TECHNICAL ADVISORY GROUP (TAG) MEETING MINUTES

Township of Woolwich
Thursday, April 8, 2021
Video Conference Hosted in Council Chambers
2nd Floor 24 Church Street West, Elmira

Present from TAG:

Tiffany Svensson, Chair*
Susan Bryant, Voting Member*
Sebastian Siebel-Achenbach, Voting Member*
Katharina Richter, Voting Member*
Linda Dickson, Voting Member*
Wilson Lau, Voting Member*
Dustin Martin, Voting Member*
Sandy Shantz, Mayor and RAC Chair*
Scott McMillan, Councillor*

Present from Staff:

Lisa Schaefer, Committee Support Specialist*
Alex Smyth, Council and Committee Facilitator

Other:

Alan Marshall, Public*
Jason Rice, MECP*
Ramin Ansari, LANXESS*
Leah Gerber, the Record*
Quinten Hunter-Rhodes, Public*
Michael Heitmann, Public*
Eric Hodgins, Region of Waterloo*
Karl Belan, Region of Waterloo*

Regrets:

David Hofbauer, Voting Member
*indicates remote participation.

Disclosures of Pecuniary Interest

No pecuniary interests were declared.

Chair Svensson acknowledged the lockdown and stay-at-home order and that there was a request to postpone any non-essential meetings. Given the current work that needs to move forward, this meeting

was deemed essential. However, in the spirit of the stay-at-home order, she is Chairing the meeting from home instead of the Township Office. As a result, it is necessary to have a back-up Chair in case of technological issues. She is suggesting Linda Dickson given her background in Chairing the Implementation Working Group for the local Source Water Protection Committee.

MOVED by Dustin Martin
SECONDED by Sebastian Siebel-Achenbach
THAT Linda Dickson act as TAG Chair should there be technical issues preventing Chair Svensson from facilitating the meeting.

…CARRIED

Approval of Previous Minutes

February 25, 2021

MOVED by Sebastian Siebel-Achenbach
SECONDED by Katharina Richter
THAT the February 25, 2021 Meeting Minutes be adopted.

…CARRIED

New Business

WSP acquiring EarthCon Consultants Inc. (EarthCon)

Chair Svensson discussed the recent acquisition and the potential impacts to TAG. Mr. Hofbauer works for WSP. While he does not think it impedes his ability to continue on as a working member of TAG, Chair Svensson reached out to all TAG members on this potential conflict of interest. She indicated that Mr. Hofbauer will recuse himself from any work where EarthCon has been involved as needed. He works with WSP's air group which is not part of the work that EarthCon has worked on so far, so it should not be a conflict of interest. TAG had no concerns with Mr. Hofbauer continuing in his capacity as a member of TAG.

Detailed Discussion and Documents Review

MECP response to LANXESS/ GHD's updates on the Evaluation of Canagagigue Creek Contaminants of Potential Concern and Conceptual Site Model, Version 2

Susan Bryant led this discussion on behalf of TAG. For a copy of her detailed review, refer to Appendix A.

Ms. Bryant summarized the substantive issues not wholly settled between MECP and LANXESS as the following:

- The matter of including the Magnitude of Exceedance of a standard as part of the frequency of exceeding a standard in determining whether the contaminant was retained as a site related COPC.
- Related to that, the question of using a criterion of 5% frequency of detection as a guideline for retaining or dropping COPC's from consideration, without considering the magnitude of exceedance.
- The question of what and where is upstream/background---especially for the Canagagigue, given that Uniroyal waste was deposited in Bolender park landfill and the current "background"

sampling location is downstream of Bolender park landfill. There are also questions concerning Shirt Factory Creek.

- The question of whether the sediment data remains too limited and that more samples should be taken in Reach 4 and the northern part of Reach 3 and analyzed for the full suite of Brownfield chemicals. The MECP asked for this and LANXESS replied that it was not needed.
- The wording in the CSM to clearly communicate that contaminated UA groundwater from 2/3 to 3/4 of Reach 4 (the uncontained portion) flows unabated into the Canagagigue Creek and will continue to do so. The estimated volume of the uncontained flow is averaged at 500,000 litres per day.

Chair Svensson noted that the above issues have been raised by TAG in various discussions and reviews of documents. TAG believes that the magnitude of exceedances and the frequency of the COPC in terms of how you filter out what is and is not a contaminant of concern has to be considered as well as the background. This will have a significant impact to the RA. The near surface water groundwater interaction and discharging to the creek evaluations are also very important. Finally, TAG supports the question from the MECP regarding if the sediment data remains too limited and that more samples should be taken at Reach 4. In conclusion, TAG supports the MECP review.

Note: A copy of Appendix A has been retained in the Clerk's Office.

LANXESS response to MECP's comments on the Supplemental East-Side Off-site Groundwater Evaluation

The discussion was led by Sebastian Siebel-Achenbach. He noted he had several technical questions but will refrain from discussing those since GHD is not in attendance. He felt there were two pertinent points to bring forward. The response from LANXESS was as a result of the MECP letter of September 30 which critiqued the report for not pulling together all the data on the east side, resulting in gaps in the interpretation. The information was there to some degree but the MECP noted that there was not a coordinated effort to determine what it meant. After reading this report, Dr. Siebel-Achenbach suggests that LANXESS has not answered why the concentrations of NDMA in the groundwater on the eastside are the way they are. The report provides some additional information on the 2019 sampling but did not answer the core question of why we still have detectable concentrations of NDMA so far from the property line on the eastside. He believes that additional work in explaining this is warranted.

Finally, Dr. Siebel-Achenbach provides some visual support for his concern by reviewing Figure 3.1 Monitoring Well Locations. He pointed to areas that continue to be a concern as raised in previous meetings.

TAG asked what the next steps of this report are. TAG was looking for this report to pull together lines of evidence and information both historical and more recent, to resolve and provide additional resolution to the questions of impacts on groundwater on the private property east of LANXESS. In response, Mr. Ansari asked that TAG put in writing the concerns and what the deficiencies are. They are also waiting to hear from the MECP. Mr. Ansari suggested a technical experts meeting be convened to review all the lines of evidence that GHD/LANXESS thinks supports their position that they do not need to sample groundwater in the location referred to as the gap. Mr. Ansari also noted that this is a process

and they submitted what they felt was a wholesome report that included all the information asked for. If it missed the mark, they will address it.

TAG asked if the shallow groundwater discharge to the Creek is being evaluated as part of the creek evaluation, for example how is groundwater flow south of RPE5 being examined and looked at. Mr. Ansari said that the CSM addresses how groundwater both on the east and west side interact with the creek. You have a groundwater divide on the east side. This divide could have historically been influenced by the waste pits.

Dustin Martin of TAG also spoke to the report. He feels that while this report did provide more detail, there is still missing requested information. For example, the fact that there are six cross sections in the report was immensely helpful but the MECP specifically suggested that groundwater flow contours and chemistry be posted, and they were not. He feels this is important given the suggestion that vertical flow may dominate in this area. Understanding the three-dimensional interaction is lacking and needed, particularly when we have the concentrations reported in well OW7-29. This is one well nest that goes from surface through multiple stratigraphic units all the way to the bedrock. There are exceeding concentrations at the surface but even higher concentrations at depth. GHD interprets in the report that the aquifers that are present in this area are thinner (and aquitards should provide increased protection), yet the vertical delineation is not achieved at this location. In one of the cross sections in Figure 6.3, the OW7 well nest can be seen to extend from surface to bedrock but looking to the left (to the south), the other wells on the property boundary all terminate at shallower depths. We do not have stratigraphic data at those locations, but we know that at OW7-29, NDMA and other contaminants have migrated to depth. For the wells on the property line, we have to ask if that same migration of contaminants could be making it to depth as well, particularly given the potential dominance of vertical flow through the aquitard units in this area.

Mr. Martin also asked if we know anything about bedrock as a potential pathway if contaminants have made it to 29 meters below surface at OW7-29. Vertical delineation of the groundwater on the east side is a core question that remains. He also stated that the OW8 nest intercepts an aquifer on the south side, but we have no wells further north to delineate how far that municipal aquifer goes under the property boundary.

Mr. Martin referenced that the MECP also discussed the domestic supply well on the Stroh property. The report posted all of the well records from the public database but there is not a lot of details discussed about them. The report figures represent all public well records in the same way, so it is difficult to distinguish which well record corresponds to the domestic supply well referenced in the report (which is assumed to be the well at the Stroh house). If a well has been drilled and then abandoned, it should be represented differently than what is potentially an active receptor. GHD references the domestic supply well on the Stroh property several times but does not identify any figure where that specific location is.

Finally, he said that some of the groundwater contours as shown on the maps are extended beyond where data are present and should be represented with dash lines instead of solid lines. Solid lines misrepresent the degree of confidence in the contour. One of those key places is on the municipal

aquifer flow figures which is where GHD indicate the domestic supply well is installed. Dustin concluded that GHD's interpretation in the absence of data is reasonable; however, when trying to make an assessment of whether a receptor is up-gradients, cross-gradient or down-gradient, we need more specifics on where we have data. Mr. Martin agreed to put a more thorough response in writing together for LANXESS. This has now been completed and is attached to the minutes as Appendix E.

Mr. Ansari said that he would be more than willing to have a conversation with relevant parties to help shorten the written questions and lessen the time this takes to move forward. Chair Svensson accepted on behalf of TAG with the understanding that it would be similar to a technical experts meeting with the subject matter champions in attendance from TAG as well as Mr. Deal, Mr. Almeida, Mr. Ansari, Mr. Rice and Mr. Ricker. Given the current stay-at-home order this would be a virtual meeting. Ms. Schaefer will help to coordinate this meeting.

Note: A copy of Appendix E has been retained in the Clerk's Office.

TAG Supplemental Comments for HHRA

Wilson Lau and Susan Bryant worked on this for TAG. Mr. Lau drafted a technical memorandum on behalf of TAG. This draft was circulated to TAG and to Mr. Ansari prior to this meeting so they could respond, comment, and prepare for the meeting.

Mr. Lau led the discussion for TAG. He noted that TAG received a submission from APT that addressed some of the concerns that the public has with the HHRA on the Creek. In particular, there were concerns with the vulnerable communities (Old Order Mennonite) downstream of the study area and how their lifestyle and culture make them particularly sensitive receptors of the HHRA. He noted that the document does a good job of highlighting key takeaways. In terms of exposure, these families tend to stay in one area for several generations. They keep livestock in their care and in terms of an exposure pathway it is more significant than what you would call a normal, average generic person in terms of consuming milk and meat products within the area. There is also mention of children playing in the creek in the floodplain area as well as using sandbar materials on their property. There was also concern for how the community is represented and how the results of the HHRA would be adequately communicated. The report went through historical RA work completed and the gaps and concerns that were not addressed. Ultimately, the submission provided some recommendations that the assumption of the HHRA must reflect the vulnerabilities of the population, that hotspots in the creek are remediated and the appropriate lines of communication are set up with the community, so they are both informed and involved as stakeholders.

Mr. Lau's draft memorandum for TAG's consideration provided more of a background in terms of the HHRA approach. He said that the ongoing exposure assessments that are going on in the vulnerable community members and how they are affected merit some additional scrutiny on upcoming discussions on risk. There are unique exposure conditions and there are clear concerns to the members of the community who could be affected. It is important that TAG has the opportunity to review the scope and adequacy of the HHRA report prior to its completion. Mr. Lau agreed to update and finalize the memorandum to reflect the discussion and input from Lanxess and MECP. A copy of the final memorandum as well as the APT submission is attached for reference in Appendix B.

Mr. Ansari responded to the items and concerns raised. See Appendix C for a copy of his presentation. He started with a general comment that a risk assessment is to assess risk and if you do not adequately understand what your COPCs are and the pathway (CSM) and receptors then you cannot do an adequate risk assessment. The parties have to agree before moving forward and he considers TAG to be one of the main community communicators and a leader in this process. Mr. Ansari said the commentary from TAG is considered for the COPC and CSM. If the MECP believes there is some element that is missing, they need to say it. It is in LANXESS's best interest to make sure the CMS and the COPC list is complete before moving on to the risk assessment.

During Mr. Ansari's presentation, TAG questioned if there was a particular stage when one starts the actual calculation and modelling of the risk once you determine your COPC and CSM and where these considerations fit into that modelling effort. TAG thinks that some characterization of the receptor is an important part of doing the risk assessment.

In terms of hot spots of DDT and dioxins being remediated as soon as possible, TAG feels it has been a very long time already, so a year seems almost like ASAP. They asked if the HHRA takes into consideration the intergenerational exposure when dealing with bio accumulative substances. Mr. Ansari was not sure and will look at it and respond soon. From an intergenerational standpoint he did say that these compounds are not passed on through genes but could possibly be passed through mother's milk. Mr. Wilson will incorporate this question and any other pertinent discussion points in his final memorandum, and this will be formally submitted as an outcome of tonight's meeting (see Appendix C).

TAG is looking for more detail on exposure and receptor characterization and how they will be defined, particularly for the pathways that were discussed here. A lot of these were not considered by the MECP in the development of the standards and were not incorporated into the O. Reg 153. TAG askes how sediment is going to be addressed when there is no framework in O. Reg 153 to consider sediment exposures. At this point the overall CSM provides a good picture of what the HHRA wants to do but we do not know how it is going to get there as this information has not been provided. There needs to be more discussion on the rational of how much exposure is appropriate and the data to back up the assumptions.

