

## **Some Concerns**

Ernie Nathaniel, March 24, 2020

### **1. The Question:**

The proponent, Sio Silica, has come to the province and said it wants to suck up sand from the sandstone aquifer. It's sort of like saying, **"We'd like to extract this high quality sand, but we're going to have to nuke the shale aquitard that separates the two main aquifers (Carbonate and Sandstone) for an area that's about 60% of the size of Winnipeg. Are you o.k. with that?"**

That is just one of the bottomline questions. Or maybe a little more to the point: **Should we be mining in drinking water aquifers?**

Location video (all videos courtesy Interlace Media, Inc.)

<https://vimeo.com/811170663/ff3d682b3a>

I didn't want to comment on the Sio Silica project until I had a chance to attend the CEC Hearings. It was important to listen to all sides to derive an impartial judgement. I now have a more thorough understanding of the Sio Silica project. This is my personal opinion from listening to the various stakeholders, including talking to local people that would be affected, whistleblowers, and scientists. This project involves around 350 wells per year, removing 1.36 million tonnes of sand per year, with up to 10,000 wells in the next 24 years, each retired after 5 day use, from 200 feet down, ... and on to the next batch of wells. "Carpet bombing" was what it was referred to by a friend.

Video: Drilling down 200 ft

<https://vimeo.com/811173763/66e6110329>

A lot of the "bombing" will be on private property, and some say you can just "say no" when they come. But they can do it the easy way, or the hard way. Not really sure what hard way will mean.

From the recent side scan sonar of the test well BRU-92-8, it looks like a wide cavern is formed, originating in the sandstone aquifer, then the shale aquitard that serves as a barrier to the upper carbonate aquifer collapses. This cavity increases in size into the carbonate aquifer. This cavity appears to grow over time, as the 4 month sonar shows, and since no subsequent sonars have been done to see how far into the carbonate aquifer the cavity eventually grows, or if indeed, it ever stops, we don't what will happen over time. (Stantec Geotechnical Assessment document)

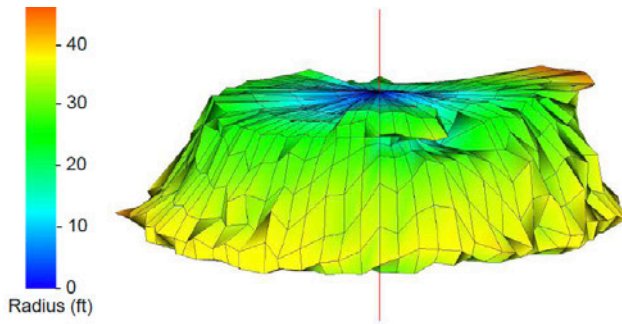


Figure 11: 3D Scan of Cavity (BRU 92-2) – View from East

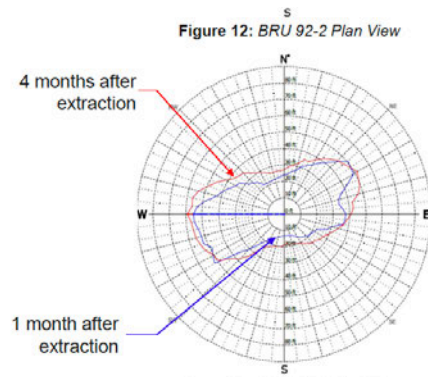


Figure 13: BRU 92-8 Plan View

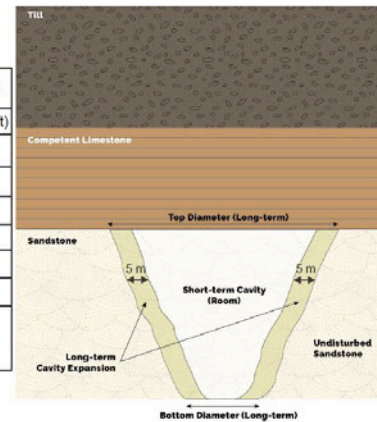
Some geological reports say that the glacial till or overburden is a strong enough support and there will be no subsidence on the surface. This of course depends on the final size of the cavity, which we don't know. As well, we have a pretty thorough mixing of the waters of the two aquifers, against Manitoba Groundwater and Well Act regulation.

The impact of this aquitard collapse was not fully realized, for me at least, until the CEC Hearings, although the data was previously submitted. The Stantec chart shows the maximum Disturbance Zone Size. But it is interesting to note that the chart only goes to a maximum of 40m diameter top of the extraction disturbance zone (the hole left after the sand is sucked up).

