

Disputed Sio Silica Responses to DLN Clarification IRs for the Vivian Sand Extraction Project

**By D.M. LeNeveu, Participant DLN
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1.0 Introduction

Manitoba Clean Environment Commission Process guidelines respecting Public Hearings Appendix A – Practice Directions Information Requests Guidelines state;

1. The parties shall engage in the IR process in a prompt and co-operative manner, in order to ensure full and timely disclosure with the minimum amount of effort and cost.
2. Proponents shall provide detailed, responsive and complete answers to information requests, along with copies of all related documentation.
3. Where the proponent is unable to answer an information request without further clarification or direction from the inquiring party, it shall promptly communicate with the inquiring party in order to resolve the difficulty.
4. Where a dispute arises regarding information requests, or the answers to information requests, the parties shall promptly communicate with each other in order to resolve the dispute in a co-operative and efficient manner.
5. In the event that such disputes cannot be resolved by the parties, the Commission will determine the matter in a summary fashion. This may include ordering the parties to meet and exchange information in order to satisfy any outstanding requests.
6. A proponent that is unable or unwilling to provide a full and adequate response to an information request will file and serve a response: a) setting out specific reasons why the proponent contends that the request is not relevant; b) setting out reasons why the information needed for an answer is unavailable, and providing alternative available information that would be useful for the party making the information request; c) setting out the reasons why the information being sought is considered confidential and any harm that would be caused by making it public; or d) otherwise explaining why a full response cannot be given to the information request.
7. To the extent possible, the process of making and responding to information requests should be completed before the beginning of the hearing of evidence.

I, CEC participant, DLN, dispute many of the Sio Silica responses to my clarification (c), information requests as documented below.

2.0 DLN-IR-001c Air Injection Request Disputes

The following Sio Silica's response to DLN-IR-001c-2 is inadequate; "*Most compressors come with a standard intake filter which is designed to remove 99% of 5 micron or larger contaminants and 95% of 3 micron or larger contaminants.*" This response does not clarify if the compressors used in the advanced exploration activities to date and the compressors to be used during production will have standard air filters. If the compressors used in production will have standard air filters, Sio Silica does not give information on the duration of use, the maintenance and cleaning of the filters, the number of filters required per year and the disposal of used filters. Up to seven or more compressors would be required to operated simultaneously and continuously for about 220 days of extraction per year. Filter maintenance and disposal requirements may be too onerous to be viable for this intensive use. Standard filters would not remove diesel fume contaminants such as NO₂, SO₂, CO₂ and benzene. Specialized filtration with chemical agents such as activated carbon

would be required as described in the DLN-IR-001 round 1 reference 1, by A. White of Parker Manufacturing. The second reference in the DLN-IR-001 round 1 by A. White of Parker Manufacturing states that 0.01 micron filters are required to remove harmful microbes as well as moisture removal mechanisms. Therefore I dispute that even if the standard filters on compressors described in the Sio Silica response are used during production that these filters would be adequate.

Sio Silica states in response to DLN-IR-001c-2-7; *“Sio is relying on standard industry practice by established leaders in the sector to be the authority on this subject.”* I dispute this statement. Standard industry practice is to use a suite of filters and methods for decontamination of the compressor air described in the references I have provided from Parker Manufacturing. Sio Silica has not implemented these methods in their sand extraction operations and has no plans to for implementation during production.

I dispute this statement in the Sio Silica response, *“In addition, as has been stated in previous IRs, the air injected comes back to surface and is not injected directly into the aquifer.”* The Sio Silica patent published in the Document #1 – Silica Extraction Method June 2, 2022 describes how the air tube can be moved below the production tube to loosen sand with pulses of compressed air. Also some air and water carrying the microbes and pollutants could leak from the bottom of the production tube carrying microbes when the air tube is within the production tube. Sio Silica has not given evidence that no air would enter the aquifer directly from the air tube.

Sio Silica states in their response; *“The water is UV treated prior to its return back to the aquifer and therefore would not contain bacteria or microbes.”* The water removed from the aquifer by air lift would contained dissolved pollutants from the air tube including nitric acid from the dissolution of NO₂ in diesel fumes, sulphuric acid from the dissolution of SO₂ and dissolved benzene. The UV filtration process removes only suspended solids not dissolved. All the dissolved pollutants form the airlifting would be returned to the aquifer.

Sio Silica did not respond to my calculations in DLN-IR-001 that showed that the emissions for the air compressor would cause a pH as low as 3.1 in the aquifer water for a capture fraction of the emissions of 0.01. This calculation was for a cavity opening of 60 meters. The concentration may be higher for the smaller extraction cavity of unspecified dimensions in the revised extraction plan of Jan. 24, 2023.

Sio Silica has finally acknowledged in the responses to clarification DLN-IR-002 that the sandstone and carbonate aquifer contains interbedded shale that is known to contain heavy metals. The acid formed from the NO₂ and SO₂ of the compressor air would release heavy metals in the aquifer. The heavy metal content of the shale aquitard has been confirmed by the geochemical analysis in the Hydrogeological Report of the EAP. The silica sand is also documented to contain heavy metals. Nitric and sulphuric acid from the compressor air would release heavy metals from the interbedded shale, the aquitard shale and the silica sand directly into the aquifers.

The allowed limit of benzene in drinking water is only five parts per billion. A small amount of benzene could contaminate a large amount of aquifer water as illustrated in my calculations in DLN-IR-001. I therefore dispute the relevance of the statement in the Sio Silica response, *“In addition, as has been stated in previous IRs, the air injected comes back to surface and is not injected directly into the aquifer.”* Pollutants dissolved from the injected air that are removed by airlift to the surface would be re-injected back into the aquifer.

I dispute the relevancy of the statement; *“Sio also took microbial samples 6 months after the extraction test both on the extraction test location including the extraction well and monitoring wells, as well as monitoring*

wells off location. The results were all negative for total coliforms and E.coli.” Sio Silica does not name the location and date of the test and where in the wells the tests were taken. If these were wells used in the hydrogeological testing they are not relevant since no air injection and sand withdrawal occurred in the hydrogeological test wells. Sampling 6 months after a test where reducing conditions upon which the microbes depend could have been re-established is not appropriate.

Sio Silica states that they will follow monitoring requirements set out by the EAB in the production and that contamination of intake air for the compressors is not a meaningful risk. Sio Silica does not respond directly to the DLN-IR-001c request as to why no air modelling studies were done on the air quality that would occur during production to assess the risk of air contamination. I assert that it is the responsibility of Sio Silica to provide the EAB with modelling results of air quality at the extraction site during production just as was done with the processing facility EAP.

The total GHG emissions for the equipment and vehicles at the processing facility given in Table 9 of the EAP for the processing facility are 1088 tonnes CO₂e per year. The total GHG yearly GHG emissions for an extraction site from Sio Silica equipment exclusive of indirect emissions from hydro power given in table 6-3 of the extraction EAP is 6785 tonnes CO₂e per year, 6.24 times the emissions from the processing facility. An air quality study was completed for the processing facility that has about the same surface area as a yearly extraction site. The maximum NO₂ concentration at the edge of the processing facility from the air quality modelling study was 95 µg/m³. Thus the expected NO₂ concentration at the edge of the extraction site would be expected to be 95x6.24= 593 µg/m³, which is well above the allowed limit of 200 µg/m³. The concentration near the emitters especially the extraction rigs with the diesel powered compressors would be much higher. Thus the contention by Sio that there would not be significant air quality impacts within the extraction site is contradicted by a direct analogy to their own air modelling studies for the processing facility.

The air modelling studies for the processing plant establish that such modelling studies and air monitoring during production are the required responsibility of Sio Silica to carry out for the extraction site. Sio Silica must provide to the Hearing a detailed air quality modelling study for the extraction site including all sources of emission just as was done for the processing facility. An air quality modelling study and required revisions to extraction plans to reduce air pollutants would be a major project alteration that would require a revision to the EAP, TAC and public comments, and review by the Hearing third party experts. The Hearing must be delayed until receipt of these required air quality modelling studies and completion of the project alterations and required reviews.

3.0 DLN-IR-002c Process Water Re-injection Request Disputes

Sio Silica states in response to DLN-IR-002c-5 concerning the gravity feed method of returning water to the aquifer; *“Sio monitored water gravity feed to the well visually. If the gravity feed flow exceeded the ability for the well to receive water the feed would be reduced or shut off completely because the water could overflow around the wellbore as the wellbore is open to atmosphere. Please note, these are testing configurations and not necessarily the configuration of the proposed extraction operations.”* I dispute that a visual method of determining if the gravity feed method could exceed the ability of the well to receive water is adequate. A measurement of the amount of water returned and the amount of water withdrawn is required. During production spillage of water on the ground surface that the well is not able to accept is inadequate. Sio Silica must specify the method to be used during production to prevent such spillage and must measure, in a proper field test, the amount water withdrawn from the aquifer and the amount of water returned by gravity feed.

Sio Silica states that the requirement of the injection well permit for measurement of the formation water pressure during injection is not required since no pressure was applied during the gravity feed water return. I dispute that this is an adequate response. Sio Silica cannot unilaterally decide to ignore requirements of a permit. Well information reports from Manitoba Groundwater show Sio Silica completed a monitoring well Bru 92-4 opening into the sandstone aquifer near the injection well Bru 92-8. Sio Silica must submit any pressure data from this well. If in fact the gravity feed method produces no pressure, the pressure measurements would verify this. It is in Sio Silica's interest to produce the pressure data during water return to the aquifer if gravity feed in fact produces no excess pressure. The Hearing must require Sio Silica to produce the pressure data as required by the injection well permit. A precedent must not be set that a proponent can simply ignore permit requirements. If Sio Silica continues to refuse to submit the pressure data from Bru 92-4, I request that the Panel subpoena this data. If no pressure data exists for gravity feed return of water tests must be done to provide this data.