TAG understands that the risk assessment is not mandatory. If there are conclusions that come out of it, such as remediation, TAG asked if there will be an instrument to enforce those actions or will that be volunteer as well. Mr. Rice said that LANXESS has agreed to do this voluntarily. If after the risk assessment process is complete and it identifies unreasonable risk to human health or the environment, the MECP will look to LANXESS to conduct risk mitigation mediation to determine the best course of action to address those risks. If they do not implement this, the MECP would consider alternative measures to have the work done such as a Control Order.

To conclude the following motion was made:

MOVED by Linda Dickson
SECONDED by Susan Bryant
THAT TAG endorses the MECP comments on the CSM and the COPC documents

...CARRIED

TAG also agreed to Mr. Ansari's offer to a discussion on the risk assessment similar to a technical experts meeting. This meeting would include Mr. Lau, Ms. Bryant, Ms. Svensson and Mr. Ansari as well as technical experts as assigned by LANXESS. Ms. Schaefer will organize this meeting.

Note: A copy of Appendix B and C have been retained in the Clerk's Office.

LANXESS 2020 Annual Monitoring Report

Katharina Richter led this discussion. Refer to Appendix D for a copy of her discussion notes.

Ms. Richter summarized at the beginning of her review by stating:
- The report was prepared by EarthCon Consultants Inc. In past years, the AMR was prepared by GHD.
- The purpose was to present and evaluate the groundwater and surface water data from 2020, in accordance with the Amended Environmental Compliance Approval (ECA) and previous Control Orders
- It summarizes data from monthly Progress Reports and reports submitted since the 2019 AMR (includes the 2019 Biomonitoring Study, Supplemental East Side Investigation Report, UA CS Containment Review, and Sediment and Soil Work Plan)
- The report was well laid out and figures were provided to support the text. The 2020 AMR was easier to follow than those from past years.

She provided a brief summary of each section of the report. She questioned if EarthCon has any recommendations with regards to increasing the effectiveness of the remediation or is what we have appropriate. She noted that the conclusions and recommendations are excellent and should be reviewed in full. She ended with a brief summary of the recommendations in the report.

TAG asked if the amendments were cross referenced with the list of recommendations noted in the report. Mr. Ansari said that yes, he believes so but will confirm for TAG. Mr. Rice noted that the ECA amendment is still in draft and has not been finalized so it can be cross checked.

To conclude the following motion was made:
MOVED by Linda Dickson
SECONDED by Katharina Richter
THAT TAG moves to accept the 2020 LANXESS Annual Monitoring Report.

...CARRIED

Note: A copy of Appendix D has been retained in the Clerk's Office.

LANXESS Monthly Progress Report – February

This review was led by Linda Dickson. Ms. Dickson provided a brief update. She noted that there was no receiver water quality data due to the presence of ice on the creek and unsafe field conditions. MECP was contacted and supported the delay for health and safety reasons. PW5 had decreased efficiency. LANXESS has planned rehabilitation of the well for March. E7 had a failed motor and did not operate between Feb 14 and 25. The motor has been replaced. Finally, LANXESS is waiting on the fabrication schedule for W9 which is expected sometime in March. Dr. Siebel-Achenbach asked what is the pump level at which the process no longer works. He asked with specific concerns about PW5. Mr. Ansari

stated that he has had conversations with Mr. Deal and Mr. Almeda on this. He will provide a written response but can say that depending on the distance to the creek and the offsite system it could be anywhere from weeks to months before you see migration. This initial response was reassuring to TAG.

Next Meeting

RAC - April 29

- Agenda will be set with the Co-Chairs and TAG Chair.

TAG – TBD

- A meeting is not being set but we do have two technical discussions that will happen shortly as discussed above. Once those meetings take place, a meeting date will be determined.

Chair Svensson noted that the Township received an email advising them that there had been a break in the main for the fire sprinkler system at the LANXESS facility. There was some water loss that went into the creek. The majority of that loss was contained and is being cleaned up. There was no further action needed.

Adjournment

The meeting adjourned at 8:59 pm
Recorder: L Schaefer

Appendix A – TAG Meeting – April 8, 2021

Report to TAG on the MECP Response to LANXESS' August 2020 Response to Comments (Evaluation of Canagagigue Creek Contaminants of Potential Concern and Conceptual Site Model, Version 2), April 1. 2021.

By Susan Bryant, for TAG meeting April 2021

This document quotes each Ministry comment from its April 9, 2020 review of these reports, followed by Lanxess's response to each comment in its letter of August 7, 2020, and then includes the Ministry's current (April 1, 2021) response to the Lanxess response.

1. "*Draft For Review: Conceptual Site Model - Canagagigue Creek - Version 2*" (Creek CSM Version 2) (GHD, November 22, 2019);
2. Draft Technical Memorandum: "*Draft for Review, Re-Evaluation of Canagagigue Creek Contaminants of Potential Concern – Version 2* (GHD, October 25, 2019).
3. "*2020 Canagagigue Creek Sediment and Soil Investigation Work Plan, LANXESS Canada* (GHD, September 11, 2020).
4. "*UA CS Containment Review,* (GHD, August 10, 2020).

In general, for most of the MECP comments, Lanxess agrees to make the requested/required changes to the COPC and the CSM, and the Ministry, in general, accepts their response. The great majority of the MECP comments are not criticisms or disagreements with the Lanxess approach, but rather requests to include in the final report more detail to justify with data and science the various choices they have made, and to present information in easily accessible formats which conform to MECP requirements and expectations. I am going to focus on the important ones and those few where there's disagreement between Lanxess and the ministry.

Attachment A concerns the comments on Creek Contaminants of Potential Concern (COPC)
Part B concerns Comments on the Conceptual Sits Model (CSM) version 2, of Nov. 22, 2019

A.1 Limited Sediment Data.

General—MECP and Lanxess agreed that the key COPCs have been identified and that the COPC doc will be finalized once the Fall 2020 sampling data confirms that all COPCs have been identified.

MECP: The company's evaluation of COPCs was based on limited sediment data. It suggests additional data sources to be used, particularly a dataset with background levels of contaminants in the Grand River watershed. The point is to determine if

contaminant concentrations in the study area suggest elevations above that which would be observed in similar area creeks within the Grand River watershed.

LANXESS replied that it had done the calculations to estimate background based on more datasets and it did not alter the COPC list. They will add this info to the final report and incorporate the new data from the fall 2020 sampling.

MECP April 1: It will review the Lanxess' work and the statistical procedures used to calculate sediment background values for the site once the fall sampling is included.

A.2. Additional Creek Data:

MECP: The Ministry requests more upstream (background) sampling in the tributaries to the creek (Shirt Factory, Landfill, drainage ditch at 6770 Line 86).The Ministry questions whether the Bolender Park upstream sampling site is truly background, since some Uniroyal waste went to the Bolender Landfill between 1962 and 1968.

LANXESS responds it will do more upstream sampling in fall 2020 in the 3 sites, and confirms that CRA's 1991 Environmental Audit says some Uniroyal waste went into Bolender Park.

MECP April 1-The Ministry accepts the response and requests justification for using the Bolender park sampling site as background when some Uniroyal waste was dumped in the Bolender landfill.

A.2 Detailed Report Comments:

a) Section 2. Study Area Description and History

MECP

a. The Ministry asks Laxness to change the wording about the shovel sampling to reflect that the Ministry did not approve this method prior to the sampling.
b. Ministry requests more detail about the infilling of a side channel in Reach 4.

LANXESS replies that it will change the wording, and that the correspondence between the company and the Ministry before the sampling are in Attachment A of the Creek Sediments and Floodplain Investigation report of March 18, 2019. Lanxess says there is no detail available on the infilling that took place in the area that is now Region's sewage treatment plant.between 1964 and 1980.

MECP April 1 The Ministry accepts the response, noting that samples composed mostly of gravel are of limited use, and that shovel samples not dominated by gravel should be used only for surface sediments and not those at depth.

b) Section 4. Re-Evaluation of Contaminants of Potential Concern

(Here, I have collapsed items a,b,c for efficiency)
MECP: In items a, b, and c in this section, the ministry requests that more specifics about the data collected, e.g. in what media, be included in the final report, an account of what data were included and excluded and the rationale for using a subset of the available data.

LANXESS explains that historical groundwater data was not included because it is not considered representative of current groundwater conditions. Lanxess also explains that historical elevated detection limits before 2011 were not considered because historical analytical methods were used. Also, elevated detection limits from 2011 to 2019 were the result of matrix effects and so these data were not considered in COPC re-evaluation. The final text will be revised to clarify, add the specifics and include justification for these choices.

MECP April 1 responds that this seems reasonable. However, clarity is required to confirm that samples collected prior to 2011 that were above the detection limit were retained in the data set, as It is the Ministry's position that the historical data above detection limits be included in the evaluations, even with elevated detection limits.

d) MECP comments that if there is a decreasing concentration trend for any compound from Reach 4 to Reach 1, then the compound is likely not naturally elevated in the creek and should not be considered background, unless a strong rationale is provided to support why this is the case.

LANXESS Response: Once the 2020 creek data is analyzed, this trend analysis will be conducted and provided to the MECP for review. TAG has requested that additional figures be added to the reports to illustrate sample locations and results. The figures will be updated in the final document.

MECP April 1 accepts this response.

e) MECP: The tables show that the magnitude of exceedance of a standard was calculated, but a description in the text is needed of how it was used as a line of evidence and in relation to low frequency of detection. The magnitude of exceedance needs to be considered as part of the frequency of exceeding a standard in determining whether the contaminant was retained as a site- related COPC.

LANXESS response: The Magnitude of exceedance (be it low or high) was not used as a method to identify COPC. Rather, identification of COPC was based on frequency of detection, relation of the chemical to current or historical LANXESS operations, historical exceedances/detections of a chemical, and comparison of site-

associated data to background data. The use of magnitude of exceedance will be clarified in the final document.

MECP April1: It is the ministry's position that the magnitude of exceedance must be used along with the other lines of evidence (i.e. frequency of detection) as a criterion to identify COPC. Otherwise, there is risk that a contaminant with a low frequency of detection but high magnitude of exceedance could be overlooked.

f) **MECP** notes that the report references US EPA guidance for 5% frequency of detection. But MECP couldn't find that reference in the report.

LANXESS responds that that attribution is incorrect. The text will be updated in the final report to read as "Low frequency of detection – if a chemical was detected in less than 5% of the collected samples it was not retained as a Site-related COPC". LANXESS suggests that chemicals that are infrequently detected may not be related to facility operations and, given the use of three other lines of evidence to screen chemicals (i.e., relation to site activity; historical exceedances/detections, and background concentrations), maintains that use of a 5% frequency of detection is an appropriate metric for chemical screening.

MECP Response April 1: The LANXESS response is not accepted. The use of 5% frequency of detection with only the other lines of evidence mentioned (relation to site activity; historical exceedances / detections, and background concentrations) should not be used as a criterion to remove a parameter from the COC list. The magnitude of exceedance must also be considered as a criterion to identify COPCs.

LANXESS Response: Once the 2020 data have been collected as part of the 2020 sampling plan, LANXESS will correspond with the MECP about a site-by-site analysis to help identify contaminant "hot spots" on top of what has been done to date.

MECP Response April 1: The LANXESS response is accepted.

g) **MECP** Comment: Clarify that the statistical outlier analysis was used only to identify hotspots and not used to remove valid data points from the analysis.

LANXESS Response: LANXESS confirms it was used only to identify hotspots and was not to remove valid data points from the analysis. Wording will be added to clarify the approach used.

MECP Response April 1: The LANXESS response is accepted.

In the interests of time, I will briefly summarize comments and responses i through j in this section, and the last section, 4.1 on Surface Water, since the main points have been covered and there is some repetition.

MECP requests justification for removing from consideration aluminum, copper and iron as COPCs because of some exceedances.

LANXESS agrees to re-evaluate once the 2020 samples are analyzed and the "what is background?" issues are settled.

MECP April 1 repeats several times that magnitude of exceedance must be used along with frequency of detection as a criterion to identify COPC.

Part B: MECP Responses to LANXESS Responses to MECP Comments on the Conceptual Site Model - Canagagigue Creek - Version 2 (GHD, November 22, 2019)

General MECP Summary: The Creek CSM Version 2 (GHD, November 22, 2019) addresses the majority of Ministry comments issued to LANXESS in the document of July 30, 2019.

MECP: Further evaluation of the groundwater to surface water pathway and on-site groundwater containment. The groundwater evaluation is required to include historical data over several years and evaluate any temporary loss of containment (UA), and discuss whether the temporary loss of containment has any significant impact on the discharge of contaminants to the creek, including on the mobilization and release of other COPCs. For example, could toluene or other compounds that are elevated in groundwater under the LANXESS site be acting as a solvent for other organic compounds and periodic releases of toluene contaminated groundwater be associated with discharges of DDT and/or dioxins to the creek?

LANXESS Response: TAG had a similar comment. On May 12, 2020, LANXESS provided a brief groundwater containment document to the MECP and discussed the matter with MECP. LANXESS' understanding is that the MECP does not consider loss-of-containment events as a significant issue. However, it has requested formal documentation and LANXESS will provide that.

LANXESS understands that the best co-solvents are polar molecules; that co-solvents need to be present in concentrations greater than 100,000 ppm to have an effect on the solubility of hydrophobic compounds. Given that toluene is non-polar and is found at concentrations below 100,000 ppm the potential for toluene to act as a cosolvent is low enough to be considered a non-issue.