Table 12: Extraction Disturbance Zone Size Based on Thickness of Competent Limestone

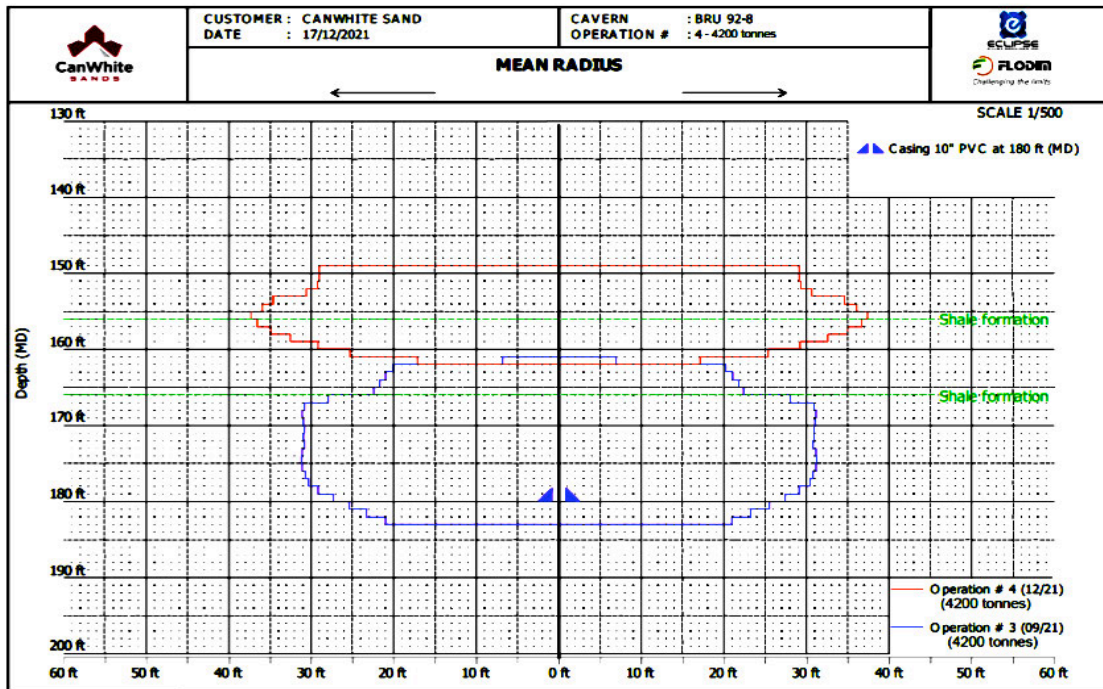
Limestone Thickness (m)/(ft)	Overburden Thickness (m)/(ft)	Long-term Allowable Limestone Unsupported Span (Diameter) (m)/(ft)	Extraction Disturbance Zone Dimensions	
			Top Diameter (m)/(ft)	Bottom Diameter (m)/(ft)
15 (49)	25 (82)	35 (114)	25 (82)	6 (20)
	35 (114)	32 (105)	22 (72)	3 (10)
20 (65)	25 (82)	43 (141)	33 (108)	14 (46)
	35 (114)	40 (131)	30 (98)	11 (36)
25 (82)	25 (82)	50 (164)	40 (131)	21 (69)
	35 (114)	47 (154)	37 (121)	18 (59)

Note 1: Bending (Tensile) is the controlling failure mechanism to determine the long-term allowable span.  
 Note 2: Extraction zone side wall slope is 65°.  
 Note 3: Extraction depth is 20 m (65 ft).



The problem is that in CECIR-009 “extraction of silica sand will create localized voids with a lateral diameter of up to **60 meters** within the Winnipeg Sandstone aquifer. The Geotechnical Analysis of the Project (Stantec, 2022) indicates that in some instances, portions of the overlying Red River Carbonate “cap rock” may collapse into the void. Although not stated explicitly, it is also inferred that the Winnipeg Shale aquitard could collapse into the void.” 60m is 20m greater than the largest allowable dimensions in the above chart, so I found this comment interesting.

Since only 2 wells were Side Scan Sonar'd, and the shale aquitard of one collapsed, that gives you a 50/50 chance of collapse. No point in worrying too much about cementing around the well at the shale area to avoid connecting the two aquifers, it's open.



The lower blue is the cavity in the Sandstone Aquifer. It has a straight across “shelf” at the bottom because the sonar could not penetrate the cloudy mixture at that point (too much reflection). The upper red diagram shows the cavity extending into the carbonate aquifer (called Limestone aquifer) at 4 months after extraction.

How much higher towards the glacial till (overburden) this grows, we don't know. So, when it says “Intact Limestone remains”, we're not really sure. So we really can't be sure of the level of probability of subsidence / sink holes at the surface.

Bending Failure – Stantec Geotechnical Assessment Summary delivered at the CEC Hearings, slide 23.