Sio Silica in response to DLN-IR-002c-13 states; *“The remaining water in the system after extraction is complete will be taken to a water treatment facility for disposal.”* This is entirely new information not previously documented in the EAP and is introduced at an inappropriate stage in the approvals process with no prior TAC, public, and third party expert comment. The amount of remaining water in the system has not been quantified. The process waste water is likely to contain toxic pollutants such as selenium, heavy metals and acid that would require specialized disposal. A treatment plant would dispose of the water to the surface environment in some manner contradicting Sio Silica's often repeated assertions that their process would result in no surface discharge of process water. The disposed of remaining water would constitute a draw on the sandstone aquifer that may along with all the other sources of permanent removal of aquifer water, be unsustainable.

Sio Silica also states; *“Where possible, water will be moved to a holding tank for the winter months to reduce the volume of water taken to a treatment facility.”* How big will this holding tank be at the extraction site? Would it be moveable to new sites each new extraction year? Would it be heated in winter? The holding tank is also entirely new information not previously documented in the EAP introduced at an inappropriate stage in the approvals process with no prior TAC, public, and third party expert comment.

The treatment of the remaining system water at a disposal facility and a remaining system water holding tank at the extraction site are major project alterations that would require an alteration to the EAP, TAC and public comments, review by the Hearing third party experts and suspension of the Hearings until this approvals process is complete. I dispute that the responses on the remaining process water are acceptable without further action. Delay of the Hearing is required until new project alterations pertaining to disposal of year end process water are adequately dealt with.

Sio Silica in response to DLN-IR-002c-24 concerning the wells that have been used for gravity feed states; *“Sio has gravity fed tested Bru 92-8 summer 2021 and Den 304-1 summer 2020.”* An email received from Manitoba groundwater Feb. 23, 2020 states; *“Information provided by the company did not act on the injection well permit intended for this location. Den 304-1 was drilled at a different location and was not used as an injection well.”* Therefore I dispute Sio Silica's statement. The evidence shows only well Bru 92-8 has been tested for gravity feed. The results of the gravity feed for Bru 92-8 were only monitored visually. This is completely inadequate testing of a critical essential feature of the extraction operation. Failure to return water to the aquifer would have severe environmental consequences and must be thoroughly tested and documented. The Hearing Panel should mandate a thorough measured testing and evaluation of the gravity feed water return method including pressure measurement. The Hearing should be delayed until the results of this testing and measurements are submitted.

Sio Silica in response to DLN-IR-002c-25 concerning the amount of water permanently removed from the aquifer in the sand stockpiles and waste streams states in part; “*The total volumes of water withdrawn were presented in the 50% and 0% re-injection scenarios of the Hydrogeology and Geochemistry Assessment for the extraction. Sio intends to re-inject all water that is removed from the sand during extraction.*” Sio Silica has misunderstood the question. I am not referring to the amount of water re-injected into the aquifer. I am referring to the amount of water that is not re-injected into the aquifer and permanently removed from the aquifer. It is essential to know if the water removed from the aquifer and not re-injected represents an unsustainable draw on the aquifer. Sio Silica has not determined the amount of water that would be permanently removed from the aquifer in the sand stockpiles at the processing plant and in all waste streams including solid waste and year end waste process water remaining in all extraction vessels. I therefore dispute that the answer to DLN-IR-002c-25 is adequate and request that the Hearing Panel require Sio Silica to provide an adequate response with detailed calculation of the amount of water permanently withdrawn from the aquifer and a determination as to the sustainability of this aquifer draw. The sustainability of the draw on the aquifer is an essential environmental consequence that must be assessed for the Hearing.

Sio Silica in response to DLN-IR-002c-26 concerning the handling and storage of geological samples states; “*Collection of samples for geochemical testing was completed in a manner that is consistent with industry standard practice as defined by the Guidelines for the Prediction of Acid Rock Drainage and Metal Leaching for Mines in British Columbia (Price 1997), the Metal Environment Neutral Drainage (MEND) Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (MEND 2009) and the Global Acid Rock Drainage (GARD) Guide (INAP 2014).*”

The Guidelines for the Prediction of Acid Rock Drainage and Metal Leaching for Mines in British Columbia (Price 1997) state;¹²

6.8 Sample Preparation

After being collected a sample should be air dried or oven dried at a low temperature. Oven drying at temperatures no higher than 40 °C will ensure most minerals are not altered. Prior to drying, the sample should be kept cool. However, drying will cause additional secondary minerals to precipitate during evaporation of the porewater, which could complicate testwork and predictions.

The Guidelines for the Prediction of Acid Rock Drainage and Metal Leaching for Mines in British Columbia (Price 1997), the Metal Environment Neutral Drainage (MEND) Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (MEND 2009) states;⁷

The geochemical conditions of the material in the field should be maintained within samples where changes will obscure or destroy the targeted properties and processes of the subsequent analyses and test work. A good example of this is the need to maintain anaerobic conditions during sampling and storage for samples from anaerobic sediments. Exposure to oxygen will change the composition of the pore water and the solubility of potential contaminants. Therefore, changes in geochemical conditions should be minimized where possible during storage. Nevertheless, some changes may be inevitable. Where differences occur they should be considered in the interpretation of the analyses and test work results.

The geochemical conditions of the material in the field should be maintained within samples where changes will obscure or destroy the targeted properties and processes of the subsequent analyses and test work. Nevertheless, some changes may be inevitable.

After being collected, samples of drill core, blast hole cuttings and unweathered or aerated waste materials and walls should be air dried or oven dried at a low temperature. Prior to and after drying, the sample should be kept cool. Drying at temperatures no higher than 40°C will ensure most minerals are not altered. However, the evaporation of the pore water will cause solutes in pore water to precipitate. Typically, the effect of solute precipitation is minimal because the solute concentration is not significant compared to the concentration of previously precipitated weathering products.

Some sulphide oxidation may occur during drying and storage. Approaches that will minimize oxidation after sampling include freezing the sample, minimizing the delay prior to drying and avoiding humid storage conditions. Anaerobic conditions may be maintained by storing the sample under nitrogen gas.

(Reproduced from Prediction Manual for Drainage Chemistry from Sulphidic Geological Materials MEND Report 1.20.1, Dec. 2009)⁷

Sio Silica has given no evidence that the core samples were air dried at temperatures no higher than 40 C and that prior to after drying the samples were kept cool. Sio Silica provides no evidence of freezing the samples before drying and maintaining anaerobic conditions by storing under nitrogen gas. The guidelines show that my stated concerns about oxidation of the samples by air exposure are valid. The references Sio Silica provides confirm the handling and storage of Sio Silica core samples was inadequate. Therefore I dispute the claim by Sio Silica that; “Collection of samples for geochemical testing was completed in a manner that is consistent with industry standard practice.”

The MEND report gives the recommended sampling frequency based on the tonnage of disturbed ore as shown in the reproduced table 8.2 below.⁷

Table 8.2 Suggested initial sampling frequency based on tonnage when sampling without prior information (adapted from BCAMDTF, 1989).

Tonnage of Unit (metric tonnes)	Minimum Number of Samples
< 10,000	3
< 100,000	8
< 1,000,000	26
< 10,000,000	80

(Reproduced from Prediction Manual for Drainage Chemistry from Sulphidic Geological Materials MEND Report 1.20.1, Dec. 2009)⁷

In the 24 year Project period in excess of 24 million tonnes of aquifer sandstone (ore) would be disturbed. Thus the number of geochemical samples should be in excess of 80 collected throughout the Project area. Sio Silica collected only three sand samples that were inadequately handled. Bru 95-3 sand sample was taken from an outdoor stockpile exposed to weathering for one year from June 2019 to June 2020 before the stockpile was covered with a tarp as illustrated in figure 4 below. The other two samples were taken in 2018 from wells Bru 146 and Bru 121-1 south of the Project area as shown in figure 3-1 of appendix A Part 1 of the EAP. The Bru 146 and Bru 121-1 samples were held in storage without protection from oxidation by air exposure for two years before analysis. We must question why the Bru 146 and 121-1 samples were used as they are outside the project area and therefore are not relevant.

The evidence from the references given by Sio Silica demonstrates that geochemical sampling must be redone with sampling methods, number of samples, and handling conforming to the stated guidelines. Samples of concretions, shale interbeds, and oolite must be taken and analyzed. The Hearing must be delayed until the results of adequate geochemical sampling are submitted.

In response to DLN-IR-002c-22 Sio Silica states; *“It is agreed that sedimentary formations including carbonate and sandstone may have interbeds of shale.”* However Sio Silica states that the shale interbeds were not tested. I assert that the shale interbeds should have been tested and still should be tested. A report by Schieber identifies shale interbeds in the Winnipeg Formation as containing iron sulphide.⁵ The geochemical tests of the Hydrogeological Report determine iron sulphide occurs in the shale of the aquitard even though the acid leaching potential is given as uncertain. This is enough evidence to establish the acid generation potential of the shale interbeds in the absence of Sio Silica testing that should have been and should be done.

