Brief Supporting the Motion for Six Material Actions to be completed by Sio Silica and Section 35 Indigenous Consultation to be held before continuation of CEC Hearing

by

D. M. LeNeveu, M.Sc. Bsc.(hons. physics), B.Ed., former Member of Canadian Society of Safety Engineering

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The two motions submitted by the participants S. McCrea representing What the Frack Manitoba and D.M. LeNeveu are;

1. An Order directing Sio Silica Corporation (the "Proponent") to complete the table 1 list of six material Actions rectifying the material deficiencies in its Application identified in the "Hydrogeology Technical Review", "Geotechnical Technical Review" Reports and "Public Comments Received From Don Sullivan and D. M. LeNeveu of What the Fack Manitoba and other public comments for the Silica Sand Extraction Project Environment Act Proposal – File No. 6119.00" and complete and file documentation of the six material actions materials prior continuation of the Hearing.

2. Delay or suspension of hearings by the CEC until completion of Section 35 of the Canadian Constitution Indigenous Consultation to be conducted by Manitoba Natural Resources and Northern Development.

The six material actions to be completed by Sio Silica before commencement of the Hearing and supporting references for the actions are given in the table 1.

Table 1. Six Material Actions

	Material Action	References
1	Pilot field tests of the treatment options for the removal of suspended particulate in process water for the UV treatment process and for disposal of wastewater and solids. Measurement of pH, dissolved oxygen, entrained air, amount of suspended and dissolved contaminants including heavy metals, and organics in the water separated for re-injection into the aquifer.	Sio Silica Supplemental Filing #3 Process Wastewater Treatment Options, Technical Memorandum by Matt Kowalski, PhD, P.Eng. Process Engineer, June 24, 2022 recommends; "*Due to uncertainty in the settling ability of the solids and unique characteristic of the wastewater it is recommended to pilot some of the recommended treatment options in order to assess the efficiency of the equipment treating the process water before proceeding with final equipment selection. It is especially recommended to pilot trial test the hydrocyclones and mobile/lamella clarifiers*."
2	Full scale field test of the latest Sio Silica well cluster design including, side sonar scans of the excavation cavity as a function of time for up to three months after the sand extraction, measurement of total sand extraction, total water extracted and as a function of extraction time, amount and location of air injection within production casing and directly into sandstone formation, water pressure measurements as a function of time at the top of the sandstone aquifer and in the carbonate aquifer during extraction, nearby test well	Arcadis Canada Inc., p.14, "*Completing full scale extraction tests to confirm performance prior to advancing the full Project*" Injection Well Permit # 2021.01.1 July 16, 2021, Manitoba Agriculture and Resource Development Water Branch for two injection wells Bru 92-8 and Bru 92-2 Condition 7: "*The injection well will be continuously monitored to ensure the*

	water quality and microbial measurements before and after sand extraction at various distances from the well cluster, noise measurements as a function of distance from the extraction wells when all five extraction wells are operating, measurement of microbial content and organic content including diesel fumes, benzene, PAHs in injected air, and measurement worker's respirable silica dust exposure using silica dust personnel monitors and area monitors.	*formation is not over-pressured*." Condition 8: "*The use of the injection well must cease immediately if any local water supplies are negatively impacted as the result of the use of the injection well*." Arcadis Canada Inc. comments on noise, microbial contamination from air and water injection.
3	New three dimensional geotechnical modelling of the latest Sio Silica design for well clusters and silica sand extraction. The modeling must include slope stability and potential liquefaction of the supporting sand pillars between excavation cavities, the potential collapse of the carbonate aquifer and the collapse of the shale aquitard. The modelling must take into account the effect of asymmetric excavation on the sand pillar stability and evaluate the potential stability of all well clusters over the entire 24 year project area taking into account the geological information from all Sio Silica Manitoba Groundwater Section well information reports of glacial till overburden, limestone and shale aquifer thicknesses and the documentation in the public comments by What the Frack Manitoba that all limestone thicknesses in Sio Silica wells east of highway 302 are less than the Stantec stability limit of 15 meters. The Sio Silica well information reports are available from What the Frack Manitoba or the Manitoba Groundwater Section. Additional well logs for Sio Silica EIS Hydrogeological Report are documented in the project registry 6119.00	Sand pillar stability: Hollander and Woodbury p. 7, 24 "*It also assumes that the limestone bridging material remains intact but does not mention if the sandstone itself may liquify and flow into the voids that are created by the mining operation. There is some indication this would occur (Betcher et al., 1995)*." Shale aquitard collapse: Arcadis Canada Inc., Executive Summary, p.16-17, conclusion #5 Asymmetric excavation – Arcadis Canada Inc., memo p. A-4 "*The results of the trial work did report a different cavity expansion with the BRU 92-8 having a cavity expansion in a SW/NE direction*." Silica Sand Extraction Project-Environment Act Proposal – File No. 6119.00 Public Comments Received From Don Sullivan p. 10-15
4	New state of the art three-dimensional hydrogeological and contaminant transport modeling of the full scale sand mining operations including using point source water injection at the top of the sandstone aquifer to model 100% re-injection of water and simultaneous point source withdrawal near the bottom of the aquifer to model sand and water extraction for the number of wells to be operating simultaneously in a well cluster. Transport of dissolved and entrained air, iron and manganese precipitates, dissolved selenium, acid, heavy metals in the sandstone and carbonate for a collapsed shale aquitard must be modelled The model must include the initial conditions of hydraulic head and ongoing recharge that is responsible for the initial hydraulic	Holländer and Woodbury hydrogeology report p.5 "*None of the analysis investigated groundwater quality changes due to the mining operations*" Appendix A Notice of Motion of the Manitoba Eco-Network and Our Line in the Sand Silica Sand Extraction Project Environment Act Proposal – File No. 6119.00 Public Comments Received From Don Sullivan and D. M. LeNeveu p. 17 "*The groundwater model simulations using the finite-element code FEFLOW v.7.3 were unrealistic. Only zero and fifty percent re-*

	head distribution, heterogeneity of material properties, sensitivity studies with respect to model boundary conditions, hydraulic properties within the excavation cavity consistent with sand removal, salinity induced dependent flow, migration of saline waters into freshwater zones east of the Red River and other necessary hydrogeology modelling conditions documented in the hydrogeology technical report of Holländer and Woodbury.	*injection of water was modelled. The fifty percent re-injection scenarios were actually drawdown simulations with about ½ the withdrawal pumping rate of the zero percent re-injection. No water re-injection actually occurred either in the modelling or in the field tests.*"
5	Comprehensive geochemical re-testing of the glacial till overburden, carbonate aquifer, shale aquitard and sandstone aquifer throughout the entire 24 year project area using at least 30 separate samples from representative locations. The samples in the sandstone must include silica sand, interbedded shale, oolite and concretions. The samples must be protected from air exposure and analyzed as soon as possible after collection. Air lift methods must not be used to extract samples as this exposes the samples to air that may oxidize any sulphide in the samples during extraction. Sonic drilling methods may be required to obtain samples from unconsolidated sandstone. Acid base accounting tests, trace metal analysis, shake flask tests and other comprehensive geochemical tests must be done on all samples. The sulphide sources in the sandstone aquifer such as concretions, oolite and interbedded shale that were not analyzed for the Sio Silica Hydrogeological Report of the EIS are documented in primary references of Watson (1985) and Schieber and Riciputi (2005) and in the public comments from What the Frack Manitoba in the project registry 6119.00.	Holländer and Woodbury, p. 9 "*The analysis for acid mine drainage, aqueous geochemistry and stable isotopes were carried out at one location only and limited samples (e.g., related to acid mine drainage) were taken*." Holländer and Woodbury, p. 42 "*Some of the samples (Winnipeg Sandstone) were even grab samples from a stockpile (p. 34). Such sampling is inadequate to be used for the geochemical analysis described later on*." Silica Sand Extraction Project Environment Act Proposal – File No. 6119.00 Public Comments Received From Don Sullivan and D. M. LeNeveu p. 2-9, p. 15 and 16 Pyrite and Marcasite Coated Grains in the Ordovician Winnipeg Formation, Canada, Jurgen Schieber and Lee Riciputi, Journal of Sedimentary Research, 2005, v. 75, 907–920, https://www.semanticscholar.org/paper/Pyrite-and-Marcasite-Coated-Grains-in-the-Winnipeg-Schieber-Riciputi/c7260c14eefc435745019d169ed8f741ed4da6df Economic Geology Report ER84-2 Silica in Manitoba By D.M .Watson Manitoba Energy and Mines Geological Services Report, 1985 http://www.manitoba.ca/iem/info/libmin/ER84-2.pdf
6	Under the topic of accidents and malfunctions, not included in the Sio Silica EIS submissions, modelling of the accumulation of the highly toxic polyacrylamide monomer, selenium, acid, and heavy metals in the recycling slurry line loop loaded at the silica sand extraction site. The methods established in a study of polyacrylamide monomer accumulation in	Technical Memorandum, Great Plains Sand, T.Holstrom, March 9,2012 https://www.scottcountymn.gov/DocumentCenter/View/880/Exhibit-M-PDF?bidId= Silica Sand Extraction Project Environment Act Proposal – File No. 6119.00 Public

