that this set of literature focuses on pipeline impacts and macroinvertebrates specifically. There are other sets of studies on impacts of pipelines on suspended sediment and other endpoints, as well as a large body of literature on sediment impacts to stream ecosystems that is partially reviewed in Anderson et al. 1996 and Levesque and Dube 2007 (see below). See also Courtice, G., & Naser, G. (2020). In-stream construction-induced suspended sediment in riverine ecosystems. River Research and Applications, 36(3), 327–337. https://doi.org/10.1002/rra.3559
- One concern about drawing inferences about a specific project based on the literature is the limited set of literature that exists and the variability in ecological context and response that is represented by that limited literature. This set of literature contains only seven primary studies, and an additional ~15 studies from the gray literature are reviewed in Reid and Anderson 1999. The majority of these studies are from Canada and western North America. According to statements by the study authors, macroinvertebrate community metrics generally returned to pre-construction or similar

to upstream conditions between one month and four years, with many highlighting the 1-year post-construction timeframe. However, as stated above, many studies from the gray literature were not accessible and often studies did not report data on how specific taxa or functional groups were impacted. As noted below for the Tsui and McCart study, these changes in important sensitive taxa or functional groups may be glossed over when reporting results for total richness, diversity, or density measures.

- This context suggests that, as highlighted in Levesque and Dube (2007), project-specific data collection and analysis of macroinvertebrate responses and recovery after pipeline crossing construction activities would still be beneficial for determining impacts and evaluating the need for post-construction remediation activities related to stream ecosystem restoration.

Annotation of Literature Considered

- **Anderson, P., Taylor, B. & Balch G. (1996). Quantifying the effects of sediment release on fish and their habitats. Canadian Manuscript Report of Fisheries and Aquatic Sciences no. 2346.**
    - Heavily based on literature review.
    - Focus is largely on fish and fish habitat.
    - Macroinvertebrate impacts largely evaluated by examining literature on suspended sediment impacts to macroinvertebrates. Notes the basic concept that sediment particle size distribution can change macroinvertebrate community composition.

- **Anderson, P. G., G-J Fraikin, C., & Chandler, T. J. (1998). Impacts and recovery in a coldwater stream following a natural gas pipeline crossing installation. International Pipeline Conference — Volume II, 1013–1022.**
  http://asmedigitalcollection.asme.org/IPC/proceedings-pdf/IPC1998/40238/1013/2507018/1013_1.pdf
    - Evaluation of open-cut crossing effects on downstream habitat, fish, and macroinvertebrates – Ontario, Canada.
    - Substantial reduction in richness and changes to community structure, including no invertebrates found at one downstream location, and dominance by sediment tolerant oligochaetes one week after construction; some recovery in total richness at 12 weeks but downstream communities still dominated by oligochaetes; return to pre-construction richness and increased diversity after one year.
    - Note that actual community structure/proportions of taxa are not provided to evaluate the generalized trends that are reported in community structure.

- **Armitage, P. D., & Gunn, R. J. M. (1996). Differential response of benthos to natural and anthropogenic disturbances in 3 lowland streams. Internationale Revue Der Gesamten Hydrobiologie, 81(2), 161–181.** https://doi.org/10.1002/iroh.19960810202
    - Monitoring of one stream in association with pipeline crossing (of unknown characteristics) at 20m above the sampling site.
    - Sand-gravel streams became silt dominated after construction, associated with increase in proportion of tolerant Chironomidae and oligochaetes; return to crustacean (Gammaridae) dominated community occurred after four years, associated with a flushing of silt and return of gravel/pebble substrate dominance.
    - Enbridge noted in its review of this study that a culvert was installed at the site immediately downstream of this location during the study and suggested that this could be responsible for reduced streamflow and increased siltation at the upstream site. Although this is a possibility, the authors excluded the culverted site from consideration.

- **Castro, J. M., Macdonald, A., Lynch, E., & Thorne, C. R. (2015). Risk-based approach to designing and reviewing pipeline stream crossings to minimize impacts to aquatic habitats and species. River Research and Applications, 31(6), 767–783.** https://doi.org/10.1002/rra.2770
    - Review article establishing framework for pipeline stream crossing assessment (no macroinvertebrate focus).
    - Highlights vulnerability factors of streams, including streams with more erodible bed materials and streams with more variable hydrology.