Sio Silica quibbles about the words potential acid generating (PAG) and uncertain acid generating and states two of the shale samples were designated as uncertain acid generating not PAG. I accept the wording “uncertain.” We cannot be uncertain about acid formation in the drinking water aquifers. Uncertainty in acid formation in the aquifer and in process water that would be returned to the aquifer is unacceptable. It must be emphasized that the UV filtration system and the screening for overs and fines would remove only suspended material and not dissolved acid and heavy metals.

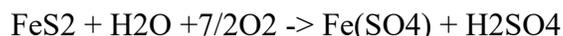
I accept the response of Sio Silica that; *“selenium leaching was only demonstrated under oxic conditions within shake flasks exposed to an unlimited supply of oxygen.”* However the results do not rule out the possibility that selenium leaching in the aquifer may occur due to oxic conditions formed by the return of aerated water and from air released into the aquifer from the airlift air tube. See the discussion for the response to DLN-IR-002c-27 below, where I have quantified the enormous but limited oxic potential due to return of aerated water. Sio silica attempts to put an incorrect onus on participants and opponents to prove detrimental conditions exist. Rather Sio Silica must provide conclusive evidence that detrimental conditions such as leaching of selenium under the conditions that could occur during extraction will not occur. I dispute the conclusion that; *“These results suggest that selenium is a constituent of potential concern that must be included in routine monitoring, and that shale may require careful management as outlined in the Waste Characterization.”* The results also demonstrate that selenium may be released into the aquifer due to oxic conditions formed by the return of aerated water and from air released into the aquifer from the airlift air tube. Thus selenium leaching is not just a waste a management problem. The demonstrated selenium potential leaching in the aquifer must be conclusively demonstrated not to occur before this Project can be allowed to proceed.

Sio Silica does not respond directly to DLN-IR-002c-27 concerning entrained air introduced into the water to be returned to the aquifer by the Sio Silica dewatering and UV filtration facilities. Sio Silica instead states that; *“The Groundwater Monitoring and Mitigation Plan will monitor groundwater in the formation and*

prior to re-injection for a suite of parameters” Sio Silica does not state any plans to measure the amount of entrained gaseous air in the water to be returned to the aquifer. Sio Silica does not dispute that returned air would oxidize sulphide in the aquitard shale, interbedded shale,⁵ oolite and concretions which Sio Silica acknowledges occurs in the sandstone.

Sio Silica in Appendix H uses average water to sand ratio of one to one by volume. Therefore the amount of returned water, using a dry sand density of 1.65 t/m³ for 1.36 million tonnes of sand per year, is 824,242 m³. The fraction of entrained air can be as high as 40% as documented in DLN IR-002. For a small value of 5% air by volume of water, a one to one ratio of the volume of water to sand and for an air density of 1.3 kg/m³, the weight of air to aquifer per year would be 53,576 kg and the volume, 41212 m³.

The oxidation of iron pyrite is often written as;¹



Thus 7 moles of O₂ produces 2 moles of sulphuric acid. The molecular weight of O₂ is 32 and H₂SO₄, 98.08. Using this data and a weight fraction of O₂ in air of 0.23 the entrained air could produce 110,022 moles of sulphuric acid. The EPA recommends the pH of drinking water be in the range of 6.5 to 8.5.² Below pH 6.5 heavy metal release can be expected. Using only the first strong dissociation of H₂SO₄, for a pH of 6.0, 110 million cubic metres of aquifer water would be contaminated per year. This is a rough calculation and ignores any bicarbonate or other neutralizing potential of the groundwater and reaction of the O₂ with other minerals. However neutralization of sulphuric acid by CaCO₃ or bicarbonate produces CO₂ which would dissolve in water to form carbonic acid.³ Oxygen reaction with other minerals would also be detrimental such as leaching of selenium and precipitation of iron and manganese. Thus the oxidation potential of the entrained air in the water returned to the aquifer is limited but enormous in terms of potential heavy metal leaching and drinking water acidification and other detrimental effects. This calculation does not include air introduced from the aquifer by the airlift air tube that would cause further acidification and heavy metal leaching of the aquifer water. Therefore I dispute the significance of the Sio Silica unsupported statement that; *“The supply of oxygen to the aquifer will not be unlimited and will therefore not allow for complete oxidation of any reduced form minerals.”*

Sio Silica responded to DLN-IR-002c-29 concerning the brown colour of a landowner’s well water at the time of Si Silica sand extraction at Centre line Road by stating, *“Sio contacted the landowner who made the complaint in issue 204 who is 1.5 miles away from the site that was active around the same time and the well in question was not in the sandstone aquifer. It was investigated by Friesen Drillers and deemed unrelated to Sio’s activities and more likely a maintenance issue.”* This response ignores the scenario I described in DLN-IR-002c-27 where bubbles of air from aerated returned water or from the airlift air tube would rise rapidly to the carbonate aquifer through the degraded or collapsed shale aquitard. The gaseous air would not be able to penetrate the glacial till due to strong capillary forces in the till and would move rapidly in the karst portion of the carbonate aquifer.¹³ Oxidizing conditions from the dissolved gaseous air would precipitate iron and manganese discolouring well water. Sio Silica has given no evidence to discount this scenario therefore I dispute the conjecture by Friesen Drillers that the brown well water was likely a maintenance issue. Rather the instance of brown water must be accepted as evidence that iron and manganese precipitation and fouling of well water has occurred due to Sio silica extraction activities until the scenario I described can be definitively ruled out by conclusive evidence. The onus is on Sio Silica to provide conclusive evidence that detriment will not occur, not the opposite, that detriment must be proven to occur.

I dispute the response to DLN-IR-002c-30. Sio Silica has not described any geochemical expertise that would be required to adequately address the queries in DLN-IR-002c.

4.0 DLN-IR-003c Slurry Line Contamination Request Disputes

In response to DLN-IR-003c-2 Sio Silica gives several inappropriate references. The reference to El Mamouni et al, 2002 refers to photolysis and microbial attack leading to natural attenuation of polymers within 48 hours. The study in DLN-IR-003c-2 pertains to the degradation of the acrylamide monomer not the polymer. Degradation of the polymer may increase the concentration of the monomer. The DLN modelling determines the accumulation of the toxic monomer acrylamide in the slurry line not the polymer. The reference by Mamouni to degradation of the macromolecule in a soil environment is also inapplicable. The slurry line and clarifier tank are not in a soil environment and the study uses the degradation rate of the monomer not the macromolecule (polymer). The study by Hennecke et.al. 2018, pertains to the polymer effect on plant growth which has no bearing on the monomer accumulation in a slurry line. The study by Marroni does refer to the monomer but in an oil sands treatment environment which is inapplicable to this study.

Sio Silica claims the study by Xiong et. al, *“does not provide any data that overwhelmingly shows that the degradation of polyacrylamide to acrylamide monomer will be an issue especially given the conditions of the process in question. The conditions the article discusses for potential breakdown of polyacrylamide to the acrylamide monomer are not likely to exist in Sio’s application”* Sio Silica does not clarify which conditions are not likely to exist that would cause breakdown of the polymer to the monomer. The conditions that Xiong et al. refer to are iron ions and acid both of which would be expected to occur in the slurry line. Sio Silica states that UV/Fenton light may promote monomer formation and there is no UV light in the slurry system. In fact UV from sunlight may be present in the clarifier tank if it is open to air is often the case. Sio Silica gives no detailed specifications for the clarifier. Thus degradation of the polymer into the monomer in the slurry line system may occur.

In any case the references to degradation of the polymer into the monomer are irrelevant. The DLN modeling uses only monomer found in the manufacturing residual. Degradation of the polymer to the monomer would only increase the results of the modeled accumulation of the monomer in the slurry line.

Sio Silica states; *“QA assures residual acrylamide monomer is <1,000ppm and in fact is more typically about 400ppm.”* The DLN modelling study used a low monomer residual concentration of 200 ppm and a higher concentration of 1000 ppm. Thus the Sio Silica statement on the residual monomer concentration corroborates the values used in the DLN modelling.

In response to DLN-IR-003c-5 Sio Silica states, *“Sio disagrees with the premise of the question as there is no build up of polyacrylamide in the slurry loop.”* This statement illustrates Sio Silica does not understand the modelling study. The accumulation of the soluble, toxic acrylamide monomer in the slurry loop was modelled not polyacrylamide. Sio Silica does not refer to the equations and methodology of the modelling and the fact that the modelling was based on industry modelling from the Great Plains silica sand processing plant. Sio Silica does not recognize that the modelling study used the same equation as the Great Plains study to establish the steady state concentration of acrylamide in the slurry loop.

Sio Silica does not seem to understand that the acrylamide monomer is soluble and will not be removed in the clarifier process. The clarifier removes only suspended material not dissolved. Fresh monomer is continually added to the loop to remove the continuous input of fresh suspended material in the loop from the silica sand. The monomer does slowly degrade in the loop. The degradation of the monomer is modelled. A steady state monomer concentration is eventually reached that the modelling demonstrates is far above

allowed limits. Sio Silica does not even mention the modelling of the accumulation of selenium in the slurry loop.

I dispute all the issues raised by Sio Silica about the modelling of accumulation of selenium and the toxic acrylamide in the slurry loop. The questions raised by Sio Silica about the degradation of the polymer into the monomer are irrelevant since only the manufacturing residual was used in the modelling. Degradation of the polymer to the monomer was not modelled. The only other issue raised by Sio Silica was the residual concentration of the monomer in the polymer after manufacturing. The Sio Silica data corroborated the data used in the DLN modelling. Rather than demonstrating flaws in the modelling the data quoted by Sio Silica confirms the values used in the modelling.