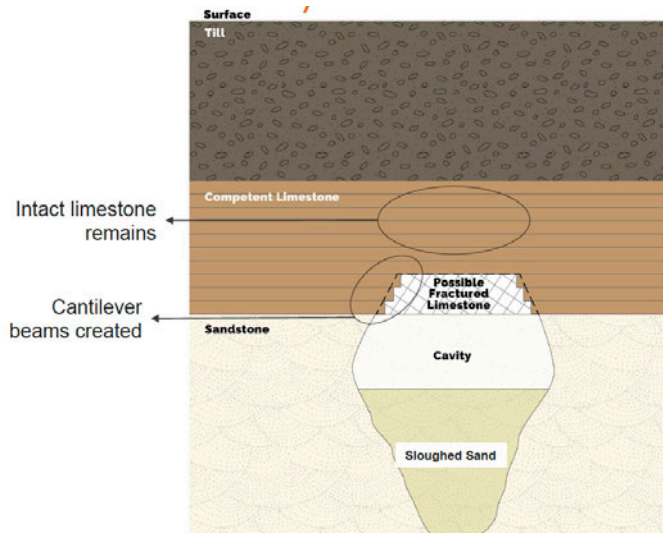
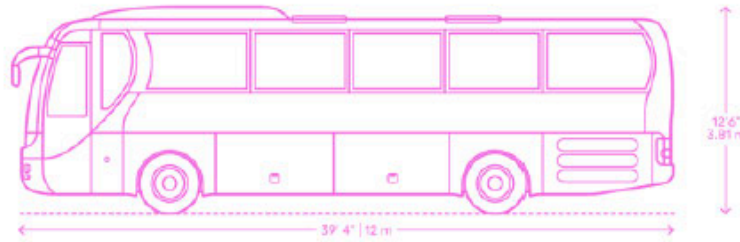
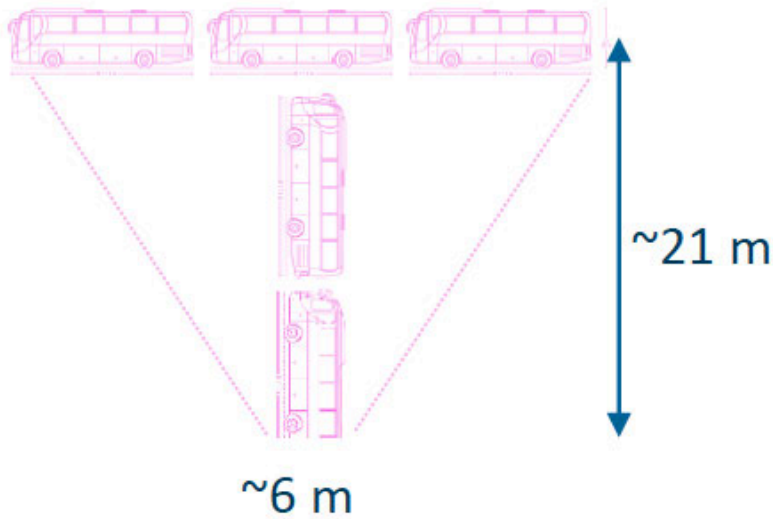


Figure 19: Graphical Representation of Bending Failure Mode

This illustration from Matrix Solutions at the CEC Hearings shows the size of the cavities relative to a city bus. This is helpful for us to see how large these cavities are:



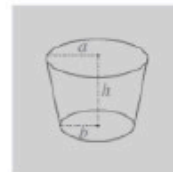
~35 m Long-term allowable unsupported span



Volume disturbance zone per well: 6,735 m<sup>3</sup>

Frustum of right circular funnel of radii  $a$ ,  $b$  and depth  $h$

$$\text{Volume} = 1/3\pi h(a^2 + ab + b^2)$$



Perhaps this is why what was originally planned as 7 wells per cluster, may be down to 1- 5 wells currently, with a minimum 60m spacing from each. But if each well has a maximum 60m cavity, and they're 60m apart, well it looks like we'll have some pretty large voids. Below: p21, Matrix Solutions presentation at the CEC Hearings

[http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/230308\\_matrix\\_presentation\\_viviansands\\_final.pdf](http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/230308_matrix_presentation_viviansands_final.pdf)

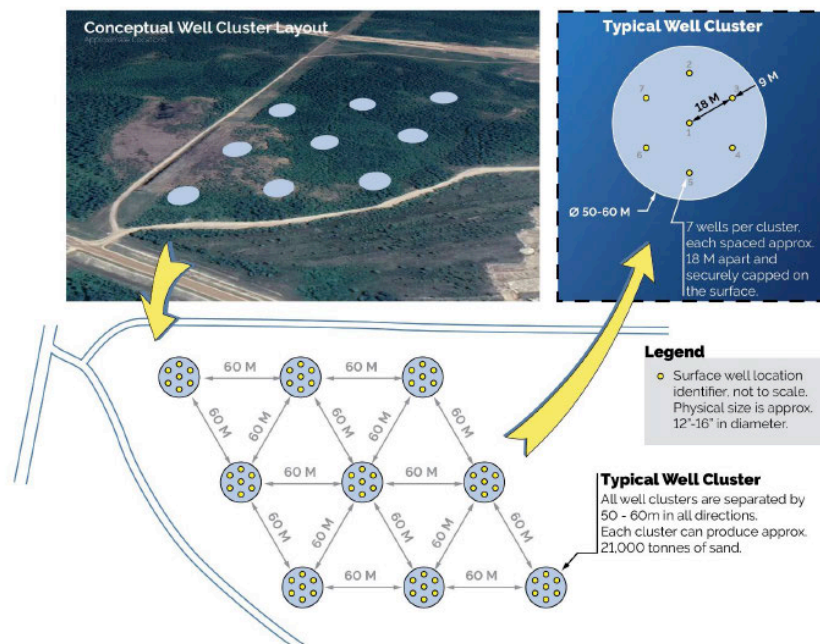
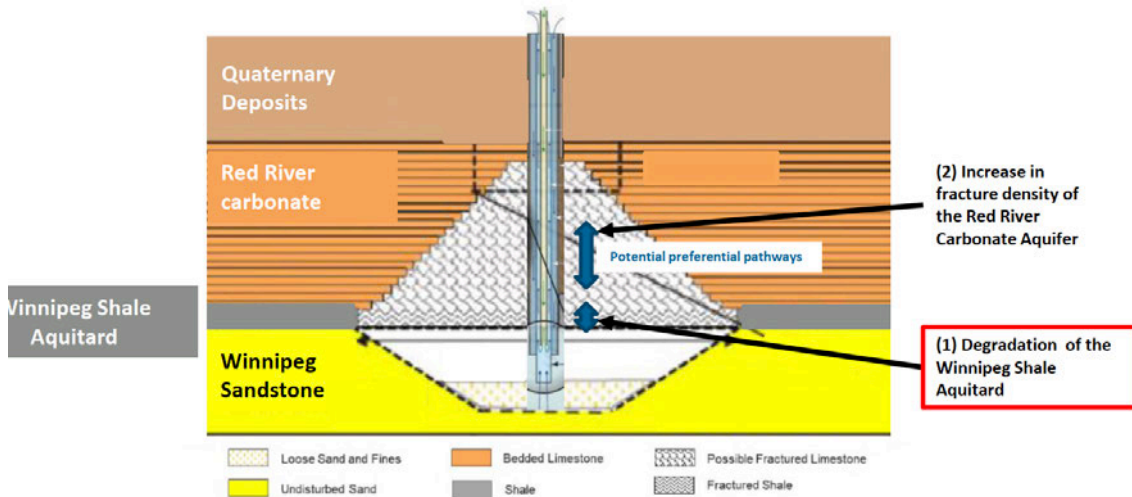