	the Great Plains Sand Plant of Jordan Minnesota closed loop system can be used for the modelling. The modeling must include the effects of injection into the slurry loop of drainage water from the French style drain under the sand stockpiles at the processing plan documented in the NOA and public comments on the NOA of April 8, 2021 in project registry 6057.00. The consequences of a malfunction associated with a large deluge and the subsequent transfer of collected drainage water from the French drain style system into the recycling slurry line loop must be analyzed. The consequences of a malfunction allowing backflow from the slurry line into the aquifer water re-injection system must be assessed. The presence of dissolved selenium (selenate) in the solids transported in the slurry line has been established in the Sio Silica Hydrogeological Report on the project registry 6119.00. The presence of shale fragments that can generate acid and heavy metals in the transported slurry line solids has been established by the documentation of the potential collapse of the shale aquitard in the Arcadis and the Holländer and Woodbury technical reports. The presence of other sources of sulphides that would generate acid and heavy metals in the silica sand transported in the slurry lines has been documented in Public Comments received from Don Sullivan and D. M. LeNeveu in the project registry 6119.00 and in the primary references of Watson (1985) and Schieber and Riciputi (2005)	Comments Received From Don Sullivan and D. M. LeNeveu p. 9-10 "*A spill from the Sio Silica slurry lines that would carry selenium, fluoride, arsenic, other toxic heavy metals, and harmful microbes could drain into fish-bearing water bodies such as the Brokenhead River and Cook's Creek. The slurry line would be expected to carry the extremely toxic acrylamide monomer from the clarifier tank. The contaminants would be ever increasing in the slurry lines as water is recycled and fresh extracted sand and flocculent is added to the slurry line and the recycled water loop*." Arcadis Canada Inc., p 26, Conclusion #14 "*The Project Proposal and supporting documents do not include an assessment of impacts that would be caused by accidents and malfunctions*." Public Registry 6057.00 Vivian Sand Processing Facility Sio Silica Corporation Proponent Response and Public Comments filed on Notice of Alteration Apr.8, 2021 and Notice of Alteration Feb. 16, 2021

Additional information to support the two motions submitted is given below.

1. Pilot field tests of the methods to remove suspended material in the UV treated water and measurement of suspended and dissolved material and microbes in the water to be re-injected to the aquifer following UV treatment.

The recommendation by Matt Kowalski, author of the Sio Silica Supplemental Filing #3 of June 24, 2022 establishes the requirement for pilot testing of the process wastewater treatment options. Dr. Kowalski recommends;

"*Due to uncertainty in the settling ability of the solids and unique characteristic of the wastewater it is recommended to pilot some of the recommended treatment options in order to assess the efficiency of the equipment treating the process water before proceeding with final equipment selection. It is especially recommended to pilot trial test the hydrocyclones and mobile/lamella clarifiers*."

The pilot testing must include measurement of the process water quality to be re-injected into the sandstone aquifer following treatment. Suspended and dissolved contaminant concentrations including, total suspended solids, including iron, manganese, organics and remaining sand fines, total dissolved material including selenium, heavy metals, acid, benzene, PAHs, chitosan monomer (glucosamine), and other dissolved organics, dissolved oxygen, entrained air, and total microbes including fungi and fungal spores must be measured in the process water and reported before and after treatment.

The amount and properties of all waste streams for the process water treatment must be recorded and determined as a function of the amount of sand extracted. Comprehensive geochemical testing and contaminant content of the waste streams must be completed and reported.

The pilot testing of the process water treatment must be done in conjunction with the field testing of silica sand extraction described in material action 2.

The concentration of respirable silica including PM10 and PM2.5 particulate must be measured at intervals within and around the sand drying beds. Data from personal respirable silica dust monitors for all workers must be reported.

All measurement data must be publicly available.

The email of July 4, 2022 from Duncanson Sander of Osler Law representing Sio Silica sent to the project public registry 6119.00, requests that the supplementary filing for process water treatment options be uploaded to the registry. The extensive UV filtration procedures, drying bed operations, and disposal of waste sludge from UV filtration constitute a major project alteration. The online posting from Environment, Climate and Parks, Permits, Licences & Approvals, Environmental Assessment and Licensing titled Licence Alterations states:

"*Proponents or licencees are required to notify the Director of the Environmental Approvals Branch when an alteration to a project is contemplated. Information on the alteration is needed so that the Branch can determine whether the alteration involves significant environmental effects. If significant effects are anticipated, the proponent or licencee will be required to file a new proposal, providing the public and the Technical Advisory Committee with an opportunity to review the altered project.*"

The Notice of Alteration for Process Wastewater treatment Options has not as yet been posted on the public registry 6119.00 for the project. However the proponent is required to notify the Director of this alteration. An alteration of this magnitude would certainly involve significant environmental effects requiring the filing of a new proposal and new public and the Technical Advisory Committee comments and proponent responses to the comments.

We assert that Sio Silica must issue to the Director a Notice of Alteration for the Process Wastewater treatment Options that must be posted on the project registry. The Notice of Alteration must contain a detailed plan for pilot testing in conformance with the recommendation by the author of the process water treatment options supplementary information, Matt Kowalski, PhD, P.Eng, issued on June 24, 2022.

Following determination by the Director whether the alteration involves significant environmental effects Sio Silica may be required to file a new proposal and respond to comments from the TAC and the public.

The evidence presented here establishes that the Hearing must not continue until completion and documentation of the pilot testing.

2. Full scale field test of the Sio Silica well cluster design

Full scale field testing as established on page 14 of the Arcadis technical report must be done for a Sio Silica cluster design. The cluster design must be based on new geotechnical modeling as specified in material action 3.

In addition to the actions specified in the table 1, Sio Silica must field test remedial measures to stabilize the shale aquitard above the extraction cavities to address Arcadis critical conclusion #5. Remedial measures may involve grouting of the aquitard over the entire cavity opening. The effectiveness of this remedial measure must be monitored using side scan sonar and/or test boreholes over a significant time period of at least three months. The shape of the extraction cavity of the well cluster must be determined and reported.

The water pressure in the sandstone and carbonate aquifers must be measured and reported at intervals around the extraction wells and the well cluster during sand extraction and water re-injection as required by injection well permits. The maximum allowable formation water pressures must be determined and the method of and data for of this determination documented. The allowable formation pressure must take into account the potential collapse of the shale aquitard including the effect on allowable pressure of remedial action such as grouting.

The volume of sand and water extracted as a function of time and the sand to water ratio must be measured and reported. The volume of water re-injected as a function of time and the sand to water re-injection ratio must be measured and reported. From these values the total yearly loss of water from the aquifer must be determined. Sio Silica must determine if this total yearly loss of water is sustainable for the Sandilands aquifer taking into account all other water withdrawals from the regional aquifer.

The volume and pressure of air injected as function of time must be measured and reported. The volume and pressure of air injected directly into the sandstone when the air tube is outside of the production pipe must be documented and reported.

The size shape and configuration of the well extraction casings must be reported including the production casing. A record of the movement and position of the production casing and the air tube with respect to the production casing as a function must be recorded and reported

An industry report by M. White, Parker Company Compressed Air Treatment Manager provides conclusive evidence for the requirement for measurement and remediation of contaminants that would be injected into the sandstone aquifer during airlift extraction.[1] Oil, vaporized from the oil breather, would be sucked into the compressor and concentrated. Therefore the air output from oil free air compressor is not oil free. Exhaust vapours from nearby diesel powered drill rigs and Sio Silica vehicles, slurry line handling equipment and vacuum trucks would be drawn into the compressor and concentrated. According to the white paper the concentration of vapours is a factor of 8, at 7 bar compression and a factor of 40, at 40 bar compression.[1] The limit of carcinogenic benzene, in water is 5 parts per billion.[3] Benzene along with other harmful hydrocarbons is present in diesel exhaust.[4]

Harmful microbes that survive the very short duration of heating in the air compressor would be injected into the sandstone aquifer.[2] The potential for injected air to remain in the production pipe will not alleviate this problem. Water entrained in the extracted that is to be re-injected into the aquifer would contain dissolved contaminants drawn into the compressor that would not be removed by the UV filtration system. These contaminants would be re-injected with the treated process water into the sandstone aquifer. Remediation measures to remove contamination from the air lift system must be specified and tested in the field by Sio

Silica.[1,2] This critical aquifer contamination pathway was not included in the EAP and has not been addressed by Sio Silica.

Remedial methods for compressor air contamination such as filtration must be specified and tested. Details on characteristics of air filters, the number of filters, the changing or cleaning frequency, and the disposition and volume of waste filters or cleaning effluent must be provided. Measurement of contaminant and microbe content of the injected air after remediation must be completed and reported by Sio Silica in the field testing.

Water quality in both aquifers must be measured and reported before and after field testing. Determination of water quality must include measurement of the concentration of suspended and dissolved contaminant concentrations including, including iron, manganese, total organics, selenium, heavy metals, acid, benzene, polyaromatic hydrocarbons (PAHs), major ions, glucosamine, dissolved oxygen, entrained air, and total microbes including fungi and fungal spores.

Noise measurements as a function of distance from the extraction wells when all five extraction wells are operating must be made and reported by Sio Silica. The noise measurement must be made with all remedial measures in place.

Sio Silica must issue on the project registry a Notice of Alteration for the full scale field test for silica sand extraction and remedial methods for shale aquitard stability and purification of injected air. Depending on a decision by the Director Sio Silica Sio Silica may be required to file a new proposal and respond to comments from the TAC and the public on the field test extraction and remedial methods for shale aquitard stability and air injection purification.