The accumulation of the acrylamide monomer, selenium and other toxins in the slurry loop are a critical environmental risk that Sio Silica has not addressed. Sio Silica demonstrates no understanding of the model process and offers no comments or criticism of the modelling.

A slurry line spill in the vicinity of the Winnipeg aqueduct that the slurry line must cross during the 24 year period of operation could be catastrophic. The extremely toxic acrylamide is not measured in Winnipeg drinking water. Spills of toxic slurry line water elsewhere would pollute the surface environment. Sio Silica is being irresponsible in ignoring the risk of accumulation of acrylamide, selenium and other toxins such as heavy metals in the slurry line.

In response to DLN-IR-003c-8-10 Sio Silica states that a leak of 50 US gallons a minute and a change in the moving average pressure of 2-5 psi within would initiate a shut down in the line within 20 minutes. Thus as much as 1000 US gallons could leak before shut down if the moving average is triggered. However a very small leak may not cause any change in moving average pressure. For instance a leak of one US gallons per minute could go undetected if it did not cause a change in pressure. A slow undetected leak could be more serious than a larger detected leak.

Sio Silica does not state how much could leak in a catastrophic slurry line breach. This would depend on the spacing of the shut down valves and the time would be required to close the valves. It is clear a substantive leak of water contaminated with acrylamide and potentially selenium, acid and heavy metals could occur. Such a leak could have catastrophic results if it occurred near the Winnipeg aqueduct.

Sio Silica states that consideration of the Winnipeg aqueduct is beyond the scope of the current application. Sio Silica states; *“It may be 13 -14 years before the slurry line would need to cross the aqueduct or more.”* Sio Silica does not deny that slurry line crossing of the aqueduct will eventually be required as part of the Project. The mandate of the Hearing is to consider the environmental effects of the entire Project.

In DLN-IR-003c I asserted approval for crossing of the Winnipeg aqueduct after licensing could be done through a Project alteration approved by the Director without approval of the City of Winnipeg. Sio Silica states in response; *“Sio notes that no crossing of the Winnipeg aqueduct would occur without permission or approval. Sio has never said that a crossing would occur without approval.”* Note that Sio Silica does not state approval by the City of Winnipeg would be obtained and does not dispute that approval only by the Director may be sufficient. I dispute that consideration of the Project’s environmental effect on the Winnipeg aqueduct should not be considered in the Hearing. I assert that the Project and the Hearing must not proceed until an agreement is made with the City of Winnipeg for the slurry line crossing of the aqueduct.

In response to DLN-IR-003c-21-23 concerning the proximity of the extraction to the Hydro transmission lines, *“Sio and Manitoba Hydro have been working towards securing approval and discussions remain*

ongoing.” The revised extraction plan submitted by Sio Silica on January 24, 2023 shows that the extraction location has been moved to avoid extraction near Hydro transmission lines. However slurry line crossing of the transmission lines would still be required. Moving of the extraction site away from the transmission lines is not adequate as approval for slurry line crossing has not been obtained. The transmission lines cross the entire breadth of the Project area. Manitoba Hydro condition for approval such as setback distances for extraction would have a negative impact on the Project by requiring movement of the extraction sites to more environmentally sensitive areas such as settled areas and the Winnipeg aqueduct.

It must be noted that there are two hydro lines that the Sio Silica extractions impinge upon, the Point du Bois line and the international transmission line to Minnesota. The revised extraction plan remains quite close to the international transmission line south of the Point du Bois line. I must assume that permission from Manitoba Hydro has not been obtained for the revised extraction plan and may not be forthcoming. Figure 1 shows the required Sio Silica crossings of infrastructure. The previous first four year extraction plan is shown in figure 1.

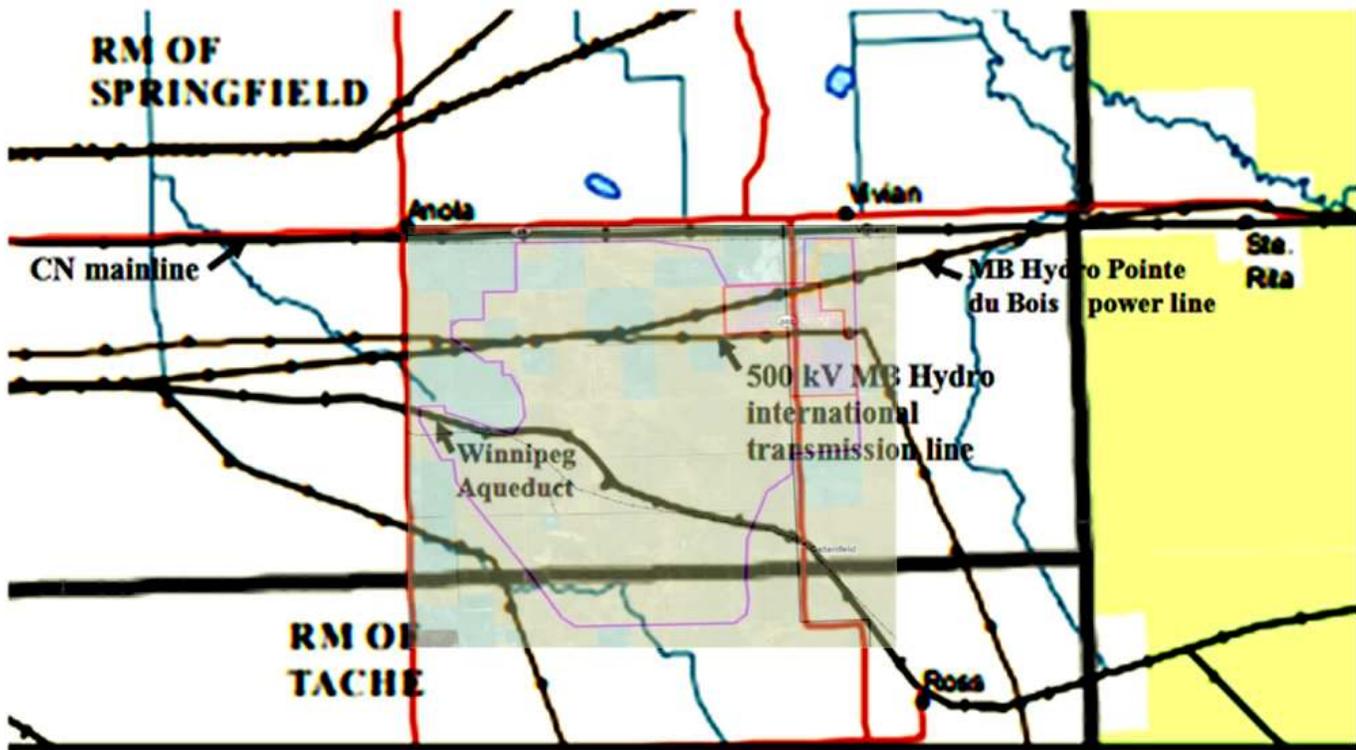


Figure 1. Infrastructure near the Sio Silica extraction area.

I dispute that Sio Silica’s response to the request to obtain Manitoba Hydro’s approval for extraction near the line and slurry line crossing of the line has been adequately answered. The Project and the Hearing must not proceed until approval is obtained from Manitoba Hydro and required conditions of approval are specified.

In response to DLN-IR-003c-12-24- 40 about water balance in the slurry line Sio Silica states; “*The water content in the sand stockpiles is unrelated to the 10 US gpm value. Sand is stockpiled and estimated 15% moisture content as stated in the Facility Project EAP.*” Sio Silica does not appear to understand about water balance in the slurry line. The amount of water entering the closed loop slurry line including the clarifier tank must equal the amount of water leaving the line on average or else the line would either dry up or overflow the clarifier. Once the slurry line is charged with water at the start of the Project, except for input from the French drain that occurs only following moisture events such as rainfall and snow melt, water enters the line

only with 3.6% water content of the sand at the extraction site as specified by Sio Silica in response to IR 009 from the CEC Participant RMSF. The 3.6% water entering with the sand at the extraction site is supplied by the 10 US gpm value as explained in the Sio Silica response to RMSF-IR-009. Water leaves the line with the 15% moisture content of the sand stockpiled at the processing facility. Thus there is an unbalance in the rate of water entering with the sand and leaving with the sand in the slurry line system.

I dispute the Sio Silica statement that; *“The water content in the sand stockpiles is unrelated to the 10 US gpm value.”* If water is removed from the close slurry loop including the clarifier tank at 15% moisture in the sand, more moisture is removed from the slurry line at the processing facility than enters at extraction site at 3.6% in the sand, the slurry line would eventually dry up and not be able to provide 15% moisture in the sand at the processing facility. Thus the water content in the stockpiles is dependent upon the water entering the line at the extraction site at 10 US gpm. This determination does not include the water in the overs and fines that would be removed at the processing facility however the water content of the overs and fines would likely be about the same as the sand at 15% and the overs and fines constitute a small portion of the slurry line content. I have brought forward the inconsistency in water balance in my public comments for the project and again in the IRs. Sio Silica consistently does not address the requirement for water balance in the slurry line. The same amount of water must enter the line that leaves on average. With 3.6% water in the sand entering the slurry line and 15% water in the sand leaving the line with no other water additions or removal the slurry line would dry up. This is not a debateable. It is a simple conservation of mass fact. Stating that the 10 US gpm that determines the 3.6% water in the sand entering the line is unrelated to the 15% water in the sand stockpiles is erroneous and demonstrates a lack of understanding of basic physics and engineering principles. The inconsistency in the amount of water in the sand entering the slurry line and leaving must be resolved.