Figure 2-3: Conceptual Extraction Well and Well Cluster Layout

## **2. Are regulations just “guidelines”?**

Are regulations just “guidelines” and not laws? Nevertheless, there is good scientific reasoning for such a regulation to not allowing aquifers to mix. However, this regulation appears to be easily “waived” by ministerial whim, and if so, I hope no one is currently in jail due to an aquifer mixing rap! However, any previous offence would be miniscule compared to what is proposed.

Whenever there’s a reasonable question, there always was a quick “don’t worry, no problem” response from Stantec, Sio Silica’s engineering firm, and Sio Silica. For example, the question of how much water will be removed by this sand extraction is legitimate. **Groundwater renewal takes an average of 1400 years.** There’s a limit to the Sandstone Aquifer’s supply, as stated in the Kennedy/Woodbury paper<sup>1</sup>. Sio’s simple answer is “we’ll remove hardly any, as we’re going to put it all back.” Brent Bullen even goes as far as saying, “It’ll be better than what was removed.” Better than already world-renowned water quality is hard to imagine.

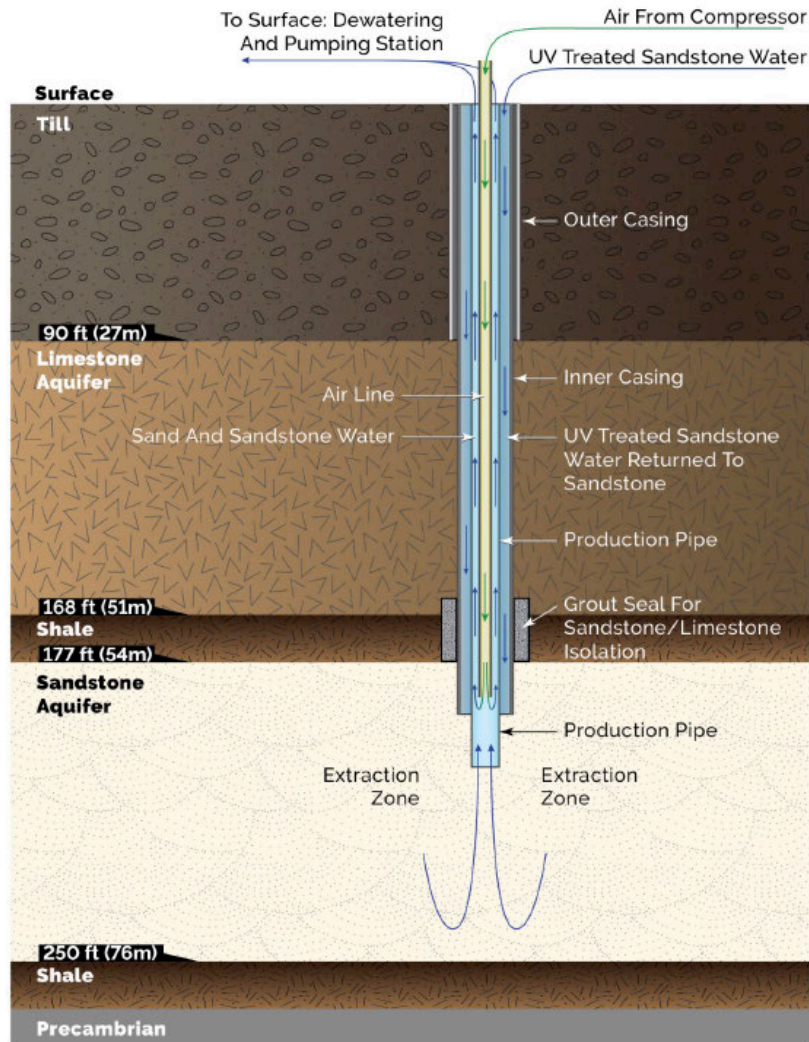
## **3. Airlift**

But let’s back up a bit. How does the sand get “sucked up”. Pulsed air is inserted into a central air-tube of the well, and the bubbles naturally rise. Sand and water slurry is pulled along with this “airlift” process in the outer space around the air tube in the production pipe. Now this air is going into the sandstone aquifer, an anaerobic environment, that has embedded shale, concretions (tracks left by prehistoric sand creatures such as trilobites) filled with pyrite, marcasite, oolite nodules with shale, and sulphides.