MECP Response: The ministry acknowledges that co-solvency is unlikely a concern based on the information provided in LANXESS' response above and the monitoring data evaluated in the creek COPCs evaluation and UA CS review documents.

MECP: Overall, it will be important to document how the risk evaluations are conducted. **The Ministry continues to offer to hold further discussions with LANXESS and GHD to develop the methods to conduct the risk evaluations.** For example, the methods to evaluate the CSM's soil – livestock - human consumption pathway need to be further elucidated. This includes other similar pathways such as, dairy, poultry and eggs exposure.

Part C: MECP Responses to LANXESS Responses to MECP Comments on the 2020 Creek Sampling Program

LANXESS: TAG provided comments about groundwater COPC not being retained. 10 UA chemicals were detected at concentrations above their groundwater criterion. However, this alone does not mean they should be considered COPCs related to the LANXESS facility. They were screened against their relation to site activity, historical exceedances/detections, and detections in surface water. Based on this screening, no groundwater COPC were retained

.

MECP Response The ministry acknowledges that groundwater loss of containment during select periods of high seasonal creek flow is not likely to be a concern to surface water receptors; however, the ministry requested LANXESS to determine whether these periods of loss could result in an adverse effect.

The ministry has since requested LANXESS to include groundwater data collected from monitoring wells located in the upper aquifer containment system (UA CS) for comparison to the ministry's Table 8 (groundwater within 30 metres of a water body) GW3 component values, developed for the protection of the aquatic life. This evaluation should be included in LANXESS' revised creek COPCs document.

Sediment Data Gaps

MECP: Collect samples from transects in the creek where data gaps exist, such as:
a. Depositional zones not sampled during the 2017 creek sampling work plan; and,
b. Further characterization of creek Reach 4 and the /northern portion of Reach 3. Sampling in Reach 4 should assess whether existing risk management measures (e.g., creek bank capping) along the creek banks are still effective, and to whether erosion of creek banks not previously capped are a source for creek contamination.

LANXESS Response: These data gaps will be addressed in the 2020 sampling.

MECP Response: The LANXESS response is accepted.

h) **.Screening Data for Full Characterization**

MECP– Even with additional data, the existing sediment dataset will remain limited and result in on-going questions regarding the quality of the creek assessment. It may be cheaper and faster to collect additional sediment samples and analyze them for the full suite of Brownfield compounds, especially in Reach 4 and the northern portion of Reach 3 to address any questions relating to concerns there are elevated concentrations of COPCs in sediment. These results would assure the Ministry and the public's representatives (e.g., RAC and TAG) that there are no additional contaminants of concern in the creek sediment.

LANXESS Response: LANXESS' believes that this list of COPCs was developed in a scientifically justifiable manner, based on datasets from surface water, groundwater, soil, creek banks and sediment from between 1995 and 2019; on the professional opinion of independent consultants; and onsite evaluations and assessments. LANXESS asserts that additional parameters do not need to be analyzed in the sediment.

MECP Response:
Sampling for additional parameters such as PAHs in sediment is required at least in areas where background data is limited. At a minimum, the ministry has recommended that the 2020 work plan should include re-sampling locations that previously had elevated PAHs. In addition, PAHs at background locations will be needed for comparison. If PAH levels are elevated above this level, then they are to be carried forward for the risk assessment.

e) Historic Creek Beds –

MECP: Collect samples where the creek was moved or naturally meandered, particularly in creek Reaches 3 and 4 to evaluate whether the historic creek beds may be a source of contamination.

LANXESS Response: These areas include the municipal sewage treatment plant, a municipal right of way for First Street, a municipal snow dump and an historical landfill (First Street). They are captured in the pump and treat system (e.g., PW5, W5A and W5B). Thus groundwater entering the Study area from these areas are captured in the groundwater monitoring program. Where possible, sediment samples will be collected in creek Reaches 3 and 4 as part of the 2020 sampling plan.

MECP Response: The LANXESS response is accepted.

Part D: MECP Responses to LANXESS Responses to MECP Comments

MECP: The Draft CSM should be updated to acknowledge the temporary losses of containment of the onsite UA1. The text currently indicates the UA CS prevents the UA1 groundwater from discharging into the creek. GHD should confirm that other sections of

the reports do not suggest that there is no discharge of contaminated groundwater into the creek because of the operation of the UA CS.

LANXESS Response: Agreed. The text will be revised to acknowledge the temporary loss of containment. The report text also goes on further to state that the groundwater to surface water discharge pathway is complete. No surface water COPC were identified as part of the evaluation completed.

MECP Response: The LANXESS response is accepted.

Susan Bryant's Summary of the Substantive Issues not wholly settled between MECP and Lanxess:

1. The matter of including the Magnitude of Exceedance of a standard as part of the frequency of exceeding a standard in determining whether the contaminant was retained as a site- related COPC.
2. Related to that, the question of using a criterion of 5% frequency of detection as a guideline for retaining or dropping COPC's from consideration, without considering the magnitude of exceedance.
3. The question of what and where is upstream/background---especially for the Canagagigue, given that Uniroyal waste was deposited in Bolender park landfill and the current "background" sampling location is downstream of that area. There are also questions concerning Shirt Factory Creek.
4. The question of whether the sediment data remains too limited and that more samples should be taken in Reach 4 and the northern part of Reach 3 and analyzed for the full suite of Brownfield chemicals.
5. The wording in the CSM to clearly communicate that contaminated UA groundwater from 2/3 to 3/4 of Reach 4 (the uncontained portion) flows unabated into the Canagagigue Creek, and will continue to do so. The estimated volume of the uncontained flow is averaged at 500,000 litres per day.

Technical Advisory Group (TAG) to the Remediation Advisory Committee (RAC)

14 April 2021

Mr. Ramin Ansari
LANXESS Canada Co./ Cie
25 Erb Street
Elmira, ON N2B 3A3

Re: Supplemental Comments for HHRA for the Canagagigue Creek

Attention: Mr. Ramin Ansari:

As a follow up to the Technical Advisory Group (TAG) meeting on April 8th, the attached submission provides supplemental comments for the HHRA for the Canagagigue Creek for your consideration. The comments reflect the discussion at the meeting as well as the related Ministry comments received on April 1, 2021.

The co-champions on this subject matter and I look forward to an opportunity to meet with your technical RA team completing the HHRA to discuss the attached supplemental comments. We appreciate the offer you made for us to have such a meeting.

Thank you in advance for considering this submission,

Tiffany Svensson, M.Sc., P.Geo.
TAG Chair/ Senior Hydrogeologist

CC: Jason Rice, MECP
Luis Almeida, GHD
TAG c/o Lisa Schaefer, Township of Woolwich
Mayor Sandy Shantz, Township of Woolwich, RAC Co-Chair
Councillor Scott McMillan, Township of Woolwich, RAC Co-Chair

Ref: TAG Supplemental Comments for HHRA April 14 2021 Final.docx

SUPPLEMENTAL COMMENTS ON APT ENVIRONMENT SUBMISSION
Written by: Wilson Lau
Date: April 12, 2021

The purpose of this submission is to provide TAG with some additional understanding regarding the attachment entitled, ***"Information for the Lanxess Site Specific Risk Assessment on the Creek—Vulnerabilities of the Old Order Mennonite Farm Community"***, received from APT Environment in February 2021.

Achieving success in the clean-up process of the Elmira Aquifer and the Canagagigue Creek requires an open framework for independent public input into the remediation process. In facilitating a public forum, it is one of the responsibilities of TAG to review written submissions (such as the attached) and make recommendations as needed.

The concern of the public regarding the on-going contaminant exposure assessments and the related vulnerable community members who may be affected, is a topic that merits additional scrutiny in the upcoming discussions of risk. The APT attachment describes some of the unique exposure conditions to persistent organic pollutants (POPs) that are of a clear concern to members of the community who could be particularly affected by health issues related to these contaminants. As the Lanxess work program proceeds towards the completion of a Human Health Risk Assessment (HHRA) on the Canagagigue Creek, it is becoming more and more apparent that community engagement and risk communication will be important factors in the public's acceptance of the report's outcomes. As a member of TAG and a practicing risk assessment specialist, it is my opinion that a community-based approach offers opportunities for engagement that would benefit from joint action in early consultation phases of an HHRA. The best framework to convey the scope/adequacy of this approach to TAG and all other stakeholders would be the formal submission of a Terms of Reference (ToR) document. This proposed document would establish the framework for the planning and decision-making process for the HHRA, and its submission will also provide an opportunity for TAG and regulatory proponents to review and evaluate the planned problem formulation (i.e., information gathering and interpretation).

The key tasks in the problem formulation stage include defining the assessment cases, defining the study area, identifying contaminants of concern (COCs), identifying the people who may be exposed to those COCs, and identifying exposure pathways and scenarios. The outcome of these tasks will inform the site-specific exposure conditions and will become the basis of risk characterisation in the HHRA. Lanxess and their consultants should be able to provide for review, their rationale for selection of these scenarios and how they intend to ensure that concerns of all stakeholders are addressed by the completion of the HHRA. A few of these concerns are identified below for consideration:

- Risk evaluation: what methods will be used to evaluate the sediment and/or soil – livestock, dairy, poultry and eggs - human consumption pathways that need to be further elucidated?
- Receptor characterisation: How will the consultant evaluate vulnerable receptors of concern (i.e., Old Order Mennonite)? Have exposure term assumptions been validated by data? Will there be considerations of cultural knowledge and practices? Will receptor characteristics for sediment exposure differ from those recommended for soil exposure?
- Toxicity assessment: how will the consultant identify and understand potential health effects that can result from exposure to each of the COCs?

Furthermore, the upcoming HHRA could consider methods of exposure assessment that have not been captured by the work completed to date. Given the concerns of the public regarding the adequacy of the

historical 2005 Crompton SSRA approach (as detailed in the attachment), it may be prudent to evaluate the feasibility of 'direct measurement' to supplement the 'predictive modelling' approach that has been historically and conventionally applied in the assessment of risk. 'Predictive modelling' here is referring to the estimation of dose or exposure based on concentrations of chemicals in environmental media (i.e., soil, sediment, groundwater, surface water, etc.), whereas 'direct measurement' refers to measurements obtained through biomonitoring activities.

In an initial effort to educate myself, I have retrieved the following article (attached to this as 'Attachment 2'). My plain language summary of the document is provided below, following my 'Recommendations':

- **Design of a human biomonitoring community-based project in the Northwest Territories Mackenzie Valley, Canada, to investigate the links between nutrition, contaminants and country foods**

Lanxess may (or may not) find suitable uses for certain aspects of this proposed framework for their own efforts. Given the public's concern regarding the unique exposure conditions related to the particular culture and lifestyle of the downstream receptors (i.e., the Old Order Mennonite farm community), it would likely be beneficial to involve and engage with these communities, give adequate time and care to those interactions, and foster meaningful relationships with the community leaders, Lanxess, and the public.

I recognize that the example provided in Attachment 2 is an ambitious template for the purposes of a baseline biomonitoring study in the Canagagigue Creek Study Area. It is anticipated that some aspects of this community-based framework could be well-received (e.g., frequency of communication, the right-to-know and principles of the return of results), and other aspects may (or may not) be overly resource-intensive given the smaller scope of this project.

Recommendations

- That TAG has the opportunity to review and comment on a ToR document as one of the preliminary steps in the risk assessment process.
    - Following the April 8, 2021 TAG meeting, it was recognized that LANXESS/GHD's documents, the Evaluation of Canagagigue Creek Contaminants of Potential Concern and Conceptual Site Model, Version 2, collectively form the terms of reference. However, details on the HHRA problem formulation steps mentioned in these supplementary comments have yet to be provided.
    - In MECP's April 1st response to LANXESS' August 2020 Response to Comments (Evaluation of Canagagigue Creek Contaminants of Potential Concern and Conceptual Site Model, Version 2), Part B, it was stated that:
      "Overall, it will be important to document how the risk evaluations are conducted. ***The Ministry continues to offer to hold further discussions with Lanxess and GHD when the time comes to develop the methods to conduct the risk evaluations.*** *For example, the methods to evaluate the CSM's soil – livestock - human consumption pathway need to be further elucidated. This includes other similar pathways such as, dairy, poultry and eggs exposure."*
    - TAG also requests for the opportunity to participate in these further discussions with Lanxess and GHD. As offered by Lanxess, this can take the form of separate meeting(s) between Lanxess, its consultants, and representatives of TAG. Formal submission of a "new" ToR document will not be necessary.
- That the concerns of APT Environment as highlighted in the February 2021 attachment are wholly considered in the risk assessment process.

Plain language summary of Ratelle, M., Laird, M., Majowicz, S., Skinner, K., Swanson, H., and B. Laird. (2018). Design of a human biomonitoring community-based project in the Northwest Territories Mackenzie Valley, Canada, to investigate the links between nutrition, contaminants and country foods. International Journal of Circumpolar Health, 77(1): 1510714.

One of the main features of this biomonitoring investigation was the extensive partnerships with collaborators within the Decho and Sahtú regions. Public consultations were initiated well in advance of the project, almost two years prior to the first sampling activities, and the exchanges varied considerably from one community to another depending on needs and expectations. These initial exchanges occurred via teleconference, email, in-person meetings with community leaders, and at least one public meeting; the results of which helped establish relationships and contextualize the relevance of the project for these communities. In this case, the right-to-know for each participant was identified as being of critical importance, both in terms return of results and in risk communication. Key documents at this stage included the production of a Community Research Agreement, agreements regarding data ownership, and Memoranda of understanding with respect to any financial agreements.