There are environmental consequences associated with the amount of water entering and leaving the slurry line. If the amount of water entering and leaving the slurry line is high at 15% in the sand, there is more of a permanent draw on the sandstone aquifer that may not be sustainable. If the amount entering and leaving the slurry line is low at 3.6% in the sand, there would be higher accumulations of acrylamide, selenium, acid and heavy metals in the line. Once again I must emphasize that amount entering the slurry line and leaving must be equal on average. If the amount of water in the sand entering the line is 3.6% then the amount of water in the sand leaving the line must be 3.6%. If the amount of water in the sand leaving the line is 15% then the amount water in the sand entering the line must be 15%. Sio Silica has not addressed the issue of water balance in the slurry lines. This issue has environmental consequences and must be resolved before the Hearing continues.

Sio Silica does not resolve the issue of the amount of water in the extracted sand as a function of extraction time raised in DLN-IR- 003- 30&31. Sio Silica states that they have measured the amount of water in the extracted sand from grab samples but does not give the data values obtained. Sio Silica refers to the revised extraction plan submitted on January 24, 2023 but this plan gives no information on the amount of water in the sand. I dispute that Sio Silica has properly answered the request about the amount of water in the extracted sand as a function of extraction time. This data must be forthcoming to assess the severe potential environmental consequences of aerated water returned the aquifer

Sio Silica’s response to the DLN-IR-003c-35&36 about the ability of the slurry loop system to accept a large amount of water from a deluge collected by the French drain system is faulty. Sio Silica responds, *“The French drain system will drain into the water recycling system. This means the first stop of the water is the clarifier, not the slurry line.”* In the request DLN-IR-003c-35&36 I meant that the clarifier is included in the slurry line loop. Returning a large amount of water to the clarifier tank as stipulated in the most recent Sio Silica response is not possible. The rate of return of water from a deluge collected by the French drain system

is estimated in my comments about the notice of alteration on the facility registry to be more than 50 m³/min. The maximum flow rate of the clarifier given in the processing facility EAP is 24.4 m³/min. The clarifier tank has a water overflow at the top to remove the clarified water. The tank must be always full, to this level. The only way a significant quantity of water could be added to the tank would be to increase the flow rate. Increasing the flow rate would decrease the detention time of the clarifier. The detention time cannot be decreased to below design levels. The flow rate to the clarifier could not possibly be raised by 50 m³/min. The inability of the slurry loop system including the clarifier to accept deluge water from the French drain system has been raised repeatedly from April 8, 2021 as documented in the Facility Project registry, and again in the IRs. Sio Silica is still responding inadequately. I dispute the statement by Sio Silica that deluge water from the French drain can be added to the clarifier. The fate of the water from the French drain has serious environmental consequences. Sio Silica's unfeasible plan to add this water to the slurry line loop and clarifier system was to avoid the environmental consequence of releasing this water to the surface. Before the Hearings commence Sio Silica must specify a feasible discharge from the French drain system that would not be detrimental to the environment.

5.0 DLN-IR-007c Process Water Treatment Options Request Disputes

Sio Silica does not respond to DLN-IR-007c-16 request concerning the entry of entrained air into the aquifer from the re-injected water. Sio Silica completely ignores the possibility of entrained gaseous air. Sio Silica has never attempted to measure the amount of entrained air in process water. Instead Sio Silica repeats a response about oxidizing conditions reducing the concentrations of iron and manganese as being beneficial. Dr. E. Pip has shown reduction in iron manganese concentrations results in precipitates that discolour and degrade the quality of drinking water. Thus oxidizing conditions are detrimental with respect to iron and manganese rather than beneficial as demonstrated the submission in the public comments by Dr. E. Pip.

I have also provided evidence that refutes the Sio Silica contention that the sand in the sandstone aquifer would filter the iron and manganese. Furthermore gaseous entrained air would rise into the carbonate through a failed aquitard resulting in iron and manganese precipitation in the carbonate aquifer where there is no sand. Sio Silica will not acknowledge and revise statements that have been shown to be inaccurate.

I dispute the response of Sio Silica to DLN-IR-007c. Sio Silica must measure and report the content of entrained air in process water before the hearing can proceed.

Sio Silica has stated in response to DLN-IR-007 and DLN-IR-007c that water reaming in dewatering vessels and UV filtration vessels would be taken to a treatment facility. Sio Silica has not given the quantity of water that would be moved to facility or identified such a facility. Given the recognized potential or uncertain sources of acid generation such as aquitard shale, shale interbeds, oolite, and concretions, selenium release and heavy metals release, an adequate treatment facility for the Sio Silica water carrying these toxins might not exist. Sio Silica has not measured the process water during extraction activities to determine the level of toxins. Sio Silica must measure the level of acid, selenium, and heavy metals in the process water tanks on surface to determine what type of treatment facility would be required, identify the facility, and ensure that the facility is capable of treating the year end Sio Silica process waste water. I therefore dispute that the response of Sio Silica with respect to the treatment of year end water in adequate. The Hearing should not proceed until Sio Silica has made a full determination about year end water treatment.

Sio Silica states; "*Sio has not said that any chemicals will be used in the filter presses that are being considered.*" I have provided evidence that such chemicals are normally used in filter presses for the coagulation of solids to aid in the pressing. Sio Silica has not determined that chemicals would not be required for the filter press. Sio Silica repeats their policy that "*chemicals aiding in the treatment process*

used commonly for coagulation and flocculation of solids are not allowed.” Sio Silica has not disputed the evidence I provided that sand bed drying of filtrate sludge from the UV filtration process is not feasible. If filter presses cannot be used in lieu of sand drying beds because of the required chemicals, the Project is at an impasse and cannot proceed. Sio Silica must identify to the Hearing the feasibility of use of filter presses without chemicals that could harm aquifer water. I therefore dispute that the Sio Silica response with respect to the use of filter presses is adequate.

6.0 DLN-IR-008c Extraction Well Cluster Design, Limestone and Sand Pillar Stability

The revised extraction plan of Jan. 24 2023 represents a wholesale departure from Document #1 – Silica Extraction Method submitted to the Hearing on June 2, 2022. The revised plan confirms my analysis of the Motion Brief and DLN-IR-008 that 60 meter cavity spans are not viable based on the data from Table 9 of the Stantec report, given in the response to public comments section of the extraction EAP.

Attachment A of the revised extraction plan does not contain information on the revised cluster cavity spans, cluster spacing, the year of extraction and the number of wells for each extraction year. The clusters in Bru 92 area are all one well per cluster. Most of the wells in Bru 83 area are one or two wells per cluster with fifteen wells at three wells per cluster. The size of the dots designating wells are larger as the number of wells per cluster increase but no cluster dimensions are given and no rational or data is given as to the size of the clusters based on the cap rock thickness (limestone). The clusters with two wells per cluster in Bru 83 are primarily east and south of the wells with one well per cluster however the limestone thickness is known to increase in a westerly direction. Thinner limestone should correspond to a decrease in wells per cluster. The eastern most clusters should have a lower number of wells. Similarly in Bru 82 most of the clusters with five wells per cluster are east of those with three or four wells per cluster. Sio Silica must provide the detailed data and analysis that support the number of wells per cluster in the revised cluster design of Attachment A.

Sio Silica should be required to supply the well and borehole data on the limestone and overburden thickness in the Bru areas shown in Attachment A of the revised extraction plan upon which the number of wells per cluster was based. This data is not proprietary. We have already obtained the well information data from Manitoba Groundwater on 44 Sio Silica wells and data from Mines on many Sio Silica boreholes

Sio Silica disagrees with the request DLN-IR008c-2 concerning the Stantec stated recommendation, *“to limit extraction to areas with competent limestone thicker than 15 m.”* Sio Silica states; *“Sio does not agree with the comments made by the author. Sio’s new extraction plan follows the Stantec geotechnical recommendations and model.”* However Sio Silica also states in response to DLN-IR008c-10; *“Sio has since issued a new Extraction Plan and no longer uses the 60 meter span value. This is now irrelevant as Sio has repeatedly acknowledged it would be implementing Table 9’s requirements.”* The statement to limit the extraction to areas with competent limestone thicker than 15 meters is written immediately before Table 9 in the Stantec Report that gives Table 9. There is no statement from Stantec that this recommendation is rescinded. All the well information reports east for Sio Silica wells east of highway 302 show limestone thickness less than 15 meters. The well information reports for Bru 92-8 Bru 92-2 and Bru 92-3 that are closest to area Bru 92 of the revised extraction plan have total limestone total thicknesses of 14.6, 14.0 and 14.2 m respectively. Thus according to the Stantec recommendation the wells in the revised extraction plan of east of highway 302 are not valid.

In DLN IR-008 I questioned the use of the FLAC two dimensional model to determine slope stability of the sand pillars between cavities that have an inherently complex three dimensional geometry. Online information on the FLAC software gives examples of how the FLAC and FLAC/Slope 2D models can be used to represent three dimensional room and pillar geometry.⁶ However the results must be considered

approximate given the inherent simplifications in reducing three dimensional complex geometry of numerous adjacent cavities with sand pillars between to a two dimensional approximation.