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<sup>1</sup> Sustainability of the Bedrock Aquifer Systems in South-Central Manitoba: Implications for Large-Scale Modelling. Paula L Kennedy & Allan D Woodbury, Canadian Water Resources Journal 2005

<sup>2</sup> North Dakota State University Publications, Iron and Manganese Removal, WQ



Example Only

Figure 2-2: Silica Sand Well Extraction Method

The pressure of the air is apparently low enough and the position of the air line is high in the production pipe that the air doesn't get out into the rest of the aquifer and allowing the slurry to only go up into the production pipe. Yet the EAP says the air tube is movable. Early efforts at sand extraction by Norlica back in the 60's had to use brute mechanical force to loosen the sand, leading one to wonder what air pressure may finally be required? The worry that air would cause oxidation, leading to precipitation of iron and manganese (Dr. Eva Pip 6119.00) and lead to the water discolouration, and iron bacteria creating slime and clogging of wells and plumbing, and acidification.<sup>2</sup>

<sup>2</sup> North Dakota State University Publications, Iron and Manganese Removal, WQ

Video: Air escaping into the aquifer

<https://vimeo.com/811173116/5722169a1e>

This slurry mixture arrives at the surface, is filtered, coagulant added, chitosan treatment, UV exposed to kill off microbes, (possibly not 100% effective due to the high flowrate required) and then returned to the aquifer. This returned water has entrained air, with maybe some microbes sneaking by the UV light, being added to the anaerobic aquifer. So we have air introduced by the airtube, perhaps with some diesel fumes, etc., created by the generators, and entrained air by the returned water after the sand has been removed at the surface. So again, “What about the embedded shale, and other acid producing elements?”

#### **4. Acidification, Selenium, leeching of heavy metals, etc.**

The response is of course, “No problem, hardly any shale to worry about.” Sio and Stantec response is that the amount of shale is negligible and will not produce acids in the quantity predicted by Dr. Pip and Dennis Lenevue. Leeching of selenium, which is highly toxic, is also negligible the proponent says. This is a tremendous risk if Stantec is wrong. The participants had asked for funding for independent studies, but was denied by the Minister Sarah Guillemard (PC-Fort Richmond). However, they managed to raise some funds, enough for a hydrogeological but inadequate for a complete geochemical study.

Sio’s response is that “Air Lifting is a method that is used regularly in the water well drilling industry.” Mark Wowchuk, former project manager for Sio test drill site, said that was true, but used only for a few seconds, not for 24/7 operation as proposed by Sio Silica, not to mention air being introduced into an anaerobic environment. We are not talking about mining, but a drinking water aquifer.

The question of the mixing of the aquifers, the carbonate having much more minerals and is a harder water, compared to the beautifully filtered sandstone. Dr. Hollander, commissioner on the CEC Panel, said, “None of the analysis discussed groundwater quality changes due to mining operations.”<sup>3</sup> The response is “Don’t worry, no problem.” Their reasoning is that the aquifers are so close in chemistry that it won’t matter. We know that so much of this area is not homogenous, so it would really depend where you test.

Also, the lawyer for Sio Silica, Sander Ducanson, trying to discredit Dr. Hollander, made the point that Hollander is an academic, and much different than an engineer.

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1030, May 2019,

<https://www.ag.ndsu.edu/publications/environment-natural-resources/iron-and-manganese-removal-1>

<sup>3</sup> Technical Review, Sio Silica Corporation’s Environment Act Project Proposal, Sep 19, 2022. PorousTec Ltd., Dr. Harmut Hollander, P. Eng, and Dr. Allan Woodbury, P.Eng. Professor Emeritus, University of Manitoba

Dr. Hollander was a professor at the University of Manitoba, and he was one of those teaching future engineers. I know the difference between applied science (engineering) and pure science (say Physics), as in research science. My Dad taught medical students and he did electron microscopy research. That was pure science. But my Dad still taught those who would be doctors and surgeons.

Those profs still know their stuff. Those engineering professors teach the students when to make appropriate approximations. Even though I chose Psychology as my final choice for my degree, I remember my 3 years in Electrical Engineering and the experience and knowledge of those profs.

From SS. Papadopulos & Associates, Inc., a report commissioned by the RM of Springfield, *"The drilling and relative rapid abandonment of a large number of wells may compromise the integrity of the Winnipeg Sandstone and Red River Carbonate aquifers and introduce preferential pathways for the vertical migration of contaminants into the aquifers."* They mention many other concerns in their report as well, yet the RM of Springfield did not introduce this report at the CEC Hearings.