The evidence presented here establishes that the Hearing must not continue until completion and documentation of the full scale field test of the Sio Silica well cluster design and associated required measurements.

3. New three dimensional geotechnical modelling of the Sio Silica design for well clusters

Evidence presented from forty-four well information reports obtained from the Manitoba Groundwater Section and the Stantec Geotechnical Analysis - Public Version in the project registry, demonstrates the Sio Silica well cluster design is not viable over the entire twenty-four year project area.

According to the data from Table 9 in Attachment A of Geotechnical Analysis for Sio Silica Extraction Project - Public Version in the proponent response to public comments on the project registry 6119.00, the long-term allowable limestone unsupported span diameter, *S*, for the Sio Silica cavities created during sand extraction can be conservatively represented by equation 1;

$$S = 1.5(L-15) - 0.3(O-25) + 35 \quad (1).$$

The Stantec maximum allowable long-term cavity spans and the values calculated from equation 1 are compared in Table 2.

Table 2. Stantec and calculated long-term allowable limestone unsupported cavity span

Competent Limestone Thickness (m)	Overburden Thickness (m)	Long-term Allowable Limestone Unsupported Span (Diameter) (m)	Equation 1 Calculated Long-term Allowable Limestone Unsupported Span (Diameter) (m)
15	25	35	35
15	35	32	32
20	25	43	42.5
20	35	40	39.5
25	25	50	50
25	35	47	47

Table 2 confirms the accuracy of equation 1 in determining the long-term allowable extraction cavity span for any overburden (glacial till) and limestone thickness.

Equation 1 applies for limestone thickness greater than or equal to 15 m, the minimum allowable limestone thickness determined by Stantec. *L* is the limestone thickness in meters. *O* is the overburden thickness in meters. Using this equation the maximum allowable span diameters have been determined for the data obtained from the Manitoba Groundwater Section from 44 Sio Silica extraction wells over the 24 year project area as shown in the figure 1 below.

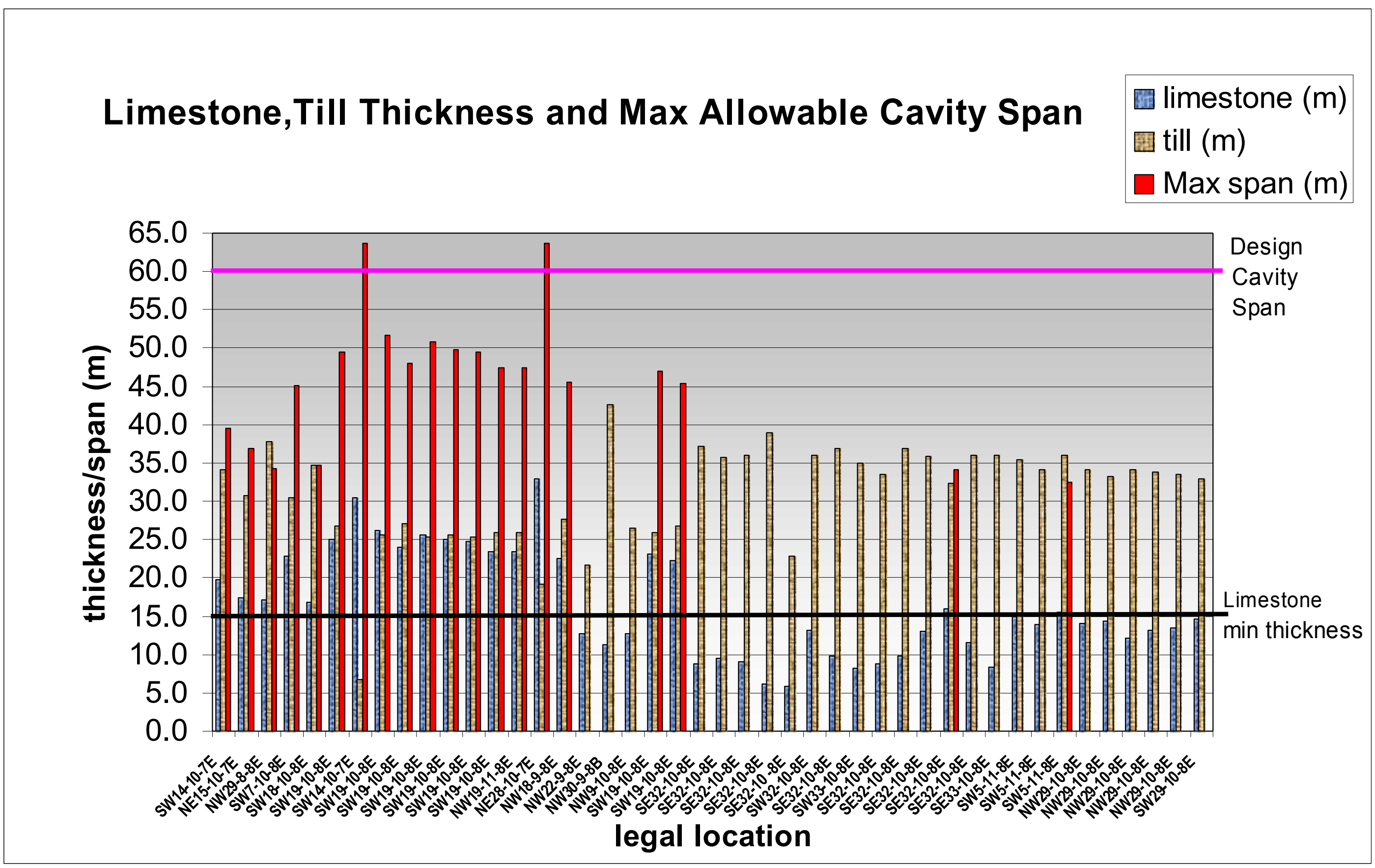

Figure 1. Limestone and till thickness and maximum allowable long-term excavation cavity span over the Sio Silica 24 year project area.

Figure 1 illustrates almost all the limestone thicknesses in the entire region east of highway 302 determined from the Sio Silica wells are less than the Stantec specified minimum thickness of 15 meters required for the well clusters. Therefore no Sio Silica sand extraction can occur east of highway 302. In the remaining Sio Silica project area the maximum allowable span limits except in two locations as shown in figure 1 are below the extraction well cluster design span of 60 meters. Thus according to the Stantec analysis, the well cluster design given in Sio Silica supplemental information Document #1 – Silica Extraction Method of June 2, 2022 is invalid and cannot be used.

The data of the till and limestone thicknesses and depth of interbedded shale layers in the sandstone obtained from forty-four Manitoba Groundwater Section Well Information Reports are given in table 3.

Table 3. Limestone and till thickness and interbedded shale depth in the sandstone aquifer for Sio Silica wells in the 24 year project area

Well PID	Well name	Legal	Limestone thickness (ft)	Limestone thickness (m)	Till thickness (m)	Till thickness (ft)	Interbedded shale depth (ft)
197860	BH 10-17	SW14-10-7E	65.0	19.8	34.1	112.0	190-335
197858	BH 14-17	NE15-10-7E	57.0	17.4	30.8	101.0	
203674	BRU-154-2	NW29-8-8E	56.0	17.1	37.8	124.0	
197923	BH2-17	SW7-10-8E	75.0	22.9	30.5	100.0	253-232
197862	BH3-17	SW18-10-8E	55.0	16.8	34.7	114.0	237-277
200818	SITE 1 82-9	SW19-10-8E	82.0	25.0	26.8	88.0	
204171	BH 108-17	SW14-10-7E	100.0	30.5	6.7	22.0	122-192
204173	BH 9B-17	SW19-10-8E	86.0	26.2	25.6	84.0	
203688	BRU 82-11	SW19-10-8E	79.0	24.1	27.1	89.0	
199982	BRU 82-5	SW19-10-8E	84.0	25.6	25.3	83.0	244-250
197859	BRU9	SW19-10-8E	82.0	25.0	25.6	84.0	247-250
197863	BH9-17	SW19-10-8E	81.0	24.7	25.3	83.0	164-315
203678	BRU 82-14	SW19-10-8E	77.0	23.5	25.9	85.0	
203699	BRU 82-10	NW19-11-8E	77.0	23.5	25.9	85.0	
199984	BRU 28-1	NE28-10-7E	108.0	32.9	19.2	63.0	
199965	BRU 117-1	NW18-9-8E	74.0	22.6	27.7	91.0	
200861	BRU 121-1	NW22-9-8E	42.0	12.8	21.6	71.0	196-199
199972	BRU 126-1	NW30-9-8B	37.0	11.3	42.7	140.0	247-259
199980	BRU 73-1	NW9-10-8E	42.0	12.8	26.5	87.0	192-210
203682	BRU 82-8	SW19-10-8E	76.0	23.2	25.9	85.0	245-263
203691	BRU 82-6	SW19-10-8E	73.0	22.2	26.8	88.0	245-253
201401	BRU 95-3	SE32-10-8E	29.0	8.8	37.2	122.0	217-226
201400	BRU 95-2	SE32-10-8E	31.0	9.4	35.7	117.0	218-230
201399	BRU 95-1	SE32-10-8E	30.0	9.1	36.0	118.0	218-228
201159		SE32-10-8E	20.0	6.1	39.0	128.0	
201398	BRU 95-5	SE32-10 -8E	19.0	5.8	22.9	75.0	
205003	BRU 95-7	SW32-10-8E	43.0	13.1	36.0	118.0	237-245
205011	monitoring	SE32-10-8E	32.0	9.8	36.9	121.0	
205013	BRU 96-1	SW33-10-8E	27.0	8.2	35.1	115.0	
205016	BRU/MW20-01	SE32-10-8E	29.0	8.8	33.5	110.0	
HR*	BRU95-6	SE32-10-8E	32.2	9.8	36.9	121.1	
HR	BRU-95-7	SE32-10-8E	43.0	13.1	35.9	117.8	237- 246
HR	BRU95-8	SE32-10-8E	52.2	15.9	32.3	106.0	
HR	BRU95-9	SE32-10-8E	38.1	11.6	36.0	118.1	
HR	BRU96-1	SE33-10-8E	27.2	8.3	36.0	118.1	
205641		SW5-11-8E	49.0	14.9	35.4	116.0	