The FLAC/Slope software requires input data including bulk modulus, shear modulus cohesion, friction angle and tensile strength of the sand. Sio Silica has given no information on how these data were measured for the sand. Sio Silica must provide the information on the sand samples taken to provide this data and what tests were done and where, to obtain the required data.

Hollander and Woodbury’s concern on the sand pillar stability has not been adequately addressed by Sio Silica. Sio Silica must give revised cluster spacing for the various sized clusters in the revised extraction plan and describe how the spacing was determined based on the FLAC modelling. An illustration of the FLAC/Slope analysis of a 2D pillar stability for a rock cavity that is being progressively mined is illustrated in figure 2.

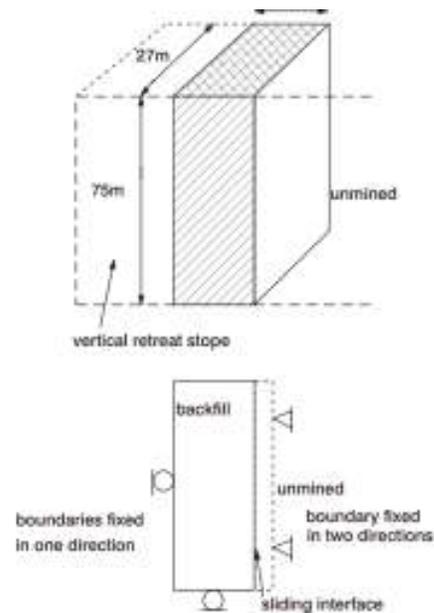
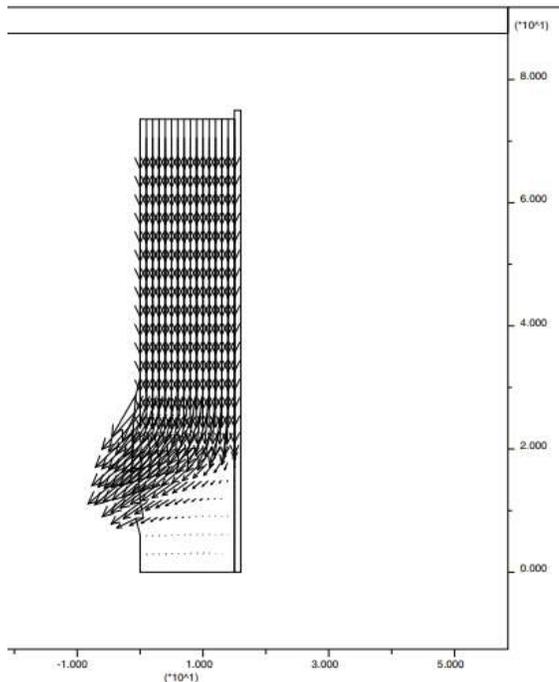


Figure 3.1 Schematic illustrating true three-dimensional backfill pillar geometry and two-dimensional representation

Figure 2. FAC modelling of the slumping of a backfill pillar in a rock mined cavity⁶
https://itasca-downloads.s3.amazonaws.com/software/applied-examples/BackfillPillar_Ex.pdf

It should be noted that the cavity in the illustration is rectangular in shape whereas the cavities from sand extraction would be approximately cylindrical with curved surfaces that would render any 2D approximation more uncertain. Sio Silica should provide a similar illustration for the revised extraction plan including an illustration of the evolution of the sand pillar slumping and the final stable pillar configuration. Such an illustration as shown above need not contain any proprietary information.

The departure from the standard 60 meter cavity span shown in the Sio Silica Document #1 – Silica Extraction Method of June 2, 2022 is a major alteration. Document #1 was issued long after the Stantec Table 9 data given in January of 2022 in the response to public comments of the extraction EAP. That Sio Silica has made a major alteration to the extraction plan of Document #1 at this late date, when the previous data from Stantec Table 9 illustrated cavity spans of 60 meters are not viable, demonstrates that Sio Silica’s extraction plans and methods are not properly established. Sio Silica has provided no data on the revised cluster cavity span other than un-dimensioned size of dots on the attachment A of the revised extraction plan.

Sio Silica must provide detailed data on the size of the cluster cavity span and the method of determination of this span length and cluster spacing based on a revised Stantec geotechnical analysis. Therefore I dispute the response to DLN-IR-008c as being incomplete. This new Stantec analysis for cluster cavity span and cluster spacing must be reviewed by the third Party technical advisors since the technical review of the Stantec analysis for Document #1 is no longer valid.

7.0 DLN-IR-009c Extraction Well Cluster Design and Sealing

I dispute Sio Silica’s response to DLN-I-009c-9 concerning the open unsealed annulus at surface of Bru 92-3 well. Sio Silica does not directly dispute that the outer annulus for well Bru 92-3 has been left unsealed at the surface. The well information report reproduced and illustrated in DLN-IR-009 figure 1b clearly demonstrates this flaw. The illustration of Bru 92-3 is repeated in figure 3.

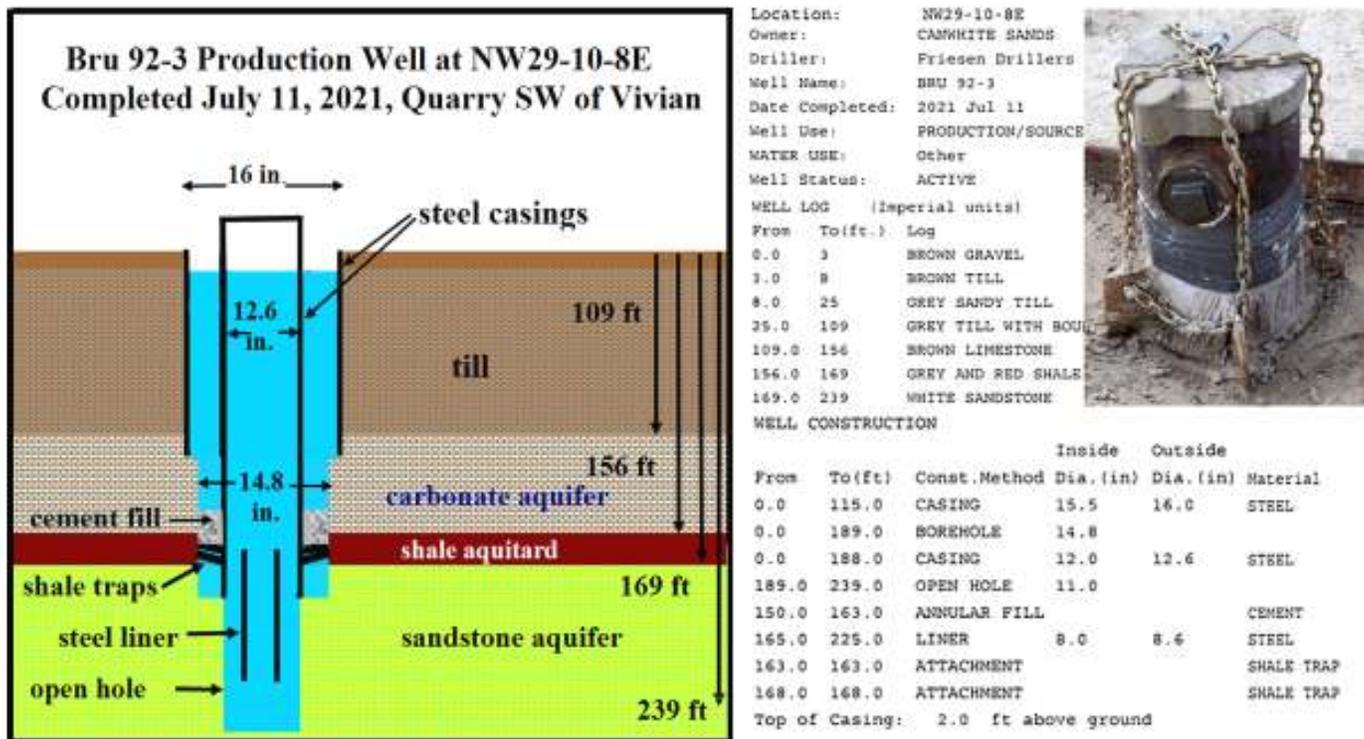


Figure 3. Bru 92-3 production well completed July 11, 2021 at a quarry south west of Vivian. Illustration by D.M. LeNeveu was based on the well information report received from Manitoba Groundwater shown on right. Photograph of well Bru 92-3 was reproduced with permission of photographer.

Sio Silica claims the well sealing complies with the regulations under the Act. Regulation 31 under The Groundwater and Water Well Act (C.C.S.M. c. G110) Well Standards Regulation December 21, 2015 states;

“Surface seal required for annular space

31(1) Subject to subsection 30(3) and except as provided in sections 32 and 33, grout must be used to seal the upper annular space of a well as follows: (b) if the depth of the well casing is greater than 6 m (20 ft), the annular space above 6 m must be filled continuously to the established ground surface.”

Well Bru 92-3 clearly violates the regulation 31(1). Well Bru 92-2 has a temporary shale trap seal at top of the annular space of well Bru- 92-2 as shown in figure 1a of DLN-IR-009. Bru 92-2 also violates the regulation that the space above 6 m must be filled continuously with grout to the established ground surface.