Dr. Hollander, part of the CEC panel, in his presentation expressed concerns, (and concurred with many concerns mentioned by Dr. Pip and Dennis Leneveu) highlights:

**Missing topics under the Numerical Groundwater Modeling:**

- Details on evaluation criteria
- Subsidence and potential pathways opening up through the limestone aquifer – [note: this was also mentioned in the Papadopulos report]

**Scenarios**

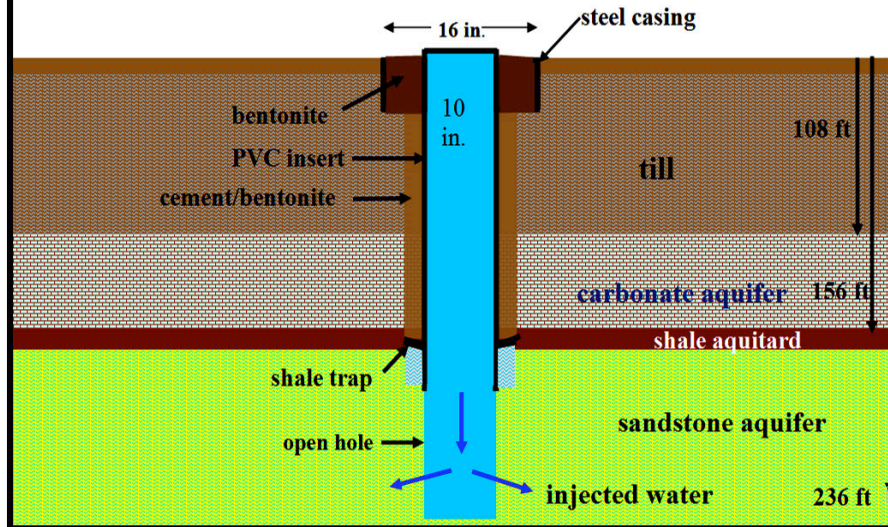
- Worst-case scenario: Failure of Winnipeg Shale was not considered in HAFR
- Partial consideration in the recent work (we were not able to review it since it was presented last week only)

**Geochemistry**

- key drivers for acid mine drainage such as dissolved oxygen (DO), pH need to be stronger considered in terms of geochemical changes
- trace metals, which are contaminants of concern for drinking water quality, not considered
- Modelling selected only low-risk scenarios and did not seek to address two major issues – a reduced water quality in general, or risk to human, aquatic, or agricultural life.

Dennis Leneveu had much concern was dwelt upon well construction, showing the shale trap in Bru 92-8, to prevent the mixing of the two aquifers. However, this is a moot point if there's no shale aquitard. ( diagram from DLN Presentation CEC Vivian Sands Extraction.ppt) Also, the room and pillar method of mining does not apply to sand mining because the sand slopes down, and doesn't maintain the "pillar", therefore the danger of subsidence, as mentioned by MLA Dr. Jon Gerrard.

**Bru 92-8 Injection well at SW29-10-8E completed Aug 13 2021  
Permit IW-2021.01-1 issued Aug 11 2021 Quarry SW of Vivian**



idence.

2022 Feb 11  
Well PID: 208473  
Location: SW29-10-8E  
UTMX:681631.6 UTM Y:5526384.6 XY Accuracy:1 EXACT [<5M] [GPS]  
UTMZ:275 Z Accuracy:4 FAIR - Shuttle at Centroid  
Owner: CANWHITE SANDS  
Driller: EARTH DRILLING CO. LTD.  
Well Name: BRU 92-8  
Date Completed: 2021 Aug 13  
Well Use: INJECTION  
WATER USE: Other  
Well Status: ACTIVE Aquifer: SANDSTONE

WELL LOG (Imperial units)