- **Courtice, G., & Naser, G. (2020). In-stream construction-induced suspended sediment in riverine ecosystems. River Research and Applications, 36(3), 327–337.** https://doi.org/10.1002/rra.3559
    - Review article focused on developing theoretical exposure risks of sediment from in-stream construction activities such as pipelines.
    - For this discussion, of note is the statement that "Habitat substrate alterations and cumulative effects should be studied to determine the role of sedimentation and multiple SS sources in ICISS exposure risk, as these topics were not considered in our study." This suggests there is limited literature focus on direct sediment alterations.

- **Lévesque, L. M., & Dubé, M. G. (2007). Review of the effects of in-stream pipeline crossing construction on aquatic ecosystems and examination of Canadian methodologies for impact assessment. In Environmental Monitoring and Assessment (Vol. 132, Issues 1–3, pp. 395–409).** https://doi.org/10.1007/s10661-006-9542-9
    - Literature review of pipeline impacts to streams – relevant citations are examined here.

- Generally, concludes that most effects diminish within two years, but focus is on downstream impacts, not recovery at immediate disturbance sites.
- Highlights aspects of streams and communities making them more susceptible to impacts or would affect recovery, including: sites with high percent fines in excavated materials, sites with low flows, sites with steep banks, tolerance of existing natural community, natural flow magnitude/frequency.
- One relevant conclusion: "Hence, individual rivers and streams will be affected differently by crossing construction, hence should have a monitoring program tailored to identify site specific sensitivities and responses to disturbance."

- **Reid, S. M., & Anderson, P. G. (1999). Effects of sediment released during open cut pipeline water crossings. Canadian Water Resources Journal, 24(3), 235–251. https://doi.org/10.4296/cwrj2403235**
  - Review of studies of open-cut pipeline crossings.
  - Included 20 studies (some with multiple reports/publications) evaluating effects – 16 of which examined macroinvertebrates in some way.
  - Seven studies noted reduction of invertebrate richness and/or abundance at and below crossings; six studies showed no/insignificant negative impacts; the remaining studies did not report on invertebrate richness/abundance.
  - According to either the individual study authors or the review authors, "recovery" of macroinvertebrates occurred between one month and two to four years, usually after one year based on eight studies. EPA notes that "recovery" was a subjective call made by either the individual study authors or the review authors.
  - EPA notes that 17 of the 20 studies were based only the gray literature – either reports or industry conference proceedings that are not peer reviewed or accessible for further, individual evaluation.

- **Reid, S., Stoklosar, S., Metikosh, S. & Evans, J. Effects of natural gas pipeline water crossing replacement on the benthic invertebrate and fish communities of Big Darby Creek, Ohio. Pages 717-723 in J.W. Goodrich-Mahoney, D.F. Mutrie, and C.A. Build, editors. Environmental Concerns in Rights-of-Way Management. Seventh International Symposium. Elsevier Science, Ltd. USACE (US Army Corps of Engineers). 1998. Integrated dredged material management plan & supplemental environmental impact statement: Columbia and Lower Willamette River Federal Navigation Channel, Final June 1998.US Army Corps of Engineers, Portland Oregon.**
  - Study of downstream impacts of open and dry cut pipeline replacement projects in Big Darby Creek, Ohio.
  - Macroinvertebrates sampled in upstream and two downstream riffles.
  - After construction, first downstream riffle saw high rate of sediment deposition and shift to clay, silt dominance. This coincided with an increase in tolerant

oligochaete abundance and shifts/variations in abundance of other groups over the next two months.
    - One year after construction, densities and richness at the first downstream riffle were similar to pre-construction levels.

- **Tsui, P. T. P., & Mccart, P. J. 1981. Effects of stream-crossing by a pipeline on the benthic macroinvertebrate communities of a small mountain stream. Hydrobiologia, 79, 271-276.**
    - Monitoring of pipeline crossing construction effects on Archibald Creek, British Columbia.
    - Sampled macroinvertebrates at four stations. The locations were located upstream 40m and downstream (10m, 75m, 100m), and were sampled 12 hrs. after backfilling then at ~45 days, ten months and 13 months post-construction.
    - Fine sediment deposition occurred extensively at the nearest two downstream stations and less so at the farthest downstream station.
    - Reduction in macroinvertebrate Shannon diversity and substantial reduction in density occurred at downstream stations.
    - Although authors report that effects were "short-term and non-residual" (and indeed many indicators did return to pre-construction levels by one year post-construction), Shannon diversity at the nearest two downstream stations did not return to pre-construction levels (and no statistical analysis is shown).
    - Specific taxa appeared not to return to pre-construction conditions at downstream stations, including several stonefly (*Alloperla, Eucapnosis, Nemoura)* and caddisfly (*Rhycophila*) taxa.
    - This suggests the limits of some of the response indicators (e.g., richness, diversity) when examined alone without knowledge of specific taxa responses.