205588	BRU2020	SW5-11-8E	45.5	13.9	34.1	112.0
205642	BH2C-20	SW5-11-8E	51.0	15.5	36.0	118.0
206788	BRU92-2	NW29-10-8E	46.0	14.0	34.1	112.0
207211	BRU92-3	NW29-10-8E	47.0	14.3	33.2	109.0
206786	BRU92-4	NW29-10-8E	40.0	12.2	34.1	112.0
207218	BRU92-6	NW29-10-8E	43.0	13.1	33.8	111.0
207219	BRU92-7	NW29-10-8E	44.0	13.4	33.5	110.0
208473	BRU92-8	SW29-10-8E	48.0	14.6	32.9	108.0

* HR indicates data taken from the Sio Silica Hydrogeological Report

The two third party technical reports have established that pillar stability analysis has not been done for the well cluster configurations. Asymmetric extraction cavity shapes must be considered in the geotechnical modeling for determination of cluster spacing in the field. Sio Silica must demonstrate the three dimensional geotechnical modeling to determine the separation of well clusters required to achieve sand pillar stability during production in the field. For the modeling Sio Silica must provide detailed plans on how such essential data such as the cohesion and modified internal angle of friction of the silica sand will be collected. Sio Silica must provide all geotechnical data on the properties of the sand already determined and newly obtained field data. The two dimensional geotechnical modeling software "FLAC" used by Stantec in the Jan. 14, 2022 report cannot be used for the three dimensional modeling required for sand pillar stability.

Sio Silica must describe all the data that will be collected on the geotechnical properties of the limestone such as tensile and shear strength and size of rock blocks and how this data will be used in the field modeling to determine allowable long-term extraction cavity span. The modeling methods to determine the maximum long term cavity span for production in the field must be demonstrated.

The stability of the shale aquitard including remedial measures such as grouting must be modeled. Sio Silica must issue revised plans for the production geometry taking into consideration no extraction can occur east of highway 302 based on the Stantec limit of 15 meter minimum limestone thickness. Sio Silica must issue revised plans on the project schedule and evaluation of the effect of implementation of these measures on the project viability.

Sio Silica must issue on the project registry a Notice of Alteration for the revised production design and the modeling and data gathering required for determination of maximum cavity span and well cluster separation during production. Pending a decision by the Director Sio Silica Sio Silica may be required to file a new proposal and respond to comments from the TAC and the public on the well cluster design methodology based on field geotechnical stability modelling.

The evidence presented here establishes that the Hearing must not continue until completion and documentation of the new three dimensional geotechnical modelling of the Sio Silica design for well clusters.

4. **New state of the art three-dimensional hydrogeological and contaminant transport modeling of the full scale sand mining operations**

The justification of the necessity of state of the art three three-dimensional hydrogeological and contaminant transport modeling of the full scale sand mining operations is established in Table 1. The requirement for modeling of the re-injection of water is further supported by the MSSAC/KGS questions for clarification regarding the consequences of net withdrawal of only 10 US gallons per minute of water per cluster.

The Sio Silica design will cause water circulation as the water re-injected at the top of the sandstone is drawn into the bottom of the production tube as illustrated in the Sio Silica patent design as shown in figure 2. This water re-circulation would act as a barrier preventing sand extraction. The three dimensional modeling, including point source water re-injection near the top of the sandstone aquifer, must determine the effectiveness of the Sio Silica extraction design.

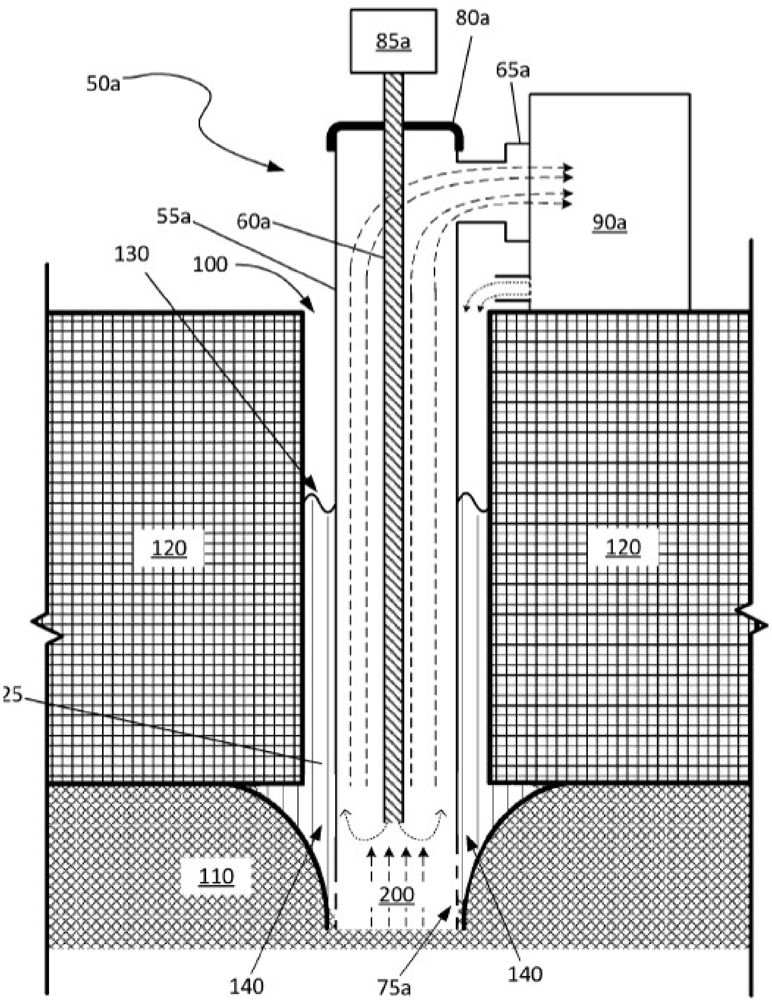

Figure 2. Drawing from Sio Silica airlift patent application.
Drawing was reproduced from the Sio Silica patent as reproduced on the project registry

The Sio Silica patent states;

"*In the present example a void 140 is formed and filled with water. It is to be appreciated as the void forms and sand moves away from the perforated wall 75a, the advantages of the perforated wall 75a are negated since the water may pass through the perforated wall. However in some examples the conduit 55a may be extended to maintain the perforated wall 75a below the sand to continue to receive the advantages of the perforated wall. Alternatively, the gas injection line 60a may be used to generate a pressure vibration or pulse air to agitate the sand such that the void 140 is partially filled by the settling of the sandstone formation 110a to cover the perforated wall 75a*."

The extension of the gas injection line to promote sand entering the water filled area around the production tube would introduce a large amount of air into the aquifer exacerbating the detrimental effects of oxidizing conditions in the aquifer including promotion of microbial and fungal growth, precipitation of iron and manganese, and oxidation of sulphide sources leading to heavy metal release.

The movement of injected air in both aquifers and the pressure resulting from the re-injected air must be modeled. The modeling must determine the ability of the head drawdown from air lifting to enable sufficient water to re-enter the aquifer by gravity alone without exerting any extra injection pressure. The water re-entry must be sufficient such there is only 10 US gallons per minute net water loss per cluster as noted in the MSSAC/ KGS questions for clarification.

Mixing of aquifer water through a compromised shale aquitard is prohibited by Manitoba Groundwater Water Well Regulations. The modeling must determine the extent of the mixing of aquifer waters. If mixing of aquifer waters cannot be prevented this project must not be allowed to proceed.

All of the technical modeling deficiencies documented in the technical report of Holländer and Woodbury must be addressed.

Sio Silica must issue on the project registry a Notice of Alteration for the documentation of the new state of the art three-dimensional hydrogeological and contaminant transport modeling of the full scale sand mining operations. Pending a decision by the Director Sio Silica Sio Silica may be required to file a new proposal and respond to comments from the TAC and the public on the new hydrogeological and contaminant transport modeling.

The evidence presented here establishes that the Hearing must not continue until completion and documentation of the new state of the art three-dimensional hydrogeological and contaminant transport modeling of the full scale sand mining operations.

5. Comprehensive geochemical re-testing of the glacial till overburden, carbonate aquifer, shale aquitard and sandstone aquifer throughout the entire 24 year project area

The justification for required comprehensive geochemical retesting over the entire 24 year project area is given in Table 1.

Further evidence for required retesting is given below.