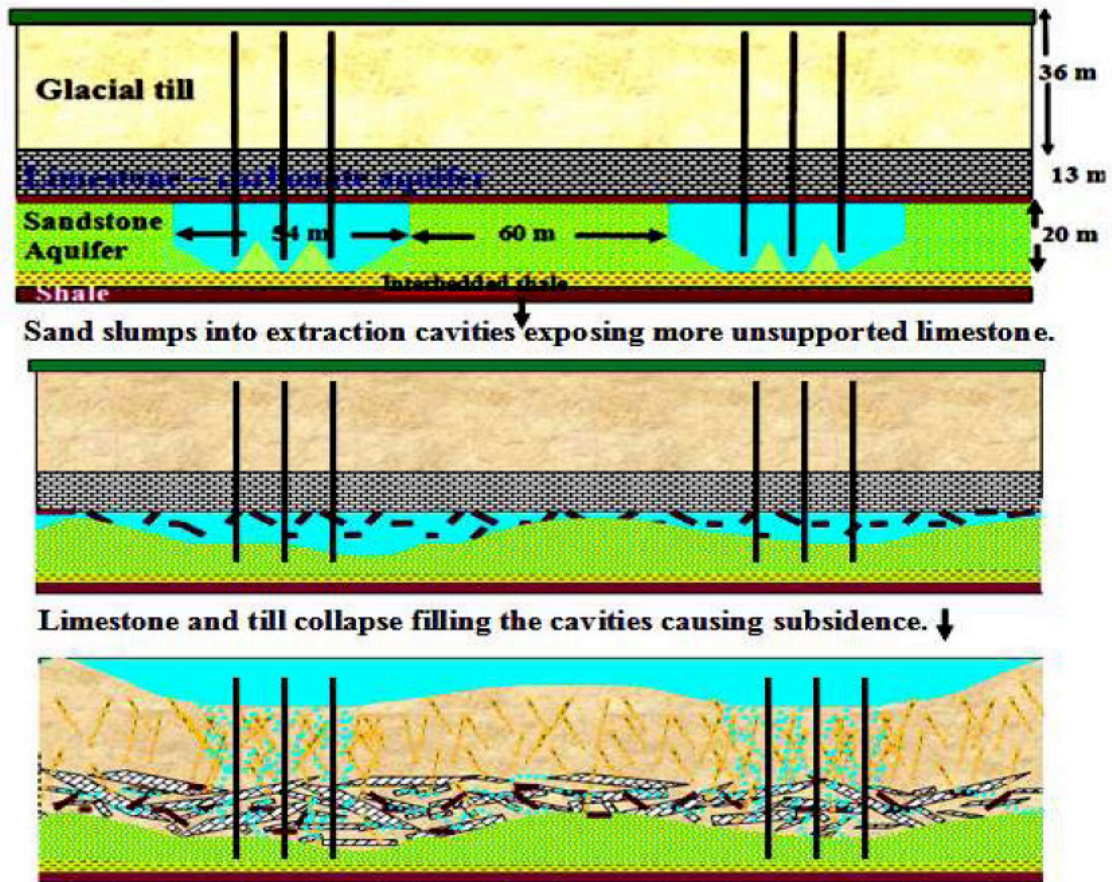
From	To(ft.)	Log
0.0	108	GREY TILL
108.0	156	PURPLE/BEIGE LIMESTONE
156.0	166	RED/GREEN SHALE
166.0	236	WHITE SANDSTONE

WELL CONSTRUCTION

From	To(ft)	Const.Method	Inside Dia.(in)	Outside Dia.(in)	Type Material
0.0	20.0	CASING	15.0	16.0	T & C STEEL
0.0	180.0	BOREHOLE	13.8		
0.0	180.0	CASING	10.0	10.8	INSERT PVC
180.0	236.0	OPEN HOLE	9.8		
126.0	162.0	ANNULAR FILL	10.8	13.8	CEMENT/BENTONITE
0.0	126.0	SURFACE SEAL			BENTONITE
162.0	162.0	SHALE TRAP			OTHER

Top of Casing: 0.0 ft above ground

This collapse of the shale aquitard is permanent. **It won't grow back.**



**Figure 58.** Collapse of limestone in the Sio Silica extraction cavities.  
*Illustration was produced by D.M. LeNeveu including figures reproduced from Sio Silica Hydrogeological Report*

## 5. Water Purification before being returned, land, noise, light

There are so many pieces to this project. Settling tanks. Which hydrocyclone model will work best? These are all hypothetical methods of treating the water, and some equipment can only be rented and not purchased. Some are not mobile, as this extraction method requires. These may be placed into huge containers or flatbeds that are moved around. Massive endeavor. What kind of roads do you need?

Even the city of Winnipeg has expressed concerns, but only after the first 4 years, where the project encroaches on the Shoal Lake Aqueduct. As a Winnipegger, I'm a little disheartened that this concern is only shown once it may affect Winnipeg. (WS-03 City of Winnipeg).



Figure 4-1: Typical Grit Removal System (Figure Courtesy of Hydro International)



Figure 4-2: VorSpin Hydrocyclone (top) and KOSUN Desilter System (below)

Types of hydrocyclones shown above from Process Wastewater Treatment Options, Sio Silica Technical Memorandum, AECOM June 2022. Then there's the Chitosan system.



Figure 4-5: Chitosan Enhanced Sand Filtration (CESF) Management Systems  
(Figure Courtesy of SECURE)

But remember the whole thing has to be mobile and then the sand is sent to the non-mobile processing plant. That would mean it would be on 18 wheelers.

Figure 4-6 shows the process flow diagram for the CESF package from SECURE. The package should be able to treat the influent of approximately 3,000 mg TSS/L to less than 10 mg/L according to the supplier.