Community involvement and engagement of local indigenous talent/resources was an important aspect in establishing both trust and project relevance. These local coordinators acted as points of contact in addition to their trained research roles in logistics, recruitment, and survey administration. During the course of the project, local knowledge was also assimilated into the study design where practical. For example, types and seasonality of foods, harvesting techniques, and language/cultural clarifications via terminology workshops helped ensure successful project delivery.

Given the scope of the Ratelle et al. (2018) biomonitoring study, which spanned 13 Dene and Métis communities, the use of a "Pilot Community" was useful. This approach allowed for focused development of questionnaires and study logistics before full rollout to the other communities. The final components of the data collected included: contact and demographic information, 24-h dietary recall questionnaire, food frequency questionnaire, health messages survey, and biological sample collection (e.g., hair, urine and/or blood).

A continued theme in community-based approach is the emphasis on communication- with collaborators and partners, with participants and communities, and with the public in general. It is evident that considerable human resources in program management will be required to ensure that the research team is able to liaise frequently with delegates, provide updates (i.e., seasonal newsletters and bi-monthly updates by phone or email), and follow-up with inquiries from a variety of sources.

In terms of the research product, the return of results was guided by two principles which included: 1) all participants receive their own individual results, and 2) all participating communities would receive their community-specific, aggregate results. Again, this process was human resource intensive and required the creation of a number of superordinate Scientific Advisory and Planning Committees which existed outside of the organizational structure of the specific research teams. Following completion of all analyses (roughly 6 – 10 months after the sampling period), the results of the biomonitoring study were disseminated at the community level via a series of preliminary, summary, and report-specific public meetings. At the participant level, personalized letters were drafted and delivered in order to communicate risk and provide individual context to the overall study results. Feedback from all of these

experiences were collated by the research team. Also, importantly, the publication of findings in scientific or general media was withheld until all participants and communities received their results. Ultimately, the findings of the community-based approach for baseline biomonitoring described by Ratelle et al. (2018) helped report on the links between contaminant exposure, nutritional status, and country food use in this specific region.

Information for the Lanxess Site Specific Risk Assessment on the Creek—Vulnerabilities of the Old Order Mennonite Farm Community
Notes made by Susan Bryant, APT Environment, February 2021

APT is concerned that as Lanxess begins the risk assessment step of the Human Health Risk Assessment on the Canagagigue Creek, everyone involved be aware of the particular culture and lifestyle of the downstream receptors—that is, the Old Order Mennonite farm community. One of the egregious failings of the 2005 Crompton SSRA was that nowhere in the Human Health Risk Assessment did it identify the downstream receptors as Old Order Mennonite farmers. It identifies this population only as "residential/recreational." Of the approximately 17 families owning the land on the Canagagigue Creek downstream of the Lanxess site, approximately 15 families are Old Order Mennonites.

We believe that the lifestyle of this community has a significant effect on the likelihood of exposure to the DDT and dioxins in the Creek and floodplains. The Mennonite farmer residents on the Creek are likely to have a higher exposure than an "ordinary" population of residents. Thus the assumptions that go into calculating their risk need to be more conservative than with an "ordinary" population.

Some aspects of their culture and situation that should be taken into account are as follows:

- Most of these families have occupied and farmed this land for several generations. Thus it is likely that the body burden of POPs in today's population is already elevated above the norm. The World Health Organization tests breast milk as the most reliable indicator of POPs in humans, which are passed on through the milk. A detailed protocol for such testing is on their website.
- Despite efforts by the GRCA to keep livestock in this area out of the Creek and floodplain, some are occasionally pastured in some areas of the floodplain, drink from the Creek, and stir up sediment in the Creek and floodplain. The families consume primarily meat raised on their own farm, vegetables raised in their own gardens, and in the past, fish caught in the Canagagigue Creek. They drink milk from their own cows. They thus have potentially greater than normal exposure to toxins through these food sources.
- Some areas of the floodplain are plowed, planted, and harvested by hand, using horses, another opportunity for exposure.
- Mennonite children play and swim in the creek and floodplain area. Their forts and swimming holes can be found along the Creek. With no access to TV or computers, Mennonite children play (and work) outside more than children in other communities.
- One family reported carting material (sand) from sandbars in the Creek up to the vegetable garden to help amend clay soil.
- Another family reported using the sandbar material (sand) for the grandchildren's sandbox.
- Some families report illnesses such as chronic fatigue syndrome, thyroid disorders, liver and other cancers, and miscarriages and reproductive problems. They ask whether these are related to contamination in the Creek. No one can answer.
- Old Order Mennonites are pacifists and generally do not participate in civic life in the larger community. They do not advocate for themselves. Thus remediating the contamination as much as possible is a social justice responsibility for the larger community on their behalf.

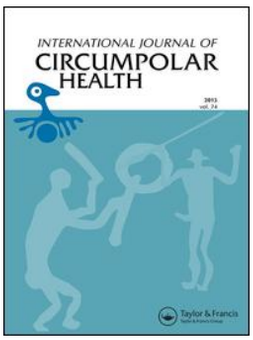
- Historically, the Creek water was highly contaminated for decades (until 1997) with chlorophenols and many other VOCs. Any person or livestock in contact with the Creek was exposed to these, in addition to the dioxins and DDTs.
- Even if and when the hot spots of very high levels of DDT and dioxins are cleaned up, the community on the Creek will continue to be exposed to chemical contamination in the creek surface water (from contaminated shallow aquifer water which flows off the site 24/7) and from further erosion of the DDT and dioxins in the on-site creekbanks. The exposure would be reduced but not eliminated.
- In the 1970s, a number of cattle died suddenly on the Creek. The farmer was compensated by Uniroyal, but no examination was done to determine the specific cause.
- The neighbour on the northeast of the site was also compensated by Uniroyal for stunted crops on his land bordering the site.

Background:

- In 1995-96, the MOE did the first study of the contaminated sediments and found dioxins and DDTs in the farmlands downstream of Uniroyal. Some samples were above the SEL (Severe Effect Level) for DDT and almost all were above MOE guidelines for dioxins in agricultural land.
- APT inquired at UPAC if either Uniroyal/Crompton or the MOE had informed the farmers of the results of the study. The answer was no. APT also recommended to Crompton and the MOE that exposure to contaminants be reduced for farms along the Creek by fencing off the floodplain and creek.
- The MOE informed the Ministry of Agriculture and Food of the soil and sediment results. Their people sampled for dioxins the milk from a tanker truck that serves farmers in the area. The protocol was poor: no samples were taken from milk exclusively from the receptor farms. The tanker sample included milk from farms not exposed to the contaminants. The sample was reported to be not above background.
- OMAFRA did not inform the farmers of the study, the sampling or any risks or exposures. It expressed its involvement as limited to "enforcing the milk act," which meant they would forbid farmers to sell their milk if the results had exceeded regulated standards.
- APT contacted the Asst. Medical Officer of Health for the Region of Waterloo, Dr. Doug Sider. We wanted to make sure that at the very least, the farmers were made aware of the risks. He held a quiet meeting with the farmers (August 1997) to inform them of the possible exposures and risks from the Creek and floodplains. He also visited individual farmers to discuss the issue with them. APT participated in the meeting and in some of the visits, along with Joy Finney, Health Promotion Officer from Woolwich Community Health in St. Jacobs.
- Dr. Sider asked farmers to volunteer samples from livestock when they were butchered. Some samples were submitted and analyzed for dioxins. The lab reported that none were above background. The lab technician also reported (on the phone to Susan Bryant) that there was very little data available for assessing background. The protocol was poor for the sampling: there was no indication of the age of the animals submitted for testing, whether they had ever been exposed to the Canagagigue Creek or floodplain, or for how long.
- These activities and alerting the families along the creek took place about 25 years ago. One hopes that the current population along the Creek remains aware of the potential risks posed by the DDTs and dioxins in the Creek. But we are unaware of any direct follow-up communication with them since by any agency.

Recommendations:

- That the assumptions that go into the risk assessment must reflect the vulnerabilities of this population.
- That the hot spots of DDT and dioxins identified in the Creek be remediated as soon as possible.
- That appropriate lines of communication be set up with the Mennonite community on the creek so that the affected population is informed.



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Design of a human biomonitoring community-based project in the Northwest Territories Mackenzie Valley, Canada, to investigate the links between nutrition, contaminants and country foods

Mylene Ratelle, Matthew Laird, Shannon Majowicz, Kelly Skinner, Heidi Swanson & Brian Laird

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Design of a human biomonitoring community-based project in the Northwest Territories Mackenzie Valley, Canada, to investigate the links between nutrition, contaminants and country foods

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ABSTRACT

Community-based projects place emphasis on a collaborative approach and facilitate research among Indigenous populations regarding local issues and challenges, such as traditional foods consumption, climate change and health safety. Country foods (locally harvested fish, game birds, land animals and plants), which contribute to improved food security, can also be a primary route of contaminant exposure among populations in remote regions. A community-based project was launched in the Dehcho and Sahtù regions of the Northwest Territories (Canada) to: 1) assess contaminants exposure and nutrition status; 2) investigate the role of country food on nutrient and contaminant levels and 3) understand the determinants of message perception on this issue. Consultation with community members, leadership, local partners and researchers was essential to refine the design of the project and implement it in a culturally relevant way. This article details the design of a community-based biomonitoring study that investigates country food use, contaminant exposure and nutritional status in Canadian subarctic First Nations in the Dehcho and Sahtù regions. Results will support environmental health policies in the future for these communities. The project was designed to explore the risks and benefits of country foods and to inform the development of public health strategies.

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KEYWORDS
Dene; First Nations; biomonitoring; contaminants; traditional foods; north; biomarker; exposure; risk assessment; community

Introduction

Contaminant exposure assessment provides key insights on the environmental determinants of health at local, regional, national and global levels. Biomonitoring measures human exposure to chemical substances using biological samples [1]. Biomonitoring projects have shown that contaminant and nutrient exposure is spatially and temporally dependent [2]. It can be influenced by both natural and anthropogenic factors that affect air and water quality, as well as the integrity of locally harvested food sources.

In remote subarctic Indigenous (First Nations, Métis and Inuit) communities of the Northwest Territories (NTs), Canada, the ongoing reliance on country foods (ie locally harvested land mammals, fish, birds and plants) is associated with improved nutrition, food security and lower rates of chronic disease [3–5]. Country foods in some Dene communities were previously estimated to provide up to 32% of the daily energy of adults, mainly through the frequent consumption of some locally harvested land animals (caribou, moose), birds (spruce hen, scoter, ptarmigan) and fish (whitefish, coney, trout, cisco, walleye, pike) [6]. However, elevated fish mercury levels discovered in some lakes of the Mackenzie Valley Basin of the NT prompted the release of a series of food consumption notices that suggested people limit their consumption of predatory fish species, such as walleye, northern pike and lake trout from specific lakes in the region [7]. Mercury is a heavy metal and chronic exposure to its organic complex (methylmercury) is associated with neurotoxicity and developmental toxicity [8,9]. Furthermore, mercury concentrations in fish were observed to increase in this region in recent years [10], and the local population wanted to better understand how to safely consume fish.

To address these concerns, a multi-year community-based biomonitoring project was developed to investigate current levels of contaminant exposure among participating First Nations communities of the Canadian subarctic in the NTs.

A community-based approach is dependant on the engagement of the community, and defined as those who are affected by the health issue, and also every group with a specific culture that can take the lead in

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engagement efforts and engage in joint action in a geographical location [11–13]. Community-based projects in the NTs usually focus on environmental monitoring (eg wildlife, contaminants, climate change) or Traditional Knowledge (TK) preservation [14–20]. Community-based approaches facilitate health programme implementation among Indigenous populations [21], and are critical for the success of environmental health projects among Northern Indigenous populations [22]. The involvement of Elders and local leaders is particularly important in the development of culturally relevant environmental health projects among such populations [23]. As per the four critical elements of community-based projects [24], communities (agents in a specific locality) were included as: i) the setting location, ii) the target group which experiences the health issue, iii) the agent vector and iv) the resource to create and implement the project.

The geographic scope of this study included First Nations communities in the Dehcho and Sahtú regions of the NTs. There are a series of existing environmental monitoring programmes active in these regions, such as the Aboriginal Aquatic Resource and Oceans Management (AAROM) [25] programme helping Indigenous groups to participate in decision-making processes by capacity building and collaborative management and the Sahtù Environment Research and Monitoring (SERM) programme [26], developing regional strategies to manage the land wisely and with respect to the local culture. The residents of communities within these regions are predominantly South Slavey and North Slavey Dene. Specifically, in these regions, more than 77% of residents are Indigenous [27]. In collaboration with regional partners, the University research members contacted 13 Dene and Métis communities (Deh Gah Gotie, Liidlii Kue, West Point, Jean Marie River, Ka'a'gee Tu, Sambaa Ke, Pehdzeh Ki, Katlodeeche, Colville Lake, Déline, K'asho Got'ine, Norman Wells, and Tulít'a) to discuss the project. These communities collectively represent 19% of Indigenous residents of the NTs [27]. Of the communities approached, nine accepted to participate in the biomonitoring project (see Figure 1).

The biomonitoring investigation discussed herein, which was designed in close collaboration with community leaders from participating First Nations of the Mackenzie Valley, included sampling of human hair, urine and blood, as well as the administration of three questionnaires. The methods and approaches taken in preparation, implementation and reporting of human biomonitoring research were adapted according to the unique regional and cultural characteristics of participating First Nations communities. The design of this community-based biomonitoring project, as well as the approaches taken to develop these procedures, is presented below. In addition to the local leadership, partners and local collaborators, an interdisciplinary team was assembled to assist the project, including experts in community-based research, human toxicology, ecotoxicology, exposure assessment, Indigenous environmental health, biology, human nutrition, lipidomics, epidemiology, risk perception and communication, and food security.