As shown in figure 3-1 of the Sio Silica Hydrogeological Report both Bru 121-1 and Bru 146 are outside the intended Sio Silica 24 year extraction area. Thus the only relevant sand sample, Bru 95-3, was taken from a sand pile exposed to weathering since July of 2019. The weathering would have oxidized pyrite and marcasite in the sand invalidating all sand acid-base accounting results reported in the Sio Silica EAP Hydrogeological Report. The sand pile was and disturbed and some was used for road building as acknowledged in answers to question in the public open house of Dec.15 2020. The remaining sand pile from which the sample for anlysis was taken was potentially contaminated with glacial till from the moving and disturbance before sampling.

Holländer and Woodbury on page 42 of their hydrogeological technical report state; "*Some of the samples (Winnipeg Sandstone) were even grab samples from a stockpile (p. 34). Such sampling is inadequate to be used for the geochemical analysis described later on*." This statement confirms that the sand sampling from the stockpile near well Bru 95-3 is not acceptable.

According to the well information reports Bru 121-1 was completed at location NW22-9-8E on Feb.19, 2019. According to borehole results obtained from the Mines Branch, Bru 141 was drilled Nov.21-23, 2018. The storage method and location of the sand samples from Bru 121-1 is not disclosed. It is likely the sand was exposed to air and oxidation of sulphide in the samples from the time of extraction to the time of analysis in December 2021.

The ALS report in Appendix A, Part 6 gives the sampling date for the Bru 121-1 and Bru 146 sand as 18-Nov-2020 however the sand samples were extracted much earlier. The collection time, the collector identity, collection method, and the storage containment of the Bru 121-1 and Bru 146 sand samples are not given and remain unspecified. To be valid samples the date, time, and method of collection and storage must be specified.

The comments in the HR on the samples collected state:

"*Bru 121-1 Winnipeg sandstone sample contains concretions of brown color containing iron oxide minerals. Bru 146_Winnipeg Sandstone sample contains concretions of brown color containing iron oxide minerals and remnants from overlying shale*"

These statements demonstrate that iron sulphide in the sand samples from Bru 121-1 and Bru 146 had oxidized to iron oxide minerals invalidating acid-base accounting results and confirms the presence of fragments of shale aquitard in the sandstone.

According to the well information report the Bru 121-1 well was flowing and left active. A flowing well condition would have complicated removal of a sand sample. It remains undocumented how the sand sample was retrieved from Bru 121-1.

A borehole record for Bru146 was obtained from Manitoba Mines Branch. Bru 146 location is south of Bru 121-1 in the flowing well area. The core log reported in borehole record shows the Bru 146 was completed 165 feet below ground surface into the shale layer. Excerpts from the borehole report for Bru 146 obtained from Manitoba Mines Branch are shown below.

Drilling commenced on the 21st of November 2018. A DR-24 rig was used to drill 8" casing to the bottom contact of the limestone. A total depth of 2165 ft was reached on the 23rd of November 2018.

Borehole licence for the work performed is BH 23-18 (Bru 146 -1). The township and range for Bru 146-1 is 21-08-08 E1M.

Hole ID	From (ft)	To (ft)	Lithology	Date Drilled
Bru 146-1	0	114	Quaternary	21-Nov-18
	114	160	Limestone	23-Nov-18
	160	165	Shale	

TABLE 1: BRU 146-1 LOGGED SECTION

Figure 3. Excerpts from the borehole record for Bru 146

The drilling did not extend into sandstone therefore there could be no sand sample for Bru146. The true location of the sample is unknown.

It remains a mystery as where the sand sample for Bru146 was actually collected and by whom. The evidence here demonstrates that the Bru 146 sand sample could not have been collected from the Bru 146 well that did not encounter sand.

The Sio Silica Hydrogeological report states;

"*Boreholes Bru 121-1 and Bru 146 were drilled as part of historical investigations. Samples of Red River Carbonate and Winnipeg Shale were collected from core boxes stored in CanWhite's core storage facility in Steinbach, and the samples of Winnipeg Sandstone associated with these locations had been previously collected and submitted by others to ALS Environmental Laboratories*"

There could be no complete chain of custody for all the sand samples analyzed from the time of extraction to the time the sample was packaged and sent for anlysis. The personnel collection the samples were identifies as "others" which is unacceptable. The carbonate and shale samples from Bru 121-1 and Bru 146 were obtained from core boxes that were not documented as being protected from air exposure and subsequent oxidation of sulphides. Airlift extraction of the sand would expose the sand to air oxidation which is unacceptable. Sonic drilling methods might be required to extract the sand as is documented in the 2014, NI43-101 report for Seymourville. Sio Silica has displayed utter negligence by lack of the documentation of the collection of the Bru 121-1 and Bru 146 sand samples. Sio Silica must document how extensive remedial sand samples over the entire 24 year project area will be extracted and protected from air exposure.

The evidence given here establishes that sand sampling and geochemical analysis must be redone. Sio Silica must collect and analyze samples of concretions, oolite and interbedded shale layers know to be pyritic as determined by primary references of Schieber and Riciputi (2005)[6] and Watson (1985)[7]. Interbedded shale layers as shown in Table 3 are reported in the forty four well information reports obtained from Manitoba Groundwater further establishing the necessity of sampling and analysis of these sources of sulphide in the sandstone aquifer. The well information reports constitute direct field evidence of extensive shale within the sandstone that was not collected and analyzed by Sio Silica in the hydrogeological study for the EAP.

Sio Silica in their response to public comments documented on the project registry 6119.00 finally admits the presence of pyritic oolite and concretions in the sandstone formation. Sio Silica states in response to public comments;

"*Oolites and concretions comprise a very small proportion (<5%) of the overall sandstone aquifer. Oolites are commonly composed of calcium carbonate and are not likely to negatively influence water quality. Due to their relatively large spherical shape, the oolites and concretions are likely to have a low reactivity in the subsurface. Some of these materials were contained within the sand samples submitted for geochemical analysis*"

Up to 5% oolites and concretions is very large with respect to acid generation potential. For example, 4% of the 1.36 million tonnes of sand to be produced per year would be 54 thousand tonnes of acid generating sulphide minerals in the extracted sand. Much more sulphide is waiting in the aquifer to become oxidized by huge amount of air introduced into the formation by sand extraction.

The extraction EAP states;

"*The sand and groundwater slurry brought to surface will pass through vibrating screens installed over a sump pit at the extraction site which will capture overs such as concretions (calcified sand) which are commonly encountered*."

This statement contradicts the Sio Silica statement in response to public comments and establishes that concretions are common and not a very small portion.

Sio Silica gives no evidence to support that oolite and concretions found near Vivian are composed of calcium carbonate. There has been no quantification of the amount of oolite and concretions in the samples in the Sio Silica EAP Hydrogeological report.

Watson writes in Economic Geography ER-84-2;[5]

"*The next layer is 0.5 to 1 m in thickness and is composed of sand with numerous desiccation cracks and burrows. These structures are filled with either silty sand or pyrite oolites. Oolites are typical of the next 2 m layer. The pyrite oolites have been described by Genik (1952). The layer in which they occur consists of up to 75% pyrite with lesser amounts of sand and silty material. In some other areas the oolites are limonite.*"[??]

Limonite is a form of iron oxide/hydroxides not calcium carbonate.[5] The oolite in the Winnipeg formation is up to 75% pyrite with silt, sand and limonite as the remainder - not calcium carbonate.

A peer reviewed paper by Schieber and Riciputi (2005) on the diagenesis of pyrite and marcasite in the Winnipeg formation states; [??]

"*Throughout the Black Island Member we find irregular iron sulfide concretions that follow burrow trails. They consist of a mixture of pyrite and marcasite in clusters and coarse aggregates with rounded quartz grains ''floating'' in the sulfide matrix*."

In the references of Watson (1985) and Schieber and Riciputi (2005), the presence of calcium carbonate is not mentioned in oolite and concretions. Calcium carbonate is found in the limestone of the carbonate aquifer deposited much earlier than the Winnipeg formation sandstone.[7]

Figure 4 shows concretions in sand extracted by Sio Silica during advanced exploration activities at the Centre Line Road site. The orange colour indicates oxidation of pyrite upon weathering and provides direct evidence that large amounts of pyritic concretions are within the sand extracted by Sio Silica.

Figure 4. Orange coloured concretions and sand extracted by Sio Silica at Centre Line Road SW of Vivian.

Images used with permission of the photographer.

Figure 5 shows fragments of shale in the sand piles extracted south of Vivian in the summer of 2019. The clumps of reddish and grey shale are consistent with collapse of the shale aquitard into the excavation cavity. The core log of well Bru 95-8 in the Sio Silica EAP Hydrogeological Report, at the extraction site south of Vivian, legal location SE32-10-8E, documents reddish brown shale in the aquitard consistent with the shale colour of figure 5.

Figure 5. Shale collected by concerned citizens near Vivian from Sio Silica extracted sand piles, spring 2020.
Images used with photographer's permission.

Figure 5 provides direct evidence that friable shale would collapse into the Sio Silica sand extraction cavities.

Holländer and Woodbury in the third party hydrogeology report state on page 9; "*The analysis for acid mine drainage, aqueous geochemistry and stable isotopes were carried out at one location only and limited samples (e.g., related to acid mine drainage) were taken*." This establishes that much more geochemical sampling and analysis for all the formations must be completed over the entire 24 year project area.

A plan and schedule for the geochemical re-sampling throughout the 24 year project area must be completed by Sio Silica and submitted as a Notice of Alteration to the project registry. Depending on a decision by the Director, Sio Silica Sio Silica may be required to file a new proposal and respond to comments from the TAC and the public on the geochemical re-sampling and analysis plan.