Sio Silica has clearly violated regulation 31(1) for wells Bru 92-3 and Bru 92-2. The open annular spaces for Bru 92-3 and Bru 92-2 connect directly into the carbonate aquifer allowing any surface contamination and fecal matter to enter into the carbonate aquifer. If this has occurred in a small number of test extraction wells it is very likely to occur repeatedly in production when over 300 wells are to be drilled per year. I request that Sio Silica confirm that the surface sealing of wells Bru 92-2 and Bru 92-3 violate the regulations of the Act and immediately properly seal these wells. Strict inspection and enforcement would be required for any further wells drilled by Sio Silica especially if Sio Silica is ever allowed to proceed to production. There are numerous other instances of improper well sealing of Sio Silica wells in the past that have been documented with photographs as shown in the public comments by T. Bell for the extraction project. Sio Silica has claimed without evidence that such unsealed wells were due to vandalism. In fact some of the wells left open in the past had partially welded seals on the pipes extending out of the ground. A vandal would have required a steel cutting torch to open such seals. Sio Silica has demonstrated that they cannot be trusted to seal wells properly. On this basis alone the Project must not be allowed to proceed.

Sio Silica still refuses to give essential data on the water to sand ratio in the extracted sand and the pressure and amount of air compressed during extraction as requested in DLN-I-009c-11. This is critical information that must be supplied in order to determine the risk to the aquifer from heavy metal leaching due to oxidizing conditions from returned water with entrained air and from air pumped directly into the aquifer. Sio Silica maintains without evidence that no air from the airlift tube would enter the aquifer despite the information from the patent that shows the air tube can be lowered directly into the sandstone to loosen sand with air compressed air pulses. The history of the air pressure used during extraction is essential information. If the air pressure greatly exceeds the fluid pressure in the sandstone there is little doubt that air would enter the sandstone directly. Information is given in the patent on the range of cubic feet per minute of compressed air injected and the typical pressure of injection therefore this information is not proprietary and already in the public domain. The data on specific air flow rate, air pressure and water to sand ratio throughout the extraction time for this particular application are essential. I dispute the Sio Silica response to the DLN-IR-009c-11 that this information is proprietary and cannot be released. I request the Hearing to subpoena this information.

I dispute the reasons that Sio Silica gives as in the response DLN-I-009c-12 to why they are not following the Manitoba regulations that require measurement and reporting of well yield information such as; “(i) *method of testing (pumping, air-lifting, bailing, recovery or other method)*, (ii) *water level immediately prior to the start of the test*, (iii) *measured rate of water discharge or estimated rate of water discharge if a measured rate cannot be made*, (iv) *water level immediately prior to the stop of the test*, (v) *duration of the test*.” Note that the requirement includes air lifting wells that Sio Silica uses. This regulation re-enforces that the data I have requested is not proprietary and must be obtained by subpoena from the Hearing if necessary.

8.0 DLN-IR-009c Shale Aquitard Degradation Request Dispute

I dispute the Sio Silica response to DLN-IR-009c-1 concerning the photographs of shale within the extracted sand piles and concerning exposure of geochemical samples to air and weathering. Sio Silica states; “*Pictures of shale do not prove that a shale aquitard would collapse. This is not substantial evidence. Geotechnical investigations and modelling completed under the direction of geotechnical engineers is the industry standard for evaluating stability of the rock mass surrounding any cavities.*” The pictures of large shale fragments in the extracted sand piles provide direct evidence of shale aquitard collapse but not

necessarily prove that it would occur everywhere. Sio Silica is reversing the onus of proof. Sio Silica must prove that photographs of large fragments of shale in the extracted sand do not provide evidence of shale aquitard collapse. How else could such large fragments with intact layering that can be picked up by hand have got there?

The geotechnical engineers of Stantec stated in Table 1 of their report in the response to public comments section of the extraction EAP that the shale aquitard is not supporting. Thus the geotechnical engineering study does give evidence that the shale aquitard is not a supporting member and therefore would be subject to collapse. The Arcadis third party technical review stated, “Based on the geotechnical information presented, as well as technical discussions with Sio Silica (6 September 2022) it is understood by Arcadis that the shale aquitard has the potential to collapse into the sand extraction.” Arcadis conclusion#5 identifies shale aquitard collapse as a critical failure mode. I assert there is conclusive evidence from geotechnical experts including Stantec and Arcadis that shale collapse would occur.

Sio Silica states; “The carbonate, shale and sand samples were collected, documented, handled and shipped to the laboratory a per standard solid phase sampling standards described in Price (2009) and MEND (2001).” I have provided conclusive evidence in DLN-IR-002c Process Water Re-injection Request Disputes above using Sio Silica’s provided references that; Sio Silica has given no evidence that the core samples were air dried at temperatures no higher than 40 C and that prior to after drying the samples were kept cool. Sio Silica provides no evidence of freezing the samples before drying and maintaining anaerobic conditions by storing under nitrogen gas. The guidelines provided by Sio Silica show that my stated concerns about oxidation of the samples by air exposure are valid. The references Sio Silica provides confirm the handling and storage of Sio Silica core samples was inadequate.

Sio Silica states; “The sand pile from which the Bru 94-3 sand sample was taken was covered by tarp and not exposed to weather for an extended period of time.” This statement is false as shown by the evidence given in my public comments for the processing facility of the uncovered sand piles south of Vivian shown in figure 17 of the public comments report. The sand for the Bru 94-3 sample was extracted from wells at Vivian in June of 2019. The tarp was placed over the exposed sand piles following a complaint of June 28, 2020 to Manitoba Workplace Safety and Health that ATV operators and passers by were being exposed to silica dust from the sand piles. The photographs below confirm these statements.

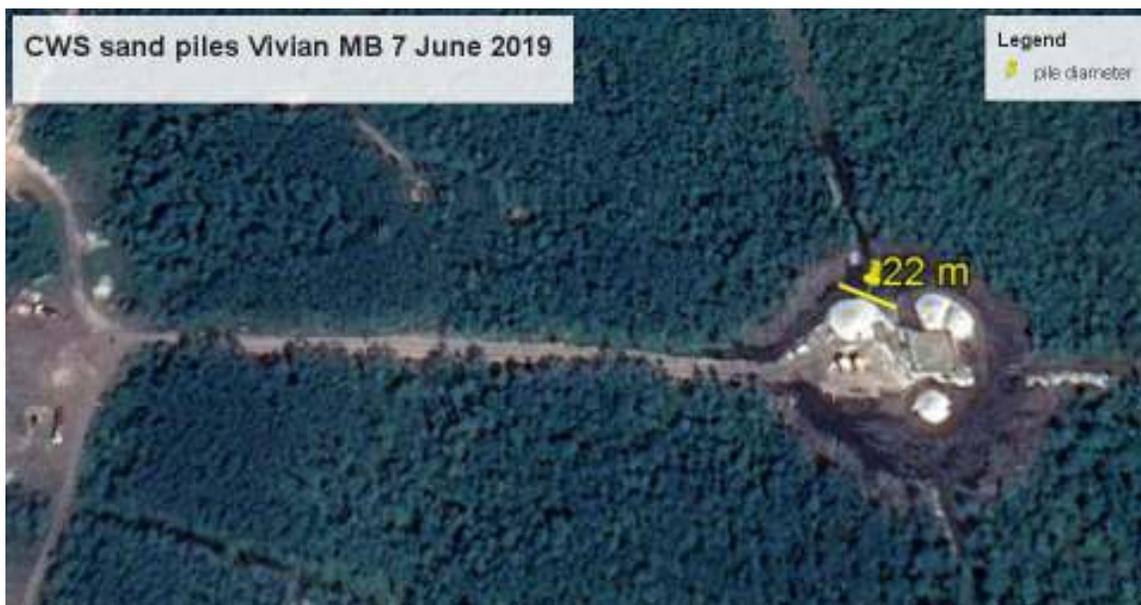




Figure 4. Google Earth image of original Sio Silica extracted sand piles and photographs of the Sio Silica silica sand piles taken June 7, 2020 (left) and Nov.14 2020. *The photographs are reproduced with the permission of the photographer.*

Sio Silica makes many statements to assert that oxidation of pyrite and marcasite would be very slow in the samples taken but gives or evidence no references to support these statements. These statements contradict the MEND sample handling guidelines reproduced in DLN-IR-002c that are designed to prevent air oxidation of samples. Why are such guidelines to prevent oxidation such as keeping the samples under nitrogen, keeping the samples frozen or cool and drying the samples recommended if oxidation of sulphides was not a problem? I have given references in my public comments that were repeated in the IRs that show significant sulphide oxidization in core samples can occur over several months. I repeat the references given in DLN IR-011 here; *“A further reference by Basu et al. (2000) describes methods to prevent oxidation of shale samples including airtight containers and refrigeration at 4 degrees. A reference, König et al. (2000) documents the oxidation of pyrite in core samples that are exposed to air during storage reporting, Massive Fe(II) to Fe(III) oxidation, which involved between 24% and 45% of the initial Fe(II), occurred within only 6 months of refrigerated storage.”* Sio Silica has not disputed the findings of these references.

Sio Silica states that; *“HCL extractable sulphate sulphur content were below the detection limit in all samples precluding sulphide oxidation in the majority of samples.”* However Appendix A Part 4 of the EAP in Table 4-4 gives the carbonate extractable sulphate of three shale samples as ranging from 0.06 to 0.12%.

The very fact that Sio Silica has not followed the MEND sampling guidelines is enough to invalid the geochemical results. Sio Silica given this evidence must acknowledge that the geochemical sample handling was inadequate and must be redone. The Hearing must be delayed until the results of new comprehensive geochemical sampling are done and the results reported.