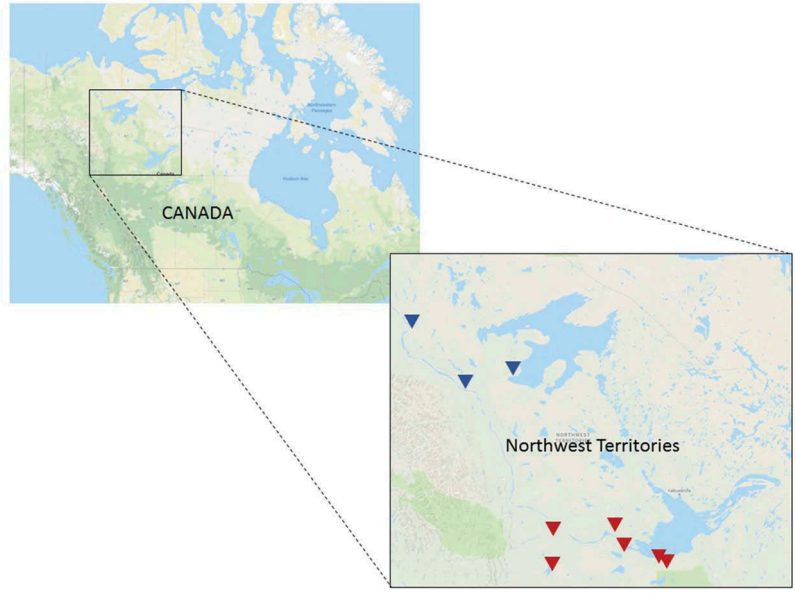

Figure 1. Northwest territories communities participating in the biomonitoring project in the Sahtú region (▼) and Dehcho region (▼).

Community-based research process

Funding and proposal

The Dehcho First Nations (AAROM's programme manager) contacted the principal investigator's team in 2014 to get support to characterise the heath issue related to mercury advisories in the region. This was the first step of collaboration, leading to the development of the backbone of the biomonitoring project. Consultation within the region started before proposal submission, and included participation in local workshops, and the development of potential collaboration with local partners. Collaborators within the Dehcho (AAROM programme) conducted an environmental health survey that profiled participants' perspectives on the effect of advisories on fish consumption, interest in participating in a biomonitoring study and interest in receiving additional information related to country foods. Results of the survey provided information required to build the foundation of the community-based biomonitoring project in the Dehcho First Nations communities.

Community consultations

Given the time and care needed to foster meaningful relationships with local community leaders, public consultation and dialogues for the research began in 2014, approximately 2 years prior to collection of the first samples. Substantial differences among communities, in terms of population size, governance structures and capacity, meant that the length of the consultation period varied considerably from one community to another. Consultations helped ensure that community needs and priorities were being met through the research, and that the purpose and scope of the project were well characterised, and a confirmation from all parties of the process moving forward. The research team initiated collaborative knowledge exchanges and public consultations at least 6 months (and up to 24 months depending on community) prior to commencing the contaminant biomonitoring study in any given community. In addition to frequent teleconference and email conversations, the research team met at least twice with community leaders in person in the community before implementing the project. Within each participating community, face-to-face meetings with community leaders (including Chiefs, presidents of local councils, senior administrators and resource managers) as well as at least one public meeting took place. When the opportunity was presented, the research team introduced the project to community leaders during council meetings. This consultation period was the first step in an ongoing process to solidify relationships and contextualise the relevance and importance of the project for participating communities.

Through these consultation efforts, communities shared information regarding local history, specific contaminant issues and sensitive topics that should not be included within the project (eg genetic testing). We received comments on community members' expectations for how the results should be returned and sought feedback on the ways by which, at the end of the project, culturally appropriate sample destruction could be accomplished. A key outcome from these community meetings was that the right-to-know for each individual had to be respected; all results should be returned to each participant, even if they were difficult to interpret from a health risk perspective.

Agreements

Throughout this process, the research team worked closely with community leaders to develop a Community Research Agreement (CRA) for each participating community. The CRA clarified the responsibilities and expectations of the research team and each participating community, defined the scope of the work, articulated the expected benefits and outcomes of the study, stated principles of informed consent and proposed a data management plan. The Chief from the pilot community (the first community to participate) provided critical advice for several aspects of the CRA, including translation of documents, potential sampling dates, important training material for hiring of local research coordinators and design of a protocol for the destruction of hair samples in a culturally appropriate manner. This process was carefully outlined to respect the rights of First Nations communities to own, control, access and possess information (OCAP®) about their peoples and comply with all aspects of the principles of First Nations data collection, protection, use and sharing [28]. OCAP® are principles established to properly conduct research with First Nations and provides standards to insure they remain stewards of their information. The principles of OCAP® were incorporated into the design and implementation of the study described herein. Expressed written consent of the leaders from participating First Nations is required prior to the dissemination of project results via publication or media contact. Memoranda of understanding were also developed to outline financial agreements between the research group and all participating communities, as well as between researchers and local health centres, for the hiring of registered nurses. Partnerships with regional health authorities enabled the research team to hire registered nurses who were

responsible for the collection of blood samples over the course of the study.

Research and ethics licences

In preparation for the project, the research team received ethics clearance for the design and methods, and then annual ethics approval for each subsequent year of the project. Ethics and licensing reviews were conducted by the University of Waterloo Research Ethics Committee, the Stanton Territorial Health Authority (STHA) for Human Research and the Aurora Research Institute. Health Canada ethics approval was also obtained regarding additional analysis of the biobanked samples that were placed in a long-term archive.

Preparation of communities

Training of local coordinators

Project funds supported the hiring of local research coordinators, each of whom signed a Confidentiality Agreement to protect the personal information of participants. Depending on the size of the community, 1–2 local research coordinators were hired to assist with logistics, participant recruitment and survey administration during the study. All local coordinators participated in a 3-h training programme (via teleconference or video conference) that provided an overview of the project, pertinent information regarding confidentiality, the process of random recruitment selection and lastly the recruitment procedure. In addition, each coordinator completed 3 h of onsite field training to familiarise themselves with the procedures for hair and urine sample collection, as well as the administration of the surveys and questionnaires. The coordinator's role included describing the informed consent process to each participant, and assisting with the implementation of the project by overseeing participant recruitment and facilitating completion of the clinical component with participants. During the biomonitoring clinic, the coordinators were responsible for assisting the researchers in explaining the various components of the study and verifying consent from participants, collecting samples of hair for chemical analysis, assisting in the shipping process and supporting participants in the completion of the electronic surveys.

Incorporating local knowledge

TK is defined by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as the *Knowledge, innovations and practices of Indigenous and local communities around the world* [29]. In addition, the Assembly of First Nations mentions that it is a collective knowledge unique to Indigenous communities, which includes food preparation and beliefs [30]. TK was integrated within several components of the contaminants biomonitoring study. Local perspectives provided by residents of the Dehcho and Sahtú regions during community consultations helped to ensure that the mission and design of this research addressed the priorities and concerns of Indigenous people of the NTs, respecting local beliefs. For example, the method for hair incineration following the project's completion was modified to reflect local cultural and spiritual beliefs. Furthermore, the study incorporated the knowledge of local harvesters and hunters in the development of the dietary surveys. This local knowledge was crucial to ensure that the questionnaires used locally relevant terms to describe country foods, and that those foods could be recognised by individuals in participating communities. Other important facets of local knowledge that were incorporated within the dietary questionnaire included the seasonality of foods, the availability and consumption of the types of food specific to each community, and the methods by which food is often prepared. The research team will continue to explore the ways by which TK can be incorporated into the creation and dissemination of project results.

Language and its role in defining and understanding concepts played a prominent role in the design of the study. Terminology workshops with Elders and local leaders were organised in collaboration with the Sahtú Renewable Resources Board, helping to clarify conceptual differences in language and the meaning of words between researchers and community members from participating communities. For example, this process illustrated that the term *contaminant* was sometimes conceptualised and translated into *a substance that kills*. Such a provocative definition had the potential to inflame anxieties and was inappropriate for use within biomonitoring research. As such, in collaboration with Elders and local language experts, options for how to translate each of the identified terms of interest were discussed, and the group arrived at a new translation for several words. Through the terminology workshop, contaminant became: *substance that got into it* [another] (Asíı̨ beta ɂajá). Time was spent during the terminology workshop to work through more meaningful and accurate translations for several words used in the biomonitoring project.

Project components and implementation

The biomonitoring project included biological sample collection (hair, urine and blood), a pair of dietary

surveys evaluating food usage patterns, and a health messages survey assessing participants' awareness and perceptions of contaminant issues. An overview of each of these six components is described in Table 1.

Pilot community

As per the recommendation of the First Nations Biomonitoring Initiative [31], before delivering the project across the Dehcho and Sahtú regions, the research team conducted a pilot study, including the sample collection clinic, in one of the participating communities. This was done to refine the project tools and logistics. The pilot community was chosen according to the initiative and interest of community members as well as Chief Gladys Norwegian's (Jean Marie River First Nation, NT) strong support for the project. This pilot project helped to ensure that the project design was relevant to community needs and context, verify the recruitment process, establish an expected participation rate and refine the project logistics (eg transportation of equipment and samples). The pilot community also provided direction to the return of results strategy.

Questionnaires used in the project were previously validated during a focus group with community members. Focus groups were held with local harvesters to ensure that the foods included in the questionnaire were relevant to the region and referred to foods using names that participants would recognise. Additionally, the food frequency survey was validated through an open community forum as well as through a test/re-test approach.

Communication

Communications with collaborators and partners

The research team provided project partners (including the Government of the Northwest Territories Department of Health and Social Services (DHSS), Northwest Territories Regional Contaminants Committee, Northwest Territories Health and Social Services Authority (NTHSSA) for the Dehcho and Sahtú regions, AAROM, and the Sahtú Renewable Resources Board (SRRB)) with periodic updates by phone or email. In addition, the research team regularly participated in the Sahtú Environmental Research and Monitoring Forum, providing further opportunities for the research team to liaise with community delegates and other researchers working in the Sahtú Region.

Communication with participants and communities

Community leaders continue to receive a seasonal newsletter and bi-monthly updates by phone or email of the study's progress within the NTs. The communication strategy with participants was adopted to reassure participants of the commitment, accessibility and presence of the research team in conducting the contaminants biomonitoring study, and to recognise the importance of participant and community involvement in this research. This strategy also served to foster long-term trust and meaningful relationships with participating communities. Handwritten post cards were sent between data collection and the returning of the results to thank participants and outlined when results would be communicated. Additionally, social media accounts were created to enhance the impact and visibility of the

Table 1. The components of the data collected.

Component	Description	Objective
Contact information	Name, address or postal office box number, phone number.	Contact to return results.
Demographics	Age, sex, ethnicity (First Nation/Métis/other).	Characterise the distribution of participants and identify groups at risk.
Other information	Height, weight, food consumption in the previous 2 h, alcohol/smoking/medications on the day of the sampling.	Better interpret the results from the biological results.
24h recall questionnaire	Questionnaire on all the foods consumed during the previous day.	A complement to the FFQ, it provides a good picture of country food intake with relationship to store bought foods. Also brings details on the nutritional intake. It helps to interpret biological levels.
Food Frequency Questionnaire (FFQ)	Questionnaire specifically on country foods consumed over the last year. Includes questions on the types of foods, frequency, portion size, cooking methods.	In complement to the 24 h recall, it provides usual food behaviour related to country foods and identify country foods the most consumed. This questionnaire can be used to reconstruct contaminant intake over the year.
Health Messages Survey	Survey on the awareness of health messages on contaminants, on the perception of risk related to contaminant exposure, and on the preferred ways to get information.	The answers will provide information to design a relevant strategy for the key messages coming from the data.
Hair collect and testing	A small full length lock of hair is collected.	Mercury analysis is done for the 2 last months of exposure.
Blood collect and testing	A registered nurse collects 18 ml of blood.	Metals are quantified in whole blood. Organic pollutants and fatty acids are measured in plasma.
Urine collect and testing	A spot urine is collected.	Metals are quantified in urine.

study in participating communities, and to improve its accessibility to study participants. Furthermore, social media became an important avenue by which the research team was contacted to conduct interviews with local media (eg local newspapers, radio). Social media has previously been identified as a means of increasing the impact and the accessibility of research for participants, including participants living in Indigenous communities [32,33].

The return of results

Principles guiding the return of results were established through direct consultation with participating communities and project partners. These principles included: i) all participants receive their own individual results and ii) all participating communities would receive their community-specific, aggregate results. Although emphasising the "right-to-know" can be challenging (ie for its potential to lead to misunderstandings and/or counter-productive interventions as the health implication is sometime unclear) [34], this approach can help foster more transparent relationships and trust in science and study participants, and can leverage health promotion and increased empowerment [35–37]. Further, community consultations indicated that respect for OCAP® principles would require the project team to return all biomarker results to participants and communities. To guide this process, a Scientific Advisory Committee (including representatives from the office of the Chief Public Health Officer, the Regional Contaminants Committee of the Northwest Territories, and Health Canada) was created in 2016.