The evidence presented here establishes that the Hearing must not continue until comprehensive geochemical re-sampling and analysis throughout the 24 year project area is completed and documented.

6. **Analysis of accidents and malfunctions, of the slurry line loaded at the silica sand extraction site including modelling of the accumulation of the highly toxic polyacrylamide monomer and selenium in the wash plant and slurry line loop.**

The justification for analysis of accidents and malfunctions of the slurry line loop including the accumulation of contaminants in the loop is provided in Table 1.

The mass balance equation for the accumulation of contaminants in the wash plant and slurry loop is given by,

$$V_p \frac{dC(t)}{dt} = Q_L C_i(t) - Q_L C(t) + M_s - \lambda_a V_p C(t) + C_o V_p \delta(t). \qquad (2)$$

$C_i(t)$ is the concentration of contaminant entering the recycle wash plant loop. M_s is the mass input rate of contaminants in the loop (assumed to be constant). C_o is the initial concentration of contaminant present in the wash water of the loop. δ is the kronecker delta function. Q_L is the loss rate of water in the slurry loop wash plant system. λ_a is the first order rate constant for degradation of the contaminant and V_p is the total volume of the slurry loop including the clarifier tank, vessels of wash plant and slurry line loop. C_i is the initial concentration of contaminant in the water entering the loop.

Assuming the initial concentration of contaminant in the loop is zero, the solution to equation (2) is,

$$C(t) = \left(\frac{M_s}{Q_L + \lambda_a V_p}\right)\left[1 - \exp\left\{-\left(\frac{Q_L + \lambda_a V_p}{V_p}\right)t\right\}\right] + \frac{Q_L}{V_p}\int_0^t C_i(t')\exp\left\{-\left(\frac{Q_L + \lambda_a V_p}{V_p}\right)(t-t')\right\}dt'. \qquad (3)$$

The initial concentration, C_i , is the concentration entering the loop from the extraction dewatering tanks and the airlifting and includes any contaminants from the French drain input. The flow of water entering the loop, Q_L, must be the same as the flow of water exiting the loop for water balance. The flow of water input from the French drain cannot change the Q_L or water balance would not be maintained. Sio Silica has not acknowledged this requirement. Sio Silica must address how water balance can be maintained during a large precipitation event that generates flow rates from the French drain much larger than Q_L.

When $C_i(t)$is zero and for long times when steady state is reached the above mass balance equation reduces to the steady state equation from the Great Plains study.

$$C_s = \left(\frac{M_s}{Q_L + \lambda_a V_p}\right) \text{ for } t >> V_p/(Q_L + \lambda_a V_p) \qquad (4)$$

If the initial contamination entering the slurry loop from he pumping stations or from the French drain system is a constant, at steady state, the last term of equation 3 reduces to $Q_L C_i / (Q_L + \lambda_a V_p)$. Any initial concentration of contaminant entering the loop would increase the level of contamination in the slurry loop.

6.1 Determination of the acrylamide content in the slurry water

The EAP for the Sio Silica Processing Facility states;

"*Water treatment will involve an outdoor clarifier capable of handling a minimum of 6,450 gpm (24,416 l/min), using food grade biodegradable flocculant (anionic polyacrylamide) as an aid for fines settling*."

Extremely toxic acrylamide monomer present in the flocculent as manufacturing residual is very soluble and would accumulate in the slurry loop water.[8,9] Degradation of the polyacrylamide in the clarifier tank would increase the toxic acrylamide concentration in the slurry loop. Equation 3 and 4 are used here to model the concentration. The parameter values for the equations must be determined.

The water loss rate from the water recirculation system at Vivian, Q_L, is dominated by the 15% water entrained in the sand stockpiles. Assuming 15% water refers to water by volume of the sand, using sand production target of 1.36 million tonnes per year and a sand dry density of 1.65 tonnes per cubic meter,[1212] the volume of water lost to the sand piles per year would be 123,636 cubic meters. At 220 operating days the loss rate from the slurry loop Q_L would be 23.4 m^3/hr. This must equal the rate of water input to the slurry line given in the Sio Silca EAP Hydrogeological study as 10 US gallons per minute per cluster. Sio Silica must determine how these two rates are the same.

The rate of water loss for the Great Plains wash plant was 35.2 m^3/hr.[??] The value of 23.4 m^3/hr for the Sio Silica slurry loop water loss rate is comparable to the Great Plains value. The value of the total water flow entering the slurry loop pertaining to 10 US gallons per minute per cluster must be determined by Sio Silica. The value of 23.7 m^3/hr is used here in the modeling for the Sio Silica slurry water loss/entry rate.

The Sio Silica draft water management plan of June 17, 2022 for Vivian states;

"*The slurry loop system needs approximately 1,325 m^3 (350,500 U.S. gallons) of water to operate*."

The volume of the Great Plains wash plant loop[8] was 1700 m^3 which is comparable to Vivian.
The Sio Silica supplementary information #3 for process wastewater treatment posted June 24, 2022 states;

"*The raw process wastewater is expected to have a solids concentration of 18,500 mg TSS/L, which will then be reduced to approximately 10,000 mg/L and directed for treatment*."

The concentration of 10,000 mg/L refers to the fines that for the re-injected water must be removed before UV treatment. Based on this information it is assumed that the fines content entering the slurry line at the extraction site would be 10,000 mg/L.

Using a slurry loop/clarifier tank water flow rate of 24.416 m^3/min and a fines concentration of 10 kg/m3 the clarifier fines loading rate for Vivian would be 14.65 tonnes/hr.

The Great Plains study uses a solid loading rate to the clarifier tank of 7 tons (6.35 metric tonnes) per hour and a polyacrylamide loading rate of 0.5 lb. per ton (0.25 kg/tonne) of solids for a total polyacrylamide loading of 1.587 kg/hr. The comparable Sio Silica polyacrylamide loading rate would be 3.66 kg/hr.

The Great Plains study used a manufacturing residual weight fraction of $2x10^{-4}$ of acrylamide monomer in the polyacrylamide. All polyacrylamide in the European Union contain less than 0.1% ($1x10^{-3}$) w/w free acrylamide monomer to avoid being considered as a category 2 carcinogen.[9] The monomer content of the polyacrylamide to be used for the Sio Silica operation is not disclosed.

The paper by Xiong et al., 2018,[10] states;

"Many previous studies have demonstrated the importance of dissolved oxygen and Fe2+ in the chemical degradation of PAM under environmental conditions. Fe2+ can be released by oxidative dissolution of pyrite minerals or other iron-bearing clays, which simultaneously acidifies the fluid."

The slurry line water will almost certainly have pyrite minerals from the collapsed shale layer, interbedded shale[5] as documented in table 3 and pyritic concretions[6] that will release Fe2+ by the oxidation dissolution of these sources of pyrite in the slurry line sand and cause degradation of the polyacrylamide to the toxic acrylamide monomer. The degradation of the polyacrylamide would increase the toxic acrylamide monomer concentration however the degradation rate remains unknown therefore the increase in the toxic acrylamide monomer from degradation was ignored. Thus the acrylamide monomer concentration calculated here would be an underestimate.

A peer reviewed paper in NPJ Clean Water Nature Partner Journal by Xiong et al., 2018,[10] states,

"*Several studies support the hypothesis that naturally occurring microbes in soils, sediments, and water systems can degrade acrylamide to the nontoxic products ammonia and acrylic acid over periods of days to months. In aquatic systems, complete degradation of acrylamide likely occurs within 2 weeks. However, in tap water, acrylamide can persist for more than 2 months"*

Using a half time of 2 months the first order rate constant for the acrylamide monomer in the slurry lines, wash plant and clarifier tank λ_a would be 4.74×10^{-4} hr^{-1} as opposed to the value of 0.125 hr^{-1} used in the Great Plains study. The EU study gives a half life in surface waters with biodegradation of 2.0×10^{-3}hr^{-1}. Biodegradation in the slurry water should be less than surface water given the high flow rates in the slurry lines and likely less organic and microbial content.

Using λ_a of 4.74×10^{-4} hr^{-1}, Q_L of 23.7 m^3/hr, V_p of 1325 m^3, and an acrylamide weight fraction of 0.1% of the polyacrylamide giving an acrylamide monomer loading rate, M_s, of 3.66 g/hr, the steady state acrylamide concentration in the Sio Silica slurry loop, C_s, at Vivian would be 151 µg/litre which is far above the allowed limit from the Great Plains study of 0.5µg/liter. For an acrylamide weight fraction of 2×10^{-4} as used in the Great Plains study C_s for Vivian would be 30.1µg/litre, which is still much above the allowed limit of 0.5µg/liter. Finally for a λ_a of 0.125 hr^{-1} and a acrylamide loading factor of 2×10^{-4} as was used in the Great Plains study C_s for Vivian would be 3.87µg/litre which is also above the allowed limit of 0.5µg/liter. Sio Silica has ignored the potential for acrylamide contamination of the slurry water that could poison surface waters or the aquifer upon leakage of the slurry lines or wash plant water. According to this analysis the steady state Sio Silica slurry line concentration of toxic acrylamide monomer would be well above allowed limits. The results and parameter values for the steady state analysis of the acrylamide concentration in the slurry loop water are summarized in table 4.