I dispute the Sio Silica response to DLN-IR-011c-6 concerning the mobility of precipitates of iron and manganese in the carbonate and sandstone. Sio Silica states without references or evidence; *“Iron and manganese oxide/oxyhydroxide that may form as a result of oxidation will precipitate out of the solution and are not expected to migrate through the aquifer to a domestic well. These solid mineral phases would precipitate relatively rapidly following interaction with any oxygen which is only likely to occur in proximity to extraction wells. Solid particles are not typically mobile in aquifers because they are present in a solid form that is denser than water and therefore settle. Further, groundwater flow velocities are very slow and are not usually high enough to entrain solids.”* Sio Silica ignores the scenario where gaseous air from the returned water and leakage from the production tube or direct injection of air to loosen sand would rise rapidly into the carbonate. The air would enter the karst and precipitate iron and manganese that would move rapidly in the karst water to domestic wells. The water in the sandstone would be agitated from the returned water and by water and sand movement into the extraction well. Iron and manganese precipitated would be easily suspended in this water. An industry paper states; *“Sometimes oxidized iron forms very fine solid particles typically between 0.1 and 0.001 micron in diameter. This ultra-fine iron is often paired with anions in the solution or organic material. The small size of these particulates renders most conventional filters ineffective.”*⁸.

I dispute the Sio Silica response to DLN-IR-011c-15 concerning references to the sand from the Wanipigow Project. Sio Silica claims that the sand at Wanipigow is from a different geological member although the sand was laid down in the same Ordovician age under the same environment at both locations. Sio Silica repeatedly claims that the sand near Vivian is from a separate Carman sand member. Sio Silica ignores the evidence I presented in the public comments for the extraction project that the Carman member is further south as shown by the Energy and Mines Bedrock Geology Compilation Map Series shown again below.⁹

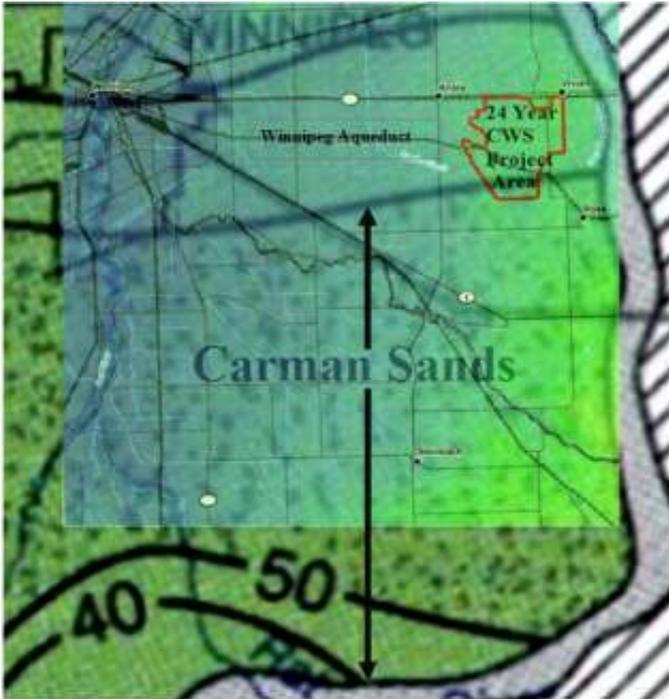


Figure 4. CWS 24 year project area overlaid on the map of the extent of the Carman sands (green speckle area) south of Vivian MB.

Figure 5. Carman sands area. *Reproduced from page 8, Questions for CanWhite Virtual Open House for the Vivian Sand Extraction Project and Hydrogeological Report by D.M. LeNeveu, Aug. 20, 2021, public comments received (1) – posted November 15, 2021 public registry 6119.0.*

Sio Silica claims the shale at Vivian is more weathered than at Wanipigow even though some of the sand outcrops at Wanipigow and the shale is therefore near surface and much more prone to weathering than at Vivian. Sio Silica continually quotes they are following industry standard methods that may be from other projects that are inapplicable. Sio Silica uses information from other projects if it supports their proposal. To properly evaluate this Proposal, information from other applicable Projects or situations can and must be used since so little information is supplied for this Project and this Project has not yet been implemented. Using information and data from other sources is standard and accepted practice. When I participated in the Seaborn Panel Environmental Review of the Canadian Concept for Canada’s Nuclear High Level Nuclear Waste we continually used applicable information from other projects such as the Swedish SKB nuclear waste disposal project.¹⁰ I therefore claim that results from Wanipigow are relevant and must be considered.

Sio Silica in response to DLN-IR-011c-15 states; “As documented in DLN-IR-007 (1) and DLN-IR-003 (2), the author is utilizing a reference claiming there is a concern for environmental impacts when there is none listed, or a reference in the wrong circumstance, or the situation is not applicable or comparable to Sio’s project.” Sometimes the url for a reference changes. However I checked the references stated by Sio Silica to be faulty. The references are still available and are relevant.

I dispute Sio Silica's statement in DLN-IR-011c-24 that; "*Details about chain of custody for test well data are irrelevant to the issues before the CEC.*" The inadequate chain of custody information for samples from wells Bru 121-1, Bru 146 and Bru 95-3 demonstrate that the samples were exposed to air much longer than indicated in the chain of custody forms. Accurate geochemical information is central for the CEC determination of the environmental effects of this Project.

Sio Silica states in response to DLN-IR-11c-25 concerning selenium leaching from the shake flask tests; "*It is not possible to predict leachable selenium concentrations from the solid phase concentration. The leachability of a metals depends on several parameters including but limited to concentration, pH, oxidation-reduction conditions, salinity, solubility limit, hydrogeology, etc., and most of these parameters were not considered in the calculation.*" The shake flasks tests are done in de-ionized water thus are not representative of the field conditions. However these tests are meant to determine if there can be a leachability problem. The tests are standard and would not be done if they are of no value. The onus is on Sio Silica to demonstrate that leaching of heavy metals would not be a problem. For instance Sio Silica should have reported results from the PHREEQC code on selenium equilibrium concentration under oxidizing conditions just as the iron and manganese concentration were reported. Until the shake flasks tests and calculations I reported on toxic levels selenium can be discounted they must be considered to require mitigation. The Hearing should not commence until indications of toxic levels of selenium occurring in aquifer waters and in the oxidizing conditions in the slurry line and surface vessels whose water would be returned to the aquifer is resolved.

I dispute the Sio Silica response to DLN-IR-11c-26 concerning gaseous air form the production pipe entering the aquifer. Sio Silica states; "*The majority of the air injected into the production pipe will return to surface.*" This is a departure from the previous statements by Sio Silica that no air would enter the aquifer from the production pipe. Sio Silica now admits that some air from the production pipe could enter the aquifer but has not quantified how much. How much air may enter the aquifer from the production pipe is a critical value that must be determined considering the oxidative release of acid, selenium and heavy metals that could occur in the aquifer due to the presence of the shale aquitard, shale interbeds, concretions and oolite. For instance the patent document states the flow of air would range from 300 to 600 cubic feet per minute. The number of compressors is unknown. Using 7 compressors, one for each extraction rig that would be running simultaneously for about 240 days per year the volume of compressor air would be $7 \times 450 \times 60 \times 24 \times 240 = 1089$ million cubic feet or 30.8 million cubic meters of air per year. From DLN-IR-002c above it was shown 41212 m^3 of entrained air in the returned water could contaminate 110 million cubic meters of aquifer water to a pH of 6.0 from sulphide oxidation. To contaminate the same amount of aquifer water would require a leakage of only 0.133% of the air sent into the production pipe. Sio Silica has never come to terms with how much aquifer water a tiny fraction of air leaking from the production pipe could contaminate. This simple calculation shows this entire process is not feasible. Sio Silica simply cannot guarantee there would be much less than 0.1% leakage of compressed air into the aquifer. The Hearing must be delayed until Sio Silica is able to specify a means to mitigate the effect of even a tiny leakage of compressed air into the aquifer.

I dispute the Sio Silica response to DLN-IR-11c-27 concerning entrained air in the surface tanks and vessels. Sio Silica states; "*Entrained air will be allowed to exsolve to the atmosphere in open tanks at ground surface.*" The open tanks shown in figure 1 of DLN-IR-002c would be entraining more air from the expanding water and sand jet entering the frac tank and the action of the plunging jet. Movement of the water from a main frac tank to other tanks down shutes would entrain more air. The screening procedure to remove overs and fines involves turbulent water that would entrain more air. The hydrocyclones downstream of the frac tanks would entrain air from the air core shown in figure 6 of DLN-IR-002. The vessels for the UV filtration of water shown in the technical memorandum for Process Water Treatment Options are closed not

allowing entrained air to escape or have turbulent flow that would entrain more air. The UV filtration and return pipes to the aquifer would be closed.

Sio Silica states; “Detailed design of the civil infrastructure, tankage and water treatment system will consider incorporation of degassing infrastructure to further reduce the quantity of entrained air in reinjected water.” This statement is an admission that methods to eliminate entrained air are a necessity that has not been included in the EAP. Methods to remove entrained air are complex and costly and may not be feasible for the large throughput of water in this Project.¹¹ Removal of entrained air would require a major project alteration, revision of the EAP and review by the TAC, public and third party technical experts. The Hearing must be delayed until a detailed plan is submitted by Sio Silica on the removal of entrained air.

9.0 Conclusion

The Hearing must not proceed until all the issues resolved in this compilation of disputes concerning the DLN-IRc requests for clarification are resolved.

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