This Scientific Advisory Committee assisted with results dissemination by providing input on the: a) design of individual results letters; b) creation of plain-language community reports and c) plans for public results forums in participating communities. In particular, this Committee informed the research team of the establishment and delivery of public health messaging related to contaminant exposure in the NTs. This process helped ensure that this messaging reinforced advice (eg General Fish Consumption Guidelines) previously published by the DHSS. Additionally, the committee provided feedback on the development of factsheets for local clinicians and medical practitioners, providing additional insights on contaminant exposure profiles and guidance values.

Community level

After all analyses were completed and results were prepared for dissemination (approximately 6–10 months after the sampling period), the research team organised a preliminary results phone meeting with community leaders to summarise key messages and findings. These key messages were also provided prior to meetings in the form of community-specific short reports. After the community results forum, a full report was refined according to feedback and concerns from the community, and delivered to community leaders. These reports summarised community-specific results in terms of participant demographics, food intake patterns and biomarker levels. Further, exposure biomarkers were reported for all the compounds analysed and compared with: i) the results from previous studies (Canadian Health Measure Survey, First Nations Biomonitoring Initiative) and ii) health-based tissue guidance values. This information helped establish baseline levels for participating communities, which enables communities to monitor any changes in exposure over time.

Participant level

All study participants who provided a hair, urine and/or blood sample received a confidential, plain-language letter detailing their contaminant exposure profiles. These letters were composed in an effort to: i) provide sufficient context so that the results were meaningful without going into so much detail as to make them overwhelming and ii) emphasise the general healthfulness and importance of country foods. Each participant letter emphasised that levels of exposure above the population average do not necessarily imply that the participant's health is at risk. Additionally, the letters incorporated several general recommendations on the types of actions individuals can take to lower their exposure to potentially harmful contaminants. With the feedback of participants from the pilot community, the researchers designed a results letter including a colour-coding system to classify the five categories of results describing whether the results exceeded the available guidance values (see Supplemental Information) in order to simplify the information provided in the letter and better communicate results. Additional materials (eg values for comparison) were available on request. On the first page, a preview of the results for three of the most harmful contaminants (ie mercury, cadmium and lead) was expressed both in value, and as a colour-coded system. The letter contained eight pages that included a letter summarising the participant's results, a table with the participant's results, recommendations on how to lower personal exposure to contaminants, as well as the General Fish Consumption Guidelines previously published by the Government of the Northwest Territories. The research

team provided results letters in person to each participant. In the event that participants were not available while the research team was in the region, the local coordinator was placed in charge of delivering the letter to the participant in the following weeks. Follow-up testing was offered to participants with biomarker levels exceeding health-based guidance values.

Media and scientific results dissemination

After the community meeting was held and participants had received their results, community leaders were asked to provide feedback on their experiences with the communication and return of results. Results were described through the media or scientific presentations only after participants and communities had received their results. Throughout this process, the research team ensured that no mention was made of any individual's results nor information which could potentially identify a study participant.

Data management and governance

All data collected in the contaminants biomonitoring study are personal and confidential. As such, data management plans have been designed to protect the information of communities and individuals. An electronic password-protected results file was created on an encrypted computer to secure all information considered personal or where potentially identifying characteristics (eg name, age, sex) were recorded. All other documents and samples were coded by a unique participant identification number and do not contain any identifiable information, whether direct or indirect. Participants' consent forms and data collection sheets are kept in a locked cabinet in a locked room in a secure wing of the School of Public Health and Health Systems at the University of Waterloo.

Each participant has the right to withdraw from the study without loss of remuneration. All samples will be discarded after 10 years through the University of Waterloo's Environmental Safety Facility. Urine and blood will be incinerated as biological waste. As per the guidelines from the University of Waterloo Research Ethics Board, data will be erased after a period of 25 years. Per a request by community leaders to ensure that the destruction and disposal of human hair samples respects and integrates culturally relevant practices, all human hair will be burned while a prayer from a spiritual leader is recited.

Collaborative future work

Community involvement

The research team continues to pursue opportunities to remain involved and maintain meaningful relationships with the communities that participated in the contaminants biomonitoring study. Annual on-the-land and community research meetings are being used to maintain visibility and impact within the region. Further capacity building opportunities are being explored, including but not limited to: the hiring of community-based social media-savvy young adults in order to maintain lines of communication between the research team and community participants, and training of local research assistants on a field-portable direct mercury analyser to enable community-based, participatory sample collection and data analysis for mercury biomonitoring. This work has been based in the Dehcho and Sahtú regions; however, similar issues and concerns are present in the other regions of the Canadian north. As such, the research team remains committed to working with interested communities to launch this type of work in other parts of the Canadian subarctic and Arctic.

Integration with research being conducted in the Northwest Territories

The contaminants biomonitoring study is complementing a long history of environmental monitoring in the NTs, a trend that is becoming increasingly associated with human health monitoring. Hair, blood and urine sampling [37–41], and country food consumption [42] have been previously assessed in an effort to monitor contaminant exposure in the Canadian North. This study serves to provide a greater understanding of the inherent linkages between country foods, nutritional status, contaminant risk and human health in First Nations communities of the Canadian subarctic. The measurement of contaminants outside of the NCP mandate through the biobank will enable a better understanding of the impacts of contaminant exposure from store-bought foods, in comparison with contaminants found in the environment and in country foods. This study represents one of the first efforts to characterise the perception and awareness of risk from contaminant exposure, and to evaluate the methods of communication most effective in communicating this risk within Indigenous communities of the NTs.

The collaborative work crosses several disciplines and the interdisciplinary research team facilitates better methodological processes addressing the challenges related to community-based research [13]. The co-location of the project with numerous other research projects (eg wildlife

and fish contaminant monitoring) is directly supporting our efforts to understand pathways of contaminants exposure, and how social change, climate change, harvest levels and resource development may affect contaminants exposure in the future. Integrating traditionally segregated disciplines, such as aquatic ecology, food choice and human ecotoxicology, is not only consistent with the Indigenous world view that humans are a vital and integral part of natural ecosystems, but is also allowing the research team to explain to communities why some traditional foods have higher levels of contaminants than others. In one community, this has led to a mitigation strategy: intensive fishing is being used to lower fish mercury levels in a lake with particularly high concentrations. In other communities, members of our team explain how contaminants get to remote regions and build up in food chains. This "demystification" of contaminants is contributing to development of mitigation and risk management strategies. Finally, the research team continues to work closely with community leaders and decision-makers at the territorial level to consider how the sociocultural implications of this research can be applied in multiple contexts (eg through global policy, public health advisories, health promotion and finally the dissemination of scientific findings).

Conclusion

The research team will continue working with community and territorial representatives to: 1) ensure that any follow-up biomonitoring continues to address community concerns; 2) identify any potential sources of contaminant exposure and 3) consider practical and efficient approaches by which people can lower their exposure. Country foods provide the people of the NTs with a host of nutritional, economic, social and cultural benefits. Therefore, it is important that messages about contaminants and country foods are carefully designed so as to balance their associated benefits and risks. It was essential for the design of the contaminants biomonitoring study described herein to integrate the sociocultural characteristics of participating communities. The results of this project will report on the links between contaminant exposure, nutritional status and country food use, and will provide important baseline data in this specific region. The outputs of this project will serve to support the development of governance and messaging tools, public health interventions and health policies that maximise the nutritional, cultural and spiritual benefits of traditional food systems while minimising the risks associated with contaminant exposure in Indigenous communities of the NTs.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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Ethics approval and consent to participate

Participants provided a free consent. Ethics approval was obtained by the University of Waterloo Research Ethics Committee (#20173, #20950), the Stanton Territorial Health Authority for Human Research (29/12/2015) and the Aurora Research Institute (#15560, #15775, #15966, #15977, #16021) and Health Canada ethics board (REB 2016-0022).

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Appendix C, TAG
Meeting April 8, 2021

LANXESS – Elmira

TAG Meeting

Ramin Ansari

April 8, 2021

Creek Risk Assessment Discussion

Recommendation

From Wilson Lau's draft March 14, 2021 Memo to TAG "Supplemental Comments on APT Environment Submission":

- (1) That TAG has the opportunity to review and comment on a ToR document as one of the preliminary steps in the risk assessment process.
- (2) That the concerns of APT Environment as highlighted in the February 2021 attachment are wholly considered in the risk assessment process.

Recommendation

Recommendations from APT Environment February 2021 Attachment (ref. Wilson Lau):

- (2a) That the assumptions that go into the risk assessment must reflect the vulnerabilities of this population.
- (2b) That the hot spots of DDT and dioxins identified in the Creek be remediated as soon as possible.
- (2c) That appropriate lines of communication be set up with the Mennonite community on the creek so that the affected population is informed.

Recommendation Commentary

(1) TAG Opportunity to Review ToR Document as Preliminary Step in RA Process

TAG has been reviewing and is in the process of reviewing documents that "substitute" for a ToR document/process (Pre-Submission Forms or PSF)

- The ToR process is part of Brownfields regulatory requirements under Ontario Regulation 153/04 Records of Site Condition (RSC) under Part XV.1 of the Environmental Protection Act (EPA).
- LANXESS is not conducting the RA for filing of a RSC under O. Reg. 153/04
  - We do not own the creek or adjacent properties, not proposing to redevelop lands for more sensitive land use, therefore, the LANXESS creek RA will not culminate in a mandatory RSC.
  - LANXESS is undertaking this entire creek work on a voluntary basis (2017-present)
- However, the RA will be completed in general accordance with O. Reg. 153/04
- For O. Reg. 153/03 RSC Filings, PSFs are an initial step which provides MECP with a general view on the approach to the RA and the RA team at an early stage, to improve the quality of RA submissions.
- The RA process is past the ToR or work-plan stage: 2 rounds of investigations, CSM preparation, and COPC evaluations
- The CSM & COPC define the scope of work and are the essence of the O. Reg. 153/04 PSF process.

So the CSM and COPCs are considered to be the TOR / work plan as they define the COCs, receptors, receptor pathways which have been already prepared & issued for stakeholder comment.

Recommendation Commentary

(2) That concerns of APT Environment February 2021 attachment are wholly considered in the RA process:

(2a) Assumptions that go into the risk assessment must reflect the vulnerabilities of this population

The assumptions that go into the Ontario risk assessment are already extremely conservative.

- These assumptions consider the worst-case exposure scenarios.
  - Lifetime of exposures -76 years
  - Consider all stages of life, from infant to adult
- The risk calculations are conservative and toxicity values have built-in safety factors.

LANXESS completed a visual assessment of the Creek in 2017, and communicated with owners*.

- Identified human activities and interactions along the entire Study Area. Went door to door for access, w/MECP; MECP also met separately.

CSM currently identifies a nearby farmer/resident that is inclusive of the Old Order Mennonite families, and others that live adjacent to the creek.

- If the addition of "e.g., Old Order Mennonite" to the description of nearby farmer/resident would help clarify this receptor, that can be done.

(2b) Hot spots of DDT and dioxins be remediated as soon as possible

"Hot spots" of DDT and dioxins identified in the Creek will be addressed, as soon as possible, to the extent:

- They are from the Site (i.e., not background from farm and town drainage, as is common),
- They pose unacceptable risks/hazards, and
- If stakeholders, including MECP experts, would agree that intrusive action would be best
  - i.e., remediation by excavation, dredging, armoring, etc.
  - In certain instances, MECP has deemed non-disturbance to be best.

Corrective Actions will be considered for all locations in the study area deemed to have unacceptable risk/hazard for applicable COPCs

- Remedial feasibility assessments, permitting, implementation, monitoring, closure

(2c) Appropriate lines of communication with the Mennonite creek community so affected population is informed

LANXESS and MECP have already been in communication with adjacent landowners.

Certainly if there is an unacceptable risk, the affected population will be appropriately notified.

- Understanding that this "community" seeks privacy, the best way to do this communication might be family or parcel specific, rather than in a TAG/RAC or other "public" meeting.
- If the "community" were amenable, we would look into a Mennonite-only private group setting to communicate.

Bottom line – if someone, individual, family, or community is deemed to have been or presently affected, we will endeavor to communicate to them the results and keep them informed and involved in recommended actions.

Example - Risk Assessment Assumptions

LANXESS CSM - Section 4.1:

- Nearby farmer/resident is anticipated to frequent the Study Area approximately 2 to 3 times per week for “recreational” purposes (e.g., low water crossings, wading in the Creek, picnics etc.).
  - This is equivalent to a nearby farmer/resident frequenting the Study Area for approximately 5 to 7 days per week during the peak summer months (July and August) and 1 to 2 days per week during the spring and fall.
- This exposure will be considered for the MECP typical lifespan (also Health Canada) of a resident which is 76 years.
  - All life stages, infant to adults, of nearby farmer/resident will be considered in that 76 years of exposure.
- CSM discusses direct-contact-exposure to BOTH (a) sediment during recreational activities and/or farming activities and (b) soils within the floodplains for this receptor.
  - Additional exposures such as consumption of meat from mammals such as sheep or cattle that may graze on the Creek floodplain and consumption of fish caught within the Study Area will also be considered for this receptor.

The toxicity values which consider both cancer and non-cancer endpoints will be used to characterize the risk and hazard to COPCs in the sediment and soils; These are conservative values selected by the MECP to develop the generic site conditions that are applicable to all Sites in Ontario.