Table 4. Slurry loop acrylamide concentration and model parameter values

Water Loss Q_L m^3/hr	Recycle Volume V_p m^3	Acrylamide Loading M_s g/hr	Decay Rate λ_a hr^{-1}	Acrylamide Con. C_s µg/litre	Allowed Limit µg/litre
23.7	1325	3.66	4.74×10^{-4}	151	0.5
23.7	1325	0.732	4.74×10^{-4}	30.1	0.5
23.7	1325	0.732	0.125	3.87	0.5

A question remains as to the time required to reach steady state. Using equation 3 the approach to steady state for the Vivian slurry like loop is given in figure 6 for a range of parameter values used for the steady state calculations.

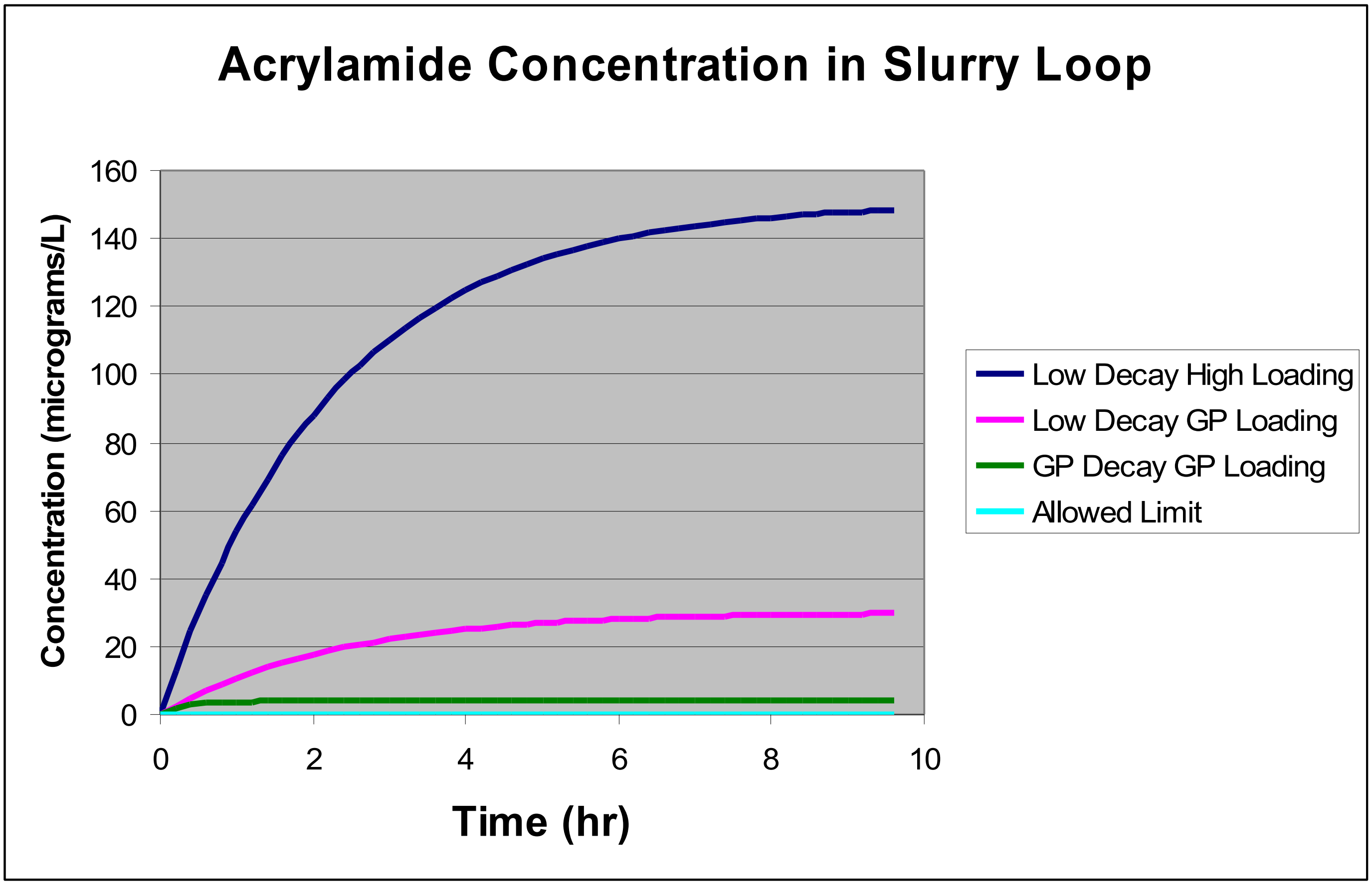

Figure 6. Acrylamide concentration in Sio Silica Slurry loop

Figure 6 illustrates the acrylamide concentration would rise to steady state values above the allowed limit in the Sio Silica slurry loop in a matter of hours. "Loading" in the legend of figure 6 refers to the mass loading rate of the acrylamide monomer in the clarifier tank of the slurry loop. "GP" indicates Great Plains values.

The loading of the acrylamide monomer used here does not include degradation due to dissolved oxygen and Fe^{2+} as documented by Xiong et al., 2018[10]. Degradation would result in much higher dissolved toxic acrylamide concentrations.

Remediation by a contaminant removal process such as reverse osmosis would be required to operate continuously. Sio Silica must specify the volume, disposal method and disposal location of the concentrated waste stream for acrylamide removal.

6.2 Determination of the selenium content in the slurry water

It has been established in the Sio Silica EAP Hydrogeological shake flask tests that shale contains selenium that would dissolve as selenate when exposed to oxidizing conditions introduced by the Sio Silica sand extraction. Sources of selenium from interbedded shale in the sandstone and other potential selenium from oolite and concretions have not been included in the evaluation. In the slurry line sloop selenium would be present in the sand and in fragments of shale from the collapsed aquitard and from interbedded shale in the sandstone formation.

The amount of shale withdrawn with the sand in each extraction cavity using an aquitard thickness of 3 meters, radius of 27 meters and density of shale of 2 tonnes cubic meter would be 13,741 tonnes. If 10% of the shale aquitard were extracted with the 21,000 tonnes of sand per cluster the shale fraction in the sand would be 0.065.

The maximum concentration for Bru 121-1 shale in the 24 hour shake flask tests was 1.64 mg/L for a liquid to solid ratio by weight of 3 to 1. In the shake flask test 37.6% of the available 13.1 ppm selenium dissolved per litre.

The mass rate of sand delivered in the slurry loop to meet the production target of 1.36 million tonnes of sand per year, for 220 days of operation per year, would be 257.6 tonnes per hour. The maximum selenium rate of discharge to the slurry line water, M_s, at a shale fraction of 0.0654 and a fraction dissolved of 0.02 is estimated to be $257.6 \times 0.0654 \times 13.1 \times 10^{-6} \times 0.02 = 4.41 \times 10^{-6}$ tonnes per hour

Using equation 4 with a first order degradation rate for shale of zero, Q_L of 23.7m^3/hr and M_s of 4.41 grams per hour, the steady state Sio Silica slurry line loop concentration of selenium would be 0.186 mg/L. Note that a very small dissolved fraction of selenium of 2% was used for this analysis and only 10% of collapsed shale aquitard. The concentration guidelines for selenium taken from the Sio Silica EAP Hydrogeological Report are shown in table 5. The steady state concentration of selenium in the slurry loop water far exceeds all guidelines.

Table 5. Selenium concentration guidelines in mg/L (data from the SIO Silica extraction EAP)

CCME FAL Acute and Chronic (aquatic life)	0.001
CCME Livestock and MWQSOG Livestock	0.05
CCME Irrigation and MWQSOG Irrigation	0.02-0.05
FIGQG Agricultural	0.001
MWQSOG MAC (Manitoba drinking water)	0.01
CDWQ MAC (Canadian drinking water)	0.05

Figure 7 illustrates the selenium concentration in the slurry line loop as a function of time for a zero initial concentration of selenium in the water entering the slurry line, Q_L of 23.7 m^3/hr , M_s of 4.41 g/hr and V_p of 1325 m^3 for the water loss, Q_L, determined for 15% water loss to sand stockpiles.