- **Young, R. J., & Mackie, G. L. (1991). Effect of oil pipeline construction on the benthic invertebrate community structure of Hodgson Creek, Northwest Territories. Canadian Journal of Zoology, 69(8), 2154–2160.** https://doi.org/10.1139/z91-301
    - Effects of pipeline construction on Hodgson Creek, Northwest Territories, Canada.
    - Sampled macroinvertebrates and other variables at two upstream stations (350m and 450 m upstream of pipeline) and three downstream stations (100, 200, and 450 m downstream of pipeline) for three months pre-construction (June, Aug, Oct) and in ten-day intervals in the spring following construction (focus was on ice-free season).
    - Differences in species richness or density between upstream and downstream reaches were not detected using analysis of covariance up to approximately nine months post construction.

    - Likely that flushing events between construction and post-construction sampling moved sediment out of downstream sampling reaches.
    - Authors do not consistently or quantitatively report responses of specific taxa and unclear if individual taxa responses were examined in detail.

<u>OTHER IMPACTS DISCUSSED</u>

- **Kaller, M.D. and W.E. Kelso. (2006). Effects of a small-scale clearing on habitat and macroinvertebrates of a coastal bottomland stream in Louisiana. The Southwestern Naturalist, 51(2), 143-151.**
    - Examined effect of small-scale clearing for pipeline crossing on stream habitat, macroinvertebrates and other variables in a third-order stream in southwestern Louisiana.
    - Sampled three reaches: one upstream 100m, one within clearing and one downstream 100m.
    - Temperature was significantly higher and dissolved oxygen, woody debris, fine organic detritus (among other variables) were significantly lower at the clearing location compared to upstream and downstream locations.
    - One dipteran genus (Bezzia) had significantly lower density in the clearing location.
    - Concluded that biological effects were minimal for the small scale of the clearing but cautions that **multiple small-scale clearings across a watershed could have negative impacts on macroinvertebrate communities**.

<u>SELECTED ARTICLES ON STREAM RESTORATION, FOCUSED ON RECENT META-ANALYSES AND REVIEWS</u>

- Al Zankana et al. 2020 - How strong is the evidence – based on macroinvertebrate community responses – that river restoration works? https://www.sciencedirect.com/science/article/pii/S1642359319301491
- Ernst, A.G., Warren, D.R. and Baldigo, B.P. (2012), Natural-channel-design restorations that changed geomorphology have little effect on macroinvertebrate communities in headwater streams. Restoration Ecology, 20: 532-540. https://doi.org/10.1111/j.1526-100X.2011.00790.x
- Miller, S.W., Budy, P. and Schmidt, J.C. (2010), Quantifying macroinvertebrate responses to in-stream habitat restoration: applications of meta-analysis to river restoration. Restoration Ecology, 18: 8-19. https://doi.org/10.1111/j.1526-100X.2009.00605.x
- England J, Angelopoulos N, Cooksley S, Dodd J, Gill A, Gilvear D, Johnson M, Naura M, O'Hare M, Tree A, et al. Best practices for monitoring and assessing the ecological

response to river restoration. Water. 2021; 13(23):3352. https://doi.org/10.3390/w13233352

- Phil Roni, Karrie Hanson & Tim Beechie (2008) Global review of the physical and biological effectiveness of stream habitat rehabilitation techniques. North American Journal of Fisheries Management, 28:3, 856-890, DOI: 10.1577/M06-169.1
- Bond, N.R. and Lake, P.S. (2003), Local habitat restoration in streams: Constraints on the effectiveness of restoration for stream biota. Ecological Management & Restoration, 4: 193-198. https://doi.org/10.1046/j.1442-8903.2003.00156.x
- Ashley H. Moerke, Kerry J. Gerard, Jo A. Latimore, Ronald A. Hellenthal, and Gary A. Lamberti. 2004. Restoration of an Indiana, USA, stream: bridging the gap between basic and applied lotic ecology. Journal of the North American Benthological Society 2004 23:3, 647-660. https://www.journals.uchicago.edu/doi/abs/10.1899/0887-3593(2004)023%3C0647:ROAIUS%3E2.0.CO;2?casa_token=le4JWmR8_aEAAAAA:4egzqoUTr8tQTtj-kf-_AKls2luYgklqWkYW4RjU-R9QzcX3LDDE-yD7DVdo2V4P6EdJv1YE3pq5