Continuing / Ongoing Creek Risk Assessment Discussions

“Notification and out-going communication is one-way, DIALOGUE is two-way”

-We endeavor to have dialogue with stakeholders


LANXESS
Energizing Chemistry

Appendix D, TAG Meeting, April 8, 2021

2020 Annual Monitoring Report, dated February 22, 2021

Summary prepared by Katharina Richter, April 8, 2021

- Prepared by EarthCon Consultants Inc. In past years, the Annual Monitoring Report (AMR) was prepared by GHD
- Purpose: To present and evaluate the groundwater and surface water data from 2020, in accordance with the Amended Environmental Compliance Approval (ECA) and previous Control Orders
- Summarizes data from monthly Progress Reports and reports submitted since the 2019 AMR (includes the 2019 Biomonitoring Study, Supplemental East Side Investigation Report, UA CS Containment Review, and Sediment and Soil Work Plan)
- The report was well laid out and figures were provided to support the text. The 2020 AMR was easier to follow than those from past years (albeit, I've only reviewed the 2019 report).

Report Summary by Section:

1.1 Purpose and scope

1.2 Site hydrogeology – refer to Municipal Aquifer Conceptual Site Model (GHD 2017)

1.3 Site remedial systems – refer to ECA

1.4 2020 monitoring programs and changes implemented

- Groundwater elevation monitoring -> Section 3
- Groundwater quality monitoring -> Section 4
- Surface water monitoring -> Section 5

2.0 Remediation System Operation and Maintenance

2.1 Upper Aquifer containment system

- 8 UA CS containment wells operated effectively, containing groundwater in UA1 and UA3 and preventing contamination of the creek. –> Section 3.2

- U+685 failed in 2020 and will be replaced in 2021. U+540 and U+560 were rehabilitated in 2020. Further rehabilitation and replacement work will continue in 2021.

2.2 On-site containment and treatment system

- On-site containment through 2 wells (PW4 and PW5)
    - primary treatment: granular activated carbon (GAC) adsorption system

- secondary treatment: UV/oxidation – to remove NDMA and residual organic compounds

- Ammonia Treatment System (ATS)

-> discharge at SS+890 and SFE when flows > 700 US gpm (Comment: Should be converted to metric system)

2.2.1 On-site Collection and Treatment System (CTS) monitoring

- pumping rates monitored at PW4, PW5 and combined UA CS flow (GUA)

- average flow did not exceed the max influent flow rate permissible

- treated effluent consistently met the Effluent Objectives for all parameters, with the exception of toluene and chlorobenzene. All exceedances were short-term, isolated events that did not reflect a deficiency in the treatment system.

- results of acute toxicity tests and chronic toxicity tests showed effluent was not acutely toxic to Rainbow Trout or *Daphnia magna*, and not chronically toxic to Fathead Minnow or *Ceriodaphnia dubia*.

2.2.2 On-site CTS Operational Performance

- both Groundwater Rayox System (GRS) and Ammonia Treatment System (ATS) worked reliably. No improvements or modifications are scheduled in 2021.

2.3 Off-site Collection and Treatment System

- designed to collect and treat groundwater from MA underneath Elmira

- 7 extraction wells, 2 stand-by extraction wells, 3 separate treatment systems on Site

2.3.1 Off-site CTS monitoring

- monitoring equipment monitored and calibrated

- influent rate was not exceeded

2.3.2 Off-site CTS operational performance

- groundwater treatment systems operated well

- W9 has not been operational since October 3, 2019 due to acute toxicity to *Daphnia magna*. The W9 treatment system will be modified and completed in 2021.

2.4 E7/E9 containment and treatment system

- E7 and E9 are former municipal supply wells that are now part of the UV/oxidation system
- treated groundwater is discharged to Landfill Creek

2.4.1 E7/E9 CTS monitoring

- only E7 operated in 2020
- average flow rate did not exceed allowable limit
- all effluent samples did not exceed the requirement

2.4.2 E7/E9 CTS operational performance

- pulse pumping was initiated in 2020 to increase NDMA mass removal
- no improvements or modifications planned for 2021

3.0 Groundwater Elevation Monitoring

- 4 groundwater containment/collection systems: UA CS, on-site CTS, off-site CTS, containment well E7
- 4 measurements (April, June, September, December)

3.1 Surficial Aquifer

- flow in 2020 is consistent with previous years' findings, primarily to the west, NW, and SW
- monitoring was also consistent with The Supplemental East Side Off-Site Groundwater Investigation, showing some movement to the east

3.2 Upper Aquifer

- Monitored through 6 monitoring pair locations and 4 creek locations
- UA CS was effective in containing shallow UA groundwater within the site

3.3 Upper Municipal Aquifer

- PW4 and PW5 were operated to inhibit migration of contaminated groundwater from the site, which they were effective in doing
- Extraction wells W3R, W5B, W6B, and containment well E7. Limits of the off-site MU NDMA and chlorobenzene plumes were contained in 2020.

3.4 Lower Municipal Aquifer

- Extraction wells W5A, W6A, W8, and containment well E7. Extraction well W9 did not operate in 2020. The ML NDMA plume was contained effectively. Routine groundwater quality data showed infrequent detection of NDMA below Ontario Drinking Water Quality Standards.

3.5 Bedrock

- The NDMA plume was contained in the bedrock by W5A and W3R.

4.0 Groundwater Quality Monitoring

- Groundwater quality monitoring included:

  - creek bank monitoring program – monitor quality of uncontained UA1 that discharges to creek

  - off-site sentry well monitoring program – part of Updated Remedial Action Plan for MA; serves to verify containment of southern edge of NDMA plume, to evaluate effectiveness of off-site CTS extraction wells, and monitor progress of RAP.

  - MU sentry well monitoring program – provides evidence that on-site CTS wells PW4 and PW5 are providing containment of contaminated MU groundwater under site

4.1 Upper Aquifer

- Greatest concentrations of NDMA in UA1 is beneath former operating ponds in SW part of site (>1µg/L). NDMA is non-detect from monitoring wells along east bank of creek, consistent with previous results

- Chlorobenzene results from NW creek bank were all less than ODWQS.

- At one location (OW127-4), chlorobenzene was noted at a greater concentration than “Table 8 Standards” (‘generic site condition standards for use within 30m of a water body in a potable ground water condition’) (conservative assumption). Chlorobenzene was not detected downstream of this location in 2020.

- At central location of east bank, chlorobenzene was not detected.

- At SE bank, chlorobenzene concentrations were below ODWQS and equal to or less than Table 8 Standard.

- Concentrations of pesticide compounds and VOCs sampled in NW bank of creek were non-detect or below Table 8 Standards.

4.2 Upper Municipal Aquifer

-As of December 2020, the concentration of chlorobenzene in all the samples was less than the ODWQS (CH-47E met mark in Dec)

- The concentration of NDMA in all samples was less than ODWQS, other than at CH-47E and CH-56B

-Long-term trends for NDMA and chlorobenzene concentrations in MU sentry wells are either decreasing or more than 50% of the results are non-detect. This provides evidence that the on-Site MU containment wells provide containment of the most heavily impacted groundwater beneath the SW portion of the site

- Recommendation that MU Sentry Well Monitoring Program be reduced from quarterly to semi-annual given persistence of non-detect results, strongly decreasing trends, and low concentrations being detected at times

- In 2020, the maximum off-site NDMA concentrations were located W of the site near OW60-26.

4.3 Lower Municipal Aquifer

- NDMA plume was reduced in 2020

- Monitoring wells CH-34A, CH-37, and CH-80A did not detect NDMA in 2020, consistent with previous results. Recommended that routine sampling at these stations end. Also recommended to monitor CH-14 and CH-16A annually, rather than biennially.

- Chlorobenzene plume was stable in 2020

4.4 Bedrock Aquifer

- extent of NDMA plume was stable with a slight increase in extent to north

5.0 Surface Water Monitoring

- monitored from 3 primary locations and 3 secondary locations during low flow

5.1 Surface Water Quality

- concentrations of most parameters were either non-detect or were not increased in downstream sample

- Concentrations of 6 broad scan parameters (alkalinity, cobalt, copper, iron, lead, nickel) were higher downstream than upstream, similar to past years. Increased alkalinity is not an adverse impact to the creek. Concentration of metals are not related to activity of the site.

- Most parameters were non-detect or less than PWQO, Interim PWQO, and ECA Schedule E criterion. Only parameter exceeded was 1 detection of bis(2-ethylhexyl)phthalate (DEHP) (detection considered an anomaly and unrelated to site) and a few detections of total phenols

(likely attributed to upstream sources, field or lab contamination, or analytical variations, and/or method interferences) and formaldehyde (likely result of standard variability in sample analysis).

- no samples exceeded ECA requirements

- Due to the elimination of industrial discharges to the Creek, as of January 21, 2020, the LANXESS facility is no longer subject to the 'Municipal Industrial Strategy for Abatement' **(**MISA) regulations.

5.2 Statistical Analysis of Primary Surface Water Quality Monitoring Data

- Statistical analysis and interpretation of surface water quality is required by the ECA on an annual basis

- No abnormalities.

5.3 Biomonitoring Programs

5.3.1 Clam and Leech Biomonitoring Program – refers to "2019 Biomonitoring Study Using Clams (Elliptio complanata) and Leeches (Nephelopsis obscura)" report by AquaTox (April 20, 2020).

5.3.2 Receiver Biomonitoring Program – refers to a study completed by Stantec in 2020, for which are report is being prepared in 2021 (received today, April 8, 2021)

6.0 Evaluation of groundwater remediation effectiveness

6.1 Remediation effectiveness methodology

- EarthCon was retained to undertake groundwater plume analytics evaluation, which provided an understanding of NDMA and chlorobenzene plumes. Analysis was conducted on historical data (since 1993) through to 2019, as many wells not sampled in 2020 as they are sampled biennially.

6.2 Remediation effectiveness results

- significant (statistically meaningful) reductions in NDMA and chlorobenzene plumes have been achieved in both the MU and ML

-EarthCon's interactive pdf presentation is attached in Appendix D.

6.2.1 NDMA Plume in the MU

-NDMA reductions: 40% plume area; 95% average concentration; 97% mass; complete plume remediation in certain areas; plume reduced by 99.2% in MU

6.2.2 NDMA Plume in the ML

-NDMA reductions: 40% plume area; 81% average concentration; 91% mass; complete plume remediation in certain areas; plume reduced by 92.6% in ML

6.2.3 Chlorobenzene Plume in the MU

- Chlorobenzene reductions: 60% plume area; 39% average concentration; 76% mass; complete plume remediation in certain areas; plume reduced by 85.2% in MU

6.2.4 Chlorobenzene Plume in the ML

- Chlorobenzene reductions: 51% plume area; 48% average concentration; 74% mass; complete plume remediation in certain areas. Text on separate analysis to calculate the on- and off-site mass reductions compared to the total plume reduction was not provided for the chlorobenzene assessment in the ML. Section 6.3 mentions off-site plume has been reduced more than 74%. Likely text section was accidentally deleted/hidden.

6.3 Remediation effectiveness discussion

- On-site and off-site CTS "has been and continues to be very effective at remediating impacted groundwater in the MA."

- Although a significant portion of the initial NDMA and chlorobenzene mass has been removed from the MA, the rates of mass-in-place reduction have declined and are approaching asymptotic levels in the off-Site plumes so that the ODWQS will not be achieved in off-Site portions of the MA by 2028. This is a common phenomenon.

- "Although contaminant mass recovery rates and mass-in-place reduction rates are declining, the Site remedial systems are still effective in continuing to remediate the MA and inhibit migration of contaminants from the Site." Does EarthCon have any recommendations with regards to increasing the effectiveness of the remediation, or is what we have going appropriate?

7.0 Conclusions and Recommendations

- The conclusions and recommendations are an excellent summary and should be reviewed in full. I've copied the most pertinent ones:

"The operation of the on-Site CTS and off-Site CTS at the Site continue to be very effective at remediating impacted groundwater in the MA. The off-Site NDMA plume mass has reduced by more than 99 percent in the MU and more than 92 percent in the ML, and the off-Site chlorobenzene plume mass has reduced by more than 89 percent in the MU and more than 74 percent in the ML.

"During 2020, the UA CS provided hydraulic containment of the southwest portion of UA_1.

"The 2020 surface water quality data confirm that hydraulic containment provided by the UA CS continues to protect the Creek from Site related groundwater contaminants that

were routinely present at concentrations greater than PWQOs prior to the commissioning of the UA CS in 1998.

“The NDMA plume extent generally decreased, with the western and northern plume margins decreasing slightly between 2019 and 2020. The extent of the 2019/2020 MU chlorobenzene plume was generally stable compared to the plume extent based on 2019 data.

“The western extent of the 2019/2020 ML NDMA plume was reduced, compared to the 2019 ML NDMA plume. The extent of the 2019/2020 ML chlorobenzene plume was generally stable compared to the plume extent based on 2019 data.

“Surface water sampling of Canagagigue Creek has revealed no evidence of adverse effects from surface water runoff, storm water outfall discharges, groundwater discharge and treated groundwater effluent discharges from the Site in 2020.”

Recommendations

“Because of the persistence of non-detect results, the strong decreasing trends and the relatively low concentration now being detected, the frequency of the MU Sentry Well Monitoring Program should be reduced from quarterly to semi-annual.

“Routine sampling of monitoring wells CH-34A and CH-37 should cease. ML monitoring wells CH-14 and CH-16A should be removed from the biennial off-Site Plume Monitoring Program and added to the annual off-Site Sentry Well Monitoring Program.

“Routine groundwater quality monitoring at CH-80A should cease. NDMA has not been detected in groundwater samples collected from CH-80A since 2006.