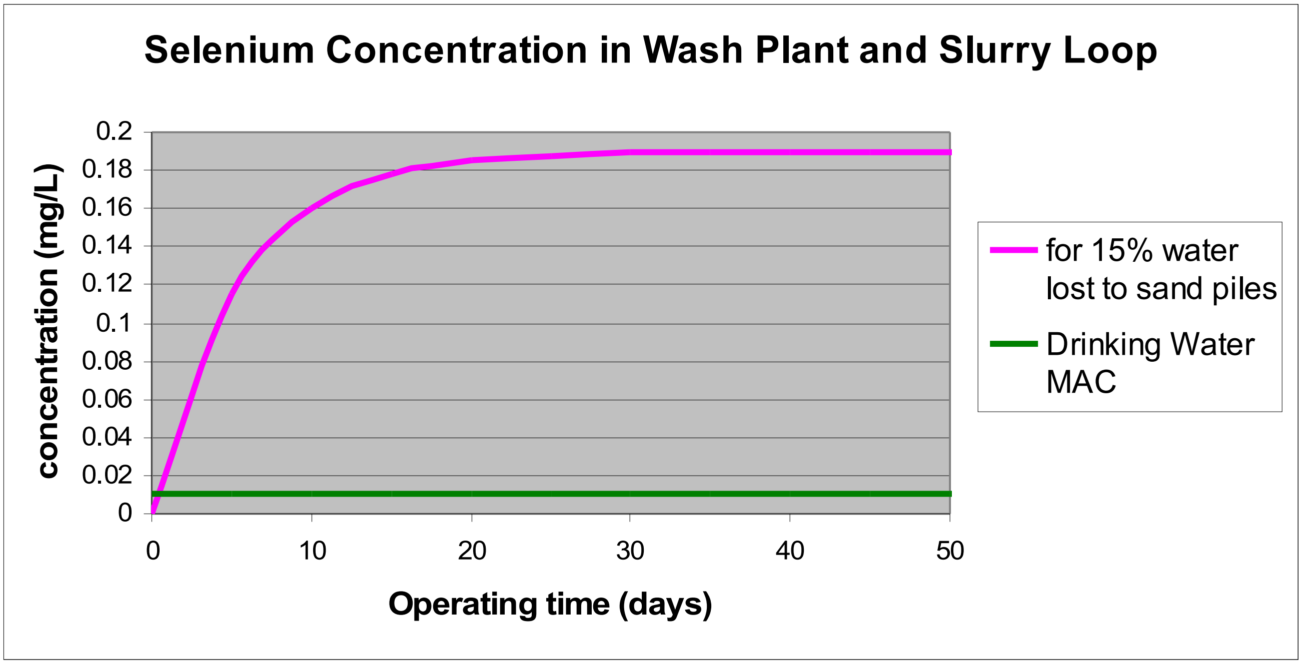

Figure 7. Selenium concentration in the Sio Silica wash plant and slurry loop water

Figure 7 illustrates that the selenium concentration would rise to steady state in the slurry loop and wash plant in about 20 days and would exceed drinking, irrigation and aquatic life water guidelines in a matter of hours. Remediation by a contaminant removal process such as reverse osmosis would be required to operate continuously. Sio Silica must specify the volume, disposal method and disposal location of the concentrated selenium waste stream.

It is essential that geochemical analysis from numerous samples of sand, interbedded shale, concretions and oolites throughout the project area be completed by Sio Silica to determine the risk of aquifer and slurry line contamination. The selenium concentration in the slurry line water could only increase with more information from comprehensive sampling.

A further consideration is dissolved contaminants from the slurry loop would be in the 15% water in the sand stockpiles. These dissolved contaminants will be baked onto the sand in the dry plant and lost to the water loop. The contaminants baked onto the sand would degrade the quality of the sand rendering the sand unsuitable high purity applications such as solar panel glass. Sio Silica must account for the contamination of the sand by accumulated dissolved contaminants from the slurry loop.

6.3 Slurry loop analysis recommendations and conclusions

The evidence provided here establishes that the Sio Silica geochemical analysis of the sandstone was invalid. The concentrations in the slurry line of acid and heavy metals cannot be evaluated without completed comprehensive third party sampling and analysis of the sandstone throughout the project area.

Sio Silica has not provided enough data on the number of wells per clusters and the number of clusters operating simultaneously to determine if the water flow rate into the slurry line equals the water loss rate to the sand stockpiles at the processing plant. Sio Silica must be required to provide this essential information.

The modeling carried out here acts as an example only. Sio Silica must review and redo the modeling carried out here according to their data sources and methods.

Sio Silica must document remedial measures such as double walled slurry lines; automated leak detection and loop shut down and spill clean up. Sio Silica must document measures to regularly measure and remove contaminants from the slurry line and measures for the disposal of the contaminants. The consequences and remediation for a malfunction associated with a large deluge or rapid snow melt and the subsequent transfer of collected drainage water from the French drain style system into the recycling slurry line loop must be analyzed and reported. Measures to prevent malfunction allowing backflow from the slurry line into the aquifer water re-injection system must be documented.

A Notice of Alteration describing the modeling and measurement of the accumulation of contaminants in the slurry line, contaminant removal methods, slurry line double wall, leak detection and shut down measures, and handling of accidents and malfunctions of the slurry lines must be posted on the project registry. Depending on a decision by the Director, Sio Silica Sio Silica may be required to file a new proposal and respond to comments from the TAC and the public on the accumulation of contaminants in, and malfunctions and accidents of the slurry line loop.

The evidence presented here establishes that the Hearing must not continue until a Sio Silica study on the accumulation of contaminants in, and malfunctions and accidents of the slurry line loop is completed.

7. **Evidence to support the motion for delay or suspension of the hearing until completion of Section 35 Indigenous Consultation to be conducted by Manitoba Natural Resources and Northern Development**

The main evidence for delay or suspension of the Hearing until completion of section 35 Indigenous consultation is provided in two letters of Aug.26, and Sept.6, 2022, regarding indigenous consultation sent to the CEC from the participants Don Sullivan (decd.) representing What the Frack Manitoba and D.M. LeNeveu.

Online guidelines from Osler Law for proponents regarding indigenous consultation state;

"*Despite consultation being a duty owed by government to potentially impacted indigenous communities, project owners will be expected to carry out significant procedural aspects of consultation. The federal or provincial government will supply project owners with a list of potentially affected indigenous communities. Consultation can involve the following:*

- *meeting with Indigenous communities to share information about the project*
- *providing reasonable resources for Indigenous communities to participate in consultation { responding to questions and concerns raised by Indigenous communities*
- *maintaining a complete record of all Indigenous consultation activities*
- *discussing any concerns or asserted impacts of the project on Indigenous or treaty rights*

Consultation requirements are circumstance-specific and dependent on the nature of the rights at stake and potential project impacts. The government, not the project owner, determines whether consultation has been adequate. Indigenous communities that believe consultation has been inadequate can have the issue determined by courts, leading to project delay."

Osler Law represents Sio Silica at the Hearing. Both the provincial government and the CEC should be informed about the Sio Silica indigenous consultation completed at the project planning state. Sio Silica must document all communications and consultation with indigenous groups including meetings of meetings, records of phone calls, records of online meetings, and dates, duration and summary or transcripts of the communications. A report of indigenous consultation undertaken by the Sio Silica must be submitted to the CEC, to the Minister of Manitoba Natural Resources and Northern Development and posted on the project registries 6057.00 and 6119.00. The Minister of Manitoba Natural Resources and Northern Development may require Sio Silica to undertake further indigenous consultation as part of the mandated Section 35 consultation process.

The CEC cannot fulfil its mandate to provide, *"advice and recommendations regarding environmental impacts and health effects as well as potential licensing conditions"* and to play a role *"in gathering input relevant to the consultation process",* without incorporating the information from the Section 35 indigenous consultation including the records of indigenous consultations with Sio Silica.

The evidence presented here establishes that the Hearing cannot continue until Sio Silica submits a report on its indigenous consultation completed in the project planning stage and until Manitoba Natural Resources and Northern Development completes the Section 35 indigenous consultation.

8. Summary Analysis and Conclusions

Based on the evidence submitted here, six material actions, Section 35 indigenous consultation, and records of the indigenous consultation with Sio Silica must be completed before continuation of the Hearing.

Any or all of the six material actions would require alterations to the project that could have significant environmental effects.

In the event that Sio Silica notifies the Director of the Environmental Approvals Branch of contemplation of alterations to a project and the Director determines that the alterations involve significant environmental affects a new project proposal and new public and TAC comments and proponent responses must be filed on the project registry.

On Oct.14, 2022 the Chair of the Hearing posted a letter stating;

"*The commission has no influence, role or involvement in the departmental regulatory process*."

However the Hearing Directive states;

"*In developing advice and recommendations, the Panel will, among other things:*
- *engage a qualified third party to conduct a technical review of the Project proposal and make that review public*
- *review all elements of the Project proposal as well as Technical Advisory Committee and public comments and the Proponent's responses*"

If after the Hearing new project proposals and new public and TAC comments and proponent responses are submitted for major project alterations the Panel would have failed in its mandate to "*review all elements of the Project proposal as well as Technical Advisory Committee and public comments and the Proponent's responses"* If during or after the Hearing new project proposals are filed, the third party technical review would not have considered significant aspects of the Project proposals and the Panel would have failed in its mandate. Therefore even though; "*the commission has no influence, role or involvement in the departmental regulatory process",* the departmental regulatory process can influence the ability of the Panel to fulfil its mandate.

The Panel cannot know ahead of time the decision of the Director. The Panel will soon rule on the motion for the six material actions which may result in project alterations with significant environmental effects. Delay by the Director until after the Hearing of a decision regarding the environmental impact of alterations from any of the six material actions of the motion would delay potential filing of new project proposals, comments from the TAC, and proponent responses thereby compromising the fulfilling of the Hearing mandate. It would appear the only possible means for the Panel to ensure fulfilment of its mandate is to delay the Hearing until a decision is made by the Director regarding the project alterations stemming from the completion of the material actions of the motion should any of the actions of the motion be approved.

We must not allow Byzantine procedural rules to interfere with the main purpose of the Hearing, to assess the environmental impacts of the project proposal. The laws of nature do not abide by the rules and regulations of man. The evidence given here establishes that without adequate remediation as determined from completion of the six material actions of the motion, two regional aquifers would be contaminated and major detrimental subsidence would occur throughout the project area. This project and the Hearing cannot be allowed to proceed without completion by Sio Silica of the material actions specified in the first motion.

Project alterations that could have significant adverse environmental effects could arise from the section 35 indigenous consultations. The Hearing continuation therefore depends on a ruling on the second motion regarding section 35 indigenous consultation.

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