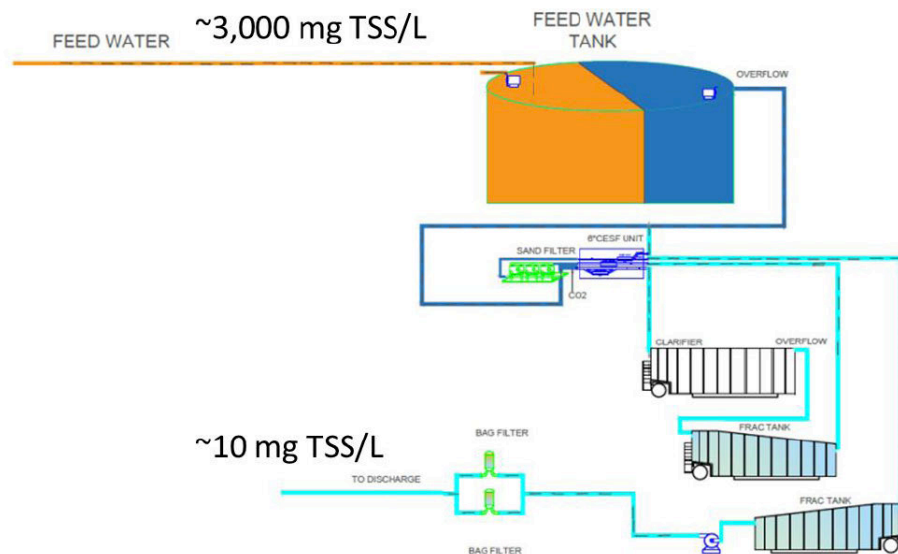


Figure 4-6: Water Treatment Process Flow Diagram for the Proposed CESF System

This system as a whole has never been done before and that's why we have these conceptual drawings. And an important caveat on p.16 of the AECOM Supplemental Information 4

*"It is important to note that this equipment is not available for purchase. Renting the equipment is currently the only option."* Of course this greatly reduces the capital cost of the operation.

Sio says they won't clear land when birds are in their nesting season, and as one resident said, that time frame is changing, sometimes earlier, sometimes later. Will Sio abandon an area because of the birds, and wait for their nesting season to be finished? And Ted Cole, a Springfield resident, struggling to get words out said, "If

you cut down an oak tree, it won't be back in 5 years." The land will be permanently changed – and probably the water too.

On the CEC website, there are dozens of documents on potential damage to the environment. <http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/index.html> It is too much for me to cover here, but there are a lot of questions. And remediation doesn't seem to work all that well. Will the tar sands ever look like the forest that it once was?

## **5. Liability and Legacy**

Who can imagine 1400 years for recharge? Now that's just for too much water being used and for it to be replenished. Contamination may be much longer than that.

This whole project is a work in progress. I've barely scratched the science behind this project, and I'm sure I've done a poor job at conveying the magnitude of this project. Check out world respected toxicologist, Dr. Eva Pip's commentary. It's 500 pages and not for the faint of heart. (<http://www.cecmanitoba.ca/hearings/silica-sand-extraction-project/doc/ws21dr.evapip.pdf>)

Sio says they will figure it out as they go, and perhaps for a normal mining project this is reasonable. But this is mining in the most precious commodity we have ... water. And it will be more precious as time goes on, perhaps even some day soon, worth much more than the silica sand of this project.

The actual purity of the sand is also questionable as this number changes. Quartz crystals for solar cells and electronics needs 99.999999999% (that's 9 nines after the decimal point). Sand from this formation shows marcasite, pyrite layers under electron microscopy. Acid washing is a method to purify sand, and then you have to deal with the acid.

Do we sell off future generations' water for temporary gain? Most of the proceeds from this project won't stay in Manitoba. What kind of environmental bargain is made if you can make solar cells to save the planet, by destroying the planet, or in our case, our drinking water? Do mining companies think about legacy? What will the second, third, or fourth generation be dealing with? There are earthquakes in Alberta due to re-insertion of water thanks to oil production. How much do the companies worry about this? Probably not as much as those in the quake area.

<https://edmonton.ctvnews.ca/largest-recorded-alberta-earthquake-not-natural-from-oilsands-wastewater-study-1.6325474>

The argument that we all want high end electronics, etc., that need these components is circular, as if sacrificing water is environmentally friendly and is just the price we have to pay. Sort of reminds me of the movie "Fury Road".

**Who pays if this thing goes south?** Where do the people of this area get the drinking water if this water is contaminated, which looks highly possible. Will Sio Silica pay for this water in perpetuity. What is the land valuation of farmland with no access to good well water?

And is there really Canadian ownership? RCT GmbH is in Germany, the consulting group that possibly wants to invest in the solar plant. Or maybe a Wisconsin sand company may want to be the owners, if this sand is used for fracking, which some, or maybe all of it might. *There is no legal binding agreement that this sand will be used for solar cells.* No doubt, market pressures will determine the end use of the sand and we may trade water for frack sand.

First it was 40 jobs at the processing plant, than 400, then 4000, and now around 8000 jobs. How much higher will it get before we finally say, "O.K. – just go ahead and do it, just don't tell us what's actually happening – we'll find out soon enough anyway."

There are always experts willing to talk on either side of an issue. Those being paid find it hard to bite the hand that feeds them. That's why many 2<sup>nd</sup> 3<sup>rd</sup> and 4<sup>th</sup> opinions from scientists and engineers from countries far and wide, may need to be consulted. We shouldn't be pressured that a decision has to be made quickly, or you'll lose the deal. **We're talking about future generations, and 100's of years. We're not buying a used car.**

**We can't risk endangering drinking water.** There must be no guesswork, plans cannot evolve by trial and error. This technology is unproven, untested, never before done in a drinking water aquifer. A patent can't be applied to a process that's been in use for years. This is a new thing.

**We will be the generation, and those of the CEC and the current government will have their names on this project for future generations to see, whose watch this was under.**

We have to appreciate this beautiful and amazing planet that God has given us, where everything works together as a system, and we have to very very careful, or that system will stop working the way it was meant to.

Just my opinion - my 2 cents.

Ernie Nathaniel, [REDACTED]  
[REDACTED]