“Surface water sampling of Canagagigue Creek has revealed no evidence of adverse effects from discharges from the Site since 1997. LANXESS will continue to manage, inspect and monitor effluent and storm water discharges from the Site to the Creek; Therefore, the additional monthly surface water quality monitoring is redundant. LANXESS has submitted an application for amendment to ECA No. 0277-BV2JU5 to optimize the surface water monitoring program to better reflect current conditions at the site.”

Comments and Questions to EarthCon:

Section 2.2: 700 US gpm should be converted to metric system

Section 2. 4: Why did E9 not operate?

Section 5.2: Text refers to Table 5.1, but I was not able to locate that table or identify what the correct reference should be.

Section 6.2.4: Text on separate analysis to calculate the on- and off-site mass reductions compared to the total plume reduction was not provided for the chlorobenzene assessment in the ML.

Section 6.3: Does EarthCon have any recommendations with regards to increasing the effectiveness of the remediation, or is what we have going appropriate?

TO: Technical Advisory Group (TAG), Township of Woolwich

FROM: Dustin Martin, TAG Member

SUBJECT: Summary & Comments on 2021 Comprehensive East Side Groundwater Report (March 31, 2021) for April 8, 2021 TAG Meeting

PREAMBLE: *These comments were prepared in draft for the April 8, 2021 TAG meeting and finalized afterwards. They provide a record of my initial comments on the 2021 Comprehensive East Side Groundwater Report prepared by GHD and dated March 31, 2021. The purpose of this written summary is two-fold:*

1) *Provide a succinct, factual summary of the report for TAG members (see Part I below)*
2) *Provide a summary of my own comments on the report. (see Part II below).*

Part I below reports a factual summary of the report and withholds any comments on content or conclusions. Part II presents a summary of my comments on the report and/or questions for LANXESS and their consultants, which can be discussed at a supplemental meeting with LANXESS regarding this investigation, as agreed upon during the April 8 TAG meeting.

PART I: Summary of Report

Stated Objective of the Report:

GHD has prepared this report on behalf of LANXESS to document the findings of the off-Site groundwater investigation as completed on the east side of the Site and on the Property from 2015 through November 2019.

The objective of the Supplemental East Side Off-Site Groundwater Investigation (GHD, 2020) was to evaluate the groundwater quality and delineate the horizontal and vertical extent of n-nitrosodimethylamine (NDMA), 2,4,6-trichlorophenol and 2,4-dichlorophenol detections in the groundwater located on the Property.

Contents:

Section 2 provides a summary of Waste Management History on the east side of the LANXESS Property. This was requested by the MECP specifically, and appears to be a reasonable summary providing useful context. Waste management unit locations are presented on Figure 2.1.

Section 3 gives a summary of investigations on the East Side dating back to 2015, with a particular focus on groundwater investigations. Results are summarized.

Sections 4 and 5 provide a summary of the scope and methodology of the 2019 Supplemental East Side Groundwater investigation. The original version of the report we're now reviewing documented this investigation.

Section 6 summarizes the results of the 2019 Supplemental East Side Groundwater Investigation and discusses the hydrogeology of the area (and provides multiple cross sections on Figures at the end of the report), groundwater flow directions, and analytical results broken down by various hydrostratigraphic units. The breakdown by hydrostratigraphic units is notable – this was specifically requested by the MECP. Additionally, groundwater flow figures are also broken down by aquifer unit, rather than simply showing "shallow" and "deep" groundwater flow directions. Analytical results from previous investigations are also discussed here.

Section 7 presents a discussion of the results, and a summary of recommendations.

Summary, Conclusions and Recommendations Presented by GHD:

Surficial Aquifer:

- Perched, restricted to northeast corner of the LANXESS Site and property
- Radial flow pattern, outwards from a topographic high near Church Street

- Strong downward hydraulic gradient
- NDMA present exceeding the ODWQS
- Other contaminants (2,4,6-Trichlorophenol and 2,4,-Dichlorophenol) either non-detect or below criteria

Upper Aquifer:

- UA is thicker near the Canagagigue Creek
- Saturated, thinner layers of sand along central and southern portion of the eastern Site boundary
- UA is present under a portion of the adjacent property (Stroh Property), in the southwestern portion near LANXESS and north along the laneway (approximately)
- Groundwater flow is interpreted to flow away from topographic high near Church St.
- Strong downward hydraulic gradient
- NDMA present, but only one marginal exceedance of ODWQS (at OW8-4)
- Other contaminants (2,4,6-Trichlorophenol and 2,4,-Dichlorophenol) either non-detect or below criteria

Upper Aquitard:

- Thick prolific aquifers beneath most of LANXESS property (and Elmira) are absent beneath the Northeastern part of the LANXESS Site, where there are fine grained silt or clay tills (i.e. aquitard units)
- Vertical gradients and fractures within the clays may be the dominant groundwater flow component in the UAT.
- NDMA: consistently greater than criteria in the UAT monitoring wells adjacent to the north and central portions of the eastern Site boundary (Figure 6.15)
- 2,4,6-Trichlorophenol and 2,4,-Dichlorophenol exceedances from onsite wells.

Lower Aquitard:

- NDMA concentration in OW7-29 was above criteria (highest observed in the program)
- 2,4,6-Trichlorophenol and 2,4,-Dichlorophenol exceeded as well
- OW188-22 – NDMA detected, 2,4,-Dichlorophenol detected once, 2,4,6-Trichlorophenol not detected

Lower Municipal Aquifer:

- Present at the newly installed monitoring wells
- Groundwater flow is to the south/southwest under the regional gradient, and west towards W5A once it is in the southern portion of the property.
- NDMA: one anomalous exceedance in August 2019, but when re-sampled in Sep 2019, it was below criteria. Some detections, but this was not consistently over criteria.

Potential Pathways/Receptors:

- Shallow groundwater for domestic supply
    - Ruled out by GHD as a pathway/receptor because the shallow units (SA, UAT, UA) either don't provide suitable yield (e.g. are aquitards) or are unsuitable for potable use due to agricultural land use
- Migration of shallow groundwater to deeper groundwater for domestic supply
    - Thick aquitard sequences interpreted to provide attenuation of contaminants. This is interpreted to be supported by the lack of impacts in deeper units, such as the ML.
        - GHD notes the exception of OW7-29.
    - Groundwater Flow in the MA is southeast away from the domestic well located in the south east portion of the Property and is captured by extraction well W5A.
- Discharge to SW
    - GHD indicated shallow SA, UA, and UAT groundwater impacted by the contaminants is remote from surface water bodies. Annual Creek Bank Monitoring Program demonstrates that surface water is not a receptor.

Conclusions/Recommendations (by GHD)

- GW Impacts are fully delineated on the Property
- No receptors being impacted
- Recommends OW191-29 be added to off-site Sentry Well Monitoring program as sentry well for domestic supply well on the Property, and the remaining wells on the Property installed since 2017 be properly sealed and abandoned.

PART II: Comments/Questions for LANXESS

1. The GHD report incorporates several comments made by MECP and TAG, including (but perhaps not limited to) the addition of a summary of waste management on the LANXESS site, the addition of several cross sections, breaking down discussions by hydrostratigraphic unit. While this report represents a significant improvement on the previous version, some comments remain outstanding.

2. Some outstanding comments, from either the MECP or TAG, are listed below. The MECP Memorandum dated September 23, 2020 and the TAG minutes discussing this report should be reviewed and considered for updates to ensure all comments are addressed.
    a. Cross sections do not present any groundwater flow contours, nor any graphical representation of chemistry results. Given the interpretation presented by GHD which places an emphasis on vertical flow through the overburden, these should be included.
    b. Discussion of the hydraulic properties (e.g. hydraulic conductivity) of the overburden, particularly the aquitard units, is sparse, despite the assertion that the aquitard units are providing protection to deeper groundwater.
    c. No water quality data were provided in the report to support the statement that NDMA has not been detected in the domestic well on the adjacent property.

3. GHD provided some more detailed discussion of the public well records which are present in the area and presented them on several figures. However, I have the following questions or comments:
    a. Can GHD identify which of these MECP well record corresponds to the domestic supply well on the Property which is referred to in the report?
    b. Have these locations been field verified?
    c. The use of each of these wells should be identified (domestic supply, test hole, etc).
    d. One pair of records is shown east of CH-19. Based on the WWIS website, this is a pair of installation (Well record 6506834) and corresponding abandonment (7221482) records. It should be flagged as such.

4. Table 5.1 presents coordinates for various wells. Some of the northings and eastings are reversed. Additionally, when plotted, these coordinates do not match the locations of the wells as shown on GHD figures.

5. The calculation of vertical gradients in Table 6.2 should be explained and units included for all fields. It appears that the reported vertical gradient is the inverse of how gradients are typically calculated.

6. Estimated linear groundwater velocities are not discussed anywhere in the report. These would be helpful for understanding the potential (or lack thereof) for contaminant migration either laterally or vertically.

7. On Figure 6.15, OW36-5(R), OW38-5(R), and OW37-5A are shown as completed in the Upper Aquitard, while the wells immediately across the property line installed at similar depths are shown as being installed in the Upper Aquifer. Is this sharp contrast interpreted to represent native stratigraphic conditions, or could it be the result of excavation and backfill?

8. The stated objective of the report is to delineate “detections” of contaminants on the Property. However:

a. No figures include the Property boundary. This makes it difficult to determine the area within which delineation is targeted.
b. Can GHD clarify if delineation of "detections" was the actual goal, or rather was the goal delineation of "impacts" (i.e. delineation of where concentrations exceed guidelines)?

9. GHD concludes that the groundwater impacts have been delineated, even in the vertical direction, however, I note the following observations:
    - The "deep" wells which are being relied upon for vertical delineation (listed in Section 7, page 27) are distant from the boundary with the LANXESS site
    - GHD points out that there is likely a strong downward component of flow and mentions the possibility of clay fractures controlling vertical movement.
    - Most impacts are along the property boundary, in the UAT, adjacent to the waste management units near the central and northern portion of the LANXESS site. Based on cross section A-A' (Figure 6.3), very few of these wells are nested with deeper wells extending into the deeper overburden.
    - OW7-29 has the highest reported concentration of NDMA in this report, despite being a deep well, below the UAT.

    a. Based on these observations:
        i. what supports GHD's suggestion that the impacts are fully delineated in the vertical direction near the property line, where most of the shallow impacts were detected?
        ii. Could impacts have migrated vertically, rather than laterally, at the property line, as seems to have happened at OW7-29?
        iii. Groundwater analytical data posted on A-A' (Figure 6.3) and other cross sections would clarify the interpreted vertical delineation.
    b. Additionally, what is GHD's interpretation of possible contaminant migration to bedrock? Is bedrock water supply a potential receptor? When was OW7-36 last sampled?

10. GHD concludes that horizontal delineation of groundwater impacts has been achieved on the Property, but note the following observations from the 2019 and 2020 Annual Monitoring Reports:

    From the 2019 Annual Monitoring Report (dated March 30, 2020)

    i. Figures 3.8 and 4.11 shows the 2019 NDMA concentration contour (0.009 ug/L) in the Upper Municipal Aquifer extending offsite onto the Property in the southeast of the LANXESS property, south of the southernmost Upper Municipal Aquifer well included in the current report/program.
    ii. OW15i (installed in the Upper Municipal Aquifer, and located in the extreme southeast of the LANXESS property) had a concentration of NDMA reported at 0.0706 ug/L (criteria is 0.009 ug/L) on September 24, 2019. See Table A.4.

    From the 2020 Annual Monitoring Report (dated February 22, 2021)

    i. Figures 3.16 through 3.19 show the 2019/2020 NDMA concentration contour (0.009 ug/L) in the Upper Municipal Aquifer extending offsite onto the Property in the southeast of the LANXESS property, south of the southernmost Upper Municipal Aquifer well included in the current report/program.
    ii. OW15i (installed in the Upper Municipal Aquifer and located in the extreme southeast of the LANXESS property) had a concentration of NDMA reported at 0.0254 ug/L (criteria is 0.009 ug/L) on September 1st 2020. See Table A.4.

    Based on the above observations: what supports the conclusion that delineation has been achieved on the Property? Based on the available data from the Annual Monitoring Reports and the current report, it

seems as though there may be impacts in the Upper Municipal Aquifer off the southeast corner of the LANXESS site (and on the southwest corner of the property) which have not been delineated. In the discussion of groundwater impacts (as summarized in Section 7), the Upper Municipal Aquifer appears to be omitted, despite the cross sections (B-B' and E-E') showing it as being interpreted to be present in the southern portion of the Property and along the Property boundary.

11. Wells OW190-26 and OW189-24 are both installed in the Lower Municipal Aquifer and had average concentrations of NDMA reported above the method detection limits, despite being shown as upgradient of the LANXESS property. There is no discussion of potential transport routes for NDMA to have reached these locations. Does GHD have an interpretation for why these detections are present at these locations?

12. Several of the groundwater flow figures have solid contours extending beyond where there is actual data presented, suggesting a higher degree of confidence in groundwater flow direction than is supported by the data. For example, contours are shown to the south of CH-19 and OW15d on Figure 6.12, but no data is presented to support their interpreted location. At a minimum, these should be represented as dashed lines. This is important given that area is assumed to be near the domestic supply well on the Property, and its elimination as a potential receptor depends in part on the interpretation of groundwater flow direction in that area.

13. In Section 7, the final paragraph of Page 27, discusses that groundwater flow is to the west and Extraction Well W5A captures groundwater flow in the Municipal Aquifer. Does GHD have a delineated capture zone for W5A demonstrating this conclusion?